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Energy Scenarios for SE Europe: A close look into the Western Balkans

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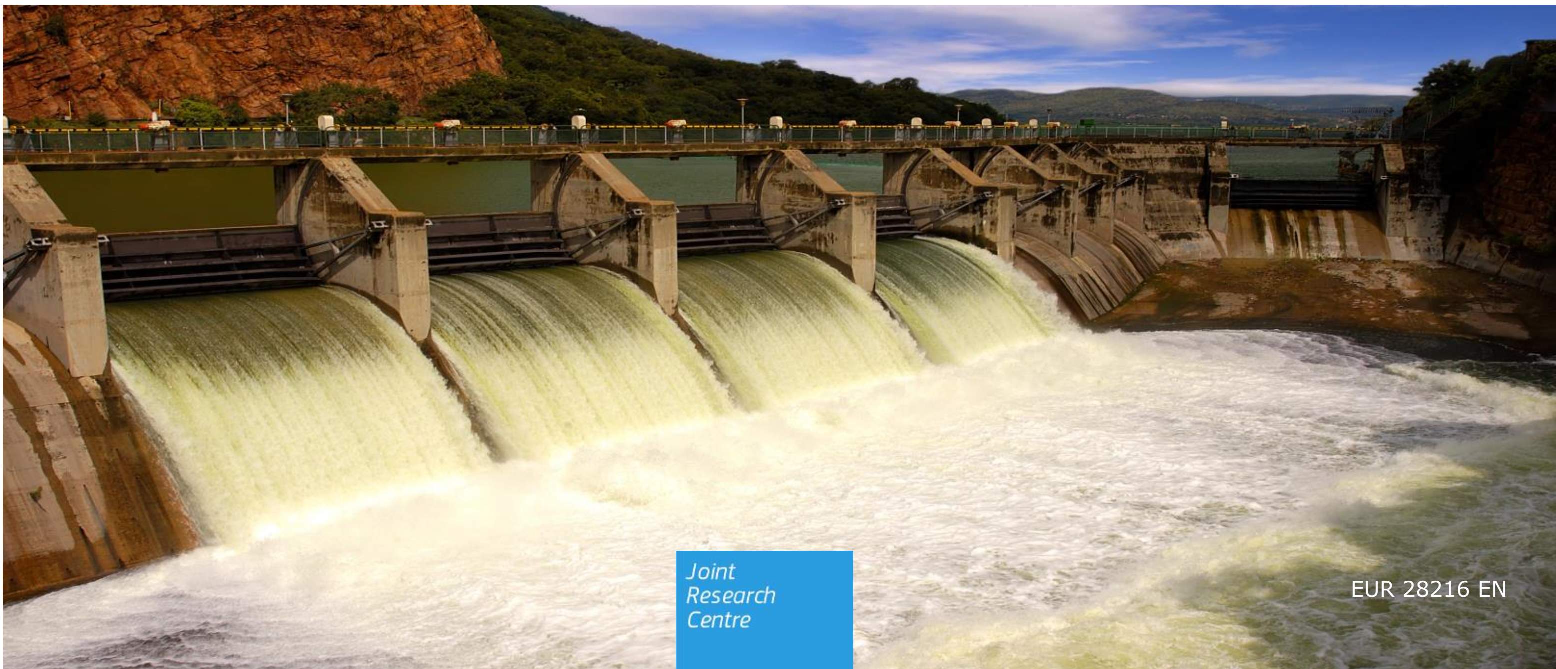

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Abstract

"The Energy Scenarios for South East Europe" thematic seminar took place on the 15th of December 2015 in Vienna, Austria. The workshop was organized by Institute of Energy and Transport of the European Commission's Joint Research Centre (JRC-IET), hosted by the Energy Community Secretariat (ECS) and sponsored by the Directorate-General for Neighbourhood and Enlargement Negotiations (DG-NEAR) in the framework of the Travel Accommodation and Conference facility for Western Balkans and Turkey, a programme of dissemination activities organised by the Commission in the EU or the beneficiary country in connection with the enlargement process and the pre-accession strategy.

The aim of the workshop was to bring together representatives from think tanks, scientific institutes, the academia and the private sector with government officials, the national statistical agencies and the local TSO representatives from the Western Balkan region to exchange views on potential energy technology deployment scenarios that could facilitate a low carbon development pathway for the enlargement countries, but also exchange on the methodologies utilised and identify challenges as well as potential pitfalls in this process.

The workshop included three sessions of specific thematic focus. The first session provided the "regional picture" with forecasts on the development of the energy and power systems in the western Balkans. The second session discussed case studies on low carbon development trajectories for specific countries in the region; and the third session explored the role of particular technologies in this context. This report comprises of long abstracts from the workshop presentations and closes with a chapter on conclusions and recommendations that resulted from the discussion sessions.

1 Introduction

1.1 Purpose of the workshop.

The objective of this day-long workshop was to explore potential energy technology deployment scenarios that could facilitate a low carbon development pathway for the enlargement countries of the Balkan peninsula, within the context of the energy union. Representatives from think tanks, scientific institutes, the academia and the private sector along with government officials, the national statistical agencies and TSO representatives from the Western Balkan region, representing Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Montenegro, Kosovo [1] and Serbia, exchanged views on potential energy technology deployment trajectories and on the utilised methodologies but also identified challenges as well as potential pitfalls in this process.

The initial focus of the workshop was on the "regional picture" with forecasts on the development of the energy and power systems in the western Balkans. Then the workshop continued on with country specific case studies on low carbon development trajectories; and concluded with the exploration of the role of particular technologies in this effort.

1.2 JRC support to the EU enlargement and integration process

The Joint Research Centre (JRC) is playing an important role in providing scientific and technological support for the European Union enlargement and integration process through two initiatives: 1) the Enlargement and Integration Action (E&IA) 2) The JRC Annual Programme of activities in the framework of DG NEAR's IPA TAC.

Since 1999, through its enlargement and integration actions (E&IA) JRC gives scientific and technical support to countries on the road towards EU membership, New Member States and Associated Countries to the Research Framework Programmes. The JRC supports the transposition of the EU laws (acquis communautaire) to national legislation and facilitates scientific and technical exchange. The activities include workshops, advanced trainings, summer schools and temporary staff positions at the JRC

In the context of the enlargement process JRC undertakes specific activities on behalf of DG NEAR, funded through the Instrument for Pre-Accession Assistance (IPA) and in particular the Travel Accommodation and Conference facility (TAC). The TAC tool allows for the organization of workshop events, in particular workshops, trainings and summer schools as well as study visits for representatives of the Enlargement countries. The aim of the workshops and trainings is to allow competent organisations in the target countries to study the scientific and technical methods and techniques behind EU policy implementation.

All Associated countries to Horizon 2020 (or in the process of association) have their representatives in the JRC Board of Governors. The Board helps with JRC strategic decision-making on scientific, technical and financial management. Individual Board members have also an important role in presenting the JRC activities in their respective countries.

Moreover there is an intensive networking activity with the JRC Enlargement National Contact Points (NCPs) appointed by the enlargement countries. Every year during the Annual Meeting with Enlargement NCPs the on-going cooperation is presented and discussed. The annual meeting is particularly relevant for further strengthening and improving the on-going cooperation with the Enlargement countries, for exchanging

[1] This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence. Thus, this territory is referred to as Kosovo in this report.

information about the activities we both are carrying out, discussing about priorities and plans.

In addition the JRC has signed Memoranda of Understanding with some Enlargement countries. The overall objective of the Memoranda is to improve cooperation in selected fields in the competence of the JRC and to host PhD students and post-doctors from these countries in the JRC Directorates and laboratories.

2 Sessions of the Workshop

2.1 Session 1: The Regional Picture

2.1.1 SE Europe Energy Outlook 2015-2016 - Work in progress: an Initial Outline Presentation (Costis Stambolis, IENE)

Presentation Abstract

The South East (SE) Europe Energy Outlook 2015-2016 is a comprehensive study, which deals with the current energy situation in the SE European region but is also concerned with its 'Outlook" from now until 2025. The study covers all 13 countries of the region. These countries include: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Slovenia, Cyprus, the former Yugoslavian Republic of Macedonia, Greece, Kosovo, Montenegro, Romania, Serbia and Turkey. The full study is expected to be published in June 2016.

This is the second time that such a major study is being undertaken by IENE. The first study was published by IENE in 2011. The study contains substantial comparative data, detailed sectorial analysis, estimates and projections. After a comprehensive introduction, in which the economic and political background of South East Europe is thoroughly presented, the study examines the impact of the regional integration process on SE Europe's energy prospects. The advent of EU's Energy Union is also discussed and analysed in relation to its anticipated catalytic role in accelerating energy market integration in SE Europe. The study comprises four main parts: country energy surveys, regional economic and energy analysis, sectorial analysis and energy investment outlook. It also includes energy demand and supply projections for 2020/2025 and beyond.

The regional energy sector analysis focuses on the region's economies, on oil (upstream, midstream, downstream), natural gas, power generation, renewable, energy efficiency, co-generation and environmental issues. A major part of the study concerns the individual countries of the region and contains an energy overview of each one of them. A set of original energy maps for the region has been created, together with comparative data tables and economic analysis.

Another important part of the study covers the energy interconnections in South East Europe and in the Black Sea region for oil, gas and electricity. The major energy projects in the region (oil and gas pipelines, gas storage, nuclear plants, hydrocarbon exploration projects, refineries, RES installations) are described and fully analysed. The study also covers latest developments in the energy market liberalization process but also the environmental and energy security considerations in South East Europe. The study concludes with an in depth analysis and projections of the current and future investment potential and business opportunities of the region's energy sector. The structure of the study is presented in the Table of Contents which follows.

The current "SE Europe Energy Outlook 2015-2016" study was carried out over the last two years (2014-2016) and is largely based on IENE's ongoing monitoring of the region's key energy issues. The need for this study emerged from IENE's quest to understand the geopolitical and geographical sphere within which it operates, but also to define and evaluate in an objective manner the major policy challenges which lie ahead in the energy sector of the region. Parallel to that, was the equally important need to identify the important investment and business opportunity areas across the region.

The present Outlook reviews the energy sectors and policies of individual countries by focusing on key policy challenges that need to be addressed over the next five to ten years. This study further discusses these policy challenges on a regional level and propose necessary initiatives both as part of the transition process envisaged within the Energy Community *(i.e. electricity and natural gas markets)* but also separately as the case may be *(e.g. regional oil and gas pipelines projects, electricity interconnections)*.

One of the key observations of the study is the need for a much better organized and continuous market surveillance and analysis. This is necessary if we are to understand better and interpret the developments and trends of the energy sector in the region. The poor statistics and lack of reliable information on projects and energy flows in general, from several countries in the area, make such a task cumbersome and tedious. IENE is already addressing this challenge in close co-operation with knowledgeable and reliable contacts and partners in each country. These partners are included in the study team with each one having contributed country profiles and sectorial analysis.

Key findings of the study include the changing energy mix as Natural Gas and Renewable Energy Sources are gradually taking over visible segments from solid fuels (coal and lignite) which for many years formed the basis for power generation in almost all countries of the region.

The ongoing and planned development of gas infrastructure terminals in several countries of the region including LNG is in line with efforts to diversify gas supplies and supplier routes. Likewise electricity grid extension, and upgrading as well as cross border interconnections are under development addressing increased needs in view of the constant addition of new independent producers.

Given the current state of affairs in SE Europe and the constant flux which characterizes most energy markets and the fact that certain key transnational projects such as main oil and gas pipelines have suffered serious drawbacks, with final investment decisions being constantly postponed, and which is bound to affect investment in the energy sector as a whole, the study provides some useful insight on background developments, at both government and company level, which are likely to affect the outcome of key projects over the coming years. The geopolitical and socio-economic impact from SE Europe's fast changing energy landscape is also discussed.

As far as the investment prospects in the energy sector of SE Europe over the next 10 years there can only be described as positive. In terms of planned investments we clearly have a multilayered situation as a group of six countries (e.g. Turkey, Bulgaria, Romania, Croatia, Greece) appear to be moving much faster than others in attracting the needed investment for a variety of energy projects while progress in the rest of the countries, is moving more slowly.

The region as a whole can be considered as presenting attractive business opportunities in almost all branches of the energy sector. Total energy related investments in SE Europe vary between €205 billion in the reference scenario up to €290 in the optimistic scenario.

According to SEEEO 2015-2016 findings the major challenges of the energy sector in SE Europe can be summarized as follows:

- **Strengthen the security of energy supply,** through:
    1. Further diversification of oil and gas supplies;
    2. Diversification of energy routes;
    3. Broadening of energy mix;
    4. Electricity and gas system interconnectivity;
    5. Expansion of LNG and underground gas storage capacity;
    6. Increase of production from indigenous energy sources;
- **Progressive decarbonisation of the energy system.**
    1. In power generation, through further penetration of RES and deployment of clean coal methods.
    2. In industry, through further gasification and electrification.

iii. In buildings, the improvement of energy efficiencies and wide use of RES and Solar Passive system.

iv. In transportation, through improvement of motor vehicle fuel efficiency, greater use of hybrids, use of electric cars in cities, broader use of public transportation systems.

- Complete the liberalisation process in electricity and gas and expand market competition right down to end user level, through further privatisations, and entry into the market of independent suppliers and traders.

Resume

Mr. Costis Stambolis is the Deputy Chairman and Executive Director of the Institute for Energy for SE Europe. He holds degrees in Architecture and Energy Studies from the RIBA and the Architectural Association in London and holds a professional practice license from the Technical Chamber of Greece (TEE).

2.1.2 SEE Electric Power Systems: generation, consumption, exchanges & transmission forecasts until 2025 *(Zoran Vujasinović, EKC)*

Presentation Abstract

The EKC regularly performs studies and forecasts on the development of the South Eastern European (SEE) and neighbouring power systems (Albania, Bulgaria, BiH, Croatia, Greece, Montenegro, the former Yugoslav Republic of Macedonia, Hungary, Kosovo, Romania, Serbia, Slovakia, Slovenia, Turkey), with regards to the current state of art and the perspective development of the electricity markets.

Our recent studies address:

- the current situation (2014) of demand, generation, exchanges and transmission
- projections until 2025, in particular:
    - demand forecasts,
    - planned installed generation (per technologies and with recognized major additions plant-by-plant for bigger units) and decommissioning,
    - planned electricity production,
    - surplus/deficit analysis,
    - transmission system development.

The EKC also performs market simulations (using our GTmax model) to determine the development of wholesale market prices.

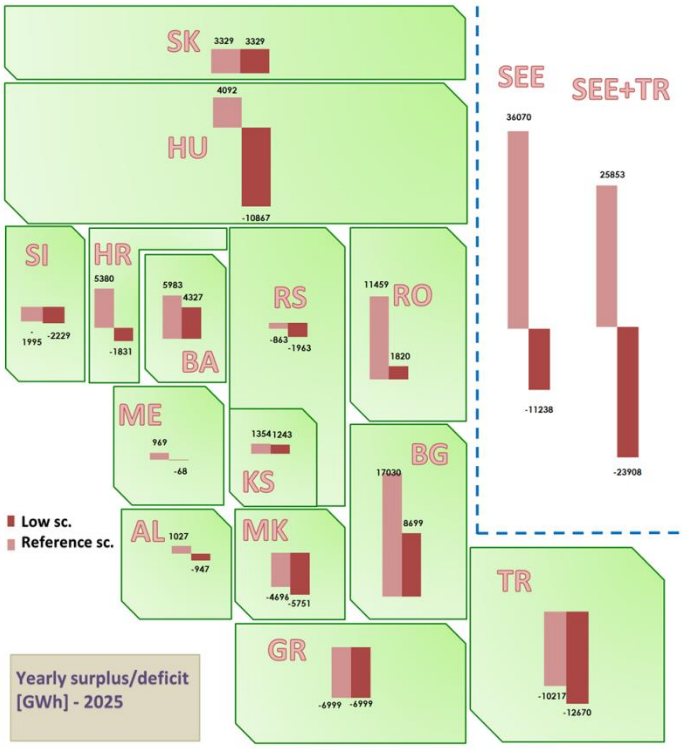

Figure 1: Schematic representation of SEE power systems

The sources of information used in the analysis are the responsible ministries of the countries concerned, regulators, transmission system operators including ENTSO-E, power exchanges, as well as internal assessments and expert analyses.

