National background report on Energy for the F.Y.R. of Macedonia *

Author:

Prof. Dr. Natasa Markovska,

Senior Researcher,

Research Center for Energy, Informatics and Materials,

Macedonian Academy of Sciences and Arts (ICEIM-MANU)

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* Note by the WBC-INCO.NET editors: the official UN reference „the former Yugoslav Republic of Macedonia“ and the project convention to use “FYR of Macedonia” have not been applied throughout the report, but the original use of the authors has been accepted.

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1. Purpose of the national background report and methodology/summary of the consultation process

a) The purpose

The purpose of this report is to articulate national priorities in energy research which will enable realization of the main strategic goals in the energy sector, stipulated in the national energy strategy, as well as of the Energy Community priorities.

The energy research priorities will be built upon the existing research capacities, and will create an enabling environment for further development of the existing and building new capacities, as well as better integration into European energy research area.

Furthermore, reflecting the national specifics, the energy research priorities will be tailored as to facilitate the partnerships "science – industry" and "science – policy-making", encouraging also intersectoral and geographical mobility of researchers.

b) Working team

Analytical expert, who has served as:

- A member of the team which developed the national energy strategy and national renewable energy strategy (knowledge of the national energy sector policy goals, seen also in a wider, Energy Community perspective)
- A leader of the Energy Working Group under the national strategy for sustainable development (holistic and integrative perspective over the energy sector)
- FP7 National Contact Point (knowledge of the European priorities in the Energy sector)
- A participant in three FP6 projects in the field of energy (experience in international cooperation and international visibility)

The ***two other energy experts*** are recognized energy researchers in the country, participants in a number of European and international research projects, as well as national research and strategic planning projects in the field of energy.

c) Consultation process

The analytical expert has conducted consultation in both directions R&D sector (mainly EU FP office within the Ministry of Education and Science, member(s) National Scientific Council, Vice president of the Macedonian Academy of Sciences and Arts) and energy sector (Team leader of the national energy strategy, Team leader of the national RES strategy and researchers from academic and business sectors)

d) Data analyses

The following documents have been analyzed and consulted:

- Energy and R&D national strategic and planning documents
- National and FP funded energy research projects (lists provided by the EU FP office within the Ministry of Education and Science)
- Background reports prepared for the WBC-INCO.Net project in the fields of social sciences and humanities and of health
- FP7 Energy working programme
- Comparative analysis of the innovation capacity in the WBC with particular focus on joint cooperation needs, prepared for WBC-INCO.Net project
- Mapping of the WBC Innovation Infrastructures, prepared for WBC-INCO.Net project
- Relevant reports from other European projects (ISEE-Mob, SCORE, ERAWATCH)
- Report on progress made by the Republic of Macedonia in preparing for EU membership (Progress Report 2011)

2. The Energy S&T system in the Republic of Macedonia

2.1 The Republic of Macedonia policy framework

2.1.1 The overall Energy policy framework

The Republic of Macedonia as a candidate country for membership in the European Union is confronted with the challenges of efficient implementation of serious reforms in the societal system, where the energy sector is of special significance for Macedonia's overall development. The Republic of Macedonia signed and ratified the ***Agreement of the Energy Charter***, ***the Energy Community Agreement, the United Nations Framework Convention on Climate Change and the Kyoto Protocol.***

According to the Energy Community Agreement Macedonia harmonizes its national legislation with the existing legislation of the European Union (acquis communautaire) on energy, environment, competition, renewable energy sources, energy efficiency and oil reserves. The strategic commitments of Macedonia in the energy sector have been incorporated in the ***Law on Energy***.

The Ministry of Economy is responsible for the energy sector. One of the sectors in the Ministry is the Energy Sector. Some of the responsibilities related to energy belong to the Ministry of Environment and Physical Planning as well as to the Ministry of Transport and Communications. For the purposes of providing support to the Government in the implementation of the energy policy, an ***Energy Agency*** has been established.

