SMART ENERGY REGIONS

Editors: Phil Jones, Werner Lang, Jo Patterson and Philipp Geyer.

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GLOSSARY

AMR	Automated Meter Reading
AMT	Metropolitan Transportation Authority of Porto
B&H	Bosnia and Herzegovina
BAU	Business-As-Usual
BEC	Better Energy Community scheme (Ireland)
BEEC	Building Energy Efficiency Code (Portugal)
BER	Building Energy Rating
BPIE	Buildings Performance Institute Europe
BRE	Building Research Establishment (UK)
BREEAM	BRE Environmental Assessment Model
CCC	Commission on Climate Change (UK)
CCDR-n	North Regional Coordination and Development Commission (Portugal)
CCGT	Combined-Cycle Gas Turbine
CDD	Cooling Degree Days
CERA	Cyprus Energy Regulatory Authority
CH	Central Heating
CHP	Combined Heat and Power
CKEA	Carlow Kilkenny Energy Agency (Ireland)
CLC	CORINE Land Cover project
COP	Coefficient Of Performance
CSH	Code for Sustainable Homes (UK)
DACH	Germany, Austria and Switzerland (European German-speaking countries)
DART	Dublin Area Rapid Transport (Ireland)
DEAP	Dwellings Energy Assessment Procedure (Ireland)
DECC	Department for Environment and Climate Change (UK)
DH	District Heating
DHW	Domestic Hot Water
DoECLG	Department of Environment, Community and Local Government (Ireland)
EAC	Electricity Authority of Cyprus
EDORA	Alternative and Renewable Energy Federation (Belgium)
EE	Energy Efficiency
EEA	European Economic Area
EEAP	Energy Efficiency Action Plan (Macedonia)
EEI	Energy Efficiency Improvement
EEZ	Exclusive Economic Zone
ENEA	National agency for new technologies, Energy and sustainable economic development (Italy)
EPB	Energy Performance of Buildings
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EPEE	European fuel poverty and Energy Efficiency project
EPS	Electric Power Industry (Serbia)
ERAB	European Research Area Board
ERDF	European Regional Development Fund
ESC	Economic and Social Cohesion
ESF	European Structural Fund
ETS	Emissions Trading System
EU	European Union

EU 15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EU25	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
EV	Electric Vehicle
FEC	Final Energy Consumption
FENERCOM	Energy Foundation of Madrid Community (Spain)
FFV	Fuel Flexible Vehicle
FIT	Feed-In Tariff
fYRoM	Former Yugoslavian Republic of Macedonia
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GMAP	Great Metropolitan Area of Porto (Portugal)
GNP	Gross National Product
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HCFC	Hydrochlorofluorocarbons
HFO	Heavy Fuel Oil
HVAC	Heating Ventilation and Air-Conditioning
ICEDD	Institute for Advice and Studies on the Sustainable Development
ICT	Information and Communication Technologies
INEGES	National Inventory of Greenhouse Gas Emissions (Romania)
IPURD	Integrated Plan for Urban Regeneration and Development (Bulgaria)
IRP	International Rate of Profit
ITMS	Intelligent Traffic Management System
JSC	Joint-Stock Company
KAPE	National Energy Conservation Agency (Poland)
KR	Kurzeme Ring (Latvia)
LA	Local Authority (UK)
LCA	Life-Cycle Analysis
LCC	Life-Cycle Costing
LCRI	Low Carbon Research Institute (UK)
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land use Change and Forestry
NAP	National Renewable Energy Action Plan (Cyprus)
NCSD	National Commission on Sustainable Development (Malta)
NDP	National Development Plan (Latvia)
NEEAP	National Energy Efficiency Action Plan
NGO	Non-Governmental Organisation
NPV	Net Present Value
NREAP	National Renewable Energy Action Plan
NSRF	National Strategic Reference Framework (Bulgaria)
NUTS	Nomenclature of Territorial units for Statistics
OJEU	Official Journal of the European Union
PAES-P	Plan of Action for Sustainable Energy for the city of Porto (Portugal)
PALET	Parkstad Limburg Energy Transmission (Netherlands)
PH	Passive House
PIEAR	Regional Environmental Energy Plan (Italy)
PNAEE	National Action Plan for Renewable Energy Efficiency (Portugal)

PNAER	National Action Plan for Renewable Energy Sources (Portugal)
PV	Photovoltaic
RDA	Regional Development Agency (Romania)
RDB	Regional Development Board (Romania)
RE	Renewable Energy
RES	Renewable Energy Sources
RET	Renewable Energy Technologies
RPI	Regional Pole of Innovation
RSL	Registered Social Landlord (UK)
SBEM	Simplified Building Energy Model
SEAI	Sustainable Energy Authority of Ireland
SEAP	Sustainable Energy Action Plan
SEE	South East Europe
SME	Small/Medium Enterprise
SWH	Solar Water Heating
SWOT analysis	Analysis of Strengths, Weaknesses, Opportunities and Threats
TEC	Total Energy Consumption
UNDP	United Nations Development Programme
UNFCCC	United Nation Framework Convention on Climate Change
USAID	US Agency for International Development
VAT	Value Added Tax
WB	World Bank
WDN	Water Distribution Network
WG	Welsh Government (UK)
ZEB	Zero Energy Buildings
ZELS	Association of Local Self Government Units (Macedonia)

Units

GW	GigaWatt
$kgCO_2eq$	Kilograms of CO_2 equivalent
$kgCO_2eq/ m^2y$	Kilograms of CO_2 equivalent per square metre per year
kgoe	kilograms of equivalent oil
ktons	KiloTonnes (1000*1000 kg)
kW	KiloWatt
kWh	KiloWatt-hours
kWh/m^2y	KiloWatt-hours per square metre per year
MJ	MegaJoule
Mtoe	Millions of tonnes of equivalent oil
MW	MegaWatt
MWp	MegaWatt peak (for photovoltaic installations)
PJ	PetaJoule
TJ	TeraJoule
toe	Tonnes of equivalent oil
tons	Tonnes (1000 kg)
TW	TeraWatt

INTRODUCTION

AUTHOR

Professor Phil Jones
Chair of Architectural Science
The Welsh School of Architecture,
Cardiff University, Bute Building,
King Edward VII Avenue, Cardiff CF10 3NB
E: jonesp@cardiff.ac.uk

1. INTRODUCTION

The Smart Energy Regions (SmartER) COST Action TU1104 (COST, 2014) takes a regional perspective on energy and the low carbon agenda. It focuses on a systems approach, including low carbon energy supply, energy demand management and energy storage, and the associated distribution networks. It looks at links between technology and training, and to end user activities, covering the fields of 'smart grids' to 'smart living'.

As part of this COST Action members have investigated how different policies are being implemented to progress the low carbon agenda and how industry and broader stakeholder groups are involved in the process. This publication is supported by COST. Cost and value are also important factors that influence the take up of low carbon technologies and lifestyles. The regional approach covers the development of policy, planning and regulations, and how government incentives and industry responses can encourage the transformation of low carbon policy to practice, through innovation and competitiveness. *Figure 1* summarises the main topics, from international 'drivers', to policy, and then to practice.

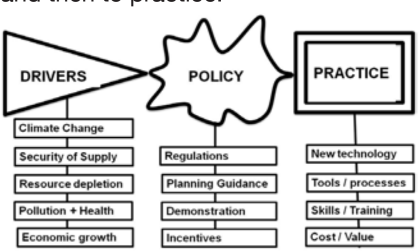

Figure 1 - Main topics associated with the route through drivers to policy to practice

In European politics, a region is the layer of government directly below the national level. The term is especially used in relation to those regions, which have some historical claim to uniqueness or independence, or differ significantly from the rest of the country. The current historical trend in Europe is for the devolution of power to the regions from central authorities. The European Sustainable Energy Innovation Alliance has called for regions to play a crucial role in relation to Europe meeting its 2020 emission reduction targets. It believes regions will have to become the innovators and bring together actors of the knowledge triangle, from innovation, research and education to create sustainable energy solutions.

For regional success it is vital to improve the cooperation between science, industry and politics, with research and innovation being key drivers of competitiveness, employment, sustainable growth and social progress. eseia promotes the formation of clusters to bring together research and innovation, addressing major challenges and fostering regional energy systems within the European Union.

SmartER follows this approach and considers the combined roles of government, industry and academia in delivering the low carbon agenda to individuals and organisations. *Government* needs to implement policy through regulations, guidance and incentives, giving clear signals to industry of its future intentions. It needs to be aware of what industry's strengths and aspirations are in relation to supplying goods and services to the region and exporting from the region. Government's commitment to raising standards can drive forward innovation and competitiveness, encouraging industry and academia partnerships.

Industry needs to plan for future changes. Industry has a diverse range of interests in relation to pushing forward the low carbon economy; manufacturing and consultancy services generally welcome change as it can result in new and high value markets. On the other hand developers and the energy utilities tend to be more conservative, and may associate change with increased costs and/or loss of profit. Government needs to take a considered and balanced approach to industry ‘lobbying’, and look at the wider economic benefits of a green economy.

Academia in general has two main interests; firstly, research partnerships with industry can drive forward innovation and assist industry with developing new products; secondly, research leads to improved understanding of low carbon technologies and applications, which can then be disseminated through education and training programmes.
The development, and joint ownership, of the understanding of low carbon regions is fundamental to future government and industry thinking. It is particularly important that decision makers and their advisers have the appropriate information for short and long term decision making. SmartER will explore the understanding and relationships between government, industry and academia in relation to the low carbon agenda, centred on the built environment, up to regional scale, and how this can help inform decision making.

BACKGROUND

Although the world’s attention has been focused on economic issues in recent years, the impacts of climate change and environmental harm associated with energy use continue to grow. This is manifest not only at a global level, but also at a local, individual and organisational level. On the 10th May 2013 the UK’s BBC reported that daily measurements of the carbon dioxide level at a US government agency laboratory on Hawaii exceeded 400 parts per million (ppm) for the first time in three to five million years. At a global level, if fossil fuels continue to be burnt at a ‘business as usual’ trajectory, in a matter of a couple of decades, we will cross the 450 ppm level, taken as the limit for keeping global warming under 20°C (BBC, 2013). At a local level, there is a growing concern over the pollution impact of burning fossil fuels, and also over the potential environmental risks associated with shale gas and open cast mining. At an individual and organisational level, there are financial risks associated with increasing energy costs and the future asset value of buildings that are not energy efficient.
Even though society has been aware of the issues associated with burning fossil fuels since the mid-70’s, their use has continued to rise. Since the start of the industrial revolution some 200 years ago, society, especially in the developed world, has locked itself into a fossil fuel economy, and the developing countries are rapidly following suit. Change will be difficult. Society has become very effective at being inefficient, and increasingly irresponsible, in the use of resources, and in particular energy. The economy has developed to support the fossil fuel habit. Amory Lovins explains in his recent book ‘Reinventing Fire’ that the fossil fuel industry receives enormous subsidies both directly and indirectly (Lovins, 2011).
Reports from the International Panel on Climate Change (IPCC) (IPCC, 2007) have frequently been referred to when developing government policy, but this policy is slow to be implemented in practice. Even the Stern review on the economics of climate change, which identifies the enormous costs faced with dealing with climate change, has not changed our behaviour (Stern, 2006).

Of more immediate concern in the European Union at the moment is the issue of security of energy supply and the enormous cost of importing energy. The EU imports some 53% of the energy it consumes. The value of imports in 2013 was more than 1 billion Euros per day, with energy supplies from Russia accounting for 42% of EU natural gas imports and 33% of oil imports. (European Commission, 2014).
The need to reduce our dependence on imported energy is closely aligned to the need to develop our low carbon economy. The low carbon economy is likely to be a major area of future growth, and one in which Europe may already be lagging behind China and US (K. Neuhoff, et al 2014). Although Europe has plenty of innovation, it has generally had limited success at implementation in the market.
There is generally a lack of investment in new technologies and the transition to a low carbon economy seems to be slow. This is of growing concern to the European Union and is driving its policy development.

LOW CARBON TRANSITION

It is not really surprising that there is a huge resistance to changing to a low carbon economy, and perhaps the 200 year dependency on fossil fuels cannot be expected to be turned around in the relatively short time available to avoid serious climate change impacts. The current austere economic period is also frequently stated as an excuse to delay climate change action. Future policy will therefore attend to adaptation to climate change as well as mitigation to reduce future impacts.

Low carbon technologies have developed considerably in recent years, but the economies of scale are slow to take effect, both in areas of low carbon energy supply and reducing energy demand. Governments tend to focus more on large scale projects on the supply side, rather than the more scattered subject of reducing demand, and they also seem to favour 'big industry' solutions. Increasingly nuclear and fossil fuel with carbon capture, and large scale wind, tidal and solar, are preferred to smaller more disparate demand side technologies. This may be considered a top down 'large scale supply' approach rather than a bottom up 'demand reduction and small scale renewables' approach. However, recent concern over the limitations of the electricity grid has resulted in increased interest in distributed energy supply and demand reduction.

Future policy needs to recognise the need to combine thinking on traditional fossil fuel energy supply and low carbon technology. Although in the long term the planet may be 'zero carbon', probably for the large part of this century, fossil fuels will still play a major part in our energy economy. The development of low and zero carbon technologies will need to accompany efforts to 'clean up' the use of fossil fuel, through carbon capture and more efficient use. Also, the transition to a low carbon economy will probably involve a combination of the 'bottom up' approach at building and community scale, as well as a 'top down' approach through large scale renewables, combined with traditional energy supplies. Both approaches will need to be linked with energy storage, both for heat and electricity, and this is likely to become a major growth area for research and development. Related to this is the conversion of electricity to heat and vice versa, in order to provide a stable and balanced energy future.

To some extent there may be some degree of 'low carbon fatigue', perhaps association with the overall negative message of climate disaster, rather than focussing on the positive aspects of a low carbon future, such as a clean healthy environment, and the economic and social benefits from a low carbon society. The economic mechanism of carbon trading, namely the European Carbon Trading System, (ETS) has not been successful, in part because of the economic downturn reducing energy use and the need to trade in carbon.

So why is it advantageous to look at the transition to a low carbon economy at a regional scale? At a regional scale, there is often devolved government decision making, with the subsequent development of policy through, for example, Building Regulations and Planning Guidance. Issues resulting from government's policy aspirations can be followed up through regional research and development activities. Although large-scale energy supply policy may be decided at a national level, associated planning issues and smaller scale energy supply is generally handled at a regional level. As is demand side management, the development of low carbon technologies and processes, and how collaborative research across the region's universities can help government and industry take forward the low carbon agenda.

There has been little attention to how the various issues across policy and practice can be 'joined-up'. An overall low carbon strategy should link government policy to business opportunities, technology advances, training and awareness raising, and, cost and value. This may be best addressed at a regional scale, where there is autonomy, understanding and decision-making that take account of specific regional attributes. This is the subject of this EU COST Action on Smart Energy Regions.

POLICY TO PRACTICE

In a recent speech, the European Commissioner for Energy, Günther Oettinger, stated that '*People's wellbeing, industrial competitiveness and the overall functioning of society are dependent on safe, secure, sustainable and affordable energy*'. He followed on by saying that: '*The energy infrastructure which will power citizens' homes, industry and services in 2050, as well as the buildings which people will use, are being designed and built now. The pattern of energy production and use in 2050 is already being set*' (Günther Oettinger, 2014).

The European Council has ambitious energy and climate change objectives for 2020, including: reduce greenhouse gas emissions by 20%, rising to 30% if the conditions are right; increasing the share of renewable energy to 20%; and, to make a 20% improvement in energy efficiency (European Commission, 2008). There is a long term commitment for 80 – 95% cuts in emissions by 2050 (European Commission, 2011).

In March 2013 the European Commission published its Green Paper entitled, 'A 2030 framework for climate and energy policies' (European Commission, 2013), which proposes a range of actions to provide clear intentions for GHG emissions beyond the current 2020 targets and on route to the long term 2050 target of 80% reduction. in GHG emissions. This 2030 policy framework aims to make the European Union's economy and energy system more competitive, secure and sustainable. It includes:

- reducing greenhouse gas emissions by 40% below the 1990 level;
- increasing the share of renewable energy to at least 27%, aimed to drive continued investment in the sector, thus helping to create growth and jobs;
- continued improvements in energy efficiency which will be considered in a review of the Energy Efficiency Directive due to be concluded later in 2014;
- reform of the EU emissions trading system responding to the issue that the ETS has had limited success;
- achieving competitive, affordable and secure energy with a set of key indicators to assess progress;
- a new governance system with a more centralised approach.

These 2030 targets, if adopted, will need to be linked to the European Commission's Integrated Energy Roadmap (European Commission, 2011) which is putting forward an action plan that:

- addresses the energy challenges in a system approach;
- consolidates and aligns the various existing technology roadmaps;
- covers the entire research and innovation chain;
- identifies pathways for work and synergies between various EU programmes, stakeholders, instruments, authorities.

This roadmap will need to practically address a series of existing challenges for implementation, including:

- how and what to prioritise in relation to short-term, medium-term, long-term targets;
- what we can learn from each other across sectors, across borders, and along value chains;
- how to create synergies among different instruments, different sectors, and different technologies;
- how to balance the (sometimes competing) targets considering technological, economic, environmental and social aspects.

The above new policy relates to evidence that, 'despite the importance of energy policy aims, there are serious gaps in delivery' (European Commission, 2011). New technologies are being developed but they are not finding their way easily into the market. Intellectual Property Rights (IPR) are often needed to encourage investors, but many low carbon technologies may not have significant IPR. Many policies, are concerned with large scale 'top down' initiatives, for example, large scale renewable, smart meters, district heating, etc. However, as stated above, there is now a growing interest in 'bottom up' solutions based around buildings and communities, adopting a systems approach to energy supply, demand and storage. The new policy is therefore intended to provide clear signals to investors and industry of the intention to drive towards the low carbon economy and to achieve economic growth in this area.

A SMART ENERGY FUTURE

At a regional scale SmartER aims to consider electricity networks and storage, smart distribution, and demand management technologies. Although buildings have become more efficient, the demand for heat still dominates the energy supply scenario in most northern European countries. Many houses needing major retrofitting measures to improve their energy efficiency and overall living conditions. In particular, the built environment has huge potential for reducing energy demand and promoting low carbon applications. Across the EU there is an ambition that all new buildings will be '(near) zero carbon'. This political aspiration has resulted in innovation in construction, and a number of government subsidised demonstrator low carbon built environment projects to see what can be achieved in practice (LCRI, 2011).

In many EU regions, activities, across energy supply and demand scenarios, have begun to highlight a range of issues associated with the energy futures. These include:

- how to balance large-scale renewables versus building scale energy efficiency measures often combined with building integrated renewables;
- the general shift to electric, including distributed PV, heat pumps, future electric vehicle charging, which places a huge demand on the grid;
- an appropriate balance between renewables versus large-scale power projects (e.g. future nuclear and shale gas);
- the need for energy storage at local level and larger scale, combined with distributed energy supply;
- capital cost and cost savings associated with low carbon buildings, and new and retrofit technologies.

Our existing energy grids are ill equipped to deal with the new mix and balance of supply and demand. However, renewal of the grid would take many years by which time technologies would change further. Therefore the role of the grid needs to be addressed and the mix of 'top down' and 'bottom up' approaches examined. Utilities are perhaps becoming more interested in renewable energy systems and storage at building and community scale, to help stabilise the situation by using renewable energy close to source, adopting a distributed supply system. This 'bottom up' approach would take the pressure of the grid, but would need to combine with the 'top down' approach of large grid scale energy supply (including renewables).

The drive towards a low carbon built environment requires development over a range of scales from new components, to buildings, to communities. At a city and regional scale, large-scale housing retrofit programmes have the potential to significantly reduce energy demand and CO_2 emissions, whilst at the same time, having other positive impacts such as affordable warmth, improving health and quality of life. New finance models are needed to provide the incentive for large scale whole house 'deep' retrofit programmes, as well as near zero carbon new build.

Generally speaking, 'low carbon' research is currently centred on technology developments at an individual component level. Current technical solutions for energy demand reduction and supply have been mainly based on a component approach. However, it is the practical implementation of low carbon technologies as part of a 'smart' system that determines the extent to which they are successful, and to what extent predicted targets can be achieved in practice. In particular, it is at the interfaces of supply and demand technologies that often determine performance. Many technologies, when applied, do not deliver their optimum performance and cost, as they are often 'bolt on' solutions, e.g. increasing insulation standards for buildings may reduce the heating demand but may not result in an appropriately reduced capacity heating system. The temporal and spatial relationships between demand and supply need to be addressed through new and emerging technologies, such as energy storage and smart controls, in order to create an appropriate balance. Therefore a more systematic and holistic approach is necessary.

This needs to be combined with the need for new financial models, which take a more systems and life cycle approach, and fully address issues of value and yield on investment in relation to low carbon developments. Building regulations are also needed to drive innovation and promoting associated high value industries, while accepting and dealing with the concern over developer costs.

Many regions have low carbon policy aspirations; however, they generally experience difficulties in implementing them into practice. There are a number of reasons for this. Firstly, the energy agenda and the shift to a low carbon economy is a moving target. Priorities change quickly in response to developments in global and local economies. Government policy can change overnight, while industry needs clear longer-term targets. The gap between technology development and its application seems to be growing which is a disincentive for innovation. There are also uncertainties over cost and skills availability associated with low carbon technologies and processes, especially at the large scale needed. Technology is being advanced at a number of scales, from energy efficiency measures in buildings to new large scale energy supply programmes. There is pressure from big industries, such as nuclear and the fossil fuel industries (e.g. linked to future shale gas opportunities). These carry big industry lobbying, and the offer of a 'business as usual' approach. It seems that governments tend to prefer big industry solutions, compared to the more disparate nature of demand reduction and distributed energy supply. Both approaches are needed if Europe is to take a lead in the global low carbon economy.

Smart Energy regions also need to link the urban and rural economies. Many regions have a post-industrial fringe, which can provide an interface of resources (land, people and infrastructure) to facilitate this link. Such links can localise the environmental footprint, improving accessibility to materials and services, and reducing transportation energy consumption and providing economic benefits by combining the urban and rural economies (*Figure 2*).

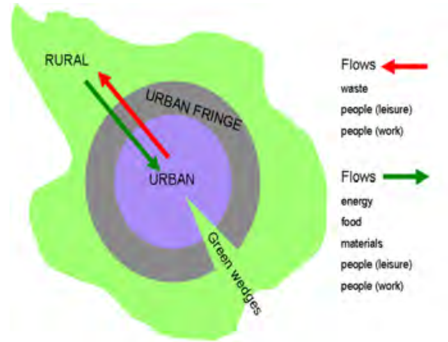

Figure 2 – Linking urban and rural economies, including energy systems;

Finally, 'smart' does not necessarily mean complex. Many existing energy management systems do not function because they are not commissioned, maintained, cannot adjust to change of use, or are simply too complicated to use. The development of new technologies through a systems approach should therefore recognise the needs and capabilities of people.

CONCLUSIONS

The economic benefits of a low carbon economy are huge, with opportunities for both wealth and job creation. There are other 'softer' societal benefits through improved quality of life, more efficient resource management and less pollution. However, the transition to a low carbon economy is not obvious and we must find a balance between the instabilities that might arise from climate change versus the instabilities from economic change.
The current tension between the 'clean' and 'dirty' economies needs to be relieved, and both sides need to work together recognising each other's views. Fossil fuel will be with us for a while, so we must learn to use it cleanly and efficiently, and at the same time develop renewables at all scales.

The biggest early win is to reduce energy demand and this can provide the bridge to the low carbon future. Whether the current austere times are an advantage or disadvantage remains to be seen, together with, to what extent the low carbon agenda can drive the economy. We must accept that delivering reductions in energy and carbon dioxide emissions, should also achieve cost and socio-economic 'products' in the development of regional built environment programmes, linking the low carbon agenda with economic growth.

The SmartER COST Action will address the above issues, through:

- the need to secure energy supply and become less reliant on energy imports;
- the need to coordinate industrial initiatives in terms of market transformation of low carbon technologies. Europe has ideas but is slow to put them into practice;
- the need for innovative and sustainable technologies, and skills, for society, at work and at home, which can be used across the economy and which can transform society;
- a systems approach at all scales linking energy supply, demand, storage and networks;
- the need for better investment tools for a more sophisticated approach to cost and value modelling.

All this seems to be best driven forward at a regional level, linking policy to industry and societal needs for maximum benefit. SmartER is identifying new technologies and processes across Europe, how these can be integrated into a systems approach, linking with government and industry, on skills and training, and cost and value models, to help facilitate the transition to a low carbon economy. It will also produce information to inform 'decision makers', including how government policy and regulations can help drive forward innovation and competitiveness in industry, and what research is needed to support the transition to a low carbon future built environment. A more positive spin is needed to promote the low carbon agenda. Rather than global impacts of climate change it may be better to promote local agendas related to cleaner environments and economic and social benefits, together with healthy, comfortable, productive energy efficient buildings.

Europe has plenty of ideas relating to the low carbon technology, the main issue is getting these ideas into practice and developing a robust low carbon economy, which can attract long-term investment and create economic growth.

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ANALYTICAL OVERVIEW

AUTHORS

Werner Lang
Technische Universität München,
Chair of Energy-Efficient and Sustainable Planning and Building (ENPB)
E: w.lang@tum.de
Arcisstrasse 21, D 80333 Munich

Philipp Geyer
Technische Universität München
Chair of Energy-Efficient and Sustainable Planning and Building (ENPB)
E: p.geyer@tum.de
Arcisstrasse 21, D 80333 Munich

1. INTRODUCTION

The focus of this handbook is to demonstrate how different policies are being implemented in the European countries participating in this Action, indicated in *Figure 1*, that are helping to progress the low-carbon agenda, and to illustrate how industry and broader stakeholder groups are involved in the process. The analysis of the regions included within this handbook together with the specific case studies will help to provide an understanding of how low carbon technologies can be made appropriate and transferable within and between regions.

Figure 1 – Map indicating the countries involved in COST Action TU1104, Smart Energy Regions

COST Action members were asked to provide case studies to illustrate low carbon initiatives taking place at a regional scale within this region. A template was provided to all participants to enable consistent information to be collected across the countries and regions and to enable a comparative study of the information provided. Data collected included:

- an overview of the region, including the general characteristics as well as information on the energy demand and supply of the region;
- the current situation, including the targets related to energy policy and other regional targets, barriers and drivers;
- a case study, including general information as well as specific information on the objectives and methods, the results and outcomes;
- conclusions including the transferability of the case study and general region approach to other regions.

The countries, the regions and the case studies are presented in *Table 1*.

The findings of the investigation are presented in the section below. Please note that the country code used in all figures refers to the region within the country and not to the country as a whole.

2. CHARACTERISTICS OF THE REGIONS

The European regions identified vary significantly with regards to culture, politics, history, economy and energy consumption together with their size, population, density, climate, topography and other aspects.
The individual characteristics of each region are presented below to help understand the strategies implemented within the wide range of European regions included within this investigation.

Population and economy
With regards to population density and geographical size there is a large variation between countries, with DK, MT, NL, NO, RS, SL, ES, SL, and CH investigating highly populated small regions mostly consisting of urban areas and their surroundings, which are heavily influenced by the nearby city.

Other countries have presented larger regions with medium population density, such as BE, CY, DE and the UK. Regions with a low population are located in largely rural areas, such as those identified by AT, BA, GR, LV, and MK.

Figure 2 illustrates the wide range of different population densities to be found within the various regions presented in this study. The lowest population density was found in the Kuldiga Municipality (LV), with approximately 14 persons per km^2. The highest density was found in the region of the Municipality of Copenhagen (DK) with approximately 6,230 persons per km^2.

Country	Country code	Region	Case study
Austria	AT	Styria	Okoregion Kaindorf
Belgium	BE	Wallonia	Energy efficiency incentives in Wallonia
Bosnia and Herzegovina	BA	Bosnia and Herzegovina	DELTER project
Bulgaria	BG	Gabrovo Municipality	Integrated Plan for Urban Regeneration and Development of Gabrovo
Cyprus	CY	Cyprus	Energy upgrading of the refugee settlement
Denmark	DK	Copenhagen region	Carlsberg development plan
Finland	FI	Tampere city region	Härmälänranta residential development
fYR Macedonia	MK	Macedonia	Karposh Municipality
Germany	DE	Bavaria	Urban Laboratory Nuremberg Western City
Greece	GR	Western Macedonia	Kozani's District Heating System
Hungary	HU	Vasvar region	Aspects of the regional building stock
Ireland	IE	Ireland	Better Energy Communities Programme
Italy	IT	Basilicata	TIMES-Basilicata model
Latvia	LV	Kuldiga region	A single computerised Kuldiga region utilities management and control system
Lithuania	LT	Kaunas region	Cogeneration power plant in village of Noreikiskes
Malta	MT	Malta	Gozo island
Netherlands	NL	Parkstad Limburg	Mine water for heating and cooling in the municipality Heerlen
Norway	NO	Trondheim municipality	The Brøset neighbourhood
Poland	PL	Podkarpackie Province	Bieszczady Mountains
Portugal	PT	North region of Portugal	The Great Metropolitan Area of Porto
Romania	RO	North-East region of Romania	County of Iasi
Serbia	RS	Belgrade region	Refurbishment of suburban apartment buildings, Karaburma
Slovenia	SI	Municipality of Maribor	EnergaP, demonstrating the impacts of the Local Energy Concept on the renovation of primary schools
Spain	ES	Autonomic Community of Madrid	Local strategies for improving the energy certification in Madrid region buildings
Switzerland	CH	Canton of Zurich	Smart City Winterthur
United Kingdom	UK	Wales	Arbed scheme

Table 1 – Regions included within the investigation together with the country, the country code and case study name

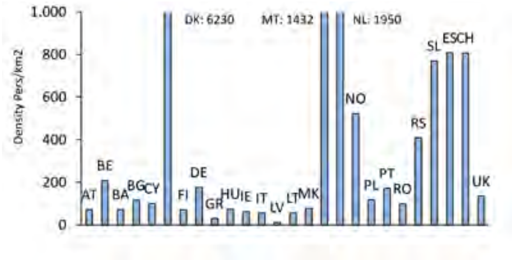


Figure 2 – Population density of the regions indicated by country code

The size of the regions also varied significantly. The smallest region was the Municipality of Copenhagen (DK) covering an area of 90 km^2. The largest area was IE totalling 70,280 km^2.

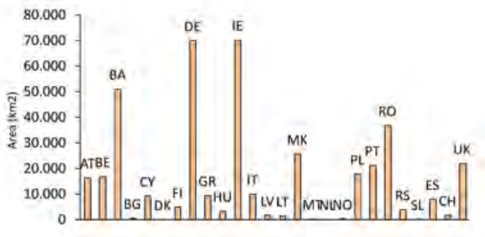


Figure 3 – Geographical size of the regions

The comparison of the area and the population density of the various regions can be seen as an indicator of the very heterogeneous structure of the various regions within Europe.

Economic situation

Independent of size and population density the ratio of the Gross Domestic Product (GDP) to employment rate can be used to indicate the economic situation of a region. This is illustrated in *Figure 4*. The employment rate is calculated by dividing the number of persons aged 20 to 64 in employment by the total population of the same age group.

It is illustrated in *Figure 4* that the most countries and their associated regions are characterised by the long-term development from an industrial society to a service-oriented society. In most European countries industrial production is increasingly shifting from highly developed countries to developing countries, such as countries in Asia. As a consequence of this transition from energy intensive industrial production economies to less energy intensive service economies the energy demand in these European countries is decreasing. This is illustrated in regions such as in the region of Wallonia (BE), where the shrinking steel industry has caused a significant reduction in CO_2 emissions enabling the region to comply with the Kyoto objectives.

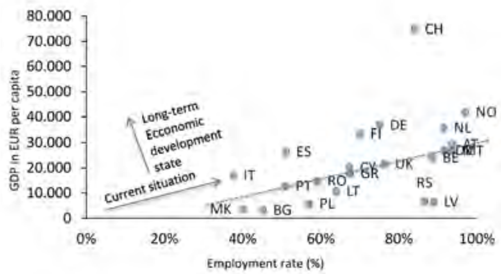


Figure 4 – Employment rate and GDP of the regions

Energy Consumption and CO_2 Emissions

Economic situation and its impact on total energy consumption of regions

As mentioned in the previous section, the economic situation seems to have a strong impact on total energy consumption.

Often, strong economic development results in a relatively high energy consumption. As shown in *Figure 5*, regions with the highest energy demand (kWh/person/year) are DE, AU, BE and IE, which also have higher GDP. Exceptions to this are NO and CH. In these countries, the regions selected show an above-average GDP, coupled with a below-average energy demand. This illustrates that care must be taken when interpreting the results, as the energy consumption cannot always be taken as an indicator for the economic productivity of a region. In some regions an economy based on industry and production results in high energy demand, while the economy of other regions, such as that selected by NO and CH, which is based on a successful service-oriented economy.

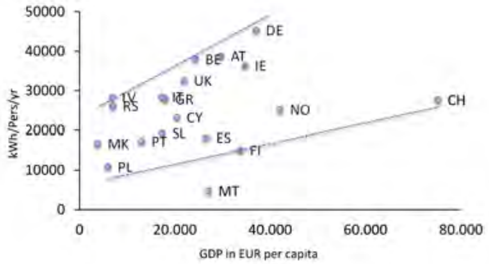


Figure 5 – Regional GDP and energy demand

The same situation can be found in regions with a lower GDP, such as the regions of LT, RS, MK and PL. These also demonstrate that total energy consumption varies despite the fact GDP being within a comparable range.

Economic situation and total amount of emissions.

When correlating GDP of a region with the total CO_2 emissions per person/year, a similar situation is experienced to the relationship of GDP and total energy consumption of a region, with the amount of emissions not being directly related to the economic situation of a region as illustrated in *Figure 6*.

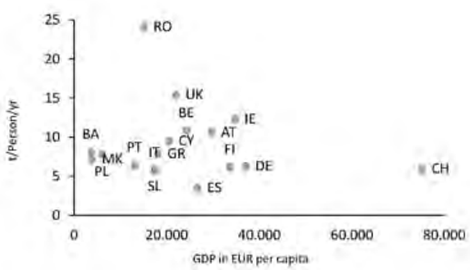


Figure 6 – GDP and emissions of the regions

The reason for this is that the total amount of emissions depends on the share of non-fossil energy sources providing the energy of a region and not on the overall energy consumption. As an example, the region of Bavaria (DE) was, until recently, heavily dependent on nuclear power, but, as a result of National policy, is now shifting to an increasing share of renewable energies. The regions GDP is high, but CO_2 emissions are relatively low. The County of Iasi (RO), is still dependent mainly on fossil fuels, while Brøset neighbourhood (NO) relies 100% on hydro power. The region of Winterthur (CH) has the highest GDP, but has low CO_2 emissions per person/year due to its large share of nuclear energy and renewable energies from hydro power (as illustrated in *Figure 6*).

Energy consumption also depends on the economic structure of a region, as heavy industries, such as steel and aluminium production consume much more energy than service-oriented economies, which are dominant in the region of CH.

Electricity

The share of renewable energy related as a proportion of energy produced within a region is a major factor determining the CO_2 emissions per kg per kWh. However, the overall share of fossil fuel as well as nuclear fuels used for the energy production has to be considered.

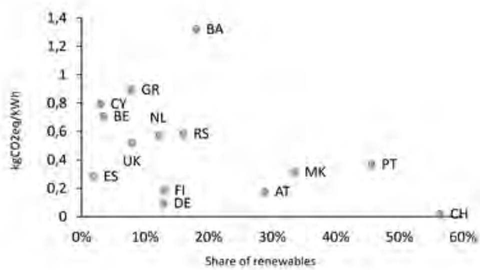


Figure 7 – Proportion of renewables and CO_2 emissions related to the total electricity supply of regions

As shown in *Figure 7*, the Winterthur region (CH) has a large proportion of renewable energy and produces a major proportion of electrical energy from nuclear power plants. This leads to a very low rate of CO_2 emissions as a result of electricity production. Different reasons are presented for other regions with low CO_2 emissions: the Municipality of Copenhagen (DK) covers a large share of its energy demand from wind power, that of DE still depends heavily on nuclear power, while that of NO depends on hydro-power. Other regions, such as that of MT, CY, BE, and CS are largely dependent on fossil fuels.

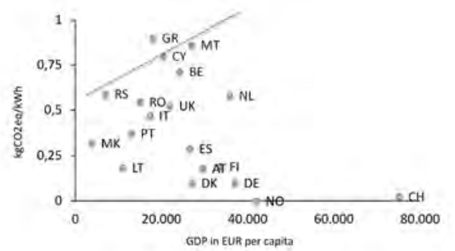


Figure 8 – GDP and CO_2 emissions related to the electricity supply of regions

Figure 8 shows the relationship of the GDP of the regions versus the amount of CO_2 emissions per kWh in the area of the electricity consumption of a region. Similar to the relationship between the GDP and the overall CO_2 emissions in kg per kWh of a region, a clear difference between regions is illustrated. While regions like that of CH have a relatively low emission rate, due to their large share of renewable energies and nuclear power, other countries, depending mainly on fossil fuels, have a significantly higher amount of CO_2 emissions related to the GDP of their region.

Climate

The amount of heating degree days (HDD) are to be regarded as an indicator for the heating energy demand of a building. This is directly related to the outside air temperatures of a region. In a similar manner, the amount of cooling degree days (CDD) is an indicator for the amount of energy required to cool a building.

As shown in *Figure 9*, the various regions show very different conditions with regard of the heating and cooling degree days. However, it is not possible to draw direct conclusions on the energy demand of the regions.

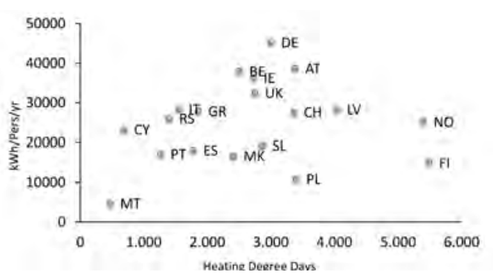


Figure 9 – Heating degree days of a region related to the energy demand of a region

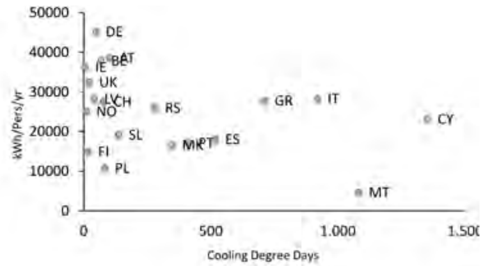


Figure 10 – Cooling degree days of a region related to the energy demand of a region

GHG reduction targets (% and years, only most relevant)

Many regions have adopted the 20-20-20 objectives of the European Union and have developed strategies based on this. However, some regions are exceeding these objectives having set their own very ambitious targets. For example, the region of the 'Municipality of Copenhagen' (DK) aims to achieve zero emission region status by 2025. The region of Parkstad Limburg (NL) plans to be carbon neutral in 2040. The region of Winterthur (CH) aims to reduce the total emissions per capita from 6 tons to 2.2 tons by 2050.

Drivers and Barriers

One of the main drivers to aid the creation of Smart Energy Regions within Europe is the Energy Efficiency Directive (2012/27/EU), which entered into force on 4th December 2012. Most of its provisions will have to be implemented by the Member States by 5th June 2014. By 30th April 2014 and every three years thereafter Member States will have to submit their National Energy Efficiency Action Plans (NEEAPs) to the Commission.

Many factors are found throughout the regions analysed that influence the drive and magnitude for increasing energy efficiency and use of renewable energies. Some of the main factors are presented in the following paragraphs.

Local drivers for smarter energy regional policy

In ES, the 'Blue Plan for Air Quality and Climate Change' was in place between 2006 and 2012. The 'Air Quality Strategy and Climate Change' of the Community of Madrid is currently being developed to follow this (2013 – 2020).

In the region of Wales, UK, both the potential for offshore and onshore wind turbines as well as the potential for tidal energy harvesting are seen as positive elements for a sustainable energy supply in the future. Another major driver for this region is the legal commitment by the Welsh Government to include sustainable development in its constitution.

In DK, the limited capacities of the power plants is acting as a driver for investments in energy efficiency measures to avoid major investments in new power plants.

In DE and CH governments have created clear and binding strategies for phasing out nuclear power plants. This has led to enhanced strategies for reducing energy demand through improving the energy efficiency of the building stock, the infrastructure and the energy system as well as increasing the share of renewable energies.

In IE, the government follows the strategy to replace peat with biomass, thereby reducing GHG emissions. The economic recession in IE has led to a considerable drop of the energy-intensive cement production. Similarly, BE was facing serious challenges with its steel industry, which has led to a considerable drop of CO_2 emissions, which has supported the country's achievements in meeting its Kyoto commitments.

Other more generic drivers, which have been identified throughout the regions investigated have been the:
- increasing necessity to tackle fuel poverty;
- increasing innovative research on low-carbon technologies.

Challenges and barriers
As noted in the previous sections, there are still major challenges existing in member countries to meet the goals to reduce the GHG emissions by reducing energy demand and increasing the share of renewable energies throughout the EU. From the regional investigations some of the major challenges have been identified as:
- poor performance of the existing building stock;
- poor performance of the energy supply systems;
- the low refurbishment rate of buildings, especially those that constructed before the mid-80s;
- poorly performing economies, which offer few options for investment in to a future-oriented energy system.

Major barriers have been identified to be:
- no proper institutional structure;
- lack of competence and clear responsibilities;
- slow bureaucracy and administration;
- political instability;
- bureaucratic and administrative corruption as mentioned in some of the case study descriptions.

Across the regions, more specific obstacles were found, such as:
- fixed electricity energy prices, which have found to be counterproductive with regard to saving electrical energy, and are in part responsible for the high share of domestic heating using electricity;
- lack of public awareness of need for energy efficiency;
- lack of relevant building materials, components and systems for the improvement of the energy efficiency of buildings;
- lack of knowledge, human resources, and of sustainable and long term financial sources for energy efficiency projects;
- lack of information about government funding;
- unresolved situations with regard to tax rebates for energy efficiency measures;
- lack of integration of sustainable development in policy areas;
- an increased percentage of unemployment.

Socio-economic Transformation
The economic situation in the countries and their regions plays a decisive role with regard to energy consumption and the opportunities for moving towards reducing energy demand and increasing supply from renewable energy systems. It has been found that the economic situation of the regions is directly related to the social situation and access to education, information, training, materials and systems as well as other resources. It is becoming clear that the transformation from a carbon-based to a carbon-free economy/society can only be successful if economic and social development are regarded as integrated entities.

As previously illustrated, the economic situation is very different across European Countries. It therefore has to be expected that the means for supporting the socio-economic transformation are very different throughout the various members of this COST Action. While the individual contributions of each member country of the Action give a detailed account of the specific situation, some of the strategies and instruments for supporting the socio-economic transition are highlighted briefly in the following section.

Regional agencies and initiatives
In RO, the North-East Regional Development Agency has been created to stimulate economic and social development in the North-East Region of the country. This has been done by developing strategies, attracting resources, identifying and implementing financing programs and offering services for encouraging sustainable economic development, partnerships and entrepreneurial spirit.

In the UK region of Wales, the initiative "One Wales One Planet" adopts a holistic approach to sustainability and places much importance on public awareness, on the involvement of local communities and on the engagement and education of children and young people to sustainable practices. With this initiative, the Government acknowledges the need to further investigate social patterns of consumption and identify successful strategies for behavioural change.

Funding / Tax incentives for investments
Funding opportunities and related instruments, such as tax incentives and feed-in tariffs are important measures for the widespread and fast implementation of energy efficiency measures and the integration of renewable energy supply systems into the energy system. In addition to this, in most of the member countries, European Structural funds from EDRF and ESF programmes are an important driver for the progression of the low-carbon and climate change agenda.

Energy policies / Legal Framework
Energy policies and the related legal framework are important instruments to encourage rapid transformation of the energy structure of a region and its associated country. Examples of how such instruments can support the integration of energy efficiency measures and the integration of renewable energy supply can be found in CY, including:

- the installation of solar systems to satisfy the domestic hot water requirements on every new building used as a residence is mandatory. To ensure the proper implementation, a technical guide of solar systems is provided by the Building Authority;
- the Electricity Authority of Cyprus (EAC) is obliged to purchase renewably generated electricity;
- local authorities identify areas where the development of renewable energy systems is allowed. This includes the definition of clear terms for the connection of photovoltaic systems and electricity generation systems using biomass and other renewable energy systems within the grid;
- adoption of the Law on the Promotion of Combined Heat and Power and the prioritisation to energy produced with combined renewable energy power generation from the transmission system operator;
- simplification and acceleration of the renewable energy licensing procedures through the adoption of principles such as the "One Stop Shop";
- the facilitation of small- scale renewable energy developments through reduced application charges and faster, non-dissuasive procedures for licensing;
- reduced fees for connection of renewable energy plants with the grid.

Similar policies can be found in other countries such as DE, MT and others.

Information / Training / Knowledge
Strategies to encourage rapid and thorough exchange of information, including programmes for education and training are of utmost importance for the transformation of our society. In addition to traditional activities at the level of universities and other educational facilities, the UK offers some further activities, such as the delivery of specific training programmes to workers and professionals. Such specific programmes offer additional career development to the workforce and provide the industry with the skills needed to

progress the low-carbon transition.
Other examples for the support of the transition to a low-carbon society include the creation of planning tools, such as the 'Wind Atlas', which has been produced for the southern part of BA, which is recognised as a region suitable for large scale wind parks.

Innovation
A wide range of innovation technologies are demonstrated throughout the case studies presented for the regions. These include strategies for the implementation of low-carbon mobility and low-carbon energy systems on a regional and urban scale. A particularly interesting example of an innovation is the minewater concept in the NL, which was developed in 2012 with the following goals:

- maximised long term use of geothermal underground for sustainable heating and cooling of buildings;
- becoming an essential part of the Sustainable Energy Structure Plan 2040 of the municipality Heerlen (carbon neutral city);
- establishing a Minewater Corporation with a sound business case or in other words a lot of connections to the grid.

3. OVERVIEW OF THE CASE STUDIES

The representatives of each member country were asked to choose a case study to demonstrate how specific methods and concepts might have an impact on a regional scale to support the creation of a 'Smart Energy Region' in the region investigated.

In addition to key information on the case study chosen, such as area, population, initial conditions and local situation, authors were asked to describe the role of the stakeholders involved, the expected outcomes with regard to the social, economic, environmental, and the technical impact on the region, such as interventions and industry innovation as well as measures and methods.

Furthermore, the case studies are meant to support the identification of specific drivers and barriers for the creation of a 'Smart Energy Region' as well as the analysis of the various systematic interactions which are needed to support the energy shift throughout Europe.

Focus areas of the case studies
Although the various regions show very different characteristics with regard to their economic, climatic, social and cultural background, as described above, it was possible to identify four common approaches from the case studies with regard to supporting the creation of Smart Energy Regions.
These are presented below:

Eco Regions
A common approach to stimulate the smart energy region approach is to identify a local area to focus ideas on to demonstrate to other areas the possibilities available to reduce energy demand and to stimulate supply from renewable sources. Common characteristics of an 'Eco Region' are:

- clearly defined spatial area, creating a framework for the making and implementation of relevant policies;
- awareness with regard to the necessity to take an integrated approach with multiple indicators and disciplines to create a 'Eco Region';
- demonstrational character with regard to potential light-house projects

Case studies related to the creation of 'Eco Regions' are provided by:

- Austria
- Belgium
- Bulgaria
- Cyprus
- Denmark
- Finland
- Germany
- Malta
- Norway
- Poland
- Romania
- Switzerland

Energy Supply / Smart Grid
Some case studies concentrate on the supply side of energy and implement intelligent demand-supply-management.
Countries presenting case studies in this area are:

- Italy
- Lithuania

Transport
An interesting topic which has a considerable impact on reducing greenhouse gas emissions on a regional scale is transport. As the main focus of the action is on the building sector, only one case studies deals with mobility exclusively:
- Portugal.

Retrofit
The retrofitting of buildings and urban areas is one of the most effective measures for the reduction of GHG emissions. However, looking at the current refurbishment rates throughout Europe it seems to be very difficult to improve the building stock within the near future. Barriers include the lack of the necessary financial means and conflicting interests of the home-owner and the tenant.

Case studies dealing with the challenges and opportunities in the field of the retrofitting of the building stock can be found in the chapters provided by:
- Denmark
- Ireland
- Macedonia
- Serbia
- Slovenia
- Spain
- United Kingdom

Methods / Tools
Due to the complex subject, the development and implementation of Smart Energy Regions is best dealt with by taking a systems based approach to capture the wide range of related aspects and to show the relevant interdependencies in a tangible manner. With that regard novel methods are required to address the energy transition in an effective way. This includes the development of necessary tools for strategic planning and control.

Countries which have presented case studies in this field are:
- Germany
- Italy
- Latvia

CONCLUSIONS

This overview provides some examples of what the concept of a Smart Energy Region in the Action is understood to involve. A broad set of issues have been found to have a significant impact on the successful adoption of low carbon technologies and associated processes on a larger, regional scale implemented in the drive to create a low-carbon built environment. These include:
- the full implications of the role of regional governance and policy;
- a lack of flexibility and shortage of skills in associated supply chains;
- a misunderstanding of capital and operational costs;
- the potential for implementation of technologies geographically;
- the benefit and cost of installing and implementing information and communication technologies (ICT) in the built environment;
- the impact on quality of life and policy and planning for the future.

A major aspect of Smart Energy Regions has been highlighted as integrative management of the different aspects, which are required to consider for reducing energy consumption and emissions on a regional level. This includes technological and environmental issues as well as social, economic and political aspects that should be considered together with how they interact. Although conditions differ, the comparison of case studies show that there are a set of common approaches. For this purpose, the following chapters provided by the partner countries involved in this Action on exemplary regions and approaches enable an exchange of knowledge with the purpose to intensify the development of smart energy regions.

ACKNOWLEDGEMENTS

The data input from the Action’s group has provided the basis for this analysis chapter. The authors thank all contributors for their patience and energy. Furthermore, the authors thank Paris Fokaides for providing the data on HDD and CDD for all regions.

AUSTRIA

AUTHOR

Gudrun Lettmayer
JOANNEUM RESEARCH-RESOURCES
A-8010 Graz, Elisabethstrasse 18
E: gudrun.lettmayer@joanneum.at.

1 OVERVIEW OF THE REGION

Characteristics of the Region
Styria is a federal province or Bundesland, located in the southeast of Austria. It is the second largest of the nine Austrian federal provinces, covering 16,401 km². The population, as of 2011, was 1,210,700. The capital is Graz with 265,000 inhabitants[1]. Styria is subdivided into 13 counties and 542 communities.

Figure 1 - Location of Styria within Austria

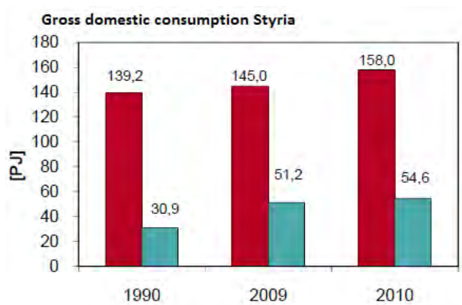
Governance: The so-called Landtag is the elected legislative authority of the Bundesland. Its legislative power covers sectors that are not explicitly a national competence. Energy policies are in large part in national legislative competence; the Landtag executes them. Styrian industry is characterised by heavy industry, mining, automobile production and other production sectors. As more than 50% of Styria is covered by forests, wood processing, pulp and paper industries are important. The GDP per capita was 29.600 (2011). The employment rate was 93.6% (2011) Data: Wirtschaftskammer Österreich (Ed.) (2013).

Energy demand and supply of the Region
In Styria, the gross energy demand increased by 25% between 1990 – 2011, the use of renewable energy sources increased by 77% in the same period (Umweltbundesamt, ed. 2012)

	Austria 2007	Austria 2011	Styria 2007	Styria 2011	Change 2007 – 2011
Domestic[2]	402.3	418.3	55.9	*	+4%
Transport	382	358.8	2.3	*	-6%
Industry	313.2	312	64.5	*	-<1%

	Austria	Styria
Domestic production	489	n.s.
Import	1.288	n.s.
Export	296	n.s.
Gross domestic consumption	1458	213
Energetic final consumption	1089	169

Table 1 – Energy demand and supply of Austria/ Styria in PJ in 2011 Statistik Austria (2013a)



Red (left): fossile Blue (right) renewable

Figure 2 – Energy gross domestic consumption Styria 1990 – 2010 (Umweltbundesamt, ed. 2012)

In Styria, the share of industry in final energy consumption is > 40%. The share of transport is increasing at 25%, private households are responsible for 25% (Kettner C. et al., 2012).

Total energy consumption
No data is available for Styria in 2011 for total energy consumption, however, the development in Styria may be compared to the Austrian trend for 2011. The increase in the "domestic" sector may be attributed to a considerable increase in the public and private services sub sector and a weaker increase in the private households sub sector.

	Austria 2007	Austria 2011	Share of TEC 2011 %	Styria 2007	Styria 2011	Share of TEC 2011 %
Coal	24	18	1.7	6.0	5.0	3.0
Oil	458	416	38.2	57.0	51.0	30.4
Gas	186	185	17.0	34.0	36.0	21.4
Renew.	139	158	14.5	27.0	29.0	17.3
Electricity	221	218	20.0	36.0	36.0	21.4
District Heating	56	73	6.7	7.0	10.0	6.0
Combust. Waste	12	20	1.8	1.0	1.0	0.6

Table 2 – Total energy consumption (TEC) by fuel in Austria/Styria in PJ

Share of energy sources for electricity production (%)

In 2010, Austria produced 61.846 GWh. Austria exported 17.363 GWh, but also imported 19.855 GWh to cover the domestic need (consumption + losses). 66% of energy production for electricity is generated from renewable sources. Austria mainly exports electricity generated from hydropower and imports electricity generated by thermal power stations. Styria consumes about 8.500 GWh/yr. and produces about 4.725 GWh/yr.[3]

Compared to 1990, Styria produces +55% (Austria: +38%). Over the last years, the percentage of fossils (esp. coal) decreased remarkably. The total share of renewables is about 57%. About 43% are produced from fossil resources including electricity self-supply by industry (Umweltbundesamt ed., 2012).

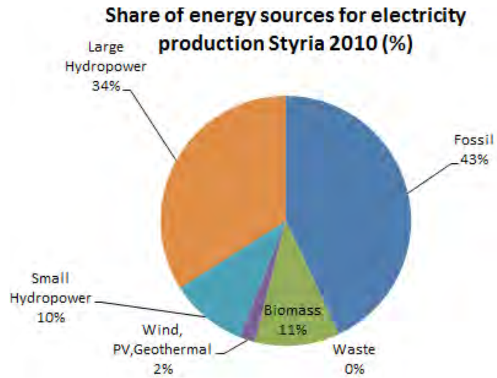


Figure 2 – Energy sources for electricity production Austria (top) and Styria 2010 (Transformation output data) (Umweltbundesamt ed., 2012).

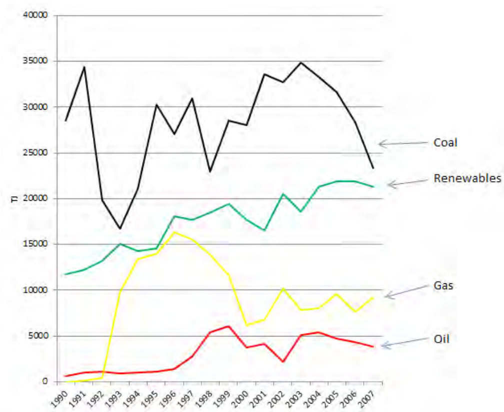


Figure 3 – Development of primary energy resources for electricity and District Heating in Styria (Transformation input data) (Umweltbundesamt ed., 2012).

GHG emission factor for electricity from grid (kg CO_2eq/kWh)

In 2010, all Austrian GHG emissions amounted to 84.6 Mio. Tons CO_2 eq. 18% of GHG total are attributed to the energy production sector (industry accounted for 31%, traffic for 27%) (Umweltbundesamt ed., 2012).

As demonstrated in Chapter "Share of energy sources for electricity production", Austria is an exporter but also an importer of electricity (mainly from fossil resources and nuclear power).

This is also reflected in the GHG emission factor for electricity.

Taking the “Austrian Power Mix”[4] for electricity as a basis (considering also imported electricity), the GHG emission factor for electricity from grid was calculated as being 181g CO_2eq/kWh in 2010 (Umweltbundesamt ed., 2012).There are no Styria specific data available.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Total GHG current emissions (ktCO_2eq, all sectors combined)
In 2010, Austria emitted 84.6 Mio.tons CO_2eq and therefore exceeded the Kyoto target by 15.8 Mio.tons.

14% of Austria’s population live in Styria.
In 2010, Styria caused 13 Mio.tons CO_2eq, i.e. 15% of Austria’s total GHG emissions.
This corresponds to 10.7 tons CO_2eq/person/year. Styria’s GHG emissions slightly decreased by 3,3% from 1990 – 2010. 2010’s CO_2 emissions are at the same level as in 1990 and correspond to 84% of GHG emissions. Industry is responsible for 42% of GHG emissions in Styria; transport for 20%; 13% from energy supply; 12%from small consumers (mainly buildings) and 10% from agriculture (Umweltbundesamt ed., 2012).

GHG reduction targets (% and years)
EU overall target is a 20% GHG reduction related to 1990, and a share of 20% renewables for energy consumption until 2020 (EU “20 – 20 – 20” target).

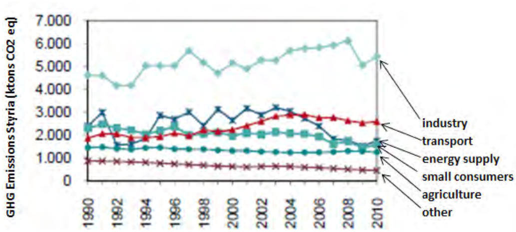


Figure 4 – GHG emissions by sectors in Styria (Umweltbundesamt ed., 2012).

For all parts of economy that are subject to the EU-ETS (mainly production and energy supply), no national or regional Bundesland-targets have been formulated. EU-ETS targets apply. The national GHG emission target for the Non-ETS sectors (effort sharing decision) is a reduction by 16% related to 2005 emissions to be reached until 2020. This target has not been broken down to the provinces (*Bundesländer*) so far.

Regional targets related to renewable energy
Austria has to raise the share of renewables for gross energy consumption to 34% by 2020. In 2008, this share was calculated as being 28.8% (Umweltbundesamt ed., 2012). Several provinces have defined regional targets based on this national target.

- In 2010, the federal government of Styria in a common process with more than 100 stakeholders, formulated a “Climate protection plan”. By this plan, Styria adopts the Austrian national energy targets for non-ETS sectors and goes beyond. Targets are defined as follows:
- GHG reduction 16% related to 2005 emissions to be reached until 2020;
- renewables: share oriented at the Styrian GDP in relation to the Austrian GDP (2010: 12,5%) (Umweltbundesamt ed., 2012);
  This corresponds to 7,5 PJ (Umweltbundesamt ed., 2012).
- until 2030, GHG reduction of at least 28% compared to 1990 (see EU 50-50 target) ”basic scenario”.

Formulation of an “innovation scenario” corresponding to EU ambitious reduction targets 30% until 2020 and 80% until 2050.

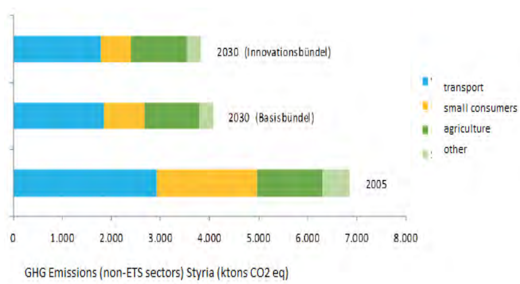


Figure 5 – Styrian targets for GHG reduction by non-ETS sectors (bottom: 2005; middle: basic scenario; top: innovation scenario) (Umweltbundesamt ed., 2012).
“Small consumers” essentially correspond to the building sector

Achievement of regional targets
To achieve these targets, the Climate Protection Plan formulates 26 packages of measures to be taken in the sectors buildings; mobility; agriculture and waste management; production; energy supply and lifestyle. Measures concentrate on sectors that can by significantly shaped at *Bundesland* level.

The sectors mobility and buildings are presented hereafter.
The Styrian overall targets for builings are:
- increase the refurbishment rate;
- increase energy efficiency in private households;
- raise the standards for new buildings.

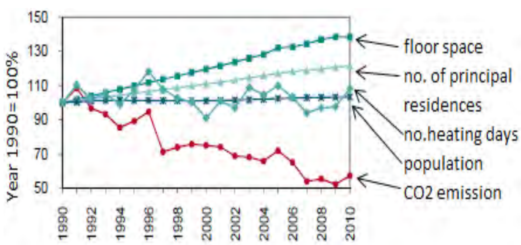


Figure 6 – Trends in private housing Styria (Umweltbundesamt ed., 2012).

The sector buildings has the biggest potential for GHG reduction in Styria as shown in *Figure 5.* This situation is due to the fact that the refurbishment rate of buildings (especially those that had been constructed before the mid 80s) is still very low. The basic target is to reach a thermal heating standard by refurbishment of 70 kWh/m²/yr.; innovation target is 50 kWh/m²/yr. For the smaller proportion of new buildings, the EPBD applies. As for them, beyond 2020, no GHG emissions are expected (100% renewables for heating – the majority of buildings will have zero-emission standards with mainly solar heating/biomass providing the remaining need for heating).

Beyond refurbishment, considerable effects are expected by fostering the switch to renewable energy sources for heat; mainly solar energy and bioenergy; and increasing their efficiency *(Umweltbundesamt ed., 2012).*

Relevant legislation and directives enacted at national level are the implementation of the building directive in Austria, obligatory energy passes for all buildings on the residential market and insulation prescriptions.

A huge number of incentives have been set to reach GHG reduction targets. Focussing on buildigs, mobility and energy supply, some are at Styrian level, the most important in number and volume are at National level There are financial incentives (grants, credits, innovation and research funding) for different target groups, but also consulting services offered as presented in *Figure 7*.

Achievements
Refurbishment rates increased considerably over the last years in Styria. The number of all-embracing energetic refurbishments attaining a maximum of GHG emission reduction for a building is still weak as illustrated in *Figure 8.*

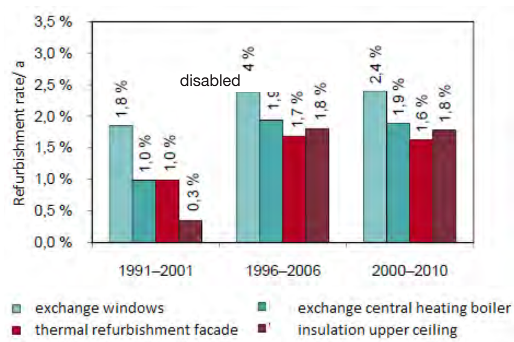


Figure 8 – Refurbishment rates in Styria (Umweltbundesamt ed., 2012).

The total energy consumption of households increased by 9% between 1990 – 2010.
The share of fossil energy sources for heating is decreasing (except gas), the share of renewables (esp. biomass) is increasing. Solar energy for thermal heat is booming: between 2004 – 2010, the additional power increased by +144% *(Umweltbundesamt ed., 2012).*

A problematic issue is the steadily raising need for electricity. Better energy efficiency is compensated by raising electrical consumption. Despite opportunities, there are still important subjective barriers in the buildings sector that

Funding/incentives by Styria /Styrian communities

	P	C	E
Photovoltaics (residential buildings or public social services)	■	■	■
Solar heating systems (residential buildings or public social services)	■	■	■
Switch to district heating	■	■	■
Modern wood heatings	■	■	■
Refurbishment of residential buildings	■	■	■
Switch to automatic wood heating systems and heat pumps	■	■	■
Electric small vehicles (handicapped persons)	■		
Bicycles for Transport, parking facilities			■
Electric, hybrid or gas vehicles for taxi enterprises			■

National funding and incentives

Heat pumps			■
CO2 reduction for in-company mobility			■
Overall thermal refurbishment			■
Electricity generation from renewables for isolated locations			■
Large scale solar heating plants			■
Energy from biomass/Biogas in Agriculture			■
Energy efficiency cheque for SME			■
District heating connection for enterprises			■
Low energy new constructions			■
Eco innovation jobs			■
Local heat supply with renewables			■
Exemplary refurbishment			■
Research Programmes Energy and Environment			■
LED systems in enterprises			■
CHP from natural gas			■
Research programme E*mission			■
Energetic use of biogenic resources			■
Production biogenic combustibles/ fuels			■
Climate protection measures in communities		■	
Micro-public transport in communities		■	
Mobility management for tourism, bicycles, regions		■	■
Energy saving in enterprises			■
Wood heating for self-sufficiency in enterprises			■
E-mobility for climate- and energy regions	■		■
Energy efficiency cheque for agriculture and forestry	■		■
Wood heating systems for privates	■		
Investment grant for energy generation from renewables	■	■	■
Research on consequences of climate change	■	■	■
Research Grants for demo projects	■	■	■
Photovoltaics	■		
Refurbishment cheque for private households	■		
Tariff support within the law on electricity from renewables	■	■	■
Vehicles with alternative drive	■	■	■
Climate and energy model regions		■	
Programme climate:active Mobility management		■	■
Programme climate:active Electro bicycles		■	■
Programme climate:active air conditioning and cooling based on renewables		■	■

Figure 7 – Financial incentives provided at Styrian and national level for target groups P (Privates), C (Communities) and E (Enterprises) (Austrian Energy Agency 2013)

hamper the success of measures: Individual access to information on individual energy saving potential and potential for renewables is lacking or difficult. Despite financial incentives, investment costs remain high. Energy prices, e.g. for fire wood/ pellets, gas, are quite unstable. And finally, attitudes still remain indifferent and there is not much readiness shown to investment in appropriate measures.

Besides buildings, mobility is the second important sector for GHG saving measures in Styria. Traffic is accountable for 20% of GHG emissions. It has been calculated that up to 1.3 million tonnes CO_2 could be saved until 2030 *(Umweltbundesamt ed., 2012).*

The main cause of traffic emission problems is the dispersed settlement structure in Styria. 33% of car journeys cover distances of up to 2 km only *(Umweltbundesamt ed., 2012).* Therefore, in the long term, the shift to an energy efficient regional planning structure is of highest priority.

In order to reduce GHG emissions and increase energy efficiency, priority is given to the following bundles of measures in this order *(Umweltbundesamt ed., 2012).*

efficient regional planning structure
↓
promotion of public transport
↓
promotion of non-motorized individual mobility
↓
promotion of alternative drive (also in transport of goods)
↓
rise efficiency of convential drive
↓
promote alternative fuels

Some of the potential measures to reduce GHG are within the competence of the provincial government, but a considerable part is under the control of the national government.
Styria has defined quite general targets:

- increase the share of emission free/low emission means of person and goods transport;
- increase the use of efficient and alternative drive systems.

All priorities mentioned above – except the regional planning long-term goal – are considered in the existing incentives scheme. The vast majority of financial and non-financial incentives is set under national responsibility (see also *Figure. 7*).

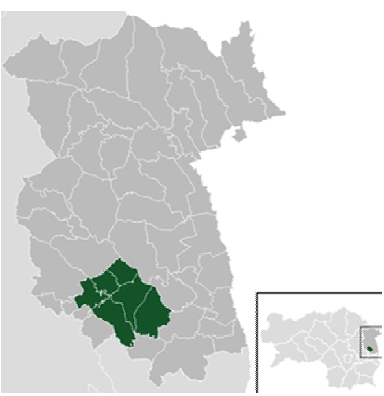
The majority of regional Styrian budget in the traffic sector strives to foster public transport systems especially in the commuter belt of the provincial capital. The discussion on efficient regional planning is underway.

Summary

- Despite achievements (especially efficiency in industry; shift to renewables), the situation of GHG emission in Styria requires effort especially in the traffic and buildings sector. These sectors are mainly driven by individual consumption patterns.
- Energy and GHG related legislation framework is mainly set at the national level.
- There are numerous financial incentives provided for measures at private, enterprise and community level.
- The most important incentives are provided at the national, not regional level.
- The Bundesland and region of Styria has mainly the duty to support and execute EU and national targets and legislation frameworks. Its individual constitutive power is limited.

3. CASE STUDY: ÖKOREGION KAINDORF

The Okoregion Kaindorf case study was selected to demonstrate how, in a bottom-up process, a group of communities in Eastern Styria decided in 2007 to develop towards an "eco-region"



Area, Population, Promoters
The eco-region is formed by a voluntary association of 6 communities (Dienersdorf, Ebersdorf, Hartl, Hofkirchen, Kaindorf and Tiefenbach) in Eastern Styria (see map above). The region has a population total of 5.600 inhabitants and covers an area of 70 km^2. It is characterised by the dominance of agriculture, supplemented by small-scale manufacturing such as food wood processing and handicraft enterprises with the absence of any bigger industries or towns. The settlement pattern is best described by scattered villages with single family homes prevailing. The region is situated about 10 km from Hartberg, a major centre providing all kinds of infrastructure. A considerable number of inhabitants are commuters to this major centre, inside the region itself and to the Styrian capital 40 km away Statistik Austria (2013b). The traffic infrastructure in terms of public transport is very poor, individual motorised mobility dominates.

It was not Styrian regulation, financial incentives or political framework that fostered or enabled the "eco-region" plan. The main driver of this initiative has been communities with strong interrelation ties and a few visionary people. Their basic motivation is to combat climate change by regional consciousness, responsibility and collective as well as individual action.

Objectives and methods[5]

The goal "Eco-region" goes beyond of what we understand as "Smart energy region".
The Eco-region Kaindorf is aiming at:

- fostering an eco-friendly circular flow economic model: Sustainability and economic viability do not exclude each other;
- attaining renewable energy self-sufficiency;

• seeking CO_2 neutrality at regional level;
• giving an example to other regions.

The formal target set by the eco-region is a reduction of regional CO_2 emissions by 50% (2011) and by 80% (2015) compared to 2006 data. CO_2 neutrality should be reached by 2020.

Methodology and structure

The Associations defined 8 thematic areas for action: Awareness building; Mobility; Buildings; Heating and electricity; Agriculture and Humus build-up; Energy saving; Regional gastronomy; Financing.

For each of these areas, a working group has been set up and a working programme formulated. The working groups are composed by interested and competent citizens.
The group elaborates on solutions and single projects, involving other groups or individuals if required. The association's Steering Committee is composed of all mayors, leaders of all working groups and other representatives of population and business. Membership is open to all individual or juristic persons (membership fees start by 10 €/yr.).

The Steering Committee serves as a coordination point for all activities, a link to the population, enterprises and communities, and decides on the use of funds. The initiative is proud not to be dependent on any external funding, although external funding incentives are being used.

Objectives of some thematic areas in short:
Awareness building
• Events to inform on climate change, raise responsibility and show ways to act
• Promote responsible, eco-friendly and regional consumption

Mobility
• Making non-motorised mobility more attractive
• Promoting e-mobility
• Promoting renewables-based fuel
• Regional mobility concept

Buildings
• Reduce CO_2 emissions by energy-saving improvements of (mainly existing) buildings

Heat and electricity
• Switch of entire region to CO_2 neutral heating systems (private households, enterprises)
• Switch of entire region to electricity supply by renewables

Energy saving/Water
• Communicate and enhance possibilities to save energy in heating, electricity and water

Agriculture and humus build-up
• Promotion of humus building in agricultural soils:[6] Raising humus contents in soils from about 3% at present to 6% in steps of 0,1%/yr.
• Promotion of agroforestry and short rotation systems in the region

Long term focus

The concept of the 'Eco-region' is the development of a process towards defined medium-term goals such as emission reduction targets and CO_2 neutrality. Besides these quantifiable objectives, the region – walking the process path – aims at exploring a more general and complex challenge: an eco-friendly circular flow economic model, unifying sustainability and economic viability.

As the process is very important to the Eco-region, they decided to establish a monitoring system of the 'Eco-region' process and the achievement of targets. In order to monitor the key variable CO_2,
a scientific partner (JOANNEUM RESEARCH) was assigned to develop an objective and transparent assessment system, the so-called online CO_2 calculator.

This tool is providing the yearly CO_2 balance of the 'Eco-region' and compares it to the past and the targets set. The 2006 values serve as monitoring base. The calculation model was tailor-made for the 'Eco-region'.
The sector data for Private households, Public buildings, Agriculture and Business are presented per sector. Data collection is done via questionnaires that are distributed by 'Eco-region' responsibles and may be downloaded from their webpage. Data is collected every 2 – 3 years (2006, 2008, 2011 so far). Results are not being published to the public in detail, but extrapolated tendencies for

the single sectors are presented.

Between 2006 and 2008, CO_2– equ-emissions could be significantly reduced. This is mainly interpreted as caused by a massive shift to green electricity. Further emission reductions could be observed in the fields of heat generation and consumption behavior.

The interpretation of results by the 'Eco-region' is influencing the adaptation and re-orientation of the working programmes. All persons who contributed by filling in a questionnaire are provided with their personal CO_2 balance.

Results

Awareness building

The 'Eco-region' Kaindorf was labelled a "FAIRTRADE" region in 2011. Workshops in schools dealt with the story and importance of fairtrade footballs. The importance of regional consumption is highlighted by common projects with retailers on climate friendly shopping. In cooperation with partner retailers, and in order to ban plastic bags, a successful plastic replacement competition took place. It was observed that inner-region shopping increased steadily.

Awareness on climate protection is expressed by regular climate talk events with experts and the very popular yearly awareness raising event "24 hrs biking for climate protection" with over 1000 international participants.

Information brochures and a regional Newspaper "Einblick" (6 times/yr.) are edited by the eco-region stakeholders.

Mobility

A strong focus is set on promoting cycling: bicycle and foot paths have been developed, financed by Styrian and national funds; a bicycle club has been founded and is supported by the region; a bicycle shop and garage opened in the region.

Another focus was alternative power: an E-scooter shop was opened and promoted electromobility in the region; together with incentive prices for E-scooters; a garage specialising in conversion of cars to biofuel; a biofuel filling station have opened; a regional mobility concept was established.

Buildings

A network for advice on energy-saving improvements, and energy efficient and eco-friendly refurbishment, and related financial incentives was established. The region organised talks and personal advice on energy efficient building, and discounts were offered by regional enterprises. An insulation show house opened.

Heat and electricity

In the meantime, all public buildings are equipped with CO_2 neutral heating. The entire Eco-region is supplied with 100% CO_2 neutral electricity.

Photovoltaic plants have been installed on all suitable public buildings. A photovoltaics investment company was funded, with citizens becoming shareholders. Where technically and economically appropriate, small renewable Bio-energy power plants were constructed, and respectively energetically improved. The region supports energy efficiency measures (as they are proposed by Styria-wide and Austria-wide programmes, see *Figure 7*) offering higher grants than most other communities.

Energy saving/water

Individual households in the region that request energy saving advice get a discount on their energy bills. This is also true for those who request thermography measurements and "energy passes".

The leasing of devices to measure energy consumption is free of charge. In a pilot project, the optimisation of street lighting during night time was tested (e.g. lighting could be activated on demand by SMS).

Agriculture and humus build-up
A set of interconnected activities linked to humus has been taking place. Expert meetings and international conferences on humus are regularly organised in the region. Information days for farmers to keep them updated on humus practices take place, where they are assisted and discounts are provided on soil diagnostics if they commit themselves to humus.

Agricultural test and demonstration sites for humus and its benefits have been installed under scientific supervision, where also field tests on biochar for soil improvement and CO_2 fixation take place. A Pyreg test plant produces biochar.

With big retailers, long term cooperation has been agreed upon: selected farmers are producing vegetables humus surfaces; a local CO_2 trading system for enterprises was established where enterprises buy certificates from farmers who humus.

Outcomes
It can be observed that nearly all central problems related to GHG emission, and core areas of activity in the Eco-region, correspond to the key aspects that were also identified for the region of Styria. Findings and initiatives from the Eco-Region illustrate detail at a local level. This illustrates that, on the one hand, the Eco-region is aware of the interdependency and complexity of emission problems; on the other hand it shows that activity is concentrated on topics that are within the Eco-region's scope of action.

Mobility for instance, is a key problem area: the main – legislative and financial – power to change things, however, lies within other levels of decision making process, i.e. the region of Styria and the state of Austria.

On the contrary, a strong focus in this region, rich in agriculture, focuses on Agriculture/ Humus formation, where it is up to individuals to set the measures. In this context, it is quite interesting that the 'Eco-region' decided to concentrate on a subject that is still not scientifically proven (Humus formation as CO_2 sink, biochar), and requires a lot of additional research.

This leads to the formulation of another strength of the Eco-region's approach: to be open for innovative solutions and activities, and open to learn from failures. The latter is explicitly formulated in the Eco-region's general principles. A look at the list of activities, where an interesting mix of established measures and innovative approaches may be found illustrates this permanent learning process.

A definite strength is the existing *"sense of togetherness"* and support from the population of the Eco-region. It appears that leading promoters, such as mayors and *key stakeholders are on the same wavelength*. Even if there is an apparent functional and clear organisation structure within the association, the role of these promoters for the implementation of the targets should not be underestimated. It's only on this basis that it is possible to set common clear budget preferences and agree on common funding for activities.

The marketing of the Eco-region and its approach outwardly has been quite successful, and additional funding at provincial, national and EU level has been acquired. This financial "success" is without any doubt as motivating as a considerable *number of services and discounts the Eco-region provides* for members (more than 30 discounts).
One of the key aspects of success is *the strong involvement of local enterprises*. Nearly all firms and tourism enterprises are members of the 'Eco- region Kaindorf'. Many of them are active members in terms of a) sponsoring; b) active project partner; and c) offering discounts.
At the same time, they also take benefit from the 'Eco-region', as new business ideas and niche products may be supported and the regional consumption idea is promoted.

Nevertheless, any ambitious target set in this context may encounter limitations in practice

'Especially if people are asked for input that does not result in immediate tangible benefits, their motivation for this input may shrink over time'.

In the case of 'Eco-region Kaindorf', the quantitative monitoring of data lags behind other activities. No CO_2 calculator results for the period after 2008 are available as the questionnaire has not been administered. According to the manager of the Eco-region, the planned 2011 survey was postponed for financial reasons. Later on, it was decided to wait for a forseeable fusion with an additional community. In the meantime, as additional funding by a federal programme could be achieved for 2014, the survey should take place this year [7].

4. CONCLUSIONS

This case study demonstrates what can be undertaken in a coordinated way, in the short term; medium term; and long-term; to combat climate change and GHG emissions at small regional level. Considering thatin Styria, there are several regions where local communities with similar characteristics are working together[8], there is a potential to enlarge the concept to incorporate other areas. Nevertheless, this might only be successful when most of success factors mentioned above may be observed.

As the 'Eco-region Kaindorf' is working in a specific setting that is characterised by intense human interaction in a relatively small area, any enlargement to the whole of Styria seems unrealistic.

The 'Eco Region Kaindorf' is seeking for exchange on similar approaches and is willing to share experiences with other regions. They are partners in an ongoing EU project called Solution (Part of Concerto III initiative). Their aim is to further develop approaches of regional energy autonomy in the long term.

FOOTNOTES

1. Wikipedia, 22 October 2013.
2. "Domestic" includes: public and private services, private households, agriculture.
3. Data: Stromnetz Steiermark 2013; does not include energy self-supply of industry or energy suppliers.
4. Calculated for a mix of: 6% coal, 2%oil, 20%gas, 65% hydropower, 8% other renewables, 1%nuclear, 1% other.
5. All subsequent data: Ökoregion Kaindorf Web page.
6. Basic assumption: A humus build-up of +3% in the upper layer <25cm bonds 125to. CO_2 / ha.
7. Personal communication Mr. Ninaus, February 2014.
8. As in Styria, there is an important community fusion programme ongoing, this potential might change to the better or the worse.

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BELGIUM

AUTHORS

Stéphane Monfils and
E: stephane.monfils@ulg.ac.be

Professor Jean-Marie Hauglustaine
E: jmhauglustaine@ulg.ac.be

University of Liege, Faculty of Science, Department of Sciences and Management of the Environment, Research Unit "Energy and Sustainable Development"

1 OVERVIEW OF THE REGION

Characteristics of the Region
On 1st January 2013, 11,082,744 people lived on the 30,528 km² of Belgian land, which comprises 3 Regions:

- Brussels Capital, the city of Brussels and its surroundings, 161 km² in which 1,147,043 people live;
- the Flemish Region, the 13,522 km² Northern part of Belgium, in which 6,376,425 inhabitants live;
- Wallonia, the Southern part of Belgium, slightly larger than the Flemish region (16,844 km²), with a population of 3,559,276. This is the Region of Belgium that this paper will focus on.

Belgium is composed of many levels of authorities, from the European level down to local ones. The federal state is governed by a federal government, competent in all matters of national (or partly national, partly regional) interests like defence, international affairs, social security, energy supply, economy, etc.

Many decisions have been delegated to regional levels of governance. Each Regional government is in charge of energy and environment matters, as well as housing, energy used in buildings, employment, transports, agriculture, public works, economic policy, trade, etc.

Belgium is furthermore divided into communities, provinces and municipalities; each has some level of decision-making authority. For instance, municipalities tend to local management and urban planning.

With regards to the economy in Wallonia:

- GDP reached €24,248 per capita in 2013 (National GDP per capita reached €32,697) (source: http://www.iweps.be).
- In 2012, unemployment reached 11.5% of the active population (15 to 64 years old people) (Forem, 2013).

Energy demand and supply of the Region
According to the "Institute for Advice and Studies on the Sustainable Development" in its 2010 energy assessment of Wallonia (ICEDD, 2011), the "energy autonomy" of Wallonia in 2010 reached a peak of 7.2% (see *Figure 1*), hardly considered very good. However, the tendency seems to be towards greater autonomy, thanks to the development of renewable energy production in Wallonia (see further developments below).

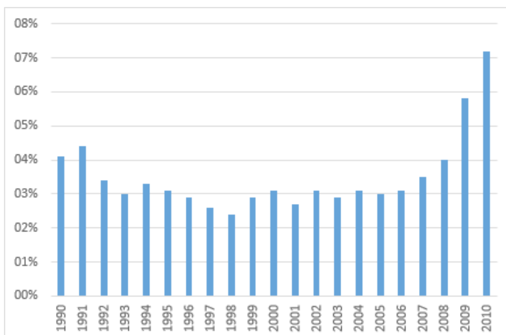

Figure 1 – Evolution of the Walloon energy autonomy (1990 – 2010) (ICEDD, 2011)

The numbers given hereunder come from the 2011 Walloon regional assessment (ICEDD, 2012).

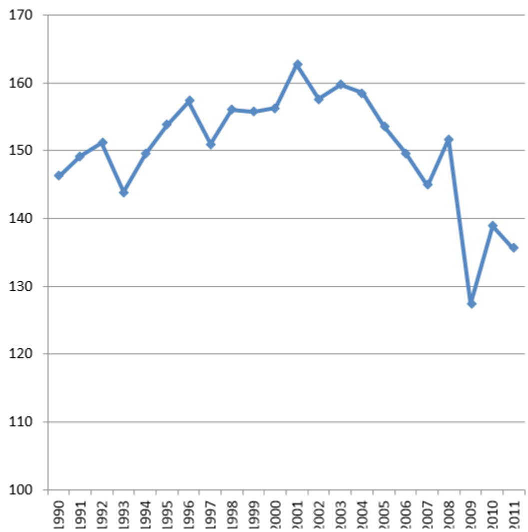

Figure 2 – Total energy consumption in Wallonia (1990 – 2011) (TWh) (ICEDD, 2012)

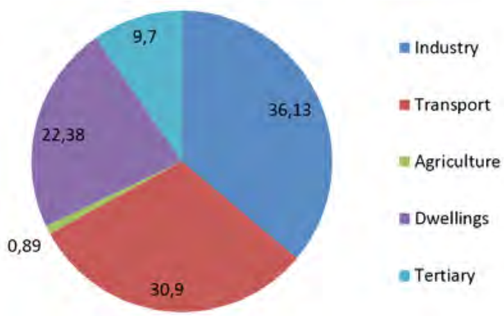

Figure 3 – Final energy consumption per sector in Wallonia in 2011 (%) (ICEDD, 2012)

The 2011 total final energy consumption is estimated at 135.4 TWh. When considering the sector repartition (*Figure 3*), the industry-related history of the Region is dominant (36.1%). As a consequence of the decline in industry there has been a sharp decrease in the total energy consumption from 2009 (visible on *Figures 2 and 4*) which can be explained by a disappointing steel industry, which has been through difficult times these past few years, which explains the Walloon achievement in meeting its Kyoto commitments. Since the beginning of the present century the transport sector (30.9%) has been outrunning the housing sector (22.4%) for second place, as visible in *Figure 4*.

The fuel repartition (*Figure 5*) is somewhat similar to most of western European countries, with a large part of the market shared by oil products (44.9%, including butane, propane and liquefied petroleum gas, or LPG), natural gas (22.2%) and electricity (17.8%).

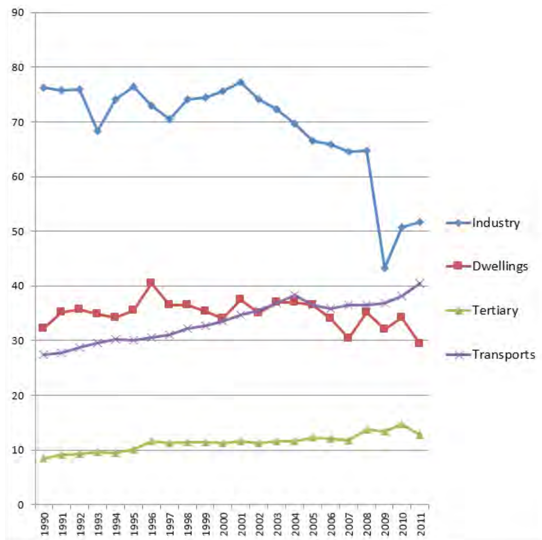

Figure 4 – Evolution of the total final energy consumption per sector in Wallonia (1990 – 2011) (TWh) (ICEDD, 2012)

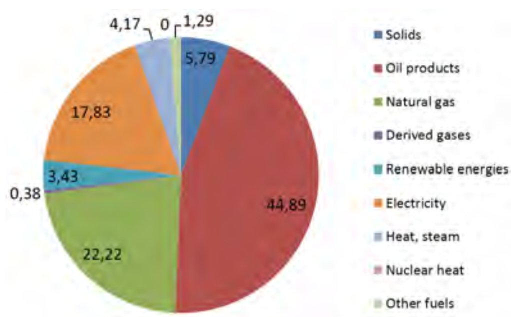

Figure 5 – Final energy consumption per fuel type in Wallonia in 2011 (%) (ICEDD, 2012)

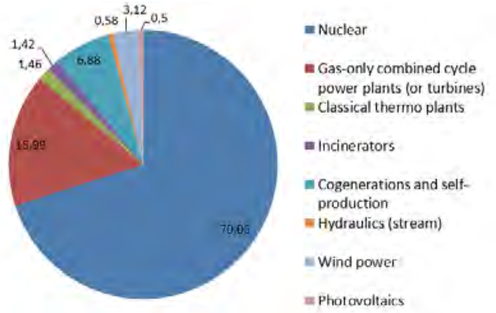

Figure 6 – Share of energy sources for electricity production in Wallonia in 2011 (%) (ICEDD, 2012)

The share of energy sources for electricity production (%) is shown in *Figure 6*. 70% is produced through nuclear processes.

The GHG emission factor for grid electricity that is used in the Walloon EPB calculations is 0.198 kgCO_2eq/MJ or 0.713 kgCO_2eq/kWhLHV (LHV = Lower Heating Value), characterising old charcoal power plants. However, other data could be considered (Energieplus, 2013):

- CWaPE (Walloon Commission for Energy): 0.456 kgCO_2eq/kWhLHV (but only combustion is considered here);
- Belgian production average factor: 0.29 kgCO_2eq/kWhLHV (summer off-peak hours: 0.264 kgCO_2eq/kWhLHV / winter peak hours: 0.335 kgCO_2eq/kWhLHV);
- France (Wallonia's main partner in electricity transactions) emissions factor, integrating the whole production cycle (extraction, transport, combustion and conditioning) (ADEME, 2013): 0.267 kgCO_2eq/kWhLHV[1].

In Wallonia, many companies are active in the production, operation, or maintenance of renewable energy specific components. By the end of 2012, there were 260 wind turbines on the Walloon territory, across 43 sites, generating 576 MW, providing 1,267 GWh (the equivalent electric consumption of 24% of the Walloon residential stock, around 362,000 households).

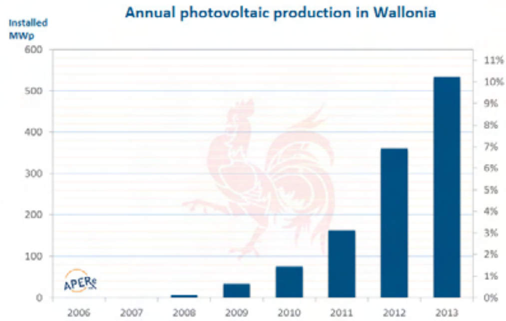

Figure 7 – Annual photovoltaic production in Wallonia (left scale: MWp installed; right scale: percentage of households' electrical consumption covered by photovoltaic installations).
Source: http://www.apere.org/index/node/134

For 2020, the Government plans to provide 1,180,000 households with 4,500 GWh of wind-produced electricity which would require the annual installation of 80 wind turbines, each with a 2.1 MW power at a cost a total of 2 billions Euros (source: Tweed cluster).

Solar energy is also a growing market for Walloon companies, including production or installation of panels or components, operation, maintenance and technological innovation. At the end of 2012, the total photovoltaic power installed in Wallonia reached 491 MWp (or 140 Wp per inhabitant), producing an estimated 6% of the Walloon residential electrical consumption (96,000 households – 337 GWh) (source: Tweed cluster).

Belgium is well known for its rainy weather and is covered in natural water streams, used to produce electricity from hydraulic installations. 106 sites were exploited by the end of 2012 (110 MW), producing an estimated 371 GWh of electricity, which is enough to supply 106,000 households. The very stable production is mainly located in Wallonia. 90 hydraulic power stations generate a total power of 109 MW for an estimated production of 367 GWh each year.

It is believed that, for Wallonia, biomass will be the renewable fuel that will most contribute to reach the 2020 objectives. In

2010, 5.5 TWh of energy used in Walloon households were produced by electric power plants using biomass (cogeneration or other), 0.2 TWh by biomethanisation, 1.5 TWh by domestic biomass fuels (pellets or wood fired boilers) and 1.9 TWh by biofuels. The total production represented 6.2% of the total final consumption.

There are 8 pellet producers in Wallonia, producing altogether 500,000 t/yr. It is far from sufficient in order to cover the total use, so that the major part is imported from Canada, East Europe, Germany and Austria (source: Tweed cluster).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The energy-related targets announced by the Walloon Government relate to three priorities:
- decrease consumption;
- develop renewable energies;
- make the energy market accessible and transparent.

Means of achieving these goals include:
- developing economic and financial tools, such as incentives, "green certificates" (the minimal guaranteed price at which a private "green" electricity producer can sell energy produced back to the grid) or collective agreements with low-energy industries and the tertiary sector;
- developing information tools, such as the Energy Performance Certificate (EPC) or advice services to the citizens;
- insuring the Energy Performance of Buildings regulations application;
- including energy management plans in environment permits;
- supporting flourishing sectors and investments in renewable sectors, to increase renewable energy sources.

As stated in the "Walloon Action Plan on Renewable Energies for 2020" developed by EDORA[2], the potential renewable energy consumption in 2020 could reach 11,232 GWh/yr for the electricity consumption (14,252 GWh/yr if offshore wind power production is considered), 14,207 GWh/yr for heating consumption and 3,210 GWh/yr for transportations, representing 18 to 20% of the total energy consumption, depending on the scenario considered (moderate or low energy demand) (EDORA, 2010).

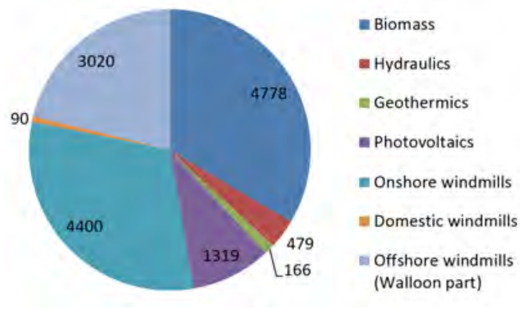

Figure 8 – Potential renewable energy sources capacity for Wallonia in 2020 (GWh) for a total of 14,252 GWh

Wallonia emitted 42,707 ktCO_2eq of GHG in 2010 (IWEPS[3], 2013), less than 80% of the 1990 emissions (54,707 ktCO_2eq) as illustrated in *Figure 9*.

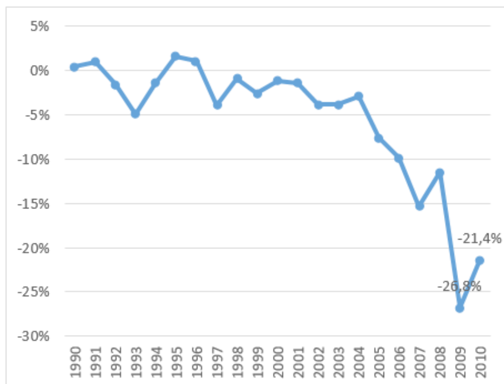

Figure 9 – GHG emissions in Wallonia between 1990 and 2010 (IWEPS, 2013)

The main reasons given for this reduction are:
- The closing of industrial plants, mainly in the steel sector;
- the increased use of natural gas and wood as fuels, in every sector;
- the improvement of processes energy efficiency;
- the decline of the agricultural sector;
- the recovery and valorisation of methane in waste treatment centres;
- the economic and energetic crisis of 2009 which led to more careful consumption. proved by the 2010 progressive rebound.

The repartition by sector is as follows (*Figure 10*)

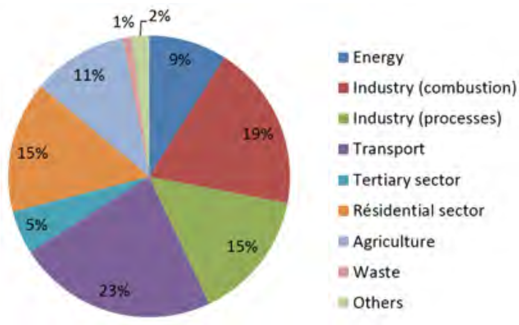

Figure 10 – Repartition of the 2010 Walloon CO_2 emissions per sector (AirClimat[4], 2012)

The Walloon Government is investigating the different scenarios provided by the European "Energy Roadmap 2050" (Europe, 2012), whilst keeping in mind the 2003 law and planning the end of nuclear production of energy (the current agenda foresees the progressive closing of the nuclear reactors between 2015 and 2025).

Wallonia has already decreased its GHG emissions by 21% between 1990 and 2011, reaching therefore its Kyoto objectives. It is believed (IWEPS, 2013) that in short term, the GHG emissions in Wallonia should reduce slightly and, with small adjustments, it would then be possible to reach a 30% decrease by 2020. In order to reach the 2050 objectives however, it will be essential to accelerate this tendency in order to reach a 4.5% annual decrease rate.

Here is a table summarising the Walloon objectives related to the CO_2 emissions, published in April 2013 by the Walloon Minister in charge of energy:

	1990	2010	2020	2050	
				worst	best
ktCO2eq	54707	42707	38295	10741	2735
%	100	78,06	70	19,63	5

Figure 11 – CO_2 emissions targets for 2020 and 2050, in Wallonia

It will be essential to target sectors that have been growing alarmingly in the past two decades: the tertiary sector (46% growth of emissions between 1990 and 2010), the transport sector (+43%) and the residential sector, which has not seen a large increase, but will not decrease as much as needed unless solid regulation for existing buildings is established. Hopefully, the new European "energy efficiency" and "renovation" Directives that are under transposal procedures will allow improvement in that sector.