The current situation can be illustrated on the example of 2014 realisation data. On a yearly basis, the biggest net exporters are Bulgaria (9.6 TWh), Romania (7.1 TWh) and BiH (2.8 TWh). The net importers with the largest deficits are Hungary (-13.3 TWh), Greece (-8.6 TWh), Turkey (-5.2 TWh) and Croatia (-3 TWh). The total deficit of the observed region (incl. Turkey) was about -21 TWh.

Due to the world economic crisis, electricity demand showed a sharp decrease in 2009, recovering slowly in 2010 and 2011, but a negative trend continued until 2014

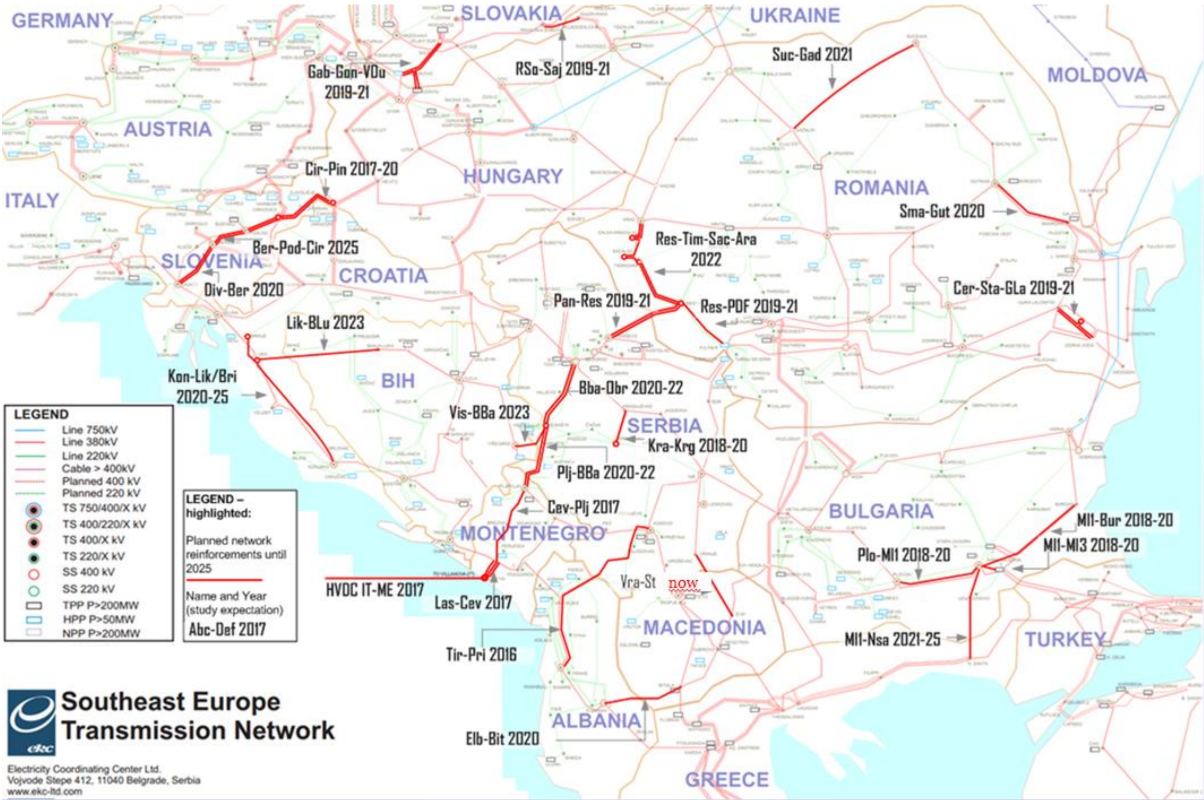

Figure 2: Southeast Europe Transmission Network

For 2015 till 2025, a gradual recovery of the economy is expected which would have a positive impact on electricity demand. In a moderate to high growth scenario an average growth rate of 1.3% is expected for the SEE region excluding Turkey, and 3.9% for the SEE region including Turkey. This would result to consumption growing from 555 TWh in 2014 to about 850 TWh in 2025. More recent data suggest scenarios with lower growth resulting in at least 4-5 TWh lower consumption for 2025.

The power systems with the highest expected average annual demand growth rate until 2025 are Turkey (5.4 - 6.2%), Kosovo (2.6%) and Montenegro (2.6%). The systems with the lowest expected average annual demand growth rate till 2025 are Romania (0.7%), Bulgaria (0.8%) and Serbia (1%).

Two power generation scenarios are created: a reference scenario, with an additional capacity of 27.2 GW installed on top of the existing 91 GW (SEE w/o TR), and a lower growth scenario with an additional capacity of 13.9 GW. For Turkey, the existing generation capacity is 70 GW. To this, 66 GW (reference scenario) or 64 GW (lower growth scenario) of generation capacity would be added. The share of thermal power plants would fall from 50% to 42%, and renewable energy sources would increase from 13% to 18%.

Turkey included, the balance position of the region would be positive in 2025 in the reference scenario: the surplus would rise from of 8.7 TWh (2020) to 25.9 TWh (2025). In the lower growth scenario, a deficit would materialise increasing from 39 TWh (2020) to 24 TWh (2025). The countries with the highest surplus would be Bulgaria, Bosnia & Herzegovina, Romania. The highest deficit would be seen in Turkey, Greece and Hungary.

There is already significant transmission infrastructure in place making the region well-connected and allowing to operate within the same synchronous area. Perspective transmission projects are mainly oriented in the export-import directions, from east to west and south-west, to the deficitary countries of southern Balkans, and towards Italy.

Resume

Mr. Zoran Vujasinović is Head of Electricity Market and Software Solutions Team, of the consulting company Electricity Coordinating Center (EKC) from Belgrade. He has a long experience in the analyses and planning of transmission networks and electricity markets. The main areas of professional engagement are electricity markets, congestion management, balancing markets, analyses and studies related to system security and capacity calculation, and related software solutions. Project leader of numerous software applications used by European TSOs.

2.1.3 Support for Low-Emission Development in South Eastern Europe *(László Szabó, REKK)*

Presentation Abstract

The objective of the project "Support for Low-Emission Development in South Eastern Europe (SLED)" was to help policy makers in Albania, the former Yugoslav Republic of Macedonia, Montenegro and Serbia to set realistic but ambitious decarbonisation pathways for their electricity sectors up to 2030. In the case of Montenegro and Albania, project results were also used in the assessment process for the Intended Nationally Determined Contributions (INDC). SLED was financed by the Austrian Development Agency and the project was coordinated by the Regional Environmental Centre. The electricity sector modelling tasks were carried out by The Regional Centre for Energy Policy Research (REKK) with its European electricity model (EEMM).

The SLED study assesses the effect of decarbonisation scenarios on electricity systems in the region, meaning the four project countries and Bosnia and Herzegovina.

The regional scenarios (Reference – REF; Currently Planned Policies – CPP; and Ambitious – AMB) use different assumptions on electricity demand and supply. Supply side factors include the deployment levels of renewable energy sources for electricity (RES-E), changes in the conventional power generation sector, and the applied energy and carbon taxation rates. On the demand side, the energy efficiency ambition levels define the consumption scenarios. The scenarios and the assumptions were agreed with the main stakeholders in the project countries (relevant ministries, transmission system operator, regulator and electricity experts). Scenario assumptions were related to six dimensions:

- carbon value;
- energy/excise tax;
- environmental standards;
- deployment of renewable energy technologies;
- deployment of conventional generation technologies; and
- electricity demand (integrating assumptions on end-use energy efficiency improvement).

The above factors all affect national CO_2 emissions either via the level of electricity production or by their impact on the fuel mix for electricity generation. As far as taxation is concerned, two factors are identified. First, the introduction of the EU ETS either as consequence of EU membership or the transposition of the EU law as required for members of the Energy Community; and second, simply the introduction of a national policy instrument placing value on carbon emissions, which alters the cost of the respective generation technologies and hence the production possibilities. The same logic applies to the introduction of the minimum tax level on energy products required by EU legislation. The electricity supply mix is affected by the introduction of European air pollution regulations: the Large Combustion Plants (LCP) Directive, for example, may force the most polluting coal plants out of operation or limit their operating hours. The development of renewables and conventional (fossil) generation capacities is the outcome of national policy decisions and — in the case of renewables — support levels. Electricity demand growth triggers higher production from the available power plant portfolio or imports.

The assessment was carried out using the EEMM and the network model of the Electricity Coordinating Center (EKC). The EEMM is a detailed, bottom-up economic simulation model covering the whole European Network of Transmission System Operators for Electricity (ENTSO-E) region, while the EKC network model covers the medium- and high-voltage network of the South East European (SEE) region.

The following main conclusions can be drawn from the scenario modelling:

Self-sufficiency in generation in 2015 turns into a 20 to 30 percent export level in 2020 due to coal and hydro capacity expansion (the relative share depending on the scenario), after which this export share gradually decreases up to 2030. Other RES technologies remain at moderate levels throughout the whole period. Natural gas–based generation units are utilised at very low level despite the new capacities built in Albania, the former Yugoslav Republic of Macedonia, Serbia and Bosnia. Carbon leakage is present in the region after 2020, irrespective of the scenario or the year.

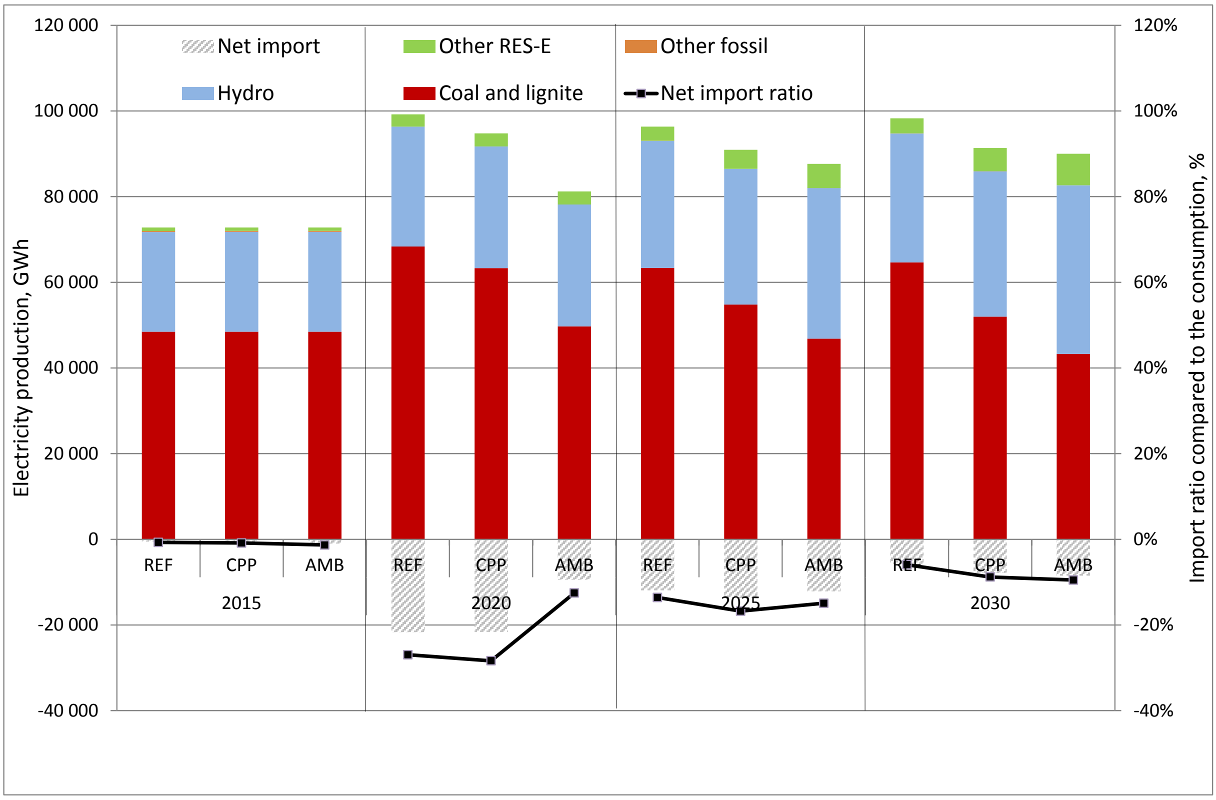

Figure 3: Regional generation mix (BA, AL, ME, MK, RS) and net imports in the three scenarios

The loss of hydro generation in years when there are unfavourable hydrological conditions is mainly substituted by imports in the first period (if it occurs up to 2020), then by coal- and lignite-based generation from 2025 onwards in most scenarios. In dry years up till 2020 hydro production is substituted mainly by import and with a limited contribution by gas, while from 2020 onwards the new coal capacities gradually increase (in Serbia and Bosnia and Herzegovina) and take a complementary role alongside imports.

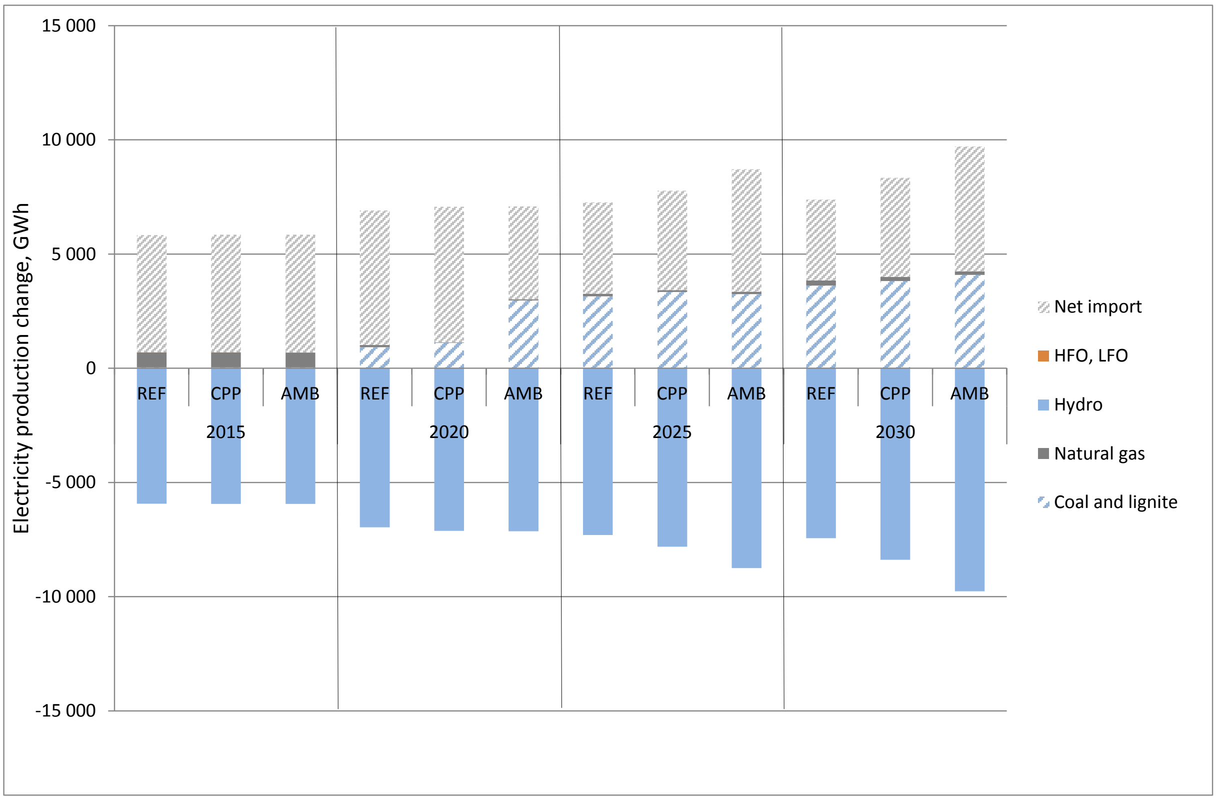

Figure 4: Change in the regional generation mix in the case of low hydro availability

Resume

Dr. László Szabó is a Senior Researcher at the Regional Centre for Energy Policy Research (REKK, Hungary). He received his PhD from the Corvinus University of Budapest in economics. After his studies, he held several positions in the Hungarian public administration: at the Ministry of Economic Affairs and also at the Hungarian Energy Office. Between 2002 and 2010 he was a researcher and a scientific officer at the Institute for Prospective Technological Studies, DG JRC of the European Commission, where he specialised in modelling energy intensive sectors and climate change related issues. He participated in several EU projects dealing with climate change mitigation and adaptation issues and also investigated energy efficiency measures, publishing the results in several peer-reviewed journals. Since 2010 his work at REKK focuses on various energy related topics, amongst them the regulation of renewable energy sources in Hungary and also in the wider region, power sector infrastructure economic assessment, climate change related issues and economic assessment of electricity market developments in the short and medium term in a regional context.

