International colloquium Decision making principles in building of electric power sources: Principi donošenja odluka pri gradnji elektroenergetskih izvora

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INVITED AUTHORS IDENTIFICATION:
(by alphabetic order)

- Prof. dr. sci.Mohsen Assadi
  University of Stavanger, Norway

- Prof. dr. sci. Fernando Pires Maciel Barbosa
  DEEC/ FEUP, University of Porto, Portugal

- Prof. dr. sci. Ferdinand Gubina
  University of Ljubljana, Slovenija

- Prof. Eva Jakobsson
  University of Stavanger, Norway

- Prof. dr. sci. Tarik Kupusović
  Hydro-Engineering Institute, Sarajevo, B&H

- Prof. dr. sci.Mirza Kušljugić
  University of Tuzla, Tuzla, B&H

- Prof. dr. sci. Zdravko N. Milovanović
  University in Banja Luka, B&H

- Prof. dr. sci. Zijo Pašić
  University of Sarajevo;
  Regular Member of Academy Sciences and Arts of B&H

- Prof. dr. sci. Wolfgang Pfaffenberger
  Jacobs University Bremen, Germany

- Prof. dr. sci. Izet Smajević
  University of Sarajevo;
  Public Electric Utility Elektroprivreda B&H d.d.-Sarajevo, B&H

- Prof. dr. sci. Tord Torisson
  Lund University, Sweden

- Dr. sci. Alfredo Višković
  HEP Croatia, Zagreb, Croatia

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Prof. dr. sci. Zijo Pašić

Development of civilization is strongly related to existence of energy resources and degree of knowledge how to use them. Today in modern civilization, spectrum of sources of energy is greater than ever and technology of their usage reached very sophisticated level. Nevertheless demands for energy are higher than ever with visible tendency of its growth. Taking into account that current industrial technologies are predominantly based on electrical energy, demand for energy mean demands for electrical energy i.e. demands for building new electric power stations, converting other kinds of energy into electrical one.

Not underestimating other, emerging, technologies in this field, majority of existing and planned to be built, electric power stations are hydro, thermo or nuclear power stations, each of them with own benefits and own negative influence to people and local and global surroundings.

Fig.1. Total view of ITAIPU. Left part shows overflow (spillway).

Prof. dr. sci. Zijo Pašić
University of Sarajevo
Regular Member of Academy Sciences and Arts of Bosnia and Herzegovina

Carefully evaluated balance between benefits and disadvantages (if other influences can be excluded) defines politics of building new electric power sources.

Illustrative examples in this sense could be hydropower station ITAIPU (Brazil, Paraguay) and electric power stations in Japan.

ITAIPU – the biggest hydroelectric power plant on Earth, with capacity of 14,000 MW, was built on river Parana (border river between Brazil and Paraguay), Fig. 1. and owned by Brazil and Paraguay on equal parts (L1; L2).

ITAIPU generates 103 TWh of electrical energy per year. It covers 26% of electrical power consumption of Brazil and 78% of electric power consumption of Paraguay. Using significantly smaller part of ¨own¨ energy (less than 5%), Paraguay is selling the rest of ¨own¨ energy to Brazil, using electrical energy as good export product.

Although 1.350km^2 of soil (mainly forest) was covered by lake (about ten thousands families were dislodged and about 30.000 wild animals had to be saved during first filling-in of the lake), as great advantages of ITAIPU are referred facts that it has capacity of fourteen nuclear power stations and that it has not any harmful emission (equivalent coal power plant would emit 92.7 million tons of carbon dioxide per year).

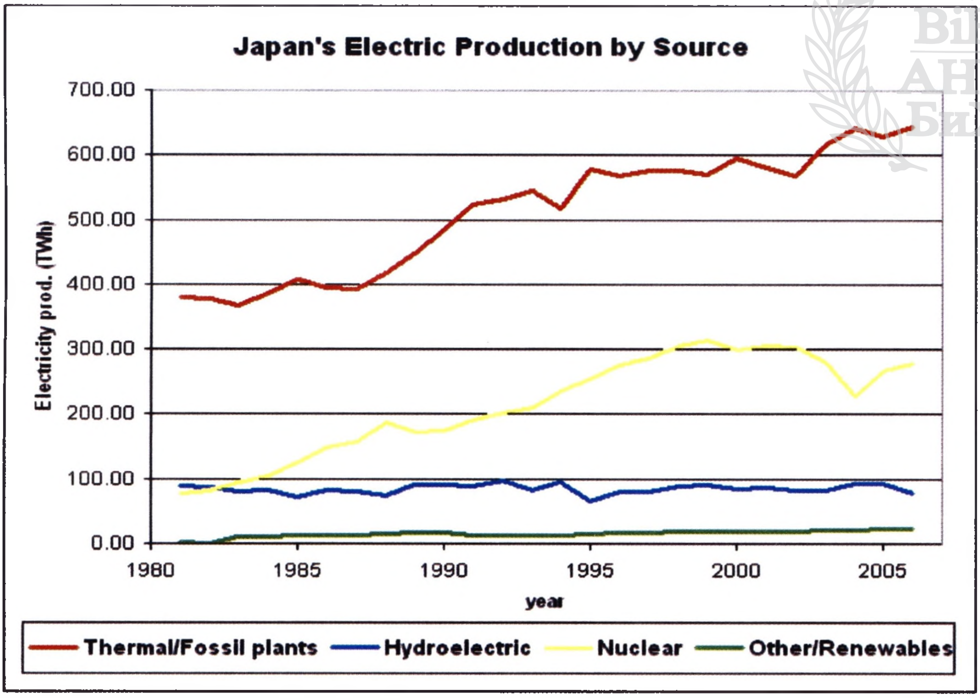

Fig.2. Production of electrical energy in Japan in the period 1980-2006

Quite opposite situation is on the opposite side of the planet Earth – in Japan. Highly industrialized country, Japan is spending over 1000TWh of electrical energy per year, Fig.2., 80% of which is based on imported fuel (L3).
Therefore since 1973 nuclear energy has been defined as national strategic priority. In 2005 there were 55 nuclear reactors in operation, located all around the country and generating about 30% of totally produced electrical energy in Japan.
Despite to the fact that Japan represents the area subjected to frequent earth-quakes, despite 17 accidents in 9 nuclear power plants in the period since 1995 to 2004 (L.4.) and despite widespread public opposition to nuclear power, building of new nuclear power plants in Japan is in progress with tendency to provide 41% of total electrical energy in Japan by 2012 and 60% by 2050.
In-between two mentioned border cases, Paraguay and Japan, it is possible to locate decision making problems in building of electrical power sources in any other country.
If taking care about own population and social progress, in decision making process each country is faced to the questions:

- How to find balance between benefit and unavoidable devastation of surroundings (dislocation of population, flooding of fertile soil, natural beauties, rare flora, air pollution and waste deposition, risk of soil and air poisoning);
- To build capacities to cover own needs for energy only (and so minimize negative impact to population and surroundings) or to cover own needs and for export also;
- To import fuel and to build electrical power sources or to import electrical energy (if possible) and not to build any electrical power sources (if country has not enough of own resources of energy);
- Which kind of fuel to import (if necessary)?

Other specific questions, not written here, also should be analyzed and answered.
Based on the fact that decision making in the field of electrical energy is sovereign right and responsibility of each independent country, presentation of experience of different countries and different aspects in this field is extremely useful. Also, because of strong mutual connections and global influence to surroundings, general decision making principles in building of electric power sources should be harmonized and respected.

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ENERGY SYSTEMS - A CRITICAL NATIONAL INFRASTRUCTURE

Prof. dr. sci. Fernando Pires Maciel Barbosa

1. Introduction

Electricity is regarded as one of the indispensable means to growth of any country's economy. This source of power is the heartbeat of everything from the huge metropolitans, industries, worldwide computer networks and our global communication systems down to our homes. Electrical energy is the lifeline for any economic and societal development of a region or country. It is central to develop countries for maintaining acquired life styles and essential to developing countries for industrialisation and escaping poverty.

Linkages between energy use and environmental quality have always been apparent, from the deforestation caused by fuel wood use even in early societies to the high levels of local air and water pollution that have commonly accompanied the early phases of industrialization. In recent decades, advances in scientific understanding and in monitoring and measurement capabilities have brought increased awareness of the more subtle environmental and human-health effects associated with energy production, conversion, and use. Fossil-fuel combustion is now known to be responsible for substantial emissions of air pollutants-including sulfur, nitrogen oxides, hydrocarbons, and soot-that play a major role in the formation of fine particulate matter, ground-level ozone, and acid rain; energy use is also a major contributor to the release of long-lived heavy metals, such as lead and mercury, and other hazardous materials into the environment. Energy-related air pollution (including poor indoor air quality from the use of solid fuels for cooking and heating) not only creates substantial public health risks, especially where emission controls are limited or nonexistent, it harms ecosystems, degrades materials and structures, and impairs agricultural productivity. In addition, the extraction, transport, and processing of primary energy sources such as coal, oil, and uranium are associated with a variety of damages or risks to land, water, and ecosystems while the wastes generated by some fuel cycles-notably nuclear electricity production-present additional disposal issues.

Although the most obvious environmental impacts from energy production and use have always been local, significant impacts-including the long-range transport of certain pollutants in the atmosphere-are now known to occur on

Prof. dr. sci. Fernando Pires Maciel Barbosa
DEEC/ FEUP, University of Porto, Portugal

regional, continental, and even transcontinental scales. And at a global level, climate change is emerging as the most consequential and most difficult energy-environment linkage of all. The production and use of energy contributes more than any other human activity to the change in *irradiative forcing* that is currently occurring in the atmosphere; in fact, fossil-fuel combustion alone currently accounts for well over half of total greenhouse gas emissions worldwide (after accounting for different gases' carbon dioxide equivalent warming potential). Since the dawn of the industrial era, carbon dioxide levels in the atmosphere have increased by about 40 percent; going forward, trends in energy production, conversion, and use-more than any other factor within human control-are likely to determine how quickly those levels continue to rise, and how far. The precise implications of the current trajectory remain unknown, but there is less and less doubt that the risks are large and more and more evidence that human-induced global warming is already underway. In its recent, Fourth Assessment report, for example, the Intergovernmental Panel on Climate Change (IPCC) [4] concluded that evidence for the warming of the Earth's climate system was now 'unequivocal' and identified a number of potential adverse impacts associated with continued warming, including increased risks to coasts, ecosystems, fresh-water resources, and human health. In this context, making the transition to lower-carbon energy options is widely acknowledged as a central imperative in the effort to reduce climate-change risks.