The activities regulating specific issues related to the performance of energy activities specified in the Law on Energy are performed by the ***Energy Regulatory Commission*** of the Republic of Macedonia.

The ***council of the municipality*** upon a proposal from the mayor, and after acquiring an opinion from the Ministry of Economy, enacts an energy development program for the municipality. They are responsible for the energy activities of public interest and of local significance.

The ***Strategy for Energy Development until 2030*** defines the most favourable long term development of the national energy sector with a view of providing a reliable and good quality energy supply to the consumers.

The following ***priorities*** have been taken into account for the realization of the above mentioned core objective:

- Maintenance, revitalization and modernization of the existing and construction of new, modern infrastructures for the purposes of energy production and utilization,
- Improvement of the energy efficiency in the production, transmission, distribution and use of energy,
- Utilization of domestic resources (reserves of lignite, hydropower potential, wind and solar energy) for electricity production,
- Increase of natural gas utilization,
- Increase of the utilization of renewable energy sources,
- Establishment of economic energy prices,
- Integrating the energy sector of the Republic of Macedonia in the regional and European market of electricity and natural gas by constructing new connections and by harmonizing the legislation with the existing acquis communitaire for energy, environment, competition and renewable energy sources.

Being prepared by the ***Research Center for Energy of the Macedonian Academy of Sciences and Arts,*** the Strategy for energy development is a good example of ***establishing a partnership between science and policy-making***, which provides the Government with an opportunity to make smart choices and take informed decisions based on scientific and competent analyses.

2.1.2 The elements of Energy research policy making

a) General S&T policy making

The Ministry of Education and Science (MES) has the overall responsibility for developing and administrating national scientific and innovation system , research policy and all levels of education. This includes the promotion of education and science, the development of the National Science System, technological development, informatics, technical culture and information system and international S&T cooperation. The Ministry provides the funds for the development of science and scientific education, national research and technology development projects and the development of the research and technology infrastructure. In addition, the Ministry of Economy, or more precisely the Energy Department within the Ministry is relevant for the energy research policy, for the overall national energy policy.

The ***Council for Scientific - Research Activities (CSR)*** is an expert advisory body to the Minister of Education and Science responsible for making decisions on the development of scientific and research activities in accordance with the needs of the Republic of Macedonia, including the annual programs of the scientific institutions, the budget for research activities, the development and maintenance of research databases, the evaluation of research activities, internal and external evaluation of the scientific – research activity and the preparation of laws regulating these issues, international cooperation, creation and maintenance of databases for the system of scientific-research etc.

The ***National Committee for Development of Scientific Research and Technological Development (NCD)*** is an expert and advisory body to the Government for science policy and the development of common scientific and technological development activity in Macedonia. NCD consists of nine members: the Minister of Education and Science, the president of Macedonian Academy of Sciences and Arts (MASA), the president of the CSR and six members from different scientific disciplines, appointed by the Government on a four-year mandate. NCD prepares opinions and suggestions for the starting points and directions of the National Programme for Government; scientific research and management of science policy; regulations concerning scientific - research; priority areas and programs for scientific research and technological development; compliance with the National Program of strategic needs of the Republic of Macedonia; measures for the development of the Republic of Macedonia in all segments, based on scientific basis; development of specific policies on the request of the Minister; the most important programs and projects for development of the Republic of Macedonia; monitoring the results and effects of the development of the country's scientific basis; initiatives on the programs and projects for international cooperation that are of particular public interest and other issues required by the Government.

The financial means for supporting scientific and research activities of public interest have been planned planned within the ***four-year National Programme for Scientific and Research Activities.*** The funds for financing research activity are from the budget of the Republic of Macedonia in accordance with the objectives and priorities identified in the National Programme and the development programs of public interest for the Republic of Macedonia, as well as from other sources: international programs and funds, local governments, legacies, gifts, contributions and other sources. According to the Law on Scientific and Research Activities, the Programme is adopted by the Government on a proposal by the MES, after a prior consultation with the NCD, MASA and the Interuniversity Conference. The programme is implemented through annual programmes, and defines the basic aims, content and range of tasks to be performed in the area of scientific activities; the methods for coordinating, monitoring and financing the activities; the relation to the economy and institutional network etc.