Energy Performance of Buildings (EPB)
Several actions have been undertaken in Wallonia in order to make energy performance evolve through the years together with public awareness.

Wallonia was the first Belgian Region to adopt a thermal regulation for buildings in 1984, which was implemented in 1985.

Following the first EPBD Directive (2002-91-CE), a temporary (and simplified) calculation sheet has been available that allows architects, on a voluntary basis, to undertake an early evaluation of their clients' house performances, in exchange for advice and subsidies. Up to then, no calculation method took so many essential parameters of the overall performance into account in any Belgian regulation, enabling builders to consider insulation, air tightness, ventilation, solar gains, internal gains and systems efficiencies. This action ("Build with energy… naturally", funded in 2004 by the Walloon Region) stopped in 2012, when the EPB Directive was completely implemented.

In order to respect European targets, Wallonia is currently setting up a roadmap towards 2020 new "near zero energy buildings". One of the goals of the 2010/31/CE Directive was to link optimum energy performance levels with costs parameters and future energy requirements for new buildings. As a result, a "cost-optimum" study has been led in order to link optimum energy and cost performances for different buildings, and to check that the difference between Walloon EPB requirements and cost optimum is not greater than 15%. A similar study, targeting existing buildings, is also being carried out.

The Energy Performance Certificate (EPC), to include energy performance as a choice during the search for an existing dwelling, has been mandatory in Wallonia since 2010.

Finally the three Belgian Regions recently came to an agreement to implement together a unique Belgian environmental performance assessment referential for the certification of sustainable buildings 'Ref-b', based on BATEX (see below), BREEAM (British certification system of sustainable buildings) and VALIDEO (a previous Belgian certification system for tertiary buildings created by the "Technical Control Bureau for Construction" (SECO) together with the Belgian Building Research Institute). 'Ref-b' certification method is currently at the end of the testing procedures, and awaits an official management structure before being released.

BATEX (for "BATiments EXemplaires" or "Exemplary Buildings") is a subsidy system created in 2007 in the Brussels' Region in order to develop and promote the exemplary renovation or construction of buildings, targeting both energy and environmental efficiency. In 2012, a "BATEX" action also began in Wallonia, with 23 residential projects including 49 dwellings granted 100 €/m² subsidy, and another action is set for 2013 – 2014.

Drivers and barriers

Subsidies can help raise community awareness on energy performance potential, along with other financial tools, which can be positive and popular (grants) or negative and unpopular (taxes). Wallonia provides subsidies in order to obtain energetic information by general audit, air tightness test, etc. or improve residential buildings' energy performance through insulation, installation of highly efficient systems such as ventilation with heat recovery, condensing boilers, heat pumps or thermal solar panels for example. These incentives can be granted separately when needed, or be part of a new procedure such as 'Ecopacks', where citizens can ask for a loan (0% interest rate, max. €30,000 for energy efficiency works + €30,000 for corollary works) for an efficient renovation of their dwelling. The capital to be reimbursed is equal to the loan, minus the incentives.

The industrial sector also has financial industry-wide agreements with the Wallonia Region since the 90's, which includes the voluntary reduction of their energy consumption and GHG emissions. In this "win-win" situation, the Walloon Region obtains energy performance engagements (which results can be attained by any measure the industry sees fit), and the industries benefit by financial and administrative advantages from the Region.
In order to raise professional sector awareness, several continued training programs are available in Wallonia. For instance, the public institute for part-time professional training (IFAPME) organises continuous training sessions in various thematic seminars, such as EPB, for self-employed workers and workers from "small and medium-sized firms" with less than 50 employees. The Belgian Building Research Institute is also providing training and skills development sessions and evening sessions, as well as technical advice on construction sites, performance agreements and a wide variety of well informative publications on the subject.

3. CASE STUDY: SMART INCENTIVES FOR SMART ENVIRONMENT-FRIENDLY BUILDING SOLUTIONS

For several years, public awareness has been raised (willingly or not) towards both energy and environmental performance of dwellings. When building or renovating, how can smart choices be made, considering the plethora of available and rapidly evolving solutions? How can the energy administration influence the choice, towards smarter solutions, when the energy requirements and the financial parameters are also evolving fast?

Objectives and methods

A study was conducted in Wallonia, with a double objective:

- evaluate the pertinence of environmental performance requirements in the call for architectural projects (therefore going further than the regional energy regulations);
- assess the importance of a smart subsidy policy in the development of environment friendly building solutions;

This raised several questions: what could be the reasonable limits, when going beyond the regional regulations, as far as environment and energy are concerned? Is it possible to point out one unique solution that would be the best compromise on several levels (performance, costs, techniques and environment)? Can all these requirements be summarised in only one CO_2 criterion? And, most importantly, is the subsidy policy (federal, regional, municipal) adapted to the overall environmental performance target?

The house for the study (see *Figure 12*) was selected to be statistically representative of the newly built Walloon housing stock on several parameters: an isolated rural house, with an average heated floor area (Ach= 178 m² here), protected volume (Vp= 551 m³ here), thermal loss envelope area (AT= 408 m² here), compactness (C= Vp/AT = 1.35 m here), proportion of windows, orientations, etc.

Recent studies show that this kind of private housing estate represents around 13% of the houses built before 1991 (Monfils, 2013). According to 2012 national statistics (statbel, 2013), around 35% of the 2012 Walloon dwellings were four-façade single-family houses. These two numbers alone enlighten the new building tendencies to detached houses.

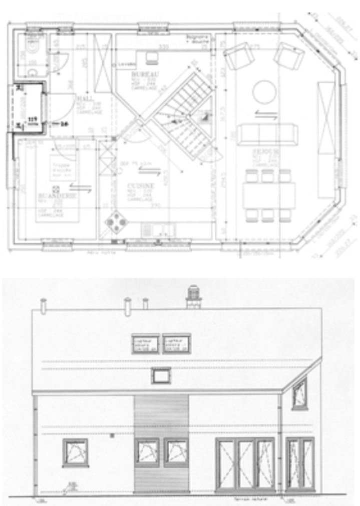

Figure 12 – Ground floor plan and South façade of the representative one-family house

In order to define the best solution(s), performances had to be assessed for different versions of this house, each with a different, but technically relevant, combination of insulation levels, air tightness performance, ventilation systems, energy vector, heating systems, domestic hot water systems and eventual renewable energy production systems. The different versions were then assessed on energy, environmental and financial performance levels and compared with a benchmark, the "basic" case.

Five different levels of insulation, identifiable by the K indicator (translating the overall level of thermal insulation, depending also on the compactness of the building; the lower the K-level, the better insulated the building) were tested. The benchmarking level (K55) just respected the energy regulation of 2007, when the study was first conducted. The actual maximum K-level is set at 35. The highest level (K18) reaches "passive" standard (0.15 W/m²K for opaque walls, and 0.8 W/m²K for windows).

Insulation levels		Vertical walls	Roof	Floors	Windows [W/m²K]	Average U value [W/m²K]	K level
Benchmark	[W/m²K]	0,5	0,3	0,58	1,9	0,61	55
	[cm]	4 (MW)	10 (MW)	4 (EPS)			
1	[W/m²K]	0,4	0,26	0,43	1,7	0,48	43
	[cm]	6 (MW)	12 (MW)	6 (EPS)			
2	[W/m²K]	0,21	0,18	0,43	1,7	0,38	34
	[cm]	14 (EPS)	18 (MW)	6 (EPS)			
3	[W/m²K]	0,14	0,15	0,28	1,7	0,31	27
	[cm]	22 (Cell.)	22 (Cell.)	10 (EPS)			
4	[W/m²K]	0,14	0,15	0,15	0,8	0,2	18
	[cm]	22 (Cell.)	22 (Cell.)	21 (EPS)			

Figure 13 – Insulation levels considered (MW = mineral wool; EPS = expanded polystyrene; Cell. = cellulose wool)

Three different values for the *air tightness* (v50, the air leak-flow per m² of thermal loss surface, with a 50 Pa of pressure difference between inside and outside) were considered: 12 m³/h.m² (regulatory by-default value), 4 m³/h.m² (level 1) and 0.8 m³/h.m² ("passive" level 2).

The three main types of ventilation systems have been selected: a completely natural ventilation system ("A", for the benchmark case only), a semi-mechanical "single flux" system ("C", with exhaust fans) and a complete mechanical "double flux" system ("D", with supply and exhaust fans, and a heat recovery unit).

Natural gas, often unavailable in isolated areas dictated the choice of *heating and domestic hot water (DHW) production systems,* as follows:

- benchmark case: low temperature oil-fired boiler.
- system 1: condensing oil-fired boiler.
- system 2: wood-fired (pellets) boiler.
- system 3: ground-water heat pump.
- system 4: for "passive" housing only, a pellet-fired stove for heat production, coupled with an electric boiler for DHW production.

In 3 cases, we have added *renewable energy* production systems: South oriented thermal solar panels to help heating DHW (Sol1: 4 m²; Sol2: 6 m²) and/or South oriented photovoltaic panels for electricity production (PV1: 2.1 kWp; PV2: 4.2 kWp).

Figure 14 summarises the parameters combination for the 13 studied cases, with energetic results presented in *Figure 15*, as given by the Walloon EPB regulation calculation method. The Ew level [-] translates the level of performance, where the primary energy consumed by the building (as built) is compared with the primary energy consumed by a same building equipped with standard systems (the current target is Ew= 80, meaning that the actual building's performance has to be at least 20% better than the standard building's). The Espec level [kWh/m².yr] gives information on the specific primary energy consumption by square meter of heated floor area (the maximum is currently set at 130 kWh/m².yr).

Case	Insulation level	Air tightness level	Ventilation	Heating and DHW system	Renewable energy ?
1	Bench (K55)	default	A	Bench	No
2	1 (K43)	default	C	1	No
3	1 (K43)	default	C	2	No
4	1 (K43)	1	D	1	No
5	2 (K34)	1	D	1	No
6	2 (K34)	1	D	3	No
7	2 (K34)	1	D	2	No
8	3 (K27)	1	D	1	No
9	3 (K27)	1	D	3	No
10	3 (K27)	1	D	2	No
11	4 (K18)	2	D	4	Sol1
12	4 (K18)	2	D	3	PV1
13	4 (K18)	2	D	4	Sol2 + PV2

Figure 14 – Parameters combination for simulated cases

Case	K - level [-]	Net Heating Demand [kWh/m².yr]	Primary Energy			Final Energy cons.			CO_2 emissions [t/yr]
			Ew - level [-]	Espec - level [kWh/m².yr]	Total consumption [MJ]	Electricity [kWh]	Oil [kWh]	Pellets [kWh]	
1	55	120,6	122	218	139.779	563	37.419	0	10,24
2	43	100,4	96	172	109.900	938	28.183	0	8,08
3	43	100,4	97	173	110.729	938	0	28.414	0,67
4	43	84,3	85	152	97.443	927	24.749	0	7,17
5	34	40,54	60	107	68.327	1.426	15.414	0	5,07
6	34	40,54	51	90	57.843	6.427	0	0	4,58
7	34	40,54	60	107	68.662	1.426	0	15.507	1,02
8	27	30,91	55	98	62.701	1.623	13.360	0	4,67
9	27	30,91	47	84	53.571	5.952	0	0	4,24
10	27	30,91	55	98	62.957	1.623	0	13.431	1,16
11	18	13,33	46	81	51.613	4.121	0	4.035	2,94
12	18	13,33	22	38	24.372	2.708	0	0	1,93
13	18	13,33	2	3	1.701	-1.194	0	3.458	0,00

Figure 15 – Energy and environmental performance results for each modelled case

The focus has now to be put on investments, incentives and costs. Energy costs are calculated with estimated consumptions and recent energy prices:

Vector	Cost [€/kWh]	Product component [%] (of the total, excl. VAT)	Price evolution scenario [%]
Day-time electricity	0.1922	55	3.2
Night-time electricity	0.1161	46	3.2
Fuel oil	0.0708	71	2.55
Pellets	0.0481	58	1

Figure 16 – Energy prices evolution

The "overinvestment" exceeding the threshold investment required to build the benchmark house will be taken into account (*Figure 18*): additional insulation, extra cost of higher air tightness performance, ventilation system upgrade cost, alternative heating and domestic hot water production system(s) costs, and eventual renewable energy production systems.

Financial incentives are obviously a big part of making performance choices. The actual financial incentive that exists when a building is built or renovated can contribute in choosing a solution instead of another one.

Incentives	Amounts
Global energy performance (1)	1,500 € if E_w<65 (and K<35) +110 € for every point below 65 Maximum: 5,000 € (+ 1,500 € if "passive" certified house)
Pellets-fired boiler	1,750 €
"Blowerdoor" air tightness test	250 €
Thermal solar panels	500 € for a 2 to 4 m² installation +100 €/m² Maximum: 5,000 €
Photovoltaic panels	min. 65 €/MWh.yr (2)

(1) Created in order to encourage "better-than-regulation" performance. The maximal Ew presently required by regulation is 80.
(2) Since 2011, PV panels' installation cannot be eligible for incentives; waiting for the new subsidy system, a transitory phase gives 1.5 "green certificate" (tradable commodity proving that electricity is produced using renewable energy sources, emitting less CO2 than usual process) of a minimal value of 65 €/MWh.yr for 10 years.

Figure 17 – Considered incentives

The parameters of the economic study for the different cases are presented below:

- use (and loan) duration: 20 years;
- rate of inflation: 1.5%;
- interest rate for mortgage loan: 3.7%;
- VAT for pellets: 6%;
- VAT for any other energy fuel: 21%;
- discount rate: 3.5%.

The first step of the economic study is to define energy prices during those 20 years, and to calculate corresponding energy bills which can be compared to the benchmarking bills. Then, the 'Net Present Value' (NPV) calculation method is used in order to evaluate whether the savings were worth the initial investments, taking incentives and energy bills into account. When the NPV is positive, the investment is profitable, which is validated by the calculation of the internal rate of profit (IRP, the discounting rate for which NPV is null). When the IRP is lower than the discounting rate (which is fixed at 3.5% here), the investment is not profitable (more funds would be raised in the bank, with a 3.5% interest rate).

NPV and IRP results are given hereunder for each project option over a 20 year period:

Case	Over-investment	Incentives	Global cost on 20 years	Net Present Value	Internal Rate of Profit
	[€]	[€]	[€]	[€]	[%]
1	0	0	93,973	0	0.00
2	3,394.78	0	79,429	13,855	8.13
3	11,142.78	1,750	58,748	33,387	7.05
4	4,710.78	2500	73,035	19,956	8.30
5	11,681.84	2,300	63,013	29,235	6.52
6	22,864.84	3,290	71,312	20,569	4.02
7	19,429.84	4,050	56,885	34,707	5.55
8	13,027.48	2,850	60,867	31,231	6.40
9	24,210.48	3,730	70,561	21,216	3.99
10	20,775.48	4,600	57,080	34,441	5.36
11	25,805.24	7,250	77,969	13,967	3.38
12	39,242.24	10,757.25	71,430	19,505	3.29
13	45,195.24	15,708.4	55,973	34,268	3.90

Figure 18 – Financial results for each project option, incentives included

Results

In the following graphs (*Figures 19 to 21*), each dot is referring to a case study, listed in the tables above. The green dotted lines represent the current new buildings energy requirements: Ew,max= 80 and Espec,max= 130 kWh/m².yr.

The *Figure 19* compares the Espec levels of each case with its CO_2 emissions. It shows that, beyond the obvious necessity to raise insulation levels in order to reach an optimal solution, the best results are awarded to models using a pellet-fired boiler for heating and DHW production. The 12th case is also part of these best solutions, thanks to the renewable energy production systems.

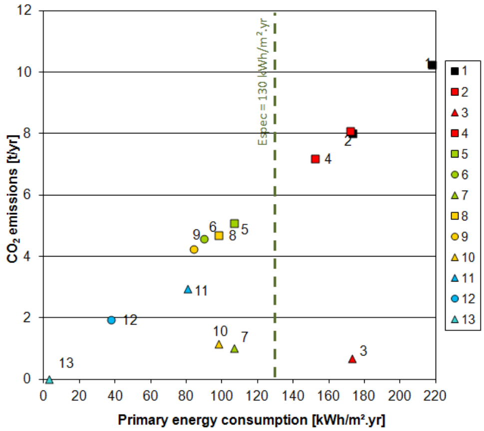

Figure 19 – Results comparison of the different

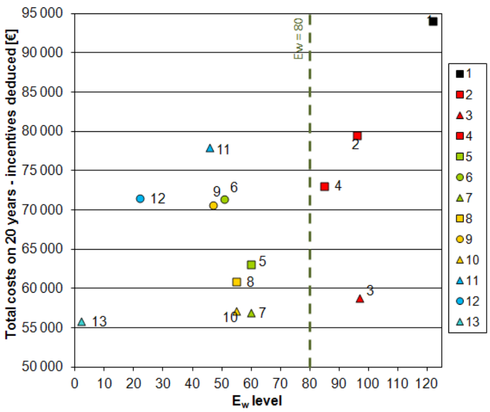

Figure 20 – Comparison of the financial (incentives included) and energy results of the different cases

The *Figure 20***,** comparing Ew levels and total costs on 20 years (incentives not included), shows that the cases that barely respect the insulation requirements (n°5 to 7) are not always the ones that cost the most after 20 years; an explanation could be found in lower overinvestment costs, in spite of the fact that energy bills are higher (and keep growing every year). Should this study be undertaken over a 30, 40 or 50 years span, global cost would have outgrown those of the more efficient – but more expensive – solutions.

Figures 21 and 22, comparing the Ew levels and NPV results for each cases, show that some solutions see their ranking drop when the financial incentives are not taken into account.

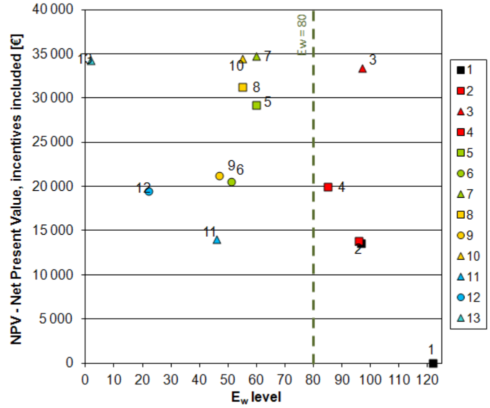

Figure 21 – Comparison of the results of the different cases: NPV (incentives included) vs energy (Ew level)

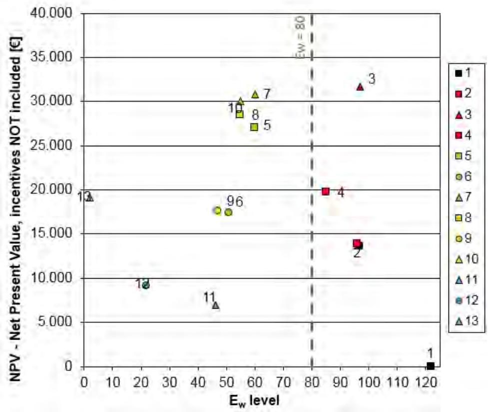

Figure 22 – Comparison of the results of the different cases: NPV (incentives NOT included) vs energy (Ew level)

For instance, the best incentives-included solution is the 13th, i.e. the highest efficient solution, which drops to the 6th best place when the financial grants are excluded, with lesser insulated models becoming more prominent (K43, K34 or K27 alike). The use of a pellet-fired boiler seems then to be the best solution, as a result of a combination of incentives, lower energy price evolution rate and lower VAT for pellets. On the other hand, heat pump solutions (n°6, 9, 12) were not identified as a strong solution as a result of higher investment costs, the absence of incentives and less advantageous use of electricity in the EPB calculations.

Financial incentives seem to allow highly efficient (but otherwise expensive) solutions, which allow the growth of sales, leading to ultimately lower prices and market opening for the product.

The influence of financial incentives is also visible in solar panel solutions: thermal solar panels receive less funding than photovoltaic panels. Consequently, solution number 11 (with 4 m² of thermal panels) is lower ranked than solution 12 (with 2,100 Wp of PV installations) or 13 (with 6 m² of thermal solar panels, but also 4,200 Wp of PV installations).

Given what has been said before, one can wonder why a clearer distinction between different insulation levels cannot be seen in the financial graphs. For instance, it is hard to point out a significant financial difference between solutions 3, 7 and 10, mainly differentiated by their insulation levels. The different ventilation systems and the grants available mainly explain the small gaps. This concludes that the current incentive system does not insist enough on the importance of insulation in the search of a better energy efficiency.

The conclusions drawn above regarding the financial incentive could be drawn from the NPV results. As far as the energy performance results are concerned, the obvious best solutions are options 11, 12 and 13, where the envelope performance is improved to the passive standard, and efficient systems are installed.

When considering the CO_2 emissions however, the best solutions are the ones using pellets for energy vectors (solutions 13, 3, 7, 10 and 11 are five of the top six), closely followed by the ones using electricity through heat pumps (solutions 12, 9 and 6 are the other three solutions of the top eight).

The overall aim of this study is to compare the energy and environmental performance results with economic and financial ones, to identify a “dominant” solution, if it exists. A dominant solution is hereby defined as a studied scenario (or combination of technical options) for which each performance result surpasses the same performance result for every other solutions. The following table (*Figure 23*) summarises the results obtained for each solution.

Case	E_w level	E_{spec} level	CO_2 emissions	Global costs on 20 years incentives included	Global costs on 20 years incentives excluded
	[-]	[kWh/m²yr]	[t/yr]	[€]	[€]
1	122	218	10,24	93973	93973
2	96	172	8,08	79429	79429
3	97	173	0,67	58748	60498
4	85	152	7,17	73035	73285
5	60	107	5,07	63013	65313
6	51	90	4,58	71312	74602
7	60	107	1,02	56885	60935
8	55	98	4,67	60867	63717
9	47	84	4,24	70561	74291
10	55	98	1,16	57080	61680
11	46	81	2,94	77969	85219
12	22	38	1,93	71430	82188
13	2	3	0	55793	71502

Figure 23 – Comparison of the results of the different cases: energy performance (Ew and Espec levels), CO_2 emissions and global costs (including or excluding incentives)

If financial incentives are included, global costs for 20 years follow more or less the energy performance results. As stated before, it is clear however that heat pumps are expensive and are not financially supported, whilst pellet users can still enjoy economic and financial advantages of this energy vector. Therefore, the dominant combination seems to be the 13th, the “near zero energy building”, allying high energy and environmental performances, and best financial investment over 20 years. Excluding financial incentives, solutions using pellets-fired boilers (solutions 3, 7 and 10) become the best option.

When financial measures are excluded, results seem to shift from the energy performance: for example, best solution (number 13) drops to the 5th place when financial incentives are excluded. As a general rule, "technological" solutions are more sensitive to the incentives: though crucial for a global performance, insulation still seems "under-granted".

4. OUTCOMES AND CONCLUSIONS

This study was first conducted when the EPB calculation method was not implemented yet in Wallonia. Since then, the results of every study made in the EPB context are used in order to upgrade the method when needed. This study allowed the assessment of available technical combinations in order to reach regulatory energy requirements; these combinations have since been used in a "sensitivity study" in the "Build with energy… naturally" action (see above).

However, in these times of fast evolution of the building regulations and technical development, building sector stakeholders become concerned, because of the economical and financial consequences that tend to diminish young households' access to dwelling construction. Although smart energy solutions exist, they are not always obvious or affordable to private investors for retrofit or new build. This study aims at the smartest decision-making on a multi-criteria basis including energy, environment and economics, which is at the centre of the consultation initiated in Wallonia, including the financial actors (banks).

This study shows how financial parameters, such as VAT and policy incentives, can open markets to efficient technology, influence choices and, mostly, help make "good" decisions at a given time. Therefore, one great outcome has been and will still be its use in the "Near Zero Energy Buildings" and "Cost Optimum" studies foreseen by the European Directives, introducing cost and economic reality in the energy requirements. In that context, the economic calculation method and tool created here proved to be very useful.

This study shows that, at a given time, when considering long-time investments, environment can be a relevant criterion to seek the smartest solution. Actual financial incentive policies mainly target energy performance, but this study shows that, in order to reach environmental performance, smart development should focus on granting solutions that also allow the reduction of GHG emissions.

Dissemination of results

The study and its results could be widely used, at least to the whole Walloon Region, if adjustments were made for example, the availability of natural gas systems in urban areas could change the whole ranking. According to regional statistics (Statbel, 2013), there is an annual 0.7% construction rate of new residential buildings in Wallonia, the potential of a set of best choices in terms of energy performance, environment and finance can be seen. The results have been communicated to the regional energy Administration who became a stakeholder, and through building sector training.

The technologies and construction works considered here are quite common, so that this study would be easily transferable to other regions calculation methods, regulations and economic situations. Adaptation to other regional specific economic and financial policies on energy performance could influence the rankings.

FOOTNOTES

1. ADEME: French Environment and Energy Control Agency.
2. Alternative and Renewable Energy Federation.
3. Walloon Institute of Evaluation, Forecasting and Statistics.
4. Walloon Agency for Air and Climate.

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BOSNIA AND HERZEGOVINA

AUTHORS

Jovan Todorovic
Elektroprenos BiH, a.d. Banja Luka,
Marije Bursac 7a, 78 000 Banja Luka,
Bosnia and Herzegovina,
E: jovan.todorovic@elprenosbih.ba

1. OVERVIEW OF THE REGION

Characteristics of the Region
The country of Bosnia and Herzegovina has an area of 51,129 km^2, and a population of 3,800,000 inhabitants. The state consists of two entities, the Republic of Srpska (RS) and the Federation of Bosnia and Herzegovina (FB&H). In 2011 the GDP per capita was €3,570 and the employment rate was 72.8 % in 2011.

The climatic conditions within Bosnia and Herzegovina (B&H) are rather varied: the northern part has continental-moderate conditions, the central part has mountain conditions and the southern part has Mediterranean conditions. The average summer temperature is 15 ^{0}C and average winter temperature is 5 ^{0}C.

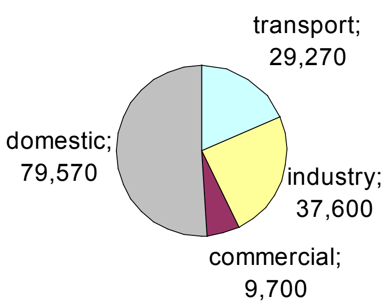

Figure 1 – Total energy consumption by sectors in TWh

Energy demand and supply of the Region
The total energy consumption is 156,140 TWh. *Figure 1* presents the distribution of the energy consumption by sectorsdescribing temporary industry development in B&H. The domestic energy consumption is the most dominant factor and the industry consumption is just a minor percentage of the pre-war industry level.

Total energy consumption by fuel is presented in *Table 1*.

Fuel Type	Share
Residual Wood	30.2%
Oil	26.8%
Electric	22.2%
Coal	10%
Gas	6.7%
Heat	3.1%

Table 1 – Share of energy consumption by fuel

Table 1 reveals that a residual wood is prevailing energy source. Mostly, it is used for heating in households without any pre-processing. Also, when burning out the air pollutants and dispersed in the air without any filtering before.

The share of energy sources for electricity production is 60% for thermal power plants and 40% for hydro power plants. The GHG emission factor for the electricity mix is 1.326 kgCO_2eq/kWh. The electricity produced originates from large scale conventional sources; large hydro and thermal power plants, there are no wind or solar farms so far.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Bosnia and Herzegovina (B&H) is about to adopt and implement regulations, mostly set by EU, in order to decrease CO_2 emission and increase total energy efficiency. B&H is member of many international agreements for the regulation of issues concerning energy efficiency and climate change. One of these is the EU Energy Community Treaty for South East Europe, signed in 2005. It is a joint regulatory framework for the cooperation within the energy market of South East European Countries and the EU covering energy, and environmental issues, fair competition, electrical consumer legal protection and oil and natural gas issues Besides these, B&H has the duty to implement directives for increasing energy efficiency in households and the generation of renewable energies among others (85/337/EC, 92/42/EEC and 93/68/EEC, 96/57/EZ).

The total GHG current emission in B&H from all sectors is 31,276 ktCO_2eq. According to the report by the Centre for Policy and Governance “Energy Sector Policy Report in Bosnia and Herzegovina”, the 2009 target set in 2009 for GHG reduction is from between 5 and 10% until 2020.

There is a great potential for an increase in energy efficiency in B&H. Currently, the energy needed to produce $1,000 of GDP is twice as high if compared to the world average.
There is also a great potential in energy savings in the field of building retrofit, as the heat dissipation from buildings is enormous.
Most of buildings in B&H have no thermal insulation at all. Since August 2013 public buildings over 500 m^2 of useful space have to provide a energy certificate, which has to be publicly available (3). Other buildings have to provide the energy certificate before the owner/tenant gets the authority approval to use the building.

Regional targets, barriers and drivers
So far there are no specific regulations and laws imposing rules and restrictions concerning building insulation, windows and overall energy efficiency, neither regional nor national scale. Also, there are no regulations and laws preventing or encouraging individuals, local communities or regions to apply measures or install materials in order to prevent energy dissipation and consequently increase energy efficiency. Thus, local communities and regions are free to choose their own approaches and methods for increasing the energy efficiency of the building sector. Furthermore, because local communities are responsible for the household heating, investments in building insulation could decrease the costs of heating and consequently save money with regard to the city budget.

The general barriers for energy efficiency improvements in B&H in all buildings are: no proper institutional structure and responsibilities; lack of drive by bureaucrats and administration; aversion to political risk and corruption. Other barriers particular for B&H include fixed electric energy prices, which creates a high share of domestic heating through electricity, together with a lack of public awareness of energy efficiency, a lack of material and human resources, and a lack of financial resources for sustainable and energy efficiency projects. (2)

There are some activities acknowledged to remove these barriers:

• *enhancement of legal and institutional framework for energy efficiency in B&H;*
- establishment of agencies for energy efficiency and other responsible authorities, i.e. regulatory bodies or departments in local or state governments responsible for these issues;
- feasibility studies, plans, estimates for energy efficiency;
- energy labels for buildings;
- installation of information systems for energy consumption monitoring.

• *sustainable and long term financial incentives for energy efficiency measures in B&H:*
- establishment of domestic funds for environmental protection in order to provide long term financial support;
- access to international funds.

• *Improvements of energy efficiency at a local level:*
- cities/municipalities support, for example free of charge few advertising panels in public places and local media, permissions for promotional activities in schools;
- support of pilot projects on a local level.

• Increase of public awareness of energy efficiency:
- strong media support of energy efficiency and energy management;
- establishment of multimedia information and education centres for energy efficiency;
- establishment and promotion of “Energy certificate of B&H”.

Responsible Ministries in both B&H entities should create a legal framework for the implementation of these activities and extend them to local communities. It should be possible to adopt appropriate strategies with a high level of freedom to adapt them to the individual need of each local community.

Also, in the near future, it is expected that first large scale projects for the utilisation of renewable energy sources will be installed and integrated into the power system of B&H. The first one expected is the wind park in Trusina, in the southern region with an installed power of 45 MW. The investor has already provided permissions from both the regulatory agency and the power transmission company. Furthermore, a Wind Atlas for B&H has been created where the southern part of the country is acknowledged as the region most suitable for large scale wind plants. The southern part of B&H has also potential for solar power generation, but it is estimated to be lower than the one of wind power. The installation of these systems for the use of renewable sources offers great opportunities for a major increase of energy efficiency and for a for significant decrease of CO_2 emissions in B&H.

3. CASE STUDY: DELTER

B&H has not fulfilled the requirements of the EU Energy Community Treaty for South East Europe regarding energy efficiency improvements and renewable energy deployment. In order to support B&H, the EU has approved a grant for the project 'DELTER'. DELTER is an EU financed project dedicated to "Support Bosnia and Herzegovina to meet the requirements of the EU Energy Community Treaty for SEE focusing on Energy Efficiency and Renewable Energy".

The project started in late October 2010 with an project office in Sarajevo and lasted over 2 years. DELTER members are very active throughout the country to implement the project equally in both B&H entities and District Brčko (4).

The partners in this project are the Ministry of Foreign Trade and Economic Relations (MoFTER) at State level, Ministry of Energy, Mining and Industry (MEMI) of Federation of B&H and the Ministry of Industry, Energy and Mining (MEED) of Republic of Srpska. Additionally, both Ministries of Spatial Planning of the entities are involved in the project. Each of them is providing significant contribution to make DELTER successful. The consultation company "Eptisa" from Spain has been engaged to support the project implementation.

Initial conditions and local situation

B&H is a country with very low energy efficiency awareness and a weak legal framework in this sector. The large amount of energy needed for $1,000 GDP alerts responsible authorities in B&H to start activities to tackle this situation. Most of obligations signed within the EU Energy Community Treaty for South East Europe have not been fulfilled yet, as there is no energy consumption data base, no liberated electricity tariffs implemented, and no plan for citizens, who need support after the subsidies stop. Furthermore, there is a lack of a proper energy efficiency framework and a strategy for investment implementation in the gas and electricity sector. Another barrier is the lack of a legal framework for the protection of gas suppliers and distributors, and the lack of a developed gas network.

Objectives and methods

The main goal of DELTER was to prepare future laws for the increase of energy efficiency in all types of buildings. One of the activities within DELTER has been to help in the preparation of materials for energy efficiency law. Both B&H entities have delegated representatives, together with experts from the DELTER project, in working groups in order to prepare a draft for the legal requirements. As a result, the final version of energy efficiency law was a combined effort of foreign experts and domestic representatives.

The goal of this activity was the preparation of a legal framework suitable for both B&H entities, taking into account all European requirements, moving B&H closer to obligations of the EU Energy Community Treaty for South East Europe. Information from these working materials will be used to present ideas in how to establish strategies for increasing the energy efficiency in B&H. According to the authors of the documentation, special attention should be paid to local communities.

The project consists of 4 components, which are:

1 Implementation of demonstration projects in the area of energy efficiency and preparation of two large feasibility studies in the area of energy efficiency and/or renewable energy;
2 Training and education of future experts in energy efficiency;
3 Public education about the topic of energy efficiency and renewable energy;
4 Elaboration of a legal framework in the area of energy efficiency and renewable energy (4).

Component 1 is the most practical part of this project. Nine demonstration projects throughout B&H, with equal distribution amongst the Entities, will show how energy efficiency can be put into practice.

Applications were received from 25 municipalities. Energy-saving potentials were examined by energy specialists and the projects were ranked based on energy efficiency, feasibility and environmental impact. A Selection Committee made the final selection of the projects (small demonstration projects), which will receive EU funding. In return, municipalities agreed to contribute in the form of installation and civil works.

Component 2 comprises training in the area of energy efficiency (EE) and renewable energy (RE) which is essential for target groups. The methods of training are in the process of being developed. An important part is appropriate training, which will be conducted throughout the lifespan of the project. The training of prospective experts will predominantly be addressed to municipal and cantonal staff of both B&H entities

Component 3 is a very important part of the DELTER project – public education and communication. While component 2 of this project is responsible to train people to have some skills and be able to transfer achieved knowledge further, component 3 of the project should have a broader impact on many target groups. The different target groups are:

- municipality representatives and other civil servants;
- media;
- teaching personnel at universities and high;
- schools;
- students;
- NGOs and other groups of the society;
- entrepreneurs;;
- general population of B&H.(4)

Due to very low awareness of energy efficiency DELTER pays special attention to the project component 4.

There will be many activities in future periods under this component. For example, regular information on DELTER development will be circulated, accompanying all DELTER components and report on the outcomes. A study tour with workshops and presentations for personnel in local and state authorities is organised to attract their attention and hopefullyinvolve them. The website established is supposed to be the main communication tool and herewith to become a platform containing different information on energy efficiency and renewable energy related mainly to B&H and the Western Balkan countries.

Realisation and outcomes

Besides training, public education and communication, DELTER is planning to implement nine small demonstration projects on energy efficiency in nine cities across B&H: Neum, Jajce, Tesanj, Zenica, Prnjavor, Trebinje, Zvornik, Visegrad and Brčko. These small projects will take place in municipal buildings such as administration buildings, schools, kinder gardens etc., and will mainly focus on windows replacement and energy efficient lighting.

Suitable candidate municipalities were selected based on eligibility criteria such as location (Federation of B&H or Republic of Srpska), size of population, and institutional capacity. In total 29 municipalities were invited to participate in close consultation with both B&H entity Ministries. These were distributed evenly from both entities and one from the District of Brč ko. DELTER finally received 25 applications fulfilling the criteria, 12 from FB&H, 12 from RS and one from the District of Brcko. DELTER representatives conducted energy audits of all 25 buildings proposed by the applicants.

Based on selection criteria such as location (FB&H or RS), energy savings, environmental impact, institutional capacities, and technical/economic feasibility, nine small energy efficiency demonstration projects were selected in close cooperation with both entities Ministries and one in the District of Brčko.

Detailed energy audits were conducted at all nine locations and DELTER prepared detailed designs and procurement documents for the nine projects.

Mayors from each beneficiary municipality and the EU Ambassador signed a Memorandum of Understanding specifying the conditions for participation and cooperation.

Tendering was performed by the EU Delegation in Sarajevo in an open tendering procedure. The deadline for tender submission and the date of tender opening was in May 2012. Besides technical assistance provided by the DELTER project, the EU Delegation in Bosnia and Herzegovina has, under a separate budget, allocated an additional €400,000 or small demonstration projects on energy efficiency, which has been distributed between the nine projects. The budget is only for technical equipment, and the beneficiaries will have to finance installation works at their own expense (5).

The most valuable aspect of this project is contribution to future laws in energy efficiency in both entities. The draft for this law is currently being prepared and is expected to be accepted by both Entities with only minor changes to the original draft. This law will create a legal framework for the financing of energy efficiency projects in the future, which is one of the most important issues.

Discussions with local authorities were carried out, and local communities recognized the need to adapt local laws in line with the national energy efficiency laws.

Results

The project has already achieved significant results with regard to increasing the public awareness of the importance of energy efficiency. The training sessions and seminars have emphasized the essential issue, which is the very low level of energy efficiency implemented to date in many sectors in Bosnia and Herzegovina. Special attention has been paid to building energy efficiency, and there have been suggestions and actions proposed to improve this situation. Nine small demonstration projects are about to reach their final phase in nine public buildings in different cities across Bosnia and Herzegovina. These demonstration projects should be good examples for local communities, demonstrating how to save energy and money, and offering further opportunities for similar projects in the sector of public building only.

DELTER has created strong communication within local communities and suggested some preliminary activities before the new energy efficiency law implemented. These include: monitoring of energy consumption of public buildings; engagement of one employee in each municipality to promote energy efficiency importance among local industry stakeholders; allocation of part of budget for energy efficiency projects and preparation of a priority list for energy efficiency projects.

4. CONCLUSIONS

Bosnia and Herzegovina is a region with very low energy efficiency in every sector. Public awareness is at a very low level. In order to follow regulations set by the EU in the energy sector, Bosnia and Herzegovina has started to make first steps by making energy efficiency improvements. Public education, training and demonstration projects have been implemented to initiate this process.

The DELTER project started in 2010 with the main goal to work on the preparation of future laws associated with energy efficiency. DELTER is also recognised as an important tool for local communities to improve public buildings as part of the energy efficiency project and to support further energy efficiency projects/plans in local communities.

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BULGARIA

AUTHORS

Elena Dimitrova
University of Architecture, Civil Engineering and Geodesy; 1, Hr. Smirnenski Blvd, 1046 Sofia
E: eldimfar@uacg.bg

Angel Burov
University of Architecture, Civil Engineering and Geodesy; 1, Hr. Smirnenski Blvd, 1046 Sofia
E: burov_far@uacg.bg

Kalinka Nakova
Municipal Energy Efficiency Network EcoEnergy
E: knakova@eneffect.bg

1 OVERVIEW OF THE REGION

Characteristics of the Region

Gabrovo Municipality, with an area of 555.57 km^2, and a population of 65,268 people (01/02/2011), is one of the 264 municipalities in Bulgaria, which are the main administrative units of local self-governance. It is the largest of four municipalities in Gabrovo District, located in the central part of the country[1] (*Figure 1*).

Figure 1 – Location of Gabrovo District in the North-Central Planning Region of Bulgaria

Gabrovo Municipality belongs in the North-Central Planning Region (NUTS2) of Bulgaria. Overall 134 settlements are located within the administrative boundaries of the municipality.

The municipality is located on the lower northern slopes of the Balkan range (*Figure 2*). Its altitude varies from 350 to 700m above the sea level.

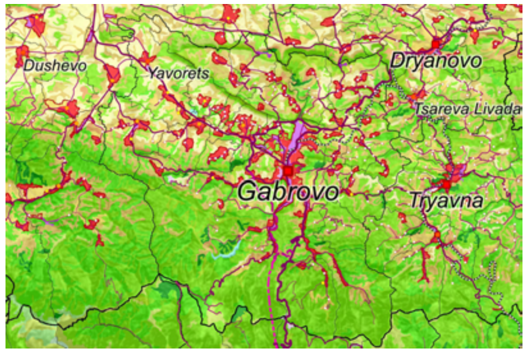

Figure 2 – Gabrovo municipality – administrative borders, transport and settlement network, and land cover. Based on CLC (EEA, 2012).

The region has a moderate continental climate, with prevailing winds from north and north-west and annual temperature range from -26^{0}C to +40^{0}C. According to the national bio-climatic ranking it belongs to a zone with predominantly comfortable climatic conditions. The snow cover lasts for about 120 days annually. The natural environment is estimated to be among the best preserved and non-polluted ones in the country (Gabrovo Municipality, 2008).

The area is one of abundant cultural heritage from the period of the National Revival when important economic but also educational and cultural development was focused there. The textile industry developed in the mid-19th century and contributed to the image of Gabrovo as 'Bulgarian Manchester'. Modern industrial development in the socialist period focused on textile, chemistry, machinery production, etc. Gabrovo is also famous as the 'Bulgarian Capital of Humour'.

The North-Central Planning Region has the second lowest GDP per capita in Bulgaria, €3,495 EUR in 2011, which compares to the mean national value being €5,240. These are among the lowest figures in the EU. Despite its currently low GDP per capita Gabrovo district has an employment rate of 45.2 % for 2012, compared to 46.6% for Bulgaria and 42.9% for the North-Central Region, and the lowest unemployment rate – 9.6% in 2012 (14.3% for North-Central Region and 12.3% for the country) (NSI, 2012). It is also among the 8 districts in the country reported in early 2013 to be of decreasing unemployment and increasing annual salaries, although at a slower pace than the average for the country (Aleksiev, 2013) .

Energy demand and supply

According to latest national reports for Bulgaria (NSI, 2014), the gross inland consumption in tons of oil equivalent in 2012 was 18,305,000 toe; with 11,321,000 primary energy production; and 6,799,000 net energy import. The energy intensity for 2012 was reported to be 0.671 goe/€1000. The share of electricity generated from renewable energy sources (RES) was 16.3%.

The country had the highest energy intensity in EU (four times higher than EU-27 average) with a lot of possibilities for savings across the whole economy and energy chain (EC Finding Mission, 2014). Transport had the largest share at 31.7% in the structure of final energy consumption by sectors in 2012, as illustrated in *Figure 3.*

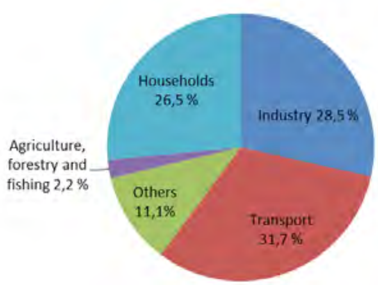

Figure 3 – Structure of final energy consumption in 2012,% by sector (NSI, 2014)

Petroleum products and electricity had a major contribution in the final energy consumption (*Figure 4*).

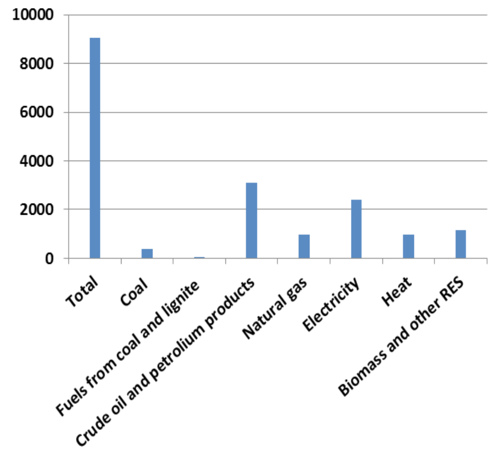

Figure 4 – Energy consumption (thousand tons of oil equivalent) by energy products in 2012 (NSI, 2014)

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The National Energy Strategy of Bulgaria until 2020 (2011) formulated the three major energy targets of the country: (i) increase of no more than 20% of national CO_2-equivalent emissions by 2020 compared to 1990; (ii) an 11% share of electricity produced from RES in the gross domestic consumption by 2010 (already reached in 2009); and (iii) a 16% share of final consumer energy from renewable energy sources (RES) by 2020.

Energy Efficiency (EE) issues are also among the targets of the practical implementation of National Strategic Reference Framework (NSRF) for the period 2007 – 2013 (EC, 2007). The NSFR was based on the national Regional Development Plan and the Operational Programme on Regional Development (OPRD) 2007 – 2013.

The Methodological Guidelines on Updating the Active Regional and Local Development Strategies and Plans, published by the Ministry of Regional Planning and Public Works (MRDPW, 2009), were meant to support the development of an integrated system for regional planning. The guidelines aimed at promoting an integral approach to regional and spatial planning and could be considered an effective instrument for integrating EE considerations at all the planning levels (Dimitrova & Nakova, 2012).

Two EC finding missions undertaken in 2013 estimated significant improvements in energy use in industry. The high share of RES (13.8% in 2010; 16% targeted for 2016) was considered a success. Yet, pending challenges of inefficient energy transformation and energy use in the residential, service and transport sectors were outlined. Slow modernisation of the district heating companies (resulting in high energy bills), the type of ownership (leading to patchy insulation of individual apartments) and inappropriate regulatory framework on prices were identified alongside a missing comprehensive energy policy, low consumer confidence, and ineffective protection of vulnerable consumers.

Recommendations were made for implementing a combination of short – and long-term reforms in the electricity, heat and gas sectors, and measures to spread burden equitably between all stakeholders. The major factors to be considered important to improve the national energy system performance included:

- the delayed and incomplete reform of the electricity sector;
- the hybrid model of the electricity market (regulated segments strongly dominating over freely negotiated ones);
- the retained central position of the state-owned energy company despite the partial privatisation of the generation assets and the distribution system;
- The current structural overcapacity of the system – partially because of shrinking consumption (EC finding mission, 2013).

Gabrovo District Plan for Energy Efficiency 2011 – 2020 (2010) strongly aims at increasing energy efficiency and at the development of renewable energy sources. As declared by the plan, this is to be achieved through:
(a) a decrease of energy consumption in state-owned buildings, (b) a better coordination and methodological support to the municipalities with regard to energy efficiency and renewable energy sources, and (c) promotion activities and measures in the field of energy efficiency and renewable energy sources. (Gabrovo District, 2010).

The SWOT analysis, on which the Plan was based, outlined important peculiarities of the process towards energy efficiency at the district level. Estimated *strengths* of the district are related to the already undertaken private initiatives, the availability of photovoltaic elements, the existing experience of the administration in energy efficiency projects, the good potential for solar and biomass-based energy production, and the Energy Efficiency Information Centre established and working in Gabrovo municipality. *Weaknesses* stem from outdated energy technologies, minor experience in the implementation of renewable energy, administrative barriers to building public-private partnerships, only partial refurbishment of state-owned and municipal buildings. It was acknowledged that only complex energy efficiency measures could result in meaningful social and economic effects. The lack of energy efficiency units and relevant experts in the district and municipal administrations was also considered an important weakness. Major *opportunities* are seen in the availability of EU funding support, the growing popularity of energy efficiency policy and the investment interest in the sector by Bulgarian and foreign companies.

Estimated *threats* comprise political instability, State policy failing to stimulate business development, bureaucratic national and EU administration; delayed decentralisation and restructuring of strategic sectors. Demographic collapse, the emigration of young people and the concentration of human and financial resources in the larger municipalities are also considered important threats to the successful implementation of the District Plan.

Based on the analysis results, an overall energy saving potential of 35,000 kW/h of the district until 2016 was defined and particular energy saving targets for public and private institutions were set.

Gabrovo municipality is one of the leading municipalities in Bulgaria for energy efficiency (EE) policy implementation. National and local capacity building in the country in the field of energy efficiency started in 1998 through a project named *Energy Efficiency Strategy to Mitigate GHG Emissions, Energy Efficiency*

Demonstration Zone in the city of Gabrovo, Republic of Bulgaria (1998 – 2004), and a funding grant of US $ 2.5 million by the Global Environmental Facility (GEF). The project was developed by the Centre for Energy Efficiency EnEffect[2] in active collaboration with the Ministry of Environment and Waters, the United Nations Development Programme (UNDP), the US Agency for International Development (USAID) and the Municipality of Gabrovo. It had two major components: (a) Local capacity building; and (b) Demonstration projects.

The main pillars of the project comprised the development of the Municipal energy efficiency network EcoEnergy, the establishment of municipal EE offices, appointment of energy efficiency managers and development of energy database, training local experts in community-level energy planning and management, streamlining communication mechanisms and information sharing among municipalities, identification of the barriers to efficient energy use and promoting adequate financing mechanisms for EE projects.

Demonstrations were targeted at the most energy-intensive sectors of the municipal economy – street lighting, district heating, and energy efficiency of buildings. Apart from the technical lessons learned and the direct economic benefits, the demonstration activities were part of building the overall municipal policy aimed at efficient use of energy resources. They mobilised public support for EE policy and stimulated important changes in public behaviour. A model for integrating public policies with investment activities was successfully tested (EnEffect, 2004). These efforts resulted in a broadly shared understanding at the municipal level in Gabrovo that energy efficiency should be part of the overall municipal policy.

Gabrovo municipality is truly ambitious about its own assets and works extensively through national and international networking. Many initiatives have been undertaken by the municipality in the last 17 years with the support of EcoEnergy network and international donor organisations, the pre-accession instruments of the EU and the EU funds available for the programming period 2007 – 2013[3]. Thus the municipal public authorities in partnership with the Technical University of Gabrovo, local experts and NGOs has implemented important innovations, being nation-wide pioneers in technical approaches, decision making, planning, capacity building and communication. Yet, the efforts had rather limited impact because of the enormous amount of investment needed for achieving a transition to overall energy efficient performance. The problem of availability and access to investment capital in energy efficiency has been a persistent barrier not only for the municipality but also for local business and households. Although both the Operational Programme on Regional Development 2007 – 2013 and the Operational Programme on Competitiveness 2007 – 2013 covered energy efficiency measures for public institutions, industrial plants and multifamily housing, often the principle of co-financing and the principle of providing the grant after the investment has been made was a considerable obstacle to applying for grants.

The municipality has been one of the 23 co-founders (in 1997) and is still a leading member of the Municipal energy efficiency network *EcoEnergy,* which unites the efforts of Bulgarian municipalities for achieving a better energy efficiency and finding solutions for important national tasks.

During the recent two decades Gabrovo municipality has repeatedly undertaken and successfully accomplished ambitious projects in the EE field. It has been a pilot municipality in numerous international projects, such as GEF/UNDP project on *Building the Local Capacity for Promoting Energy Efficiency in Private and Public Buildings* (2006 – 2010) (UNDP, 2010); and MODEL Project on energy management in municipalities within the *Intelligent Energy Europe* Programme (2007 – 2010). The MODEL project activities resulted in establishing a municipal Energy management unit, an Energy Programme and an Action Plan. *Annual Information Energy Days* were launched in the municipality. A number of events and information campaigns were also organised to promote energy efficiency. The MODEL Award 2008 was a recognition for the active commitment and achievements of the municipality.

Gabrovo municipality is an active participant in several EU funded projects on energy efficiency:

- the Covenant capaCITY Project, supporting the development of sustainable energy municipalities in Europe through capacity building and action plans implementation;
- the NET-COM Project, building national platforms for dialogue in support of the Covenant of Mayors
- passREg Project (Passive House Regions with Renewable Energy), aimed to trigger the successful implementation of Nearly Zero Energy Buildings (NZEBs);
- the EuroPHit Project, training in ‘step-by-step’ EE retrofitting of buildings.
- the MORE4NRG project, INTERREG IVC program, through which the solar energy production potential of Gabrovo district was assessed, based on existing database and photovoltaic GIS (PVGIS).

The completion of the *Sun* kindergarten to Passive House (PH) standards (developed with the support of EcoEnergy) was a key element of the overall policy of Gabrovo to promote energy efficient buildings and to keep a strong and visible focus on social issues (*Figure 5*).
The project concept was to attain energy class ‘A’ for net energy demand according to Bulgarian regulations while complying with the PH standards for provision of year-round comfort at minimum exploitation costs.

The *Mateevs* complex in *Etara* quarter in the city of Gabrovo (capacity of 26.81 kW; amount energy sold in 2010 – 11,907 kWh) is the largest photovoltaic system in the district and among the important private initiatives in implementing renewable energy sources (Gabrovo District Plan for EE 2011 – 2020).

Figure 5 – The Sun kindergarten in Gabrovo - the first passive public building in the country: (source: Passive House Buildings, 2013)

3. CASE STUDY: THE INTEGRATED PLAN FOR URBAN REGENERATION AND DEVELOPMENT OF GABROVO

Despite the considerable experience accumulated by Gabrovo Municipality in approaching energy efficiency issues through sector plans, integrating energy efficiency aspects in an urban plan for the whole city was a new type of activity to undertake. There was no such previous experience elsewhere in the country either. Such an EE-sensitive urban planning was undertaken within the recently developed and already enacted Integrated Plan for Urban Regeneration and Development (IPURD) for Gabrovo, the administrative centre of the municipality, a city with an area of 1,878 ha and population of 58,367.[4]

IPURDs are classified as medium-term documents developed in accordance with the long-term strategic documents – the general development plans, in order to support the EC funding policy in Bulgaria. The plans aim at identifying urban areas that are lagging behind or have specific potential. They should define necessary strategic interventions and practical action – implementation programs with sets of projects envisaged to have synergistic effects, which could be funded under various operational programmes or by other sources. Systems of indicators concerning the positive change with regard to impacts on the regional and local development and particular practical results are on the part of monitoring and evaluation. The expected IPURD influence on the development of the major urban city centres up to 2020 stems from the requirement that any further funding of urban development projects under EU Structural and Cohesion Funds in the period 2014 – 2020 should be in line with the enacted integrated plans.

The IPURD elaboration for 36 Bulgarian municipal and agglomeration centres was funded by the European Regional Development Fund (ERDF) through the Operational Programme for regional development.
The contracts signed in June 2011 between the Ministry of Regional Development and Public Works, in its capacity of a managing authority of the Operational Programme, and the Mayors

of 36 municipalities in the country, provided an overall funding of 21.2 million (about €10.5 million,) under the *Support for Integrated Plans for Urban Regeneration and Development scheme* (BG161PO001/1.4-07/2010). The city of Gabrovo project (BG161PO001/1.4-07/2010/031-02) was registered in the national management and monitoring information system as BG161PO001-1.4.07-0030-C0001.

The Methodological Guidelines on IPURD development, published by the Ministry of Regional Development and Public Works (MRDPW) in 2010, were to frame and unify the process by defining the steps of a holistic approach and the minimum of required procedures in the development and approval of integrated plans – including analyses, evaluation criteria, strategic aspects, implementation programmes for the intervention zones, feasibility studies, public participation, etc. The aim was to increase the overall urban planning efficiency at the local level and to provide for synergy through the spatial and temporal coordination of policies, resources and actors. Up to three intervention zones had to be defined in each of the municipal centres – at least one zone with prevailing social character, and also zones with economic development potential and with public functions of high general importance to the city. Among the priorities to be achieved (economic development, social integration, environmental protection and risk prevention, high quality urban environment, accessibility and self-governance), energy efficiency was mentioned mainly with regard to environmental protection measures. The EE aspects to be explicitly addressed by the plans concerned buildings with poor energy efficiency in the zones with prevailing social character and with public functions of general importance to the city.

The Municipal Council of Gabrovo approved the requested three intervention zones for the IPURD to address. The zones cover more than 60% of the city area (*Figure 6*).

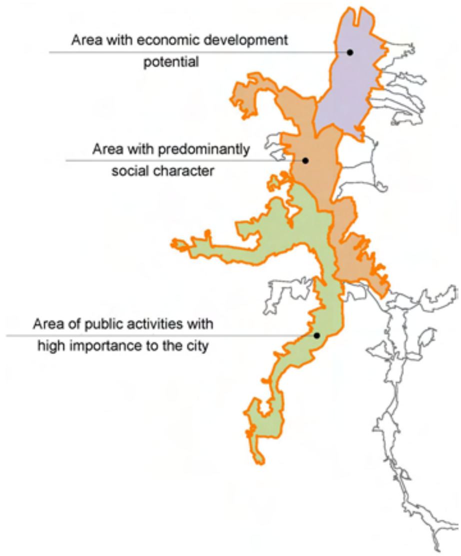

Figure 6 – The three intervention zones defined by the IPURD of Gabrovo (Gabrovo Municipality& Urban Vision, 2013)

The large number of actors involved in the IPURD elaboration and implementation responded to the complexity and scale of the urban processes addressed by the plan:

- a Management Team (the chief architect of the municipality and two experts in project management) and a Workgroup (the deputy mayors, the chief architect of the municipality, the Heads of the specialised departments at the municipality, technical experts);
- the *Urban Vision* Consultancy Consortium - built by three companies, specialised in (i) urban planning and legislation, (ii) statistics and econometrics, and (iii) spatial data and geodesy. The multidisciplinary team covered many specific fields related to planning and design, governance and development, infrastructure and environment;
- managers, experts and civil servants from the state agencies at the regional and district level, the municipal administration, municipal and utility companies;
- the Technical University Gabrovo;
- professional and sector business organisations;
- non-governmental networks and local non-governmental organisations, civil activists;
- the political parties represented in the Municipal Council.

The Management team and the Work group were responsible for guiding and supporting the process of preparation and approval of the plan, and for communicating with the consultancies and the general public. The Consultancy consortium had to develop the structure and content of the document and to lead the process towards a broad agreement on the vision, priorities and specific interventions as part of the public procurement for the services included in the IPURD preparation. The municipal managers and experts took part in various phases associated with their responsibilities and tasks. The representatives of the business, civic, educational and political organisations took part in two public hearings, three thematic round tables, focus groups, communication events, interviews and field study visits.

The stakeholders to be involved in the plan implementation are all those who took part in its preparation plan and many more who would undertake interventions at various sites in the city. The main target groups and beneficiaries in the intervention zones included most of the city residents, and many users of public services, facilities and spaces from the municipality, the district, and the region, as well as visitors from the country and abroad.

Gabrovo Plan was developed with the presumption that considerable potential could be mobilised for a more comprehensive approach to estimated energy efficiency challenges. Possible EE-sensitive urban interventions were taken into consideration. Appropriate conditions for overcoming key constraints and practical steps to guide the transition in the supply and demand models were envisaged. Relevant energy efficiency measures and the implementation of renewable energy sources were recommended where appropriate in the intervention zones.

The stakeholders directly involved in the initiatives and projects contributing to greater energy efficiency, were the managers of public institutions and facilities, utility companies and operators, etc. Potential public-private partnerships in designing, building and operating of various business and public assets or in providing public services were also envisaged by the plan. Their potential involvement aimed at building smart energy networks, organising small-scale co-generation facilities and retrofitting or providing new buildings with excellent energy performance.

Energy management issues that were considered particularly important at the regional and local level comprised:

- supply – the privately owned power generation plants (district heating in particular) working in a non-competitive environment of protectionism or with ineffective control and sanctions for low environmental performance;
- distribution – the established regional monopolism (the only concessioner company in the region applying non-transparent criteria for grid access, thus hampering community planning efforts);
- demand – the shrinking population of the municipality (resulting in a growing share of uninhabited flats and single-family houses); the fragmented EE measures by individual households to insulate their apartments (resulting in the ‘patchy’ view of the facades); the outdated rolling stock of the urban and suburban public transport services, which had stimulated a growing motorisation rate and high share of private car trips.

Some of the industrial enterprises in the region had implemented energy saving measures and invested in technological modernisation, including highly efficient co-generation facilities through available EU funding.

Objectives and methods

Four main goals were outlined in the strategic part of the integrated plan:

i. guaranteeing access to environment, services and opportunities for a life of full value and dignity;
ii. effective use of resources contributing to the mitigation and adaptation to climate change;
iii. introducing technological, social and governance innovations at the urban level to provide new opportunities;
iv. encouraging citizens’ and business activity for the development of civil society in Gabrovo.

The specific EE-related objectives addressed under the second main goal comprise:

- large-scale implementation of energy efficiency measures, encouragement for using renewable energy sources and for reasonable energy savings;
- flexible public infrastructure that would effectively meet all the local needs;
- clearance and/or conversion of non-functioning buildings and sites;
- risk prevention with regard to natural disasters and climatic extremes.

A number of horizontal projects were proposed to interconnect the four main goals (*Figure 7*). These include the development of systems for monitoring and evaluation of the material and energy flows associated with the implementation of the projects envisaged by the Plan (the *Urban Metabolism* horizontal project) and the evaluation of their water, carbon and general ecological footprint (the *Green City* horizontal project).

Connecting households to decentralised and smart energy production and distribution networks was considered appropriate in more than 40 small localities all over the intervention zones (the Energy Nearby model project) and within the Gabrovo Gas project.

Figure 7 – Extract, Program for Horizontal projects (Gabrovo Municipality & Urban Vision, 2013)

Improved access to a more energy efficient built environment with basic social goods (safer public open spaces with energy efficient lighting; more efficient water, sewage, heating and gas provision infrastructure) is envisaged through 4 groups of rehabilitation projects (*People and Streets, Life-giving Water, the Town's Gardens, The Heart of the Neighbourhood*) in all the intervention zones (*Figure 8*).

Guaranteeing the thermal comfort in multi-family residential houses and public facilities is the main focus of ten project groups (Renovation of Homes, Cultural Edifices, The Municipal Centre, Efficient Institutions, My Favourite School, Contemporary Education, Sporting Gabrovo, Home for Everybody, Fairy Childhood, Healthy Community).
The step-by-step implementation of these projects until 2020 is expected to provide energy efficiency measures and renewable energy sources to 50 pre-fabricated panel blocks of flats and to 50 municipal and state-owned buildings.

Transport infrastructure and services demotivating car use and providing improved urban mobility are the focus of two projects - *Mobile Town and Pedelec (e-bikes)*.
Six groups of co-working and retrofitting oriented projects (Brownfields, Global Gabrovo, Flexible Business, Dispersed Tech-Park, Labour is a Song, Added Value) were planned in the intervention zone with economic development potential and in the one with public functions of high general importance.

Figure 8 – Extract, Program for the intervention zone with prevailing social character (Gabrovo Municipality & Urban Vision, 2013)

Expected social benefits from the focus on the energy perspective stem from providing the city households with effective know-how in the field of domestic resource and energy efficiency and independence, sustainable lifestyles and behavioural patterns (the Neighbourhood Steward Partnership project in the intervention zone with prevailing social character). The envisaged positive economic benefits are related to the incentives and opportunities available through EU funding for energy and cost savings by households, companies and public institutions. The positive environmental outcomes are expected to result from the ubiquitous energy efficiency measures and the use of alternative (renewable) energy sources. These are expected to decrease both energy demand and input in production, and the final energy consumption at the city level, also resulting in lower GHG emissions.

The plan aims at guaranteeing the continuity of action and the integrity of EE-aimed approaches for all the numerous interventions to be undertaken in the city. It provides an open framework to accommodate conventional measures in parallel with possible future innovations in urban planning and management, monitoring and evaluation, construction and maintenance, mobility, etc. The IPURD is sensitive to system interactions and provides for effective information management, communicating benefits and learning by doing. The methods applied in developing the plan comprise content analysis of official documents, field studies, empirical descriptions and expert assessments, factor and indicator analysis, multi-criteria assessment, scenario approach.

The Integrated Plan was officially adopted by the Municipal Council on June 20, 2013, and its implementation challenges are still ahead. Expected barriers are related to unsolved problems with energy distribution at the national level and the lack of continuity in energy policy implementation due to strong external and internal pressures. There is also a general lack of confidence in the effectiveness of long-term measures due to considerable political uncertainty, the contested energy market, the demographic decline and the on-going impoverishment of large social groups.

The potential investments anticipated by the IPURD of Gabrovo through its 74 projects are about €160 million. Considerable influence is therefore possible through the plan in support of smart energy solutions in future urban development.

The strong focus of Gabrovo plan on EE considerations and innovative smart energy approaches was due to the matching understanding of the municipality and the expert consortium about the major importance of the energy aspects for development.
The previous experience of the municipality in the EE field contributed for building confidence in all stakeholders about the policy relevance.

The plan was also an important practical step in applying an innovative approach to the overall urban planning process in the country. The experience gained in Gabrovo could be effectively transferred to other municipalities in the country within the ongoing process of IPURD elaboration for other municipalities.
The important drivers for positive change in the field comprise:

- the overall EU policy and particular documents on energy efficiency and RES, providing a consistent framework to work towards the national targets in the field;
- the growing awareness at the national level about the importance of integrating action aimed at higher EE into regional development and spatial planning documents;
- the proactive attitude and innovative thinking of a growing number of local and regional actors – municipalities and municipal networks, NGOs, business organisations.
- the systematic interactions becoming more visible and influential at both the national level (through the National municipal energy network EcoEnergy) and the European level (the Covenant of Mayors).

4. CONCLUSIONS

Spatial planning policy in Bulgaria tries nowadays to establish the background for a greater sensitivity to energy efficiency aspects in urban development, which has to be further focused upon and supported at the national level. The elaboration of the Integrated Plan for Urban Regeneration and Development (IPURD) of the city of Gabrovo illustrates an effective effort for integrating EE considerations and for developing smart energy solutions at the urban planning level.

The IPURD elaboration also outlined the difficulties staying ahead in the process due to the lack or insufficiency of relevant database and of more explicit requirements for EE monitoring and assessment in the planning process. The ongoing process of IPURD development throughout other cities and towns in the country could be a good chance for transfer of the innovative practice of Gabrovo to other Bulgarian municipalities – yet only if the knowledge and skills for implementing the methodological approach are timely and convincingly disseminated.

The process needs holistic and strategic thinking and a much higher level of interdisciplinary expert support. Despite the growing awareness, the broadening policy framework and the increasing institutional capacity at all levels, there is still a gap to overcome – the minor sensitivity of urban planning to energy losses and the lack of effective interdisciplinary approaches to promote energy efficiency as a key factor at the urban level. Further consistent monitoring of urban processes and analyses of changes during the plan implementation period would provide for the capacity-building to enable the development of context-specific smart energy approaches in the urban planning field.

FOOTNOTES

1. The 28 districts ('oblast' in Bulgarian language) are the administrative divisions of the national government, also corresponding to level 3 of EU hierarchical system for socio-economic analysis NUTS (Nomenclature of Territorial Units for Statistics).
2. EnEffect is a non-profit expert NGO working in the field of energy management.
3. Especially the European Regional Development Fund (ERDF) through the Operational Programme for Regional Development (OPRD), 2007 – 2013.
4. The reported shrinking rate of the city is 12.1%. (MLSP, 2011).

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CYPRUS

AUTHORS

Dr.-Ing. Paris A. Fokaides
Frederick University eng.fp@frederick.ac.cy
School of Engineering and Applied Sciences
7, Y. Frederickou Str.,
Nicosia 1036, Cyprus

Angeliki Kylili
Frederick Research Center
res.ka@frederick.ac.cy

1 OVERVIEW OF THE REGION

Characteristics of the Region
Cyprus is the third largest Mediterranean island with a surface area of 9,251 square kilometres. It lies in the north-eastern corner of the Mediterranean Sea, approximately centred on latitude 35° N and longitude 33° E.
The population of the Republic of Cyprus is 952,100 (2012) of whom 681,000 belong to the Greek Cypriot community (71.5%); 90; 100 (9.5%) to the Turkish Cypriot community (estimate) and 181.000 (19.0%) are foreign citizens residing in Cyprus (Statistical Service of the Republic of Cyprus, 2012a).

Cyprus is an independent sovereign Republic with a presidential system of government. The President, who is both the Head of State and Government and of a multi-party system, is elected by universal suffrage for a five-year term of office. Executive and legislative power is exercised through a Council of Ministers appointed by the President, who has the right of final veto on decisions of the Council of Ministers and laws or decisions of the House of Representatives concerning foreign affairs, defence or security. The Judiciary is independent of the executive and the legislature.

Cyprus has been a divided island since 1974. Currently the Government of the Republic of Cyprus controls only of the southern part of Cyprus, while the Turkish Republic of Northern Cyprus that is only officially recognised by Turkey, has control of the northern part of Cyprus. The Government of the Republic of Cyprus is the sole internationally recognised authority on the island though in reality its power extends only to the southern part of Cyprus (Aspects of Cyprus website, 2013).

Cyprus is divided into six districts; Nicosia, Larnaca, Limassol, Famagusta, Paphos, and Kerynia, of which each has its own municipalities and communities. However, the central Government is the sole administrator of executive and legislative power, which finances the municipalities and communities for the implementation of tasks.

The economy of Cyprus can generally be characterised as small, open and free market, with services constituting its engine power. In fact the services sector is the fastest growing area and accounts for about 81% of GDP. During the past 30 years, Cyprus has exhibited rising living standards and the GDP per capita of the country has reached €20,500. It is ranked 23rd in the world in terms of Quality of life Index (Countryeconomy.com website, 2013; Economist Intelligence Unit, 2005). This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period from the Republic of Cyprus establishment in 1960 up to the Turkish invasion in 1974, to an exporter of manufactured goods from the latter part of the 1970s up to the early 1980s, to the current international tourist, business and services centre since the 1980s.

However, the international economic recession has seen the Cyprus economy contract since 2009. The recession primarily affected the construction, real estate and tourism sectors, while the employment rate as a percentage of the population of ages 20 – 64 dropped to 67.4% from 70.9% in 2008 (Statistical Service of the Republic of Cyprus. 2012b).

Energy demand and supply of the Region
Cyprus has no indigenous hydrocarbons nor is interconnected with other energy networks (oil, natural gas or electricity). Consequently,

the country's small energy system operates in isolation and heavily relies on imported fuels for electricity generation (Fokaides and Kylili, 2014). In 2010, the final energy consumption and the electricity consumption have reached 1,909 ktoe and 4,881 GWh respectively (CIE, 2012; CERA, 2011). This observable increase can be attributed to the major increase of electricity consumption and also to the increase in road transport fuels for private vehicles, since public transport is not well developed in Cyprus and there are no trains. The shares in the energy balance of 2010 are: transport 56%; of which 15% for aviation and 41% for road transport; 17% households; 12% services; 13% industry; 2% agriculture; and are shown in *Figure 1* (CIE, 2012).

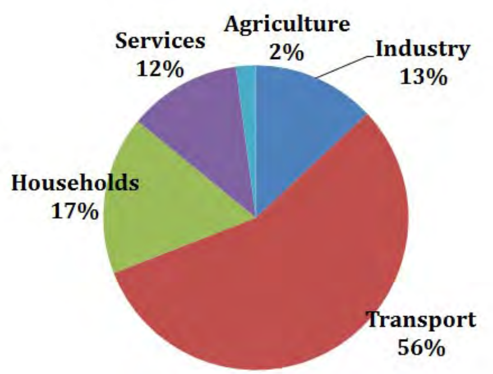

Figure 1 – Energy consumption per sector of Cyprus in 2010

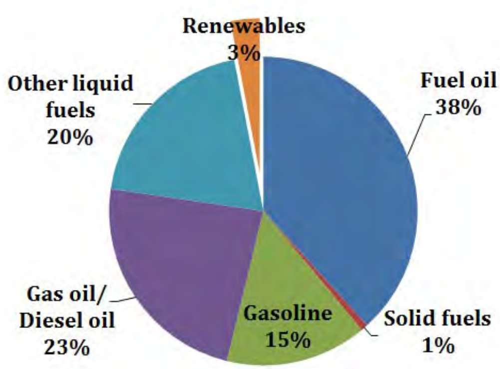

Figure – 2 Energy consumption per fuel of Cyprus in 2010

While there are currently no deposits of fossil fuels to be found on the island the dominant energy source of final consumers is imported oil. The country's energy needs, totalling to 2685 ktoe, are satisfied primarily through fuel oil (38%), gas and diesel oil (20%), gasoline (15%) and other solid and liquid fuels (21%). The contribution of renewable energy sources (RES) to the overall energy consumption still remains at very low levels (3%) (*Figure 2*).

The electricity production in Cyprus reached 5,272.365 MWh in 2010 (CERA, 2011). Currently, the country's electricity generation relies on imported heavy fuel oil (HFO) and gasoil. Cyprus power generation system consists of three thermal power stations at Moni, Dhekelia, and Vasilikos, with a total installed capacity of 1438M We (prior to the Mari naval base explosion in July 2011 that destroyed 60% of the island's power generating capacity (Zachariadis and Poullikkas, 2012) that generate 5,204.897 MWh, or the 98.7% of the total electricity production (Fokaides and Kylili, 2014).

Steam units at Vasilikos are used for base load generation, while the steam units of Dhekelia are used for base and intermediate load generation. The steam units at Moni as well as the gas turbines are mainly used during system peak loading. All stations use HFO for the steam turbine units and gasoil for the gas turbine units.

Exploration, research and exploitation of hydrocarbons in the Exclusive Economic Zone (EEZ) of Cyprus have shown significant reserves of natural gas. The Government and foreign energy institutes estimate that there may be up to 200 trillion cubic feet (tcf) or (5,67 trillion cubic meters) of natural gas recoverable in the Cyprus EEZ (CIT, 2012). Thus the combined cycle units will use gasoil as fuel for their first few years of their operation until the arrival of natural gas in Cyprus, which is expected to be available on the island in 2015. All three power stations are owned and operated by the Electricity Authority of Cyprus (EAC) which currently is the sole producer of electricity from conventional fuel on the island.

Regarding the share of RES in electrical energy generation, it amounted to 62,958 MWh or 1.2% of the total electricity production in 2010. The same year wind parks generated 33,286 MWh, while 647 small rooftop PV systems and PV parks generated another 4,840 MWh. The total production of electricity from biomass / biogas fed into the grid in 2010 amounted to 24,802 MWh. Despite the very low penetration level of RES in Cyprus, a large amount of licenses have been recently granted by CERA pertaining to electricity generation from wind parks, PV parks and, to a smaller extent, biomass plants.

The generating system efficiency in Cyprus, based on the total units generated by the EAC's three power stations, reached only the 36.1% in 2010 (EAC, 2011), so that the GHG emission factor for electricity from grid is calculated at 0.8 kgCO_2eq/kWh. The assumption for this calculation takes into consideration the end to primary energy conversion factor of HFO, 2.7. (Infotrend Innovations/BRE – MCIT, 2009). The primary energy is considered to include the delivered non-renewable fossil-fuelled energy plus an allowance for the energy "overhead" incurred in extracting, processing, and transporting a fuel or other energy carrier to the building. Hence, the primary energy factors denote kWh of primary non-renewable fossil fuelled energy per kWh of the building's delivered energy.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Through its energy related legislation and policies, the European Union (EU) is not only targeting to contribute to the global effort to tackle climate change, but also aspires to offer its Member States a more secure, competitive and affordable energy supply that is less vulnerable with regard to the global fuel market. The EU also promotes technological development and innovation, as well as economic growth. As a result the EU has set a number of challenging goals to be achieved by 2020 under the Directive 2009/28/EC on renewable energy, also known as the '20/20/20 goals'. These include:

- raising the share of EU energy consumption produced from renewable resources to 20%;
- a 20% improvement in the EU's energy efficiency;
- a 20% reduction in EU greenhouse gas emissions from 1990 levels.

Like any other of the EU Member States, Cyprus has also adopted these stringent targets and integrated them into its own legislation. In particular the National Renewable Energy Action Plan (NAP) of Cyprus sets out the Governments roadmap for fulfilling the legal obligation towards the EU policies. The NAP aims to install 192MW of solar PVs, 75MW of concentrated solar power, 300MW of wind turbines and 17MW of biomass by 2020 (The Republic of Cyprus – MCIT, 2010). The binding targets for Cyprus for the 2020 milestone relating to the energy demand and supply in buildings and mobility include:

- achieving at least a 13% share of the RES contribution to the final use of energy;
- achieving at least a 10% share of RES contribution to the road transport consumption.

The policies and measures that have been adopted to facilitate the achievement of the above mentioned targets are:

- mandatory solar system installation to satisfy the Domestic Hot Water requirements on every new residential building, according to the Technical Guide of Solar Systems and according to the terms of the competent Building Authority;
- installation of provisions for use of power generation systems using RES on every new building. Installation of these provisions must be in consultation with the electricity supplier and must include;
- Installation of larger electricity meter boxes in the building in order to provide additional available space for installation of the RES system meter;
- Installation of the appropriate conduit starting from the meter box and ending at the possible future RES system installation location;
- The revision of legislation on the energy performance of buildings and the Action Plan for buildings with almost zero energy consumption are expected to introduce obligations for the minimum quantity of energy from RES on all new buildings;
- Subsidies, tax decreases and reduced

circulation fees to Hybrid Vehicles, Fuel Flexible Vehicle (FFV)/ Dual Propulsion Vehicles, Electric Vehicle, and low carbon emission vehicles (≤120 g CO_2/km);
- discounts in the registration tax and circulation fees for vehicles other than gas or petrol driven vehicles and dual propulsion vehicles;
- obligation of the conventional fuel suppliers to mix in biofuels so that the average annual energy content of biogas in conventional fuel amounts to at least 2% of the total energy content of conventional fuel placed in the market.

Additional broader measures taken to increase the national energy security and the RES utilisation for electricity generation include:
- the diversification of energy sources through implementation of the strategic goal for introduction of natural gas into the country's energy mix;
- increasing the country's energy self-sufficiency and strengthening of its geostrategic role in the greater area through the development of research actions related to the island's fossil fuel energy potential;
- the maximisation of efficient utilisation of renewable energy sources aiming to replace energy from imported sources;
- energy saving both in the primary form and its final use;
- ensuring sufficient electric power supply potential;
- the development of the country's self sufficiency in relation to the import of primary fuels by maintaining sufficient security stocks;
- the adoption of an ambitious plan to install 192MW of solar PVs, 75MW of concentrated solar power, 300MW of wind turbines and 17MW of biomass by 2020;
- the adoption of a number of regulatory measures for the promotion and regulation of RES electricity generation;
- establishment of a number of organisations, including the Cyprus Institute of Energy, the Special Fund, the Cyprus Energy Agency, the Cyprus Regulatory Authority (CERA), and the Cyprus Transmission System Operator;
- the obligation of the Electricity Authority of Cyprus (EAC) to purchase RES generated electricity;
- the determination of the areas where RES development is allowed;
- the definition of clear terms for connection of photovoltaic systems, electricity generation systems using biomass and other RES systems with the grid;
- adoption of the Law on the Promotion of Combined Heat and Power and the prioritisation to energy produced with combined RES power generation from the Transmission System Operator;
- simplification and acceleration of the RES licensing procedures through the adoption of principles such as the "One Stop Shop";
- the organisation of information campaigns, day events, seminars and expositions on the developments in RES technologies;
- the adoption of a number of financial measures for the promotion and regulation of RES electricity generation;
- support Scheme Plans;
- the facilitation of small scale RES developments through reduced application charges and faster, non-dissuasive supporting procedures for licensing;
- reduced fees for connection of RES plants with the grid.

The EU commitment towards the Kyoto Protocol for a reduction of the GHGs to at least 80% below the benchmark 1990 levels by 2050 is the driving force of the its energy strategy. While the current total GHG emissions of Cyprus stand at 9,154 thousands of tonnes of CO_2 equivalent, the NAP outlines for the achievement of at least 5% reduction of GHG emissions from 2005 (9,311 ktCO_2eq) by 2020, for categories outside the scope of the Greenhouse Gas Emission Allowance Trading Scheme.

Other Regional targets, barriers and drivers
An additional target regarding the built environment set by the EU to its Member States is outlined in the Directive 2006/32/EC on energy end-use efficiency and energy services, applicable since 2006. The directive aims to achieve 9% overall energy savings until the ninth year of its application through energy services and other energy efficiency improvement measures.

The promotion of RES utilisation, as well as energy consumption minimisation efforts are not only driven by the national policy obligations. Additional drivers include the RES market development and competiveness, the technological advancements of the energy-related field such as smart grids, the thrust of the local research foundations for the development of this field, as well as the interest of engineers and architects to transform the building sector into a more environment friendly one.

The observable slow pace of the transformation of the built environment and RES development in Cyprus can be attributed to a number of barriers:

- the bureaucracy conditions that prevail in the country make the licensing procedures for RES projects very slow;
- the conflict of the developers and investors to keep their personal earnings high;
- the technology immaturity and the associated high costs of the technologies;
- the lack of know-how and public awareness of the technologies and the energy related measures.

Among the aspirations of Cyprus is large scale application of net metering. A pilot net metering program has been applied since 2012 to selected governmental buildings and a few communities. The target of the program is to gain significant experience and know-how on the net metering for its application to the whole country. Also the Cyprus Energy Agency has developed and put in operation Sustainable Energy Action Plans for 14 municipalities and communities that include proposed measures regarding the energy savings, RES utilisation and carbon emissions reductions of the built environment, as well as the increase of the public and the private sector's awareness concerning these aspects.

Regarding the co-generation of heat and electricity and the efficient usage of heat, no policies or measures have been adopted. This is primarily due to the fact that the climate of Cyprus consists of hot summers and mild winters, leading to reduced total heating demands.

Additionally, the reduced size of the cities and the country itself does not encourage the development of mass transport communication systems. However, the municipality of Nicosia has identified the benefits of the development of a mass transport system and is currently making efforts for the establishment of rail lines in Cyprus.

3. CASE STUDY: ENERGY UPGRADING OF THE REFUGEE SETTLEMENTS

The case study to be presented involves the upgrading of the refugee settlement in Yeri to a smart energy region. The settlement is located at 35° 6'9.53"N latitude and 33°24'54.07"E longitude and covers an area of 2km^2 (*Figure 3*). Yeri is located 10 km south east of the capital Nicosia. The population of Yeri before 1974 and the displacement of 200,000 Greek-Cypriots from the northern to the southern part of Cyprus, was only a few hundreds. In an effort to house the displaced families, the Government of Cyprus developed refugee settlements in several municipalities and communities in the southern part of Cyprus, among of which was Yeri. Consequently, by 1982, Yeri's population reached 2,500 and by the 2011 census it had a total population of around 6500 (Wikipedia, 2013).

Figure 3 – Location of the refugee settlement in Yeri

The following aspects will be quantified by means of specific scenarios, and the impact of the implementation of these activities will be examined:

- energy upgrade of the buildings' envelope;
- enhancing the energy efficiency on the demand side;
- raising of the awareness of the residents towards reducing energy consumption;

- reduction of fossil fuel use and CO_2 emissions aiming to the utilisation of renewable energy technologies;
- promotion of smart grids and rationalisation of energy management practice;
- promotion of green transportation.

The expected outcomes target the social, economic, environmental, and technical upgrading of the region, and are given below:
- reduction of GHG emissions through the promotion of low carbon practices;
- economic upgrading through achieving cost savings;
- technical upgrading for improving the primary energy factors of the community's energy system.

The measures to be applied to the case study for the achievement of the main objective regarding the energy performance upgrading of the refugee settlement in Yeri to a smart energy region are the following:
- improvements of the building envelopes and thermal bridges to achieve reduced heat losses/ gains;
- employment of more energy and cost efficient systems, appliances, equipment, and other building services to achieve reduced energy consumption;
- employment of solar thermal for domestic hot water; and/or biomass boiler for domestic heating and/or a 7 kW PV installation to provide electricity for increase the share of renewables generating energy.

The methodology employed in the case study considers the evolution of the buildings in Yeri, considering energy consumption, through a number of scenarios. Also, the upgrading of the settlement's buildings is based on a theoretical model and was implemented using the Simplified Building Energy Model (SBEM) software (Infotrend Innovations/BRE – MCIT, 2009).

Background and current conditions

The municipality of Yeri and the residents of the refugee settlement are the key stakeholders for the realisation of the energy upgrading of the dwellings within the settlement to smart energy buildings. The local authorities are responsible not only for the initiation of this action, but also for its promotion and transfer of knowledge and awareness amongst the members of the settlement. The Town Planning Authority is another main stakeholder of this study case. The Town Planning Authority is directly involved with the urban and spatial planning, while the Housing Section of the department undertakes the planning, design and management of public housing, almost exclusively serving displaced refugees. Other stakeholders involved include the Energy Service and the Electricity Authority of Cyprus (EAC). The Energy Service is responsible for monitoring and coordinating the supply and availability of sufficient energy capacity for domestic needs, the preparation and implementation of programmes promoting energy conservation and utilisation of RES according to the European Policy, as well as the development of the national policies and guidelines regarding energy issues. The EAC is the major generator and distributor of power of Cyprus, and therefore is directly involved with this case study regarding the infrastructure of power delivery for domestic purposes.

The dwellings of the refugee settlement in Yeri have been built according to the standards of construction of the 1970's. According to Fokaides et al. (2011), the building stock of the settlement presents the following characteristics:
- the average building area per habitant in Cyprus is 52.3 m^2;
- the primary energy consumption of dwellings per total area is 200 kWh/m^2year;
- the wall average overall heat transfer coefficient (U Value) is 1.51 W/m^2K;
- the exposed roof average U Value is 3.3 W/m^2K;
- the glazed surfaces average U Value is 3.9 W/m^2K.

The primary energy consumption of dwellings is mainly attributed to heating ventilation and air-conditioning (HVAC) systems, lighting, and other building services. The two dominant heating systems used in Cyprus are the heating oil boiler and air conditioning. The heating boilers have an average efficiency of 80%. Whereas A/Cs average coefficient of performance (COP) equals to 2. It is also worth mentioning that the cooling demands exceed the heating demands due to the local climatic conditions of the island. Particularly in Cyprus cooling degree days (CDD) sum up to 2000 days per year whereas heating degree days (HDD) are less than 1000. Additionally the lighting needs of the dwellings are typically satisfied by incandescent light bulbs, while solar heaters provide domestic hot water (DHW) to the dwelling.

The residents of the settlement typically move outside of the borders of the community on a daily basis for their everyday activities, such as occupation, shopping etc.. The Yeri community does not host any significant business activities.

For this reason in terms of the case study, the aspect of transportation was not considered, as transport activities are rather limited within the boundaries of the community.

Case study scenarios

The business as usual scenario (BAU) assumes the adoption of all the provisions given in the Energy Performance of Buildings Directive (EPBD) 2002/91/EC by the dwellings of the settlement. Using a matrix of scenarios the effect of different development paths for the building stock were investigated. The matrix was based on two variables, namely the potential consumption of a building and the potential contribution of on-site renewable energy technologies. Regarding the first variable, the three possible cases that were examined were:

1. Consumption of buildings in 2020 at the same levels as the typical levels in the BAU scenario, but considering the end to primary energy conversion factor to be 2.27 (SC1);
2. Consumption reduced by 10% compared to SC1 (SC2);

Table 1 – Investigated scenarios considering the energy consumption and the RET penetration in Cyprus by 2020

	Table 1 Energy Consumption scenarios			
		SC1: 2020 dwelling energy consumption same as typical buildings	SC2: 2020 dwelling energy consumption reduced by 10% compared to SC1	SC3: 2020 dwelling energy consumption reduced by 20% compared to SC1
Renewable penetration scenarios	RET1: Use of solar thermal for domestic hot water	SC1-RET1	SC2-RET1	SC3-RET1
	RET2: Use of solar thermal for domestic hot water and biomass boiler for domestic heating	SC1-RET2	SC2-RET2	SC3-RET2
	RET3: Use of solar thermal for domestic hot water, biomass boiler for domestic heating and a 7 kW PV installation for electricity	SC1-RET3	SC2-RET3	SC3-RET3

3. Consumption reduced by 20% compared to SC1 due to more stringent minimum requirements regarding the thermal performance of buildings (SC3).

Regarding the possible contribution of on-site renewable energy technologies, three scenarios were considered:
1. Contribution of RES in existing buildings in 2020 in the same levels as the typical, which includes solar thermal systems that satisfy the 80% of the domestic hot water demands (RET1);
2. Installation of solar thermal heater for domestic hot water and of a biomass boiler to satisfy 100% of the demands for space heating (RET2);
3. Installation of solar thermal heater for domestic hot water, of a biomass boiler to satisfy 100% of the demands for space heating and of a 7 kW nominal power solar PV on-site system (RET3).

It is also worth mentioning that the matrix scenarios assume that the end to primary conversion factor will be reduced to 2.27 in 2020 from today's 2.7, according to the assumption that Cyprus will reach its 2020 targets as described in its NAP that anticipates a share of 16% by renewable energy technologies (RET) by 2020 (Infotrend Innovations/BRE – MCIT, 2009; The Republic of Cyprus – MCIT, 2010). This assumption is considered realistic, based on the progress of RET installations in Cyprus few years after the adoption of Cyprus' NAP (2009). The matrix scenarios are summarised in *Table 1*.

Long term focus
The types of buildings within the refugee settlements are similar and constitute a large percentage of the existing building stock of Cyprus - around the 20%. Accordingly, upgrading these areas into smart energy regions will contribute significantly into achieving the national 2020 targets. The long term focus of this Case Study is to encourage the local Government for the development and implementation of an action plan for the transformation of the all the refugee settlements in Cyprus into a smart energy regions, using energy simulation software including SBEM integrated with additional design tools.

4. RESULTS

Business as usual (BAU) scenario:
The BAU scenario assumes the adoption of all the requirements given in the EPBD, and *Table 2* indicates the changes to the structure of the buildings that are obligatory to occur according to the relevant legislation. *Figure 4* presents the significant improvement that is achieved in the energy consumption of the buildings after the implementation of the EPBD –71 KWh/m^{2}year reduction of the building's energy consumption. This reduction can be mainly attributed to the reduction of the end to primary energy conversion factor from 2.7 to 2.27, as well as to the decrease of the average U Values for masonry, roof and glazes elements to 0.50 W/m^{2}K, 0.5 W/m^{2}K and 3.1 W/m^{2}K respectively (Fokaides et al., 2011).

Matrix scenarios
The energy consumption of the buildings in the settlement for the 9 investigated scenarios is presented in *Figure 5* in the form of a bubble chart. The radius of the bubble and the vertical axis represents the magnitude of the energy consumption; and the horizontal axis indicates the examined scenarios with regard to the potential energy consumption reduction.
The case study has resulted to the following findings:
- the promotion of energy efficiency measures and RES utilisation within the settlements can reduce the energy consumption of the buildings of the settlement in the range of 107 kWh/m^{2}year to – 22 kWh/m^{2}year, where the negative sign is indicative of excess energy generation;
- in the case of the business as usual scenario the building energy consumption will be reduced to 107 kWh/m^{2}year by 2020, however this can be mainly attributed to the reduction of the end to primary energy conversion factor.

	Prior to the EPBD adoption	After the EPBD adoption (BAU scenario)
Construction element	Thermal transmittance (U- Value) [W/m2K]	
Masonry	1.5	0.5
Roof (tiles)	3.3	0.5
Glazing	3.9	3.1

Table 2 – Typical thermal transmittance values of the buildings in before and after the adoption of the EPBD

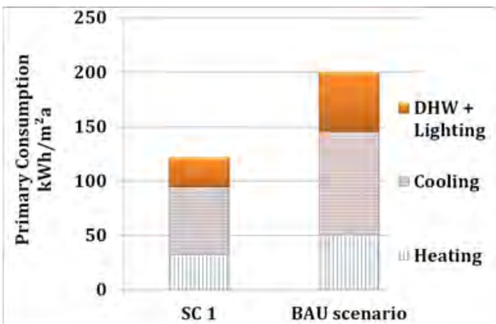

Figure 4 – Typical buildings' primary energy consumption in kWh/m²a compared to the primary energy consumption in the business as usual scenario (Fokaides et al., 2011)

- the employment of RET to cover the heating demands of the buildings can reduce the primary energy consumption up to 61 kWh/m² year;
- the fact that space cooling requires a large percentage of the energy demands in Cyprus increases the significance of the RET that are generating electricity. Since the only abundant renewable energy source in Cyprus is the sun, it is recommended solar technologies, in particular solar PV, should be mainly promoted for the buildings of the settlement;
- given that the domestic hot water demands are satisfied by a solar thermal system and the heating demands by a biomass boiler, the installation of a 7 kW solar PV system can transform a building into a nearly zero energy building (ZEB).

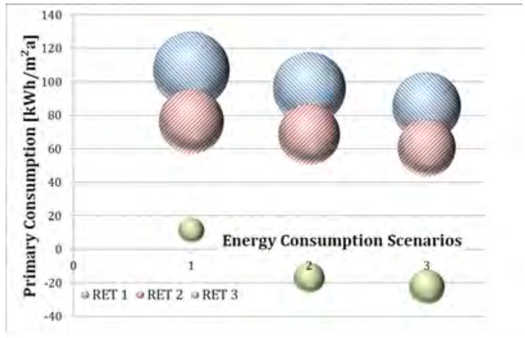

Figure 5 – Primary energy consumption in kWh/m²a of investigated scenarios

Outcomes

The achieved outcomes of the Case Study regarding the transformation of the refugee settlement in Yeri into a smart energy region are enlisted as follows:

- considering the fact that Cyprus has an extremely high electricity retail cost of 0.16–0.24 €/kWh, cost savings of at least 19.0 €/m2a (Poulikkas, 2013) can be achieved through the transformation of their area into a smart energy region;
- the benefits from reducing the energy consumption and employing RES have been scientifically proven to the local authorities through the case study, encouraging them to continue to the implementation of the case study to the settlement of Yeri;
- the knowledge regarding the energy improvement of the building and the significance of upgrading of the settlement into a smart energy region has been developed.

The added value of the outcomes of this case study is indicative as the findings can be related to other regions in Europe as well. According to the Buildings Performance Institute Europe (BPIE) report (2011), a substantial share of the European existing building stock is older than 50 years. Also, many of hundreds of years old buildings exist across Europe, many of which are still in use. In fact, more than 40% of the European residential buildings have been constructed before the 1960s. Countries with the largest shares of old buildings include the UK, Denmark, Sweden, France, Czech Republic and Bulgaria. Thereafter, the building stock of these European countries should be facing similar energy challenges and can be related to the settlement presented in this case study.

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DENMARK

AUTHORS

Morten Elle
Aalborg University, Faculty of Engineering and Science, Department of Development and planning, elle@plan.aau.dk A.C. Meyers Vænge 15, A2, DK2450 Copenhagen SV, Denmark.

Torben Dahl
Royal Danish Academy of Fine Arts, School of Architecture, torben.dahl@kadk.dk Philip de Langes Alle 10, DK1435 Copenhagen K. Denmark.

Jonna Majgaard Krarup
Royal Danish Academy of Fine Arts, School of Architecture, jonna.krarup@kadk.dk Philip de Langes Alle 10, DK1435 Copenhagen K. Denmark.

1 OVERVIEW OF THE REGION

Characteristics of the Region
In the Danish context, it is a challenge that the Copenhagen Region does not exist as an administrative entity. The municipal reform in 2007 moved most of the tasks the regions previously had to either the national level or the municipal level. The new regions were shaped in order to fit their main task: to manage hospitals. The former Greater Copenhagen Region is today covered by the most of the Capital Region and part of Region Zealand.

The region named the Capital Region includes the remote island of Bornholm. The Greater Copenhagen Region only still exists in relation to spatial planning. Municipal spatial planning has to comply with the frames set by the national planning authorities.