Another issue that will continue to dominate regional, national, and international energy policy debates over the next several decades is energy security. Defined as access to adequate supplies of energy when needed, in the form needed, and at affordable prices, energy security remains a central priority for all nations concerned with promoting healthy economic growth and maintaining internal as well as external stability. In the near to medium term, energy security concerns are almost certain to focus on oil and, to a lesser extent, on natural gas. As demand for these resources grows and as reserves of relatively cheap and readily accessible supplies decline in many parts of the world, the potential for supply disruptions, trade conflicts, and price shocks is likely to increase. Already, there is concern that the current environment of tight supplies and high and volatile prices is exacerbating trade imbalances, slowing global economic growth, and directly or indirectly complicating efforts to promote international peace and security. The problem is particularly acute for many developing countries that devote a large fraction of their foreign exchange earnings to oil imports, thus reducing the resources available to support investments needed for economic growth and social development.

Electrical energy is a high quality form of energy which is not found in nature. Instead it has to be obtained from the conversion in power plants of other types of energy supplies.

These energy supplies can broadly be divided into two classes:

- Renewable energy which is obtained from continuous or repetitive currents of energy occurring in the natural environment
- Non-renewable energy which is obtained from static stores of energy that remain boundless released by human interaction

2. The Electricity Power Systems - the new paradigm

The industrialised world has satisfied the demand for electrical energy by developing technologies for the generation of electricity which use mainly non-renewable energy supplies such as coal or nuclear. These environmentally hazardous generation technologies continue to be the backbone of the electricity generation system. The need for harnessing renewable energy supplies is apparent as world population increases and as each individual presses for a higher standard of living in terms of material goods especially in rural and developing regions.

Energy supply in Europe has been dominated by the large scale centralized combustion of fossil fuels (coal, oil and gas), nuclear and hydro power, with energy delivered over long distance to consumers. Concerning the Europe sustainable development, this traditional economy of scale presents some drawbacks.

Fig 1 and Fig 2 show the new and the old paradigm of the structure of the new power systems.

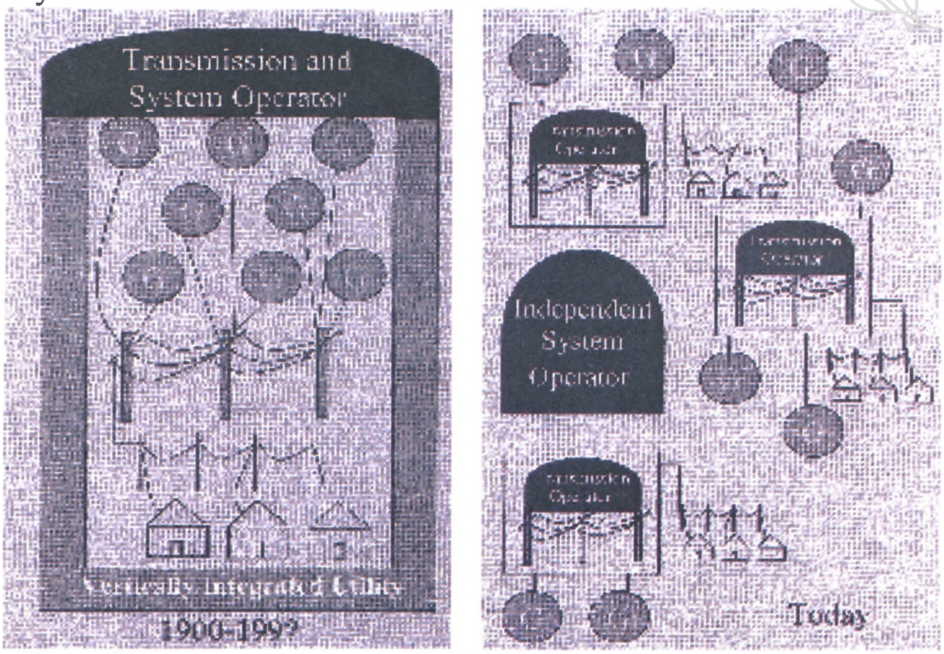


Fig. 1-The new and the old paradigm of the structure of power systems

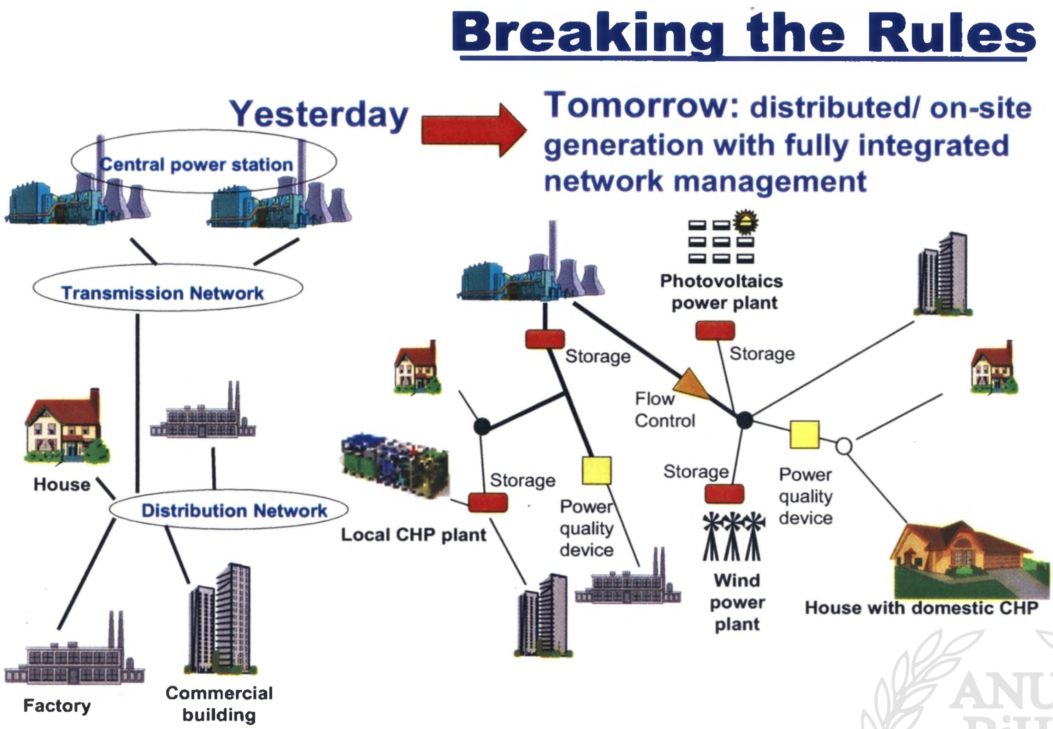


Fig.2 - Yesterday and tomorrow power systems

As societies began to modernize and shift from traditional forms of energy (such as wood, crop residues, and dung) to commercial forms of energy (liquid or gaseous fuels and electricity), their energy consumption per capita and per unit of economic output (gross domestic product) often grew rapidly. At a later stage of development, however, further growth in energy consumption typically slowed as the market for energy-using devices reached a point of saturation and as wealthier economies shifted away from more energy-intensive manufacturing and toward a greater role for the less energy-intensive service sector. The rate of growth in energy consumption also diminished in some industrialized countries as a result of concerted energy efficiency and conservation programs that were launched in the wake of sharp oil price increases in the early 1970s. Figure 3 shows declining energy intensity trends for OECD and non-OECD countries over the last 18 years.

In recent years, the energy intensity of the world's industrialized economies has been declining at an average annual rate of 1.1 percent per year, while the energy intensity of the non-OECD economies has been declining, on average, even faster (presumably because these economies start from a base of higher intensity and lower efficiency). Because the rate of decline in energy intensity has generally not been sufficient to offset GDP (gross domestic product) growth, total energy consumption has continued to grow in industrialized countries and is growing even faster in many developing countries.

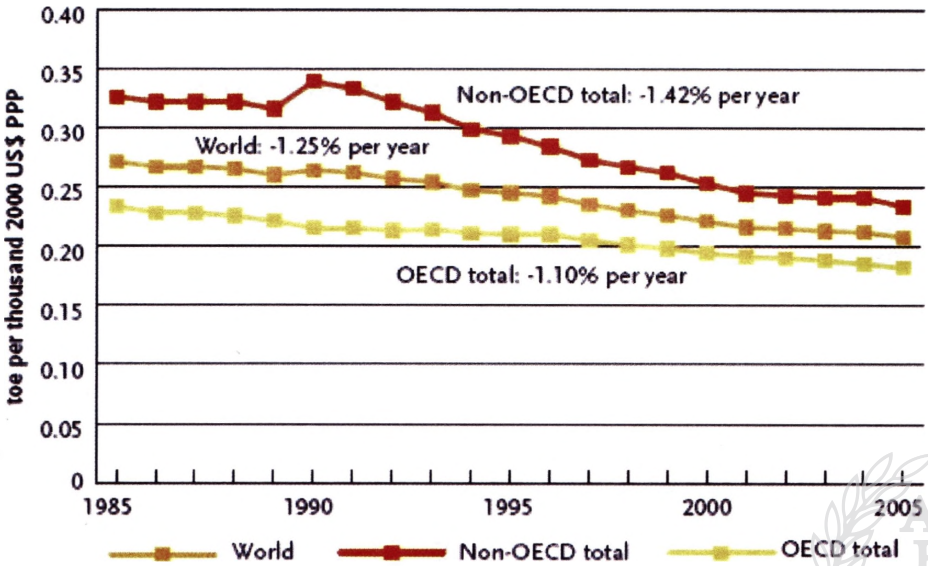


Fig. 3 - Energy intensity versus time, 1985-2005 [5]

Looking ahead, current projections suggest that the world's population will grow by another 50 percent over the first half of this century (to approximately 9 billion by 2050), world income will roughly quadruple, and energy consumption will either double or triple, depending on the pace of future reductions in energy intensity. But projections are notoriously unreliable: patterns of development, structural economic shifts, population growth, and lifestyle choices will all have a profound impact on future trends.

Even small changes in average year-to-year growth or in the rate of intensity reductions can produce very different energy and emissions outcomes over the course of several decades. Simply boosting the historical rate of decline in energy intensity from 1 percent per year to 2 percent per year on a global average basis, for example, would reduce energy demand in 2030 by 26 percent below the business-as-usual base case.

Numerous engineering analyses suggest that intensity reductions of this magnitude could be achieved by concerted investments in energy efficiency over the next half century, but even seemingly modest changes in annual average rates of improvement can be difficult to sustain in practice, especially over long periods of time, and may require significant policy commitments.