The latest available data from the State Statistical office of the Republic of Macedonia (SSORM) show that the ***Macedonian GERD*** was €15.08 million in 2008, which is equivalent to ***0.22% of its GDP***, and €10.40 million in 2007, which represent 0.17% of the GDP. These figures show that Macedonian expenditures on R&D are still considerably lagging behind the EU average expenditures on R&D. The engineering scientific fields, including energy, participated with 47.5% in the total GERD in 2007.

b) Energy research policy making

There are ***no specific provisions*** for research policy making in the energy field. The Energy strategy identifies a need for strengthening the capacities of the institutions and the companies that perform scientific and research activities, applicative and educational activities in the field of energy.

It should be recommended that the energy research is directed towards enabling realization of the key priorities in the energy sector, stipulated in the Energy strategy. Furthermore, the energy research policy should be tailored as to facilitate better integration of the Macedonian energy research into European energy research area and finally to support partnerships “science – industry” and “science – policy-making” and encourage intersectoral and geographical mobility of researchers.

2.2 Overview of Energy research activities

2.2.1 Energy research projects

a) National projects

During the period 2010-2012 the Ministry of Education and Science has supported 8 projects in the field of energy within the Calls for technological development, most of them related to energy efficiency, biomass, hydropotential etc.

b) FP6 projects[1]

b1. RISE, Renewables for Isolated Systems-Energy supply and Waste Water Treatment; Faculty of Electrical Engineering and Information Technologies, Macedonian Academy of Sciences and Arts, Bioengineering DOO - BIG (SME), MEPSO (Transmission system operator), 3 years; €434,900.

b2. MORE MICROGRIDS, Advanced Architectures and Control Concepts for More Microgrids, Faculty of Electrical Engineering and Information Technologies, Macedonian Academy of Sciences and Arts, Bioengineering DOO - BIG (SME); 2 years; €279,000.

b3. LPAMS, Production Process for Industrial Fabrication of Low Price Amorphous-microcrystalline Silicon Solar Cells; Macedonian Academy of Sciences and Arts, 3 years; €84,000.

b4. RES INTEGRATION, Rural Sustainable Development through Integration of Renewable Energy Technologies in Poor European Regions; Macedonian Geothermal Association; 3 years; €150,000.

b5. EU Geo Capacity, Assessing European Capacity for Geological Storage of Carbon Dioxide, Macedonian Geothermal Association; 3 years; €18,000.

b6. RECOVER, Renewable Energy Coordinated Development in the WBC; Macedonian Geothermal Association ; 2 years; €18,120.

b7. ACCENT, Acceleration of the Cost Competitive Biomass Use for Energy purposes in the WBC; Macedonian Geothermal Association; 2years; €23,120.

b8. VBPC-RES, Virtual Balkan Power Centre for Advance of Renewable Energy Sources in Western Balkans; Faculty of Electrical Engineering and Information Technologies; 3 years; €54,239.

c) FP7 projects[2]

c1. BEE, Biomass Energy Europe; Macedonian Geothermal Association; 33 months; €37,985.

c2. CEUBIOM, Classification of European Biomass Potential for Bioenergy Using Terrestrial and Earth Observations; Balkan Foundation for Sustainable Development; 33 months; €40,018

c3. RENAISSANCE, Testing Innovative Strategies for Clean Urban Transport for Historic European Cities; Faculty for Technical Sciences, University "St. Kliment Ohridski" Bitola, Public Transport Enterprise Skopje, Municipality of Skopje; 4 years; €234,400.

c4. SmartGrids ERA-NET, Ministry of Education and Science, 4 years; €38,338.

c5. SEETSOC, South-East European TSO Challenges; Ss. Cyril and Methodius University, Faculty of electrical engineering and information technologies, Operator of Power Transmission System of Macedonia-MEPSO, 3 years; €156,000.

