European Commission

Proceeding of the Workshop

"Benchmarking Energy Sustainability in Cities"

25th of November 2014
Politecnico di Torino,
Torino (Italy)

Edited by:

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Abstract
Energy efficiency is a strategic component of urban sustainability. The aim of this workshop is to address benchmarking techniques in energy efficiency and sustainability as a management tool in the context of urban and local community actions towards sustainability. The workshop also identifies and discusses methodologies and tools to measure urban sustainable energy and energy efficiency in cities. It is well known that standard benchmarking techniques, such as per capita or GDP normalization, are missing important features of the collected data used for benchmarking. Rigorous benchmarking techniques are likely to play an increasingly important role for policy-making authorities and for local authorities to assess their energy efficiency actions, to monitor their performance, exchange experience and learn from each other. In order to develop reliable and robust benchmarking techniques, different databases on energy consumption and location should be integrated with statistical and energy performance assessment methodologies. A special session was dedicated to databases, methodologies and GIS based tools for assessing energy sustainability in urban areas.

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Benchmarking Energy Sustainability in Cities

Scientific Workshop

Organized by Joint Research Centre – European Commission and Politecnico di Torino

Aula Magna Lingotto

via Nizza 230, Politecnico di Torino, 10126 Torino (Italy)

25 November 2014

Energy efficiency is a strategic component of urban sustainability.

The aim of this workshop is to address benchmarking techniques in energy efficiency and sustainability as a management tool in the context of urban and local community actions towards sustainability.

The workshop will also identify and discuss methodologies and tools to measure urban sustainable energy and energy efficiency in cities.

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Opening Session

9.00– 9.30

- **Heinz Ossenbrink** Head of Renewables and Energy Efficiency Unit, Institute for Energy and Transport, European Commission DG JRC
- **Marco Masoero** Head of Energy Department, Politecnico di Torino, Italy

*Session 1 – **Monitoring Sustainable Energy Action Plans in Cities***

9.30 – 12.30

Chair: ***Paolo Bertoldi***, European Commission-DG JRC

- **The Covenant of Mayors: Statistical Analysis and Performance Indicators -6 Years Assessment.** *Albana Kona*, European Commission-DG JRC
- **Torino Energy Action Plan- Monitoring phase.** *Roberto Pagani*, Politecnico di Torino, Italy
- **Strategies Towards Energy Performance and Urban Planning in Glasgow, Ghent, Riga and Gothenburg: STEP UP.** *Nickolas Purshouse*, Institute for Future Cities, Glasgow, UK
- **The carbon*n* Climate Registry (cCR).** *Ana Marques*, ICLEI World Secretariat, Bonn, Germany
- **Climate and Energy Targets of Selected U.S. Cities: Progress Toward Their Achievement and Related Implementation Lessons Learned.** *David Ribeiro*, American Council for an Energy-Efficient Economy, USA
- **International Standards for Cities and the World Council on City Data a Next Step for Smart Cities**. *Nico Tillie*, World Council on City Data, Toronto, Canada

Session 2 – **Benchmarking Energy Sustainability in Cities**

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- **BEST, GREAT, and ELITE: A Low Carbon Eco-city Evaluation Tools.** *Nan Zhou*, Lawrence Berkeley National Laboratory, Berkeley, USA
- **Identifying the Methodological Characteristics of European Green City Rankings.** *Jurian V. Meijering*, Wageningen University, The Netherlands
- **Energy Efficiency Rating of Districts, Case Finland.** *Asa Hedman*, VTT Technical Research Centre of Finland, Finland
- **Benchmarking for Comparative Analysis of International Airports Based on a Sustainability Ranking Index.** *Şiir KILKIŞ*, KTH Royal Institute of Technology, Sweden

*Session 3 – **Databases, Methodologies and GIS based tools for Benchmarking Energy Sustainability in Cities***

16.00 – 18.00

Chair: **Roberto Pagani**, Politecnico di Torino, Italy

- **Multi-criteria Methodology for SEAPs.** *Maria F. Norese*, Politecnico di Torino, Italy
- **Planning Model for Environmental Data in the Province of Venice.** *Romano Selva*, e-ambiente, Italy
- **Standard Geodata Models for Energy Performance of Buildings: Experiences from Sunshine and GeoSmartCity Projects.** *Piergiorgio Cipriano*, Sinergis, Italy
- **New Bottom-up Methodology to Evaluate Winter Thermal Energy Needs and Fuels Consumption in the Residential Sector.** *Giulio Cerino Abdin*, Politecnico di Torino, Italy

Benchmarking Energy Sustainability in Cities

The scientific workshop "Benchmarking Energy Sustainability in Cities" was organized jointly by the European Commission-JRC and Politecnico di Torino on November 25, 2014 at the Lingotto Hall of Politecnico di Torino in Turin, Italy.

The Workshop brought together international experts to deliberate and share experiences on the challenges and issues of utilizing benchmarking techniques to measure energy efficiency and sustainability in cities.

The total of fifteen presentations that were presented in the three sessions of the Workshop provided different perspectives on the use of benchmarking techniques as a management tool in the context of urban and local community actions towards sustainability, including signatory cities under the Covenant of Mayors (CoM) initiative. Furthermore, the presentations allowed for the identification and evaluation of tools and methodologies to measure urban sustainable energy and energy efficiency in cities.

The three sessions of the scientific workshop were namely "Monitoring Sustainable Energy Action Plans in Cities" (Session 1), "Benchmarking Energy Sustainability in Cities" (Session 2), and "Databases, Methodologies and GIS based Tools for Benchmarking Energy Sustainability in Cities" (Session 3).

The Proceedings of this scientific workshop documents the vast array of knowledge and expertise that was presented by the international experts from Europe and abroad together with the key findings and recommendations, which are as summarized below.

Key Findings and Recommendations

Session 1 – Monitoring Sustainable Energy Action Plans in Cities

- **Recommendation 1:** Cities are increasingly in the forefront of making changes in Energy Sustainability. This momentum of cities needs to be supported with adequate policies and increased policy learning with robust benchmarking techniques. Small signatories in CoM need support from regional and provincial agencies through the Covenant territorial coordinators. In addition, there is a need to expand the usage of energy density maps for reliable data on cities and efficient thermal energy networks. Robust methods of benchmarking are needed to let those cities who are performing better inspire other cities.

- **Recommendation 2:** The monitoring of results of Sustainable Energy Action Plans (SEAPs) in cities is necessary to follow-up on the progress that is made by cities towards reaching their CO_2 emission reduction targets. The monitoring process is also necessary to keep the energy efficiency and renewable energy measures of the city dynamic and open for improvement with SEAPs being a "living document" Best practices have emphasized the usage of calls for actions to integrate new measures into existing strategies (e.g. Torino) and the matching of companion cities (e.g. Glasgow, Ghent, Riga and Gothenburg) to transfer experiences to relatively more novice cities. The concept of an "Enhanced SEAP" has also been proposed based on a pipeline of integrative approaches leading up to the monitoring stages, including scenario analyses. Beyond the signatory and submission stages of SEAPs, CoM signatory cities should benefit from these best practices in monitoring the results of the measures that are included in the SEAPs.

- **Recommendation 3**: The diffusion of standards for the reporting and monitoring stages may increase spillover for policy learning and benchmarking. In the Workshop, experiences from the carbon*n* Climate Registry (cCR) and ACEEE City Scorecard among others provided key perspectives for reporting and monitoring practices. The cCR provides flexibility for cities in selecting the indicators on which to report. The ACEEE City Scorecard assigns grades to cities based on the extent of coverage of policy areas in local government operations, buildings, energy and water utilities, transportation, and community-wide measures. At the same time, progress is being made in the standardization process based on the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), which provides a robust framework for accounting and reporting city-wide greenhouse gas emissions, and ISO 37120:2014 on "Sustainable Development of Communities - Indicators for City Services and Quality of Life."

Session 2 – Benchmarking Energy Sustainability in Cities

- **Recommendation 4:** Benchmarking is a potentially valuable tool for stimulating the learning process from best practices and improving city performances in energy sustainability. At the same time, the techniques that are used for benchmarking, including the processes for data collection, any kind of index construction, selection criteria for the sample, indicator value aggregation, and weighting of the dimensions must be fully transparent since the results of such techniques can vary widely based on the chosen methodology. As a result, in a sensitivity analysis approach, there is a need to be able to compare the variation in the results when different benchmarking techniques are used. Consensus-building processes may further be used to justify the selection of indicators, the data sample, and benchmarking techniques.

- **Recommendation 5**: Rather than comparing cities and/or airports servicing the cities to one another, benchmarking techniques may also be used to aid city planners, policymakers, managers, and researchers in choosing between different scenarios. The example of rating the energy efficiency of districts (e.g. Finland) and the case of various tools to provide a quick assessment of the magnitude and sources of a city's energy and carbon footprints (e.g. China) can indicate areas of possible policy intervention. The interfaces of such tools should allow for the entry of relevant data that will allow a fair comparison of scenarios across various policy measures, which may include local energy production and transport options for low carbon development in cities.

Session 3 – Databases, Methodologies and GIS based Tools for Benchmarking Energy Sustainability in Cities

- **Recommendation 6:** Multi-criteria methodologies may be used to provide policy making support to evaluate the different options that are available to a city in reaching the same CO_2 reduction target. These options may include a combination of different measures that define different strategies that may be pursued by the city. Principles based on the marginal mode of concordance and discordance can be useful in evaluating the different strategies that are available from the viewpoints of various stakeholders, including viewpoints of technical and decision-making interests. Multi-criteria methodologies may further be used to enhance the consensus-building process in determining the selection of strategies for cities' energy systems.

- **Recommendation 7**: Bottom-up methodologies and GIS based tools may be integrated into processes of benchmarking energy sustainability in cities. These may include the evaluation of winter thermal energy needs and fuel consumption, the creation of 3-D maps to pre-certify buildings at an urban scale for an energy assessment of buildings, and optimize energy consumption based on energy modelling of buildings. The regulatory framework and platforms for open source data sharing may further support related efforts.

The INSPIRE Directive has already established an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment.

Session 1 – Monitoring Sustainable Energy Action Plans in Cities

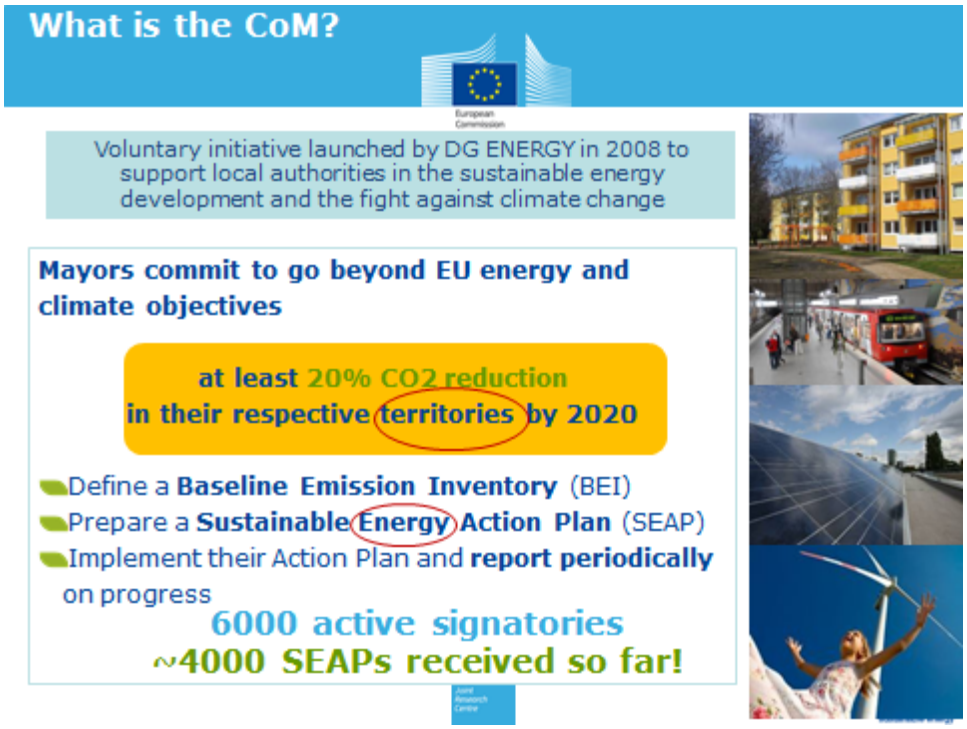
I. The Covenant of Mayors: Statistical Analysis and Performance Indicators -6 Years Assessment.

Albana Kona, Paolo Bertoldi, Isabella Maschio, Giulia Melica, Irena Gabrielaitiene, Silvia Rivas Calvete, Paolo Zancanella, Yamina Saheb, Hans Bloem

European Commission, Joint Research Centre, Institute for Energy and Transport, Ispra, Italy

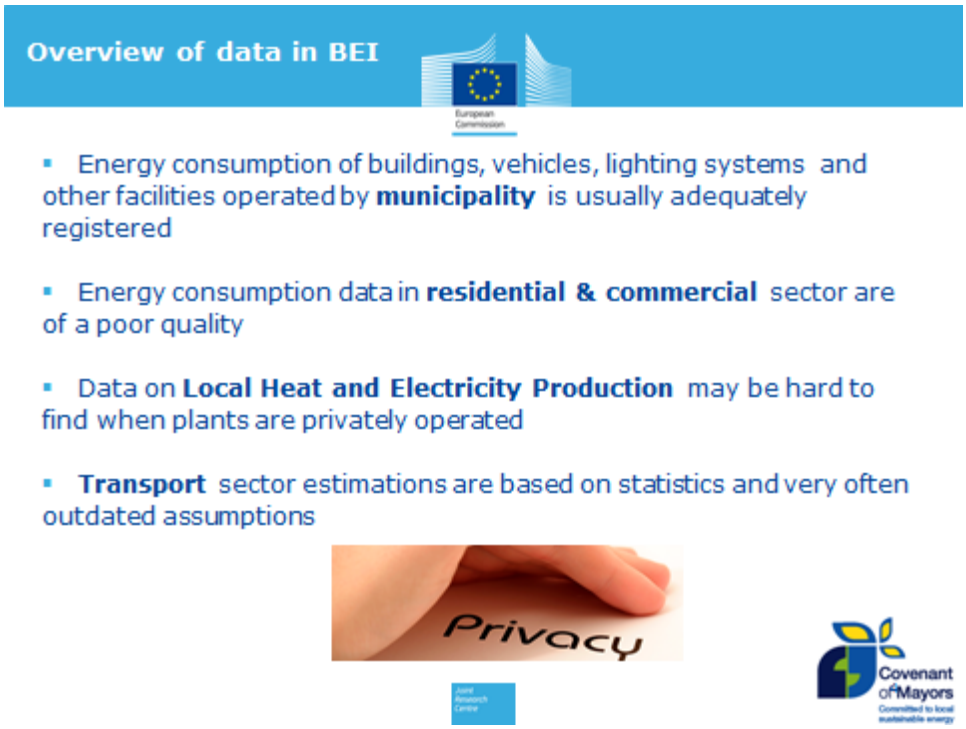
The Covenant of Mayors (CoM) is the mainstream European movement involving local authorities voluntarily committing to meet and exceed the European Union 20% CO_2 reduction objective by 2020 by increasing energy efficiency and through the use of renewable energy sources on their territories

One of the commitments undertaken by Covenant signatories is to submit, within a year from signing up to the initiative, a Sustainable Energy Action Plan (SEAP), which is based on the results of the Baseline Emission Inventory (BEI) and includes all the planned measures to be implemented in order to achieve the 20% CO2 emission reduction target. Data from BEIs and SEAPs are transmitted by each signatory to the European Commission via an online template.



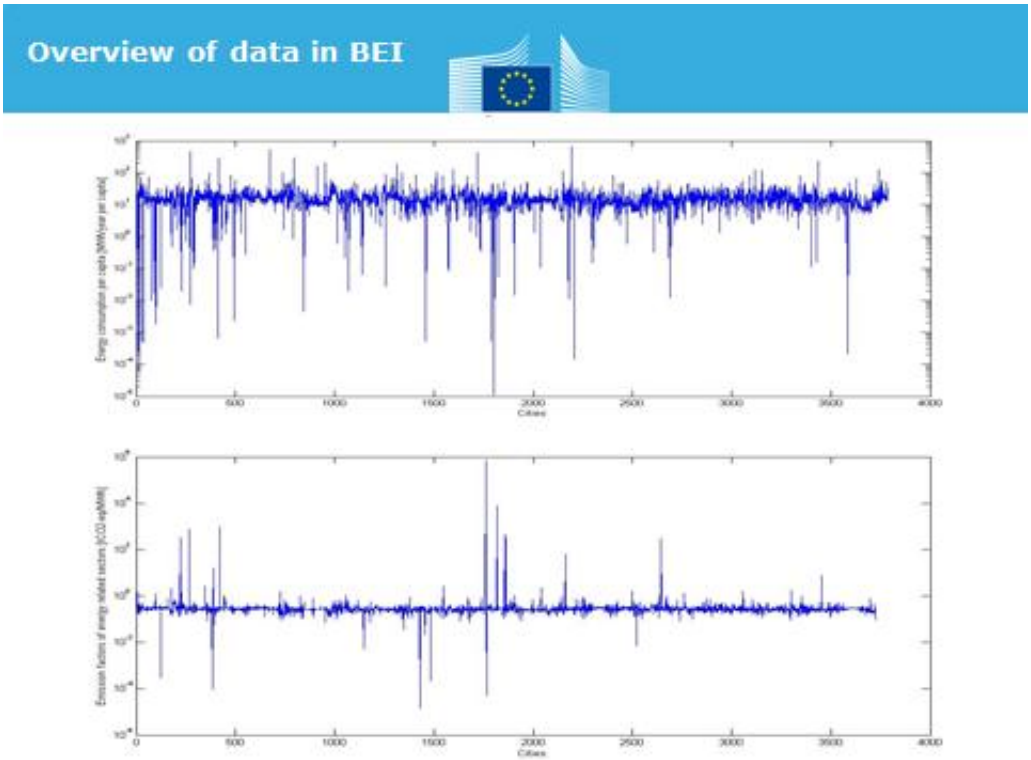
All the data provided in the current assessment are reported by the signatories in an on-line template provided on the web-site of CoM. The on-line template must reflect accurately the content of the official SEAP document, and the coherence of certain key figures is the checked by JRC.

For the current paper, when performing the analysis on energy consumption and emission parameters in cities, the data considered was related to the SEAPs submitted as of 13th May 2014. Yet, given the voluntary aspect and the difficulty of adapting sometimes local specificities into the general proposed framework, not all the data could be considered reliable, therefore a methodology has been developed to build a robust sample.



The results of the current assessment derive from a data set built according to a methodology developed by JRC "Methodology for Robust Data Statistics in CoM", to assess the effectiveness of the CoM initiative in terms of energy savings, clean energy production and CO_2 emission reduction. Further details on the methodology can be found in the Annex "Methodology for Robust Data Statistics in CoM ".

In order to describe through descriptive statistics our set of data, we need to define some parameters like the mean, the standard deviation, the Skewness and kurtosis. As it can be seen in the figure, which reports the energy consumption per capita in cities, there are many outliers and the frequency distribution is far for being normal. In statistics, an outlier is an observation point that is distant from other observations.

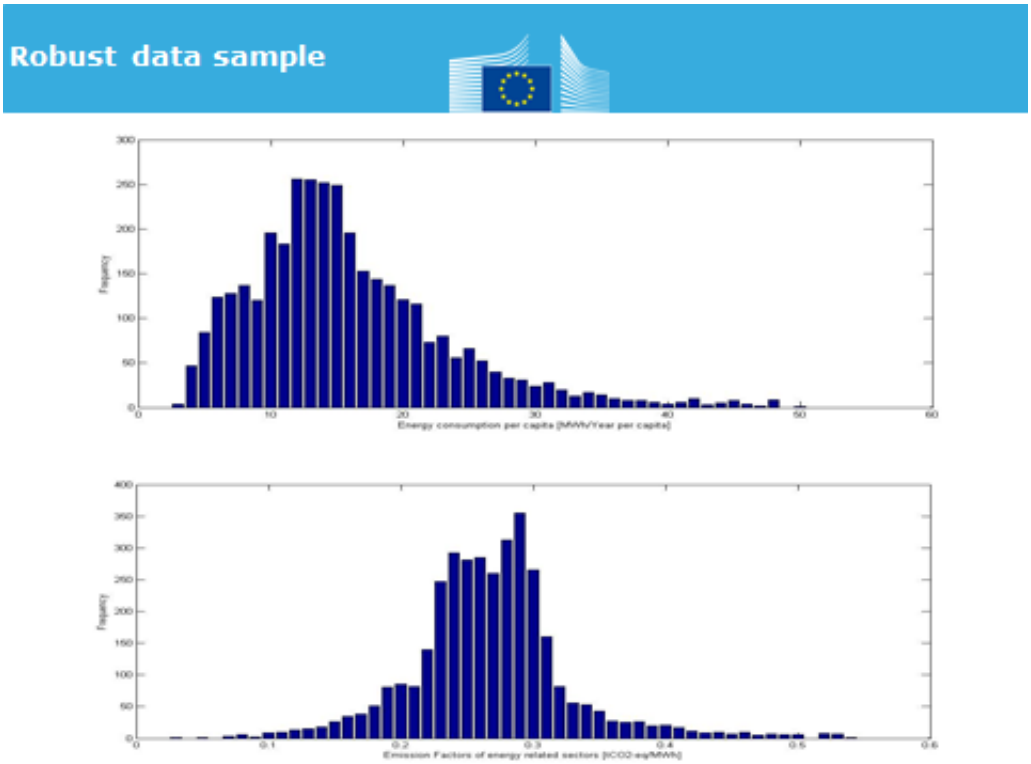


In order to remove the outliers, a methodology has been developed to select a robust data sample of cities. The methodology is based on selecting cities with reliable data on energy consumption per capita and CO_2 emission factors for energy related sectors in cities.

The mean, standard deviation, skewness and kurtosis were calculated at the beginning for each set of data. Secondly a Generalised Extreme studentized method was applied for removing the outliers. Similar methodologies, in literature, have been applied to detect outliers or abnormal energy consumptions in buildings. As result of the applied methodology, a sample of cities was selected.

In the first figure is represented the frequency distribution of the average final energy consumption per capita in cities in bins from 1-50 MWh/annual. In the vertical axes is reported the number of occurrences (cities) for each range of Final energy consumption per capita.

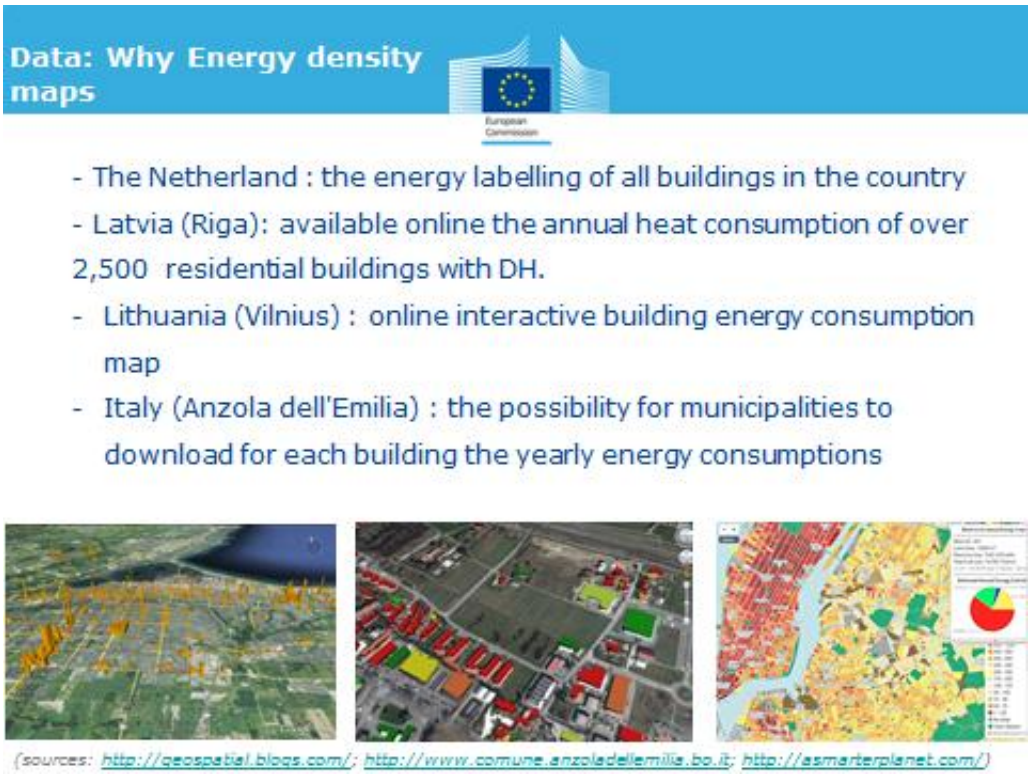
While in second figure is represented the frequency distribution of the average emission factors (energy related sectors) in cities in bins from 0.1-0.6 tCO2-eq/MWh. In the vertical axes is reported the number of occurrences (cities) for each range of Emission Factor of energy related sectors in cities



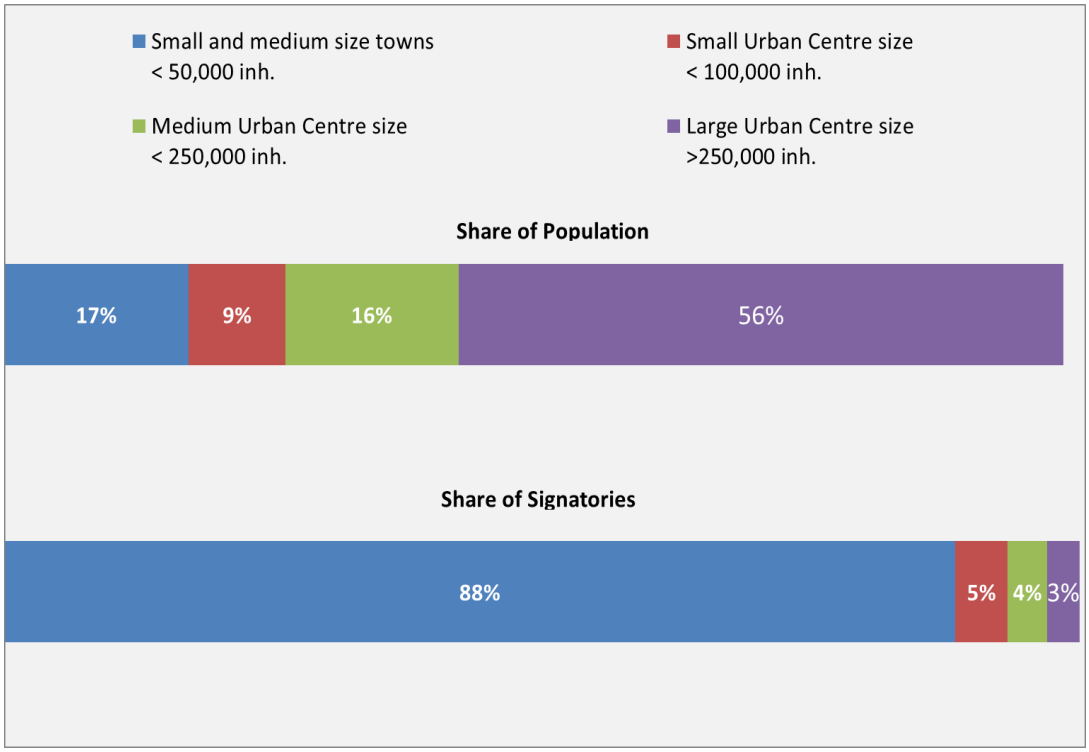
In order to identify the high energy usage in a city on which to target energy savings, municipalities need higher granularity, specifically at the building and property level, expressed in units of kWh/m^2, i.e. Energy Density Maps.

In 2012, the Canadian Horizon Utilities Corporation gave a very interesting presentation on using energy density mapping to help take the guesswork out of identifying customers on whom to target conservation and demand management (CDM) programs. The data was aggregated at a relatively course level of granularity and expressed in terms of gigajoules/hectare.

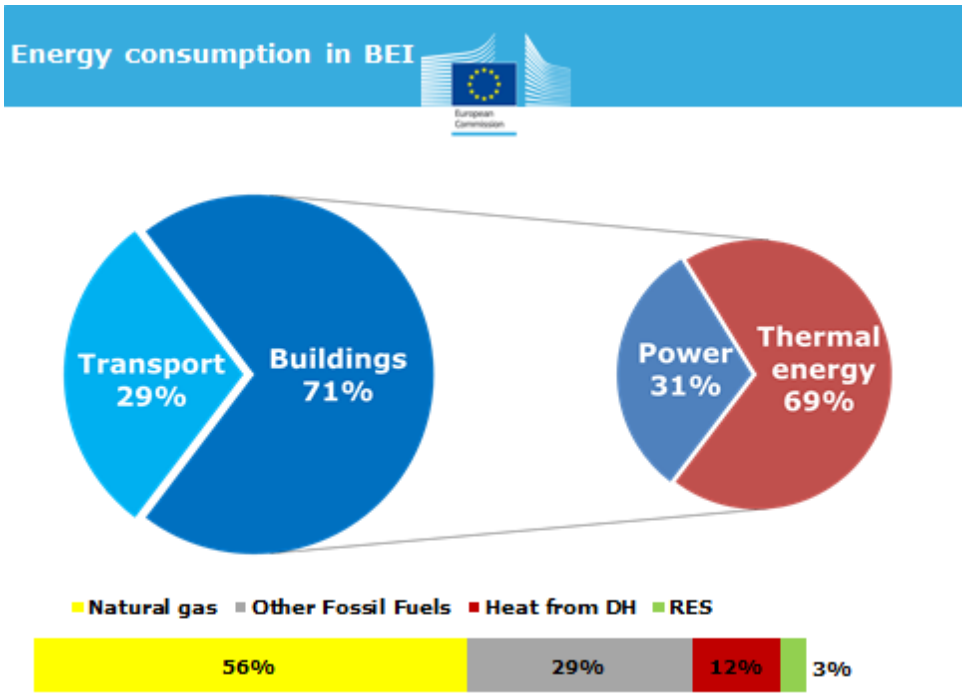
In the following are presented some examples from CoM and other initiatives where the Energy density maps are used.



The shares of final energy consumption per Signatories' category are shown in following graph. Small and medium size towns represent only 17% of the overall final energy consumption. While in terms of inhabitants they represent 88% of the CoM population.



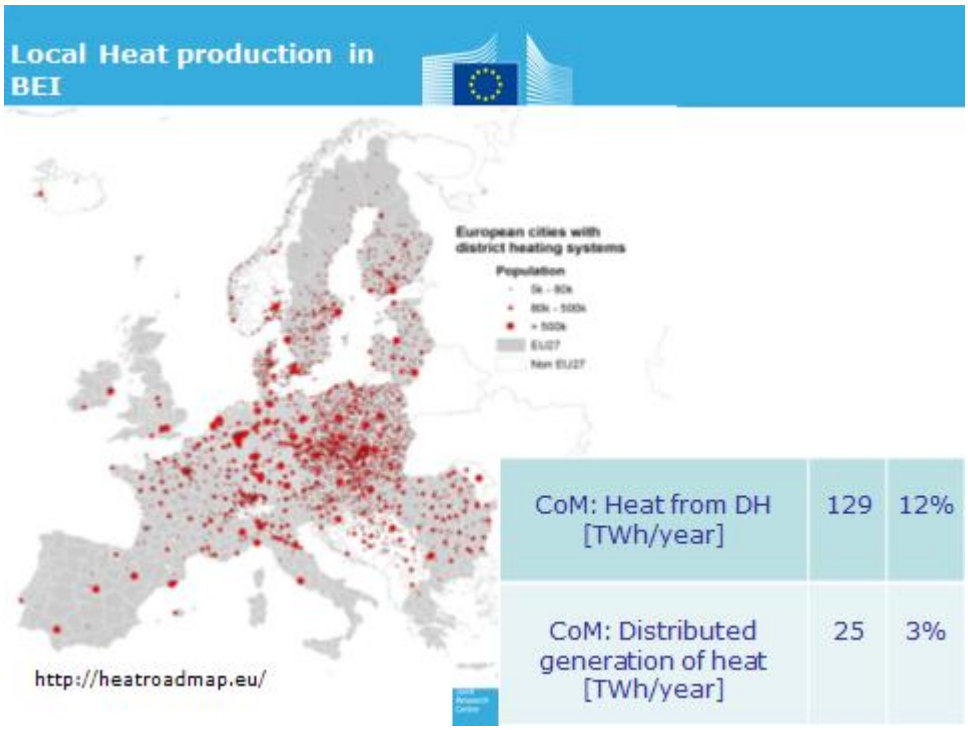
The Final energy Consumption in urban areas derive mainly from two macro sectors: buildings and transport. The total final energy consumption is 2,358 TWh/year, where the highest values are reached in the residential sector. The table reports also the amount of electricity, heat/fuel consumptions per sectors in CoM. The highest share of electricity and heat is consumed in the Residential sector, while the highest fuel consumption in the Transport sector is consumed in the Private and commercial Transportation



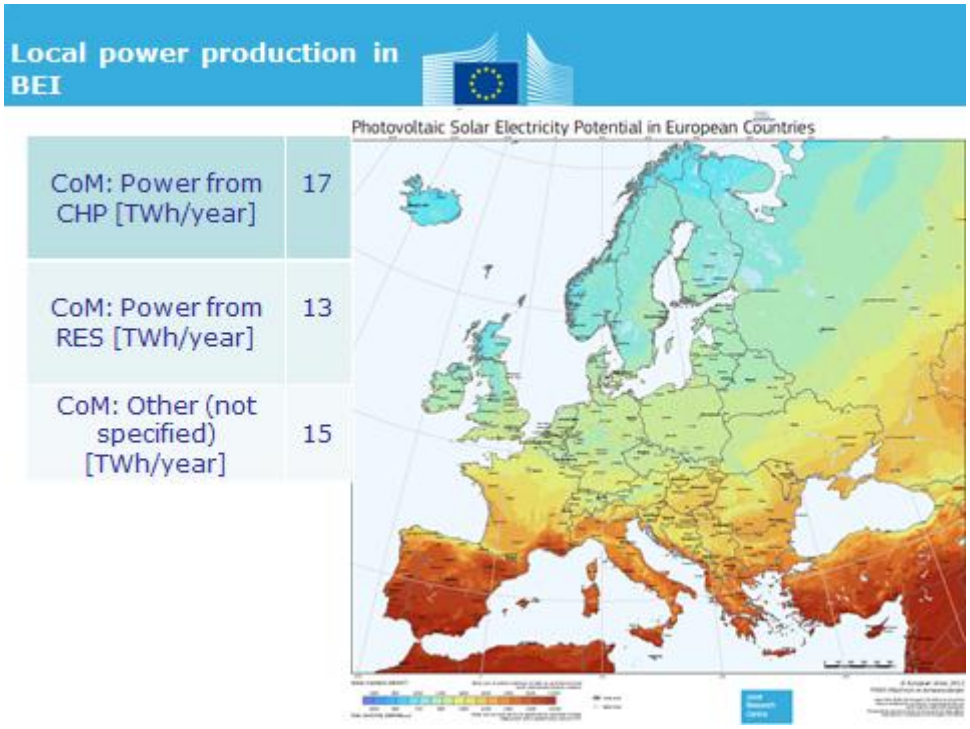
In the BEIs template, signatories also report the amount of local energy production. In the following section, data from the BEIs data set as of 13th of May 2014 on local electricity production and local heat production and distributed through District Heating and Cooling (DHC) networks are reported.

The table displays the amount of local heat production in CoM. The share of heat derived from CHP power stations using mainly fossil fuels as primary source is 39%. While 16% of Local Heat production is a distributed generation using Renewable sources (geothermal, biomass and solar).

The results of CoM confirm the share of heat supplied by DHN as reported in the project heatroadmap.eu



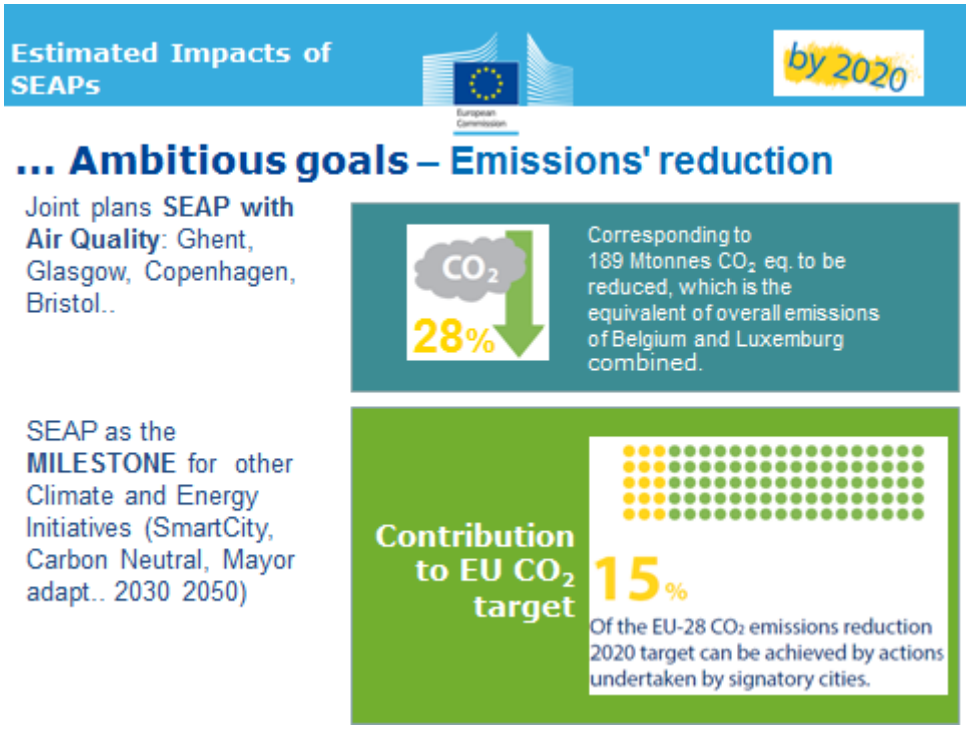
The following table reports the amount of local electricity production in CoM, classified according to the type of conversion technology. The highest share of electricity is produced by the Combined Heat and Power plants CHP (39%).



The SEAP document reports the actions/measures planned by the signatories, together with relevant project management information on

I. Estimated energy savings in 2020;
II. Estimated local energy production in 2020;
III. Estimated GHG emission reduction in 2020.

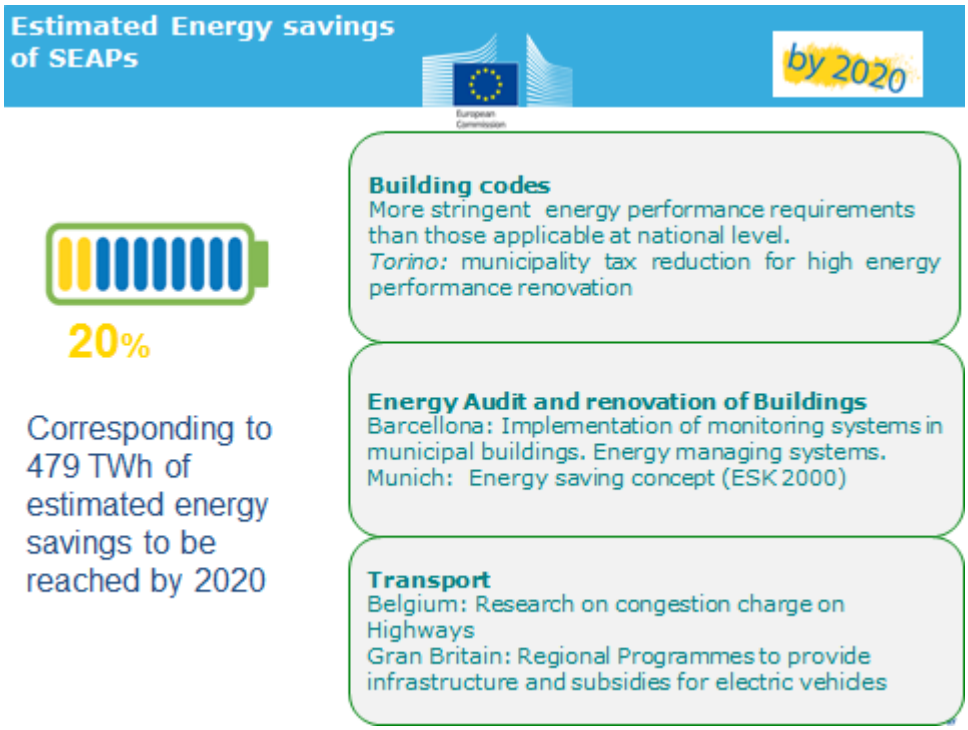
Although the minimum commitment was to reduce the current emissions by 20%, CoM signatories who have already submitted a SEAP and are part of the sample have estimated an overall reduction of more than 28%.



The following graph shows the estimations on Energy savings by 2020.

The reduction target will be achieved through energy efficiency measures in the municipal territories along with energy production from renewables and more efficient energy conversion technologies like CHPs. In fact, the estimated Energy savings by 2020, correspond to **20%** of the energy consumption in the CoM signatories' territories.

It is important to highlight that the biggest Energy savings (52%) are estimated to take place in the Building sector, followed by the transport sector with a share of 25%. Other sectors comprehend measures planned in areas of Public procurement, in Land Use Planning, Working with citizens.



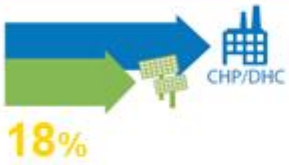
The following graph represents the estimations on Energy production per sector by 2020.

The Estimated Local Energy production is calculated as the summation of current Local Energy production and the Estimated Local Energy production in the SEAPs.

Based on this analysis, we can affirm that the estimation for 2020 in CoM signatories of Local Energy production from Renewable sources and by more efficient energy generation technologies (CHPs connected with District Heating Networks), the share of local energy production will be **18%** of the total energy consumption.

Estimated Local Energy Production of SEAPs

by 2020



Corresponding to 133 TWh of energy mainly from CHP, PV and wind power. 130% increase of energy prod. from RES

Source: SEAP Sonderborg (DK)

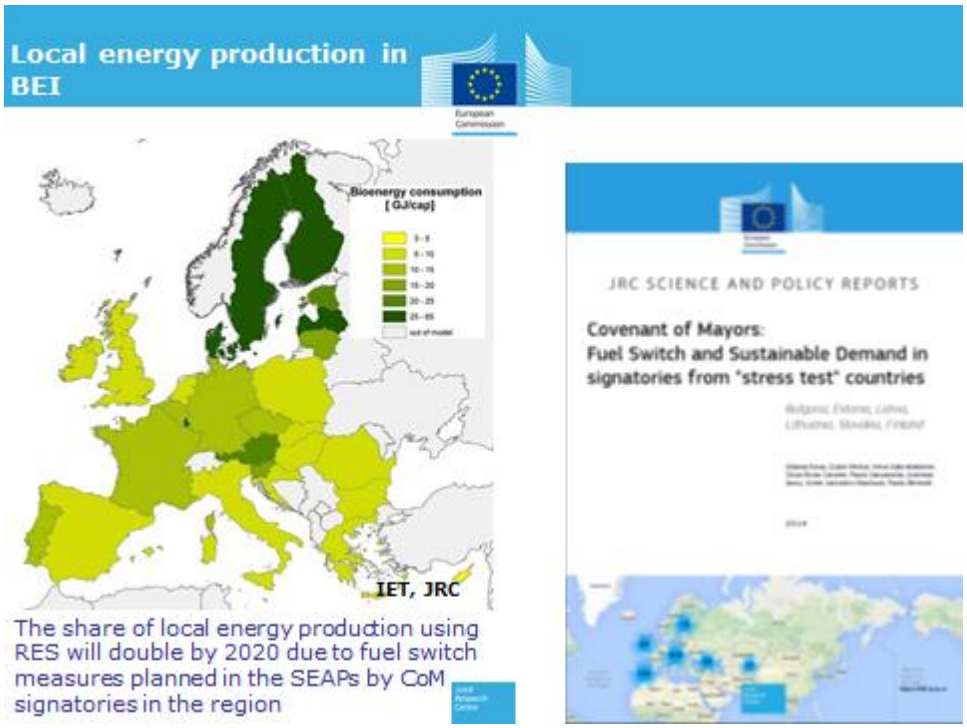
Local power production in BEI

http://heatroadmap.eu/

Some examples from CoM

- **Tampere (FI):** two wood-based district heating and one waste-to-energy CHP plant
- **Warsaw (PL):** two co-generation plants to significantly reduce CO2 emissions and switch from fossil to biofuel
- **Torino (IT):** waste-to-energy CHP plant

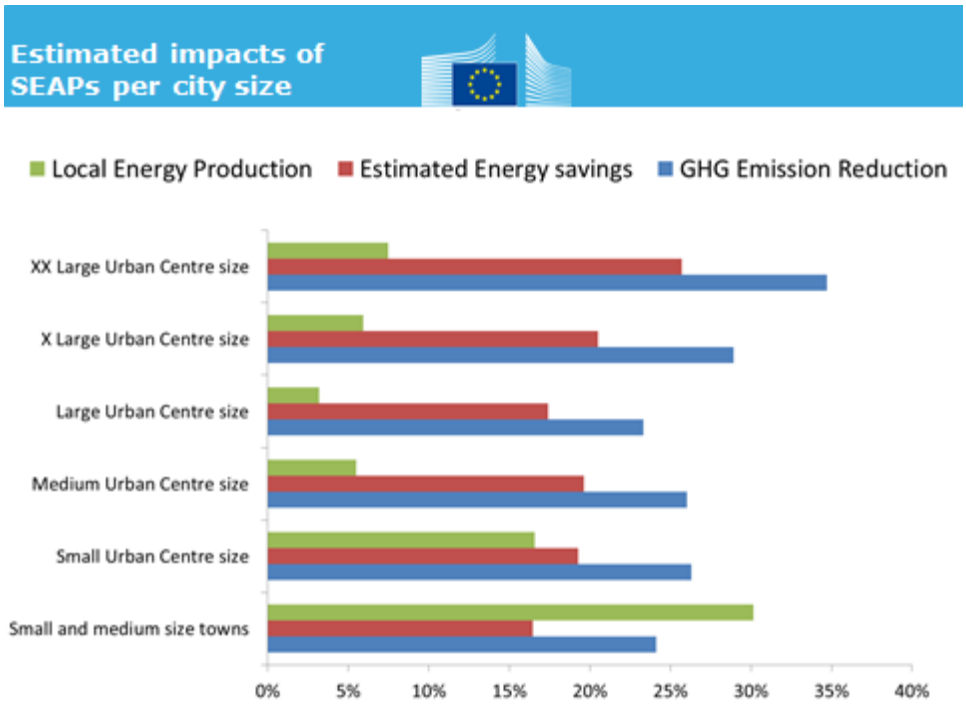
The CoM report (Kona et. al 2014) on "stress test" countries confirm the data on Local Energy production from RES, mapped in the National Renewable energy Action Plans in these countries.



In the following figure are shown the shares of GHG Emission reduction, Estimated Energy savings and Local Energy production in the different categories of urban centres based on the population size.

- Blue bars refer to the ratio between the estimated GHG Emission Reduction by 2020 and the current GHG Emission in BEIs ;
- Red bars refer to the ratio between the estimated energy savings by 2020 and the Final Energy consumption in BEIs;
- Green bars refer to the ratio between the Estimated Local energy production by 2020 and the Final Energy Consumption in BEIs.

Clearly, from this graph the majority of GHG Emission Reduction will take place in Large Urban centres (more than 250,000 inhabitants) with more than 30%, and this will be attained through energy efficiency in Buildings and in Transportation. While the highest share of estimated Local energy production by 2020 are foreseen in Small medium towns (30%).



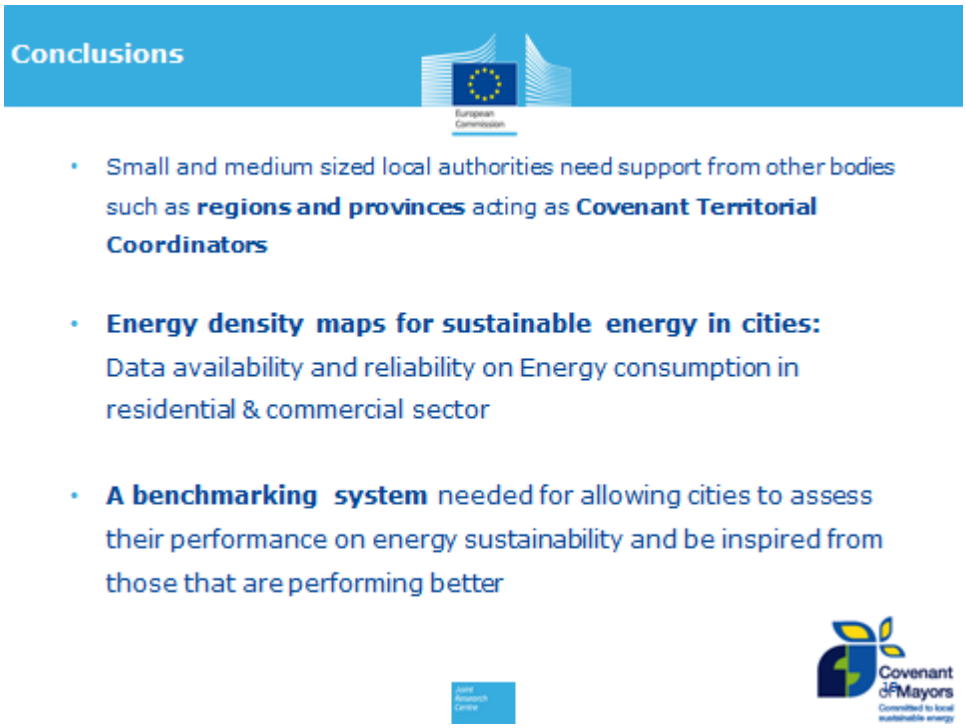
This report provides an overview of the Covenant of Mayors (CoM) initiative as of mid May 2014.

Overall, city-level emissions and energy consumption per capita from the "CoM data set 2014" is compatible with international datasets at national level (Eurostat, IEA).

By implementing the CoM programme, the European Commission has given visibility to the role of local authorities and their relevant contribution to EU2020 targets. The majority of signatories with a submitted Sustainable Energy Action Plan are small and medium towns, representing **88%** of the total number of signatories. Nevertheless, signatories categorized as SMSTs account for a limited share of energy consumption, (16%) overall. Since the regional context appears to be the most important common factor for SMSTs, in order to maximize the potential represented by the CoM initiative, an efficient approach would be to encourage the development of Joint Action Plans and promote the rule of **Covenant Territorial Coordinators** (CTCs).