Confronted with the near certainty of continued growth in overall energy demand, even with concerted efforts to further improve efficiency, reduce energy intensity, and promote a more equitable distribution of resources, the scale of the sustainability challenge becomes more daunting still when one considers the current mix of resources used to meet human energy needs. Figure 4 shows total primary energy consumption for the OECD countries, developing countries, and transition economies (where the latter category chiefly includes Eastern European countries and the former Soviet Union), while Figures 5 and 6 show global primary energy consumption and global electricity production, broken down by fuel source.

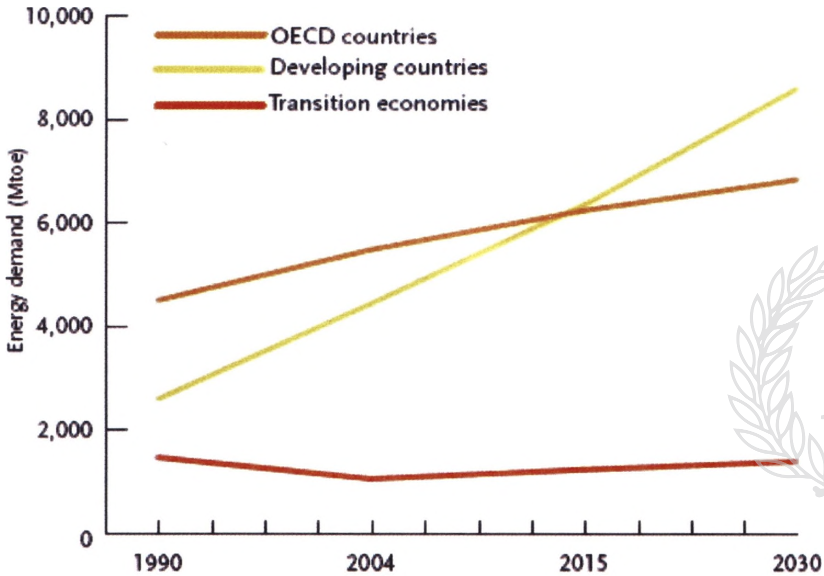


Fig. 4 - Regional shares in world energy demand [5]

Non-renewable, carbon-emitting fossil fuels (coal, oil, and natural gas) account for approximately 80 percent of world primary energy consumption (Figure 5). Traditional biomass comprises the next largest share (10 percent) while nuclear, hydropower, and other renewable resources (including modern biomass, wind, and solar power), respectively, account for 6, 2, and 1 percent of the total. Figure 6 shows the mix of fuels used to generate electricity worldwide. Again, fossil fuels-primarily coal and natural gas-dominate the resource mix, accounting for two-thirds of global electricity production. The nuclear and hydropower contributions are roughly equal at 16 percent of the total, while non-hydro renewables account for approximately 2 percent of global production.

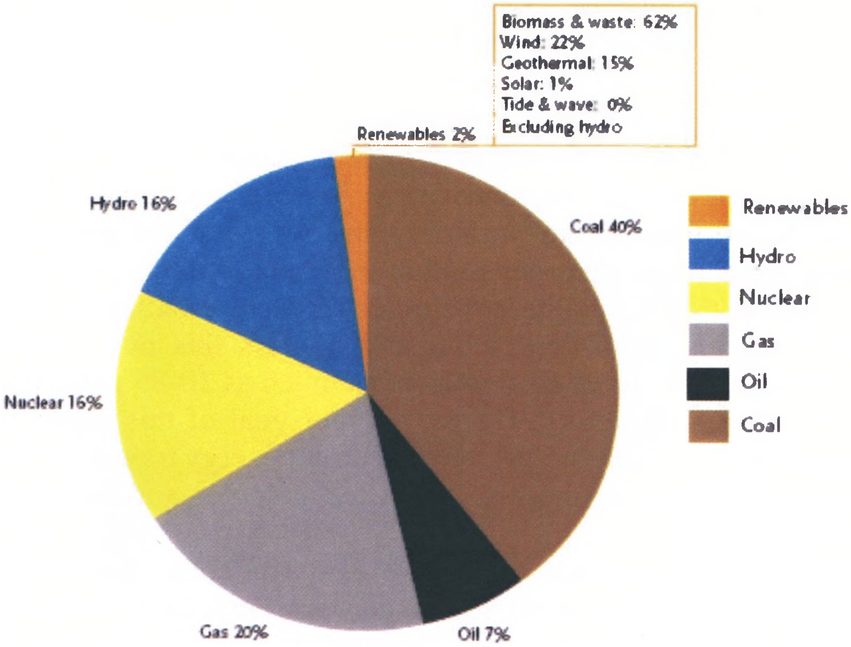


Fig.5 - World primary energy consumption by fuel, 2004 [3]

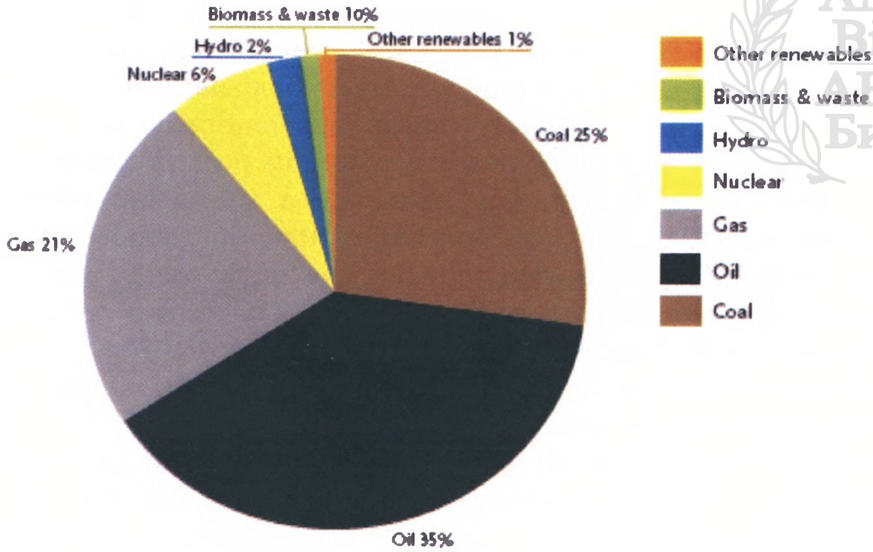


Fig 6 - World electricity production by energy source, 2004 [3]

Most projections indicate that fossil fuels will continue to dominate the world's energy mix for decades to come, with overall demand for these fuels and resulting carbon emissions rising accordingly.

IEA's [5] projections assume moderate growth in the use of renewable energy technologies. But since non-hydro renewable accounted for only 2 percent of world electricity production in 2004, fossil-fuel consumption and global carbon emissions continue to grow strongly by 2030. Indeed current forecasts suggest that a continuation of business-as-usual trends will produce a roughly 55 percent increase in carbon dioxide emissions over the next two decades.

The implications of these projections, from a climate perspective alone, are sobering. Limiting global warming to a 2-3 degrees Celsius change will require stabilizing atmospheric concentrations of greenhouse gases somewhere in the range of 450-550 parts per million in carbon dioxide equivalent terms. Based on numerous IPCC (Intergovernmental Panel on Climate Change) [4] developed scenarios, achieving stabilization within this range could require absolute reductions in global emissions of as much as 30-85 percent compared to 2000 levels by mid-century. Hence, a major goal of this report is to offer recommendations for shifting the world's current energy trajectory through the accelerated deployment of more efficient technologies and sustainable, low-carbon energy sources.

The consequences of current trends are also troubling, however, from an energy security perspective given the longer-term outlook for conventional oil supplies and given the energy expenditures and environmental impacts it implies, for countries struggling to meet basic social and economic-development needs. Recent forecasts suggest that a continuation of business-as-usual trends will produce a nearly 40 percent increase in world oil consumption by 2030, at a time when many experts predict that production of readily accessible, relatively cheap conventional oil will be rapidly approaching (or may have already reached) its peak. Moreover, IEA reference case projections, though they anticipate a substantial increase in energy consumption by developing countries, assume only modest progress over the next several decades toward reducing the large energy inequities that now characterize different parts of the world. This is perhaps not surprising insofar as the IEA projections are based on extrapolating past trends into the future; as such they do not account for the possibility that developing countries might follow a different trajectory than industrialized countries.

On one hand, a significant amount of Europe's generation capacity, both coal and nuclear fuel, is reaching the end of its useful life and the network infrastructure is also old, requiring investments in a short-term on the transmission and distribution system.

Renewable energy replaces conventional fuels in four distinct sectors: power generation, hot water and space heating, transport fuels and rural (off-grid) energy. In power generation, renewable energy supplies about 3.4% percent of global electricity production (excluding large hydropower) (Fig.7).

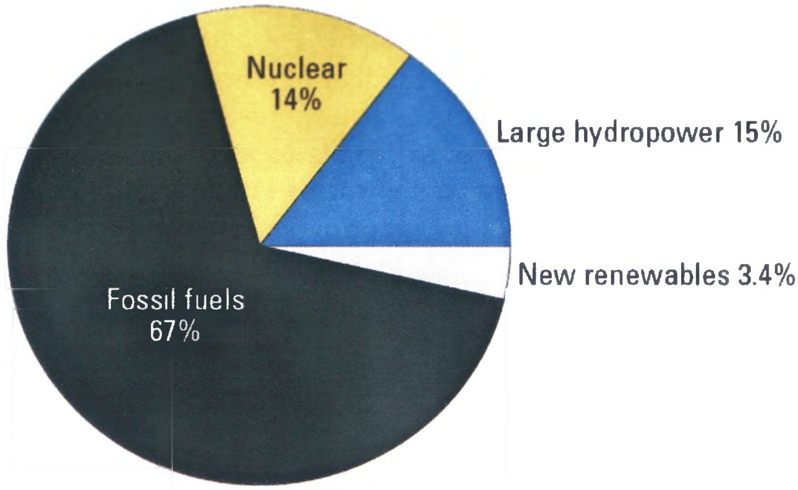


Fig. 7 - Share of global Electricity from renewable energy, 2006 [8]

On the other hand, the continuous increasing demand for energy, in particular for electricity, has stressed a number of shortcomings:

- High level of dependency of imported fuels leading to potential price rises and potential supply disruptions;
- Large environmental impact on greenhouse gases and other pollutants;
- Increased transmission losses;
- Continuous upgrading of transmission and distribution systems.