[1] Acronym, Title; Macedonian partners; duration; EC funding for Macedonian partners

[2] Acronym, Title; Macedonian partners; duration; EC funding for Macedonian partners

c6. GEOCOM, Geothermal Communities - demonstrating the cascading use of geothermal energy for district heating with small scale RES integration and retrofitting measures; Macedonian Geothermal Association, Municipality of Kocani; 5 years; €45,000

c7. EAGLE, Development and demonstration of a dynamic, web-based, renewable energy rating platform; Macedonian association for solar energy- SOLAR; 3 years; €10,000.

c8. COMPOSOL, Fibre Reinforced Composite Reflectors for Concentrated Solar Power Plants; Center for Plasma Technologies - PLASMA ltd.; 2 years; €220,000.

c9. PolySol, Development of a modular, all-POLYmer SOLar thermal collector for domestic hot water preparation and space heating; Center for Plasma Technologies - PLASMA ltd. 2 years; €250,000.

d) Other international projects

The country was for the first time eligible for participation in the 2011 call for proposals for the Intelligent Energy program.

2.2.2 Key competencies in Energy research fields

Based on the FP funded projects, it can be concluded that the bulk of the competences in the energy research is connected with the renewable energy sources, along the following sub-themes:

- RES deployment (technical aspects and sustainable development of rural areas)
- RES technologies (solar thermal collector, geothermal heating, solar cell, concentrated solar power plant)
- Distributed generation (Microgrids)
- RES potential (biomass potential assessment and categorization)

In addition, on the bases of FP participation, research competencies can be identified in the following areas:

- Sustainable urban transport
- Power transmission networks
- Smart grids

Considerable competences for strategic energy planning can be associated with the Research Center for Energy, Informatics and Materials of the Macedonian Academy of Sciences and Arts, ICEIM-MANU. It is among the key players in the country with regards to the strategic planning in energy and related fields of vital national importance. Hence, in cooperation with the other stakeholders in the energy sector, it developed the National Energy Strategy (adopted by the Government in April 2010), National Strategy for Renewable Energy Sources (adopted in September 2010), and National Strategy for Sustainable Development (responsible for the sector energy; adopted in February 2010). The Centre is the steward of the MARKAL-Macedonia model developed under the framework of the USAID Strategic Planning task which has been used to analyze the implications of energy efficiency and renewable energy sources on the national energy system development. ICEIM-MANU has also been active in the field of Climate Change for more than a decade. The main activities include preparation of the National Inventory of GHG Emissions and Mitigation Analyses for the purpose of the National Communications under the UNFCCC. In particular, the Centre deals with Climate Change and Energy issues, including environmental and economic evaluation of energy technologies and policies, as well as developing mitigation strategies.

2.2.3 Energy research infrastructure

a) Academic sector

a1. Research Center for Energy, Informatics and Materials of the Macedonian Academy of Sciences and Arts, ICEIM-MANU (3 FP6[3])

[3] Only projects in the thematic area of energy are considered

a2. Public universities

a2.1 Ss. Cyril and Methodius University (UKIM), Skopje

- Faculty of electrical engineering and information technologies (3FP6, 1 FP7)
- Faculty of mechanical engineering
- Faculty of civil engineering
- Faculty of architecture

a2.2 University St. Kliment Ohridski, Bitola

- Faculty of technical sciences (1 FP7)

a2.3 University “Goce Delcev” (UGD), Stip

- Faculty of electrical engineering
- Faculty of mechanical engineering
- Faculty of mining and geology

a2.4 State university of Tetovo

- Faculty of applied sciences

a3. Private universities

a3.1 South East European University, Tetovo

- Institute for environment and health

b) Industry

- Center for Plasma Technologies - PLASMA ltd (2 FP7)
- Bioengineering DOO - BIG (SME) (2FP6)

c) Associations

- Macedonian Geothermal Association (4FP6, 2 FP7)
- Macedonian association for solar energy- SOLAR (1 FP7)
- Balkan Foundation for Sustainable Development (1FP7)
- Macedonian Center for Energy Efficiency, MACEF

d) Utilities

- Operator of Power Transmission System of Macedonia-MEPSO (1FP6, 1FP7)
- Public Transport Enterprise Skopje (1 FP7)

e) Municipalities

- Municipality of Skopje (1FP7)
- Municipality of Kocani (1FP7)