Individual cities' Sustainable Energy Action Plans (SEAPs) are currently developed. The SEAPs are flexible structures, with only one binding target (voluntary declared curbing CO_2 emission). It is upon possibilities or opportunities that municipalities have to find the right mixture of actions on getting local energy demand under control and increasing the use of local renewable sources.

Moreover, the SEAPs may contribute to a more wide vision of sustainability in urban areas by encouraging the integration of energy systems and optimized balancing of demand supply.



In the coming years, signatories are challenged with the monitoring phase of CoM initiative. Bottom-up methodologies and GIS based tools may be integrated. These may include the evaluation of winter thermal energy needs and fuel consumption, the creation of 3-D maps to pre-certify buildings at an urban scale for an energy assessment of buildings, and optimize energy consumption based on energy modelling of buildings. The regulatory framework and platforms for open source data sharing may further support related efforts. The INSPIRE Directive has already established an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment. The idea is promote the use of harmonised and interoperable geodata in the energy domain.

Furthermore, a benchmarking system will be developed to allow cities to assess sustainability and be inspired from those that are performing better. We need to support this momentum of cities with adequate policies and increase policy learning with benchmarking.

Next steps

Measuring and monitoring energy sustainability at the city level can be challenging…

Indicators can help local governments to identify which **strategies** allow the greatest improvement

Energy efficiency in buildings
Sustainable transport
Local energy production

Enhance Energy security
Hourly frequency balance of energy at city level

Benchmarking Energy sustainability in Cities

II. Torino Energy Action Plan- Monitoring Phase

Roberto Pagani, Lorenzo Savio, Giacomo Chiesa

Politecnico di Torino, Italy

TAPE (Turin Energy Action Plan 2012)

Since the '90, the city of Torino has implemented targeted environmental policies reaching important results in terms of total emission reduction. Several public and private stakeholders, who already brought the CO_2 balance of Torino to the 18% reduction from 1991 to 2005, have been involved in 2009 in the elaboration of a new Strategic Plan for Sustainable Energy.

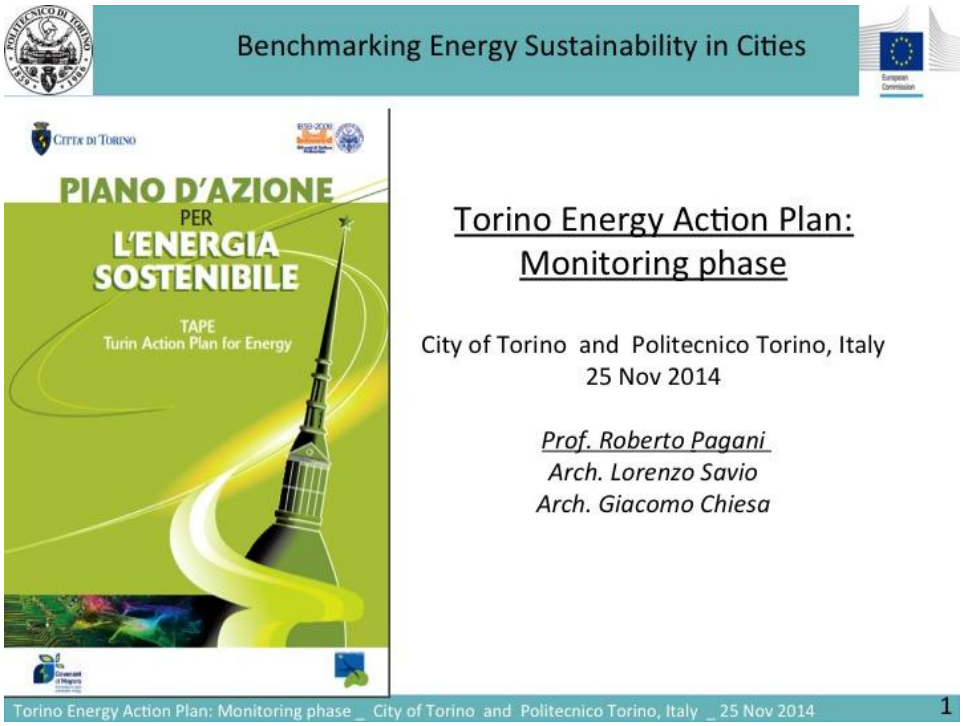
The goal of Torino, joining the Covenant of Mayors, was to strengthen the on-going actions, coordinated by the City Administration. This brought in October 2010 to the approval of the Torino Energy Action Plan (TAPE) by the City Council. The Action Plan aims at reaching a CO_2 emission reduction of over 40% by 2020 compared to the 1991 data of the first Energy Action Plan developed by Torino. The topic of the CO_2 emission reduction has become a central goal, which the Administration wants to attain in all sectors: buildings, transports, public lighting, wastes and water management. Since the beginning of the 90's the energy consumption, and the related CO_2 emissions, have been particularly influenced by the intensive industrial activities, the housing stock and the mainly private transportation. Torino is the capital city of a region with 4,5 million inhabitants and is located in the centre of a metropolitan area with 1,704,000 inhabitants. Part of the strong industrial legacy of Torino - established from the 50's onwards – consists of its number of residential and municipal buildings, largely inefficient. This has always been a weak point for the energy performances of the city. The residential sector was responsible for the 40% of CO_2 emissions in 1991, and 34% in 2005. However, the implemented strategies have always tried to turn the problem into an opportunity, as shown by the constant expansion of the district heating network.

The forecasted CO_2 reduction – over 40% between 1991 and 2020 – shows a sharper curve in the next years compared to the past fifteen years. This is due to the implementation of very efficient measures, carried out in a short time period. The key elements of this strategy are the strong improvement of existing buildings energy performances, the exploitation of renewable energies, an innovative mobility plan to reduce the impact of private vehicles in favour of public transports, and a significant increase of the district heating network, based on co-generation, that will cover 45% of the total building stock. A CO_2 emission reduction over 40% by 2020 - compared to 1991 values - represents a big challenge for the city. The important industrial asset of Torino makes this goal even more ambitious, since the emission policies of large industrial settlements cannot be decided by a city, which has a limited jurisdiction.

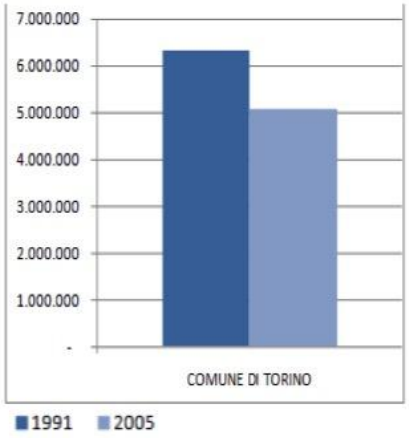
Implementing and Monitoring the Plan

After the TAPE adoption, in 2010, Torino is carrying out the actions' monitoring, supported by the Research Team of Politecnico Torino (Polito) having supported the City in the energy action plan and CoM application. The monitoring phase is crucial for the success in achieving the CO_2 reduction targets and can also be the occasion for a revision and refurbishment of the Plan, introducing new strategic actions, and strengthening the collaboration between all stakeholders.

The Polito Research Team is part of the Tape Office (the Municipal Office in charge of TAPE) and envisaged 5 working steps for the monitoring implementation: *1) Re-framing, 2) Managing, 3) Monitoring, 4) Action checking, 5) Identifying new actions.*



Inventories 1991 – 2005

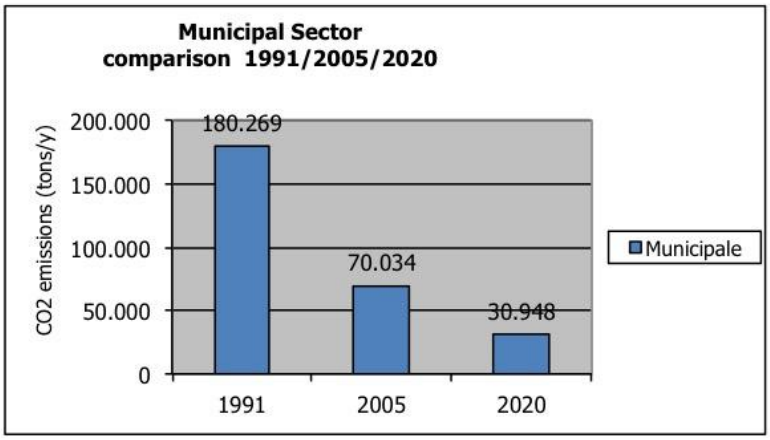


TEST : Turin Energy & Environmental Strategy
City of Turin : baseline 1991

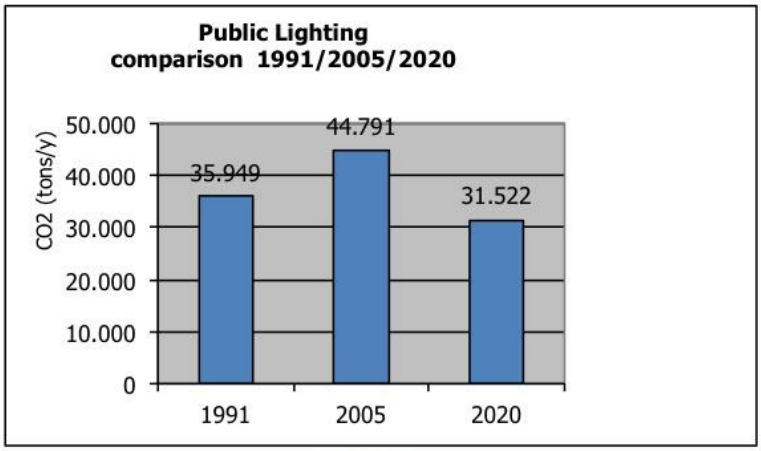
TAPE : Turin Energy Action Plan
City of Turin : baseline 2005

CO_2 Emissions Reduction 1991-2005

-18,7%

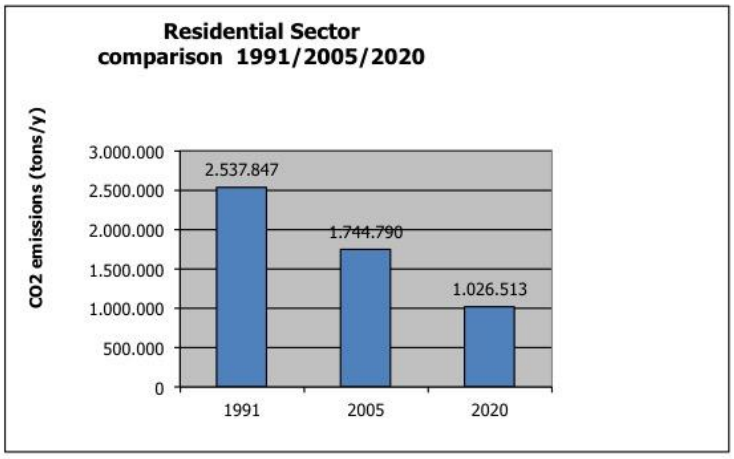


reduction 2005-2020 55,8%
reduction 1991-2020 82,8%

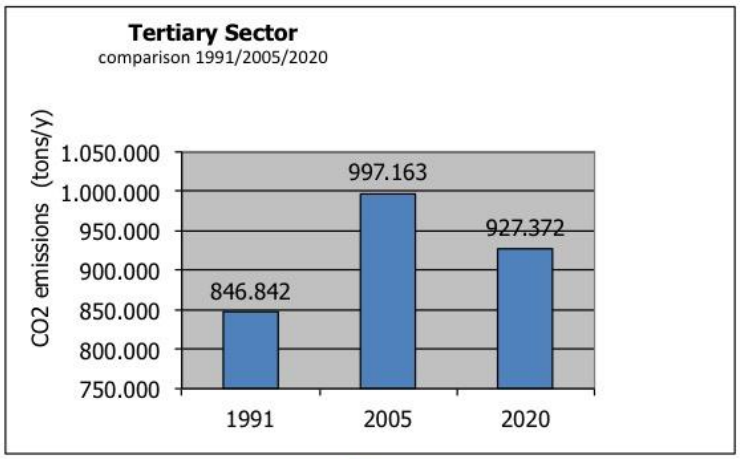


reduction 2005-2020 29,6%
reduction 1991-2020 12,3%

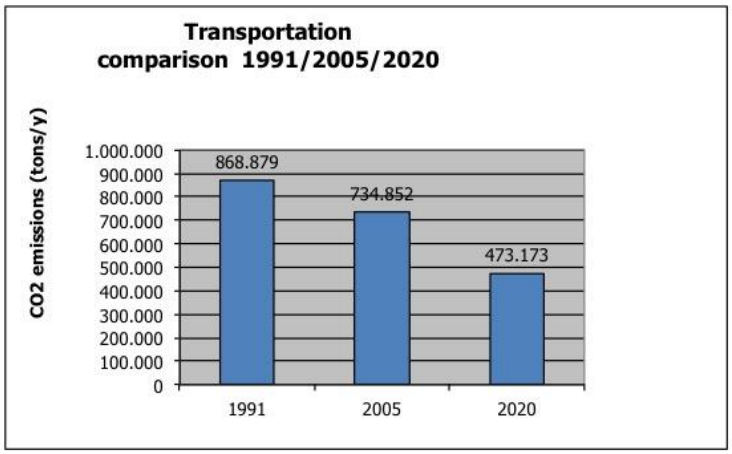
Benchmarking Energy Sustainability in Cities



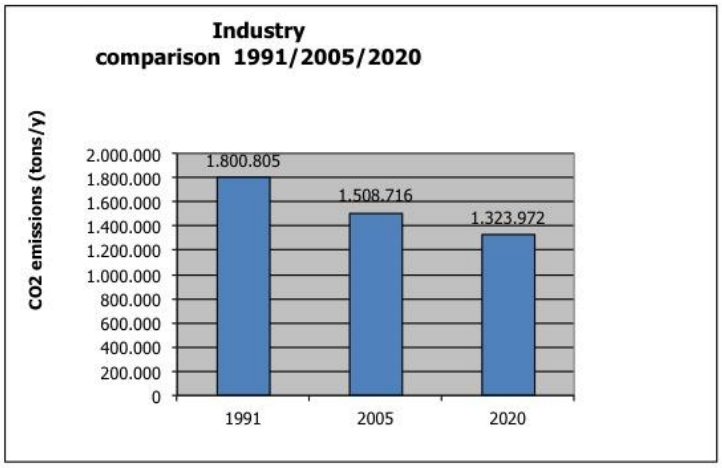
reduction 2005-2020 41,2%
reduction 1991-2020 59,6%



reduction 2005-2020 7%
increment 1991-2020 9,5%



reduction 2005-2020 35,6%
reduction 1991-2020 45,5%



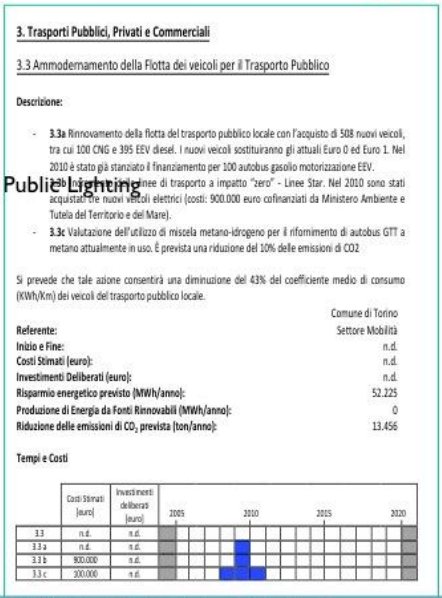
reduction 2005-2020 12,2%

reduction 1991-2020 26,4%

51 ACTION SHEETS

- Building and Tertiary:

  Municipal, Tertiary, Residential, Public Lighting
- Industry
- Transport private and commercial
- Local production of electricity
- District heating
- Urban Planning
- Green procurement
- Stakeholders' involvement



3. Trasporti Pubblici, Privati e Commerciali

3.3 Ammodernamento della Flotta dei veicoli per il Trasporto Pubblico

Descrizione:

- **3.3a** Rinnovamento della flotta del trasporto pubblico locale con l'acquisto di 508 nuovi veicoli, tra cui 100 CNG e 395 EEV diesel. I nuovi veicoli sostituiranno gli attuali Euro 0 ed Euro 1. Nel 2010 è stato già stanziato il finanziamento per 100 autobus gasolio motorizzazione EEV.
- **3.3b** Introduzione di linee di trasporto a impatto "zero" - Linee Star. Nel 2010 sono stati acquistati 7 nuovi veicoli elettrici (costi: 900.000 euro cofinanziati da Ministero Ambiente e Tutela del Territorio e del Mare).
- **3.3c** Valutazione dell'utilizzo di miscela metano-idrogeno per il rifornimento di autobus GTT a metano attualmente in uso. È prevista una riduzione del 10% delle emissioni di CO2

Si prevede che tale azione consentirà una diminuzione del 43% del coefficiente medio di consumo (KWh/Km) dei veicoli del trasporto pubblico locale.

	Comune di Torino
Referente:	Settore Mobilità
Inizio e Fine:	n.d.
Costi Stimati (euro):	n.d.
Investimenti Deliberati (euro):	n.d.
Risparmio energetico previsto (MWh/anno):	52.225
Produzione di Energia da Fonti Rinnovabili (MWh/anno):	0
Riduzione delle emissioni di CO_2 prevista (ton/anno):	13.456

Tempi e Costi

	Costi Stimati (euro)	Investimenti deliberati (euro)	2005	2010	2015	2020
3.3	n.d.	n.d.				
3.3 a	n.d.	n.d.				
3.3 b	900.000	n.d.				
3.3 c	100.000	n.d.				

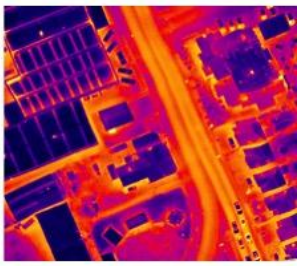
Residential Buildings Retrofit

KEY ACTIONS:

- energy retrofit of residential building before 1990
- termoregulation systems and heat meters
- substitution of burners with high efficiency heating systems
- installation of solar thermal heaters in new buildings and refurbishments
- energy certification

Benchmarking Energy Sustainability in Cities

District Heating Network



KEY ACTIONS:

- expanding the Torino district heating in co-generation

2005: 39 million m^3 of buildings
2020: 67 million m^3 of buildings

CO_2 emission reduction 2005 - 2020
568.080 t/y

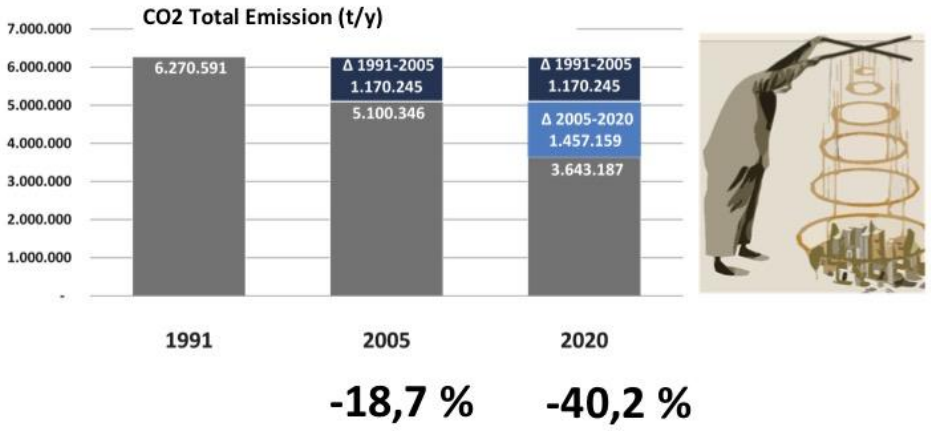
Sustainable Urban Mobility

KEY ACTIONS:

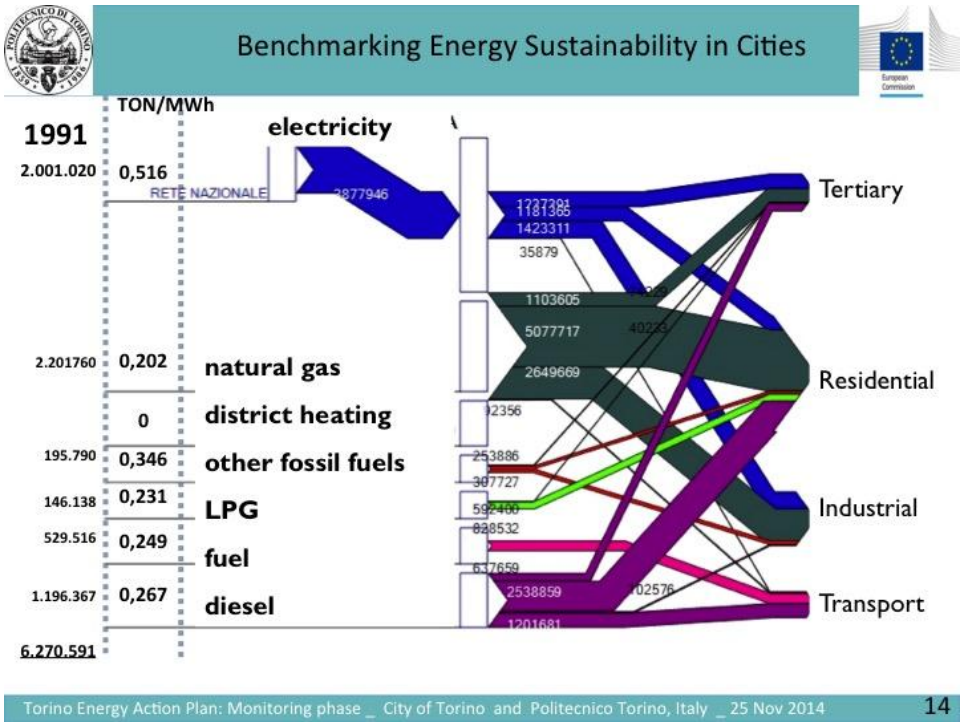
- completing the new line of Torino Subway
- new fleet of public transportation
- increase of efficiency of private transportation
- increase of cycling mobility
- substitution of private vehicles with low emission vehicles

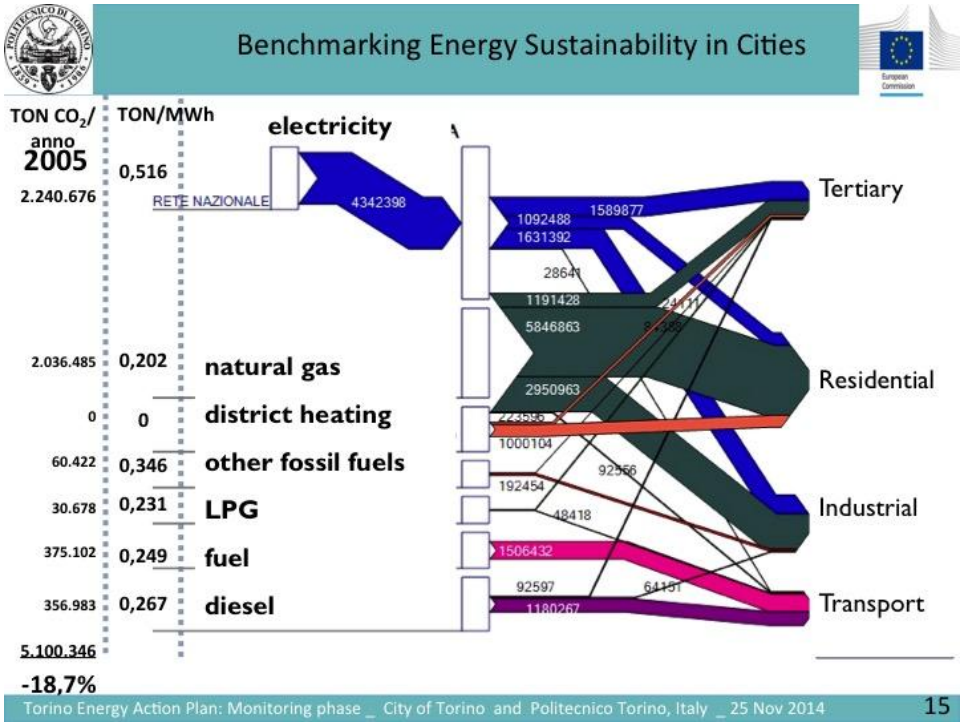
CO_2 emission reduction 2005 - 2020
261.679 t/y

Benchmarking Energy Sustainability in Cities

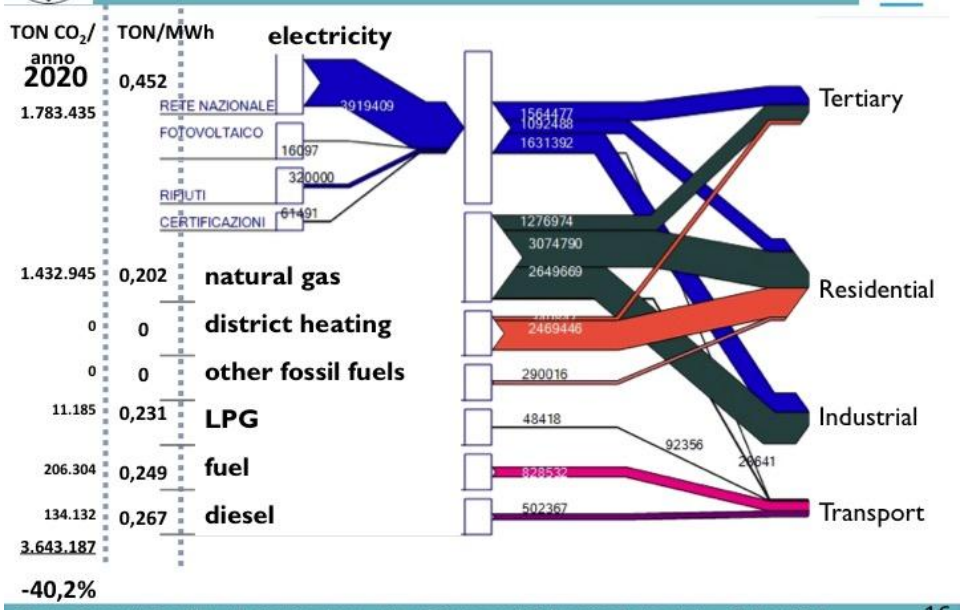


-18,7 % **-40,2 %**

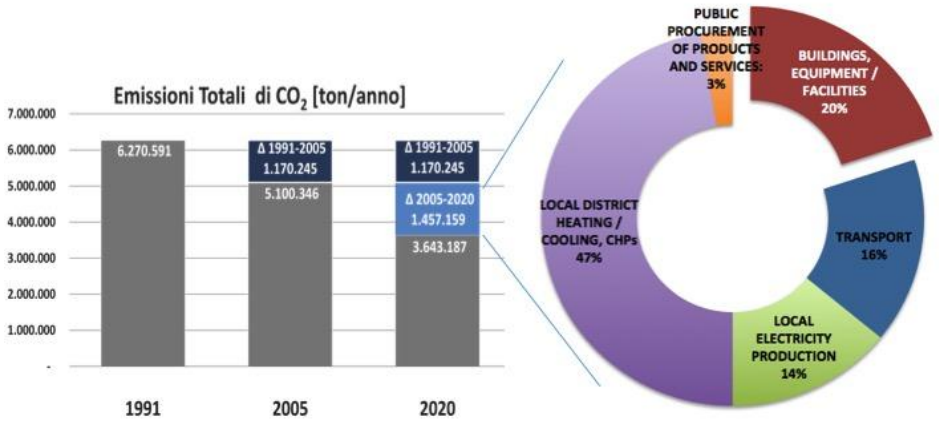

Benchmarking Energy Sustainability in Cities
TON/MWh
1991
2.001.020
0,516
electricity
RETE NAZIONALE
3877946
Tertiary
1237391
1181385
1423311
35879
1103605
5077717
40223
2.201760
0,202
natural gas
2649669
Residential
0
district heating
195.790
0,346
other fossil fuels
253886
307727
146.138
0,231
LPG
529.516
0,249
fuel
828532
637659
Industrial
1.196.367
0,267
diesel
2538859
102576
Transport
1201681
6.270.591
Torino Energy Action Plan: Monitoring phase _ City of Torino and Politecnico Torino, Italy _ 25 Nov 2014
14


Benchmarking Energy Sustainability in Cities
TON CO2/ anno
2005
2.240.676
TON/MWh
0,516
electricity
RETE NAZIONALE
4342398
Tertiary
1092488
1589877
1631392
28641
1191428
5846863
2.036.485
0,202
natural gas
2950963
Residential
0
0
district heating
1000104
60.422
0,346
other fossil fuels
92556
192454
30.678
0,231
LPG
48418
Industrial
375.102
0,249
fuel
1506432
92597
64151
356.983
0,267
diesel
1180267
Transport
5.100.346
-18,7%
Torino Energy Action Plan: Monitoring phase _ City of Torino and Politecnico Torino, Italy _ 25 Nov 2014
15

Benchmarking Energy Sustainability in Cities



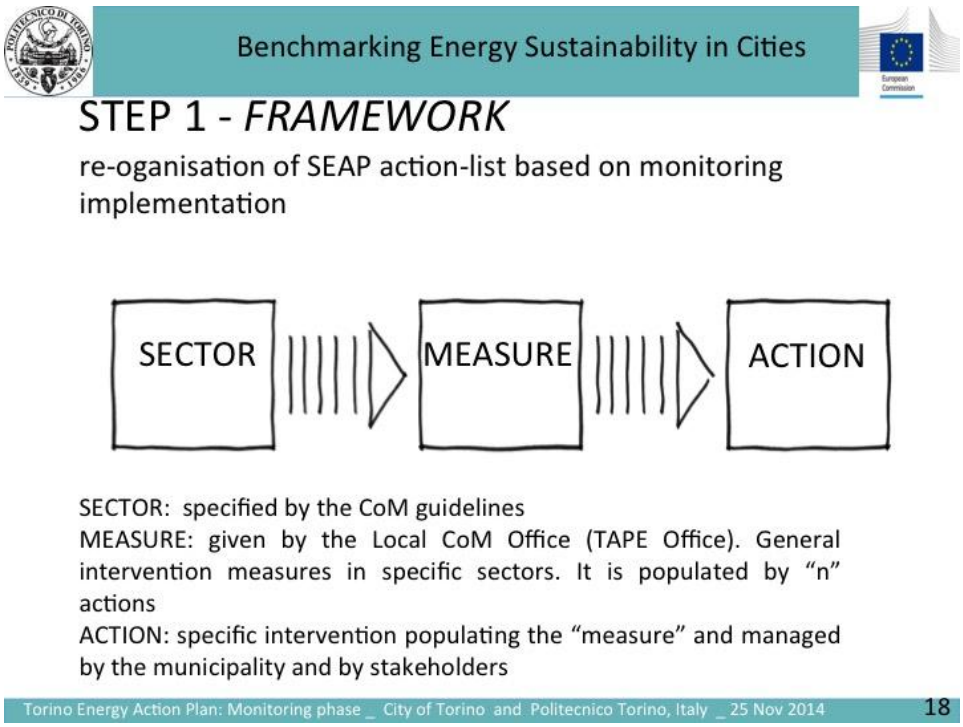
Benchmarking Energy Sustainability in Cities

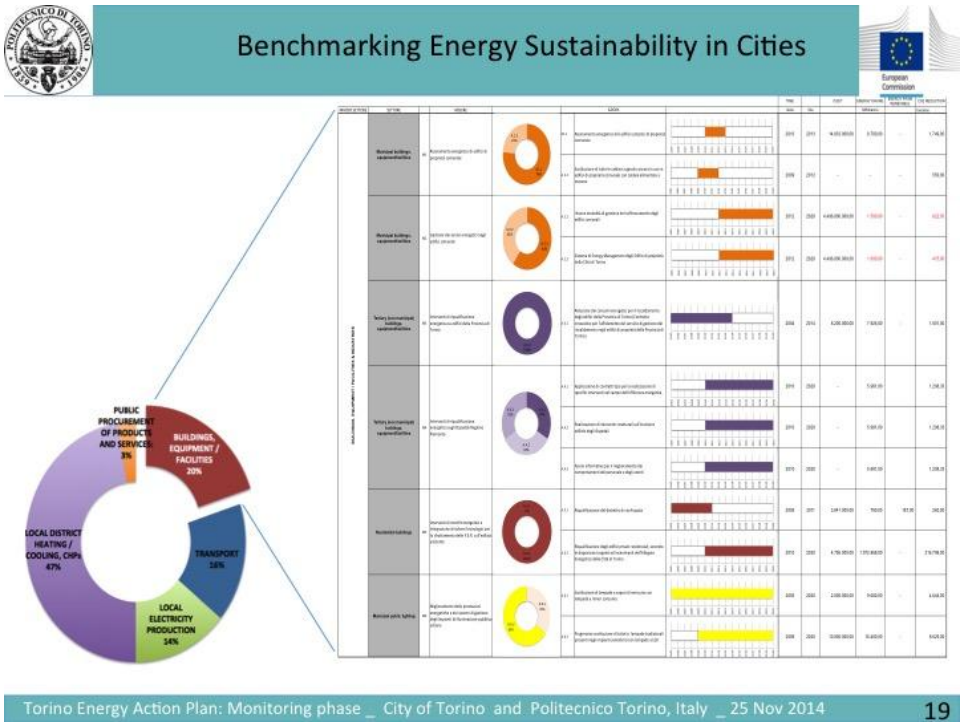


Re-framing

It consists of a general re-definition of the original structure of the plan, by splitting it into Measures and Actions. The *Measure* consists of an identified strategy, pursued by the City for a specific sector in order to achieve the target of the Covenant of Mayors. A Measure has a long-term deadline (2020 or more), it is active for the full duration of the Action Plan, and it incorporates multiple actions.
The *Action* consists of a specific project, whose costs are clearly determined, as well as timing and results (reduction of energy consumption, energy production from renewables, reduction of CO_2 emissions). Each Action is univocally referred to a specific Measure. The set of measures is the long-term strategy of the city, while the actions are projects to reach the objectives of a particular measure.

Measures are in a limited number, identified at the beginning and step-by-step incremented or adapted; Actions are not pre-determined, they are potentially an infinite number, but all classified in specific Measures.





Managing

A redefinition of the management structure is taking place, assigning specific activities and roles to all TAPE team members. Three main tasks are set: the Tape Office, the Measure Leader and the Action Leader.

Role of Tape Office

- defining, in agreement with the Municipality, the long term vision of the Plan and its set of Measures;

- identifying, in agreement with the Municipality, a responsible for each Measure;

- managing and monitoring the implementation of TAPE;

- supporting the Action Leader in various assessments: energy saving, energy production from renewables, and CO_2 reduction;

- preparing and submitting the monitoring reports, as required by the Covenant of Mayors Office.

Within the Tape Office a responsible for each city' sector is identified, with the following tasks: keeping contact with the various Measure Leaders, checking the Action Monitoring

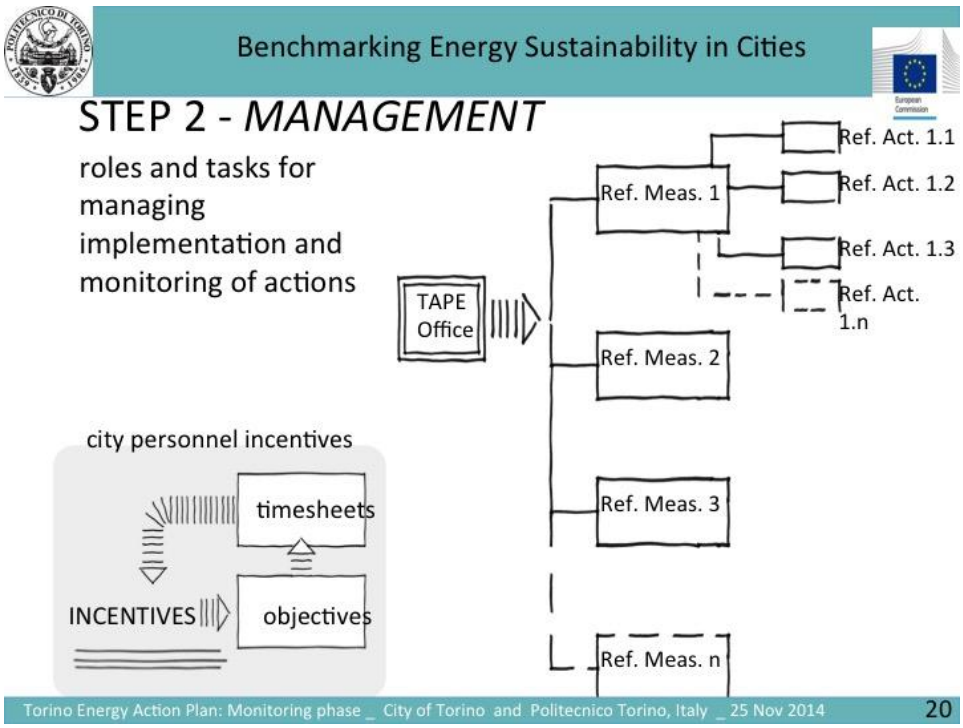
forms, upgrading methodologies, assessing energy saving and emission reduction of each Action

Role of Measure Leader:

- providing the overall management and specific expertise for specific Measures;
- identifying and coordinating the responsibles of each Action;
- formulating and proposing to the Tape Office new Measures and/or Actions to be incorporated in TAPE

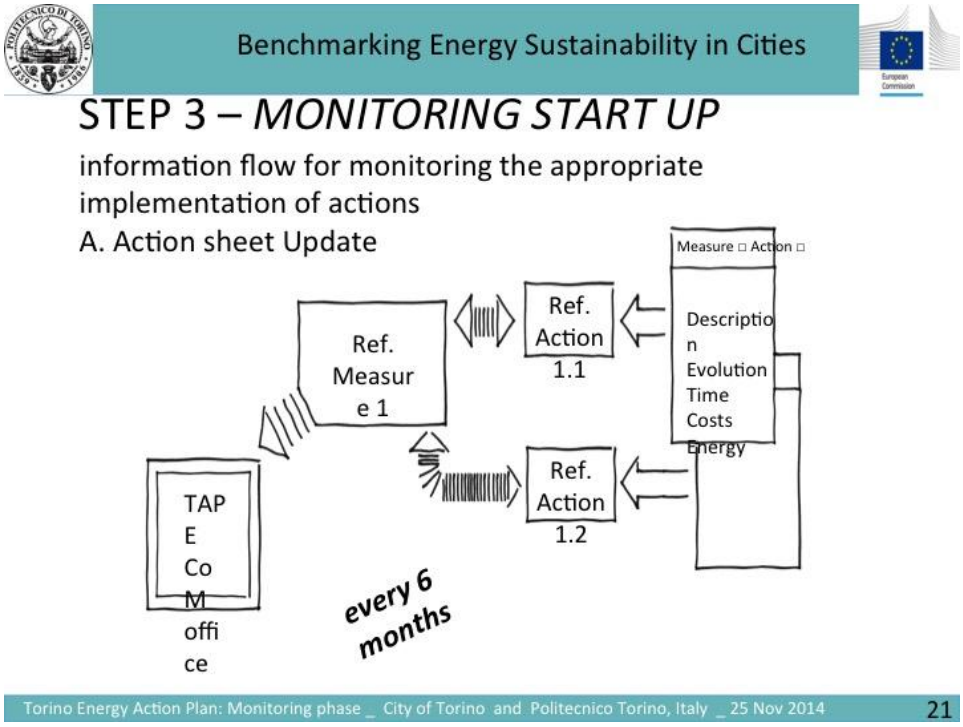
Role of Action Leader

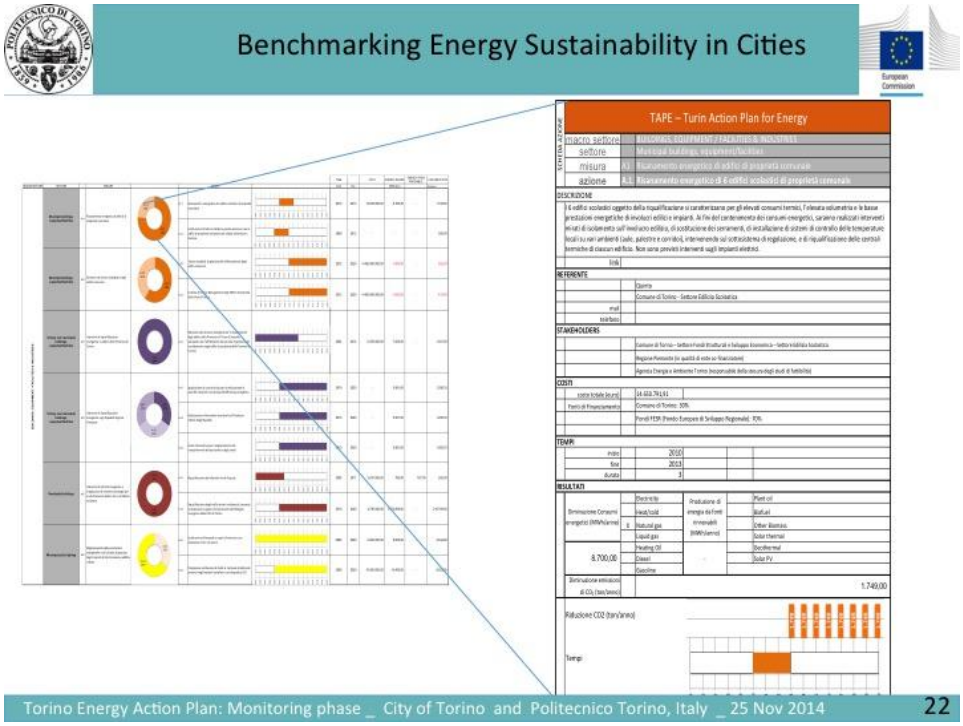
- managing specific projects or a specific Action. This collaboration with the Tape Office must be recognised as part of the working "targets" of the Action Leader and, where civil servant, be submitted on "personnel timesheet";
- filling both the Action form and the Monitoring form;
- checking and updating costs, timing and expected/final results;
- managing the relationships with third parties involved in the Action (Municipal, Regional, private bodies, ...);
- collaborating with the Tape Office by providing the necessary data for estimating energy savings, production from renewables, and CO_2 emission reductions.



Monitoring

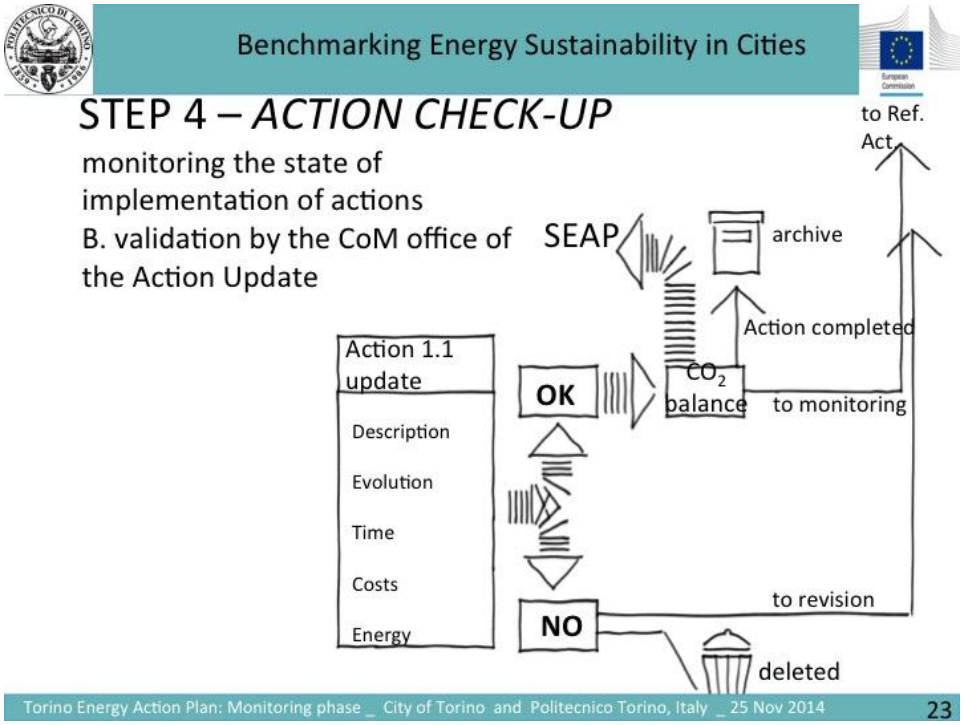
Starting-up the overview and monitoring of the TAPE actions. Each Action Leader must fill a monitoring form, provided by the Tape Office. Each monitoring form must be reviewed by the Measure Leader, before its submission to the Tape Office.





Action checking

All monitoring forms, submitted by the Action Leaders, are to be validated by the Tape Office. The completed Actions are filed.



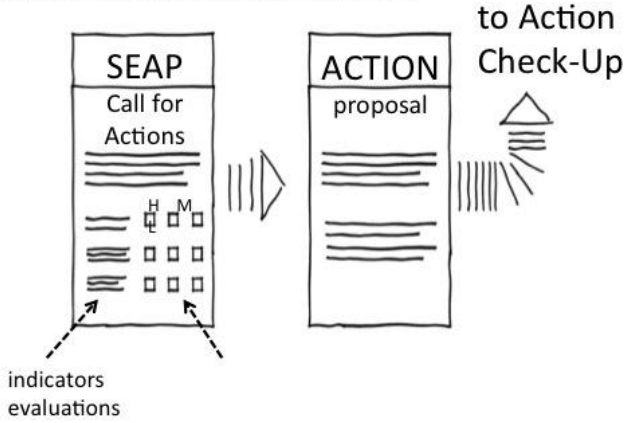
Identifying new Actions

In parallel to monitoring, the implementation of current actions and the formulation of new actions need to progress or be planned. An Open Call mechanism will be tested, where stakeholders can candidate new actions, by completing a dedicated form. The Tape Office will collect the candidate actions, checking them, and assess their compatibility with the action plan. The selected new actions will then be integrated into related Measures.

SCHEDA MONITORAGGIO	TAPE – Turin Action Plan for Energy	
	macro settore	BUILDINGS, EQUIPMENT / FACILITIES & INDUSTRIES
	settore	Municipal buildings, equipment/facilities
	misura	A3 Risanamento ed efficientamento degli edifici di proprietà comunale
	azione	A3.1 Risanamento energetico di 6 edifici scolastici di proprietà comunale
DESCRIZIONE		
		I 6 edifici scolastici oggetto della riqualificazione si caratterizzano per gli elevati consumi termici, l'elevata volumetria e le basse prestazioni energetiche di involucri edilizi e impianti. Ai fini del contenimento dei consumi energetici, saranno realizzati interventi mirati di isolamento sull'involucro edilizio, di sostituzione dei serramenti, di installazione di sistemi di controllo delle temperature locali su vari ambienti (aule, palestre e corridoi), intervenendo sul sottosistema di regolazione, e di riqualificazione delle centrali termiche di ciascun edificio. Non sono previsti interventi sugli impianti elettrici.
	link	
REFERENTE		
		Quinto
		Comune di Torino - Settore Edilizia Scolastica
	mail	
	telefono	
STAKEHOLDERS		
		Comune di Torino – Settore Fondi Strutturali e Sviluppo Economico – Settore Edilizia Scolastica
		Regione Piemonte (in qualità di ente co-finanziatore)
		Agenzia Energia e Ambiente Torino (responsabile della misura degli stati di fattibilità)
COSTI		
	costo totale (euro)	14.658.791,91
	Fonti di Finanziamento	Comune di Torino: 30%
		Fondi FESR (Fondo Europeo di Sviluppo Regionale) : 70%
TEMPI		
		stima / monitoraggio
	inizio	2010 / 2010
	fine	2013 / 2015
	durata	3 / 5
		Nota: sono stati completati gli interventi solo su 4 dei 6 edifici scolastici
RISULTATI		
		stima / monitoraggio
	Diminuzione Consumi energetici (MWh/anno)	8.700,00 / 6.960,00 / 80%
		Nota: sono stati completati gli interventi solo su 4 dei 6 edifici scolastici
	Produzione di energia da fonti rinnovabili (MWh/anno)	- / - / -
	Diminuzione emissioni di CO_2 (ton/anno)	1.749,00 / 2.200,00 / 126%
		Nota: sono stati superati i costi stimati a inizio progetto
	Riduzione CO2 (ton/anno)	
	Tempi	

STEP 5 – *NEW ACTIONS*

«Call for actions» by the municipality and open to stakeholders, involved in determining and planning new actions to be incorporated in the SEAP



III. Strategies Towards Energy Performance and Urban Planning in Glasgow, Ghent, Riga and Gothenburg: STEP UP

Nickolas Purshouse, Institute for Future Cities, Glasgow, UK

STEP UP is funded by the Seventh Framework programme of the EU under the energy theme. It aims to help cities with their strategic sustainable city planning and STEP UP stands for Strategies Towards Energy Performance and Urban Planning. It is linked to the EU Covenant of Mayors process whereby signatories commit to produce a Sustainable Energy Action Plan. This in turn was established to deliver against EU2020 targets for GGG reductions (20%); renewable energy as a share of energy consumption (20%); and improvement in energy efficiency (20%). The STEP UP project was conceived and has been carried out to ensure that the SEAP process is robust and can help local government deliver on these targets through their SEAPs. Part of that process is also ensuring that cities work with the right stakeholders on the SEAP. In STEP UP, there is an explicit link to both commercial (often energy companies, banks or regeneration agencies) and research partners (often a University). The presentation "STEP UP- Strategies Towards Energy Performance in Urban Planning" provided he results of the STEP UP project. In addition, the presentation provided insight to help municipalities deliver enhanced Sustainable Energy Action Plans.

STEP UP - Strategies Towards Energy Performance In Urban Planning

www.stepupsmartcities.eu

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 314679.