2.1.4 South East Europe 2050 Energy Model *(Naida Taso & Ana Rankovic, SEE Change Net)*

Introduction

The South East Europe 2050 Energy Model is a policy tool designed to develop low carbon energy and emission pathways for South East Europe (SEE)[2]. The purpose of the tool is to show possible energy system pathways, which better meet EU standards and goals. The model consists of 7 energy models for 7 states (Albania, Bosnia and Herzegovina, Croatia, the former Yugoslav Republic of Macedonia, Kosovo, Montenegro, Serbia), as well as one regional model, and allows users to make sensible choices about the energy future of SEE that are in line with EU goals. The model was created by a regional team of researchers from civil society organizations (CSOs) and international experts under the framework of the SEE SEP (South East Europe Sustainable Energy Policy) project, with lead partner SEE Change Net [1] and 17 CSO partners from the SEE region and the EU. It is a result of 2 years of work which included the collection of data, literature review, consultations with stakeholders in more than 500 meetings, modelling energy pathways for 7 countries, with special focus on the transparency of data. It is presented in 2 formats: a medium complexity interface featuring energy data for each country (South East Europe 2050 Carbon Calculator [2]), and an animated video game that enables the public to develop his or her desirable energy future in SEE (South East Europe 2050 Energy Model [3]). Both web tools are available in English and in local languages.

Users can control the output of the models by making choices using a number of "levers". These levers make a change in either the supply or demand of energy in a particular sector, for example building additional wind farms, or reducing the distance people travel by car. The combination of these choices creates a "pathway", and the model then displays the implications of the pathway over time (for example in terms of energy demand, supply, emissions or costs). For each lever there is a number of options to choose from – most will have four possible "levels" labelled 1, 2, 3 and 4. Levels 1 to 4 are defined in the following way:

- Level 1: low or no effort;
- Level 2: effort described by most stakeholders as achievable;
- Level 3: effort needing significant change – hard but deliverable;
- Level 4: the maximum possible due to physical/engineering/behavioural constraints only.

This presentation briefly presents some of the results, while a full technical report provides a detailed analysis of two key pathways: a coal-dependent case called the "Road to Nowhere" based on all planned coal investments and the "EU Road" case where South East European countries successfully comply with the current EU environmental and climate policies [4]

Supply side of the model

Fossil fuels dominate the total energy mix in the Western Balkan region. Coal is the largest source, accounting for 41% of primary energy demand. Another 34% comes from oil, with gas providing 13%. Renewable sources – predominantly hydroelectricity and firewood for heating – make up 10% of total energy use. The region's electricity production mainly comes from coal/lignite (61%) – much of it from old, inefficient and highly polluting plants [5]. The rest comes from large hydropower which brings its own legal, environmental and social problems [6].

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[2] SEE hereinafter refers to Albania, Bosnia and Herzegovina, Croatia, the former Yugoslav Republic of Macedonia, Kosovo, Montenegro and Serbia.

Meanwhile, most parts of the region enjoy more than 250 days of sunshine per year. SEE has massive potential for using solar energy from domestic rooftop photovoltaic panels and water heaters. To date, this vast renewable resource has barely been touched.

By calculating the total roof space available for solar PV (taking into account solar thermal panels) on residential and public buildings based on the existing data and using average solar irradiation, the modelling team calculated a maximum technical potential for each country. This method suggests that even without the use of arable land to build solar parks, there is a huge potential in this technology.

Despite many areas with strong potential for wind power, SEE lags far behind the rest of Europe. While several countries are in the process of constructing their first wind farms, electricity generated from wind in the region is negligible. Based on the newly issued Wind Atlas Balkan commissioned by KFW [7] and very detailed data on capacity factors measured on different locations commissioned by SEE Change Net from Sander and Partner [4], 2050 energy models include values for potential use of onshore wind technology. According to this data average capacity factors in productive areas in the region range from 25% in Albania to 32% in Montenegro.

Country	Solar PV Maximum technical potential in 2050 (GW)	Onshore wind Maximum technical potential in 2050 (GW)
Albania	2.68	2.55
Bosnia and Herzegovina	6.36	7.55
Croatia	9.73	4.97
Kosovo*	3.9	1.55
fYRO Macedonia	3.63	1.25
Montenegro	1.18	0.72
Serbia	14.38	10.36

Table 1: Potential for Solar PV and Onshore wind technologies from SEE 2050 Energy Model, Level 4

Replacement of fossil fuels as the primary sources of energy for electricity generation and transportation needs to take place over the next few decades for the region to meet EU energy and climate targets. Growing penetration of renewable energy sources and expected shift to plug-in hybrid electric vehicles (PHEVs) and all electric vehicles (EVs) will require a much more dynamic electric infrastructure. The design of smart grids in the future will take advantage of storage in dealing with more dynamic loads and sources.

Demand side of the model

Traditionally, in many areas of SEE institutions, decision-makers were inclined towards increased energy supply as the centrepiece of energy policy, leaving important economic and social benefits of energy efficiency marginalised. Due in part to this mind set SEE countries are performing significantly below the EU average regarding energy efficiency

[8]. Throughout the region there are significant transmission and distribution losses. Almost 50% of all energy consumed in the region is consumed by buildings, and much of that energy is wasted as a result of inefficient buildings envelope and heating systems. The industrial and the transport sectors are also significant consumers.

The SEE 2050 Energy Model - as an open data tool - presents an attempt to also assess the importance of demand side sectors such as building, transport and industry in supporting a low-carbon energy transition in SEE as well as to offer policy insights on how the energy saving potentials can be best captured.

In the residential sector, for example, taking into account that, as part of the accession process to join the European Union, SEE countries are obliged to sooner or later meet the energy efficiency obligations under the acquis, the 2050 energy models present results for different energy and emissions pathways, reflecting different speeds of introduction and levels of the ambitiousness of the region's policy decisions and technology choices. This is illustrated in the table below.

	Performance of new buildings
Level 1	Heat demand of new home will decrease to standard of "very low energy" house of 30kWh/heated m² by 2030 without additional improvements by 2050
Level 2	Heat demand of each new home will decrease to standard of "very low energy" house of 30kWh/m² by 2025 and furthermore to "passive house" level by 2035
Level 3	Heat demand of each new home will decrease to standard of "passive house" level by 2025
Level 4	Heat demand of each new home will decrease to standard of "passive house" by 2020[3]

Table 2: Summary of assumptions for performance levels of new buildings, SEE 2050 Energy Model

Running an analysis using the SEE 2050 Energy Model shows that, even with the expected growth in floor space per person and thermal comfort for citizens of the region[4], by 2050 it is possible to greatly reduce the demand for heating and cooling in residential buildings (up to 50% below current levels) [2].

As a policy implication, SEE 2050 Energy Model results highlight the primary importance of ambitious energy performance levels in building codes for both new and retrofit buildings as well as the significance of early action. Considering the long lifetime of buildings, energy use for heating and cooling in 2050 will be still strongly determined by retrofit residential buildings. Relying only on the high energy performance of new buildings will not be sufficient to reach EU climate and energy objectives and attention should be paid to the existing buildings as well. At the same time, the SEE 2050 Energy Model cautions that if performance levels for retrofits remain low, increasing the speed and rate of retrofitting will leave significant fraction of energy saving potential locked-in.

Transport is another area with great opportunities for energy savings, where for example modal shift and shared vehicles alone can substantially reduce energy and costs even if kilometres travelled by person increase substantially by 2050. This overlaps with

[3] Assumptions (level 1—4) for Croatia differ, since it is already EU Member State
[4] The models assume 85% of home space will be heated by 2050.

measures needed to decrease high rates of motorized pollution, fatal accidents, congestion and noise present in the region, especially in the cities. In industries such as steel, cement and aluminium, currently available technologies allow for limited but nonetheless considerable potential for emissions and energy reductions.

	Level 1	Level 2	Level 3	Level 4
Non-motorized transport	3%	5%	8%	10%
Share of bus pkm in total (%)	32%	35%	37%	40%
Share of rail pkm in total (%)	4%	7%	9%	12%
Share of car pkm in total (%)	61%	53%	46%	38%

Table 3: Summary of assumptions for modal split in passenger transport in the region in 2050, SEE 2050 Energy Model

For energy efficiency to scale, as has been assumed in higher ambition levels in SEE 2050 Energy Model, SEE governments' priority for energy efficiency must be questioned [9]. As shown in the Energy Community study, $500 million earmarked for energy efficiency projects has been underutilised at the time of publishing [8]. There is a need in the region to improve governance [10] and to ensure that effective energy efficiency implementation systems are in place. There is also a need for both bilateral and multilateral external support to prioritise energy efficiency [11], to provide capacity building and to help the region design and implement energy efficiency measures.

Less ambitious energy efficiency targets will widen the already existing gap between SEE and the EU, and countries of South East Europe may not be able to reach the level of energy performance of advanced member states in the future. Unaddressed efficiency will in the long run increase costs to public finances, to businesses and to individuals and will undermine large potential to meet future energy needs without resorting to more marginal and harmful sources of energy.

Costing and the SEE 2050 Energy Model

Supply side cost assumptions in the SEE 2050 Energy Model are based on an analysis of LCOE (Levelized Cost Of Electricity) and investment costs for different supply technologies in South East Europe, made by Mr. Guy Turner, former Chief Economist of Bloomberg and founder of Trove Research [12]. Table below details the range of capital expenditure costs over time for the different technologies explored in the SEE 2050 Energy Model. These costs do not include any calculation of externalities which would greatly impact the cost of fossil fuel based solutions and is a factor which will be modelled in future versions of this work.

Technology	CAPEX 2015	CAPEX 2020	CAPEX 2025	CAPEX 2030	CAPEX 2035	CAPEX 2040	CAPEX 2045	CAPEX 2050
Coal (low-high)	1600–2300	1600–2300	1600–2300	1600–2300	1600–2300	1600–2300	1600–2300	1600–2300
Gas	688–738	674–723	664–712	654–701	640–686	626–672	612–657	599–642
Onshore wind	1200–1400	1140–1330	1313–1125	1110–1295	1107–1292	1104–1288	1092–1274	1080–1260
Large hydro	1270–3320	1270–3320	1270–3320	1270–3320	1270–3320	1270–3320	1270–3320	1270–3320
Small hydro	1270–5000	1270–5000	1270–5000	1270–5000	1270–5000	1270–5000	1270–5000	1270–5000
Solar PV	869–1127	669–868	474–614	278–361	261–338	243–316	222–287	200–259

Table 4: Range of capital expenditure cost for different technologies in South East Europe until 2050 in €/kW, SEE 2050 Energy Model

Supply and demand side costs, with their pre-defined trajectories by 2050, enable the SEE 2050 Energy Model to compare overall energy system costs across different energy transition pathways.

Running an analysis using the SEE 2050 Energy Model shows that pathways which meet the EU goal of 80% reduction in GHG emissions from 1990 levels could be directly competitive or about 1.5 billion EUR less per year compared to pathways based on fossil fuels in infrastructural capital, operating, maintenance, and fuel costs [12].

Decisions and investments made today will either prevent or enable the SEE countries in meeting the 2050 climate and decarbonisation targets. The SEE 2050 Energy Model shows that all the accession countries of SEE could meet the 2020, 2030 and 2050 energy targets and within a reasonable cost envelope compared to their current plans. This now active policy tool is unique within our region and represents the first and only attempt to build a fact-based dialogue around open source data using verified costs.

With potential for use of renewables and rapid development in technology, alongside large energy efficiency potential, it is not a question of feasibility but of willingness in choosing the right pathway for SEE region.

Resumes

Ms. Ana Ranković, is co-founder of civil society organization Fractal, based in Belgrade. Her areas of work and research include crosscutting issues between conflict transformation, sustainable development and energy and environment. Over the last 3 years she has worked with the team of 18 CSOs from South East Europe, under the regional program SEESEP. It included building 7 national and the regional SEE 2050 Energy Model, where her role has been to support collaboration on regional level as well as alignment and integration of national modelling efforts through ongoing facilitation and data management assistance. Her contribution also included research and coordination around demand side modelling, especially buildings and transport sectors.

Ms. Naida Taso is an Energy Specialist at SEE Change Net since 2012, working on the South East Europe Sustainable Energy Policy (SEE SEP) Programme as a team leader for the supply side of the energy modelling. She studied at the Faculty of Electrical Engineering at the University of Sarajevo. She has completed both her Bachelor’s and Master’s degree in Renewable Energy (Geothermal Energy and Small Hydro Power Plants). Among many conferences and workshops where she presented outcomes of her work, she also presented the South East Europe 2050 Energy Model on the "International conference on the 2050 Calculator" in Taipei, Taiwan.

2.2 Session 2: Country Case Studies

2.2.1 Exploring energy scenarios for South-East European Countries in a regional context: A case study for Albania *(Mario Tot, IAEA)*

Presentation Abstract

The Republic of Albania is a small, open economy and thus very much dependent on international trade and international market prices. Likewise, the Albanian energy sector is small and is highly reliant on fuel imports and, especially, electricity exchanges with its neighbours.

This case study analyses alternative future energy supply options of Albania. The analysis extends beyond the national territory and accounts for the existing and future possible links to neighbouring countries as well as potential energy system development within the region. The main factors influencing future deployment of electricity supply options were identified to develop alternative electricity supply strategies:

- Availability of primary energy forms and technological options for electricity generation:
    - Natural gas – Supply routes are subject to decision of parties involved in the regional projects;
    - Coal – Use of regional resources and/or import is subject to GHG regulations;
    - Development of nuclear power programs and its regional dimension;
- Fuel prices and electricity market;
- Environmental regulation (future obligation to mitigate GHG emissions); and
- Security of supply issues and policies.

In the above context, the study examines three main electricity supply scenarios:

- The Reference Scenario assumes continuation of the current energy trends and policies. In this scenario natural gas is not reaching the region and nuclear power is not an option;
- The Competition Scenario assumes free competition between all electricity supply options taking into account their earliest availability;
- The Renewable Energy Scenario assumes free competition between electricity supply options and active state policy on promotion and use of renewables; and
- The Natural Gas Scenario assumes the 'gasification' of the region including the intensive use of natural gas for electricity generation.

Large and small hydro projects are the most competitive options. Reliance on domestic hydro generation and fuel oil/diesel for thermal plants would gradually worsen electricity supply, leading to an increased dependence on import and larger uncertainty due to variable hydro conditions. Hydrological patterns are similar in whole sub-region and hydro potential is limited and cannot supply long term electricity demand. Share of imported electricity in total electricity supply by 2040 would be in the range 22-34% (even though all identified remaining hydro potential is employed). These factors indicate that a continuation of current trends and policies risks increased electricity supply problems. Therefore, consideration of other options is necessary.

Coal is the most competitive among alternatives, but brings environmental issues and risks. Deployment of coal options would require the development of appropriate infrastructure. Timely actions would be needed to make this option implementable in the assumed time framework (i.e. from 2020). Under the coal option, carbon dioxide emission would increase significantly. Therefore, use of coal in electricity generation will have to be balanced against expected future commitments in emission mitigation and avoidance.

Natural gas brings uncertainty in terms of availability and prices, as its availability is closely related to the regional gas supply projects. These projects bring uncertainty over

the earliest year at which the gas option would be available. The second component to be taken into account is the price competitiveness and the volatility of natural gas prices. Coupled with the hydro option, natural gas proves to be able to contribute to the security of electricity supply (reduction of electricity import), while maintaining relatively low carbon intensity.