3. Renewable Energy Systems

Renewable Energy Systems (RES) and Distributed Generation (DG) for heating, cooling and electricity have the potential to become the foundation of a future more sustainable energy supply system. Their scale deployment will transform the energy landscape from a system dominated by the centralized combustion of fossil fuels to a new one in which new technologies, environmentally friendly, contribute to a substantial development. On the other hand, DG can offer additional value to the grid system operators by providing:

- Deferral of investment to transmission and distribution systems;
- Reduction of losses in the distribution system;
- Provision of network support services or ancillary services.

From an investment view point, it is generally easier to find sites for RES and DG than for large central power plants and, in addition, such units can be installed in a short time, near to the end consumer. The widespread integration of RES and DG together with energy efficiency, covering supply and demand, has provided support to achieve the major EU policy objectives:

- Sustainable energy development, combating climate changes and reducing air pollutants is the paradigm of the future power systems. The shift from the large scale combustion of fossil fuels to a more decentralized energy supply based on RES has contributed for meeting the Kyoto commitments, regarding the emission of greenhouse gases, particularly CO2: 8% reduction of emissions from 1990 levels by 2008-2010 and 20% by 2020 compared to 1990;
- Security and diversity of energy supply. Reducing the external energy dependence is crucial for the development of a dynamic and sustainable economy for Europe;
- Increasing the penetration of RES, doubling their share in energy supply quota from 6% to 12% of gross Energy consumption and raising their part in electricity production from 14% in 2001 to 22% is an objective to be attained by 2010.
- Energy marked liberalization, increasing opportunities for smaller scale generators.

The main objective of any generation and distribution utility is to satisfy the demand of customers with a high quality product. This product namely electricity must be supplied continuously round the clock.

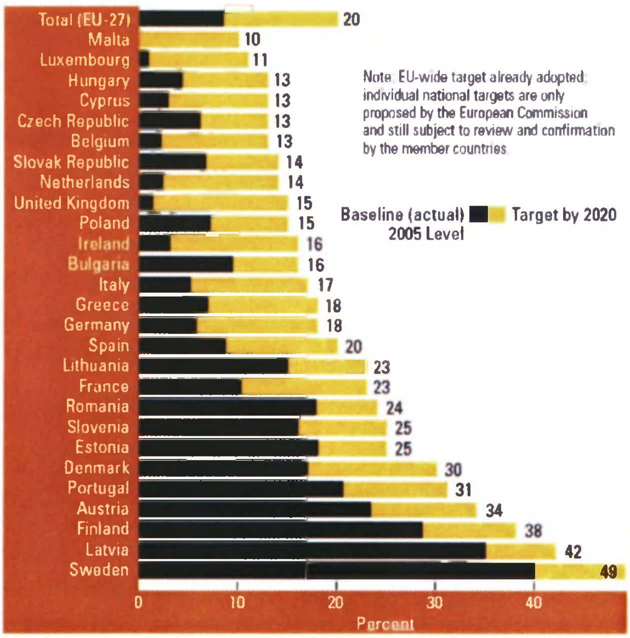


Fig. 8 - EU Renewable Energy Targets - Share of Final Energy by 2020 [8]

Wind generation, photovoltaic's panels, fuel cells and microturbines - just to mention a few- are new forms of electricity under development (Fig.14). They define the so called RES (**R**enewable **E**nergy **S**ystems) and involve the exploitation off distribution sources through the concept of DG (**D**istributed **G**eneration). Today, wind power and CHP (**C**ombined **H**eat and **P**ower) are entering into a competitive level with traditional forms of energy generation. Tomorrow it is expected that one speaks also about microgeneration (microturbines. Micro-CHP, photovoltaic systems and fuel cells).
Wind energy is the renewable energy source that had a higher growing in the last decades and can be considered a hope in future based on clean and sustainable energy (Figs. 9,10,11,12 and 13).

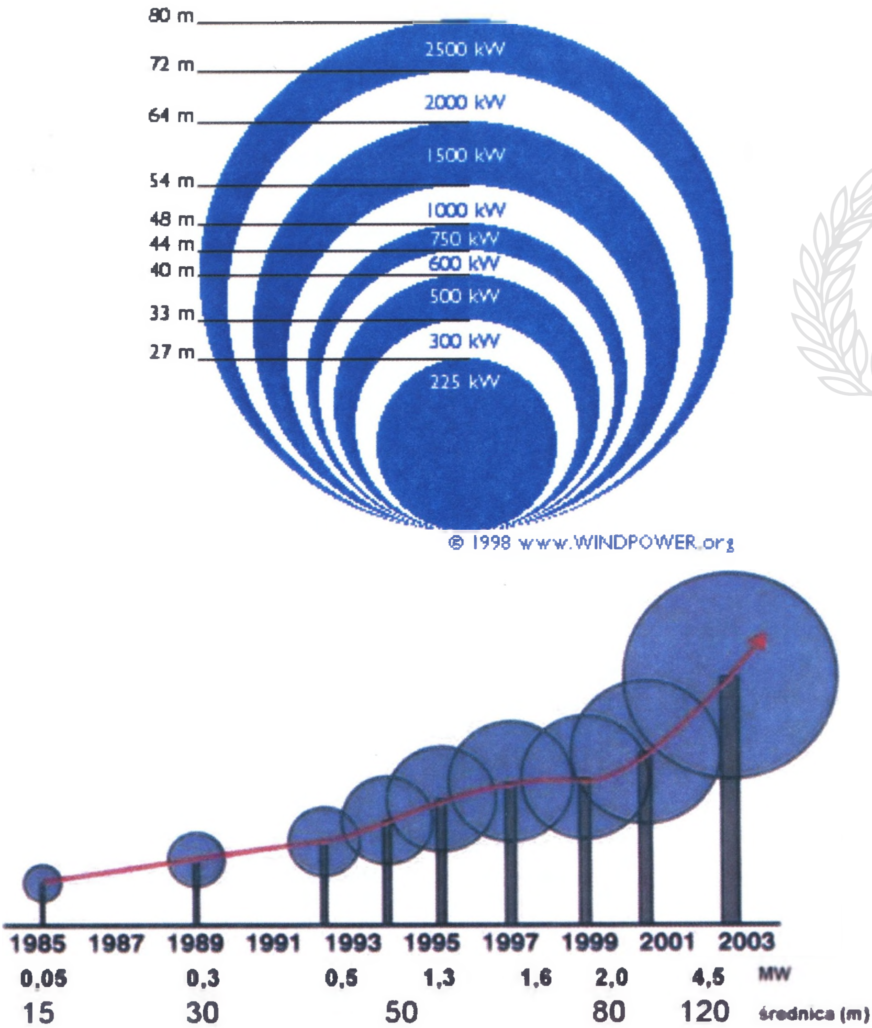
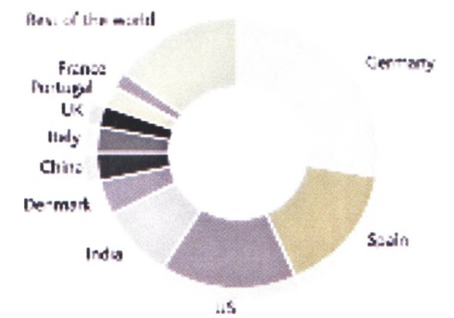


Fig.9 -Technology development -wind energy [6]

However, the integration of both RES and DG into the overall power systems operation requires that energy generation in both transmission and distribution systems can no longer be considered as passive appendage. Reliability, safety and quality of power are the main issues linked to the large-scale deployment of DER (**D**istributed **E**nergy **R**esources) so that their effect on the European transmission and distribution networks cannot be neglected. Rather, it must be addressed with a comprehensive system approach.

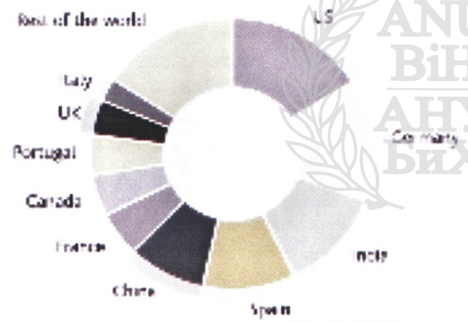
Following the increasing penetration of DG in MV networks, dissemination of small size dispersed microgeneration systems connected to LV distribution systems is expected to become one of the means to face the continuous demand growth. The need to reduce greenhouse gas emissions, recent technological developments related with the improvement of microgeneration efficiency and the possibility of exploiting RES are important factors that will contribute, in a short term, to an effective integration of microgeneration in LV grids.

TOP 10 TOTAL INSTALLED CAPACITY



	MW	%
Germany	20,622	27.8
Spain	11,615	15.6
US	11,603	15.6
India	6,270	8.4
Denmark	3,136	4.2
China	2,604	3.5
Italy	2,123	2.9
UK	1,963	2.6
Portugal	1,716	2.3
France	1.567	2.1
Rest of the world	11,005	14.8
Total top 10	63,218	85.2
Total	74,223	

TOP 10 NEW CAPACITY



	MW	%
US	2.454	16.1
Germany	2.233	14.7
India	1.840	12.1
Spain	1.587	10.4
China	1.347	8.9
France	810	5.3
Canada	776	5.1
Portugal	694	4.6
UK	634	4.2
Italy	417	2.7
Rest of the world	2.405	15.8
Total top 10	12.792	84.2
Total	15.197	

Fig.11- The top 10 wind power installed capacity and the top 10 new wind power capacity countries [7]

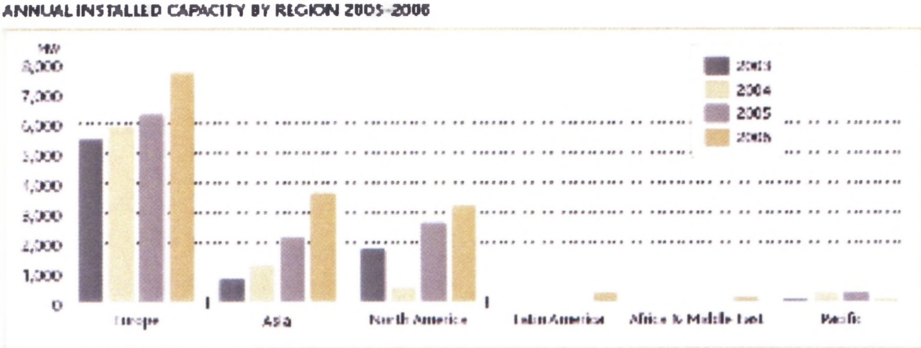


Fig 10 - Annual wind power installed capacity by region 2005-2006 [7]