Institute for Future Cities

UNIVERSITY of STRATHCLYDE
INSTITUTE FOR FUTURE CITIES

Institute for Future Cities aims to improve quality of human life across the world through innovative research that enables cities to be understood in new ways

STEP UP

- EU FP7 funded energy planning project running until Summer 2015
- 4 European cities: Ghent, Glasgow, Gothenburg and Riga
- 12 Partners: each city council works with commercial and research partner

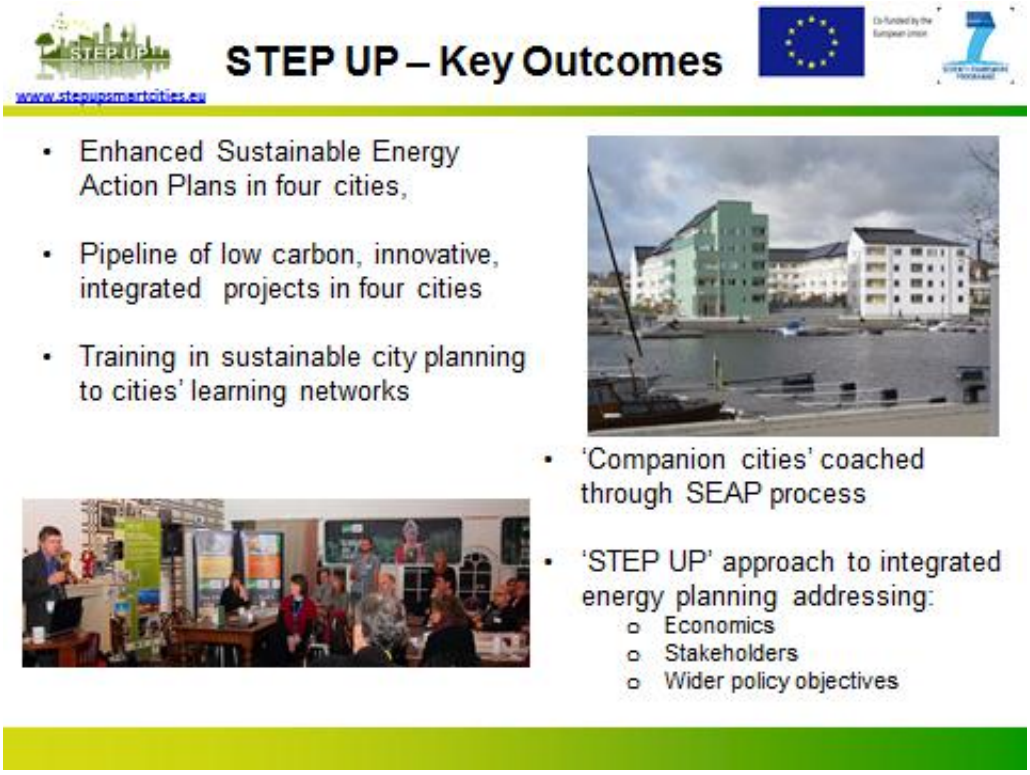
STEP UP Website:
www.stepupsmartcities.eu

STEP UP Twitter:
https://twitter.com/StepUpEU

Key outcomes for the four partner cities are their own enhanced SEAPs but also pipelines of low carbon, integrated projects that are robust and capable of delivering energy reductions, carbon savings or new renewable energy as part of the SEAP action plans.

STEP UP aims to coach 'companion cities' in each respective country (Sweden, Latvia, Belgium and the UK) through the SEAP process (or certain aspects of this) and train professionals working within the cities or municipalities on aspects such as building energy efficiency techniques, district heating systems and so on.

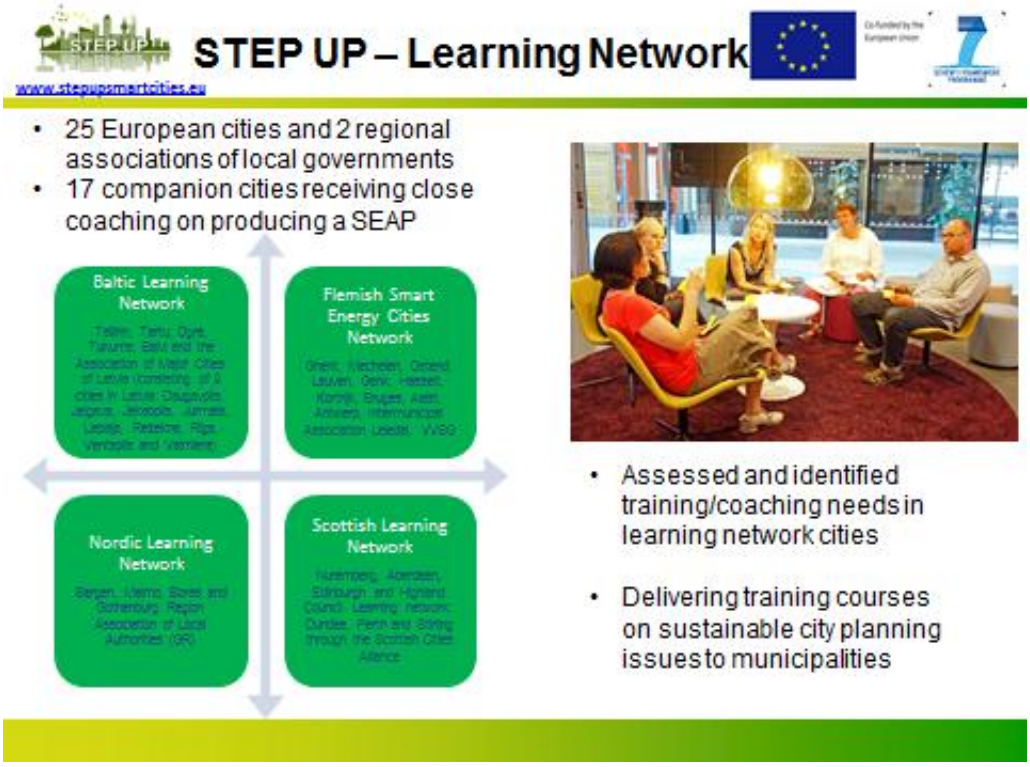
One key aspect that STEP UP is trying to demonstrate throughout the project and in its dissemination is that integrated is good economics (in that a planned and strategic approach to energy is good economically for a city and deliverable economically). The process must incorporate a wide range of stakeholders that and can deliver wider policy objectives (such as improving security of energy supplies, urban regeneration and tackling fuel poverty) and thereby makes cities better places to live, work, learn and do business.

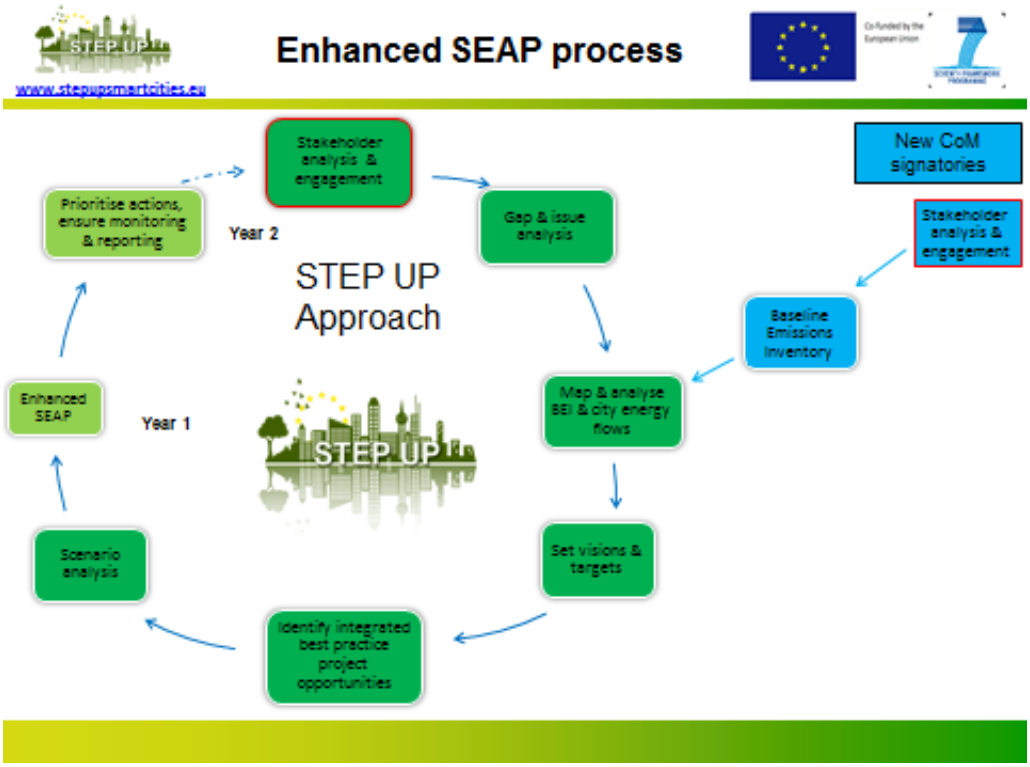


STEP UP cities have followed the same process to develop enhanced SEAPs

Approaches taken to achieve each stage have varied due to:

- Local context
- Data availability
- Expertise





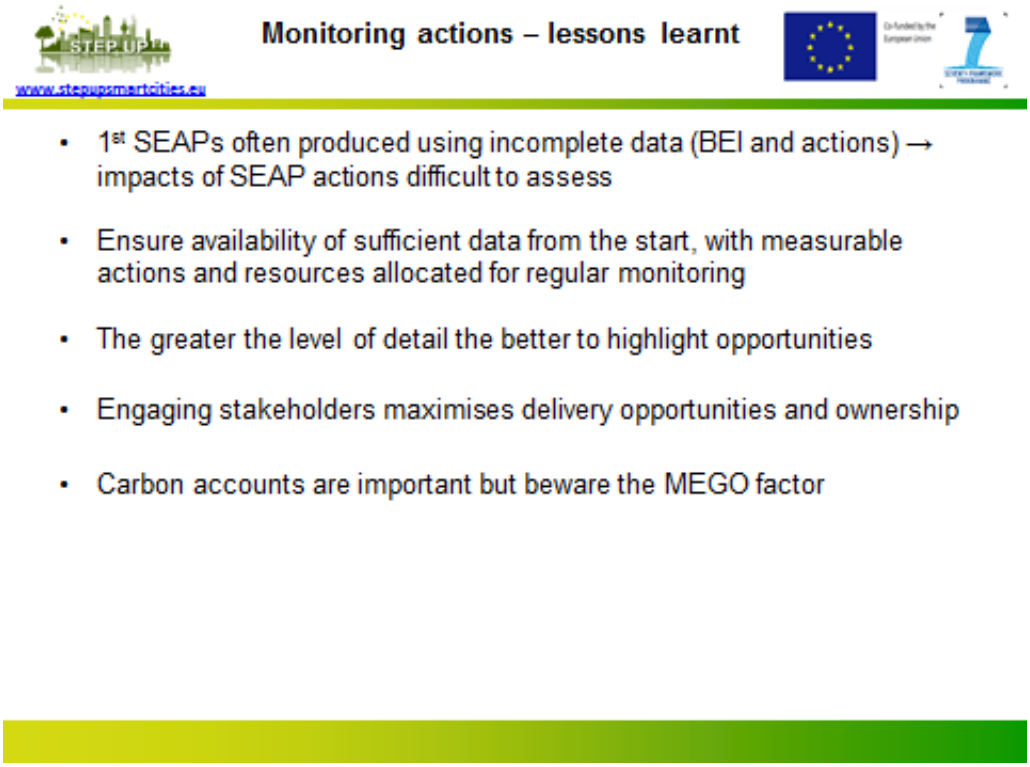
Regarding Gap and Issue Analysis:

The first SEAPs produced by STEP UP cities (and many others submitted to the CoM) were often produced using incomplete data (BEI and actions) and therefore the impacts of SEAP actions can be difficult to assess.

A key finding from STEP UP is that it is important to ensure availability of sufficient data from the start, with measurable actions and resources allocated for regular monitoring.

The conduct of a gap and issues analysis on the current SEAP and external feedback from stakeholders on this makes analysis of current SEAP more objective and the enhanced SEAP development more robust.

It is important to engage stakeholders throughout the SEAP development process and into implementation.



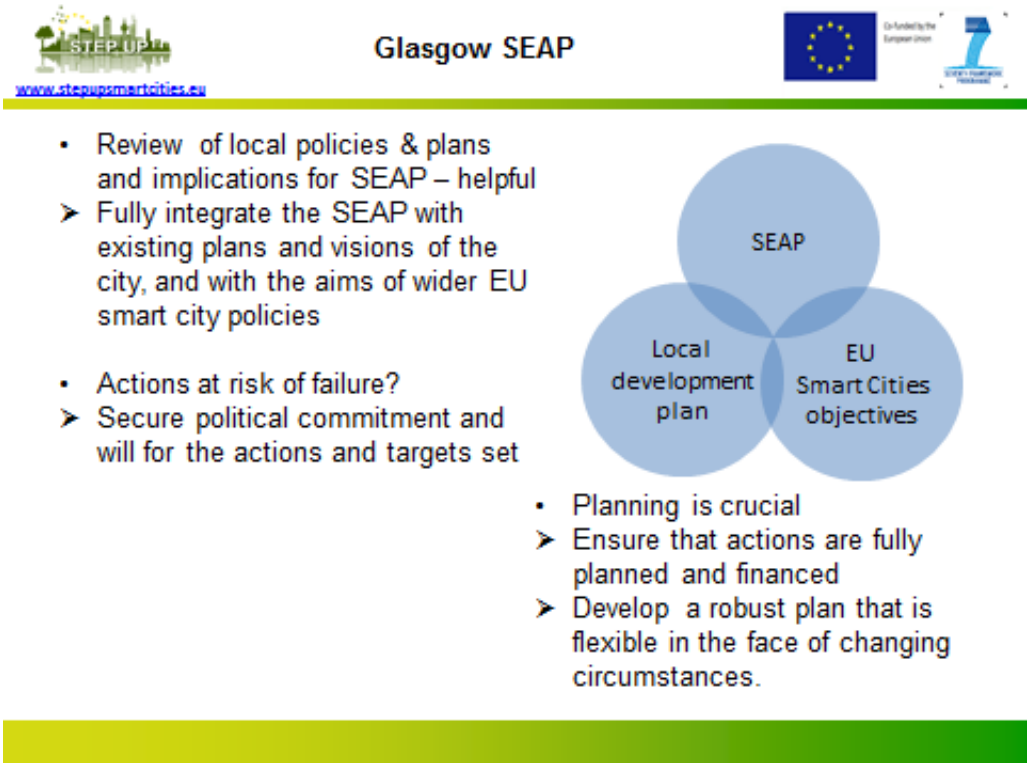
A review of local policies, plans, and implications for the SEAP is helping in orienting the SEAP towards a changing policy landscape.

It is important to fully integrate the SEAP with existing plans and visions of the city, and with the aims of wider EU climate, renewable energy, and smart city policies

An example (diagram) is how the SEAP should interact with the Local Development Plan but also with the plans developed at an EU level.Hence, the SEAP is oriented to the high level targets and aspirations of the EU in terms of developing smart and sustainable cities and seeks to achieve this through the SEAP and through spatial development plans.

It is important to secure political commitment and will for the actions and targets set to avoid risk of failure or non-implementation.

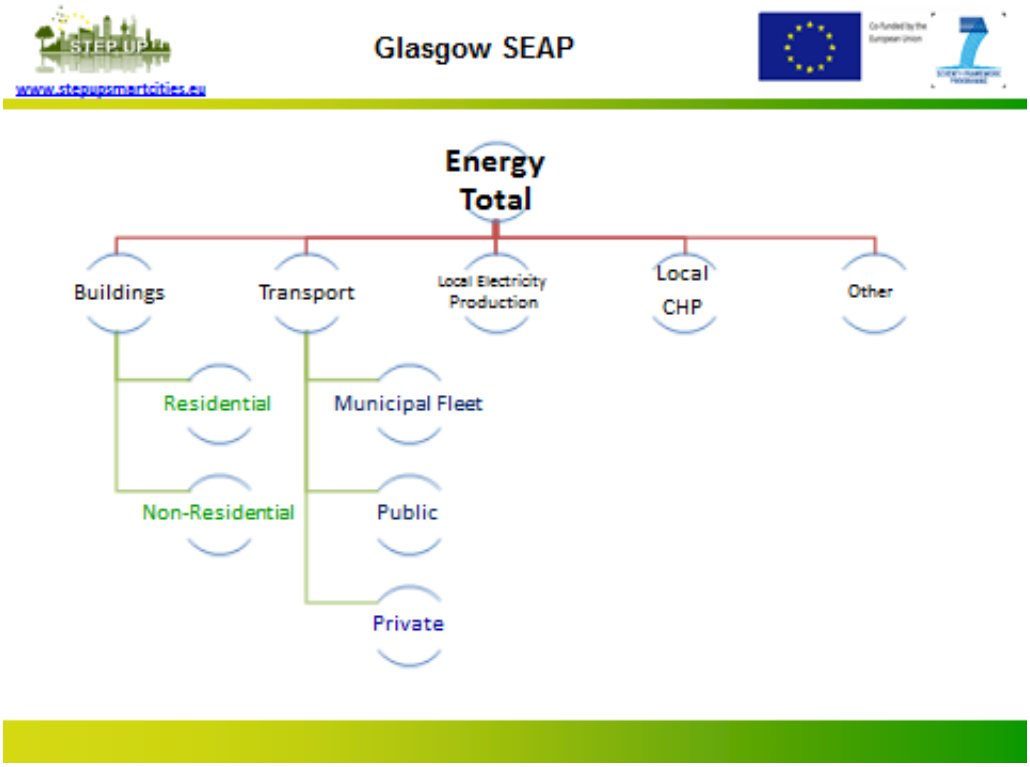
Planning is crucial to ensure that actions in the SEAP are fully planned and financed but also that the SEAP is flexible in the face of changing circumstances.



Key findings of STEP UP are:

Stakeholder engagement is essential – both sector and citizen focussed as this improves the chances that the SEAP will reflect local views and be owned and implemented by the municipality and local stakeholders.

Current and projected energy flow analysis – if conducted well and using up-to-date data and GIS enhances the BEI by providing a spatial analyss of energy demands across the City.



- 2 years data behind (meaning cities do not know exactly the impact of actions, CO_2 emissions, changes in energy prices/market, impact of economy, etc)
- Different approaches in methodology when calculating CO_2 emissions. There are numerous assumptions (buildings – energy consumption from domestic and non-domestic; transport sector, private and freight)
- Confidentiality on the data regarding high energy users
- Waste and waster water treatment challenges/difficulties

Glasgow's carbon accounting

CITY WIDE
- DECC data
- Energy consumption for LA (city wide)
- CO_2 emissions for LA

2012

LOCAL AUTHORITY
- Energy consumption and CO_2 emissions for Council estate (GCC and ALEO'S)
- Carbon Management Plan
- Carbon Reduction Commitment

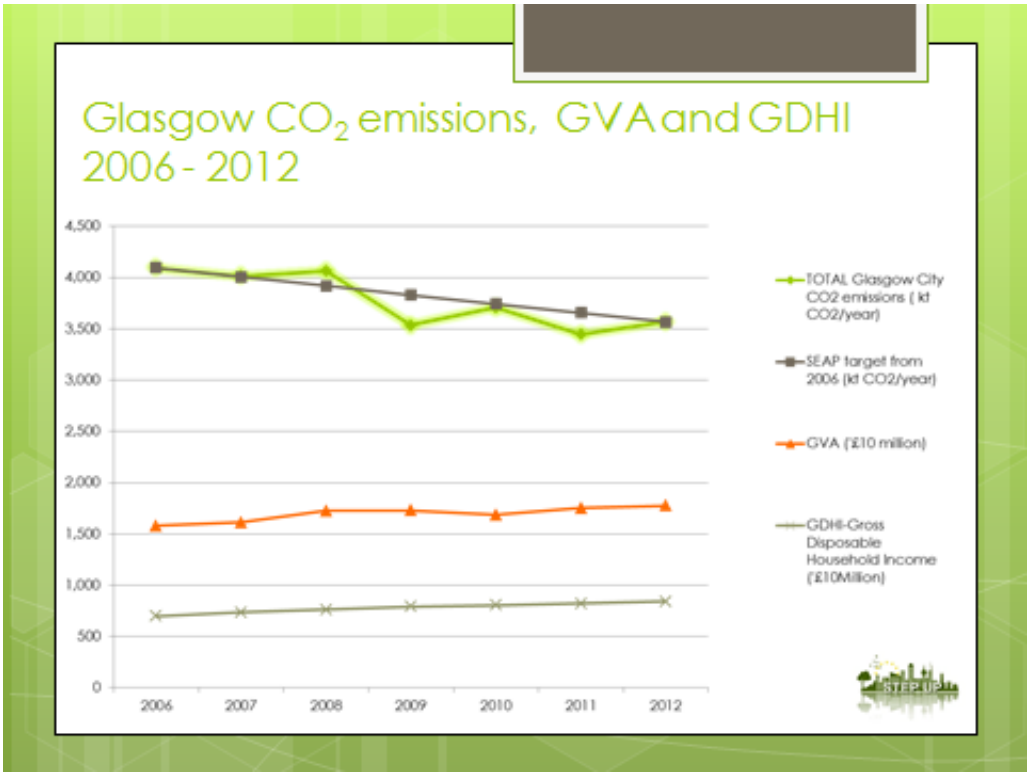
2014

Energy model
- Buildings only (no Transport sector)
- Residential and Non-Residential
- Gas and electricity consumption (different uses, heating, lighting, cooking)

2013

Glasgow CO_2 emissions and energy consumption

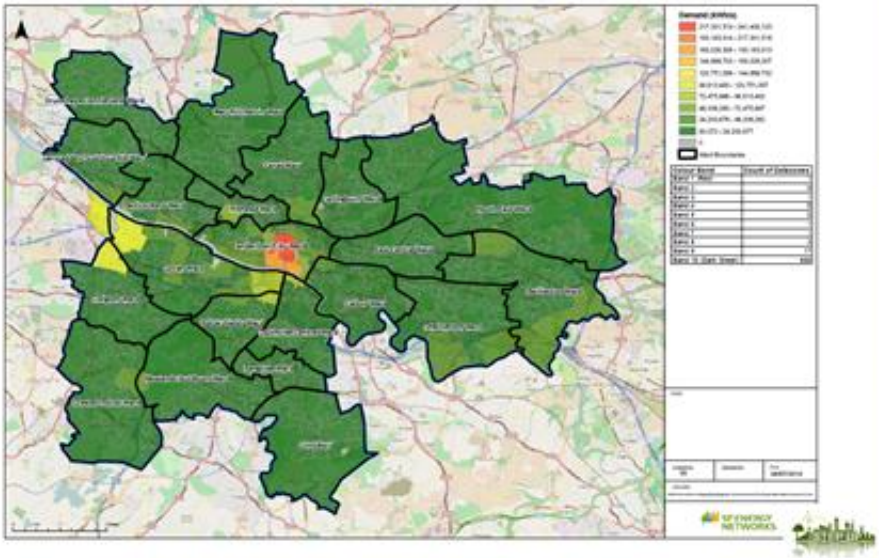
Other datasets: Fuel poverty, Health, Demographic growth, Economic indicators



CHALLENGES and OPPORTUNITIES

- Reliance on DECC UK data and need for localised carbon accounts
- Building a city wide emissions inventory
- Challenges in gathering local data on energy consumption
- Integrating CO2 emissions data with economic and social data
- Developing 3D models of energy, heat, transport and other systems

Glasgow buildings energy consumption by ward

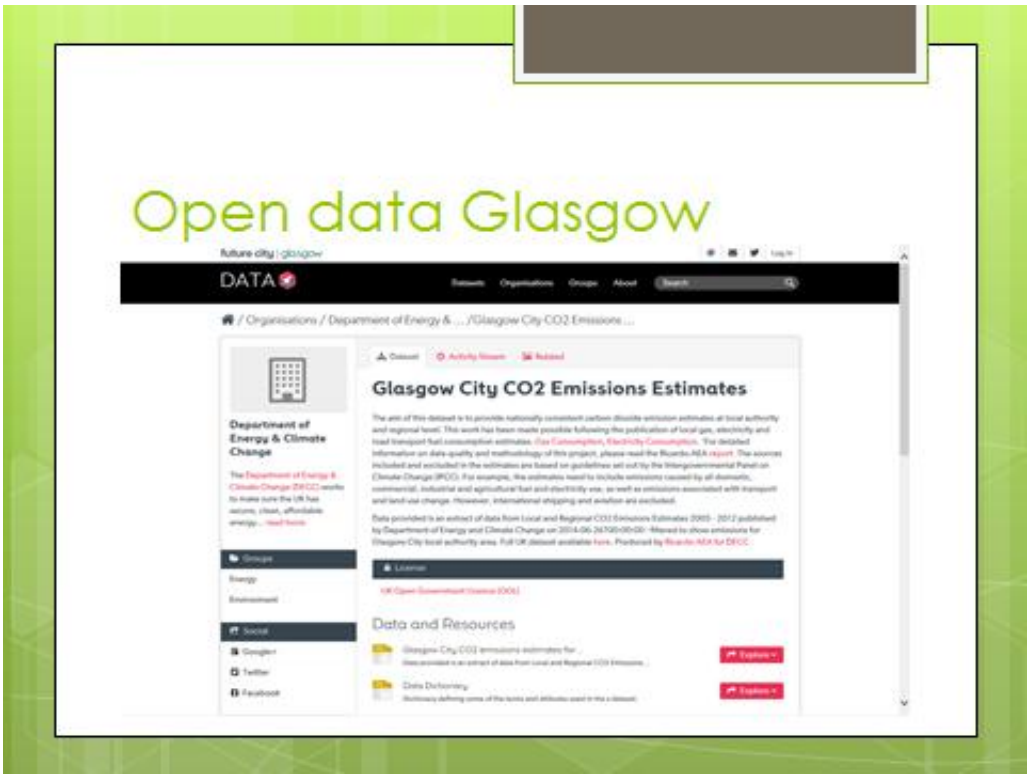


The new City Technology Platform will integrate the data streams, analyse the information, present it in a meaningful format and make it open for use by the public, businesses and academics alike. It will be accessed through websites and smartphone apps including a data portal, a mapping portal, and the MyGlasgow dashboard.

It will mean people could potentially use their smartphones to access real time information for practical purposes like finding an empty off street parking space in the city centre or monitoring the energy use in schools.

Improvements will also be made to the existing MyGlasgow phone app which allows residents to report problems like potholes or graffiti. After reporting an issue people, currently do not know what is happening with their complaint. In the future they will be able to receive feedback on their report and track it's progress.

The public will also be able to create their own customised City Dashboard (example pictured right). Depending on their interests, the public will be able to download widgets to their phones, tablets or computers with information on everything from Glasgow's weather to air pollution levels in the city, traffic alerts and flood warnings.

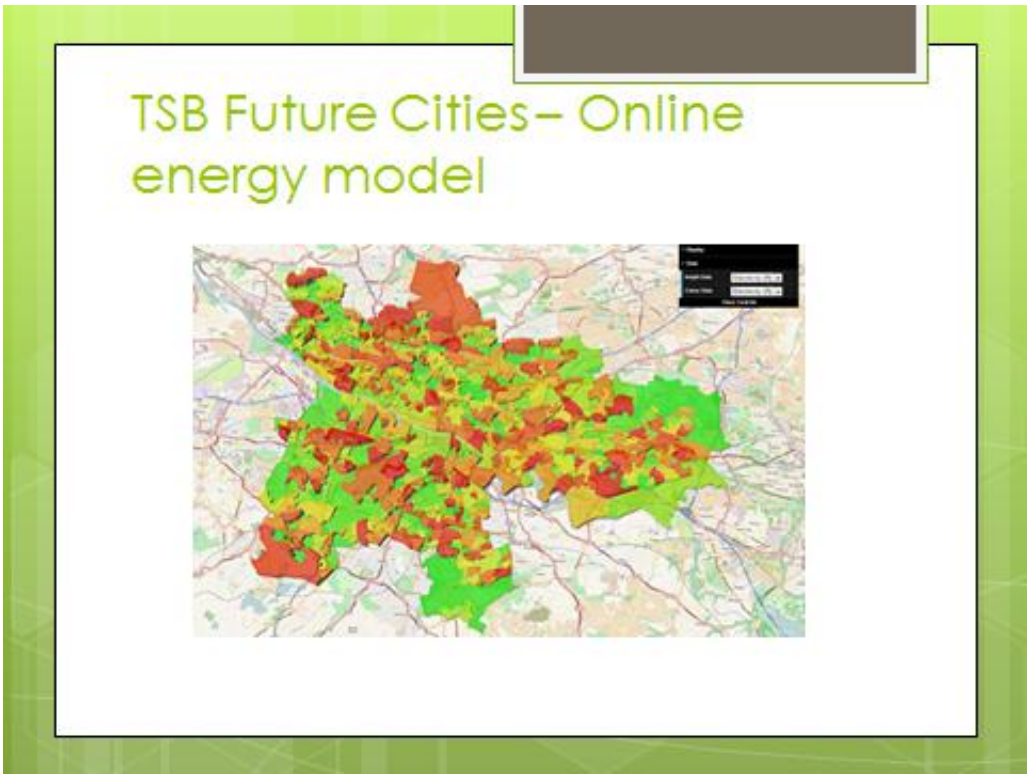


IES is now working with Glasgow City Council to develop an online system, which will enable citizens to evaluate the energy efficiency of their dwellings and get recommendations of possible improvements, including retrofit solutions, renewables, and other energy conservation measures.

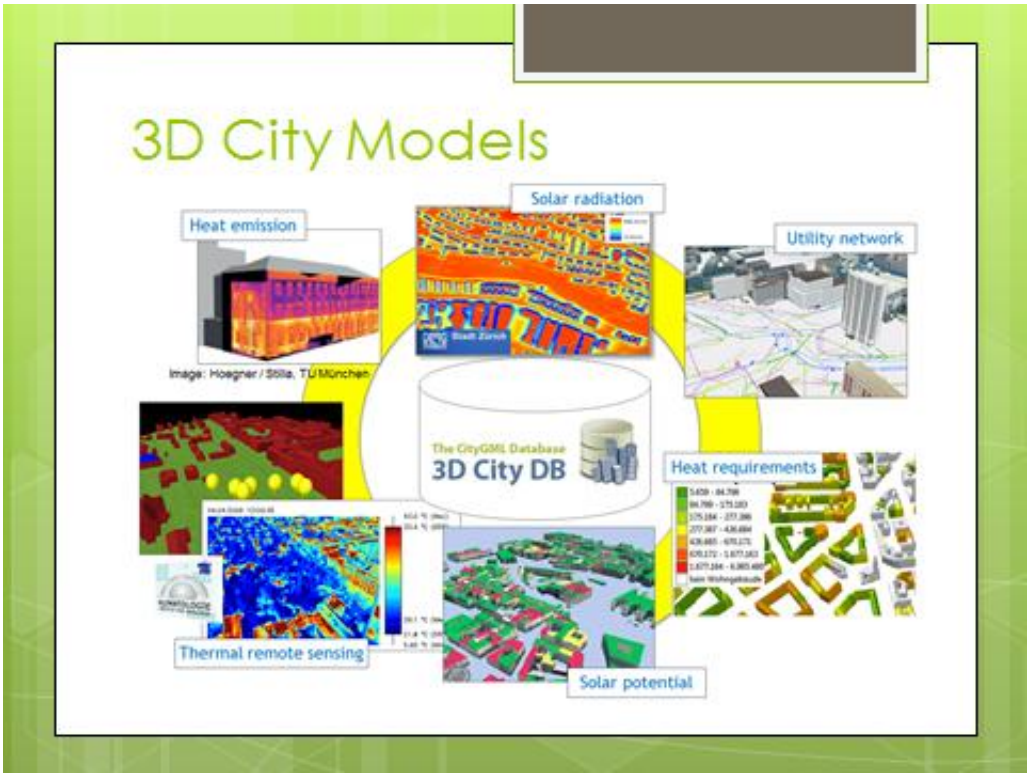
We will develop a 3D web portal that will allow users to view the city's energy performance at both district and building level. A mobile app will also be created for building and home owners to understand their energy use, examine simple energy conservation measures to help them reduce their consumption and provide them with potential retrofit solutions that will be applicable to their buildings.

The app will act as a gateway between users and technology suppliers and will ultimately facilitate city-scale assessments of energy use. The importance of providing a means to conduct the latter cannot be overstated, in terms of the associated potential economic and environmental benefits for Glasgow.

This is an exciting project for IES and Glasgow, and one that continues to move the focus from the building to the city. The "R & D section" of the project website can be visited to find out about other research projects. These projects explore how cities can operate intelligently; in order to benefit its inhabitants and our environment.



3D city database for Berlin, Univ of Bonn and City of Berlin:



Communication and **dissemination** throughout the SEAP process is essential to ensure ownership and implementation. It is helpful to have a local communication and dissemination plan and to involve local PR professionals in the process.

Monitoring of the plan must be in place to ensure that actions that are agreed in the SEAP are implemented and reported.

Political support and leadership is vital preferably from the Mayor, Council leaders and other senior politicians from the start of the SEAP process.

The SEAP process is demanding and requires **sufficient resource,** which can be allocated if there is political support.

A key deliverable for STEP UP has been the development of Masters degree courses at both University of Strathclyde and Riga Technical University. This came out of a recognition in STEP UP that the implementation of enhanced energy planning in cities would require professionals with an understanding of how cities function; the importance of sustainable, secure energy to city development; and governance and leadership within cities.

UoS have developed an MSc in Leadership for Global Sustainable Cities and RTU have developed a Masters in Energy Efficient Infrastructure for Smart Cities. The two courses complement each other well and there will be exchanges between the two Universities and others from the STEP UP cities.

STEP UP – Masters Degrees

www.stepupsmartcities.eu

Energy Efficient Infrastructure for Smart Cities
Riga Technical University

UNIVERSITY of STRATHCLYDE
INSTITUTE FOR FUTURE CITIES

Global Sustainable Cities - University of Strathclyde

- 12 month multidisciplinary programme
- Graduates gain skills designing and delivering urban sustainability strategies
- Based on real world experience from international sustainable cities projects such as STEP UP

STEP UP – Further Information

www.stepupsmartcities.eu

STEP UP Website: www.stepupsmartcities.eu
STEP UP Twitter: https://twitter.com/StepUpEU

IV. The carbon*n* Climate Registry (cCR)

Ana Marques, Senior Project Officer, Low Carbon, ICLEI – Local Governments for Sustainability (ICLEI),
World Secretariat, Bonn, Germany.

Relevant global developments:

In its capacity as Local Governments and Municipal Authorities (LGMA) Constituency focal point at the United Nations Framework Convention on Climate Change (UNFCCC), ICLEI[1] created the carbon*n* Climate Registry (cCR)[2]. The cCR is a global reporting platform to enhance transparency, accountability, and credibility of climate action for local and subnational governments. It was launched at the World Mayors Summit on Climate Mexico City, 21 November 2010 (just prior to the 16th Conference of the Parties - COP16 - in Cancún) to provide national governments and UN agencies an overview of local climate action developments, and to have a global reporting platform that would step-by-step support standardization and address MRV for local climate action – Measurable, Reportable, Verifiable – for all interested cities around the globe.

Local governments voluntarily report their:

- Commitments: climate and energy targets or goals
- Performance: GHG inventories and other information to enable calculation of benchmarking indicators
- Actions: mitigation and adaptation actions.

The most recent development is that the cCR has been adopted as the designated reporting platform of the Compact of Mayors – a historic agreement between major city networks and cities themselves to disclose their climate mitigation and adaptation data in a more transparent way – and to accelerate local climate action. It is aimed at the leaders globally.
The Compact of Mayors is endorsed by major global organizations, including UN-Habitat, World Bank, WRI, etc., with many other organizations exploring how they can support this initiative. Explorations are underway to assess the possibility of aligning with other reporting platforms, such as the Covenant of Mayors – with the overall goal of reducing the need for cities to report more than once.

[1] ICLEI is the world's leading network of over 1,000 cities, towns and metropolises committed to building a sustainable future. We help our Members to make their cities sustainable, low-carbon, resilient, biodiverse, resource-efficient, healthy and happy, with a green economy and smart infrastructure - impacting over 20% of the global population in 88 countries. <http://www.iclei.org>

[2] <www.carbonn.org>

Benchmarking

Addressing the three main areas of reporting in the cCR – Performance, Commitments, and Actions – the presentation introduces the main data types gathered in each section, as well as the derived benchmarking indicators used to assess city performance.
Examples are given for the energy sector and buildings subsector. While "benchmarking" performance through time within a given city is fairly simple, as long as there is consistency in the methods used for data collection and calculations, comparison of indicators between cities needs to be made with caution.

The key challenges to effective benchmarking identified through the operation of the cCR are:
- Differences between regions:
  - Accepted methodologies (boundary, scope, calculation methods, etc.),
  - Access to data,
  - Economic activities present locally, and
  - Local Government mandates in countries.
- Data-entry errors can also occur.

The measures ICLEI takes to address these challenges are:
- Operating a flexible reporting framework recognizing different local/regional contexts;
- Working towards a universally accepted standard, namely the Global Protocol for Community scale.
Greenhouse Gas Emissions (GPC), to be released at COP20 in Lima, December 2014, and minimize data-input errors through a range of measures, which includes:
  - Setting-up of basic data quality checks mechanisms in the platform and in the offline reporting sheet
  - Capacity building sessions for local government staff responsible for GHG's measurement, reporting, and verification.

Conclusion

ICLEI recognizes the value of benchmarking energy sustainability in cities for the purpose of identification and dissemination of good practices between local governments, and recommending replication in their specific contexts. To support this, ICLEI has been taking steps towards benchmarking in both:
- Urban sustainability (e.g. participation in the ISO 37120 development process)
- Urban infrastructure systems and sectors performance, namely through the cCR, the "City profile" being pilot-tested under the Urban-LEDS project (www.urban-leds.org), and by promoting the adoption of a global standard for community-scale inventories (GPC), among other steps.

However, considering the challenges identified, currently ICLEI mostly uses the benchmarking information internally, to identify potential areas of support needed by ICLEI members, with due care to avoid unfair comparisons between cities.

The relevance of benchmarking for purposes of financing local climate actions will be further explored in the future, particularly using key performance indicators of proposed projects.

carbon*n* Climate Registry

Benchmarking Energy Sustainability in Cities

Turin, 25 November 2014

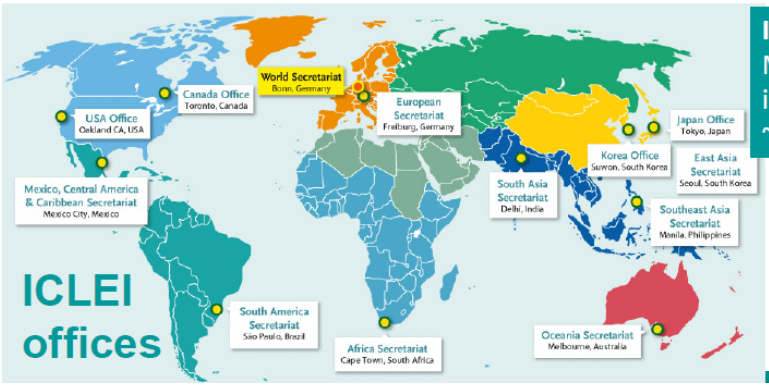
Ana Marques
ICLEI – Local Governments for Sustainability
ICLEI World Secretariat, Bonn

Contents

- Introducing ICLEI
- Introducing the carbon*n* Climate Registry (cCR)
- Energy sustainability indicators in the cCR
  - Key benchmarking challenges
  - Addressing key challenges

Introducing ICLEI

- International membership association of Local Governments (LGs)
- Established in 1990 in New York – for cities, by cities
- Thematic city network: technical guidance, peer-learning, exchange
- Focal Point for LGMA Constituency at the UNFCCC, and Observer



ICLEI members:
More than 1000 cities in 88 countries
~660 million people

www.carbonn.org

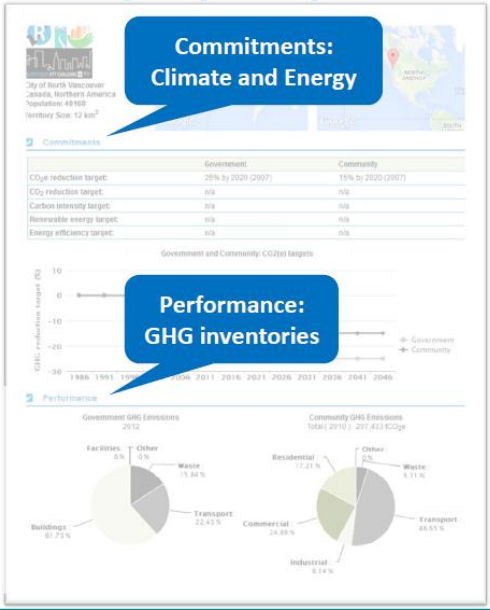
Introducing the carbon*n* Climate Registry (cCR)

Introducing the cCR

- Global reporting platform for local and subnational climate data
- Launched at the World Mayors Summit on Climate
  Mexico City, 21 Nov. 2010 (COP16 in Cancun)

Three areas of reporting:

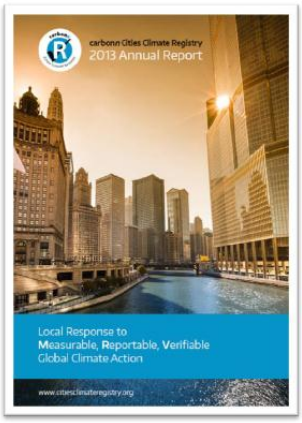
City report: public



Introducing the cCR

- Open and free use by **local AND subnational governments**
- Reporting can be done at any time
- Analyses made twice a year
  - Latest public report available at:

    http://carbonn.org/cCCR-2013-annual-report.pdf



- Operated by: carbonn center.org

Introducing the cCR

a) A **common global platform** for cities and regions

b) Sharing **good practice**, raising level of **ambition**

c) Strengthening **credibility of local climate action,** therefore easing access to financing

d) Towards **Measurable, Reportable, Verifiable (MRV)**

e) Direct **input into UNFCCC process** through ICLEI

Local Government Climate Roadmap

http://www.iclei.org/climate-roadmap

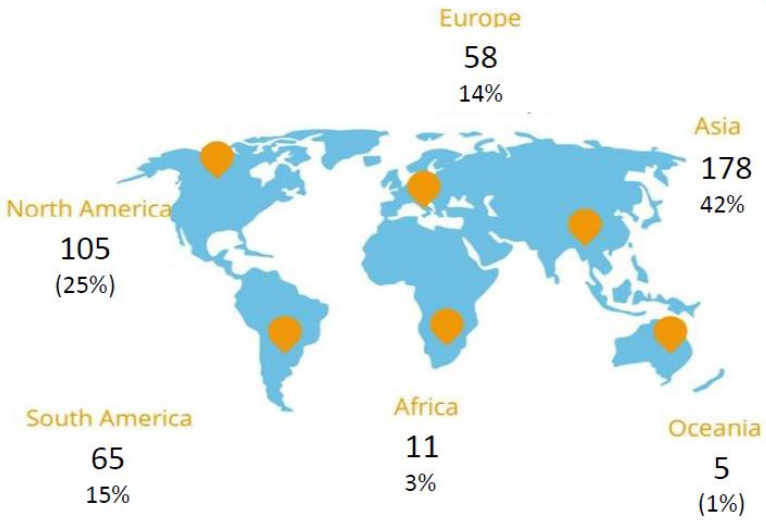
Introducing the cCR

The cCR in numbers

465	44	423	940	4244	2.28
Number of reporting cities & local governments	Countries	Population (million)	Climate & Energy Commitments	Mitigation and Adaptation Actions	Reported GHG Emissions (GtCO2e/yr)

Situation as of 15.10.2014

Reporting in cCR, by Region



Situation as of 31.03.2014

www.carbonn.org

Energy sustainability indicators in carbon*n* Climate Registry (cCR)

Information gathered in cCR

Performance

- GHG inventories
  - Community-scale
  - LG operations
- City and Community information
- Energy generation and consumption
- Sectorial information

Commitments

- CO_2
  - Base year
  - Target year
  - Target value
- CO_2eq
- Carbon intensity
- Renewable Energy
- Energy Efficiency

Actions

- Costs
- Status
- Impacts
  - GHG mitigation
  - Energy savings
  - Renewable energy
  - Co-benefits

Benchmarking indicators from cCR

Performance

- GHG inventories
  - t CO2e/year
- City and Community
  - t CO2e/hab/year
  - t CO2e/km2/year
  - …
- Energy
  - t CO2e/MWh
  - MWh/hab/year
  - …
- Sectorial

Commitments

- Ambition level
  - Rate of reduction
- Aggregated commitment
  - Annual
  - Accumulated

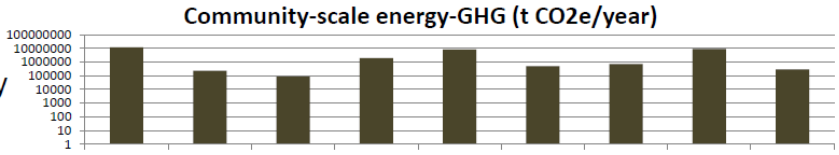
…

Actions

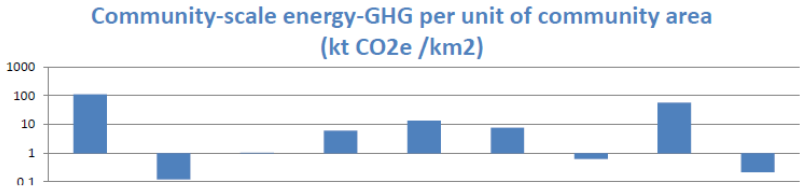
- Costs
  - Share of budget
  - Specific costs
- Impacts
  - GHG mitigation/ year
  - Saved MWh/ year
  - RE MWh/year

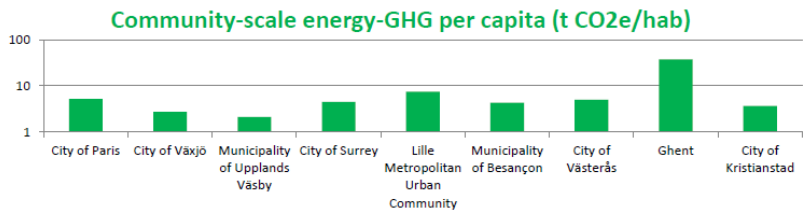
Indicators shed a different light (i)

- GHG inventory total



- Indicator examples

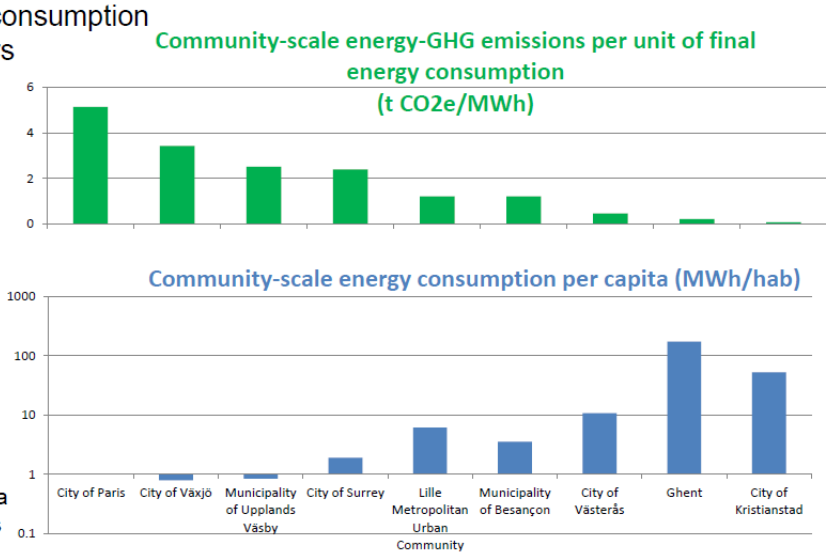




Note:
logaritmic scales
Source: cCR data reported by cities

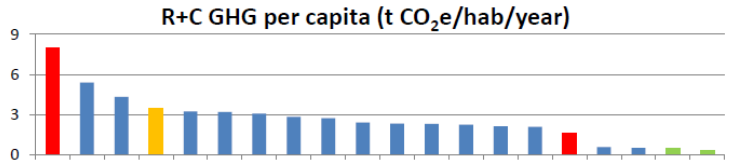
Indicators shed a different light (ii)

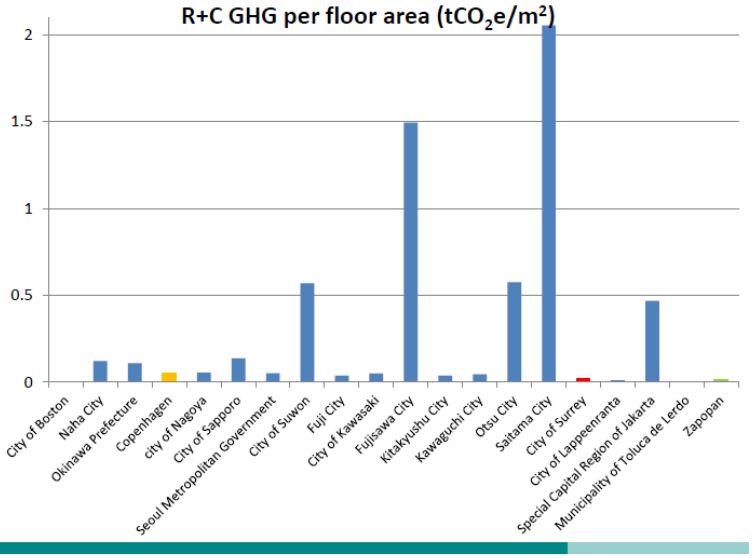
- Community-scale energy consumption indicators



Source: cCR data reported by cities

...(iii) Buildings sector





R+C = Residential, Commercial and Institutional buildings

- Asia
- North America
- Latin America
- Europe

Source: cCR data reported by cities

Addressing outliers

Deviations from typical value ranges:

How to distinguish what is real from artifacts which are due to errors or methodological limitations?

While „benchmarking“through time within a given city is fairly simple, comparison between cities needs to be made with caution, as explained in next slide.

Key benchmarking challenges

- Differences accross regions and cities:
  - Accepted methodologies
    - Boundary, scope, calculation methods, etc.
  - Access to data
  - Different economic activities present or dominant
  - Different Local Government‘s mandates
- Data-entry errors

Addressing the key challenges

- Flexible reporting framework recognizing different local/regional contexts
- Towards a universally accepted standard
  - Global Protocol for Community-scale Greenhouse Gas Emissions – will be released at COP20
  - essential for a globally reliable framework for reporting and benchmarking
- Setting-up mechanisms to minimize data-input errors through measures at different levels

Compact of Mayors

- Historic initiative between major city-platforms: inviting their members to report their climate data in one single platform
- Endorsed by UN-Habitat, World Bank, WRI, etc.
- Launched at the Climate Summit 2014, in NY.

Compact of Mayors

cCR is the designated repository of information

- GHG inventory reporting aligned with GPC
- Mitigation targets defined in a more transparent way
- Enabling aggregation of local climate commitments
- Includes mitigation and adaptation.