The nuclear option offers stable generation costs and low emissions, but requires large upfront investment and long lead time for overall infrastructure preparation. The development of a nuclear power programme is an interesting option from the regional point of view due to the relatively large unit size (compared to the size of the Albanian system and economy).

At present, Albania is almost fully relying on hydro power. There are several more river basins to be developed, but the share of hydro power in electricity supply is expected to decrease in the future. Potential for other renewable options (i.e. wind and solar) is significant, but wider use of these sources depends on the state policy. At present, only small hydro is a competitive option.

Albania and the region are relying on hydro generation and relatively old, low efficient coal plants. Hydrology variations cause electricity supply problems and the region is a net importer of electricity.

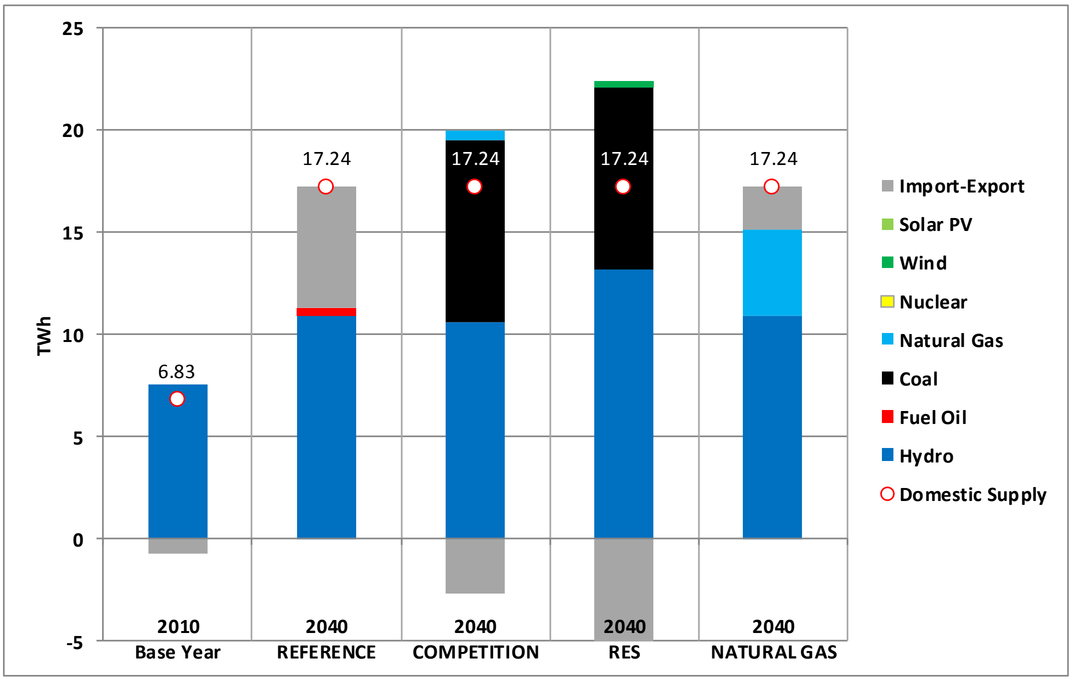

Figure 5 Power generation scenarios for Albania in 2040

Hydro based electricity will continue to dominate the regional generation portfolio. Analysis shows that hydro potential available in four of the region's power systems is competitive and hydro capacities should be significantly developed in the future. On the other side, security of supply requires a diversified supply portfolio and more "firm" capacity is needed to dampen seasonal variability.

One of the most competitive options in the region is large, low-cost coal in Kosovo area. However, extensive use of this abundant resource would cause major environmental concerns.

Techno - economic analysis shows that existing interconnections are enough to support power exchanges under normal conditions. Submarine interconnections to Italy depend on the assumed difference in market prices and generating options available in SEE area.

Environmental policies will play a key role in the selection of future electricity generation options. Countries under consideration presently do not have obligation to reduce GHG emissions. The introduction of a region-wide policy framework or emission mitigation strategies are expected to significantly influence competitiveness of different generation options, especially as countries continue to progress towards EU accession.

Resume

Mr. Mario Tot joined the IAEA's Planning and Economic Studies Section as an Energy Systems Analyst in January 2011, where he works on capacity building in Member States in the area of sustainable energy issues and planning, cooperate with Member States towards meeting their national energy development objectives and collaborate within the Section on developing and enhancing energy modelling tools, as well as preparing and contributing to analyses and studies. Before joining the IAEA, Mr. Tot was a Senior Researcher and Deputy Head of the Department for Energy Generation and Conversion at Energy Institute Hrvoje Pozar, Zagreb, Croatia (1999-2010). He worked in the field of long term power generation expansion planning and sustainable energy system development. Mr. Tot holds a Master Degree in Electrical Engineering from University of Zagreb and is currently studying for his PhD at the same university. He is author or co-author of more than 80 technical and scientific papers and reports.

2.2.2 Integration of the Balkan region into the JRC-EU-TIMES model *(Rocco De Miglio, E4SMA)*

Presentation Abstract

According to the European Union's definition, the Western Balkans region refers to the area of Albania and all the former Yugoslavia (excluding Slovenia) with a population of approximately 25 million. Countries present high levels of energy intensity (in some cases even greater than the world average, around 0.25 toe/thousand USD_{2000}), large amounts of energy imports (35%-55% in terms of fraction of the total primary energy supply, mainly oil and oil products), increasing energy-demand trends (annual growth rates up to 3-3.5%), and, more in general, high investment needs for generation and transmission capacities as well as for demand equipment stocks.

Several modelling experiences have been undertaken in the past years (mainly at country level) with the aim to explore emission scenarios, energy-related strategies and to assess policies and measures. But reliable energy-related data are few for most of the countries in the area, with severe implications in terms of comparability of the energy systems performances, and in the monitoring of the impacts/effects of the energy-environmental measures. The need for harmonisation of approaches to data collection and processing, as well as of planning methodologies, assumptions and metrics, with European and international standards has been also recently emphasised by the recent ECRAN [13] project.

Existing "physical" interconnections (power grid and natural gas infrastructure) and "strategic" decisions (energy-environmental measures and investments to tackle the "key" challenge of a sustainable development of the countries) make the "integrated" analysis of a Pan-European (including the Balkans) energy system much more consistent/promising than the sum of stand-alone planning exercises and outcomes.

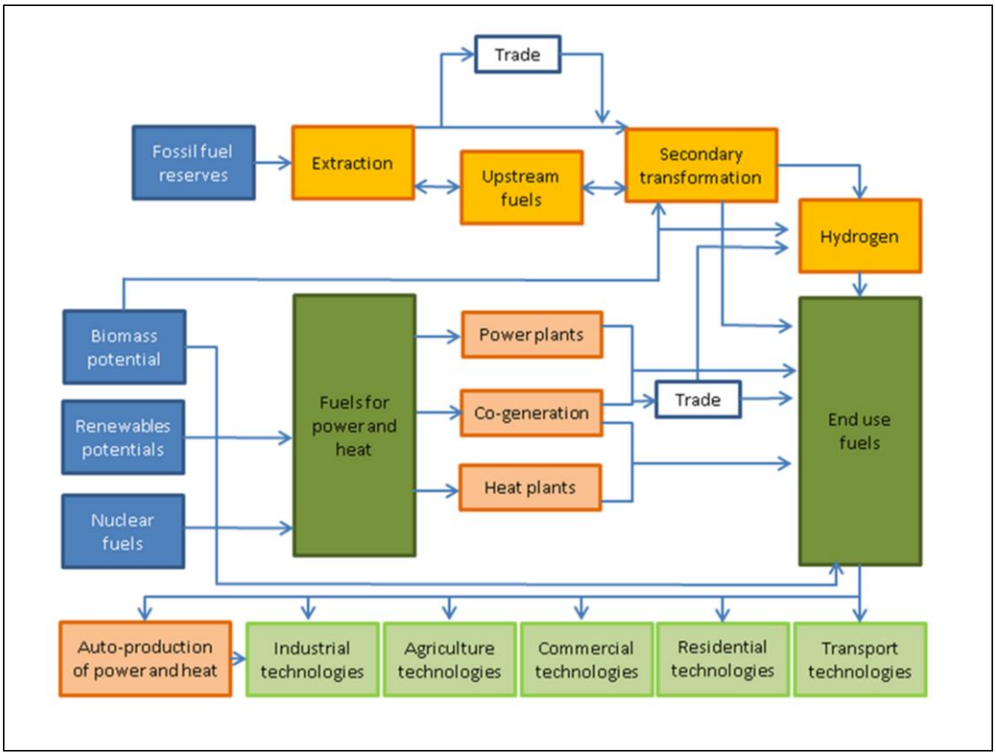

Figure 6: Reference Energy System of the JRC-EU-TIMES model

The JRC-EU-TIMES model (JET) [14] is a bottom-up, technology rich model of the whole European energy system, representing 28 EU Member States (EU28) plus Switzerland, Iceland and Norway and the seven Balkan countries (Albania, Kosovo, FYROM, Montenegro, Serbia, Croatia, Bosnia & Herzegovina) from 2010 to 2050 (and beyond), with each country constituting one region of the model.

The structure of the model is reported in the figure below. Supply side and demand side are both explicitly represented for each region, and cross-border flows and capacities are also taken into consideration. When the model is solved, the intra-temporal and inter-temporal equilibrium is calculated and two complementary sets of system elements reported: economic aspects (investment costs, prices, etc.) and technical aspects (energy consumption, emissions, etc.).

The model is driven by a set of demands for energy services in all sectors: agriculture, residential, commercial, industry, and transportation.

In order to allow a fully consistent integration of the Balkan countries in the JET structure, a step-based loop procedure for the description and calibration of the seven Balkan national energy systems in the base year (2010) was undertaken – breakdown procedure of the National Energy Balance "by end-use", for residential and commercial sectors – on the basis of the following steps:

- allocation of a consumption fraction by "dwelling type" and by "end-use", based on the shares of "similar" countries and other simple assumptions (e.g. coal and biomass in the rural areas, district heating and natural gas delivered in the urban (multi-apartment) context, connection to district heating systems or natural gas distribution networks for both space heating and water heating demands),
- technical description of existing demand technologies (flow-in, flow-out, efficiency, availability factor), and allocation of a fraction of consumption to each process, in order to calculate the demand share covered by each single device represented in the model;
- re-adjustment of allocations at steps 1) and 2) in order to get consistent values for the most important control-variables (indicators).

Resumes

Mr. Rocco De Miglio is an expert in Management Engineering, more particularly in the development and the application of decision support systems in the energy field. Since 2004 he worked as a research collaborator at Politecnico di Torino, taking part in several energy-system related projects within the European context. Since the beginning of 2011 he has been fully engaged in the activities of E4SMA, as system analyst and modeller, working with decision science techniques and tools such as TIMES-VEDA, LEAP, Visual Promethee, and others. Among the other activities, he supported the development and use of the Italian multiregional energy system model (MONET), the further extension and update of the JRC-EU-TIMES model, as well as the design of energy system models of Kazakhstan and of the Central Asian Caspian area. He also took part on the preparation of the Third National Communication of Kazakhstan for the UNFCCC. Mr. De Miglio has recently undertaken hands-on trainings with the key stakeholders and contributed to the further capacity building of local experts, within the framework for Technical Assistance to support the reform of the Energy Sector for the Republic of Egypt.

2.2.3 The new Serbian Energy Sector Development Strategy until 2025 and projections until 2030 *(Biljana Ramić, Ministry of Mining and Energy Republic of Serbia & Dejan Ivezić, University of Belgrade)*

Presentation Abstract

In accordance with the Energy Law - the main Serbian strategic documents are as follows:

- Energy strategy (with the projections up to 2030), adopted by Serbian Assembly on December 4th, 2015)
- Program for the Implementation of the Energy Strategy (defines activities, measures and projects for the period of 6 years)
- Energy balance (annual document: realisation for the previous year, estimation for the current year and projection for the following year; improvement of the energy statistics: IPA 2010 project and IPA 2012 project).

Providing energy security, energy market development and overall transition towards a sustainable energy sector are proposed as the key principles in "The Energy Sector Development Strategy of the Republic of Serbia for the period until 2025 with projections to 2030". The Strategy proposes a development of the energy sector in the Republic of Serbia with significantly less impact on the environment. In the same time, the proposed development should be market and economically efficient enough to generate sector own development and to represent the generator and the basis for economic development.

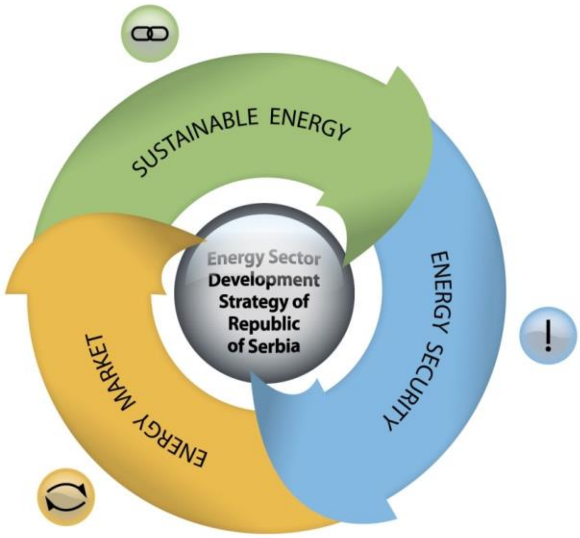

Figure 7: Serbian new energy strategy pillars.

The new Energy strategy is written in accordance with the energy strategy of the Energy Community, but also, with an idea to be a realistic strategic document based on the structure of the Serbian energy sector, the availability of energy resources and the potentials of fossil fuels and renewable energy sources, possibilities of improvement of the energy mix with a more significant share of RES, the implementation of the security of supply aspect, the acceptance of energy efficiency as a new energy source, and a strong implementation of environmental aspects for the future energy sector development.

The main principles and priorities of the Strategy are, as follows:

- Energy Security
    - Reliable, safe and quality supply of energy,

- Creating conditions for the safe and reliable energy systems operation and sustainable development;

- Energy Market
    - Energy market competition based on the principles of non-discrimination, publicity and transparency,
    - Energy and energy sources' customers protection,
    - Electricity and natural gas market development and their connecting with the regional and internal EU market,
    - Connecting the energy system of the Republic of Serbia with the energy systems of other countries;
- Sustainable Energy
    - Providing conditions for promoting energy efficiency in carrying out energy activities and energy consumption,
    - Creating economic, commercial and financial conditions for generating energy from RES and combined heat and electricity generation,
    - Creating conditions for the use of new energy sources,
    - Promoting environmental protection in all energy related areas,
    - Creating conditions for investments into the energy sector.

The Strategy has proposed and analysed two different scenarios for the energy sector development. The reference (BAU) scenario refers to the continuation of the current energy consumption trend, while the second scenario implies the maximum promotion of measures for energy efficiency improvement within all phases of energy sector cycle.

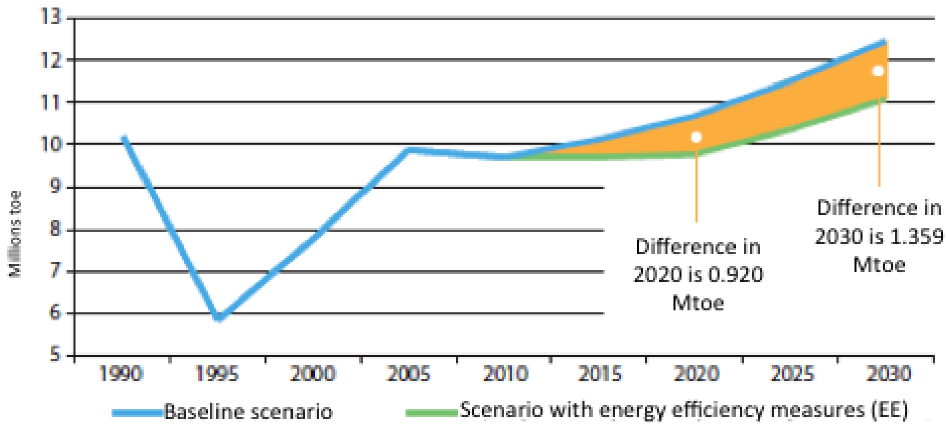

Figure 8: Projections of final energy consumption by different scenarios

Basic assumptions used for scenario development, projections of final energy demand (presented at figure above) and primary energy supply are discussed, as well as relevant indicators. Analysis of both proposed scenarios include the analysis of the current state, strategic objectives and activities, as well as priority actions for all energy sectors. An appropriate legislative, institutional and socio-economic framework is analysed through the impact of international obligations, the development of an institutional framework, a legal and market framework, the social and economic aspects of planned development, as well as through horizontal harmonisation of the energy and related sectors. Based on the results of the proposed scenarios, possible developments of the Serbian energy sector until 2050 are discussed.