2.3 Key drivers of Energy research

2.3.1 Main Energy sector trends in the Republic of Macedonia

Macedonia is strongly dependent on energy imports. It does not have any sources of oil or of natural gas, and in recent years it faces an ever increasing electricity imports. The increase of fuel imports and the increase of fuel prices on the global market greatly contribute to the growth of the trade deficit

of the Republic of Macedonia. In the long run, unless the situation improves, energy fuel imports can also have adverse impacts on the inflation, foreign currency reserves and the macroeconomic stability of the country in general.

Since Macedonia became independent, particularly in the period from 1991 to 2008, several energy strategies have been prepared, using foreign financial sources. However, these strategies have not been adopted nor realized by the Government of the Republic of Macedonia. The absence of vision and the lack of a long term strategy for the development and operation of the energy sector have led to a strong stagnation in its development and promotion.

Overall, the detailed diagnostics of key problems burdening the energy sector in the Republic of Macedonia includes:

- Pronounced energy deficiency;
- Long term depressed energy prices, especially electricity prices, and lack of stimuli to save;
- Obsolete technologies and lack of investments for maintenance, modernization and expansion of the existing capacities, as well as construction of new capacities;
- Unfavourable industrial infrastructure which determines high energy intensity;
- High electricity losses (both technical and commercial);
- Low energy efficiency;
- Lack of complex programs for saving of energy, especially in the household sector, but also in the other sectors comprising large consumers;
- Unfavourable structure of the energy mix from an environmental and economic aspect;
- Incomplete harmonization of the legislation with the European standards with respect to price policies, competition and environment.

These conditions in the area of the energy sector in the country already deliver major negative economic implications, and in the long run they could be transformed in a serious limiting factor of the economic development. Alternative approaches have been proposed to overcome all of the previously mentioned problems by focusing on their strengths and weaknesses.

2.3.2 Main socio-economic challenges in the Republic of Macedonia

Almost all strategic national documents developed recently, in one way or another, recognize the ***progress toward European integration***, the i***ncreased competitiveness of the national economy***, ***crime prevention***, ***prevention of brain-drain*** and ***decrease of the unemployment rate*** as the most important economical and societal challenges in the Republic of Macedonia.

Specifically for the energy sector, the core challenge, which is the provision of ***energy security,*** requires greater diversification of the energy resources by type, sources and suppliers, active role of the regional energy market and the European energy community. This requires maximizing the use of the domestic resources and a strategically viable long term connection policy to the main energy ducts in the region and abroad.

Intensified efforts for ***improvement of the energy efficiency*** in production, transmission, distribution and use of energy, particularly electricity, are required.

The ***maximization of the utilization of the renewable energy sources*** belongs to the priority activities in the energy field.

All preconditions for ***greater utilization of natural gas*** should be provided for.

The gradual ***shift of the energy sector in Macedonia to market conditions*** is already a reality. The Republic of Macedonia accepted a model of mixed state and private ownership in the energy sector. When deciding about the profiling of the future ownership structure in the energy sector of the Republic of Macedonia, one must especially bear in mind the advantages and disadvantages of the state versus private ownership.

The transition to ***market prices for electricity*** will improve the investment climate, will strengthen the interest to introduce renewable energy sources and improve the energy efficiency.

Considering that certain natural monopolies, such as the transmission and distribution of electricity and natural gas and the distribution of heat, will continue to exist, the ***measures for elimination of the misuse of the monopoly position*** of any entity should be strengthened.