Compact of Mayors is complementary to
the Covenant of Mayors,
not conflicting.

Contact

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V. Climate and Energy Targets of Selected U.S. Cities: Progress Toward Their Achievement and Related Implementation Lessons Learned.

David Ribeiro, American Council for an Energy-Efficient Economy, USA

ACEEE
American Council for an Energy-Efficient Economy

Climate and Energy Targets of Selected U.S. Cities: Progress and Lessons Learned

David Ribeiro
Research Analyst, Utilities, State, and Local Policy

November 25, 2014
Workshop on Benchmarking Energy Sustainability in Cities

The American Council for an Energy-Efficient Economy (ACEEE)

- ACEEE is a 501(c)(3) nonprofit that acts as a catalyst to advance energy efficiency policies, programs, technologies, investments, & behaviors
- 50 staff; headquarters in Washington, D.C.
- Focus on end-use efficiency in industry, buildings, & transportation
- Other research in economic analysis; behavior; energy efficiency programs; national, state, & local policy
- Funding:
  - Foundation Grants (52%)
  - Contract Work & Gov't. Grants (20%)
  - Conferences & Publications (20%)
  - Contributions & Other (8%)

www.aceee.org @ACEEEdc

ACEEE is a nonprofit based in Washington, DC. ACEEE works to advance energy efficiency policies, technologies, investments, and behaviors throughout the U.S. on the national, state, and local levels.

The focus of ACEEE is on end-use efficiency in the industrial, buildings, and transportation sectors but there is also other research in economic analysis and behavior.

The Council is mainly recognized for some foundational research, mostly the State Energy Efficiency Scorecard, but also the City and International Scorecards.

There are two ways that ACEEE has benchmarked cities and energy efficiency, each with important aspects of lessons learned. The practice of a "City Energy Efficiency Scorecard" evaluates states based on their policy efforts and recommends ways to improve performance in policy areas. The policy areas involve energy efficiency in cities, including in local government operations, buildings, energy and water utilities, transportation, and the community as a whole. The results are summarized by assigning one of six performance levels or "tiers" to states with Boston, Portland, New York City, San Francisco, Seattle and Austin taking place in the first tier.

1. Compared cities based on locally enacted EE policies in City Scorecard
    - Focus on programs and policies
    - Highlight important *actions* that can be taken by cities – and focusing on best practice metrics
    - Comprehensive roadmap for cities
2. Assessing cities' progress toward EE-related goals that they had adopted
    - Based on publicly inventory data from cities, we have measured their progress toward goals and tried to identify some drivers of success
3. Lessons Learned from these efforts

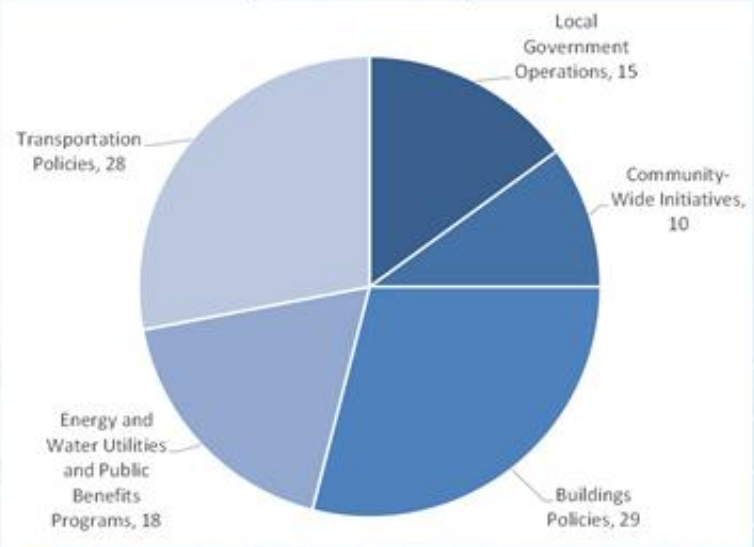
In the Scorecard, cities are evaluated in over 60 metrics that are organized into 5 policy areas. There is a total of 100 points is available.

The Scorecard scoring focuses on best practice metrics, such as actions, policies, and the implementation of policies, rather than specific outcomes (like energy savings). The process developed scores and weightings and used information on the documented potential savings.

City Energy Benchmarking

- *City Energy Efficiency Scorecard*
- City Assessment of Progress Toward Energy-Efficiency Related Goals
- Lessons Learned

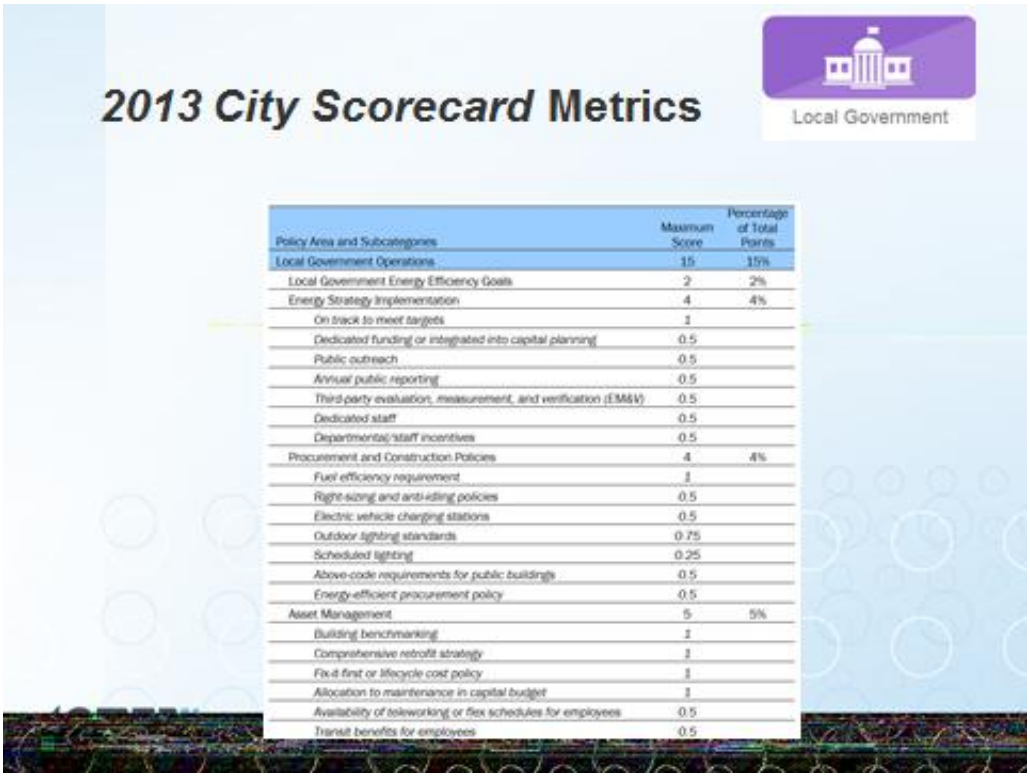
City Scorecard Scoring (100 total)



As an example, the following are metrics for the local government operations chapter from the 2013 City Scorecard.

- For procurement and construction policies, we looked into fuel efficiency requirements, right-sizing policies, lighting standards, and procurement policies
- We translated these qualitative metrics into numeric scores to arrive at scores

The contents of the four other areas can also be provided with examples.



Policy Area and Subcategories	Maximum Score	Percentage of Total Points
Local Government Operations	15	15%
Local Government Energy Efficiency Goals	2	2%
Energy Strategy Implementation	4	4%
On track to meet targets	1	
Dedicated funding or integrated into capital planning	0.5	
Public outreach	0.5	
Annual public reporting	0.5	
Third-party evaluation, measurement, and verification (EM&V)	0.5	
Dedicated staff	0.5	
Departmental/staff incentives	0.5	
Procurement and Construction Policies	4	4%
Fuel efficiency requirement	1	
Right-sizing and anti-idling policies	0.5	
Electric vehicle charging stations	0.5	
Outdoor lighting standards	0.75	
Scheduled lighting	0.25	
Above-code requirements for public buildings	0.5	
Energy-efficient procurement policy	0.5	
Asset Management	5	5%
Building benchmarking	1	
Comprehensive retrofit strategy	1	
Fix-it first or lifecycle cost policy	1	
Allocation to maintenance in capital budget	1	
Availability of teleworking or flex schedules for employees	0.5	
Transit benefits for employees	0.5	

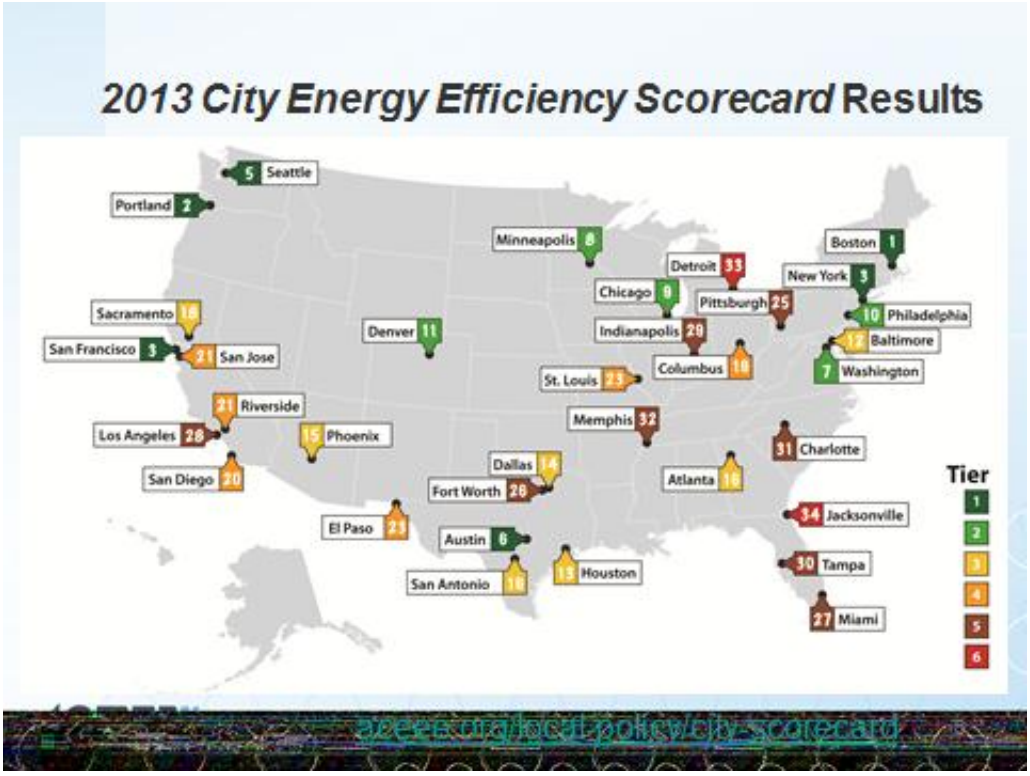
There are different scoring tiers of communities in the bottom right hand part of the map. Boston took the top spot in 2013, Portland took the second place, and New York and San Francisco tied for third place.

The takeaways lessons from the Scorecard implementation are as follows:

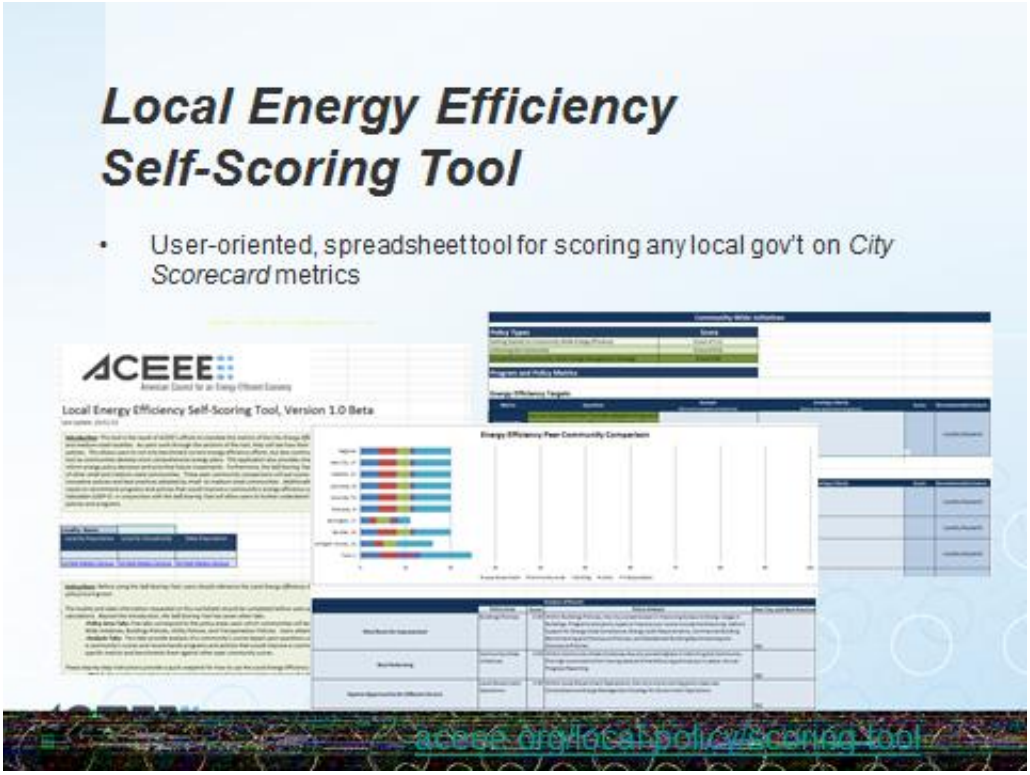
- Top scoring cities have comprehensive efficiency strategies and broad ranging policies or programs, often history of implementing efficiency;
- There is a wide gap in cities (76 for Boston and 17 for Jacksonville): Many at the top have community-wide initiatives and are focusing on improving implementation; lower ones have local goals that are in earlier stage of community-wide measures;
- All cities, including the highest scoring ones, have room for improvement

The next iteration of the City Scorecard will take place in Spring of 2015 and include:

- Most improved section
- More cities; from 34 to around 50



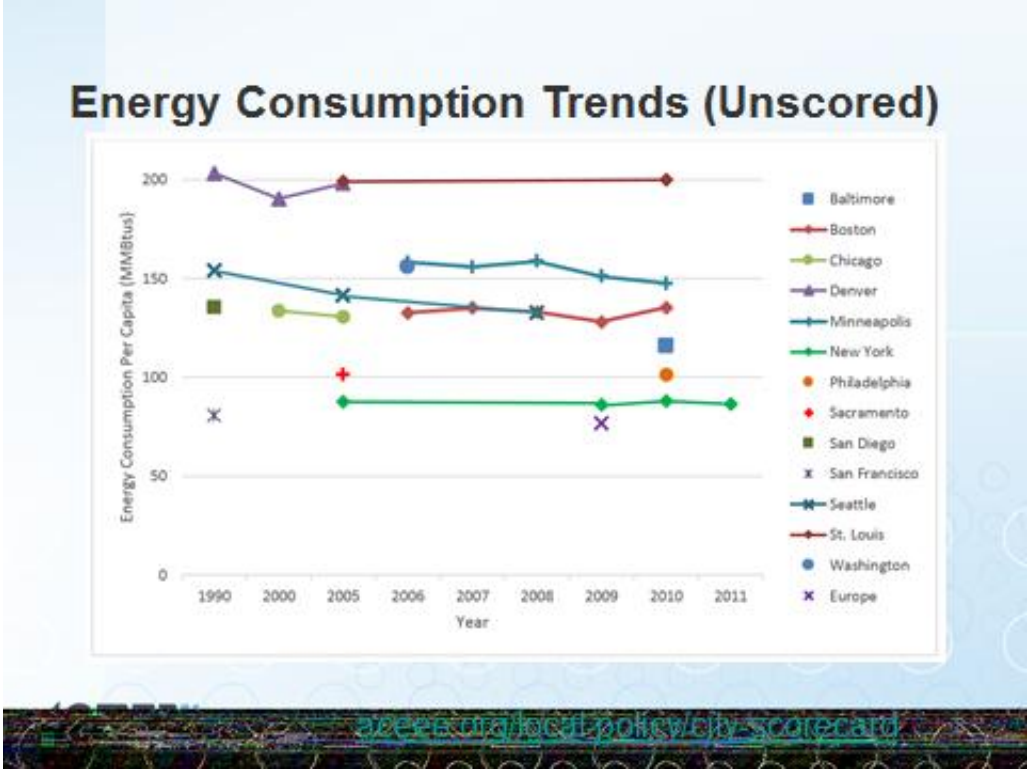
There is also a local energy efficiency self-scoring tool, which was developed as a tool any city can use to develop an equivalent city scorecard score. In addition, anyone that is not including in the Scorecard can use this tool to evaluate their own cities. This tool was developed with the U.S. in mind.



Regarding the energy saving performance in an un-scored chapter of the Scorecard,

- We looked at some different trends at a high level. For example, we see that per capita energy use in many cities is relatively flat.
- The more important finding is that the energy data was sparsely available for many cities (13 out of 34 cities).

An upcoming research will compare the performance of U.S. and European cities.

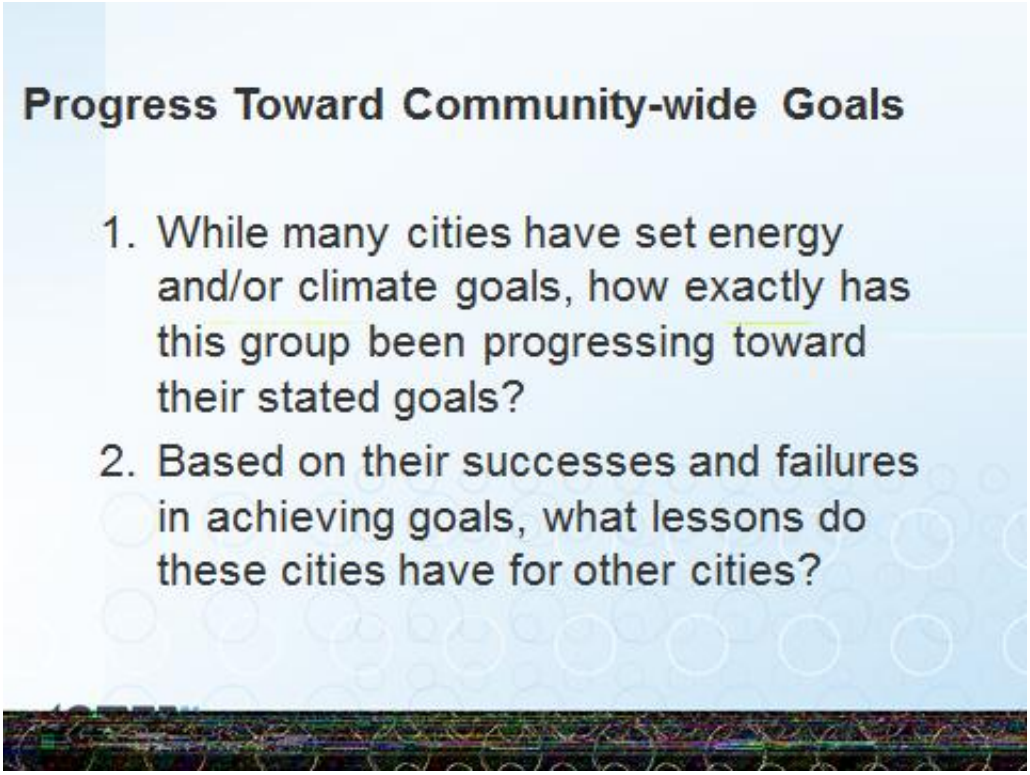


In addition, we developed additional research trying to connect energy outcomes to program and policy implementation.

1. Specifically, we looked at community-wide targets in a selection of cities and evaluated cities based on their progress toward targets

2. Then, based on successes and failures, we tried to identify lessons learned

Important note on definition: We are looking at community-wide goals. Only those goals that spur energy use reductions across all sectors of local economies are considered. Secondary, goals applicable to specific sectors, such as the buildings sectors, or fuel sources, such as renewable energy, were not considered.



Based on the reviewed information for 79 communities:

- Slightly > 30% of the sample, 25 communities, had stated community-wide goals and at least two energy-related inventories (allowing us to measure progress)
- For those 25 communities, we projected their future emissions reductions based upon their current progress to date
- Based on projections of future emissions reductions, we found 11% of sample, 9 communities, are on track for at least one community-wide goal – Tables 1 and 2
- 5% of sample were on track for all community-wide goals – Table 2

Initial Takeaways:

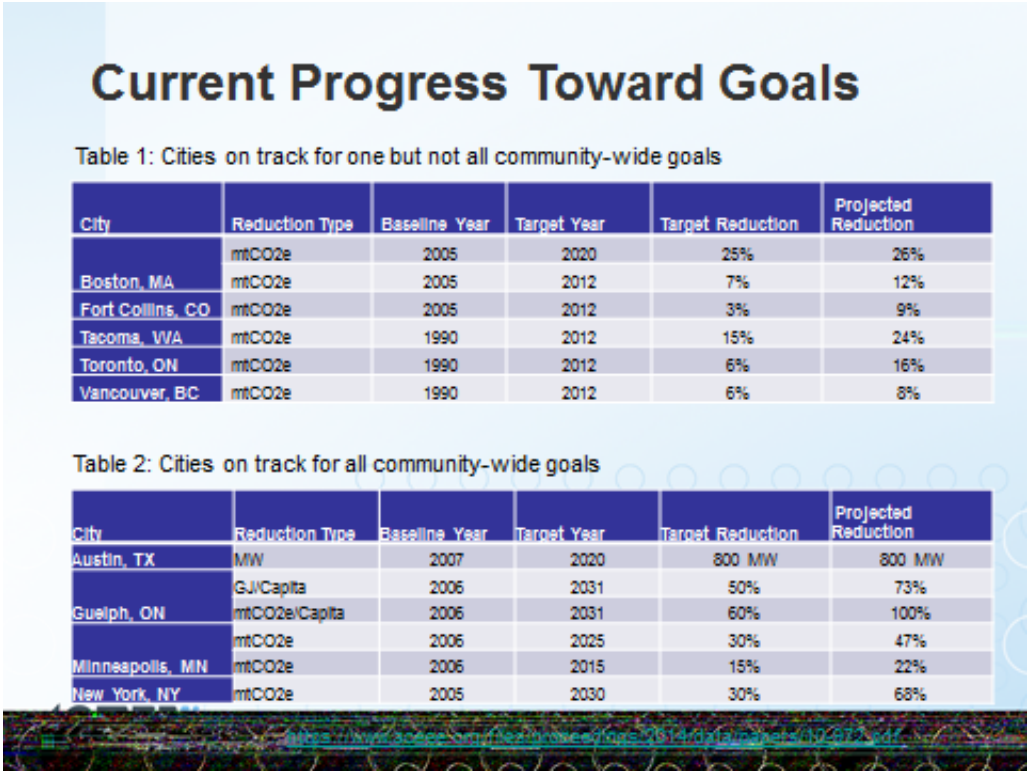
- 89% of the cities are either not on track for goals, not setting them, or not being able to evaluate them. As a result, there is room for improvement
- No city is on track for a long-term goal
    - Table 2 - communities did not set a post 2030 or post 2031 goal
    - Those that are on track for at least one goal are not on track for their 2050 goals

- Boston is the closest to the goal of reducing emissions by 80% under 2050 levels. The city is projected to reduce emissions by 79%.

Regarding the reason why communities were or were not achieving success, we limited our sample size to 11 cities.

- First, we choose U.S. cities that were on track and were not on track and then focused only on climate-based goals.

This was continued by looking at external factors, such as changes in employment, business establishments, and population and compared to changes in CO_2 emissions. It has been found that several cities achieved significant reductions while achieving economic growth, i.e. an economic decoupling.



Current Progress Toward Goals

Table 1: Cities on track for one but not all community-wide goals

City	Reduction Type	Baseline Year	Target Year	Target Reduction	Projected Reduction
Boston, MA	mtCO2e	2005	2020	25%	26%
	mtCO2e	2005	2012	7%	12%
Fort Collins, CO	mtCO2e	2005	2012	3%	9%
Tacoma, WA	mtCO2e	1990	2012	15%	24%
Toronto, ON	mtCO2e	1990	2012	6%	16%
Vancouver, BC	mtCO2e	1990	2012	6%	8%

Table 2: Cities on track for all community-wide goals

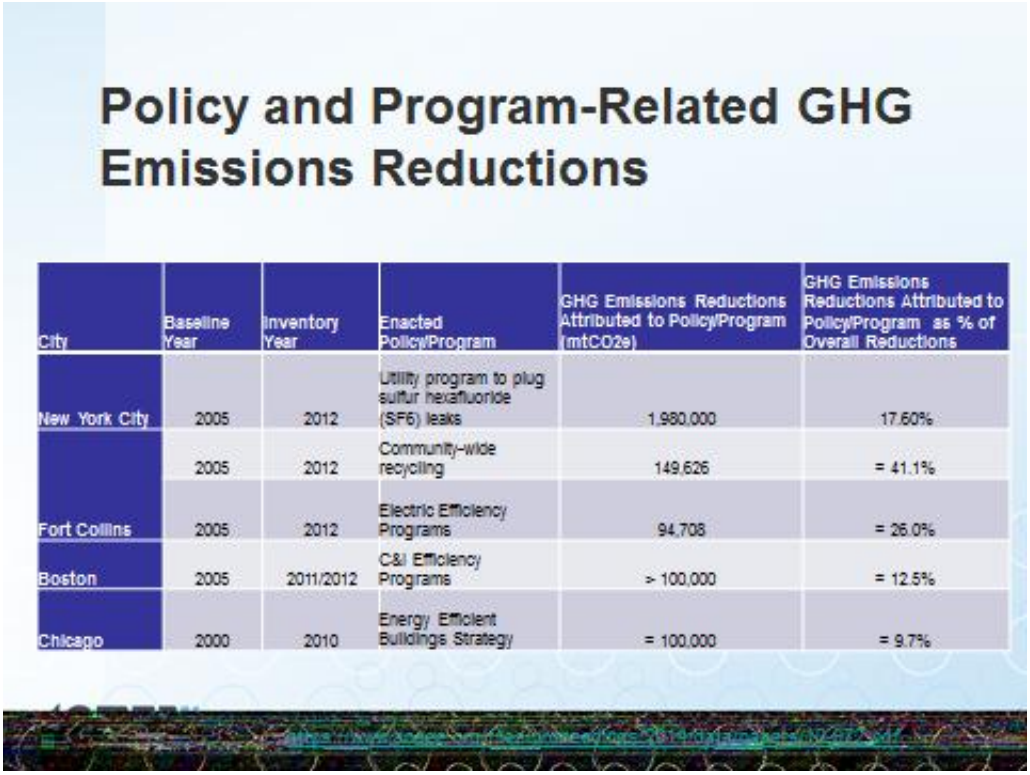
City	Reduction Type	Baseline Year	Target Year	Target Reduction	Projected Reduction
Austin, TX	MW	2007	2020	800 MW	800 MW
Guelph, ON	GJ/Capita	2006	2031	50%	73%
	mtCO2e/Capita	2006	2031	60%	100%
Minneapolis, MN	mtCO2e	2006	2025	30%	47%
	mtCO2e	2006	2015	15%	22%
New York, NY	mtCO2e	2005	2030	30%	68%

Data on specific policies and programs that reduced emissions:

- Based on data from inventories, sustainability reports, and sustainability staff, it is found that policy and program-specific data on emissions impacts is *tracked infrequently and is not readily available*
- Based on the chart, emissions savings from the five programs for which specific impacts were available in the 11 cities were closely analyzed.
    - Some of the data are approximations, including the savings in Boston and Chicago, indicating the inexact nature of these measures.
- Considering the fact that these programs only represent a fraction of the initiatives in the cities, we analyzed the difficulty of evaluating savings on a portfolio-wide basis

In three of five cities, it was possible to measure the savings from energy efficiency programs.

- For example, the C&I Efficiency Programs described here are largely due to the Renew Boston Initiative
    - Renew Boston provides technical assistance and financial incentives to business and industrial consumers, including free energy analysis and incentives to cover a portion of the costs of efficiency upgrades



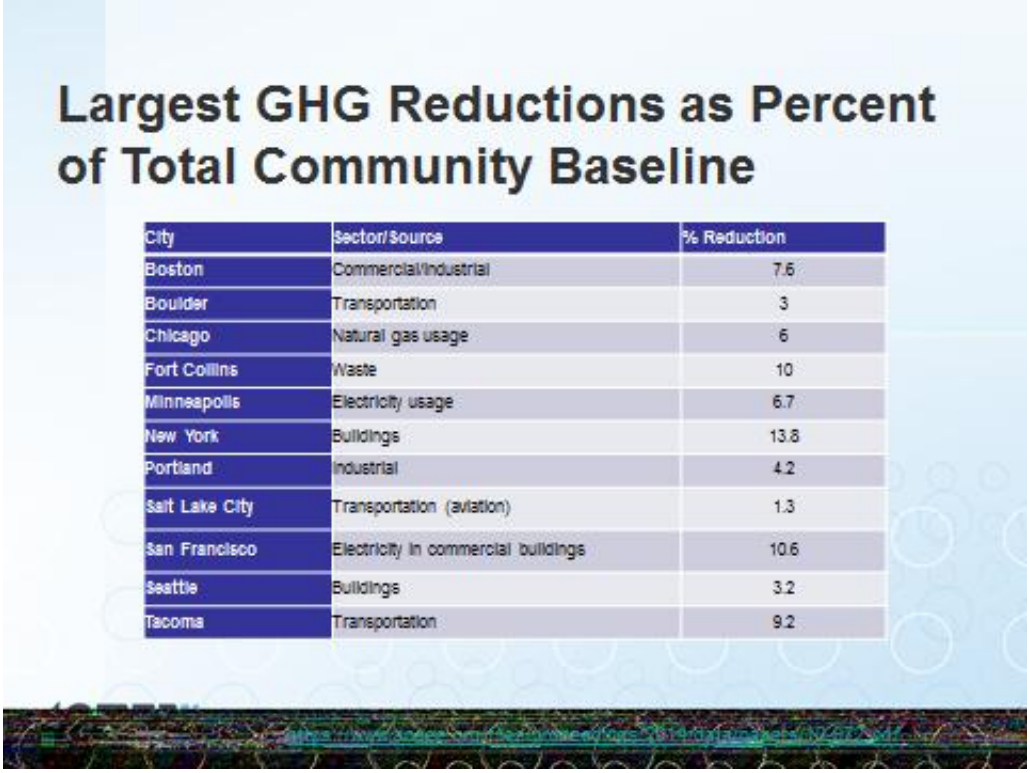
Policy and Program-Related GHG Emissions Reductions

City	Baseline Year	Inventory Year	Enacted Policy/Program	GHG Emissions Reductions Attributed to Policy/Program (mtCO2e)	GHG Emissions Reductions Attributed to Policy/Program as % of Overall Reductions
New York City	2005	2012	Utility program to plug sulfur hexafluoride (SF6) leaks	1,980,000	17.60%
Fort Collins	2005	2012	Community-wide recycling	149,626	= 41.1%
	2005	2012	Electric Efficiency Programs	94,708	= 26.0%
Boston	2005	2011/2012	C&I Efficiency Programs	> 100,000	= 12.5%
Chicago	2000	2010	Energy Efficient Buildings Strategy	= 100,000	= 9.7%

Because it was not possible to find much information on program and policy-specific data, it was necessary to take a different approach. For this reason, we gauged the influence of policy-related factors by focusing on the sectors/sources in each community that achieved the greatest emissions reductions and explored the policy- and program-related efforts in those sectors. It is not possible to draw causal linkages but it is possible to generally gauge the influence of policies.

Focus on sectors/sources with the greatest emissions reductions based upon community baseline:

- **Electricity usage:** whether community-wide as in the case of Minneapolis or within specific end-use sectors, such as buildings, electricity usage was responsible for the largest overall emissions reductions in five communities, namely New York, Minneapolis, Boston, San Francisco, and Seattle.
    - Reductions in emissions factors of electricity supply was one of the major trends impacting building emissions reductions
        - In San Francisco, community electricity emissions factor decreased by 46% between 1990 and 2010
        - It is difficult to quantify the drivers, such as the various factors involved, including economic growth, energy price fluctuations, weather, and the availability of alternative fuel sources, influence emissions from the combustion of fossil fuels
    - Even more challenging for municipalities is adding in market forces or state and locally enacted policies, such as EERSs, RPS, and CnTs
- **Efficiency** also contributed to reduced emissions in several cities
    - The Renew Boston program partially served the sector that saw the greatest reduction in comparison to the community baseline
    - It was being pursued in other cities including Chicago, Seattle, and Portland



The lack of data on specific programs and policies impacts prevented us from coming up with a specific program and policy recommendations. Lessons learned are broader, and structural strategies to facilitate the proper environment for success are needed.

1. It is important to regularly measure and monitor emissions savings in standardized format

    - This is where we go back to the example of Chicago and the 87.5% reduction in stationary and industrial processes between 2000 and 2010.

    - Chicago's 2010 GHG Inventory used a different methodology than previous inventories, so it is difficult to establish trends because recently calculated emissions levels cannot accurately be compared against historical baselines. The stationary and industrial processes sources comparison indicated an 87.5% reduction in emissions between 2010 and 2000, but the authors concede that this reduction figure is due to vastly differently methodologies rather than actual reductions. This discrepancy prevents independent evaluators along with municipal staff from assessing community progress over time.

    - The other end of the spectrum is New York City, which releases annual inventories. In addition, Salt Lake City and Minneapolis have online portals providing data on a range of energy-related metrics.

- Such regular measurement and monitoring allow communities to access progress in certain sectors and inform future decision-making processes.
- All communities could benefit from expanded evaluations of specific policies and programs to gauge the resulting energy and GHG impacts.

2. Community Partnerships - Some cities who have achieved GHG savings partnered with community institutions to leverage their own local government efforts

- Boston regards its partnerships with both its electric and natural gas utilities as part of the key innovations of its Renew Boston Initiative. The electric utility loans a full-time program manager to the initiative and both utilities provide funding to support outreach work. Representatives from both utilities also serve on the Renew Boston Strategy Board.
- In Portland, the city partners with community organizations to promote its reuse and waste prevention initiatives. For example, a coalition of reuse organizations called ReUse PDX partnered with Portland's Be Resourceful Campaign at several events to promote reuse initiatives (Portland 2012).
- These initiatives are particularly notable because Boston and Portland successful achieved GHG savings in each sector for which these programs were designed.

3. Developing strategies that are specific to a city's emissions energy and or emissions profiles

- Different communities achieve reductions in different sectors of their local economies
- Tacoma's transportation sector experienced the largest reductions in community-wide emissions. Furthermore, emissions from on-road vehicles were reduced by 15% between 2012 and 2000. Tacoma actively took steps to achieve these reductions by installing metered parking to discourage single-occupancy vehicles and reducing parking minimums in the downtown area
- Boston, on the other hand, focused much of its efforts on its energy efficiency program for buildings based on Renew Boston.
- While all of the above approaches may encompass all avenues to achieve savings, communities with limited resources who are looking to prioritize policies or programs may not have the capacity to pursue such a course of action. Therefore, communities would be well served by developing policy-related strategies tailored to the energy consumption or emissions profile of their given community.

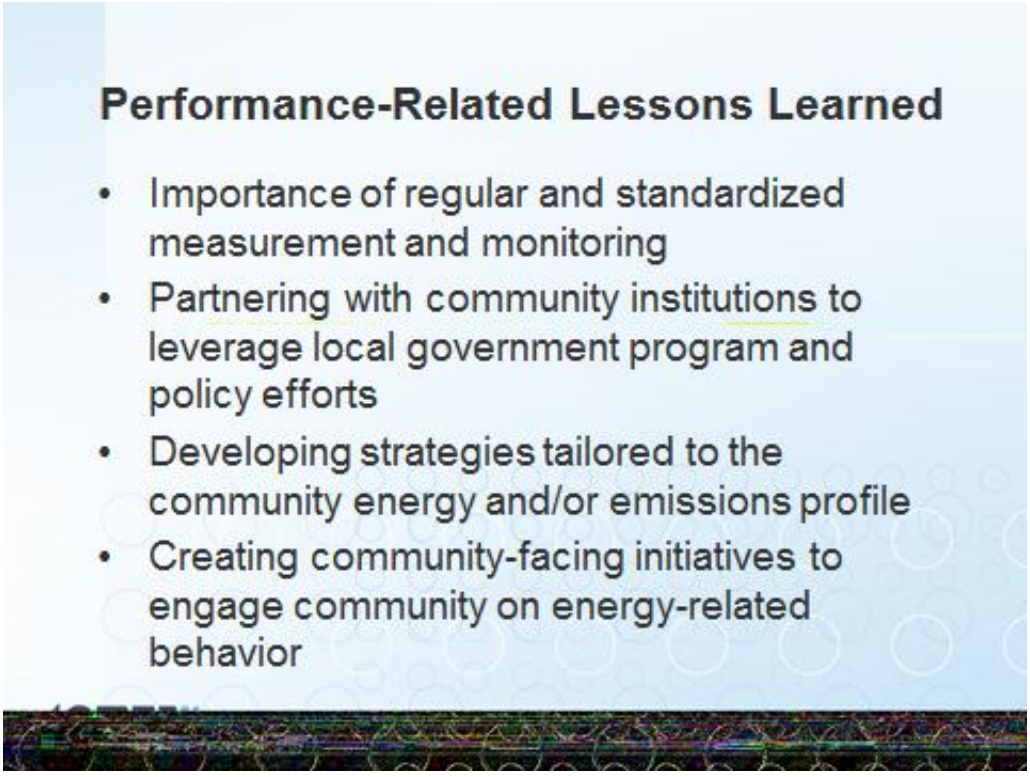
- An exception may be pursing energy-saving or GHG-reducing initiatives in the waste sector as communities universally achieved savings due to their waste management initiatives

4. City Leadership with Community-wide Initiatives

- Municipal governments in several communities on track to achieving their goals have shown an outward commitment to reducing emissions by creating initiatives to engage residents regarding their energy-related behavior

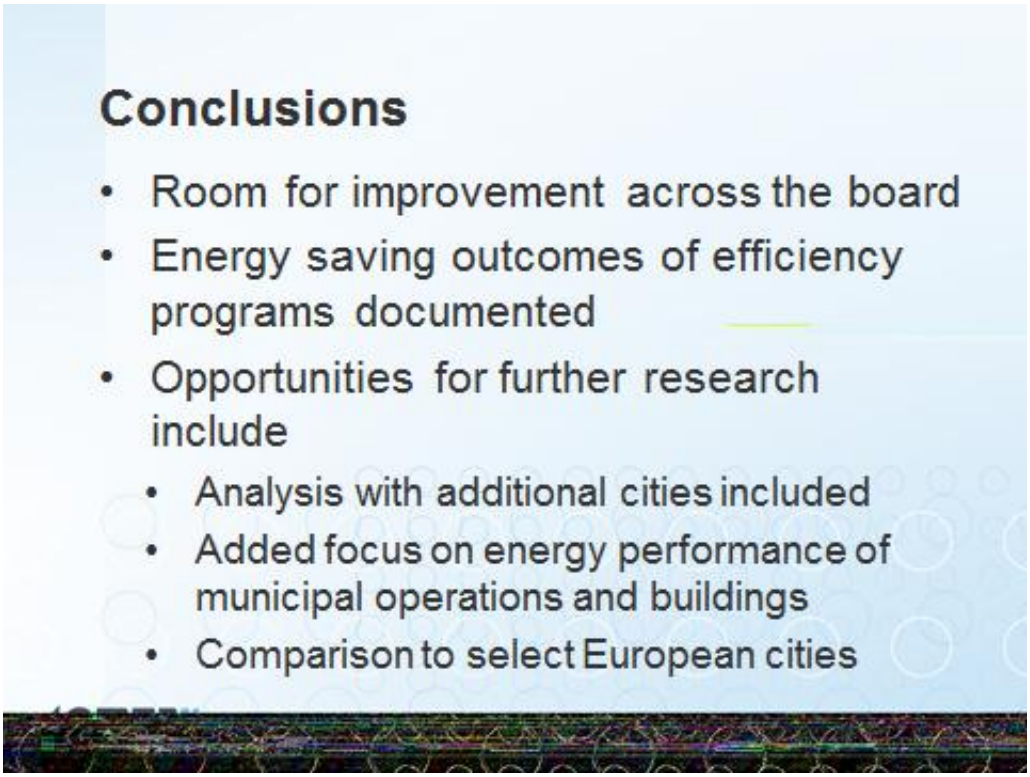
- Fort Collins created the voluntary ClimateWise program for local businesses to increase energy savings, reduce waste, and increase alternative transportation through free technical assistance, public recognition, and networking opportunities. In 2012, 163,663 $mtCO_{2e}$ in avoided emissions was attributed to its efforts Other examples are GreeNYC in New York City and Greenovate in Boston.

- Visible, community-wide initiatives not only advertise the municipal leadership's commitment toward goals, but also provide an opportunity to engage community residents in a dialog that can result in significant energy or GHG savings.



Many communities have demonstrated leadership by adopting energy or climate goals and some have achieved sizeable energy or climate savings in pursuit of these goals. Yet, only 11% of the communities that were evaluated are on track for at least one community-wide goal and only 5% are on track for all their goals. The remaining communities were not on track for goals, did not have quantitative data that allowed us to evaluate goals, or simply did not have goals. Many exogenous and endogenous policy-related factors can impact energy or GHG savings and the role of these factors varies from community to community. It is difficult to articulate broad trends regarding the causes of missed targets.

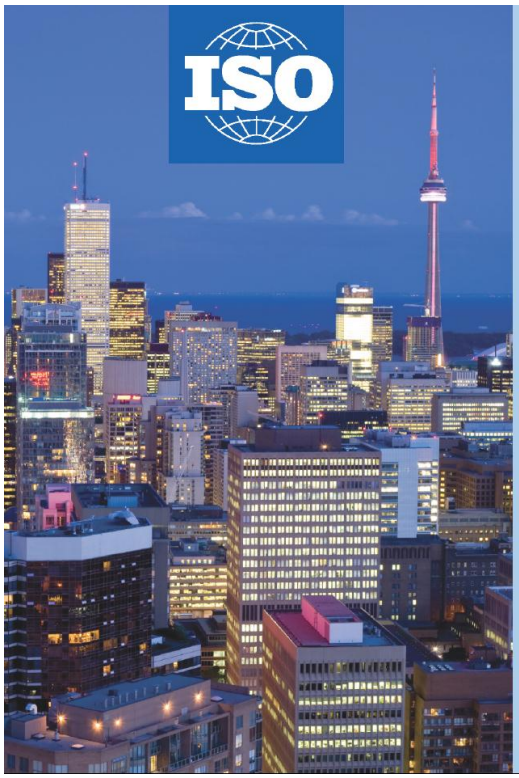
Future research on several topics could flesh out our analysis. A similar assessment with a larger sample size, such as all the communities in the USDN network or all signatory communities to the Mayors Climate Protection Agreement, may provide more comprehensive findings. A more detailed exploration of the policy/program and sector factors from the larger sample of communities could provide additional insights as well. Finally, rather than only evaluating communities against goals they set for themselves, a deeper analysis of the efficacy of the goals themselves may highlight communities that are truly leaders in energy-related programs and policies.



VI. International Standards for Cities and the World Council on City Data - A Next Step for Smart Cities

Nico Tillie, World Council on City Data, Toronto, Canada

In a time when the innovations and technology curves continue exponentially, how do we as society prepare for what 2015 and beyond holds? What is the nature of the handshake between technology and smarter, more informed city building? Moreover, how do we plan, track progress and build more liveable cities 2015-2030? 2050? The presentation on "International Standards for Cities and the World Council on City Data - A Next Step for Smart Cities" provides an answer to these and other questions.



ISO 37120 Sustainable Development of Communities: Indicators for City Services and Quality of Life

World Council on City Data™

Piloting ISO 37120
Building ISO 37121

BUILDING THE GLOBAL STANDARD FOR CITY DATA

PART 1

2008-2012

Many rankings, assessments, city/companies/inhabitants want **feedback** to improve.

	City	Country	Rating
1	Melbourne	Australia	97.5
2	Vienna	Austria	97.4
3	Vancouver	Canada	97.3
4	Toronto	Canada	97.2
5	Calgary	Canada	96.6
6	Sydney	Australia	96.1
7	Helsinki	Finland	96.0
8	Perth	Australia	95.9
9	Adelaide	Australia	95.9
10	Auckland	New Zealand	95.7

	City	Country	Rating
1	Vienna	Austria	108.6
2	Zurich	Switzerland	108
3	Geneva	Switzerland	107.9
4	Auckland	New Zealand	107.4
	Vancouver	Canada	107.4
6	Düsseldorf	Germany	107.2
7	Frankfurt	Germany	107
	Munich	Germany	107
9	Bern	Switzerland	106.5
10	Sydney	Australia	106.3

	City	Country	2009
1	Munich	Germany	(04)
2	Copenhagen	Denmark	(02)
3	Zurich	Switzerland	(01)
4	Tokyo	Japan	(03)
5	Helsinki	Finland	(05)
=6	Stockholm	Sweden	(06)
7	Paris	France	(08)
8	Vienna	Austria	(07)
9	Melbourne	Australia	(09)
10	Madrid	Spain	(12)

Extra attention needed for

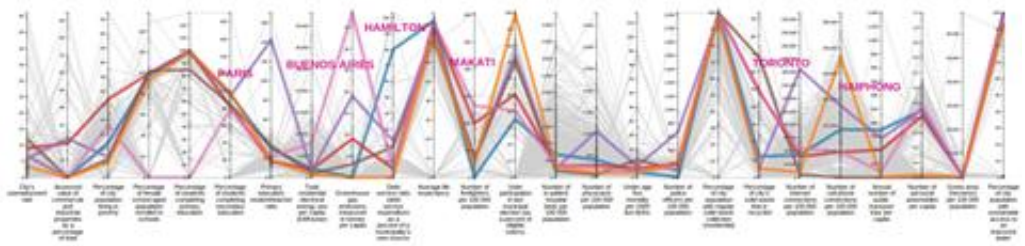
- Many rankings, standardization needed
- Feedback on your score
- standardized 3rd party verified data
- Indicator evolution
- Weighing black box
- Resilience, adaptation capacity
- Governance
- Use of local potentials (renewables)
- Indirect impacts of consumption elsewhere..so footprint

Other challenges in this Field of City Data

- **City data often collected nationally – Not locally**
- **No Standardized definitions on what to measure**
- **No Standardized methodologies on how to measure**
- **Weak or nonexistent baseline data in cities**
- **No mechanism for data and knowledge sharing across cities**

Global City Indicators Facility

Comparative Analytics:



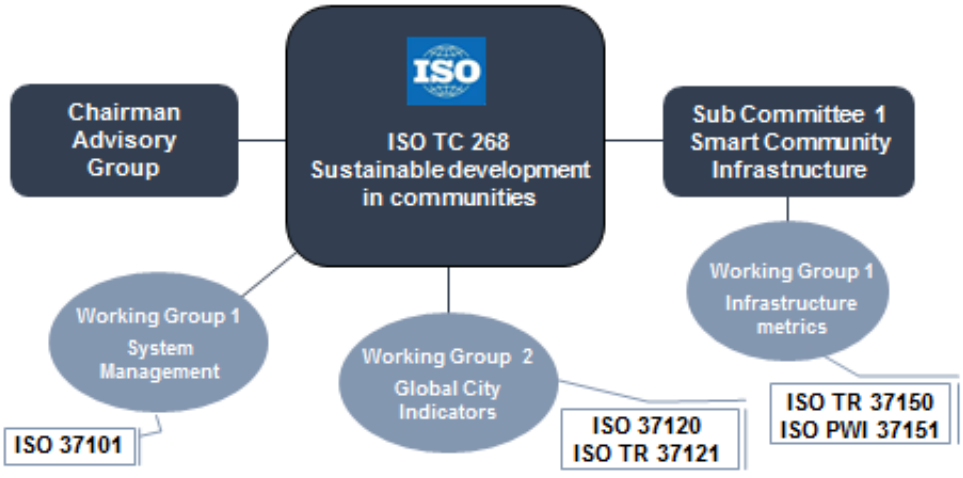
Cities and Aging
Aggregation Studies
etc.

BUILDING THE GLOBAL STANDARD FOR CITY DATA

PART 2

2012-2014

Our ISO Internal Lead Position to Build Additional City Indicator Standards and New Indicators on Resilient Cities – We **Chair Working Group 2** and are **Voting Members** of TC268, TC268 CAG, WG1 and SC1 WG1



TC268 Working Group 2 – City Indicators

ISO Development

- 20 countries
- 6 International Meetings
- 5 drafts, 300 comments

Published

- The first ISO Standard on Global City Indicators, May 15th 2014

What is ISO 37120?