Resume

Dr. Dejan Ivezić is full professor at the University of Belgrade-Faculty of Mining and Geology, and manager of Centre for Energy. He teaches graduate and postgraduate courses in energy modelling and control of energy processes. His teaching and research interests include sustainable development, environmental protection concerning negative impact of energy activities, energy efficiency and renewable energy sources utilization and conservation of natural resources. He also, directed and cooperated in projects related to exploitation and maintenance of energy facilities, machines and equipment etc.

Ms. Biljana Ramić, MSc mechanical engineer has been employed in the Ministry of Mining and Energy, Republic of Serbia, since 2003. She is on the position of the Head of the Department for the strategic planning in the energy sector. She is in charge for the preparation and monitoring energy strategy, program for the implementation energy strategy, energy balance. Her job includes also development many terms of references for project proposal and monitoring projects realization from IPA, Norwegian donation, KfW or financed through the budget of Republic of Serbia She was the representative of Republic of Serbia in the Task Force in Energy Community for development of Energy strategy of Energy Community and PECI list, representative of Republic of Serbia in Energy Community in matters concerning energy statistics. She is the representative of Serbia as one of the coordinators for energy in the Pillar 2 (Transport and Energy) on the EU Strategy for Adriatic and Ionian Sea (EUSAIR). She is also Member of Ministry's Working group for security of supply and the member of the Government negotiation group for Chapter 15.

2.2.4 Updating the strategy for energy development of the FYR Macedonia until 2035: Lessons Learned *(Viktor Andonov, Ministry of Economy of FYR Macedonia & Aleksandar Dedinec, RCESD-MASA)*

Presentation Abstract

In preparation of the updated Strategy for energy development of the FYR Macedonia, cooperation between the government and key energy stakeholders in the country was essential. According to the Energy Law of the FYR Macedonia, the Government is required every five years to adopt a Strategy for energy development for a period of 20 years. IT is also obliged to adopt a five-year program for the implementation of the Strategy. The implementation of the program is monitored through annual reports that should also be adopted by the Government. The last Strategy for energy development was adopted by the Government in 2010 and as a result of commitments the plan was to adopt a new Strategy in 2015. The process of preparation of the new Strategy started at the end of 2014. The currently adopted Strategy was developed by the Research Center for Energy and Sustainable Development (RCESD) at the Macedonian Academy of Sciences and Arts (MASA). As a result of the good institutional cooperation between the Ministry of Economy and RCESD, it was decided that this Center should also prepare the new Strategy. The preparation of the new strategy was financially supported by the USAID through the TETRATECH Company, which, at that time, was implementing a regional project. At the beginning, all sides included in the process agreed that for the analyses under the new strategy the MARKAL energy planning model will be used, because RCESD already has accumulated a lot of experiences in the application of this model for energy planning.

The process for the preparation of the Strategy was improved by establishing an Advisory Committee with the main goal to serve as a link between the Ministries of the Government, the key energy stakeholders and the experts. Hence, the main tasks of this body were: providing and verifying input data needed for the MARKAL model, accepting the frame of the Strategy and scenarios and analysing and confirming obtained results. Some employees of the Ministry of Economy were involved in the process of modelling, which considerably contributed to their understanding of the process of modelling and planning. Also, experts from USAID and TETRATECH were involved to comment and discuss the results.

The first stage was to present the MARKAL model to the Advisory Committee members and explain what input data are needed and what kind of outputs can be obtained from the model.

In parallel with the collection of the required data for the MARKAL model, the model was adjusted to the requirements of the Ministry regarding the planning period. One of the problems was related to the inconsistencies of the input data received from different sources, and even from the same data source when obtained on different occasions. After the in-depth analyses of the input data the model was calibrated using all new data. The first step was the creation of a document with twenty four scenarios. The main goal of this document was to see the energy development of the FYR Macedonia using different values for the key drivers which are GDP growth and population growth. Since energy development depends on the available energy sources and their prices, as well as on the available technologies for production, transmission and consumption of energy, their efficiencies and costs, different scenarios were created also making a variety of assumptions for these issues. This document together with separate documents with the strengths, weaknesses, opportunities, and threats (SWOT) matrix and Benchmark analyses, were presented to the Advisory Committee. After a discussion and after receiving all the comments from the Advisory Committee members, the draft version of the Strategy was developed. In this version only three scenarios were presented: Baseline, Energy Efficiency and Energy Efficiency and Renewable Energy Sources. The draft version was presented again and after that the final version was developed

including additional sensitivity analyses and indicators in order to compare the results obtained from the model and actual data from the EU-28.

The process for the preparation of the national energy development strategy was successful thanks to the establishment of the Advisory Committee. Despite the fact that committee members occasionally ventured on issues beyond their area of expertise the committee's feedback in the process was particularly beneficial. Moreover, the collaboration among the Ministry of Economy, USAID, TETRATECH and the RCESD-MASA was highly satisfactory, which was of utmost importance for the whole process.

Resume

Mr. Viktor Andonov is a MSc in electrical engineering, working with the Energy Department in the Ministry of Economy of the FYR Macedonia since 2006. In the period 2009 – 2012 he was "core" group member of the strategic planning team in the framework of the Macedonian Academy of Science and Arts working with the MARKAL software for strategic planning. He is the National Coordinator for energy statistics and member of the Security of Supply Coordination Group in the Secretariat of the energy community.

Mr. Aleksandar Dedinec is an expert modeller and analyst specializing in the energy, energy efficiency and climate change sectors. At present he is a Research Assistant at the Research Center for Energy and Sustainable Development of the Macedonian Academy of Sciences and Arts (RCESD-MASA) and a PhD candidate at the Faculty of Electrical Engineering and Information Technologies. He is one of the lead persons on the MARKAL energy strategy modelling in Macedonia. He is participating in several projects related to energy strategies, energy efficiency and renewable energy sources, as well as climate change, including: GHG inventories, climate change mitigation in various sectors, energy efficiency and GHG emissions indicators, and strategic energy planning. Mr. Dedinec holds a Master of Science in Electrical Engineering and Information Technologies. He is also experienced in computer science, robotics, and automation.

2.3 Session 3: Technology aspects

2.3.1 Carbon Capture and Storage Options for Electricity Generation in South Eastern Europe *(Mr. Damir PEŠUT, EIHP)*

Background

Power markets in the South Eastern Europe (SEE) are dominated by national public companies. Generation expansion in the region is influenced by projects in neighbouring systems, foreseen interconnections to the large Italian market, the availability of natural gas supply from outside of the region (transit area), future obligations regarding greenhouse gas (GHG) emissions and of use of renewable sources as well as energy efficiency policies.

A detailed power system model of the South Eastern Europe was developed comprising Croatia (HR), Bosnia and Herzegovina (BA), Serbia (RS), Kosovo (KO), Montenegro (MN), Albania (AL) and former Yugoslavian Republic of Macedonia (MK). Connections to the neighbouring zones were modelled as market nodes with predefined prices and capacity limits. It is expected that all countries will become full member countries of the EU by the end of the planning horizon (i.e. by 2030).

The important framework in which power and energy systems operate throughout the SEE area is the Energy Community (EC) and the ongoing and expected integration processes of the countries into the European Union's energy map.

The conflicts of the 1990s led to the disintegration of a unified energy system. The South Eastern European region needed a framework in which it could cooperate on: rebuilding energy networks, ensuring the stability for vital investment, and creating the conditions in which its economies can be rebuilt effectively.

Parallel to the evolution of the European internal energy market, the EU took an active role in promoting stability and sustainable development in SEE. The integration of the electricity market was the first initiative, later followed by the integration of gas markets and the harmonization of the legal framework for energy and the environment.

In October 2005 the European Community and Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, the former Yugoslav Republic of Macedonia, Romania, Serbia and UNMIK on behalf of Kosovo signed the Treaty establishing the Energy Community (EC). The Energy Community extends the EU internal energy market to South Eastern Europe on the ground of a legally binding framework. Following the ratification and notification process, the Treaty entered into force on 1 July 2006.

Figure 9: Countries to be referred to as the SEE area

The Contracting Parties have committed themselves to implement the relevant *acquis communautaire*[***]. The Treaty includes key EU legal acts in the area of electricity, gas, the environment and renewable energy.

In the south east European area under consideration the electricity market is characterized by the domination of national power companies. In most cases these companies are publicly owned and control both generation and distribution/supply assets. There is no organized market place, and trade among parties is bilateral. Throughout the region there are private investors in the power generation area, mainly in the wind and other small scale renewable, but there is also a substantial interest in large scale coal and hydro based projects.

Apart from the existing and planned power generation projects in the south east European area, future development of electricity markets is influenced by energy projects in neighbouring systems, such as the nuclear power programs in Romania, Bulgaria and Slovenia, the foreseen connections to the Italian market, the availability of natural gas from outside the region, the anticipated obligations in reduction and/or stabilization of GHG emissions, the use of renewables and the implementation of energy efficiency policies.

Aims

The objectives of the current analysis were twofold. On one hand the objective was to consider the development of power generation in SEE and the estimation of the future role and competitiveness of natural gas technologies.

On the other hand, an additional objective was to assess the potential deployment of Carbon Capture and Storage (CCS) technologies in SEE for the period up to 2030. There are different aspects that could be considered in this evaluation (e.g. regulation, environmental, security) while the analysis focuses on the techno-economic assessment of CCS.

CCS is one of the technologies under consideration for the reduction of carbon dioxide (CO_2) emissions and it is particularly suitable for thermal power generation (i.e. for concentrated CO_2 emission sources). The development of CCS power plants is also of interest to the different activities in the gas and oil industries (e.g. transportation, Enhanced Oil/Gas Recovery, exploration activities) and certain synergies between gas/oil and power industries could be achieved by the careful and timely development of an appropriate regulatory framework for the implementation of CCS projects.

Methods

Our analysis summarises results of the three studies [15] [16] [17] to which authors contributed since 2009. The first study [17] considers possible natural gas demand in SEE and estimates the feasibility of the envisaged regional gasification project subject to the natural gas supply from outside of the region (i.e. construction of transit gas pipelines for the Western European gas markets).

Natural gas markets in the SEE countries are relatively small in terms of current and future gas consumption. Inevitably, it is more difficult to develop and finance infrastructure for the future natural gas consumption. Case studies for the development of local gas networks (i.e. city/town level) showed economic viability of the expansion assuming that gas can be supplied (i.e. transported) to the region at reasonable cost.

To increase the penetration of natural gas in the SEE region large investments in the transmission infrastructure are needed in order to bring the natural gas to the SEE markets. In order to make transmission infrastructure investments economically viable, immediate operation is required after their completion. In other words development of the transmission networks requires simultaneous and coordinated development of gas power plants as "anchor" loads. Distribution networks then can be built and gradually develop upon this base. The study has used power development scenarios from [18] to estimate the amount of gas demand in the power sector. To make the gas investments viable in the first place, one of the key finding was to have a minimum of 2 to 2.5 Bcm of "anchor" demand from the first year of operation of the new gas transmission infrastructure.

The second study [16] identified cornerstones in gas consumption, country by country, i.e. system by system. Apart for some industries (e.g. petrochemical), the main consumers of natural gas in the region could be power plants. Therefore a techno-economic model of the power generation expansion in countries under consideration was established using the Wien Automatic System Package (WASP) [19]. The same model was used in the study [18], but this time the authors assumed a more conservative (and more realistic) approach in terms of slower development and full integration of the regional power market. The previously mentioned study [18] assumed a completely integrated power market and the power projects were purely based on their economic viability. These assumptions led to a result in which large coal-based power plants were constructed in one sub-region while thermal power plants in other sub-regions gradually phased out. This study also neglected the potential influence of expected future obligations of CO_2 emission reduction.

The study [16] analysed the natural gas demand for the period up to 2030 based on the projections of the total useful heat demand (in households, services and industry) in the region. This consumption was then complemented with the projected consumption of natural gas from power plants and refineries.

Analysis of the energy demand in the reference or base year (2006) uses International Energy Agency (IEA) statistics [20]. Energy balances of the countries were cross-checked and updated using the latest supplementary data collected by authors from different publicly available sources and reports. In some previous projects authors have conducted several surveys of the current energy demand patterns in the regions.

Demand analyses and projections were repeated for two economic development scenarios – reference (expected increase of the Gross Domestic Product (GDP)) and pessimistic (lower increase of GDP).

Development of the power market was assessed taking into account possible limits in CO_2 emission and using a country by country approach. Model was not integrated across the region, but limited trade options were simulated. A techno-economic model was used in iterations to take into account possible dynamics of natural gas network development.

In this way, the development of the gas transportation network in any sub-region was not possible before gas power plants were planned (i.e. before gas option was competitive option in power generation in any particular sub-area).

Using motor fuels and heating demand analysis and projections, oil refining capacities in the region were estimated and consumption of natural gas in those facilities was calculated (energy for transformations). Non-energy consumption of natural gas in chemical and fertilizer facilities was also taken into account. Demand analysis and projections were done country by country.

Finally the study [17] work was based on an integrated regional power system model taking into account interconnections between national power systems, as well as incorporating CCS options for coal and gas power plants. For this purpose a linear programming framework using the International Atomic Energy Agency's (IAEA) Model for Energy Supply Strategy Alternatives and their General Environmental Impact (MESSAGE, [21]).

Results

Some countries under consideration have already exploited their hydro potential while some have large reserves of lignite (and to some extent of brown coal). Different, system wide and specific power plant (pre)feasibility studies give priority to the construction of coal based power plants using the domestic, readily available and low priced lignite resource.

The general direction of national energy policies in the region is reaching a high degree of power supply security by the development of domestic resources (mostly coal and to the limited extent hydro) while constantly improving environmental compatibility of future power projects. The second sub-objective is of a particular interest in this work as it opens a door to the natural gas power plant projects, especially from the point of view of CO_2 emission reduction potential as an interim measure in climate change combat. Other important advantages of gas power plants are their operational flexibility and speed at which those project can be implemented once the gas supply route is established (usually about 3 years which is much shorter compared to a large coal, hydro or nuclear project).

The following figure compares the projected consumption of natural gas for two scenarios – referent and lower GDP as it was estimated in [16].

At the beginning of the period (2006 was the base year) natural gas consumption was 5.48 Bcm and is expected to increase in 2030 to 21.05 and 19.71 Bcm, for referent and pessimistic scenarios respectively as presented in the next figure.

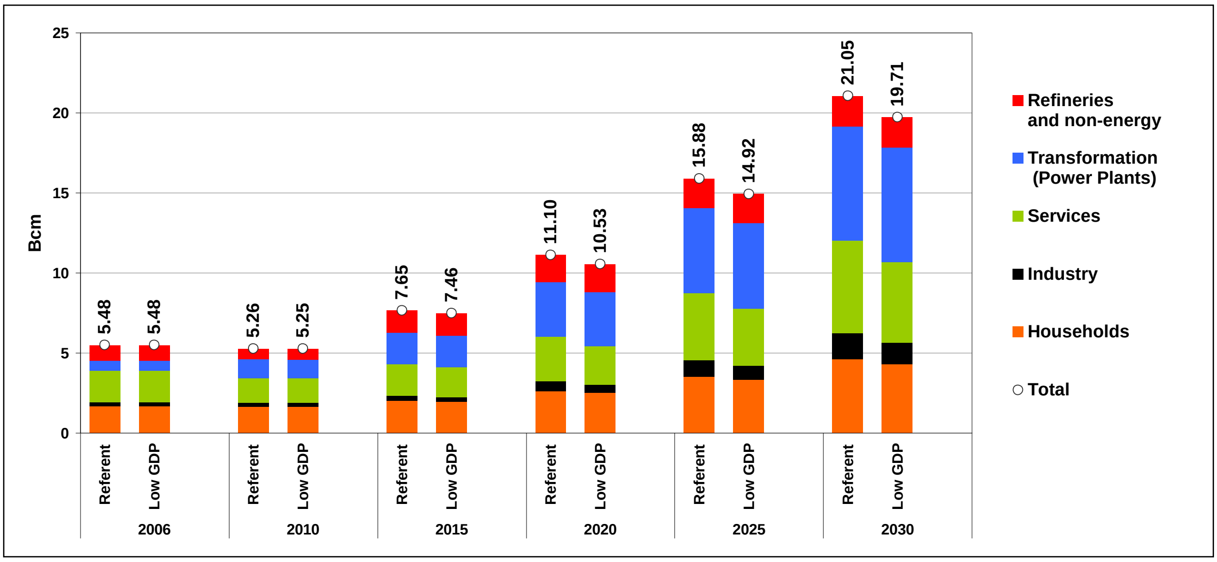

Figure 10: Projected total consumption of natural gas in SEE region (referent and pessimistic scenarios) until 2030 [16]

The highest relative increase in natural gas consumption is expected from systems in which gas networks are at the very beginning of their development. Absolute consumption in those systems will however remain below consumption levels in more mature markets. Total consumption will increase by almost four times from 2006 to 2030.