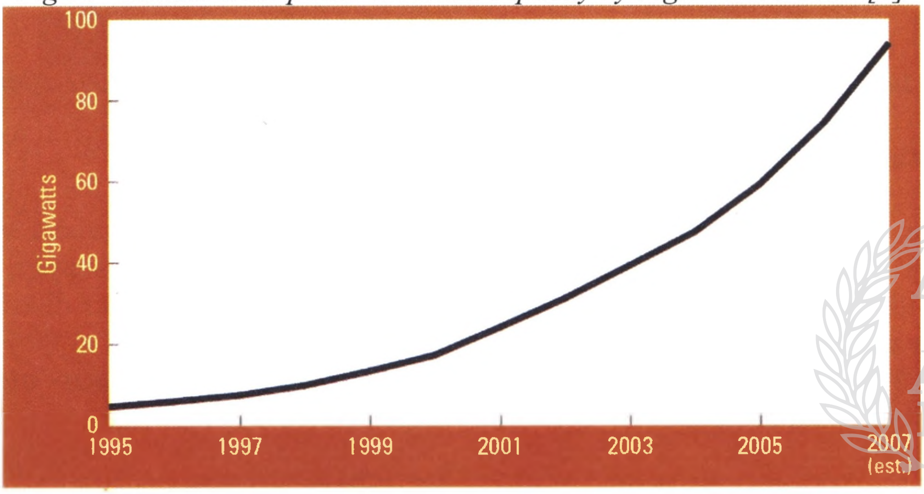


Fig. 12 - Wind Power, existing World Capacity, 1995-2007 [8]

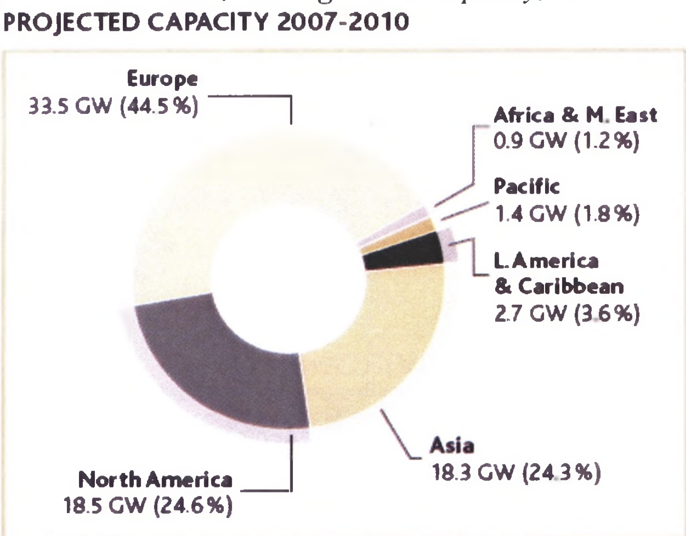


Fig. 13-Targets of wind capacity to be installed [7]

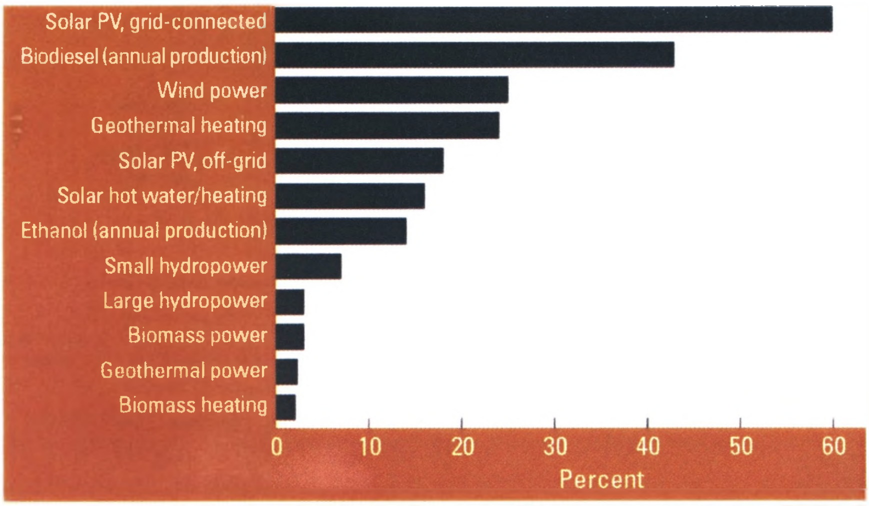


Fig. 14-Average annual growth rates of renewable energy capacity, 2002-2006 [8]

4. Future electricity markets and networks

Future electricity markets and networks must provide all consumers with a highly reliable, flexible, accessible and cost-effective power supply, fully exploiting the use of both large centralized generators and smaller distributed power sources across Europe.
Fig. 15 shows the three driving forces of the new power systems- marked, security and environment.

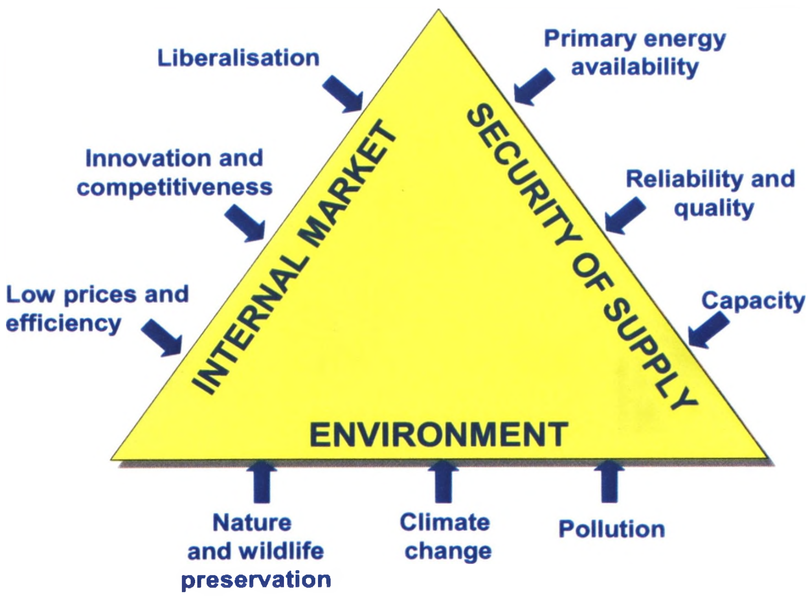


Fig. 15 - The three driving forces of the new power systems [2]

End users will become significantly more interactive with both markets and grids; electricity will be generated by centralised and dispersed sources; and grid systems will become more inter-operable at a European level to enhance security and cost-effectiveness. This new concept of electricity networks is described as the 'SmartGrids' [2] vision. It will enable a highly effective response to the rising challenges and opportunities, bringing benefits to all network users and wider stakeholders.

In recent years there has been a growing awareness, within the electricity supply industry, of the need to reinvent Europe's electricity networks in order to meet the demands of 21st century customers.

The Distribution Network is defined as the system covering all wires and equipment that play a role in supplying all medium to low voltage consumers and also giving network connection to DG technologies. Distributed Generation, becoming an integral part of European energy system, should provide consumers and energy providers with safe, affordable, clean, reliable, flexible and readily accessible energy services. DG has the fundamental benefit of producing electricity at or close to the point of consumption.

This reduces the losses resulting from delivery to customers and allows waste heat from generators to be used beneficially. Promoting and deploying distributed generation and, indeed, technologies that facilitate demand participation, therefore have the potential to benefit energy consumers, the European energy system and the environment through the optimization of the value chain from energy suppliers to active end customers utilising SmartGrid infrastructures.

Electricity market liberalization is increasing the interest of different stakeholders to the energy field. Over the coming years, energy supply will become more and more tailored to customer needs. Beside high focus on quality of service and cost reduction, total connectivity, energy "on demand", a service oriented portfolio and flexible contract management will play a leading role to fulfil customer expectations.

One of the enablers for this development is research for a set of "plug and play" interfacing modules for network connection of demand and DG using standardization and modularization, leading to lower costs throughout the power delivery chain and faster and simpler connections for generation and demand users. These plug and play interfacing modules will be environmentally friendly and can, to a high degree, be customized to individual needs. Through standardization, modularization and programmable functionality an economy of scale will be possible, leading to lower costs and more expandable systems.

Enhancing this work with multidirectional communication and control systems for horizontal and vertical integration, will facilitate participation of customers and DG in system operation resulting in effective distribution control for the benefit of power quality and reliability enhancement at the connection point. In this context, metering services and statistical metering tools represent the gateway for the access to the "active network", to the transaction platform, to the decentralized facilities and are requisite to support fully the electricity demand evolution. For that reason, electronic meters and Automated Meter Management systems represent the enabling advanced hardware and software technologies to facilitate and inform customer preferences and opportunities in the energy field and to optimize demand forecasting.

This can offer the customer choice and quality of supply at relatively low cost provided that minimal technical requirements are met and measurable, enabling network operators to maximize efficiency, flexibility and reliability through the use of smart advanced technologies.

One of the major problems limiting the wider penetration of Distributed Energy Resources (DER) in today's power systems is the lack of harmonization of grid connection requirements and the lack of compatibility of fault protection systems and metering. Differentiated definitions of grid connection requirements for the various types of generators are needed because of their different nature. Further obstacles arise from the operational engineering requirements of the networks where DER is connected. At distribution level, power flow constraints may lead to local reinforcement, in particular related to bi-directionality and possible conflicting requirements with natural gas and heat distribution networks (Combined Heat and Power). Where such obstacles are found in practice, appropriate research should be initiated to alleviate the constraints.

The objective assessment of DER effects on the network performance emphasizes the need for new system structures. Examples include: inadequacy of existing dynamic simulation tools to handle large numbers of power electronic converters in the power system and of analytical tools to study planning and development of networks taking into account the stochastic nature of DER, both in steady state and under dynamic conditions. Deterministic approaches based on maximum-minimum conditions are generally far too conservative, unnecessarily limiting a larger penetration of DER or underestimating its potential benefits. A stochastic approach is needed.

Much of the equipment of the present electricity networks was installed with a nominal design life of about 40 years. Increasingly this equipment is reaching the onset of significant unreliability in its life cycle. Meanwhile, the amount of load has grown beyond what has been predicted when the grid system was planned and designed.

Demand has doubled since the 1960s; peak demand and its timing have also changed and will continue to do so in ever less predictable ways. In recent years, environmental policies are encouraging lower carbon generation including renewable energy sources, generally using smaller unit sizes with a far less predictable output. These developments call for the re-engineering of Europe's electricity grids incorporating an innovative response to ensure cost-effective investment.