- set of standardized indicators that provide a uniform approach to what is measured, and how that measurement is to be undertaken
- 100 Indicators – standardized definitions and methodology, **46 Core** and 54 Supporting
- Common language for reporting

17 Themes

City Services and Quality of Life

Economy
Education
Energy
Environment
Finance
Fire and Emergency Response
Governance
Health
Recreation
Safety
Shelter
Solid Waste
Telecommunication and Innovation
Transportation
Urban Planning
Wastewater
Water and Sanitation

46 CORE ISO 37120 CITY INDICATORS

Economy
-City's unemployment rate
-Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties
-Percentage of city population living in poverty

Education
-Percentage of female school-aged population enrolled in school
-Percentage of students completing primary education
-Percentage of students completing secondary education
-Primary education student/teacher ratio

Energy
-Total residential electrical use per capita (kWh/year)
-Percentage of city population with authorized electrical service
-Energy consumption of public buildings per year (kWh/m²)
-Percentage of total energy derived from renewable sources, as a share of the city's total energy consumption

Environment
-Fine particulate matter (PM2.5) concentration
-Particulate matter (PM10) concentration
-Greenhouse gas emissions measured in tonnes per capita

Finance
-Debt service ratio (debt service expenditure as a percentage of a municipality's own-source revenue)

Fire and emergency response
-Number of firefighters per 100 000 population
-Number of fire related deaths per 100 000 population
-Number of natural disaster-related deaths per 100 000 population

Governance
-Voter participation in last municipal election (as a percentage of eligible voters)
-Women as a percentage of total elected to city-level office

Health
-Average life expectancy
-Number of in-patient hospital beds per 100 000 population
-Number of physicians per 100 000 population
-Under age five mortality per 1 000 live births

Safety
-Number of police officers per 100 000 population
-Number of homicides per 100 000 population

Shelter
-Percentage of city population living in slums

Solid waste
-Percentage of city population with regular solid waste collection (residential)
-Total collected municipal solid waste per capita
-Percentage of city's solid waste that is recycled

Telecommunication and Innovation
-Number of Internet connections per 100 000 population
-Number of cell phone connections per 100 000 population

Transportation
-Km of high capacity public transport system per 100 000 population
-Km of light passenger transport system per 100 000 population
-Annual number of public transport trips per capita
-Number of personal automobiles per capita

Urban Planning
-Green area (hectares) per 100 000 population

Wastewater
-Percentage of city population served by wastewater collection
-Percentage of the city's wastewater that has received no treatment
-Percentage of the city's wastewater receiving primary treatment
-Percentage of the city's wastewater receiving secondary treatment
-Percentage of the city's wastewater receiving tertiary treatment

Water and Sanitation
-Percentage of city population with potable water supply service
-Percentage of city population with sustainable access to an improved water source
-Percentage of population with access to improved sanitation
-Total domestic water consumption per capita (litres/day)

ISO 37120 – Indicators for City Services and Quality of Life		
Theme	**Core Indicator**	**Supporting Indicator**
Economy	City's unemployment rate	% of persons in full-time employment
	Assessed value of commercial and industrial properties as a % of total assessed value of all properties	Youth unemployment rate
	% of city population living in poverty	Number of businesses per 100 000 population
		Number of new patents per 100 000 population per year
Education	% of female school-aged population enrolled in schools	% of male school-aged population enrolled in schools
	% of students completing primary education: survival rate	% of school-aged population enrolled in schools
	% of students completing secondary education: survival rate	Number of higher education degrees per 100 000 population
	Primary education students/teacher ratio	
Energy	Total residential electrical energy use per capita (kWh/year)	Total electrical energy use per capita (kWh/year)
	% of city population with authorized electrical service	Average number of electrical interruptions per customer per year
	Energy consumption of public buildings per year (kWh/ m^2)	Average length of electrical interruptions
	% of total energy derived from renewable sources, as a share of the city's total energy consumption	
Environment	Fine particulate matter (PM2.5) concentration	NO_2 (nitrogen dioxide) concentration
	Particulate matter (PM10) concentration	SO_2 (sulphur dioxide) concentration
	Greenhouse gas emissions measured in tonnes per capita	O_3 (Ozone) concentration
		Noise pollution
		% change in number of native species

ISO 37120 – Indicators for City Services and Quality of Life		
Theme	**Core Indicator**	**Supporting Indicator**
Finance	Debt Service ratio (debt service expenditure as a % of a municipality's own-source revenue)	Capital spending as a percentage of total expenditures
		Own-source revenue as a percentage of total revenues
		Tax collected as a percentage of tax billed
Fire and Emergency Response	Number of firefighters per 100 000 population	Number of volunteer and part-time firefighter per 100 000 population
	Numbers of fire related deaths per 100 000 population	Response time for emergency response services from initial call
	Number of disaster related deaths per 100 000 population	Response time for fire department from initial calls
Governance	Voter participation in last municipal election (as % of eligible voters)	% of women employed in the city government workforce
	Women as a % of total elected to city-level office	Number of convictions for corruption and/or bribery by city officials per 100 000 population
		Citizen's representation: number of local officials elected to office per 100 000 population
		Number of registered voters as a % of the voting age population
Health	Average life expectancy	Number of nursing and midwifery personnel per 100 000 population
	Number of in-patient hospital beds per 100 000 population	Number of mental health practitioners per 100 000 population
	Number of physicians per 100 000 population	Suicide rate per 100 000 population
	Under age five mortality per 1 000 live births	

ISO 37120 – Indicators for City Services and Quality of Life		
Theme	**Core Indicator**	**Supporting Indicator**
Recreation		Square meters of public indoor recreation space per capita
		Square meters of public outdoor recreation space per capita
Safety	Number of police officers per 100 000 population	Crimes against property per 100 000
	Number of homicides per 100 000 population	Response time for police department from initial call
		Violent crime rate per 100 000 population
Shelter	% of city population living in slums	Number of homeless per 100 000 population
		Percentage of households that exist without registered legal tiles
Solid Waste	% of city population with regular waste collection (residential)	% of the city's solid waste that is disposed of in a sanitary landfill
	Total collected municipal solid waste per capita per year	% of the city's solid waste that is disposed of in an incinerator
	% of the city's solid waste that is recycled	% of the city's solid waste that is burned openly
		% of the city's solid waste that is disposed of in an open dump
		% of the city's solid waste that is disposed of by other means
		Hazardous Waste Generation per capita (tonnes)
		% of the city's hazardous waste that is recycled
Telecommunications and Innovation	Number of internet connections per 100 000 population	Number of landline phone connections per 100 000 population
	Number of cell phone connections	

ISO 37120 – Indicators for City Services and Quality of Life		
Theme	**Core Indicator**	**Supporting Indicator**
Transportation	Km of light passenger public transport system per 100 000 population	Number of two-wheel motorized vehicles per capita
	Annual number of public transport trips per capita	Km of bicycle paths and lanes per 100 000 population
	Number of personal automobiles per capita	Transportation fatalities per 100 000 population
		Commercial air connectivity (number of non-stop commercial air destinations)
Urban Planning	Green area (hectares) per 100 000 population	Annual number of trees planted
		Areal size of informal settlements as a percentage of city area
		Jobs/housing ratio
Wastewater	% of city population served by wastewater collection	
	% of the city's wastewater that has received no treatment	
	% of the city's wastewater receiving primary treatment	
	% of the city's wastewater receiving secondary treatment	
	% of the city's wastewater receiving tertiary treatment	
Water and Sanitation	% of city population with potable water supply service	Total water consumption per capita (litres/day)
	% of city population with sustainable access to an improved water source	Average annual hours of water service interruption per household
	% of population with access to improved sanitation	% of water loss (unaccounted for water)
	Total domestic water consumption per capita (litres/day)	

Why is this Standard Important?

- Effective City **Governance** with **Performance Measurement**
- **Transparency** – Bridging divide between Civil Society and Government
- Guides City Management and **Sustainability Planning**
- Facilitates **Learning** Across Cities – Globally and Locally
- Comparative Analysis for Policy Development
- **Open Data** – third party verified data

Who are the Users?

- Applicable to **any city**, municipality or **local government**
- **Mayors**, city managers, **planners**, politicians, **researchers**, business leaders, designers and other professionals – and **citizens**
- Assessment and Analytics for International Agencies and Corporate Partners

How Can the Standard be Used?

- Assessing city's **performance** for improving quality of life
- **Cost efficiencies** in city budgets
- Increasing **accountability**/open data/financial risk and insurance/risk assessment
- Leveraging **funds** for projects and infrastructure
- **Benchmarking** – locally and globally
- Benchmarking for projects, monitoring progress and success
- City **apps**

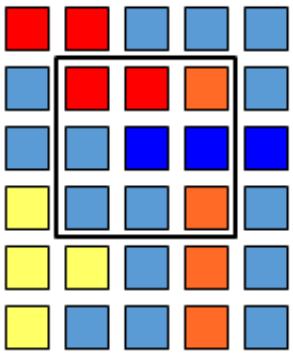
Local example (Standardized) data and smart city planning

Local Social Index
Local Health index
Local Safety index

For Policticians

breeam

For developers



Core is 3rd party verified data to compare to other cities / rest is local

Hackaton with Open Data for CleanWeb in Rotterdam

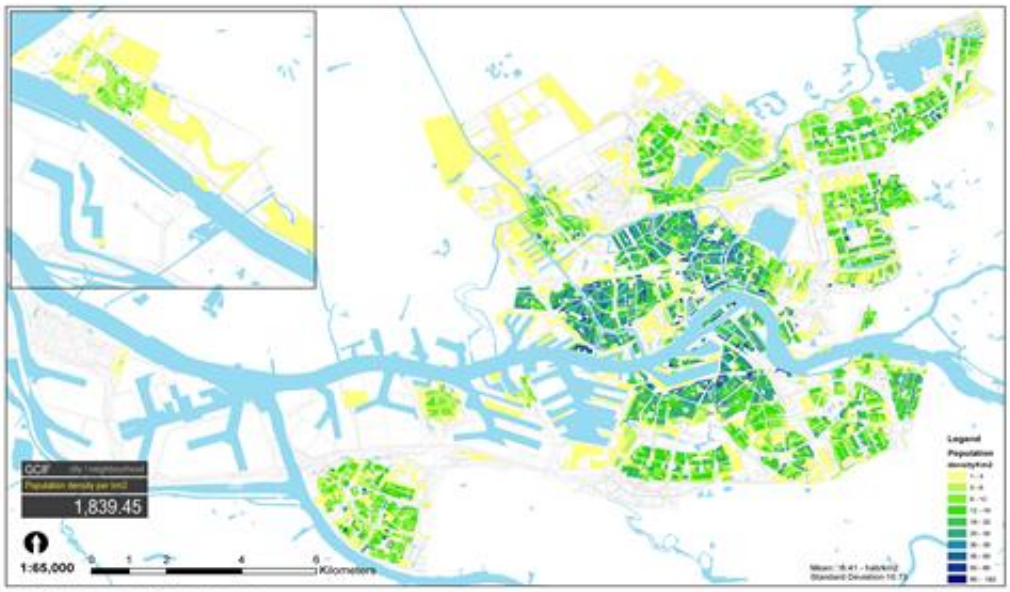
For innovation

For investers expats

For people neighborhoods

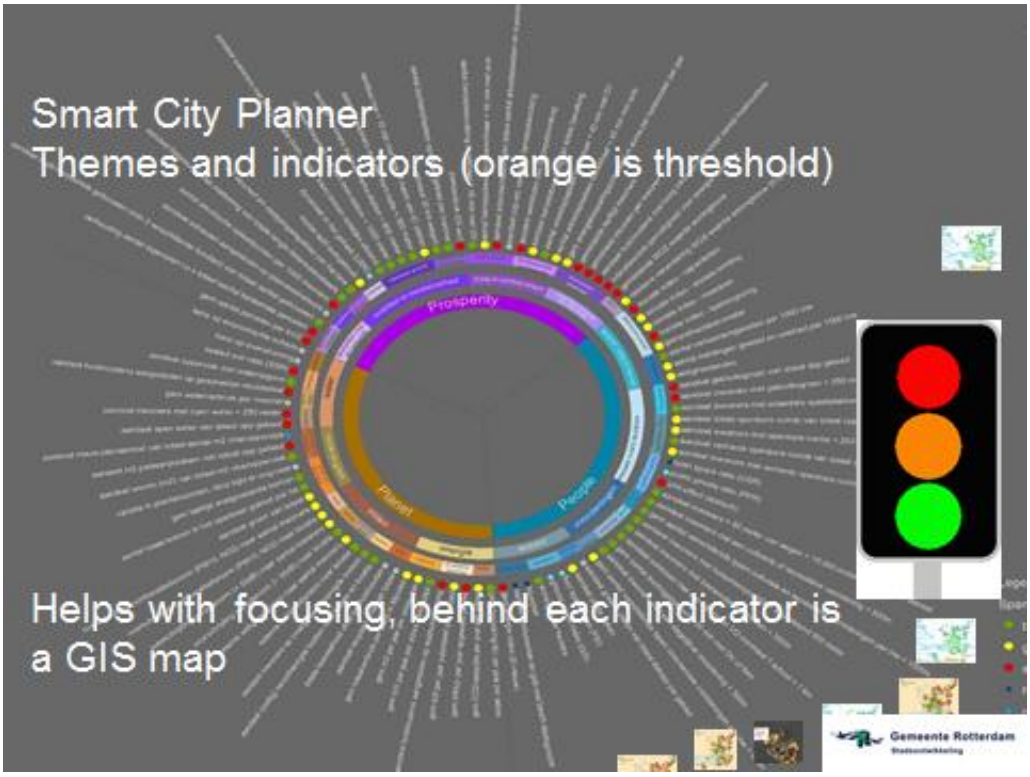
Gemeente Rotterdam

Makes mapping easier. A map is easier to read than many excell sheets



GCIF Indicators

Urban Planning, Shelter and Environmen - Population density per Km2



Facilitate the transition, Use 'smart city planner' for co-creation

Put open, objective data on the table

Red number 1

Waterproblems, recreation shortage

Possible solution : watergarden, square

Watersquare finished Nov 2012

Study from the 'De urbanisten' Rotterdam

Gemeente Rotterdam

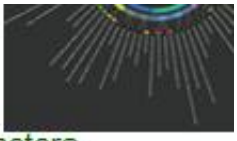
Watersquare medium rainfall

By: Florian Boer, de Urbanisten Rotterdam

Watersquare heavy rainfall

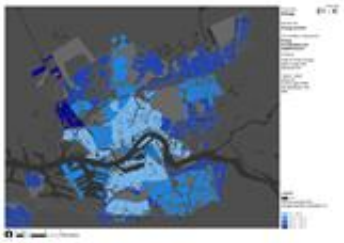
By: Florian Boer, de Urbanisten Rotterdam

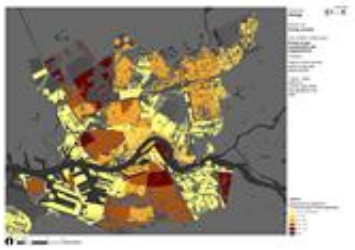
Red dot number 2:



High energy use, low income, energy too expensive

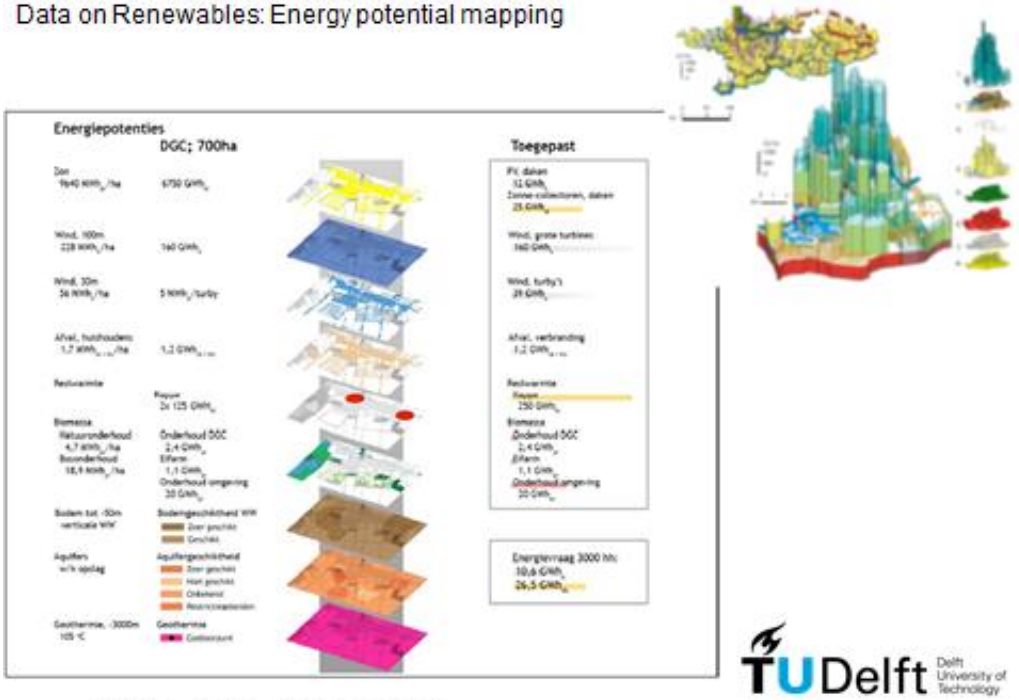
Possible solution: Energy efficiency measures, smart meters, insulation, ESCO, solar thermal, pv, other renewables etc





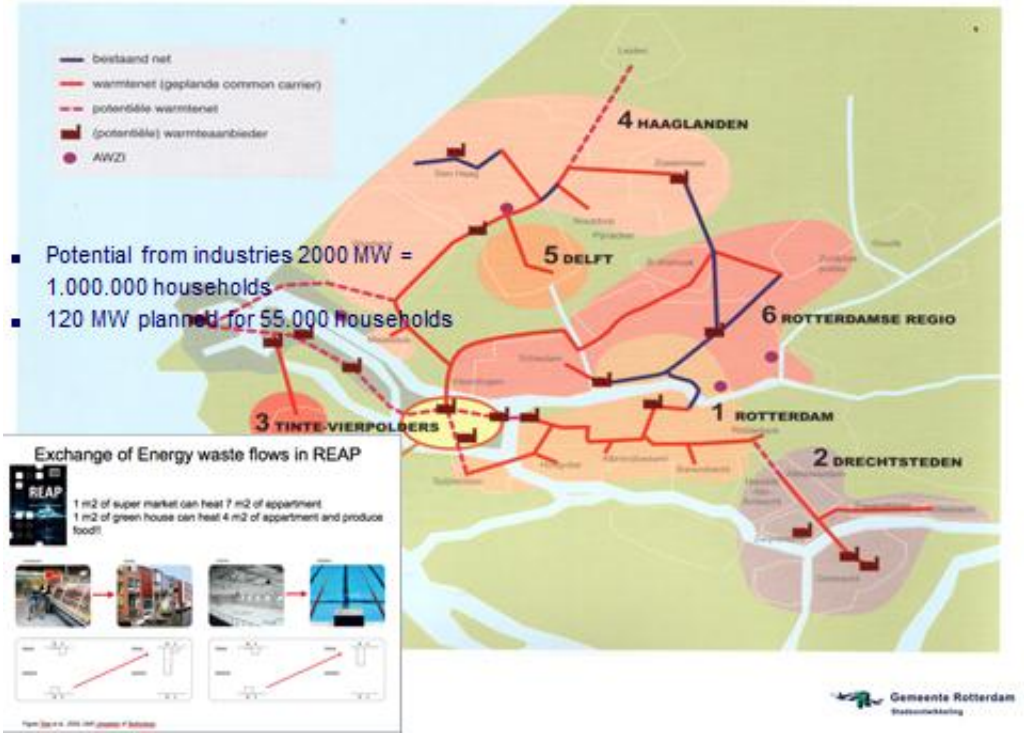
Link Energy Atlas solar data, with home ownership, indicators in 3d

Data on Renewables: Energy potential mapping

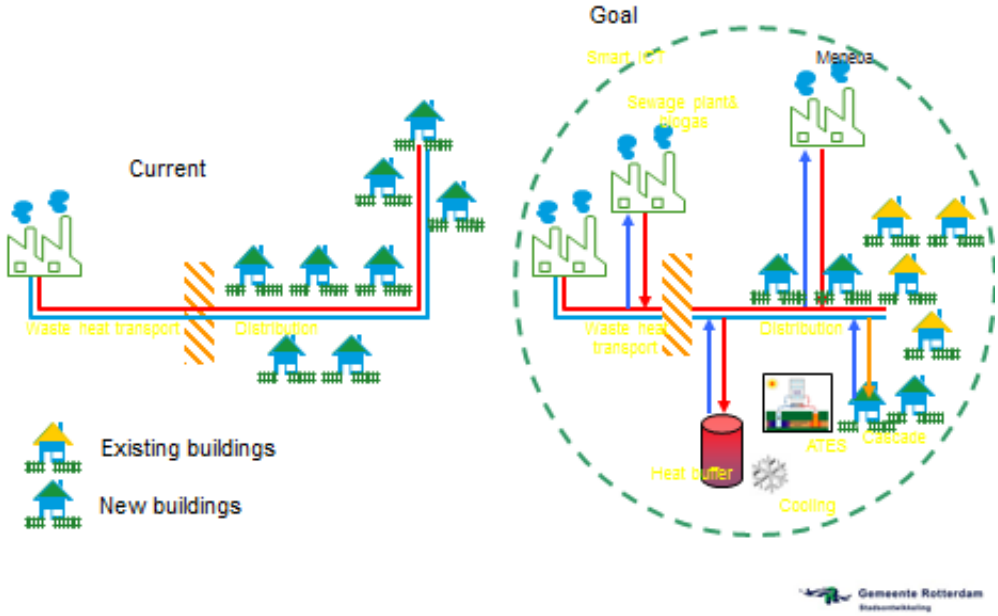


By: A. Van den Dobbelsteen Delft University of Technology

Data on energy waste flows for District heating networks



To make the step from traditional district heating/cooling to smart district heating / cooling



Data to inform stakeholders with simple standardized data

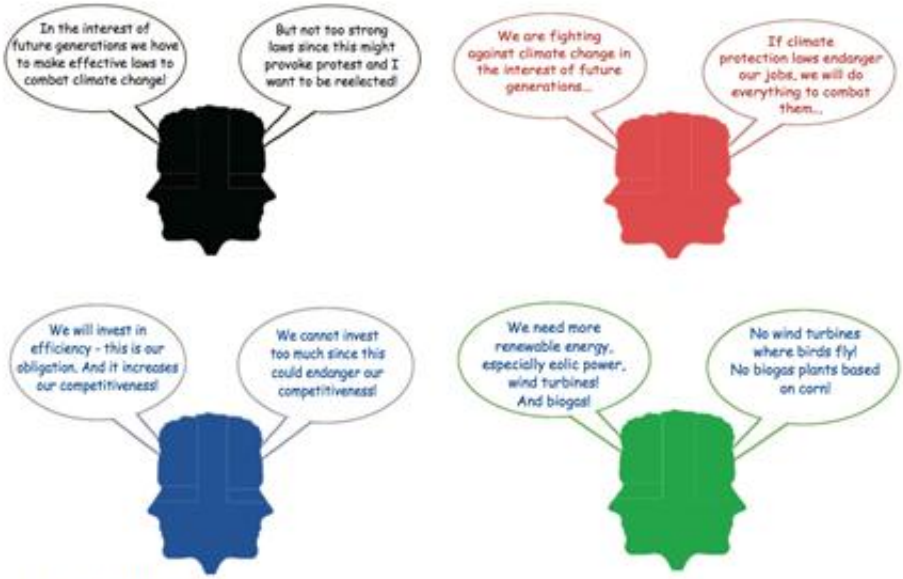
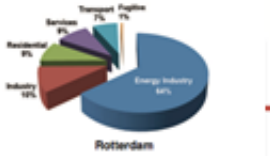


Figure from Eucn2 project

Scenario program GRIP

GRIP Scenariotool
by S. Carney.



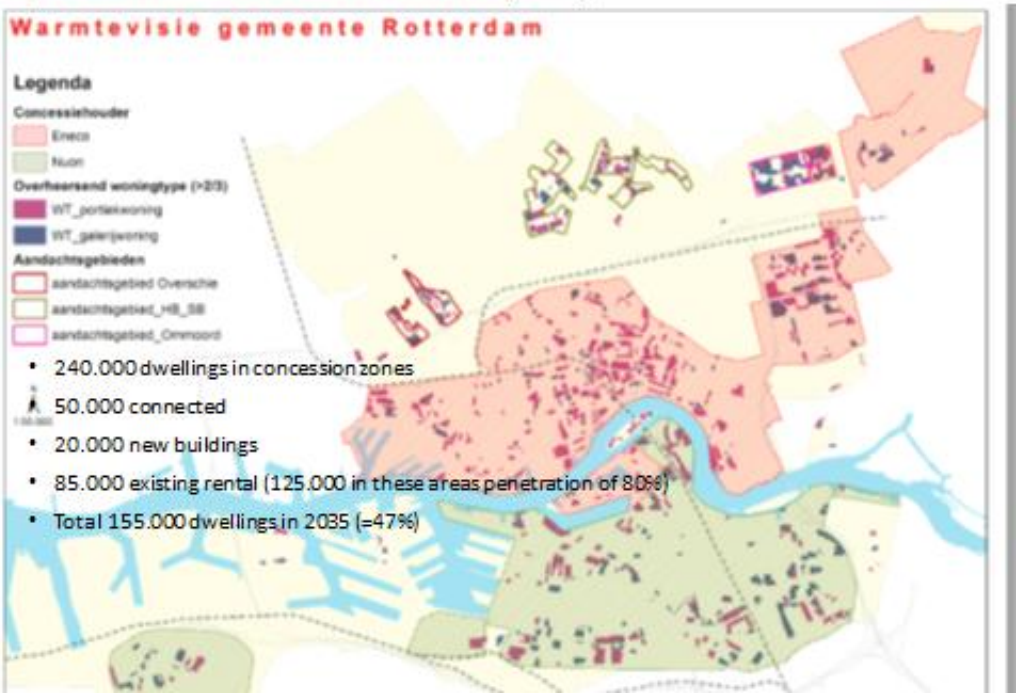
- Primary energy data all sectors
- Energy consumption Energy Supply
- economic and demographic data

Energie en CO_2 data in GRIP scenario stakeholders built a scenario, storyline and play with primary energy input and see direct CO2 emissions.

Best Practice voor Convenant of Mayor's
Joint Research Centre of Europese Union
Best Practice ICLEI

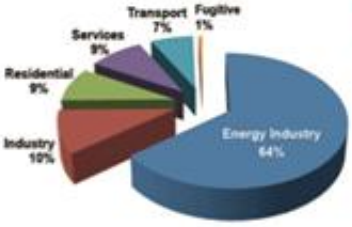
New Energy MIX and see direct CO2 effects per sector. Feeds into SEAP

Having these results we can than use GIS and combine data for optimal locations where District Heating can go

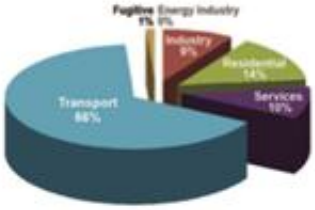


GRIP results of 15 metropolitan regions: Built up per sector; many differences in Europe

Average of all 14 EUCO2 partners



Rotterdam



Oslo

Brussels

12-1-2015 44

BUILDING THE GLOBAL STANDARD FOR CITY DATA

PART 3

2014-2016 – NEW Resilience

ISO – New City Indicators

NEXT STEPS AT THE ISO
New Work Item Approved

Title:

Inventory and Review of Existing Indicators for Sustainable Development and Resilience in Cities ALSO ENERGY

ISO 37121–resilience and sustainability

Review and Development of New Indicators on Sustainability and Resilience – New Themes

- Emergency Preparedness
- Changes in rainfall and storm surges
- Protection of biodiversity
- **Energy consumption**
- **Alternative energy**
- Risk assessment
- **Resilience Infrastructure**
- **Smart Grid**
- Economic resilience
- Political resilience
- **Walkability & Accessibility**
- **Transit & Mobility**
- Water & Waste Management
- **Green buildings**

IMPLEMENTING THE GLOBAL STANDARD ON CITY DATA

PART 4

THE 37120 PILOT TODAY


BUILDING WITH OUR GLOBAL PARTNERS - 2008 TO TODAY
Ontario
UNIVERSITY OF TORONTO
cisco
PHILIPS
GDF SUEZ
BY PEOPLE FOR PEOPLE
SIEMENS
THE WORLD BANK
OECD
THE EXECUTIVE COUNCIL
百達金融集團
BAIDA FINANCE GROUP
Scotiabank
PM
UN HABITAT
IDB
IDRC CRDI
UNEP
UNESCO
IBI GROUP
unicef
Cities Alliance
Cities Without Slums
ICLEI
MAYTREE


BUILDING THE WORLD COUNCIL ON CITY DATA
•The **WCCD** becomes a **global platform for creative learning** partnerships across cities, international organizations, corporate partners, and academia to further innovation, envision alternative futures, and build better and more livable cities.
•City Data, Analytics, Visualization
•Publications, City Awards and Recognitions
•Workshops and Global Summits
•**Drafting New International Standards**
•Develop Strategies on Big Data for Cities

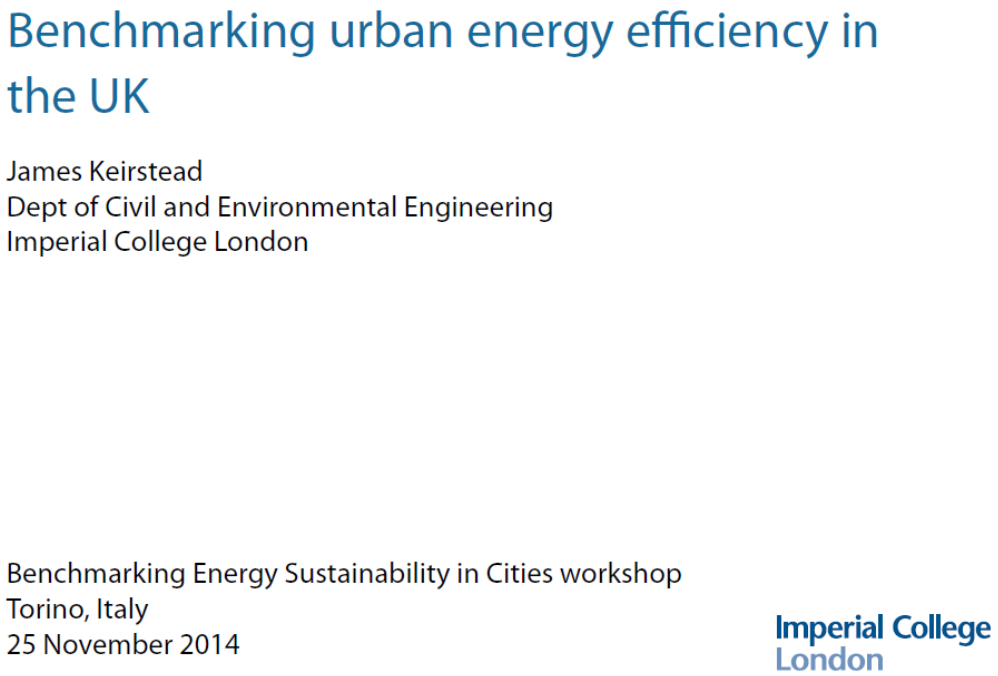
How to become an ISO 37120 City

Session 2 –Benchmarking Energy Sustainability in Cities

VII. Benchmarking Urban Energy Efficiency in the UK

James Keirstead, Imperial College London, UK
(Keirstead 2013)

This study asks the question, what is the 'best' way to measure urban energy efficiency? There has been recent interest in identifying efficient cities with best practices that can be shared, a process known as benchmarking. Previous studies have used relatively simple metrics that provide limited insight on the complexity of urban energy efficiency and arguably, fail to provide a 'fair' measure of urban performance. Using a data set of 198 urban UK local administrative units, three methods are compared: ratio measures, regression residuals, and data envelopment analysis. The results show that each method has its own strengths and weaknesses regarding the ease of interpretation, ability to identify outliers, and provide consistent rankings. Efficient areas are divers, but are not ably found in low income areas of large conurbations such as London, whereas industrial areas are consistently ranked as inefficient. The results highlight the shortcomings of the underlying production-based energy accounts. Ideally urban energy efficiency benchmarks would be built on consumption-based accounts, but interim recommendations are made regarding the use of efficiency measures that improve upon current practice and facilitate wider conversations about what it means for a specific city to be energy-efficient within an interconnected economy.



Cities and energy policy

Boris makes his usual mark
Evening Standard, 15 Dec 2009

Boris Johnson is among 80 mayors at the climate change conference in Copenhagen but he managed to cause a stir at today's morning meeting. As everyone talked about working together, London's leader declared cities should be doing their best to make each other "green with envy."

Ritt Bjerregaard, Mayor of Copenhagen, looked horrified and said we should "not be competing", while the deputy mayor of Barcelona declared herself "very aggrieved with the Mayor of London".

Imperial College London

Urban benchmarking

A definition

"the systematic continuous method …of identifying, learning and implementing the most effective practices and capacities from other cities in order for one's own city to improve its actions in what it offers"

– Luque-Martínez and Muñoz Leiva (2005: 414)

Imperial College London

Urban benchmarking

Examples from urban competitiveness

> *"[t]he ability of an (urban) economy to attract and maintain firms with stable or rising market shares in an activity while maintaining or increasing standards of living for those who participate in it."*
>
> *– Storper (1997: 20)*

A review of 22 such studies questioned their utility (Greene et al. 2007):

- Unlike firms, cities often pursue a variety of outputs (economic and social).
- How to define urban boundaries to facilitate meaningful comparisons with other jurisdictions.
- General approach: collect indicators, normalise scores, weight, aggregate, rank.

Imperial College London

Urban benchmarking

Examples from urban sustainability

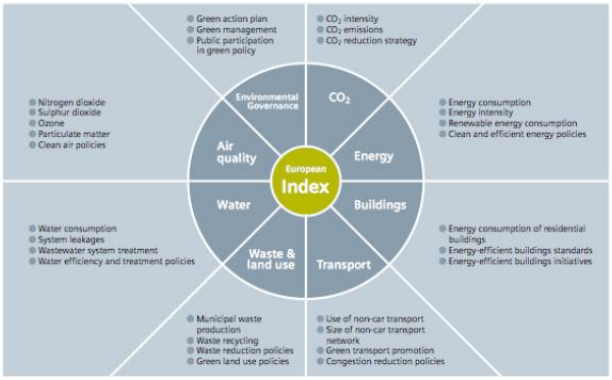
Widens the assessment to include environmental, as well as economic and social goals.

- Huge diversity but "no indicator sets that are universally accepted, backed by compelling theory, rigorous data collection and analysis, and influential in policy" (Parris and Kates 2003)
- Difficulty defining urban sustainability means metrics are often superficial
- Use of *à la carte* indicator sets grouped into themes, sometimes aggregated to summary lists

Imperial College London

Urban benchmarking

The Siemens Green City Index (Siemens 2012)



Overall Results

Rank	City	Score
1	Copenhagen	87.31
2	Stockholm	86.65
3	Oslo	83.98
4	Vienna	83.34
5	Amsterdam	83.03
6	Zurich	82.31
7	Helsinki	79.29
8	Berlin	79.01
9	Brussels	78.01
10	Paris	73.21
11	London	71.56
12	Madrid	67.08
13	Vilnius	62.77
14	Rome	62.58
15	Riga	59.57
16	Warsaw	59.04
17	Budapest	57.55
18	Lisbon	57.25
19	Ljubljana	56.39
20	Bratislava	56.09
21	Dublin	53.98
22	Athens	53.09
23	Tallinn	52.98
24	Prague	49.78
25	Istanbul	45.20
26	Zagreb	42.36
27	Belgrade	40.03
28	Bucharest	39.14
29	Sofia	36.85
30	Kiev	32.33

Imperial College London

Urban benchmarking

Examples from urban infrastructure systems

Examples include transport systems, water supply, waste management, or energy systems.

- May be used to evaluate performance of natural monopoly infrastructures
- Closer to original firm-level use of benchmarking

TABLE I

Some resources and service parameters in collection systems vs. related measurement units, which were considered important by some stakeholders in the case-study area

	Service parameters		
Resources	Collected waste amount (t)	Number of served households (hs)	Number of served inhabitants (i)
Financial cost (€)	t/€	hs/€	i/€
Number of man-hours (M)	t/M or t/shift	hs/M	i/M
Number of trucks (C)	t/C	hs/C	i/C

Source: Municipal Councils of the Thessaloniki Urban Area, 2000.

Source: Karagiannidis et al. (2004)

- Ambiguous urban boundaries may still pose a challenge

Imperial College London

Literature review conclusions

- Benchmarking should be informed by a clear view of what is being measured and the purpose of the analysis
- Cities pose unique problems for benchmarking, e.g. boundary definitions and limited data
- Most studies aim for ranked lists, supported by underlying indicators grouped into broad categories
- The interpretation of the results can be complex. Need to be careful of confounding variables.

Imperial College London

Methods

Keirstead (2013) compares three benchmarking approaches:

- Grouped ratio measures
- Regression residuals
- Data envelopment analysis

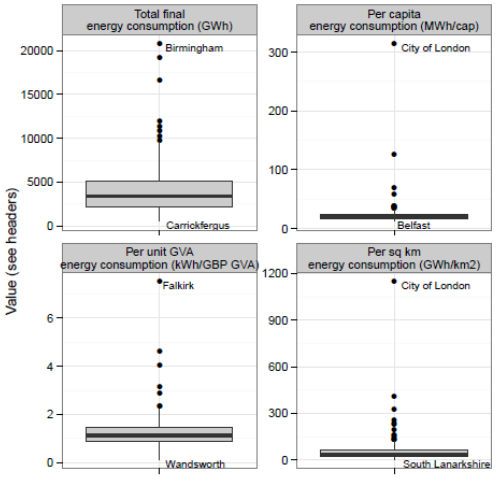
Naïve ratio measures (e.g. kWh per capita), weighted indicator aggregation, energy and exergy efficiency all rejected as lacking sufficient data or discriminatory ability.

Metrics tested on 198 urban local administrative districts within the UK.

Imperial College London

Ratio measures

Basic metrics on final energy consumption per capita, per GVA, per area were calculated.



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Regression residuals

Model energy consumption using linear regression:

$$y_i = \beta \mathbf{X}_i + \varepsilon_i$$

ε_i is thus a measure of deviation from predicted energy consumption for a city with given characteristics $\mathbf{X}_i$. Data are log-transformed so $r_i = e^{\varepsilon_i} = 1$ for average performance, < 1 for better performance, > 1 for worse performance.

r^2 of underlying model poor though $(0.245, p \ll 0.01)$.

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Ratio measures

More interesting results come when grouping cities into peer groups using ONS "area classifications"

- Assigns each LAD to one of thirteen clusters, e.g. Regional Centres, Centres with Industry, Thriving London Periphery
- Based on statistical analysis of age, ethinicity, population density, tenure, economic structure, and other features

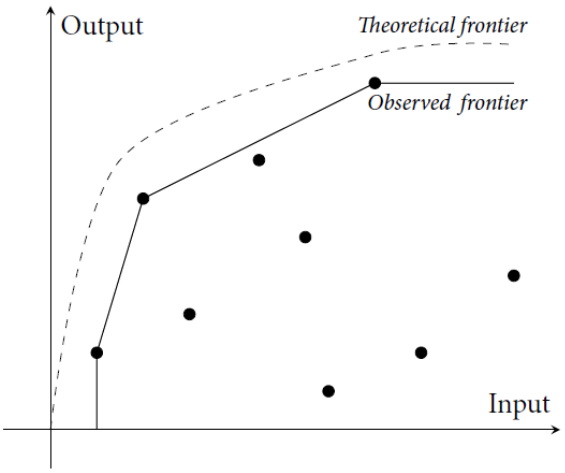
Area classification	Rank	Name	Total final energy (MWh/capita)
London Suburbs	1	Redbridge, England	13.108
	2	Waltham Forest, England	13.617
	3	Merton, England	14.211
	4	Harrow, England	14.528
	5	Croydon, England	15.066
	6	Luton, England	16.031
	7	Barnet, England	16.375
	8	Ealing, England	16.483
	9	Greenwich, England	18.247
	10	Hounslow, England	19.370

Regression residuals

Rank	LAU name	Total final energy consumption (MWh/capita)	r_i (fraction of $e^{\hat{y}}$)
1	South Lanarkshire, Scotland	22.786	0.572
2	Barking and Dagenham, England	13.855	0.617
3	Belfast, Northern Ireland	12.336	0.674
4	Weymouth and Portland, England	14.376	0.688
5	South Tyneside, England	16.124	0.689
⋮			⋮
194	Slough, England	33.939	1.793
195	Neath Port Talbot, Wales	57.692	2.611
196	Thurrock, England	68.961	3.005
197	Falkirk, Scotland	125.823	5.492
198	City of London, England	314.730	8.758

Table: Most and least energy efficiency urban UK LAUs, ranked by regression residuals. Residual r_i = fraction of expected value, i.e. average performance equals 1.0.

Data envelopment analysis



Inputs:

- Energy consumption (kWh/cap)
- Population
- Land Area
- Climate

Outputs:

- Gross value added (£/cap)
- CO_2 emissions
- Average life expectancy
- Access time to services

Imperial College London

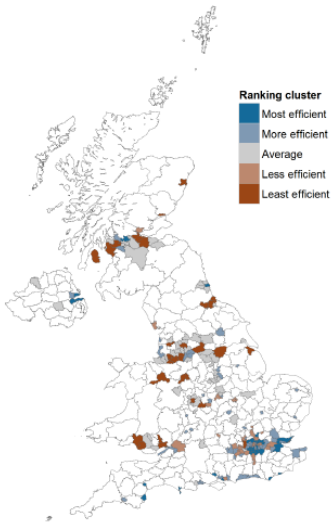
Data envelopment analysis

Rank	City	Total final energy consumption (MWh/capita)	Efficiency score
1	Gosport, England	13.215	1.265
2	Barking and Dagenham, England	13.855	1.169
3	Southwark, England	16.518	1.086
4	Tower Hamlets, England	23.567	1.081
5	Exeter, England	16.336	1.075
⋮			⋮
194	Darlington, England	26.548	0.672
195	Trafford, England	31.939	0.669
196	Doncaster, England	26.987	0.668
197	Craigavon, Northern Ireland	20.751	0.665
198	Falkirk, Scotland	125.823	0.634

Table: Most and least energy efficient urban UK LAUs, ranked by data envelopment analysis efficiency score.

Overall Results

Interactive website



http://bit.ly/1swpzDu

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Conclusion

Which method is best?

- Do methods change overall ranking of cities? *Not much. Correlation between metrics. Clear groups of inefficient and efficient cities.*
- Do methods discriminate between cities? *Residuals follow normal distribution, DEA has bounds on its range which constrains outliers.*
- Do methods encourage better than best practice? *Not explicitly but possible.*

Policy implications?

- UK local authorities have limited degrees of freedom in energy policy, but new opportunities emerging. Benchmarking could help promote local policy success.
- Measures of direct energy efficiency should be used with care; pity the cities with oil refineries and heavy industry!

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VIII. BEST, GREAT, and ELITE: A low carbon eco-city evaluation tools

Nan Zhou, Lawrence Berkeley National Laboratory, Berkeley, USA
(Nan Zhou 2014)

China is pursuing the development of low-carbon eco-cities to limit carbon dioxide and other greenhouse gases emissions; however, it is unclear what constitutes a low-carbon eco-city and how to evaluate it. The eco and low-carbon indicator tool for evaluating cities (ELITE cities) was developed by researchers at the Lawrence Berkeley National Laboratory in 2012 to evaluate cities' performance by comparing them against benchmark performance goals as well as rank them against other cities in China. ELITE cities measures progress on 33 key indicators selected to represent priority issues within eight primary categories. An excel-based tool was then developed to package the key indicators, indicator benchmarks, explanation of indicators, point calculation functions and transparency-oriented data recording instructions. ELITE cities could be a useful and effective tool for local city government in defining the broad outlines of a low-carbon eco-city and assessing the progress of cities' efforts towards this goal.

ELITE cities can also be used by higher-level governments to assess city performance and discern best practices. This paper explains the general framework of the ELITE cities tool, the methods by which the indicators and indicator benchmarks were established, and a detailed guide on tool applications.

Table 3
Final ELITE cities indicators and benchmarks.

Primary category	Indicator name	Indicator scope	Units	Benchmark	Source
Energy/ Climate	CO_2 intensity	Total carbon dioxide (CO_2) emissions per capita	tons/capita year	2.19 tons/cap year	UN Habitat State of the World Cities 2008/2009, Part 3, p. 135; Oslo is picked as the benchmark.
	Residential building energy intensity	All residential building average energy intensity per square meter building space	kilowatt-hours per square meter per year (kWh/m^2 year)	Cold climate: 88 kWh/m^2 year severe cold climate: 132.7 kWh/m^2 year hot summer cold winter climate: 69.7 kWh/m^2 year hot summer warm winter climate: 54.7 kWh/m^2 year moderate: 50 kWh/m^2 year	Jiang Yi, China Building Energy Efficiency Develepment Report.
	Public building electricity intensity	Public building average electricity intensity per square meter	kWh/m^2 year	70 kWh/m^2 year	Jiang Yi, China Building Energy Efficiency Development Report. Shenzhen data is set as the benchmark.
	Share of renewable electricity	Renewable energy (excluding nuclear) as a share of total city purchased electricity	% of total electricity purchased	20%	National 12th Five-Year Plan for New Energy Development and Caofeidian Eco-city Indicator System's target.
Water	Municipal water consumption	Municipal water consumption per capita	liter/capita day	52.1 l/cap day	Hamburg (2009).
	Industrial water consumption	Industrial water consumption per industrial GDP	liter/annual 10,000 Renminbi (RMB)	80.5 l/10,000 RMB	World Bank, TRACE tool.
	Wastewater treatment rate	Percentage of wastewater receiving at least primary treatment	% of total wastewater	100%	LBNL expert team decision.
	Drinking water quality	Percentage of total drinking water meeting Grade III or above	% of total drinking water	100%	LBNL expert team decision.
	Recycled water use	Percentage of annual municipal water use sourced from water reclamation	% of total municipal water	30%	MOHURD eco-garden city program standard.
	Energy intensity of drinking water	Energy intensity of drinking water	Kilowatt-hours per liter (kWh/l)	0.10 kWh/l	World Bank, TRACE tool. Sydney (2009).
Air	PM_{10} concentrations	Daily average PM_{10} concentration	Micrograms per cubic meter (g/m^3)	20 μg/m^3	WHO (2006). 24-h mean.
	NO_x concentrations	Daily average NO_x concentration	g/m^3	40 μg/m^3	WHO (2006). 24-h mean.
	SO_2 concentrations	Daily average SO_2 concentration	g/m^3	20 μg/m^3	WHO (2006). 24-h mean.
	Air pollution days	Proportion of days per year that air quality meets Level II standard ("blue sky" threshold)	% of total days per year	100%	LBNL expert team decision.
Waste	Municipal waste intensity	kilograms (kg) of total collected MSW per capita	kg/capita/year	0.29 kg/cap/year	Shanghai target.
	Municipal waste treatment rate	Percentage of collected MSW receiving "harmless" treatment	% of total collected MSW	100%	LBNL expert team decision.
	Industrial recycling rate	Comprehensive industrial waste utilization rate	% of industrial solid wastes	100%	LBNL expert team decision.
Mobility	Public transportation network penetration	Public transport penetration rate as a proportion of total city area	kilometers per square kilometer (km/km^2)	4 km/km^2	Upper end of national target: code for transport planning on urban road. (GB 50,220-95): 3.2.2
	Public transportation share of trips	Share of public transportation trips in all trips	% of all trips/year	60%	12th Five-Year Comprehensive Plan for Transport System, national target city with 10 million population.
	Access to public transportation	Percentage of built area within 500 meters of public transit	% of built area	90%	MOHURD, Public Transport Demonstration Project, html
	Municipal fleet improvement	Proportion of energy-efficient and new-fuel vehicles (electric, hybrid, biofuel, <1.6 l-and-below cars) in the city vehicle fleet and taxi fleet	% of total vehicles	100%	LBNL expert team decision.
Economic health	Employment	Registered unemployment rate	% of eligible adults	3%	Chinese City Statistic Yearbook, Chongqing 12th Five-Year Plan, 2015 target.
	Environmental protection spending ratio	Ratio of environmental protection spending to GDP	% of annual GDP	3%	National 12th Five-Year Plan for Environmental Protection.
	R&D investment ratio	Ratio of R&D spending to GDP	% of annual GDP	5.5%	Beijing 12th Five-Year Plan

Table 3 (*Continued*)

Primary category	Indicator name	Indicator scope	Units	Benchmark	Source
	Organic certification of agricultural land	Percentage of total agricultural land area certified as organic	% of agricultural land	1%	FiBL-IFOAM survey.
Land use	Green space intensity	Average per capita public urban boundary inclusive green space	m^2 of green space/capita	100 m^2/capita	EIU Asia, Hong Kong average.
	Share of mixed-use zoning	Percent of total city land zoned for mixed use	% of total area	13.3%	Manhattan of New York is reported as 13.3%
	Population density	Land use per capita	m^2 per capita	100	Land and population data from China City Statistical Yearbook.
Social health	Health care availability	Health care practitioners per 1000 persons	Health care practitioners per 1,000 persons	14	Beijing 12th Five-Year Plan; China Statistic Yearbook 2011.
	Share of workers from higher education	Percent of employed population with university degree	% of employed persons	45%	U.S. ACS 2010, San Jose as benchmark.
	Internet connectivity	Percent of households with an internet connection	% of households	100%	LBNL expert team decision.
	Eco-city planning completeness	Eco-city planning and policy completeness	100 points – 10 policies with full points awarded for achieving the policy and 0 points for not achieving the policy*.	100%	LBNL expert team decision.
	Affordable housing availability	Percentage of total housing designated as "affordable"	% of total housing	20%	National target as 12th Five-Year Plan.

Note: PM_{10} = particulate matter < 10 μm in diameter; NO_x = nitrogen oxides; SO_2 = sulfur dioxide.

* Policies for the eco-city planning completeness indicator: has the city conducted a carbon inventory? has the city undertaken energy audits of its own operations, including city service entities and public buildings? has the city conducted an audit of water consumption in the city and losses in distribution systems? has the city conducted an audit of the contents of its municipal waste stream? has the city conducted an audit of mobility patterns of its residents? does the city regularly survey residents regarding their perspectives of city environmental quality? has the city established a low-carbon development plan? does the city have a single online platform to inform citizens of progress towards low-carbon eco-city goals? does the city government have a department that manages and/or tracks all low-carbon development activities by the city's government departments? does the city have a low-carbon eco-city district or industrial park demonstration project?

IX. Identifying the Methodological Characteristics of European Green City Rankings

Jurian V. Meijering, Wageningen University, The Netherlands
(Jurian V. Meijering 2014)

City rankings that aim to measure the environmental sustainability of European cities may contribute to the evaluation and development of environmental policy of European cities. The objective of this study is to identify and evaluate the methodological characteristics of these city rankings. First, a methodology was developed to systematically identify methodological characteristics of city rankings within different steps of the ranking development process. Second, six city rankings (European Energy Award, European Green Capital Award, European Green City Index, European Soot-free City Ranking, RES Champions League, Urban Ecosystem Europe) were examined. Official websites and any methodological documents found on those websites were content analyzed using the developed methodology. Interviews with representatives of the city rankings were conducted to acquire any additional information. Results showed that the city rankings varied greatly with respect to their methodological characteristics and that all city rankings had methodological weaknesses. Developers of city rankings are advised to use the methodology developed in this study to find methodological weaknesses and improve their ranking. In addition, developers ought to be more transparent about the methodological characteristics of their city rankings. End-users of city rankings are advised to use the developed methodology to identify and evaluate the methodological characteristics of city rankings before deciding to act on ranking results.

Identifying the methodological characteristics of European green city rankings

November 25th 2014

Jurian Meijering, Hilde Tobi - Wageningen University

Kristine Kern - University of Potsdam & Leibniz Institute for Regional Development and Structural Planning

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Introduction

- Nearly 75% of Europeans live in cities[1]
- The European Union is committed to making Europe's cities healthy, attractive and sustainable[1]

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[1] European Union, 2010. Making our cities attractive and sustainable. How the EU contributes to improving the urban environment. Publications Office of the European Union, Luxembourg.