Final natural gas consumption (households, services and industry) in the pessimistic scenario is expected to be 12% below the referent scenario. At the same time, the expected drop in the total natural gas demand is expected to be only 6%.

Almost all of the existing thermal power plants will be decommissioned by 2030 and they will have to be replaced by new units. The gap between the current power supply and the expected increase of power consumption will have to be closed by the construction of new generation capacities.

The main generation options in the region are coal based thermal power plants and large hydro power plants. The use of natural gas for electricity generation is limited due to the lack of gas networks. Only some sub regions have suitable gas supply. But by 2020 gas network should be well developed. The development of large scale gas supply routes from Russia and/or the Caspian area is expected.

In [17] evaluation of the technical potential of CCS was done on all levels (capturing, transportation and storage capacity). A linear programming model was used to carry out techno-economic analysis.

Several scenarios were considered to analyse the future power generation mix (free competition or reference scenario, national security of supply policies, market integration, limited CO_2 emission, CO_2 price/trade, subsidies for the development of CCS and/or renewables and other).

The following results were analysed and compared across scenarios:

- Structure of the primary energy for power generation;
- Structure of the production capacity;
- Structure of the power generation;
- Investment into new power plants;
- Carbon dioxide emission (total and intensity per kWh);

- Total generation system costs (i.e. total discounted cost of operation and construction of power plants);
- Shadow prices i.e. marginal cost of power generation and
- Average production cost.

Total annual emissions from power generation in the region are 55.2 Mt of CO_2, of which 50.5 Mt are attributed to coal plants. A lack of local power production is evident.

A screening curve analysis shows that in the reference case the most competitive option is the conventional coal generation, followed by natural gas and nuclear. If a CO_2 price of 25 USD per ton of CO_2 emitted is introduced, coal and nuclear options are close, followed by gas. CCS still rests above these. Further increase of carbon tax to 50 USD/ton CO_2 leaves nuclear as the most competitive, while coal, CCS coal and gas options compete for the second place. The competitiveness of CCS gas options is heavily influenced by natural gas prices. But from the investor's point of view gas plants are more attractive as they are less investment intensive and are more flexible in sitting and operation.

At the beginning of the period the region is a net importer of power. Electricity imports are expected to further increase until 2015. However, if plans for the development of local coal resources are to be realized by 2020, there could be complete reversal of the situation and the region could become a net electricity exporter. The role of natural gas option for electricity generation can be significant, especially as a solution during a transition towards low emission technologies (renewables, CCS, nuclear). The attractiveness of CCS options is directly related to the future GHG policies, while CCS in combination with Enhanced Oil Recovery (EOR) represents a promising technological option from an economical point of view.

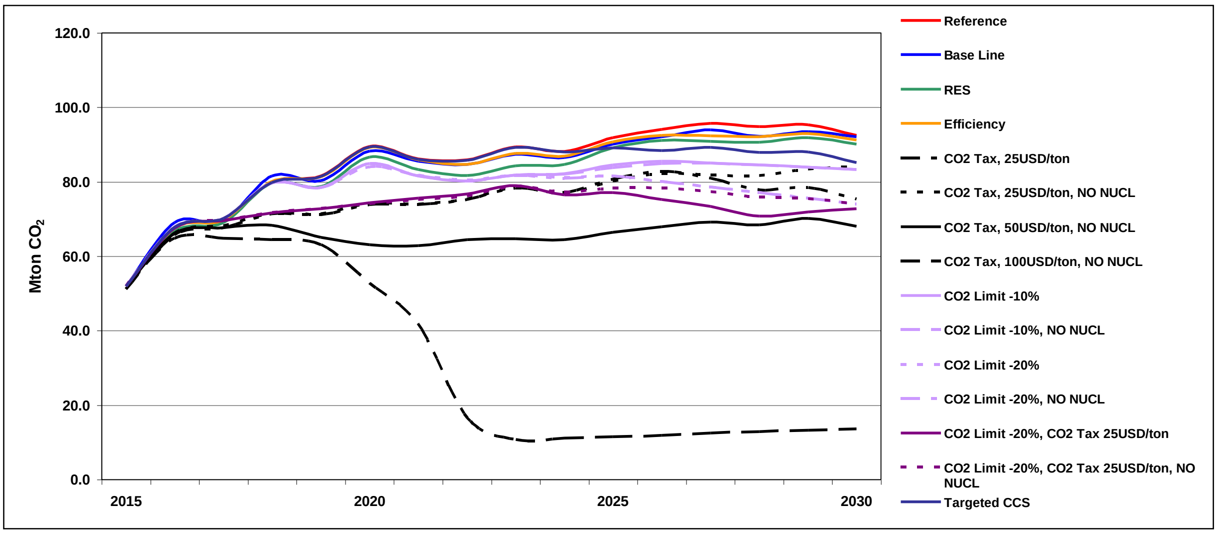

Figure 11: CO2 emission from power plants in SEE area for different development scenarios [17]

Under free market competition, annual CO_2 emissions increase to 91.9 Mton in 2030, i.e. by 75%. Cumulative CO_2 emissions reach 1355 Mton. Under this scenario the CCS option is not competitive. The inclusion of an EOR option shows that CCS could be competitive without any further policies – i.e. it is competitive if coupled with oil/gas extraction. The EOR option assumed that an injection of CCS into existing oil/gas fields could yield a benefit of 40 USD per ton of CO_2 injected. The main problem in the application of EOR is the modest capacity (potential) of EOR options in the region and the lack of a regulatory framework.

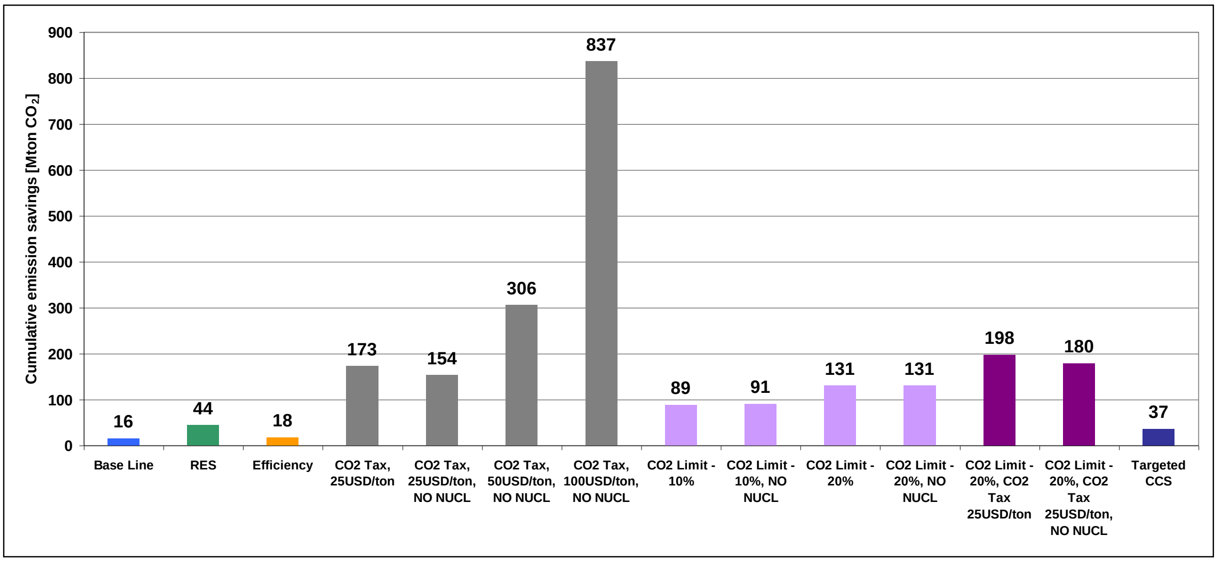

Figure 12: Cumulative CO2 emission reduction from power systems in SEE area for different development scenarios [17]

Beyond business as usual, increased energy efficiency and renewables' scenarios were used to compare the influence of different policies on total costs, CO_2 emissions and electricity prices. Under these scenarios the CCS option was not competitive, but certain carbon emission savings could be achieved. At the same time, average generation prices are higher compared to the free competition scenario.

The group of cases simulated under the CO_2 price scenario showed that the CCS option becomes competitive when the CO_2 price reaches approximately 50USD/ton. At the same time, alternatives like hydro and wind increased their share in total generation. Cumulative CO_2 emissions are decreased by 22% compared to the free competition scenario. By the end of the planning horizon approximately 63 Mton of CO_2 is stored underground. At the same time, average generation costs increased by almost 50%, while marginal prices increase by 40%.

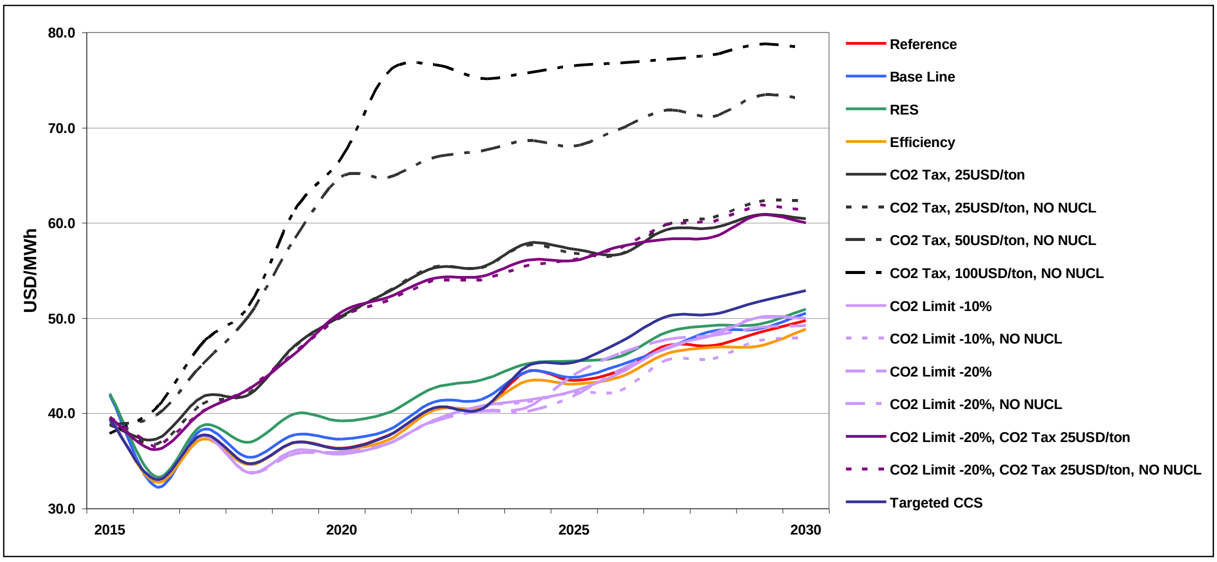

Figure 13: Average power generation costs in SEE area for different development scenarios [17]

An increase of the CO_2 price to 100 USD/ton leads to region-wide application of CCS, including retrofit of existing and/or new conventional coal and gas units (i.e. retrofit of power units constructed between today and 2020). At the end of the period practically all plants are equipped with CCS. Cumulative emissions drop sharply and are 62% below the reference scenario level. At the end of the period 650 Mton of CO_2 are stored underground, out of which 300 Mton are from CCS retrofitted plants. High carbon prices are followed by further increases in average generation costs which are now more than 60% higher. Marginal prices are on average increased by 47% compared to the reference scenario.

Summary/Conclusions

CCS technologies will compete in the market with the nuclear alternative and their maturity and fast commercialization will be key elements. CCS combined with EOR could substantially change the picture and make CCS an attractive and strongly competitive alternative without further financial incentives (but a regulatory framework must be set). Targeted development of a certain number of CCS projects would require relatively large investments but it would have a mild influence on average generation costs and thus could promote CCS and open-up the space for its faster deployment. At the same time additional research and field work is needed to verify the existence and suitability of underground formations for long term disposal of carbon dioxide.

Resume

Mr. Damir Pešut has 35 years of experience in the energy system industry. Main areas of expertise include energy demand forecasting, power system operations and expansion planning methodologies, energy pricing and finance, and energy sector organization and management. He leads a team of researchers and analysts in performing energy planning in the Republic of Croatia, Monte Negro, Bosnia and Herzegovina, Macedonia and Albania. Activities include development of regional energy sector master plans, conducting gasification and electrification studies, assessing the potential introduction of demand side management (DSM) programs and renewable sources in energy supply, as well as organizational and institutional requirements. Mr. Pešut is among the most experienced users of the International Atomic Energy Agency's (IAEA) Model for Analysis of Energy Demand (MAED) and is regularly recruited by the IAEA to serve as an invited expert for technical assistance missions and training courses on the use of this program.

2.3.2 Identification of technical indicators for creating natural gas supply policies: The Balkan case *(Atanas Kochov & Daniela Mladenovska, Ss. Cyril and Methodius University, Skopje)*

Presentation Abstract

Natural gas import dependency is a common feature for the Balkan countries. In the former Yugoslav Republic of Macedonia, the situation is even more vulnerable, due to the 100% natural gas import dependency which is fully supplied from one source - Russian gas. The absence of supply diversification disables competition and leads to insignificant gas consumption especially in the residential sector. There is an urgent need to include new supply sources and routes. According to the paradigm of sustainability, an optimal selection of an energy system, a supply source or route requires compliance with economic, social, environmental and technical factors. The last one is quite significant mainly due to energy security issues, which are in particular emphasized by EC authorities. The main indicators (technical set of indicators) taken in consideration for describing the security of supply are: Gas intensity, Net gas import dependency, Share of domestic natural gas production, Geopolitical risk and the Transit Risk Index (TRI). Since the former Yugoslav Republic of Macedonia is not a natural gas producer, the indicator "Share of domestic natural gas production" has been excluded from further elaboration. Regarding the numerous factors that are relevant for decision making, this multifold problem solution requires a multifold approach. In terms of determining the relative importance of each technical indicator a Multi-criteria Decision Making (MCDM) method and an Analytical Hierarchy Process (AHP) technique were used. The calculation of weights was based on the preferences of 34 experts. In terms of supply possibilities six supply options were identified, which are later mapped into alternatives. The results (weights values) are shown on Figure [13]. A decision making software was utilised to calculate the final ranking of the selected alternatives versus the technical indicators. The results are shown on Figure [14].