With establishment of a ***competitive national energy market,*** and with active participation in the ***regional energy market***, with a good and fair regulation, including concession, efficient protection of ownership rights, as well as improvements of the other segments of the investment climate and considering the obvious energy deficiency of the region, the inflow of foreign capital in the energy sector of the country could be significant. This will lead to a stable and sustainable development of the Macedonian economy.

The Government should strengthen the special program developed to ***support the vulnerable consumers***.

Environmental protection in the energy sector means acting primarily through energy efficiency, renewable energy sources, selection of fuels and modern technologies which are environmentally friendly, good quality legislation and monitoring, education and public awareness, as well as promotion of positive examples.

As to the main challenges for R&D, thus far they have revolved around the following three topics. Firstly, the challenge is ***to increase investment in R&D sector***, more specifically to facilitate discussions to encourage the government in increasing the level of the public budget and to develop tax incentives for R&D investments. Another important aspect is to encourage the active role of the private sector to stimulate its own involvement with investments in R&D. Secondly, there is a challenge ***to strengthen the science-business interface***. This means establishing links between education and research with the labour market, increasing the transfer of knowledge between public and private sector, strengthening the linkages between universities, businesses and industry thus achieving the ultimate goals for the policy makers. And lastly, the challenge is ***to develop R&D human capital and reduce the brain drain***. This includes but is not limited to creating funds and scholarships in order to increase the salaries, strengthening and upgrading the existing network of scientists, improving institutional infrastructure, equipment and materials in order to increase the competitiveness of research in our country, as well as adopting a modern approach to scientific development.

3. Integration of the Republic of Macedonia in the European Research Area in the field of Energy

In the 2011 report on progress made by the Republic of Macedonia in preparing for EU membership (Progress Report 2011), the following has been stated about the integration in the European Research Area:

"***Little progress can be reported in the area of integration into the European Research Area***. Following the adoption of amendments to the Law on higher education, 40% of the tuition fees are invested in fundamental and applied research and in modernisation of infrastructures. Some equipment was procured for universities and laboratories. However, the investment in research, from both the public and the private sector, remains very low (estimated at around 0.2% of GDP in 2010). In addition, the lack of reliable statistics makes implementation and monitoring difficult. Preparations in this area are moderately advanced. Nominations have been made in most governance bodies, including in the European Research Area Committee (ERAC) and the Strategy Forum for International Cooperation (SFIC). However, attendance at their meetings is irregular, due to the lack of administrative capacity."

The Progress Report 2011 has acknowledged a good progress with regards to the country's participation in the framework programmes and identified the theme of energy as an example of good participation in FP7:

"***Good progress is being made as regards the country's participation in the framework programmes***. There was an increase both in the number of applications submitted and selected, and in the amount of funds received, under the Seventh EU Framework Programme for Research and Development (FP7). ***Participation is good in the energy***, ICT and environment themes; however, partaking in Marie Curie actions and involvement of SMEs remains very low. The Joint Research Committee was established. The Committee monitored progress under FP7 since the association and established at its February meeting that additional efforts are required to increase participation in FP7."

The Table 1 presents FP participation of Macedonian institutions in energy theme. FP 6 projects are mostly of STREP (Specific Target Research Project) type, financed under WBC International Cooperation (INCO) program, where energy was one of the priorities. Partnerships among academic institutions and industry (SME) were created at national level (e.g. projects b1, b2)

As far as FP7- energy participation is concerned, 6 of the projects are financed under subprogram of cooperation, 2 under SME targeted subprogram and 1 under the subprogram of capacities. Almost half of the total EC contribution goes to an industry partner (projects c8, c9).

Macedonia has also appointed a national contact point (NCP Energy), while the Macedonian representative has not participated in the work of the FP7 Program Committee on Energy.