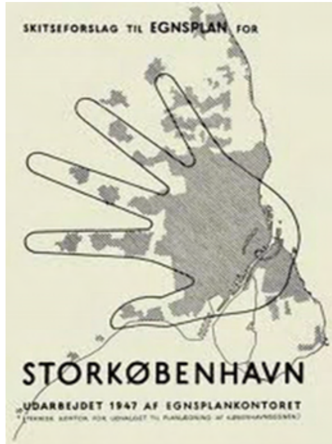

Figure 1 – The ‘Fingerplan’ for the development of the Copenhagen region, 1947

The most famous attempt to develop a regional plan for Greater Copenhagen was the so-called ‘Fingerplan’ from 1947. This plan covered the municipalities in the centre of the City: Copenhagen and Frederiksberg, and some of the surrounding suburban municipalities. Using this understanding of the Copenhagen Region, the region consists of an urban fabric with approximately 1.2 million inhabitants.

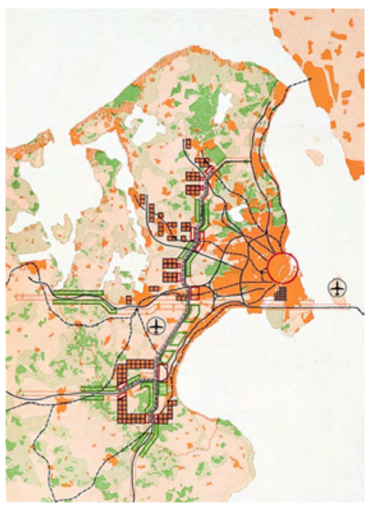

Figure 2 – Greater Copenhagen Region

The later version (2013) of the plan for the Greater Copenhagen Region includes more rural areas and a number of semi-independent towns like Køge, Roskilde, Hillerød and Helsingør. In this understanding of the region it has approximately 1.9 million inhabitants. It could be argued that an even larger region exists, when considering different resource use/allocation, for instance taking the extraction of drinking water or typical daily commuting into consideration. In that way all of Zealand can be considered as representing the Greater Copenhagen Region, with a population of approximately 2.4 million.

Figure 3 – Öresundsregion

An even larger version of the region is 'Öresundsregionen' which in some definitions includes the entire Region Skåne located in southern part of Sweden, as well as the island Sjælland and the capital Copenhagen in Denmark. The Öresundsregionen has a population of approximately 3.7 million inhabitants. A smaller version only includes the old Greater Copenhagen region and only parts of Skåne. The Öresund Bridge has almost made the City of Malmö – with approximately 310,000 inhabitants – a part of Copenhagen.

Probably the most adequate way of dealing with the Copenhagen region in relation to Smart Energy Regions is to use the Municipality of Copenhagen because the municipality exists as an administrative and policy making unit, thus, being able to offer relevant data as a smart energy region.

Characteristics of the Region

The municipality of Copenhagen has an area of 89.79 km^2 and a population of 559,440 inhabitants (www.statistikbanken.dk, 2013). In the municipality of Copenhagen the local government of Copenhagen consists of a governing body, called the City Council, and an administrative branch. The City Council is made up of seven committees: the Finance Committee and six standing committees, each of which has its own specialised field of responsibility. Energy policies are primarily dealt with in the Committee for Technology and Environment and in the Finance Committee. The Finance Committee is the overarching committee, which coordinates and plans the total management of the City of Copenhagen. It comprises the chairmen of each of the standing committees plus six other members of the Council. The Finance Committee is chaired by the Lord Mayor. Each committee is linked to a particular section of the administrative branch of Copenhagen's local government.

The City of Copenhagen has seven administrations. Each administration deals with the tasks related to its standing committee. Questions related to environment, energy, transport and urban planning are dealt with in two of these administrations: The Finance Administration and the Technical and Environmental Administration.

The economy for Danish citizens expressed in GDP per capita is €27,100 (DK, 2010). The employment rate in Copenhagen Municipality is 91.7% (CPH, 2012). In Copenhagen you find some of the leading industry clusters in Europe:
- medicon Valley offers an abundance of exciting opportunities for pharma, life science and biotech companies;
- Copenhagen Cleantech Cluster is one of the world's strongest clusters, focusing on aiding Cleantech research, development and implementation – (Copenhagen Capacity 2014).

Energy demand and supply of the Region
- total energy consumption: domestic, commercial, industry, total energy consumption: domestic,commercial, industry: 7,900 GWh (2011). Transport is 2,900 GWh, including air transport (Planenergi 2013);

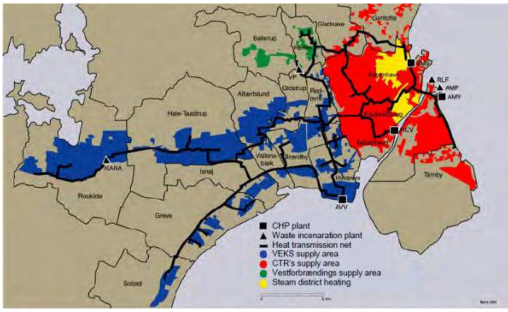

Figure 4 – Map of different supply areas of Copenhagen district heating system and CHP plant locations. Red colour indicates the supply area for Copenhagen central municipalities (CTR) and blue colour shows the supply area of the western municipalities (VEKS)

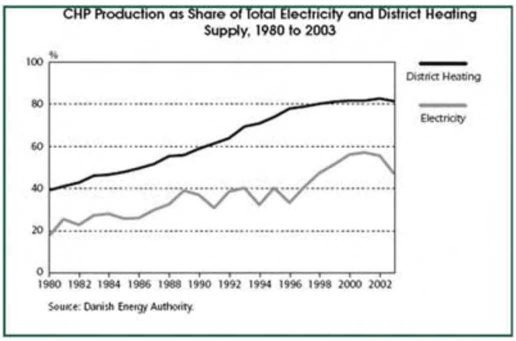

Figure 5 – Cogeneration Heat and electricity production development (Danish Energy Authority)

- 35% is used for electricity production (2,463 GWh, 2011);
- the average GHG emission factor for electricity is relatively low (0.100 kgCO_2/KWh) due to the Nordic countries use of wind, water and nuclear power for Electricity production. (European average 0.500 kgCO_2/KWh);
- the share of renewables in electricity generation in 2011 was 29%;
- cogeneration was identified as a cornerstone of the Danish energy conservation strategy in 1975. Three decades of responsible and dedicated policy-making have paid off: between 1980 and 2005, the share of CHP in the total electricity produced in Denmark doubled from less than 20% in 1980 to 42.6% in 2006, and the share of CHP in heat provision increased to 75%; this has resulted in a 15% decrease in CO_2 emissions a year.
- the share of carbon neutral fuel in heating in 2011was 42%;
- the total CO_2 emissions in 2011 was 1,857,000 tonnes for the region.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The following chapter is to great extent extracted from ‘CPH 2025 Climate Plan’, a document produced by the City of Copenhagen, Technical and Environmental Administration in 2012.

Overall goals and objectives
Copenhagen wants to be the world’s first carbon neutral capital by 2025. This is an ambitious plan requiring long-term action, but it is realistic. The city is already well underway. In 2011, Copenhagen had reduced CO_2 emissions by 21% compared to 2005.

In 2009, the City Council unanimously adopted the Climate Plan for Copenhagen, setting down goals for achieving a 20% reduction in CO_2 emissions by 2015. In addition, a vision for a carbon neutral Copenhagen in 2025 was formulated.

Energy and Transport in Focus
To achieve carbon neutrality by 2025, Copenhagen must use less energy than it does today and also switch to green energy production.

To counteract continued increased emissions e.g. transport, Copenhagen must produce a surplus of green energy corresponding to these emissions. The initiatives are categorised into four themes: energy consumption, energy production, green mobility and city administration initiatives.

Energy savings account for nearly 7% of CO_2 reductions. Additionally, energy savings play an important role in relation to reducing the economic costs of the Climate Plan.
The reason is that every time Copenhageners save energy, Copenhagen avoids having to invest in production capacity in new power plants. Initiatives include energy retrofitting of existing buildings, implementing low-energy new build, promotion of solar cells

together with an improved framework for the construction sector.

Energy production initiatives account for 74% of the total CO_2 reduction in Copenhagen. These include installing onshore and offshore wind turbines, establishing a new biomass-fired combined heat and power plants, establishing a geo-thermal plants and the phasing out of fossil fuels for peak load production. Furthermore, Copenhagen is able to reduce CO_2 emissions from district heating production by separating and re-using plastic from the waste stream.

A broad range of initiatives in the transport area account for just over 11% of CO_2 reductions. The main transport initiatives include activities to promote cycling, biogas and hybrid buses and the introduction of electrical and hydrogen powered cars. In addition to this, new fuels for the heavy traffic in Copenhagen as well as initiatives focusing on efficiency and climate behaviour all play an important role. The City of Copenhagen wants to lead the way and reduce its CO_2 emissions considerably. To implement this, the City Administration will set activities in motion focusing on energy consumption, mobility, operations and management together with climate-friendly conduct among its employees.

Cycling strategy

The cycling strategy for Copenhagen takes its point of departure in the following circumstances:

- the bicycle is low, practical – and common sense technology that anyone can use and afford;
- cycling is based on non-fossil ‘fuel’;
- cycling has additional health benefits;
- cycling can support public space to be perceived as public domains, and thus supporting the development of social sustainability and people’s perception of an improved quality of life;
- cycling in combination with other means of public transportation and supported by carefully street design encourage people to everyday cycling instead of using cars on both a local and on a regional level.

Since 1995, the City of Copenhagen has done cycle accounts that record the mileage for bikes including the distance travelled, etc. For 2012 the figures tell that 36% of everyone working or studying in Copenhagen used a bicycle. In 1996 the figure was 30% and in 2002 32%. 1.27 million kilometres were travelled by bike every working day. In 1996 0.93 million kilometres were travelled by bike every working day, and in 2002 the number had increased to 1.11 million kilometres. There are 650,000 bicycles in Copenhagen (Centre) and 125,000 cars so that 5.2 times more bicycles than cars are in the city. Moreover, 28% of families with two children have a cargo bike and in 17% of households a cargo bike replaces a car. Furthermore, there is no significant correlation between income and the use of bicycles. Both rich and relatively poor inhabitants use bicycles. (Halldórsdóttir 2011).

The ambition to further stimulate people cycling on a regional level is supported by:

- facilitating connections between public transportation and cycling;
- construction of new cycling tracks and lanes;
- improving existing cycling tracks and lanes – by widening the lanes on behalf of the car area;
- positioning of ‘air stations’ (facilities with bicycle pumps) along the cycle super highways;
- green traffic light waves.

Plans for how many new bike paths and bike lanes to be made in Copenhagen next year have been developed. The so-called Cycle Track Plan covers the period 2006 – 2016 and indicates the order of almost 70 kilometres of new bike paths and bike lanes. The cost of completing the plan is estimated to approximately €50 million.

In 2012 there were:

- 359 km of cycle track;
- 24 km of cycle lanes;
- 43 km of green cycle routes;
- 32.5 of cycle super highways (June 2013).

Copenhageners are also stimulated to cycle by making the conditions for car driving difficult through one-way roads, fewer and more expensive parking areas.

The bicycle is a typical means of transportation in Denmark. Both adults and children cycle on an everyday basis and throughout the year. Danish children are trained in cycling and traffic rules in school in collaboration between the school and the police.

Immigrants to DK (adults and children) are also offered to learn to ride a bike as part of the official integration process.

Overall targets

Targets set for the region to be reached 2025:

- 20% reduction in heating compared to 2010;
- 20% reduction in electricity consumption in commercial and service sector compared to 2010;
- 10% Reduction in electricity consumption in households compared to 2010.

Reduction of CO_2 emissions

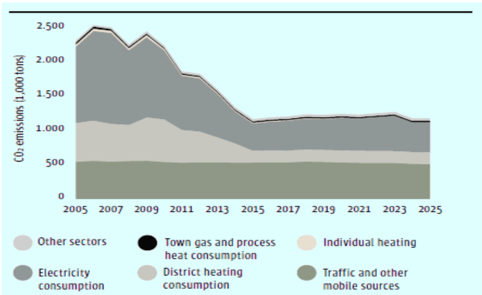

FIGURE 1 // Development of CO_2 emissions up to 2025 provided that no further initiatives or policies are initiated.

Figure 6 – Development of CO_2 emissions up to 2025 mainly due to introduction of wind turbines and new renewable energy-based cogeneration using biomass

When the objectives for existing buildings have been reached, heat consumption is reduced by almost 1,000 GWh and electricity by 250 GWh compared to 2010 levels. Energy savings and installation of solar cells, which provide currently 1% of the electricity, will reduce CO_2 emissions by a total of 80,000 tonnes.

These objectives will be achieved by:

- improving the building framework and conditions;
- develop a strategy for energy in construction;
- develop and test funding for the realisation of energy savings;
- working to change legislation to increase energy efficiency.

Towards 2025, Copenhagen will initiate and implement a variety of activities to reduce energy consumption of buildings. The following describes the main initiatives together with the initiatives, which will be implemented shortly to ensure frameworks and solutions to achieve energy savings up to 2025.

Economy

Copenhagen's total cost to implement the initiatives which will help to reduce energy consumption in the buildings in Copenhagen, is expected to be less than €23 million to 2025. This includes concept and model development, and funding for demonstration projects in new and existing buildings. By reducing heat consumption by 2025 by 20% and electricity consumption by 20% in sales and service companies and 10% in households respectively, the total economic savings amount to approximately €215 million.

A couple living in an apartment will save approximately €535 in 2025 per year on their energy consumption if the objectives are met.

The total investment in new construction and renovation of existing construction will require investments of up to €24 billion until 2025. The total investment in PVs in the private sector is estimated to be €60 million up to 2025.

Other Regional targets, barriers and drivers

Turning Copenhagen into a smart city means user-friendly development while also reducing consumption of resources. The starting point for the smart city is the unified whole. That is to say, limitations in capacity, renewable energy production, consumer patterns and consumer needs will be integrated into the solutions which are finally implemented.

With the smart city initiative, the City of Copenhagen wants to select the most energy-efficient solutions such as giving high priority to electricity largely produced by renewables and to ensure that the potential for flexible energy consumption is utilised. The City Administration will use its own vehicles and buildings to test and implement new technology.

Digital infrastructure
Smart city Copenhagen will monitor energy consumption – amongst other things by controlling the energy consumption in buildings – and learn from it. Access to public energy consumption data creates a scope for new services and new information for the benefit of both Copenhageners and businesses. The City of Copenhagen will be collaborating with relevant partners to ensure an open digital infrastructure so that Copenhagen will have an open platform for new and innovative solutions.

Flexible consumption and Smart Grid
In the future, the Danish energy supply will consist of increased amounts of renewable energy. This requires an increasingly flexible consumption and, together with a Smart Grid can accommodate more renewable energy being fed into the system. A Smart Grid must be the link between energy production and user.

The City of Copenhagen will, together with external players, strive to examine the possibilities of implementing a scheme whereby Copenhagen residents, businesses and authorities will have more opportunities to select and use electricity when the share of renewable energy in the over-all energy production is high.

The City of Copenhagen will also launch several initiatives to ensure intelligent recharging of the City Administration's own electric cars.
To minimize the production of district heating in plants producing heat only – which happens during very cold periods – the City Administration will, in collaboration with Copenhagen Energy, examine whether the heating system could be made more flexible.

3. CASE STUDY: CARLSBERG DEVELOPMENT PLAN

Carlsberg has, for more than 160 years, brewed beer in Valby – a city district in the western part of central Copenhagen. The area has been a closed industrial area of 33 hectares with production buildings, basements and brewer family Jacobsen's private homes and gardens in the centre of Copenhagen.

In 2006, Carlsberg decided to move beer production to Fredericia and release the large areas in Valby to urban development. The vision is to make the area into an attractive and open urban area, being an integral part of Copenhagen – the Carlsberg City District is called "Our Town".

Figure 7 – The entrance to the Carlsberg Brewery area between the foundations of the "Elephant tower", built by architect Vilhelm Dahlerup, 1901

The idea is to conserve and recycle industrial buildings in conjunction with new construction of high architectural quality with a strong focus on sustainability in both the choice of materials and agglomeration operation with regard to water, heat, etc.

Although the production of beer has moved and new features were introduced into the area, the company Carlsberg A/S will continue to be present in the area with its international headquarters, Carlsberg Denmark, Jacobsen Brew house, Research Centre, the visitor centre and perhaps new activities in the future.
Carlsberg A/S launched in the autumn of 2006 an open international architectural competition "Our Town" was run to get ideas on how the 33-acre brewery site could be developed.
The vision was to create a new, vibrant neighbourhood with an intense urban life as a result of a dense urban structure with a mix of residential, commercial, trade, culture and leisure with an estimated population of 4 – 6000 (3000 dwellings). Sustainability played a major role in the competition and in the description of the winning project.

Carlsberg A/S and the Danish architect firm

"Entasis", who won the competition, along with other consultants prepared the basis for a local plan in collaboration with the municipality of Copenhagen.

Figure 8 – The Carlsberg area I Copenhagen. Illustration from the winning proposal "Carlsberg – vores by" by ENTASIS

Objectives and methods

The vision for the area is that citizens and visitors will experience the area, with its spaces and citizens linked together by one identity: inclusiveness and space. Inclusiveness can be seen and experienced in many ways:
Cultural inclusiveness: The district should reflect the inspiration the modern human being – the cosmopolitan – finds in globalisation. The inspiration found in architecture, function, light, smells, etc.;

Social inclusiveness: Carlsberg will embrace all social classes, generations and many ethnic groups. Modern people have broken out of dogmatic circles to follow their inspiration and desire. The city lives through its diversity;
Architectural inclusiveness: The district must be perceived as a laboratory where the typologies public space, the old buildings, the tower house and city houses are experienced cognitive and developmental;

Environmental inclusiveness: Carlsberg will be the first town in fully developed form manages to produce a surplus of energy;
Experiencing Diversity: The city should offer great diversity in experiences and functions. Common to these experiences, the city's ambition of "the good life" breaks through.

District heating and renewable energy systems (RES)

Copenhagen Municipality as a whole is covered by a district heating plan, which makes it mandatory for larger buildings with a heating capacity above 0.25 MW to use district heating only. Alternative heating and energy sources such as solar collectors and PVs presume dispensation from the heating supply legislation. The use of district heating and renewable energy systems in the Carlsberg area thus complies with the overall energy and CO_2 targets for Copenhagen Municipality.

Green mobility in Carlsberg

Developing the Carlsberg area as a sustainable urban neighbourhood does imply a number of considerations concerning transport. The area is designed for a limited car-based transport, the streets are predominantly meant for urban life, not for cars. The idea of establishing a metro-station in the area dominated the early phases of the project. The metro-station should be served by the circle-line 'Metro-city-ringen'. However, the private part: Carlsberg and the public part could not reach an agreement concerning the financing of the station. Hence, the idea of a metro-station in the area was replaced with the idea of moving the existing nearby urban rail station 'Enghave Station' a few hundred metres closer to centre of the Carlsberg area, making it more convenient for the future residents to use urban rail. This project has now been confirmed.

Another central discussion in relation to the development of Carlsberg is car parking. 95% of all cars will be parked in underground facilities. The questions are: How many cars should these facilities provide space for and who should invest in the facilities? In the original negotiations, the Municipality argued for 1 parking lot per 200m^2 of floor space.

Carlsberg argued for 1 parking lot per 100 m^2 of floor space, because the area should be considered a mix of business development and residential development. The negotiations ended in a compromise: 1 parking lot per 133 m^2 of floor space. It is estimated that each lot will cost approximately €65,000. For a part of the potential future residents, belonging to the creative segment in Copenhagen, it is not seen as positive to have access to parking. Other potential future residents would, however, consider access to parking as a must. Nobody is eager to finance the construction of the parking facilities, not even those actors who consider access to parking as a must.

Re-Cycling Carlsberg

The reduction of CO_2 emissions from transport and transportation is part of the ambition to create and support people's perception of an improved quality of life in the area. The notion of the good life and reduction of CO_2 emissions are thus seen as essential and interrelated concepts and ambitions in developing the area successfully. The Masterplan, Vores By, describes the components (streets, squares etc.) of the area's infrastructural organisation and its relationship to adjacent urban road systems and public transport.

Streets, alleys and squares are functionally classified, as well as the definitions of different types of streetscapes, characters and traffic types. Some streets and squares are designated as shared spaces, in some only limited driving will be permitted, and in others driving will not be allowed. The dominant modes of transport are walking and cycling.

At a local level the plans for Carlsberg district follows the strategies and ambitions to stimulate bicycle and pedestrian traffic, and public transport as formulated at regional level for Greater Copenhagen. The ambition to develop Copenhagen to an *Environmental Metropolis* and a *Metropolis for People in 2015*, is supported in the plans for the Carlsberg area, and carried out through the spatial organisation, its relations to adjective urban areas, the design of the streetscapes and the imbedded stimulation of walking and cycling.

Stimulation of bicycle, pedestrian and public transportation is regarded as essential tools supporting this ambition. As shown above behavioural and attitudinal measures are emphasised and supported. The cycling training programs target both school children and adults through organised and systematic courses offered and organised by public authorities, the school system, and through volunteers (NGO) initiatives. People's behaviour and attitude towards cycling are sought supported through the spatial organisation and urban design.

The ambition is to create a common understanding among the Copenhagen residents of the beneficial good of bicycling on both society level and on an individual level, and thus to support people's perception of an improved quality of everyday life both on a local and on a regional level, and at the same time to reduce CO_2 emission.

Long term focus

Copenhagen will in the coming years foresee an extraordinary population growth. At the same time the city has the ambition of becoming the world's first carbon-neutral Capital by 2025. This provides an excellent opportunity for creating a sustainable city in terms of both environmental and economic growth.

Copenhagen has the declared dedication to collaborate with cities, knowledge institutions and enterprises on an international scale in the development of new, innovative, sustainable solutions.

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FINLAND

AUTHOR

Jukka Heinonen
Aalto University, Department of Real Estate, Planning and Geoinformatics
E: jukka.heinonen@aalto.fi

Markku Norvasuo
Aalto University, Department of Real Estate, Planning and Geoinformatics
E: markku.norvasuo@aalto.fi

1 OVERVIEW OF THE REGION

Characteristics of the Region

Tampere City Region is an inland region located in Western Finland approximately 200 km away from Helsinki and Turku, the two main coastal cities in Finland. Tampere City Region consists of the central city Tampere and seven surrounding smaller municipalities: Kangasala, Lempäälä, Nokia, Orivesi, Pirkkala, Vesilahti and Ylöjärvi.

Figure 1 – The location of Tampere City Region (tampereenseutu.fi)

The surface area of the region is 4,977 km^2 and it hosts approximately 365,000 inhabitants. It is the leading economic region in Western Finland and the second largest economic region in Finland after Helsinki Metropolitan Area, the capital region. The GDP of the region was €12,265 M in 2010 (Statistics Finland, 2014a), or €33,600 per capita which is just above the average in Finland. The unemployment rate has increased rapidly in Tampere Central Region during the economic crisis of the recent years. At the end of 2013 the unemployment rate was 15.3% (Tampereen kaupunkiseutu, 2014) which is well above the national average of 8.7% in Finland (Statistics Finland, 2014b).

Tampere City Region is one of the fastest growing economic regions in Finland. The population of the region is estimated to increase by 90,000 by 2030, mostly due to domestic migration from smaller rural and semi-urban municipalities in Finland (Tampereen kaupunkiseutu, 2010).

The governance of the region consists of a joint authority formed by the municipalities of Tampere City Region and of the municipal governance within each of the region's eight municipalities. The first development strategy for the region was accepted in 2005 and a board was selected to steer the execution of the strategy. The regional governance is based on voluntary cooperation of the municipalities. The aim is to coordinate, for example, land use planning, traffic infrastructure development and energy services within the region. The municipalities have agreed to intensify the cooperation in the near future. An important step in this development was the signing of a joint 2030 climate strategy in 2010 by the mayors of the municipalities of Tampere City Region, and the regional council (Tampereen kaupunkiseutu, 2010). With the strategy, the municipalities in the region committed to jointly work towards a more sustainable region, and devote significant resources to achieving the set target of reducing the per capita GHG emissions of the region by 40% by 2030 compared to the 1990 levels.

Energy demand and supply of the Region

The overall electricity use in the region was slightly over 3,100 GWh in 2010 (Tampereen kaupunkiseutu, 2010). The largest share was used by private households and industry as *Figure 2* shows. In addition to *Figure 2*, approximately 340 GWh/a of electricity is used for space heating.

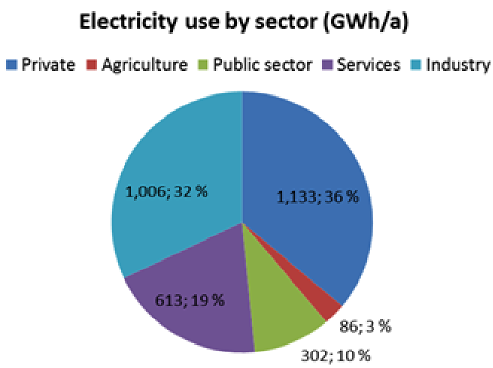

Figure 2. Electricity use by sector in Tampere region in 2010

The majority of spaces are heated with Combined Heat and Power (CHP) heat or with heat produced by the specific heat production plants in the region. The biggest provider is Tampereen Sähkölaitos, but there are smaller scale heat plants in the smaller municipalities.

Of the property specific heat sources, oil is the most commonly used. Heat pumps are implemented at an increasing pace, but their overall share is still low. In addition, in low-rise areas property specific fireplaces with wood heating is also an important mode of heating. According to the Finnish Forest Institute, METLA, as much as of 40% heating energy requirements is produced by firewood in detached houses in Finland on average, meaning 4.6 m^3 of wood being burned per annum in each detached houses (Torvelainen, 2009). *Table 1* comprises the heat use and fuels/production modes.

The housing sector is by far the largest sector with close to 1,300 GWh annual heat demand (2010 reference year) as presented in *Table 2*. From this perspective, industry appears to be a small scale heat user with its only 200 GWh annual demand, but industry's own excess heat use covers the majority of the need and is not included in the statistics in *Table 2*. Other sectors use a noticeable amount, approximately 700 GWh. *Table 2* presents the heat purchase by end-use sector and the distribution between different producers within the region.

Fuel/production mode	GWh
District heat	2,182
Electricity used for heating	363
Property specific firewood	306
Oil	265
Heat pump production	170
Other	54
Total	3,238

Table 1 – Heat supply by fuel/production mode for the region.

Locality	Producer	Industry	Housing	Other
		GWh	GWh	GWh
Kangasala	Kangasalan lämpö	2.7	40.2	19.7
Lempäälä	Lempäälän lämpö	3.9	24	16.2
Nokia	Fortum Power and Heat	11.1	56	33.9
Pirkkala	Tampereen sähkölaitos	5.5	29	9.8
Tampere	Tampereen sähkölaitos	166.7	1,102	600.3
Ylöjärvi	Tampereen sähkölaitos	9.5	23.6	19.6
Ylöjärvi	Pirken Oy	0	4.3	5.6
Total		199	1,279	705

Table 2 – Heat purchases by end-use sector and producer in 2010 in Tampere City Region.

Energy production in the region is predominantly based on CHP production. The production volume is dominated by Tampereen Sähkölaitos, the biggest CHP provider in the region, which thus defines the energy production related GHG emissions as well. In 2011 Tampereen Sähkölaitos produced 1,502 GWh electric energy (gross) and 2,173 GWh thermal energy.

The fuels used for electricity generation consisted of natural gas (76%), peat (13%), and wood fuels (11%). For district heating natural gas (66%), peat (17%), wood fuels (15%), and oil (2%) was used (Tampereen Sähkölaitos, 2013). The other two important power plants rely heavily on fossil fuels as well, as depicted in *Table 3*.

Because of the high share of CHP production in the region, the region's GHG emissions can vary significantly between different reports. With CHP production, the GHG emissions intensities depend heavily on the adopted allocation method, not just on the fuel-mixes of the power plants.

Plant	Heat (Gwh/a)	Power (Gwh/a)	Fuels (Gwh/a)
Tampereen sähkölaitos: Naistenlahti 1	690	688	1,582 natural gas
Naistenlahti 2 Lielahti Hydro power	561 752	283 731 48	211 wood, 782 peat, 10 natural gas, 4 oil 1,732 natural gas
Nokian lämpövoima	367	388	1,108 natural gas

Table 3 – The production volumes and used fuels of the CHP and power plants in the region.

For example regarding the largest provider in the region. Tampereen Sähkölaitos, the emissions intensities are 266 gCO2eq/kWh for both heat and electricity according to the energy method (the overall emissions divided according to the produced amounts of heat and electricity). However, if the shared benefit method is taken, which is the most common in Finland since it credits heat more as a co-product of electricity production, the intensities are 178 gCO2eq/kWh for heat and 388 gCO2eq/kWh for electricity. A third number is provided by the annual report of Tampereen Sähkölaitos, according to which the GHG intensity of their overall production was 191 gCO2eq/kWh (Tampereen Sähkölaitos, 2013a).

Furthermore, the emissions of the sold energy differ significantly from the production emissions. All the electricity is first sold to the grid and then bought back according to the demand. Because of the high share of Norwegian hydropower in the Nordic grid, the GHG intensity of sold electricity of Tampereen Sähkölaitos in 2012 was only 115 gCO2eq/kWh (Tampereen Sähkölaitos, 2013b).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The GHG reduction targets set by the Tampere City Region municipalities, announced in the 2030 climate strategy, are derived from the 20-20-20 target and the long term goal of 85 – 90% reduction by 2050 of EU, and the 80% reduction target by the year 2050 compared to year 1990 for Finland set by the Finnish government (Government Foresight Report of 2009).

The main target is to reduce the GHGs by 40% by 2030 relative to 1990 level. In the strategy the main target is divided into sectorial targets and action plans. The key elements of the action plan are:

- dense infill development around a lively downtown;
- public transport as the easiest alternative with an overall modal share of 25% of all trips within the region;
- high quality and diverse housing areas with highly energy efficient buildings;
- increased overall energy efficiency produced predominantly with renewable fuels.

(Tampereen kaupunkiseutu, 2010).

The ECO^2 programme of the City of Tampere proposes even more rigorous targets: the GHG reduction target should be 30% for the year 2020, 50% for year 2030, and 80% for the year 2050.

The GHG emissions from the region can be measured in several different ways. From the production perspective, including the emission actually occurring within the region, the emissions would seem to be on an increasing path, although primarily due to increasing population. Total GHG emissions have been estimated with the so called Kasvener model (Finnish Environment Institute, 2014) for the City of Tampere and for the whole region (Tampereen Kaupunkiseutu, 2010). According to these assessments, in the City of Tampere the GHG emissions have increased from slightly over 1,500,000 tons of CO2eq/yr in 1990 to over 1,600,000 tons in 2007, which is the newest available year data. At the same time the population of the region has increased from 172 000 to approximately 208 000, which means that the per capita emissions have somewhat decreased during the same period to slightly below eight tons of CO2eq/yr per capita.

Regarding the whole region, the only assessment with Kasvener is from 2006 (the base year). According to that, the emissions in 2006 were approximately 2,300,000 tons of CO2eq or 6.4 tons per capita (Tampereen Kaupunkiseutu, 2010).

The majority of the emissions in the region originate from energy production. District heat and electricity cause over 50% of the overall emissions, followed by transportation with a share of over 20%. Other fuel combustion causes approximately 10% of the overall emissions. Waste management and agriculture are other included categories with minor shares.

From the consumption perspective, including all the emissions caused by the residents of the region regardless of the geographic location where the emissions actually occur, the emissions for Tampere region have been estimated by Heinonen and Junnila (2011) for the year 2006. They divided the region into three groups of municipalities, where Tampere as the most densely populated central city forms one group; the more urbanized surrounding municipalities of Lempäälä, Nokia and Pirkkala one group (UCT in *Figure 2*); and the more rural type of municipalities Kangasala, Orivesi, Vesilahti and Ylöjärvi the third group (RCT in *Figure 2*).

According to their assessment, the annual average per capita emissions vary relatively little within the region, from 10 to 11 tons of CO2eq with the lowest emissions found from the group of urbanized surrounding municipalities, and the highest from the more rural type of surrounding cities. When compared to the above presented production-based figures, their study depicts how the assessment perspective affects the results. Tampere region is a relatively affluent region and the high consumption volume is largely satisfied with imported goods from elsewhere in Finland and abroad, the residents thus causing a significant amount of emissions outside of the region. *Figure 3* shows how energy and transport-related emissions still dominate, but how consumption of goods and services adds a significant share as well.

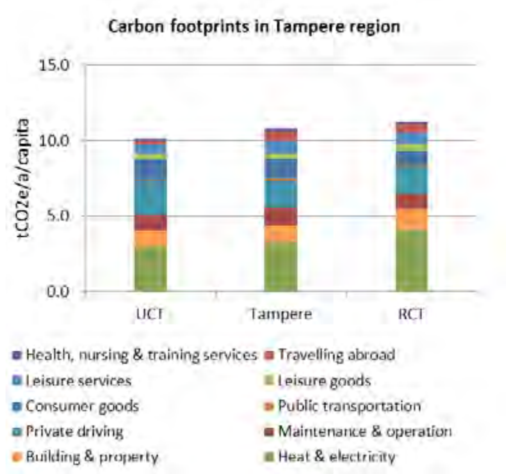

Figure 3 – The average per capita consumption-based GHG emissions (carbon footprints) in Tampere region in 2006.

Other Regional targets, barriers and drivers

Tampere region is one of the fastest growing regions in Finland, and as much as 20,000 new inhabitants are expected to move to the region by 2030. To fulfil the special needs of this migration requires a significant amount of new residential and other space construction. To mitigate the impact from this construction, the climate strategy for Tampere region for 2030 requires all new buildings to be built according to ‘class A’ energy efficiency. This should improve efficiency by 30% compared to year 2009 and over 50% in comparison to the average of the existing building stock. Several demonstration projects are on the way or proposed to construct and plan for better energy efficiency, ‘even exceeding the ‘class A’ energy efficiency requirement (e.g. for energy town plans and nearly zero and zero energy projects).

Mobility is another main issue in the climate action plan of the region. The main objectives for climate-friendly mobility pertain to public transport, cycling and other light traffic. For the City Council’s term of office 2009 – 2012, the objective for the modal share of public transport was a minimum of 18%. In the climate vision for 2030, the target share for public transport in 2030 is at least 25%, and for walking and cycling also 25%. Simultaneously, GHG emissions from transport should have diminished by at least 20% (compared to year 1990). The announced means to achieve these targets are increased density through infill development and an increase in the use of biofuels. Partially the means to achieve the targets have been left open for now as well (Tampereen Kaupunkiseutu, 2010).

Certain challenges for the execution of the regional climate policies and action plans are set by the structure of the regional decision-making bodies. Currently the municipalities of Tampere region possess the majority of the executive power. In the future the effectiveness of the regional policies could be increased with closer regional cooperation and regional planning. Also state subsidies are important drivers. Furthermore, connections between land use and transportation issues should be improved and the decisions coordinated at the regional level.

Energy production

Whereas the region is relatively well covered with district heating infrastructure and the majority of heat is produced in CHP plants, the dominating fuels are currently non-renewable. In 2012, natural gas formed a share of approximately 70% of the CHP production of Tampereen Sähkölaitos and peat a share of well over 10% (Tampereen Sähkölaitos, 2013a). This situation sets an important barrier for achieving the climate targets of the region, and thus Tampereen Sähkölaitos has committed to increase the amount of renewable fuels to as high as 30% by the year 2020. In the production of CHP this would mean replacing oil and natural gas by forest residues. In heating, technological innovations favour the use of wood chips, pellets and chopped wood. Biogas, biomass fuel, and solar energy would be appropriate for small-scale CHP as well. In addition, refuse incineration is a developing and promising technology, although the GHG impact of this production mode depends heavily on certain assumptions.

3. CASE STUDY: HÄRMÄLÄNRANTA RESIDENTIAL DEVELOPMENT

The case study area Härmälänranta is located five kilometres southwest from the centre of the city of Tampere, on the waterfront of lake Pyhäjärvi.

Figure 4 – The location of Härmälänranta residential area (Skanska Kodit, 2013).

The properties are located in a former industrial area which will now be turned into an eco-efficient high quality residential area. Sustainability has been an important driver in the planning of the area. High energy efficiency of the buildings and diverse selection of local services which reduce commuting are among the key means to achieve high eco-efficiency. In addition, efficient public transport connections to the city center are planned to further reduce private driving. Brownfield development replacing a former industrial area will increase the eco-efficiency as well, since energy and transport infrastructures are already there (Skanska Kodit, 2013).

The area will be built in two phases of which the first one is currently under development. The first phase includes seven similar multi-story apartment buildings, each with approximately 3,000 gross square metres. The buildings will contain 28 apartments each, and about 500 residents will reside in the area once finished. Altogether 160,000 gross square meters of living space and at least 4,300 gross square meters of office space will be built to the area, and it will be home to approximately 3,200 residents.

Skanska Kodit is the main building contractor responsible for the development of the area. To create an appealing brand for the area Skanska collaborates with several architect companies and branding specialists (Skanska Kodit, 2013). For the city of Tampere, Härmälänranta is one important step in its attempts to reach the climate change mitigation goals set for the near future.

An existing infrastructure for district heating is available in Härmälänranta. However, since the local power plant relies heavily on non-renewable fuels, alternative local site-specific production possibilities have been investigated as explained further in the next section. Located within the existing city structure and thus being an infill development site, transportation infrastructure is already present. Local bus lines serve the area and freeway connections are located nearby. The existing neighbourhoods that surround Härmälänranta also offer diverse services in close proximity.

Objectives and methods

Härmälänranta aims to contribute to environmental and social sustainability of the region by offering the residents a neighbourhood with diverse local services, which are expected to reduce the need for private transportation and to create a local community that enhances the social wellbeing in the area. From the environmental sustainability perspective one main expectation for the case area is to be one of the key projects leading the development towards a less carbon-intensive Tampere.

The key methods for reducing GHG emissions are high energy efficiency levels of the buildings and the existing infrastructure for district heating. These are expected to lead to significantly lower use phase GHG emissions from Härmälänranta than in the region currently. The economic and environmental feasibility of further reducing the use phase GHGs with selected local site-specific renewable production options have been studied as well. Below, these potentials are presented according to the recent study of Ristimäki et al. (2013), who utilised simultaneous life cycle assessment (LCA) and life cycle costing (LCC) to analyse the costs and GHGs in different time horizons.

The construction phase emissions, including the embodied emissions in the construction materials, create an additional perspective to GHG mitigation potential of such new residential developments as Härmälänranta. Tampere is expecting the high energy efficiency of the new buildings to decrease the buildings related energy demand and GHG emissions relatively quickly, by 30% by 2030 according to the 2030 climate strategy of the region (Tampereen Kaupunkiseutu, 2010). However, these estimated values omit totally the construction phase emissions and look only at the use phase energy use and the derived emissions. According to Säynäjoki et al. (2012) it is possible that the construction phase emissions of a new residential building are high enough to actually only increase the combined cumulative emissions from the construction phase and use phase until 2030. Kyrö et al. have actually calculated for the city of Tampere that the building stock cumulative emissions increase for decades as the result of renewing the building stock at the current rate even if the new buildings are very energy efficient compared to the existing stock (Kyrö et al. 2012).

Thus, even if the use phase of a building causes the majority of the emissions over the whole life cycle, in short-term and even in middle-term the construction phase emissions may dominate and thus hinder the GHG potential of increased building energy efficiency. In Härmälänranta this perspective has been partly taken into account. The building contractor Skanska Kodit has tried to minimise the material requirements by design optimisation. In addition, new insulation materials are utilised in the first phase buildings in Härmälänranta. The impact of these choices is still largely unknown, however, but underway is a GHG assessment focusing on the construction phase emissions which will shed light on the issue during 2014.

Long term focus
Many of the planning and design choices in Härmälänranta are targeted to increase the long-term eco-efficiency and sustainability of the area, especially the energy demand and production related decisions studied by Ristimäki et al. (2013). Ristimäki et al. investigated the mid and long-term economic, and greenhouse gas impacts of selected alternative site-specific energy production methods with life cycle costing and life cycle assessment. Their study included four possible options:

1. Business As Usual (BAU) option of district heating and electricity from the local provider;
2. District heating and 90% of electricity from the local provider and 10% with local on-site photovoltaic panels;
3. Ground source heat pump producing the heat, electricity (including operating power for the pump) from the local provider;
4. Ground source heat pump producing the heat, 90% of electricity coming from the local provider and 10% with local on-site photovoltaic panels.

The study covered 25, 50 and 100 year time-spans.

Results
In the Finnish Energy Audit system (Motiva Oy, 2013) the Härmälänranta buildings will be placed in the highest category A in an A-G classification with the estimated overall use phase energy (heat and electricity) of slightly less than 100 kWh/m2yr. The energy efficiency will thus exceed the minimum requirements of the 2010 National building Code, which already reduces the energy use by over 50% in comparison to the average of the existing building stock. Notwithstanding, the study of Ristimäki et al. (2013) shows that further reductions could be achieved in a life cycle affordable way. According to the study, option 4 would be the most effective to decrease the emissions caused during the use phase of the buildings with regard to the BAU option.
The GHG assessment results from Ristimäki et al. (2013) are shown in *Table 4*.

Year	1. District heating	2. District heating incl. 10% photovoltaic panels	3. Ground source heat pump	4. Ground source heat pump incl. 10% photovoltaic panels
25	45,832	44,425	35,167	33,738
50	68,857	65,946	46,916	43,983
100	112,599	106,483	68,087	61,949

Table 4 – Life-cycle GHG emissions of the compared four energy options in 25, 50 and 100 years time-spans (tons of CO2eq) (Ristimäki et al., 2013).

Option 4 would actually be both the most GHG effective as well as life cycle affordable from the cost perspective. Compared to the BAU option (1), all the alternative solutions would reduce the GHG emissions over all the covered time-spans, and even the life cycle costs over the longest 100 years period.

In option 4 the GHG reduction would be more than 20% even over the shortest 25-year time-span and increase up to approximately 40% over the 100-year time-span. The cost differences remain much smaller, but with the assumed price changes the lowest GHG options are the most life cycle affordable as well.

Outcomes
Härmälänranta is expected to contribute to achieving the regional GHG mitigation targets. High building energy efficiency will assure that the use phase emissions from energy use in the area will be significantly lower than the regional average, over 50% in comparison to the average of the building stock of the region. According to Ristimäki et al. (2013) the use phase GHGs could be reduced further by local site-specific renewable energy production.

There are two important shortcomings in the presented emissions assessments:
Firstly, only the use phase emissions are taken into account. While these have traditionally dominated in the overall life cycle of a building, the relative importance of the construction phase (direct and embodied) emissions is increasing as the use phase energy efficiency increases. In addition, when the currently set rather short-term GHG reduction targets are concerned, the construction phase emissions may actually arise into a major role, as shown by Säynäjoki et al. (2012). They call the hidden phenomenon “the carbon spike” of construction, since when put into a temporal perspective, the construction phase emissions appear very high in the beginning and the payback time may be decades long even with the highest energy efficiency buildings. Taking this phenomenon into account depicts how difficult short-term GHG reductions are to achieve with infrastructure development.

Secondly, the study of Ristimäki et al. (2013) does not assess the grid-level impacts of the local site-specific energy production options. While the local options in their study seem to favour district heating, the results contain an important uncertainty. In the end the effectiveness of a certain local energy system is relative to the overall grid impacts, particularly if the system is not totally independent.
For example, the ground source heat pumps in the study of Ristimäki et al. would use electricity from the grid to operate. It would thus be possible that the use of the ground source heat pumps would actually lead to an increase in the electricity demand in the grid and potentially result in more excess heat waste from the CHP plant. Furthermore, if the increased electricity demand would require spare production capacity to be utilised, the production fuels would be predominantly coal and natural gas. Thus the results of a GHG assessment would actually rely heavily on whether the electricity would be assumed to be the grid average or the so called marginal production. These uncertainties depict that further information about the potential of the local solutions to replace the (least GHG effective) grid production would be needed to assess the real GHG impacts.

Finally, increasing building energy efficiency might lead to a rebound-effect, which can significantly reduce the GHG benefits.
If the increase in the energy efficiency leads to monetary savings in energy costs, not compensated by the cost of the residence, the money will the most likely be spent elsewhere with the consequence of new GHG emissions. The same applies to private transportation and reduction in the degree of household motorisation, as Heinonen et al. (2013) demonstrate.

An interesting thought can be derived from these remarks on the actual eco-efficiency of the area. If sufficient local service supply can be attracted to the area to really create local lifestyles among the residents, the local low-GHG energy solutions would reduce the GHGs from all the local services as well and support low-carbon living even if the service demand would be increased as a rebound effect of reduced driving and housing energy costs.

4. CONCLUSIONS

The Härmälänranta development demonstrates a conversion from former industrial to new residential use, where industrial history has been used in branding. Even if many of the industrial buildings on the area have been demolished, a few of them will be converted to new uses, like sports and cultural services. A combination of lakeside nature and outdoor activities, industrial heritage, urban infrastructure, and the availability of services are cornerstones of the marketing strategy for home buyers (Skanska Kodit, 2013).

Industrial heritage cannot be regarded a factor of sustainability as such, but often such locations bring about factors that contribute to the sustainability of a new development at the same site. Firstly, the existing buildings that are saved and renovated to be part of the new development reduce the need for new construction, which often causes higher construction phase carbon spike than refurbishment of an existing building according to Säynäjoki et al. (2012). Secondly, the potentially favourable position of the site, as with Härmälänranta, makes development practicable and can reduce for example the infrastructure related emissions.

The process in Härmälänranta follows international patterns of urban renewal and city branding. Sustainability adds to the achieved urban image. When assessing the possibilities of generalisation, these two factors have to be distinguished.

On urban level, the most important factors affecting sustainability are good connections inside the city, density, proximity of services, and the availability of district heating. These attributes are location-dependent. The basic residential layout and house typologies are relatively common in Finland. The apartment buildings do not form downtown-type closed blocks but are widely applied in suburban areas. Furthermore, the primary methods for diminishing GHG impacts, high building level energy-efficiency and the use of district heating, are widely applicable for various buildings.

As stated before, various solutions for heating may be applied. Even if district heating is common in Finnish urban areas, also ground source heat pumps can be used. The systemic integration of the demonstration project is relatively loose and allows various technological choices.

To sum up, the possibility of creating similar residential areas is partly dependent on attractiveness factors that are not easily generalised. However, the solutions affecting energy efficiency are widely applicable in other circumstances. In addition, the presented uncertainties in the GHG reductions assessments regarding the Härmälänranta case area depict how difficult achieving true emissions reductions can be, especially in the short-term.

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fYR MACEDONIA

AUTHORS

Roberta Apostolska, Professor, D-r
Institute of Earthquake Engineering and Engineering Seismology-IZIIS,
University "Ss. Cyril and Methodius",
Skopje, RM
E: roberta.apostolska@jrc.ec.europa.eu

Todorka Samardzioska, Associate Professor, D-r
Civil Engineering Faculty,
University "Ss. Cyril and Methodius",
Skopje, RM
E: samardzioska@gf.ukim.edu.mk

1. OVERVIEW OF THE REGION

Characteristics of the Region

The Former Yugoslav Republic of Macedonia (fYR Macedonia) is located in the central Balkan peninsula in Southeast Europe. It is one of the successor states of the former Yugoslavia, from which it declared independence in 1991.

It is a landlocked country that is geographically clearly defined by a central valley formed by the Vardar River and framed along its borders by mountain ranges. The terrain is mostly rugged. There are 1,100 large sources of water among which around fifty ponds and three natural lakes. The climate is transitional with three main climatic zones: temperate Mediterranean, mountainous, and mildly continental.

The fYR Macedonia covers an area of 25,713 km^2. The population of the region is 2,061,044 inhabitants. Population density calculated on the basis of land area is 82.7 inhabitants/km^2. The country's capital is Skopje and the total population in the Skopje region is 609,140 inhabitants, with population density of 335 inhabitants/km^2. There are eight non-administrative units – statistical regions that are formed by grouping the municipalities as administrative units of lower level; Vardar region (7.5% of the total population in 2012), East region (8.7%), Southwest region (10.7%), Southeast region (8.4%), Pelagonia region (11.3%), Polog region (15.4%), Northeast region (7.5%) and Skopje region (29.6%). All data in the above paragraph is according to the fourth edition of the State Statistical Office, ("Regions of the Republic of Macedonia, 2013", as at 30.06.2012).

The Former Yugoslav Republic of Macedonia is a parliamentary democracy with an executive government. The Assembly is made up of 120 seats and the members are elected every four years. The role of the President of the Republic is mostly ceremonial, with the real power resting in the hands of the President of the Government (Prime Minister). The members of the executive government are chosen by the Prime Minister and there are ministers for each branch of the society (in total 23 members).

The country suffered severe economic difficulties after independence (1991) and during the transition to a market economy. According to Eurostat data (as at 15.11.2013; http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00114), Macedonian PPS GDP per capita stood at 35% of the EU average in 2012. Refer to the State Statistical Office ("Regions of the Republic of Macedonia, 2013", p. 45), the gross domestic product in 2011 was €3,632 per capita. The maximum share of GDP comes from sector: Mining; manufacturing; electricity, gas, steam and air conditioning supply; water supply; sewerage, waste management and remediation activities, and for 2011 it was 18.7% (http://www.stat.gov.mk/OblastOpsto_en.aspx?id=7). In the year 2012, the employment rate was 39%, with the highest observed rate in the Skopje region (38%) and the lowest observed one in the Northeast Region (24.6%), ("Regions of the Republic of Macedonia, 2013", p. 32).

According to the data of the State Statistical Office, at risk of poverty rate in the fYR Macedonia in 2011 was 27.1% (http://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?rbrtxt=115, table T-01: Poverty and social exclusion indicators). Within this framework, 26.9% of the population can't afford to keep their home adequately warm i.e. suffer from fuel poverty (http://www.stat.gov.mk/PrikaziSoopstenie_en.aspx?rbrtxt=115, table T-07: Materially deprived persons in relation to certain items, 2011).

Within the Government, the ministry responsible for the energy sector is the Ministry of Economy. Part of the responsibilities related to energy belong also to the Ministry of Environment and Physical Planning as well as to the Ministry of Transport and Communications. For the purposes of providing support to the Government in the implementation of the energy policy, and Energy Agency has been formed. Government of the Former Yugoslav Republic of Macedonia in 2010 adopted "Strategy on energy development in the Republic of Macedonia until 2030". The main objective of this strategy is to provide a reliable and good quality energy supply to the consumers, (Ministry of Economy of RM, 2010).

Energy demand and supply of the Region
Most of the data in this Country report, if not differently indicated, origin from the State Statistical Office of Republic of Macedonia. Energy Statistics 2000 – 2010 (2012).
Total primary energy production of the fYRoM in 2010 is 19.4 TWh[1,2] (*Figure 1*).

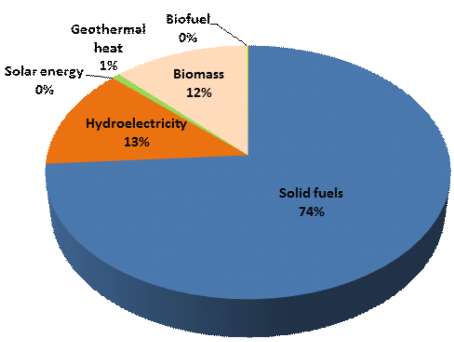

Figure 1 – Total primary energy production in fYRoMin 2010 (Energy statistics 2012: T-01.1)

The total energy demand (gross inland consumption[3]) in the region in 2010 is 34.5 TWh (*Figure 2*).

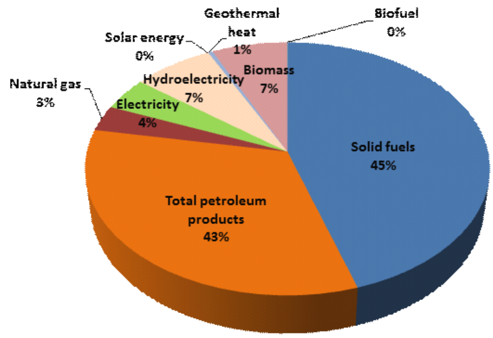

Figure 2 – Total energy demand in fYRoM in 2010 (Energy statistics 2012: T-01.6)

Final energy consumption in the region for all sectors (manufacturing, construction, transport, household use, services and agriculture etc.) adds up to 21.5TWh in 2010 (*Figure 3*).

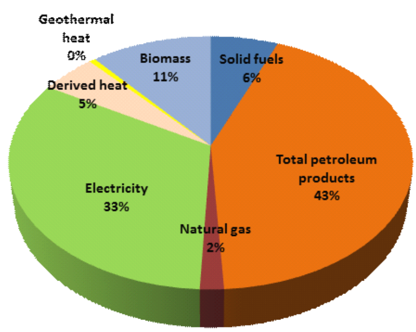

Figure 3 – Final energy consumption in fYRoM in 2010 (Energy statistics 2012: T-01.7)

Presented data shows that petroleum products (43%) and electricity (33%) contribute the most to total final energy consumption. Final energy consumption in the region in 2010 for the three main sectors is: industrial sector with 6.3TWh, domestic sector with 6.5TWh and the transport sector with 5.5TWh. Other sectors consume 3.2TWh.

The energy dependency (calculated as the ratio between the net import of energy and the total energy demand in the region), which indicates the extent to which the country relies on imports to meet its energy needs is 44%, (Energy statistics 2012: T-01.3). The share of energy sources for electricity production can be seen in *Table 1*. 66% of electricity is generated from public thermal power stations.

Energy Source	**GWh/ (in 2010)**
Total	**7.258**
Renewable electricity	2.429
Public thermal power station	4.802
Autoproduction thermal power stations and CHP plants	27

Table 1 – Gross electricity production by type of plant in fYRoM in 2010, (Energy statistics 2012: T-02.18)

The share of electricity from renewable sources in total electricity production is 33.5% and in gross national electricity consumption[4] is 28% *Figure 4* shows the proportion of renewable energy production according to the source. Due to the hydrological conditions in the region, hydroelectricity is the most harvested among the renewable sources, following by biomass whilst solar power offers a minimal contribution.

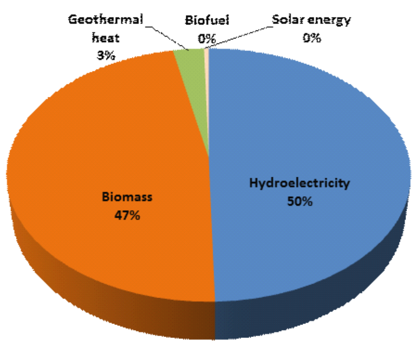

Figure 4 – Renewable energy production by source, in fYRoM in 2010, (Energy statistics 2012: T-01.12)

Two additional parameters that provide indicators of the energy demand and consumption of the region are gross inland production per capita which is 16.8MWh and final energy consumption in households per capita which is 3.14MWh, in 2010.

The average value of CO_2eq emissions per capita for the year 2000 (according to the official census data) is 7.16 t CO_2-eq/capita, (Atanasovska, 2010). According to the WB data (http://data.worldbank.org/indicator/EN.ATM.CO_2E.PC) this value is 5.2t CO_2-eq/capita, for the period 2009-2013. Comparing the above value with 9.2 t CO_2-eq/capita in the EU-15 in 2011 (GHG trends and projections in the EU-15), the emissions are lower which may reflect the overall economic situation in the country.

GHG emissions by each per sector (agriculture, waste, transport, industry, heating and electricity) are integrated in order to project the total national GHG emissions over the period 2008-2025 (*Figure 5*). The total GHG emission factor in 2010 is slightly over 15000 ktCO_2-eq and for electricity is slightly over 9600 ktCO_2-eq. The above projected values stand for so called baseline scenario which is based on the existing thermal power plants with domestic lignite and it is the most destructive environmental scenario for the development of the Macedonian power system (Atanasovska, 2010). This kind of thermal power plant with domestic lignite produce 74% of total primary energy production in the region (*Figure 1*).

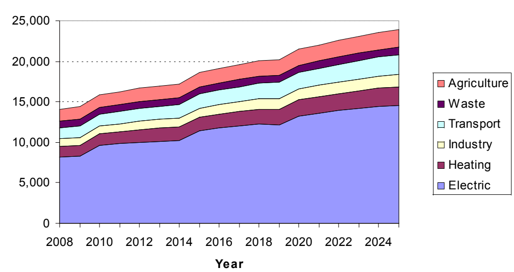

Figure 5 – Projection of the total GHG emissions – baseline scenario

GHG emission factor for electricity from the grid in 2010 is 1.32kgCO_2-eq/kWh. This factor is significantly above EU-27 average electricity emissions factors, (0.38 kgCO_2-eq/kWh in 2008, http://www.eea.europa.eu/data-and-maps/figures/trends-in-energy-ghg-emission).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Targets set for the region are presented in the National Document "First energy efficiency action plan (EEAP) of the Republic of Macedonia by 2018", developed pursuant to the Directive 2006/32/EC. This EEAP covers the period 2010 – 2018 and sets the total national indicative target for energy savings of at least 9% of final inland energy consumption by 2018 compared to the average final inland energy consumption registered in the period 2002 – 2006. National indicative energy savings targets for 2018 are 199.78ktoe, (*Table 2*) which is 12.2% of average energy consumption for the last five years (1636ktoe). The short term set target for 2012 was 4.04% of the average energy consumption (66.10ktoe).

National indicative energy saving targets for 2018	ktoe
Total	**199.78**
Residential	40.51
Commercial and services	24.19
Industry	90.45
Transport sector	44.63

Table 2 – National indicative energy saving targets (First energy efficiency action plan of the Republic of Macedonia by 2018)

These targets (*Table 2* and *Figure 6*) should be achieved through set of comprehensive Energy Efficiency Improvement (EEI) program and measures. Different EEI measures are anticipated for the different sectors. The most efficient ones in the residential sector are Adoption and enforcement of Building Energy Codes and EE Retrofits in existing buildings, (50% of the energy savings in this sector). For the commercial and services sector, again Adoption and enforcement of Building Energy Codes and EE Retrofits of Hospitals participate with 46% in corresponding energy savings. Cogeneration and Clean Development Mechanism take more than 71% of the total energy savings in industry sector. In the sector of transport, renewal of the national road vehicle fleet and Promotion of sustainable urban transport systems should provide 65% of energy saving in the sector (for more details refer to tables 1.1.1; 1.2.1; 1.3.1 and 1.4.1 in the EEAP 2011).

Potential savings of 57.1% in residential buildings and 28.6% in commercial and public buildings in 2020 have been identified refer to above listed EEI.

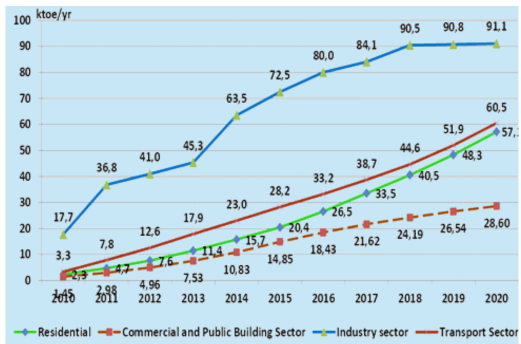

Figure 6 – Goals in potential of energy savings according to the Strategy of EE, up to 2020

Total GHG current emissions (in ktCO_2-eq) from all sectors can be seen in *Figure 7*. This indicates that energy production generates 74% of GHG emissions for the Region.

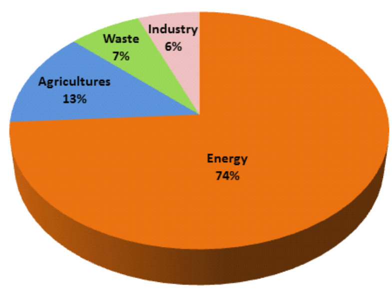

Figure 7 – Total GHG current emissions for 2013

Projection of the GHG missions from all sectors in the period 2008 – 2025 can be seen in *Table 3*.

Scenario	2008	2025
Baseline scenario	14040	23947
First mitigation scenario	13904	20348
Second mitigation scenario	12645	16743

Table 3 – Projection of the GHG emissions 2008 – 2025 in ktCO$_2$-eq, (Atanasovska, 2010)

The first mitigation scenario is the variant of utilising the capacity of the gas pipeline for electricity generation in two gas. Combined Heat and Power (CHPs) that would replace the lignite-fired plants from the baseline scenario. The second mitigation scenario, besides CHPs, assumes reduction in electricity needs by about 2,000 GWh, which is a result of the liberalisation of the electricity market for large industrial consumers. Furthermore, it assumes that at the end of 2025, the cumulative effect of the progressively increasing utilisation of renewable energy sources (small hydropower, wind, and biomass) for electricity generation would annually generate 180 GWh. The anticipated GHG reduction target in 2020 is 20% for the first mitigation scenario and 30% for the second mitigation scenario (*Figure 8*.)

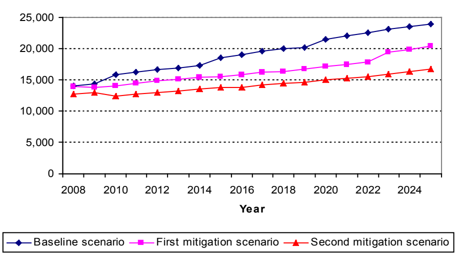

Figure 8 – Projection of the total GHG emissions, for all three scenarios, 2008 – 2025, (ktCO$_2$-eq)

Other Regional targets, barriers and drivers
The Strategy for Development of the Energy Sector in Macedonia is mostly based on the conclusions from the analysis of the situation in the energy sector of Macedonia (SWOT– strengths and weaknesses – *Table 4*) as well as the other comparative (benchmark) analysis. (Strategy for energy development in the Republic of Macedonia until 2030, (2010)).

STRENGTHS
Strategic geographic location
Unutilised potential of renewable energy sources
New legislation and bodies in accordance with the European regulation and the Athens memorandum
Strengthened activities in the areas of energy efficiency and renewable energy sources
WEAKNESSES
Long term lack of strategic planning
Weak economic power of the state for investments in the energy sector
Weak geopolitical location
The country is poor with domestic energy resources and largely depends on energy imports
Unfavourable combination of energy sources
Insufficient and obsolete electricity generation capacities
Low energy efficiency in the generation, transmission, distribution and utilisation of energy
Incomplete secondary legislation for energy efficiency and RES
High electricity consumption in the residential sector
Insufficient capacities

Table 4 – SWOT analysis in the energy sector

The lack of National Regulations on energy performance of buildings has been an obstacle for the improvement of buildings in fYRoM for many years, together with education for certification of energy controllers. National Regulations were delivered in July 2013 which should lead to an improvement in the energy performance of buildings in the long term.

The fYR Macedonia has participated/is participating in the following projects which represent good practice and can boost development in the field:

- *RENA* – Regional Environmental Network for EU Accession – financed by EU to enhance regional cooperation in the Western Balkans and Turkey in the field of environment in the prospect of EU accession; (http://www.renanetwork.org/)
- *LOCSEE* – Low Carbon South East Europe - to strengthen the capacity and knowledge of public authorities and other institutions dealing with the climate change in the SEE (South East Europe) countries and to develop a systematic cross-sectorial approach for creation of low carbon policies in SEE. The partnership comprises 17 partners from the SEE region; (http://www.locsee.eu/)
- *BUILD UP SKILLS MK* - Building capacities in the construction sector- supported by Intelligent Energy Europe to define the path that needs to be followed in the country in the next seven years for the upgrade of skills and qualifications of the building workers in the practical application of EE and RES measures as the national energy targets for 2020 could be met; (http://www.buildupskills.mk)
- *UNDP project - Energy efficiency in building sector* – financed by Austrian Development Cooperation to contribute to the processes of reducing the energy consumption in residential and public buildings, regulate energy losses and greenhouse gas emissions, and increase the Macedonian's energy independence. Within this project "Energy Efficiency in Public Buildings: Guideline for Energy Efficiency Retrofits, (2011)" was published; (http://www.eeportal.mk/en/About/1/Project-info/24)

In the above listed projects Macedonian beneficiaries include the: Ministry of Environment and Physical Planning, Ministry of Economy, Association of Local Self Government Units (ZELS), Economic Chamber, Energy Agency, Civil Engineering Institute "Macedonia", Faculty of Electrical Engineering and Information Technologies and Association for business and consultancy "Kreacija".

Tables 5, 6 and *7* present the share of renewable energy sources (RES) and the final energy consumption (FEC) for the lowest limits (LL) and the highest limits (UL) for the target year 2030. The percentage share of RES in the country, in 2030 will be between 21.1% and 27.7% with average value (realistically achievable) of nearly 25%, (Strategy for energy development in the Republic of Macedonia until 2030, (2010)). This target is in line with the EU_27 MS national targets in 2020 which average values is 21.5% (Directive 2009/28/EC, Annex I).

Scenario	**2030 LL**	**2030 UL**
Electricity from RES	3898	5301
Heat from RES	3183	3445
Biofuels	1700	1900
TOTAL RES	8781	10646
Final energy consumption	41710	38560
RES share (%)	**21.1%**	**27.6%**

Table 5 – Share of the RES in the FEC (GWh)

Scenario	**2030 LL**	**2030 UL**
Hydro power plants	3430	4410
Wind power plants	360	720
Photovoltaic	28	56
Biomass	50	70
Biogas	30	45
Total electricity from RES	**3898**	**5301**

Table 6 – Electricity from RES, (GWh)
Table 7. Heat from RES, [GWh]

Scenario	**2030 LL**	**2030 UL**
Biomass	2540	2630
Solar energy	83	155
Geothermal energy	560	660
Total heat from RES	**3183**	**3445**

Table 7 – Heat from RES, (GWh)

It is necessary to reduce the energy import dependency (in total 15.2TWh or 44%) by improving the energy efficiency in the production, transmission, distribution and utilisation of energy and by higher energy production from RES and other domestic resources (*Figure 9*). Also, it is necessary to increase the share of natural gas in the energy consumption and reduce the relative share of electricity (*Figure 3*).

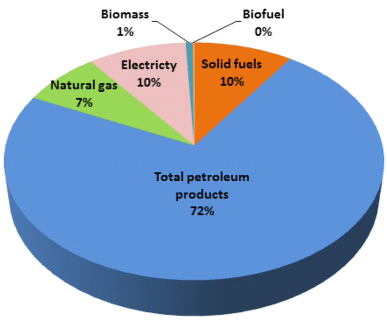

Figure 9 – Net import by energy commodities (Energy statistics 2012: T-01.2)

Innovative strategies/initiatives

Unique sectorial collaboration within the frame of the EUbuild Energy Efficency project, (http://www.eubuild.com/eng) has led to Association of Turkish Building Material Producers being launched. The main objective is to contribute the development of the financial instruments and mechanisms in order to build up the market for energy efficient products and methods in the partner countries, (Albania, Montenegro, Bosnia and Herzegovina, Serbia, fYRoM and Turkey).

Another project, MARIE - Mediterranean Building Rethinking for Energy Efficient Improvement, objective is to co-construct a Mediterranean strategy for the energy efficiency of buildings ("MEDBEES"). This is based on a supply and demand analysis for energy renovation and will encourage and facilitate the energy renovation of Mediterranean buildings. More ongoing projects for energy efficiency at fYRoM can be found the web page of the Energy Agency (http://www.ea.gov.mk).

Emerging technologies

Improvement of energy efficiency in the construction of new buildings and in the improvement of existing buildings by integrating energy efficient ecological materials in an environmentally friendly way is a current trend in Macedonia.

Electric vehicles are being promoted for mobility in Macedonia, which will establish a sustainable energy, energy efficiency, healthy environment, zero emission of CO_2 and other greenhouse gases. Dissemination of information regarding this issue was done on the "International EV conference in Macedonia – Electric vehicles new trends in mobility" (June, 2013) and accompanied leaflet was published (http://www.eusew.eu/upload/events/851_11218_elektromobilnost%20macedonia.pdf).

3. CASE STUDY: KARPOSH MUNICIPALITY, SKOPJE

The municipality of Karposh is a compound part of the City of Skopje, one of the ten municipalities of Skopje. It consists of 14 unites called local communities, out of which 12 are urban and two are rural. It is the fourth biggest municipality in the City of Skopje with more than 59,666 inhabitants covering an area of $35km^2$.

The Municipality of Karposh is a pioneer in the country in application of the energy efficiency policies at the local level. Besides the Municipality many other stakeholders including Governmental institutions, citizens of Municipality of Karposh, NGOs, Association of Local Self Government Units (ZELS), business sector, as well as, international stakeholders are involved in activities.

As a first initiative the "Program for energy efficiency 2008-2012" was issued And within the framework of this program the following activities were carried out:

1. reconstructed public facilities – 10 primary schools and 3 kindergartens applying EEM, (*Figure 10*);
2. reconstructed 4 residential buildings with collaboration with "Habitat Macedonia", applying EEM, (Q≤100 kWh/m^2 per year);

3. construction of 63 new buildings according “Regulation on energy efficiency measures”, (Q≤70 kWh/m² per year).

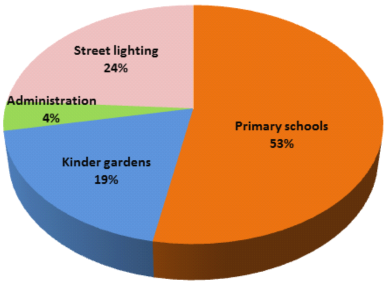

Figure 10 – Annual energy consumption – 2007, (Data base of Municipality of Karposh)

The Municipality of Karposh is one of the first users of the software tool for energy monitoring Ex-CITE, (*Figure 11*). The data is being updated monthly.

Figure 11 – External Climate and Inventory Tool for Energy efficiency application (ExCITE)

Ex-CITE is a software tool developed within the framework of the above cited UNDP project to strengthen the capacities of the local government units comprising the databases for climatological parameters and the inventory data. It is an internet application that connects processes of entering data for buildings, street lighting, energy consumption and energy expenses on the one side and climatologically data needed for calculating energy performance on the other. It offers a standardised format of reporting on the energy consumption of public buildings.

The new “Program for Energy efficiency 2013 – 2015) was issued in July 2013.

Objectives and methods

All interventions, measures and methods applied in the Municipality are thoroughly describe in the “Catalogue for energy efficiency facilities in Municipality of Karposh”, published in August 2013, (http://www.karpos.gov.mk/). 13 public facilities (10 primary schools and 3 kindergartens) were retrofitted and some of the applied EEM are: thermal insulation of walls and facades; new floor and roof insulation; replacement of windows and doors with EE frames; cleaning and replacement of the heating system etc. Four residential buildings were reconstructed with full thermal insulation of walls and replacements of carpentry with EE windows. These buildings are only part of the 165 buildings that should be retrofitted within the next three years in the frame of the new “Program for Energy efficiency 2013 – 2015”. The 63 new buildings are constructed according to the issued “Regulation on energy efficiency measures” with Q≤70 kWh/m2 per year).

Long term focus

Considering the long term focus the following activities are anticipated:

- application of the new “Program for energy efficiency 2013 – 2015”. The total number of planed projects is 15 and the anticipated projects budget is about €12.The projected energy saving in 2015 in the street lighting is 26.5%, in primary schools is 50% and in the kindergarten is 33.9% (in reference to 2007);
- drafting of local environmental action plan;
- energy efficiency and using of renewable sources of energy in the kindergartens and primary schools in the Municipality of Karposh;
- new energy efficient facades of over forty existing buildings in the Municipality of Karposh, with inhabitants’ participation;
- establishing of public-private partnership in the field of infrastructure for construction of natural gas, geothermal waters, photovoltaic and technical water networks.

Outcomes

As a result of the applied energy efficiency measures within the “Program for energy efficiency 2008 – 2012”, there has been a reduction of the energy consumption in the buildings under Municipality governance from 9,819 MWh/per year in 2007 to 7,443MWh/per year in 2012, i.e. 25.2%. This equates to a reduction of CO_2-eq for 2,381 t. The energy savings in the street lighting was 8.7%, in primary schools was 32% and in the kindergarten was 4.2% (in reference to 2007).

The second important outcome is "Regulation on energy efficiency measure" (2012) which provides 40% to 70% less consumption of energy in comparison with the same buildings construct/retrofit without applications of EEM. Application of this regulation is mandatory for the Municipality of Karposh.

In general, application of the energy efficiency policy at the Municipality level was acknowledged as pioneering and a successful activity in the fYRoM which brought together different local stakeholders and different funding schemes.

Drivers for further realisation of such type of programmes include:
- increased competence and responsibility for the municipality due to the process of decentralisation;
- funds available for local self-government from the EU (IPA) 2008;
- the Mayor of Municipality of Karposh signed EUInitiative Covenant of Mayors 2012, for 20% reduction of CO_2-eq until 2020.

Perceived barriers include:
- international perception of instability of the region;
- unstable economic conditions for development;
- lack of interest of the local banks to invest in the retrofitting programmes;
- possible territory reorganisation of the City of Skopje.

4. CONCLUSIONS

The Municipality of Karposh represents typical building urban stock in fYRoM. The age of the existing building stock and traditional type of construction, entire environmental, economic and social conditions can be found in most of the urban areas in the country which give possibility to transfer this "good practice" into other municipalities in the region.

It is important to emphasise that the outcomes achieved to date are based mostly on the available Municipality's capacities. The Unit for Energy Efficiency (EE) exists within the frame of the Municipality and its experts are working on the application of the EE policy. Funding is mostly based on Municipality budget, as well as through grants from EU or other international institutions. In the future, transfer of this positive experience is feasible through training programmes (for the Municipalities in the country) and through twinning projects (or other available instruments) across the wider region.

FOOTNOTES

1. (1toe = 12MWh, http://www.bp.com/conversionfactors.jsp)
2. Biomass = Wood Fuel + Wood Waste and Other Solid Waste.
3. It is a balance category calculated as: primary production + imports + variations of stocks – exports.
4. Gross national electricity consumption is a sum of net import and total electricity production.

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GERMANY

AUTHORS

Werner Lang
Technische Universität München
Chair of Energy-Efficient and Sustainable Planning and Building (ENPB),
w.lang@tum.de
Arcisstrasse 21, D 80290 München

Philipp Geyer
Technische Universität München
Chair of Energy-Efficient and Sustainable Planning and Building (ENPB),
p.geyer@tum.de
Arcisstrasse 21, D 80290 München

1 OVERVIEW OF THE REGION

Characteristics of the Region
The Region of Bavaria is one of sixteen states in the Federal Republic of Germany. It is the second biggest state in Germany with more than 12.5 million inhabitants and with an area of 70,000 square kilometres. The state capital of Bavaria is Munich with famous cultural and architectural characteristics. Located close to the Alps and characterised by rural landscape Bavaria has developed a strong innovative region in recent decades. High-tech industries combined with historical way of life pave the way for the future development of Bavaria. Economic prosperity is founded upon innovative small and medium-sized companies and is reflected in an extremely high GDP of around €37,000 per capita and an employment rate of 75% in the year 2010.

The environmental and energy sector in Bavaria consists of many international market leaders, which have a proven long-term competitiveness in their fields, such as automotive industries. The recent global crisis intensified the need for a stable legislative framework, which secures and provides conditions for local value creation which are the focus of current Bavarian economic and energy policies.

Due to the federal organisation, every state has a sovereign constitution and is able to shape its own areas of legislation. This is particularly true for the energy sector, where local regulations for buildings and incentives for renewable energies have been established locally. With respect to these regulations and incentives, Bavaria is one of the leading regions in Germany.

Energy demand and supply of the Region
The region of Bavaria has a detailed energy strategy established by the Bavarian Government (2011). The goals and data within this paper, unless indicated otherwise, originate from this document. Total primary energy demand of Bavaria in 2008, as shown in *Table 1*, was 567 TWh and was mainly based on petroleum products, nuclear power and gas. Renewable energies amount to 10.1% with a strong growing trend (12.9% in 2010, Federal Working Group of Energy Balances, 2013). The total final energy consumption of Bavaria totalled 390 TWh in the year 2010 which was subdivided into three sectors: domestic sector with 181 TWh, commercial-industrial sector with 87 TWh, and the transport sector with 123 TWh (Federal Working Group of Energy Balances, 2013).

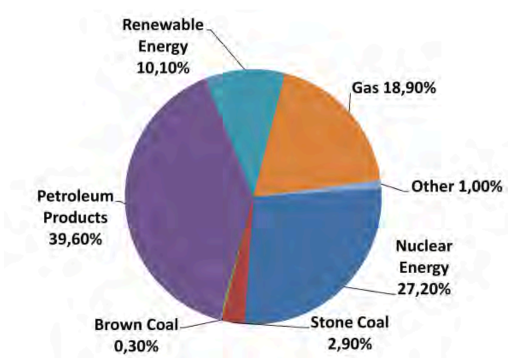

Figure 1 – Total primary energy demand of Bavaria in 2008 (100% = 567 TWh, Source: Bavaria Government 2011)

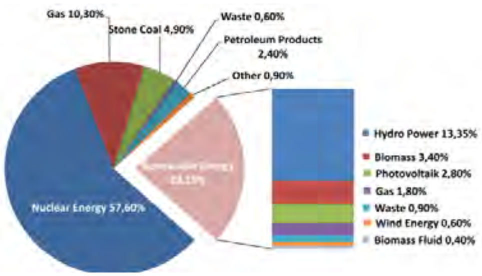

Figure 2 – Electric energy supply of Bavaria in 2009 (100% = 85 TWh, Source: Bavaria Government 2011)

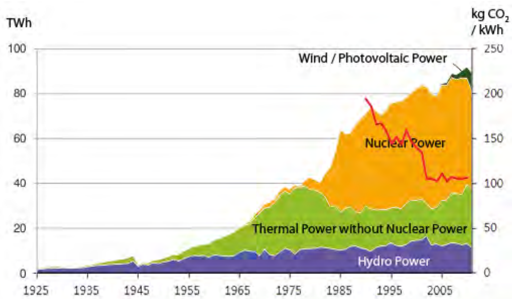

Figure 3 – History of the energy sources for electricity supply in Bavaria and CO_2 emissions including electricity imports from 1925 to 2011. The red line shows the kg CO_2 emission per kWh electricity. (Data / source: www.statistik.bayern.de)

The average CO_2 emissions amount to 6 tons per capita per annum (the national average for Germany is about 9 tons). This is mainly caused by the low-emission energy supply, as shown in *Figure 3*, resulting in very low GHG emissions for electricity from the grid at slightly above 100 g CO_2/kWh (the average in Germany in 2012: 546 g CO2/kWh, source: www.Umweltbundesamt.de). This low figure for Bavaria is a result of the high percentage of nuclear power and an increasing share of renewable energies. However, the phasing out of nuclear power is a challenge for a climate-friendly energy supply in the future. Bavaria leads Germany in terms of the use of hydro energy, solar energy, biomass, and geothermal energy. Furthermore, Bavaria has a good developed and modern gas infrastructure which enables petroleum gas to be a feasible substitute for nuclear power. In contrast, Bavaria does not have much coal-fired power. Coastal areas of Germany dominate the potential for wind energy.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Germany aims to decrease its CO_2 emissions by 40% until 2020 increasing up to 80% to 95% by 2050 compared to 1990 levels. Renewable energies are to achieve share of gross final energy consumption by 2020 increasing to 60% by 2050. For electricity consumption, the share of renewable is planned to be at least 35% in 2020 increasing to 80% in 2050.

Due to the fact that climate protection is a number one priority of the Bavarian Government, the region's policy is fully supportive to the Federal Governments climate goals. Bavaria faces the challenge of climate change. Bavaria had a total GHG emission of 80 million tons of CO_2 equivalents (6.4 tons per capita and year) in 2010 (Federal Statistical Office 2012) and aims to reduce CO_2 emissions to below 6 tons by 2020. That is only possible by extending renewable energies and increasing energy efficiency.

Until now Bavaria covers its energy consumption within its domestic boundaries; however, this could become difficult in the future as energy production depends more and more on renewable energies. Offshore wind farms and grid-connected PV systems located outside of Bavaria might offer a chance to solve this problem. According to policies, the government intends to keep Bavaria as independent as possible of energy imports. In the next 10 years, the aim is for renewable energies to cover up to 50% of the Bavarian electricity demand; that's double what is provided today. Regarding the share of renewables in final energy consumption, Bavaria aims at accomplishing 20% and thus excels the given EU goal by 10%.

Other Regional targets, barriers and drivers
One important measure in Bavaria is a significant reduction of heat demand of 20% for residential buildings and 15% for industry

by the year 2021. Furthermore, the renewable share in electricity supply should be increased to 50% by the year 2021. These regional targets have been initiated by the Bavarian Government and are clearly political goals. To achieve these objectives of climate protection, political goals and compliance are necessary together with a stable supply of climate-friendly technologies. The political framework accompanied by the German nuclear phase-out, which started in 2011 and shall be finalised in 2022, demonstrates a stronger shift to natural gas is exemplary for a European Energy Region and its transformation. Nevertheless, the increased CO_2 emissions through this intensified substitution of natural gas needs to be compensated by an efficiency increase in the areas of heating energy and mobility.

Bavaria will accomplish this by a massive investment in new cross-nation power lines, improved regional power grids and additional renewable power sources. Gas-fired power plants will replace old nuclear plants progressively. Furthermore, major improvements are required in the generation and usage of heat and energy usage for mobility. This should be supported by investments focussing on energy storage and innovative energy research projects.
A broad variety of renewable energies have to be promoted based on water, wind, solar, geothermic potentials etc. Therefore socially compliant, economic reasonable and environmentally compatible solutions are required.

In Bavaria solar irradiation is very high and suitable soil is available so that solar and geothermal energy sources could be used effectively. Due to German energy saving policies ('Energieeinsparverordnung', EnEV = energy saving ordinance and 'Gesetz zur Förderung Erneuerbarer Energien im Wärmebereich', EEWärmeG = law for the promotion of renewable energies for heat use) many new buildings use renewable energy sources. At present, there are about 500,000 solar collectors and 80,000 heat pumps installed in Bavaria. Additional instalments in existing buildings tend to be approx. 25,000 solar collectors and 3,000 head pumps per year. The Bavarian Government uses financial incentives and information campaigns to strengthen these numbers with an initiative called "Energiewende vor Ort" (local energy transition) which aims to encourage local and regional energy suppliers to multiply investments in renewable energy plants.

On the demand side, the building sector accounts for a major part of the energy demand and related emissions. The sector causes approx. 35% of the emissions and has a share of 40% of the total energy demand. Moreover, heat demand and domestic hot water account for 90% of these emissions. Although in the last 10 years reductions in demand have been realised, the potential of energy saving and respective emission avoidance has not been exploited. Demand by existing buildings is large due to high renovation costs and a lack of information on government funding available. If the current trend continues, only 10% of the required 20% of savings will be realised; and it will not be possible to reach the 50% goal in 2050. Therefore, Bavaria is going to have to optimise the subsidies to promote energy-focused building refurbishment and to abolish legal barriers. For this reason, the government plans to increase the CO_2 retrofitting program of the KfW banking group by another 4 billion Euro. Furthermore, the programme will be extended in duration and applicability. Tax incentives are also planned to support the realisation of the energy saving potential.
The case study presented in the second part of the text deals with the delay of investments for the energy transition and its interrelation with economic and social factors.

Transport accounted for 38% of the CO_2 in the year 2010 in the region (Bavarian Office for Statistics). Based on a study by the European Commission, public transportation will increase by one third until the year 2030 in Bavaria which indicates the need for efficient, sustainable and climate-friendly systems of transportation. Within urban areas, this implies concentration of residential areas including decrease of soil sealing for motorised transport and better distribution of use in urban structures to avoid traffic, so that inhabitants can reach their everyday needs within short distance ("Stadt der kurzen Wege", Short-distance city). Furthermore, a more widespread and optimised urban transport system enhancing bicycle and pedestrian traffic could transform traffic flows to more climate-friendly modes. Finally, it is essential for the economy in Bavaria to guarantee the security of energy supply especially for those, which develop future-proofed technologies next to competitive energy prices.

3. CASE STUDY: URBAN LABORATORY NUREMBERG WESTERN CITY

The impacts of global change are increasingly affecting cities and urban agglomerations. Economic, social, technological and ecological changes, such as climate change or the energy policy transformations in Germany ('Energiewende' = energy transition) impose significant challenges, which are of major importance for the existing neighbourhoods and communities in urban areas.

The interdisciplinary research project 'City Lab Nuremberg West' at the 'Technische Universität München' (TUM) commissioned by the City of Nuremberg investigated how the urban district Nuremberg Western City (*Figure 4*) dealt with these challenges. The main goal of the study was to establish long-term strategies for the development of a liveable and sustainable future for this urban district. The innovation of the study consisted of the energy planning for an urban structure to suit the local economic and social conditions of the district and to provide feasible strategies for different conditions. The main hypothesis of this approach was that a sustainable and energy-efficient urban area is only achievable taking into account social and economic aspects.

Figure 4 – District of Nuremberg Western City (Zitat) (Author: Isabell Nemeth)

An interdisciplinary team of scientists has been working together on the 'Urban Laboratory Nuremberg West' project. Knowledge of different working methods, levels of detail and references was crucial to create a base for the interdisciplinary collaboration of the various disciplines and work areas, such as urban planning, landscape planning, resource consumption and energy efficiency and transport planning.

Initial conditions and local situation
Located in the German state of Bavaria, the city of Nuremberg has a population of 500,000 inhabitants; the metropolitan region includes 3.5 million inhabitants. The district Nuremberg Western City connects Nuremberg to the nearby city of Fürth. It has 20,000 inhabitants in an area of 3.25 km^2. Nuremberg and particularly its the district Western City have been impacted by economic change since the 1970's when the labour market declined and the city's economy shifted from traditional manufacturing (metal, steel, and textiles) to other sectors including communications, energy technology, and consumer electronics.

As these economic changes occurred, former industrial sites and their related infrastructure have become increasingly marginalised. Analogue to the urban structures grown during industrialisation, the structures of energy demand and supply are complex. With respect to energy demand, there is a large range of building types reaching from farm houses with an age of several hundred years to highly energy-efficient new buildings. More than half of the residential buildings in the area of Nuremberg Western City was constructed before 1948. As a consequence, façades are decorative resulting in challenges with regard to the thermal improvement of the building envelope. Furthermore, as a result of the industrial history of the quarter, more than 50% of the heated buildings are non-residential, which may change depending on future development.

The loss of economic investment and the traditional manufacturing sector raises questions about the identity of the area and appropriate urban development goals. Along with the economic change and the associated job losses and increasing poverty levels in Nuremberg, planners must also grapple with pressing issues of sustainability and the related 'Energiewende', which requires a shift to renewable energy sources and the major renovation of existing buildings and infrastructure, such as water, energy and transport. Requirements of the energy transition, while benefitting the environment, may negatively impact already vulnerable population groups if the burden of their implementation falls on the poor.

Objectives and methods

The goal of the case study was to create a strategy for the sustainable redevelopment of Nuremberg Western City. The emphasis was placed on minimising the dependency on fossil fuels. The results of this 'laboratory' are expected to enable the city of Nuremberg to implement strategies for the future development that address the social, economic, and ecological aspects of sustainability, and are able to be implemented both at an individual neighbourhood as well as on a citywide and even regional level. Using this approach, the study will provide the city with feasible strategies for different situations of urban development. Furthermore, it is intended to analyse how this work can be applied to other post-industrial cities, regions and nations.

Long term focus

This study has a long-term focus until the year 2050, which distinguishes it from the usual techniques of urban energy planning which are typically more short term. This long-term approach and strategic planning are crucial with regard to economic feasibility and realisation of these measures such as the infrastructure of the city including energy systems, individual and public transport, as well as water supply and sewage systems. Particularly with regard to the development of key projects, sites and locations, long-term strategies are inevitable, as the short-term realisation of supposedly appropriate projects on specific locations might prohibit the future viability of sustainable projects in these locations. By the conducting this prototype research, the aim is to bring the innovation of long-term analysis and strategy development to the practice of urban planning. The horizon to 2050 is a significant innovation as usual integrated urban development plans (= Integriertes Stadtentwicklungskonzept, INSEK) only take account of a medium-term period in future.

To deal with the uncertainty involved with long-term planning, three alternative development paths for a plausible future were defined and examined. These development paths represent strategies towards a sustainable and liveable city dependent on possible economic development patterns, which are economic growth, economic standstill or economic decline. It is important to mention, that in each of these three visions the concept of a liveable city was taken as an indispensable element for the development. As part of the overall work of the Urban Laboratory Nuremberg Western City, these three development paths were analysed with regard to the functional aspects and the physical development of this part of the city, to the implications on the use of resources and to mobility and transport.

The modelling and the stochastic simulation of the long-term energy demand is based on the residential building stock, which was available as geo-referenced data describing the building's footprints. The data also includes information on the height of the buildings and thus conform to CityGML Level-of-Detail 1. The use of the digital cadastral map shown in *Figure 5* allowed the identification how the buildings are surrounded by other built structures – an aspect that has a high impact on the energy demand. This was combined with information on the construction age classification in certain residential blocks, which allowed for the calculation of the specific energy demand with a satisfactory accuracy.

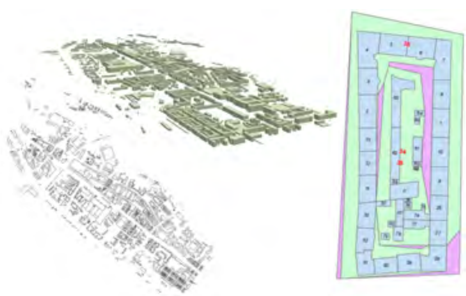

Figure 5 – Digital cadastral map of Nuremberg Western City (Zitat) (Author: Isabell Nemeth)

The energy demand of non-residential buildings was based on the determination of their function and from assigning specific energy consumptions according to their use. For both sectors, the model includes the energy consumption of all processes inside the buildings. In residential buildings, this is derived from the shape of the building; in non-residential buildings, the type of the company and its energy consumption determines the demand of process energy. Furthermore, the model includes retrofitting measures by a stochastic approach. The method assigns a probability to the different parts of the buildings to be renewed and energetically improved. With the exception of the limitation of a lack of information on the specific technical equipment of the heating system, this method allows to simulate the energy demand for the specific conditions with good approximation.

The sustainable and liveable urban district approach requires the integration of a very wide range of topics, such as economy, health, mobility, culture, identity, food supply, quality of the built environment and many other aspects. As this research project could not include all these topics, focal points were chosen, which cover the dimensions of sustainability with its main energy consumers in the domestic and the transport sector. Significant factors in the analysis include 'functionality', 'energy and resource consumption', 'mobility' and 'urban quality'. It becomes apparent that many different sectors contribute to the emergence of a city worth living in, both in terms of content as well as in terms of the various administrative levels, such as the state, the city and the private level.

This intersectoral analysis and development requires an integrative systemic view.
The dependencies of the many individual aspects, related to the various sectors and disciplines lead to a complex system that needs consideration for a long-term urban development. To detect and investigate the dependencies of the various factors, a method of systems modelling was developed, which was based on sensitivity modelling described by Frederic Vester (2007). This methodology served to detect the influences between variables and trends of various sectors in an expert discussion at TUM and to map their effects. On this basis, a quantitative system model was developed and simulated. Experiments with this system simulation model served to examine the future development paths, their relation to the energy consumption and emissions, and their involved risks.
The stochastic modelling and simulation of the building stock in detail allowed to identify the key parameters to reduce the energy consumption and the interactions with other sectors, such as investments in building and the economic urban conditions.
The examination of these parameters by stochastic energy simulation and the systems modelling led to strategies for low energy urban regions.

System simulation and results

As result of the stochastic simulations, four major parameters controlling the retrofit of the building stock and its energy consumption and emissions were found. These parameters are the retrofitting rate, the quality of the building envelope, the type of energy sources, and the quality of the building technology, which are presented below.

The retrofitting activity of improving the building envelope has an essential effect on the reduction of the heat energy demand of the residential buildings. However, according to Diefenbach et al. (2010) the current retrofitting rate for buildings constructed before 1978 is approximately 0.8% p.a., which is far below the potential possible level. For a climate-neutral building stock, a doubling of the yearly retrofitting is assumed to be necessary. Therefore, in the simulation, the retrofitting rate was doubled and an increase of the energetical retrofitting was tested.

The parameter building envelope has already been significantly increased, driven by regulations ('Energieeinsparverordnung', EnEV = energy saving ordination). Therefore, increasing the rate of buildings envelope improvement is limited. Considering the retrofitting rate and building envelope, simulations show that the doubling of the retrofitting rate and an increase of the energetically improved retrofitting of 10% per 10 years using an energetic high-quality building envelope according to passive-house standard has the potential to reduce the heat demand of residential buildings by 44% until the year 2050 compared to 2012 in Nuremberg Western City.

The parameter energy source is particularly well situated in Nuremberg Western City. The area of the study contains a large district heating system. A high share of heat for this system comes from the biomass heating power plant, Sandreuth, which assists with a massive reduction of the emissions. The goal of reducing the emissions by 2050 requires an increased development of this district heating network. For this reason, the share of connected buildings until 2050 of 45% was increased to 65%. This eliminates the supply by coal, oil, and electricity for heat generation and thus massively decreases the emissions with respective effect on the air quality.

For the parameter 'quality of building technology', potential energy use is limited due to the wide-spread application of the condensing boiler technology and associated efficiency are already achieved. Therefore, the effectiveness of heat generation technology will not change a lot by 2050. Heat pumps are the only exception with their share in the heat supply of buildings is estimated to be 8 to 10%. However, for this quality of building technology, the potential of reducing primary energy demand and respective emissions is limited due to the use of the German electricity mix. Systemic interdependencies are of major importance. The potential to reduce energy consumption and emission is linked to other factors and parameters in the district. For example, the retrofit of a building's envelope requires economic investments in buildings. This leads to a need of economic activity to allowing the investments. These activities have impact on transport activities and further energy consumption as consequence; also, the potential for quality of life and of liveability of the urban structure accompanies economic activities and investments especially in the case of Nuremberg Western City.

The development of a model for dynamic system simulation of the period until 2050 serves to capture these interdependencies. Firstly the stochastic simulation of the building stock, allowed for modelling the dependency of the reduction of energy consumption

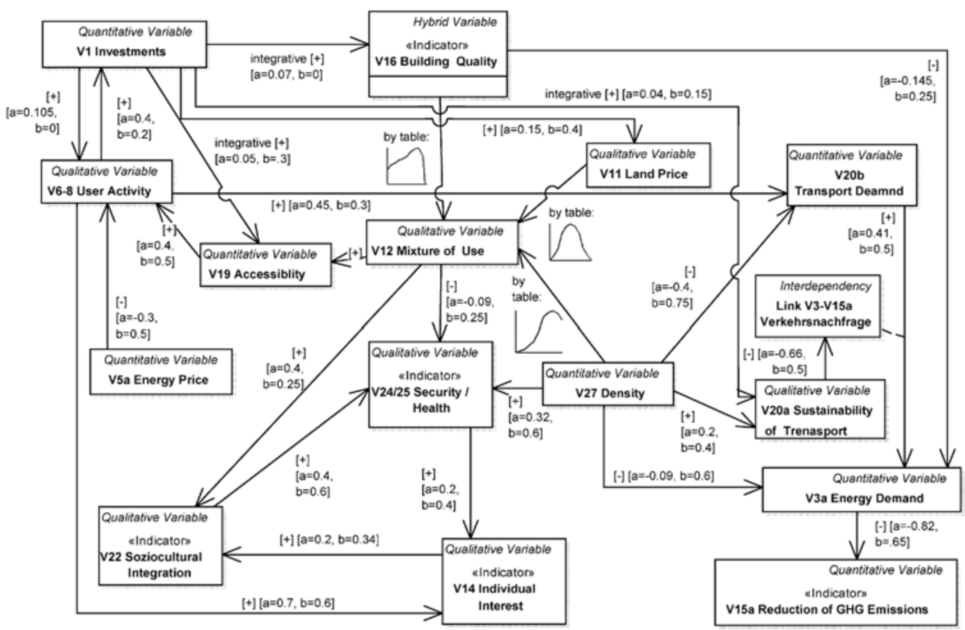

Figure 6 – Systems model of the interdependencies of the built environment and urban transport with the social and economic factors of sustainability

depending on investments in the building stock. Furthermore, well know studies, such as Kenworthy and Laube (1996) and Fischer (1985), and statistics of the City of Nuremberg (2012) served as a data source to develop the systems model and its quantitative interdependencies. *Figure 6* shows the partial effect structure used in the Nuremberg Western City project. All interdependencies shown in this figure are quantified either by the simulation or by looking up statistical data or by other studies that are comparable to Nuremberg Western City.