- Various city rankings exist that measure the environmental sustainability of European cities.
- Some of these rankings focus at urban environmental sustainability as a whole, which include the European Green Capital Award, European Green City Index, Urban Ecosystem Europe.
- Others focus on certain specific categories/dimensions of urban environmental sustainability.
- So, the European energy award and the RES champions league focus specifically on energy, while the soot free European city ranking focusses specifically on air quality.

- Rankings make it easy for urban policy makers to see how well they are doing in comparison to other cities, in which areas they perform well, and where improvement is possible.
- As such, city rankings may contribute to the evaluation and development of urban environmental policy.
- Sadly, however, people rarely ask themselves *how* a ranking was developed.
- Also in the literature, the methodology of city rankings is rarely considered.
- Therefore, our research objective was to identify and evaluate the methodological characteristics of existing city rankings that aim to measure the environmental sustainability of European cities.

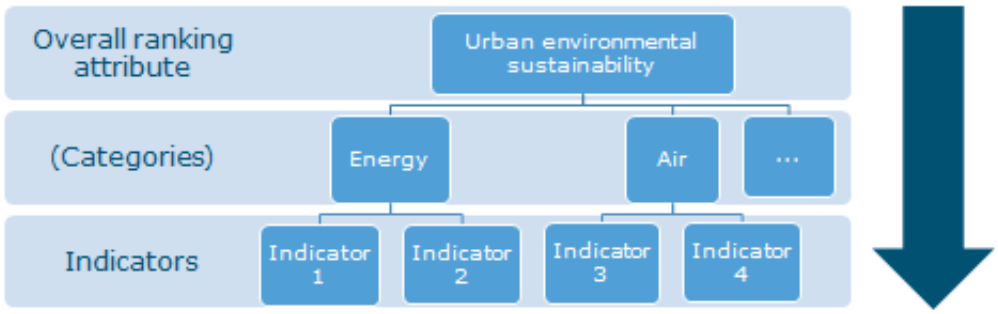
The steps that were followed to satisfy the research objective were as follows:

- We started our study by looking at the ranking development process
- The development of a ranking consists of several phases
- We used literature to identify methodological issues within each phase
- By first identifying issues of rankings in general, we could then use them to identify the methodological characteristics of various city rankings.

- Most rankings have an overall ranking attribute: the concept on which the objects or cities are finally ranked (e.g. city environmental sustainability performance)
- This ranking attribute is too complex to measure directly
- As a result, it is decomposed into several categories like energy, air, water, waste.
- Then, for each category indicators are selected to measure the performance of a city in that category.

Issues in ranking development

1. Decomposition of overall ranking attribute



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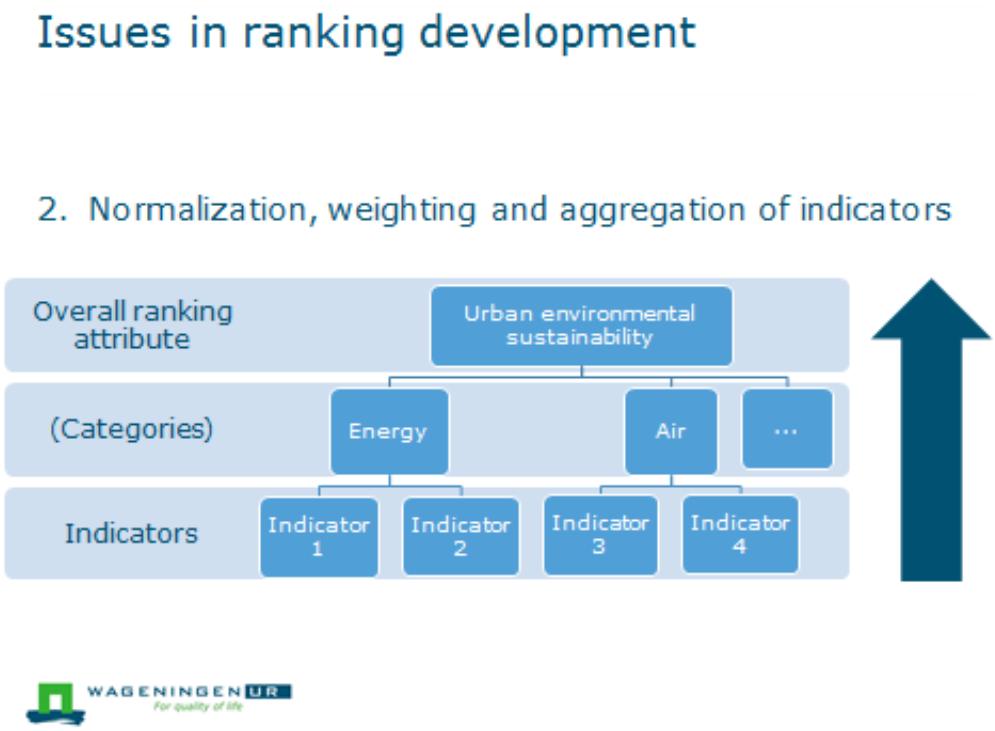
- Now, data is of course collected on the indicators.
- All that data on all those indicators somehow needs to be combined into a single rank number that shows how good or bad a city performs when it comes to urban environmental sustainability.
- Different indicators measure different things on different measurement scales.
- Therefore, the measurement scales of these indicators needs to be normalized.
- Also, maybe some indicators are more important than others and decisions need to be made about how to weigh the indicators.
- Finally, the normalized and weighted indicator values need to be aggregated, combined into an overall score on the overall ranking attribute
- Now, there are a lot of different normalization, weighting, and aggregation techniques.
- So, which ones do you use?
- It is very important to carefully substantiate these decisions, because research has shown that when you change a technique, the whole ranking may be turned upside down (Jacobs et al., 2005; Maretzke, 2006; Schwengler & Binder, 2006)!



Regarding the selection of cities: how to decide which cities to include in a ranking?

- This is an important question, because there are many different types of cities.
- Is it fair to compare a rather small capital city like Ljubljana with London when it comes to environmental sustainability?
- It is not only city size that matters. Other characteristics like geography, history, and type of economy may be important.

Issues in ranking development

3. Selection of cities
   - Selection criteria & sampling strategy

4. Data-collection
   - Data sources & methods
   - Evaluation of qualitative data

Finally, the reporting of results showed the following characteristics.

- There are many different ways in which to report the results of rankings.
- Of course, it is possible to just publish the final ranking, but this may be misleading.
- Also transparency is important. It is important to consider the degree to which the developers are transparent on their methodology for the rankings.
- It is important to consider whether the developers discuss the robustness of the ranking.

Issues in ranking development

5. Reporting of results
   - Rankings and ratings
   - Transparency about methodological characteristics
   - Discussion of ranking robustness

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	City
1	Copenhagen
2	Stockholm
3	Oslo
4	Vienna
5	Amsterdam
6	Zurich
7	Helsinki
8	Berlin
9	Brussels
10	Paris

Based on our review of the literature on methodological issues of ranking, we decided to examine six European green city rankings in more detail.

These rankings all had a European scope, the rankings were based on an indicator system and the rankings were measuring environmental sustainability. Finally, the ranking was publicly published a ranking within 2007-2012

Methodology

- Six European green city rankings were examined:

Ranking title	Initiator
European Energy Award	Forum European Energy Award
European Green Capital Award	European Commission
European Green City Index	Siemens
RES League	Comité de Liaison Energies Renouvelables
Soot-free European City Ranking	Bund für Umwelt- und Naturschutz Deutschland
Urban Ecosystem Europe	Ambiente Italia

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Methodology

- Data sources:
  - Official websites
  - Official ranking reports
  - Any methodological background documents
  - Developers of city rankings
- Data extracted by means of:
  - Coding scheme
  - Semi-structured interviews

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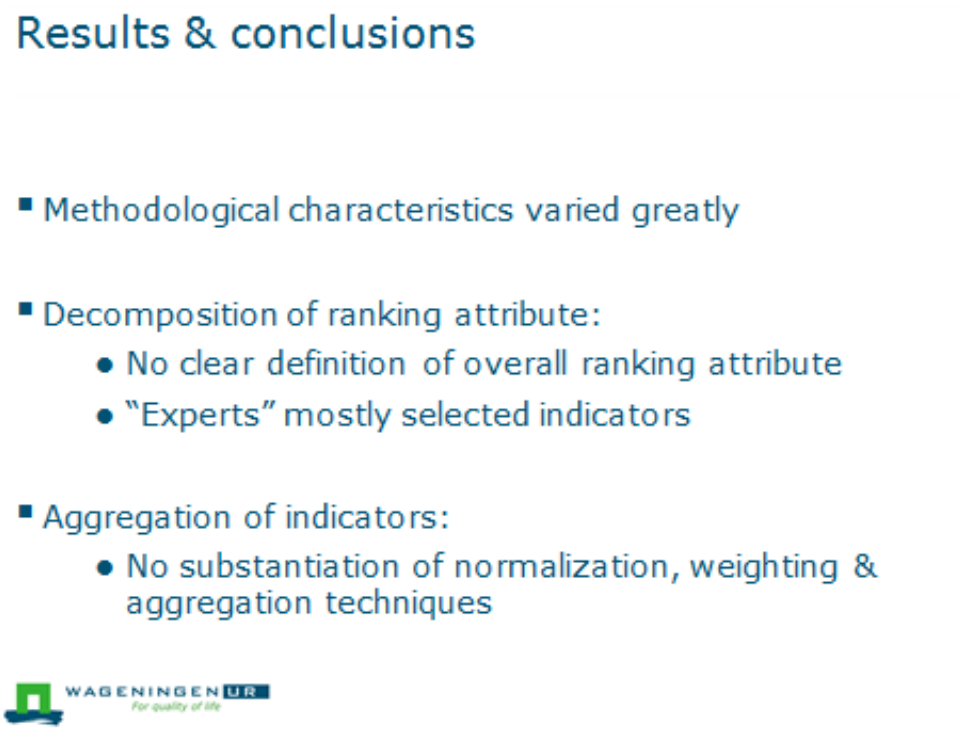
- We found out that the methodological characteristics varied greatly.
- This may explain why some cities had a rather high position in one ranking and a rather low position in another.
- What was found most surprising or shocking was that most of the city rankings did not provide a clear definition of the overall ranking attribute.
- This is troublesome since the overall ranking attribute forms the foundation of the entire ranking.
- But when there is no clear definition, on what are you actually trying to rank the cities?
- If this is not clear, then how can you decompose the ranking attribute into categories and select appropriate indicators?
- Most of the city rankings used "experts" to select indicators.
- Often, it was not clear how the experts were chosen, to what extent they were unbiased, and to what extent the selection of indicators by the experts followed a systematic procedure.
- Different city rankings used different techniques to combine the data on the individual indicators into one single rank number.
- However, the normalization, weighting, and aggregation techniques used, were hardly substantiated.

This is important, because as stated earlier, the techniques that are used can have a big effect on the final ranking outcome.



- Cities were mainly selected based on population size and geographical location.
- Other city characteristics were hardly used.
- Some research has been done into city typologies.
- Some researchers have categorized European cities into different city types based on various characteristics.
- These city typologies have not yet been used in city rankings, but may prove useful/promising.
- Different city rankings used different data sources.
- Of course, local city administrations were often used, but also NGO's and different kinds of "experts".
- Often not only quantitative, but also qualitative data were collected from data sources (e.g. policy plans)
- Of course, this qualitative data needs to be quantified and this was often done by "experts".
- Experts is a very broad term, it can refer to people working within the organization that developed the ranking or people working for NGO's.
- Regarding the reporting of results, none of the six city rankings provided all the necessary information on the methodology of their ranking.
- Some rankings provided more information than others.
- Some rankings did publish a separate methodological background document, but even in the document, there was missing information.
- In contrast, it was relatively easy to arrange interviews with the developers of the rankings.
- The developers of the rankings were willing to provide as much information as possible.
- Discussion of the ranking robustness was non-existent.

Results & conclusions

- Selection of cities:
  - Main criteria: population size, geographical location
- Data-collection:
  - Many different sources were used
  - Qualitative data evaluated by "experts"
- Reporting of results:
  - Little transparency methodological characteristics
  - No discussion of ranking robustness

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- Based on our research we formulated the following recommendations.
  - Clearly define the overall ranking attribute.
  - Make sure it is absolutely clear on what you actually want to rank your cities.
  - Based on this, substantiate the selection of indicators and the normalization, weighting, and aggregation procedure.
  - The Delphi method may provide opportunities here.
  - The Delphi method is a structured/systematic data-collection procedure in which experts are used to achieve a certain level of agreement on a given topic.
  - In the context of European green city rankings, the Delphi method could be used to let experts achieve agreement on the selection and maybe even the weighting of indicators.
  - This is something I want to investigate further in my next study.
  - As stated earlier, a ranking on an overall ranking attribute depends heavily on the normalization, weighting, and aggregation techniques used.
  - Maybe we should stop with combining data on various indicators into a single rank number.
  - Instead, it may be more useful to define the concept of urban environmental sustainability, select appropriate indicators, make sure we collect valid and reliable data on those indicators, and just report results on the indicator level.

- Last, but not least, developers of city rankings need to be transparent about their methodology.
- If they do report a ranking on an overall ranking attribute, it is at least clear how that ranking was developed.

Recommendations

- End-users of city rankings:
  - Look beyond the overall ranking
  - Evaluate the methodological characteristics of city rankings before acting on their results
- Developers of city rankings:
  - Clearly define the overall ranking attribute
  - Substantiate the selection of indicators and their aggregation (Delphi method)
  - Report results on overall and indicator level
  - Be transparent about ranking methodology

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Want to know more?

- Read our paper:
  - Meijering, J.V., Tobi, H., & Kern, K. (2014). Identifying the methodological characteristics of European green city rankings. *Ecological Indicators*, 43: 132-142, DOI: 10.1016/j.ecolind.2014.02.026
- Meet me during the workshop
- Contact me after the workshop
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X. Energy Efficiency Rating of Districts, Case Finland

Asa Hedman, VTT Technical Research Centre of Finland, Finland
(Asa Hedma 2014)

There is an increasing political pressure on city planning to create more energy efficient city plans. Not only does the city plan enables and promotes energy efficient solutions, but it also needs to be clearly assessed how energy efficient the plans are. City planners often have no or poor know-how about energy efficiency and building technologies, which makes it difficult for them to answer to this need without new guidelines and tools. An easy to use tool for the assessment of the energy efficiency of detailed city plans was developed. The aim of the tool is for city planners to easily be able to assess the energy efficiency of the proposed detailed city plan and to be able to compare the impacts of changes in the plan. The tool is designed to be used with no in-depth knowledge about energy or building technology. With a wide use of the tool, it is possible that many missed opportunities for improving energy efficiency in the city can be avoided. Furthermore, it will provide better opportunities for sustainable solutions leading to less harmful environmental impact and reduced CO_2 emissions.

Energy Efficiency Rating of Districts, case Finland

Asa Hedman
Senior Scientist (M.Sc. (Tech))
VTT Technical Research Centre of Finland

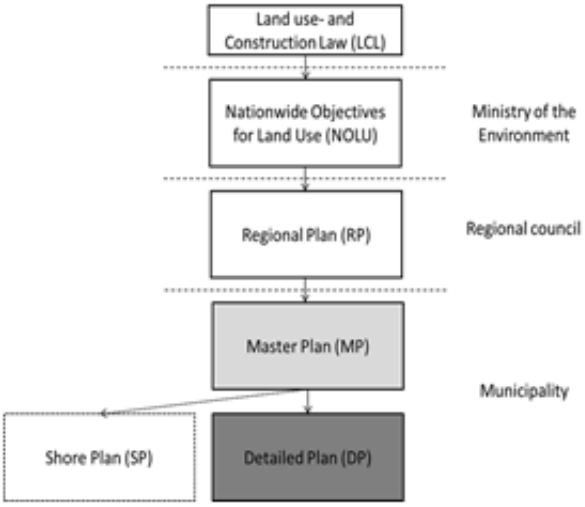
Content

- Background
- The energy efficiency rating tool
- Results from case studies
- Guidelines
- Conclusions

Background

- The development of energy efficiency rating system for districts was started in the project "Ekotaajama" (2010-2012)
- 5 Finnish cities were involved. (Jyväskylä, Toivakka, Multia, Petäjävesi, Jämsä and Kannonkoski)
- Funding: national funding agency Tekes + Sitra + Cities
- The focus was on smaller rural cities.
- Focus was on detaild city planning level
- A planning tool was developed
- Design guidelines were done
- Case analyses was done on 5 case districts

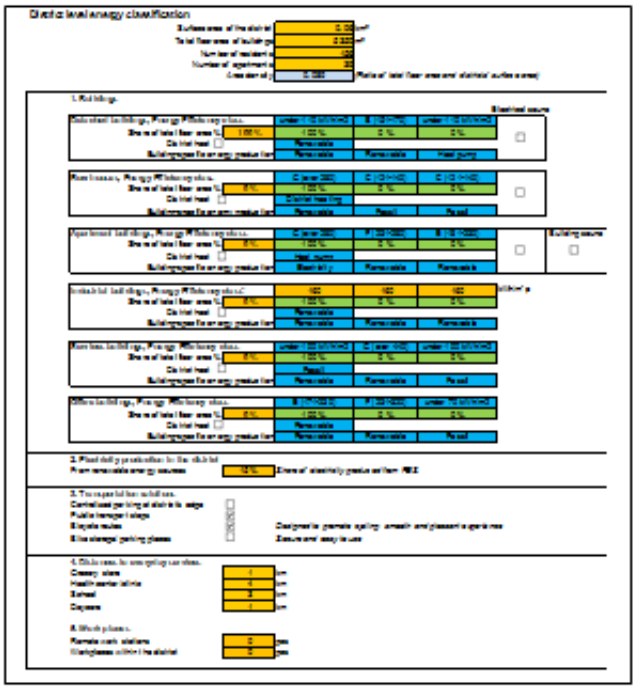
The city planning process in Finland



Finlex, 1999

About the tool

- Energy efficiency rating is based on primary energy consumption, in order to take into account both energy demand and used energy source.
- The tool is designed to compare different solutions within one district; therefore results comparing different districts are not comparable with each other.
- In order to get a good understanding about the expectations for the tool discussions were held with city planners from five case rural districts in Finland.
- Additional to these interviews the results from a questionnaire that was done for city planners was used.



District level energy classification

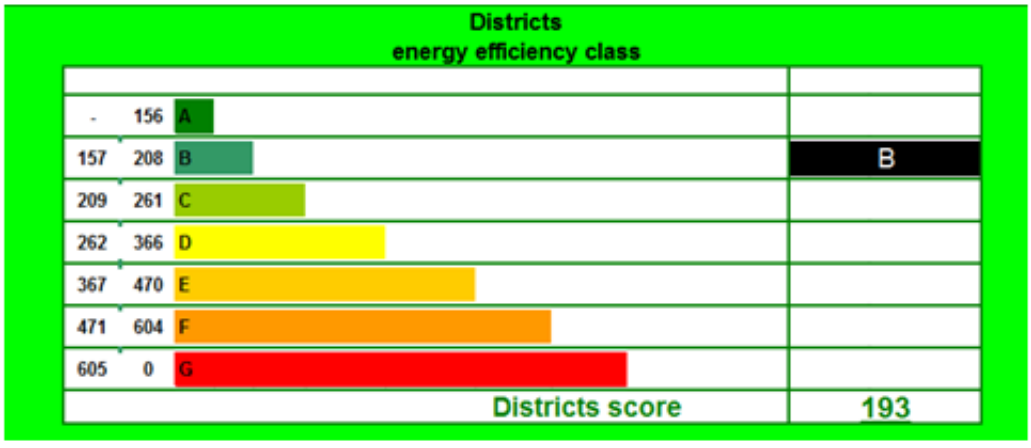
Surface area of the district	0.06	km²
Total floor area of buildings	5 350	m²
Number of residents	150	
Number of apartments	35	
Area density	0.089	*(Ratio of total floor area and districts' surface area)*

1. Buildings

					Electrical sauna
Detached buildings, Energy Efficiency class		under 110 kWh/m2	B (101-115)	under 110 kWh/m2	
Share of total floor area %	100 %	100 %	0 %	0 %	☐
District heat	☐	Renewable			
Building-specific energy production		Renewable	Renewable	Heat pump	
Row houses, Energy Efficiency class		C (over 260)	C (121-140)	C (121-140)	
Share of total floor area %	0 %	100 %	0 %	0 %	☐
District heat	☐	District heating			
Building-specific energy production		Renewable	Fossil	Fossil	
Apartment buildings, Energy Efficiency class		G (over 380)	F (251-280)	E (181-230)	Building sauna
Share of total floor area %	0 %	100 %	0 %	0 %	☐ ☐
District heat	☐	Heat pump			
Building-specific energy production		Electricity	Renewable	Renewable	
Industrial buildings, Energy Efficiency class*		160	160	160	kWh/m²/a
Share of total floor area %	0 %	100 %	0 %	0 %	
District heat	☐	Renewable			
Building-specific energy production*		Renewable	Renewable	Renewable	
Services buildings, Energy Efficiency class		under 100 kWh/m2	G (over 440)	under 100 kWh/m2	
Share of total floor area %	0 %	100 %	0 %	0 %	
District heat	☐	Fossil			
Building-specific energy production		Renewable	Renewable	Fossil	
Office buildings, Energy Efficiency class		E (171-230)	F (251-320)	under 70 kWh/m2	
Share of total floor area %	0 %	100 %	0 %	0 %	
District heat	☐	Renewable			
Building-specific energy production		Renewable	Renewable	Fossil	

2. Electricity production in the district		
From renewable energy sources	15 %	*Share of electricity produced from RES*
3. Transportation solutions		
Centralized parking at districts edge	☐	
Public transport stops	☑	
Bicycle routes	☑	*Designed to promote cycling: smooth and pleasant experience*
Bike storage/parking places	☐	*Secure and easy to use*
4. Distances to everyday services		
Grocery store	1 km	
Health center/clinic	4 km	
School	3 km	
Daycare	1 km	
5. Work places		
Remote work stations	0 pcs	
Workplaces within the district	0 pcs	

Results



E-number as a basis

- The Finnish E-number describing the total energy demand of the building was used as basis for the rating. It entails all energy use in building, including electricity, heating energy, and cooling energy demands.
- In addition, the energy source used is also taken into account in the E-number of the building by multiplying the energy demands with energy conversion factors of used energy sources.
- For some building types there is no E-number system, (industrial buildings, churches etc.). For these kinds of buildings, a classification value was given in the tool to give estimates what is "normal energy demand level" and "low energy demand level", which were based on the estimations provided by a Finnish construction element manufacturer [SP Elements, 2010]

Choosing heating energy system

- To ensure the simple usage of the rating tool, the heating energy source could be chosen from the following:
  - renewable energy systems
  - heat pumps
  - fossil fuels
  - electricity.

- Similar classification of used energy sources and their energy conversion factors are used in the Finnish building regulations from 2012
- For each building type, the user of the tool has the possibility to select three different heat production systems. This is convenient especially when larger districts are analysed and buildings might not have uniform heating systems.

	Energy conversion factor
Electricity	1,7
District heating	0,7
District cooling	0,4
Fossil energy sources	1
Renewable energy sources (including wood and other biofules)	0,5

For ground heat pumps an estimation of the yearly Coefficiency of Performance (COP) of 2.5 is used in the rating tool. This COP factor is set in the Finnish building regulations for the calculation of energy consumption of building, if better performance of heat pump cannot be proven.

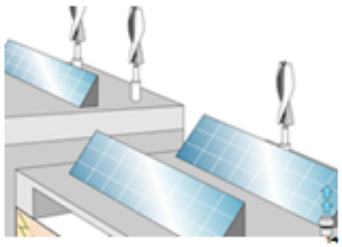
- heat distribution losses from the distribution network tend to decrease when the density of the built area increases. This is due to the increased energy consumption per distance of district heating network. This dependency was taken into account in the tool. The estimation of heat distribution losses was added to the total energy demand, if a district heating system was chosen as the used energy system in the tool.

Heat distribution losses relative to the density of the area (e_a)

e_a	
under 0.1	25.0 %
0.1-0.3	15.6 %
0.3-0.5	9.8 %
0.5-1.0	5.9 %
1.0-2.0	2.8 %
over 2.0	2.0 %

Renewable electricity

- An input value in the tool is the percentage value of how much of the district's electricity need is produced in the district from renewable energy sources.
- A guideline is needed for city planners to assess how much of the electricity need of a district can be covered locally in the district with different installations of photovoltaic panels or wind turbines. For getting actually realistic and accurate energy production potentials, simulations would be needed.



Transport

- Energy use caused by transport was considered only in regards to transport performances that can be influenced by the detailed city plan, which means that the focus was on the transport inside of the district. Studied solutions in the detailed plans are:
  - centralised parking in the outskirts of the district
  - bus stops
  - proper and separate ways for walking or bicycling and storage spaces for bicycles.
- The effect of the actions aiming to reduce the use of private cars was estimated on the basis of the modal split research results of city of Freiburg, Germany.
- The distance to daily services and the number of workplaces in the district influence the transport demand significantly and was taken into account in the tool.

	Share of trips made by car relative to distance		
	30 %	75 %	90 %
Grocery store	less than 0.9 km	0.9-1.5 km	over 1.5 km
Day-care	less than 0.9 km	0.9-1.5 km	over 1.5 km
School	less than 1.6 km	1.6-3 km	over 3 km
Health care centre	less than 0.9 km	0.9-1.5km	over 1.5 km

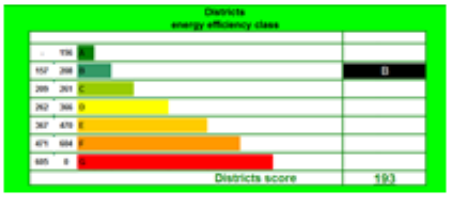
Energy efficiency rating points

- $\text{E-number} = \frac{\sum_i (E_{\text{cons},i} - E_{\text{prod},i}) f_i + E_{\text{trans}}}{A_{\text{net}}}$ (1)

- where i = Energy source
- E_{cons} = Energy consumption [kWh]
- E_{prod} = Energy production [kWh]
- f = Energy conversion factor
- E_{trans} = Energy consumption of transportation [kWh]
- A_{net} = Net floor area of the building [m^2]

The energy efficiency class

- The rating of the district is made based on a comparison between the performance of best and worst scenarios.
- The classification scale is similar to the building energy certificate in Finland. [Ministry of environment, 2012]
- By putting input values describing the best available solution in terms of energy efficiency we define this as the A-class, the worst case scenarios values gives us the G class. The classification is then linearly divided between these.



Case analyses

- 5 cases
- Assessed real planning alternatives
- In addition sensitivity analyses was done to show impacts of different decisions

Basic info	Säynätsalo	Kannonkoski	Jämsä	Petäjävesi	Toivakka
Districts total area [km2]	0,06	0,0466	0,616	0,66	0,05
Total floor area [m2]	5350	4004	39095	12650	2615
Numer of residents	156	156	150	200	85
Number of apartments	39	26	45	50	22
Density (floor area/total area)	0,09	0,09	0,06	0,02	0,05
Type and energ class of buildings					
One family houses [%, class]	80% A	100% C	70% A	100% A	100% A
Detached houses [%, class]	10% A				
High rise buildings [%, class]	10% A				
Industrial buildings [%, kWh/m2,a]			30% 160		
Electrical saunas in individual buildings?	yes	yes	yes	yes	yes
Heat transmission					
Local heat network	x		x		
No network, building specific heating systems		x		x	x

Basic info	Säynätsalo	Kannonkoski	Jämsä	Petäjävesi	Toivakka
Energy source					
Electrical heating				50 %	
Fossil fuel					
Renewable sources	100 %		100 %	50 %	50 %
Heat pumps		100 %			50 %
Renwable electricity	10 %	30 %	10 %	10 %	10 %
Transport					
Centralised parking	no	yes	no	no	no
Bus stops	yes	yes	yes	no	yes
Bicycle lanes	yes	yes	yes	no	yes
Parking place for bicycles	no	no	no	no	no
Distance to service					
Grocery store	3 km	10 km	1 km	5 km	1 km
Health service	5 km	10 km	1 km	5 km	1 km
School	3 km	10 km	1 km	3 km	1 km
Day care	3 km	10 km	1 km	3 km	1 km
Working places					
Remote points	0	0	0	0	0
Working places	0	0	20	0	0
Result					
Primary energy	199	263	164	230	200
Energy class	**B**	**D**	**C**	**C**	**B**

Detailed analyses in Säynätsalo

Energy system analysis in the Säynätsalo case district.

	Local heat network	Heat source	Renewable electricity production	Total primary energy need [kWh/m²]	Total rating
1	yes	Renewable	100 %	105	A
2	yes	Fossil	100 %	168	A
3	no	Fossil	100 %	143	A
4	no	Electricity	100 %	213	C
5	no	Renewable	100 %	93	A
6	no	Renewable	75 %	105	A
7	no	Renewable	50 %	117	A
8	no	Renewable	25 %	129	A
9	no	Renewable	0 %	142	A

Distribution losses of DH impact

Same end result with 100% fossils in heating as in electricity

Case Säynätsalo

	Building type	Buildings energy class	Heat source	Sauna?	Total primary energy need [kWh/m2]	Total rating
1	One family	A	Renewable	no	142	A
2	One family	B	Renewable	no	152	A
3	One family	A	Electricity	no	262	D
4	One family	B	Electricity	no	296	D
5	One family	A	Renewable	no	142	A
6	One family	A	Renewable	yes	153	A
7	High rise	A	Renewable	no	117	A

Impact of energy system

Impact of building type

Impact of saun (Peaks NOT considered!!)

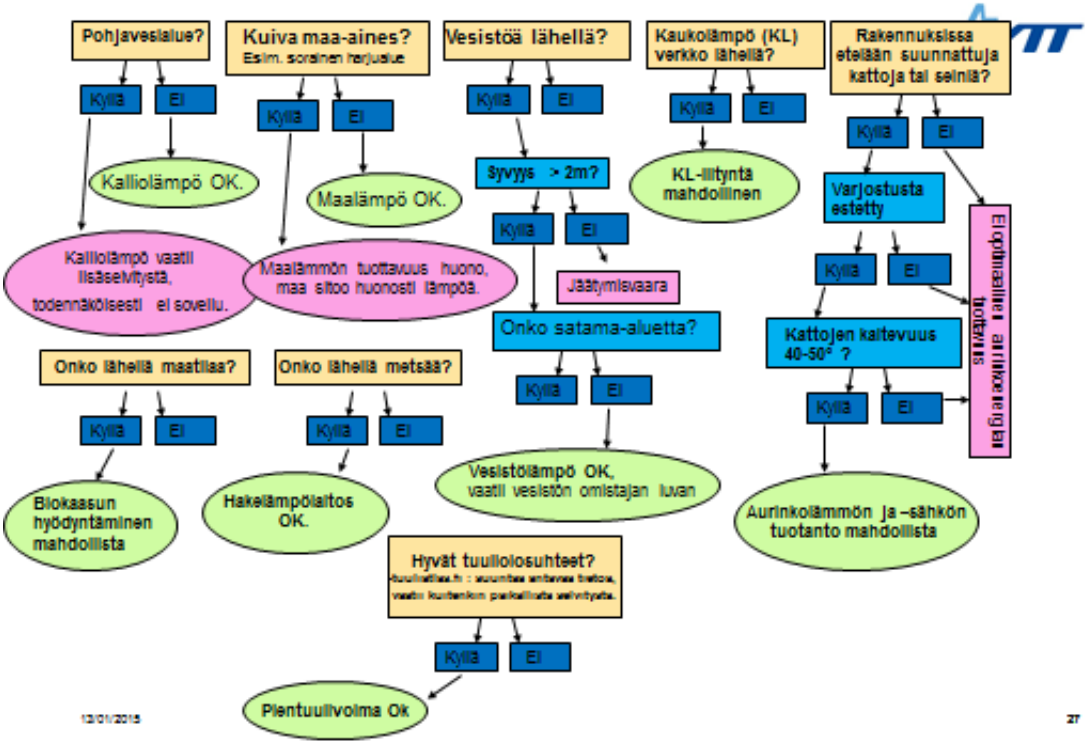
Transportation analyses

	Distance to daily services	Public transport and bicycle lanes in the plan	Working places	Total primary energy need [kWh/m2]	Total rating
1	0	yes	0	124	A
2	0	no	0	135	A
3	0	no	50	96	A
4	3 km	no	50	109	A
5	20 km	no	50	181	C
6	0	yes	50	93	A
7	20 km	no	0	219	C

Best and worst

Guidelines for city planners

- Guidelines were also done for city planners about how to increase energy efficiency.



Conclusions

- Tools and guidelines are needed
- Tool must be easy to use
- Rely on existing processess and assessments as much as possible (E-number in this case)
- Must be continuously developed
- Tools needed for the regional plan level, for assessing where to plan new residential areas.

XI. Benchmarking for Comparative Analysis of International Airports Based on a Sustainability Ranking Index

Şiir KILKIŞ, KTH Royal Institute of Technology, Sweden

Sustainable airports need to be assessed as an integral aspect of sustainable cities. This presentation provides a methodology for the sustainability ranking of select airports as a management tool to compare and analyze the actions of airports to be more sustainable.

In particular, the presentation benchmarks a sample of 8 airports that are among the busiest and best airports in the world, including Amsterdam Schiphol Airport, Atatürk International Airport, Barcelona El Prat Airport, Frankfurt Airport, London Gatwick Airport, London Heathrow Airport, Munich Airport, and Seoul Incheon International Airport. Such a sample of airports extends to 8 cities that are signatories to the Covenant of Mayors (CoM) or have districts that are signatories to the CoM. In this scope, all cities and/or districts to which the international airports in the sample give service have Sustainable Energy Action Plans (SEAPs). In contrast, airports have limited coverage in the scope of measures that are included in SEAPs.

The method of benchmarking airports is based on a composite indicator with 5 dimensions and 25 indicators. The dimensions are airport services, energy consumption, CO_2 emissions, environmental management (water quality, waste recycling) and biodiversity, atmosphere (air and noise pollution), and low emission transport. The values of the data collection are provided along with the details of the process of normalization and aggregation. The results indicate that a ranking of the airports are possible based on key sustainability indicators. Based on the result, the top three international airports in the sample are Frankfurt Airport, Amsterdam Schiphol Airport, and Munich Airport. A comparison with a counterpart index of the cities indicates that in some cases, the international airport has a better sustainability performance than the city that it serves. In this case, the airport can provide an important source of policy learning for the city.

The paper concludes with advice to partially offset the environmental impact of airports and the feasibility of doing so. It is expected that the comparative results of the paper will be useful for airport managers and policy makers in improving their strategies towards more sustainable airports and for a more sustainable aviation sector not only on the air but also on the ground. At the same time, policy makers should extend the scope of sustainable cities to sustainable airports.

Benchmarking for Comparative Analysis of International Airports Based on a Sustainability Ranking Index

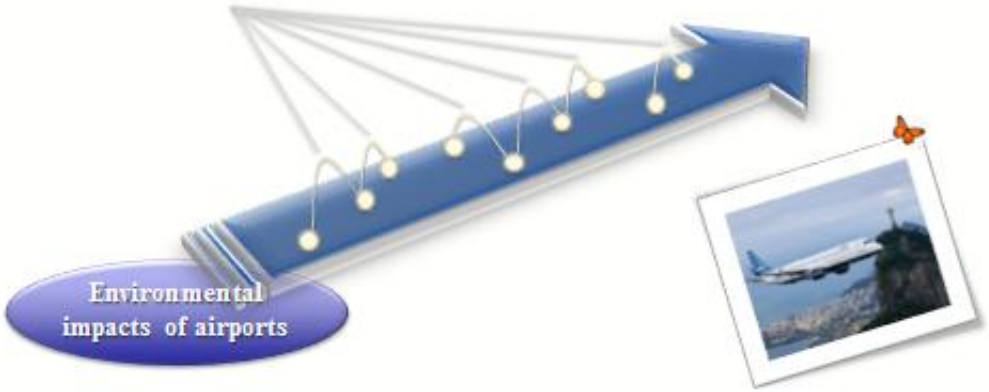
Şiir KILKIŞ, PhD
KTH Royal Institute of Technology

Şan KILKIŞ
Delft University of Technology (TUDelft)

Introduction

Research Objective:

To establish and apply a methodology to benchmark airports with features that may contribute to a more **sustainable aviation sector on the ground and sustainable cities**



Literature Review

Environmental impacts of individual airports	Aspects involving more than one airport	Comparative approach of airports
•Silvester et al. •Kılkış •Zietsman et al.	•Stettler et al. •Barrett et al. •Forsyth •Carvalho et al. •Gegg et al. •Kivits et al. •Solomon et al.	• Janić • Graham • ACI • Skytrax Contribution of the research

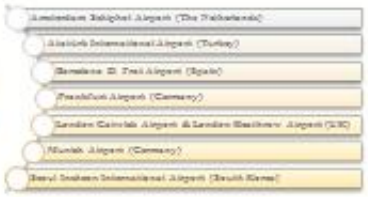
Need for a benchmarking methodology for sustainable airports

Index Methodology

Sustainability Ranking of Airports (SRA) Index

- **Index construction**
  - 5 dimensions, 25 indicators

- **Data sample**
  - 8 airports (among 40 busiest and best)



- **Data collection**
  - 8 airports x 5 dimensions x 5 indicators
- **Data analysis**
  - Application of the min-max method

Index Construction

Sustainability Ranking of Airports (SRA) Index

- **Index construction**
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  - Application of the min-max method

Index Construction

Dimension 1

$$D_1(P) = \alpha_1 (I_{1.1} + I_{1.2} + I_{1.3} + I_{1.4} + I_{1.5})$$

Index Construction

Dimension 2

$$D_2(P) = \alpha_2 (I_{2.1} + I_{2.2} + I_{2.3} + I_{2.4} + I_{2.5})$$

Index Construction

Dimension 3

$$D_3(P) = \alpha_3 (I_{3.1} + I_{3.2} + I_{3.3} + I_{3.4} + I_{3.5})$$

Index Construction

Dimension 4

$$D_4(P) = \alpha_4 (I_{4.1} + I_{4.2} + I_{4.3} + I_{4.4} + I_{4.5})$$

Index Construction

Dimension 5

$$D5(P) = \alpha 5\ (I5.1 + I5.2 + I5.3 + I5.4 + I5.5)$$

Data Sample

Sustainability Ranking of Airports (SRA) Index

- **Index construction**
  - 5 dimensions, 25 indicators
- **Data sample**
  - 8 airports (among 40 busiest and best)
- **Data collection**
  - 8 airports x 5 dimensions x 5 indicators
- **Data analysis**
  - Application of the min-max method

Data Sample

	Airport Code	ACI Busiest Airport Rank	Skytrax Best Airport Rank	Sustainability Reporting	Relevant Data Coverage				
					Energy	CO2 Emissions	Water	Waste	Air Quality
Beijing Capital International Airport	PEK	2	5	-					
Heathrow Airport	LHR	3	10	✓	✓	✓	✓	✓	✓
Tokyo International Airport	HND	4	9	-					
Dubai International Airport	DXB	7	33	-					
Hong Kong International Airport	HKG	11	6	✓					
Frankfurt Airport	FRA	12	11	✓	✓	✓	✓	✓	✓
Singapore Changi Airport	SIN	13	1	-					
Amsterdam Schiphol Airport	AMS	14	9	✓	✓	✓	✓	✓	✓
Denver International Airport	DEN	15	26	✓	✓				
Ataturk International Airport	IST	18	22	✓	✓	✓	✓	✓	✓
Kuala Lumpur International Airport	KUL	20	14	-					
San Francisco International Airport	SFO	22	60	-					
Seoul Incheon International Airport	ICN	25	2	✓	✓	✓	✓	✓	✓
Munich Airport	MUC	30	6	✓	✓	✓	✓	✓	✓
Sydney Airport	SYD	31	31	-					
London Gatwick Airport	LGW	37	25	✓	✓	✓	✓	✓	✓
Narita International Airport	NRT	38	16	-					
Barcelona El Prat Airport	BCN	39	39	✓	✓	✓	✓	✓	✓

Data Sample

Amsterdam ↔ Schiphol 21.9 km

İstanbul ↔ Atatürk 16.8 km

Data Sample

Barcelona ↔ El Prat 17.3 km

Frankfurt ↔ Airport 19.4 km

Data Sample

London ↔ Heathrow 17.7km

London ↔ Gatwick 32.2 km

Data Sample

Munich ↔ Airport 37.2 km

Seoul ↔ Airport 44.3 km

Data Collection

Dimension 1

- **Airport Services and Quality**
- Energy Consumption and Generation
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- Atmosphere and Low Emission Transport

International Airport	D1. Airport Services and Quality				
	ASQ Assurance	Best Airport Ranking	Number of Passengers	Passenger Traffic Growth	Revenue (m Euro)
Amsterdam (AMS)	1	3	52,569,250	3.0	1382.0
Atatürk (IST)	1	32	51,172,626	13.6	414.0
Barcelona (BCN)	1	2	35,210,735	0.2	1103.0
Frankfurt (FRA)	1	11	58,036,948	0.9	774.9
Gatwick (LGW)	1	35	35,448,590	3.6	-35.4
Heathrow (LHR)	1	10	72,368,030	3.3	270.1
Munich (MUC)	1	6	38,672,644	0.8	11868.8
Seoul (ICN)	2	2	41,679,758	6.5	556.4

Data Collection

Dimension 2

- Airport Services and Quality
- **Energy Consumption and Generation**
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- Atmosphere and Low Emission Transport

International Airport	D2. Energy Consumption and Generation				
	Energy Consumed (Tonnes)	Energy per Passenger (Tonnes)	ISO 50001 Certification	Energy-Saving Measures	On-Site Production
Amsterdam (AMS)	105,631.3	0.0020	2	4	3
Atatürk (IST)	62,856.5	0.0012	1	2	3
Barcelona (BCN)	72,920.8	0.0021	1	2	0
Frankfurt (FRA)	68,787.6	0.0012	1	5	3
Gatwick (LGW)	43,542.3	0.0012	1	7	0
Heathrow (LHR)	60,275.2	0.0008	1	2	2
Munich (MUC)	33,877.9	0.0009	1	2	3
Seoul (ICN)	86,318.0	0.0021	1	2	0

Data Collection

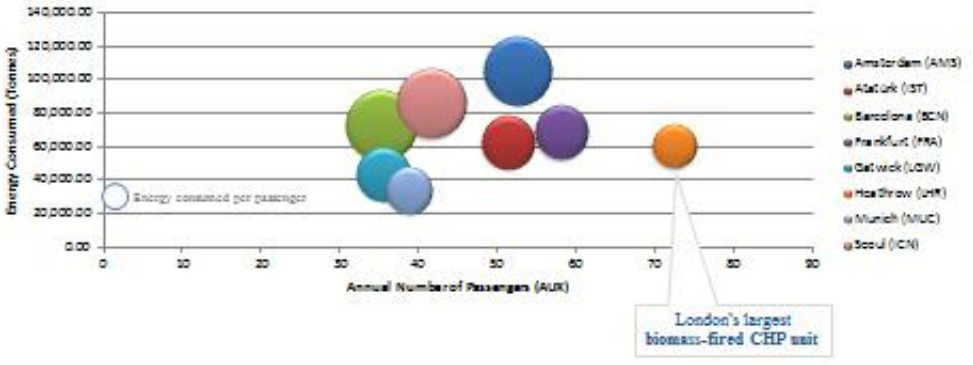
Dimension 2

- Airport Services and Quality
- **Energy Consumption and Generation**
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- Atmosphere and Low Emission Transport

	Classification of Energy Related Measures	AMS	IST	BCN	FRA	LGW	LHR	MUC	ICN
Savings	LED Lighting (1: Building Only; 2: Both Building and Runway)	1	1	1	1	2	1	1	1
	Efficient Electric Motors (Baggage system area, etc)				1	1			
	Energy Harvesting (Waste heat of steam motors, etc)	1			1	1			
	Building Certification (BREEAM, GreenV, LEED, etc)	1			1	1			
	Reducing Taxing Time (1: Base; 2: Optimization)	2	1	1	1	2	1	1	1
Production	Efficient On-Site Production (1: Natural Gas CHP; 2: Biomass CHP; 3: Trigeneration)	1	3		1		2	3	
	Pilot On-Site PV Panels (1: Planning stage; 2: Pilot implementation)	2			1				
	On-Site Hydrogen Fuel Cell				1				

Data Collection

Dimension 2



Data Collection

Dimension 3

- Airport Services and Quality
- Energy Consumption and Generation
- **CO_2 Emissions and Mitigation Planning**
- Environmental Management and Biodiversity
- Atmosphere and Low Emission Transport

International Airport	D3. CO_2 Emissions and Mitigation Planning				
	CO_2 Emissions (Tonnes)	CO_2 per Passenger (Tonnes)	CO_2 Emissions per Tonne Energy	ACA Level (1, 2, 3, 4)	CO_2 Neutrality Target
Amsterdam (AMS)	112,829.7	0.0021	1.0681	3	1
Atatürk (IST)	131,697.1	0.0026	1.7460	2	0
Barcelona (BCN)	90,617.8	0.0026	1.2427	1	0
Frankfurt (FRA)	250,000.0	0.0043	3.6344	3	1
Gatwick (LGW)	62,069.0	0.0018	1.4255	1	0
Heathrow (LHR)	284,000.0	0.0039	4.7117	3	1
Munich (MUC)	150,553.0	0.0039	4.4440	3	1
Seoul (ICN)	190,327.0	0.0046	2.2050	3	1

Data Collection

Dimension 4

- Airport Services and Quality
- Energy Consumption and Generation
- CO_2 Emissions and Mitigation Planning
- **Environmental Management and Biodiversity**
- Atmosphere and Low Emission Transport

International Airport	D4. Environmental Management and Biodiversity				
	Water Withdrawal (m^3)	ISO 14001 Certification	Waste Generated (Tonnes)	Percentage of Recycled Waste	Biodiversity (hectares)
Amsterdam (AMS)	841,108	1	15,570	35	0
Atatürk (IST)	818,762	1	4,350	18	0
Barcelona (BCN)	1,200,000	1	4,000	33	0
Frankfurt (FRA)	1,181,000	2	25,000	83	0
Gatwick (LGW)	754,599	1	8,803	40	125
Heathrow (LHR)	1,714,993	1	110,000	38	100
Munich (MUC)	803,876	2	16,513	38	4525
Seoul (ICN)	946,000	1	12,298	75	70

Data Collection

Dimension 5

- Airport Services and Quality
- Energy Consumption and Generation
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- **Atmosphere and Low Emission Transport**

International Airport	D5. Atmosphere and Low-Emission Transport				
	PM_{10} Matter ($\mu g/m^3$)	Abating Noise for dB(A) ≤ 60	Low-Emission Ground Vehicle	Share of Public Transport	Biofuels in Aviation
Amsterdam (AMS)	25.2	2	2	38.2	50
Atatürk (IST)	32.0	1	1	37.0	0
Barcelona (BCN)	16.0	1	1	34.0	0
Frankfurt (FRA)	19.0	2	4	41.0	25
Gatwick (LGW)	21.9	2	1	42.0	0
Heathrow (LHR)	40.0	2	3	33.0	0
Munich (MUC)	18.0	1	2	38.0	0
Seoul (ICN)	48.0	1	3	44.0	0

Data Collection

Dimension 5

- Airport Services and Quality
- Energy Consumption and Generation
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- **Atmosphere and Low Emission Transport**

	Classification of Vehicle Related Measures	AMS	IST	BCN	FRA	LGW	LHR	MUC	ICN
Savings	Usage of Biofuels in Airport Vehicles/Taxis	1					1	1	
	Usage of Hybrid Electric Vehicles (~ 10%)				1				
	Electric Vehicle - PV Garage Roof Integration				1				
	Hydrogen Fuel Cell Vehicles						1		1
	Magnetic Levitation Trains in Public Transport								1

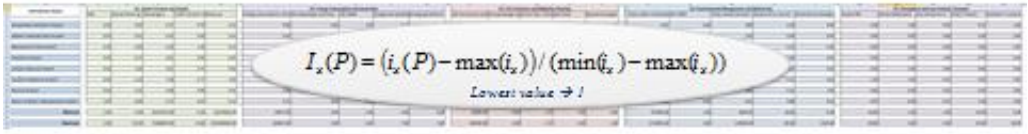
Data Analysis

Sustainability Ranking of Airports (SRA) Index

- Index construction
  - 5 dimensions, 25 indicators
- Data sample
  - 8 airports (among 40 busiest and best)

- Data collection
  - 8 airports x 5 dimensions x 6 indicators

- Data analysis
  - Application of the min-max method



$$I_z(P) = \left(i_z(P) - \max(i_z)\right) / \left(\min(i_z) - \max(i_z)\right)$$

Lowest value → 1

Data Analysis

Sustainability Ranking of Airports (SRA) Index

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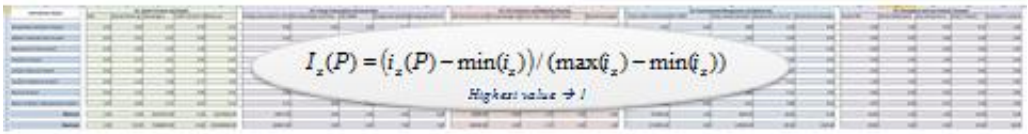
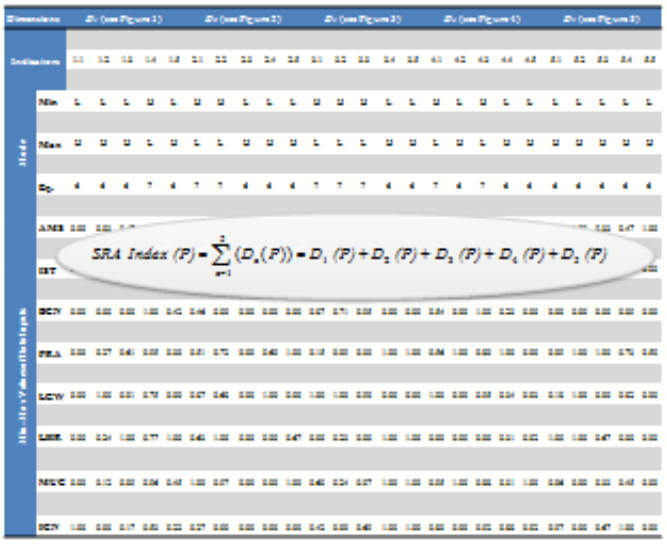


$$I_z(P) = \left(i_z(P) - \min(i_z)\right) / \left(\max(i_z) - \min(i_z)\right)$$

Highest value → 1

Data Analysis

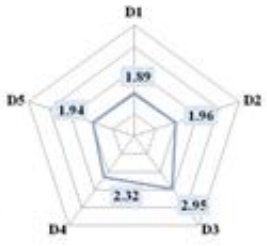
- Airport Services and Quality
- Energy Consumption and Generation
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- Atmosphere and Low Emission Transport



Results and Discussion

Average Values

- Airport Services and Quality
- Energy Consumption and Generation
- CO_2 Emissions and Mitigation Planning
- Environmental Management and Biodiversity
- Atmosphere and Low Emission Transport



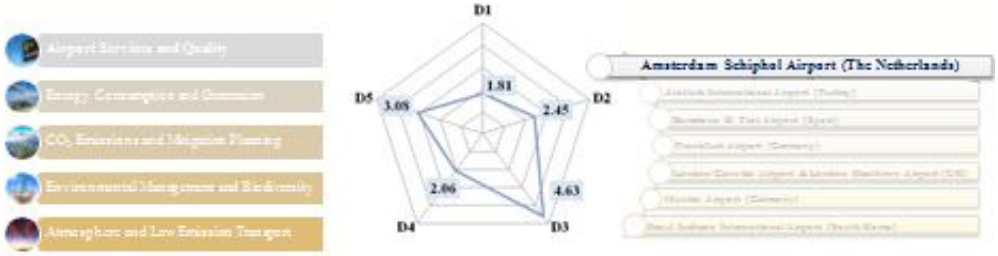
- Amsterdam Schiphol Airport (The Netherlands)
- Istanbul International Airport (Turkey)
- Barcelona El Prat Airport (Spain)
- Frankfurt Airport (Germany)
- London Gatwick Airport & London Heathrow Airport (UK)
- Munich Airport (Germany)
- Seoul Incheon International Airport (South Korea)

***SRA* (Average) = 2.21**

* Dimensions are equally weighted (0.2) before being summed.