Table 1. Macedonian participation in FP- energy theme

	FP6	**FP7**[4]
Number of projects	8	9
EC contribution (for energy theme) [€]	1,061,379	1,031,741
Percentage of the overall EC contribution	17%[5]	10%[6]
Number of MK partners in the consortia of energy projects	5 (2 academic, 1 industry, 1 association, 1 utility)	10 (2 academic, 1 industry, 3 associations, 2 utilities, 2 municipalities)

4. SWOT analysis of the Energy research capacity in the Republic of Macedonia

4.1 Strengths

- Relatively good participation in FP- energy theme
- Relatively good research competences in some areas
- Increasing number of non-academic researchers (from industry, associations, utilities, municipalities)

4.2 Weaknesses

- Unsatisfactory level of public and private funds for energy research
- Relatively low international visibility (low number of peer reviewed international publications)
- Poor research infrastructure in some areas

4.3 Opportunities

- Collaboration between academia and industry
- International and regional cooperation
- Mobility of researchers (intersectoral and geographical)
- Potential for innovations

[4] Until April 2012

[5] The overall EC contribution amounts €6,200,000

[6] The overall EC contribution amounts €10,000,000

4.4 Threats

- Destabilization of the economic and political climate in the country

5. Energy research priorities for the Republic of Macedonia

The countries in the region, including Macedonia, are in a process of integration in the European Union and the energy policy is under pressure to align with the EU energy-climate objectives, including opening energy markets, removing subsidies from fossil fuels, reducing greenhouse gas emissions, increasing energy efficiency and increasing the share of renewable energy. These countries are in the process of negotiating the goals that should be reached by 2020 and will be influenced by the regional energy market gradually being introduced.

Since mid twentieth century the energy security of Southeast Europe (SEE) has been based on local deposits of coal and significant hydro potential, with some nuclear, gas and oil. The coal, mainly lignite, is important employer which sustains whole communities. Most SEE countries, including Macedonia maintain low regulated tariffs and while incumbent utilities generally cover their low (historic) costs, they do not support new investment. The higher cost electricity produced from thermal power plants is partially cross-subsidized by hydropower, which investment has been long paid off. Europe-wide market liberalization and build-up of wind energy in the SEE region will bring overproduction of electricity during nights as repetition to what happened in the other markets. Flexible thermal power plants will be in great demand by 2020, while base load blocks of today will be gradually phased out. Seeking techno-economic optimum, the region will be under pressure between following EU's example of importing gas or continuing with exploiting its coal in a much more efficient and flexible way with introduction of new combustion technologies. The coal communities will need significant investments in order to allow for the transition to new types of jobs. Significant investment in new energy technologies, like energy efficiency and renewables would be beneficial for this process, but the region has other priorities for scarce funds.

The national energy research priorities presented in this report enable

- Addressing the challenges for the national energy policy associated with the EU integration
- Mobilization of the existing research capacities, building new capacities, as well as better integration into the European energy research area
- Facilitation of the "science – industry" and "science – policy-making" partnerships, encouraging also intersectoral and geographical mobility of researchers.

5.1 Energy Research priorities on the basis of the country's readiness

5.1.1 Knowledge tools for energy related policy making

The focus should be on development and application of models for planning and optimization the energy system, which will enable scientific and competent analyses and provide the Government with an opportunity to make smart decisions about

- energy markets liberalization,
- subsidies removal from fossil fuels,
- greenhouse gas emissions reduction (setting the reduction target),
- energy efficiency increase,
- increase in the renewable energy share.

This priority is particularly important for the country's EU integration (alignment with EU energy-climate objectives), mobilization of the existing research capacities and for "science – policy-making" partnership.

5.1.2 Flexible use of coal

The focus should be on revitalization of the existing and introduction of new combustion technologies, which would enable flexible operation of coal power plants in liberalized energy systems.

This priority is particularly important for energy security, since the flexible use will lead to the lifetime extension of the existing domestic coal reserves and to the improved renewable energy absorption capacity of the power system.