In most cases, linear dependencies described by a factor a and an offset b serve the modelling of these interdependencies. Only in some cases, such as the link of the building quality (V16) to the mixture of use (V12), more sophisticated functions serve for the modelling of the dependency; these functions are described by tables in combination with interpolation. The system model resulting from modelling all these interdependencies provides the base for the simulation described in the following text.

In the dynamic system simulation, different experiments were carried out to determine the behaviour of each of the three potential development paths under several circumstances and to learn more about sensitivities and risks of each of these development paths. *Figure 7* shows the baseline results (orange line) of the partial simulation made for the scenario "Knowledge economy hub", which is an economic high-activity development path, together with an experiment (blue line). The purpose of this experiment was the examination what effect a delay of investments by ten years has on the development of the district. This experiment helps to assess the risk that the development path will fail due to delayed investments. Furthermore, it determines the sensitivity of the energy consumption in the development path to this risk.

In the results of the experiment shown in *Figure 7*, the dependence of the building quality (V16) on the investments (V1) is clearly shown. Building quality increases only in case of investments. These investments are based on economic prosperity. However, the user activity (V6 8) and the respective transport connected to this economic prosperity lead to energy consumptions (V3a) nearly levelling out the energy savings of retrofitted buildings. However, the increased user activity and a more pleasant built environment cause a significant better fulfilment of individual interests (V14), the inhabitants and working people are more content. Therefore, an economic sane state can lead to a more liveable urban environment.

Outcomes

The developed methods improve the energy efficiency of urban structures considering the interaction with its social and economic conditions and with the specific conditions of urban planning, which the application in the case study shows. This analysis provides a base to evidence that strategies are realisable within a specific urban environment. One important prerequisite for the delivery of the project was the close collaboration between the different involved disciplines at TUM and with the city of Nuremberg. Furthermore, the identification of interactions, interfaces and systemic interdependencies helped to understand the cross-sectoral behaviour of the urban structure and thus influences on its energy-efficiency and the emissions. Main barriers for the delivery of the project were regulations of data protection and data monopolies of energy suppliers. In summary, the project showed that the economic and social conditions of an urban quarter are important drivers of the energy transition. Furthermore, it is required to implement energy-efficiency and sustainability as specific measures in urban planning to enable their realisation.

4. CONCLUSIONS

Nuremberg Western City typically represents urban building stock in Bavaria. The structure is frequently found in non-centre districts. The age of the residential buildings is slightly higher with a higher proportion built before 1948. Furthermore, the building stock of the case study's district is in a poorer condition compared to the Bavarian average. In contrast, the good energy supply infrastructure within the case study district, namely the high share of renewable heat energy from biomass, and the façade decoration, both reducing the potential of future energy efficiency measures, which partly reduces options of energy-efficiency measures, compensate for this potential bias. Therefore, a transfer of the case study to the region – limited to the urban structures – seems appropriate.

The method of combined systems modelling and simulation forms an integrative approach that is deemed necessary to model and plan a real energy transition for specific built structures. Due to the interdependencies of energy-efficiency and emissions on technological, social, and economic conditions, a cross-sectoral approach is required. The detailed stochastic simulation of the building stock and of its retrofitting process allows the correct determination of its energy-efficiency potential. The inclusion of investments in the building stock and further economic and social factors from other studies allow for the linkage to the relevant factors for urban structures. The abstraction and aggregation in a systems model lead to integrative conclusions. We think such a system-based approach is necessary to examine the sectors of urban structures in an integrative way, to assess potentials correctly and to develop feasible well-performing strategies for a sustainable and liveable built environment. This not only concerns cities of Bavaria or Germany but urban structures in general as many energy issues in cities have a multi-sectoral character.

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AUTHOR

Professor C. Koroneos
University of Western Macedonia,
Bakola & Salviera, 50100 Kozani
Dept. of Mechanical Engineering
E: koroneos@aix.meng.auth.gr

Evanthia A. Nanaki, PhD
University of Western Macedonia
E: evananaki@gmail.com

Dimitris Rovas
Aristotle University of Thessaloniki
E: drovas@gmail.com

Assistant Professor Demetri Bouris
National Technical University of Athens,
Dept. Mechanical Engineering
E: dbouris@fluid.mech.ntua.gr

1 OVERVIEW OF THE REGION

Characteristics of the Region
On 1/12/2011, the Architecture of Governance and Decentralised Administration program, also known as Kalikratis, reformed the administrative division of Greece and redefined the self-government regions. Under this, Western Macedonia is one of the thirteen administrative regions of Greece.

The region of Western Macedonia (*Figure 1 – 2*) is situated in north-western Greece, bordering with the regions of Central Macedonia (east), Thessaly (south), Epirus (west), and bounded to the north at the international borders of Greece with the Former Yugoslav Republic of Macedonia (FYROM / Bitola region) and Albania (Korçë County).Its territory spreads to 9,450 km^2 and hosts about 300,000 inhabitants (as per 2011 census), thus it is a low-density populated region (30 inhabitants/km^2, while the country average is 79.7 inhabitants/km^2). This is mainly attributed to the mountainous nature of the region, as 82% of the total surface consists of mountainous and semi-mountainous areas. This is also reflected in the population distribution, as the major part of the population (56%) lives in rural areas. The capital of the region is Kozani with 53,880 inhabitants. Other main towns are Ptolemaida with 37,289 inhabitants, Grevena with 17,610 inhabitants, Florina with 19,985 inhabitants and Kastoria with 16,958 respectively.

Figure 1 – Region of Western Macedonia

Figure 2 – Borders of Region of Western Macedonia (Wikipedia, 2014)

The average GDP of Western Macedonia reached €18,000 (2010 value) in the second quarter of 2013, and the employment rate was 67.5% (Hellenic Statistical Authority, 2011). Its economy is mainly based on agriculture and livestock; nevertheless, the sector of manufacturing also plays a crucial role in the economy. To be more specific, 70% of the Gross Domestic Product from the primary sector is attributed to agriculture cultivation; whereas 30% is attributed to stockbreeding. The Region of Western Macedonia has one operational Industrial Area in Florina and another one under construction in Kozani. The secondary sector is very important for the regional economy, mainly due to the mining activities.

The production of electric power, as 70% of country's total power is produced in the region, (Regulatory Authority for Energy, 2013).

"Soft" structures have not followed the general improvement of heavy infrastructures, a situation that has to be remedied, in order to achieve an overall higher economic development of the region. As far as the research and development services are concerned these are at a rather low level: only 3.5% of the country's total research foundations are situated in the Region. Among them, the University of Western Macedonia as well as the Technological Educational Institute plays an important role in supporting the regional research and educational efforts. Some of its more famous products are marbles, saffron (krokos Kozanis), fruits, Florina peppers, local wines (Kozani, Amyntaio), furs (Kastoria, Siatista) and specialised arts and crafts industry.

The Egnatia motorway (Trans-European Network) crosses the region. Along with its two vertical national roads, it forms a network that dramatically improves the transport conditions in the region and alters its traditional "isolated" image, mainly due to its mountainous landscape. On the other hand, the railroad network is insufficient and the two airports (Kozani and Kastoria) can only serve small passenger planes. The telecommunication network has drastically improved over the last decade, providing the regional population with adequate services and modern facilities. During the past years tourism has been developed in the region mainly for winter sports. It is the only Greek region without a sea coast, but there are a lot of lakes, mountains, picturesque villages and two big skiing centres in Florina (Vigla) and Grevena (Vasilitsa), and one other skiing center under construction in Kozani (Velvendos).

There is a commitment of the Regional Authority of Western Macedonia, the local authorities and other regional stakeholders to exploit the competitive advantages of the Region and to promote its historical and technological profile in the fields of Energy and Environment.

Certain regional policies and actions have been promoted towards that direction. A Regional Innovation Pole of Western Macedonia has been created, following the collaborative approach of regional research, technology and business organisations. The aim of the Pole is to design and implement a corresponding programme promoting innovation in the field of energy, under the coordination of the regional authority of Western Macedonia. The Regional Innovation Pole of Western Macedonia aims at improving collaboration between research, innovation and production, technology transfer and new products and services in the field of energy as well as the creation of permanent mechanisms for technology and innovation development and promotion. The administrative building of West Macedonia region is located in Zone of Alternate Urban Planning (ZEP) in the city of Kozani (www.depepok.com)

Energy demand and supply of the Region
The total electricity consumption for the region of Western Macedonia reached 960 GWh in 2011, (Hellenic Statistical Authority, 2011). Of the total of West Macedonia's energy consumption, 79% is related to the domestic, industrial and commercial sectors while the remaining 21% is used for agriculture, public and municipal authorities and street lighting sectors (*Figure 3*).

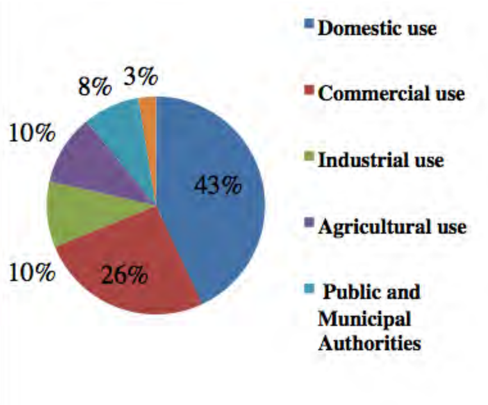

Figure 3 – Distribution of electricity consumption in Western Macedonia

Figure 4 shows that the share of consumption by fuel is dominated by petroleum products and gas, with electricity at 21%. Electricity production from renewable sources accounted for 6% in 2011.

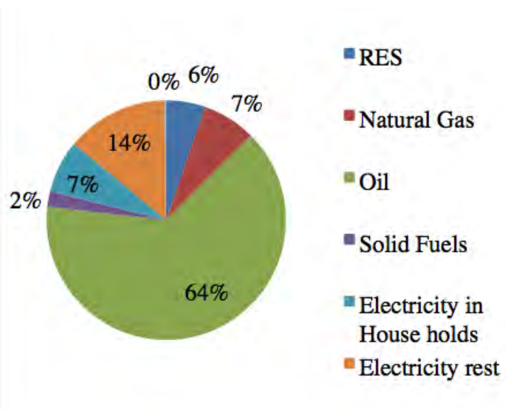

Figure 4 – Energy consumption in Western Macedonia by fuel

The Western Macedonia territory also holds great potential for the development of renewable energy sources through innovative technologies such as hydroelectric plants, PV parks and wind farms. It is noted that West Macedonia is a mountainous region, a factor playing crucial role in the construction of an artificial lake and a hydroelectric plant with capacity of 375 MW, producing 1,880M Whe annually in the Polyfytos area. In addition, there are several small hydroelectric plants in use with total capacity of 8.5 MW and several under construction in the prefectures of Kozani and Grevena. There are also operating PV parks of 23.7 MW and wind farms of total installed capacity of 24 MW.

Apart from the mountainous borders to fYR Macedonia and Albania where a high average wind speed is noted (around 8m/sec mainly in Kastoria and Florina), the rest of the region has a fairly low wind speed (around 4m/sec) (ISFTA, 2013).

Western Macedonia has one of the highest solar irradiation potentials in Greece (around 1800 kWh/m2a) and is thus an ideal place for PV installations (JRC, 2013).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

In 2008, greenhouse gases emissions in Greece were at 126.89 Mt CO2eq equivalent, showing an increase of 22.8% compared to 1990 levels. Greenhouse gases stemming from the energy sector in 2008, accounted for 82% of total greenhouse emissions and increased by approximately 34.1% compared to 1990 levels. Emissions from industrial processes in 2008 represent a percentage of approximately 8.4% of the total emissions and increased by approximately 10.7% compared to 1990 levels. The fluctuation is attributed to the cease of HCFC-22 production. The contribution of the solvents and other products use sectors to total emissions is minor (0.3% of the total emissions) but has slightly increased compared to 1990 level of emissions. The agriculture sector accounted for 7.0% of the total emissions in 2008, a decrease of approximately 21.4% compared to 1990 levels. Total emissions reduction is mainly due to the reduction of N_2O emissions from agricultural soils, because of the reduction in the use of synthetic nitrogen fertilizers. The contribution of the waste sector total emissions came up to 2%. The above mentioned data are presented in *Figure* 5 (Koroneos et al, 2011).

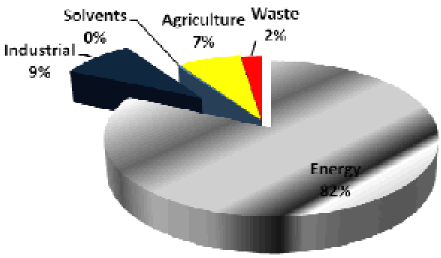

Figure 5 – Greece's GHG emissions per sector in 2008 (MECG, 2009)

Western Macedonia as part of Greece and the EU, has adopted targets for sustainability and environmental protection. With respect to the future development of the power system in Greece, the latest MEECC (Ministry of Environment, Energy and Climate Change) report on the long-term development of the system, entitled "Energy Roadmap to 2050" (March 2012) was analysed. The report examines the 2020-2050 period, using the National Renewable Energy Action Plan (NREAP) as a starting point. The NREAP presents the development plan for the national energy system, with the aim of achieving the obligatory targets set by Directive 2009/28/EC and by law 3851/2010 of the Greek Parliament.

The penetration of RES in the energy system according to the NREAP is presented in *Figure 6* along with the 2020 targets: 20% of the gross end-use energy consumption for heating and cooling, 40% of the electricity consumption and 10% of the energy used in transport.

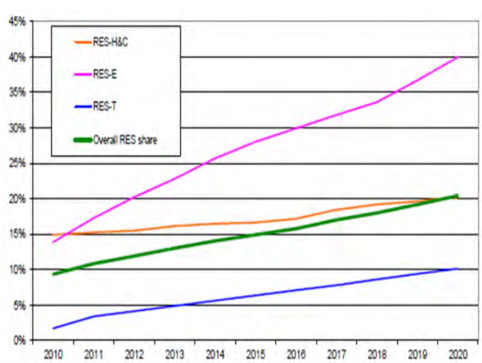

Figure 6 – RES penetration according to the National Renewable Energy Action Plan (NREAP) (Greek Energy Roadmap to 2050)

Figure 7 demonstrates that the main factor to achieve the national targets by 2020 is the reduction of the electricity produced by lignite power stations. Lignite-fired installed capacity is expected to drop to a total of 3,250 MW, while natural gas power production will rise to 5,130 MW. The total RES power in 2020 is expected to rise to 13,271 MW, consisting mainly of wind farms (7,500 MW) and hydroelectric (HEP) stations (4,530 MW, including pumping units), followed by PVs (2,200 MW), biomass and solar-thermal (250 MW) and geothermal (120 MW) units (Greek Energy Roadmap to 2050).

Other Regional targets, barriers and drivers
From previous studies (Koroneos and Nanaki, 2007) it has been pointed out that during the period 1990-2005 the Gross Domestic Product (GDP) had significantly grown in Greece. This growth was strongly related to an increase in the energy consumption, which in turn was related to an increase in the volume of emissions of greenhouse gases.

Furthermore, in the same study it was shown that the generation of municipal waste was a positive function of aggregate income levels and economic prosperity. As the gross income of Greece in the past decade increased, the waste generation showed also an increase. It is pointed out that during the period of 1990 – 1995the GHG increased with an average annual rate of 0.85% while GDP increased with an annual rate of 1.7%. During the period of 1996 – 2000, GHG increased with an annual rate of 3.8% which is higher than the rate of increase of GDP for the same period (3.4%). Finally, the average annual rate of emissions decreased during the period of 2000 – 2008 by 0.9%, while GDP increased with a rate of approximately 4.0% (www.statistics.gr).

The substantial increase of GHG emissions from road transport is directly linked to the increase of fleet vehicles and to the increase of transportation activity. Mobility during the period of 1990 – 2008 was of clear economic importance in Greek society, allowing factors of production (people and goods) to move around to where they could be profitably employed. Nevertheless, mobility is associated with transport per passenger, which is strongly related to energy consumption and GHG (Koroneos and Nanaki, 2007b).

As far as the energy efficiency of buildings is concerned, it is noted that over 74% of the existing Greek housing stock has inadequate insulation (Balaras et al, 2007 – Healy, 2003) resulting in total yearly energy loss of 83.5 million GJ. The energy loss through walls accounts for MJ/m^2 per year whereas energy loss through the roof is up to 53 MJ/m^2 per year. Wall insulation and weather proofing of openings can reduce the GHG emissions by at least 4 Mtonnes CO2eq *(Balaras et al, 2007)*. Larger energy savings can be achieved when building new houses with the use of environmental friendly technologies such as solar cooling and geothermal cooling (Koroneos et al).

Another issue that arises in the transition to a low-carbon energy system is the need for a strong and flexible energy grid, which calls for additional investment and bears potential conflict with environmental protection and landscape conservation. Despite the increasing production of renewable energy, there are weaknesses in the system of support policies, which are established in Greece as a Nation. There is a need to diversify policies in order to adapt to different development stages of low-carbon technologies. Engagement with industry is essential for the adoption of new technologies and procedures and the delivery of sustainability not only in Western Macedonia but also in Greece.
Regarding the transition towards low-carbon mobility, the necessity to discourage the use of private vehicles is acknowledged while encouraging alternatives such as walking, cycling, car-sharing, personal travel planning and low-carbon public transport. A number of initial measures have already been taken e.g. parking restrictions and pedestrian streets in the city center of Kozani as well as some cycling paths. Another necessary step is the roll-out of electric and hybrid cars, in order to meet the EU targets for reduction of emissions from vehicles. As the low-carbon transition requires not only a technical upgrade but also a shift in people's everyday practice, it is necessary in this context to further investigate social patterns of consumption and identify successful strategies for behavioural change. A holistic approach to sustainability involving public awareness, and the involvement of local communities and the engagement and education of children and young people to sustainable practices should be engaged.

3. CASE STUDY: KOZANI'S DISTRICT HEATING SYSTEM

The Kozani District Heating System covers most of the city of Kozani and is connected to the Ag. Dimitrios power station nearby. It has been selected as a case study to illustrate the possibility to reduce pollution and dependence on oil imports.

A District Heating (DH) System supplies large areas, including apartment complexes, commercial and official buildings. Heat is transferred via hot water that is economically produced by environmentally friendly combined heat-and-power plants (CHP) or other large-scale heat-production facilities. This innovative type of heating system makes it possible to reduce energy consumption by 53% and to reduce air pollutants by 46%, compared with a Central Heating (CH) system which is installed in individual apartment complexes.

CHP – also known as cogeneration – is a way to increase the efficiency of power plants. Standard power plants effectively use just 40% of the fuel they burn to produce electricity. Sixty % of the fuel used in the electric production process ends up being rejected or "wasted" up the smokestack. CHP uses this rejected heat to heat buildings in a surrounding area through a district energy system. CHP is only possible when there is an area near an industrial plant that has a need for the heat – a downtown area, a college campus or an industrial development.

Figure 7 – Pump Station "A3'' of Kozani District Heating

Clients receive heat through hot water circulating in the district heating network. The primary flow temperature of the district heating water usually varies between 60 and 120° C, depending on the system. The temperature is at its lowest in summer, when heat is only needed for hot water. The temperature of water returning from clients to the production plants ranges usually between 25 and 65°C. In buildings, heat is used for heating rooms, for providing hot tap water and for air conditioning. District Heating consumers can also receive heat from a heating plant using for example biomass as fuel.

Typically, CHP systems can be either centralised or decentralised. Centralised CHP are usually much larger than decentralised CHP. Centralised CHP plants were originally electricity plants (generating only electricity), while decentralised CHP plants were originally heating plants (generating only heat).

District heating is used in the residential sector of Kozani (*Figure 7*) in order to provide space heating and hot water demands of different categories of buildings including apartment buildings, duplexes and single family dwellings). The total yearly energy required for heating and hot water production for households in the Region of West Macedonia reaches 2,874,763 GJ/year (Ministry of Development, 2008).

Kozani's district heating system serves more than 17,000 customers out of 55,000 citizens. The total surface area heated is 1,625,000 m^2, out of which 5% covers the public sector. The installed thermal power for serving the base load is 70 MWth. The temperatures outgoing-return are 120oC-65oC respectively. The total distribution network has a length of 285 km, and the company responsible for operating the system is the Municipal district heating company of Kozani. The serving period is from October until the end of April. The peak heating load exceeds 125 MWth, with an annual demand of 230,000 MWh. The annual amount of heat is produced by 90% in the lignite power plant and by 10% in an 80 MWth peak load unit using oil or Liquefied Petroleum Gas (LPG).

The transmission and distribution system is consisted of a two-pipe system in closed circulation. The pipes are installed in parallel, one pipe for the supply of the hot water to the consumers and the other pipe for the return of the hot water for reheating. In each building there is a thermal substation with indirect connection (*Figure 8*).

Figure 8 – Two pipe distribution system for supply and return of hot water

In order to optimise in the long term performance of the District Heating System of Kozani, the Municipal District Heating Company of Company of Kozani has appointed Grontmij (www.grontmij.co.uk) a consultant specialist company. The cooperation started in 2001 with a review of the district heating operation. The review concluded with a number of recommendations to system improvements, which have been implemented over the years. The cooperation is ongoing assuring that Kozani district heating operates with front line principles and technologies.

A number of sub-projects have been realised over the past years. The project activities include:

- strengthening of transmission pipeline by a dn500mm pipeline over 17 km, including hydraulic calculations and tender documents;
- strengthening of distribution network, including hydraulic calculations in a hilly landscape;
- review of the existing SCADA system and recommendations for a new improved SCADA system;
- strategy for increased efficiency and lower return temperature of overall system operation.

This action plan includes:
- demand side management;
- information campaign;
- improved consumer installations at connection points and internally at the customers;
- recommendations to tariff system improvements;
- training of the operation staff;
- design and quality assurance with installation of accumulator plant of 3000 m3 including operation and SCADA system;
- pre-feasibility study for district cooling systems based on absorption cooling (district heating) and mechanical cooling system.

Long term focus

A Regional Innovation Pole (Best Practice Report, 2010) has been developed in order to cope up with the future challenges.
The Regional Pole of Innovation of Western Macedonia (RPIWM) is a union of institutions from private and wider public sector that aim to increase:
- the technological and innovative regional records;
- the creation of environment of innovation and regional conscience in Western Macedonia in the main axe of Energy;
- the increase of competitiveness of regional economy.

The institutions that participate in this effort and, under the auspices of the Region of Western Macedonia, constitute a network of collaboration, are the following:
- University of Western Macedonia;
- ISFTA /CPERI;
- polytechnic colleges in Kozani;
- laboratories of research of higher education Institutions and polytechnic colleges;
- developmental companies;
- enterprises and teams of enterprises;
- chambers and Contacts of enterprises.

The target of the Pole is the reinforcement of regional competitiveness, via the strengthening of research, technological and innovative actions of the Region, as well as the reinforcement of activities of institutions and enterprises in these areas. The Regional Innovation Pole identified the following priority areas:

A.1 Environmental management and support of PPC 's operational decisions system for the region of Kozani, Ptolemaida, Amyntaio and Florina.

A.2 Advanced measures for the improvement of operation of lignite based power plants and for reduction of CO^2 emissions.

A.3 Co-combustion of secondary fuels (biomass) with lignite in a power plant.

A.4 Pilot application of use of cube blocks with high content in flying ash.

A.5 Development and evaluation of innovative catalytic systems for hydrogen production from biogas.

A.6 Promotion of exploitation of wind energy in the region of Western Macedonia.

A.7 Development and manufacture of solar air conditioning devices with small power consumption.

A.8 Study for energy savings and the optimal use of energy at small medium enterprises.
The long-term objectives of RPI of West Macedonia include the following aspects:
- support of demand from SME's of "wider" region of products of research and promotion of technological activities in the enterprises themselves;
- institutional support of the technological, organisational and commercial problems that enterprises face;
- creation of excellent regional conditions of attracting individual and legal entities, with the existence and maintenance of possibility of access in satisfactory energy inquiring infrastructure and installations of high technology, in IT networks, banks of information, libraries etc;
- creation of favourable financing environment for the growth of institutions of research and technology with the creation of collaboration and financing by Greek and foreigner banking or other financing institutions and venture capital companies.

Outcomes

The District Heating (DH)System in Kozani has resulted not only in abatement of air emissions, but the scheme also brought positive economic and social impacts, including a reduction in energy bills. To be more specific, since the district heating system was set in operation in 1993, the following benefits to the city of Kozani, its residents as well as the national economy, have been reported:

- the operation of the DH system has contributed significantly to the reduction of gaseous and particles emissions and especially in a city which is greatly affected by the 60-years old neighbouring lignite industry;
- the operation of the DH system substitutes yearly more than 20,000 tons oil equivalent, with an obvious benefit for the national economy;
- for every resident there is an annual saving of €70 from the use of DH system instead of oil. Consequently, the city of Kozani provides disposable income €2,900,000 per year;
- the operation of the DH system provides potential for further development of the are in the primary and secondary sectors of the economy (e.g. greenhouses or special plantations.

The district heating system in Kozani has a significant contribution to the reduction of gas emissions during the winter period, particularly in smoke concentration and in SO2 concentration. Based on data collected from the Municipal enterprise of Ptolemaida, the average smoke concentration in the air during January 1988 (before DH) was 58 μg/m^3, while in January 1995 (after DH) was 13 μg/m^3. The equivalent values for SO2 were 55 μg/m^3 and 19 μg/m^3 respectively. As for Kozani the average smoke concentration in the air during January of 1988 was 62 μg/m^3, while in January 1995 it was 22 μg/m3 (District Heating Company of Kozani, 2002). The relevant values for SO2 were 170 μg/m^3 and 15 μg/m^3 (*Figure 9*). There is also a reduction in CO^2 emissions reaching approximately 45% compared to 1990 levels (www.tpt.gr).

The sulphur contained in heating oil and also the deficient combustion conditions in small central heating boilers in towns are to a large extent the factors responsible for the concentration of sulphur oxides, nitrogen oxides and particulate matter in the towns' atmosphere which have adverse effects on public health and also at the environment.

The pricing policy of the district heating company in the town of Kozani since its operation was determined by the following factors:

- the legal status and the public welfare character of the companies;
- their economic viability;
- the attraction of new customers to their district heating networks;
- the covering of the financial and operating requirements of the companies, and finally;
- the parameters which determine the energy market on a national level and especially the cost of diesel oil.

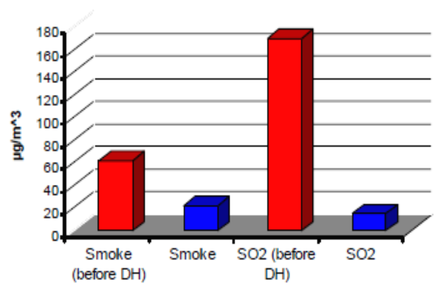

Figure 9 – Average smoke and sulphur oxides air concentration, before (red) and after (blue) the operation of the DH

Bearing in mind the above, the selling price of thermal energy for the companies' consumers is about 65% of its production cost using heating oil. To determine the final cost, the length of the heating period – 7 months – and the efficiency of boilers (0.85 – 0.90%) were taken into consideration. In practice, the benefit for consumers so far from the operation of the installation has been more than 40% if we take into account the fact that the boilers which were replaced were old and poorly maintained and therefore inefficient.

4. CONCLUSIONS

There is a variety of studies document the environmental benefits of District Heating. For instance the Ecoheatcool (Ecoheatcool, 2006) study supported by the European Commission confirms the possibility of saving an extra 404 million tons of CO^2 annually (additional to the 113 million tons/year avoided by DH in 2003) in the time horizon 2020 by doubling and improving District Heating across

32 European countries. At the same time, higher energy efficiency will reduce primary energy supply by 2.6% (2003) or 2,1 EJ (50,7 Mtoe)/year (equal to primary energy supply of Sweden). Increased security of supply will reduce the import dependency by 4,5 EJ (105,4 Mtoe)/year (equal to primary energy supply of Poland). In this respect, the implementation of district heating system in the Region of West Macedonia will bring environmental, economic and social benefits.

In addition, the creation of environmental, social and technical mechanisms of undertaking the research and confrontation of technological, organisational and commercial problems that occupy the enterprises via the Regional Innovation Pole will certainly play a crucial role in the Region's sustainable energy development. This is in alliancw to the context of the objectives set in the European Commission's Europe 2020 strategy and specifically the Innovation Union flagship action, the Regional Innovation Monitor Plus (RIM Plus), which provides a unique platform for sharing knowledge and know-how on major innovation policy trends in European Union (EU) regions. Based on the work of a network of experts, RIM Plus provides detailed information on regional innovation policies for 20 EU Member States: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden and the United Kingdom (Region Innovation Monitor Plus).

Having begun over 20 years ago the Kozani District heating system is an example of a sustainable mechanism to reduce air pollution and dependency on oil while increasing the overall efficiency of power stations by exploiting the Combined Heat and Power approach. Economic and social benefits are directly related to the end user aiding its acceptability among the population. It is proposed that a number of European regions that fit the pattern of power stations near moderately populated cities could implement the scheme and reap environmental, economic and social benefits.

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HUNGARY

AUTHORS

Ákos Nemcsics
Óbuda University
Tavaszmezo utca 17, H-1084 Budapest

Ildikó Molnár,
Szent István University
Thököly út, H-1146, Budapest

Antal Ürmös
Óbuda University,
Tavaszmezo utca 17, H-1084 Budapest

1 OVERVIEW OF THE REGION

Characteristics of the Region
The region of Vasvár presented in this case study is located in Vas County in the Western part of the country, which is one of the 19 counties of Hungary. The region of Vasvár is one of the 7 regions of Vas County and is considered to be a medium-sized region (see *Figure 1*) (1).

Figure 1 – Illustration of the Vasvár region as a part of Vas County, which is located in west part of Hungary

Hungary covers an area of 93,000 km^2 and has a population of approximately ten million inhabitants. Vas County has a territory of 3,336 km^2 and it has a population of 261,569 inhabitants (21). Its centre is Szombathely. The Vasvár region is part of Vas County and its territory is 474 km^2. It has a population of 14,395 (TEIR, 2010) inhabitants. With 36 inhabitants/km^2, the population density is the lowest in the county. Its centre is Vasvár, which is an old historic town. Although initially Vasvár used to be the center of the whole county, nowadays it is the smallest town in Vas County but it has kept its leading cultural role. Other towns in Vas County include Sárvár, Körmend, Celldömölk, Kőszeg and Szentgotthárd.

The employment rate of the region is good (60%) in comparison to other regions of Hungary. While the unemployment rate in the Eastern part of the country exceeds 20 %, it is below 5% in Vasvár region. GDP per capita in Hungary reaches €10,168. GDP in the Western regions is higher than in the Eastern regions, similarly to the employment rate.

The reason this region has been selected is that there are a large number of adobe houses. We have dealt with the renovation of these houses and its impacts on the environment. Adobe is a natural building material made from sand, clay, water, and some kind of fibrous orrganic material (branches, straw, and/or manure), which the builders shape into bricks (using frames) and dry out in the sun.

The structure made from these materials is very solid and long-lasting. In Vasvár region this building method has a long history. The building technology is very similar to the technology of moulded wand and slide-jalousie reinforced concrete. The renovation of these houses is not only important from the perspective of the cultural heritage but also from the energy saving aspect as well. Instead of building new houses and demolishing the existing ones, renovating them can result in energy saving and reduced CO_2 emission. *Figure 2* presents the distribution of building materials within the building stock

Due to cheap, local raw materials and good physical properties (thermal and humidity balance effect) adobe architecture has become fashionable again. Houses have been built with this material mainly in Europe but adobe walled buildings (churches, research institutes, etc.) are common in Africa or Asia as well. The building technology using adobe walls is very diverse (17,18).

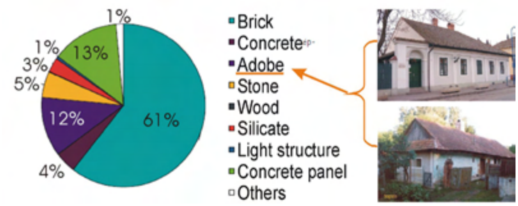

Figure 2 – Houses in Hungary according to the building material. A large number of the buildings are from adobe

At present, Szombathely is the administrative and economic centre of Vas County. In the past it used to be Vasvár, while nowadays, Vasvár is the smallest town in Vas County. The interrelation of the settlements can be investigated with the help of the measure of complexity. Hence we are going to examine the Vasvár region. We have already described our research in our earlier publications (26, 27). The results of our research can help us in the planning of sustainability. The sizes vs. sequence number graphs are showed in *Figure 3*.

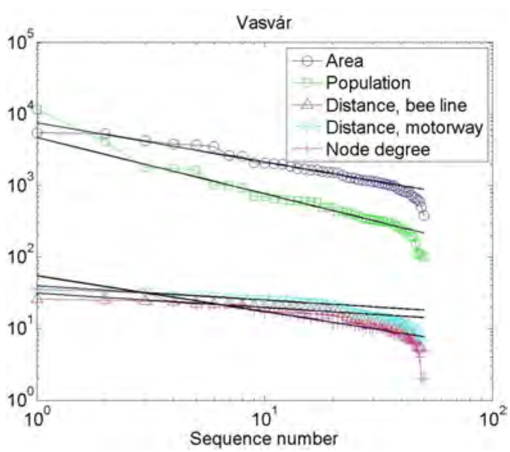

Figure 3 – The sizes vs. sequence number graphs for Vasvár regions. The meaning of the symbols are inserted in the figure

Area, population, distances in bee line and motorway, and node degree exponents are calculated for the region (2, 3). The exponents for Vasvár are also in sequence: -5.471x10-1, -7.852x10-1, -1.999x10-1, -1.989x10-1, -5.012x10-1, respectively.) You can clearly see that the steepnesses are nearly similar, thus the settlement structures are unified. Although Vasvár has lost its role as an economical centre, it has preserved its role as a cultural centre.

Energy demand and supply of the Region

The percentage of the energy demand in the region is in accordance with the national average (*Figure 4*). Hungary has more industrialised parts mainly around larger cities or in the Northern middle mountains. There are also agricultural areas where energy varies. The Vasvár region is closer to the average in this perspective. The pie chart below illustrates the percentage of the energy demand (4 – 9).

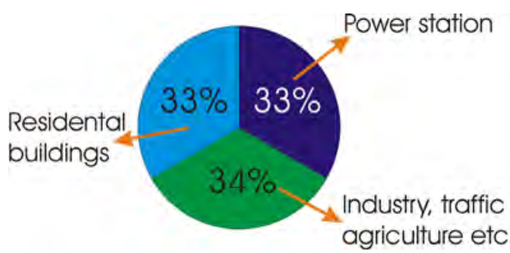

Figure 4 – Distribution of the primary energy demand among the main user sectors. The energy demand of the residential buildings is very important

The energy demand of residential buildings accounts for 33% of the total. This value depends on the quality and the type of the buildings. The structure of the settlements influences the type and also the quality of residential buildings. The comparison of the town vs. village ratio is shown in *Figure 5*.

Figure 5 – The structure of the settlements influences the type of residential buildings

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Setting and meeting the targets related to energy policy is primarily based measures of CO_2 emissions. *Figure 6* illustrates the trend for CO_2 emissions changes from 1970 to 2010, including the breakdown for the main sources of emissions (6 – 9).

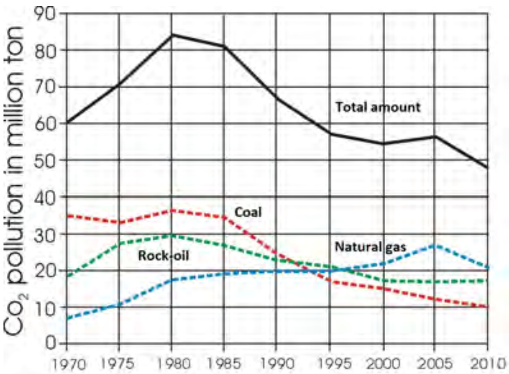

Figure 6 – CO_2 emissions of Hungary.

The black solid line shows the total amount of pollution. The dotted lines represent the contributions from different primary fuels. The red, green and blue lines represent coal, rock-oil, and natural-gas, respectively. CO_2 pollution was $48x10^6$ tons. 31% originated from the production of electricity and heat; 27% from traffic, transport; 21% from industrial source; 17% from communal sector; 13% from other sources. The data relates to all of Hungary but it applies to all the region as well. The utilisation of renewable energy sources is very low.

The major aim for the future is to use solar energy for water heating in a more efficient way in the region. In this region, the use of solar energy for heating purpose or electric energy is not yet widespread. This can be explained by the fact that the population of the region simply cannot afford it. The region is rich in forests, which are full of wood waste that can be used to operate machines run by biomass.

The main aims of the Hungarian energy policy include security of supply, sustainability and competitiveness. The priority of environmental issues and the adjustment to the aims of the EU are emphasised. In order to create a balanced structure of the energy resources, the proportion of domestic energy resources needs to be increased as much as possible. One of the keys to achieve technological development is supporting education and R&D in the field of energy in Hungary. (28, 29)

Other important objectives include reducing energy consumption per unit, increasing the proportion of energy gained from waste and supporting environmentally-friendly technologies. It is important to harmonise the Hungarian energy policy with climate policies. By funding the production of fuels made from renewable energy resources, the transport policy can also became more environmentally friendly. One must also take into consideration the importance of funds provided by the state and the EU so that we could achieve these goals. In the public sector it is also essential to increase environmental awareness by introducing environmental studies into the National Curriculum. By building awareness, it is possible that the population might start to reduce its energy consumption.

Other Regional targets, barriers and drivers

A guideline of the European Parliament and Council 2006/32/EK (ESD) imposes an energy efficiency action plan (NEEAP)* that each member country has to draw up. This action plan outlines all of the running and planned measures of energy efficiency, which will make it possible to reduce energy consumption in Hungary by ca. 10 % in the span of nine years between 2008-2016 (28, 29). The action plan is crucial to achieve the reduction of energy consumption by 20 % until 2020 imposed by the European Union. As a result it will also be possible to reduce the GHG emissions by 20 %. The action plan involves the following areas: the construction requirements of new buildings; the number of residential buildings; the number of communal buildings (especially buildings owned by the state and local councils); education; transportation; public transport; and technologies which can influence the volume of the energy demand. It is clear that residential buildings are of primary importance therefore our case study also reflects on this issue.

In the public sector the process includes keeping and controlling the energetic regulations of buildings and restricting gradually these regulations. Renewing the buildings of the public sector in view of energy efficiency is of absolute priority. It can demonstrate the state's commitment towards environmental issues, and it can make energy saving and efficiency campaigns and programs more credible. It can also lead to energy saving, more efficient budget management and more efficient leadership.

In the transport sector the following energy policies have been introduced: in order to reduce freight traffic, road tariffs have been imposed on freight vehicles, and the P+R system has been developed to encourage commuters to use public transport. In addition to a more sensible transport system, it is also important to create better transport ethics. A major advantage of this area is that it holds geothermal water at 78°C at 2,100 m below the ground surface. This geothermal water is used in district heating and in thermal baths. The utilised heat energy in 2010 was 13,386 GJ/year which from thermal water was 3,951 (GJ/year). The major aim for the future is to utilise more efficiently their available geothermal water resources (23).

3. CASE STUDY: SOME ASPECTS OF THE REGIONAL BUILDING STOCK

As the arguments above illustrate, one of the most important factors for energy demand in Hungary is the building stock (10 – 14). In the region that we have studied, the number of adobe houses is substantial. and they are also part of the cultural heritage. In this case study we will look at how it is possible to meet energy efficiency requirements while protecting the cultural heritage. Adobe houses are only known in certain parts of Europe. This is a traditional building method which fits in the local environment perfectly. Walls are contructed with hard composite materials, which made of local resources.

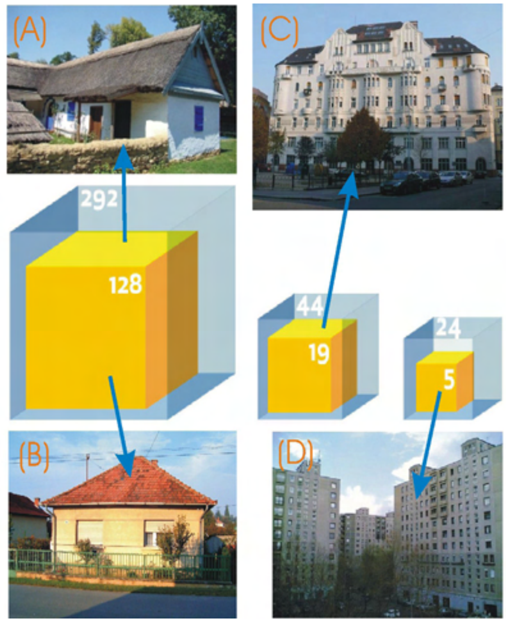

Figure 7 – Energy saving potential in the case of different types of buildings. (A) traditional cottage in a village, (B) a detached house in the suburbs of a city or in the country side, (C) in a block of flats of the city centre, (D) a block of flats mainly in suburbs built in the socialist era. The blue cubes represent the total primary energy consumption per year (in PJ), the yellow cubes represent the energy saving potential (in PJ)

Despite 73% of the European population living in towns (23 – 25), this value is is only 64% in Hungary. The energy demand for different building types is also different. In the region of our case study, the proportion of the rural population of villages is even higher and they live in adobe houses. Therefore the solution to this problem is a major architectural and energetic task.

In the *Figure 7* we illustrate the possible volume of energy saving comparing different types of buildings.

Buildings and houses in Hungary according to the building material is shown in *Figure 6*. Energy consumption and saving potential in the case of different building types are shown in *Figure 5*. There are two types of houses in a village. We can mention the village of Kám as a typical example in this region. The number of adobe houses in poorer villages (e.g. Csipkerek) is higher than in wealthier villages (e.g. Alsóújlak). One of the buildings is the traditional rural house (A) built from adobe or brick. The other one is a conventional detached house (B) built from a new type of brick. The third one is a traditional block of flats built from bricks (C). There are three types of the residential buildings in the Vasvár. The fourth one is a block of flats built from reinforced concrete (built in the socialist era). Houses built with adobe walls are very popular in the Hungarian vernacular architecture and are particularly characteristic in the region of our case study. A large number of buildings are built with this material.

Objectives and methods

The aim is to preserve houses built from adobe, representing Hungary's cultural heritage by renovating and making them environmentally friendly and comfortable. This can only be achieved if the people living in these houses do not consider them outdated and obsolete, so they will notbuild another house (15 – 17). In addition to technological aspects, cultural aspects – changes in the way of thinking – are also essential. In our investigation Life Cycle Assessment has an important role as well.

Long term focus

Sustainability has to be taken into account in the long term. However, preserving and renovating old houses and buildings is more important in the short term. Long term sustainability can be problematic as houses made of adobe walls need more care than brick walled houses. However using state of the art materials, one can make these houses modern, so that and additional care is not required. Preserving cultural heritage definitely supports long term solutions.

Discussions

It is possible to build houses with bricks dried in the sun but the sliding frame solution is also a possibility. The fleckered – plastered structure within the frame is also another possible solution. All of these three technologies used to be common in vernacular architecture in Hungary. Nowadays, only the first two solutions are mainly used. Stokers built with adobe walls are also very common. There are more types of adobe houses. The most common one is the adobe brick dried in the sun, which is used to build traditional brick walls. Another common wall is the wicker built on a wooden structure, which is covered with clay. We also mentioned in the introduction the technique of slided form-work similar to the monolitic reinforced concrete. This is the most common technique. Adobe wall architecture is excellent in the Hungarian climate because winters are cold and summers are hot. It is necessary to store the heat. Due to global warming summers are getting hotter, thus the heat storage capacity of newly built brick and lightweight houses is not needed. As a result, many air conditioners are installed in newly built houses. Well-insulated lightweight houses are appropriate in the North and in mountainous areas where the temperature does not exceed 20-25 oC in summer. Hungarian climate changed sensibly in the past 25 – 30 years. In summer, it is very common that temperatures rise above 35 oC. Earlier temperatures above 30 oC were unusual and were considered to be tremendously hot. Local people are not accustomed to the new warmer climate , thusthey use air conditioners more often. Unfortunately, air conditioners are not operated by solar cells but by mains electricity, which leads to high CO_2 emissions and contributes to global warming. Therefore, the characteristics of adobe homes are favourable to changes in the climate.

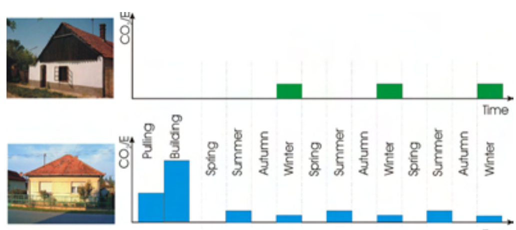

Figure 8 – Comparison of the life cycle of original adobe walled houses and brick walled houses substituted the original buildings

In winter, only heating demand requires energy in the case of adobe houses. In the case of newly-built houses, demolishing the old house, constructing the new house and heating/ cooling the space all require additional energy (*Figure 8*).

The environmental impacts of adobewalled houses are lower than those of brick houses (which were built to replace them) since adobe-walled houses need heating only in winter. In summer the indoorclimate is very comfortable. Newly built houses are likely to need less heating in winter because they have better insulation. However, in summer the building can often be very warm inside. We can conclude that adobe walled houses have good energetic performance (16 – 20). Finally the demolition of adobe walled houses and the construction of new houses both need additional energy (*Figure 8*).

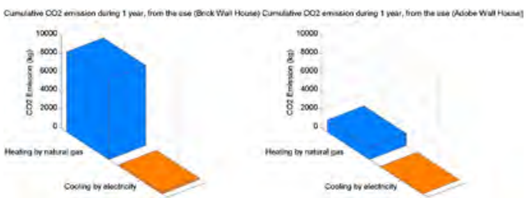

Figure 9 – Results of LCA analysis

We conducted an LCA analysis with the help of the software "Gabi" (30). The results related to CO_2 emission generated by heating and cooling are shown in *Figure 9*. Unfortunately, adobe-walled houses are associated with poverty and underdevelopment in Hungary. Therefore, most people have them demolished and have brick houses built instead. Among the educated population, building adobe-walled houses has become fashionable again. People educated with higher education are more concerned with the environment and they are looking for healthier and more environmentally-friendly solutions. Nowadays many publications have been written about adobe clay architecture but unfortunately not enough to change the public attitude.

Outcomes and results

The most important argument against adobe-wall buildings in the past was they are quite uncomfortable, however this objection is nowadays no longer valid as high-tech building technologies (e.g. water-tightness) have eliminated this disadvantage. Sometimes the dwellers feel embarrassed that they live in an adobe building, therefore they shape and plaster the appearance of their house, as if the wall is made of brick. Although the excellent physical features of the building remain, the value of the cultural heritage is lost.

The main enemy of such an adobe wall building is water (rain, splashed water and ground water). The walls are susceptible of becoming wet if van der Wall forces between Sum-micron particles keep the building materials together instead of chemical bonds. As a result of the humidity, the bonding force weakens.

The most important aspect is the roof structure and the cover of the house, which have to be perfectly built. There are several solutions on the market available for water insulation against ground water, including pressed metal plate built-in into the wall, different chemicals inserted into several drilled holes etc.
This solution can be achieved individually. Bevel holes must be drilled into the wall above the ground-wall and they have to be filled with chemicals. The chemicals are absorbed by the wall and thus insulate it. It is a cheap and simple solution.

In many cases, there is need to renew neglected buildings. Continuous rain and damaged roof can crack the wall; therefore humidity must be eliminated to save the wall. Inorder to stop the wire ropes are fixed to the wall. The fragile surface of the adobe wall cannot hold any painting or plaster, hence there will must be a thin wire mesh fixed on it with large nails, and it must be plastered with a thin layer in a traditional manner. The building with the renewed adobe wall will be more energy efficient and healthy (e.g. humidity balancing), furthermore its traditional space enables a very calming mood.

4. CONCLUSIONS

In this work we showed that in Vasvár region (and also for the whole of Hungary) the adobe clay architecture corresponds to the climate, which is proved by vernacular architecture. It is highlighted that preserved and energy efficient adobe clay buildings can present representative cultural heritage.

The presented project started about 10 years ago with the preservation of adobe press-houses (31 – 33). As press-houses are only temporary homes, there is no energetic data available about them. There are no energetic details concerning residential buildings, so regarding energetic and CO_2 emission, we can only provide quantitative results from LCA analyses. There are no specific measurement results available now.

If we can avoid building new houses, we can reduce CO_2 emission. In addition, air-conditioning is unnecessary in the summer, so we can also avoid CO_2 emission and save fossil energy sources.

According to calculations, during the renovation of adobe houses, these houses can reach category D through these investments. Energy consumption can be reduced by 45-50 %, saving up to an estimated 260 kWh/m^2year. This means saving 1100 m^3 of gas per year in the case of a 50 m^2 heated area. In hungarian florints it means saving 150,000 Hufs per year, corresponding to €500 per year (23).

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IRELAND

AUTHORS

Oliver Kinnane
Department of Civil, Structural and Environmental Engineering,Trinity College Dublin
E: oliver.kinnane@tcd.ie

Derek Sinnott
Department of the Built Environment, Waterford Institute of Technology
E: dsinnott@wit.ie

1 OVERVIEW OF THE REGION

Characteristics of the Region

The Republic of Ireland, on the western periphery of Europe, occupies approximately 85% of the island of Ireland. With a land area of 70,280 km^2 and a population of 4,588,252 (CSO, 2011) the Republic has one of the lowest population densities in Europe, 65.3 people/km^2.

The Republic of Ireland is governed by a parliament based in Dublin. Within the state, 34 Local Authorities exist, consisting of 29 county councils and 5 city councils. The Local Authorities are responsible for matters such as planning, local roads, sanitation, and local energy policy. A further tier below consists of 5 borough councils and seventy-five town councils with limited responsibility.

Figure 1 – Local authorities Ireland. Reproduced, OSI

The Irish economy is a modern knowledge economy focused on services and technology. Ireland's economy has undergone significant change in recent decades. It has been transformed from the predominantly agricultural economy that it was until the 1980s. However, in the early 1990s, Ireland experienced unprecedented economic growth fuelled by a dramatic rise in consumer spending, construction and investment, which became known as the now infamous 'Celtic Tiger' period. Ireland's economy became over exposed to construction resulting in a burst property bubble that led to the Irish banking crisis and subsequent recession since 2008.

Unemployment in Ireland has risen in the years since 2008 to 14.7% of the population at the 2011 census (Eurostat, 2013). It currently is estimated at 13.9% of the workforce. The employment rate currently is 60%, significantly less than the EU Commission's Europe 2020 Strategy employment target of 75%.

In the 2011 census GDP totalled €159 billion and GNP €112 billion (IRENA, 2013), approximately €35,000 and €27,000 per capita respectively. GDP is viewed as an unreliable indicator of the Irish economy due to the large number of multi national corporations based in Ireland. Instead GNP is often used as the indicative measure. However, the impact of the repatriation of wealth by these companies has also been adjudged to effect the reliability of GNP (ESRI, 2013).

Due to a low corporate tax rate, English speaking and highly educated population, Ireland is today the location of many multinational corporations that dominate much of the economy. Hence, the Irish economy is heavily reliant on foreign direct investment. However, exports from these multi national companies contribute significantly to the national income. Ireland is one of the largest exporters of pharmaceutical and software-related goods and services in the world. Companies such as Pfizer, Intel, Facebook, Google and Microsoft all have significant operations in Ireland.

The Department of Communications, Energy and Natural Resources (DCENR) has responsibility for the energy sector and for the regulation, protection and development of the natural resources of Ireland. The Department of the Environment, Community and Local Government (DECLG) is responsible for the environmental protection, sustainable development, communities and housing. The Sustainable Energy Authority of Ireland (SEAI) is Ireland's national energy authority with a mission to play a leading role in the transformation of Ireland to a society based on sustainable energy structures, technologies and practices. Its remit relates mainly to improving energy efficiency, advancing the development and competitive deployment of renewable sources of energy and combined heat and power, and reducing the environmental impact of energy production and use.

There are currently 13 Local Energy Agencies in the Republic of Ireland providing a range of services to the public and private sector to promote energy conservation, energy efficiency and renewable energy within the region (AIEA, 2013).

Energy demand and supply of the Region
Primary energy use in the Republic of Ireland was 167 TWh and 37 TWh per million persons in 2011 equating to approximately 13.6 Mtoe (EC, 2013). This is distributed between sectors; transport (4.3 Mtoe), domestic (2.7 Mtoe), services (1.3 Mtoe), industry (2.2 Mtoe) and agriculture (0.3 Mtoe) (*Figure 1*).

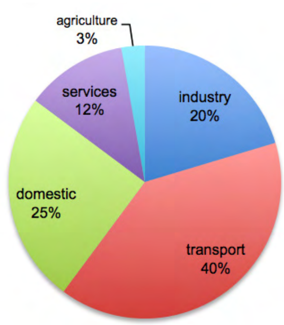

Figure 1 – Energy consumption (Mtoe) by sector in Ireland. Chart developed using data from European Commission 2011 data (SEAI, 2012a)

Accounting for the largest proportion of sectorial energy consumption, transport fuel is closely aligned to the mode of transport used. The SEAI detail the breakdown of transport fuel as: kerosene is used for almost all air transport, fuel oil for shipping and electricity currently is consumed by the Dublin Area Rapid Transport (DART) system and, since 2004, by Luas light rail system. Petrol and diesel are the common fuels for road transport.

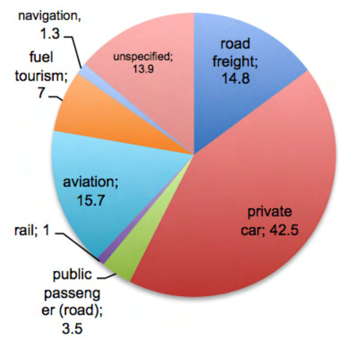

Figure 2 – Energy demand proportion by mode of transport

Domestic energy consumption accounts for 25% of the total energy consumed in Ireland. Much of the Irish housing stock was built to poor standards during the recent building boom, particularly when viewed relative to European standards. In Ireland approximately 867,000 (or 52%) (2011) of all housing was constructed before the minimum insulation standards were introduced in 1979. The average Irish dwelling in 2005 emitted 47% more CO_2 than the average dwelling in the UK; 104% higher than the EU-27 average (Lewis, 2008). In 2010 the average dwelling used 22,500 kWh and emitted 7.5 tCO_2, equivalent to a D rating on the Building Energy Rating scale (Roadmap, 2012). Some of the higher CO_2 emissions can be attributed to Ireland's dependence on fossil fuels including oil, gas, coal and peat for the production of electricity and lack of an all-Ireland natural gas network.

Due to significant public opposition Ireland has remained a nuclear free country. Renewable energy accounts for approximately 6.7% of the Republic of Ireland's energy requirements

(EC, 2013). The Irish government has committed to increasing this to 33% by 2020. The major source of renewable energy in Ireland is wind, with capacity ever increasing.

If the estimated 19.82 billion cubic metres of natural gas reserves, much of which is due to come online in coming years, can be extracted it will provide the full energy requirement of Ireland for the next 13 years. However, currently most of Ireland's gas comes through interconnectors between Ireland and the UK and into Europe. The distribution of Ireland's energy consumption by fuel type is shown in *Figure 2.*

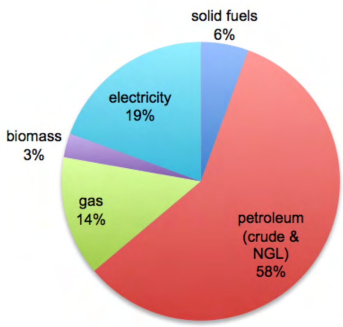

Figure 3 – Energy consumption (Mtoe) by fuel in Ireland. Chart developed using data from European Commission 2009 data (EC, 2013)

Ireland's electricity production totalled 26.96 TWh in 2012, a total of 6023 kWh/capita (International Energy Agency, 2013).

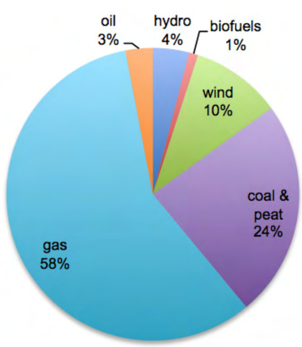

Figure 4 – Electricity production by source in Ireland. Chart developed using data from IEA 2012 data (IEA, 2009)

Much of Ireland's electricity is produced through the combustion of fossil fuel sources; however, there is a growing focus on renewable technologies, particularly wind energy as viable alternatives. The European Commission estimate that 17.6% of gross final energy for electricity generation was from renewable sources (EC, 2013).

In Ireland electricity consumption is almost equally distributed between industrial, residential and commercial sectors. Oil dominates as the source of fuel for transport that as documented accounts for the largest sector of energy consumption.

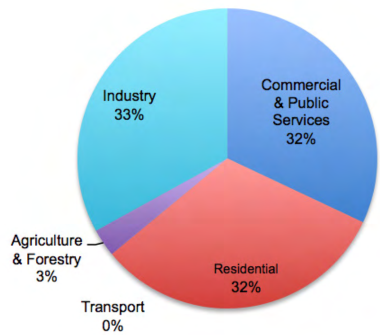

Figure 5 – Electricity consumption by source in Ireland. Chart developed using data from IEA 2012 data (IEA, 2009)

Natural gas as a source for electricity production has been on the rise since the late 1970s and now accounts for over 58% of means of electricity production. Also a single electricity market operates in Ireland, between the Republic of Ireland and Northern Ireland, facilitated by three interconnectors.

Wind power in the Republic of Ireland is a significant and growing electricity source. By 2012 its total has grown to 1,738 GWh an increase of 38% since 2009 (EWEA, 2012). This growth is due to considerable investment in wind energy with the continued development of numerous wind farms around Ireland. The Irish government has heavily backed wind energy as the key (central) to achieving the RES-E targets (see subsequent section) and supplying 1,763 MW (March 2013) equating to 15.5% of the national electricity demand is currently the largest contributing resource of renewable electricity in Ireland (IWEA, 2013), with capacity constantly increasing, in part with a plan to export wind-generated electricity to the UK. However a number of commentators are expressing doubt with regard to the economic sense of this policy.

Ireland's first wind farm, commissioned in 1992, consists 21 wind turbines, with a total installed capacity of 6.45 MW; tiny by today's standards. In 2012, 125MW of wind energy were installed and by the end of the year, 179 wind farms were on-line and operational. The greatest concentration of wind farms is in the west of Ireland where they are exposed to the North Atlantic and our prevailing South Westerly winds.

At the end of 2006, permission had been granted for 1620 MW of offshore wind generation at the Arklow bank of the east coast of Ireland (Alliance, 2009). However, even with a higher capacity factor than onshore wind there is currently only one offshore wind farm comprising 7 x 3.6 MW turbines (25.2 MW), operating since 2004, in Irish waters. Higher capital costs and high site dependency and the lack of a support scheme for offshore wind such as a Renewable Energy Feed in Tariff (REFIT 2) scheme available for onshore wind small hydro and landfill gas are some challenges to development.

An ageing transmission network significantly hinders the Republic of Ireland's electricity strategy. The Grid25 initiative (EirGrid, 2013) outlines plans to significantly renew the national energy grid between now and 2025. Grid25 involves a 3.2 billion investment to build 800km of new power lines and upgrade 2,000 km of existing lines, which will double the size of the current electricity Grid. This is particularly pertinent considering Ireland's continued focus on wind energy and the varying availability of power that comes from wind farms.

It is proposed that Grid25 will significantly reduce Ireland's dependency on imported fuel for electricity production. This infrastructure is vital to enable Ireland use its indigenous natural resource, wind for economic and environmental benefit. The carbon intensity of electricity has fallen from 896 gCO2/kWh CO_2 in 1990 to 489 gCO2/kWh in 2011 (SEAI, 2012a).

Although natural resources like wind and ocean are not specific to Ireland, it is particularly well placed geographically to benefit from them. Hence, renewable energy technologies relevant to these resources are growing. Given favourable policy and infrastructural developments, there exists the potential to exceed domestic electricity demand by 2030, scaled up to generate 16 GW of onshore wind and 30 GW of offshore wind energy generating up to 140,000 GWh by 2050 (SEAI, 2011).

However, at the end of 2011 Ireland had only 2% (1.6 GW of 93.7 GW) of the European market share for installed capacity (EWEA, 2012). With respect of its small population wind power in Ireland in 2010 was 320 W/person when the EU27 average was 169 W/person (EWEA, 2012).

Tidal and wave technology development is currently the focus of a number of commercial and academic organisations in Ireland. Although ocean energy technologies are being trialled in Irish waters there remains a considerable amount of research before such technologies are commercially viable.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Ireland's Climate Change Response Bill 2010 proposes an 80% GHG emissions reduction target by 2050 relative to levels of 1990 (DCENR, 2013a). More pressing however, under EU legislation, Ireland is obliged to achieve very ambitious energy efficiency targets to reduce energy consumption by 20% on 2005 levels, by 2020.

Ireland ratified the Kyoto Protocol in May 2002 and was legally bound to meet the greenhouse gas (GHG) emissions target to limit the increase. Under the Kyoto Protocol, Ireland was required to limit total national greenhouse gas emissions to 314.2 $MtCO_2eq$ over the five year period 2008 – 2012 which is equivalent to 62.8 $MtCO_2eq$ per year (EPA, 2013). However, Ireland failed to meet these targets.

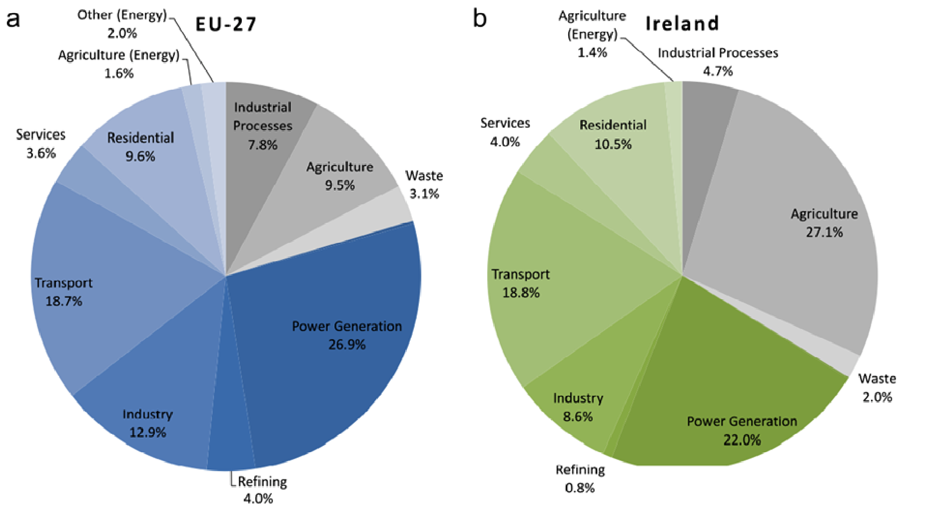

Figure 6 – GHG emissions share in Ireland in comparison with the EU-27 (2005 data) (Image taken from Chiodi et al., 2013)

The average annual energy-related CO_2 emissions in the period 2008 – 2011 were 40 Mt, or 34% above 1990 levels (in 2011 it was = 37 Mt or 23% above 1990 levels) (SEAI, 2012a).

In 2013, Ireland reaffirmed its commitment to reach the 20% energy savings and 20% renewables by 2020 in its second National Energy Efficiency Action Plan (NEEAP) to 2020, published in February 2013 (DCENR, 2013b). In total the NEEAP outlines 97 actions to meet the targets across six areas: Public Sector, Residential, Business, Transport, Energy Supply, and Cross-Sectoral. In accordance with the European Directive 2006 (EC, 2006) and recognising that they should act as an exemplar the Government has set specific energy savings targets of 33% in the public sector.

Ambitious targets have been proposed for the domestic sector. Although specific targets are not outlined, the Residential Energy Roadmap proposes that the average energy consumption of Irish dwellings could be reduced by 60 – 65% (8,000-9,000 kWh) with continued energy efficiency retrofit programmes, first initiated in 2009 (SEAI, 2013a). It is further proposed that total residential CO_2 emissions could be reduced by up to 90% by 2050 with an extensive programme of energy efficiency retrofit and deployment of renewable energy.

The Government has set a target of 12% renewable heat biomass and geothermal by 2020. Renewable energy contribution to thermal energy (RES-H) was 4.8% in 2011 (SEAI, 2012a). With regard to renewable energy (RE) policy, under Directive 2009/28/EC, Ireland has committed to a binding renewable energy target of 16% of energy demand, by 2020. The National Renewable Energy Action Plan (NREAP) sets out measures to deliver this target across three sectors of energy infrastructure, electricity, transport and heating. NREAP sets a target of 40% of electricity production must come from renewable sources. To meet the RES-E 40% target Ireland will need to add approximately 275MW of wind energy per year between 2013 and 2020 (IWEA, 2013).

Total renewable energy supply grew, from 168 ktoe (1.95TWh) to 680 ktoe (7.91TWh) between 1990 and 2010, an increase of 305% (7.2% per year on average) over the period (SEAI, 2012b). In 2011, renewable energy grew by 24% to 782 ktoe (9.1TWh) equating to 6.4% of Ireland's gross final energy use. It is clear that a substantial transformation of the RE infrastructure will have to happen to meet the targets.

Irelands GHG emissions for 2011 was 57 $MtCO_2eq$, a reduction of 6.7% from 2010 GHG levels. Ireland's GHG emissions totalled 62.3 $MtCO_2eq$ in 2009. This is a decrease from 2005 levels of 69 $MtCO_2eq$, however, in contrast to the EU generally Ireland's GHG emissions have increased since 1990. A 24% increase is observed between 1990 and 2005 (Chiodi et al., 2013), the years of significant economic growth in Ireland.

The reasons for the 2011 reduction include the recession and consequent drop in cement production. However, the increase in the use of wind energy, and changes in vehicle taxation to encourage the use of lower emissions vehicles have also been significant drivers along with milder winter weather.

Agriculture remains the single biggest contributor to overall emissions, making up 32% of the total in 2011. Agriculture contributes to global balances of greenhouse gases (GHGs) through emissions of nitrous oxide and methane and through emissions and/or sequestration of carbon dioxide.

Other Regional targets, barriers and drivers
Bioenergy is identified in Ireland's NREAP as having a significant role to play in the production of electricity, transport and heat. The government has set a target for peat power stations to achieve 30% co-firing with biomass by 2015, replacing approximately 900,000 energy tonnes of peat nationally. This is a dependable renewable electricity supply that will help to balance the intermittent supply from wind. Edenderry Power Station, commissioned in 2000, is a 128 MW (gross) baseload, 117.6 MW (net) output plant. The modern bubbling fluidised bed boiler technology, which allows a multi-fuel capability, consumes just over 1 million tonnes (7.7PJ) of fuel each year. The normal bed temperature of the boiler is 9100C. The plant incorporates a sulphur dioxide abatement system, electrostatic precipitator for dust removal and seven forced draft cooling towers. Co-firing trials using sawdust and woodchips commenced in 2002, but it was not until 2008 when final planning consent to permit co-firing was obtained that commercial co-firing commenced.

The amount of renewable electricity (RES-E) generated has increased steadily over the period, as shown in *Table 1*, from 15,200 MWh in 2008 (≈2% co-firing) to 193,800 MWh in 2013. (≈26% co-firing). Achieving 30% co-firing by 2015 which will replace 300,000 energy tonnes of peat, yield ≈258,000 tonnes of CO_2 abatement and produce ≈227500 MWh RES-E at the plant looks certain to be achieved.

Barriers exist within the biomass industry. Currently there are over 3,000 hectares of energy crops grown in Ireland. However, the market is immature and often the outlet is not within a viable transport distance. Bord Na Mona state that haulage costs outside a 120km radius of their Edenderry Plant is rendering crops uneconomic for producers.

Beyond 2015 there is potential to replace 500,000 energy tonnes per year. The plant has a considerable tolerance for both particle size (< 40 mm) and moisture content (10 – 60% for individual biomass materials and 45 – 55% for peat & biomass fuel blend) of biomass materials. The biomass will come from three principal sectors: Irish forests, energy crops and imported agro-industrial residues such as palm kernel shells, almond shells and olive stones. It is recognised that close monitoring and control of the biomass chemical parameters and the ash melting characteristics is required. Willow is preferred as an energy crop over miscanthus owing to the high chlorine content of the latter which affects the efficient running of the plant.

The National Renewable Energy Action Plan (NREAP) has factored 75 MW installed capacity with an expected gross electricity generation of 230 GWh from ocean energy into the modelled scenario to meet the binding 2020 targets. This is in expectation of technological and commercial viability by then. The Irish Department of Energy and Natural Resources (DCENR) has developed a Draft Offshore Renewable Energy Development Plan which describes the policy context for development in Irish waters of offshore wind, wave and tidal. However, conflicting views exist to the possible technical success and benefit to the Irish energy sector of these technologies.
Some studies have predicted that a fully developed ocean energy sector here could be worth €9 billion (SQW, 2013). However, a recent

Marine Renewables Industry Association study said the technology challenges faced by ocean energy, particularly in the wave field, coupled with the slow pace of policy development and implementation, make these projections unlikely (MRIA, 2013). A 1.2 MW tidal energy device has been operating successfully since 2008 in Strangford Lough in Northern Ireland.

One driver for reducing GHG is the focus on energy retrofits in the domestic sector. The government has to date invested €230 million in the retrofit of 139,000 Irish homes. This is expected to bring 950 GWh of saving by 2020. It is proposed that total residential CO_2 emissions could be reduced by up to 90% by 2050 with an extensive programme of energy efficiency retrofit (Roadmap 2012).

Along with the inadequate transmission grid earlier discussed, a second significant limiting factor to Ireland energy sustainability is the lack of power storage facilities in the state (DCENR, 2013b). The Electricity Supply Board (ESB) runs a single pumped storage facility. Others have been proposed but none yet built.

Ireland has been keen to adopt the EU Directive on the Energy Performance of Buildings (EPBD) into national legislation, mainly through the Building Control Act 2005 and Statutory Instrument SI No. 666 European Communities (Energy Performance of Buildings) Regulations 2006. Ireland's building regulations are relatively strict with an unceasing focus on reducing U values of building elements. However, enforcement is deficient and building assessment is generally limited in Ireland with few buildings having undergone assessment or certification (IGBC, 2013).

Since 2009 the SEAI has operated a domestic retrofit funding programme where domestic homeowners may apply online to the National Better Energy Home Scheme to receive 30% funding as a grant towards the cost of energy efficiency retrofit measures implemented.

This scheme excluded the most vulnerable in society being those on the social housing list as the fuel poor whom do not own their home, nor have access to 70% of the cost to complete EE retrofit measures in savings or through lending.

The Better Energy Homes and Warmer Homes is a follow on programme, launched in 2013, which has allocated €32 million to grants for the energy efficiency retrofit of domestic properties. The Better Energy Communities (BEC) Programme, also launched March 2013, is a national upgrade programme to retrofit Ireland's building stock to improve the thermal and electrical efficiency, thereby reducing fossil fuel use, running costs and greenhouse gas emissions. The programme is designed to generate innovative and pioneering partnerships at community level whereby one or more organisations come together to develop a single project in one or more locations, in urban or rural settings. These partnerships will encourage cost effective project delivery model and stimulate employment as a result of the upgrading works. This programme is pertinent to the case study presented in the subsequent section.

Transport is Ireland's biggest energy demand sector, and private cars constitute the largest proportion of this sector (see *Figure 2*). Ireland's target, under the Renewable Energy Supply Directive, is for 10% of its transport energy to be supplied by renewable sources by 2020. With respect of this, taxation drivers have been implemented. In 2008 the private car taxation system was altered to encourage the use of lower emissions vehicles. Prior to 2008 vehicles had been taxed based on engine size. Now instead they are taxed based on CO_2 emissions. Ireland has been proposed as an ideal location for the implementation of a cross-country electric car programme due to its relatively small size and hence proximity of urban centres.

The construction industry in Ireland has been in serious decline since 2007. "Green" Public Procurement might now be seen as a real driver for innovation. The Government's Action Plan on Green Public Procurement – "Green Tenders" – that was published in 2012 aims to provide a framework for procurement in an energy efficient and sustainable way. Focus has also been given to providing professional, fully accredited, targeted training courses to construction workers. Specific energy training for builders has been established as part of an EU-wide initiative ("Build Up Skills," 2013).

3. CASE STUDY: KILKENNY BOROUGH AND ENVIRONS, BETTER ENERGY COMMUNITIES PROGRAMME

Kilkenny Borough and Environs, as shown in *Figure 7*, has a population of 24,423 (borough 8,711 & environs 15,712) according to the 2011 National Census in an area of approximately 10km^2. There is a wide range of low-rise domestic building types in Kilkenny ranging in age from a several hundred years old to newly constructed. Housing is predominantly privately owned but there are a number of social housing units provided by the local authority and also by local parish housing communities and other social housing charity agencies.

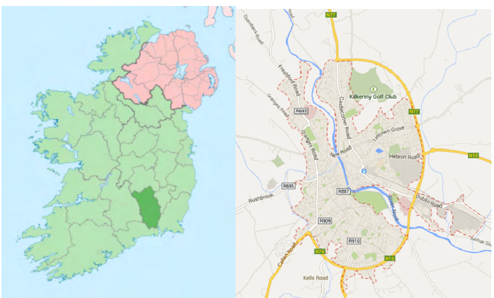

Figure 7 – Kilkenny Borough & Environs (Wikipedia and Google Maps)

The Carlow Kilkenny Energy Agency (CKEA) is a local energy agency that operates in the Counties of Carlow and Kilkenny since 2002, supporting and driving sustainable primarily projects for the citizens and the local authorities. As part of this role the CKEA work closely with the Local Authorities in Carlow and Kilkenny to deliver sustainable projects in all sectors. The Kilkenny Local Authority Senior Management Team identified the improvement of the aging social housing as a priority for 2013. As a result the CKEA set about preparing an application the Better Energy Community (BEC) Projects in 2013. The SEAI designed the national BEC programme to test innovative and pioneering partnerships between for example, the public and private sectors for the delivery of energy savings within a community.
Funding is awarded on the basis of a competitive assessment criteria, under the following headings (SEAI, 2013b)

- *Value For Money:* Savings in terms of the magnitude of the energy savings, in absolute terms and relative to the cost of implementation and the cost of funding by SEAI;
- *Partnership:* Organisation and development of collaborative delivery models, which will inform longer term initiatives for activating energy retrofit investment;
- *Innovation/technical aspect:* This may be in the form of technological application across multiple solutions, buildings or sites, or of the organisational delivery model with regard to finance, procurement and/ or contractual mechanism;
- *Quality and Delivery:* The quality of the project including robustness of the project plan, project management and capability to complete the project by the deadline.

An equal 25 mark weighting is awarded to each evaluation criterion.

Objectives and methods

Funding for programmes such as the Better Energy Warmer Homes scheme are limited to privately owned properties where the occupier is in, or at risk of, fuel poverty; estimated at 10 – 13% of the Irish households in 2009/2010 (SEAI 2013c) Local Authorities and Voluntary Housing associations are not permitted to apply for this grant aid as the property owners and tenants are not classified as domestic applicants. Though the programmes are beneficial with emphasis being placed on the fuel poor (>10% of income spend on domestic energy) there was a detrimental social effect for privately owned dwellings, where those in ownership of their properties were upgrading them but their socially housed neighbours were not permitted to do so. Prior to the 2013 BEC programme, national funding for the upgrading of local authority (LA) owned housing prioritised returning of vacant stock to use. This is the first time that owners of multiple social and affordable housing units could apply for grant aid to retrofit them and reduce the exposure to fuel poverty for their economically disadvantaged tenants.
The CKEA brought the stakeholders together with Kilkenny County Council to describe the potential project. Initial conditions for engagement required that the occupants/ tenants of the dwellings were majority fuel poor

and qualified for fuel allowance through Social Welfare System of Ireland. A total of 7 voluntary housing groups were contacted and invited to engage with the project. Positive feedback from 4 voluntary housing groups resulted in a firm commitment to proceed with a 2013 application.

The 4 property owners are:

- Kilkenny County Council - 128 housing units;
- St. Johns Parish Housing – 6 housing units;
- SOS Housing Association – 15 housing units;
- Switzers Housing – 18 housing units including apartments.

The Sustainable Energy Authority of Ireland (SEAI) is supporting the programme with funding through the Irish EU Structural Funds at 50% Capital Cost co-funded by the Irish Government and the European Union.

In accordance with Part 5 of S.I. No. 542 of 2009, the European Communities (Energy End-use Efficiency and Energy Services) Regulations 2009 Energy Suppliers are obliged to achieve Energy Saving Targets. To do so Energy Suppliers may establish voluntary agreements with their final customers for the purpose of promoting energy efficiency. The BEC programme promotes a partnership approach whereby the energy supplier can claim credits for the project if they are involved from the outset and bring additional expertise and funding. One of Ireland's major utility suppliers was chosen as the preferred partner and is contributing 3.5% of the capital budget in exchange for the savings credits. The credits are awarded to the project based on savings made where 1 kWh/year= 1 credit.

The credits help the utility supplier meet its Energy Saving Targets set in accordance with Regulation 16 and 17 of SI 542/2009.

The technical stakeholders include the:

- Carlow Kilkenny Energy Agency – Project co-ordination;
- Kilkenny County Council Housing Department – Project management and contractor procurement;
- Waterford Institute of Technology – Energy Monitoring Programme;
- Electric Ireland – Energy Credit Management.

The Total Capital Expenditure for Project is estimated at €2.5 million:

- SEAI (EU and National Funding) – 80%;
- Obliged Utility Partner – 3.5%;
- LA Funding – 16.5%.

Each measure completed on each housing unit is eligible for Credits for which the obligated party will secure in return for their capital contribution. A sample of the measure credits is shown in *Table 1*.

Measure and Specification	Energy Credits kWh/yr	
	Apartment	House
Roof Insulation		
Insulation as per TGD L 2008	800	1,300
Ceiling U-Value 0.16 W/m^{2}K		
Rafter U-Value 0.2W/m^{2}K		
Flat Roof U-Value 0.22 W/m^{2}K		
Wall Insulation		
External U-Value 0.27 W/m^{2}K	3,750	5,900
Internal dry lining U-Value 0.27 W/m^{2}K	3,200	5,000
Cavity Wall U-Value 0.50 W/m^{2}K	2,050	3,250
Floor Insulation		
External U-Value 0.36 W/m^{2}K	700	1,100
Windows and Doors		
Full window and doors U-Value 1.4 W/m^{2}K	1,050	1,650
Boiler		
High Efficiency (90% +) gas/oil boiler with integrated heating controls and full zone control on space and water heating	4,900	7,700

Table 1 – Energy Saving Credits Sample – Taken from (SEAI, 2013b)

Typical interventions of each dwelling where applicable included:

- attic insulation - on the rafter;
- pumped cavity wall insulation where practicable;
- window and external door replacement;
- high efficiency gas boiler with programmable heating controls;
- high efficiency multi-fuel stove;
- whole house energy efficient lighting.

All works under the scheme were to be completed by 30th October 2013. A pre-and post-upgrading Building Energy Rating (BER) was completed on each dwelling to certify the improvement in building performance. This, in reality, is an estimated saving generated. On-going monitoring of 10% of the upgraded dwellings is tracking actual building performance, allowing a critical analysis of theoretical savings from the BER. Monitoring will be complete in November 2014.

The multi-fuel stoves were installed in place of the traditional open fireplaces. There were 16 local contractors employed through local authority framework of builders engaged to implement these measures throughout the project. Approximately 100 construction professionals were employed to complete the project. Throughout the implementation stage the workers attended practical training and up-skill talks on retrofit measures.

Results

It is anticipated that the total savings generated by the project will be in the region of 2,152,482 kWh per year; equating to an average 12,889 kWh per annum per dwelling. Based on Ireland's fuel mix, this in credit terms equates to 5,701 kgCO_2 per dwelling being saved annually for the conversion factors as listed by SEAI (SEAI, 2013b).

4. CONCLUSIONS

The programme embraces a transparent and competitive selection process. The Better Energy Community programme encourages housing agencies to act as a collective and access >50% grant aid through SEAI administered EU and National Funding.
The main benefit of large scale upgrading was the efficient procurement of the project resulting in a considerable lowering of cost per measure. The average upgrade costs according to the DoECLG in 2011 were circa €15,000 plus VAT nationally to bring houses to a C1 standard 150-175 kWh/m2yr total primary energy consumption) in the DEAP Building Energy Rating. DEAP is the national methodology for calculating and assessing the energy performance of dwellings. Compared to the national average, cost savings in the region of 40% were realised through the efficient delivery of this project.
There are many real issues that affect the performance of a building and these will be monitored and recorded to better educate the tenants and housing bodies in terms of maximising the reduction in energy consumption and assisting the drive to Nearly Zero Buildings for socially deprived.

Based on the successful implementation of the project, the CKEA plan to develop a next generation model for clustered social housing extending to more communities in the region. This will require integration of a social housing procurement software program that is currently under development and hoped to be implemented in 2014. It is intended in 2014 to widen out to larger groups of voluntary housing entities. Launched in early 2014, a new standardised National Local Authority Framework for Contractors has come into effect, increasing transparency and competition. The scale of speed of implementation of the process will build momentum within the community.

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ITALY

AUTHORS

Senatro Di Leo
E: senatro.dileo@imaa.cnr.it

Monica Salvia
E: monica.salvia@imaa.cnr.it
National Research Council of Italy, Institute of Methodologies for Environmental Analysis (CNR-IMAA), C.da Santa Loja, 85050 Tito Scalo (PZ), Italy.

1 OVERVIEW OF THE REGION

Characteristics of the Region

Basilicata is a small region in Southern Italy, with 577,562 inhabitants (2011), which covers an area of 9,992 square kilometres, representing only 3.3% of the Italian surface. It is one of the 20 regions of the Italian Republic (*Figure 1*). Basilicata is split into two provinces: Province of Potenza and Province of Matera. Basilicata is bounded to the west by Campania, to the north and east by Puglia and to the south by Calabria and has two small coastlines, on Tyrrhenian Sea (to the west) and on Ionian Sea (to the south-east).

Figure 1 – The Basilicata Region

The trend of the population is in decline (*Figure 2*). From 2001 to 2011 there was a reduction of about twenty thousand inhabitants mainly due to low birth rates and migration towards other regions. After Valle d'Aosta, Basilicata is the Italian region with the lowest population density, with about 60.8 inhabitants per square kilometres respect to the national average of 201 inhabitants per square kilometre. This is mainly due to the prevalent mountainous morphology of the territory and a low economic growth.

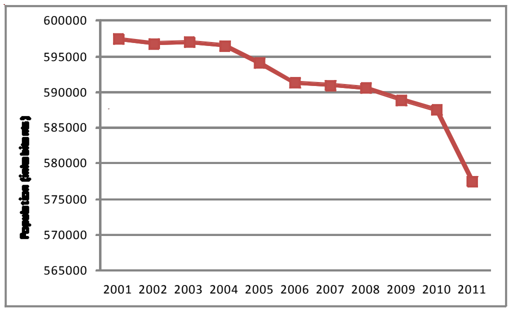

Figure 2 – Population of Basilicata 2001 – 2011 (Source: Istat, 2013)

In 2007 the Gross Domestic Product (GDP) of Basilicata was about €18,900 per capita, slightly higher than the average value in Southern Italy (€17,300 per capita) but consistently lower than the national average GDP (€26,000 per capita) (*Table 1*).

Euro per capita	2005	2006	2007
Province of Potenza	17,300	18,400	19,200
Province of Matera	16,700	17,700	18,300
Basilicata Region	17,100	18,200	18,900
Southern Italy	16,100	16,800	17,300
Italy	24,400	25,200	26,000

Table 1 – GDP values in 2005-2007 (Source: Regional Statistics Yearbook, Basilicata 2010)

The local economy is based on agriculture, in particular cereals, potatoes, vines and olives. The Basilicata industry sector is dominated by food and drink, artificial fibres, non-metallic mineral and chemical industries.

In the Val d'Agri area considerable mining of hydrocarbons is present, with preliminary treatment of extracted oil. In the North of the Region the largest Italian car maker (FIAT) has an important industrial centre. Tourism is increasing, mainly on the coastal areas, but it is still under the national average.

The total employment rate in Basilicata (37.6%) is lower than the national average (44.9%). In 2012, the labour market in Basilicata was affected by the contraction in economic activity with a decline of employees and hours worked. This has resulted in an increase in the unemployment rate (14.5% in 2012), which remains lower than the average value of Southern Italy but higher than the average Italian total.

The unemployment rate by level of education is always lower than national values. In particular, 8.4% of graduates and doctorates were unemployed in 2009 (*Table 2*).

Level of education	Basilicata	Italy
Primary school	10.9	9.9
Secondary school of first degree	12.5	9.4
Secondary school of second degree (2 – 3 years)	10.4	7.6
Secondary school of second degree (4 – 5 years)	11.6	7.2
Degree/ Doctorate	8.4	5.5
Total	11.2	7.8

Table 2 – Unemployment rate (%) by level of education. Years 2009 (Source: Regional Statistics Yearbook, Basilicata 2010)

Energy demand and supply of the Region
In 2010 the Basilicata Regional Authority approved the Regional Environmental Energy Plan (PIEAR) containing the regional energy strategy to be implemented to 2020. According to the PIEAR, in 2007 the total energy consumption was 59.23 PJ, mainly due to the Industrial sector (47%), followed by Transport (29%), Residential (13%), Commercial (8%) and Agriculture (4%) (*Figure 3*).

Natural gas and diesel are the most used fuels (23%): natural gas is mainly consumed by Industry (6.3 PJ) and Residential (5 PJ), whereas Transport is the largest consumer of diesel (10.5 PJ). Also electricity contributes substantially to the final energy consumption (18%), with 10.5 PJ of which 6.3 PJ in Industry, 2.02 PJ in Commercial and 1.84 PJ in Residential (*Figure 4*).

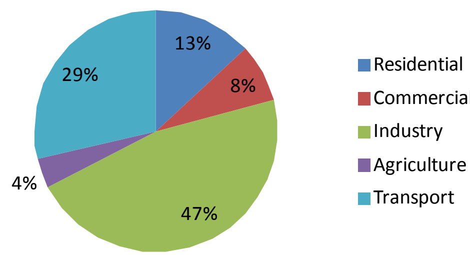

Figure 3 – Share of energy consumption by sector, 2007

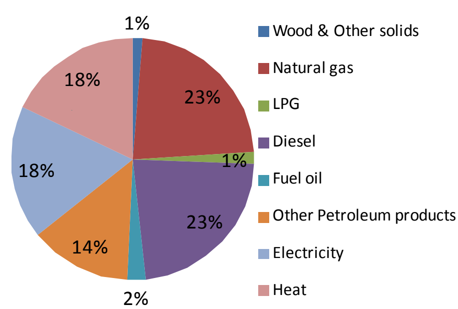

Figure 4 – Share of energy consumption by fuel, 2007

In *Table 3* a summary of energy consumption in 2007, by fuel and sector, is reported.

Energy source	RES	COM	IND	AGR	TRA	Total
Wood and Other solids	0.29	-	0.44	-	-	0.77
Natural						
Gas	5.02	2.14	6.3	0.04	0.06	13.56
LPG	0.24	0.14	0.24	-	0.25	0.87
Diesel	0.38	0.24	0.27	2.01	10.54	13.44
Fuel						
Oil	0.002	0.04	1.43	-	-	1.47
Other petroleum						
Products	-	-	1.98	-	6.07	8.05
Electricity	1.84	2.02	6.28	0.26	0.1	10.5
Heat	-	0.0003	10.6	-	-	10.6
Total	7.77	4.57	27.6	2.3	17.02	59.23

Legend: Residential RES, Commercial COM, Industry IND, Agriculture AGR and Transport TRA

Table 3 – Energy consumption (PJ) by fuel and sector, 2007 (Source: CNR-IMAA elaborations on PIEAR data and ENEA statistics)

The Region is heavily dependent on imported electricity from neighbouring regions, importing about 881.1 GWh in 2012, which is 29% of the consumed electricity (TERNA data). Thermoelectric power plants are powered by fossil fuels for a total power of 343 MW and 868 GWh of net production and are characterised by an efficiency level below the national average, as they are quite old installations. The installed capacity of cogeneration plants is about 70% of the overall thermoelectric power plants.

Regarding electricity production from renewable sources, in 2012 the main contribution was provided by wind power plants with a net production of 586 GWh and 369 MW of installed capacity. In the same year, hydroelectricity production was 304 GWh with an installed capacity of 129 MW. Most of the electricity production is provided by the Italy's largest power company (ENEL Production), which in Basilicata has three hydroelectric plants for a total capacity of 123 MW. Furthermore with the introduction of the "energy bill" there has been an increase in permits for the installation of photovoltaic (PV) systems, which has led to 330 MW of installed capacity and 586 GWh of electricity production from PV.

Basilicata holds the largest oil reservoir of continental Europe with a quantity of crude oil and natural gas extracted from its underground (actually about 90,000 barrels per day and 3 million of m^3 per day) (*Figure 5*).

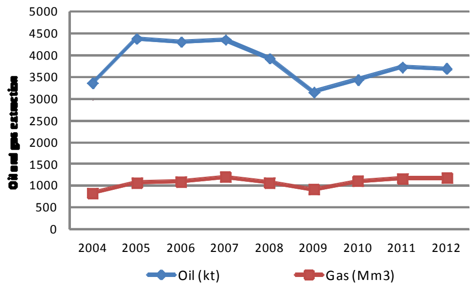

Figure 5 – Oil and gas extraction from Basilicata Region (Source: Umnig Office - Economic Development Ministry, 2013)

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The Italian targets of the EU Climate Package by 2020 set the reduction of 13% for CO_2 emissions compared to 2005 levels and at least 17% of energy production from renewable sources compared to the gross final consumption of energy.

Italy's Budget Law 2008 (DL n. 208/2008) introduced the concept of "burden sharing", which involves the decision to split among regions the duties to achieve the EU target set for Italy for a 17% share of renewable energy by 2020. Only on 15 March 2012 this Law was acknowledged by a Ministerial Decree which set, in the particular case of Basilicata Region, an increase of the total share of thermal and electric energy produced by renewable energy sources in order to reach 33.1% of the gross final consumption within 2020, with the intermediate targets listed in *Table 4*. It should be pointed out that the reference value of the temporal trajectory of the regional targets on renewable energy is obtained by the ratio between the consumption from renewable sources and the gross final consumption. This value does not refer to a specific year, as it combines the latest information related to different years.

Also, the Italian economic and financial programming document 2008 – 2011 introduced a CO_2 emissions sharing mechanism among Regions. These provisions aimed to give more responsibility to regions and were enforced by Law 13/2009, which established a burden-sharing criterion based on the European 2020 target (IEA, 2009). In this case a ministerial decree has not been issued yet.

Year	Target
Reference value	7.9
2012	16.1
2014	19.6
2016	23.4
2018	27.8
2020	33.1

Table 4 – Trajectory of the targets (%) for renewables in the gross final consumption for the Basilicata Region (Ministerial decree of 15 March 2012)

Estimations of ktCO^2 emissions in 2000 – 2006 were estimated by ENEA and reported in *Figure 6*. In this period the contribution of the Basilicata Region was about 0.7% of the CO_2 total emissions for Italy. In 2006 the regional average amount of CO_2 polluted per MWh produced was 0.47, lower than the national average value of 0.59 tCO_2/MWh (Mankuso E., 2011).

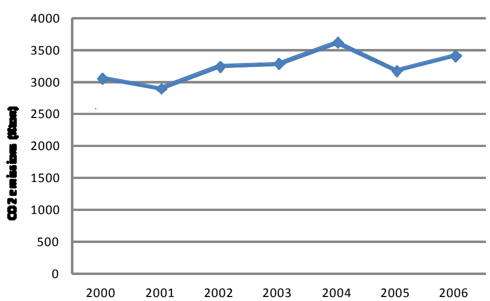

Figure 6 – CO_2 emissions of the Basilicata Region (2000 – 2006) (Source: Mankuso E., 2011)

In 2006 the highest contribution was made by the Civil sector (Commercial and Residential) which represents 1434 ktCO^2, that is 42% of the total regional emissions, followed by Transport (953 ktCO^2, 28%), Energy Production (538 ktCO^2, 16%), Industry (345 ktCO^2, 10%) and Agriculture (149 ktCO^2, 4%).

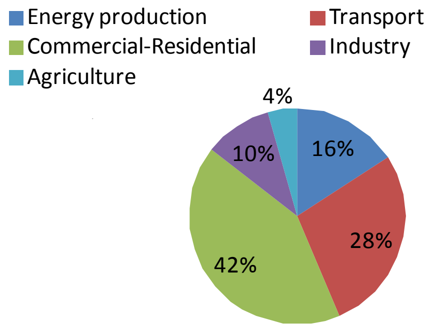

Figure 7 – CO_2 emissions by sector - 2006 (Source: Mankuso E., 2011)

The target of the PIEAR is the reduction of CO_2 emission of about 65% by 2020 compared to 1990 (2,231 ktCO^2).

Other Regional targets, barriers and drivers
Basilicata Region has favourable climatic conditions and topography for renewable resources development. There is a large availability of renewable energy sources including biomass, hydro, solar and wind. Delays in the installation of renewable technologies have been mainly caused by complex bureaucratic and administrative procedures. Moreover there has been legislative instability due to constant changes both in the regulations and incentive system. All these aspects could discourage private investors, already suffering from the present economic crisis and long term pay-pack periods.

The regional energy strategy is set by the Regional Energy Plan, in accordance with the instructions provided by the EU, the commitments made by the Italian Government and the uniqueness and potential of its territory. The Regional Energy Plan sets four main objectives: the reduction of fuel consumption and energy bills, the increase of electricity production from renewable sources, the increase of thermal energy from renewable sources and the creation of an energy district in Val d'Agri.

Reduction of energy consumption
In order to achieve an overall energy saving of 20%, the PIEAR proposes actions mainly focused on the efficiency of public and private buildings. In particular, it establishes the provision of grants for the implementation of measures to improve the energy performance of public and private buildings.

Measures to improve energy efficiency are also planned for public transport, encouraging the rationalisation of urban and extra-urban mobility. On the other hand, in private transport the use of more efficient engines is promoted. The plan encourages the distributed generation of electricity and, in particular, the installation of auto-production plants from renewable sources, connected to electricity distribution grids in low and medium voltage and localised in proximity of end-users.

Similarly, it promotes coupled production of electricity and heat (Combine Heat and Power). It favours the installation of auto-production plants, connected to electricity distribution grids at low and medium voltage as well as to distribution networks of steam or hot water, located in proximity to the users.

Increase of electricity production from renewable sources
Based on the potential of its territory, the Basilicata Region intends to satisfy the domestic needs of electricity almost exclusively through the use of plants powered by renewable sources. In *Figure 8*, the trend of electricity production for source in 2005 – 2012 is reported (TERNA, 2013).