Results and Discussion

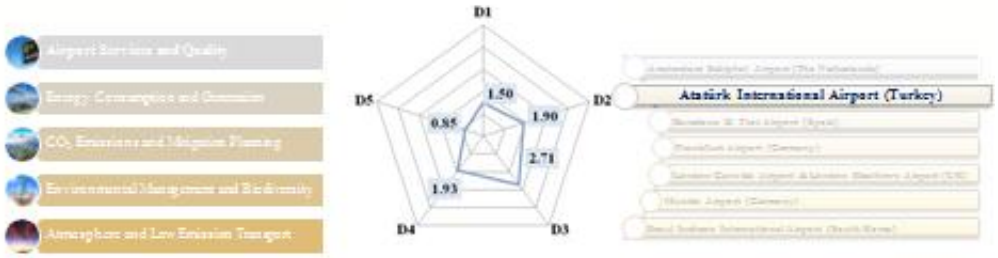
Amsterdam Schiphol Airport



***SRA* (AMS) = 2.81**

Results and Discussion

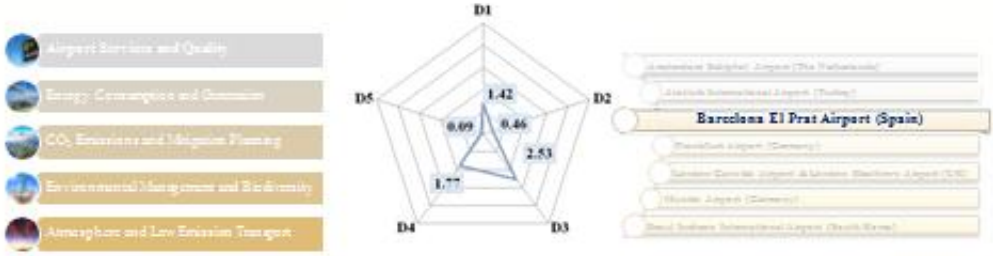
Atatürk International Airport



***SRA* (IST) = 1.78**

Results and Discussion

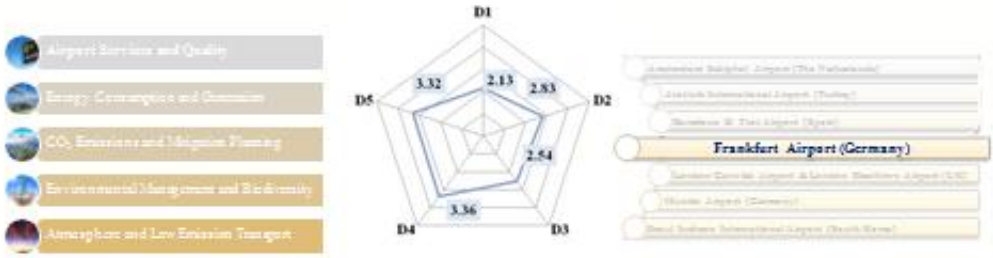
Barcelona El Prat Airport



SRA (BCL) = 1.25

Results and Discussion

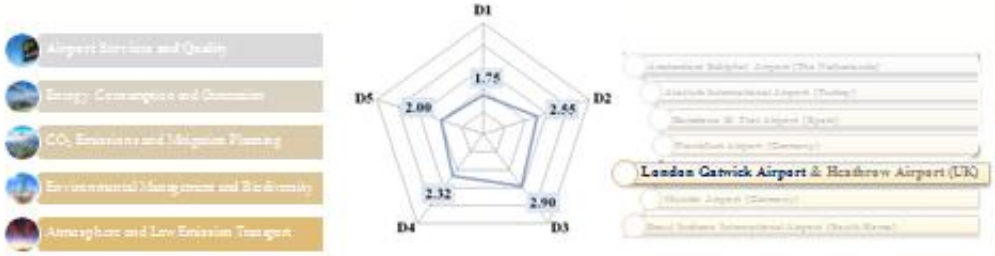
Frankfurt Airport



SRA (FRA) = 2.84

Results and Discussion

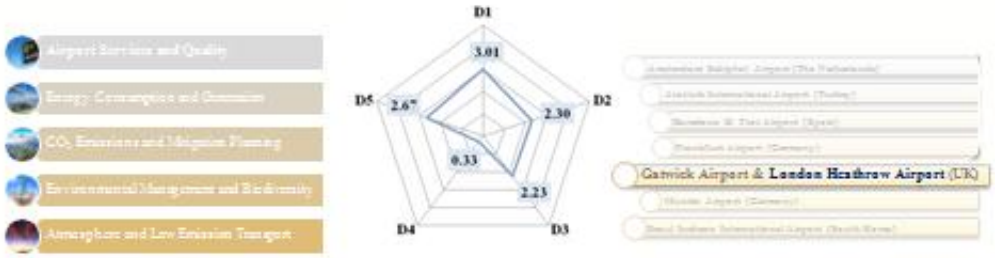
London Gatwick Airport



***SRA* (LGW) = 2.30**

Results and Discussion

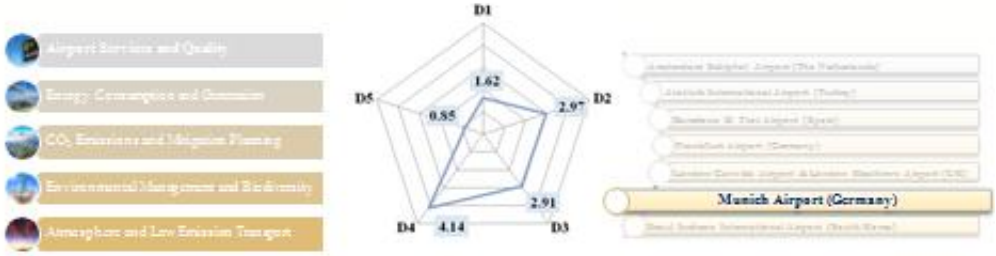
London Heathrow Airport



***SRA* (LHW) = 2.11**

Results and Discussion

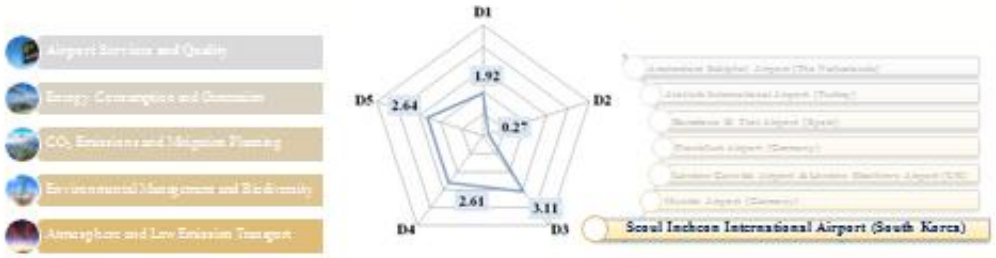
Munich Airport



***SRA* (MUN) = 2.50**

Results and Discussion

Seoul Incheon International Airport



***SRA* (ICN) = 2.11**

Results and Discussion

SRA Index Results

Rank	Airport	Score
1	FRA	2.84
2	AMS	2.81
3	MUC	2.50
4	LGW	2.30
5	ICN	2.11
6	LHR	2.11
7	IST	1.78
8	BCN	1.25

Best Practices Overview

Airport Services and Quality

- Not compromising from the quality of airport services when there is greater passenger traffic

Energy Consumption and Generation

- LED lighting in building armatures and the runway, efficient electric motors in baggage claim areas
- Natural gas or biomass based CHP, trigeneration, PV panels, and/or on-site hydrogen fuel cells
- Energy harvesting, such as the recovery of the waste heat in baggage claim areas, data centers, etc.

CO_2 Emissions and Mitigation Planning

- Reducing heating, cooling, and electricity loads of terminal and operational buildings
- Optimized measures to reduce taxiing time and continuous descent angle approaches
- AC-GPS devices to supply power to parked and/or taxiing aircraft

Environmental Management and Biodiversity

- Recycling cooking oil produced in the restaurants in the airport terminals for biofuel in apron vehicles
- Harvesting and treating precipitation on the runways for channeling back into groundwater reservoirs

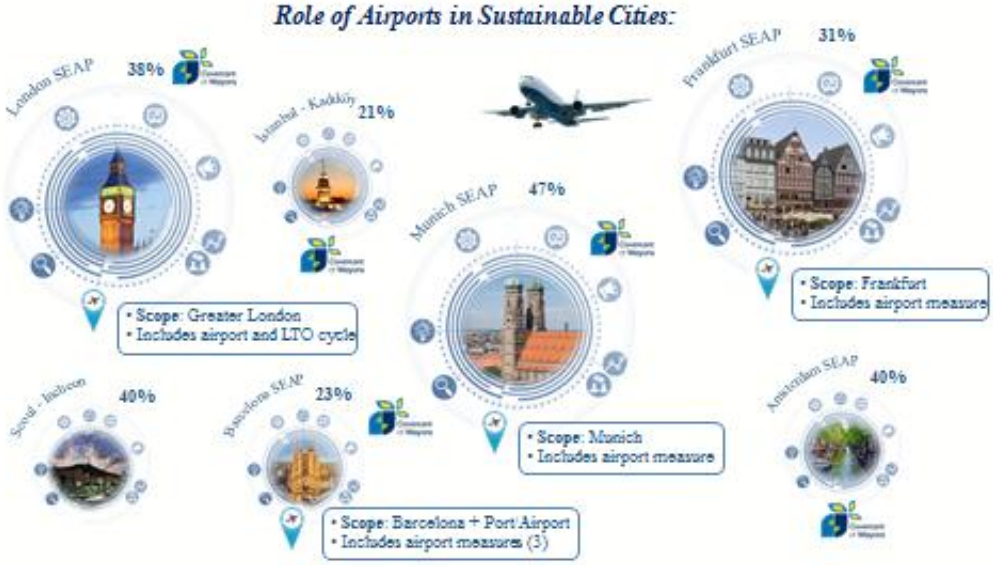
Atmosphere and Low Emission Transport

- Actively monitoring air quality (e.g. taking samples from the hives of airport honey bees)
- Taking measures to stay within noise abatement targets at dB(A) ≤60
- Low-emission ground (apron) vehicles and magnetic levitation trains

Airport – City Linkages

Airport – City Linkages

Role of Airports in Sustainable Cities:

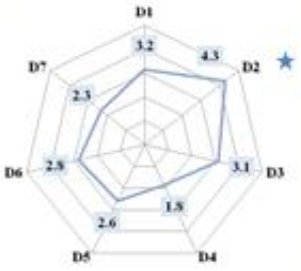


SDEWES* City Index

* Sustainable Development of Energy, Water and Environment Systems

Barcelona – Istanbul Comparison

Barcelona



Istanbul

***SDEWES* (Barcelona) = 2.87**

***SDEWES* (Istanbul) = 1.71**

Conclusions

- *Airports that may have top technology in one dimension (e.g. trigeneration technology), may not be the most sustainable airport*

- ***Well-rounded policy efforts across multiple dimensions** are needed to reduce the environmental impact of the best and busiest airports*
  - *Isolated projects that may bring valuable publicity are not sufficient for "lifting off" to a more sustainable aviation sector on the ground*

- *Airport managers and policy makers are encouraged to adopt a wide ranging view of sustainable airports, **including for sustainable cities***

Grazie!

Session 3 – Databases, Methodologies, and GIS based Tools for Benchmarking Energy Sustainability in Cities

XII. Multi-criteria Methodology for SEAPs

Maria F. Norese, Politecnico di Torino, Italy
(Giuliano Dall'O' 2013)

For municipalities that have joined the Covenant of Mayors promoted by the European Commission, the Sustainable Energy Action Plan (SEAP) represents a strategic tool for achieving the greenhouse gas reductions required by 2020. So far, as the energy retrofit actions in the residential building stock are concerned, which in the small-to-medium municipalities are responsible for more than 60% of CO_2 emissions, the scenarios for intervening are normally decided on the basis of an economic (cost/performance) analysis. This type of analysis, however, does not take into account important aspects for small and medium-sized communities, such as social aspects, environmental impacts, local economic development and employment. A more comprehensive and effective tool to support the choices of public administrators is the multi-criteria analysis. This study proposes a methodology that integrates multi-criteria analysis in order to support Public Administration/Local Authorities in programming Sustainable Energy Action Plans with a more targeted approach to sustainability. The methodology, based on the ELECTRE III method, has been applied to some medium-size municipalities in the Lombardy region of Italy. The results obtained with this approach have been considered interesting and could be improved using the municipalities as a reference for other municipalities in Italy.

A multi-criteria methodology for Sustainable Energy Action Plans

Maria Franca Norese, DIGEP - Politecnico di Torino

BEST - Politecnico di Milano

The decision context

Sustainable Energy Action Plan (SEAP) a strategic tool promoted by the European Commission for the municipalities with the aim of achieving the greenhouse gas reductions

SEAP should combines energy efficiency measures and technologies by taking a whole-building approach and a system perspective

Actions of energy retrofit are normally decided on the basis of an economic analysis that calculates the ratio cost/performance

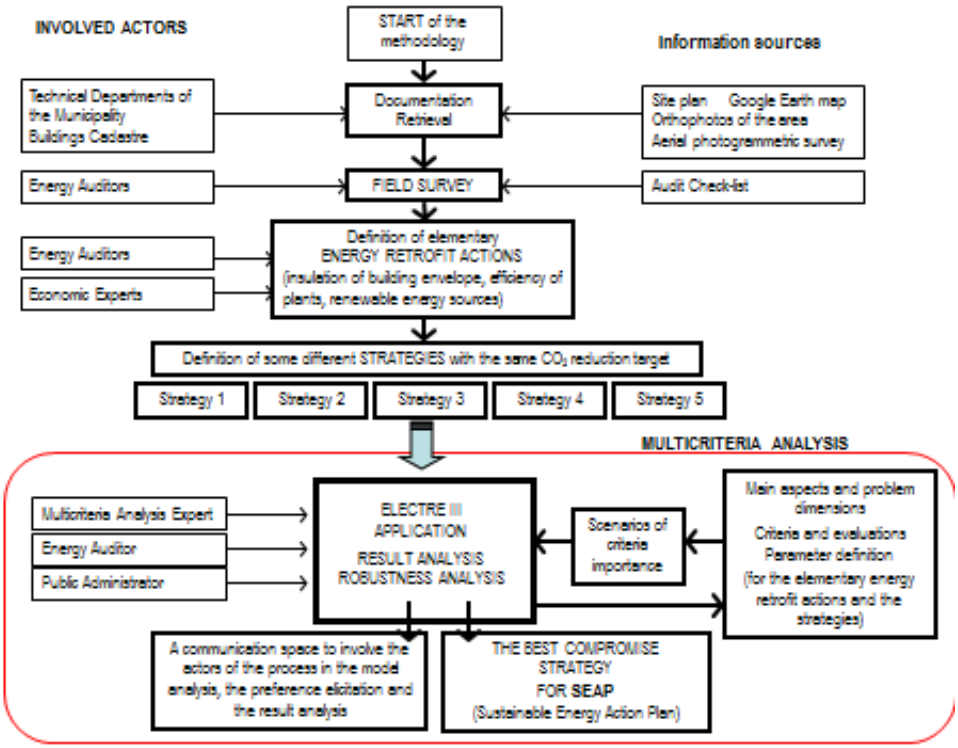
Social aspects, environmental impacts, local economic development and employment are not taken into account but they are important aspects for small and medium-sized communities

The decision aiding context

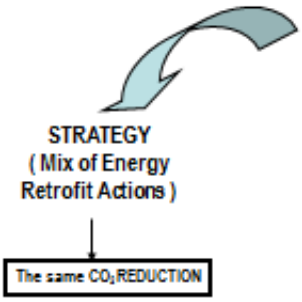
A multiple criteria model
socio-economical aspects, environmental impacts, technical opportunities and constraints

could support the public administrators in their planning action more comprehensively and effectively

The application of an MC method could orient their choices



The strategies



	Energy retrofit measures
a1	external wall thermal insulation
a2	roof thermal insulation
a3	windows replacement
a4	boiler replacement
a5	Thermostatic Radiator Valve (TRV) installation
a6	electric lighting replacement
a7	electric home appliances replacement
a8	solar thermal collector
a9	photovoltaic modules installation

Strategies	a1_easy	a1_pot	a2	a3	a4	a5	a6	a7	a8	a9	CO_2 eq [ton]
s1	80%	50%	73%	80%	50%	70%	70%	70%	3%	5%	11.060
s2	75%	45%	70%	75%	50%	70%	70%	70%	10%	13%	
s3	70%	40%	60%	70%	50%	70%	70%	70%	20%	26%	
s4	60%	30%	45%	60%	50%	70%	70%	70%	40%	49%	
s5	40%	15%	25%	40%	50%	70%	70%	70%	80%	82%	

The application of the methodology

The methodology was applied to two medium-size Municipalities in Italy near Milan (*Energies 2013, 6*) by means of an incremental approach

- **A collective result analysis at each step (clarification of the main concepts, control of the uncertainties, new modeling proposals)**
- **Technical scenarios of weight but also the acquisition of the DM preferences**
- **Robustness analysis in relation to the model variants (two structure variants, nine weight scenarios and several changes of parameters and evaluation scales)**

Structuring the MC model: the main problems

Dimensions	Criteria
Technological	Service life
	Maintenance
	In situ performance
Environmental	Embodied energy
	Renewable energy
	Waste production
Socio-economical	Local employment
	Family investment
	Architectonical impact

Consistency of the Technological dimension with the DM point of view?

Have to be included criteria that are important in the scientific field, but here do not discriminate the alternative strategies?

Dimensions	Criteria
Environmental	Embodied energy
	Renewable energy
	Waste production
	Architectonical impact
Socio-economical	Local employment
	Family investment
	Maintenance
	In situ performance

MC model, evaluations and parameters

Criteria
Service life
Maintenance
In situ performance
Embodied energy
Renewable energy
Waste production
Local employment
Family investment
Architectonical impact

Dimensions	Technological			Enviromental			Socio-Economical		
Criteria	A1	A2	A3	B1	B2	B3	C1	C2	C3
Unit (preference versus)	% (+)	€ (+)	% (+)	GJ (+)	MWh (+)	Ton (+)	Man-day (+)	€/fam (+)	Rank (+)
a1	8	448.492	3	144.138	1.145	2.314	441.015	19.903	1
a2	23	520.733	10	156.835	3.088	2.176	437.933	19.092	2
a3	46	630.825	20	176.842	6.176	2.033	433.635	18.269	3
a4	89	836.499	40	213.433	11.756	1.754	428.532	16.687	4
a5	162	1.165.921	80	266.317	20.331	1.288	417.413	13.679	5
q	-	50.000	-	10.000	2.000	200	1.500	200	-
s	20	100.000	10	20.000	5.000	500	3.000	500	-
v	130	600.000	-	-	-	1.000	-	6.000	5
weight 33-33-33	8.3	16.7	8.3	11.1	11.1	11.1	11.1	11.1	11.1

Strategy evaluations, thresholds of indifference (q), preference (s) and veto (v), scenarios of weights for dimensions and criteria (%).

Multicriteria Analysis: the outranking method ELECTRE III

The outranking relation is a preference relation based on the concordance-discordance principle. It consists in declaring that an action is at least as good as another if a "majority" of the criteria supports this assertion (concordance condition) and if the opposition of the other criteria do not generate "too strong" reasons (non-discordance condition)

$S = I \cup Q \cup P$

Indifference (I) Strict or net preference (P) Weak preference (Q)

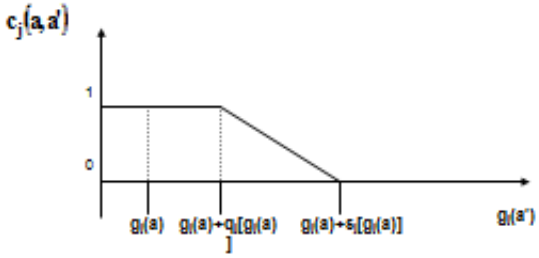
Incomparability (N)

Multicriteria model: actions $a_i \in A$, criteria $g_j \in J$ $\forall a_i \in A \Rightarrow g_j(a_i) \in E$ intercriteri parameters : relative importance coefficients (weights) $g_j \in J \Rightarrow p_j$ and thresholds of different nature

- (a, a') g_j (a) g_j (a') modeling of the outranking relation (phase I of the ELECTRE method)
- decision rule application, in relation to the decision problem statement (phase II)

Multicriteria Analysis: phase I of ELECTRE III

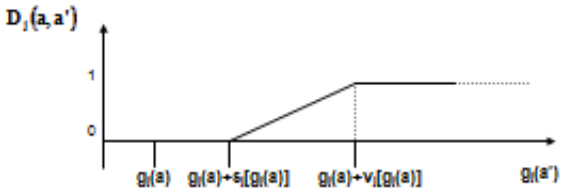
Marginal index of concordance



Concordance index

$C(a,a') = \Sigma\, p_j\, c_j(a,a')$

Marginal index of discordance



Index of outranking credibility

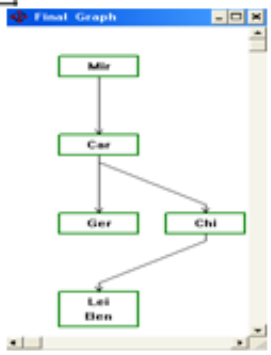
$\delta(a,a') = C(a,a') \prod [1-D_j(a,a') / 1-C(a,a')]$

Multicriteria Analysis: the phase II of ELECTRE III

$\sigma(a, a')$	a_1	a_2	a_3	a_4	a_5	a_6
a_1	-	0,82	0,75	0,52	0,56	0,43
a_2	0,40	-	0,74	0,83	0,45	0,50
a_3	0,50	0,44	-	0,60	0,22	0,24
a_4	0,74	0,46	0,72	-	0,20	0,14
a_5	0,83	0,90	0,73	0,76	-	0,55
a_6	0,65	0,74	1	0,90	0,77	-

Descending Distillation

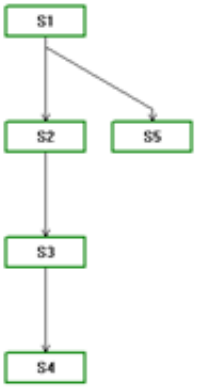
Ascending Distillation



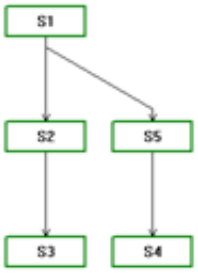
First model: results in relation to five weight scenarios (different importance of the Technological, Environmental and Socio-Economical dimensions)

T/E/SE: 33-33-33

T/E/SE: 44-28-28

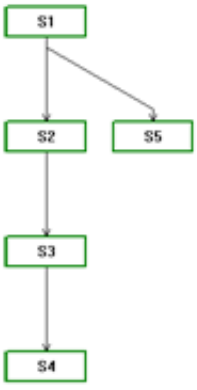


T/E/SE: 28-45-27

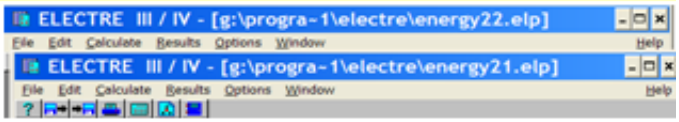


T/E/SE: 28-27-45

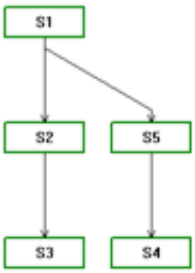
T/E/SE Melzi: 28-27-45



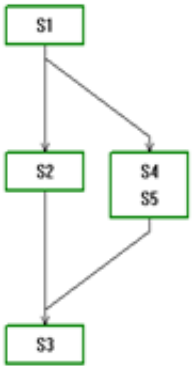
Second model: results in relation to four scenarios (different importance of the Environmental and the Socio-Economical dimensions)



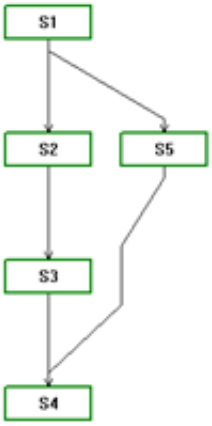
E/SE: 50-50



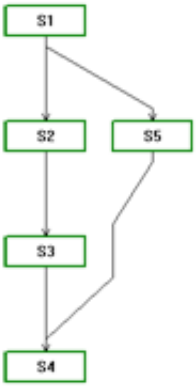
E/SE: 60-40



E/SE: 42-58



E/SE Melzi: 35-65



XIII. Planning Model for Environmental Data in the Province of Venice

Romano Selva, e-ambiente, Italy

Benchmarking Energy Sustainability in Cities

Planning model environmental data in Province of Venice

Romano Selva
Turin, November, 25th 2014

eAmbiente
eEnergia

SEAP: AN «OLISTIC» MECHANISM

Coordination:
- With the province
- Vision
- Training

Municipal
- Official adhesion
- Strategy
- Planning

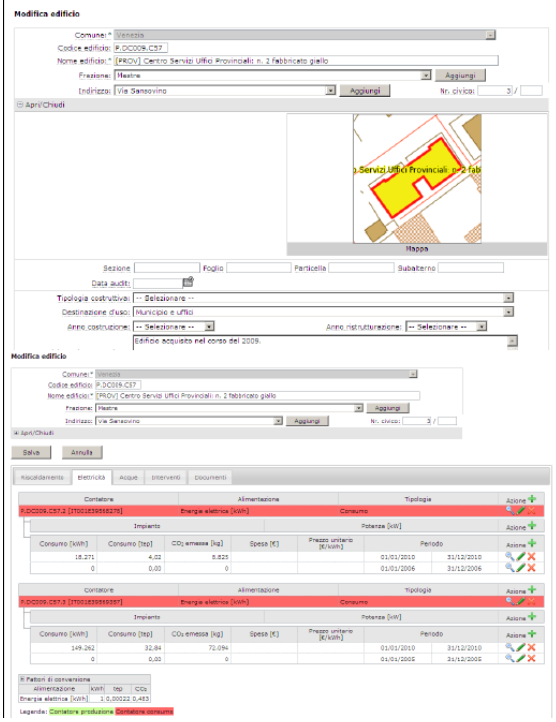
Operative office, which work toghether with citizens

29 NOVEMBER 2012: OFFICIAL SIGN AT CA' CORNER

22 Municipalities of Venice Province which signed the ELENA project

1. CAMPONOGARA
2. CAORLE
3. CEGGIA
4. CINTO CAOMAGGIORE
5. DOLO
6. FOSSALTA DI PIAVE
7. FOSSALTA DI PORTOGRUARO
8. GRUARO
9. MARTELLAGO
10. MIRA
11. MUSILE DI PIAVE
12. NOALE
13. NOVENTA DI PIAVE
14. PORTOGRUARO
15. SALZANO
16. SAN DONÀ DI PIAVE
17. SAN MICHELE AL TAGLIAMENTO
18. SANTO STINO DI LIVENZA
19. SPINEA
20. TORRE DI MOSTO
21. VENEZIA
22. VIGONOVO

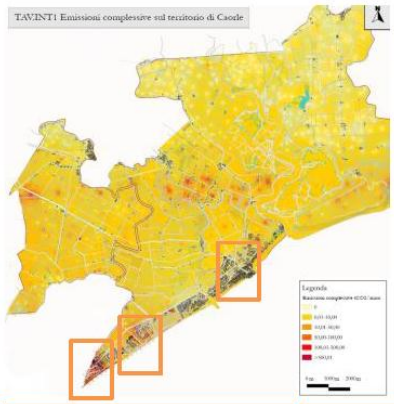
GIS APPLICATION FOR ENERGY INTESITY IN THE TERRITORY



For each building it is possible to collect (and divide into layers):

- Position
- Constructive technique
- List of intervention
- **Energy demand history**

ENERGY PLANNING: RESEARCH AND INNOVATION

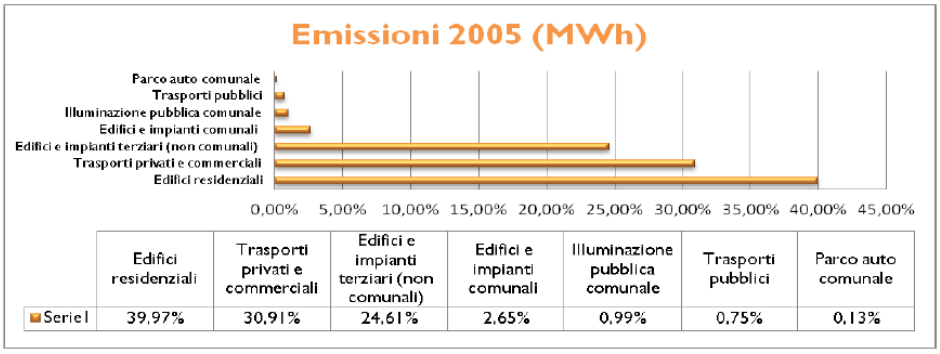


Planning with a specific focus on energy issues means:

-Highlight specific energy demand area
-Avoid grid powerlock
-Reaching of a good energy balance between distributed energy production and distributed energy demand

Source: Energia e territorio: la variabile energetica nella pianificazione territoriale di Caorle
Lisa Macor

M.VENEZIA
AZIONI PER L'AMBIENTE

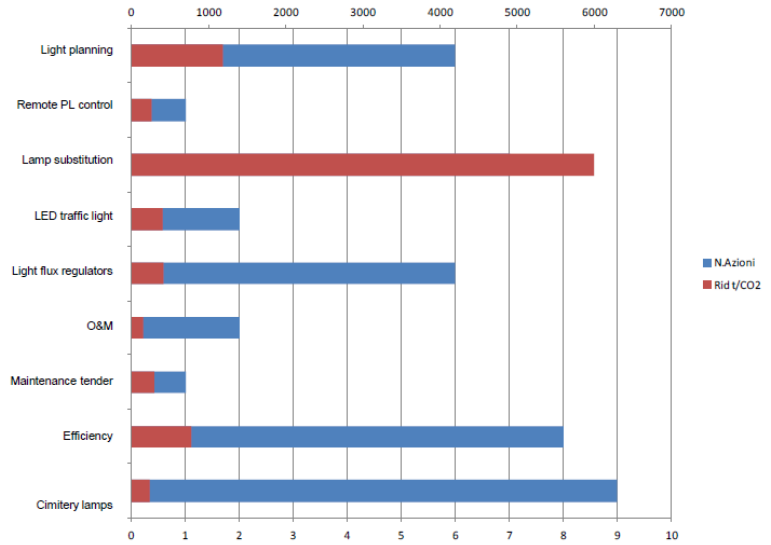


	Edifici residenziali	Trasporti privati e commerciali	Edifici e impianti terziari (non comunali)	Edifici e impianti comunali	Illuminazione pubblica comunale	Trasporti pubblici	Parco auto comunale
Serie1	39,97%	30,91%	24,61%	2,65%	0,99%	0,75%	0,13%

- **Private buildings: 39,97%**
- **transport: 30,91%**
- **Commercial and turist: 24,61%**

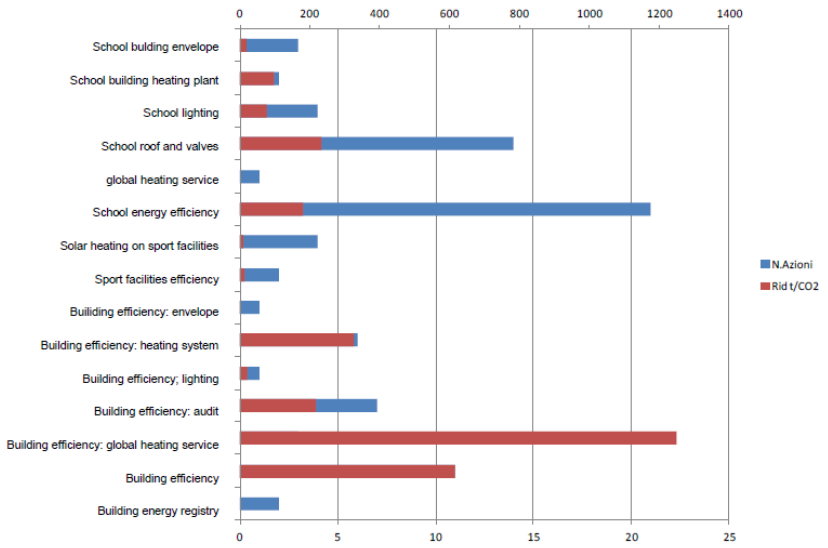
Source: Comune di Caorle, energy bills, Provincia di Venezia

PUBLIC LIGHTING



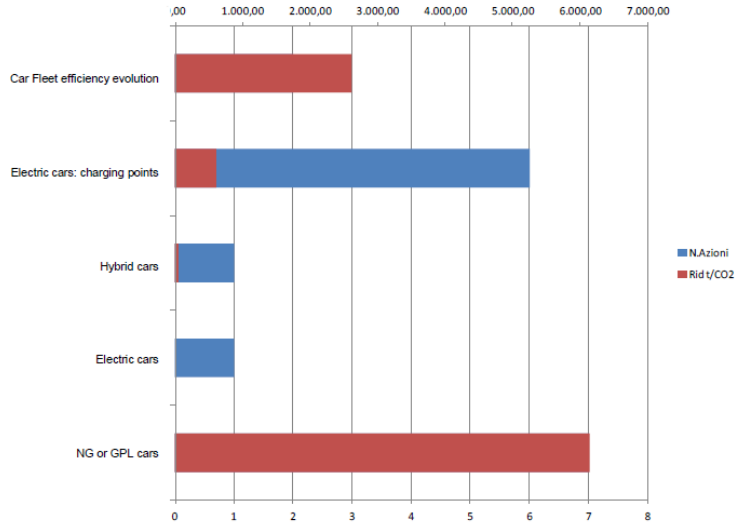
Numb. Of actions	GHG reduction t/CO2
42	9.706,30

PUBLIC BUILDINGS



Numb. Of actions	GHG reduction t/CO2
82	3.062,30

Transport: private and public



Numb. Of actions	GHG reduction t/CO2
17	9.419,79

PLANNING

Numb. Of actions	GHG reduction t/CO2
18	11.413,77

FROM ANALYSIS TO ACTION: «ELENA» PROJECT IN VENICE PROVINCE

Elena mechanism "European Local ENergy Assistance" **give technical support to local public bodies in order to boost investments in sustainable energy**

Each project shall cover a minimum investment of 30 M€

Support on project development with:

- Technician expertises
- Feasibilities studies
- Tender
- Financial structure

INVESTMENT SECTOR

- **Investment on public buildings, social housing and public lighting**
- **Urban transport**, in order to support energy efficiency and renewable fuels
- **Local energy infrastructure,** in order to support smart grid, ICT, etc

ELENA: THE PROJECT IN THE PROVINCE OF VENICE

MUNICIPALITY - COMUNE		BUILDINGS	PUBLIC LIGHTING	ENERGY, GRIDS
CAMPOLONGO MAGGIORE		-	-	1.300.000
CAMPONOGARA		591.000	-	-
CAORLE		456.806	-	-
CHIOGGIA		4.625.520	-	-
CONCORDIA SAGITTARIA		-	337.600	-
DOLO		-	1.897.700	-
ERACLEA		96.404	705.000	-
FIESSO D'ARTICO		435.000	100.000	-
FOSSALTA DI PIAVE		555.000	500.000	1.000.000
FOSSALTA DI PORTOGRUARO		439.200	200.000	-
FOSSÒ		176.000	550.000	770.000
JESOLO		2.037.300	395.400	-
MIRANO		2.290.728	1.670.180	-
MUSILE DI PIAVE		145.000	1.476.688	-
NOALE		237.700	-	-
NOVENTA DI PIAVE		65.000	104.103	-
PORTOGRUARO		-	1.808.809	-
SAN DONÀ DI PIAVE		2.172.800	5.037.070	-
SANTA MARIA DI SALA		3.125.570	1.910.000	-
SANTO STINO DI LIVENZA		-	386.100	-
SPINEA		250.000	212.170	-
TORRE DI MOSTO		830.000	720.000	-
VIGONOVO		1.027.550	-	-
COMUNI		19.556.578	18.010.819	3.070.000
PROVINCIA		2.717.100	3.700.000	-
TOTAL		22.273.678	21.710.819	3.070.000
TOTAL INVESTM.	**47.054.497**	**127 edifici pubblici**	**27.771 punti luce**	**4 reti di teleriscaldamento**

202020 PROVINCIA DI VENEZIA
AZIONI PER L'AMBIENTE

ELENA: THE PROJECT IN THE PROVINCE OF VENICE; FOCUS ON PUBLIC LIGHTING

MUNICIPALITY - COMUNE									€/MWh
	202020	TECHNICAL DATA - DATI TECNICI							230,0
	CoM adhesion (group) Patto dei Sindaci (gruppo)	Lamps to n° be replaced Lampade n° sostituz.	Investment	Foreseen savings (€) Risparmio previsto (€)	Simple pay back (only energy reduction)	White certificates TEE (€)	Energy cost savings (€)	Materials supply cost savings (10%) (€)	Pay back (subsidies + energy reduction)
CINTO CAOMAGGIORE	1	555	344.628	49.951	6,9	28.176	21.606	34.463	5,2
CONCORDIA SAGITTARIA	2	343	205.450	21.606	9,5	17.311	3.601	20.545	7,6
DOLO	1	2.713	1.762.150	154.592	11,4	137.629	25.765	176.215	9,2
ERACLEA	2	1.406	705.000	131.649	5,4	59.651	19.747	70.500	4,2
FIESSO D'ARTICO	2	-	100.000	24.624	4,1	-	4.104	10.000	3,5
FOSSALTA DI PIAVE	1	511	390.000	33.852	11,5	25.942	5.642	39.000	9,4
FOSSALTA DI PORTOGRUARO	1	200	195.000	18.533	10,5	10.153	3.089	19.500	8,8
FOSSÒ	2	600	440.000	38.580	11,4	30.460	6.430	44.000	9,3
JESOLO	/	5.847	2.433.400	195.360	12,5	296.833	32.560	243.340	9,5
MIRANO	2	3.500	1.369.000	126.000	10,9	177.684	21.000	136.900	8,2
MUSILE DI PIAVE	1	1.530	983.450	85.313	11,5	77.673	14.219	98.345	9,3
NOALE	1								
NOVENTA DI PIAVE	1	195	104.103	9.270	11,2	9.900	1.545	10.410	8,9
PORTOGRUARO	1	2.544	1.808.809	172.441	10,5	129.151	28.740	180.881	8,5
SAN DONÀ DI PIAVE	1	8.393	5.037.070	515.698	9,8	425.984	85.943	503.707	7,8
SANTA MARIA DI SALA	2	2.800	1.820.000	165.581	11,0	142.147	27.597	182.000	8,9
SANTO STINO DI LIVENZA	1	932	386.100	47.979	8,0	47.315	8.276	38.610	6,1
SPINEA	1	251	212.170	17.590	12,1	12.742	10.612	21.217	9,5
TORRE DI MOSTO	1	1.200	780.000	69.696	11,2	60.920	11.616	78.000	9,0
VIGONOVO	1		-						
PROVINCIA	/	3.281	2.286.014,5	252.908,0	9,0	166.565,8	42.151,3	228.601,5	7,3
TOTAL		**33.514**	**21.362.343,7**					**AVG**	**7,9**

202020 PROVINCIA DI VENEZIA
AZIONI PER L'AMBIENTE

CITTÀ SOSTENIBILE

La via italiana alle Smart City

"Cittàà Sostenibile" is a project by Rimini Fiera which developed within the platform Ecomondo from 2009 and occupying an exhibition area of 6000 square meters, within which takes form an ideal model of Sustainable City.



This project 2014 aims to showcase solutions, technologies and projects that improve the quality of life of citizens and enhance the development of the territories in a sustainable.

Is establishing a model of "urban sprawl". A city that expands physically and functionally the territory, integrating with other local systems and urban in a new settlement system, widespread but highly interconnected.




CITTÀ SOSTENIBILE 2014

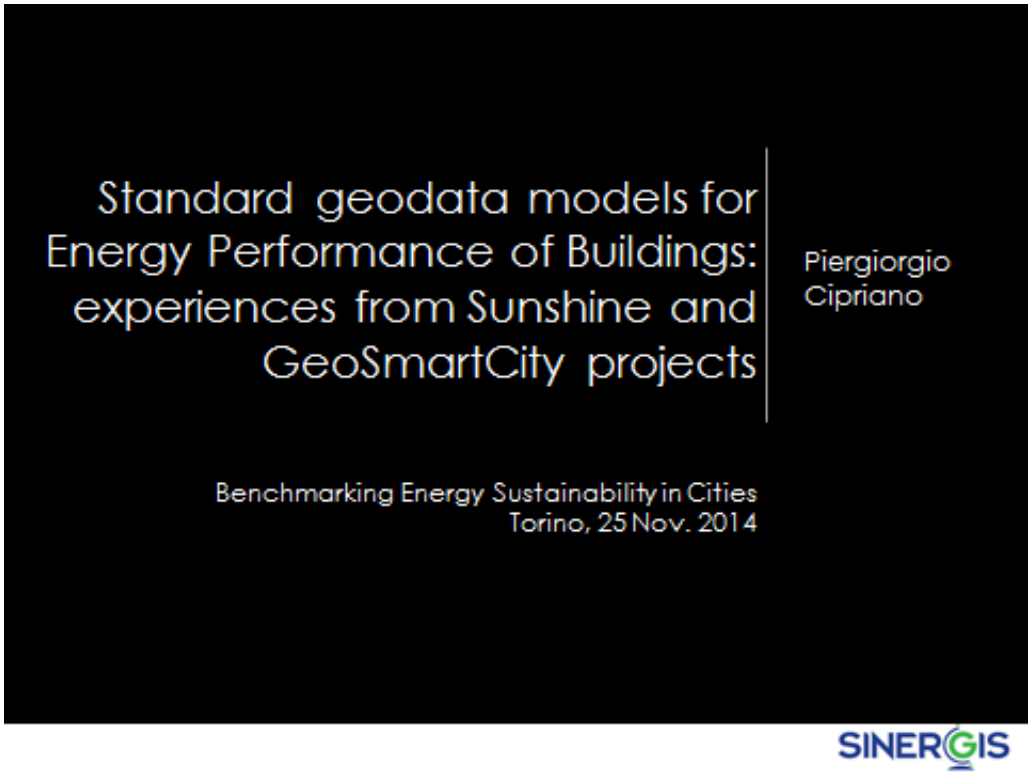
LA CITTÀ DELLE RETI INTELLIGENTI

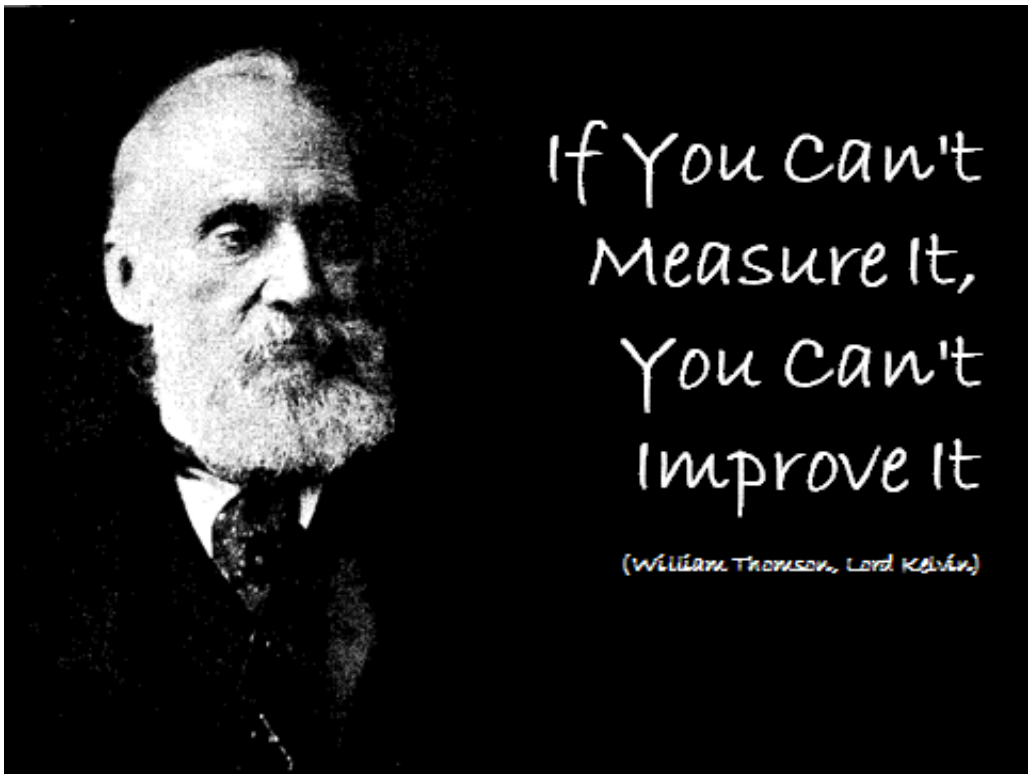
sito web: www.cittasostenibile.net
e-mail: info@cittasostenibile.net
facebook: SustainableCity.Ecomondo
twitter: Citta_Sostenib
linkedIN: Città_Sostenibile

202020 PROVINCIA DI VENEZIA AZIONI PER L'AMBIENTE

XIV. Standard Geodata Models for Energy Performance of Buildings: Experiences from Sunshine and GeoSmartCity projects

Piergiorgio Cipriano, Sinergis, Italy

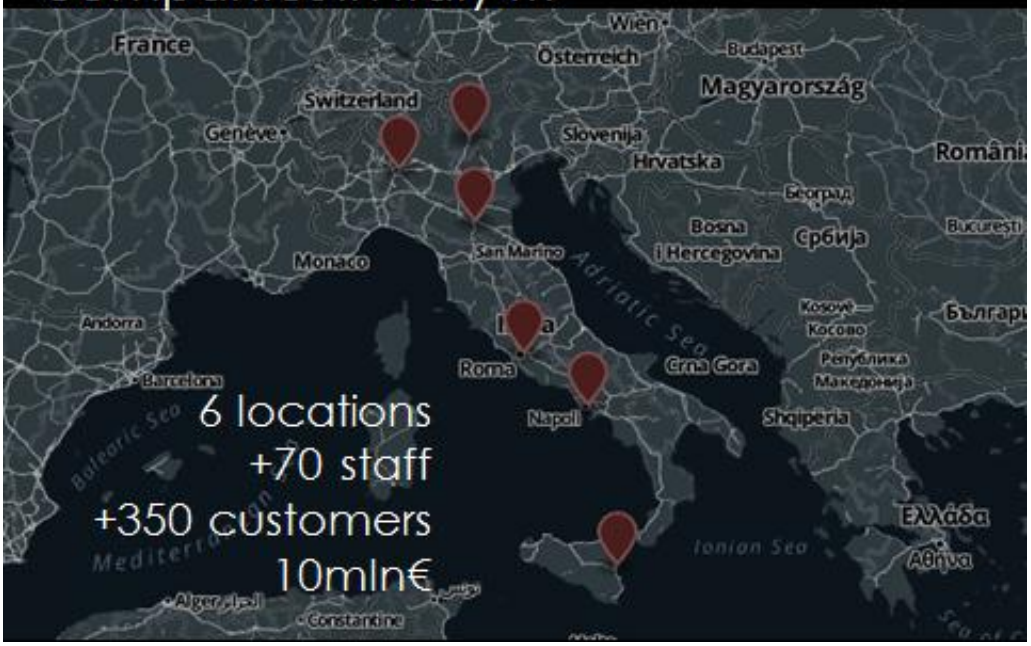




From Z to A

maps are easier to read than numbers and text

Sinergis is one of the major Geo-ICT companies in Italy …



SUNSHINE

www.sunshineproject.eu

smart urban services based on open standards to support energy efficiency of buildings

Pilot cities:

Ferrara, Trento, Cles (IT), Paola (MT), Zagreb (HR), Lamia (GR)

Partners:
Fondazione Graphitech (coor), GStandards, Sinergis, Cadzow Communication Cons., Grafica Light, Informatica Trentina, Egsian International, Fundacion Esade, Trentino Network, HEP ESCO, Meteogrid, Urbasofia, Urbanistcni Institute, GeoSYS, SET

GeoSmartCity

www.geosmartcity.eu

open data hub for data distribution on "energy", based on INSPIRE Directive

Pilots cities:

Reggio Emilia, (IT) Girona (ES), Oeiras (PT), Maroussi (GR), Turku (FI)

Partners:
GISIG (coor), Sinergis, Intergraph, Asplan Viak Internet, Egsian Italia, Tracasa, Comune di Genova, Ticass, TUAS, VMM, Geobid, Universitat de Girona, Comune di Reggio Emilia, Municipia

One goal is to improve this kind of maps:

http://energielabelatlas.nl/#zuid-holland/delft/17/52.0122/4.3612

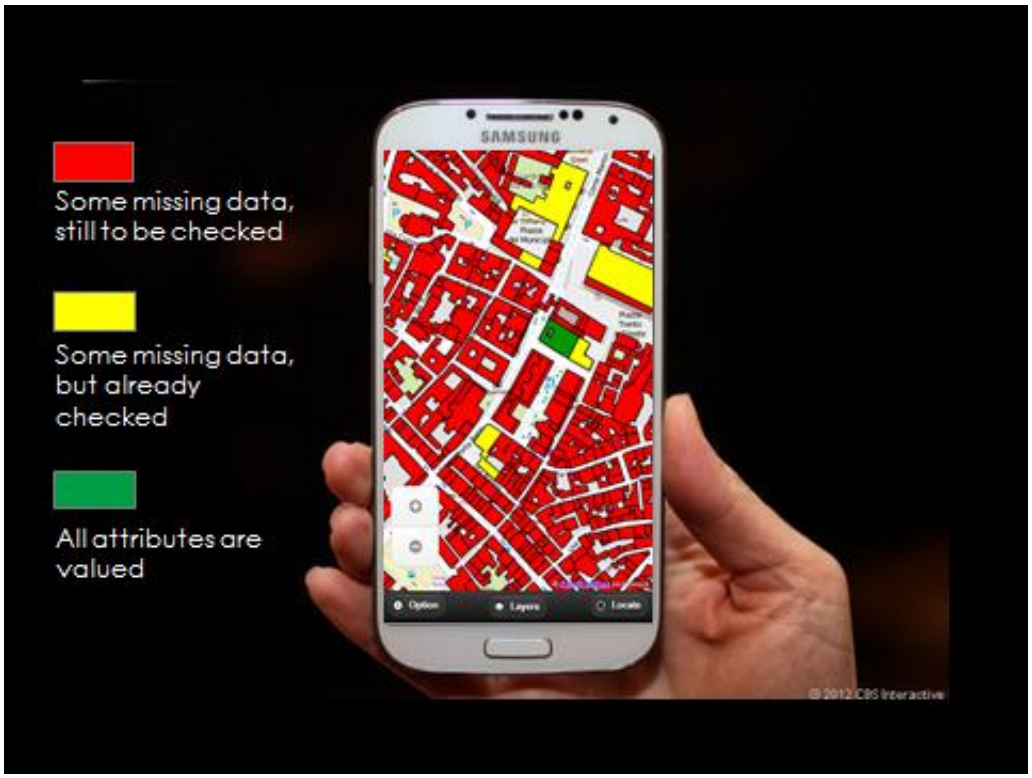
Sunshine WP4

- Buildings Efficiency Certification estimation
- Set of software modules to:
  1. Import buildings geodata into database
  2. View/editing buildings data
  3. Check completeness on the field (app)
  4. Calculate "energy maps"
- Modules 1, 2 and 3 already deployed
- #3 needs pilots to organize "on-the-field" campaign for quality checks
- #4 already developed and now in testing

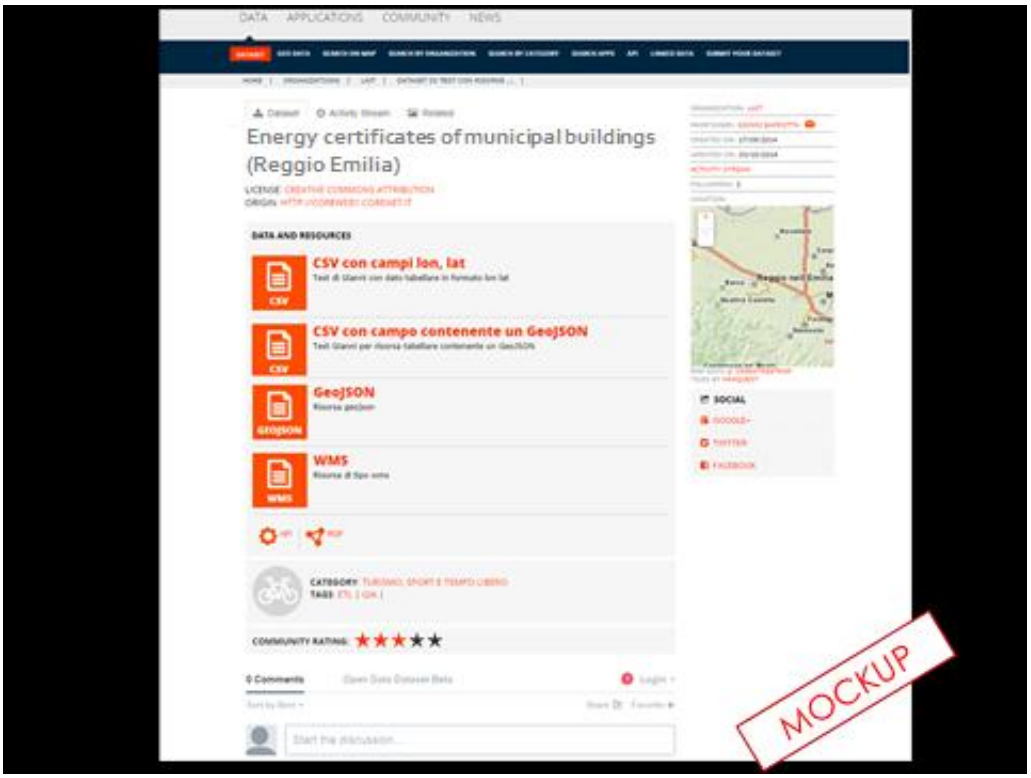
Buildings' data of Ferrara have been collected, but some attributes are still missing or need to be checked (e.g. "uses of building").