As very significant investments will be required to renew this infrastructure, it is likely that the most efficient way forward will be to incorporate new technologies and solutions when planning and executing asset renewal. This approach 'designs-in' greater network capability, flexibility and functionality will also enable Europe's networks to respond to the challenges and uncertainties as yet unforeseen.

Asset management is hindered by the traditional paradigms of reliability and long pay back periods (>30 years) associated with capital-intensive plant. The underlying uncertainty associated with recovery of such long-term investments calls for an improved knowledge of the condition and natural life cycles of networks and their components. Any consideration of future electricity networks should take into account also the life-expectancies of future new and refurbished assets - and the functional performance expectations (e.g. reliability, security, availability, accessibility, flexibility, adaptability, safety, environmental impact, aesthetic impact, operational impact, efficiency, and whole-life cost) of all stakeholders with respect to those assets from installation to disposal.

The goal is to realise robust and inter-operable European grid architecture to support the internal electricity markets and wider EU policy objectives. The European grid can be envisaged as a platform to facilitate the coexistence of intelligent local, self-controlling (smart) grids and active consumer participation, with high amounts of distributed generation on the one hand and large-scale centralised power plants and renewable bulk power injections on the other. The European grid will also have to fulfil control functions that are significant challenges to decentralise e.g. supply/demand balancing (frequency control).

The interconnection of the system could be increased e.g. by selective reinforcements or by co-ordinated action to create an ultra high voltage ac or dc transmission system architecture. Such development of the network has to take place in the context of a liberalised market with many independent players. It will require both engineering innovation and effective dialogue between the European transmission system operators in order to establish a highly inter-operable European network architecture that is coherent, viable as a business proposition, and consistent with national regulatory and commercial frameworks.

The future European grid will differ from the present in several aspects such as greater large scale cross-border energy trading, the presence of variable large-scale (e.g. off shore) wind power sources Fig 4, cross-border grid ancillary services (e.g. trading of reserve power) and the interaction of more dispersed generation and demand side management. There will almost certainly be new power flow patterns within member state grids. Better utilisation of grids and more fluctuating power in-feeds from renewable sources call for improved power flow controls at the transmission level (e.g. HVDC, FACTS), to enable renewable bulk power generation facilities to provide ancillary services and for methods to safeguard the stability of these more complex and inter-dependent transmission and distribution systems. Regional interconnection and local distribution (e.g. including mini and micro grids) will have to be developed and integrated into the architecture.

5. Blackouts

Power system blackouts have been a historical problem in interconnected grids. However in recent years, frequency and severity of this phenomenon has considerably increased. This may be in part the consequence of new regulations and restrictions imposed by power system deregulation. In fact, it is not possible to completely prevent these catastrophic failures. However by improving monitoring control and protection techniques, frequency and severity of the blackouts may be reduced

Whilst energy remains a major component of economic growth, such deficiencies have a direct impact on the world economical development, stability concerning the security of energy supply, environmental protection and well-being of world's citizens. These issues provided the main drivers for energy research in a sustainable development.

6. Conclusions

The demand for energy is proportional to the world's wealth. Current efforts in controlling the resulting rise in energy demand mainly focus on efficiency improvement and sustainable conversion technology.

Security of supply has been always a key factor in the development of electric power systems. Adequacy, quality of supply, stability and reliability and costs has to be carefully considered when planning the future of the electric power systems.

Energy systems need to be fundamentally restructured and rethought to take in account namely:

- Improvements of security standards in the context of critical infrastructures;
- Integration of both central and distributed generation;

- Integration of innovative technologies into existing grids;
- Harmonisation of equipment standards to allow "plug-and-play";
- The impact of neighbouring electricity systems.

An efficient approach to energy supply has to ensure that all relevant factors are considered in the system development for the future.

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SUSTAINABLE ENERGY AS EXPORT COMMODITY

Prof. dr. sci. Mohsen Assadi, Prof. Eva Jakobsson and
Prof. dr. sci.Tord Torisson

Introduction

Ever increasing energy demand supported mainly by fossil fuels, and the assumed impact of anthropologic CO2 emission on climate change put the environmental friendly energy production in the global focus. Sustainable energy solutions and increased use of renewable energy sources have become the ultimate goal of the world.

The leaders of Europe have decided to support an offensive CO2 emission target and EU-leaders have agreed on reduction of CO2 emission by 20% by year 2020, compared to 1999 emission level. According to the International Energy Agency (IEA) prognoses, electricity demand within EU will increase by about 30% until 2030. Fulfillment of 20% emission reduction in combination with considerable increase in electricity production is a challenging task that will require European mobilization. Besides increased demand for electricity within EU, there will be a considerable reduction in power generation capacity in Europe during coming decades due to phase out of ageing power plants. Therefore, there will be a strong export market for electricity based on renewable energy sources as commodity.

Among renewable energy sources, e. g. solar, wind, wave, biomass, etc., the most substantial and efficient contribution is provided by hydro power and biomass based thermal power plants. Therefore there will be a need to exploit unused resources of hydro and biomass within Europe to reach the ambitious emission goals stated by the Europe's leaders.

Bosnia and Herzegovina (BiH) is one of the European countries that has unexploited hydro and biomass resources. Building new power plants in BiH and modernizing the existing plants would provide a strong base for export of renewable energy to Europe and thereby facilitate economical development of the country for decades.

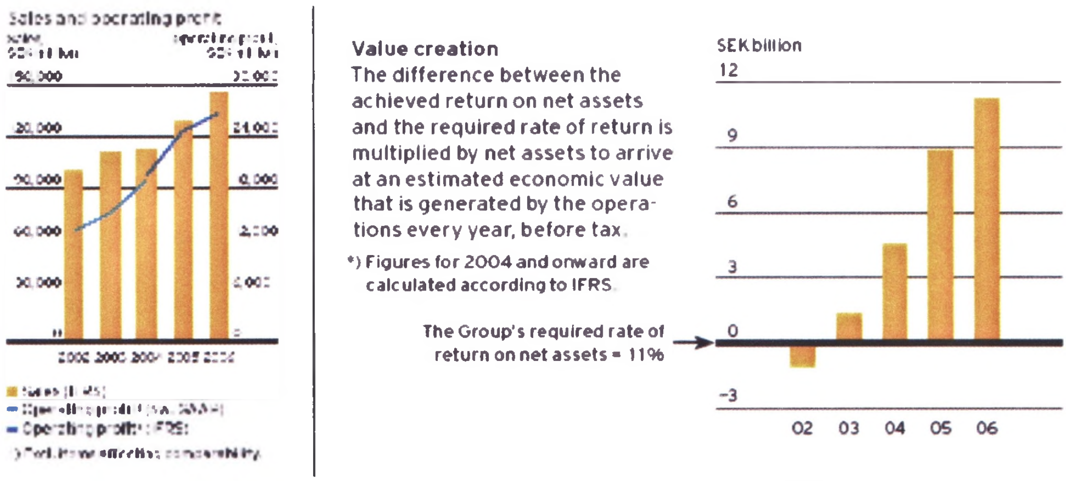
Building new hydro power plants as well as utilization of biomass for power production has considerable impact on local environment and the life of the people living in affected areas. To be able to combine economical develop-

Prof. dr. sci. Mohsen Assadi, University of Stavanger, Norway
Prof. Eva Jakobsson, University of Stavanger, Norway
Prof. dr. sci. Tord Torisson, Lund University, Sweden

ment and prosperity of the country with high level of public acceptance for the local impact on the environment, one needs to learn from experiences gained so far. The Scandinavian countries, especially Norway and Sweden, have long experience of both building hydro power and utilizing biomass as energy source. This paper provides a historical review of hydro power exploitation in Norway and Sweden, and gives a short review of status of biomass based power generation in Sweden.

Electricity as export commodity

The continuously increasing oil prices, higher extraction cost for unexploited oil reserves, risk for catastrophic climate change caused by anthropogenic CO2 emissions in combination with increasing demand for electricity and energy require new electricity generation capacity based on renewable energy sources and CO2 free technologies.
A high carbon price needs to be introduced, according to international experts, to provide necessary instruments and insurances for energy producers to invest in CO2 capture plants. CO2 capture requires large investments irrespective of the capture technology selected. Besides, the efficiency penalty of about 10%-points imposed by CO2 capture reduces the total amount of power produced by these plants. This will result in higher electricity prices from power plants equipped with CO2 capture. A review of energy companies' revenue during the last five years, e.g. Vattenfall that has a large nuclear power production capacity, shows that there is a huge opportunity for increased revenue for companies who can produce CO2 free electricity in today's market.



Figur 1: Vattenfall's result, annual report 2006.

The need for electricity will increase by about 30% within EU and with about 85% worldwide during the coming decades according to IEA's prognosis See figure 2 (Source VGB 2007).

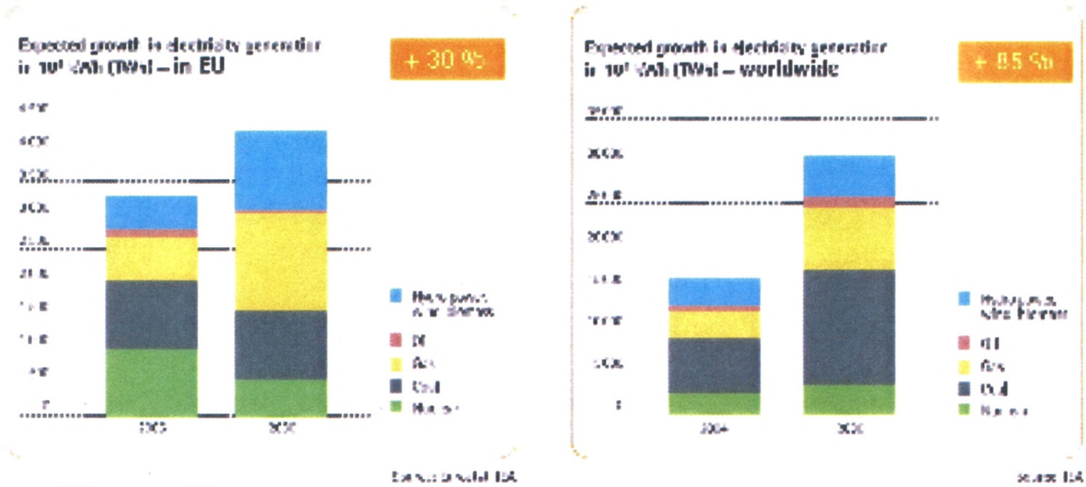
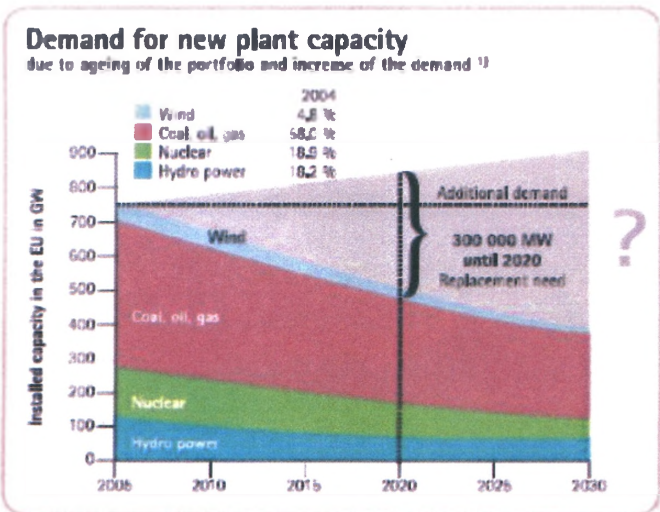