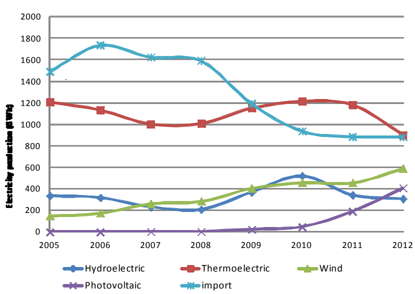

Figure 8 – Electricity production by source
Figure 8 shows an increase in the contribution of renewable energy sources in recent years.

In particular PV power generation increased from 45.7 GWh in 2010 to 407 GWh in 2012 and wind generation from 284 GWh in 2008 to 588 GWh in 2012.

Such an increase in electricity production from renewables has led to a reduction of electricity import from other regions, which halved in 2012 (881 GWh) compared to 2007 (1625 GWh). Moreover, this caused also a reduction in the share of traditional fossil fuels respect to the total electricity production, as resumed in *Table 5*.

Year	Electricity from thermoelectric respect to total production	Import of electricity respect to total consumption
2005	71	47
2006	70	52
2007	67	52
2008	67	51
2009	59	38
2010	54	29
2011	55	29
2012	41	29

Table 5 – Shares of electricity production (%) and import (%).

The Regional Energy Plan forecasts an electricity demand of 3800 GWh in 2020, with a deficit of 2300 GWh. According to the PIEAR, this deficit in electricity production will be pursued through an increased exploitation of locally available renewable energy sources (RES), as summarised in *Table 6.*

Renewable energy source	Share (%)	Electricity production (GWh/year)	Installed capacity (MWe)
Wind	60	1374	981
Solar and photovoltaic	20	458	359
Biomasses	15	343	50
Hydroelectric	5	114	48
Total	100	2289	1438

Table 6 – Renewable energy targets by 2020 (Source: Basilicata Regional Authority, 2010)

It has to be pointed out that this planned increase of electricity production from renewable sources will exacerbate problems already present in the transmission and distribution networks. In order to ensure the security of electricity regional supply and improve the quality of service for citizens and businesses, it is necessary to work on strengthening, streamlining and rationalising the primary and secondary electricity grid in Basilicata. To this end, the Basilicata Regional Authority is promoting a memorandum of understanding with TERNA, the company that manages electricity transmission in Italy, to intervene on the high-voltage transmission network. On the other hand, measures on the distribution networks at low and medium voltage will be also necessary.

The proposed interventions will be aimed to develop networks to transport and distribute electricity in an efficient and rational way, to manage the flow of energy produced by the individual production plants from renewable sources by encouraging distributed generation. To achieve this it will be important to use innovative technologies and computer control systems for transmission and distribution networks in order to improve the management of energy flows. The Regional Energy Plan indicates the importance of implementing pilot projects for the application of smart grids in local areas (micro-grids). The reduction of electrical losses in transmission and distribution networks is a more evident advantage: in fact, the use of electricity in the neighbourhoods of generation sites allows an achievement of higher efficiencies and savings in financial resources. Other valuable advantages of micro-grid installations are related to new jobs opportunities for technical graduates (engineers, informatics), technicians and specialised workers for the micro-grid operation and maintenance. The micro-grids have also a positive impact on the Medium Voltage and High Voltage macro-grids because they produce a decreasing of the electrical congestion on the Medium and High Voltage networks, thus reducing the investments addressed to solve this crucial aspect.

An important aspect concerns the simplification of authorisation procedures in order to facilitate public and private investors, for example, shortening the time for the issuance of permits and simplifying the documentation to be produced. For this reason, the Basilicata region has committed itself to harmonise the regional energy legislation with the national framework, taking into account also the provisions for environmental and landscape legislation.

Production of thermal energy from biomass and biofuels

An important objective of PIEAR is to increase the production of thermal energy using woody biomass and biofuels. In particular it aims to promote the energy valorisation of lignocellulosic biomass from forest management, agriculture and cow and pig breeding as well as local industries. A priority of the regional initiatives is the construction of district heating and mini-heating networks, especially for systems serving new public and residential buildings for which there is a less complex design and management.

Creating an energy district in Val d'Agri

As already mentioned in Basilicata, more exactly in the Val d'Agri area, there is a very large oil field currently undergoing extraction activities. In this area, the Regional Authority has planned to realise an energy district, in which developing research and technology innovation, involving universities and research centres operating in Basilicata. The main aim is to establish, in this energy district, industries that specialise in the production of innovative materials, systems and components for improving energy end-uses, both in the civil and productive sector. Other peculiarities of the district should be: the creation of innovative and experimental facilities for the production of energy from renewable sources, carrying out research and experimental activities on biofuels production and the creation of an energy park aimed at highlighting the most advanced technologies in the field of renewable energy and energy efficiency (including the construction of a demonstrative zero emissions building characterized by energy self-sufficiency).

Innovative strategies/initiatives

Also in Basilicata the EU and national challenges on climate and energy issues have been acknowledged by local authorities, committing themselves to improve the quality of life of citizens through sustainable urban development.

This is confirmed by the recent involvement of the multi-tier regional government systems in several international initiatives and networking activities, often supported by scientific institutions and universities. In particular, the Municipality of Potenza is currently involved in two South East Europe projects (EnVision2020 "ENergy VISION 2020 for South East European Cities" and RE-SEEties "Towards resource efficient urban communities in SEE"), the Province of Potenza is leading the INTERREG IVC RENERGY "Regional Strategies for Energy Conscious Communities" whereas the Basilicata Region is contributing to the LIFE08 ENV FACTOR20 "Forwarding demonstrative ACTions on a Regional and local scale to reach UE targets of the European Plan 20/20/20" (2010 – 2012) and in the SEE ORIENTGATE "A structured network for integration of climate knowledge into policy and territorial planning" (2012 – 2014)

The increasing interest in energy policy and energy programming is also proved by the increasing number of municipalities of Basilicata, which have become members to the Covenant of Mayors (CoM). Since 2010, when the Potenza and Matera Provinces became supporting structures of the CoM, 71 cities (representing 54% of the whole number of municipalities in the region) have committed to go beyond the objectives of EU energy policy in terms of reduction in CO_2 emissions and are developing Sustainable Energy Action Plans (SEAPs).

Recently it a general increase in interest on Smart Cities initiatives has been observed aimed to help cities to start planning their future in a new way: adopting a comprehensive multi-sector approach and accelerating innovation to become more sustainable and resilient. In this framework, funded by a National Calls for bids on "Smart Cities and Communities and Social Innovation" launched in 2012 by the Ministry of Education, University and Research (MIUR), the "SMART Basilicata" project started on 30 November 2012 with a duration of 30 months.

SMART Basilicata is a coordinated project aimed to promote smartness among different local areas in Basilicata. The project constitutes a unique attempt in which, by working together, multi-layer public authorities, private enterprises, research organisations and universities have drafted the basis for a regional strategy for smart-related issues. The project is structured around five main operating objectives (Smart Environment, Smart Energy, Smart Mobility, Smart Culture & Tourism, Smart Participation) which are smartly integrated in a systematic approach towards a more sustainable configuration of the regional widespread "town" (Figure 9). All the research activities converge into four "demonstrators" located in different areas of Basilicata (SMART_ENV: Val d'Agri/Basilicata, SMART_Energy: Val d'Agri, SMART_STREET: Potenza, sMArTERA: Matera). The aim is to provide reference models for territorial development fostering the participation of multiple stakeholders from the public sector, civil society, and the private sector.

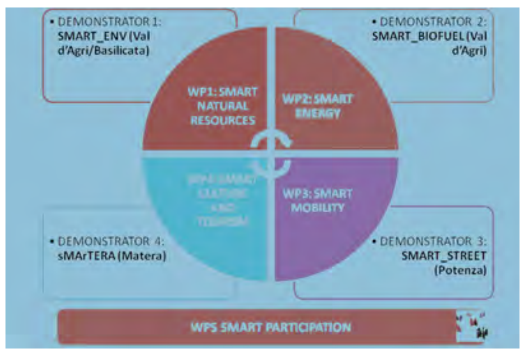

Figure 9 – Structure of the "Smart Basilicata" project

The local areas involved in this study are characterised by different dimensions, cultural identities, vocation and peculiarities whereas the replicability of the proposed solutions makes SMART Basilicata a "smart" attempt to draw a common innovation strategy on the medium/long term with a regional perspective.

3. CASE STUDY: THE TIMES-BASILICATA MODEL

The case study is focused on the Basilicata regional energy system both supply and end-use demands. It is based on the implementation of the TIMES-Basilicata model (Di Leo et al., 2013) to analyse the regional energy system and its evolution on the medium-long time horizon from 2007, the reference base year, to 2030. The main objectives, methodological aspects and results obtained are described in the following sections.

Objectives and methods

The TIMES, acronym of The Integrated MARKAL/EFOM System, is a powerful energy, economic, environment planning tool developed under the ETSAP programme of the International Energy Agency (ETSAP, 2013). It is largely utilised by numerous scientific communities to derive and study optimal development energy-environment scenarios at level of separate Communities, Province, Region, State or in a multi-regions approach, analysing in depth problems related to security of energy supply, mitigation of climate change and air pollution on a medium-long time horizon. The TIMES model allows a bottom-up technology-oriented representation of energy systems, representing energy flows from supply to end-use demands through the network of technologies, including both fossil and renewable energy vectors (Loulou et al, 2005). The energy systems evolution over the time horizon is described starting from a statistical reference year by introducing key data and constraints in the multi-period structure. The input data concern resources availability, technical, economical and environmental features of technologies, exogenous constraints. The model individualises the minimum-cost solutions by scenario and defines the optimal levels of utilisation of resources and technologies that accomplish the system's constraints and scenario assumptions.
TIMES-Basilicata is a decision support tool for regional energy planning that has been developed at CNR-IMAA as part of the MONET Italy model, a twenty-regions energy model (Lanati F. *et al*., 2012). The data input of the TIMES-Basilicata model is structured around three sets of elaborate Excel spreadsheets, represented in the structure of *Figure 10*.

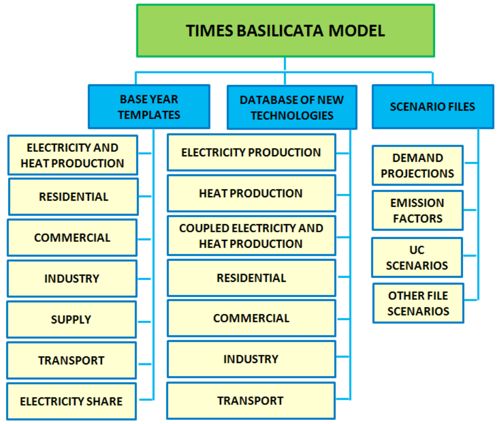

Figure 10 – Structure of the TIMES-Basilicata model

The first set deals with seven "*Base year templates*". This group involves six sector-by-sector templates which hold the data necessary to calibrate the energy flows of the base-year for the analysed end-use demands: Commercial (COM), Residential (RES), Industry and Agriculture (IND), Transport (TRA), Electricity and Heat production (ELC), and Energy Supply (SUP). In particular, these spreadsheets contain the following information: base-year energy flows, technical and economic characterisation of the existing technology stocks, transmission efficiencies. The representation of the base year is completed by the Electricity Share (SHR) template aimed to convert (through dummy technologies) the electricity at different levels of voltage into new electricity flows consumed in different industrial sectors and Agriculture.
The second set focuses on the database of new technologies ("*Subres new techs*"): new technological options are introduced and described by their technical and economic parameters distinguishing among Electricity Production (ELE), Heat Production (HET), Coupled Electricity and Heat Production (CHP), Residential (RES), Commercial (COM), Industry (IND) and Transport (TRA).

Last but not least there are the *"Scenario files"*: in order to build up alternative scenarios,

different sets of coherent assumptions about the future trajectories of demand are defined (Demand Projections) as well as exogenous constraints (User Constraints).
The characterisation of the Basilicata energy system is completed by a spreadsheet containing emission factors (both GHGs and local air pollutants) and with other files that will take into account other aspects in further studies (e.g. external costs, life cycle inventory impacts). As mentioned in previous sections, according to the Basilicata Regional Energy Plan an important role could be played by the development of distributed electricity generation, in particular micro-grids.

Assessing the possible contribution of micro-grids towards a more efficient regional energy system and reducing present distribution losses was one of the main aim of this study. The micro-grid concept was therefore introduced into the TIMES-Basilicata by reducing the transmission and distribution losses for the micro-grid generated electricity, keeping unchanged all the other parameters characterising different generating sources (capital costs, O&M costs, efficiency).

Results

In order to provide a sound basis of comparison, the first step dealt with the implementation of a Business As Usual (BAU) scenario for the Basilicata region energy system, characterised by the current energy trends and policies in use.

Two alternative scenarios were then built up to evaluate the micro-grids contribution. In particular, the MICRO-GRID1 scenario analyses the situation in which all the photovoltaic plants characterising the BAU scenario (with an increasing capacity from 36 MW in 2010 to 170 MW in 2030), operate in a micro-grids modality. Furthermore, the MICRO-GRID2 scenario investigates on the opportunity to introduce, in addition to PV plants, co-generative gas turbines (with a capacity of 26 MW constant on the time horizon), operating in micro-grids modality. In such a case, the energy credits in terms of substitution of imported electricity are also taken into account.

The amount of electricity generated over the time period 2010 – 2030 in the baseline configuration is represented in *Figure 11*.

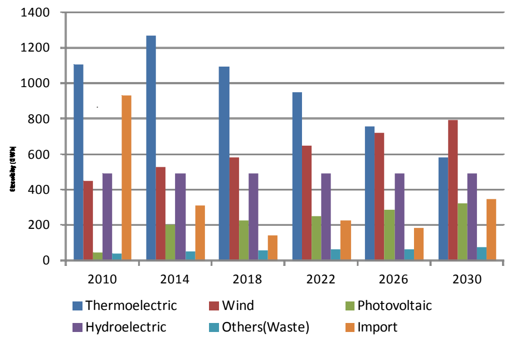

Figure 11 – Electricity production, 2010 – 2030

It can be observed that the total electricity generated in the region increases from 2149 GWh (2010) to 2277 GWh (2030) in the investigated period, while the imported electricity decreases from 935 GWh (2010) to 351 GWh (2030). The decrease of imported electricity is due mainly to two factors. The first is a reduction of the electricity consumption induced by the decrease of resident population. In fact according to ISTAT forecasts (ISTAT, 2013) the number of inhabitants could pass from 577,600 in 2007 to 531,500 in 2030. The second is due to an increase of the renewable energy generated in the region in particular from wind plants (454 GWh in 2010 up to 796 GWh in 2030) and photovoltaic plant (from 45.2 GWh in 2010 to 323 GWh in 2030).

This sharp increase of RES sources contribution determines a significant reduction in the thermoelectric plant generation (1110 GWh in 2010 to 585 GWh in 2030 with a peak of 1269 GWh in 2014).

The energy losses of High, Medium and Low Voltage networks are shown in *Table 7*: they are on average 5.2%, 5.5% and 8.2% respectively for the High, Medium and Low Voltage networks.

	High Voltage	Medium Voltage	Low Voltage
2010	155	141	117
2014	138	127	107
2018	123	112	94
2022	124	113	99
2026	116	105	95
2030	119	110	99

Table 7 – BAU scenario: Energy losses in transmission and distribution networks (GWh)

In the MICRO-GRID1 scenario all the photovoltaic plants operate in a micro-grid framework: the corresponding generated electricity fulfils the electrical loads allowing a decrease in the network losses strongly dependent from the micro-grid topology (e.g. the distance between the plant and the loads). The following values have been assumed for the losses reduction:

- 0.5% at Medium Voltage and 0.8% at Low Voltage for the PV plants connected to the Medium Voltage network;
- 0.8% for the PV plants connected to the Low Voltage network;

The decrease of electrical losses causes a corresponding decrease of the total electricity demand (with the same consumption) as reported in *Table 8*, in which the percentages of micro-grids generation is compared with the loss reductions.

	Electricity generated in micro-grid	Loss reduction in the region networks
2010	1.5	1.4
2014	7.2	6.7
2018	8.8	8.1
2022	9.8	9.1
2026	11.6	11.0
2030	12.5	13.8

Table 8 – Decrease of losses in local networks compared to the amount of electricity generated in micro-grid (%)

The decrease of energy demand leads to a reduction of imports with relevant benefits also on the national grid.

In the MICRO-GRID2 scenario, co-generative gas turbines operate in a micro-grid framework from 2014, with a yearly energy production of 138.1 GWh. The amount of electricity produced by the gas turbines nearly replaces the imports. The corresponding electricity produced over the investigated period is reported in *Figure 12*.

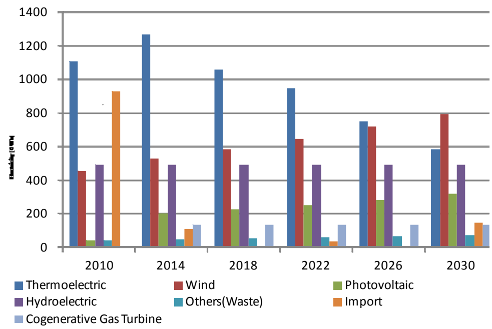

Figure 11 – Electricity production, 2010 – 2030

It can be observed that the total electricity generated in the region increases from 2,149 GWh (2010) to 2,277 GWh (2030) in the investigated period, while the imported electricity decreases from 935 GWh (2010) to 351 GWh (2030). The decrease of imported electricity is due mainly to two factors. The first is a reduction of the electricity consumption induced by the decrease of resident population. In fact according to ISTAT forecasts (ISTAT, 2013) the number of inhabitants could pass from 577,600 in 2007 to 531,500 in 2030. The second is due to an increase of the renewable energy generated in the region in particular from wind plants (454 GWh in 2010 up to 796 GWh in 2030) and photovoltaic plant (from 45.2 GWh in 2010 to 323 GWh in 2030).

This sharp increase of RES sources contribution determines a significant reduction in the thermoelectric plant generation (1110 GWh in 2010 to 585 GWh in 2030 with a peak of 1,269 GWh in 2014). The energy losses of High, Medium and Low Voltage networks are shown in *Table 7*: they are on average 5.2%, 5.5% and 8.2% respectively for the High, Medium and Low Voltage networks.

	High Voltage	Medium Voltage	Low Voltage
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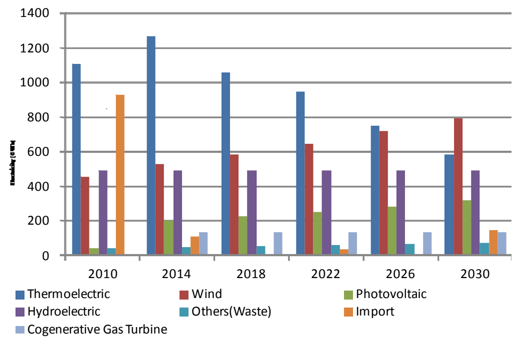

Figure 12 – MICRO-GRID2 scenario: Generation of electricity

The comparison between *Figure 11* and *Figure 12* underlines the significant changes in the mix of electricity production, fostered by an enhanced utilisation of micro-grids. As expected, network losses in the MICRO-GRID2 scenario, shown in *Figure 13*, decrease noticeably respect to the BAU scenario, ranging from 44 to 65 GWh respectively in the years 2014 and 2030. Respect to the MICRO-GRID1 scenario, energy losses reduction passes from 3 GWh in 2014 to 20 GWh in 2030.

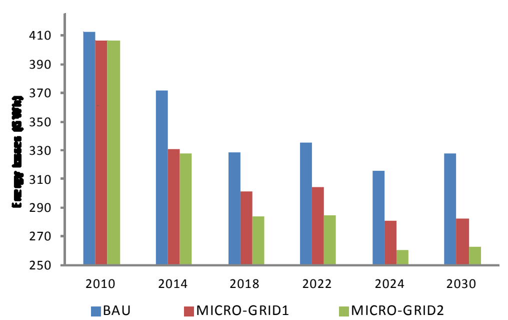

Figure 13 – Comparison of the total electricity losses between BAU and alternative scenarios

The trend of CO_2 emissions by electricity production is decreasing on the time horizon (*Figure 14*), due to an increasing contribution of renewable sources.

In the BAU and MICRO-GRID1 scenarios CO_2 emissions decreases from 517 kton in 2010 to 272 kton in 2030. In the MICRO-GRID2 scenario the co-generative gas turbines, operating in micro-grids and substituting electricity import, produce an increase of CO_2 emissions of 64 kton in 2030.

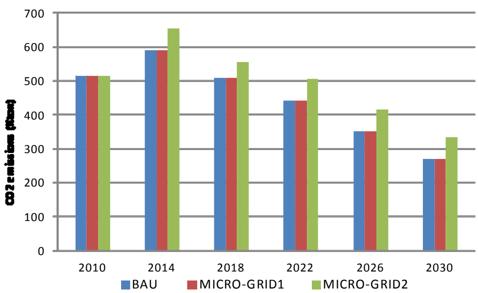

Figure 14 – CO_2 Emissions by electricity production in different scenarios

In term of costs (Table 9), for the BAU scenario the sum of electricity generation costs and transmission and distribution costs reaches 259 MEuro in 2030 with a peak of €318 million in 2014. The activation of the technologies operating in micro-grid has as a consequence a reduction in the transmission and distribution costs. In the MICRO-GRID1 scenario a reduction of costs is observed respect to the BAU scenario with the highest reduction of minus €21.4 million, -9.3% in 2018. Highest reductions are obtained in the MICRO-GRID2 scenario with values reaching minus €33.4 million (-14.5%) in 2018 respect to the BAU scenario.

	BAU	MICRO-GRID1		MICRO-GRID2	
	MEuro	MEuro	(%)	MEuro	(%)
2010	260	-2.1	-0.8%	-2.1	-0.8%
2014	318	-19.0	-6.0%	-30.5	-9.6%
2018	231	-21.4	-9.3%	-33.4	-14.5%
2022	258	-12.5	-4.8%	-27.6	-10.7%
2026	248	-16.8	-6.8%	-32.5	-13.1%
2030	259	-12.0	-4.6%	-28.9	-11.1%

Table 9 – Comparison of the electricity total cost (generation, transmission and distribution): costs reduction due to the introduction of micro-grids in the two analysed scenarios compared to the baseline situation (BAU)

4. CONCLUSIONS

The implementation of the TIMES Basilicata model allowed to analyse the evolution of the regional energy system in the medium term. The main focus was on the analysis of electricity production and the consequences derived by the micro-grids introduction. Taking into account the current incentive system, an increase of electricity production from renewable energy sources, especially wind and PV, can be implemented on the short term time horizon). This means a larger valorisation of the regional potential of renewables, with a decrease of electricity production from fossil fuels and a reduction of electricity imports from other regions.

The scenario analysis highlights the main advantages in terms of energy efficiency related to the installation of micro-grids, under the analysed scenarios, with a decrease of transmission and distribution losses ranging from 12% to 20% (MICRO-GRID2 scenario) and a higher efficiency of the overall power system ranging from 1.7% to 2.5%, respectively in the years 2014 and 2030. The results point out that the micro-grids could constitute a favourable structure for electricity generation from distributed sources, and in particular from renewables, replacing the electricity generated by fossil-fuel power stations. These considerations are generally applicable also in other local communities characterised by a large availability of RES, making micro-grids a highly replicable alternative.

This study shows how the TIMES model can be usefully applied at regional/local scale to support the definition of energy-environmental strategies on the medium-long term. In particular, it proves how the introduction of new technologies (such as micro-grids) can impact on the overall energy system. To this end the scenario analysis is particularly effective to provide decision-makers with an overall picture of the main benefits related to different choices/technologies in terms of energy, GHG emissions and money saving.

ACKNOWLEDGEMENTS

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LATVIA

AUTHORS

A. Zabasta, N. Kunicina, A. Korjakins,
A. Zhiravecka, A. Patlins,
Riga Technical University,
E: Anatolijs.Zabasta@rtu.lv
E: Nadezda.Kunicina@rtu.lv
E: Aleksandrs.Korjakins@rtu.lv
E: Anastasija.Zhiravecka@rtu.lv
E: Antons.Patlins@rtu.lv
Kalku st 1, office 217, Riga, Latvia LV1658

1. OVERVIEW OF THE REGION

Characteristics of the Region
The Kuldiga region is a municipality of the Kurzeme District in the western part of Latvia. The region was formed in 2009 according to administrative territorial criteria merging 13 parishes (see *Figure 1*).

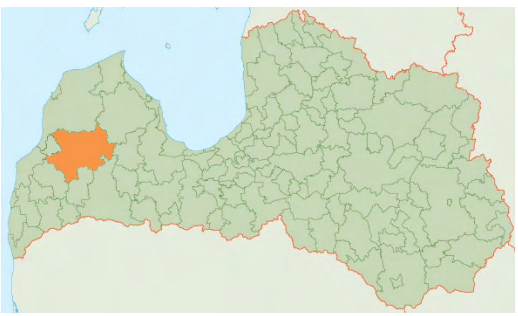

Figure 1 – Kuldiga region at the map of Latvia (http://www.kuldigasilt.lv)

The Kuldiga region has an area of 17,567 km^2, and a population 24,539 (2013). The population density is 14 people per km^2. 13,335 people live in the main town of Kuldiga (see *Figure.2*)

The region is governed by the Regional council (Dome), which is elected once every four years. There are 17 deputies in the Regional council. The Region is responsible for all governance functions within its territory. The administration centre is situated in Kuldiga town. A small part of the functions are centralised in Kurzeme district, for example passenger transport between regions of the district.

GDP in per capital is €6,802 in 2010 compared to Latvia which is at €8,674. The employment rate was 88.9% at 2013 compared to the whole of Latvia 89.2%. Most of the economically active population (90%) work in agriculture and forestry related industries.

Energy demand and supply of the Region
The most significant local energy resources are fossil fuel, gas, wood and hydro energy obtained from hydropower plants situated at river Daugava (Daugava HPP cascade). Solid fuels, oil products and electricity are imported from several countries, whilst Russia is the only supplier of natural gas. The split of energy flow shows the relatively high dependence from energy import – only 33% of total energy consumption is covered by local energy sources.

In 2012 total energy consumption for heat and electricity in Latvia was 13,068 GWh - that is 1.7% more than in 2008 and 8.9% more in comparison with 2011. The ratio between heat and electricity demand is about 1:1 ± 9%. Shortages of electricity or sales of electricity surplus are managed using interconnections between regions and suppliers. Variable hydro resources influence the amount of electricity produced by Daugava HPP cascade. In 2011 the total consumption of electricity was 7,340 GWh, which was 23.9% higher than the total consumption in 2000. Such significant growth in energy consumption can be explained by a steady development of industry and energy consumption before 2008, now halted due to the current economic crisis.

The diagram in *Figure 2* shows the total energy consumption for the sectors domestic, commercial, industry, and transport as well as the total energy production and the primary energy consumption flows in Latvia 2011. (Ministry of Economics, 2013).

Information specific to the Kuldiga region is not available. Taking in account the energy consumption in Latvia 55,708 GWh (polsis.mk.gov.lv/LoadAtt/file7092.doc) and accordance per capita in Latvia as 27 MWh

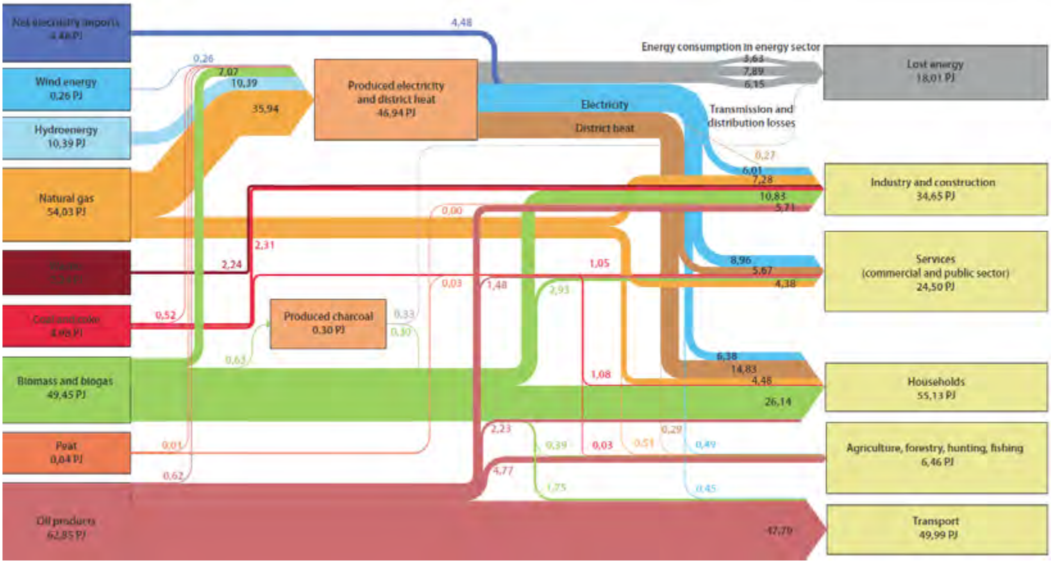

Figure 2 – Primary energy production and consumption flows in Latvia 2011

per year, the energy consumption of Kuldiga region can be estimated at around 696.35 GWh per year in 2010 and 2011. The total amount of GHG emissions in Latvia is shown in *Table 1* (Cabinet of Ministers Decree No. 348). This data is relevant to all Latvia. Information for Kuldiga or for other regions is not available.

	1990	2004	2008	2010
TOTAL	25.894	10.746	11.95	11.43

Table 1 – Total amount of GHG emissions in Latvia, $MtCO_2e$

The total amount of GHG emissions in Latvia is shown at Table 2.

	2015	2020
TOTAL, $MtCO_2e$	12.54	13.32

Table 2 – Total amount of GHG emissions in Latvia

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The Kuldiga region did not create its own strategic planning documents, but follows the National Strategy for Sustainable Development of Latvia (Strategy, 2002), which aims to define the direction for the country's sustainable development.

Consumption of energy in Latvia is influenced by:

1. New technologies in industry and insulation of building, that will reduce consumption of energy;
2. Development of the economy, with new companies and factories in Latvia, that require additional energy.

As results the consumption of energy will increase to 16.5% in 2020 in comparison with 2010.

The document setting the policy objectives related to energy and climate change focuses on the following aspects:

- ensure the contribution of Latvia to the prevention of global climate change in such a manner that does not hinder the economic development of the country;
- promote the development of the energy industry in accordance with a balanced and sustainable economic development;

- decrease air pollutants emanating from energy facilities;
- decrease air pollution caused by transport;
- increase the use of renewable (local) energy resources;
- switch to more environmentally friendly fuels;
- increase the use of CHP;
- increase the security of the energy supply;
- ensure heating energy conservation in buildings;
- use highly efficient technologies for electrical appliances;
- implement a system to analyse and check the energy consumption.

Other Regional targets, barriers and drivers
The municipality of Kuldiga region has identified the following priorities for its budget in 2013:

- reconstruct streets and engineering communications;
- take care of the welfare of the people including new social measures;
- improve the learning and working environment in schools and kindergartens;
- develop cultural, sports and tourism infrastructure and activities;
- support initiatives for citizens and businesses for usefulness of their own region.

The infrastructure and economic development of Kuldiga region in 2013 is planned to implement European Union funded projects. The pre-financing of the projects is envisaged by loan. According to the Latvian National Development Plan 2014 - 2020 (NDP 2014-2020) one of the main priorities is “Energy efficiency and energy production”. The NDP goal is “To ensure the sustainable use of energy resources by promoting access to markets, sectorial energy intensity and emissions intensity reduction, local renewable energy consumption an increasing share of the total volume, focusing on competitive energy prices.”

Unfortunately, the main barrier in the implementation of these programs is insufficient funding by the Latvian state. According to the European Union’s statistical office “Eurostat”, data year 2012 Latvian Gross Domestic Product (GDP) per capita was the third lowest in the European Union (EU) countries, only 62% of the average.

A new wood chip powered biomass co-generation plant was built in Kuldiga in 2012, (Kuldiga Heat, 2012). Its thermal energy production is: Q = 3.06 MW and its electricity production is: P = 0.727 MW. The new plant will supply consumers in Kuldiga with full heat capacity during the coldest winter months, as well as supplying new connections.

In 2012 Latvenergo AS, the biggest state owned power supplier, Smart Technology (2012) concluded an agreement with RL Ministry of Environmental Protection and Regional Development and Environmental Investment Fund regarding the implementation of the project “Promoting Energy Efficiency in Households Using Smart Technologies”. As part of the project, smart electricity meters have been purchased and installed in 500 households. A data readout system will be introduced and each household will be able to view detailed information regarding its electricity consumption using the *www.e-latvenergo.lv* customer self-service portal, as well as receiving advice on the necessary energy efficiency measures.

The project entails evaluation of the potential of smart metering systems and therefore for changing the habits of consumers and improving the energy efficiency, providing households participating in the project with information about their actual electricity consumption, consumption times. The project should promote reduction of CO_2 emissions, and promote involvement in energy efficiency and environmental protection activities.
It is expected that a 10% reduction in CO_2 emissions will be achieved as a result of the project.

Kurzeme Ring project
Kurzeme Ring (KR) (“Kurzemes Loks”, 2012) is an energy infrastructure project, which is planned to construct a 330 kV high-voltage, 800 MW, and 340 km power lines in the western part of Latvia in order to protect against failures and crashes. Kurzeme electricity consumption is likely to be increasing due to development of region.

KR is part of a larger project, the NordBalt, of which Estonia, Latvia and Sweden are involved which is attempting to improve pan Baltic energy security. This international energy infrastructure project will be developed as a result the Baltic electricity market, providing electricity purchase, sale and transit opportunities with other countries of the European Union. An existing 110 kV electricity transmission network in KR cannot provide sufficient electricity supply to the Kurzeme region and therefore requires reconstruction. KR will reduce the possibility of accidents due to weather extremes, and will reduce the time of accident prevention. The project will enhance the electric power reliability in the Kurzeme district and will encourage new users connecting.

In the Kuldiga region the installation of wind power stations, and the use of geothermal energy will decrease the emission of CO_2 through the efficient use of natural resources. Some of these projects will be supported by the European Regional Development Fund program.

3. CASE STUDY: A SINGLE COMPUTERISED KULDIGA REGION UTILITIES MANAGEMENT AND CONTROL SYSTEM

In 2009 Latvia implemented an administrative reform aimed to move from a two level local public government system (1st level - 26 regions and 6 cities comprised, and the 2nd level - approximately 400 parish councils) to a one level structure (110 new regions and 9 cities). Before the administrative reform, public district heating (DH) and water supply management had been operating in each parish, town or city substantively, but due to reform, the water infrastructure DH ownership and maintenance has been shifted from the parish level to regional ownership. Therefore, the new established regions have faced an important problem, on how to organise DH and water supply services throughout the region area.

Before the reform, each parish administration operated public infrastructure all alone, in rare cases getting contributions and resources from the regional budget. The majority of parishes did not have sufficient competence and enough of resources to maintain adequate infrastructure that was partially built with the support of EU funds. Therefore, the majority of regional governments recognised the necessity to create a single system for providing utility services across the territory.

A study carried out by the authors covering three regions in the Kurzeme district: Kuldiga (see *Figure 3* and *4*), Aizpute and Ventspils, revealed common problems (Zabašta, 2010). Each parish independently performed public water and DH services, maintained accounting and obtained payments from customers. Therefore, the regional administrations did not have correct information concerning the overall situation on its territory. Since each parish maintained its own customer billing and property accounting system, the regional administration was not able to provide a common policy related to clients and debtors, due to a lack of timely information. A significant part of the regional property was not equipped with water and heat meters at the entrance to the building, thus water consumption in many cases was determined by local consumption standards, for example, per person and sometimes by the number of animals owned by property owner. Different water tariffs were applied, which were not determined based on actual costs. Because of privatisation formerly public DH, water supply and sewerage infrastructure, in many parishes it ended up in private hands and the new owners charged.

Figure 3 – Kuldiga town centre – a library building

Objectives and methods
This case study is based on research of public utilities and public services, provided after the Kuldiga region had been created during administrative territorial reform in Latvia in 2009. The case study includes Kuldiga Heat and Kuldiga Water.

Figure 4 – The view of Kuldiga town

According to Information Society and Media Directorate General, at least 20% of water is wasted during distribution because of leaks. 20 – 30% additional charge is included in client bills to cover losses in water distribution systems in Latvian municipalities. Therefore reducing waste water will decrease electrical energy consumption for drinking water and sewage water pumping.

The objective of the research in the Kuldiga region related to the issues of district heating, water supply and public facilities services and included:

- identifying the regional public water management, DH and public facilities companies' technical support, human resources, financial resources and maintenance organisation;
- providing recommendations on how to optimise the public utilities organisation and management by offering the necessary action plan for single computerised water and DH networks management and control framework.

In order to offer a computerised model for optimising water supply and DH management in the regions under consideration, the following steps were taken:

- development of a description of the technical solution;
- preparation of a description of the technical equipment and technical documentation;
- preparation of an indicative cost estimate and recommendation about implementation steps.

The outcomes of the study are related to the following fields: Social, Economic, Environmental, and Technical. These research outcomes are intended to be used for further development and modernisation of the regional utility companies and public facilities. Furthermore, the outcomes provide new guidance for the industry to strive towards technological solutions required by municipalities and public utilities.
The following methods have been used: stakeholder's interviews (the heads and the specialists of utility companies; Regional Council key personnel); statistics investigations; innovative projects experience research related to ICT technology accommodation for local needs. The working group responsible for the research included representatives of utility companies, Regional council and parishes representatives, and Ventspils High Technology Park researchers.

Long term focus
The case study aims to demonstrate the development of a computerised system for public utilities including district heating and water distribution networks. For example in 2010 – 2012 the project "E-Water", financed by ERAB, was implemented in four Latvian and one Lithuanian region. The project "Smart Metering", devoted to technology development and accommodation on behalf of water and heat suppliers in municipalities, was implemented in Ventspils region (Kurzeme) in cooperation with researchers of Ventspils University College, Kaunas Technical University, Latvian Internet Association and Ventspils Water Company in 2012 - 2013.

Three Regional councils declared the intention to create a single utility service in the region in order to ensure effective use of human and technical resources. Therefore, in order to fulfil this goal, the introduction of ICT solution will become one of the long term regional development priorities.

Results

Kuldiga Heat Ltd

Kuldiga Heat provides heating to the city inhabitants and businesses. In the winter of 2009-2010 the heat for most of Kuldiga was produced by the new woodchip plant in Lapeglu Street, built in 2009 with the support of the European Union, which also produces electricity together with heat. The city has another 7 plants with less power using wood, woodchips and diesel.

Modernisation of heating mains and woodchip boiler construction helped to optimise the plant – nine small boilers were closed. By spring 2010 a cogeneration plant was constructed on the former boiler house site, to produce heat together with electricity. The cogeneration plant will store hot water in the summer, so at the end of the heating season it will not be necessary to operate the woodchip plant. 21 heat plants operate in the parishes of the region, predominantly using wood as fuel. In 2009 all the regional plants supplied 21,490 MWh of heating energy. Approximately 94% was supplied to Kuldiga city. Clients received bills on for €1,425,337, but clients' debt was about 9.5%.

Kuldiga Water Ltd

Kuldiga Water supplies residents with drinking water, as well as dealing with wastewater collection and treatment.

Water extraction in the city is based on 5 existing artesian wells. All wells are in good condition. Wells are operated automatically, depending on the water level in the two underground reservoirs. The city operates a modern iron removal plant. The purified water is in full compliance with EU requirements. In 2009-2010, it was planned to implement the European Union Cohesion Fund project "Development of water in Kuldiga municipality" for a value of €13.1 million. The project aimed to improve service quality, water supply and drainage system efficiency, separate rainwater from sewage, and increase service coverage and connection to the sewage system.

The main project benefit is a complete improvement to the drinking water supply in urban areas on the left bank of the river Venta. The project planned to reconstruct drainage system to provide a complete waste collection and transport in order to minimise groundwater infiltration and to prevent direct rainwater penetration into the fecal sewage system. According to Mercè Griera i Fisa, about 3% of electricity consumption is used by water pumping. The biggest electricity bill in many municipalities is the sewage treatment. Therefore decreasing the volume of drinking water, sewage and rainwater treatment will significantly reduce energy needs.

Kuldiga Water maintains 33.1 km of Water Distribution Networks (WDN) and about 60 km of sewerage network; however, it is only 32% of the total WDN. Other 70 km of WDN is operated by each parish separately. Tariffs per 1 m^3 vary significantly among parishes, but some of them do not charge per m3, due to the lack of water flow meters. In 2009 clients received bills were for €891,303 . Clients' debt was about 13.3%, which did not differ from other regions.

Kuldiga Heat Ltd issues and opportunities

Issues:

One of the main problems is that cash flow is seasonal, therefore the main income occurs during the heating season. During summer, revenues are only from advanced payments for heating in apartment buildings and from hot water sales. The company has only three lines of revenue, which implies a financial risk if any of the the systems fails to perform according to plan.

Outside the heating season, employees have insufficient load if additional works for 'external customers' are not carried out. Hot water production during the summer months ensures a loss because of the low water consumption. Loss from the heating mains is greater than 50%.

Increasing the number of water consumers in apartment buildings requires large investment, because the internal supply system in houses was limited by cutting the hot water pipes between floors. Substations regulators, pumps, heat exchange devices are physically deteriorated, therefore capital investment are necessary, since the substations were constructed in 1995. Substation equipment is generally outdated and in most cases, it is not possible to connect remote data reading and controlling equipment. Company experts admit the heat loss due to leaks and the lack of effective measurement of consumption on clients' site is about 10-15%.

Opportunities:
In order to improve effectiveness of the company, it is recommended to continue to expand construction of the heating mains in Kuldiga city, thus making it possible to increase the number of customers, while providing employees with workload in between the heating seasons. There is also a need to connect the counties district heating system, while expanding its customer base and creating the opportunity for professional and perhaps more effectively management of the existing system. It is recommended that community scale plants are installed within municipal properties such as schools.

When plant reconstruction takes place, it is possible to replace equipment in order to perform remote data reading. Providing plumbing services for Kuldiga Service Utility buildings, could ensure additional workload. The company should also specialise in small-size, local plant construction and renovation services.

Parishes issues and opportunities
Issues:
The most typical issue is that there are a small number of heat consumers with centralised heating systems (mainly houses with 12-24 flats each). The other problem is a lack of qualified staff for heating services. The volume of produced thermal energy often is not calculated and existing boilers cannot be controlled remotely, because of outdated equipment.

Nowadays district heating is subsidised from the municipal budget. Except for Pelchu parish, blocks of flats are not equipped with substations, therefore it not possible to run boilers at optimal mode which are fired only according to the outside temperature – if the temperature is higher, the boiler temperature output will be reduced. It is not possible to regulate heat consumption on clients' premises. Also, due to very low income, residents have a limited ability to pay.

Opportunities:
The maintenance of district heating should be handed over to Kuldiga Heat. In cooperation with housing services providers this could resolve building management issues, allow installation of heat substations and monitoring systems in the houses. It could be possible to choose alternative forms of heating to district heating such as installing wood pellets, woodchip or corn boilers in each block, or maybe for two blocks. An automated system could be used remotely to read and control it.

Kuldiga Water Ltd issues and opportunities
Issues:
Worn and damaged pipes make up a large part of the water supply and sewerage networks in Kuldiga. There is a large drinking water loss due to leaks and unauthorised water extraction, estimated about 25 - 35% of the total supplied amount. The proportion of rain and groundwater in sewer water quantity as a result of weather fluctuations creates require additional power usage, thus increasing the company expenses.

A large part of the company equipment is physically worn and needs a specialised vehicle fleet renewal. Since the economic crisis hit construction business, its output declined sharply so there is a lack of new water and sewer construction requirements. Issues of sewage sludge disposal is not resolved, with options available being resource intensive and financially costly.

Opportunities:
Implementation of the project "Water Development Project in Kuldiga municipality" will enable to connect around 600 households to the centralised water supply and sewerage services. The project will drastically reduce potable water network losses and the proportion of rain/ groundwater in the sewerage system.

A reduction in construction costs enabled the construction of the water and sewage networks in Parventa Kuldiga and ensured compliance with the EU "Water Directive" by the year 2015. Thanks to Regional reform, the newly established Kuldiga Region enables to take over parishes' water network in municipalities. It helps to implement a new policy related to water supply and sanitation, as well as centralised management, including customer database management and billing for services rendered.

Recommended solutions for services and functions sharing between Kuldiga Heat, and parishes and villages
It has been identified that the optimal governance model during the transition period could be one where the responsibility for heat production and supply is by "Kuldiga Heat" in Kuldiga town, while in rural areas public building heating would be the responsbility of each parish administration. The authors propose to nominate the company "Kuldiga Heat" as a knowledgeable authority for all matters related to the boiler houses and DH network reconstruction related issues. The local authorities and businesses can help to solve reconstruction issues with "Kuldiga Heat" in order to carry forward the harmonisation of district heating in the region.

Along with the plants and DH network reconstruction, it is recommend to install remote monitoring and control capabilities. When a plant or a heating unit is equipped with remote monitoring and control equipment, it is possible to review the situation and possibly pass that object under "Kuldiga Heat" responsibility and maintenance.

A model for district heating staff establishment plan and management structure
There are no plans, in the near future to reorganise the structure and the service of district heating. If in the future a separate parish heat system was transferred to "Kuldiga Heat", the functions and responsibilities of the parish would be reviewed.

It is proposed that a model for a single district heating service company should be created through the following steps:

- introduction of remote monitoring and control system;
- creation of a unified emergency service for all utilities in the region;
- harmonisation of overlapping function among municipality-owned utilities;
- creation of housing management department;
- development of a uniform accounting system in municipality owned utilities in order to ensure that the data are comparable.

Possible solutions for services and functions sharing between Kuldiga Water, and parishes and villages
It was recognised that the optimal governance model for the near future could be one where the responsibility of of water distribution networks in Kuldiga town is of "Kuldiga Water". It is proposed that in rural areas parishes should start to hand over their water distribution networks to "Kuldiga Water" and the authors propose to declare the company "Kuldiga Water" as knowledgeable authority within the water distribution networks, including all matters related to the network construction, and reconstruction related issues.

Model for region water management staff establishment plan and management structure
Parishes should keep at their disposal a competent supervisor, who is familiar with urban infrastructure, including water management and who can perform any operational activity before Kuldiga Water experts' arrival. The parish staff for effective management of water resources management should supplement Kuldiga Water workforce. It was found that the functions that overlap should be combined and operated on the principles of mutual cooperation, such as for water emergency service. In the near future, changes for Kuldiga Water budget are not planned.

A model for a single region water supply services company should be created through the following steps:

- introduction of remote monitoring and control system;
- creation of a single emergency service for all utilities in the region;
- elaboration of unified customer database and payment tracking system;

• single tariff list;
• water consumption metering.

Technical solution for a single computerised Kuldiga region utilities management and control system
Available technology research shows that water and heating management could be significantly enhanced through automated metering information extraction and treatment system. “Kuldiga Heat” and “Kuldiga Water” experts recognise that computerised DH and water distribution network management and control system will help detect cold and hot water leaks faster and more precisely. Talsi Water company experience showed water losses decreasing by 30-40%. In 2009, the largest Latvian municipality-owned heat utility, Riga Heat, implemented a pilot project, installing remote automated metering devices in 30 substations, which proved a way of energy saving due to faster detecting of leaks and illegal connections.

A suitable framework of general functional and technical description is given in this section of the document. Implementation of recommended system would ensure end consumers received the best quality of water and heat service delivery, including a reasonable cost of services, as well as efficiency and transparency in tariffs.
In practice there are different automated meters data reading and transmission solutions (AMR) options, including “wire system”, “part wireless system” and “wireless remote reading system”. Taking into account pluses and minuses, wireless remote reading system is recommended.

Utilities management and control system conceptual model
A recommended conceptual model of control system for water supply and district heating services should comprise such elements.

Data readers
The water meter with pulse output according to the specification requirements of the minimum and nominal consumption should be installed. Customer with installed software and devices will be able to read remotely water consumption data for all the set points at the rate of at least once per hour.

General Packet Radio Service (GPRS) usage
Technical solutions for GPRS offer many different options, the implementation of which does not require a long development times and high costs. For example, it can be telemetry services that often used to communicate with remote objects (stationary or moving). The amount of data to be transferred is not great, but much more important is a continuous communications option with this object, saving the need for the physical presence at the object in case of an accident or checking.

Since modern Global System for Mobile (GSM) networks cover all Latvian territory, it can be concluded that the GPRS service is advantageous to use, if there is no Wi-Fi or ZigBee network. Mobile network operators offer advantageous rates. Given that the Kurzeme District covers three regions, it can be expected that the GPRS usage prices justify use of this solution.

Technical solution alignment with existing IT systems
A unified automated water management and control system must be compatible with existing information systems used for accounting and billing to customers in Kurzeme region. To this end, software will be developed to ensure the exchange of data between the existing systems and the central server of new information systems.

At the moment the Kuldiga region utilities use WinNAMS and Horizon Information System: WinNAMS system is the most popular program used by housing service providers and other utility companies. It provides the broadest functionality in the market, it is easily adaptable to different requirements and it has a convenient and intuitive user interface. The system has several WinNAMS modules, such as billing module, web access module and management cost accounting module.

The HORIZON program is used for enterprise management, finance management and accounting purposes. The program is maintained to ensure its functionality changes according to Latvian laws and regulations and for companies operating processes development. For client billing a special

HORIZON program module is used, which is specifically designed for water-supply and sewage disposal services providers.

Reference model
Considering the previously mentioned technical solutions for water distribution and DH network management and control system of the conceptual model was chosen (see *Figure 4*). This system mainly uses a GPRS network to connect and transfer data between the gateways - concentrators and the main data centre. The system also uses Radio Frequency (RF) transmitters working to transmit data between measurement points and gateways – concentrators. This technical solution will provide customers technical services, and a number of benefits, which are summarised in Table 2 opposite.

Two options for data centre development have been considered:

- first option: data centre for Kuldiga region only;
- second option: data centre is developed for the whole Kurzeme District. This option will be more cost effective particularly if the data centre serves at least two regions.

Water and heat networks management and control system development have been considered in two stages:

- first stage: the system comprehends all planned objects excluding metering equipment installed in client apartments;
- second stage: client apartments will also be equipped with metering equipment.

Summary and conclusions
First option: a data centre is developed only for the Kuldiga region. First stage investment exceeds €359,000. At the second stage, when client individual apartments will be equipped with metering equipment, an additional €306,700 will be needed. Total: €665,700.

Second option: a data centre is developed for all Kurzeme district needs. First stage investment exceeds €389,129. At the second stage, when client individual apartments buildings will be equipped with metering equipment, additional €306,744 will be needed. Total: €695,873.

In the case where a water and heat network management and control system is set up in Kuldiga Aizputes and Ventspils regions, the 2nd option, which involves a data centre for the whole Kurzeme district, would be a more cost effective solution when considering both investment and maintenance cost. Cost savings arise as each data centre requires additional security measures, including fire protection, a power supply from at least from two independent sources and local power backup. The main cost saving during operation arises as fewer staff are required in one centre. Recruiting and retaining qualified IT staff is a difficult for municipal councils.

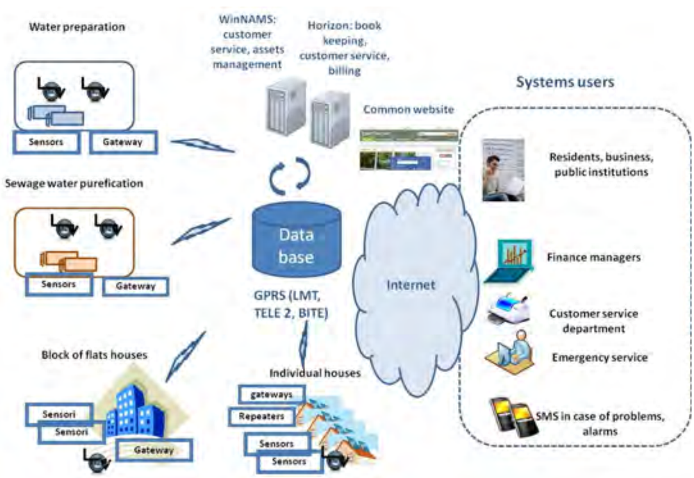

Figure 4 – Utilities management and control system conceptual reference model

Functions	Customers
Accurate, consolidated, timely information on the elevated, subordinates, and the consumption of water and heat energy volume. Ability to make analysis: consumption by time, by clients, etc., to identify outstanding, or discharge water volumes and potential leaks. Opportunity to rationalise and transform the emergency and dispatching services.	Kuldiga Water ltd, Kuldiga Heat ltd and Kuldiga Utilities Services ltd management
Information on water treatment plant operation: which of the pumps works, but which does not, in what working regime. Regular information on the raised and supplied into the network of water volumes. Information about sewage purification stations and pumped drainage water volumes: the pumps are working, or not, and in what working mode. Warnings about unusual water consumption (an accident or fraud). Data on the pump in the boiler house operations. Staff to be on duty at home can receive SMS alerts on the issues.	Kuldiga Water ltd, Kuldiga Heat ltd and Kuldiga Utilities Services ltd technical staff
Data about supplied water volumes to apartment blocks, individual homes, public institutions and companies. Information on the amount of heat consumed by substations. Information on consumption of hot water and heat energy volumes by apartments. Automatic transfer of data from the System database to existing IT systems. The possibilities of customer invoices publish on the Internet and send e-mail (to withdraw from bills sending by post). Refuse data collection on the phone or with subscriber book assistance. No need to carry water meter measuring inventory on client sites.	Kuldiga Water ltd, Kuldiga Heat ltd and Kuldiga Utilities Services ltd Customer Services and Finance department.
Data of apartment blocks water volumes consumption. Data about supplied on cold and warm water volumes apartment house apartments.	Kuldiga Utilities Services ltd management and technical staff
Technicians in counties will be able to make connections to the system using internet. Thus metering data will be available on line.	Parishes staff
Ability to receive bills on website or via e-mail and get bill information via SMS.	Clients: residents and companies

Table 2 – Technical solution advantages and services for users

Outcomes
The research has revealed that the public services, provided by community utilities, are decentralised, fragmented and inefficient. The introduction of a single computerised utility management and control system in the Kuldiga region would improve social, economic, environmental and technical situation of the region. The development of the single utility management and control system was supported by all involved utilities and region council members. The main barriers include:

- lack of financial resources;
- fears related to increasing of tariffs;
- the lack of technical competencies;
- the necessity to adjust legislation.

4. CONCLUSIONS

Research provided for three Kurzeme regions, has revealed common problems:

- fragmentation in the providers of public water and DH services;
- lack of single accounting and billing system for clients in parishes and towns;
- lack of correct information concerning the services provision and consumption.

A significant part of municipal property was not equipped with water and heat meters at the entrance of the buildings and in clients' premises, thus water and thermal energy consumption in many cases are determined by local consumption standards. Cold and hot water leaks in distribution networks are not detected, because of the lack of appropriate data about the state of the networks.

In order to improve efficiency of public services it is suggested to reorganise municipality owned utilities and equip them with Information and communication technology tools. This case study provides information on how to improve efficiency of district heating and water distribution networks, which would encourage savings of heat energy and natural resourses. A study carried out in a frame of the project LV0076 "Development of community facilities system model in the Kurzeme region" revealed similar problems in Ventspils and Aizpute regions where the research team offered similar solutions including to merge fragmented local municipal companiesand to provide a model of computerised control system for district heating and water supply services.

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LITHUANIA

AUTHORS

Lina Seduikyte
Kaunas University of Technology
Faculty of Civil Engineering and Architecture
Studentu st. 48, LT-51367, Kaunas, Lithuania,
E: lina.seduikyte@ktu.lt

Andrius Jurelionis
Kaunas University of Technology
Faculty of Civil Engineering and Architecture
Studentu st. 48, LT-51367, Kaunas, Lithuania,
E: andrius.jurelionis@ktu.lt

Rokas Valancius
Kaunas University of Technology
Faculty of Civil Engineering and Architecture
Studentu st. 48, LT-51367, Kaunas, Lithuania,
E: rokas.valancius@gmail.com

1 OVERVIEW OF THE REGION

Characteristics of the Region

Kaunas district municipality is located near one of the largest cities in Lithuania – Kaunas. The district area covers 1,496 km^2. About 86,600 people live in the district. It is one of the densest districts in Lithuania. Kaunas district municipality has 25 sub-districts, which include 371 villages, 9 towns and 3 cities.

Figure 1 – Map of Kaunas district municipality

The decision making body of the municipality is Council elected in general elections every four years. The Council comprises 27 members. The Council composes the Council Board consisting of 7 members. The Council, by the Mayors proposal, appoints the Director of Administration of the municipality who heads the administration and carries out decisions of the Council. The head of the municipality is the Mayor.

Figure 2 presents the evolution of Lithuania GDP Annual per Capita and the total GDP. In 2012, 19.6 % of total Lithuanian GDP was produced in Kaunas Region. This region includes six districts, Kaunas; Kedainiai; Kaisiadoriai; Jonava; Prienai; Raseiniai; and major cities as Kaunas and Birstonas.

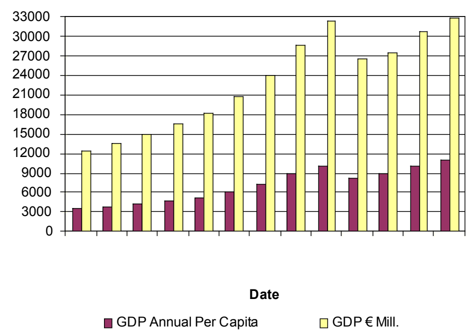

Figure 2 – Lithuania GDP Annual per Capita evolution and GDP € Million (http://countryeconomy.com/gdp/lithuania)

By 2007, unemployment rate in Kaunas region had declined reaching 4.2%, lower than the national average (4.3%). However, the unemployment rate in the period of 2007 – 2009 increased rapidly to 13.2%. Unemployment and employment rates (15 – 64 years) for Kaunas region are presented in *Figure 3*. According to the data from Kaunas territorial employment office, unemployment in Kaunas city and Kaunas district municipality was 8.9% for September, 2013.

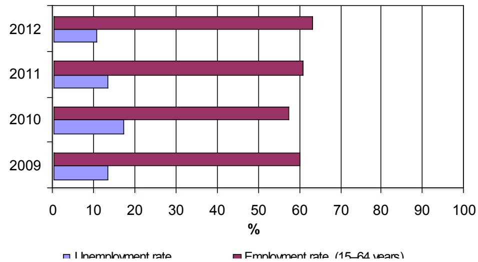

Figure 3 – Unemployment rate and employment rate (15 – 64 years) for Kaunas region

Energy demand and supply of the Region
By order of the Ministry of Economy of the Republic of Lithuania, the Lithuanian Energy Institute has prepared a study on "The use of existing renewable sources (biomass, hydropower, solar energy, geothermal energy) and municipal waste for energy production in municipalities of Lithuania". The data from the study, regarding total energy consumption for Kaunas district municipality, is presented in *Table 1*.

The most important problem related to energy consumption is GHG emissions, sincethe largest source of air pollution is represented by the burning of fossil fuel. It is important to use less polluting resources and ensure lower heat losses during heat transfer processes.

Table 2 presents GHG emission factors for electricity and heat production (VI LRTI (2012).

	Total energy consumption, ktne				
Category	Electricity	Heating	Natural Gas	Fuel for stoves, mazut	Renewable energy (biomass)
Industry	1.91	-	1.23	-	1.02
Construction	0.11	0.02	0.01	0.21	0.05
Agriculture	0.48	0.69	2.94	1.17	0.3
Municipality facilities	8.01	1.74	-	5.91	-
Domestic	1.72	2.12	3.32	10	26
Transport	0.14	-	0.5	0.1	-

Table 1 – Total energy consumption for Kaunas district municipality (2008), ktne (LEI (2009)

Used emission factors	Units		Comments
	t/MWh	t/tne	
Electricity emission's factors of the country	0.185	2.15	Based on data of GHG inventory for 2008 and the production of electricity in Lithuania in 2008.
District heating's, locally produced, emission factors	0.228	2.64	Based on data of GHG inventory for 2008 and the production of heating energy in Kaunas district municipality in 2008.

Table 2 – HG emission factors for electricity and heat production (VI LRTI (2012)

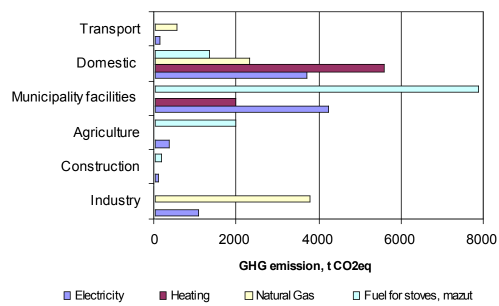

Figure 4 – GHG emission due to total energy consumption for Kaunas district municipality (2008), CO_2eq ((VI LRTI (2012)

GHG emissions due to total energy consumption for Kaunas district municipality (2008) are 9,590 tCO_2eq and are presented in *Figure 4* (VI LRTI, 2012).

Table 3 shows major projects planned for heating supply systems which directly influence the opportunities for GHG emissions reduction in Kaunas district municipality.

Nr.	Central heating supply system	Period of implementation	Project
1.	Babtai town	2011 – 2016	Gasification of Babtai town.
2.	All analysed region	2011 – 2016	Renovation of district heating, stokehold conversion to burn biomass, renovation of consumers' heating system.
3.	All analysed region	2011 – 2016	Implementation of buildings' heat energy savings – insulation of buildings, replacement of windows and doors, reconstruction of heating systems.

Table 3 – Heating supply projects planed for Kaunas district municipality

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

After the adoption in 2008 of the EU Climate and Energy Package, the European Commission launched the Covenant of Mayors to endorse and support the efforts deployed by local authorities in the implementation of sustainable energy policies. By their commitments, Covenant signatories aim to meet and exceed the European Union 20% objective ofreduction in CO_2 emissions by 2020.

Signatories	Population	Adhesion	Status
Akmene district municipality, LT	25,729	26 Oct 2011	
Anykščiai, LT	32,137	30 Oct 2008	
Elektrėnai , LT	24,920	24 Apr 2013	
Jurbarkas, LT	29,706	29 Nov 2012	
Kaunas, LT	353,800	22 Jan 2009	
Kaunas District Municipality, LT	86,600	28 Feb 2013	
Pakruojis, LT	27,008	25 Sep 2008	
Šilalė, LT	29,775	30 Oct 2008	
Šilutės, LT	54,500	16 Oct 2008	
Telšiai, LT	47,818	13 Dec 2012	
Trakai , LT	33,604	27 Dec 2012	
Utena, LT	31,940	29 Nov 2012	
Vilkaviškis, LT	47,978	31 Oct 2008	
Vilnius, LT	553,904	15 Oct 2012	

Table 4 – Signatories of the Covenant of Mayors in Lithuania (http://www.covenantofmayors.eu/about/covenant-of-mayors_en.html)

There are 14 signatories in Lithuania at this moment, including Kaunas district municipality. Local governments play a crucial role in mitigating the effects of climate change, all the more so when considering that 80% of energy consumption and CO_2 emissions is associated with urban activity. Development of sustainable energy is the main energy policy set out in the National Energy Strategy (Ministry of Energy of the Republic of Lithuania, 2010). In the National Strategy sustainable development is understood as a compromise between the environmental, economic and social goals of society, providing opportunities for the welfare of present and future generations within the permissible limits of environmental impact. While preparing the development plan for sustainable energy action, big consideration is given to climate change and the mitigation of the problem. The main methods to decrease GHG emissions in the energy sector are increasing of the energy efficiency and increasing the use of renewable energy sources.

In 2012, Kaunas district municipality prepared a plan for strategic development for the period of 2013 – 2020, where two of the main parts are the development of sustainable energy and the mitigation of climate change.

In Lithuania, climate change policies and implementations are defined by the country's international agreements: the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the commitments to the European Union. The "Energy Efficiency Plan" (Ministry of Economy of the Republic of Lithuania, 2008) provides a summary of tools to increase energy efficiency. These measures are summarised in Table 5. From the table it can be seen that there are targets of energy efficiency tools addressing the domestic, trade and services, industry and transport sectors, but also there are additionally separated horizontal and cross-sectoral tools.

Sector	Tools	Expected savings until 2016, GWh	%
Domestic	Domestic strategy, Program of modernisation of multifamily houses, EU structural funds	1770	37.5
Trade and services	EU structural funds, Program of modernisation of public houses, Green purchase and requirements of effectiveness for purchase	229	5
Industry	Voluntary agreements with industry, co-generation, EU Structural Funds	395	8.5
Transport	Program of Energy efficiency in transport, checkup, etc.	460	9.5
Horizontal and cross-sectoral tools	NES, NEVEDP STR (building envelope, heating, ventilation, air conditioning), qualification and certification schemes, "smart" energy meters, fiscal measures, information, education	1871	39.5
Total		4725	100

Table 5 – Tools to increase energy efficiency

The National overall targets for 2020 are:

1) the renewable energy part in the transport sector increase to at least 10%;
2) electricity produced from the renewable energy sources increase to at least 20%;
3) district heating energy produced from the renewable energy sources increase to at least 60% and for the households - the renewable energy sources increase to at least 80%.

According to the national emission factors and prediction of energy consumption by different fuels, evaluation of GHG emission for Kaunas district municipality is presented in *Figure 5*. Reduction of GHG emission because of increase of renewable energy sources (RES) and reduction of organic fuel consumption by 2020 is evaluated in *Table 6*.

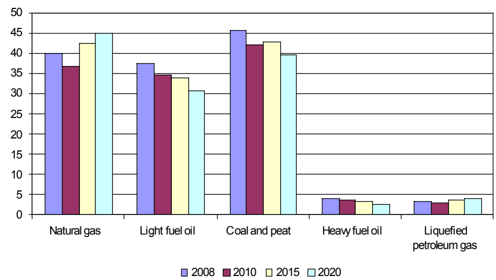

Figure 5 – GHG emissions from final energy consumption in Kaunas district municipality (VI LRTI (2012)

Organic fuel	Changes in the consumption of the organic fuel, tne	Reduction of GHG emission, t CO_2eq
Natural gas	2.13	4.57
Light fuel oil	-2.28	-6.48
Coal and peat	-1.51	-5.79
Heavy fuel oil	-0.45	-1.40
Liquefied petroleum gas	0.29	0.83
Total	-1.82	-8.28
%	4.6%	7%

Table 6 – Reduction of GHG emission because of increase of AES in Kaunas district municipality (VI LRTI (2012)

Other Regional targets, barriers and drivers

Kaunas district municipality's Strengths:

Economic development:

- great location;
- a large number of professionals;
- an attractive tourist environment; increasing

foreign investment;
- a well-developed business infrastructure;
- a relatively large part of the country's agricultural production;
- the district has a free economic zone;
- road network connecting the region with other regions and municipalities is well-developed;
- a relatively low air pollution index;
- an increase of secondary raw materials collection;
- the municipality's administrations is focusing on the development of engineering infrastructure, and environmental issues;
- residents are interested in solar power and energy crops and investments in the production of biomass crops.

Social development:
- declining number of social risk families and children living in such families;
- development of infrastructure for people with disabilities;
- the school network is well developed and meets the current needs; the education level is high and corresponds to the national average;
- increased number of culture, sports and health facilities.

Kaunas district municipality's Weaknesses:
Economic development:
- the economic crisis has affected Kaunas district economic development and growth of the unemployment;
- a small purchasing power;
- emigration;
- industry concentration in large cities;
- slow growth of ecological farms and non-traditional crafts;
- limited financial capacity of municipality to provide funds for maintenance of roads;
- poorly developed telecommunications system in rural areas, poor communication lines (or not installed) prevents the development of information technology;
- regional heating network is relatively old with poor insulation;
- poor water network in villages with high water losses.

Social development:
- shortage of specific transport for the provision of social services for people with disabilities;
- educational institutions are not rapidly renewed, they do not meet the needs of culture, libraries, and sports facilities material base;
- passive society, youth social exclusion, poor motivation for activities.

Kaunas district municipality's Opportunities:
Economic development;
- free economic zone;
- development of ecological farms;
- opportunity to use EU structural funds to implement energy saving tools;
- education of society and involvement in environmental projects;
- wind power development;
- solar power development;
- development of energy crops;
- development of biomass production.

Social development:
- district may use different national and international funds for the development and implementation of social projects;
- modernisation of the material base of cultural institutions;
- development of higher education forms adapted for adults.

Kaunas district municipality's threats:
Economic development:
- the lack of attention to cultural heritage;
- errors of health care reform;
- undeveloped business culture;
- competitor municipalities for example, Kaunas and Kedainiai districts can make decisions that enhance the attractiveness of the business in those areas impacting on other districts;
- low movement of information technologies may leave local companies uncompetitive.

Social development:
- increase of social - economical problems due to rising unemployment.

The following objectives and priorities are raised for the implementation of strategy of development of sustainable energy and climate change mitigation in Kaunas district municipality (VI LRTI (2012):
- Growth of economics and regional competitiveness by modernisation of energy

infrastructure and reducing energy losses and implementation of innovative energy technologies;
- Social development and improvement of quality of life, proceeding to sustainable use and energy savings, by changing people's behavior and introduction of innovative energy technologies and products, ensuring energy savings and energy cost reduction;
- Maintenance of environmental quality, by introduction of new energy production and consumption technologies, increasing renewable energy use and energy saving.

3. CASE STUDY: COGENERATION POWER PLANT IN VILLAGE OF NOREIKISKES

Noreikiskes is a village with 926 residentslocated in Kaunas district municipality. The A. Stulginskis University (former Lithuanian University of Agriculture) is located in the area. Over the past few years many individual housing projects have been undertaken in Noreikiskes. It is expected that young families with average and higher incomes will become residents of these new houses.

Figure 6 – Noreikiskes

The Joint-Stock Company (JSC) "Kauno energija" provides the biggest amount of heat for Kaunas district municipality as a whole. From the 1st January, 2010 the company also provides hot water. The main shareholder is Kaunas city municipality (93.05%).

Objectives and methods
Stricter requirements for protecting the environment, increasing prices of traditional fuel (natural gas, fuel oil) and competition in energy markets have all encouraged JSC "Kauno energija" to look for cheaper and environmentally cleaner energy production methods and to provide higher quality and safer products for consumers and the environment.

In 2000, JSC "Kauno vandenys" was running the largest biogas power plant, where the Kaunas' sewage sludge was processed into biogas. Annual production from the two bioreactors is about 2.8 million m^3 of good quality (with 70 % methane concentration) biogas. Part of the produced biogas is burned in two 1.9 MW hot water boilers. Hot water is used to heat the company's premises and the recycled sludge.

Figure 7 – JSC "Kauno vandenys"

The Lithuanian Energy Institute and Department of Thermal and Nuclear Energy of Kaunas University of Technology performed tests on JSC "Kauno vandenys" biogas composition, and found that biogas contains methane (CH4) – 67.4 %, CO_2 – 30 %, CO – 0.3 %. It should be noted that CH4 stimulates the green house effect up to 21 times more intensively than CO_2. Therefore, in order to reduce the negative impact of biogas on the environment and to get economical benefits, special emphasis was given to rational use of these gasses while burning in energy facilities.

Since only part of biogas was burned in JSC "Kauno vandenys", a decision was made to use the remaining part in Noreikiskes.

In December of 2001, JSC "Kauno energija" and JSC "Kauno vandenys" signed agreement regarding the buying and selling of biogas.

From 2002, an ineffective old boiler was used for the biogas in Noreikiskes. Since 2004, JSC "Kauno energija" began looking for a solution to increase the effectiveness of biogas and reduce the negative impact on the environment.

According to Lithuanian energy policies, which deal with heat supply problems, one of the best technical solutions is the implementation of cogeneration. It was therefore planned to build 5 cogenerators in Noreikiskes. Cogeneration is the use of a heat engine or power station to simultaneously generate electricity and useful heat. Cogeneration, as rational way of using energy, allows savings in primary energy. If cogeneration is widely used, it can have significant impact on diverse economical growth in the country: while saving the money, reducing import of fuel, increasing industrial growth of equipment manufacture.

Long term focus

- lower atmospheric pollution;
- energy production from renewable energy sources (biogas);
- improvement in the reliability of energy supply;
- increase in the effectiveness of energy production;
- reduction of the cost of heat production, which will stabilise the rising prices of heating for residents;
- lower pollution fees;
- minor dependence on fuel import.

Outcomes

- in 2005, 5 cogenerators (Cento T 150SP BIO) were built with 150 kW electrical and 210 kW heat power in Noreikiskes. Total electrical power of cogeneration power plants is 750 kW, with 1050 kW of heating powe;
- the main fuel is biogas, supplied from JSC "Kauno vandenys" water treatment facilities.
- the payback period of the project is expected to be 4.2 years;
- annual production of electricity – 5.7 million kWh;
- cogeneration power plant control equipment is connected by 10/0.4 kV transformer to JSC "VST" electricity distribution networks.

Figure 8 – Biogas engines in Noreikiskes power plant

- produced electricity is used for JSC "Kauno energija" needs (0.7 million kWh) and the rest is sold to the network (5 million kWh). Parameters of cogeneration power plant are presented in Table 7;
- "Green" energy produced in cogeneration power plant is provided to Noreikiskes residents, and the University's buildings. Hot water needs are completely covered by capacity of cogeneration power plant. Up to 25% heating needs is also covered.

Parameters	Units	Per hour	Per year
Designed production of electricity by nominal capacity (7600 hours / year)	kWh	750	5.7 million
Designed production of heat energy by nominal capacity (7600 hours / year)	kWh	1050	8.0 million
Consumption of biogas at 4819 kcal/kg colorific value	Nm3/h	260	2.4 million

Total efficiency factor of fuel 87.6%.
Table 7 – Parameters of Noreikiskes cogeneration power plant (http://www.lsta.lt/lt/articles/view/7)

- After the project implementation, Noreikiskes cogeneration power plant will burn 2,398.86 thousand m^3 of biogas. The benefits of replacing traditional energy sources with biogas from a water treatment company include:
- using of waste products (environmental);
- saving money due to minor fuel imports (economical);
- reducing dependence from fuel importers (social);
- increasing the reliability of energy supply (technical);
- solving environmental problems and increasing its quality (environmental).

The example of Noreikiskes cogeneration power plant should encourage other companies to engage with similar projects. However, these kind of projects are very expensive, thus cost is the main barrier. The education of society is also playing a large role in this kind of projects, as companies and residents should understand the benefits of implementing alternative and smart energy systems.

4. CONCLUSIONS

The implementation of cogeneration power plants in the region had the following positive impacts in different fields:

- energy security: contributing to EU and Lithuanian Energy's strategic objectives to reduce dependence on imported fuels. Utilising biogas ensures the security of supply as the fuel supply cannot be shut off as a result of political factors;
- economic benefit: saving countries' financial resources, as the price of biogas is half the cost of fossil fuel. The capital also remains in the country, on the contrary to the import of natural gas;
- social benefit: creating of new jobs and increasin employment; promoting new infrastructures for biogas production;
- ecological security: decreasing the pollution of the environment. Contributing to the national and EU environmental commitments.

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MALTA

AUTHORS

Professor Vincent Buhagiar
E: vincent.buhagiar@um.edu.mt
Dr. Ing. Simon Paul Borg
Department of Environmental Design
Faculty for the Built Environment
University of Malta,
Msida MSD 2080, MALTA
E: simon.p.borg@um.edu.mt

Ing. Mark J. Azzopardi
Abertax Quality Ltd.
E: mark@ambjent.org

Spec. Eur.Ing. Ruben Paul Borg
Department of Construction & Property Management
Faculty for the Built Environment,
University of Malta
Msida MSD 2080, MALTA
E: ruben.p.borg@um.edu.mt

1. OVERVIEW OF THE REGION

Characteristics of the Region
Malta, or more specifically the Maltese Archipelago, comprises the inhabited islands of Malta, Gozo and Comino, together with a few uninhabited islands, collectively termed as Malta. As an entity, Malta, after its independence from the United Kingdom in 1964, and after becoming a democratic republic in 1974, joined the European Union in 2004. It is concurrently part of the Commonwealth of Nations and the United Nations. It is an independent Island State and has had its own self government since 1964.

As a hierarchical system of governance, Malta has a President, as head of state, the Prime Minister, Parliament, and finally Local Councils (equivalent to Municipalities – albeit on a town-scale).

On a regional level, there are no large-scale municipalities as such due to its size, however at town level there are Local Councils as a political system of local government for each town. There are no intermediate levels between local government and national government and the levels of the six districts serve primarily for geographic, and statistical purposes (i).

The Maltese Islands cover an area of 316 km^2 accommodating a population which based on the latest census carried out in 2011 (ii) is of 452,515. This is equivalent to 1,432 people per sq.km, making Malta the seventh most densely populated sovereign state in the world (iii).

Figure 1 – Map of the Malta, Gozo & Comino

Malta boasts a free-market economy, with its Gross Domestic Product (GDP in € per capita) standing at €6.756 billion total (2012 estimates) or €5,500 per capita. At present Malta has an employment rate of 93.6% (2011 estimate) (iv).

Energy demand and supply of the Region
The total energy consumption (2011 basis) was equivalent to 813,014 tonnes of fuel.

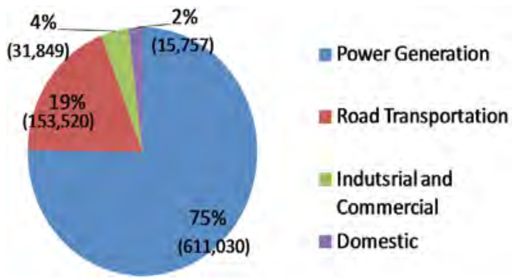

Figure 2 – Total Fuel Consumption by Sector

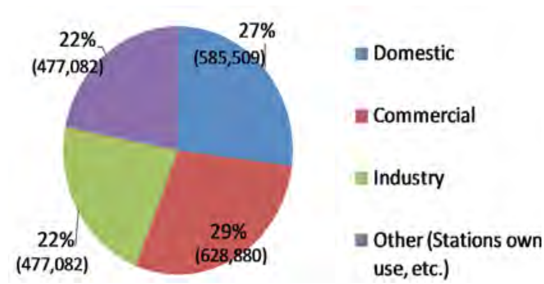

Figure 3 - Electricity Consumption by Sector

As can be seen from *Figure 2*, 75% of the total fuel consumption went into power (electricity) generation, with the balance (19%) making up road transport, (4%) industrial and commercial processes and (2%) fuel usage in the residential sector. A small fraction also goes for agricultural activities, but this is a very small amount.

Electricity consumption

The power generation sector, is as discussed above, the main fuel consuming sector. In fact close to 100% of the electricity produced is derived from fossil fuel (in 2011 this fuel mix was divided as follows HFO/Gasoil (84%/16%) (v). Malta presently has an independent isolated grid system, relying solely on imported fossil fuels, although work is underway to connect the Islands to the European electricity grid (end 2014), and a gas-pipeline interconnection planned to feed its power generation sector. Coal for electricity generation used to be imported until the mid-1990s but this was stopped for environmental reasons. The shift and plant investment was made towards conventional fuel oil.

The total electricity generation (vi) (based on 2011 values) was of around 2,168,553 MWh, supplied from one (Government-owned) utility, Enemalta Corporation. As shown in *Figure 3*, consumption is categorised as per following sectors: Domestic: 27%; Commercial: 29%; Industry: 22%; and other (including stations own use, etc.), 22%.

GHG emission factor for electricity from the grid (kgCO^{2}eq/kWh) based on averages between the two power stations, as calculated at generation stands at 0.86 kgCO^{2}eq/kWh. Total GHG from current emissions due to electricity (ktonCO^{2}eq), (from all sectors combined) currently stands at 1,865 ktonCO^{2}eq.

Other fuel consuming sectors

In terms of other fuel consuming sectors petrol and diesel oil are the two main fuels used in the transport sector, with biodiesel and Liquefied Petroleum Gas (LPG) making up only a marginal faction of the total fuel consumption used in the road transport sector. Outside the road transport sector, LPG, used for space heating and cooking and heating oil (diesel oil) are the two main fuels used in the industrial, commercial and residential sector.

Renewable Energy Sources (RES)

According to the Ministry for Energy & Conservation of Water (MECW), through reporting by the Malta Resources Authority, the local energy regulator, as per records for 2012, the share of RES (Renewable Energy Sources) as a percentage of the total energy consumption stood at 1.8%, with the greatest contribution going for thermal energy, namely, RES-Heat having 50% of the share and the rest divided between RES-Electricity and RES-Transport.

The principal RES technologies present in Malta) are:

- photovoltaics (Grid-Connected PV) in the form of free-standing, grid connected systems, predominantly installed on top of residential, commercial and industrial roofs;

- Solar Water Heaters (SWH) for the provision of hot water in residential, hospitality and commercial premises;
- relatively large scale waste-to-energy technologies, including anaerobic digesters for municipal solid waste treatment, sewage treatment plants and engineered landfill gas treatment plants.

The possibility of installing large scale RES in Malta is probably limited for now by the fact that it is a small island grid and the potential instability an embedded large RES plant may cause. Therefore by and large small PV installations have been installed so far on household or factory rooftops, mostly assisted through Government and EU funding schemes. The currently ongoing project to connect Malta to mainland Europe via an interconnector should increase the possibilities for large scale RES plants due to a more stable grid.

Overview of the Energy Supply Chain
As discussed earlier Malta's energy supply chain is characterised by fuel imports, which predominantly are used in the power generation and road transport sectors. Pending any permanent means of gas link and being an island country, fuel imports into Malta are done exclusively through shipments.

Although electricity generation is liberalised, Malta enjoys a derogation from the Electricity Supply Directive in that it has one single distribution operator and electricity supplier, that is, Enemalta Corporation. The internal fuel market at wholesale and retail level is also liberalised although the specific circumstances of Malta which has a low market throughput, effectively has created a situation where whereas the retail sector is fragmented into many small parties, the wholesale sector is run by only 2 to 3 companies based on the fuel being imported.

With respect to renewables there are various importers of RES systems in Malta, particularly Photovoltaic systems and Solar Water Heaters. The Malta Resources Authority publishes lists of registered products relating to the provision of energy services including PV and solar water heaters (vii).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

With respect to Energy Policy and energy targets for Malta as one region given its 2004 accession as an EU Member State, Malta is bound to respect targets set through the various EU Directives and international agreements. In this regard, particularly important among others are, the RES Directive (Directive 2009/28/EC), the Energy-Efficiency Directive (Directive 2012/27/EC) and the Building Performance Directive (EPBD Recast) (Directive 2010/31/EC). These are transposed directly into national law, in accordance with local conditions and parameters in the respective sector.

Malta's overall GHG reduction targets are based on the following set of actions listed in the National Energy Efficiency Action Plan (NEEAP) and National Renewable Energy Action Plan (NREAP):

- end-use energy efficiency improvement of 9% by 2016;
- primary energy efficiency improvement of 22% by 2020;
- renewable energy target set to 10% of final energy consumption by 2020;
- bio-fuel contribution in the fuel mix: 10% of final energy consumption of fuels by 2020;
- tightening of existing minimum standards as from 2013 and a further tightening by 2017. By 2018 Public Authority Buildings will qualify for nearly zero energy buildings; and
- reduction in GHG emissions under Effort Sharing Decision: +5% over 2005 levels by 2020.

The targets set are not easy to implement and all do come with a number of challenges, predominantly given Malta's size and isolation. Being a small and isolated country Malta does not benefit from the totality of the benefits usually associated with RES and energy-efficiency technologies;

- technology costs – Malta imports most of these technologies from aboard with currently no direct investment in the local industry (apart from the retailing aspect);
- country footprint – being a small state with a total footprint not exceeding 316 sq.km, Malta has a limited land resource where to

accommodate large RES. Moreover, being at a high premium, the available land space has to compete with other aspects such as environmental and economical.

Policies relevant to the built environment and its allied fields

Planning policies
In Malta one of the most important sustainable development initiatives related to planning has been the setting up of the National Commission for Sustainable Development. One of the principal tasks of the NCSD is to prepare a strategic plan for the period 2007 – 2016, entitled a 'National Strategy for Sustainable Development' *Energy and economy planning are incorporated in the aforementioned NCSD strategic document*.

Mobility and transport policies
As discussed in Malta's Indicative National Energy Efficiency Target for 2020 in accordance with Article 3 of Directive 2012/27/EC (viii) of 2013, apart from increasing the share of biofuels, an improved modal shift, improved traffic management, re-injuvinating Malta's private car fleet and electro-mobility remain key targets for a cleaner and more efficient transport sector. Amongst the proposed measures one may list:

- the continuous improvements to the Public Bus Transport System to further encourage modal shift from private to public transport;
- the establishment of core Intelligent Traffic Management System (ITMS) to improve traffic management;
- promotion of the use of the established cross harbour ferries and vertical connectivity;
- promotion of Green Travel Plans, including car sharing and electric car usage from the local authorities;
- deployment of a National Electric Car Charging Network by 2014 and demonstration projects to improve citizen perception and potentially encourage uptake; and
- promotion of energy efficient vehicles: Fiscal and other measures aimed to encourage the uptake of new environmentally friendly vehicles using efficient engine technologies.

Community awareness policies
Fiscal incentives (in the form of grants and Feed-in Tariff (FIT) payable per unit of electricity exported in the case of PV) established to promote the widespread use of PV and SWH at domestic and commercial levels.

Public dissemination through media and EU-funded projects aimed specifically at increasing awareness on RES technologies and energy-efficiency behaviour.

Community awareness was also publicised by the Housing Authority directly through social housing at building level. This came about through the implementation of new physical interventions at various housing estates. Such measures namely comprise PV systems, solar water heating, natural ventilation as well as other standard measures in line with today's building technology standards (e.g. insulation, double glazing, etc.). Apparently this had the most significant effect on the community as families and households became more aware of their own energy consumption.

Industry engagement policies
Malta's industry is based on various sectors as a result of a pro-active policy towards diversification, value-added and innovation. One of the methods used to engage industry with RES was the launch of various finite budget PV schemes with up to 85% subsidy, with 8-year contracts for a prescribed feed-in tariff, ranging from €0.22 reduced to €0.18 per kWh generated, scaled down in percentage subsidy and rate, in accordance with the payback period, given a lower cost of the PV technology.

Tourism, construction and manufacturing are amongst the main industries in Malta. A significantly large sector of the economy is formed by small businesses (mostly micro-businesses, meaning that they employ less than 10 people) which are typically family-owned. In 2004 there were 30,790 such enterprises (29,670 of which were micro) which employed 44,624 people (micro-enterprises) and 22,685 (small enterprises, meaning between 10 and 49 employees). This means a total of 67,309 workers. To put this in perspective, in the same year 216 medium and large enterprises employed 35,500 people in 2004.

Malta Enterprise is the Government's support agency for industry and implements industrial policy including the administration of incentives for the expansion of industry and the development of innovative enterprises. The agency's main focus is on enterprises demonstrating commitment towards growth and employment and specifically provides incentives for manufacturing, ICT, Healthcare, Pharmaceuticals, Biotechnology and others. The tourism sector falls under the responsibility of the Malta Tourism Authority although Malta Enterprise also used to administer an energy efficiency scheme for the hospitality sector.

Malta's incentive policy for industry centres mainly on investment tax credits whereby companies in certain sectors which invest in immovable assets or which employ people are eligible for discounts on their tax bills depending on their size, and subject to state aid rules. Investments in installations related to energy efficient and renewables are also eligible for such tax credits.

A particular emphasis is placed on micro-enterprises which are by far the most numerous in Malta. A micro-invest tax credit scheme (ix) was available until the end of 2012 to help these companies with certain types of investments, including investments in energy efficient and clean energy generation.

The recent budget (2014) announced by the Government will re-open this scheme placing a favourable discrimination on Gozitan micro-enterprises (Gozo companies are eligible for a 65% tax credit whilst others will get 45%).

Incentives also exist to help innovative start-ups, which can include enterprises involved in energy efficiency, clean energy or environmental technologies. Furthermore there is a paid for business advisory scheme whereby businesses can benefit from expert support in various areas including energy efficiency and the provision of energy audits. There are also schemes to help businesses achieve environmental certification, particularly in the hospitality industry and with a new emphasis on holiday farmhouses in Gozo.

Malta's current energy policy (x) proposes that the Government, through Malta Enterprise, will *"promote investment in renewable sources of energy and energy efficiency, pursuing job creation in the energy industry, serving both Malta and other countries."*

Malta Enterprise, through it '*Business First'* agency, also makes available a Business Advisory Scheme (xi) to industry through which companies can source expert advice in various areas which include Environmental and Energy auditing.

It has to be noted that Malta is currently revising its energy policy in some detail with some schemes, that were available until recently, some of which were already taken up completely and now closed.

Policies towards education, training and skills development

Malta's *Building Industry Consultative Council* (BICC) in collaboration with the *Malta College of Art, Science & Technology* (MCAST), as Malta's main educational centre for vocational courses are promoting a project known as Build-Up Skills, whose aim is to create a National Education Platform that will develop a detailed National Qualifications Roadmap for the local construction industry.

The Malta Resources Authority expects retailers and installers of renewable systems and of insulation and double glazing to be competent and publishes a list of licensees and authorised service providers in the energy sector including a list of engineers who can certify PV systems (xii) The University of Malta's Institute for Sustainable Energy offers a course in the installation of solar heating and photovoltaic systems (xiii) .

The Malta Environment and Planning Authority has issued guidelines regarding the installation of PV systems (xiv). The Malta Resources Authority dedicates part of its website to disseminating information on climate change (xv). Various recommendations contained in Malta's National Climate Change Adaptation Strategy deal with Education, one example being Recommendation 82:

"The policy implementation recommendations relating to climate change adaptation are very often not scientific or technical solutions but behavioural solutions. Consequently, the Climate Change Committee for Adaptation proposes, if the recommendations of this Report are to be successfully implemented, the implementation of a sustained education and communications campaign that is both long term and targets simultaneously different sectors of the public".

At a professional level (architects and civil engineers) the Faculty for the Built Environment at the University of Malta, formerly the Faculty for Architecture and Civil Engineering, has over the recent years seen a transition aimed at holistically addressing all those features related with the built environment including not only areas which strictly are pertinent with environmental aspects but also other areas related towards a sustainable building industry.

Policies towards energy generation from waste
The Waste Management Plan for the Maltese Islands refers to the recovery of energy from waste within existing and future facilities as an important step in sustainable waste management, with waste considered as a resource. Waste also contributes towards the Renewable Directive targets. The plan further identifies the opportunity to recover energy from waste (xvii) .

Policies towards technical innovation
A number of R&D incentives aimed specifically towards the creation of new composite building elements with a view to improve thermal performance of such elements, in line with latest building legislation.

Policies towards buildings' eficiency
Although building's energy efficiency has never been assessed and quantified on a national level, in general, the existing Maltese building stock is known to have high thermal inertia with a slow response to the microclimate.

Use of thermal insulation in-between walls was never the typical construction method, since Maltese winters are quite mild (average of +12degC). Today only a few new buildings are deploying cavity insulation. This is mainly stemming from recent Government grant schemes as energy saving measures, namely double glazing and roof insulation. Developers and home owners were equally obliged to follow such measures in accordance with the latest current local legislation, now in force, as detailed below.

As part of its EU acceding obligations Malta in 2006 adopted LN 1002 of 2006 a direct transposition of Directive 2002/91/EC on the Energy Performance of Buildings (EPBD). Through this legislating new buildings and buildings undergoing major renovation were required to follow *"Technical Guidance Part F – Conservation of Fuel, Energy and Natural Resources"* - a generic list of minimum energy performance requirements for all buildings in Malta. As of 2012 with the coming into force of LN 376 of 2012 (transposing the recast EPBD - Directive 2010/31/EC) local authorities have started the process of establishing reference values for energy consumption of different typologies of existing buildings, with the scope of creating cost-optimal reference values for the energy performance of Maltese buildings.

Once these studies are completed it is expected that in line with what was presented in Malta's Indicative National Energy Efficiency Target for 2020 in accordance with Article 3 of Directive 2012/27/EC of 2013, (xviii) minimum requirements for energy performance of buildings will most probably be progressively revised towards a near-zero energy building target set for 2020 (xix).

Policies towards efficient generation and usage of heat
At primary energy level, recent investments in the local thermally run power stations have seen a drastic increase in the efficiency of grid sourced electricity. Heat recovery from such thermal stations for use in, for example, district heating is a non-starter since the infrastructure required does not justify the nominal heating required, limited to not more than a 1 month worth. Notwithstanding this a number of entities given their particular conditions and energy requirements (requiring year long space and domestic water heating) are looking and investing in CHP plants.
Due to its Mediterranean climate there is a

greater accent on cooling buildings. Depending on building size and other criteria (incl. cost, space available, etc.), this is typically achieved through de-centralised systems (split-unit AC being the most common devices) for residential buildings and centralised HVAC systems for large buildings. Good educational campaigns and a relatively energy conscious population has made sure that a good segment of the market share of these HVAC systems are of the energy efficient type.

3. CASE STUDY: Gozo

Gozo is identified as a distinct geographical region. It has a superficial area of 67km^2 and a population of 31,926 as in 2011. Most of the residents live around town hubs or in smaller villages (xx).

Promoted as a different region from Malta the main stakeholders include the Ministry for Gozo and Individual Local Councils representing each town and village together with other smaller local stakeholders include the Gozo Tourism Authority, Commercial Entities, Residents Associations and various NGOs. These include mainly those NGOs that are pro-environmental in one or many ways. The respective website shows an exhaustive list of all registered NGOs in Malta to date (Jan 2014); (as per national directory of 'environmental organisations') (xxi)

Initial conditions and local situation for the region: Gozo's Energy Consumption: (Electricity Statistics based on 2010)

- total Generated: 2,113,112 MWh;
- used in Stations: 121,623 MWh;
- industrial: (Malta) 460,413; (Gozo) 6,190 MWh;
- commercial: (Malta) 597,120 MWh; (Gozo) 28,434 MWh;
- domestic:(Malta) 434,875 MWh; (Gozo) 40,528 MWh;
- other: 423,939MWh.

Objectives and methods

The expected outcomes based on the three main pillars of sustainability are: Social, economic, and environmental fields. These are best described (collectively) in the masterplan for Gozo as a region, in a recently published Eco-plan for Gozo, concisely termed as Eco-Gozo. An extract form this document highlights its main thrust:

"Gozo, the second largest island in the Maltese archipelago, measuring about one third the size of Malta, and home to around 30,000 permanent inhabitants lies 25 minutes away by ferry from the most northern point of Malta. The island is in itself considered a Region known for its remarkable landscape consisting of pristine coastline and untouched country trails. Developed enough to guarantee a sustainable economic activity, Gozo is a natural masterpiece shaped through 7000 years of culture. Based on the values of sustainability and the need to protect the natural environment of Gozo, the Government of Malta has embarked on an ambitious vision to transform Gozo into an eco-island by 2020. The eco-island vision opens up to most sectors which determine life on the island and at the same time unites everything into one perspective and a common strategy. The four main pillars of this strategy bring together the environmental challenges on the island, the economic aspirations of its people, the development of society, and the preservation of its cultural identity" (xxii)

Interventions, measures and methods applied
The Eco-Gozo initiative includes quite a substantial number of actions and proposals. The following are only a short list of some of the actions which have been carried out. The short list covers aspects related to waste management, energy conservation and efficiency, water conservation and renewable energy technologies. Information is derived and adapted from the Eco-Gozo website. An exhaustive list of projects can be found on the same website.

Increased use of Sustainable Energy in the Ministry for Gozo: A PV system installed on top of the Ministry for Gozo roofs has over the period January-June 2012 generated around 40,000 units of electricity (kWh), covering around 30% of all the energy demand of the building.

Underground Recycle Waste Stream: One particular local council in Gozo, San Lawrenz, has proposed an underground recycled-waste system underneath a public street to encourage selective collection and recovery of packaging for subsequent recycling. The aim of such an action was to eliminate the negative visual impact on the urban landscape.