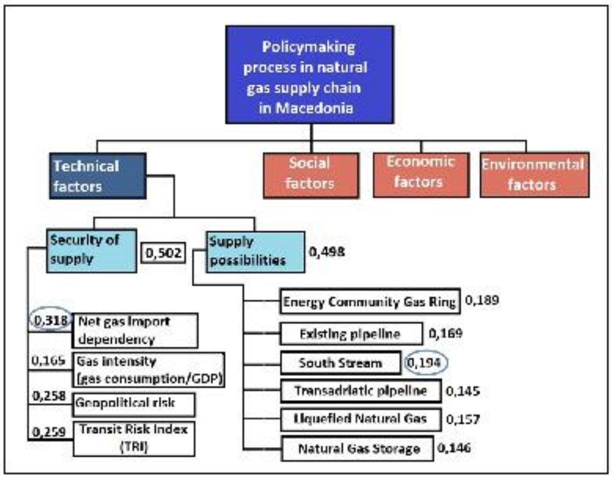

Figure 14: Weighting factors of technical indicators

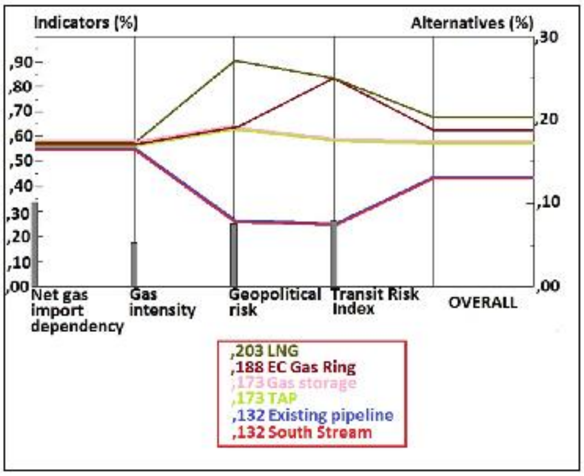

Figure 15: Ranking of the alternatives versus technical set of indicators.

The preferences of the experts resulted in the greatest weighting factor for "Net gas import dependency", and South Stream project as the most suitable supply route and source. Regarding the ranking from the assessment of the alternatives, the best rank is for the LNG (Liquefied Natural Gas) concept, while the EC (Energy Community) Gas Ring is right behind it. The EC Gas Ring project is quite significant for several reasons: it connects regional gas markets, it contributes to significant diversification of supply, it provides significant improvement of supply security and price competition.

On regional cooperation and economy development, the South Stream finished last, mostly due to the diversification of supply obstacle. The last option has the lowest grades in terms of Geopolitical risk and the TRI (Transit Risk Index). The security and diversification of natural gas supply became even more important due to the three established objectives of the European Union (EU)'s energy policy – security, sustainability and competitiveness. Similarly, for the time being, top level policy makers in the former Yugoslav Republic of Macedonia do not consider LNG as a serious option. They actually decided to engage in the South Stream project – at least at the time when it was still a realistic option. This also might be a reason for the highest weighting factor assigned to it by the stakeholders in the first phase of the research. The multi-attribute approach is a sound tool that facilitates preventing subjectivity among all concerned parties (decision makers), especially when it comes to serious projects such as energy infrastructure projects.

Resume

Dr. Atanas Kochov is currently the Dean of the Faculty of Mechanical Engineering and the head of the Laboratory for Metal Forming Processes, at the Sts. Cyril and Methodius University in Skopje. Since 2007 Professor Kocov is the member of the Council of Science and research and national coordinator for research in technical sciences. He was reelected in 2009 as a member of the Ministerial Council for science and technology. Dr. Kocov has also served as the General Manager of the Centre for Research, Development and Continuing Research from 2005 to 2008. The centre was established in cooperation with USAID mission in his country with the main aim to introduce technology innovation in SME's. Dr. Kocov has been national coordinator for the UNIDO project for a National Cleaner production Center, which was established in 2006 and still on-going.

In additional to his teaching experience at Sts. Cyril and Methodius University, Dr. Kocov has taught at the University of Washington (Seattle, USA) and the University of Applied Sciences in Wildau, Germany. He previously held a variety of consultancy positions for organizations such as ALOKA Holding Europe for medical equipment, Engerosistem, and the United States Trade and Development Agency for definitional mission for Balkan gasification, TDI FDI - Ireland. Professor Kocov is also a member of numerous professional bodies, including his country's Society of Mechanical Engineering and the American Society of Mechanical Engineering and hold a PhD in Mechanical Engineering.

Ms. Daniela Mladenovska, born 1974, B.Sc. (1998) and MSc (2004) in Mechanical Engineering, and PhD (2015) from the Ss. Cyril and Methodius University in Skopje, Faculty of Mechanical Engineering. Since 1999, Mladenovska has been employed at JSC Macedonian Power Plants, and in the past 16 years, has worked at different positions within the company: engineer for boilers, head of maintenance, head of production, manager of the Branch, engineer for development and investments. Currently she is holding the position of Branch technical manager. Since 2014 she is included in EUREM project, as a national trainer for energy efficiency in the industry.

2.3.3 Impacts of financial de-risking strategy on costs of solar electricity *(Nadejda Komendantova, IIASA ETH)*

In 2014 the new annual investment into renewable power and fuels reached 270 billion US dollars, the solar photovoltaic (PV) capacity in total was 177 GW and concentrating solar thermal power (CSP) was 4.4 GW. Solar power, especially PV, attracted 55% of new investment into renewable energy sources (REN, 21). The majority of investment into new PV capacity happened in China, Japan, US, UK and Germany, the majority of investment into new CSP went to US and India. Also in 2014 the total PV capacity was the highest in Germany, China, Japan, Italy and US and total CSP capacity was the highest in Spain, US, India, UAE and Algeria. Even though Germany is the largest European producer of renewable energy, the South European region has 40-60% higher solar capacity (figure 15).

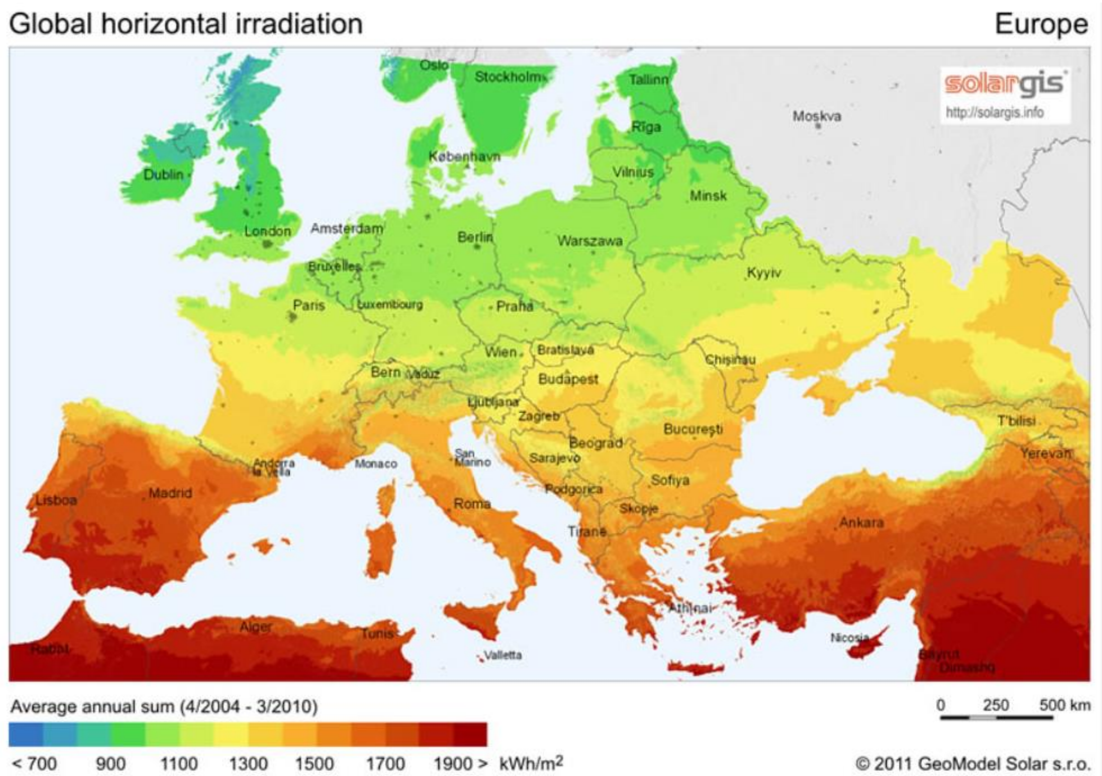

Figure 16: Global solar horizontal irradiation in Europe. (Source: GeoModel Solar, 2011)

Traditionally national governments and international organizations were mainly financing deployment of large-scale solar projects, however, in the last decade the focus of investment shifted from centralized publicly led investment to private – public partnerships or private ventures. Even though the South Eastern European countries adopted renewable energies support policies, the number of renewable energy projects and the volume of private investment into solar projects still remain low. For instance, Bosnia and Herzegovina and Serbia established renewable energy targets (40% and 27% by 2020), feed-in-tariff (FIT) and capital subsidies, the former Yugoslav Republic of Macedonia and Montenegro have renewable energy targets (28% and 33% by 2020) and FIT. One of the reasons for low volumes of investment into solar projects in the region is that investors perceive technology or the region, or both, as being risky and their risk aversion drives investment behaviour. Based on the behaviour economics literature, the risk perception is an estimation of stakeholders about combination of likelihood of occurrence of a negative event and its associated financial impact. Risk perceptions are often connected with such negative events as construction delays, loss of assets and default in payment by customers. Risk aversion regarding high investment risks leads the bankers to raise interest rates (cost of debt) and risk aversion of equity investors make them raise the return expectations (cost of equity). Risk perceptions impact deployment of renewable energies much stronger than of fossil fuels because of the high upfront investment (figure 16).

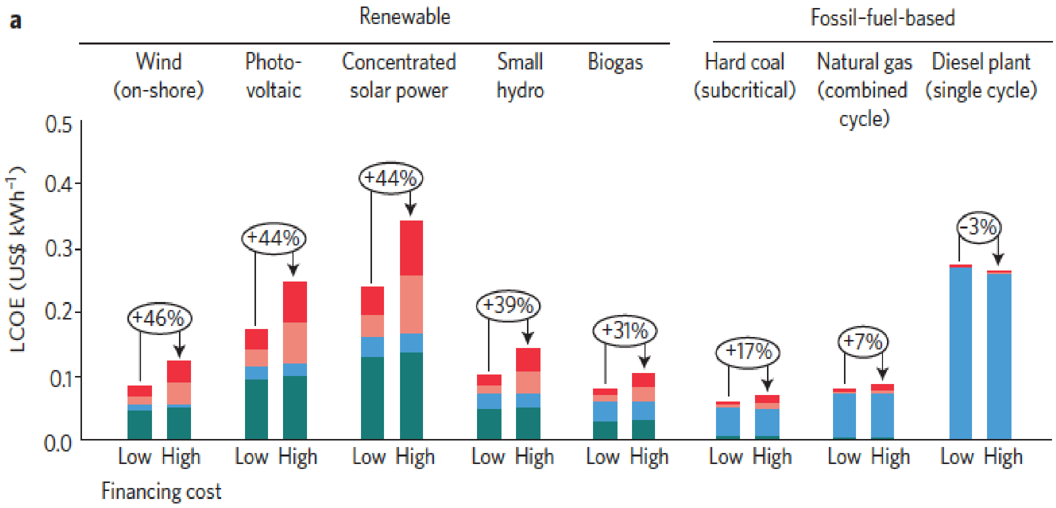

Figure 17: Impacts of risk on levelised costs of electricity (LCOE), where dark red bars are cost of equity, light red bars costs of debt, blue – operating expenditures, including fuel, and green – capital expenditures and depreciation. (Source: [22])

The following examples show that risk perceptions impact LCOE and increase the weighted average costs of capital (WACC) required for realization of the solar electricity generation projects, such as concentrated solar power (CSP) and photovoltaic (PV). The example of deployment of CSP at a location with similar conditions, namely, high volumes of horizontal solar irradiance but low volumes of investment into solar projects, such as North Africa, showed that risk aversion is a major human barrier for deployment of CSP and that regulatory and political risks are perceived as most serious and likely to happen [23]. The risks are perceived as being most probable during the permitting stage of the CSP project cycle, in comparison to the construction, operation and management phases, and mainly due to the complex bureaucratic procedures, which are perceived as being more problematic than the existing regulatory or legal framework or other governance risks [24].

The CSP market remains less developed than other renewable energies, however the year 2014 saw a growth of new capacity by 27% and the diversification of technologies in operation with the largest linear Fresnel and tower CSP plants coming online. Modelling of the impacts of risk perceptions on LCOE from CSP showed the difference between 12€ cents/kWh and 24€ cents/kWh in scenarios when investors expect 5% of internal rate of return on CSP project finance or 20% (Figure 18).

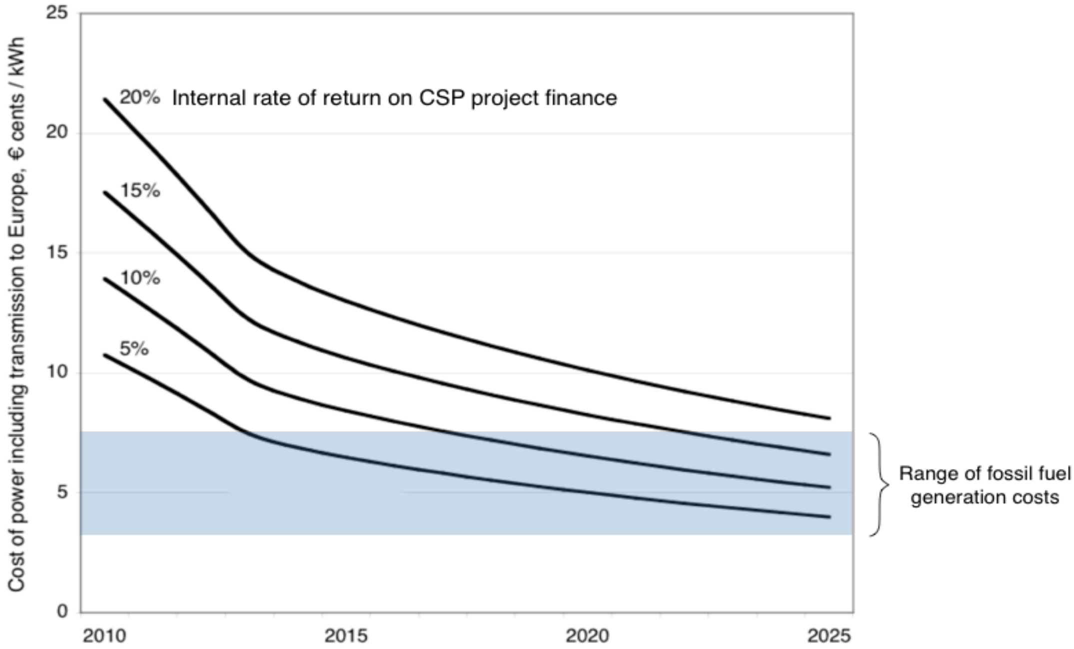

Figure 18: Impacts of expectations on internal rate of return on CSP project finance. (Source: [25])

The modelling of impacts of each category of risk on WACC by applying the financing costs waterfall concept developed by UNDP (2013) allowed to compare WACC for the Euro area with developing countries, like North Africa, and showed the financing gap of several percentage points (figure 18). The comparison of LCOE for CSP generated in North Africa and in Europe showed that even though North Africa has a substantially higher solar potential than Europe, the resulting LCOE for Europe (0.25 USD/kWh) is not dramatically higher than the mean for North Africa (0.21 USD/kWh), which is due to substantially lower financing costs in Europe than in the North African region. The modelling also showed that if a CSP investor in North Africa could get project financing at a cost equivalent to that in Europe, the LCOE could be reduced from 0.21 USD/kWh to 0.15 USD/kWh or by 32%.