Figure 2: IEA prognosis for increase electricity demand in EU and worldwide

Beside this growth in demand, phasing out aging power plants that need to be replaced with new generation capacity will open a huge export market for countries/companies that can produce and deliver CO2 free electricity. The potential for building up welfare state underpinned with green electricity as export commodity can't be underestimated. (See figure 3, Source: VGB)



1) The planned operation years of the power plants in the EU vary considerably.
Aging curves are only qualitatively. Source: EU - Energy and Transport Outlook

Figure 3: Combination of increased electricity demand and phasing out old plants

The unexploited capacity of hydro power and the grate potential for biomass based electricity production in BiH, combined with a strategic geographical location, in vicinity of large industry nations such as Italy, Germany, Austria, etc., opens an important export market for “green” electricity for BiH.
To be able to utilize these natural resources in a long run, a tremendous upfront investment would be required. Since the country is not in a position to day to make the necessary investments by them selves, there would be a need for collaboration with external investors.
Providing necessary guaranties for social and political stability would be crucial to attract foreign investors. A democratic and transparent process during contracting, planning and construction, as well as provision of necessary information about the benefits for the region and the country would facilitate involvement of the local inhabitants. This approach would result in stability and harmony needed to carry out such a country wide project.
Having the protection of the local environment and the prosperity of all the citizens’ of the country as highest priority for the “green electricity” project are most probably the main key factors for a successful implementation.

Bio fuel based electricity production in Sweden

An overview of the energy status

The current energy supply in Sweden is unique in many ways. No coal and very small amount of natural gas is used. The electricity is mainly produced by hydro power (about 50%) and nuclear power (ca. 50%).

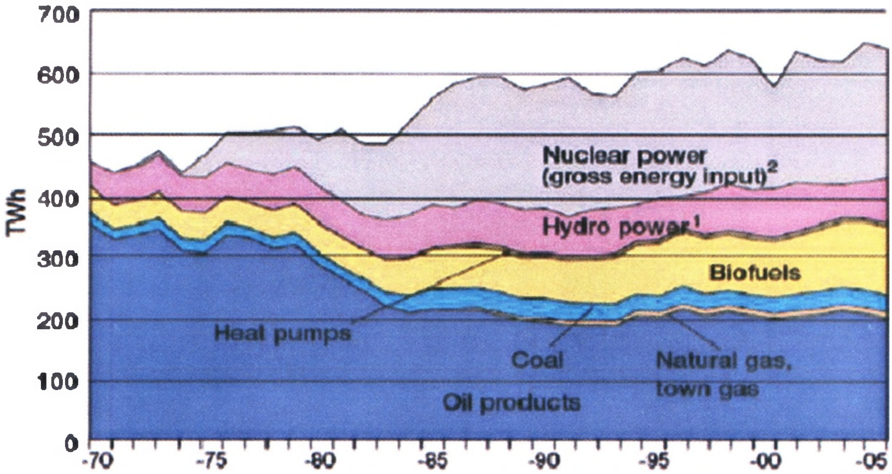


Figure 4: Energy Supply in Sweden 1970-2005

The heat supply in dense populated areas is covered by district heating and private houses use electrical heating, heat pumps and some oil and biomass. Heat and electricity production for the forest industry and pulp and paper industry are produced utilizing bio fueled combined heat and power.

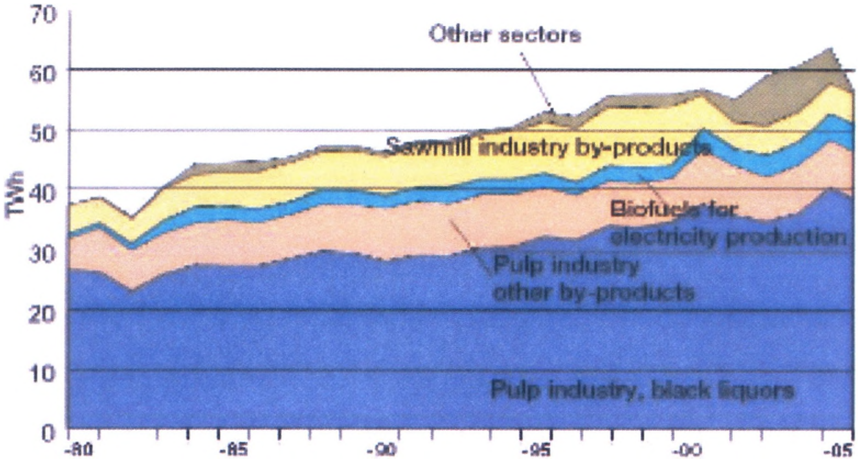


Figure 5: Use of bio-fuels in industry 1980-2005

The energy situation in Sweden before year 2000

During 60th and 70th the nuclear power was built in Sweden. The district heating net was expanded rapidly during 70th and 80th to facilitate replacement of oil by bio fuel.

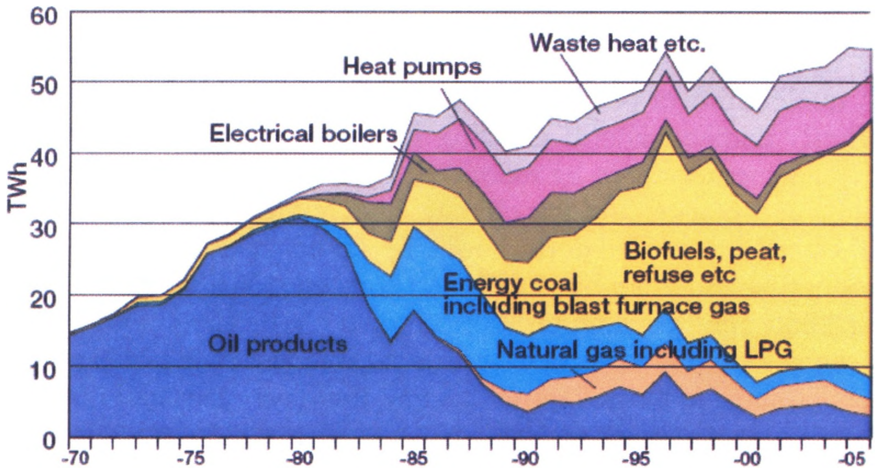


Figure 6: Development of district heating in Sweden

This was followed by construction and use of large scale heat pumps and bio fueled boilers in central heat stations and small scale heat pumps in private houses aiming at phasing out oil and electrical heating. During 80th and 90th large scale energy efficiency plans were implemented at the end user side. These measures resulted in reduction of fossil fuel use for heat and electricity production in Sweden to just a few percentage of the total energy supply in year 2000. The fossil fuel was then mostly used for transportation.

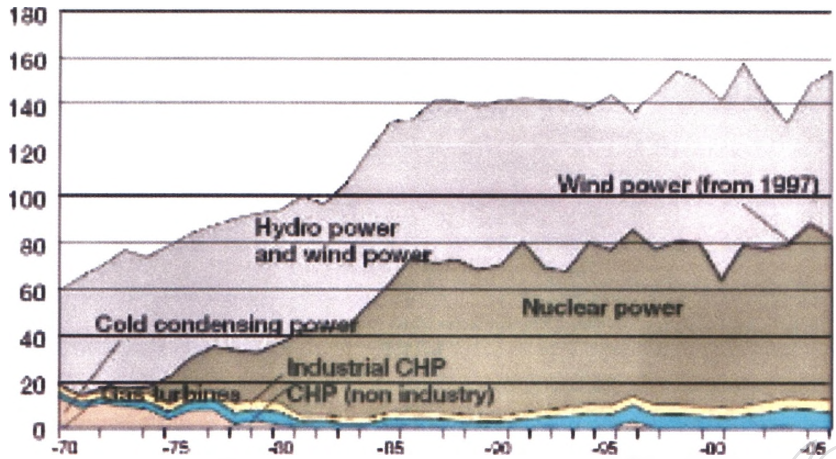


Figure 7: Electricity production in Sweden (150 TWh)

After year 2000- The climate change was the major driving force

In the beginning of year 2000, CO2 emission from heat and electricity production in Sweden was negligible. However, there was a decision in place concerning the nuclear plants' phase out, which stands for about 50% of the Swedish electricity production. The major question was, "how should the phase out of nuclear plants be realized without increase in CO2 emissions?" However, nuclear power phase out is not considered as impending any more.
The electricity demand is still growing in Sweden. Since neither nuclear nor hydro power generation can be extended, because of lack of political support and people's acceptance, and the climate change has become a major concern, increased electricity production should be taken care of by increased wind power production and more bio fuel based combined heat and power (CHP).
After year 2000 until now about 30 bio fueled CHP plants with 20 to 40 MW electrical power output have been build in Sweden. The smallest bio fueled CHP plants connected to the district heating net have electrical output of about 3 MW.
The research and development in Sweden has been directed towards producing as much electricity as possible in CHP plants, utilizing the existing heat demand. There are also plans to replace the natural gas used in gas turbine based CHP plants with biogas. In parallel large investments have been made to

increase the electricity production from wind power, and various types of subsidies have been introduced to support electricity production based on renewable energy sources.
The positive environmental profile of bio fuel as CO2 neutral has being questioned lately as well as use of agricultural land for bio fuel production. The market pries for bio fuel has also increased considerably, due to the demand. Meanwhile the resistance against extension of nuclear and hydro power has weakened.

Two typical examples of bio fueled CHP plants in Sweden Lund

- Fuel: Locally produced biomass (Straw, wood chips, etc.)
- Electrical output: 47 MW
- Heat output: 100 MW
- Investment: 200 Million Euro
- Operational hours: ca 4000 hours/y.