SAVE and REDUCE: Eco-Gozo Home Consultancy Visits: The project aimed to inform the Gozitan community on how to reduce the carbon and water footprints of their household and to encourage appropriate waste management practices. The scope of the project, was to provide consultancy visits to all households in Gozo using officers, trained to provide advice to families on energy and water conservation, renewable energy options and waste separation. An information booklet was also distributed to all the households.

Energy Efficiency and Energy Audits: Twelve energy audits in government premises were carried out, amongst which is the Administrative Centre in Victoria where most of the Government offices and the Ministry for Gozo are found, were conducted.

Water Reservoir at Gozo Stadium: Fresh water is scarce in Malta, and most of the drinking water comes either from the (depleting) ground water aquifer or energy intensive reverse osmosis plants. A project carried out by the Gozo Football Association comprised the building of two water reservoirs at the Gozo Stadium. This water conservation practice reduced the dependency on extracted water from the aquifer drastically.

Installation of Decorative Energy Efficient Luminaries: Through this project the Fontana Local Council has provided energy-efficient lighting, while embellishing the area by the installation of decorative luminaries, complemented with street furniture and paving of public open spaces and pedestrian areas.

Outcome and results

Improving the energy efficiency in Gozo is not easily quantified as it has no isolated system and being connected to the main grid and power stations in Malta creates a situation where the specific savings are only viewed as aggregated values. Also certain projects are still at concept stage with no detailed evaluation having been carried out

The main driver and scope of these projects has been throughout the regional aspect of Gozo, which attracted dedicated EU funding for particular situation. Its double insularity has always been considered as a drawback in many aspects. Nonetheless its double insularity is also what most attracts Maltese and foreigners alike towards its beauty. In this context the specific projects, which are not only of a purely technical nature but are also aimed at resource conservation (e.g. water conservation) are seen as part of a holistic plan towards preserving the pristine conditions of Gozo as an isolated green island.

As discussed most of these projects attracted EU funding and one of the barriers encountered in developing this eco-Gozo plan is that since the capital costs of these projects/technologies are high, without dedicated local or EU funding few of these projects would have materialised.

Other aspects of the projects

There is a general desire by the business community in Gozo, to expand in terms of its current financial investment dimension. In a way, if not addressed properly this may be conflicting with the idea of a sustainable Gozo. A delicate balance between the Island's economic development and the island's sustainable ambition must therefore be struck.

4. CONCLUSIONS

The potential of Gozo as a stand alone case study as a region given its manageable scale, can easily act as a showcase to promote the reduction of energy consumption and CO_2 emissions. Its size renders it to be easily replicated or extended to the whole archipelago of Malta, comprising buildings of different types and varying size within all three sectors (industrial, commercial and the domestic sectors), towards a more coherent energy supply and demand of the region.

On a national level, the energy picture is bound to change, and quite imminently. With a new Government sworn in (March 2013), there is clearly an intended shift in "fuels' policy" from the use of HFO (Heavy Fuel Oil) and diesel to gas. However this is not the only change, as gas can be ferried in on special ships or through a dedicated gas pipeline.

At another level, the electrical interconnection with mainland Europe is now soon coming to it completion. A contractual agreement was signed between Malta and Italy, and the actual cable-laying which has already started is expected to be completed by the end of 2014.

In the transport sector, a major energy guzzler, responsible for 20% of the national energy bill and emissions, new fiscal incentives are already in place to convert petrol vehicles to run on LPG, complemented with the new gas outlet points at existing established service stations.

Therefore the energy scenarios in Malta are multiple. Government's forecasts are tuned towards minimising energy costs, increasing energy efficiency and eliminating energy poverty – but aren't these the three underlying pillars of sustainability? Above all these point towards a better quality of life for all.

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THE NETHERLANDS

AUTHORS

Louis Hiddes
E: l.hiddes@mijnwater.com

Jo Stefens
E: j.stefens@ou.nl

René Verhoeven
E: r.verhoeven@mijnwater.com

Marlie Dix
E: m.dix@mijnwater.com

Herman Eijdems
E: h.eijdems@mijnwater.com

Open University (OU)/Mijnwater BV
Valkenburgerweg 177
6419AT Heerlen The Netherlands

1. OVERVIEW OF THE REGION

Characteristics of the Region

The region Parkstad Limburg has 249,873 (2013) inhabitants and consists of eight municipalities. Parkstad Limburg covers a total area of 211 km^2. This results in a population density of 1,184 inhabitants per km^2. Heerlen is the main city. The region has 122,416 dwellings, of which are 54% owner-occupied, 32% socially rented and 14% privately rented. Parkstad Limburg has approximately 15,000 companies and institutions. The GDP of Parkstad Limburg is €29,700, 17% less than the GDP of the Netherlands of €35,800.

The number of households with an income is 101,000 (2011). The employment rate for inhabitants between 16 and 64 years is 69%. The region is surrounded by attractive scenery and its districts, which in former times used to be small villages, have their own atmosphere and culture. Heerlen is a centre of activity with a regional function including bigger companies as ABP/APG, CBS and DSM. A key tourist attraction is the furniture mall, with approximately 4 million visitors per year.

In the past, Parkstad Limburg was the energy centre of the Netherlands due to coal mining industry. Nowadays, new energy is a major priority for the region of Parkstad Limburg as it is one of its historical strengths. The region acts as a breeding ground for expertise with practical experiments for the application of new technology and production facilities. In the coming years, for example, the innovation program BIHTS (Building Integrated High Tech Systems) of the Municipality of Heerlen, Zuyd University/The District of Tomorrow at Avantis, the incubator-E and multinational SGS stimulates the development of cross-border knowledge and supports innovative entrepreneurship in this field. Other interesting examples are sustainable housing in Kerkrade West, Raywavers at Avantis and of course Minewater. As a result of this, also educational/ research institutions, entrepreneurs and government focus on the application of new energy in the built environment in this region.

Energy demand and supply of the Region

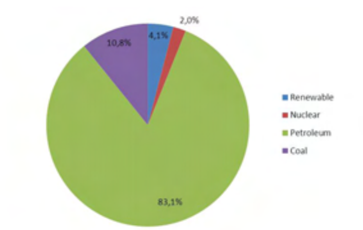

Figure 1 – Share energy sources Parkstad Limburg (2011)

Total energy consumption Parkstad: 29.6 PJ from which 369 million m^3 gas and 1.272 million kWh electricity, 53 million litre petrol, 55 million litre diesel, 3.6 million litre LPG.

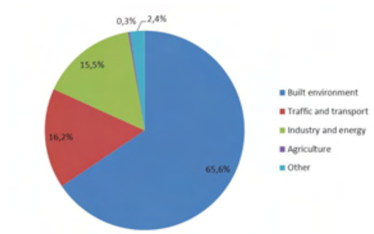

Figure 2 – Distribution energy consumption per sector Parkstad Limburg (2011)

The total CO_2-equivalent emissions from the built environment is 958 million tonnes per year, based on a GHG emission factor for electricity from the grid of 0,581 $kgCO_2eq$ per kWh.

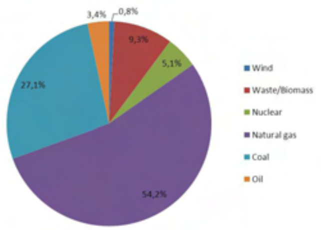

Figure 3 – Share energy sources electricity production (%) Parkstad Limburg (2011)

The energy costs per dwelling in Parkstad Limburg (2011) are €1,685 per year, which is 6.6% above the average for The Netherlands (€1,580 per dwelling, per year). The energy poverty index derived from these figures is 5.7% (average for The Netherlands is 4.4%).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Targets set for the Parkstad Limburg region:
- 25% CO_2 reduction in 2020 compared to 1990
- 70% CO_2 reduction in 2030 compared to 1990
- Carbon neutral in 2040

The regional governance in Parkstad Limburg is aware of the need for energy transition in the region. The share of renewable sources is rather poor. The Dutch government has set a target of 14% renewable energy in 2020. Parkstad Limburg wants to fulfil its share. Therefore a regional ambition study has been set up, called “Parkstad Limburg Energy Transmission” (PALET). The PALET study shows the roadmap for a Carbon Neutral Region in 2040 and was endorsed by the councils of the 8 municipalities.

The first step, a study of the current situation, as a reference for future scenarios, has been made. The administration of the region want to connect energy targets by other aims, like the development of high tech business, increased employment and the well-being of the inhabitants. The approach is based on a realistic spatial integration of technical measures and support for the transition by the population. Due to the PALET study 33% (10.1 PJ) of the reduction for 2040 has to come from energy saving measures. The remaining 67% (19.5 PJ) will be from renewable sources.

As a second step the potential of energy savings for buildings has been investigated. Saving packages have been formulated to improve energy labels from an average of E (dwellings) and G (commercial) to A standard or better. The packages are formulated thus that they give a reasonable approach in financial, technical and organisational way. If the saving packages are applied on the building characteristics in the region (with 90% terraced houses and semi-detached houses from 1950 – 1970) the energy savings for buildings count up to 25% of the total energy consumption in the Region. In pilot projects (like cost neutral renovation towards zero-energy use in Kerkrade) Parkstad Limburg is taking a the practical approach. The remaining 8% of the energy saving target of 33% has to be achieved in the transport electrical vehicles, and industry sectors (forced by environmental regulations).

As a third step an investigation of regional opportunities for renewable sources has been carried out. Potential studies and location maps have been set up for wind, water, biomass, thermal storage and solar energy. Former mining infrastructure is located within the area as a result of previous extraction in the area. This is different from the situation in the rest of the Netherlands, where layers of sand and clay form aquifers due to a high level of groundwater. The potential study shows the remaining energy demand (which is 67% of the total primary energy consumption) can be filled in with solar energy (67%), by thermal storage and geothermal sources (25%) and by wind and regional harvested biomass (8%). The emissions of the remaining fossil energy use (oil and gas, 28%) will be compensated by the export of solar energy. If the full potential for renewable sources in Parkstad Limburg will be exploited the region is able to become a net energy delivering area.

Summarising, this means that 120,000 homes will be renovated, 35% electric cars, nearly 900 acres of solar panels on roofs and in fields, 52 wind turbines, more than 100,000 tons biomass processing and large-scale deployment of thermal storage using by example the minewater. This is an outline of the regional challenge, which will be translated into regional implementation plans.

Other Regional targets, barriers and drivers

The Region has a lot of potential. There is a high potential from inter regional collaboration with the Aachen area in Germany and the Liege area in Belgium. Heerlen and nearby Aachen/ Maastricht have high rated technical schools and universities. Moreover the neighbouring regions (in Belgium and Germany) form an attractive market for the export of technology and sustainable energy. The Region has a relatively high density of built environment and there is a cultural and social cohesion from the past which might be addressed to gain support for innovative and sustainable ambitions. There is a modern infrastructure with regards to ICT e.g. access to internet, and broadband and the region is well connected by highways and railways to the rest of the Netherlands and to Germany and Belgium.

The Region has a number of challenges. It faces a dated building stock with poor insulation levels, which needs to be modernised for up-to-date living comfort. Also there is still damage to buildings and due to groundwater raise even new cases of damage from the old mining activities. The Region is facing a high level of unemployment due to the abolition of the coal mining industry. As a potential regional stimulation funds may be addressed, but some expertise has to be found outside the region. Distance from the Dutch government and other institutions also acts as a barrier to progress.

Innovative strategies/initiatives

The 8 municipalities of Parkstad have committed themselves to a common ambition and strategy for sustainability as described below. The Trias Energetica is an important instrument for the transition from conventional to sustainable energy supply. For achieving carbon neutrality reformulation is needed as shown in *Figure 4*. Fossil use is eliminated. Reuse of energy is put in. Important factors affecting the life of individuals include: comfort, health, well-being, entertainment, mobility and affordability. These elements can be fulfilled in a conventional or sustainable way as shown in *Figures 5* and *6*. The difference between conventional and sustainable living is the use of renewable resources, the continuous reuse of energy and the addition of the elements time and intelligence

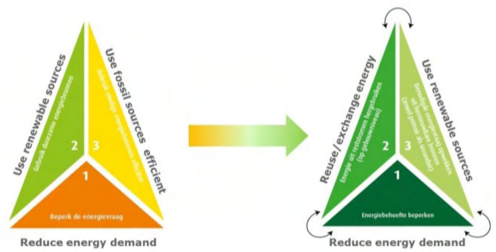

Figure 4 – Reformulation Trias Energetica

Figure 5 – Conventional way of living

Figure 6 – Sustainable way of living

A larger energy saving potential can be found by a better approach of the loss of exergy. Exergy is the maximum fraction of an energy form which (in a reversible process) can be transformed into work. The remaining part is called anergy, and this corresponds to the waste heat. The exergetic efficiency of conventional energy systems for buildings is less than 20%. Due to energy storage and the use of heat pumps the exergetic efficiency improves towards 40 – 50%. For further utilisation of anergy the elements time and intelligence are essential. Time refers to the supply and demand of all kinds of energy flows at the right time. However supply and demand are not always in balance. The production of renewable energy from wind and sun for instance can be very erratic depending on weather conditions. A solution can be found in buffering and conversion into other types of energy, such as gas (hydrogen or methane), heat or cold. Surplus of renewable electricity may, for example be converted into sustainable heat or cold by heat pumps and stored. With intelligence, energy flows on the supply and demand side can be predicted, controlled and influenced to achieve optimal operation.

Emerging technologies

The main technology is the development and exploitation of the regional hydraulic network. The minewater back bone for this network was established in 2003 and connects sinks and sources from the mines to the building areas. The further development is the transformation of this network towards a hybrid intelligent and adaptive energy infrastructure with multiple renewable energy sources and power generation, cluster grids, electrical and thermal storage buffers and the application of demand and supply side management for optimal power generation, energy supply, storage and exchange. The minewater source is a distinctive and unifying feature for the Parkstad region in regard to the rest of the Netherlands. Nevertheless the Minewater 3.0 design is universal and a blue-print for smart hybrid sustainable energy infrastructures with multiple sources. It has the potential to be exploited in many urban areas (not only mining areas) in Europe and the rest of the world.

3. CASE STUDY: MINEWATER FOR HEATING AND COOLING IN THE MUNICIPALITY HEERLEN

The Minewater project originated from the idea to utilise minewater as a geothermic source for sustainable energy. Minewater in deeper layers of the former coal mines has a raised temperature up to 30°C which can be used to heat buildings. The upper layers provide cooling water with temperatures of 15 – 18 °C.

Under the European Interreg IIIB NWE programme and the 6th Framework Program project EC-REMINING-lowex a research and development period was started which lasted from 2003 to 2007. In 2007 construction began and in 2008 the Minewater pilot system (Minewater 1.0) was put into operation with the first two building connections.

At the end of 2011 the municipality of Heerlen decided that the Minewater project should become a private company, initially with 100% shares held by municipality Heerlen. After this decision a new period started and in 2012 Minewater 2.0 was further developed with the objective to secure optimal long term use of geothermal underground for sustainable heating and cooling of buildings, to become an essential part of the Sustainable Energy Structure Plan 2040 of the municipality Heerlen (carbon neutral city), to realise a Minewater Corporation with a sound business case, to promote local employment, to involve local educational and research institutions and to achieve a high social involvement and sustainability awareness of the inhabitants.

Minewater 2.0 is the transformation of the straight forward geothermal minewater pilot system into a full-scale hybrid sustainable energy infrastructure, a smart grid for the sustainable heating and cooling of buildings. Since June 2013 the Minewater 2.0 system is successfully in operation with two new connections and a further roll out is expected. The prospect is that by 2016, 25 buildings will be connected to the grid with a total of 800,000 m^2 of floor area, 11% of the total built environment. This results in a CO_2 emission reduction of 65% for these connections on heating and cooling. At this moment 175,000 m^2 of floor area is already contracted.

Currently the Minewater Corporation (Mijnwater BV) is working on a long-term sustainability vision for the municipality of Heerlen and the Parkstad Limburg region under the heading “Sustainable Living”, also referred as Minewater 3.0. The objective “Creating a brave new area” in Heerlen can serve as an example for other parts of Parkstad Limburg and the rest of the Netherlands. Time and intelligence are the key elements to be used to achieve a comfortable, healthy and affordable living for the total population.

The following paragraphs the different phases of Minewater are described more in detail.

Minewater 1.0

Minewater 1.0 is the term used for the initial minewater system at Heerlen, developed in the period 2003 – 2008. A straightforward pilot system to investigate how the minewater of the abandoned coal mines of Oranje Nassau could be used as a geothermal source for the sustainable low-energy heating and cooling of buildings. *Figure 7* shows the Minewater 1.0 system in geographical perspective.

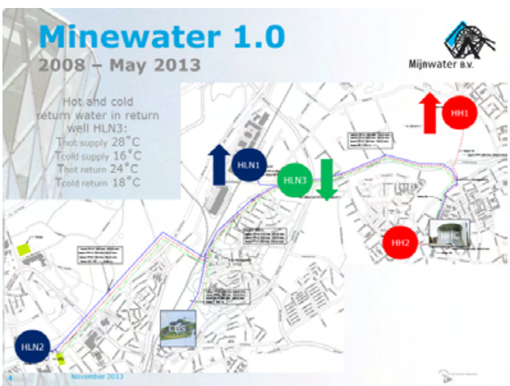

Figure 7 – Minewater 1.0 in geographical perspective

Five wells have been drilled to the stone drifts in the underground. Two hot wells in the northern part of Heerlen with a depth of 700 meters below surface for the extraction of hot minewater with a temperature of about 28°C, two cold wells in the southern part of Heerlen with a depth of 250 meters for the extraction of cold minewater with a temperature of about 16°C. A fifth well in the middle part of Heerlen with a depth of 350 meters is used for the injecting of the cooled hot and warmed cold minewater with intermediate temperatures between 18 – 22°C.

Until 2012 one hot well HH1, one cold well HLN1 and the return well HLN3 were in operation with two end-users: the office of the Central Bureau of Statistics (CBS; 22,000 m^2) and the complex Heerlerheide Centrum (HHC; homes, supermarket, offices, community facilities, catering; 30,000 m^2, see *Figure 8*). Heat pumps in each building are used to provide the base load of heat and cold demand with low-ex temperatures.

Figure 8 – The energy station is situated in the basement of the the Gen Coel building, Heerlerheide Centrum (HHC)

Figure 9 shows the 3-D simulation model of the minewater reservoir made by Vito.

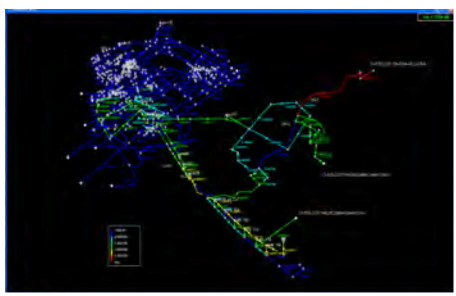

Figure 9 – 3D model of the underground geometry of the mine with overview of the flow and initial temperature conditions (VITO).

The simulations of Vito and also practical measurements show that the pilot way of operation causes depletion of the minewater reservoir on the long term, especially when the capacity is increased as intended. Other restrictions of the Minewater 1.0 system were a limited hydraulic and thermal capacity, a not demand-driven system (a simple change-over system) with in summer only cold supply and in winter only heat supply and no heat/cold exchange was possible.

Minewater 2.0

Minewater 2.0 was developed based on the exchange/reuse of heat and cold instead of purely heat and cold supply, thus utilising the lost anergy. Other elements are the storage of heat and cold in the minewater reservoir instead of depleting it, a system able to combine multiple (renewable) energy sources and power generation, maximising the hydraulic and thermal minewater capacity (reservoir, wells and grid), a fully automatic controlled and demand driven system (heat/cold supply at any time), the addition of heat and cold storage in the buildings and cluster grids (Minewater 3.0) and a system suitable for demand and supply side management in near future (Minewater 3.0)

Energy exchange will be realised between buildings by means of local cluster grids and between these geographically dispersed cluster grids through the existing minewater grid. This means that a building is no longer just an energy consumer but also an energy supplier. A building that extracts hot water (e.g. 27 °C) for heating from the hot pipe of the cluster grid returns cold water back to the cold pipe of the cluster grid (< 15 °C). This cold water can be instantly uses by other buildings connected to the grid for cooling. Heating and cooling of the buildings can occur passively and/or actively by using heat pumps. This depends on the available temperatures in de cluster grid (cold 8 – 20 ˚C; heat 27 – 50 ˚C) and the requested release temperatures of the building (cold 5 – 18 ˚C; heat 30 – 50 ˚C). Additional heating and cooling can be delivered by solar collectors and other suitable devices, like a bio-CHP, which can raise the supply temperature for heating up to 50 – 55 ˚C. A completely new boiler house design is developed, suited to handle this wide range of supply temperatures and to achieve high exergy efficiencies by maximising passive (re-) use of heat and cold and by raising the heat pump efficiencies up to a COP of 7 and more.

Energy storage

The production wells (HH1 and HLN1) supply the shortage of heat and cold to the minewater backbone. The surplus of heat and cold will be stored in the minewater reservoir through the injection wells (HH2 and HLN2). The current return/injection well (HLN3) will be out of order and only be used in case of exceptional situations.

Regeneration

Unwanted intermediate return temperatures as applied in the minewater pilot system cause depletion of the minewater reservoir on the long term. To eliminate this effect it is necessary that the used return water is heated up (≥ 28 ˚C) or cooled down (≤ 16 ˚C) sufficiently to meet the natural geothermal temperatures and injected in the corresponding hot or cold part of the minewater reservoir. It is also important that the heat and cold extraction and infiltration has to be balanced on a yearly basis. The return temperatures to minewater reservoir are determined by the operation of the boiler houses installations of the end-users. They have to ensure that the extracted hot (27 – 50 ˚C) or cold water (8 – 20 ˚C) from the cluster grid is cooled down (< 15˚C) or heated up (> 29˚C) sufficiently. This is included as a condition in the contract with the end users. *Figure 11* shows the final situation of Minewater 2.0.

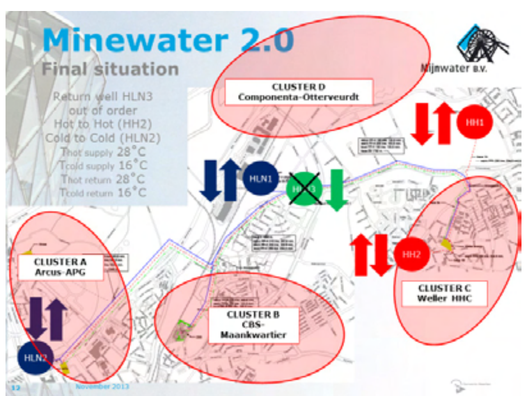

Figure 11 – Final situation of Minewater 2.0.

Since June 2013 the Minewater 2.0 system has been successfully in operation with the first cluster A and two new connections, the existing retrofitted low-ex building of APG (32,000 m^2) and the newly constructed low-ex building of the Arcus College (30,000 m^2).

APG is a pension fund that owns a data centre. A heat pump will provide the cooling of the data centre and heating of the building. The waste heat of 15.000 GJ per year will be provided to the new cluster network A or heat exchange in the cluster and other buildings connected to the minewater backbone. The APG building will show a total CO_2 reduction of 118% compared to the former situation, extraordinary for a building constructed in 1974.

The newly constructed Arcus College has heat pumps to provide the base load of heating (85%) and cooling (60%). A total CO_2 reduction of 45% is reached compared to traditional heating and cooling with natural gas boilers and electrical chillers.

Multiple energy sources and power generation
The capacity of the minewater system is finite. For realising the objectives of the Sustainable Structure Plan of Heerlen a combination of minewater with other renewable energy sources such as biomass and/or solar energy and waste heat is necessary. The minewater energy infrastructure can be used to connect these energy sources to buildings. A lot of initiatives are already planned or under construction e.g. a bio-CHP, a closed greenhouse and waste heat of an additional data centre or cooling towers for peak cold demands. All these energy sources are locally situated and will be connected to the nearest cluster grid to supply their heat and cold to the corresponding cluster and through the minewater backbone to other clusters.

Maximising hydraulic and thermal capacity of the minewater system
To maximise the hydraulic capacity of the current minewater grid several measures were realised in 2013. At the hot and cold production wells the well pumps are replaced and pressure boosting systems are installed as shown in *Figure 12*.

Figure 12 – Putting in place of the minewater installation production well

The existing minewater return pipe will be used for additional supply and disposal of hot or cold minewater. At the cluster grid A, a cluster installation with booster pumps for energy exchange between the minewater and cluster grid are installed as shown in *Figure 13*.

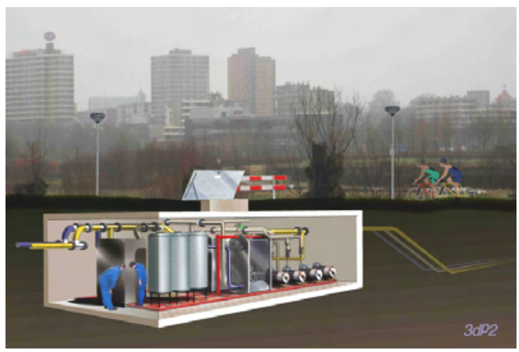

Figure 13 – Artist impression cluster installation

Sophisticated injections valves are applied at the hot and cold injection wells and in the near future all wells become bidirectional for further capacity enlargement, back-up and smart production and injection of minewater.

Fully automatic and demand driven operation
The Minewater system 2.0 is fully automatic and demand driven with 3 levels of control as shown in *Figure 14*.

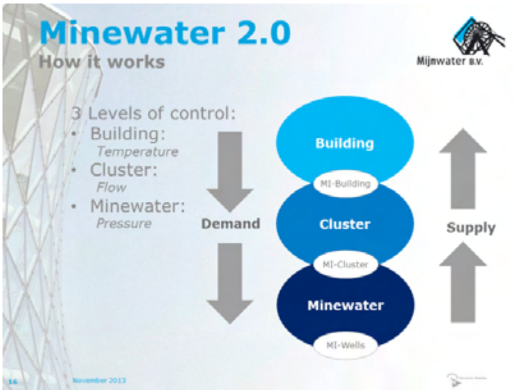

Figure 14 – Visualisation of the three levels of control

All buildings (first level) are connected to a cluster network (second level). Several clusters are connected to the minewater backbone and reservoir (third level). At each level (building, cluster, minewater) there is a net heat or cold demand. The buildings determine the demand of the cluster. The cluster provides what the buildings demand. The clusters determine the demand of the minewater backbone. The minewater backbone and minewater wells provides what the clusters demand.

Exchange at the interface between the levels takes place with autonomous substations (MI = Minewater Installation). Each level works with another independent process control parameter. To show how it works a typical process situation is shown in the artist impression of *Figure 15*.

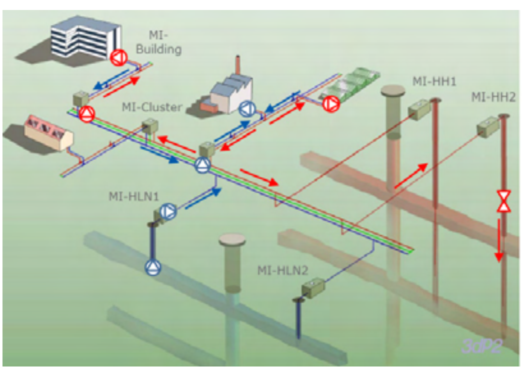

Figure 15 – Artist impression Minewater 2.0 with typical process situation

Minewater installation building
Frequency controlled pumps and 3-way valves provides hot or cold water from the cluster network to the heat exchanger for heating and cooling of the building. The minewater installation works fully autonomously with selected signal exchange between the minewater installation and the boiler house (heat pump installation) of the building.

Minewater installation cluster
The cluster installation with 2 heat exchangers and 3 booster pumps is located in the field, mounted on a skid and placed in an underground precast concrete basement, a very compact and cost-effective solution as shown in *Figure 13*.

Production wells
The functionality can be divided in two steps. First the well pump which brings the minewater from about 120 m deep to the surface and deliver it with a pressure head of 3 bars to the pressurised boosting system. Secondly the pressurised boosting system provides the distribution and required pre-set pressure at the connected cluster grids.

Because the system needs to operate fully automatic and demand driven a pressurised buffer system for start/stop operation of the well pumps is applied. The installations are also prefabricated and mounted on skids and placed in an underground basement as shown in *Figure 12*.

Infiltration wells
The hot and cold infiltration wells fulfil two functions. First the injection of the surplus of hot and cold minewater in the minewater reservoir with a minimal injection pressure head of 2 bars to prevent degassing. Secondly the support of energy exchange between the cluster grids through the minewater backbone. By means of algorithm it can be determined per injection well whether there is a surplus of heat and cold. With the measured extracted minewater flows at the cluster installation of each cluster grid this can be defined.

The injection valves are equipped with an independent hydraulic pressure control system to control the injection pressure at a great depth from the surface. With a simple control box the valves are remote adjustable. The Minewater 2.0 system sets high quality standards to the injection valves to fulfil the requirements.

Central Monitoring System (CMS)
For fully automatic demand driven operation of all the energy trains at the building, cluster and minewater level a very sophisticated process control and monitoring system is needed as shown in *Figure 16*.

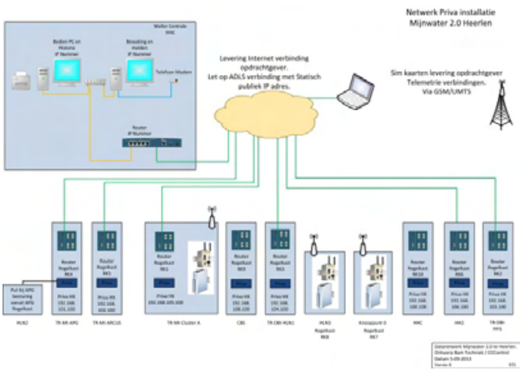

Figure 16 – Structure Central Monitoring System

Communication between the substations occurs through a fast internet connection. The central monitoring system is the central control room from which all substations are approached, visualised and monitored. All substations together form one virtual minewater installation. A very new application in the built environment.

Business case for Minewater 2.0
The experience from Minewater 1.0 is used for developing a Minewater Corporation that can exploit commercial offers to interested building owners for connecting to the cluster grid. The building owner pays a standing charge for the minewater connection while he runs his own heat pump installation. For optimal energy exchange and further development of the hybrid sustainable energy structure it is preferable that the Minewater Corporation becomes the owner of the boiler houses in the buildings (heat pump included). The fees for the heat and cold supply are based on the avoided costs by using gas boilers, electrical chillers and avoided additional measures. This gives Minewater Corporation more opportunities for optimising the energy supply and exploitation in combination with collective sustainable energy production plants connected to the smart Minewater 2.0 grid. The business case of the Minewater Corporation should provide a competitive offer to potential customers, tempting them to join the Minewater 2.0 system. Such a healthy business case is also needed to attract private or public shareholders to secure the continuity of the provision.

Minewater 3.0

The key element for Minewater 3.0 is to add techniques for intelligence and the time factor to the system. In collaboration with local partners and local educational and research institutions the Minewater Corporation examines how these techniques can be developed and implemented into the energy infrastructure of Minewater 2.0. Time and intelligence means, in regard to the Minewater system, the application of energy buffers and the dosing of the power supply on the buildings. These buildings are gathered in clusters, which exchange heat and cold mutually. On cluster level an optimisation is carried out in time (flattening of peak demands) and in combination with demand and supply management (intelligence). The optimal deployment of multiple sustainable sources (minewater, air, solar, biomass, wind) and enhancement of the efficiency and capacity of the cluster networks and minewater network is a leading strategy for the intelligent management process. Minewater 3.0 is furthermore based on a couple of visions, principles and insights on sustainability and economics that are described in the next paragraphs.

Trias Energetica
The new Trias Energetica (see *Figure 4*) has led to a couple of Minewater basics. First the use of an energy exchange system instead of an energy supply system, as already applied in Minewater 2.0 system. Secondly the addition of energy neutral sources like wind and solar, which demand all-electric (heat pump driven) building solutions now.

Conventional versus sustainable infrastructure
Conventional energy infrastructures are purely based on a one-way flow as shown in *Figure 17*.

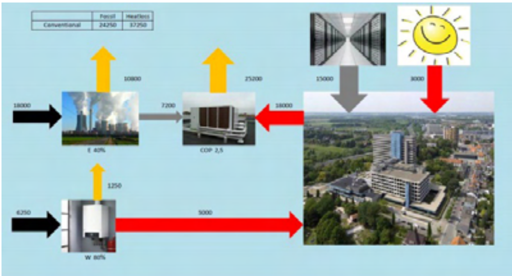

Figure 17 – Conventional energy infrastructure

After consumption the energy for heating and cooling is lost. In a sustainable energy infrastructure the heat losses are minimised and energy is being redrawn from the building.

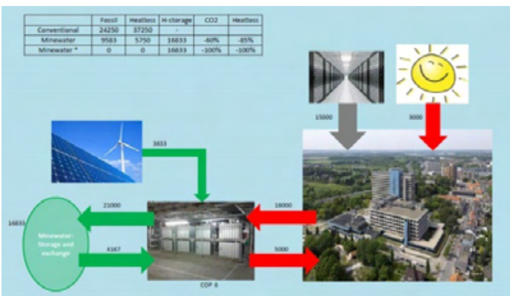

Figure 18 – Sustainable energy infrastructure with limited renewable electricity generation

The losses concern mainly the efficiency of the conventional electrical power plant. A heat-loss reduction of 85% and a CO_2 emission reduction of 60% can be achieved. This approach is needed to reach a carbon neutral built environment base on low-exergy principles and limited renewable electricity generation based on wind, sun or biomass as shown in *Figure 18*.

Low-ex temperatures, energy storage and demand and supply side management
Higher energy reuse and efficiencies and lower generation capacities are feasible with low-ex heating and cooling temperatures, additional energy storage at the building and in the cluster grid and demand and supply side management, as shown in *Figure 19*.

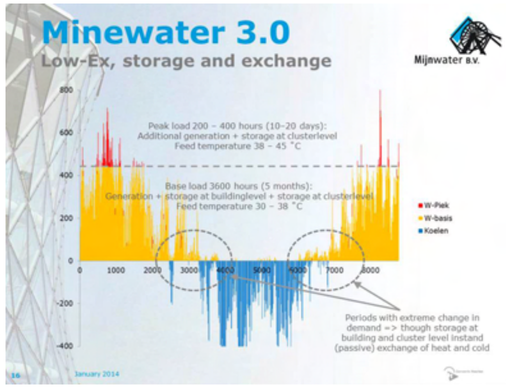

Figure 19 – Demand curve of a typical building related to H/C-temperature and storage

The required heating or cooling temperature is determined by the building envelope, the season and the design and mode of operation of the boiler house and the release system. The peak-load period is rather short. Efficiency is less important. Peak shaving is possible with the energy buffers which during base load periods can be used for maximising energy exchange/reuse on hourly/daily (building) and weekly/monthly basis (cluster grid).

Economics of sustainable heat/cold generation
The Netherlands raise offset energy taxes on gas and electricity. These results in tax expenditures on gas per GJ generated heat by a boiler which are much higher than heat generated by an electrical heat pump as shown in *Figure 20*. So investment space is created for renewable heat and cold generation with heat pumps as applied in the Minewater 2.0 system. Also is taken into account the advantage of generated cold during heating which can be passively reused by the application of energy storage in the buildings or in the cluster network especially during mid-season. The energy costs will further decline by applying demand and supply side management as intended with Minewater 3.0.

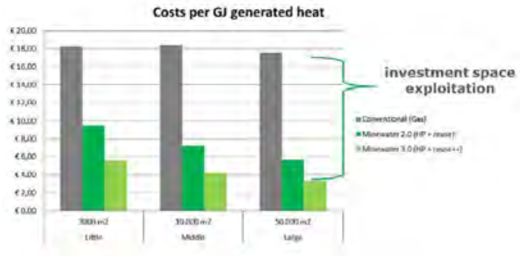

Figure 20 – Energy costs per GJ generated heat (all-in) for several building sizes

Zero-energy greenhouse in Heerlen
A typical example of “Sustaining living” project is the planed zero-energy greenhouse at the Heerlen Open University Campus.

Figure 21 – Example Zero-Greenhouse base on Villa Flora Floriade Venlo The Netherlands 2012

A greenhouse of 10,000 m^2, in combination with a bio CHP and minewater provide sustainable heating, cooling and electricity to the buildings on the campus and greenhouse. This greenhouse can be utilised for various purposes, such as a ‘living lab’, the production of sustainable and healthy food, hydroponic cultivation, various health aspects, research into quality in the environ¬ment, etc. The greenhouse will function as a ‘hot spot’ for students on campus, but also for Heerlen’s inhabitant. Although the city already plays a prominent role in the development of new energy by giving substantial financial contributions to sustainable projects, the innovative zero-energy greenhouse will also offer development chances for entrepreneurs and centers of expertise and employment opportunities for the local and regional population.

4. CONCLUSIONS

The Minewater project in Heerlen is upgraded from a straightforward energy delivery system into a smart grid for heating and cooling with a full scale hybrid sustainable energy structure called Minewater 2.0. In 2016 in total 800,000 m2 floor area will be provided with minewater, giving a CO_2 emission reduction of 65% on heating and cooling for these connections. The Minewater 2.0 project shows smart and cost effective solutions. No rocket science but creative thinking and new use of available technique. Minewater BV will trigger a genuine energy transition. New connections are being realised at this very moment and we are constantly looking for innovative solutions and improvements to the system. In this challenge local educational and research institutions in the Parkstad Limburg region are being involved. Cluster grids are a profound solution to provide energy exchange between buildings. By multiple sustainable power generation the thermal capacity and efficiency of the minewater grid and cluster grids can be strongly increased. Further technical development will be necessary to develop fine tuning in cost effective design and operation of the smart energy grid.

The Minewater Corporation that developed Minewater 2.0 proves that heat pump operation with low-ex heat sources can be commercial feasible. Because it is economic feasibility the Minewater 2.0 system can and will become an essential part of the Sustainable Energy Structure Plan of Heerlen which reaches out towards 2040 (carbon neutral city).
Minewater 3.0 will continue to focus on deploying alternatives for the generation of the required sustainable heating and cooling and the recovery of latent heat and cold (raise of exergy) based on strong and clear sustainable principles.

The minewater source is a distinctive and unifying feature for the Parkstad region in regard to the rest of the Netherlands. Nevertheless the Minewater 3.0 design is universal and a blue-print for smart hybrid sustainable energy infrastructures. It has the potential to be exploited in many urban areas (not only mining areas) in Europe and the rest of the world.

Due to the high temperatures in deeper layers the mines provide a suitable and efficient thermal storage feature for an urban grid. The know-how for exploiting this storage is applicable in all former (water filled) mining areas over the world.

The planned zero-energy greenhouse of 10,000 m^2 at Heerlen's Open University Campus is an outstanding example of "Sustainable living".

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NORWAY

AUTHOR

Professor Thomas Berker, PhD
Department of Interdisciplinary Studies of Culture, Norwegian University of Science and Technology 7491 Trondheim
E: thomas.berker@ntnu.no

1 OVERVIEW OF THE REGION

Trondheim municipality, located some 400 kilometers north of the capital Oslo, covers an area of 342 km^2 with a population of 180,000. It is the third largest of 428 Norwegian municipalities that are grouped into 19 administrative regions called counties. Trondheim municipality contributes roughly two thirds to the population to the surrounding county, Sør-Trøndelag. In terms of area and population the municipality corresponds roughly to the city of Trondheim.

The GDP of Sør-Trøndelag county was estimated to be €42,000 per capita in 2011, which was just below the average in Norway. The county produces 4.3% of the national GDP which is far below the off-shore industry (24.4 %) and somewhat below the capital region (Oslo: 16.1 %) and regions with a high concentration of oil industry (Rogaland and Hordaland that contributed 7.7 % each, (SSB 2013).

Total stationary household energy consumption in Trondheim municipality in 2009 was 1.3 TWh, which corresponded to 7.8 MWh per inhabitant and was just below the average in Norway (9.4 MWh, source SSB 2011a). Energy consumption in Trondheim municipality by fuel type (Gwh, 2009, source SSB 2011b)

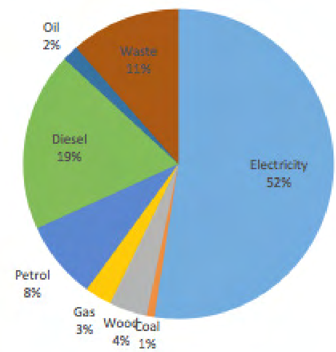

Figure 1 – Energy consumption in Trondheim municipality by fuel type (Gwh, 2009, source SSB 2011b)

Total energy consumption in the municipality is roughly divided equally between the service sector, households, industry and transport.

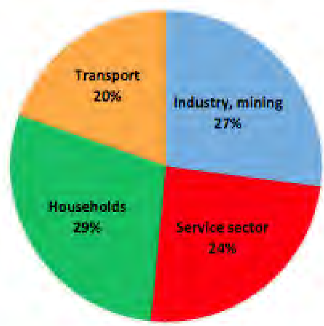

Figure 2 – Energy consumption in Trondheim municipality by sector (GWh, 2009, source SSB 2011b)

More than half of the total energy consumed in the municipality comes from electricity. The GHG emission factor for electricity from grid is in theory zero since Norway covers its electricity demand almost completely by domestic hydropower. Since Norway is part of the common Nordic electricity market (NorPool), the actual factor varies according to the degree of cross-border trading. For instance, a total factor of 0.033 kg CO_2eq/kWh (2010) was estimated for October 2010 based on data from the Norwegian Water Resources and Energy Directorate (Klimakalkulatoren 2010).

The total emissions from Norwegian territory was 52.7 million tons CO_2 equivalent emissions in 2012. Approximately one quarter of this is related to oil and gas production (which corresponds to the offshore contribution to the GDP). A further 19% is caused by road traffic (SSB 2014).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

In 2012, a common market for electricity certificates between Norway and Sweden was established. In this program, both countries have committed to finance 13.2 TWh renewable electricity, no matter where there are produced. Power producers receive one certificate for every MWh of renewable electricity generated.

A market is created through the fact that energy suppliers are required by law to buy certificates that correspond to the amount of electricity they sell. This scheme which is meant to encourage local renewable energy production on the Norwegian side has led to concerns that an oversupply of (not only) renewable energy may lead to low prices. This is usually countered by the general argument for energy efficiency in Norway which is to use as much as possible of the zero emission electricity produced by hydro power plants (and other additional renewable sources such as wind) to substitute other emission intensive activities.

A typical example for this strategy is the efforts to electrify the offshore industry through offshore wind farms (Øyslebø and Korpås 2011). On the smaller scale of a municipality, an example from Trondheim is a project with the aim to electrify the municipality's car pool. Electric cars in general are subsidised rather heavily in Norway through generous tax breaks, no annual registration fees, free parking at municipal parking spaces, and no road charges (that are quite common).

This made the most popular EV, the Nissan Leaf, the most sold new car in January 2014 (5.7% of 11,385 newly registered cars).

Another example for the substitution strategy is the planning process for the Brøset area with its "holistic" focus on emissions connected to the whole of everyday life is another example (case study as described below).

There are no official quantitative targets for energy or emissions reduction set for the region. However, the so-called Lian declaration (2007) commits the centre-left coalition government of the municipality "to be one of the drivers for GHG reduction and sustainable development" and to strive for "a better political control of the urban development" which includes the "municipal ownership of the development areas".

Norway has adopted a policy of incrementally increasing energy performance demands in the built environment. According to a government white paper from 2012, the next revision (to be implemented in 2015) will include requirements that correspond to "passive house levels". Even though the exact definition of "passive house levels" is discussed controversially (Müller and Berker 2012) this would be a considerable step forward from the current minimal requirements that allow for mutual compensation for instance between maximum window area of 20% of the heated floor area and a U-value of 1.2 W/m^2K. That means that the window area can be increased if the U-value is adapted correspondingly. Moreover, the mandatory use of district heating (based mainly on waste incineration) for newly developed housing areas is currently under discussion.

Trondheim's population is growing rapidly, as is the case with all urban regions in Norway. This growth has led to a pressure to develop new housing areas. Besides this population growth, regional drivers for energy and emission reduction specific to the municipality and the surrounding Sør-Trøndelag county are intermittent energy "shortages" that produce higher electricity prices for short periods of time. In the past these were caused by low precipitation in conjunction with some energy production facilities (e.g. Swedish nuclear power plants) being temporarily off-line. In addition, Trondheim municipality hosts Norway's only technical university and Scandinavia's largest private research institution (Sintef). This gives the region abundant access to engineering expertise.

3. CASE STUDY: THE BRØSET NEIGHBOURHOOD

The case study presented here is an example for an ambitious partnership between the municipality, the state housing bank of Norway and the local university and research institutions harnessing local drivers for the development of a new neighbourhood in Trondheim. The Brøset area is one of the few areas for significant new housing development (regulated for some 4000 inhabitants) that is relatively close to the city centre (ca. four km distance). The area which covers 35ha is owned partially by Statsbygg (the Norwegian Public Construction and Property Management Organisation) and South Trøndelag county. The area is now used for agriculture and a psychiatric clinic but it has been regulated for development as housing for many years already.

Objectives and methods

The main goal of the Brøset development is the reduction of per capita GHG emissions to approximately one third of 2012 levels. Given the pressure to develop new housing in all Norwegian urban areas the Brøset case is also a pilot for sustainable planning and construction in Norway in general. This role is formalised in Brøset's central role in the Norwegian "Cities of the future" network that is funded by the Norwegian government.

An overarching focus of the research this case study is part of ("Towards carbon neutral settlements" funded by the Research Council of Norway within the Renergi program) was to study and change current planning and design processes in order to enable more ambitious environmental goals. This is based on the observation that high environmental ambitions that break with standard expectations for urban development tend to be sidelined during standard planning processes.
The case study employed methods such as research interviews with both experts and future users of the area, energy and waste, mobility and architectural modeling in order to identify specific potentials and solutions for the area. The work was organised in an interdisciplinary way involving architects, engineers and social scientists. The active involvement of the researchers in the municipality's work and of the municipality's representatives in research meetings added an action research dimension to the project. Observations gathered in this very time consuming aspect – one researcher participated in virtually all relevant meetings at the municipality - are published by Gansmo (2012).

The case study started by exploring and subsequently defining environmental objectives in a holistic but at the same time also evidence-based way. The master plan from 2013 defines them as follows:

1. environmental consequences should have to be explored and documented systematically and continually during planning, construction and operation;
2. energy consumption in the building stock should be at least CO_2 neutral in order to compensate for other sources of GHG emissions (transport etc.);
3. buildings and infrastructure should be organised so that energy consumption is minimised;
4. passive energy design should be used. Use of sun radiation and protection against wind is to be optimised;
5. a LCA focusing on GHG emissions is to be conducted; Waste has to be measured and priced for every household; an extended participation process during the whole development has to be sustained.

In 2011 an open and parallel planning competition' was held. Diverging from traditional practice, four teams, together with researchers, produced four alternative visions of the areas future shape and functions. These visions then were broadly discussed by the local public (for presentations of the results see: http://www.skyscrapercity.com/showthread.php?p=73964009).

After this competition was held a master plan was developed and an additional research project in 2012 helped to establish an experimental pavilion which is surrounded by areas used for urban agriculture. In this project the results of the planning competition were presented on-site and group discussions were conducted with prospective users of the area in order to explore a wide array of possible green lifestyles.

Results and outcomes

Especially the "open and parallel" planning competition that focused on knowledge transfer between academia, municipality and competition participants – instead of competition – marks a clear deviation from the business-as-usual approach to municipal planning. It is reasonable to assume that the main outcome of the processes surrounding the Brøset development so far is learning among the participants about alternative planning strategies for the realisation of high environmental goals. The whole process was supported strongly by active individuals at all levels within the municipality both in administrative and the political branches. Without this engagement that went far beyond business-as-usual involvement the ambitious Brøset development would not have come as far as it has today.

Despite this progress, the researchers also encountered a series of challenges. In the course of the four years that the researchers accompanied the process within the municipality there was considerable exchange of participants. At one point the supportive leader of the relevant authority within the municipality left for another job and the individuals that are in charge of the process now (in 2014) belong to a completely different department. When individuals leave the project, when new individuals are added, and when a project shifts between departments within the organisation, knowledge gained may spread to new projects, and new participants may add new insights. However, these fluctuations may also endanger continuity within the development process, which is particularly dangerous when the standard way of doing things is left in favour of the exploration of innovative ways. In this situation the involvement of the researchers is a valuable asset – even though the individuals within this group shift as well according to academic rhythms (e.g. PhD and postdoc cycles and funding periods).

Another challenge that emerged during the process was the shared ownership of the area. The political process to get all owners in line with the municipality took a long time and is not completed at the time of this writing (February 2014). For instance, for a long time the owners signaled that they would not accept loosing money because of high environmental goals of the development. This shows that administrative and political support at the level of the municipality is important but not sufficient. In this case the concerted action of a national actor, the land owner Statsbygg, a regional entity, the other land owner Sør-Trøndelag county and the local municpality would have significantly improved the chances to translate regional planning with high environmental ambitions into an actual low carbon neighborhood.

4. CONCLUSIONS

The Brøset case covers the early planning of a low carbon neighbourhood. The commitment to alternative planning processes has created a promising starting point but faces an uncertain future. Whether conventional implementation processes will be used or innovative alternatives will be sought is open and this will impact on the future of the neighbourhood. Brøset may very well end up as another example where widely published ambitions leave hardly any mark on the resulting neighbourhood. However, the process thus far has kept the door open for these ambitious alternatives and this is probably as much as can be expected from a planning process for a low carbon neighbourhood. In this sense the experiences made should be transferable to other municpalities in Norway and beyond. A continuation of the close collaboration between municipality and researchers in a research context with broad public engagement would encourage a positive development.

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POLAND

AUTHORS

Adam Rybka
Faculty of Civil and Environmental Engineering
Rzeszow
University of Technology
E: akbyr@prz.edu.pl

Jan Gorski
Faculty of Energy and Fuels
AGH University of Science and Technology
E: jgorski@agh.edu.pl

Anna Pomykała
Faculty of Civil and Environmental
Engineering,
Rzeszow, University of Technology
E: pomykalcia@gmail.com

Magda Sęp
Faculty of Civil and Environmental
Engineering,
Rzeszow, University of Technology
E: msep@prz.edu.pl

1 OVERVIEW OF THE REGION

Characteristics of the Region

Podkarpackie Province is situated the south-east Poland. There are (as of 2012) 2,128,687 inhabitants living in Podkarpackie which is 5.5% of the whole population in the country. There are 117 people per 1 km^2 and the Province is seventh in the country as far as the population density is concerned.

The geographical area of the region is 17 844 km^2. The capital is Rzeszow (183 133 inhabitants).[1] Podkarpackie is subdivided into 21 *poviats*.

Figure 1 - Administrative division of Poland

Governance: The Subcarpathian Regional Assembly is the regional legislature of the Province of Podkarpackie. It is a unicameral body consisting of thirty-three councillors elected in free elections for a 4-year term. Members of the Assembly are elected from five districts, and serve four-year terms. Districts do not have the constituencies' formal names. Instead, each constituency has a number and territorial description. The institution is Podkarpacki Voivode (Podkarpacki Province), appointed by the Prime Minister. In the office there are also three delegations: in Krosno, Przemyśl, Tarnobrzeg.

Energy policies are in large part determined by in national bodies, with the local governments implementing them.

Industry in the Podkarpackie Region is characterised by aircraft industry, heavy industry, mining, bus vehicle production and other production sectors. As more than 52% of Podkarpackie Region is covered by forests and 40% are agricultural land, wood processing industry and energy producing industries are important.

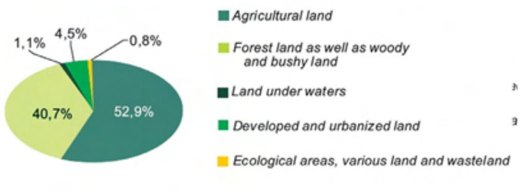

Figure 2 – Structure of the voivodship/provincial area in 2013 (geodestic status as of 1 January)[2]

The average GDP per capita in 2012 for Podkarpackie Region was €5,952.[3] In 2011 the employment rate was registered at 57%.[4] The issue of fuel poverty is difficult to estimate in Podkarpackie Region, but the five partner countries of the EPEE project have come up with this definition: "Fuel poverty as a household's difficulty, sometimes even inability, to adequately heat its dwelling at a fair, income indexed price."[5] According to KAPE fuel poverty in Subcarpathian region is high and is estimated close to 21.6%,comparing to the whole country – 17% (2011 year)[6]

Energy demand and supply of the Region
In Poland the primary energy consumption in 2012 achieved 1102407.7 GWh. Share of renewable energy in gross final energy consumption in 2011 was 10.4%.[7]

Energy self-sufficiency of Podkarpackie Region in fuel and energy can be defined as the ratio of obtaining to total consumption of primary energy. The share of renewable energy in 2007 was 2%. During the next three years this is expected to quadruple.

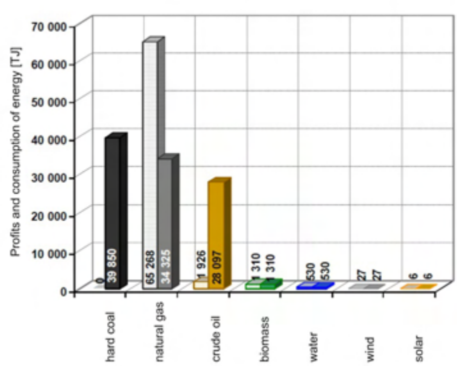

Figure 3 – Energy profits and consumption of energy in Podkarpackie Region 2007[8]

There are no data available for Podkarpackie Region about the total energy consumption (TEC) by sectors, however, the development in Podkarpackie Region may be comparable to the average TEC of the nation.

The level of final energy consumption in Poland tended to increase in years 2000 – 2010. The major change in sectoral structure consisted in shift from industry to transport. The share of industry fell from 32% (2000) to 23% (2010). During this period share of transport increased from 17% to 26%. The agriculture sector recorded a decline and service sector growth of the share. Households remained the biggest consumer with market share of 32%. These changes reflect the development trends of the economy with the increased trade with foreign countries. This resulted in higher energy consumption in transport, and the activities undertaken in the industrial sector (growth of efficiency associated with rising energy prices) and the results of actions taken by public authorities (e.g. pro-efficiency programs targeted to households).

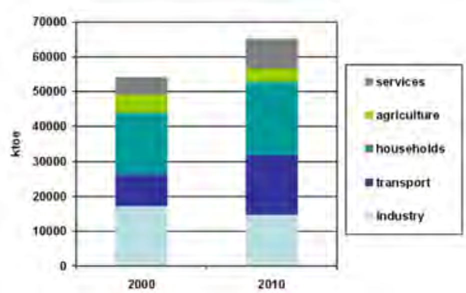

Figure 4 – Total energy consumption by sectors in Poland[9]

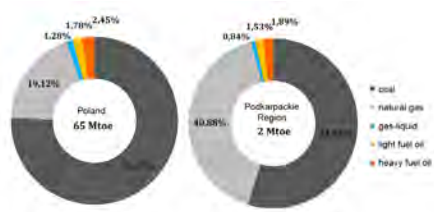

Figure 5 – Total energy consumption (TEC) by fuel in Poland/Podkarpackie Region 2010[10]

Share of energy sources for electricity production (%)

Poland is fortunate to possess strong potential renewable energy resources. According to the European Environmental Agency, Poland holds over 3600 TWh (terawatt hours) of commercially exploitable wind power. Poland ranks only behind France, Germany and Spain in biogas potential produced through landfills, sewage, and agricultural residues. Poland's ample farms and forests offer more unutilised biomass potential than any other EU country. However, currently 57% of electricity in Poland is produced from bituminous coal and 32% from brown coal. Wind and other renewables represent 7% of electricity and 3% of total energy production.

Electricity demand in Poland is steadily rising, and renewables represent the fastest growing source of electrical power. In 2004, wind accounted for just 0.1% of Polish energy production. By 2010, wind power reached the 1% threshold. *Figure 6* illustrates the significant growth of renewable energy in Poland. Wind energy production is decreasing because developers face an array of hurdles that is hindering exploitation of Poland's wind resources lack of zoning plans, costly ornithological research, existence of secret low altitude military flight routes, payback period is uncertain.[11]

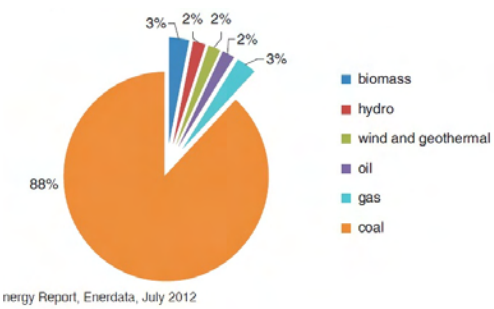

Figure 6 – Structure of electricity in Poland in 2012

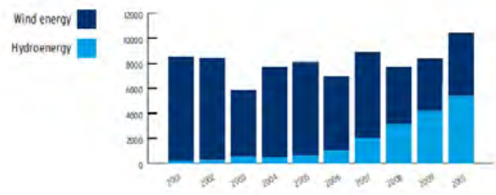

Figure 7 – Growth of electricity production from renewable sources in Poland I years 2001 – 2010[12]

Electricity production in Podkarpackie Region can be grouped depending on the generation as illustrated in *Table 1*.

Production GWh (2010)	Poland	Podkarpackie Region
Total Production	157657,6	2662,3
Conventional power station - commercial	152065,0	2541,0
Conventional power station - industrial	7524,0	19,0
Hydropower and renewable energy	10888,8	315,7

Table 1 – Production of electricity by type of power plant in Podkarpackie Region in 2010

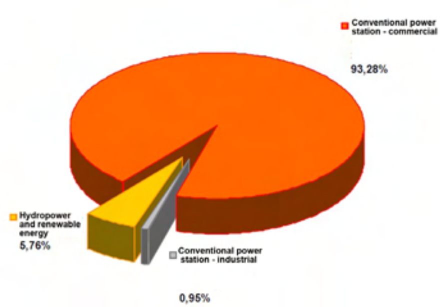

Figure 8 – Energy sources for electricity production Podkarpackie Region 2010[13]

GHG emission factor

Poland emitted 304.7 million tonnes of CO_2 in 2007. The most emissive power sector was coal, which was responsible for the emission of 212.4 million tonnes of CO_2, mainly the burning of oil in transport contributed to the issue of 62.7 million tonnes of CO_2, and natural gas 27.1 million tonnes of CO_2.

In the Podkarpackie Region issued 3567.7 thousand. tonnes of CO_2 (1.6% of national emissions).

Produce of one kWh in Poland obtained at 668 grams of CO_2 emissions. High coefficient of emissivity is a result of structure of the raw materials used in Poland to produce electricity, which is obtained mainly as a result of burning coal with a high index of carbonisation.

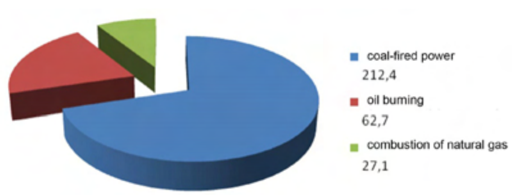

Figure 9 – GHG emissions by sectors in Poland (2007)[14]

In the Podkarpackie Region there are 82 industrial plants, particularly burdensome for clean air (at 31st December 2007). At the end of 2006, there were 88 plants, which indicates a decreasing number of this type. 64 plants have facilities to reduce pollution dust, 23 have a devices to reduce pollution gas, which means that some plants have both types of devices. According to data from 31st December 2007, emissions stand at 2.7 thousand tons. This fact confirms the significant improvement, as the level of emissions in 2006 amounted to 3.2 thousand tons and 4.3 thousand tons in 2005.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

GHG reduction targets (% and years)

EU assumed that by the year 2020 the share of energy from renewable sources in gross final energy consumption will increase to 20% (for Poland it is 15%).

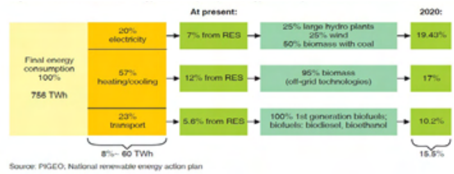

Figure 10 – Share of renewable energy sources (RES) in energy consumption in 2010 and forecast for 2020

Consumption of energy from renewable sources in transport will achieve 10%. GHG reduction targets (% and years) for the EU overall target is a 20% renewable for Energy consumption until 2020 (EU "20-20-20 target").

Primary energy intensity in Poland fell very rapidly: dropped by 4.2 %/year between 1990 – 2009. That improvement mainly took place between 1990 – 2000 of -4.7%/year.

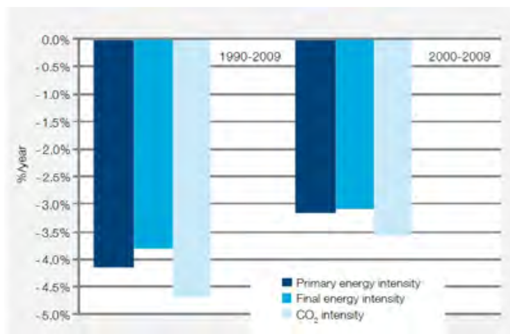

Figure 11 – Energy and CO_2 intensity trends in Poland[15]

Poland was, is and will be in the foreseeable future based on coal. The share of coal consumption in fuel consumption for Poland was 75.4% in 2010, and 55% for the Podkarpackie Region. The importance of coal for the Polish economy, of course, stems from having huge deposits of coal. Therefore, Poland is a country with a relatively safe source of energy supply compared to other EU countries. However, the high share of coal in the economy is associated with high CO_2 emissions.[16]

Podkarpackie Region participates at many EU structural funds such:

- operational Programme Development of Eastern Poland (OP DEP);[17]

- operational Programme 'Podkarpackie' a part of European Regional Development Fund (ERDF) (2007– 2013);[18]
- ENESCOM – Project financed by IEE program.[19]

The expected effects of EU supporting founds can be estimated on the level up to 20 – 30% decreasing the GHG emissions and energy consumption in Poland at the time horizon 2020.

The source of energy data in many cases is different from information gathering systems. This study was based on strategic documents of the region, "Characteristics of energy security in the perspective of the Sub-Carpathian Region for 2020 and 2030".

Regional targets related to renewable energy

Poland has to raise the share of renewables for gross energy consumption to 15% by 2020. In 2010, this share was calculated as being 9.5%. According to the conditions this level should be achieved by 2014. Several provinces have defined regional targets based on the national target.[20]

Taking into account the specificity of the region, the following actions are recommended by Podkarpacka Agencja Energetyczna, to improve the energy security of the region:

- carry out activities directed at diversifying sources of energy in a maximum use of their own fuel resources taking into account the possibility of obtaining energy from renewable sources;
- rationally and efficiently use natural gas reserves located in the Podkarpackie Region;
- create favorable conditions for the emergence of intelligent Smart Grid;
- develop infrastructure to generate energy from renewable sources;
- support the implementation of the comprehensive thermal modernisation of buildings located in our region, in order to increase their energy efficiency;
- adapt electricity system to collect energy from renewable sources;
- introduce an energy management system, in particular the implementation plans for heat, electricity and gas fuels including the renewable energy in each municipality of Podkarpackie Region;
- promote activities in the field of energy efficiency in buildings and promote energy-efficient and passive construction;[21]
- as an important example of impact on the regional approach a Facebook campaign called Krakow Smog Alert was thus launched, and quickly gained city-wide interest and support. Indeed, the overwhelming response in the first few weeks of the campaign created a sense of urgency and political space for local policy makers to seek real solutions for improved air quality in Krakow. It's official – councillors have banned the use of wood and coal in heating systems in Krakow and across Malopolska Region – one of the most polluted areas of Europe. The likely allocation of EU funds is set to bring about a breakthrough success for a popular and dearly needed campaign for better air quality in Krakow.[22] There are also bottom up voluntary schemes that have been implemented at a regional scale. A lot of recently initiatives are proposed by high schools in Podkarpackie Province, for example: Postgraduate studies "Renewable Energy Sources" at the Faculty of Mathematics and Natural Sciences, University of Rzeszow;[23]
- postgraduate studies" Audit and certification of energy performance of buildings" at Rzeszow University of Technology,
- full-time studies "Alternative energy sources and processing" and postgraduate studies "Thermo-modernisation and renewable energy sources" at the Faculty of Mechanical Engineering and Aeronautics, Rzeszow University of Technology.[24]

The actual offer of full-time studies in area of Renewable Energy Resources (OZE) in Poland consists over 30 high-schools in all regions and academic centers in Poland.[26] A lot of new clusters have been started in the Podkarpackie Region oriented towards the sustainable development and efficient energy use such presented two examples:

- subcarpathian Renewable Energy Cluster, [27]
- Malopolska – Podkarpacie Clean Energy Cluster (PKOE).[28]

Database of Renewable Energy will provide access to extensive and up-to-date information on conventional and, most importantly, innovative energy plants or installations in regions selected as study areas.

Achievement of regional targets
In 2011 the production of energy in the Podkarpackie Region was at 2.876.5 GWh. Production of energy produced from renewable sources was at 319.7 GWh, which accounted for 11.1% of the total volume produced in the Podkarpackie Region. This share was higher than the average share of energy produced from renewable energy sources in total production calculated for the whole country. Detailed data presented in the table below.

Type	Amount	Power (MW)
Producing from biomass	2	1.98
Run-of-the-river hydroelectric plant	13	10.51
Pumped-storage hydroelectric plant	1	168.60
Producing from biogas from sewage treatment plant	8	2.74
Wind power plant on land	24	61.99
Producing from biogas from landfill	3	1.65

Table 2 – The installed capacity of renewable energy sources in Podkarpackie Region (2012)[29]

Despite the enormous possibilities of using solar energy in Poland, it is a less than 1% in the production of electricity from renewable sources, but in obtaining thermal energy from solar energy is growing steadily, which in 2009 reached the level of 23.2 GWh water and wind energy in 2009: 8550 and 3878 [TJ]). In the Podkarpackie region many important initiatives are being developed green energy systems (in this new 3 large wind farms developed by “Subcarpatian Renewable Energy Cluster”):

- Martifer Renewables and the Ikea Group have today officially opened a 26-MW wind farm in Rymanów, in the Podkarpackie province, south-east Poland;
- The Project: “Installation of renewable energy systems on the public utility buildings and private houses in the Communes which are members of the Union of the Wisłoka River Basin Communes “ within the framework of the Swiss-Polish Cooperation Programme (supported by 465 mln CHF) includes purchase and installation of solar systems both for private and public beneficiaries and purchase and installation of photovoltaic systems for public buildings;[30]
- City of Rzeszów PRT Project – The project (total investment 55 Million USD) will reduce emissions from automobile traffic, one of the major sources of air pollution in the city. Further goals are the reduction of greenhouse gas emissions consistent with climate change mitigation as well as the costs associated with liquid fuels. The introduction of alternative, less-polluting means of transport that rely in part on renewable energy is a consistent step in Rzeszow’s sustainable development policy implementation. The intention is rapid development and introduction of innovative new technologies together with protection of already highly rated environmental amenities;[31]
- solar installation on the building of a Nursing Home in Rzeszow – 48 kW thermal power, (28 flat-plate collectors, and active area 67.5 square meters);
- the solar installation at the swimming pool in Glogow Mlp – 58 kW, (24 flat-plate collectors, 58 square meters);[32]
- new project – solar installation in the indoor swimming pool and outdoor swimming pools system in Mielec – 136 flat collectors, 265 m^2, 788 000 PLN (85% costs co-financing from the European Regional Development Fund);[33]
- installation of photovoltaic facade of administrative buildings Airport “Rzeszów-Jasionka,” along with the installation of a biomass boiler and upgrading the internal electric network.[34]

The Polish NEEAP states that during the last 20 years, Poland has made significant progress towards energy efficiency. Polish energy efficiency policy includes goals to maintain zero-energy economic growth and to consistently lower the energy consumption of the Polish economy to reach the level of EU-15.

Energy efficiency in the public sector Poland has implemented several measures related to energy efficiency in the public sector, among others, producing an open register of persons authorised to prepare energy performance certificates for buildings. The NEEAP further includes measures to decrease energy consumption in public utility facilities and states that the public sector will play an exemplary role in implementing and promoting nearly zero-energy buildings for public utility facilities.

Further initiatives include:

- Podkarpacka Energy Management Agency Ltd. (PAE) – it is an energy management agency. It is based in a region of agricultural character and has potential for RES and biofuel production. Areas of expertise: Its training courses help people in the region to develop small businesses in RES. It helps citizens to find a way to save energy in their houses by using solar technologies. It also has an information program for clients that want to produce ecologically clean energy;[35]
- Rzeszow Regional Development Agency (RARR SA) – The RARR SA Agency operates within national and European co-operation networks. It has obtained accreditation with the Polish Agency for the Development of Enterprise as far as training, information, consulting financial as well as pro-innovative services are concerned. It is a member of the National Service System for SME's (KSU) in Poland and the network of the Innovation Relay Centres in Europe;[36]
- SOLAR-BIN S.A. – Funded in 1990 the Company for Energy-saving Technology Promotion SOLAR-BIN S.A. Company's ambitious aim is activity on the regional market and promotion of modern, energy-saving and environment-saving technologies;[37]
- Podkarpacka Energy Management Agency (PAE) – The Regional Agency for renewable and efficient energy use. Podkarpacka Energy Agency implements now the project "Database of Renewable Energy Sources in Podkarpackie Region" under the Integrated Regional Operational Programme, Measure 2.6 Regional Innovation Strategies and Transfer of Knowledge. Database of Renewable Energy will provide access to an extensive and up-to-date information on conventional and, most importantly, unconventional energy plants or installations in regions selected as study areas;[38]
- Association Horizons - Association "Horizons" works in the area of promotion and implementation of innovation, in the scientists and economical societies for development of the Podkarpackie Region;
- Subcarpathian Renewable Energy Cluster (PKOE) – The PKEO aims at creating networks of cooperation between representatives of regional universities, business support institutions, administrative bodies and entrepreneurs from the renewable energy sector;
- the AGH Educational and Research Laboratory of Renewable Energy Sources and Energy Saving in Miekinia.

Important News: Cracow University of Science and Technology (AGH) received EU grants for two projects, including the largest in its history project - the construction of the Energy Centre. This will be the most modern and largest energy research center in Poland, its creation will cost nearly PLN 190 million, including over PLN 62 million from EU funds.

3. CASE STUDY: BIESZCZADY MOUNTAINS

Figure 10 – Coordinates for Bieszczady Mountains

Figure 11 – Location of the eco-region

This case study was selected to demonstrate how a bottom-up process, driven by a group of communities in South Podkarpacie Region, aimed to develop an eco-region – Local Action Group Green Bieszczady (Stowarzyszenie Lokalna Grupa Działania – "Zielone Bieszczady"). The eco-region programme, initiated in September 2008, was formed by an association of five communities: Czarna, Lutowiska, Olszanica, Solina, Ustrzyki Dolne and two organisations: Bieszczady Foundation and Bieszczady District in South Podkarpacie Region.

The region has a total population of 33,000 inhabitants and covers an area of 1417,02 km^2. The region is characterised by the dominance of agriculture, supplemented by a few food/ wood processing and handcraft enterprises and absence of any bigger industries of towns. The settlement pattern is scattered in villages with single family homes prevailing. The region is situated about 16 km from a major center Solina providing all kind of infrastructure. An important center, inside the region itself and to the Podkarpackie capital Rzeszow (101 km away). Traffic infrastructure in terms of public transport is rather poor, individual motorised mobility is common.

It was not Podkarpacie Region regulation, incentives or political framework that fostered or enabled the eco-region plan. The main driver of this initiative has been communities with interrelation ties and a people from Local Action Group, Green Bieszczady. Their basic motivation was to create an eco-region by an awareness of its people, responsibility and collective as well as individual action.

Objectives and methods

The goal of the eco-region goes beyond of what we understand as "Smart energy region". Eco-region Green Bieszczady is aiming at:

- fostering an eco-friendly circular flow economic model: sustainability and economic viability do not exclude each other;
- attaining renewable energy self-sufficiency;
- seeking eco methods to archive neutrality at local level;
- giving an example to other regions;
- dissemination and exchange of information on initiatives related to the activation of the population in rural areas;
- activation within the framework established support system, business processes related to international economic exchange among business organisations operating in the Podkarpackie Province;
- supporting local businesses operating in the Polish part of the Carpathian Euroregion, with engaging market producers of traditional, regional, local and organic produce and edible forest products;
- creating the conditions for the establishment and development of cooperation between entities in the area of the Project and the European partners, as well as the conditions for the transfer of experience gained by them in the area covered by the project.

The target here is not so much to reduce the emissions of CO_2 but to prevent further increases.. Eco-region has small percentage of industrialisation and the electricity is supplied only by hydroelectric plant. Local business is focused on creating natural and regional products.

Long term focus

The Solina Dam is the largest dam and hydroelectric plant in Poland. It is located in Solina Municipality. Its construction created the largest artificial lake in Poland - Lake Solina. It has four turbines which were initially capable of generating 136 MW of electricity. Two of the turbines can also reverse flow to store energy to optimise power generation. The installation of new technologies (hydraulic-mechanical-electrical control has been replaced by the electronic memory-programmable digital controller) and the replacement of the old turbines resulted in the dam currently generating 200 MW of electricity. The Solina Dam supplies electricity to all in Bieszczady Mountains area.

The Biosphere Reserve “Eastern Carpathians”, the only tripartite reserve by UNESCO in the world, distinguishes itself by a remarkable variety of natural and cultural treasures. Extensive areas of natural forest and one of the last refuges of wild Carpathian wildlife can be found there, including large predators. Features of the natural environment are combined with a wealth of culture and traditions. For centuries, the region was an area where different cultures, nations and ethnic groups come together: the Vlachs, Lemko, Poles and Slovaks. Today, it is unique landscape allows for the creation of a beautiful wooden architecture, secular and sacred, and agricultural and pastoral traditions. In this small, lost corner of Central and Eastern Europe nature and history of the Eastern Carpathians combines the three neighboring countries, forming the basis of their cooperation and integration as well as an opportunity to develop cross-border initiatives, such as the heritage trail “Green Bicycle – Greenway Eastern Carpathians”.

Among the local initiatives that are implemented in track of the “Green Bicycle - Greenway Eastern Carpathians” are original projects in the field of ecotourism development (creating conditions for the development of water tourism, cycling and horse riding in Bobrka and Lesko). An initiative to promote local crafts (play tradition of weaving in Glade, workshops, artistic ceramics and eco-museum the farm in Jankowce), regional events and fairs (agrotourism fair, Boykos festival) and other interesting initiatives. The construction of such a pathway associated with the need to establish cooperation and simultaneous participation for all municipalities Bieszczady, has allowed it to create a noticeable because of the tourist product, which may be an international tourist attraction. The Bieszczady Mountain region is interested in establishing cooperation with similar regions in Switzerland.

The concept of the Eco-region is the development of a process towards defined medium-term goals (emission reduction target and CO_2 neutrality). Besides these quantifiable objectives, the region – walking the process path - aims at exploring a more general and complex challenge: an eco-friendly circular flow economic model, unifying sustainability and economic viability.

There are no accurate studies which illustrate emission of CO_2 in the Bieszczady Mountains region. Electricity in the region comes from renewable energy source (hydropower plant). Householders and local businessmen are interested in saving money, water and energy using renewable energy sources (solar panels).

Results

- development of bicycle and foot path (financed by Podkarpackie and EU founds)
- promotion of non-motorised forms of transport and environmentally friendly forms of tourism
- use of local resources (natural, cultural, accommodation and food service and local products)
- providing information and opportunities to better understand the eco-region, its challenges, local initiatives, activities, organisations, etc.
- preserve the landscape and contribute to the protection of natural and cultural heritage
- common projects with retailers: climate friendly shopping
- entire eco-region supplied with 100% CO_2 neutral electricity without additional costs
- construction or energetic improvement of small renewable energy power plants (bioenergy), where technically and economically appropriate.

Outcomes

It can be observed that nearly all central problems related to greenhouse gases emission and core areas of activity in the eco-region correspond to the key aspects that were also identified at the level of the region of Podkarpacie. Nevertheless, the focuses set reflect the particular local situation in the eco-region. This fact shows that, on the one hand, the eco-region is aware of the interdependency and complexity of emission problems; on the other hand it show that activity is concentrated on topics that are within the eco-region's scope of action.

On the contrary, a strong focus in this region rich in agricultural surfaces and population is set on agriculture. A definite advantage is the existing "sense of togetherness" and identification in the population of the eco-region. The marketing of the eco-region and its approach outwardly is done quite successfully and additional funding at provincial, national and EU level has been acquired. One of the key aspects of success is the strong involvement of local enterprises. Nearly all firms and tourism enterprises are members of the eco-region – Local Action Group Green Bieszczady. Many of them are active members in terms of active project partner. At the same time, they also take their benefit from the eco-region, as new business ideas and niche products, may be supported and the regional consumption idea as such is promoted.

4. CONCLUSIONS

This case study demonstrates changes that can be made in a coordinated way (on the short term, medium term and long-term) to combat climate change and GHG emissions at small regional level. As in Podkarpackie, there are several regions where communities in vicinity similar characteristics are working together, there is a potential to enlarge the concept to other areas. As the Eco-region Green Bieszczady is working in a specific setting that is characterised by intense human interaction in a relatively small area, any enlargement to the whole of Podkarpackie seems unrealistic. The Eco-region Bieszczady is seeking for exchange on similar approaches and is willing to give an example to other regions.

The eco-region Zielone Bieszczady (Green Bieszczady) is looking to exchange knowledge with other regions. They are partners in ongoing projects called Alpine-Carpathian Cooperation Bridge (their aim is to promote local entrepreneurs, traditional and ecological products) and Solution (their aim is to further develop approaches of regional energy autonomy on the long term).

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PORTUGAL

AUTHORS

Cecilia Rocha
FEUP-Citta
E: carocha@fe.up.pt

Helena Corvacho
FEUP-CEC
E: corvacho@fe.up.pt

Fernando Alves
FEUP-Citta
E: alves@fe.up.pt

Rua Dr. Roberto Frias
s/n, 4200-465 Porto, Portugal

1. OVERVIEW OF THE REGION

According to the last Census results the North Region of Portugal has a population of 3,689,682 inhabitants and covers an area of 21,286 km^2 (density of 173 inhabitants per km^2). The North Region is one of the five regions of Mainland Portugal, according to the NUTS II subdivision and includes the 8 NUTS III sub-regions shown in *Figure 1*. It is bordered in the North and East by Spain, in the South by the Central Region and in the West by the Atlantic Ocean.

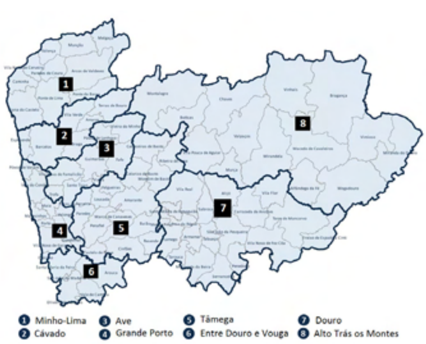


Figure 1 – North Region – NUTS III

For each of the five administrative regions of Mainland Portugal, there is a Regional Coordination and Development Commission, which is a decentralised body of the central government not an authority in itself since, besides municipalities, there is no other intermediate level authority in Portugal. The North Regional Coordination and Development Commission (CCDR-n) is a decentralised body of the central government established in the North. Its mission is to promote the conditions to develop integration and sustainability of Portuguese North Region (NUT II), thereby contributing to the national cohesion and competitiveness.

CCDR-n, is a body that has administrative and financial autonomy, is tasked with coordinating and promoting governmental policies with regard to Regional Planning and Development, Environment, Spatial Planning, Inter-Regional and Cross-Border Co-operation and also supports Local Government and Inter-Municipal Associations. Its fields of intervention also concerns the management of regional operational programmes financed by European Union (EU) funds, as well as other regional development finance instruments, including structural funds.

The GDP of the North Region, in 2010, represented 28 % of the Portuguese GDP, with €48,542 million, corresponding to €13,000 per capita (*Figure 2*).

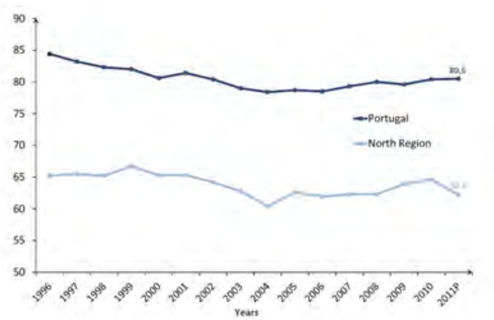


Figure 2 – Evolution of GDP per inhabitant in PPP (EU27 = 100 index) (CCDR-n, 2013)

In the sector of agriculture, the region has a leading position in milk and wine production. Port wine, produced in the region, is the main national agricultural export.

In industrial sector, the traditional branches of textiles, footwear and other leather products, wood and furniture and cork are concentrated in North region. Food industry has also a significant expression in North Region, representing around 30% of the national total. With respect to the employment, a scenario of economic crisis is revealed with quickly growing unemployment rates across all Portuguese regions.

	1stQ-2012	2ndQ-2013	3rdQ-2013
Portugal	**14.9**	**16.4**	**15.6**
North	15.1	17.2	16.6
Centre	11.8	11.5	11.2
Lisbon	16.5	19.3	17.9
Alentejo	15.4	17.2	16.1
Algarve	20.0	16.9	13.8
Azores	13.9	16.1	17.7
Madeira	16.1	18.8	17.3

Table 1 – Unemployment rate (%) by region for NUTS II (INE, 2013)

However, as *Table 1* reveals, for the North Region, in the second and third quarters of 2013, the unemployment rate is slightly decreasing and was about 17.2% and 16.6%, respectively.

Regarding the employment rate, for Portugal and as it can be observed in *Figure 3*, it has decreased below 50% but, over the last three quarters, has shown a small recovery to 51%. Concerning the North region, the trends are the same, reaching a minimum in the 1st quarter (49.5%) and recovering to an employment rate of 50.4%, being 56.2% for men and 45.1% for women, since the 2nd semester of 2013.

Figure 3 – Employment rate (%) for Portugal, by trimester, since 2011 (INE, 2013)

Energy demand and supply of the Region
The data for total final energy consumption by activity sector and by energy source are not available for the regions but only for the whole country, although they can be expected to be very similar in terms of percentage distribution. In *Figure 4*, it is possible to see a consistent trend, since 2005, regarding a decrease in energy consumption for all sectors of activity.

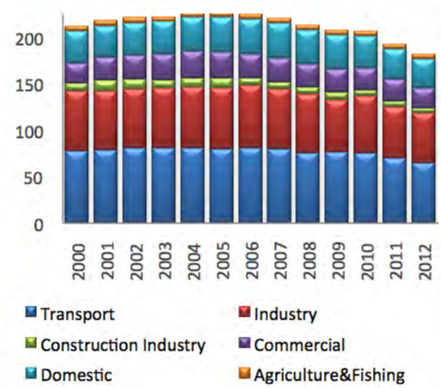


Figure 4 – Total final energy consumption for Portugal, by activity sector, for 2000 – 2011, in thousands of GWh, from(DGEG, 2013)

The final energy consumption in Portugal was 181,293 GWh in 2012, 15.1% less compared to 2008. It is emphasised that the decrease observed in 2011 (-6.8%) and 2012 (-5.6%) were the most significant in the period, corresponding to the beginning of the economic crisis.

Regarding the structure of final energy consumption by sector, it remained unchanged between 2008 and 2012, and the sectors of transport (35.5%), industry (29.6%) and residential (17.0%), showed the highest final energy consumption.

With the negative evolution of the national economy, from 2011 all sectors of activity showed a decrease in final energy consumption. It is stressed the negative variation in 2011, compared to 2010, of industry sector (-11.4%) and of transport sector (-6.8%), as well as the one observed in 2012, compared to 2011, in construction (-21.3%) and transport (-8.6%) sectors (INE, 2013).

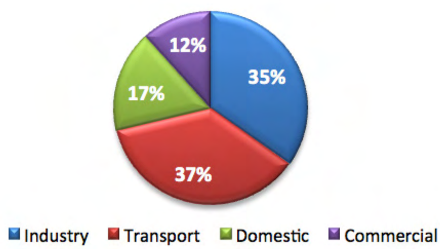


Figure 5 – Total final energy consumption, by activity sector, for 2011 (DGEG, 2013)

For the year 2011, *Figure 5* shows with more detail the partition of the total energy consumption (191,954 GWh) amongst the most relevant activity sectors, where it is observed that transport and industry are the most demanding sectors.

Regarding the total final energy consumption, by energy source, it is obvious when observing *Figure 6*, that oil is still the prevailing source of energy followed, at great distance, by electricity.

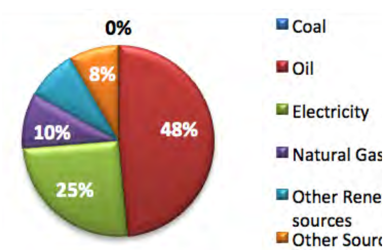


Figure 6 – Total final energy consumption by energy source, in 2011 (DGEG, 2013)

The total electricity consumption in the North Region of Portugal, in 2011, was about 15,226 GWh, distributed by the different sectors as shown in *Table 2*.

Sector	GWh	
Residential buildings	4,834	32%
Non-residential buildings	3,491	23%
Industry	5,377	35%
Agriculture	145	1%
Streets lighting	566	4%
Indoor lighting of State Buildings	775	5%
Others	38	0%

Table 2 – Total consumption of electricity in the North Region, in 2011 (INE, 2011)

For the nominal indoor conditions considered by the Portuguese Energy Performance Certification Scheme and for a reference scenario considering an energy tariff of €0.10/kWh, the fuel poverty rate for mainland Portugal was estimated to be of 92% (Magalhães & Leal, 2012).

This very high level of fuel poverty is related to the high current prices of energy, to a low energy efficiency of the housing stock and to a low income of the households. However the realism of the nominal indoor conditions is questionable and there is a significant variation of the energy bill depending on the tariff scenario.

For the electricity production and the share of energy sources, management is undertaken at a national level and so there are no specific figures available for the North Region (*Figure 7*). However, in the case of wind and hydraulic sources, it was possible to derive those values from the information available. In 2012, the north of Portugal accounted for 34.6% of the total electricity produced, with 21% from large dams and about 14% to wind power.

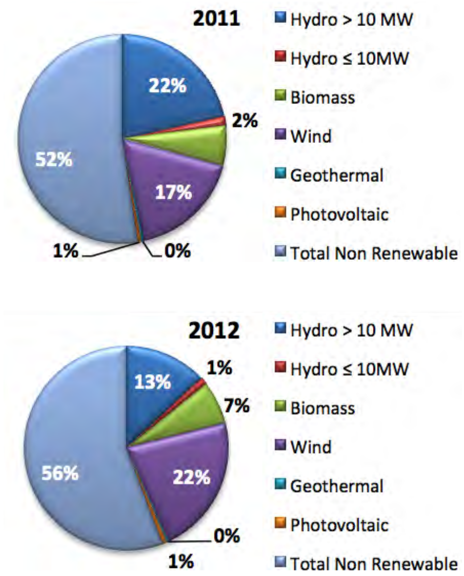


Figure 7 – Share of energy sources for national electricity production (2011 and 2012) (DGEG, 2013)

With respect to the total GHG emissions, according to the Portuguese Environmental Statistics released in 2013, the total for 2011 was 68,452 ktCO2eq, from all sectors combined or 63,132 ktCO_2eq if was also considered the influence of LULUCF (Land Use, Land Use Change and Forestry) (INE, 2013). Based on the last Portuguese National Inventory Report on Greenhouse Gases, 1990 – 2011 (APA, et al., 2013) and considering emissions data of 2009, the Northern Region contributes with 24% of total GHG emissions of the country. In terms of GHG emissions per area, the North is above the national average, with 808 against 773 tCO_2eq/km^2, although, regarding emissions per capita the situation is the opposite with 4.7 against 6.7 tCO_2eq per capita.

The *GHG emissions factor* for electricity from the grid, produced exclusively in Portugal, was at approximately, 0.375 kCO_2eq/kWh for 2009, obtained from the data collected by DGEG (Directorate General for Energy and Geology) (APA, 2011). It is intended that the GHG emission factor for the reference scenario, in 2020, decrease to 0.132 kCO_2eq/kWh (ADEPorto & CMPorto, 2013).

Considering energy related technology, in August 2013, Portugal had 10,887 MW of installed capacity for electricity production from renewable sources (RES). The share of RES in gross consumption of electricity for the purposes of the Directive was 45.6% in 2012, considering only the Continent. In 2012, Portugal was fourth in the European Union (EU15) for generating renewable energy (DGEG, 2013).

A priority for national investment includes the construction of seven out of the ten new hydropower plants in the country to be built in the North. This corresponds to an increase of more than 50% of the current potential.

Wind power has been an important national strategic focus over the past decade particularly in the North Region, having gone through a strong growth in the region. This has included various sectors of industrial activity contributing to the “wind cluster” and constituting a field of continuous technological innovation, given the purpose of energy optimisation.

The encouragement of the energy production from biomass, in line with the National Strategy for Energy - “ENE 2020” and with the National Strategy for Forests, should also be mentioned as it represents about 7% of the electricity produced.

Regarding wave energy generation, there are technological developments on the way, and it can be expected that it can become an option in the near future. In the North Region, two priority areas for potential installation of wave energy parks were identified(CCDR-n, 2011).

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Promoting a more sustainable environment and, in particular, the containment of the growth in greenhouse gas (GHG) emissions, is one of the priority areas for action defined by the United Nations and the European Commission.

For the Northern Region and with regard to Environment, Energy and Sustainability the main concerns include promoting a low carbon economy, reducing the specific energy consumption through energy efficiency, increasing the share of renewable energy, improving air and water quality, the treatment of municipal solid waste and the preservation of biodiversity. The region takes an important role in the national context, particularly in the domain of renewable energy, presenting a high potential, mainly in hydropower and wind power, and in addition, biomass, solar radiation and wave energy.

Concerning the existence of targets for energy demand and supply, those are set at national level and involve the National Strategy for Energy 2020 (ENE2020), National Action Plan for Energy Efficiency (PNAEE2016), the National Action Plan for Renewable Energy Sources (PNAER2020) and the National Program for Climate Change (PNAC2020). Each region must contribute for the national targets but there are no specific regional targets defined.

These legal instruments (ENE2020, PNAEE2016, PNAER2020 and PNAC2020) intend to ensure the compliance with the commitments made by Portugal in the context of the related European policies under Energy-Climate Package 20-20-20.The end purpose is to achieve by 2020: a reduction of 20% in emissions of GHG in relation to 1990 levels; 20% share of energy from renewable sources in gross final consumption and 20% reduction of primary energy consumption. For Portugal and for 2020, was established a general goal of reduction in primary energy consumption of 25% and a specific goal of 30% reduction, for the Public Administration.

Similarly, to other European countries, Portugal is taking actions regarding energy and climate change whose purpose is to achieve lower targets of GHG emissions over the years, higher energy efficiency and a stronger participation of renewable sources on energy production.
In the present year of 2013, Portugal approved action plans for energy efficiency and renewable energy sources (PNAEE and PNAER, respectively) establish the following targets for the next years:

PNAEE2016 targets:
- for 2016, an estimate of savings of 17,442 GWh, corresponding to 8.2% reduction of energy consumption,comparing with the average consumption 2001 – 2005;
- for 2020, a decrease of 91,860 GWh in primary energy, comparing with the energy demand projection of PRIMES model from European Commission (26% of 348,837 GWh).

The expected impacts, in terms of CO_2 emissions, are expressed in *Table 3*, by sector of activity, with respect to the energy efficiency policies and show a reduction of about 5.1 $MtCO_2eq$ by 2020.

Reducing GHG emissions (tCO_2eq)savings		
	2016	**2020**
Transport	227,273	422,441
Dwellings and Office buildings	1,400,941	2,543,735
Industry	399,504	890,765
Public buildings	489,647	1,108,715
Agriculture	92,571	123,541
TOTAL	2,609,936	5,089,197

Table 3 – Impact of PNAEE2016 on CO_2 emissions (PCM, 2013)

PNAER2020 targets:
- incorporating 10% of Renewable Energy Sources (RES) on transport;
- for 2020, the share of RES in gross final energy consumption is 31% – the fifth highest in the EU.

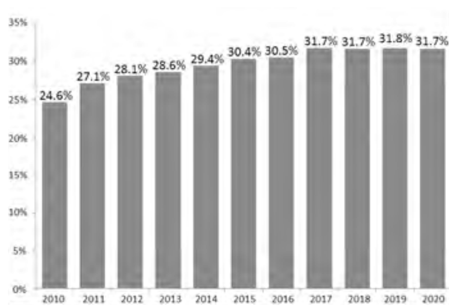


Figure 8 – Pace of expanding renewable energies

Regarding CO_2 emissions, the compliance with PNAER2020 will provide an estimated reduction of 28.6 $MtCO_2eq$, by 2020, which corresponds approximately to €286 million (CO_2 = 10 €/ton).

The recast Directive (Directive 2010/31/EU) on the Energy Performance of Buildings (EPBD), published on 19th of May 2010, was integrated in the Portuguese legal framework in 2013, with the DL 118/2013, which also includes the Building Energy Efficiency Codes (BEEC) for Dwellings and for Commercial & Office buildings.The implementation of the former directive and former BEEC, promoted the use of innovative technologies to improve buildings efficiency and provided incentive to the use of RES for efficient generation and usage of heat.

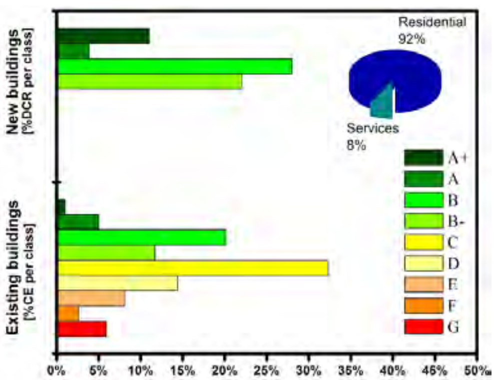


Figure 9 – Energy label distribution for new and existing buildings (Gonçalves, et al., 2013)

Following the requirements of the BEEC, since 2007 until December 2012, more than 555,000EPCs (Energy Performance Certificates) were issued, about 80% of these correspond to existing buildings, upon sale or rent. The results of those certificates, according to the energy label are visible in *Figure 9*.

Other Regional targets, barriers and drivers

It must be pointed out that, in terms of building energy efficiency, the old part of the building stock in the North Region and the existence of many historical places with severe restrictions for renovation actions constitute a barrier for the improvement of energy efficiency. On the other hand the Western part of North Region is one of the most populated zones in the country with a large housing stock where significant renovation actions can be implemented mainly in a large number of buildings that were built in the 70's and 80's, when no building energy efficiency code was into force.

With an important concentration of the construction industry and construction working force in the North some efforts have been made lately in what concerns training for energy efficiency. Specific training programs on subjects like insulation technics, solar collectors' installation and efficient windows were launched.

Concerning *climate-friendly mobility,* the new PNAER gives continuity to the Mobi.E project which led to the creation of the Electric Mobility Network, an integrated network linking various stations in Portugal that enable electric vehicles to recharge, using a charge card.

It is estimated that the number of electric vehicles in Portugal will grow at an average annual rate of 44% between 2011 and 2020, totalling 33,663 electric vehicles, including passenger cars, goods vehicles, buses and motorcycles, as shown in *Figure 10*.