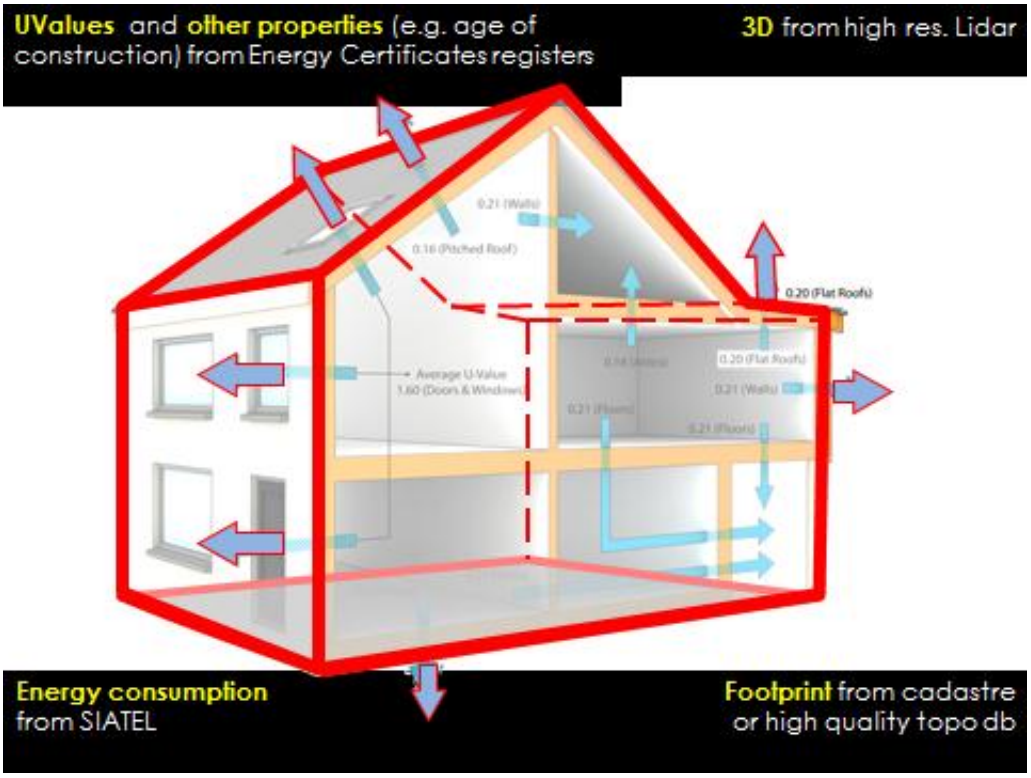
An *on-the-field* campaign is organized, involving few people from the local Faculty of Architecture, for twenty days.

The staff uses smartphones and tablets to edit attributes via WFS-T service, and updates data on PostGIS database.

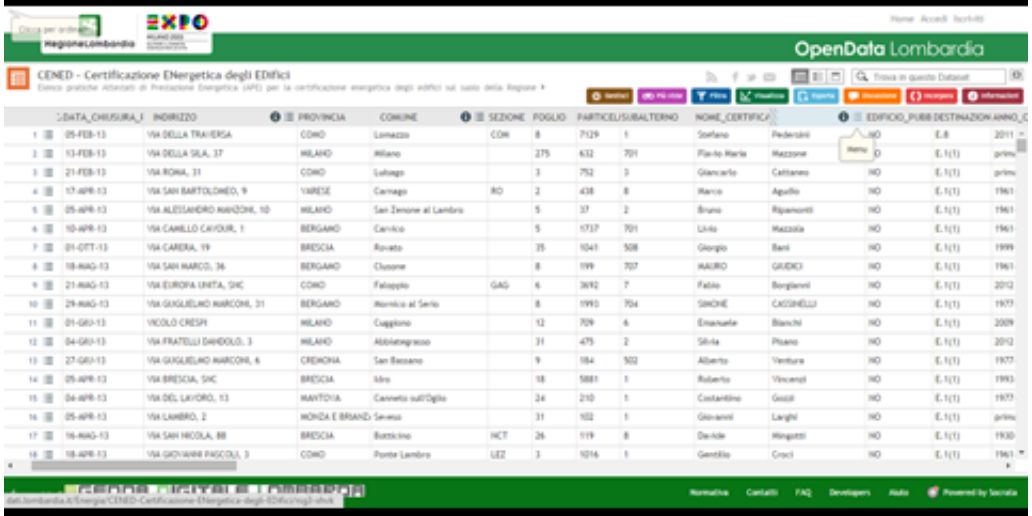

Some missing data, still to be checked
Some missing data, but already checked
All attributes are valued
SAMSUNG
Option
Layers
Locate
© 2012 CBS Interactive


REGISTER
LOGIN | SOCIAL
GeoSmartCity
open energy
open underground
DATA
APPLICATIONS
COMMUNITY
NEWS
41 datasets found
Gas / electricity consumption of residential buildings
Municipal buildings energy certificates
GSE photovoltaic panels installed
Energy consumption data from smart meters (municipal buildings)
ORGANIZZAZIONI
REGGIO EMILIA
GIRONA
CATEGORIE
MOCKUP


DATA
APPLICATIONS
COMMUNITY
NEWS
Energy certificates of municipal buildings (Reggio Emilia)
DATA AND RESOURCES
CSV con campi lon, lat
CSV con campo contenente un GeoJSON
GeoJSON
WMS
SOCIAL
MOCKUP


UValues and other properties (e.g. age of construction) from Energy Certificates registers
3D from high res. Lidar
0.21 (Walls)
0.16 (Pitched Roof)
0.20 (Flat Roofs)
Average U-Value
1.60 (Doors & Windows)
0.21 (Floors)
Energy consumption from SIATEL
Footprint from cadastre or high quality topo db

Energy certificates open data

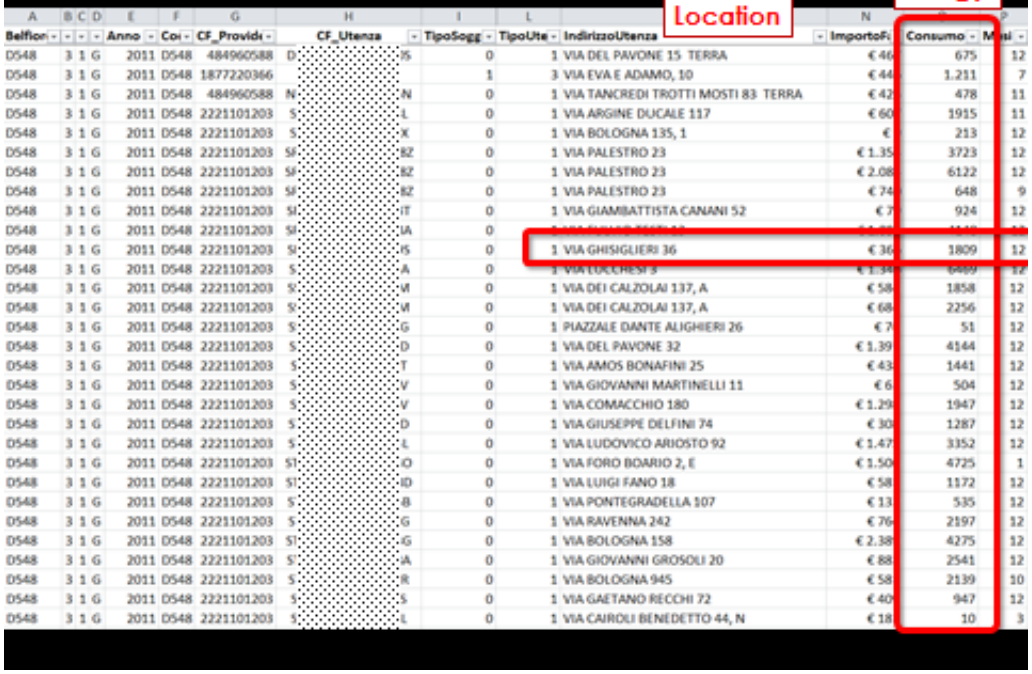


https://www.dati.lombardia.it/Energia/CENED-Certificazione-ENergetica-degli-EDifici/rsg3-xhvk

Energy consumption SIATEL

http://www.agenziaentrate.gov.it/wps/content/nsilib/nsi/home/servizi+online/servizi+per+enti/siatel+puntofisco/accesso+siatel+v20+puntofisco

Energy consumption SIATEL



A	B	C	D	E	F	G	H	I	L		N	O	P
Belfior				Anno	Coi	CF_Provid	CF_Utenza	TipoSogg	TipoUte	IndirizzoUtenza	ImportoF	Consumo	Mesi
D548	3	1	G	2011	D548	484960588	D	IS	0	1 VIA DEL PAVONE 15 TERRA	€ 46	675	12
D548	3	1	G	2011	D548	1877220366			1	3 VIA EVA E ADAMO, 10	€ 44	1.211	7
D548	3	1	G	2011	D548	484960588	N	N	0	1 VIA TANCREDI TROTTI MOSTI 83 TERRA	€ 42	478	11
D548	3	1	G	2011	D548	2221101203	S	L	0	1 VIA ARGINE DUCALE 117	€ 60	1915	11
D548	3	1	G	2011	D548	2221101203	S	X	0	1 VIA BOLOGNA 135, 1	€	213	12
D548	3	1	G	2011	D548	2221101203	SI	BZ	0	1 VIA PALESTRO 23	€ 1.35	3723	12
D548	3	1	G	2011	D548	2221101203	SI	BZ	0	1 VIA PALESTRO 23	€ 2.08	6122	12
D548	3	1	G	2011	D548	2221101203	SI	BZ	0	1 VIA PALESTRO 23	€ 74	648	9
D548	3	1	G	2011	D548	2221101203	SI	IT	0	1 VIA GIAMBATTISTA CANANI 52	€ 7	924	12
D548	3	1	G	2011	D548	2221101203	SI	IA	0	[illegible]	[illegible]	[illegible]	[illegible]
D548	3	1	G	2011	D548	2221101203	SI	IS	0	1 VIA GHISIGLIERI 36	€ 36	1809	12
D548	3	1	G	2011	D548	2221101203	S	A	0	1 VIA LUCCHESI 3	€ 1.34	6469	12
D548	3	1	G	2011	D548	2221101203	S	VI	0	1 VIA DEI CALZOLAI 137, A	€ 58	1858	12
D548	3	1	G	2011	D548	2221101203	S	VI	0	1 VIA DEI CALZOLAI 137, A	€ 68	2256	12
D548	3	1	G	2011	D548	2221101203	S	G	0	1 PIAZZALE DANTE ALIGHIERI 26	€ 7	51	12
D548	3	1	G	2011	D548	2221101203	S	D	0	1 VIA DEL PAVONE 32	€ 1.39	4144	12
D548	3	1	G	2011	D548	2221101203	S	T	0	1 VIA AMOS BONAFINI 25	€ 43	1441	12
D548	3	1	G	2011	D548	2221101203	S	V	0	1 VIA GIOVANNI MARTINELLI 11	€ 6	504	12
D548	3	1	G	2011	D548	2221101203	S	V	0	1 VIA COMACCHIO 180	€ 1.29	1947	12
D548	3	1	G	2011	D548	2221101203	S	D	0	1 VIA GIUSEPPE DELFINI 74	€ 30	1287	12
D548	3	1	G	2011	D548	2221101203	S	L	0	1 VIA LUDOVICO ARIOSTO 92	€ 1.47	3352	12
D548	3	1	G	2011	D548	2221101203	SI	O	0	1 VIA FORO BOARIO 2, E	€ 1.50	4725	1
D548	3	1	G	2011	D548	2221101203	SI	ID	0	1 VIA LUIGI FANO 18	€ 58	1172	12
D548	3	1	G	2011	D548	2221101203	S	B	0	1 VIA PONTEGRADELLA 107	€ 13	535	12
D548	3	1	G	2011	D548	2221101203	S	G	0	1 VIA RAVENNA 242	€ 76	2197	12
D548	3	1	G	2011	D548	2221101203	SI	G	0	1 VIA BOLOGNA 158	€ 2.38	4275	12
D548	3	1	G	2011	D548	2221101203	S	A	0	1 VIA GIOVANNI GROSOLI 20	€ 88	2541	12
D548	3	1	G	2011	D548	2221101203	S	R	0	1 VIA BOLOGNA 945	€ 58	2139	10
D548	3	1	G	2011	D548	2221101203	S	S	0	1 VIA GAETANO RECCHI 72	€ 40	947	12
D548	3	1	G	2011	D548	2221101203	S	L	0	1 VIA CAIROLI BENEDETTO 44, N	€ 18	10	3

Energy consumption geocoded

Code	Street name	Numbe	Secondai	Cad.Til	Cad.Bdg
3.789	VIA GHISIGLIERI	28		389	00075
3.789	VIA GHISIGLIERI	29		389	00240
3.789	VIA GHISIGLIERI	30		389	00918
3.789	VIA GHISIGLIERI	31		389	00304
3.789	VIA GHISIGLIERI	33		389	00305
3.789	VIA GHISIGLIERI	36		389	00336
3.789	VIA GHISIGLIERI	37		389	00360
3.789	VIA GHISIGLIERI	38		389	00357
3.789	VIA GHISIGLIERI	39		389	00376
3.789	VIA GHISIGLIERI	40		389	00357
3.789	VIA GHISIGLIERI	41		389	00384
3.789	VIA GHISIGLIERI	42		389	00357
3.789	VIA GHISIGLIERI	43		389	00385
3.789	VIA GHISIGLIERI	44		389	00365
3.789	VIA GHISIGLIERI	45		389	00386
3.789	VIA GHISIGLIERI	47		389	00398
3.789	VIA GHISIGLIERI	48		389	00365
3.789	VIA GHISIGLIERI	49		389	00398
3.789	VIA GHISIGLIERI	50		389	00365

Need for harmonised data

CityGML

CityGML Building

CityGML vs. Graphics Formats

virtualcitySYSTEMS

Semantics

∅

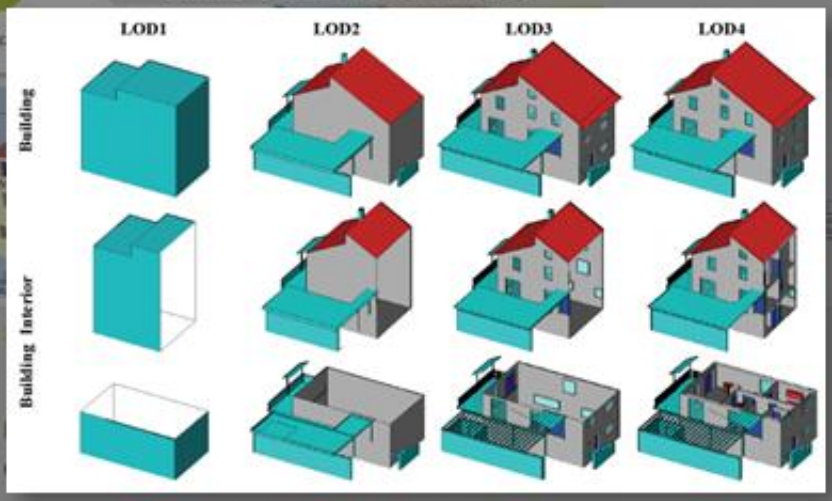
Geometry

- Unstructured geometry models enriched with appearance information, **however:** no or little semantics
  - 3D graphics formats such as VRML, X3D, KML/COLLADA, CAD
  - Suitable for (and tailored to) visualization and simple line-of-sight analysis

source: http://www.rev-mac.com/docs/CityGML.pdf

CityGML Building

Spatio-semantic coherence

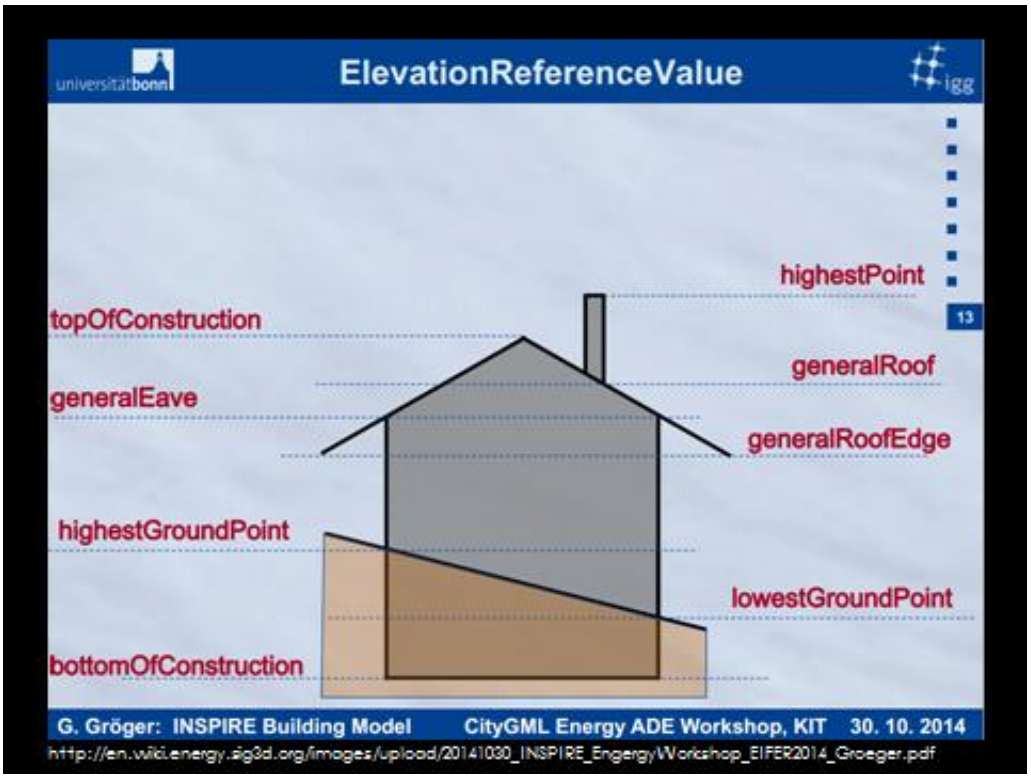


source: http://www.rev-mac.com/docs/CityGML.pdf

CityGML Building Energy ADE

http://en.wiki.energy.sig3d.org/index.php/Main_Page

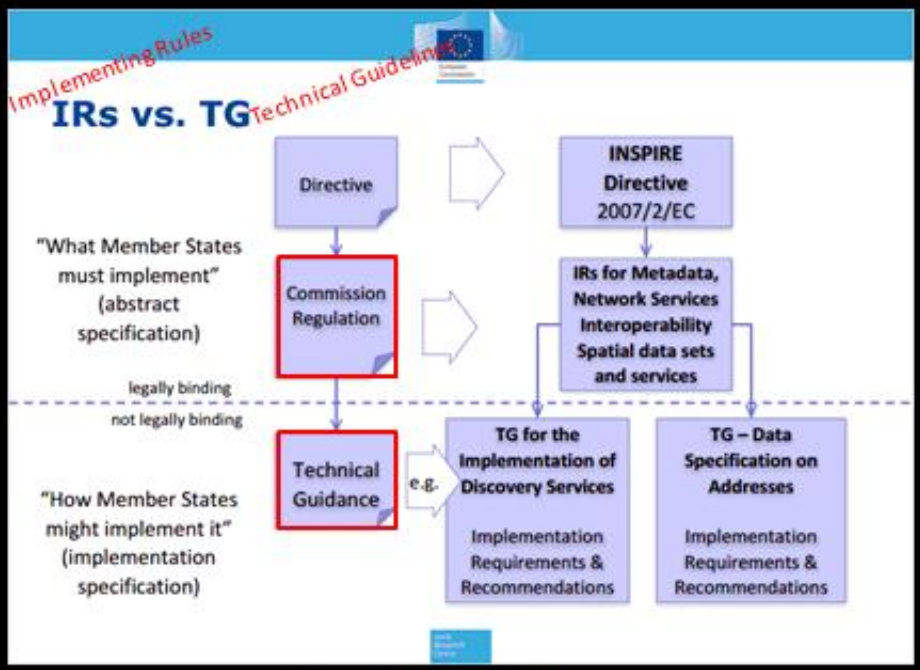
INSPIRE


universitätbonn
ElevationReferenceValue
igg
highestPoint
topOfConstruction
generalRoof
generalEave
generalRoofEdge
highestGroundPoint
lowestGroundPoint
bottomOfConstruction
13
G. Gröger: INSPIRE Building Model
CityGML Energy ADE Workshop, KIT 30. 10. 2014
http://en.wiki.energy.sig3d.org/images/upload/20141030_INSPIRE_EngergyWorkshop_EIFER2014_Groeger.pdf


INSPIRE - Infrastructure for Spatial Information in Europe
LOD2
LOD3
LOD4
Building
Building Interior

INSPIRE and "Energy"

INSPIRE is a European Directive (2007/2/CE) defining principles and Implementing Rules for the sharing of interoperable data and services among public organisations in EU



http://tinyurl.com/krh329m

Conclusions

- There are a lot of available standards, models, tools, methodologies, but …
  … we need real data about real buildings, at large scale
- Geodata represent the best example of interoperability at data and ICT levels
- Models for data interoperability:
  - BEDES
  - CityGML
  - INSPIRE
  - Green Button

SUNSHINE

www.sunshineproject.eu

- Focus on interoperability to facilitate the integration of datasets from different sources (e.g. cadastral, energy consumption data, energy certificates, …) to estimate energy performance at large scale

- In 2015 we will have a CityGML extension for Energy with buildings properties for:
  - Physics and materials
  - Energy Systems (HVAC)
  - Occupants

- At the same time, we are going to implement an open data hub where to host geodata about buildings:
  - Municipal
  - Residential
  - Tertiary

… and to provide tools to facilitate CoM signatories to collect, process and publish actual data related for the Monitoring of Emission Inventory

GeoSmartCity

www.geosmartcity.eu

XV. New Bottom-up Methodology to Evaluate Winter Thermal Energy Needs and Fuels Consumption in the Residential Sector

Giulio Cerino Abdin, Politecnico di Torino, Italy

Woody biomass exploitation will be a key factor to achieve renewable energy production targets in the 2020 and 2030 European policies. However, current and provisional balances between local supply and demand of woody biomasses show a substantial disequilibrium, both at the European and Italian level.

The use of wood biomass in residential applications has a significant share, especially in rural areas. Nevertheless, an accurate estimation of the amount of biomass used for these purposes is not always available and it is not easy to undertake.

The study focuses on the need of a linked analysis of the buildings features and biomass-fired thermal plant stock. With this purpose, in the framework of the European project RENERFOR (Alcotra), a model (BRUSA) is developed to calculate the net thermal energy needs of the residential building stock on the basis of the information collected at individual building level. This model allows evaluating biomass consumptions and defining energy saving scenarios. The model includes a GIS analysis in order to locate the biomass consumptions in the studied area.

The results of the study showed a huge discrepancy between local supply and demand of biomasses for energy purposes in the residential sector.
Thanks to the model an estimation of the introduction of policy schemes has been performed, analysing different energy saving measures.

The analysis shows the needs and the results of a dedicated planning in biomass uses in the residential sector, in order to balance local supply and demand of biomass.

New bottom-up methodology to evaluate winter thermal energy needs and fuels consumption in the residential sector.

Turin, November 25

POLITECNICO DI TORINO
Dipartimento Energia
Sistemi per l'Energia e l'Ambiente
A. POGGIO, G. CERINO ABDIN, A. CROCETTA, L. DEGIORGIS, M. JARRE, M. NOUSSAN

RENERFOR

Piedmont Region (*leader*)
Province of Turin
Province of Cuneo
Valle d'Aosta Region
Liguria Region

Région Rhône-Alpes
Département de la Savoie
Région Provence-Alpes-Côte d'Azur

RENERFOR project

renerfor

FONDO EUROPEO DI SVILUPPO REGIONALE

alcotra

data	Province of Turin - IT	Province of Cuneo - IT
Area	6,800 m^2	6,900 m^2
Municipalities	315	250
Inhabitants	2,3 million 52% in Turin municipality and neighbourhoods;	0,6 million 9% in Cuneo municipality;
Dwellings	1,1 million 15% holiday houses	0,3 million 28% holiday houses

Supply vs demand analysis

Supply

ipla istituto per le piante da legno e l'ambiente ipla spa

Demand

POLITECNICO DI TORINO
Dipartimento Energia

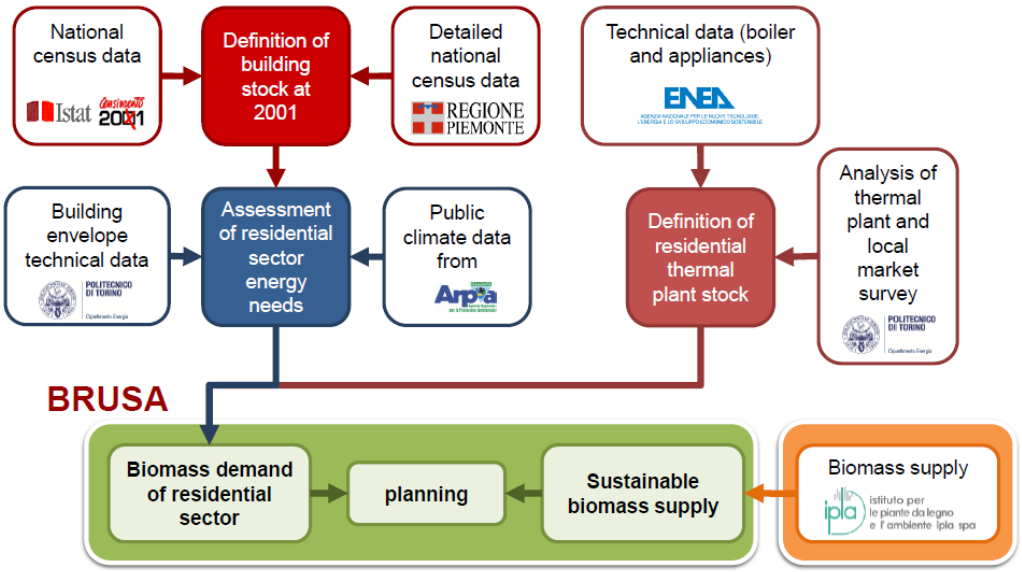
Assessment of wood biomass actual and potential supply

wood log | chip | pellet

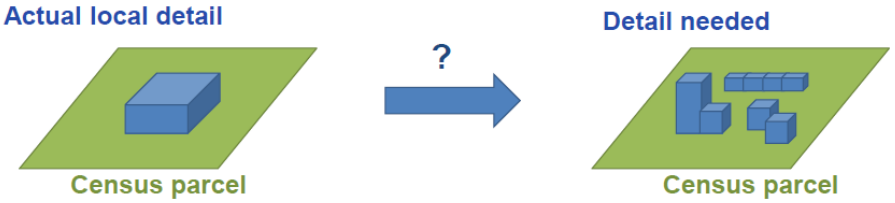
Assessment of actual and potential biomass needs for heating and electricity production

DH systems / CHP system / Power Plant | boilers | appliances

BRUSA – flow chart



Conceptual model



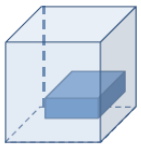
Model features:

- Based mainly on unique database;
- Data collected from public database;
- Definition of a repeatable and updatable methodology;
- Needs of high detailed district description (actual data are available like joined information).

Model application phases

Residential buildings

1. **Dwelling detail**



Detailed census data

ISTAT 2001

2. **Building modelling**

ISTAT 2001 data aggregation

Computational model

3. **Local modelling**

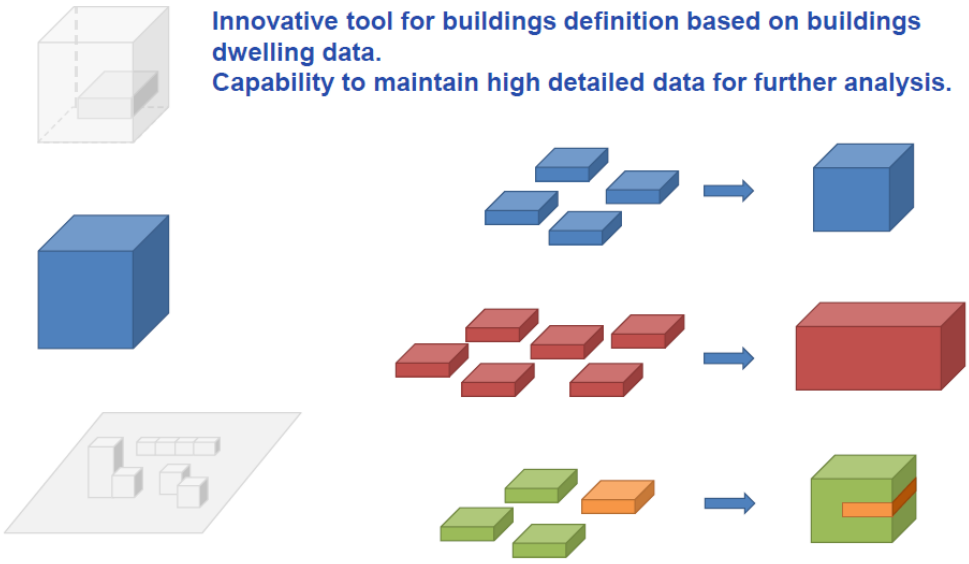
ISTAT 2001 data aggregation

Computational model

Building modelling

Buildings modelling

Innovative tool for buildings definition based on buildings dwelling data.
Capability to maintain high detailed data for further analysis.



Building modelling

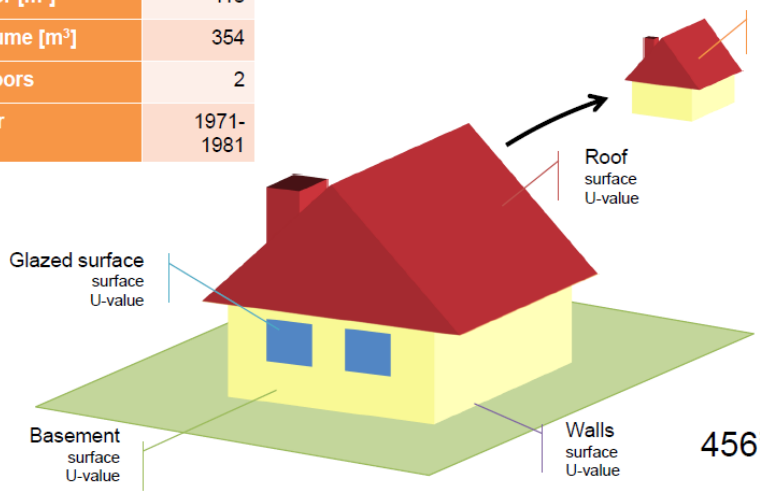
Parcel #9	
Buildings	32
Dwellings	45
Residential	17
Holiday	28
Volume [m³]	8770
HDD	2767

Building #8	
Dwellings	2
Residential	2
Volume [m³]	354
# floors	2
Year	1971-1981

Dwelling #1	
Thermal plant	Independent + appliances
Fuels	Natural gas + wood
Floor [m²]	60
Volume [m³]	180

Building modelling

Building #8	
Floor [m²]	118
Volume [m³]	354
# floors	2
Year	1971-1981



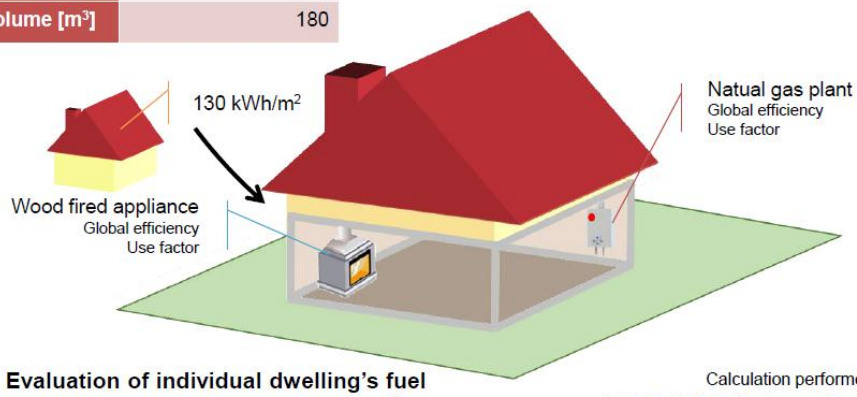
Calculation performed on
456'984 buildings

Individual building analysis

Building modelling

Dwelling #1	
Thermal plant	Independent + appliances
Fuels	Natural gas + wood
Floor [m^2]	60
Volume [m^3]	180

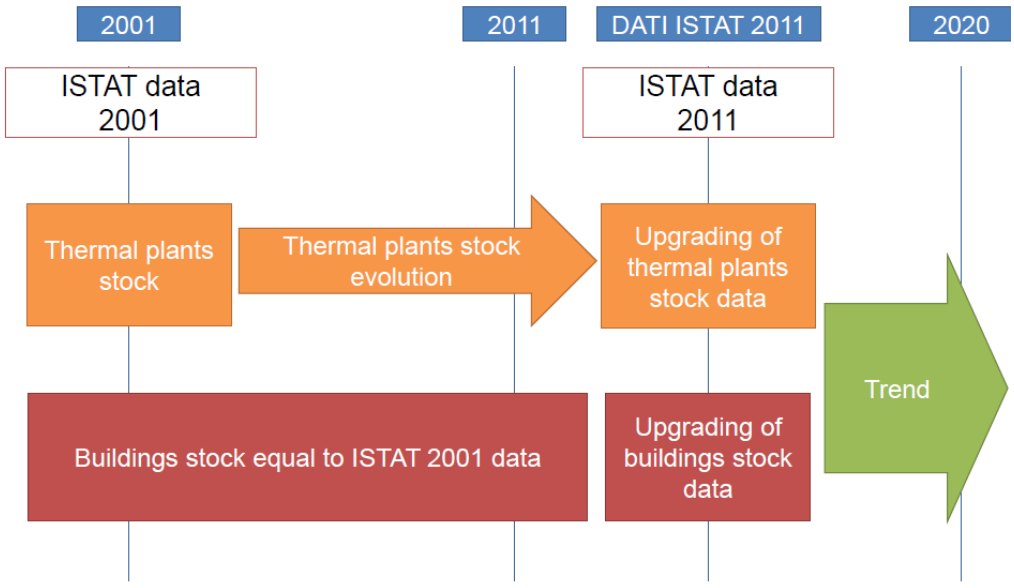
Fuel consumption



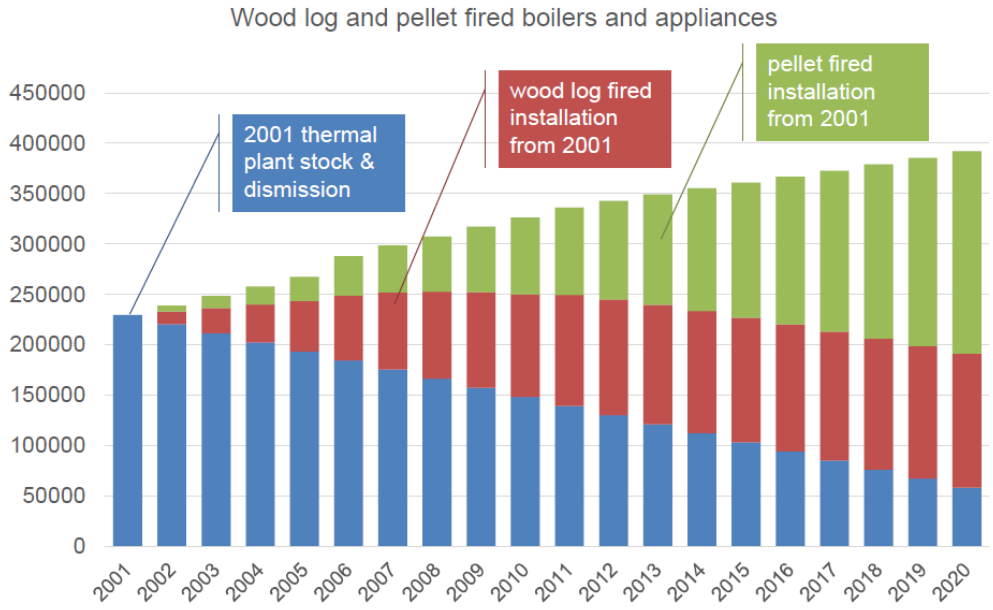
Evaluation of individual dwelling's fuel consumption

Calculation performed on
1'391'661 dwellings

Timeline description



Thermal plant stock evolution: market survey and trend



Thermal plant stock evolution: methodology

Replacement and dismission

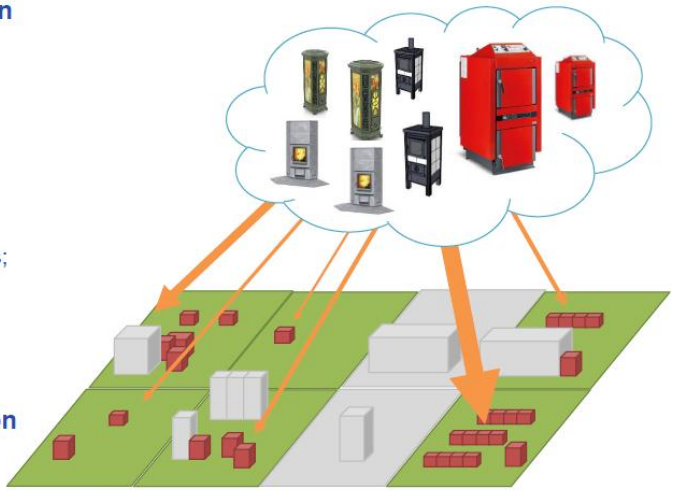
- based on useful mean life of boiler/appliance.

New installation (selling)
-Monte Carlo method-

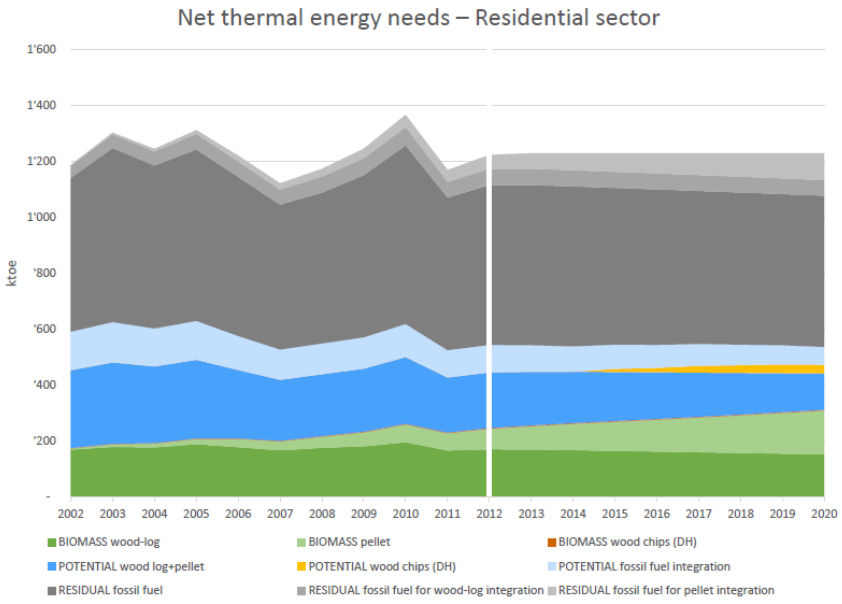
- Dwelling with no biomass uses;
- Buildings up to 3 floor and in extra-urban area;
- Market penetration for each municipality;

Incentive program simulation

- Replacement of gasoil fired boilers in municipality with no gas supply (2011);



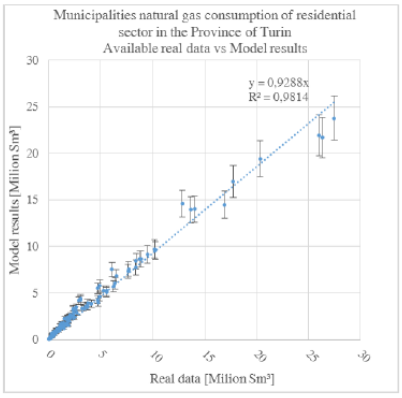
Thermal energy needs – Residential sector



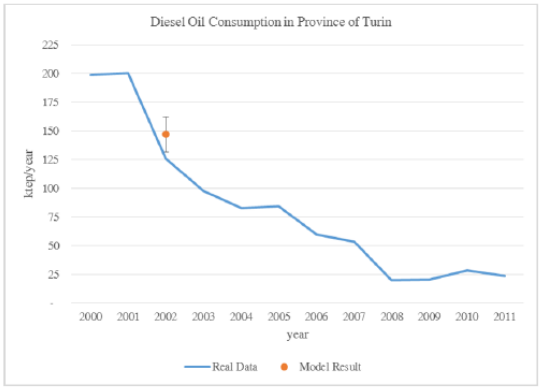
Fossil fuel needs – Residential sector

Comparison with local energy data (Province of Turin – 8th Energy Report)

Natural gas

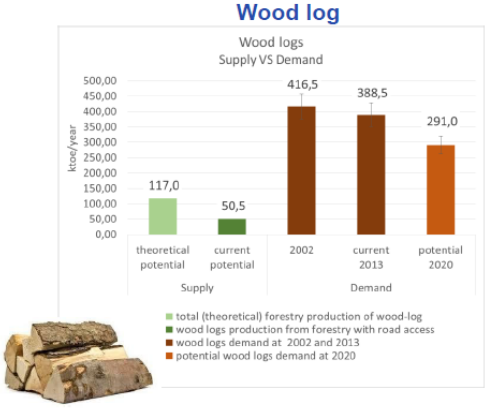


Diesel Oil



Wood biomass needs – Residential sector

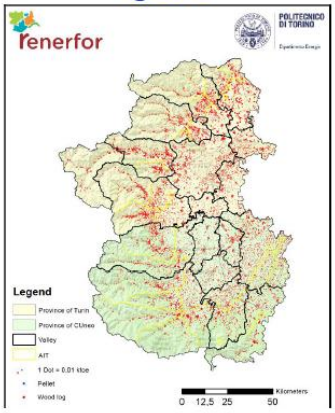
Wood log



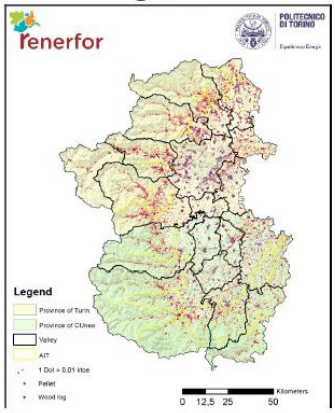
Pellet

Wood biomass needs – GIS Model

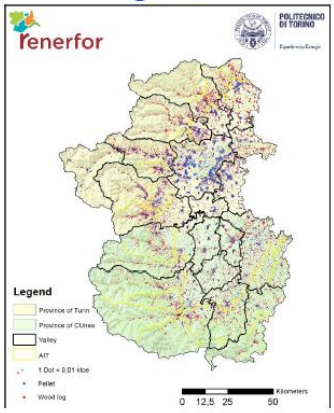
Wood log & pellet @ 2002



Wood log & pellet @ 2011

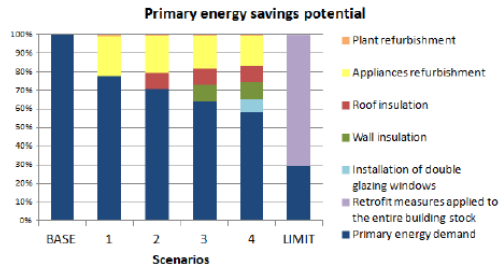


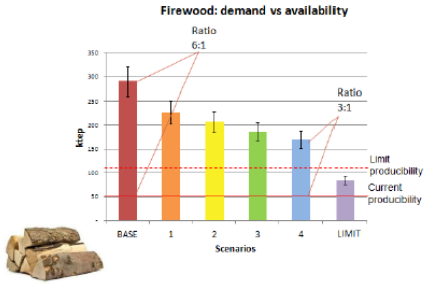
Wood log & pellet @ 2020

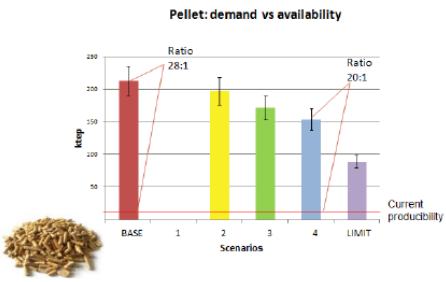


Scenarios analysis and results

ENERGY RETROFIT MEASURES		SCENARIOS				
		1	2	3	4	5
	Thermal plant refurbishment (firewood devices installed before 2005)	✓	✓	✓	✓	✓
	Roof insulation (buildings < 1961)		✓	✓	✓	✓
	Wall insulation (buildings between 1961 and 1981)			✓	✓	✓
	Installation of double glazing windows (buildings < 1981)				✓	✓
	All the energy retrofit measures applied to the entire building stock.					✓







Conclusions

- The use of sample buildings could be critical in the primary energy needs evaluations, in non homogeneous building stocks;
- Bottom-up methodologies are a good choice in the analysis of primary energy needs of large building stocks;
- To perform complete analysis bottom up methodologies requires huge amount of data;
- With respect to local planning good results could be achieved with open data and available dataset;

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... thank you

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