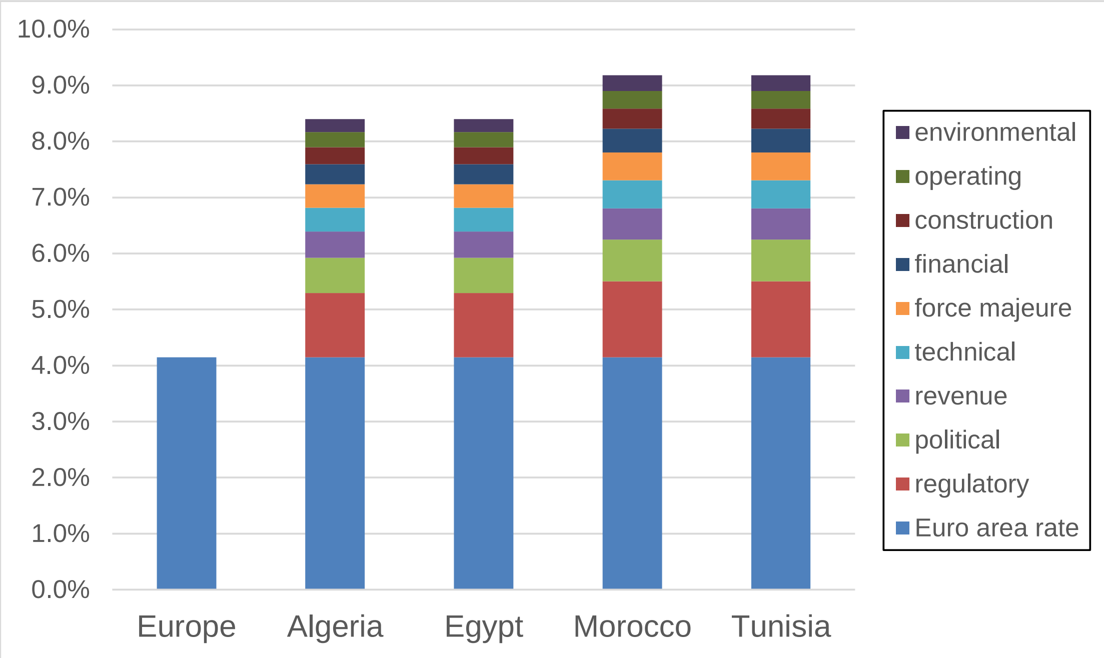

Figure 19: Financing cost gap. (Source: [26])

The volumes of solar PV electricity are growing steadily with more than 60% of existing PV capacities being added during the last three years. Such development happens due to falling costs, which made solar generated PV cost competitive with fossil fuels in a number of countries. The year 2014 was not only the 60th anniversary year when the first solar PV cell was demonstrated to the public, it was also a record year when over 40GW of new capacity was added. Modelling of the LCOE of PV in 189 countries showed that LCOE is influenced not only by availability of solar resource but also by WACC (figures 19a and 19b). This figure shows effect of solar irradiance on LCOE and that in countries where GHI is above global average (1,862 kWh/m²/a), LCOE is lower (dark green & blue), vice versa for countries with below average GHI (orange and red). Effects are as expected; LCOE is generally lower along equator and higher in high latitude countries. The figure 5b shows that in countries where WACC is above uniform rate of 6.4%, LCOE is higher. In contrary to the figure 5a, it shows that LCOE is higher along equator in countries with less favourable financing framework and where risks for investment are perceived as being higher. The actual deployment of PV capacities shows that indeed investors prefer countries with not only favourable solar resources but also with favourable financing framework with the highest share of PV being currently deployed in Germany, China, Japan, Italy and US. In general, EU continues to be the leader in terms of regional operating capacity and contribution of PV to the electricity supply with such countries as Czech Republic, where solar irradiance is not the highest in the world.

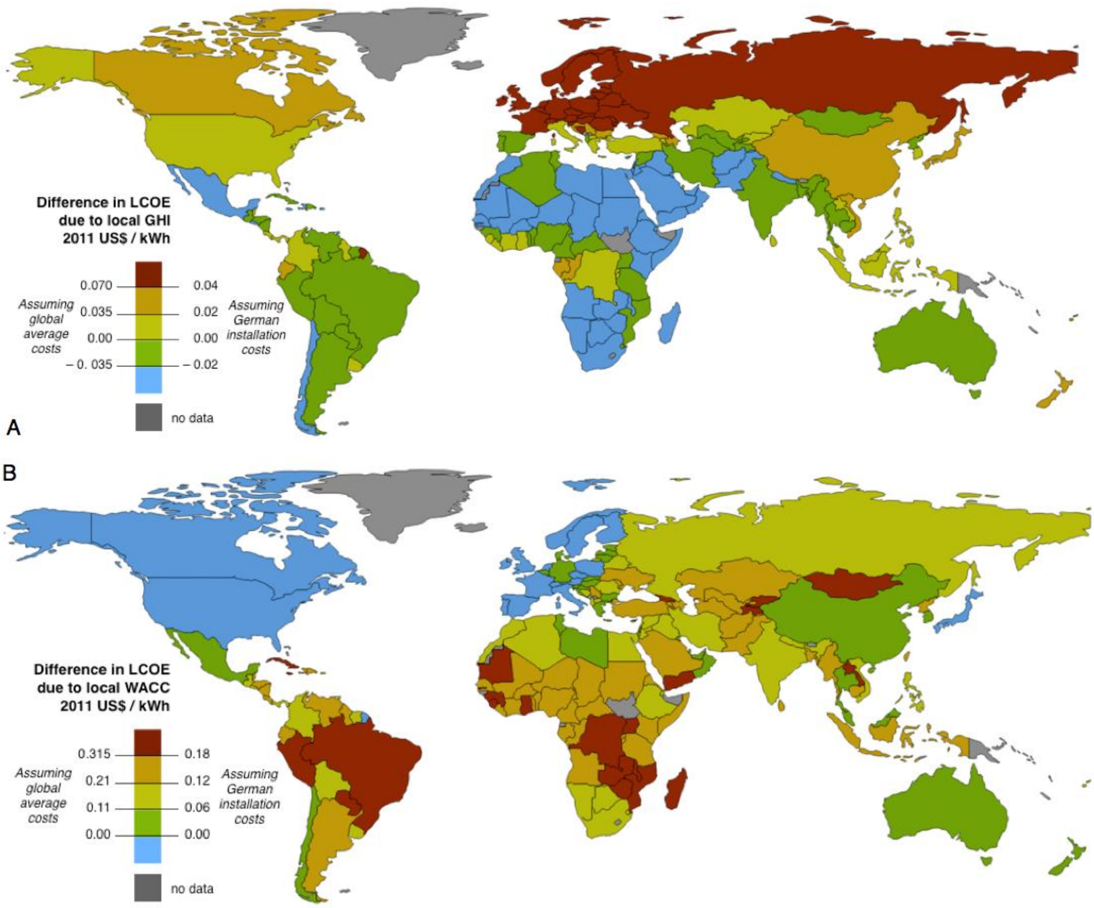

Figure 20 A, B: effects of horizontal solar irradiance and of WACC on LCOE of solar PV (US$2011/kWh). (Source: [27])

The above-mentioned results show that access to financial resources in developing and transition economies is crucial for deployment of solar capacities and that there is a need to de-risk investment into solar projects and to address risk aversion of investors. Two types of de-risking would be necessary such as financial and policy de-risking. The financial de-risking helps to transfer impacts of negative events to other parties with such mechanisms as risk insurance or guarantees of public stakeholders to cover damages. The policy de-risking reduces likelihood of a negative event. It requires the removal of barriers for investment and improvement of local governance institutions to streamline the permitting procedures to reduce construction delays. Therefore, risk perceptions of stakeholders really matter for private investment into solar projects in transition and developing economies. If risk aversion is not addressed, the deployment of solar projects will be delayed or will be much more expensive. The major changes are needed not only to provide financing mechanisms but also to address governance framework for renewable energy investment, including regulation and bureaucratic procedures on permitting of new power stations.

Resume

Dr. Nadejda Komendantova is a coordinator of the research theme "Governance in transition" within the Risk and Resilience Program. Her research interests include participatory and multi-risk governance, based on the understanding of views and risk perceptions of involved stakeholders, of governance structures, market and civil society as well as social institutions and political processes towards more adaptive and inclusive governance approach, which is central to the science-policy interface. Nadejda is currently a principal investigator of the project "Linking climate change mitigation, energy security and regional development in climate and energy model regions in

Austria" (LINKS) project. She is also a work package leader in the project "MENA Sustainable ELECtricity Trajectories Energy for sustainable development in North Africa and the Middle East" (MENA-SELECT) supported by the German Federal Ministry for Economic Cooperation and Development (BMZ).

3 Key Messages

3.1 Status Quo

The Western Balkan countries are currently in the enlargement process. Albania, the former Yugoslav Republic of Macedonia, Montenegro and Serbia already have initiated accession negotiations with the EU, while Bosnia and Herzegovina as well as Kosovo currently have been granted the status of potential candidate country.

With the 2005 Energy Community treaty, the Western Balkans committed to structurally reform their energy systems while developing an integrated regional energy market The 3rd Energy Package transposition to national law, provides a legal and regulatory framework for unbundling and further opening energy markets in the region, for strengthening the National Regulatory Authorities as well as for effectively ensuring customer protection and regional cooperation. Yet the region is facing an inheriting challenge of fragmentation that impedes overarching planning for integrated energy system development. Moreover, the electricity sector in the region is characterised by dominant state owned utilities, with public service obligations and regulated prices. At the same time wholesale markets are nationally oriented and thus are lacking competition, liquidity and substantial market price signals which result in divergent electricity prices in the region. The completion of the liberalisation process for the power systems would result in the expansion of market competition right down to end user level.

The Western Balkan countries present high levels of energy intensity, in some cases even greater than the world average, large amounts of energy imports, mainly oil and oil products as well as electricity, increasing energy demand trends, and high investment needs for generation and transmission capacities as well as demand equipment stocks. Power generation in the region is dominated by ageing coal power plants and by hydropower generation. However no significant investments in new capacity have taken place since the early 1990's. Gradual recovery from the recent economic crisis is expected which will result in increases of the electricity demand for the region from 2015 on. Thus, the region faces substantial investment needs for the near future.

Significant investments are also required if gas is to play a significant role in the region's future energy systems. The fact that certain key transnational projects such as main oil and gas pipelines have suffered serious drawbacks, with final investment decisions being constantly postponed, the geopolitical and socio-economic impact from SE Europe’s fast changing energy landscape is bound to affect investment in the energy sector as a whole. While the security of energy supply and the decarbonisation of the energy systems in the region remain a challenge.

3.2 Scenarios

The Western Balkan countries are expected to reflect the highest average annual demand growth rate within Europe. Scenarios suggest that final electricity consumption could increase more than twofold until 2040. Therefore, countries are faced with significant decisions in their current energy policy, as the question on whether they should pursue coal or gas based capacity developments or increase hydro and renewable generation, remains open. Present lack of carbon pricing however, along with uncertain timing of EU accession makes this decision very ambiguous and volatile.

Therefore the exploration of possible energy scenarios up to 2050 for the Western Balkans, which is the purpose of the current workshop, is imperative. The study of energy development scenarios provides a quantitative assessment for the comparison of different potential energy technology deployment pathways in the region as a whole. Moreover, such analysis facilitates the extension of the EU internal energy market to South East Europe and the adoption of the acquis communautaire in the field of energy policy by providing concrete recommendations on possible low carbon development strategies. Specifically such analysis would indicate the technological options available for delivering security of supply while increasing the share of low carbon supply and increasing energy efficiency.

Possible scenarios include: the broadening of the energy portfolio including renewable energy along with the enhancement of the interconnectivity of the electricity and gas systems; the further diversification of oil and gas supplies as well as of the potential energy routes; the expansion of LNG terminals and underground gas storage capacity in tandem with increased production from indigenous energy sources.

Progressive decarbonisation scenarios of the energy system could entail additional penetration of RES and the deployment of clean coal methods for the power generation sector; the gasification and electrification of various end use energy services in tandem with energy efficiency measures for the industrial and building sectors; while for the transportation sector, improvement of the motor vehicle fleets fuel efficiency can be achieved through the greater use of hybrid vehicles the use of electric cars in large urban centers and the use of public transportation systems.

3.3 Technologies

3.3.1 Coal

The thermal generation in the Western Balkans is dominated by lignite The region contains substantial lignite reserves, especially in the Kosovo area. If coal is to play a role in future low carbon energy systems, it becomes imperative to facilitate the deployment of CCS. Yet, investment into new generation has been modest until now. Investments into new coal capacities is increasingly scrutinised by environmental organisations and some Western European development banks have stopped funding coal projects.

3.3.2 Natural Gas

The Western Balkan region doesn't have significant domestic natural gas resources, thus this option poses the trade-off of higher import dependency and thus an incremental risk for the security of supply. As a consequence, natural gas only plays a marginal role in the region's power generation although plans exist for the construction of several combined cycle gas fired plants. The anticipated natural gas consumption for the Western Balkans requires competitively priced gas to arrive to the region either via a pipeline network or LNG terminals. This is reflected in the ongoing and planned development of gas infrastructure terminals in several countries of the region. From an environmental and climate policy perspective, natural gas is considered preferable to coal due to its lower carbon intensity. Yet, high carbon prices are a prerequisite for significant gas deployment in the Balkans.

3.3.3 Hydro

Dependence on hydropower generation is expected to continue, as some countries still have significant potential in hydro based generation yet not equally distributed across the countries. Additional interconnection capacity would be requires as well as enhanced regional cooperation. Yet, despite the carbon neutrality, environmental concerns might limit the exploitation of the full potential.

3.3.4 Renewable energy

Renewable energy for electricity generation (excluding hydropower) is at a relatively early stage of development in South Eastern Europe as it is representing less than 1% of the electricity supply. A substantial potential for both wind and solar energy has been identified however and capacities are expected to significantly increase in future.

However the financing of renewable energy and energy efficiency projects in the region remains a challenge. Risk mitigation is essential for generating value for investors while limiting costs for local authorities. The Green for Growth Fund Southern Europe is an example for the financial instruments that can be used, as RES projects in the region require active state support.

3.3.5 Nuclear

There currently is no nuclear power plant in the Western Balkans region. While nuclear generation technologies provide stable generation cost and low carbon emissions, yet they requires substantial upfront investment and infrastructure preparation, including the creation of competent regulatory bodies. As a result, any nuclear development would have long lead time going beyond 2030. As in the case of coal, nuclear power development faces opposition from some environmental groups.

3.3.6 Networks

Electricity grid extension and upgrading as well as cross border interconnections are under development. These will enable an integration of the currently fragmented market. .It is expected that the electricity transmission system will require additional reinforcements in the future in order to cope with the planned RES generation deployment.

3.4 Data and regional information

An integrated planning approach for the Western Balkans region requires monitoring of the energy markets and analysis of key trends. Limited statistics from several countries in the area, make such a task cumbersome and tedious. Still, not all the countries collect and provide energy data conforming to EUROSTAT reporting requirements, so that reliable energy-related data are few with severe implications in terms of comparability of the energy systems performances, and in the monitoring of the impacts and effects of energy policies and environmental regulation.

Furthermore, the assessment of policies and measures and the modelling of emission scenarios is considered a prerequisite of the development of concrete climate policies with GHG emission reduction targets in the context of EU 2020 Climate and Energy Package, the expected EU 2030 climate and energy framework. This reason renders the harmonisation of the methodologies to data collection and processing, including the preparation of national communications imperative.

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5 List of abbreviations and definitions

BiH: Bosnia and Herzegovina

CSO: Civil Society Organizations

CSP: Concentrated Solar Power

DG-NEAR: Directorate-General for Neighbourhood and Enlargement Negotiations

E&IA: Enlargement and Integration Actions

E4SMA: Energy Engineering Economic Environment Systems Modelling and Analysis

EC: European Commission

ECS: Energy Community Secretariat

EEMM: European Electricity Market Model

EIHP: Energy Institute Hrvoje Požar

EKC: Electricity Coordinating Center

ENTSOE: European Network of Transmission System Operators for Electricity

FIT: Feed-In-Tariff

IAEA: International Atomic Energy Agency

IENE: Institute of Energy for South East Europe

IET: Institute of Energy and Transport

IIASA: International Institute for Applied Systems Analysis

ETH: Swiss Federal Institute of Technology

INDC: Intended Nationally Determined Contributions

JRC: Joint Research Centre

LCOE: Levelised Costs Of Electricity

LCP: Large Combustion Plants

NCP: National Contact Points

NRA: National Regulatory Authority

PV: Photovoltaic

PX: Power Exchange

RCESD-MASA: Research Center for Energy and Sustainable Development - Macedonian Academy of Sciences and Arts

REKK: Regional Centre for Energy Policy Research

RES: Renewable Energy Sources

SEE: South East Europe

SLED: Support for Low-Emission Development in South Eastern Europe

TAC: Travel Accommodation and Conference facility

TPP: Thermal Power Plant

TSO: Transmission System Operator

WACC: Weighted Average Costs of Capital

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