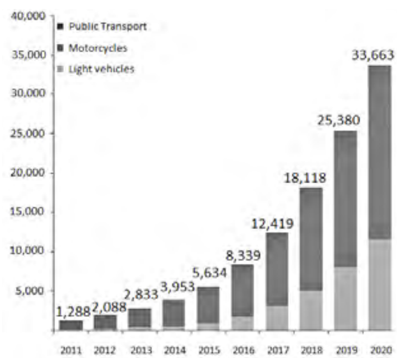


Figure 10 – Estimated evolution of electric vehicles in Portugal (PCM, 2013)

Improving access to *Information and Communication Technologies* (ICT), as well as its use and quality, corresponds to one of the thematic objectives set by the European Union for the period 2014 – 2020. Also, "Digital Agenda for Europe" is one of seven flagship initiatives of the Europe 2020 Strategy, aimed at promoting smart, sustainable and inclusive growth.

The coverage of basic broadband (which allows access to the Internet of at least 2 MB/s) was already very close to universal coverage in the Northern Region, in 2011, in line with EU targets set for 2013.

Broadband coverage of new generation (at least 30 MB/s) at regional level is quite high but shows significant intra-regional disparities. In areas of lower population density, the coverage of this type of service does not exceed 35%. With the exception of Greater Porto and Entre-Douro and Vouga, the sub-regional North territories present values are still far from 100% global coverage targeted by the EU for 2020.

Regarding broadband penetration and Internet use by citizens, the Northern Region stands out negatively, both in the national and European levels. Less than half the population of the North uses the Internet on a regular basis (at least once a week) and the same applies to the use of e-commerce.

3. THE GREAT METROPOLITAN AREAOF PORTO: AN APPROACH TO CLIMATE-FRIENDLY MOBILITY

The city of Porto is located in the Northern region, has an area of 41.66 km² with a population of 237,591 inhabitants and a density of 5,703 inhabitants per km², according to the last census (2011). The city is the capital of the Great Metropolitan Area of Porto (GMAP), which comprises 17 municipalities, within an area of 2,246 km² and with a population of 2,381,595 inhabitants. The geographical situation of GMAP within the northern region is shown in *Figure 11*.

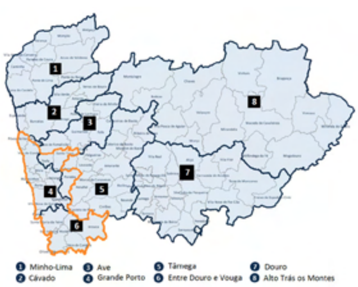
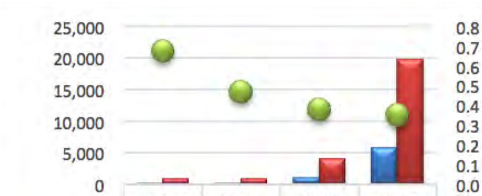


Figure 11 – Great Metropolitan Area of Porto in the Northern Region of Portugal

Although this metropolitan area only covers about 10% of the entire region, its population is almost 2/3 of the total and the contribution for the regional GHG emissions is about 50%. This highlights the economical relevance of GMAP in not only the industrial sector but also regarding the transport sector (density of roads, traffic), residential sector, etc.

In *Figure 12*, some figures are presented that emphasise Porto as the capital city of the metropolitan area, providing all the primary institutional services, major education and health facilities, polarising commuting movements, namely, a high population density, a strong production of GHG emissions per area unit, but an average CO_2eq emission significantly below the national average.



	PT	Norte	GAMP	Porto
inhab/km2	115	173	1,061	5,703
CO2/km2	773	808	4,004	19,750
CO2/inhab	0.7	0.5	0.4	0.3

Figure 12 – Density parameters for population and GHG emissions (in tCO_2eq/km^2 and $tCO_2eq/inhab$) for different geographical levels

As Porto has such relevance in the regional context, it was considered that any intervention developed in this city could have the potential to engage a regional change. With this purpose,the Municipality of Porto, through the creation of the Energy Agency of Porto, in 2006, began an innovative journey in the approach to the subject of energy within the city. The most relevant milestones of the agency action were:

- the elaboration of the Energy Matrix of Porto in 2007, reported to 2004;
- the signature of the Covenant of Mayors in 2009 and;
- the approval of the 2010 Plan of Action for Sustainable Energy for the city of Porto (PAES-P).

The Porto Strategy for Sustainability was based on a diagnosis and on an energy strategy for urban sustainability, meeting the objectives of the European Commission for 2020, taking action on not only specific energy systems and vectors but, mainly,with interventions on the scale of city activities and energy users sectors, like buildings and transport. In what concerns CO_2 emissions the PAES-P aims to go even further, reducing them by about 45% in 2020. The main "stakeholders" of the city were consulted throughout the process and were called to evaluate the planned actions in their areas of responsibility, such as EDP – Gas; LIPOR – Inter-municipalities Waste Management of Greater Porto; Metro of Porto and STCP (Society of Collective Transport of Porto).

As stated in the energy matrix of Porto for 2004, the transport sector is the most demanding, in terms of final energy consumption and, together with office buildings, it is responsible for more than 2/3 of the GHG emissions in Porto. In this context and making use of the opportunity provided by the construction of a new Metro network in recent years (since 2003); it was considered that the analysis of environmental implications (GHG emissions) of the modal shift towards the Metro offered great interest.

Initial conditions and local situation
As a starting point, one should consider the situation without the influence of the Metro system. Unfortunately, the data available on GHG emissions does not allow going back that far. Meanwhile, considering the information included on PAES-P and related documents (AdEPorto, et al., 2008), (AdEPorto, 2009), it is possible to compare the years 2004 and 2008, as shown in *Figure 13*, regarding CO_2 emissions, not only at local level but also with the influence of indirect CO_2 emissions.

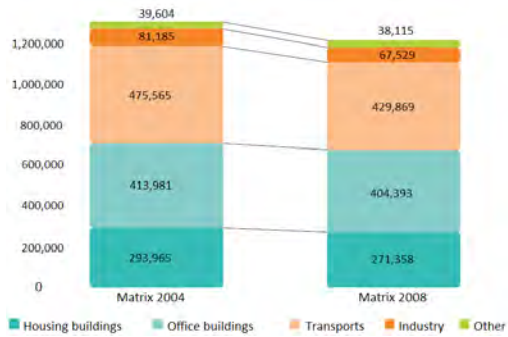


Figure 13 – Energy matrix 2004 vs 2008: CO_2 emissions, in tCO_2eq, by activity sector (ADEPorto & CMPorto, 2013)

These indirect emissions result from converting primary into final energy, which does not occur in Porto, and represent about 30% of those CO_2 emissions, according to differences detected in data from APA (APA, et al., 2013) and AdEPorto (ADEPorto & CMPorto, 2013), respectively, emissions produced locally and global emissions (local plus indirect). This CO_2 emissions decrease reflects a reduction on primary and final energy consumption by, respectively, 11% and 12%. Those changes,which in housing means a decreased of 6.2% in final energy and 7.7% in CO_2 emissions for the period 2004/2008, are in part due to the loss of population, but probably also to the transfer from electricity to natural gas.

With respect to transport, there was a reduction in final energy consumption by 10.5%, corresponding to a 10% decrease in CO_2 emissions, most likely due to the opening of new Metro lines in 2005, the reformulation of STCP network (part of the fleet runs on natural gas) and the continued migration of people from Porto to the neighbouring municipalities. In general terms, there was an average reduction on CO_2 emissions of 7.1%, with a particular focus on industry (17%) followed by the transport sector (9.6%) and dwellings (7.7%).

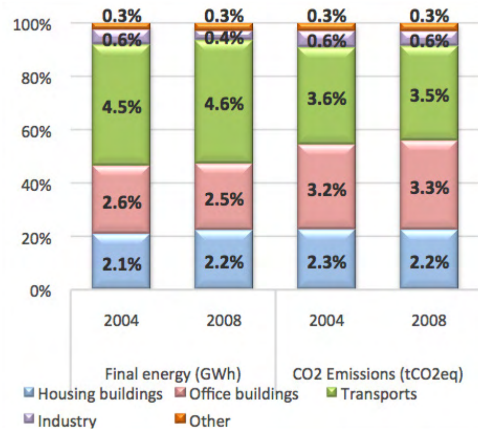


Figure 14 – Energy matrix 2004 vs 2008, distribution by activity sector, adapted from (ADEPorto & CMPorto, 2013)

As it is possible to observe in *Figure 14*, transport and buildings account for 90% of CO_2 emissions, from which 36% are related to the transport sector. In 2004, from the perspective of the "supply", the energy matrix of the transport sector is dominated by diesel (57% of energy and 58% of emissions) followed by petrol (39% energy and 38% of emissions). The individual weight of the remaining energy vectors (natural gas, LPG and electricity) is not significant, although about half the STCP fleet runs with natural gas. The matrix of transport is dominated by road transport headed by individual transport (55%). The public transport represents only 7% of primary energy for mobility, being 1% by rail (train and metro) and the remaining 6% by road, provided by STCP, where the energetic weight of natural gas is higher than diesel.

In PAES-P some benchmarking indicators for Porto and for Portugal are provided, regarding the use of primary energy per capita for transport, which are indicated in *Table 4*, showing that in Porto, for 2008, the consumption is higher than the national average by 10% and with a greater use of petrol.

Benchmarking demographic indicators (2008)		
	Porto	**Portugal**
Population density (hab/km^2)	5,786	114
Number of inhabitants	238,954	10,529,255

Benchmarking indicator for energy and CO_2				
Emissions	Energy	Emissions	Energy	Emissions
Total of primary energy in the transport sector (MWh/inhabitant) | (tCO_2/inhabitant)				
	7.74	1.99	7.01	1.82
Final energy in the transport sector (MWh/inhabitant) | (tCO_2/inhabitant)				
Diesel	4.34	1.16	4.66	1.24
Petrol	3.03	0.76	2.19	0.55
Electricity	0.05	0.02	0.05	0.02
Natural gas	0.26	0.05	-	-

Table 4 – Benchmarking indicators for the transportation sector (ADEPorto & CMPorto, 2013)

A particular attention will be given to the Metro of Porto (*Figure 15*), as the chosen case study, since it represents the most used public transport mode and along the first 10 years (Dec 2002 – Dec 2012) it transported about 380 million customers and registered, in 2012, 54.5 million trips (journeys/ validations).

The fleet consists of 102 vehicles, driving 9000 persons per hour and per line with an average speed of 28 km/h. This is clearly higher than the average speed of the private transport in the centre of the city, very much conditioned by traffic lights, bus stops and bus lanes, crosswalks and traffic congestion, mostly in rush hours. In peri urban areas, however, private transport speed can reach the one of the Metro and can often exceed it, as there are less circulation constraints.

Figure 15 – The Metro of Porto (source: Photographer António Chaves - Metro do Porto, S.A. Archive)

Presently, the Metro of Porto has a network with 6 lines and 66 km of extension, along which there are 81 stations both on surface or underground, according to the Metro profile, which has been constructed along the years as indicated in *Table 5*.

Metro Network (31/12)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Length (km)	12	16	35	59	59	60	60	66	66	66
Number of stations	18	23	45	69	69	70	70	80	81	81

Table 5 – Development of the Metro of Porto

The majority of customers of the Metro of Porto are obviously resident in the 6 municipalities covered by the network: Póvoa de Varzim, Vila do Conde, Maia, Matosinhos, Porto, Vila Nova de Gaia e Gondomar. From Porto come 27.1% of the customers, followed by Vila Nova de Gaia (20.9%), Matosinhos (14.2%), Maia (10.1%), Gondomar (9.6%), Vila do Conde (4.8%) and Póvoa do Varzim (1.7%). However, the percentage of customers living in locations not served by Metro also has some expression (11.3% of total), especially for residents in Valongo (1.6%) and Espinho (1.0%).

Objectives and methods

The objective of the presentation of this case study is to illustrate, whenever possible in a quantified way, the impact of public policies and investments in reducing GHG emissions, not only at local level but mainly, with a regional or even larger geographical focus.

As previously mentioned, when studying the emissions related to transport modal split it is important to consider not only the emissions emitted locally by the different transport modes but also the emissions associated to the transformation of the primary energy sources in the final energy to be used by those transport modes. Given the environmentally friendly nature of light rail, it was necessary to perform the calculation of the emissions avoided by this mode of transport as an alternative to more polluting ones.

For those calculations a modal shift was assumed from other forms of transportation to the Metro obtained from inquiries conducted in the study: "*Assessment of the Global Impact Project Phase 1 of the Metro of Porto*"(FEUP & U.NOVA, 2008). According to that study, the inquired population was considered to be representative of the average users of Metro and was captured from other modes as follows:

- 23.6% from Individual Transport (IT);
- 65.4% from Public Transport (PT) (includes travel by train and bus);
- 11% from Non-Motorised Transport (NMT) (includes walking and cycling, for example).

Some knowledge on CO_2 emissions from individual transport, buses and trains was also needed. Regarding public transport, STCP and CP (Comboios de Portugal, the Portuguese railway operations company), the companies operating those services, were consulted and they provided that information.

With respect to the individual transport, the update of the emission factor depends on the particular characteristics of the fleet and the use profile of vehicles, information quite difficult to access. The alternative consisted in using a factor estimated from average rates of increase/decrease of CO_2 emissions from road transport published for the last 4 years in INERPA - the National Atmospheric Emissions Inventory. The emission factors used in these calculations are indicated in *Table 6*.

	2007	2008	2009	2010	2011	2012
STCP	98.46	98.46	94.39	99.33	109.60	106.16
CP	29.41	29.41	29.41	29.41	29.41	29.41
TI	724.45	724.45	724.45	719.7	712.7	703.8

Table 6 – CO_2 emission conversion factors for PT (STCP and CP) and IT, in gCO_2eq per passenger of Metro

The estimation of the emissions avoided locally from IT and PT is included in *Figure 17*. The number of passengers travelling by metro is another essential piece of information. That information was provided by "Metro do Porto", together with the "loads by section", presented in *Figure 16*, which correspond to the number of passengers who travelled between each pair of stations. The urban sections exhibit values more than ten times higher than those at the extremities of the Metro network.

Figure 16 – Passenger flows by section in both directions, adapted from (Metro do Porto, 2013)

Results

Since 2003, when the first line of Metro started to be operated, environmental and social benefits were emphasised by the company as one of the most important achievements for the city, at that time, and later for the entire GMAP.

In social terms, the implementation of the Metro system brought identifiable benefits,such as a decrease in travel time, a reduction in the number of road accidents, a lower pressure on parking and a reduction in operation costs of other transport companies. Moreover the inter-social-class character of the Metro and its territorial coverage contributed, more than any other way of transport, to the connection and integration of different urban areas which present sometimes significantly contrasted social matrices (Pinho and Villares, 2009).

Apart from environmental issues like resources, water and waste management, historical and architectural preservation, landscape, etc., energy management and the contribution for the reduction of national and local/ regional GHG emissions were the most referred contributions for the society and the environment.

Following the methodology expressed in the previous section, from 2007 until 2012 – the figures for 2013 are not available yet– it was possible to quantify the savings provided by the development of the Metro network.

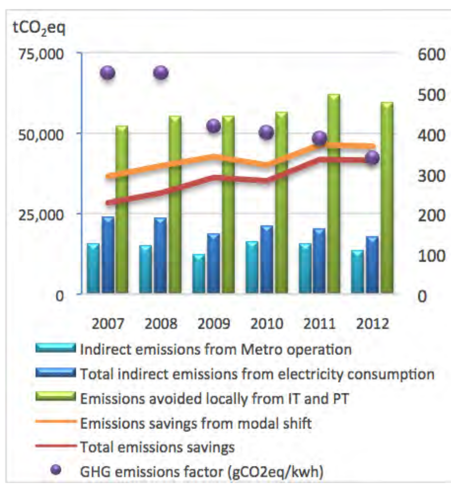


Figure 17 – CO_2 emissions and saving derived from Metro operation

Data was gathered from several Metro do Porto "Sustainability Reports" (Metro do Porto, 2008 to 2012), from DGEG (Directorate General for

Energy and Geology) and the results of those calculations are summarised in *Figure 17*.
It is interesting, although expected, to notice that the emissions avoided locally have been increasing until 2011, suffering a slight decrease in 2012 that might continue in 2013. This decrease is related with the economic crisis the Portuguese are facing that firstly arose in individual vehicles use but also arrivedat public transport. According to the latest statistics of INE, Metro do Porto and STCP, there was a reduction in the number of persons using public transport.

Another point that should also be stressed is related to the efforts made, not only by Metro do Porto but also by STCP (the bus public transport operator), regarding the improvement in operational efficiency, either reducing the energy consumption with more efficient vehicles, by the reformulation of the network – lately having almost a complementary network for both modes of transport.

Long term focus
Efficiency measures have encouraged modal shift from the individual to the collective transport. Those measures will have to be articulated and, as the public transport system is improved, it will be possible to introduce some restraining measures to the use of private transport. The possible actions might include:

- improvement of public transportation services: the construction of new Metro lines in 2005 and 2006 demonstrates a significant reduction in fuel consumption and incorporated: The introduction of high frequency lines and good quality of service in strategic areas that allow integration between transportation modes; the adequacy between supply and demand; the improvement of circulation conditions for road public transportation with bus corridors and traffic light systems that give them priority; and the implementation of parking areas associated to inter-modality;
- improvement of energy efficiency: with energy audit for detailed classification of energy usage, according to the type of transport, leading to rationalisation measures of consumption. In particular, the Metro of Porto has been developing studies with the industry and with university researchers (Universities of Porto and of Minho) in order to achieve a better energy efficiency in its vehicles operation;
- awareness training and information: actions to raise the awareness of transport companies and individual drivers on economic and defensive driving; High priority on reducing individual motorised transport by encouraging collective forms of transport (Metro/STCP/CP), encourage inter-modality, creating an infrastructure of cycling lanes and promoting pedestrian pathways;
- implementation of the Urban Mobility Program: in the “PNAEE” - National Plan of Action for Energy Efficiency, there is a system of incentives under the name of Urban Mobility Program, which supports the measures related to the modal and commuting needs of public transport in major cities and business areas;
- incorporation of biofuels in petrol and diesel: in the scope of “ENE “ - National Strategy for Energy, the incorporation of biofuels was approved which subsequently led to the Decree - Law 49 /2009 where a mandatory incorporation of biofuels in road fuels, up to a maximum of 20%, is established (this objective is also outlined in “PNAER” - National Plan of Action for Renewable Energy, July 2010);
- *creation of the Metropolitan Transportation Authority:* The Metropolitan Transportation Authority of Porto (AMT) was formally constituted and its duties, arising from their legal regime of the Law n. 1/2009, include the fields of planning, organisation, operation, financing, monitoring and development of public transport; One of the main proposals for achieving the objectives is the gradual modal shift in the Great Metropolitan Area of Porto from private transport to public transport; The progress of this measure, the improvement of energy efficiency and the impact on the reduction of CO_2 emissions in the city of Porto, will be recorded during the monitoring of the implementation of the “PAES-P”;
- The Mobility Shop: is an instrument of mobility management, it is a concept that has been developed worldwide and aims to reduce the volume of traffic, limiting trips made in private transport and encouraging the use of sustainable modes of transport

(public transport, cycling or pedestrian); The "Mobility Shop" arose from the participation of the Municipality of Porto in the community project "MOST" (Mobility Management Strategies for the Next Decades), having as main objective the development and evaluation of strategies for mobility management in European countries; The "Mobility Shop" is integrated within the community project Civitas Plus (www.civitas.eu) , where the Municipality of Porto leads a consortium of several institutions of the city;

- priority Measures for Public Transport in the City of Porto: The report of the Priority Measures for Public Transport in the City of Porto, which was presented in September 2008, aimed for the improvement of the speed of public vehicles and the lifting of existing constraint points in the city of Porto. This report aimed to enhance public transport, making public space more efficient and appropriate to users, taking measures to minimise the impact of the buses movement within the city and also fostering the creation of interfaces dedicated to the road transport service, promoting the concentration of services.

4.CONCLUSIONS

The data presented for the chosen case study show clearly that the Metro of Porto has contributed to the economic, social and environmental sustainability of the Great Metropolitan Area of Porto, offering a service, which has been progressively extended to a larger region and to a higher number of users. As stated before, Porto has a great relevance in the regional context and any change carried out in its area has the potential to engage a regional change due to the many regional connections to it and to its attractiveness.

The example of the Metro of Porto can certainly be replicated in other areas of the North Region and in other regions of the country, naturally with the necessary local adjustments in function of socio-economic conditions of the population, the foreseen demographic variation, the type of use of the territory and possible changes in urban occupation due to more demanding urban functions, the public equipment's in presence or to be built in the near future - as potential generators of daily movements, the existing transport network and the different mobility pattern sand also the characteristics of the territory which can restrict, for instance, pedestrian mobility and favor the use of public transport, namely, Metro.

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ROMANIA

AUTHORS

Professor Radu ANDREI
Technical University Gheorghe Asachi,
43 Prof. Dimitrie Mangeron Str.,
code 700050, Iasi
E: radu.andrei.d@gmail.com

Professor. Gheorghe LUCACI
Polytechnic University of Timisoara,
E: gheorghe.lucaci@ct.upt.ro

Professor Nicolae TARANU
Technical University Gheorghe Asachi,
E: taranu@ce.tuiasi.ro

Associate Professor Liliana-Mihaela MOGA
Dunarea de Jos University,
E: liliana.moga@gmail.com

Dr. Alina- Mihaela NICUTA
Technical University Gheorghe Asachi,
E: alinanicuta@yahoo.com

Mihaela CONDURAT, PhD Student
Technical University Gheorghe Asachi,
E: conduratmihaela@yahoo.com

1. OVERVIEW OF THE REGION

Characteristics of the Region

With an area of 238,391 km^2, Romania is the eighth largest country of the European Union and the seventh largest population of the European Union with 22,760,449 inhabitants. The North East Region is one of the eight Development Regions of Romania (Romania Central.com.a) located, as shown in *Figure 1*, in the East side of the country.

Figure 1 – The Eight Development Regions of Romania (Romania Central.com. a)

Figure 2 – The North East Region of Romania (google.ro/the North East region of Romania)

As illustrated on *Figure 2*, the North-East Region consists of the six counties: Bacau, Botosani, Iasi, Neamt, Suceava and Vaslui.

This Region hosts 17.25 % of Romania's total population on 15.5 % of its total territory. The Nord East Region, as other development regions, does not have any administrative power, its main function being to co-ordinate, through its Regional Development Board, development projects and manage funds from the European Union. The Regional Development Board is a deliberative organism that coordinates, through its Regional Development Agency (RDA), the entire regional development process.

The North East Regional Development Board (RDB) involves the presidents of County Councils in the region, representatives of County Municipalities, representatives of Towns and representatives of Communes. The main tasks of the RDB consists of coordinating and monitoring the achievements of the regional development policy and objectives, providing an equal and fair approach toward all the counties from the region. This body also analyses and approves the regional development strategy and programs, approves criteria, priorities, distribution and destinations of Regional Development Fund, monitors the funds allocated to RDA from National Regional Development Fund, analyses and approves selection criteria and priorities for regional development projects, analyses and approves regional development projects proposed by RDA, approves documents designed to obtain "disadvantage area" status. Thus the RDA is a generator of economic and social development in the North East Region. RDA develops strategies, attracts resources, identifies and implements financing programmes and offers services for stimulating sustainable economic development, partnerships and entrepreneurial spirit.

The economy of North East Region is mainly agricultural, especially towards the North, even though there are a number of industrial cities, especially Iasi, Bacău and Suceava. Iasi, the largest city in North East is one of the wealthiest cities of the country. The region's richest counties are, in order: Iasi, Bacău, Suceava, Neamt, Vaslui and Botosani. The disparities between the North East Region and the other regions (Romania.Central.com-a), expressed in terms of percentage of population and percentage of GDP, at the level of year 2005, is significant, as shown in *Figure 3*.

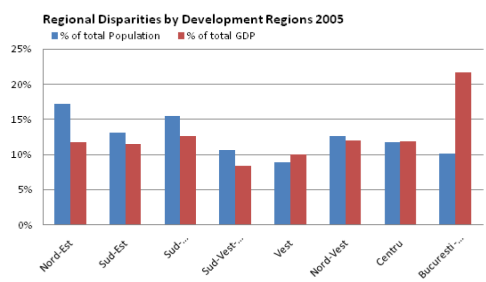

Figure 3 – Regional Disparities by Development Regions of Romania (Romania.Central.com. a)

This undesired situation has not improved overthe years. Thus, according to statistical data (INS.a) presented in Table 1, the regional GDP per capita, at the level of 2010 year, was the lowest in Romania, at about two-thirds of the national average.

Name of Region	2010	Regional GDP weight co-efficient
Country level :	24435.9	1.00
North-East Region	**15014.8**	**0.61**
South-East Region	20076.8	0.82
South Muntenia Region	20288.2	0.83
South-West Oltenia	18735.1	0.77
West Region	27640.0	1.13
North-West Region	21827.2	0.89
Central Region	23428.3	1.47
Bucharest-Ilfov Region	58137.0	2.38

Table 1 – Country and Regional GDP per capita/ year 2010 (euro/capita) (INS.a)

According to published economic studies (Romania Central.com. b) the Region contributed 11.81 % to the total GDP in 2005. The population is concentrated in the rural areas. In 2006, the region North East featured the lowest GDP per capita of all in Romania and even Europe, reaching with 3,051 € just 67.8 % of the Romanian average. Romania's employment rate on the segment of working population aged between 15 and 64 years old (INS.b) at the level of year 2011 was 59.1%.

Energy demand and supply of the Region
According to official sources (INS.b), total energy consumption, at the level of year 2011, expressed in thousands tonnes of oil equivalent for domestic, commercial, industry, and transport for the North East Region, was 22,750 tonnes (2,646 TWh) of equivalent oil, as shown in *Table 2*.

Energy consumption	2011
Industry (including construction)	7,093
Agriculture, forestry, fishery	433
Transport	5,313
Other activities	2,028
Population	7,883
Total	22,750[2]) (2,646 TWh)

Table 2 – Distribution of energy consumption[1]) (INS.b)

1) Thousands tonnes of oil equivalent/oil equivalent
2) Oil equivalent (10000 kcal/kg).

According to the same source (INS.c), the total energy consumption by fuel, at the level of year 2011, expressed in thousand tonnes of oil equivalent and percentage from the total is given in *Table 3.*

	2011
Total[2])	29,048 (3378 TWh)
Electric energy	1,242 4.28%
Coal	8,147 28.05%
Crude oil	8,472 29.17%
Natural gas[3])	11,187 38.50%

Table 3 – Total energy consumption by fuel[1]) (INS.c)

1) Oil equivalent (10000 kcal/kg).
2) Including energy products obtained and consumed in households.
3) Excluding gasoline and ethane from extraction oil-wells which are included in crude oil.

In *Table 4*, the share of various energy sources for electricity production (%), (INS.d) is presented. In this table, the share of renewable energy, like wind, solar, etc is included in the figure corresponding to Crude oil 3).

	2011	%
Coal	8,298	19.80
Natural gas[2])	12,676	30.23
Crude oil[3]), [4])	10,426	24.87
Imported petroleum products	2,319	5.53
Fuel wood (including biomass)	3,524	8.41
Other fuels	269	0.64
Hydroelectric and nuclear-electric energy	4,286	10.22
Imported electric energy	89	0.21
Energy from non-conventional sources	37	0.09
Total	41924[1]) (4876 TWh)	100%

Table 4 – Share of Energy Sources for Electricity for year 2011 (INS.d)

1) Oil equivalent (10000 kcal/kg).
2) Including energy products obtained and consumed in households.
3) Excluding gasoline and ethane from extraction oil-wells which are included in crude oil
4) Including wind energy

The actual thermal energy production and distribution, based on power plants functioning with coal or other fuels, is characterised by low efficiency and losses. Alternatives have emerged during recent years, mainly in cities, replacing centralised heating systems and increasing the number of private flat heating systems installed, based on gas or electricity. Besides low efficiency and loss of energy during transport to users, an important reason for this significant shift is the fact that the owner can arrange and control a more suitable scheme of heating their own home, in terms of temperature and duration of heating. More importantly the quantity of fuel (gas or electricity) can be controlled over a specific period of time.

In cities with lower economic strength, the existing thermal power distribution system is under continuous modernisation. In areas with developed primary wood processing, uncontrolled sawdust deposits have a negative impact on land surfaces. Fuel made of waste wood (e.g. sawdust briquettes) can be used as an alternative for primary wood fuel

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Romania has established threshold values nationwide relating to energy demand and supply objectives. Thus, by year 2020, Romania should reach the following indicators for Energy and Climate change:

- decrease of greenhouse gas emissions by at least 20% compared to 1990;
- increase by 24% the percentage of renewable energy sources in total energy consumption;
- increase of energy efficiency by 19%.

The status of Green House Gas (GHG), expressed in thousand tonnes of emissions (INS.e), at the national level is shown in Table 5, and the targets of its reduction in the next years are given in Table 6 from opposite:

	2005	2010
Total GHG emissions (CO^2 eq.)	148,889.37	121,354.55

Table 5 – Total GHG Emissions at national level (thousand tone, kt) (INS.e)

According to the latest available data (for 2010) from the National Inventory of Greenhouse Gas Emissions (INEGES) (Romania's National Reform Programme 2011 – 2013: Implementation Report - March 2012), greenhouse gas total GHG emissions (excluding Land-use, land-use change and forestry) decreased by 51.48% during 1990-2010 (from 255,350.08 Gg CO_2 equivalent to 123,904.19 Gg CO2 equivalent), and total GHG emissions (including LULUCF) decreased by 56.55% during 1990-2010 (from 227,947.70 Gg CO2 equivalent to 99,041.50 Gg CO2 equivalent), both values well below the Romanian maximum GHG emissions for 2020.

The strategy objectives for 2020/ achieved 2014	European Union	Romania
Decrease of greenhouse gas emissions (GHG) (compared to those from 1990)	20%	20%
Share of renewable energy sources in final gross consumption	20%	24%
Increase of energy efficiency	20%	19%

Table 6 – GHG Reduction Targets (Romania's National Reform Programme 2011 – 2013: Implementation Report – March 2012)

Also, the overall objective of the North-East Region for the period 2007 – 2013 was to reduce the existing gap compared with other more developed regions of Romania (see *Table 1*) by increasing the regional competitiveness and attractiveness.

Thus, the EFFECT project (EFFECT Project), in which Romania is a partner through North-East Regional Development Agency (ADR - North-East) was designed to contribute to achieving the EU energy strategy and meet the need for innovation and alignment of public procurement procedures in the countries EEA area community requirements. The EFFECT project established from the need to innovate SEE countries public procurement procedures and stimulate their integration with energy efficiency criteria in order to meet EU Public Procurement requirements and to contribute to achieve EU energy strategy objectives.EU public procurement impacts more than 16% on EU GDP and it is an important for public authorities to effectively address energy efficiency policies fostering the production and consumption of energy efficient products and services and adoption of energy technologies.

Established in 1999 through the association of the 6 counties in North-East Romania and by the enforcement of the Law no 151/1998, North-East Regional Development Agency is a reference organisation for regional development system in Romania. As a public utility NGO, the agency's mission is to generate economic and social development in the North-East Region of Romania by developing strategies, attracting resources, identifying and implementing financing programs and offering services for encouraging sustainable economic development, partnerships and entrepreneurial spirit. By participating in the EFFECT project, North-East RDA makes important steps towards achieving its objectives of:

- stimulating intra – and interregional partnerships as well as the international ones through promoting projects of common interest;
- promoting innovation, know-how and technology transfer by consolidating the link between the business, research, technological and scientific environments;
- promoting regional opportunities in order to attract Romanian and foreign investors.

The achievements of more than 12 years of activity includes: an absorption rate of 85% allocated pre-accession PHARE ESC funds within more than six hundred implemented projects, and over 5,000 new jobs created. The North-East Regional Development Plan 2007-2013 will be mainly implemented through the Regional Operational Program that allocated to our region €654 million Euros.

More than 1,100 projects applied for funding under this program to date which indicates the amount of work to be covered, but above all, the trust in the professional capacity of RDA North-East to deliver efficient implementation. Together with their collaborators, project beneficiaries, members of North-East Regional Development Board, colleagues from various ministries or international partners, are making efforts in mobilising regional resources to reach a major goal – to upgrade the development level of our region.

All countries involved in the project have structural weaknesses due to difficulties in producing energy from renewable sources and spread the concept of rational use of energy. These are highlighted by unfavourable legislative conditions, institutional hurdles and low skills, lack of available information and poor awareness, which causes a lack of perception, demand and acceptance.

Other Regional targets, barriers and drivers
One of the important drivers to achieve the targets related to the energy policy is the strategy for North-East region 2007-2013 which is financed from Regional Operative Program and structural instruments, and includes the Action 1.5 "Energy Infrastructure Development".The existence of the research, development and innovation infrastructure at the regional level, which involves 73 research and development units representing 12% of the total nationwide, also constitutes an important driver.

Another important target in the Region is the rehabilitation and modernisation of county roads and streets including the construction and rehabilitation of ring roads. The objectives for this are the rehabilitation of county roads connecting the national road network and the -Trans European Network (TEN), the upgrading of urban streets in order to improve urban traffic flow, to reduce journey time and to eliminate bottlenecks in the access points to the city.

Expertise in renewable energy is located in Universities and Research Centres. Three University Centres having undertake research on scienceand technological development, promoting an informative society, sustaining actions for energy efficiency, management of local plans in energetic fields. Various methods of evaluation and reduction of the actual negative impact (noise, CO_2e emissions, fuel consumption, etc) have been investigated in the Region of Iasi. An analysis of the rolling stock and the fixed plant involved in transportation and the evaluation of traffic emissions on various roads and streets has been recently undertaken by the Technical University Gheorghe Asachi of Iasi(Horobet, 2013). Romania's national policy on renewable energy has been developed and implemented in the difficult context of specific economic phenomena of transition from a centralised economy to a market economy and lately to post-transition policy. The main objective for the energy infrastructure development at a national level, is to improve the living standard of its residents and increase the attractiveness of investments in urban environment by creating, expanding and upgrading energy infrastructure. The measure undertaken in order to achieve these objectives, consists of the following:

- construction, rehabilitation and modernisation of energetic heating distribution and thermal plants;
- construction and/or expansion, upgrading, rehabilitation and modernisation of natural gas networks;
- construction, modernisation and development of renewable energy sources (biomass, solar, wind).

In the context of EU membership negotiations, the Romanian Government has developed the National Development Plan (NDP) 2007-2013. In this document the issue of Renewable Energy Sources (RES) valorisation is approached in the chapters "Analyze on the current situation" and "Development Strategy". NDP highlights the potential RES according to previous strategies. The main goals established in Romania regarding the promotion of bio-fuels are as follow:

- by the end of 2010, the percentage of bio-fuel in total energy usage for transportation sectors should reach at least 5.75% (target set by Directive 2003/30/EC.);
- by 2020, the percentage of bio-fuel should be at least 10%, based on the development of new bio-fuels generations;
- the measures undertaken by the Romanian Government in cooperation with Environmental Ministry, in order to support the strategic objectives for promoting the usage of renewable energy sources implied a pilot program named "Green House";
- in 2008 has been approved the Order of the Ministry for Environment and Sustainable Development for the program of replacement and development of classical heating systems using solar, geothermal and wind energy;
- the program objectives consisted of collecting finances from the Environmental Fund Projects.

The potential key beneficiaries of investment programs might be economic operators, forest districts, Administrative Territorial Units and Educational Institutions, Individuals, Housing Associations and non-government organisations. At country level there is a National Regional Development Council, with a decisive role on the development and policy implementation. Promoting the use of bio-fuels and other renewable fuels for transport has been the subject for the Government Decision HG 1844/2005 completed with HG456/2007. At July 1st, 2007 – gasoline fuel has reached the level of 4% bio-fuel by volume.

At a Regional level, the process of development planning provides a strategic base essential for the inclusion of measures and implementing projects. Thus, as part of a Joint Implementation (JI) project for Kyoto Protocol (Wikipedia.b), the North-East Region in partnership with Denmark has developed a biomass heating unit in the city of Vatra Dornei, the largest of its kind in Romania. This unit provides heat for about one third of the city of Vatra Dornei and leads to a significant reduction of GHG as compared to fossil fuels.

Investments in the energy sector can also drive long and medium term competitiveness of other economic sectors, becoming an income source. Economic competitiveness and sustainable development are based on efficient energy use in the whole chain including natural resources, production, transport, distribution and final use and technological innovation that will reduce the energy consumption.
Potential alternative energy sources and their distribution on the Romanian territory are illustrated in *Figure 4*.

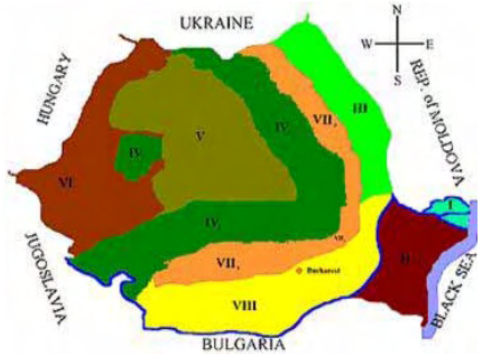

Figure 4 – Distribution of Potential Alternative Energy Sources in Romania (Romanian Renewable Energy Association)

- I Danube delta (solar energy);
- II Dobrogea (solar and wind energy);
- III Moldavia (biomass, small hydro and wind power);
- IV Carpathian Mountains (biomass and small hydropower);
- V Transylvanian Plateau (small hydropower);
- VI Western Plain (geothermal energy);
- VII Subcarpathians (biomass & small hydropower);
- VIII South Plain (biomass, geothermal and solar energy).

In 2007 there were about 20 companies with green certificates producing renewable energy, with installed power plants of 47 MW in Romania. In recent years, the number of alternative energy sources (solar, wind, biomass) has largely increased and previously constructed systems have been upgraded. Of special interest to individual consumers was the "Green House Program" (afm.ro/casa_verde), a Government program intended to finance the implementation of alternative sources production systems. Rehabilitation and extension of the national electricity distribution and gas networks must also be achieved along with interconnection to national and European grids, which will ensure a higher degree of security of supply.

Taking into consideration that Romania technically has potential significant availability of renewable energy, at this point only a very small proportion is used, with the exception of hydroelectric. To ensure a sustainable future energy production must always take into consideration the carrying capacity of the environment for the quantity and quality of energy and pollution problems generated. In order to minimise the environmental impact of energy production, it is necessary to reduce the emissions from Large Combustion Plants whose running is essential for the National Power Grid, as these are the main polluters in the energy sector.

Significant research in Universities of the North East Region is being carried out on the assimilation and implementation of new sources of energy in different fields, on the efficient use of various "cold" technologies in housing construction and also in the transport vehicles and infrastructure. New modes of transportation including cycling routes and hybrid vehicles are encouraged to be used and implemented as a result of existing EU projects like CIVITAS, EFFECT, etc. At the same time, green construction technologies for housing and for transport infrastructure are being researched and implemented. Thus, in the field of road and street construction, new concepts and construction technologies, developed recently, in the frame of Technical University Gheorghe Asachi of Iasi, such as Long Lasting Flexible Pavements (LLFP) (Tanasele, 2013) involving new concepts of pavement structures, will extend the life of asphalt roads from 25 to 50 years, thus contributing to significantly reduced costs and emissions, during the construction and maintenance processes. In similar way, the implementation of the new developments in the field of concrete pavements (Puslau, 2012) such as Long Lasting Rigid Pavement (LLRP), Steel Fibre Reinforced Concrete, Rolling Compacting Concrete (RCC), will have similar impact on reduced costs and emissions.

3. CASE STUDY: COUNTY OF IASI

The overall aim of this case study is to evaluate the existing needs for energy and the status of the actual energy consumption in order to improve and develop better strategies for:

- production of non-renewable energies;
- limitation of the actual use of the existing power plants, by decentralising power

plant supply and extending the network of individual/private gas heating installations;

- Undertaking appropriate traffic management policies, such as implementing alternative daily permits of the user of vehicles, in order to drastically reduce the actual GHG emissions and traffic impacts expressed in terms of barrier effects.

Figure 5 – General Map of the County of Iasi (google.ro/Iasi County)

Figure 5 represents the general map of the County of Iasi which has an area of 5,476m$^{2.}$

Figure 5 illustrates the County of Iasi which has an area of 5,476 km^2. According to the 2012 data provided by the County Population Register Service, the total registered population of the county is 873,662 people. The Institutions involved in decision process for Iasi County are the City hall, Prefecture, and City Council. The Administrative Divisions of Iasi County has 2 municipalities, 3 towns and 93 communes. Iasi County is predominantly agricultural due to its topography. Industry is concentrated in the cities Iasi, Pascani, Hârlău, Târgu Frumos and Podu Iloaiei. The main industries are software, pharmaceuticals, automotive, metallurgy and heavy equipment manufacturing, electronics and electrotechnics, textiles and food production. The city of Iasi is the most important city in the North East Region, and one of the most important cultural centres in Romania. It has the oldest University in the country, and, until the formation of the United Principalities, it was the capital of Moldavia.

Objectives and methods

In the field of production of renewable energy, international companies together with other stakeholders are involved in the design and construction of wind farms located in the county of Iasi due to the wind speed being favourable, as shown in *Table 7*.

Scobinti Iasi	ACK srl Romania	40 MW	Scobinti-Iasi
Ruginoasa Iasi	Moldova-Eolian srl Romania	100 MW	Ruginoasa-Iasi

Table 7 – List of wind farms developed during 2012 in the county of Iasi

In the field of waste management, Iasi County Council has developed a partnership with districts from Republic of Moldova, under the bilateral treaties signed with the district of Ungheni. As a result of this the IASI Intercommunity Development Association was formed, which manages the waste problem for the whole county, its purpose being to attract funding from EU using the Sectoral Operational Programme. The operation of waste management is not well developed, with over 51% from the total number of Iasi localities not having a management service for waste. The situation is better regarding water supplies which has 59% coverage. Regarding the water network, some public authorities have prepared development projects under the SAPARD project, while some of them are being prepared under the National Rural Development Program.

Long term focus

The financial resources of the local authorities from county of Iasi are dependent on the degree of access to public or private transport. Some localities isolated from eastern Iasi County have difficult accessing urban services due to distance and poor quality road infrastructure. Poor technical condition of roads and streets, provides a barrier effect to development expressed in terms of increased pollution such as noise, vibration, emissions (NC, CO2e, NOx, etc) and habitat mortality. Recent research (Horobet, 2013) undertaken in the frame of Tehnical University Gheorghe Asachi.

of Iasi, demonstrated that the barrier effect will double in the period 2010-2035, thus justifying the urgent need forspecific action in this field. These results are presented in *Figure 6*, *Figure 7* and *Figure 8*.

These figures illustrate that a reduced barrier effect does not exist at the level of 2010 year and that the barrier effect almost doubles between 2010 to 2035, reaching to 64.13%;

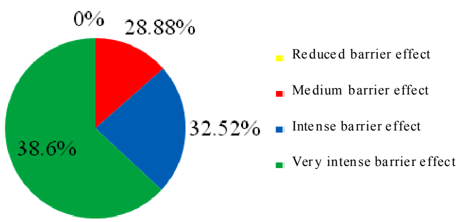

Figure 6 – Barrier effect on national roads for 2010

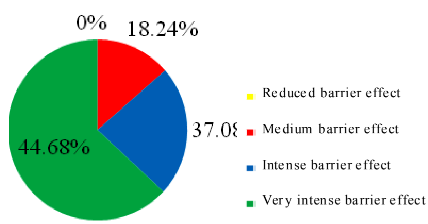

Figure 7 – Barrier effect produced on national roads for 2025

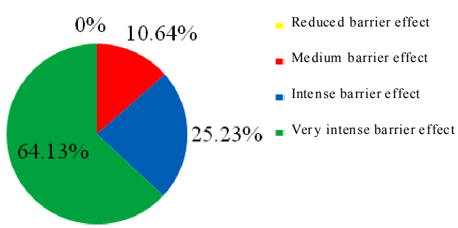

Figure 8 – Barrier effect produced on national roads for 2035

In the long term it is envisaged that the projects and research trends should be further developedbased on the existing experience and expertise, and should be improved and completed with the existing knowledge and know-how , acquired by active participation of specialists , in international research programs that focus on this issues. This will involve developing technical training programs for persons involved in accessing funds, dissemination of the positive results and sharing experiences.

The development strategy of the County is heading primarily towards ensuring and improving where the situation requires providing a healthy living environment for future generations.

Outcomes and barriers

The main drivers for a Smart Energy Region include ‘green projects’ involving wind, solar, hydro and biomass energy sources as described above. In this context, the following outcomes and achievements are highlighted:

- refurbishment of over 67% of the total old building infrastructure of the main towns in the County;
- construction of wind farms located in Scobinti and Ruginoasa as mentioned in Table 7;
- achievement of the ongoing SAPARD projects on waste management at the level of Iasi County;
- experimenting and promoting green technologies for the construction and rehabilitation of County roads;
- evaluation and implementation of specific risk and pollution assessment using GIS methods for existing damaged infrastructure of the Iasi City (Atanasiu, Bratianu, Leon, 2008), particularly in urban areas with a high potential of seismic hazard. The extension of the evaluation methodology and the use of GIS technology for developing digital maps of seismic vulnerability and of negative effects of lack of rehabilitation existing built infrastructure.

The most important barrier in preventing the implementation and extension of such 'green projects' is a lack of finance and funds at regional and national level. A second most important barrier is technical in that the assimilation and implementation of 'green technologies' requires a high level of expertise, new research and 'know how' and appropriate transfer of this knowledge.

A third barrier is psychological, with the resistance of the people to implement the new technologies.

The main drivers to the energy shift include political, technical and economic which will depend significantly on energy policies adopted by local and national government.

4. CONCLUSIONS

1. In accordance with sustainable development objectives set at a European level, Iasi county strategy follows horizontal sustainable development principles through attention to environment protection with direct impact on the quality of inhabitants life.

2. Harnessing energy resources represents a challenge and also an important opportunity for Iasi County, both from the point of view of environmental protection and quality of life of the inhabitants, as well as from the perspective of economic development.

3. A clear assessment of the efficiency and effectiveness of interventions on the rehabilitation of existing buildings, roads and streets, whilst taking into consideration future economic functionalities, will provide certainty of the rehabilitation of infrastructure components in the county of Iasi

4. For the successful achievement of a 'North-East Smart Energy Region' there is a great need to assure a systematic interaction between the all stakeholders involved including central and local government, the North-East Regional Development Agency (ADR), Universities and regional environment agencies. Also, it is very important to identify the financial, technical and psychological barriers, as mentioned above, in order to undertake the appropriate measure to overcome them.
5. The case study, involving the county of Iasi, is representative for the North-East Region with regard to all the aspects describing a 'Smart Energy Region' including significant achievement and future driver in the field of reduction of energy consumption in both housing and transportation fields.
6. The main initiatives in the 'green projects' described above could be applied to the whole Region, thus contributing to the diversification of various sources of energy, and at the same time by adopting 'green construction of housing and transport technologies' to reduce the high demand for energy in the Region.
7. The initial results of North-East Region and particularly of the county Iasi study could be transferred to the other low developed regions of Romania, such as South West Oltenia and the South East.

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SERBIA

AUTHORS

Aleksandra Krstic-Furundzic
Faculty of Architecture
University of Belgrade
E: akrstic@arh.bg.ac.rs
Bulevar kralja Aleksandra 73/II, Belgrade

Aleksandra Djukic
Faculty of Architecture
University of Belgrade
E: adjukic@afrodita.rcub.bg.ac.rs
Bulevar kralja Aleksandra 73/II, Belgrade

1. OVERVIEW OF THE REGION

Characteristics of the Region
The region of research is the region of Belgrade. Boundaries of Belgrades region overlap with the boundaries of its metropolitan area. Belgrade is the capital and largest city of Serbia, the third largest city in South East Europe, after Istanbul and Athens, and among the largest in Danubian Europe. It is also one of the five regions in the Republic of Serbia, with more than 1.63 million inhabitants and covers an area of 3,974 km^2. It covers 3.6% of the territory of Serbia, and 24% of the country's population lives in the city. The city lies on two international waterways, at the confluence of the Sava and Danube rivers, where Central Europe's Pannonia Plain meets the Balkans. The city is placed along the pan-European corridors X and VII.

According the Law of Spatial plan of Republic of Serbia (Gazette RS 88/10) and Law of Regional Development, Belgrade's metropolitan area is a region (it belongs to NUTS 2 category). Belgrade also has a special administrative status within Serbia and it is one of five statistical regions of Serbia (*Figure 1*), with its own autonomous city government. Its metropolitan territory is divided into 17 municipalities, each having its own local council.

According the results from 2011, Belgrade region is one of the most developed in Serbia with GDP around €7,000 per capita, and an employment rate of 86.6%. More than 35% of Serbia's GDP is generated by the Belgrade region, which also has over 30% of Serbia's employed population.

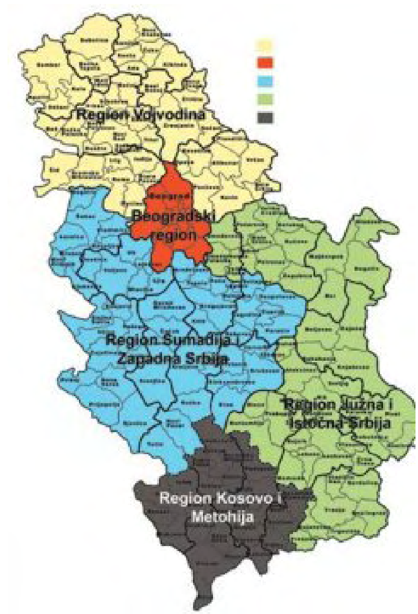


Figure 1 – Statistical (NUTS) regions of Serbia

Energy demand and supply of the Belgrade region
Energy balance of the Republic of Serbia assumes that all energy flows are observed in the three energy systems (Official Gazette of the Republic of Serbia, No. 122/2012):

- the system of primary (total) energy presents the structure of the available primary energy consumption. It is domestic production based on the use of its own resources of primary energy (coal, oil, natural gas, hydro and other renewable sources) and net imports of primary energy, including net imports of electricity. Showing the use of Renewable Energy Sources (RES) includes hydro usage statistics, production and use of geothermal and production of biomass and firewood.
- the system of transformation of primary energy presents the energy required for the

process of transformation of primary energy (including own consumption, losses in transformation, transmission and distribution of energy to the end users). The structure of this level consists of hydro power plants, thermal power plants – power plants, heating plants, industrial power plants, oil refineries, coal processing, and furnaces.

- the system of final energy integrates the final energy consumption for non-energy purposes and for energy purposes. Final energy consumption for energy purposes is expressed in two ways. The first method involves the structure of the sector, such as industry, transport and other (households, public and commercial activities and agriculture). Another method involves the structure of energy sources: solid fuels, liquid fuels, gaseous fuels, electricity, thermal energy, renewable energy. Since there is no reliable data on the structure of final energy consumption for energy purposes, this structure is mostly estimated.

The final energy consumption of Belgrade region added up to 95,346 TJ[1] (26,485 GWh) in the year 2012. It sub-divides into five sectors (*Figure 2*): the industrial sector with 19,620 TJ (5450 GWh), the housing sector with 29,340 TJ (8150 GWh), the commercial sector with 20,952 TJ (5820 GWh), the transport sector with 441,592 TJ (6310 GWh) and the agricultural sector with 2718 TJ (755 GWh), (Energoprojekt Entel, 2008b, p. 59).

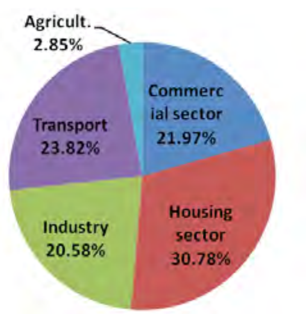


Figure 2 – Final energy consumption of Belgrade region according to sectors in 2012

The total (primary) energy consumption of Belgrade region added up to 153,252 TJ (42,570 GWh) in the year 2012. It subdivides into five sectors (*Figure 3*): The industrial sector with 32,450 TJ (9014 GWh), the housing sector with 57,916 TJ (16088 GWh), the commercial sector with 34,844 TJ (9679 GWh), the transport sector with 24602 TJ (6834 GWh) and the agricultural sector with 3438 TJ (955 GWh), (Energoprojekt Entel, 2008b, p. 65).

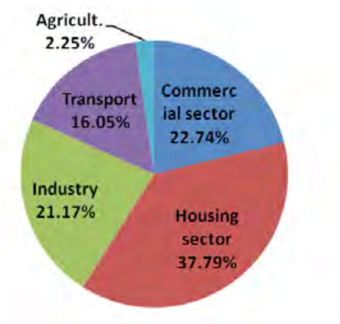


Figure 3 – Primary (Total) energy consumption of Belgrade region according to sectors in 2012

Total primary energy consumption in 2012 amounted to 16,247 Mtoe. Import dependence Serbia in 2012 amounted to 34%. In 2012, most imported crude oil 48%, natural gas 37%, coal 14% (Energy profile of Republic of Serbia for 2012, p.9).

The consumption structure of the transformation process, dominated by coal consumption with 67%, followed by crude oil and petroleum products 11%, natural gas 4%, hydro 8% and 9% of firewood, while geothermal energy less than 1% (Energy profile of Republic of Serbia for 2012, p. 9).
Total final energy consumption in Serbia in 2012 amounted to 10,404 Mtoe, of which the feedstock consumed 0,897 Mtoe, while final energy consumption for energy purposes was 9,507 Mtoe. By sector of final energy consumption is mostly consumed in the household sector 35%, followed by industry 30%, transport 24%, while other sectors accounted for 13%. On the other hand, the energy in final energy consumption was dominated by petroleum products by 29%

[1] Terajoule (TJ) equals 0,2778 Gigawatthours (GWh)

and electricity by 26%, followed by coal 12%, natural gas 13% and heat with 9% and renewable sources of energy (firewood and geothermal energy) accounted for 11% (Energy profile of Republic of Serbia for 2012, p. 10). Serbia's energy dependence has increased by 7% in 2012 compared to 2011 with 34% of primary energy being imported. Import dependence of Serbia is the largest when it comes to natural gas, following with oil. Serbia produces more than 98% of coal needed by the country. The structure of domestic coal is 98% lignite, while 2% were hard and brown coal and about 95% is consumed for power generation in thermal power plants.

Renewable energy sources in Serbia are hydroelectric, wind and solar energy, as well as the production and consumption of thermal energy from geothermal and solid biomass. The planned structure of primary energy from renewable sources for 2013 is 16%, while the defined goal is 27% in 2020; the share of biomass in renewable is 58%, hydroelectricity 41%, while wind, sun, etc. account for less than 1% (Energy balance of Republic of Serbia 2013, p. 10).

Biomass resources represent a significant potential energy source for Serbia. Serbia could replace 25% of their total energy produced with biomass facilities (Draft Energy Development Strategy of the Republic of Serbia by 2025. with projections to the 2030, 2013). The overall annual biomass potential in Serbia is approximately 28,000GWh. The predominant source of biomass in Serbia is agriculture (70%) with the rest coming from woody biomass. Serbia has some of the best solar resource in Europe. Its solar radiation average is around 40 percent higher than the European average. Annual solar irradiation for the country is approximately 1,400kWh/m^2. The lowest measured values of solar radiation in Serbia are comparable to the highest values in the leading countries in solar utilisation such as Germany and Austria.

Geothermal investigations in Serbia began in 1974, after the first world oil crisis. An assessment of geothermal resources has been made for all of Serbia. Detailed investigations in twenty localities are in progress. The territory of Serbia has favourable geothermal characteristics. Exploration to date has shown that geothermal energy use in Serbia for power generation can provide a significant component of the national energy balance. The prospective geothermal reserves in the reservoirs of the geothermal systems amount to 10 to the power of 6. The prospects for use of heat pumps on pumped ground water from alluvial deposits along major rivers are very good. Serbia has approximately 2,770 MW of hydroelectric capacity, which generates a third of their power. A majority of the capacity is from 11 large power plants. Only about 30 MW of capacity comes from small hydroelectric plants (less than 10 MW). Serbia is looking to double its hydroelectric capacity with about 2,800 MW of planned capacity (UDI, World Electric Power Plants Database, June 2009; Energy profile of Republic of Serbia).

As far as electricity is concerned, Serbia can meet the needs by own production, and produces more than 97%, while imports about 3% (Energy profile of Republic of Serbia).

Total energy consumption by fuel (%) in Belgrade region

The structure of final energy consumption in Belgrade region consists of the following fuel types (*Figure 2*; Energoprojekt Entel, 2008b, p.60):

- solid fuel – 6.44% (1705 GWh/a) in 2012; 7.9% (1927,74 GWh/a) in 2006;
- liquid fuel – 41.99% (11120 GWh/a) in 2012; 43.45% (10602 GWh/a) in 2006;
- natural gas – 7.74% (2050 GWh/a) in 2012; 3.68% (896,82 GWh/a) in 2006;
- electrical energy – 28.31% (7500 GWh/a) in 2012; 29.10% (7099,20 GWh/a) in 2006;
- thermal energy – 11.78% (3120 GWh/a) in 2012; 11.50% (2804,95 GWh/a) in 2006;
- renewable energy sources – 3.74% (990 GWh/a) in 2012; 4.37% (1064,88 GWh/a) in 2006.

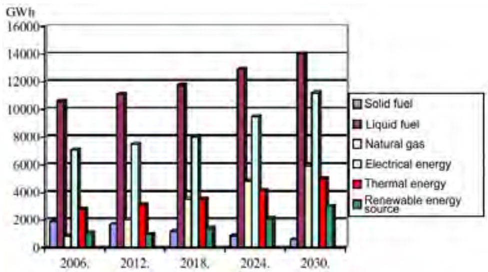


Figure 2 – Final energy consumption of Belgrade region according to type of fuel

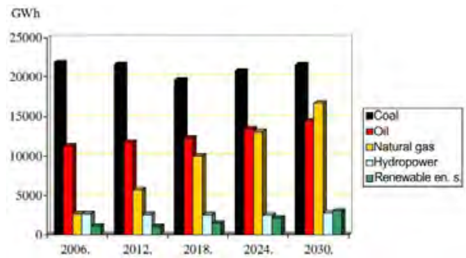


Figure 3 – Primary (Total) energy consumption of Belgrade region according to sources of energy

Primary (Total) energy consumption of Belgrade region according to sources of energy is (*Figure 3*; Energoprojekt Entel, 2008b, p.65):

- renewable energy sources – 2.34% (990 GWh/a) in 2012; 2.65% (1065 GWh/a) in 2006;
- coal – 50.71% (21587 GWh/a) in 2012; 54.31% (21860 GWh/a) in 2006;
- natural gas – 13.46% (5728 GWh/a) in 2012; 8.47% (3409 GWh/a) in 2006;
- oil and liquid gas – 27.56% (11733 GWh/a) in 2012; 28% (11270 GWh/a) in 2006;
- Hydropower – 5.93% (2522 GWh/a) in 2012; 6.57% (2645 GWh/a) in 2006.

Share of energy sources for electricity production

The thermal power plant in Belgrade region - Corporate Enterprise "Thermal Power Plants Nikola Tesla" produced and distributed to Electric Power System, 1,544,234.000 kWh of electricity in March 2012. The participation of the Corporal Enterprise "Thermal Power Plant Nikola Tesla" in the total production of EPS is 41.7%, and in the production of all power plants in the system 57.45%.

Serbia has significant potential for electricity generation and the structure of production is shown in *Table 3*.

Year	2006	2012
Thermal power plants (light fuel)	71.31	71.77
Hydro power plants	28.22	25.86
Cogeneration of natural gas	0.47	2.14
Renewable sources	0.00	0.23

Table 3 – Structure of electricity production in Serbia, %

Year	2006	2012
Final consumption GWh/a	7099.2	7500.0
Losses in distribution %	14.7	14.0
Amount of losses	1222.0	1221.0
Primary (total) energy GWh/a	8321.2	8721.0

Table 4 – Appraisal of electrical energy consumption and losses

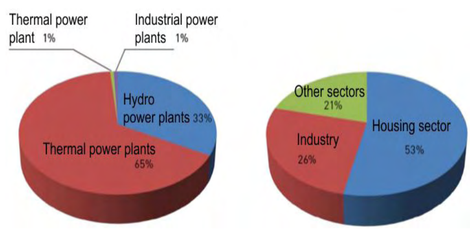


Figure 4 – Electricity production (left) and consumption (right) in Serbia in 2010 (Energy profile RS)

Appraisal of electrical energy production is shown in *Table 4* and *Figure 4*. The final electrical energy consumption of Belgrade region is shown in *Table 4*, in GWh/a, while consumption according to sectors is shown in *Figures 4*. A large amount of electricity is produced from carbon-intensive fuels – coal in power plants with low efficiency. Electricity consumption per capita in Serbia is shown in *Table 5*.

Republic of Serbia	2010	2011	2012
Efficiency of transformation (FE/PE)	0.57	0.57	0.59
Consumption of PE (kg en/capita)	2134	2224.5	2232.6
Electricity consumption (kWh/capita)	3789	3878	3898
Share of household electricity consumption%	53	52	53

Table 5 – Electricity consumption per capita in Serbia (Energy balance of RS, 2012)

GHG emission factor for electricity from grid
According to the regulations on energy efficiency in buildings, CO_2 emissions, which occur during the operation of the buildings, shall be determined on the basis of specific CO_2 emission data for individual energy sources. The annual primary energy required for the operation of the building by source of energy, must be multiplied by the specific data of CO_2 emissions, which is given in the Regulations and specific emissions for electricity is 0.53 kg/kWh. Data regarding carbon dioxide emissions in Serbia are presented in *Table 6*.

Carbon dioxide emissions							
Total		Carbon intensity		Per capita		Kg per 2005 PPP $ of GDP	
Thousand metric tons		Kg per kg of oil equivalent energy use		Metric tons			
1990	2009	1990	2009	1990	2009	1990	2009
	46.25		3.0		6.3		0.7

Table 6 – Carbon dioxide emissions, Serbia (World Development indicators, 2013)

Serbia is an energy intensive country, as well as Belgrade region – energy is not used efficiently. In addition, the electrical and thermal energy are produced in the most ancient plants that mainly use lignite as a fuel that has a relatively high level of emissions of greenhouse gases. Serbian energy sector has been hit hard by falling behind in maintenance and investments 90s, and suffered considerable damage during the war in 1999 year. Total emissions of greenhouse gases (*Figure 5*) measured per unit of gross domestic product (intensity of emission of gases with greenhouse effect Serbian economy) are among the highest in Europe (Energy profile of Republic of Serbia).

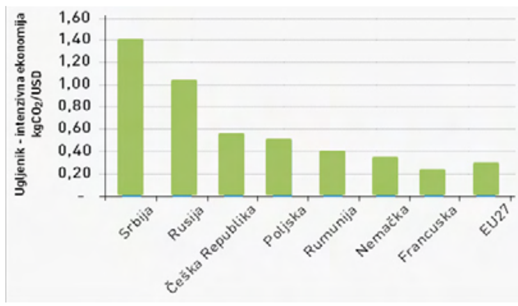


Figure 5 – Carbon dioxide emissions per unit of GDP/a measured by purchasing power parity in the 2009th (International Energy Agency, 2011)

Share of energy sources for thermal energy production (%)
For heat generation in the Belgrade district heating plants natural gas, liquid fuel, coal and municipality waste are used. Share of energy sources for thermal energy production is shown in *Table 7* and *Figure 6*.

Year	2006	2012
Natural gas	82.1	85.3
Liquid fuel	14.8	12.0
Coal	3.1	2.5
Municipal waste	0.0	0.2

Table 7 – Structure of fuel in district heating systems, %

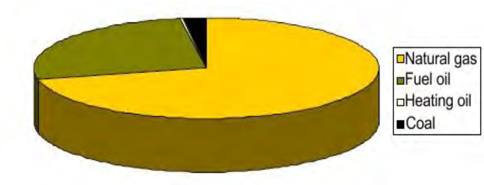


Figure 6 – The structure of heat power by fuels in Belgrade`s region

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

In order to reduce energy dependence of Serbia, it is necessary to fulfill three conditions (Energy profile of Republic of Serbia):

- to increase the production of energy from its own energy resources, primarily refers to hydro because Serbia has a dense river network, as well as to increase production of energy from renewable sources;
- to change the pricing policy that Serbia made only losses. Changing the pricing policy would mean higher prices and billing of electricity consumption according to actual consumption, rather than m^2 heating area. Both measures would certainly lead to a more rational use of electricity by households, and the decline in energy deficit RS, and indirectly reducing the import of electricity and energy;
- to set the legal and institutional framework to enable the production and sale of electricity to residents and companies.

Department of Energy, Secretariat of Housing and Municipal Affairs of the City of Belgrade, in cooperation with "Energoprojekt Entel" a. d. and the expert committee, formed by the City, created the Energy Development Strategy of the City of Belgrade. Energy Development Strategy of the City of Belgrade is in line with the objectives, concept and strategy to priority set out in the Strategy for Development of the City of Belgrade and the Strategy of Energy Development of the Republic of Serbia.
As part of the Energy Strategy of Belgrade, which covers the period up to 2030, the current situation in all aspects of production, transmission and consumption of all forms of energy is analysed and such strategic directions of the strategy are defined allowing the objectives to be achieved by ensuring sustainable development and efficient management of energy. When drafting this document modern statistical methods, Eurostat have been applied in order to achieve optimal effects while satisfying the energy needs of the City.

Calculation of final energy consumption by 2030, indicates that the following factors have a relatively large impact on energy consumption in Belgrade: assumed dynamics of growth of living standards and industrial production and dynamics of increasing energy efficiency, especially in the heating of buildings. The highest energy consumption is in households, and lowest in agriculture, and hence the fastest growing its percentage share of final energy consumption. In the case of achieving the projected growth of certain sectors, the total annual final energy consumption in Belgrade in 2030 would reach 39,860 KWh (Table 8), or 3,247,343 toe, so that consumption per capita increased from 1.31 toe (in 2006) to 2.14 toe by the year 2030.

Final energy consumption, GWh					
Year	2006	2012	2018	2024	2030
Industry	5037	5450	5800	6300	6920
Housing sector	7930	8150	8800	10560	12350
Commercial sector	5130	5820	6840	8000	9280
Transport	5807	6310	6950	8060	9450
Agriculture	491	755	1060	1495	1860
Total	24395	26485	29450	34415	39860

Share in percent, %					
Year	2006	2012	2018	2024	2030
Industry	20.65	20.58	19.69	18.31	17.36
Housing sector	32.51	30.78	29.88	30.68	30.98
Commercial sector	21.03	21.97	23.23	23.25	23.28
Transport	23.80	23.82	23.60	23.42	23.71
Agriculture	2.01	2.85	3.60	4.34	4.67
Total	100.00	100.00	100.00	100.00	100.00

Table 8 – Appraisal of final energy consumption of Belgrade region according to sectors with projections by 2030

Appraisal of final energy consumption of Belgrade region according to sectors and energy sources with projections by 2030 is shown in *Figure 7*.

Primary (Total) energy consumption, GWh					
Year	2006	2012	2018	2024	2030
Industry	8378	9014	9468	10443	10984
Housing sector	16429	16088	15663	17853	19960
Commercial sector	8812	9679	11006	12410	13779
Transport	6020	6834	7819	9492	11386
Agriculture	610	955	1369	1852	2344
Total	40249	42570	45326	52050	58453
Share in percent, %					
Year	2006	2012	2018	2024	2030
Industry	20.81	21.17	20.89	20.06	18.79
Housing sector	40.81	37.79	34.56	34.30	34.15
Commercial sector	21.91	22.74	24.28	23.84	23.57
Transport	14.95	16.05	17.25	18.24	19.48
Agriculture	1.52	2.25	3.02	3.56	4.01
Total	100.0	100.00	100.0	100.	100.0

Table 9 – Appraisal of Primary (Total) energy consumption of Belgrade region according to sectors with projections by 2030

The assumed structure of final energy consumption by type of fuel is given in *Table 10* and *Figure 8* (Energoprojekt Entel, 2008b, p.60 data). It can be concluded that the commitment to the reduction of the share of coal and liquid fuels in final energy consumption is present, due to environmental reasons and in order to increase the consumption of natural gas. However, liquid fuels remain the dominant fuel in the final energy consumption despite the partial substitution with natural gas. Share of electrical energy is maintained at almost the same level (by 2030 dropped by only 1%), similar to the share of thermal energy (by 2030, rising only by 1%). The strategic decision to increase the share of renewable energy is evident.

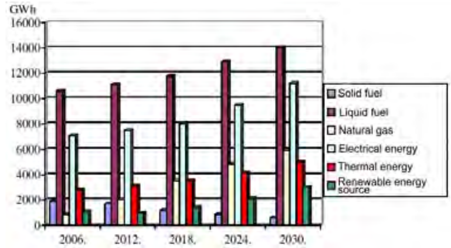
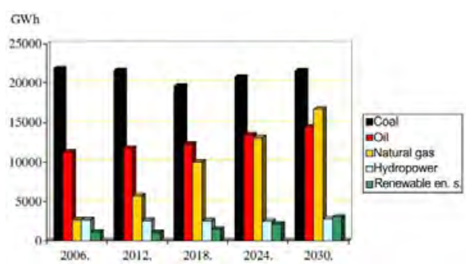


Figure 8 – Projections of the structure of total final energy consumption in Belgrade region according to types of fuel, until 2030

PRIMARY (TOTAL) ENERGY, GWH/A, (%)					
YEAR	2006	2012	2018	2024	2030
Renewable energy source	1065.0 (4.37)	990.0 (3.74)	1420.0 (4.82)	2130.0 (6.19)	3000.0 (7.53)
Solid fuel	1927.7 (7.90)	170.05 (6.44)	1190.0 (4.04)	885.0 (2.57)	620.0 (1.56)
Natural gas	896.8 (3.68)	2050.0 (7.74)	3550.0 (12.05)	4850.0 (14.09)	5940.0 (14.98)
Liquid gas	10602 (43.45)	11120 (41.99)	11780 (40.00)	12890 (37.45)	14050 (35.25)
Electrical energy	7099.0 (29.10)	7500.0 (28.31)	8010.0 (27.20)	9500.0 (27.61)	11220 (28.14)
Thermal energy	2805.0 (11.5)	3120.0 (11.8)	3500.0 (11.9)	4160.0 (12.1)	5000.0 (12.5)
Total	24395 (100)	26485 (100)	29450 (100)	34415 (100)	39860 (100)

Table 10 – Appraisal of final energy consumption of Belgrade region according to type of fuel with projections by 2030

Appraisal of primary (total) energy consumption of Belgrade region according to sources of energy sectors with projections by 2030.is shown in *Table 11* and *Figure 9* (Energoprojekt Entel, 2008b, p.65).



9 – Appraisal of Primary (Total) energy consumption of Belgrade region according to sources of energy with projections by 2030

PRIMARY (TOTAL) ENERGY, GWH/A, (%)					
YEAR	2006	2012	2018	2024	2030
Renewable energy source	1065 (2.65)	990 (2.34)	1420 (3.13)	2130 (4.09)	3000 (5.13)
Coal	21860 (54.31)	21587 (50.71)	19637 (43.32)	20959 (40.27)	21560 (36.88)
Natural gas	3409 (8.47)	5738 (13.46)	9501 (20.96)	13072 (25.11)	16682 (24.71)
Oil and liquid gas	11270 (28.00)	11733 (27.56)	12318 (27.18)	13416 (25.77)	14441 (24.71)
Hydro power	2645 (6.57)	2522 (5.93)	2449 (5.41)	2475 (4.75)	2770 (4.74)
Total	40249 (100.0)	42570 (100.0)	45336 (100.0)	52052 (100.0)	58353 (100.0)

Table 11 – Appraisal of Primary (Total) energy consumption of Belgrade region according to sources of energy with projections by 2030

Bearing in mind the level of efficiency of thermal power plants, with their improvements through rehabilitation of existing and construction of new facilities (*Table 12*), especially those with a combined gas-steam cycle, and the gradual reduction of losses (*Table 13*) in the distribution of electricity, amount of primary energy (coal, liquid fuels and gas) needed for the production of electricity required for the area of the City of Belgrade, is analysed. Use of hydropower and wind, as renewable energy sources, is taken into consideration in the assessment of electrical energy production.

Year	2006	2012	2018	2024	2030
Thermal power plants	71.31	71.77	65.15	61.92	56.27
Hydro power plants	28.22	25.86	22.14	24.30	22.07
Cogeneration of natural gas	0.47	2.14	11.82	11.23	18.42
Renewable sources	0.00	0.23	0.89	2.55	3.24

Table 12 – Structure of electricity production in Serbia (%) with projection by 2030

Year	2006	2012	2018	2024	2030
Final consumption GWh/a	7099.2	7500	8010	9500	11220
Losses in distribution %	14.7	14	13	12	11
Amount of losses GWh/a	1222	1221	1197	1295	1387
Primary (total) energy	8321.2	8721	9207	10795	12607

Table 13 – Appraisal of electrical energy consumption and losses

In the process of heat production priority is given to natural gas (*Table 14*), which contributes to reduction of environmental pollution.

Year	2006	2012	2018	2024	2030
Natural gas	82.1	85.3	89.1	92.7	94.5
Liquid fuel	14.8	12.0	7.8	3.9	1.4
Coal	3.1	2.5	2.3	2.2	2.1
Municipal waste	0.0	0.2	0.8	1.2	2.0

Table 14 – Structure of fuel in district heating system (%) with projection by 2030

According to a most recent study, entitled European Green City Index, Belgrade is in 27th place by the state of key environmental parameters (score 40.3/100) (Economist Intelligence Unit 2009). One of the included parameters is CO_2 emissions. According to those criteria, Belgrade is in 28th place, and according to transport criteria it is in 29th place. Cities were evaluated based on eight environmental categories. The categories include CO_2 emissions, energy, buildings, transport, water, land use, and air quality. The best ranking for Belgrade was for the energy parameter (17th place). The reason for this lies in the decline and reduction of heavy industry, as a consequence of the situation in the 1990s. The worst result for Belgrade was in the field of transport and water. In these categories Belgrade ranked 29th of 30 European cities (transport 3.98/8.81; water 3.90/9.21).

CO_2 emissions per capita are 3.9t compared to the average CO_2 emissions of 5.2t. Considering this sub-category Belgrade is ranked 7th in the overall ranking and 1st in the category of mid-size cities. The reason for this is reflected in the fact that the majority of electricity production in Serbia comes from hydropower (Djukic, Vukmirovic, IJJTE, 2011).

Serbia has not yet conducted a full greenhouse gas inventory and is yet to submit its First National Communication under the UNFCCC. Based on vehicle inventories, fuel use and vehicle mode share, the estimated total GHG emissions in 2008 from Belgrade's passenger road transport is 449,490 tonnes. It is estimated that over 60% percent of the total air emissions in Belgrade come directly from automobile sources, with private cars constituting a growing fraction of these emissions (Support to Sustainable Transport in the City of Belgrade, 2010).

The transport sector, which accounted for 11% of total CO_2 emissions in Serbia already in 1999, represents the fastest growing source of CO_2 emissions in Serbia and Belgrade today. The main factors contributing to GHG emissions in the transport sector in Belgrade are: (1) the large number of vehicles registered and operating in Belgrade (more than 420,000 cars in 2007, or one third of all vehicles in the country); (2) a relatively high proportion of old cars, with an average car age of 13 years and corresponding high levels of gasoline consumption exceeding 10 liters/100 km (or about 0.23 kg CO_2 /km); (3) increasing road congestion, which results in stop-and-go maneuvering and therefore poor fuel economy and higher emissions of GHG; (4) high intensity of freight transport (11,000 lorries and trucks enter the city every day); (5) 8000 taxis are operating in the city (Support to Sustainable Transport in the City Of Belgrade Project Document).

The study shows that 40% of people go to work using public transport while the remaining 35% walk or use bikes. This is 75% which is more than the 63% of using a non-motor transport as the average value for European cities. This result was achieved thanks to the extensive public transport system. However, public transport vehicles (buses, trams and trolleys) are in very bad condition, so work is needed to modernise them. The traffic control and management system is outdated (Economist Intelligence Unit 2009).

Specific energy-related technology present in the region

The Electric Power Industry of Serbia (EPS) encompasses coal mines, electric power sources (hydroelectric power plants, thermal power plants, heating plants) and grid distribution systems (Environment in Serbia, 2007, SEEPA).

The 1990 – 2005 period was characterised by reduced energy consumption by 6% and a predominant use of fossil fuels (coal, oil and gas). However, a trend of slow reduction of fossil fuel consumption is perceptible as their share decreased from 97.9% to 93.6% and the energy consumption from renewable resources (hydroelectric power plants) increased from 4.7% to 6.9% (Environment in Serbia, 2007, SEEPA).

Over the 1990 – 2005 periods, the structure of energy consumption changed significantly. The highest increase in energy consumption was achieved in the transport sector – 29.5%, slightly lower in the sectors of households, agriculture, public and commerce – 10.4%, while a decline of 36.7% was recorded in the industrial sector (Environment in Serbia, 2007, SEEPA).

Current Situation

Initiatives and measures for improving the state of transport and CO_2 emissions

The strategic approach of Belgrade in this domain is defined in the General Plan of Belgrade 2021, Transportation Model of Belgrade 2007, Traffic Master Plan of Belgrade: Smart Plan 2021 and the Development Strategy for the City of Belgrade 2012. One of the targets for the Belgrade region is reduction of GHG emissions and increasing use of sustainable and non-motorised modes of travel, as well as reduction of 285 tons of CO_2 per year until 2014 in the transport sector.

In accordance with these documents, the Secretariat of Transport of the City of Belgrade and other institutions implement various initiatives and projects in order to resolve these problems. The aim is to increase the use of public transport to a level of 50%, and in addition to encourage other forms of sustainable transport, i.e. walking and cycling.

One of the projects of that kind, which showed good results, is the implementation of parking zones in the centre of the city. This project restricts the duration of parking to 1 hour, 2 hours and 3 hours depending on the zone. When the time expires, the driver is required to move the car to another location. This measure led to the reduction in the number of cars in the central city area (City of Belgrade, 2011).

In accordance with these goals pedestrian and bicycle transport should be significantly improved. The main tasks related to this are: freeing public space intended for pedestrians from parked vehicles and other barriers, increasing attractiveness of public transport, and creating conditions for realisation of attractive pedestrian and cycle spaces and routes.

Regional targets, barriers and drivers

Climate-friendly mobility

The City of Belgrade Development Strategy from 2009, in the topic area related to traffic, provides for the construction and development of the transport system of Belgrade. This will allow sustainable mobility of citizens, still supporting the rapid development of the city and its competitiveness in the region of Southern Europe (Stojkov, 2008). One of the operational goals is the implementation of a transport system that will contribute to the environmental optimisation of the city. This will be achieved by:

- construction of the first line of the high capacity public transport system in Belgrade;
- stimulating the use of Beovoz trains in commuter transport (shorter but more reliable intervals) in the public transport system of the City;
- reorganisation of public city transport in the vicinity of the Beovoz train corridor as well as within the whole network;
- introduction of river passenger transport;
- increasing the attractiveness of trolley buses and trams (which are powered by electricity);
- increased level of transport safety;
- development of new technologies (traffic management and control, ITS);
- development of bicycle transport;
- stimulating pedestrian transport;
- rehabilitation and modernisation of city streets in urban centre in line with transport demands and standards;
- Modernisation of local roads (Stojkov, 2008);
- Fuel shifting towards low-carbon fuels.

Reducing the average distance of trips (mode-shifting to higher capacity public transport options will improve the load factor; and better integration of land-use planning around transport corridors combined with improved parking management).

The Strategy envisages the retaining of the level of passenger car travel, amounting to 25 – 30%. The use of public transport must reach the level of 45 – 50% of daily trips and ensure a high level of service. Walking is planned at a level of 20 – 25% in intercity movement. Para transit (cycling, taxi and other types of collective transport) must reach the level of 5 – 10% of daily trips (City of Belgrade, 2005). As part of its Transportation Management Plan, the City of Belgrade has initiated various programs such as Park and Ride facilities and increased bus lines to reduce congestion into Central Belgrade.

3. CASE STUDY: REFURBISHMENT OF SUBURBAN APARTMENT BUILDINGS, KARABURMA

Karaburma is a residential area and one of the most populous neighbourhoods of Belgrade, with a combined population of 34,343.
The buildings were built in the late 1950s and early 1960s for workers who were employed in factories in the area. During the 1980s and 1990s most of the factories were closed.
The fact that buildings were designed without consideration to energy consumption, as well as the building deterioration, are the reasons of negative consequences in terms of the poor living conditions, health problems of the residents and greater wasting of energy.

The main technical problems can be summarised as follows: poor thermal and noise insulation of the envelope (facades, roofs, ground floors) and noise insulating efficiency of door and window frames; leaking of the roofs; lack of district heating. A technical problem that should also be indicated is accessibility for disabled, particularly caused by the lack of elevators.

The renovation has been funded by by private investors (building contractors). Through the improvement of the existing buildings investors gain the right to annex the attic or a few floors, which results in construction of new housing units. The investors gain profit by selling these additional flats. Although the main motivation of investors is profit, it can be concluded that the improvement of housing conditions is achieved which promotes the refurbishment of suburban districts affected by social, economic and architectural deterioration.

Objectives and methods

The refurbishment of about hundreds of similar detached buildings was carried out along the main streets around the settlement (see *Figure 10*).

Figure 10 – Buildings in Vojvode Micka Street, Karaburma, bird's eye view

The main objectives of the refurbishment are the compliance with new regulation in terms of accessibility and energy efficiency, the fulfillment of the real needs of the users as well as the improvement of the building's architectural and technical quality. The following main refurbishment strategies are foreseen: improvement of living comfort, especially thermal comfort and energy efficiency of buildings, as well as visual identity and appearance of buildings and settlement.

Figure 11a – View of the buildings type 2 (in the streets Vojvode Micka) before the refurbishment (source: Krstic-Furundzic A., 2012)

Figure 11b – View of the buildings type 2 (in the streets Vojvode Micka) after the refurbishment (source: Krstic-Furundzic A., 2012)

The improvement of living comfort and building appearance was achieved by annex of attics, addition of balconies as new structures and organised closing (glazing) of balconies, as well as by laying of thermal insulation on the facade surface and painting in different colors resulting in housing variation (see *Figures 11a, b*).
The refurbishment undertaken involves the building system and main roof load-bearing members being made of the same material as the building (masonry construction) while the roof structure is wooden. The addition of balconies is created as the new concrete structures (see *Figures 11a, b*). The balconies' slabs are supported partly by the building structure and partly by columns placed on the front. The same concept is applied in case of enlargement of existing balconies, which enabled better usability of the balcony, glazing options provided in advance and good appearance of the building.

These interventions resulted in:

- the recovery of lodgings with new typology of flats coming from attic annex;
- creation of improved dwelling typology by addition of new or enlargement of existing balconies;
- organised closing (glazing) of balconies or glazing options provided in advance creating new living spaces.

As masonry walls had no thermal insulation, their thermal performance was as follows: walls have high thermal transmittance, i.e.

U-value=1.06W/m2K; low inner surface temperature is obvious, thermal bridges are present, condensation is present; walls are wet and freezing is possible; mold growth is noticeable. Box type windows with float glass (4mm) are unfavourable, U-value=3.5W/m2K. Resulting high heat losses during the winter period, led to an increase of conventional fuels consumption and environmental pollution. Improvement of thermal performances of external walls included installing thermal insulation, breaking thermal bridges and replacing windows. All these measures were applied in case of refurbishment of existing buildings in Karaburma settlement.
The refurbishment of the envelopes of existing buildings included:

- laying of thermal insulation on the facade external surfaces – 5cm of expanded polystyrene is added to masonry 19cm tick walls which provided U-value=0,46W/m2K;
- replacement of existing wooden windows with double glazed windows made of three or five-chamber PVC profiles, U-value=2.3W/m^2K (subject to consent of the tenant);
- placing of thermal insulation of 10cm of expanded polystyrene (U=0,171W/m^2K) on the new roof structures.

Results
Installation of external wall insulation enables thermal bridges to be broken, as moisture is reduced, the temperature of inner wall surface is higher and provides existing external massive wall to be converted into energy rational structure consisting of three layers: existing solid wall as thermal storage layer, thermal insulation and external protective and final layer as re-cladding (Krstic-Furundzic), A.,1998). After improvement U-value=0,46W/m2K of external walls is litter higher than defined by actual regulations (0,40W/m^2K), that is due the refurbishment was done before new regulations on energy efficiency of buildings.

Since the refurbishment took place in the last three years, monitoring period has not long enough to provide conclusive evidence. However, by interviewing residents data on energy consumption for heating before and after refurbishment were provided (see *Table 15*).

	Heated floor area (m^2)	Primarly energy demands for heating			CO_2 emissions (kg/a)
		(kWh/month)	(kWh/a)	(kWh/m^2/a)	
Before refurbishment	64	4750	28500	445.30	15105
After refurbishment	69	2750	16500	239.12	8745
Savings/CO_2 reduction		2000	12000	206.18	6360

Table 16 – Primary energy demands for heating and CO_2 emissions before and after refurbishment (data for one standard flat)

In analysis of CO_2 emissions, as the apartments are heated with electrical energy, there were taken into account characteristics of electrical power network of Serbia (Regulations on Energy Efficiency of Buildings), indicating that the electrical power network for production of 1 kWh realises the emissions of 0.53 $kgCO_2$/kWh. CO_2 emissions before and after refurbishment are shown in *Table 16*.

Application of the described refurbishment measures enabled: improvement of spatial and thermal comfort, higher inner surface temperature, thermal bridges break, reduction in heat losses in winter and overheating in summer, thereby achieving energy savings and reduces consumption of conventional energy sources and environmental pollution. New appearance of buildings and blocks of flats is achieved by balconies and attic annex and variously painted facades.

Intervention is significant, but it is necessary that all buildings which were designed without consideration to energy consumption should be refurbished. Therefore, a transfer of the case study to the region—limited to the residential area of multi-family housing – seems appropriate.

Outcomes
In general terms, renovation of residential buildings in Karaburma could be recognised as a successful rehabilitation funded by private investors (building contractors).

It could be apply on the improvement of the existing privately owned multi-family residential buildings where investors gain profit by selling additional flats.

Apart from the resulting abatement of CO_2 emissions, and improvement of energy performances, the refurbishment also brought positive economic and social impacts, including a reduction in energy bills. Many interventions such as external wall insulation, glazing of balconies and replacement of windows have improved the thermal comfort of the properties together with their external appearance.
An important positive effect of the large-scale and regional approach is - recognising the affordable model due to the coast of intervention and investors.
Despite the positive overall outcomes, a set of issues have been identified as barriers to the achievement of better results:

- of investments, the improvement was just from energy class G to D;
- shortage of knowledge and skills on innovative measures among the professionals and the workers involved in the retrofits;
- private ownership of apartments in multi-family houses.

On the other hand, a series of conditions have been identified as active drivers:

- energy savings of about 40%:
- increase of the value of a property (apartments) for 30%.

4. CONCLUSIONS

As regards the Republic of Serbia, in conformity with Decision 2009/05 of the Ministerial Council of the Energy Community, the first Action Plan covers the period from 2010 to 2012 and sets the average indicative target for this period at 1.5% of domestic energy end use in 2008, and the end target at a minimum of 9% of energy end use in the ninth year of implementation (at the end of 2018). The energy end-use savings target of 1.5% will be attained by implementing measures towards increasing energy efficiency in household, public and commercial sectors (0.0235 Mtoe), industry (0.0566 Mtoe) and transportation (0.0453 Mtoe). During the APEE implementation period, the Republic of Serbia should continue introducing considerable legislative, fiscal, financial and organisational measures in the interest of full implementation of and adherence to the Directive.

In Belgrade, many of housing settlements dating from the late fifties and the sixties of the 20th century and represent a large percentage of the city's building stock. Most of them are consisted of a numerous of buildings with the same or similar layouts. Up to the seventies the buildings were designed without consideration of energy demands and consumption. Nowadays they are characterised by some social, architectural and technical problems, but building decay is the main problem. Old-age, lack of maintenance, poor quality of materials and improper design cause deterioration of buildings. Improvement of housing settlements is becoming increasingly inevitable. The same characteristics were feature of housing settlement Karaburma until the building refurbishment began in 2009. The improvement of living comfort and building appearance was achieved by annex of attics, addition of balconies as new structures and organised closing (glazing) of balconies, as well as by laying of thermal insulation on the facade surface and it's painting in different colours resulting in housing diversity as well as improvement of facade thermal performances. It is evident that heating demands are less for about 40 percent compared with heating demands before refurbishment, which means that the energy savings of about 40 percent are achieved and thus reduced environmental pollution. Achieved benefits contribute to other tenants opt for intervention.

Applied intervention for improving the energy performance of the multi-family housing sector can bring environmental, economic and social benefits, both on local and regional level.
It could be applied also in residential area in cities and towns throughout Serbia.

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SLOVENIA

AUTHORS

Metka Sitar
University of Maribor,
Faculty of Civil Engineering,
Architecture Department,
Smetanova ulica 17, 2000 Maribor,
Slovenia
E: metka.sitar@um.si

Vlasta Krmelj
EnergaP – Energy Agency of Podravje,
Institution for sustainable energy use
Smetanova ulica 31, 2000 Maribor,
Slovenia
E: vlasta.krmelj@energap.si

1. OVERVIEW OF THE REGION

Characteristics of the Region

Slovenia has a long tradition of regionalism and local self-government. Since there is no official intermediate level between the national and the local one, the municipalities are the basic administrative unites of local autonomy. There are 211 municipalities in Slovenia and The Municipality of Maribor (MOM) is the second biggest one after the Municipality of Ljubljana, the Slovenian capitol. Its territory is spread over 147,50 km^2 and had 113,487 inhabitants, representing 12% of Slovenian population (2 mio). Within the territory of urban region there are 33 settlements, with an average population density of 730 inhabitants/km^2, (in Slovenia 102 inhabitants/km^2). The MOM territory is divided in 6 administrative communities and 11 city districts.

The exceptional geostrategic position in the North East of Slovenia, between the Alps and Pannonia Lowlands, is of special advantage for MOM. The City of Maribor as the centre of the MOM is also the formal centre of the Statistical Region of Podravje with 310,743 inhabitants, which has no administrative function. Beside, Maribor is the University City with around 22,000 students that form the second biggest University institution in Slovenia. As an important national and international traffic hub, the MOM is at the crossing of two main European transportation routes, the first one linking the North West with the South East, and the second one linking the South East to the North West. Accordingly, it is the centre of administration, education, health services, cultural and financial institutions, and media for the North Eastern Slovenia.

According to the data by Census 2012, the MOM's GDP per capita is €17,343 that is close to the Slovenian average of €17,361. The active population comprises 37,137 people, but on the other hand, the unemployment rate of 14.1% is one of the highest in Slovenia. During past decades, the region suffered deep economic and social crisis and loss of traditional industries. Recently, the MOM has considerably improved its urban, social, and cultural image, as Maribor was the European Capital of Culture in 2012 and the European Youth Capital in 2013.

Figure 1 – Slovenia and the Municipality of Maribor

The MOM's position in Central Europe is at the meeting point of five regional entities of morphologically dominant typologies with influence on the diversity of economic activities. The first one belongs to the river Drava valley as the main axes for the transportation and the electrical energy supply for the region. The second one is the Pohorje hills with favourable conditions for livestock and tourism. The third one is hilly area of the Kozjak, covered mainly by forests. The fourth one is the attractive wine region of Slovenske gorice with vineyards and orchards, spreading to the agricultural land along the river Drava, which is the fifth one. Over the centuries, urban development of the city region has been growing along the both of the river Drava, yet the historical city centre of Maribor is situated at the left bank. After the WWII, the residential and industrial areas have predominantly appeared at the right banks of the river. Currently, in the redevelopment processes in these suburban the new centres are growing followed by extremely dispersed urban pattern in the outskirts.

Figure 2 – City of Maribor

Energy demand and supply of the Region

When considering the Sub-Pannonia climatic conditions, the MOM is characterised by continental climate with an average yearly temperature of 9.4°C, the lowest average temperature of – 1.3°C in January and the highest of 19.7°C in July. Despite the yearly average of 266 sunny days the climatic conditions determine enormous energy consumption during a long heating period of 227 days. According to the Census 2010, the total energy consumption was 2,198 GWh.

The majority of energy consumption belongs to the domestic described as buildings (905 GWh), followed by transport sector (645 GWh), other consumers, mainly the industrial and commercial sector (636 GWh), and public lighting (11 GWh). Accordingly, the consumers of all sectors produced a total of 686,931 tons of CO_2 emissions that equal 6.1 tons per citizen. Concerning the energy source and the specifics of individual sectors, the CO_2 emissions share is differentiating in large. The largest shares belong to the public lighting (0,51 kgCO_2/kWh) and other consumers (0,40 kgCO_2/kWh), while the smallest share belongs to buildings (0,28 kgCO_2/kWh) and transport (0,25 kgCO_2/kWh). The highest CO_2 emissions within the street lighting sector are caused by the electricity as a energy source while in buildings also renewable sources and fossil fuels with lower CO_2 emissions than electricity are used (*Figure 3*).

Concerning the consumption of energy, the ratio between the energy for electricity and the energy for heating is 37:63, and the ratio for the production of CO_2 emissions between electricity and heating is 59:41.

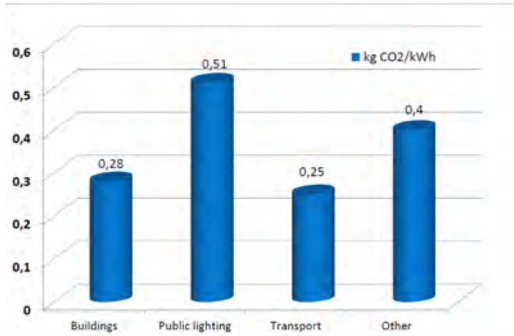

Figure 3 – CO_2 emissions from energy consumed in MOM, 2010

Currently, the energy for electricity is produced by hydro, coal and nuclear energy. Electricity is basicly produced by thermal power plants (47.5%), followed by nuclear (24.2%) hydro (30.9%) and photovoltaic energy sources (1.74%). The measurement of the CO_2 emissions is standardised by Technical Guidelines as 0,553 kg/kWh. In yearly calculation the exact emissions are determined by the % of primary sourced used for the energy production.

For the conventional combustion heating technologies mainly traditional energy sources as petroleum products, gas, and wooden biomass are used. According to the Census 2010, the share of renewable energy production (REP) for electricity was in total 299 GWh (51.67%). The share of renewable energy production for heating amounts at 16%. There was some additional energy produced for electricity by two small cogeneration stations, one small hydroelectric power plant and some photovoltaic modules, and for heating via heat pipes.

The analyses on REP capacity for the MOM have determined the high potential of sun- and wooden biomass energy, as well as of geothermal energy while the research on the potential of biogas is still in the preparation phase. However, for the next future there is no ambition to upgrade conventional technologies, but to eliminate petroleum products for heating.

The most informative data of energy consumption indicate the shares by individual consumers, as presented in *Figure. 4* in detail. The ratio between sectors of buildings and equipment and transport is 70:30, while the residential buildings achieved the highest share of 40% of total energy consumption in the MOM.

Buildings and equipment	**Energy consumption Share in %**
Municipality buildings (kindergartens, schools, administration buildings)	1.04
Residential buildings	40.15
Municipal public lighting	0.50
Other	28.95
Subtotal	70.64
Transport	
Municipality vehicles	0.01
Public transport	1.64
Private and commercial cars	27.71
Subtotal	29.36
Total	100.00

Figure 4 – The shares of energy consumption in the MOM, 2010

2. CURRENT SITUATION: THE ENERGY POLICY TARGETS VERSUS IMPLEMENTATION

During the 1990s and 2000s, a range of EU energy directives and guidelines were adapted with the intention of harmonising national legislation. A few of them are directly transferred in the national Energy Law, while the others are integrated in different sectors' documents, such as environmental protection, spatial planning, building construction, public procurement, and public-private partnership. In 2004, the MOM Spatial Development Strategy 2002 stated the main aspects of the long-term perspectives including the energy sector. Among others, it has introduced a new instrument, the Local Energy Concept for regions, cities, and local communities. In 2005, the Development Strategy of Slovenia defined the main sustainability criteria, such as the encouragement of energy-saving measures and the re-usage of materials. The energy-efficiency and renewable energy-sources were set as priorities for raising the awareness of public concern about the negative climate change impacts on build environment.