5.1.3 Energy efficiency

The focus should be on large integration of energy efficiency in buildings (residential, public and commercial) since this sector exhibits the highest potential for final and primary energy consumption savings and improvements in energy efficiency. This potential needs to be harnessed through the research into optimisation and validation of proved and demonstration of new concepts and technologies for buildings. This incorporates the combination of sustainable strategies and technologies for increased energy efficiency, the use of renewable energy and co- and poly-generation and the integration of demand management measures and devices in cities and communities. The energy efficiency in buildings is highly important for smart grids (priority 5.1.5), since the real value of a smart grid cannot be unlocked without energy efficient buildings connected to it.

This priority is particularly important for alignment with the EU energy-climate objectives, “science – industry” partnership, involvement of municipalities and local companies, as well as for creating new types of jobs.

5.1.4 Renewable energy sources

The focus should be on solar thermal energy, biomass and biofuels. In the case of solar thermal energy there is a relatively well developed research capacities in industry (several SMEs) and relatively high potential for mass utilization of the technology. Biomass, due to its significant share in the energy mix, is very important source for meeting the renewable energy target. Same holds true for biofuels, given the specific renewable energy target for the EU transport sector

The research in the first sub-theme should be aimed at developing higher efficiency and lower cost solar systems with high performing collectors (e.g. using plastic materials with high thermal and optical performances). The research in the second sub-theme should be focused on the assessment of the potential of various biomass types, definition of the ways for efficient utilization of each biomass type, as well as development of advanced technologies and practices for biomass utilization, including co-generation and co-firing. The third sub-theme should be focused on domestic production of biofuels.

This priority is particularly important for alignment with the EU energy-climate objectives, “science – industry” partnership, mobilization of the existing research capacities (particularly in solar thermal sub-theme), involvement of municipalities and local companies, particularly from rural areas, as well as for creating new types of jobs.

5.1.5 Smart grids

For electricity networks, the goals are transforming the current electricity grids into a resilient and interactive (customers/operators) service networks, controlling the real time flows, facilitating the demand side management and removing the obstacles to the large-scale deployment and effective integration of renewable energy sources and distributed generation. Also, smart grids ultimately can play a role in helping to integrate electrified transportation effectively and efficiently. This will necessitate the research, development and demonstration of key enabling technologies (e.g. innovative ICT solutions, storage technologies for renewable energy sources, power electronics and superconducting devices) including the development of new control and reliability tools for electricity systems.

This priority is of prominent multidisciplinary nature, since it includes ICT, physics, chemistry, material sciences and various fields of power engineering. As such it is particularly important for mobilization of the existing research capacities, “science – industry” partnership and better integration in the European energy research area.

5.1.6 Summary of the contributions of the selected energy research priorities

The potential contributions for the country associated with the selected energy research can be summarized as shown in Table 2.

Contribution A - EU integration (alignment with the EU energy-climate objectives)

Contribution B - energy security

Contribution C - “science –policy-making” partnership

Contribution D - “science – industry” partnership

Contribution E - mobilization of the existing research capacities

Contribution F - involvement of municipalities and local companies

Contribution G - creating new types of jobs

Contribution H - multidisciplinary approach and better integration in the European energy research area.

Table 2. Contributions of the selected energy research priorities

Priorities	***Contributions***							
	A	B	C	D	E	F	G	H
Knowledge tools for energy related policy making	X		X		X			
Flexible use of coal		X						
Energy efficiency – Energy efficiency in buildings	X			X		X	X	
Renewable energy sources – Solar thermal – Biomass – Biofuels	X	X		X	X	X	X	
Smart grids				X	X			X

5.2 Energy Research priorities on the basis of future potential

5.2.1 Innovative R&D addressing specific components or technologies

A key aim is the optimisation of the local community energy system, balancing a significant reduction in energy demand with the most affordable and sustainable supply solutions

- Energy neutral building
- Poly-generation
- Smart metering
- Integrated energy control of buildings (and neighbourhoods)
- Electric vehicles (and their deployment)
- Eco-innovation
- Integration of energy and resources flows

5.2.2 Developing interconnections among national systems of network energies

A key aim is to facilitate regional approach to energy trade, balancing, resource management and strategic energy planning.