Another new instrument of crucial importance for the implementation of sustainability measures was the Law on Public-Private Partnerships. Introduced in 2006, it enables concrete actions over the building sector concerning the refurbishment and renovation of new and existing buildings. In parallel, in 2006 the Environmental Protection Law introduced operational programmes providing specific measures for the reduction of energy operating-costs, renewable-energy sources and environmentally friendly materials incorporated also within the Local Energy Concept. Further, a series of documents based on the Resolution on the National Energy Program 2004, the Law on Energy 2005, and the National Energy Efficiency Action Plan 2008 – 2016 initiated energy-efficiency measures for new and existing buildings.

The renewed version aims at achieving a 20% reduction of GHG emissions, a 20% increase in energy-efficiency, and a 25% special additional increase in renewable-energy involvement. Energy-efficient measures are also the central promotion topic for financial incentives provided by the Environmental Public Fund (Eco Fund) for new and existing buildings. Established in 2008, the Eco Fund offers subsidies and affordable loans for energy efficient, environmentally friendly energy sources and systems for private and public investments. Recent conditions regarding energy policies' implementations seek the establishment of new organisation at local levels, especially about the substantial need for the adaptation of the users' behaviour to the new conditions. In this regard, supported by EU co-financing, several regional energy agencies were established.

Among Slovenian municipalities, the MOM was extremely active during the last period, especially in view of the acceptance, programming and implementation of environmental protection measures. A range of energy savings measures was included as sustainability goals in strategic documents at local level. The Urban Development Concept for the City Municipality of Maribor was the first modern spatial planning document in independent Slovenia, launched in 2001.

Parallel, following the principles of the Aalborg Charter of European Cities towards Sustainability (1999) the City Council of Maribor adopted the Local Agenda 21 and the Environmental Action Program 2004 – 2008. In these documents, under the sustainability umbrella, the strategic goals as energy saving and the reduction of the CO_2 emissions are integrated. Finally, in 2006, the MOM and 17 small neighbouring municipalities established the Energy Agency of Podravje (EnergaP) as a coordination body, covering the territory of 180,000 inhabitants. During following years, the majority of activities were dedicated to the MOM, especially concerning the data collection.

In 2009, the MOM adopted the Local Energy Concept (LEC). It identifies a list of long-term sustainability objectives dedicated to the reduction of energy consumption and the raising of the REP. In the Action Plan, the main targets for 2020 are the reduction of the total CO_2 emissions at 20% compared to 2010, and yearly reduction of 137,386 tons of CO_2 emissions each year after 2020. Within the Action Plan objectives, the most relevant ones are the reduction of energy use (REU) at 20% in public buildings and street lighting, increase of the share of the REP in all sectors at 25%, and in public bus system at 10% by 2020. Concerning the construction sector, special attention is paid to the low energy buildings standard for new buildings. For the street lighting, the limit of energy consumption is maximum 44 kWh of energy consumption per capita per year.

The sustainability goals for 2020 are set as 30% reduction of greenhouse gas (GHG) emissions, 20% increase of REP, as well as 20% increase of energy efficiency in total by public transportation, households and companies.

The EnergaP targets, barriers and drivers

The awareness of the effects of energy efficiency measures on the users' behaviour is of paramount importance among activities of EnergaP. In this view, the EnergaP is permanently performing information, advice, and training concerning energy efficiency, renewable energy sources, and sustainable mobility. Within energy management issues, the EnergaP offers support for the preparation of local/regional energy plans, and the energy audits for public and private buildings, among others.

Concerning the information and educational campaign, EnergaP started the activities for the young generation between 6 and 15. Further, around 40 workshops and training courses for the city administration and interested citizens were organised. These incentives were encouraged also by the international cooperation, such as the network of EU Covenant of Mayors' Initiative signed in 2011, which promotes the importance of sustainable energy use for city development and the networking of local authorities and experts in research and practice. In 2009, the EnergaP upgraded the activities by the preparing of the LEC that determined the key guidelines for increasing the energy-efficiency, in particular in public buildings. One of the main objectives the reduction of energy consumption at minimum 3% yearly was adopted. In addition, the LEC highlighted the activities oriented towards the improvement of knowledge on energy-efficiency and energy renewable policies for initiating a network were of particular importance for neighbouring municipalities.

Among the first activities concerning the reduction of energy consumption, the EnergaP started with systematical collection of the data on it in public buildings. In municipalities, public buildings include administration and office buildings, primary schools, and kindergartens. The EnergaP coordinated the energy management system in form of different initiatives for city districts supporting the introduction of the centralised energy management system, incorporating the data on energy consumption, energy costs and CO_2 emissions, and the integration of REP.

EnergaP, established by financial support of EU, acts also as a contact point for European networks, serving the local, regional, and national players, as well as for the collaboration in the field of energy-management incentive funds at national and EU level.

Additionally, in the transport sector sustainable mobility was the topic of several research projects conducted by EnergaP. They set the theoretical and practical basis for increasing the awareness of the efficient energy use, followed by presenting the best practice models to the community. In order to achieve the LEC's objectives, the EnergaP also integrated the motivation of the industrial and commercial sector, which interest for the energy issues seemed to be declining.

One of the first projects initiated by the EnergaP was the international three-year' 'Minus3%' Project, established by five European cities as project partners: Dublin, Derry, Graz, Malacky, Teruel, and Maribor in the period 2009 – 2011. The main objective was to develop innovative methodology for the monitoring and assessment of energy consumption in existing buildings as a new instrument adaptable for other regions. The 'showcase project' was dedicated to the analyses and monitoring the energy-efficiency in 120 public buildings. As a main idea, the financial model on how to achieve the 3% savings yearly was systematically prepared. The first part focused on the step-by-step energy management process, dealing with the commitments, roles, and responsibilities of the energy manager and his team, the setting up of the energy database, and action plan, which integrates the implementation of appropriate measures in practice. The second part was a showcase project dedicated to concrete renovation of the building of the primary school (Osnovna šola Tone Cufar) in Maribor that integrated the refurbishment of facades, roof and floors, the retrofitting of entrance doors and windows, and the renovation of the heating system. In case of the renovation of heating system, the modern gas condensation boilers replaced old fuel driven boilers.

Within the Minus3% Project the Central Energy Management System (CEMS), launched in September 2008, has been tested. As one of the main initiatives by EnergaP, the CEMS was prepared in collaboration with experts and companies for controlling and monitoring the energy consumption for electricity and heating in public buildings. Among them, for the MOM primary schools and kindergartens were most relevant in view of energy costs, as well as GHG emissions. Based on the information and communication technologies, the CEMS enables the access to energy database for individual units, buildings, and group of buildings via Internet. The database's intention was primarily recording of authorised persons for monthly controlling of electricity and heat consumption, including costs, taxes and fees. Additional data on certain values, such as weather conditions, fuel prices, specific energy delivery agreements, and physical characteristics of buildings are included in the model. The system automatically calculates the GHG emissions concerning the source of energy for individual building, analyses the data and presents the results in different modes.

The most indicative data is the calculation of costs of energy consumption in € per unit of one m^2 or user per building. The controlling of energy consumption, costs, and CO_2 is based on the comparison between the calculated and the predicted savings over years. It enables the controlling of the system's functionality, and, in parallel, motivates the users for savings higher than the calculated ones. In such a case, the costs are attributed back to the users. Since the CEMS is based on the four-steps-principle planning– doing–checking–acting, the EnergaP acts as the main manager to overview both, the users' and buildings' energy consumption.

3. CASE STUDY: THE ENERGAP, DEMONSTRATING THE IMPACTS OF THE LOCAL ENERGY CONCEPT ON THE RENOVATION OF PRIMARY SCHOOLS

Although the relatively small number of public buildings (461) is using only 5% of total energy consumption, schools and kindergartens account for a large share of energy costs for the MOM, since the three quarters share of the existing buildings are estimated as inappropriate. Additionally, in public buildings also the inappropriate users' behaviour is a fact. On the other hand, high number of privately owned residential buildings have recently intensively improved the energy efficiency by renovation processes, financially supported by national subsidy schemes introduced by Eco Fund recently.

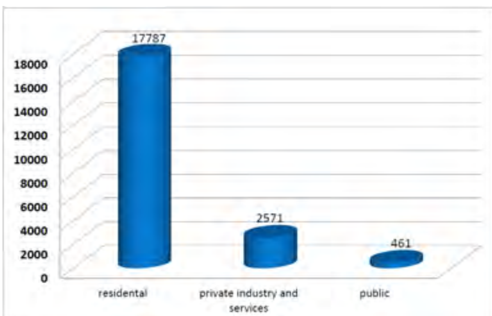

Figure 5 – Number and type of buildings in Maribor, (Census, 2010)

In regard to the improvement of the energy efficiency, the CEMS represents a special benchmarking system that enables the monitoring of energy consumption, the CO_2 emissions, and the financial saving potentials for individual buildings and a group of buildings on a monthly basis, by integrating different technologies for optimisation of energy systems. This experience is of paramount importance for the EnergaP ambition to implement the system also at national level.

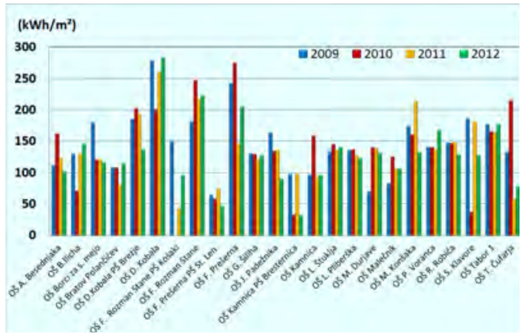

Figure 6 – Energy consumption for heating in 24 primary schools

The case study represents the results of the CEMS introduced in regard to the renovation of 24 primary schools in MOM. *Figure 6* indicates the results of the renovation presented by energy consumption for heating in kWh/m2 in 2009, 2010, 2011, and 2012. The results have confirmed the viability of the investment in the energy-efficiency refurbishment measures as reasonable.

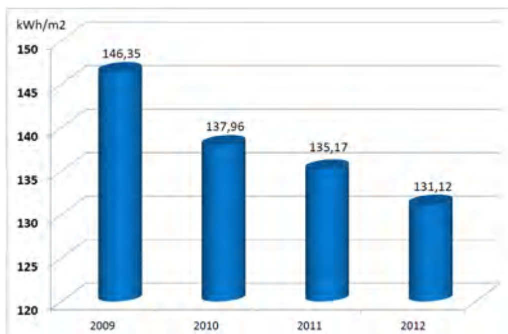

Figure 7 – Specific energy consumption for heat production in kWh per m² in 24 primary schools

The average specific energy consumption decreased from year to year, as presented in *Figure 7.* The first targeted value of the action was to reach the energy consumption of 80 kWh/m² by systematic step-by-step renovation process as experienced in the frame of the Minus3% Project. In 2012, the target of 3% of savings per year was achieved. *Figure 8* clearly demonstrates the savings in case of the renovation of the one primary school (Tone Cufar Maribor), already mentioned in frame of the Minus3% Project.

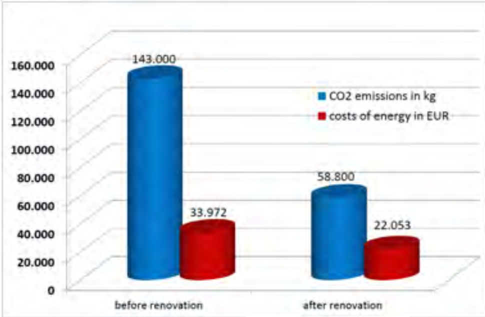

Figure 8 – Comparison of the CO_2 emissions and costs before and after the renovation of the primary school Tone Cufar Maribor

Concerning financial results in 2010, the MOM's investment in energy efficient renovation of 24 primary schools was €581,963, resulted in 5.7% energy savings and the decrease of specific energy consumption for heating from 146,35 kWh/m^2 to 137,96 kWh/m^2. In 2011, the investment of €337,191 resulted in 2% energy savings and the specific energy for heating decrease from 137,96 kWh/m^2 to 135,17 kWh/m^2. The CEMS' results have been presented to the decision makers annually, in order to encourage them for undertaking adequate changes of the implementation methods. Positive experience with the implementation of the CEMS is supporting the EnergaP tendency to develop an optimal methodology for energy efficient measures in the processes of renovation. Based on the experience with primary schools in the MOM, the renovation comprises the improvement of thermal insulation of the envelope including the facades, roofs and basements, the retrofitting of windows and doors, as well as the renewal of heating systems.

4. CONCLUSIONS

Energy efficiency represents one of the main challenges for local and regional communities in Slovenia. Concerning the stimulation of the energy savings and reduction of the CO_2 emissions, the experience of the CEMS in public buildings, especially in primary schools and kindergartens, has shown that for an appropriate management for improving the energy efficiency of buildings an integrated approach for the optimising energy consumption is needed. In this regard, the adoption of the CEMS for controlling and monitoring the energy use in primary schools and kindergartens was of essential importance. Although first reactions to the implementation of the CEMS were rather sceptical, the system soon gained the reputation of the Slovenia's showcase for a long-term management. The special attention was payed to the transparency of financial and operational issues, including the users' behaviour that enables the prediction of the maintenance costs not only for the users, but also for the owners and potential investors.

For the MOM economy, the construction sector is of paramount importance for the realisation of measures related to increasing investments in energy efficiency in new and existing buildings. A range of positive impacts has been also registered in relation to various energy efficiency activities that appered as a key element for new commercial opportunities and job creation. At the national level, in 2012 the Eco Fund subsidies of €23.6 million resulted in the investment in energy efficient renovations of nearly €132.0 million that inclusively the tax rate of at 8.5% caused the tax revenues for the state budget of €11.2 million. Additionally, as a survey among providers of co-financed energy efficiency measures indicates, the construction industry has employed more than 1,000 workers excluding the number of jobs for the manufacturing industry of construction materials and products in Slovenia.

Based on the adoption of long-term vision of a clean, green and interconnected city municipality that integrates innovative economies for sustainable communities, the MOM's ambition is the image of an economically, socially and environmentally sustainable city region that was documented as a long perspective vision in the Development Strategy of Maribor 2030. In regard to the negative impacts on the environment, energy efficiency is one of the main challenges for local communities. However, the existing technical and technological infrastructure for the implementation of the measures planned seems to be insufficient to meet these extremely high energy efficiency objectives at national, regional and local level.

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SPAIN

AUTHORS

Giuseppe La Ferla
Chapman Taylor/Universidad Politécnica de Madrid.
E: la_ferla@mailpersonal.com.

Jaume Roset Calzada
Universitat Politècnica de Catalunya.
E: Jaime.roset@upc.edu

Petra Amparo Lopez Jiménez
Universitat Politècnica de València
E: palopez@upv.es

1. OVERVIEW OF THE REGION

The Autonomic Community of Madrid is one of the seventeen entities in the Spanish Constitutional Monarchy with a Parliamentary Government according to the Constitution of 1978. It is the third biggest region in Spain with 6.5 million inhabitants in an area of 8,022 km^2 (810 inhabitants per km^2). The capital is the Municipality of Madrid, which is the capital of Spain. It is located in the geographic centre of the Spanish Peninsula.

The levels of authorities include: the National Government, the Regional Autonomic Government and the Local Municipality. Due to the Autonomic Government, the Regional Parliament defines its own legislation in several areas.

The economic situation is characterised by a GDP of around €26,580 per capita (the second highest in the country in 2012). Its economy is based on approximately 76% in services, 13% in industry, 11% in construction and 0.2% in agriculture. The service sector is one of the most important sectors in the economy of the region; this region has the greatest concentration of major companies with respect to the rest of the country, and collectively the largest number of new technology companies as well.

The employment rate was 51.1% of active population in the 2012.

Energy demand and supply of the Region
The regional energy strategy is based on the National Energy Efficient Action Plan 2011–2020 (NEEAP) and the Regional Community of Madrid Strategic Action Plan 2004 – 2012, that is still in action.

The total energy consumption of the region was 118,533 TWh in 2012, equivalent to 11.4% of the total national consumption. It is subdivided into four main sectors: transport with 60,197 TWh (50.8%), domestic with 27,865 TWh (23.5%), services with 15,898 TWh (13.4%) and industrial sector with 10,106 TWh (8.5%). (*Figure 1*).

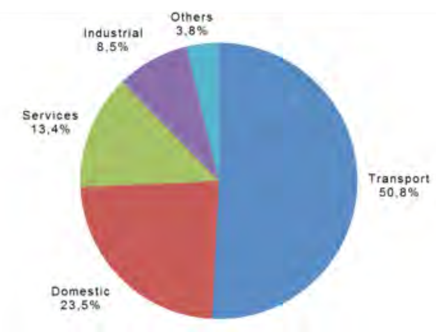


Figure 1 – Total energy consumption in Madrid Region by use in 2012

The total final energy consumption by fuel in the region was: oil 66,070 TWh (55.7%), electricity 26,121 TWh (22.0%), natural gas 23,539 TWh (19.9%) and thermic energy 2,407 TWh (2%) (*Figure 2*). This increased between 2000 and 2012 from 11,536 TWh (about 10.8%), even though the maximum was reached in 2009 and from then it has started to decrease.
The consumption per inhabitant is around 18,259 kWh, less than 20,585 kWh during 2000

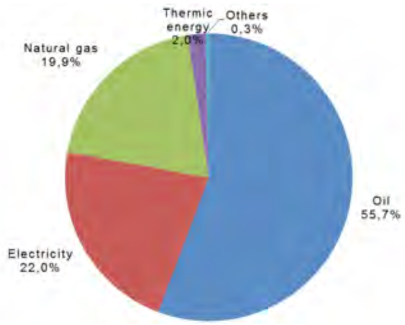


Figure 2 – Total energy consumption by fuel in Madrid Region in 2012

The electricity consumption has increased in the last 12 years by 4,356 TWh (about 20%) with a compounded annual growth rate of 1.53%.

The total GHG emissions from all sectors combined were 23,501 ktCO_2eq in 2011, while in 2005 the emissions had reached the highest value ever of 27,700 ktCO_2eq. (*Figure 3*).

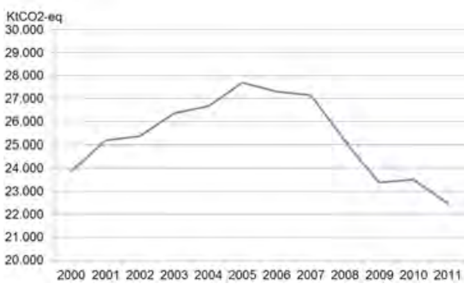


Figure 3 – History of CO_2 – eq emissions in Madrid Region from 2000 to 2011. (www.magrama.gob.es)

The production of energy in the Region was 2,212 GWh in 2012, which amounts to 1.87% of the total final consumption and 4.22% considering cogeneration; however, regional energy production has grown by 54.3% since 2000. It can be broken down into: biomass 1442,120 GWh (65.2%); waste treatment 264,001 GWh (11.9%); hydraulic 70,943 GWh (6.3%); solid urban waste 183,754 GWh (8.3 %); solar thermal 169,798 GWh (7.7%) and PV 80,247 GWh (3.6%) (*Figure 4*).

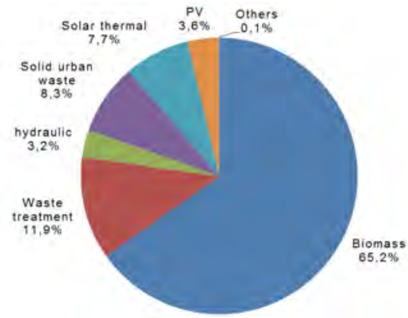


Figure 4 – Energy production by fuel in Madrid Region in 2012

The electric energy generated was 2,221 GWh, 8.5% of the total electric consumption. The share of energy sources for electricity production was: waste and biomass 1,104.85 GWh (49.6%); cogeneration 965.290 GWh (43.7%); hydraulic 69.78 GWh (3.2%); and photovoltaic 81.41 GWh (3.6%).

The region is totally energy dependent on the rest of the country. The high population density, the high concentration of service companies and a lack of sources for intensive energy production explain the high demand of electric energy from the service sector with 11,885 TWh (43.5%), the domestic sector with 8,548 TWh (32.7%), industry with 3,547 TWh (13.6%), and transport with only 1,884 TWh (7.2%). Total demand for electricity is 26.12 TWh (2012).

2. CURRENT SITUATION: TARGETS ELATED TO ENERGY POLICY

Due to the dependency on imported energy and according to the Regional Strategic Action Plan, the Autonomic Community of Madrid aims to improve the efficiency of use of the energy products, to promote savings and to reduce the intensity of energy consumption. In the Strategy for Air Quality and Climate Change (2006 – 2012) – the Blue Plan – the target was to gradually reduce the demand for total energy consumption by 10% as well as to double the annual energy production from renewable sources, and to reduce CO_2 emissions by 15% by 2016 and by 20% by 2020.

A new Air Quality Strategy and Climate Change of the Community of Madrid (2013 – 2020) is currently under development.

Other Regional targets, barriers and drivers
The Regional Government with the support of the FENERCOM (Energy Foundation of Madrid Community) is providing incentives and information campaigns to drive the issues regarding energy in all sectors, encouraging local and regional energy suppliers to multiply efforts towards renewable energy systems (see, at references, FENERCOM 2004 – 2013). Large sector focused information campaigns have been launched since 2005 including:

- Madrid Solar' is a campaign organised by the Directorate General of Industry, Energy and Mines with the collaboration of the nine major energy companies to encourage the use of thermal and photovoltaic solar energy;
- 'Madrid Label Energy Saving' is a campaign directed at industry, the commercial sector and end-users to promote A class energy level appliances (€38 million funding);
- 'Madrid Welcomes Energy Saving' aimed at the tourism sector, which has a great potential for energy savings;
- 'Madrid Factory Energy Saving Programme' is directed at the regional industry which is responsible for 12% of total energy consumption;
- 'Madrid Education Energy Saving Programme' is a campaign directed at the educational institutions and their students;
- 'Madrid Manages Energy Savings Programme' is directed at public sector managers and workers of the region to allow effective implementation and active collaboration on energy issues.

All these campaigns are supported with technical guides such as the Guide of Energy Refurbishment for Residential Buildings, the Guide of Energetic Auditory in Supermarkets, etc., publications, meetings and other disseminations at all stakeholder levels.

The main objectives and strategies for each of the sectors studied are:

- industrial sector – reduction of emissions through the application of best available technology and the promotion of innovation and technological development in the industries of the region. In addition, encouragement of pollution prevention through the intensification of inspections and periodic on-site audits;
- residential and Public sector – promotion of sustainable urban development. It will therefore be necessary to incorporate specific environmental criteria into planning instruments; to promote energy efficiency in buildings, both existing and newly built, considering an average of 400g of CO_2 emission per KWh;
- transport sector – delivery of a strategy action plan to reduce traffic congestion in the regional area, modifying the mobility behaviour of citizens. Encouragement of the development of alternative ways of mobility, using new eco-friendly fuels, improving the technical performance of vehicles and promoting public transport.

Despite the level of campaigning, programmes and other activities, after the Regional Community of Madrid Strategic Action Plan (2004 – 2012) and the Strategy for Air Quality and Climate Change (2006 – 2012), there is a lack of new holistic and pragmatic plans with clear strategic targets.

3. CASE STUDY: LOCAL STRATEGIES FOR IMPROVING THE ENERGETIC CERTIFICATION IN MADRID REGION BUILDINGS

This case study investigates how energy certification could be used to improve residential buildings in the Madrid Region. A recent refurbishment of dwellings in San Cristobal de Los Angeles will serve as a working example.

The accomplishment of European Regulation is fundamental in every Spanish region in terms of energy efficiency in buildings. The need for an Energy Performance Certificate (EPC) for a building arises from the partial transposition of the European Directive 2010/31/EU of 2010. In Spain the Royal Decree 47/2007 incorporated the basic procedure for certification of energy efficiency of existing buildings.

The Royal Decree 235/2013, of 5 April 2013, approved the basic procedure for the certification of the energy-efficiency of buildings. The application of the Decree was voluntary until June 2013. After this date the implementation of this legislation was transferred at regional level. Thus each different region has the capability to set the parameters for the Energy Performance Certificate (EPC) of buildings within its territory.

An EPC is required when constructing a new building and when renting or selling an existing building.

Figure 5 – Energy efficiency Categories

The EPC classifies the performance of a property, providing a score of energy efficiency and CO_2 emissions of a building on a scale from A to G, where A is very efficient and G is very inefficient.

An EPC is produced using standard calculation methods with standard assumptions about energy use so that the performance of a building can easily be compared with another building of the same typology. This allows prospective buyers, tenants, owners and occupiers to see and compare information on the energy efficiency and CO_2 emissions of a building. In this way, they can consider energy savings and fuel costs as part of their investment decision. An EPC will include a list of recommendations on cost effectiveness and other measurements, such as low and zero carbon rating systems in order to improve the energy rating of the building. The EPC also contains information about the rating that could be theoretically achieved if all recommendations are implemented.
In Spain, the control on the application of the EPC is done by different regional governmental agencies. Different regions have applied their own regulations, which have taken form into Decrees at different times. Thus currently all regions (called Communities) have their own instruction for EPC control. Some examples are:

Figure 6 – Spanish Regions for the EPC considerations

- Andalucia: Order 25 June 2008;
- Galicia: Decree 42/2009;
- Canarias: Decree 26/2009;
- Extremadura. Decree 136/2008;
- Valencian Community: Decree 112/2009;
- Cataluña: new Decree 235/2013;

The final objective of monitoring energy consumption in buildings is the reduction of demand. Apart from environmental benefits of decreased energy consumption, it has been shown, on average, that higher energy ratings result in substantially higher sale values or rental values of buildings (about 8% and 4.4% in Austria and 3.2% and 2.3% in Belgium, respectively).

The acquisition of an EPC has been compulsory in Madrid region since June 2013. At the end of August 2013, more than 100,000 spanish houses had obtained an EPC. 85% of these are located in the Madrid region or Cataluña, due to the high population densities in Madrid and Barcelona. In addition, the register for the EPC is being delivered very quicly in these regions, thanks to computerised system for the registration of buildings.

The "Dirección General de Industria, Energía y Minas de la Comunidad de Madrid" (General Direction for Industry, Energy and Mines of the Madrid Community) indicates the percentage of building types that have achieved energy certification: flats: 77.5%; detached houses: 13.6%; offices: 4.5%; commercial 1.3%; others: 3.1% (*Figure 7*).

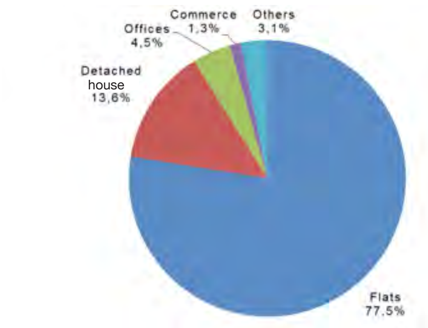


Figure 7 – Distribution of building typologies in the Madrid Region that have achieved the EPC

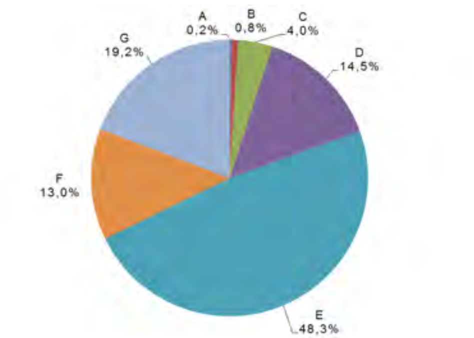


Figure 8 – illustrates the step changes for achieving an EPC

Figure 8 illustrates that most buildings assessed to date have achieved an E or F score. As E and F are "bad" scores, thus the efficiency in these buildings can be deeply improved.

Objectives and methods

San Cristobal de Los Angeles is a neighbourhood in the city of Madrid and it can be described as a typical example of the whole region. San Cristobal de Los Angeles has 18,000 inhabitants – 40% have recently immigrated to Spain and unemployment is at nearly 50%. A high proportion of the population arrived in Madrid from the South of Spain during the 1950's, as a result a large proportion of the population are over 65 years old. This combination of population groups creates significant social problems.

Environmental and technical measures

In order to improve the overall efficiency of the area, which includes 28 shared properties, new buildings were constructed at the same time as existing ones were refurbished. The main challenge was dealing with the high energy consumption of existing buildings, due to poor orientation and certain conditions of the façades. Two residential blocks that have been refurbished in San Cristobal de Madrid are presented in detail:

- area of intervention: 2,240 m^2 and 3,370 m^2;
- client: "Empresa Municipal de Vivienda y Suelo" and "Ayuntamiento De Madrid" (Madrid Municipality);
- architects: Margarita de Luxán and Gloria Gómez Muñoz.

Both energy demand and supply opportunities were considered before redesigning the building together with climatic conditions for the definition of strategies for passive heting/cooling. A study of the possibilities considered: solar gains based on the urban layout; dominant winds for ventilation; and improvement of the building envelope.

Remedial action undertaken on existing buildings included: orientation optimisation, envelope improvement and better accessibility.

New buildings were designed using bio-climatic principles. Natural chimneys were used to avoid the need of conventional cooling services such as air-conditioners.

Figure 9 – New building. Natural chimney

Figure 12 – New building – West façade

Of particular note is the improvement of accessibility to the refurbished apartments, where low power elevators and new staircases have been incorporated. No established form of evaluation is available to assess social benefits for elderly people using elevators instead of stairs.

Figure 13 – Renovated building – East façade

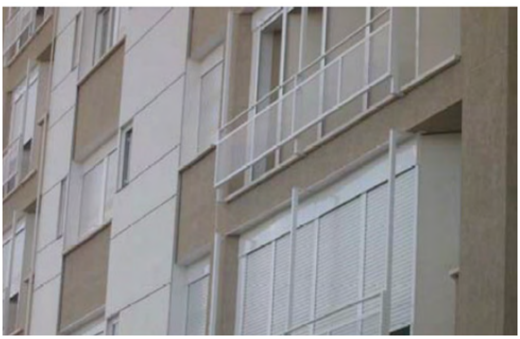


Figure 10 – New building – East façade

Figure 14 – Rehabilitated building – North and East façades

Figure 11 – New building – South façade

Figure 15 – Rehabilitated building – West façades

Long term focus
The implementation of similar measures to all properties across the whole neighbourhood has been planned. The plan also included social issues, mobility, etc. By extending these "refurbished neighbourhoods" to all similar municipalities across the region would allow the improvement of the whole regional building stock.

Energy simulations have been undertaken using software, mainly 'Design Builder', and the potential to use software for urban scale modelling, such as EnviMet is currently being investigated (Vidmar, 2013).

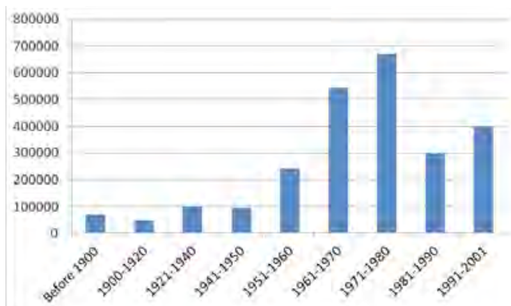
Results
Passive measures have been used with the goal of achieving acceptable comfort conditions in the dwellings for of the time 80%, for both winter and summer. According to calculations, the specific energy consumption of buildings for air conditioning (heating and cooling) before the intervention was 54.44 kWh/m^2/yr (EPC class E). Thanks to the implemented measures, a consumption of 20.36 kWh/m^2/yr (EPC class C) was achieved, meaning a 62.6% reduction in energy demand.

Outcomes
From a social and economic point of view, any public intervention that improves the quality of life whilst maintaining or saving energy costs is good for the neighbourhood. From an environmental and technical point of view, this project was awarded with an 'Isover Energy Efficiency' Award 2007. Unfortunately, with the current economic situation in Spain, a lack of investment is the most crucial barrier for the delivery of similar interventions.

4. CONCLUSIONS

A general analysis of energy consumption in the Madrid Region and implications in energy certification in buildings (EPC) are presented. As a particular case, the intervention in the neighbourhood of San Cristobal de Los Angeles is described. Reductions of energy consumption and CO_2 emissions are significant compared to initial performance. The case study demonstrates the potential of applying this refurbishment strategy to other buildings of the same typology in the region and outside the regional borders, in areas with similar climatic conditions.

In 2001 there were 508,882 residential buildings containing 2,478,145 dwellings across the whole region of "Comunidad de Madrid". These figures allow optimism to enable more detailed projects (INEweb). Figure 16, indicates the number of dwellings that have been built during different time periods.



x – axis the period of construction,
y – axis the number of dwellings.

Figure 16 – Distribution of construction per year in Madrid Region

Regulation on thermal performance was established in 1980, which defines the scope of work, as buildings built before this time will require the most work. About 1,200,000 dwellings in the Madrid region were built during the period 1961– 1980 which require significant retrofitting. This work could benefit the region economically, providing employment in the construction sector.

A simple calculation illustrates the possibilities: a building improved from EPC class F (140 kWh/m^{2}yr) to C (60kWh/m^{2}yr) would result in a saving of 80 kWh/m[2]. Since each dwelling is about 50 m[2], 4,000 kWh/y and 200,000 buildings would result in savings of 80 GWh per year. As a result of the energetic mix in Spain, assumptions can be made that 453 g CO_2/kWh is from electric energy and 201 g CO_2/kWh from gas use. For the Madrid region, it could be assumed that 7 times more energy is required for heating than for cooling. Therefore, for each 800 kWh, 700 kWh will be obtained from gas and 100 kWh by electricity (Maña, 2003). This results in the following calculations:

- for gas, a reduction of 70 GWh (0.2 kgCO_2/kWh) will save 14 million of kg CO_2;
- for electricity, a reduction of 10 GWh (0.45 kg CO_2/kWh) will save 4.5 million of kg CO_2.The Spanish regions that received internal immigration at those times including Catalunya, Comunidad Valenciana, etc. are likely to be in similar population situation.

Since the use of EPC is compulsory in Spain and has to be adapted for each region, it is proposed by the authors to quantify energy and emissions improvement as the jump from a previous (worse) label to a new (better) label. As EPC is used in a lot of EU countries, this method could be exported and applied directly.

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SWITZERLAND

AUTHORS

V. Carabias-Hütter

E. Lobsiger-Kägi

C. Moser

D. Sanchez

ZHAW Zurich University of Applied Sciences, Institute of Sustainable Development, Postfach, 8401 Winterthur, Switzerland, E: cahu@zhaw.ch

1. OVERVIEW OF THE REGION

Characteristics of the Region
International importance and local independence, economic dynamism and congeniality, passion and pragmatism, cultural and scenic variety, the bundled energy of the metropolis and the blissful peace of unspoilt nature: these contrasting qualities are hallmarks of the Canton of Zurich, which regularly receives top rankings in international quality of living surveys (AWA, 2010).

Zurich is a canton of Switzerland. Whereas Switzerland per se is already a small country, it is a Confederation comprising as many as 26 member states, i.e. the cantons. Some areas, such as defence and foreign policy, are in the hands of the Confederation. Other areas, such as infrastructure and education, are within the remit of the cantons. The communes (municipalities) are the smallest units. Just like every modern state, the Canton of Zurich has three levels of authorities: The (executive) government, the (legislative) parliament, and the (judicial) authority.

The Canton of Zurich has a population (as of 31 December 2012) of 1,406,083 and covers an area of 1,729 km^2. The canton is located in the North East of Switzerland (north of the Alps) and the city of Zürich is its capital. Its neighbouring cantons are Schaffhausen to the north, Aargau to the west, the cantons of Zug and Schwyz to the south and the cantons of Thurgau and St. Gallen to the east. Cantons cooperate on inter-cantonal issues. The official language is German. Most of the land is cultivated, but the canton of Zurich is not considered as an agricultural area. The lands to the north and east are more agricultural, but in every part of the canton manufacturing predominates. The canton of Zurich is noted for machinery. Silk and cotton weaving were important in the past, but have now ceased to be of importance. There is a large paper industry. Small and middle sized companies are important contributors to the economy of the canton of Zurich. The city of Zürich is a major banking centre, and insurance is also of importance.

As of 2011, Zurich had an unemployment rate of approximately 3% and a GDP of €75,078 – per capita.

Energy demand and supply of the Region
The Statistical Office is the Centre of Excellence for public statistics in the Canton of Zurich. Following key data on energy consumption in the Canton of Zurich is taken from its Statistical Yearbook 2012, the share of energy sources for electricity production is provided by the Swiss Federal Office of Energy in 2011 and all information is valid for the year 2010:

- total energy consumption (including domestic, commercial, industry, transport): 38.8 TWh total energy consumption; 9 TWh electric power (not itemised by users);
- total energy consumption by fuel (%): 6.174 TWh – approximately 42%;
- share of energy sources for electricity production (%).

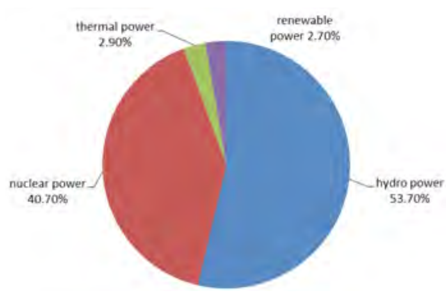

Figure 1 – Distribution of energy sources for electricity production in the Canton of Zurich

The GHG emissions per kWh delivered electricity from grid (low voltage) for the year 2009 amounts to around 0.024 kgCO_2eq/kWh for the Swiss power generation (Frischknecht et al., 2012). Imported electricity of unknown origin (approx. 80%) as well as power from known sources (produced in fossil-thermal power stations, approximately 10%) from outside Switzerland are responsible for a major contribution towards the national GHG emissions of 6.05 tonnes per person and year. Specific energy related technologies present in the region are: Hydropower, Solar, Biomass, District heating (Waste), Geothermics.

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

The long term energy policy of the Canton of Zürich aims on maintaining respectively enabling a high, but eco-friendly standard of living. By 2050 CO_2 emissions are to be reduced from today's levels of 6.05 tonnes per person and year down to 2.2 tonnes.

By 2034, all remaining nuclear power plants in Switzerland, some of which are the oldest in Europe, will be taken off the grid which is in accordance with the new political decision taken by the Swiss Federal Council in the wake of the Fukushima disaster. The overall target is therefore to transform the energy supply from nuclear and hydropower based to a more sustainable, renewable one. Security of supply is often identified as one of the principle challenges in this context. For all these aspects, support and promotion of innovation beyond R&D is of key relevance as well.

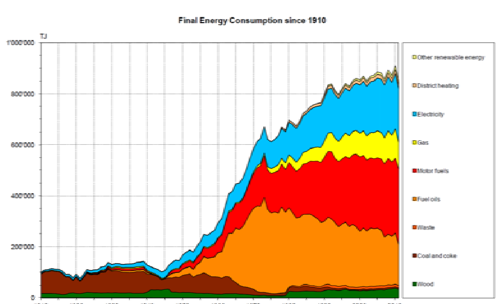

Figure 2 – History of the final energy consumption in Switzerland since 1910 (www.bfe.admin.ch).

Part of the efforts lie in replacing fossil fuel energy sources with renewables and promotion of energy efficiency measures. These goals are to be achieved by means of a domestically generated, sufficient and reliable energy supply with economical competitive pricing.

Transforming the European energy system is imperative for reasons of climate, security and the economy. The European Energy 2020 strategy underlines the need to rebalance energy actions in favour of a demand-driven policy, empowering consumers and decoupling economic growth from energy use. In this respect, increased energy efficiency and higher shares of renewable energy sources are in line with the Swiss energy policy.

Other Regional targets, barriers and drivers

The 2000 Watt Society is the vision of a society in which the world's raw materials are used in a sustainable and fair manner. Spreng et al. (2001) outline this vision not as waiving of today's life-standard and comfort, but the facilitation of a modern lifestyle based on technological solutions, management concepts and social innovations, which increase energy efficiency.

In comparison with the rest of the EU, energy prices in Switzerland and in the Canton of Zurich are very moderate. These prices are, among other factors, possible due to lucrative energy trading (pump storage power plants) and favourable contracts with neighbouring countries, particularly France. With the expiration of these contracts by 2020 and a general increase of the energy demand, electricity prices are likely to rise.

In addition, the liberalisation of the Swiss electricity market is only a matter of time because the EU presupposes this step if Switzerland wants to participate in future in energy trade. As mentioned earlier, the remaining nuclear power plants are to be de-commissioned by the year 2034. This framework is likely to promote and support the long-term energy goals in Switzerland and respectively in the Canton of Zurich, but at the same time it also poses new challenges with respect to the gradually rising energy demand.

Another possible obstruction for these goals might be the fact that the Canton of Zurich is one of the shareholders of the AXPO Group, a major power utility company in Switzerland. Technical innovation is expected in the areas of photovoltaics and wind energy. MINERGIE® is a sustainability brand for new and refurbished buildings. It is mutually supported by the Swiss Confederation, the Swiss Cantons along with Trade and Industry and is registered in Switzerland and around the world. Specific energy consumption is used as the main indicator to quantify the required building quality. In this way, a reliable assessment can be assured. Only the final energy consumed is relevant within the assessment. An increase of renewable energies as well as of energy efficiency is expected due to efforts made by the new energy policy “Energy Strategy 2050”.

Mobility related energy consumption is a significant part of the total energy demand. The effectiveness of the mobility system is at the same time recognised as an important condition for the economic development of an area. The mobility strategies in the Canton of Zurich in general and in the city of Zurich (the centre and key traffic generator of the canton as well as of the whole Switzerland) are based on a two-level approach. A very strategic and rather softly defined “top down” approach, combined with a rather simple, still coherently implemented, “bottom up” approach. The idea is to disaggregate the main “problem” defined by the long-term vision into more manageable, sometimes very local climate-friendly mobility measures. The sum of little steps in the right direction will result in a big step towards the main goal, among them are:

- bicycle promotion programmes in the cities;
- extension of the transportation services (ZVV) and infrastructure;
- car Sharing (Mobility);
- measures and means to support non-motorised traffic in urban areas including parking fees and penalties.

An example for bicycle promotion programmes are for instance efforts made in Zürich (Züri rollt) or discussions held in Winterthur for the introduction of a “Bicycle Highway”.

The Canton of Zurich recognises that mobility plays a leading role in the efficient development of the built environment of the area. At the same time it states that the traffic shouldn’t be seen as an independent problem but on the contrary, land-use and landscape planning should be synergically used to model mobility demand and habits.

The canton of Zurich is characterised by a very dense public transport network characterised by an effective combination and integration of mid and long-term systems including train, regional train / S-Bahn with short distance diffused distribution systems, local buses and trams. The actual planning tools and instruments (agglomeration program, parking policies, etc.) clearly push the development further in this direction. This results in a rather constant growth of the public transport passengers flows. The trend is clearly readable by the analysis of the traffic flows towards the centre of the canton (the city of Zurich) where the regional train passenger flows show an increment of about 220% in 20 years, whereas the car traffic on the same direction remained more or less constant.

Switzerland has one of the highest broadband penetration rates in Europe (allowing in 2012 for 85% of households with access to Internet). Broadband access replaced dial-up telephone communications as the main growth area, and Digital Subscriber Line DSL networks have overtaken cable Internet access as the principal technology for broadband access. Strong growth in mobile broadband has added to the mix.

Innovative strategies/initiatives

In Switzerland, the 2000 watt society is on top of the agenda as a vision enabling the implementation of best practices in sustainable building design, construction and operation (in line with BREEAM for instance). The concept addresses not only personal or household energy use, but the total for the whole society, divided by the population.

The vision of the 2000 Watt Society calls for a continuous reduction in energy needs to 2000 watts per person. This target should be achieved as quickly as possible. By the year 2050, the amount of fossil energy sources can be cut in half from the current figure of 3000 watts to 1500 watts per person. There are good reasons for the extended time horizon: the change requires rigorous adjustment of the infrastructure and an intelligent lifestyle (cf. Novatlantis, 2011), otherwise the 2000 watt society will remain merely a vision.

Another interesting approach having an impact on a regional scale is the smart city concept being not only multi-dimensional but also future-oriented in tackling energy consumption and CO_2 emissions. It follows an urban development strategy whereby focussing on how (Internet-related) technologies enhance the lives of citizens, empowering them for contributing to urban change and realising their ambitions.

CASE STUDY: WINTERTHUR

According to Caragliu et al. (2011, p. 70) a city can be declared “smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance”.

Promoted by Smart City Switzerland, a process has been initiated in the City of Winterthur bringing all relevant stakeholders (from the local administration, energy supplier, NGO and universities) together in order to identify potential areas of application, in which lighthouse projects (such as innovative living and mobility concepts, load shift approaches, infrastructure sharing systems, that have the potential to inspire adopters of these concepts) shall be developed to finally be successful implemented with the aim of reducing energy consumption (cf. Carabias et al., 2014).

Figure 3 – Photo of the city of Winterthur (source: www.statistik.zh.ch)

The city of Winterthur covers an area of 68.1 km^2 and counts in 2012 a population of 104,366.

Smart City Switzerland (www.smartcity-switzerland.ch), mandated by Swiss Federal Office of Energy, managed to bring together local stakeholders: different departments of the city of Winterthur, the local energy supply utility (Stadtwerk), the ZHAW Zurich University of Applied Sciences, local associations, as the regional energy cluster, local companies and real estate developer.

The energy supply in Winterthur is managed by “Stadtwerk Winterthur”, the local utility, owned by the municipality. Electricity in Winterthur still comes mainly from nuclear (57%) and hydropower (23%); 19% is generated in the local waste incineration plant and 1% by photovoltaics. The city of Winterthur bears since 1999 the label “Energiestadt” (European Energy Award), which was received from the Association “EnergieSchweiz für Gemeinden”. The label is a performance record for municipalities which take steps to convert their municipal energy policy into a more sustainable one. Measures include for instance promotion of renewable energies, eco-friendly mobility and efficient exploitation of resources. Thanks to these efforts, primary energy consumption and CO_2 emissions in Winterthur today are already lower than the Swiss average. The reason is mainly a good system of public transport and a high percentage of heat and electricity produced by the public waste incineration plant. But a few years ago the inhabitants of Winterthur voted for the target of a 2000 watt society to be part of the constitution.

Figure 4 – Elements of the smart city concept as elaborated in Switzerland (source: www.smartcity-schweiz.ch).

Objectives and methods
The current political umbrella strategy of the city of Winterthur is to move towards a 2000 Watt Society (and a 2-ton-CO_2-society respectively) by the year 2050, which will require a reduction in energy consumption by a factor 2 to 3. In addition, in 2011 it was decided at federal level to phase out nuclear electricity at the latest by 2034. Both strategic decisions will require the promotion and enforced implementation of alternative and renewable energy sources such as hydropower, solar energy, wind energy, geothermal energy etc. The path towards a 2000 watt society is described in the energy concept for 2050 ("Energiekonzept 2050"). In the following three major fields measures have to be taken.

Retrofitting of buildings and implementation of heating and cooling systems based on renewable energy sources (e.g. enlargement of existing district heating system); Improving the efficiency of electrical appliances, improving efficient use of electrical appliances (e.g. pilot study with smart meters and feedback started 2012), ICT-based information systems to enable sharing of transport vehicles and other appliances, ICT-Tools and infrastructure to increase comfort of bicycle use (e.g. parking guidance system, bicycle fast lanes).

Long term focus
Lighthouse projects in the City of Winterthur will tackle issues at the intersection of the transport, energy and ICT sectors. They should forge strong partnerships with local leaders and municipal authorities to gain the vital support and visibility necessary to engage and empower citizens and local stakeholders to reduce greenhouse gas emissions and energy consumption and more widely to improve inhabitants' living conditions.

Results
The Smart City Winterthur initiative is considered as Swiss partner in a tri-national DACH cooperation together with Karlsruhe (Germany) and Salzburg (Austria). So far six meetings have been held in Winterthur and the identified ideas for lighthouse projects have been clustered into promising implementation fields: mobility (i.e. electro-mobility, car-sharing, cycling), buildings (i.e. multi-generation houses, smart retrofitting), power supply management (i.e. load management, behaviour change, patterns of energy consumption, energy hub). The DACH cooperation is intended to facilitate the exchange of knowledge and experiences towards energy efficient cities. First meetings between these three cities have shown many common topics and a huge potential to learn from each other.

Outcomes
So far, relevant stakeholders for transforming Winterthur into a Smart City have come together to form a working group, where potential lighthouse projects shall be identified with the aim to start their implementation in 2014. Further results are not yet available. Leading a smart city initiative requires a comprehensive understanding of the complexities and interconnections among social and technical factors of services and physical environments in a city. In Winterthur an important driver is that current activities (towards a smart city) are in line with the national energy efficiency directives, with the local energy masterplan as well as with research being undertaken at ZHAW Zurich University of Applied Sciences. Furthermore, the support of the local government could only be secured by confirming that no additional financial burden would approach the city of Winterthur by joining the DACH initiative on Smart Cities. On the contrary, the planned lighthouse projects shall be supported by the Swiss Federal Office of Energy.

In the current times of economic crisis, the city of Winterthur has lost important income necessary to support the activities of the local administration. Therefore, several administrative units have to reduce their activities and it is very difficult to initiate new ones. More effort had to be made to explain the long-term benefits of Smart City initiatives.

Technological innovation is a means to smart city, not an end. IT is just a facilitator for creating a new type of innovative environment, which requires the comprehensive and balanced development of creative skills and innovation-oriented institutions. The specific ICT-Tools will be developed in the projects itself.

Systematic interactions have been established on several levels. The www.smartcity-switzerland.ch platform is coordinating on behalf of the Swiss Federal Office of Energy the promotion of Smart City activities as lighthouse projects. In this context, the Smart City Winterthur initiative has enabled more regular meetings between relevant local stakeholders, such as energy, environmental, and city development departments, local energy supplier, NGO and research institutions. Furthermore, Karlsruhe and Salzburg will exchange information with Winterthur (DACH).

4. CONCLUSIONS

The smart city can be seen as the engine of transformation at regional level, a partnership with the objective to catalyse progress in areas where energy production, distribution and use; mobility and transport; and ICT are intimately linked and offer new interdisciplinary opportunities to improve services while reducing energy and resource consumption. The city is viewed as an integrated energy system, where space and energy planning converge, including coordination with energy supply and demand, energy efficiency in buildings and mobility at regional level.
In this respect, the following potentials of the case study are promising for the whole region: reduction of energy consumption / emissions, extension of activities to whole region / other buildings types / sectors (comparison to the "Energy supply and demand of the region").

The promoter of this project is Smart City Switzerland, which is part of a whole set of energy initiatives regarding communities and regions. Among them there is also a program "Energy Region", which is being established at the moment. Results and lessons learnt from the Smart City project in Winterthur will certainly be integrated in the "Energy Region" concept. Furthermore it is essential to integrate also the region around the city. For example people from around the city, who are commuting to the city, have to be involved in mobility concepts. Smart energy production and storage schemes have to be created in collaboration with the surrounding communities, as they have other (natural) resources available. Only the intelligent combination of different resources and services can lead to a smart city and therefore to a smart region.

The overall project targets are: i) developing and testing innovative solutions for integrating technical systems to improve energy efficiency while considering societal and economic constraints, ii) implementations of projects to interlink technologies and socio-economic structures in the areas of buildings, mobility, supply and disposal structures, and communication, iii) promotion of know-how and synergies between different stakeholders, iv) exchange of experiences and best practice examples among participants; v) development of participatory processes to realise a "smart project"; vi) information, awareness raising, and activation of the public.

The Smart city initiative aims at accelerating the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas. The purpose of lighthouse projects is to demonstrate good practices with regards to energy efficiency efforts and increase of renewable energy. It is therefore explicitely desired and envisioned to have a transfer of the case studies to other regions. As a large part of the region of the Canton of Zurich has an urban character, there is a large potential for knowledge transfer.

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UNITED KINGDOM

AUTHORS

Professor Phil Jones
E: JonesP@cardiff.ac.uk

Joanne Patterson
E: Patterson@cardiff.ac.uk

Fabrizio Varriale
E: VarrialeF@cardiff.ac.uk

Welsh School of Architecture
Cardiff University
Bute Building, King Edward VII Avenue,
Cardiff CF10 3NB

1. OVERVIEW OF THE REGION

Characteristics of the Region

Wales is a clearly defined area on the West side of Great Britain, categorised as level-1 NUTS region. Its territory spreads for almost 22,000 km^2 and hosts over 3 million inhabitants, mainly concentrated in the settlements in the South-West. The average population density is around 147 people per km^2. Cardiff, the capital city, has a population of around 330,000 people, although the larger "city region" area reaches 1.2 million inhabitants (City Regions task and finish group, 2012).

Wales is one of the four countries that constitute the United Kingdom. Although always acknowledged as culturally different, Wales was governed by the UK Government in Westminster London until the end of the 1990's, when it gained partial self-government through the Government of Wales Act of 1998. The successive Act of 2006 defined the structure and role of the National Assembly for Wales (the Parliament) and of the Welsh Government. Twenty-two areas are identified for local administration purposes in Wales. These are referred to as Local Authorities (LA), which vary in size and population.

In comparison to the rest of the UK, the Welsh economy is less developed and suffering from the decline of coal extraction and its related heavy industry from last century. The average Welsh GDP per capita in 2008 was €21,900, just 74% of the average for Great Britain[1] and only 87% of the European average (EuroStat, 2011, p.7). In 2012 the employment rate was registered at 76.3% (StatsWales, 2013a). In the same year a task-group appointed by the Welsh Government released its final report on the economic performance of Wales highlighting that cities generate only 33% of wealth in Wales, the lowest rate in the UK. The reason is identified in the lack of "critical mass" due to the small size of the Welsh cities (City Regions task and finish group, 2012, p.5).

Wales is in fact a rather rural country, since 82% of its territory is considered rural area (Kitchen and Marsden, 2006, p.19). Despite the poor agricultural value, the Welsh natural environment has always represented an essential resource for the population, providing fishing grounds, pasturage for the livestock, significant mining opportunities and, more recently, increasingly attracting tourism. Indeed 30% of land area and 70% of coastal environment in Wales are considered of high natural value (Kitchen and Marsden, 2006, p.19). The Welsh territory also holds great potential for the development of renewable energy sources through technologies such as biomass, wind-farms and tidal and marine energy. Moreover, it has been estimated that the environment related sector provides one sixth of the jobs in Wales, and generates approximately 9% of the Welsh GDP (Kitchen and Marsden, 2006, p.20).

The issue of fuel poverty is a very common problem in Wales. In 2010, 26% of the population was estimated to be suffering from fuel poverty (WG, 2012, p.2), meaning that they spend more than 10% of their income for domestic space heating.

Energy demand and supply of the Region
Although Wales accounts for 7% (97.85 TWh) of the energy consumption in the UK (DECC, 2012, p.7), *Figure 1* shows that in 2010 the average consumption per capita in Wales was higher than the average of Scotland, greater London and Great Britain (DECC, 2012, p.8). This indicates that there may be potential for considerable reductions through energy efficiency interventions.

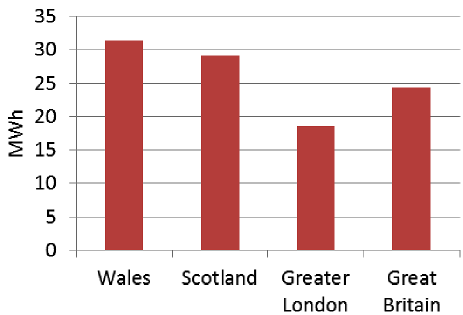

Figure 1 - Average energy consumption per thousand inhabitants in 2010 (MWh) (DECC, 2012, p.8)

Approximately half of the total Welsh energy consumption is related to the industrial and commercial sectors (46.41 TWh), whilst the remaining half belongs to the domestic (26.4 TWh) and transport (22.96 TWh) sectors (DECC, 2012, p.10). *Figure 2* shows that the share of consumption by fuel is dominated by petroleum products and gas, with electricity at 16.2% (WG, 2013a, p.11). Electricity is produced mainly by gas (39.1%), coal (22.6%) and nuclear energy (19.7%) (WG, 2013a, p.4). Electricity production from renewable sources accounted for 7.9% (2.16 TWh) in 2011, while it remained still around 3% in 2004 (StatsWales, 2013b), showing an increase of 5% over a 7 years period.

Figure 4 shows the proportion of renewable energy production according to the source. Due to the Welsh climate, wind power is the most harvested among the renewable sources, while solar power provides a minimal contribution (WG, 2013a, p.7).

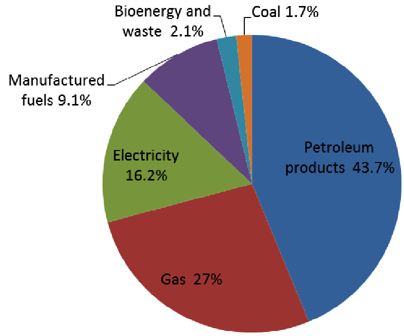

Figure 2 – Energy consumption in Wales by fuel, 2010 (WG, 2013, p.11)

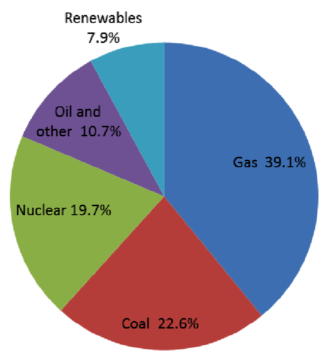

Figure 3 – Production of electric energy in Wales by source, 2011 (WG, 2013, p.4)

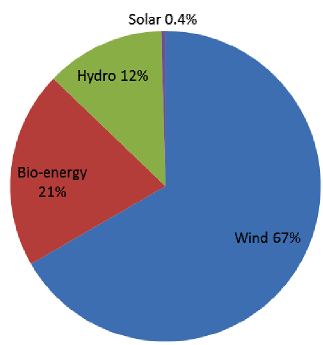

Figure 4 – Renewable energy production by source, 2011 (WG, 2013, p.7)

Out of the 27,284 GWh of electricity generated in Wales in 2011, about 15.6% were used by the energy generators themselves, whilst 13.4% were transferred to England and 5.3% were lost due to transmission and distribution losses (DECC, 2012b, p.5). In May 2013, 39 power plants owned by major generators were operating in the territory of Wales (DECC, 2013b). As *figures 5* and *6* show, wind plants were actually the largest by number and installed capacity.

The energy sector of the UK was reformed and privatised with the Utilities Act 2000. National Grid is the private company that owns and manages the national transmission network of England and Wales, whilst energy is delivered by smaller networks owned by different companies. North and South Wales are covered respectively by Scottish Power and Western Power Distribution. Electricity, but also gas, is bought from generators and sold to customers by the suppliers, companies which generally do not hold any network asset, although there are exceptions such as Scottish Power. Six "big suppliers" are commonly identified in the UK as those companies holding the large majority of customers for the supply of electricity and gas.

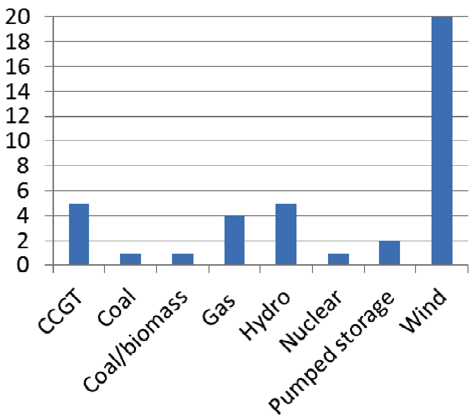

Figure 5 – Number of power plants in Wales (DECC, 2013b)

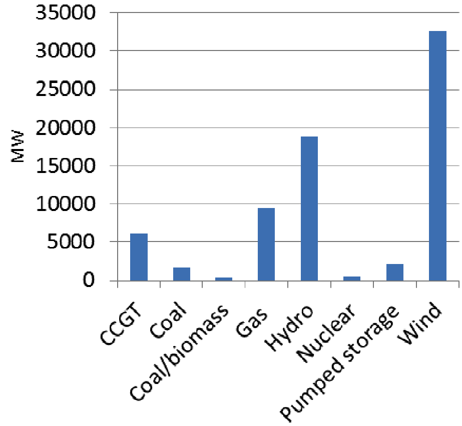

Figure 6 – Installed capacity (MW) of power plants in Wales (DECC, 2013b)

2. CURRENT SITUATION: TARGETS RELATED TO ENERGY POLICY

Greenhouse gas (GHG) from all sectors in Wales is reported as 46,639 ktCO_2eq in 2010 (Aether and AEA, 2012, p.8). Since the electricity network of Wales is not separated from the rest of the UK, the emission conversion factor is taken from the UK-wide value of 0.5246 kgCO_2eq/kWh (Carbon Trust, 2011, p.3). *Figure 7* shows a general trend of reduction in emissions from 2005 levels, although in 2010 emissions increased due to a harsh winter and a rise in the carbon intensity of the UK energy grid (CCC, 2013, p.16). In 2011, according to UK-wide data, emissions in Wales are expected to have fallen again, mainly due to economic unfavourable conditions (CCC, 2013, p.20).

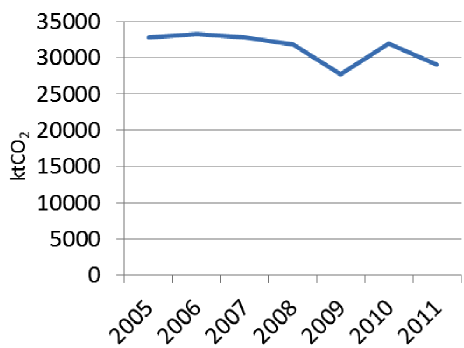

Figure 7 – Total emissions in Wales (ktCO_2) (DECC, 2013a)

Wales, as part of the UK and the EU, has adopted targets for sustainability and environmental protection. By 2020, energy from renewable sources should account for 20% of the total production, and GHG emissions should be reduced by 20% from 1990 levels. By 2050, GHG emissions should be reduced by 80% from 1990 levels (Rotheray, 2008). The Welsh Government has committed to a more ambitious programme, aiming for a 3% reduction in carbon emissions every year from 2011 (WG, 2009a, p.33). This yearly reduction is to be achieved through the delivery of UK Government policy (40%), through Welsh Government own policy in areas of devolved competence (30%) and through "wider contributions from others" (30%) (CCC, 2013, p.12). The latter includes businesses, public sector, communities, etc., but remains the weaker part of the strategy since it has not been specified in detail (CCC, 2013, p.13).

The leadership of the Government is a fundamental driver for the Welsh low-carbon transition. Wales has developed its own constitution which provides opportunity to integrate principles of sustainability at its core, whilst laying a legal duty on its Government to pursue sustainable development. Following this duty, the Government has progressively developed a set of strategies, policies and tools to plan, foster and monitor the Welsh transition to sustainability. Nonetheless, the latter is still encountering many obstacles, including cultural and organisational issues which can limit the transition more than technical problems. A study of Welsh institutional governance (Williams and Thomas, 2004) indicates that sustainable development is still often perceived as something limited to environmental concerns, and not as an overarching principle that demands full integration in every sector. A lack of leadership due to limited commitment from local authorities can generate uncertainty in the commercial sector and in the public perception. Confusion also tends to increase due to the presence of many schemes, frameworks and stakeholders (Williams and Thomas, 2004).

Other Regional targets, barriers and drivers
European Structural funds from EDRF and ESF programmes are an important driver in Wales for the progression of the low-carbon and climate change agenda. Since North and West Wales are eligible under the Convergence Objective, and Mid and South Wales are eligible under the Competitiveness Objective, the Welsh Government has access to both funding streams. Projects approved between 2007 and 2013 have received EU funds according to the following Strategic Frameworks:

- climate change: £105 million;
- innovation, R & D, Technology: £218 million;
- materials Efficiency: £12.5 million;
- sustainable Transport: £245 million;
- sustainable Regeneration: £263 million.

Overall, projects within the Climate Change framework are estimated to save 9.27 ktCO_2eq and generate 34.72 GWh from renewable energy (WEFO, 2014).

The approach of the Welsh Government towards sustainable development is laid out in the plan "One Wales One Planet" (WG, 2009a). This document sets the strategies, principles and procedures for delivery and monitoring of sustainability in key areas, such as planning, transport, housing and economy, which have been revised and expanded in dedicated policies more recently. The strategy stresses the necessity to integrate sustainability objectives in every policy framework through the adoption of target setting and monitoring procedures (WG, 2009a. p.30). The advancement of Wales towards sustainable development is indeed assessed periodically through an official report following the scheme principles and indicators (WG, 2009a). The Committee on Climate Change has recently acknowledged that the overall methodology is appropriate, although some indicators are still under development and thus assessment in those areas is not possible yet (CCC, 2013, p.12 – 13).

Researchers have argued that it is necessary to improve the integration and coordination of policy on sustainable development at all levels of Welsh governance (Williams and Thomas, 2004). This approach was included in "One Wales:One Planet" (WG, 2009a. p.26). Sustainable development was also introduced in the two main planning instruments at the regional level: the "Wales Spatial Plan" and

"Planning Policy Wales". The former was updated in 2008 and represents a strategic territorial view of the future of Wales (WG, 2008). The latter regulates land use and urban development in Wales, and provides rules for the design of Local Development Plans (WG, 2012c). These are prepared by Local Authorities in accordance with the Spatial Plan and the principles of sustainability. Planning Policy Wales is complemented by topic-based guidance, Technical Advisory Notes on a range of subjects, including one on sustainable buildings (WG, 2010c).

"One Wales:One Planet" includes the need to promote the development of local energy generation projects and the installation of small renewable sources in buildings (WG, 2009a, p.53). The recent "Energy Wales: A low-carbon transition" stresses the necessity to develop advanced renewable plants and to adapt the energy distribution grid to support the increasing share of electricity obtained from renewables large plants and small sources (WG, 2012a, p.11). Positive examples of community led projects for local renewable energy generation also exist in Wales, suggesting that bottom-up initiatives can be successful and could be replicated by other communities. Awel Aman Tawe Community Energy is a project located in the Swansea and Amman Valleys aimed at the construction of a two-turbines wind farm worth £ 6 million. Respect and conservation of the natural environment are ensured by the small team of local staff and volunteers that manages the project, which is expected to generate about £200,000 annual income that will be reinvested into local initiatives (Awel Aman Tawe, 2011).

While already harvesting wind energy from on-shore and off-shore plants, a great potential for Wales lies in the exploitation of tidal energy. *Figure 8* shows an estimate of the potential for renewable electricity generation by 2020/2025 (WG, 2010b, p.19). In order to develop low-carbon technologies capable to exploit this potential, the Low Carbon Research Institute (LCRI) was set up in 2008 through governmental funding to coordinate and progress the necessary research and dissemination. The LCRI brings together several researchers from 6 Welsh universities to explore and test solutions in the fields of renewable energy generation, low-carbon built environment and skills training (LCRI, 2013).

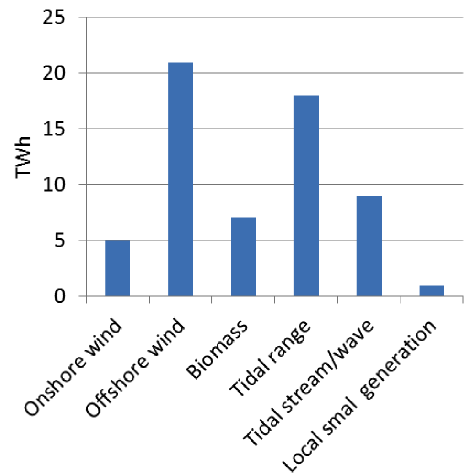

Figure 8 – Potential annual output (TWh) of renewable sources for electricity production in Wales by 2020/2025 (WG, 2010b, p.19)

In order to widen the scope of its energy policy, the Welsh Government intends to put pressure at UK level for greater devolution of energy planning and consenting power (WG, 2012a, p.13). The UK Secretary of State for Energy and Climate Change retains the power to make decisions for energy generation projects above 50 MW for onshore and 1 MW for offshore plants (Upton, 2013, p.44). Thus discussions are underway at UK level to construct a barrage on the Severn estuary to harvest tidal energy, expected to generate 5% of the UK energy demand (Hafren Power, 2013, p.6).

The potential to use nuclear power as a temporary source while moving from fossil fuels to renewable sources is much debated in the UK. The position of the Welsh Government is to avoid the construction of new plants while supporting existing sites (Environment and Sustainability Committee, 2012, p.16).

Another issue that arises in the transition to a low-carbon energy system is the need for a strong and flexible energy transportation grid, which calls for additional investment and bears potential conflict with environmental protection and landscape conservation. In fact National

Grid (the company owning the UK energy infrastructure) has recently announced that its project for the Mid Wales Connection will comprise about 13 km of underground cables, over 53 of total length, to minimise the visual impact on the Meifod Valley (National Grid, 2013).

Despite the increasing production of renewable energy, research has shown weaknesses in the system of support policies, which are established at UK level. There is a need to diversify policies in order to adapt to different development stages of low-carbon technologies (Foxon et al, 2005). Policies supporting low-carbon technologies should be unified with those focused on innovation and it is necessary to adopt a system-thinking approach shifting the aim of policies from short-term efficiency to long-term innovation (Foxon and Pearson, 2007). Several researchers suggested that a review process on the policies should pursue coherence, stability, effectiveness and market-appeal (Haas et al, 2011; Verbruggen and Lauber, 2012; Woodman and Mitchell, 2011).

The “One Wales:One Planet” document includes establishing an attractive environment for the development of sustainable businesses (WG, 2009a, pp. 53-54). This is supported by the energy strategy issued by the Welsh Government “Energy Wales: A low-carbon transition”, which suggests that savings from energy efficiency interventions are reinvested to support further reductions, and clearly states the will to ensure that local communities and companies benefit from every energy development that takes place in Wales. It also contains the intention to foster the development of competitive Welsh supply chains (WG, 2012a, p.17).

Engagement with industry is essential for the adoption of new technologies and procedures and the delivery of sustainability. “One Wales:One Planet” declares the will of the Government to support companies in the adoption of energy efficiency measures in their business and in the integration of sustainability as a business objective. This approach is coupled with the progressive enforcement of environmental and energy standards on companies. To foster innovative local businesses in the renewable sector, the plan recommends adequate support for the research & design and the commercialisation of low-carbon technologies (WG, 2009a, p.54).

The active role pursued by the Welsh Government to progress the low-carbon agenda has favoured the birth of dedicated bodies such as “Cynnal Cymru” and “Constructing Excellence in Wales” (CEW). Cynnal Cymru, previously named the Sustainable Development Forum for Wales, was established in 2002 by the Welsh Government to help the progress towards sustainable development through networking and knowledge dissemination (Cynnal Cymru, 2012). CEW is a public funded agency aimed at promoting innovation and sustainability in the building sector. It also delivers the Low/Zero Carbon Hub Wales, a dissemination and support network for Government and industry. These initiatives, together with other institutions which are present in Wales with dedicated chapters, such as WWF, the Energy Saving Trust or the Carbon Trust, contribute to the delivery of a regional scale approach to sustainable development.

Within “Capturing the potential – A green jobs strategy for Wales” (WG, 2009b), the Welsh Government set the strategies for exploiting potential job opportunities brought by low-carbon technologies implementation. The delivery of specific training programmes such as DLCS[2], BEST[3] and WEST[4] to workers and professionals offers career development to the workforce and provide the industry with the skills needed to progress the low-carbon transition.

Building requirements in the UK legislation have progressively increased over recent years in order to reduce emissions from new buildings. Part L of the Approved Documents regulates “conservation of fuel and power” and therefore energy consumption and CO_2 emissions. Although minimum values are set for important building components such as external walls and glazing, the current approach is focused on overall building performance, leaving designers a greater level of freedom in the choice of how to achieve the required performance (Hamza and Greenwood, 2009).

In order to go beyond the current Building regulations, the Welsh Government has introduced the Welsh Sustainable Building Standard. From 2011 every publicly funded new residential building is required to comply with Code for Sustainable Homes (CSH) level 3, while non-residential buildings must achieve an “excellent” rating in the relative BREAAM category. CSH and BREAAM are recognised sustainability assessment methods developed by BRE to consider not only CO_2 emissions but also other environmental issues such as water, waste and pollutants.

Building Regulations were recently devolved to Wales (WG, 2012b) with the aim to introduce higher requirements for all new buildings. However, in July 2013 the Welsh Government decided to decrease the GHG emissions target to be imposed by Building Regulations on new buildings. The target for 2016 was brought down from a 40% to an 8% cut in GHG emissions (Sargeant, 2013). This target reduction has been criticised as a short-term favour to the large constructors, while on a long-term perspective the lack of higher building standards will impact negatively on the energy bills paid by future building occupants in a regime of rising energy costs (Henry, 2013; James, 2013).

The existing building stock of Wales presents many challenges to the implementation of energy efficiency interventions, especially in the housing sector. One of the main barriers for the de-carbonisation of the Welsh stock is the high proportion of hard-to-treat older properties, the highest of UK (Hunt, 2011, p.25). The Welsh Government has stated its intention to continue financing energy retrofit schemes (WG, 2009, p.38) whilst the Sustainable Development Commission highlighted the need to share and scale up examples of good practice (Sustainable Development Commission, 2009. p.8). The Welsh Government included in its energy strategy the need to support households in the adoption energy efficiency measures, tools and behaviour (WG, 2012a, p.21). Recently the Climate Change Committee has pointed out that, although Wales has successfully delivered a series of schemes for the improvement of the building stock, more needs to be done to support the implementation of the new schemes. In addition, the lack of an appropriate house survey for the whole Wales makes it difficult to track energy consumption and identify space for further improvements (CCC, 2013, p.30-31). Moreover, research has shown that basic retrofit measures are economically accessible but can only deliver CO_2 emission reduction up to 30%. On the other hand, more extensive retrofit interventions can deliver reduction up to 60% but require significant financial investments, therefore posing a substantial barrier to the UK Government’s 80% target reduction (Jones et al, 2013).

Regarding the transition towards low-carbon mobility, the necessity to discourage the use of private vehicles is acknowledged while encouraging alternatives such as walking, cycling, car-sharing, personal travel planning and low-carbon public transport (WG, 2009; Sustainable Development Commission, 2009). Another necessary step is the roll-out of electric and hybrid cars, in order to meet the EU targets for reduction of emissions from vehicles (WG, 2010).

As the low-carbon transition requires not only a technical upgrade but also a shift in people’s everyday practice, the Government acknowledges the need to further investigate social patterns of consumption and identify successful strategies for behavioural change. “One Wales:One Planet” adopts a holistic approach to sustainability and places much importance on public awareness, on the involvement of local communities and on the engagement and education of children and young people to sustainable practices (WG, 2009, p.26).

Although separated from the low-carbon agenda, the Welsh Government has its own strategy for the development of Information and Communication Technologies (ICT). “Digital Wales” aims at spreading the benefits of ICT to the Welsh population and businesses and at improving public services (WG, 2013d). Access to the internet from Welsh households has recently grown to 73% (StatsWales, 2013c), although data shows that low-income population groups have difficulty using the internet due to lack of basic skills (WG, 2013f, pp.4 – 6). In cooperation with British Telecom, the Welsh Government is working on “Superfast Cymru”, a plan to deliver high-speed next generation broadband to 96% of households and businesses by 2016 (WG, 2013e).

3. CASE STUDY: THE ARBED SCHEME

Arbed, which means “to save” in Welsh, is a large scale retrofit scheme promoted by the Welsh Government to improve the energy performance of the existing housing stock of Wales. The scheme was divided into two main phases. Phase One, implemented between 2009 and 2012, was the largest of its kind in the UK, providing more than £60 million for interventions of energy retrofit on residential properties. Addressing low-income households in Strategic Regeneration Areas, the scheme targeted social housing estates. Phase Two has recently started and will end in 2015.

Data on construction type (available for 56% of the houses) indicates that solid wall and cavity wall properties account roughly for one fourth of the Welsh stock each, while the remaining half are considered non-traditional construction. Data on property type (available for 84% of the houses) indicates that 45% of the buildings are terraced houses, 26% are flats, 24% are semi-detached, and only 4% and 1% are, respectively, bungalows and detached houses. Regarding the main heating fuel used in the retrofitted properties, the great majority (79%) is connected to the gas mains, whilst 15% use electricity, 6% coal and less than 1% use oil or LPG (Burrell and Heath, 2011, pp.4 – 6).

Objectives and methods

The Welsh Government stated three main objectives to be achieved through Arbed:

- environmental: to reduce energy consumption and thus GHG emissions from the existing housing stock;
- social: to reduce the number of people in condition of fuel poverty;
- economic: to create local jobs and business opportunities (WG, 2013c).

Phase One was implemented across Wales through the delivery of 31 local projects, which covered 18 out of 22 Welsh Local Authorities (Woosey, 2012). For example, in South Wales the scheme was delivered through the programme “Warm Wales”, named after the Community Interest Company that was commissioned for the management of 6 local projects.

Funding for the scheme came from different sources: £36.6 million was provided by the Welsh Government, whilst the Registered Social Landlords (RSL) and Local Authorities (LA) involved in the projects provided £22 million from direct funding and additional £10 million from UK energy schemes CERT[5] and CESP[6] (Woosey, 2012). Overall, 6,700 energy-efficiency measures were installed in over 6,000 properties, for a total estimated saving of 12,000 tonnes of CO_2 per year (Burrell and Heath, 2011, p.7). As can be seen in figure 9, the most implemented measure in Arbed Phase One was the insulation of solid walls. Other interventions included the installation of photovoltaic and solar hot water panels and switching fuel from coal or oil to gas, through boiler replacement. It must be noted that fuel switch brings the highest reduction in GHG emissions, due to the change in emission factor (Patterson, 2012, p.36).

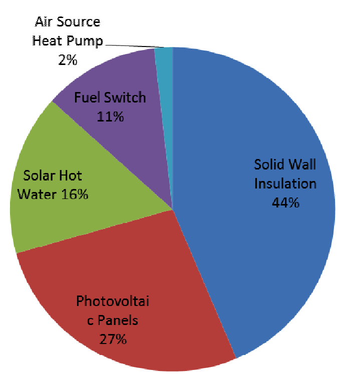

Figure 9 - Measures implemented in Arbed Phase One (Burrell and Heath, 2011. p.6)

Long term focus

The division of Arbed into two main phases was introduced to enable learning from Phase One to improve the delivery of the Phase Two. However, the time gap between the phases hindered the potential to retain in Phase Two the skills developed during Phase One (De Laurentis and Hunt, 2012, p.27).

Phase Two of the Arbed scheme started in 2012 with the objective of intervening on over 4,800 homes for an estimated saving of 2.54 $ktCO_2$ (WG, 2013b). Arbed aims to increase the share of private households to at least 50% of the total number of retrofitted.

The funding streams for Phase Two are different, with £33 million provided by European ERDF funds and £11 million by the Welsh Government. The structure for the delivery of the scheme has also changed, as Phase Two is delivered by two scheme manager companies selected through a tender process through the OJEU (WG, 2013b). The scheme managers are effectively top tier contractors, fully responsible for the local delivery of the scheme from survey to installation. This centralised structure for procurement has been introduced to facilitate the generation of economies of scale (De Laurentis and Hunt, 2012, p.29).

Outcomes

In general terms, Arbed Phase One was recognised as a successful retrofit programme in bringing together different funding sources, operating on a large scale and involving local stakeholders (Woosey, 2012, p.6).

Apart from the resulting abatement of GHG emissions, the scheme also brought positive economic and social impacts, including a reduction in energy bills estimated to bring households about £90 million of savings over the life span of the retrofits (Burrell and Heath, 2011, p.7). Many interventions such as external wall insulation have improved the thermal comfort of the properties together with their external appearance.

Particular attention was given to maximize the share of Welsh companies and manufacturers involved in the scheme. Eight companies have benefited from being involved in Arbed gaining accreditation for renewables installation. A series of training courses have been delivered to foster the skills needed for the correct installation of the measures, thus improving the quality of the local workforce (Burrell and Heath, 2011, p.7). For example, within the Warm Wales programme, 1,704 training weeks were undertaken for an investment of £1 million (Patterson, 2012, p.38).

An important positive effect of the large scale and regional approach of Arbed is the reduction of retrofit cost due to economies of scale. Bulk purchase of materials and coordination of the installation process allowed for 20-50% savings in respect to the cost for individual retrofits reported by the Energy Saving Trust (Burrell and Heath, 2011, p.19).

In addition, it is acknowledged that Arbed produced a significant change in the attitude of RSLs involved towards low-carbon technologies: while technologies installed were previously regarded as novel interventions, they are now more commonly implemented measures (De Laurentis and Hunt, 2012, p.27). Despite the positive overall outcomes of Phase One, a set of issues have been identified as barriers to the achievement of better results:

- lack of a clear planning and of an organised structure hindered the delivery stage of the scheme.
- more time was necessary at the beginning of the scheme to liaise with landlords, companies and householders.
- the presence of many levels of stakeholders has brought confusion (Burrell and Heath, 2011, pp.9 – 12).
- lack of appropriate surveys for properties increased the uncertainties related to the costs associated with the interventions.
- shortage of knowledge and skills on innovative measures among the professionals and the workers involved in the retrofits. Thus poor executions have been reported for several properties (Patterson, 2012, pp.56 – 63).

On the other hand, a series of conditions have been identified as active drivers that facilitated the delivery of Arbed Phase One:

- presence of efficient and prepared contractors;
- access to large-scale funding;
- benefits of economies of scale;
- presence of dedicated personnel liaising on-site with householders and the local community also proved successful as in the example of the 15 “Energy wardens” that facilitated the delivery of the Warm Wales programme (Patterson, 2012).

Evaluations of Arbed Phase One (Burrell and Heath, 2011; Patterson, 2012; Woosey, 2012) have provided a set of recommendations valid for Arbed Phase Two and other similar schemes, including:

- adequate timing and planning has shown to be essential for correct organization;
- necessity for detailed and updated survey data on the properties involved. This would allow the selection of the most appropriate retrofit measures to be implemented in each building, thus maximizing the outcomes;
- supply of materials and workforce should be carefully planned to support local economy and avoid shortage of skills during delivery;
- performance of the retrofitted properties should be monitored and evaluated before and after the works where possible;
- households should be provided with dedicated assistance for the correct use and maintenance of the installed technologies.

4. CONCLUSIONS

The Arbed scheme, despite its weaknesses and drawbacks, provides a successful example for tackling the energy performance of the housing sector at a regional scale bringing together environmental, economic and social benefits. Assuming the availability of funds, the method could be replicated to cover the majority of the Welsh housing stock. With appropriate modifications, the scheme could address buildings in the non-residential sector that belong to identified typologies and present repetitive features. In order to take advantage of economies of scale, appropriate measures need to be standardised and replicable, and this is possible if the retrofitted buildings have similar features. Thus in other European regions, where the housing stock may present more variation in typology, each building would need tailored measures and therefore the benefits of economies of scale would be reduced.

Intervention across a considerable number of properties was possible due to large agencies such as RSL or LA owning a large proportion of the Welsh housing stock. In other European regions, the housing stock can be more privately owned and thus less easily approached as a whole.

FOOTNOTES

1. Note that “Great Britain” refers only to England, Scotland and Wales, while “UK” includes also Northern Ireland.
2. Delivering Low Carbon Skills.
3. Built Environment Sustainability Training.
4. Welsh Energy Sector Training.
5. Carbon Emission Reduction Target.
6. Community Energy Saving Programme.

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CONTACT DETAILS

EDITORS

Phil Jones
E: jonesp@cardiff.ac.uk

Jo Patterson
E: patterson@cardiff.ac.uk

Welsh School of Architecture
Cardiff University
Bute Building, King Edward VII Avenue,
Cardiff CF10 3NB, Wales, UK

Werner Lang
E: w.lang@tum.de

Philipp Geyer
E: p.geyer@tum.de

Technische Universität München,
Energy-Efficient and Sustainable Planning and Building (ENPB), Arcisstrasse 21,
D 80290 München

CONTRIBUTING AUTHORS

Austria

Gudrun Lettmayer
E: gudrun.lettmayer@joanneum.at
JOANNEUM RESEARCH-RESOURCES,
A-8010 Graz, Elisabethstrasse 18, Austria

Belgium

Jean-Marie Hauglustaine
E: jmhauglustaine@ulg.ac.be

Stéphane Monfils
E: stephane.monfils@ulg.ac.be

University of Liege, Faculty of Science,
Department of Sciences and Management of the Environment, Research Unit
“Energy and Sustainable Development”

Bosnia and Herzegovina

Jovan Todorovic
E: jovan.todorovic@elprenosbih.ba
Elektroprenos BiH, a.d. Banja Luka,
Marije Bursac 7a, 78 000 Banja Luka Bosnia and Herzegovinia

Bulgaria

Elena Dimitrova
E: eldim_far@uacg.bg

Angel Burov
E: burov_far@uacg.bg

University of Architecture,
Civil Engineering and Geodesy,
1, Hr. Smirnenski Blvd,
1046 Sofia

Kalinka Nakova
E: knakova@eneffect.bg
Municipal Energy Efficiency Network
EcoEnergy

Cyprus

Paris Fokaides
E: eng.fp@frederick.ac.cy
Frederick University
School of Engineering and Applied Sciences
7, Y. Frederickou Str., Nicosia 103, Cyprus

Angeliki Kilili
E: res.ka@frederick.ac.cy
Frederick Research Centre

Denmark

Morten Elle
E: elle@plan.aau.dk
Aalborg University,
Faculty of Engineering and Science,
Department of Development and Planning,
A.C. Meyers Vænge 15, A2, DK2450
Copenhagen SV

Torben Dahl
E: torben.dahl@kadk.dk
Royal Danish Academy of Fine Arts,
School of Architecture,
Philip de Langes Alle 10,
DK1435 Copenhagen K

Jonna Majgaard Krarup
E: jonna.krarup@kadk.dk
Royal Danish Academy of Fine Arts,
School of Architecture,
Philip de Langes Alle 10,
DK1435 Copenhagen K

Finland
Jukka Heinonen
E: jukka.heinonen@aalto.fi

Markku Norvasuo
E: markku.norvasuo@aalto.fi

Aalto University, Department of Real Estate, Planning and Geoinformatics

fYR Macedonia
Roberta Apostolska
E: roberta.apostolska@jrc.ec.europa.eu
Institute of Earthquake Engineering and Engineering Seismology -IZIIS, University “Ss. Cyril and Methodius”, Skopje, fYR Macedonia

Todorka Samardzioska
E: samardzioska@gf.ukim.edu.mk
Civil Engineering Faculty, University “Ss. Cyril and Methodius”, Skopje, fYR Macedonia

Germany
Werner Lang
E: w.lang@tum.de

Philipp Geyer
E: p.geyer@tum.de

Technische Universität München, Energy-Efficient and Sustainable Planning and Building (ENPB), Arcisstrasse 21, D 80290 München

Greece
Christopher Koroneos
E: koroneos@aix.meng.auth.gr

Evanthia Nanaki
E: evananaki@gmail.com
University of Western Macedonia

University of Western Macedonia, Bakola& Salviera, 50100 Kozani
Dept. of Mechanical Engineering

Dimitris Rovas
E: drovas@gmail.com
Aristotle University of Thessaloniki

Demetri Bouris
E: dbouris@fluid.mech.ntua.gr
National Technical University of Athens, Dept. Mechanical Engineering

Hungary
Ákos Nemcsics
Óbuda University, Tavaszmezo utca 17, H-1084 Budapest

Ildikó Molnár
Szent István University, Thököly út, H-1146, Budapest

Antal Ürmös
Óbuda University, Tavaszmezo utca 17, H-1084 Budapest

Ireland
Oliver Kinnane
E: oliver.kinnane@tcd.ie
Department of Civil, Structural and Environmental Engineering, Trinity College Dublin

Derek Sinnott
E: dsinnott@wit.ie
Department of the Built Environment, Waterford Institute of Technology

Italy
Senatro Di Leo
E: senatro.dileo@imaa.cnr.it

Monica Salvia
E: monica.salvia@imaa.cnr.it

National Research Council of Italy, Institute of Methodologies for Environmental Analysis (CNR-IMAA), C.da Santa Loja, 85050 Tito Scalo (PZ), Italy

Latvia
Anatolijs Zabasta
E: Anatolijs.Zabasta@rtu.lv

Nadezda Kunicina
E: Nadezda.Kunicina@rtu.lv

Aleksandrs Korjakins
E: Aleksandrs.Korjakins@rtu.lv

Anastasija Zhiravecka
E: Anastasija.Zhiravecka@rtu.lv

Antons Patlins
E: Antons.Patlins@rtu.lv

Riga Technical University,
Kalku st 1, office 217, Riga, Latvia LV1658

Lithuania

Lina Seduikyte
E: lina.seduikyte@ktu.lt

Andrius Jurelionis
E: andrius.jurelionis@ktu.lt

Rokas Valancius
E: rokas.valancius@gmail.com

Kaunas University of Technology,
Faculty of Civil Engineering and Architecture,
Studentu st. 48, LT-51367,
Kaunas, Lithuania

Malta

Vincent Buhagiar
E: vincent.buhagiar@um.edu.mt

Simon Paul Borg
E: simon.p.borg@um.edu.mt

Department of Environmental Design
Faculty for the Built Environment
University of Malta, Msida MSD 2080, Malta

Mark Azzorpardi
E: mark@ambjent.org
Abertax Quality Ltd.

Ruben Paul Borg
E: ruben.p.borg@um.edu.mt
Department of Construction & Property
Management Faculty for the Built
Environment, University of Malta
Msida MSD 2080, Malta

Netherlands

Louis Hiddes
E: l.hiddes@mijnwater.com

Jo Stefens
E: j.stefens@ou.nl

René Verhoeven
E: r.verhoeven@mijnwater.com

Marlie Dix
E: m.dix@mijnwater.com

Herman Eijdems
E: h.eijdems@mijnwater.com

Open University (OU)/Mijnwater BV
Valkenburgerweg 177
6419AT Heerlen The Netherlands

Norway

Thomas Berker
E: thomas.berker@ntnu.no
Department of Interdisciplinary Studies of
Culture, Norwegian University of Science
and Technology 7491 Trondheim, Norway

Poland

Adam Rybka
E: akbyr@prz.edu.pl
Rzeszow University of Technology

Jan Gorsky
E: jgorski@agh.edu.pl
AGH University of Science and Technology

Magdalena Sep
E: msep@prz.edu.pl
Rzeszow University of Technology

Anna Pomykala
E: pomykalcia@gmail.com
Rzeszow University of Technology

Portugal

Cecilia Rocha
E: carocha@fe.up.pt

Helena Corvacho
E: corvacho@fe.up.pt

Fernando Alves
E: alves@fe.up.pt

FEUP-Citta, Rua Dr. RobertoFrias, s/n,
4200-465 Porto, Portugal

Romania

Radu Andrei
E: radu.andrei.d@gmail.com
Technical University ”Gh. Asachi”,
43 Prof. Dimitrie Mangeron Str.,
code 700050, Iasi

Gheorghe Lucaci
E: gheorghe.lucaci@ct.upt.ro
Polytechnic University of Timisoara

Liliana-Mihaela Moga
E: liliana.moga@gmail.com
Dunărea de Jos University

Nicolae Taranu
E: taranu@ce.tuiasi.ro
Technical University ”Gh. Asachi”,

Alina-Mihaela Nicuta
E: alinanicuta@yahoo.com
Technical University ”Gh. Asachi”,

Mihaela Condurat
E: conduratmihaela@yahoo.com
Technical University ”Gh. Asachi”,

Serbia

Aleksandra Krstic-Furundzic
E: akrstic@arh.bg.ac.rs

Aleksandra Djukic
E: adjukic@afrodita.rcub.bg.ac.rs

Faculty of Architecture, University of Belgrade, Bulevar kralja Aleksandra 73/II, Belgrade

Slovenia

Metka Sitar
E: metka.sitar@um.si
University of Maribor, Faculty of Civil Engineering, Architecture Department, Smetanova ulica 17, 2000 Maribor, Slovenia

Vlasta Krmelj
E: vlasta.krmelj@energap.si
EnergaP – Energy Agency of Podravje, Institution for sustainable energy use Smetanova ulica 31, 2000 Maribor, Slovenia

Spain

Giuseppe La Ferla
E: la_ferla@mailpersonal.com
Chapman Taylor/Universidad Politécnica de Madrid

Jaume Roset Calzada
E: Jaime.roset@upc.edu
Universitat Politècnica de Catalunya

Petra Amparo Lopez-Jimenez
E: palopez@upv.es
Universitat Politècnica de València

Switzerland

Vicente Carabias-Hütter
E: cahu@zhaw.ch

Evelyn Lobsiger-Kägi

Corinne Moser

Diego Sanchez

ZHAW Zurich University of Applied Sciences, Institute of Sustainable Development, Postfach, 8401 Winterthur, Switzerland

United Kingdom

Phil Jones
E: JonesP@cardiff.ac.uk

Joanne Patterson
E: Patterson@cardiff.ac.uk

Fabrizio Varriale
E: VarrialeF@cardiff.ac.uk

Welsh School of Architecture Cardiff University Bute Building, King Edward VII Avenue, Cardiff CF10 3NB, Wales, UK

COST DESCRIPTION

THE ORGANISATION OF COST

COST - European Cooperation in Science and Technology is an intergovernmental framework aimed at facilitating the collaboration and networking of scientists and researchers at European level. It was established in 1971 by 19 member countries and currently includes 35 member countries across Europe, and Israel as a cooperating state.

COST funds pan-European, bottom-up networks of scientists and researchers across all science and technology fields. These networks, called 'COST Actions', promote international coordination of nationally-funded research.

By fostering the networking of researchers at an international level, COST enables break-through scientific developments leading to new concepts and products, thereby contributing to strengthening Europe's research and innovation capacities.

COST's mission focuses in particular on:

- building capacity by connecting high quality scientific communities throughout Europe and worldwide;
- providing networking opportunities for early career investigators;
- increasing the impact of research on policy makers, regulatory bodies and national decision makers as well as the private sector.

Through its inclusiveness, COST supports the integration of research communities, leverages national research investments and addresses issues of global relevance.

Every year thousands of European scientists benefit from being involved in COST Actions, allowing the pooling of national research funding to achieve common goals.

As a precursor of advanced multidisciplinary research, COST anticipates and complements the activities of EU Framework Programmes, constituting a "bridge" towards the scientific communities of emerging countries. In particular, COST Actions are also open to participation by non-European scientists coming from neighbour countries (for example Albania, Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Jordan, Lebanon, Libya, Moldova, Montenegro, Morocco, the Palestinian Authority, Russia, Syria, Tunisia and Ukraine) and from a number of international partner countries.

COST's budget for networking activities has traditionally been provided by successive EU RTD Framework Programmes. COST is currently executed by the European Science Foundation (ESF) through the COST Office on a mandate by the European Commission, and the framework is governed by a Committee of Senior Officials (CSO) representing all its 35 member countries.

More information about COST is available at www.cost.eu.

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EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

This publication is supported by COST.

This book presents work undertaken as part of the COST Action Smart Energy Regions (SMARTER). It illustrates how relevant policies are being implemented in 26 European countries participating in the Action and how these are helping to progress the low carbon agenda relevant at a regional scale, illustrating how industry and broader stakeholder groups can be involved in the process.

Specific case studies have been identified to illustrate projects and initiatives that are helping to progress the low carbon agenda at a regional scale to help to provide an understanding of how low carbon technologies are relevant and transferable within and between regions.

This work supports the broader aims and objectives of the Smart Energy Regions COST Action to investigate the drivers and barriers that may impact on the large scale implementation of low carbon technologies in the built environment essential to meet the targets for sustainable development set by the EU and national governments.

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