This plant, which is under construction, consists of a circulating fluidized bed (CFB) a grating boiler and a back pressure steam turbine.

Västhamnsverket (Helsingborg)

- Fuel: Biomass and natural gas
- Electrical output: 126,7 MW
- Heat output: 186 MW
- Operational hours: ca. 4000 hours /y

This hybrid plant consists of a bio fueled boiler, a modern gas turbine with heat recovery steam generator (HRSG) and a common steam turbine, where the steam from the boiler and the HRSG is expanded.
There are lot of experience accumulated about building large scale bio fueled power plants connected to the district heating net and industrial CHP both in Sweden and other Scandinavian countries. The technology used is based on boilers and steam turbines, i.e. the Rankine cycle. The boilers are usually constructed as CFB boilers and noticeable progress has been made to increase the turbine inlet temperature up to the level of to 600C, resulting in increased plant electrical efficiency.
Construction and expansion of the district heating net has contributed considerably to increased share of biomass in the energy sector and reduced use of oil.
Large efforts have been made to replace natural gas with biogas in gas turbine based power plants. Thermal gasification, anaerobic biogas production as well as direct biomass firing in gas turbines have been tested and developed. However, non of the methods for replacing natural gas with biomass have

been successful so far besides bio gas from anaerobic gas production in smaller plants.
Electricity production in CHP plants depends on the variation in heat demand and electricity production in wind power plants depends on the weather. However, the large hydro power production in Sweden makes production and control of electricity separated from heat demand and wind/weather possible. Therefore, building CHP and wind power, integrated into the energy production system in Sweden is possible to a large extend.

Historical imprints on the Scandinavian hydropower systems

Controlling water

It is calculated that today 40 000 dams, higher than 15 meters, are raised in rivers all over the world. Approximately five times all the river water in the world (10 000 km^3) are stored in reservoirs. 400 000 km^2 are flooded by dammed water. 80 % of the Northern Hemisphere (USA, Canada, Europe and former Soviet Union) discharge is moderately or heavily regulated. Rivers untouched by man is probably not to be found any more.
The concrete wall is often a modern monument over a state leader or a political system - the Chinese Three Gorges project being one of the latest of its kind. A further example is the well-known Hoover dam in the Colorado River that became a symbol of the American progress. However, big water projects can also turn into symbols of failure. During the growing environmental consciousness in the post-war period, the dam changed from a symbol for progress to a monument of man's control over nature or a symbol of the human degradation of nature.
Control - both technical and formal - of the water system is required for this. Theoretically there is no difference between the build up of a hydropower system or construction of drainage system in a wetland or lowering a lake or maintaining timber floating in a water system or to uphold a net of ditches between fields in an agrarian landscape or perhaps, most apparent, an irrigation system. These are all built up water infrastructures stretching out and binding together the water flow through the landscape to an ever-increasing extent. These infrastructures have an integrated duality. They are both a part of the hydrological cycle at the same time as man controls them. Their complexity consist on one side of a melting together of the non-human and the human in the water infrastructure and on the other side of several demands on the water that have to coexist in the system. As these infrastructures are linked to the water circulation, they depend on and compete with each other. For example there can be different purposes for using water, as between those who want to

dam water - pro-dammers - and those who want to protect their land from flooding - anti-dammers. Mill and sawmill owners, other waterpower users and hydropower developers represent pro-dammers. Their interest is in controlling the flowing water and storing the water to use it when the demand for power increases. A modern anti-dammers interest is the environmentalists who want to stop the harnessing of rivers.
The development of rivers affects the water system ranging over large geographical areas. Changes occur both up and down stream. These encroachments affect the ecological system. Changes in the water system also affect people who live along the watercourses, regardless of the historical context. The structure and scale of the conflict of interests is, however, dependent on the historical situation and the level of technology. By this the hydro-power-based electricity system also plays a part in the general conflict between up- and down-stream interests in the water system, as we have several examples of in the great international river basins of the world.
The modern criticism against hydropower development was from the beginning essentially esthetic. These pioneer critics were an elite of environmentalists, scientists and tourists who wanted to preserve parts of the water circulation in its natural state. After 1970 environmental groups formulated criticism against hydropower development with a distinct ecological platform. One can for example mention that in 1993 the four most important unharnessed rivers in Sweden - the Torne, Kalix, Pite and Vindeln - were declared "National Rivers" by Parliament and were to be free flowing in the future. There are also world wide efforts to reconstruct rivers.
Water related conflicts and systems of norms reflect social relations, rather than, for example, climatic or geographical conditions. These water related conflicts have been governed by normative systems, which developed simultaneously to the build-up of water related infrastructures. They set opportunities and limits for private or public control over the water system.
Water related norms have often occurred in form of special water laws, concerning who owns the water or how one can make alterations in water. The laws have either hindered alteration, frozen water development, or given priority to alterations in watercourses. In Europe most rivers were public. But in Scandinavia, as long as we have had written laws, watercourses have been regarded as private property.

The legacy of the Scandinavian hydro power systems

At the turn of the century Sweden and Norway was heavily dependent on the import of mineral coal. A development of hydropower would give the states a greater independence from this import dependency. Looking from outside one

could at a first glance find these two Scandinavian hydropower-rich countries very alike. However the developments of technical systems are dependent on a social context, its formation is stamped by the historical situation in which the actors find themselves. But the actors can also recreate social conditions in order to better serve their technical ends. The extent to which the actors achieve their goal depends on the society in which the technical system is created. Because of this the stories here told of two neighboring Scandinavian countries are very different.
In the following the Norwegian and Swedish hydropower development is discussed in its earlier days, at the end of the 19th and beginning of the 20th century. The institutions founded during the pioneer years of hydropower development have characterized energy production up till the liberalization of the energy sector in the late 1900s. The comparison starts by discussing some geographical conditions. In the following some institutional terms are discussed, followed by a description of the hydropower policy in Norway and Sweden. Some observation on the organization of the hydropower sectors in Norway and Sweden is also presented.

Geography

Geographical conditions as topographic, and precipitation are of importance for the design of a hydropower based electricity system. Norway could be described as an Eldorado of flowing water. In 1906 a German expert described it like this:
In Norway it is possible to develop hydropower with very small recourses. The country is scarcely inhabited, it is possible to purchase entire catchments, connect them and regulate the water inflow. Norway is shaped for hydropower development. There are large high-lying lakes, which are easy and inexpensive to dam. It is not complicated to gather several catchments districts and with small extra costs form the discharge completely evenly."
Contrary to Sweden the most powerful waterfalls are situated in the south and the harbors of the southern parts of the country are ice-free. The Swedish hydropower treasures was to be found in northern Sweden, were harbors were closed during winter. In comparison Swedish rivers are longer, usually with larger volume of discharge, but with lower height of fall. The technical solution was to gather the height of fall to be able to take out larger effect. An advantage was that the Swedish lakes were placed far upstream in the catchments and could be used as regulation reservoirs for a larger part of the catchments. But the river valleys were more flat than the Norwegian. This meant that a higher water level in reservoirs affected more land - and more people - than in Norway.

Institutional framework and politics

To place the Scandinavian water legislation in a water law context some relevant concepts describing different ways of dividing flowing water have to be introduced: riparianism, and its two differing principles concerning what ways alterations in the watercourses can be carried out: **natural flow rule** and the principle of **reasonable use**. The principle postulates that only the riparian that owns the shore of a lake or a watercourse has the right to use the water contiguous to his shore. All riparians, regardless of the length of, for example, the riverbank, have the same kind of right to the water contiguous to their shore. The riparians do not have to harness their water. The natural flow rule is often replaced with a second variant of riparianism; the principle of reasonable use. This made it possible to alter the flow of water, even if it affected other riparians. The principle was obviously essential for increasing the energy taken from the watercourses. The criteria for reasonable use have changed depending on the historical context. Variables such as benefit for society or the user has often been used as definition of reasonable use. This means that changes in the definition of reasonable use can lead to abrupt changes in watercourses.

As already indicated, the Swedish landscape is characterized by abundant water. Historically one of the main concerns for the Swedish farming population was that the rainwater remained in the fields and drowned the seeds. Therefore, it was important to keep the watercourses open for the direct outlet of water from the cultivated land. The natural flow was important for the anti-dammers. At the end of the nineteenth century, the principle concerning the natural flow rule was established. This was a piece of legislation passed by a parliament in which agrarian interests were heavily represented. A special rights institute - the *kungsådran* ("the kings vein") - defended the principle. In watercourses governed by "the kings vein", a third of the water should always be allowed to flow freely, and it was forbidden to build dams across watercourses. In 1899 Parliament passed an ordinance allowing the building over of "the kings vein" with government permission. Dams were built up in the big rivers. Control of the watercourses had passed over to the dam-owners. But it proved to be impossible to get permission to regulate the rivers. Dissatisfaction of the situation spread among the engineers. They had the knowledge of how to perform efficient harnessing and they assisted to build hydropower plants possessing capacity far over what they could be used for. The director-general of The State Power Board complained that: *"water was allowed to flow identical on Sunday as on weekday"*. It was thus absolutely essential for the hydro-power industry to change the legislation, partly so that they could fully exploit the major investments, and partly for the sake of future

expansion. The motivation was thus not only the need for more power, but also the need to demonstrate the reliability of the new system. The system developers in Sweden had to show that the energy system could grow and satisfy the power demand. The Norwegian water law framework was to be found in the Watercourse law of 1887. It was anchored in riparianism. Riparians were not allowed to harm navigation, log driving or change the water flow - an exponent for the natural flow rule. However, the Watercourse law opened for harnessing waterfalls or regulation of the water flow "in the service of industries". This made the law liberal to expropriation and other types of force when it came to industrial use of waterfalls. The law has been characterized as an expropriation law. As a consequent many riparians accepted selling water falls because of the expropriation threat. The Norwegian canal director wrote about the law: "*To my knowledge, there are no other water law, that to this amount give the control of the development to the private owners own decision without any interference or control by the state*".
Parliamentarianism was on the way in Sweden. In 1907 the right to vote for Parliament was extended to all adult men. As a consequence the relative strengths in Parliament shifted. Certainly, the number of speakers for agrarian interests diminished. New political winds, principally represented by the Social Democrats, could increase in strength. The Left forces were not opponents to development of rivers, but they were supporters of stronger state control of hydropower development. In their opinion profits from the expansion of power should benefit all the members of society. It became a political affair and a legal power struggle. The conflict over water regulation at the beginning of the century became the stage where the contemporary oppositions, individual-society, country-city, local-national and agrarian-industrial, were acted out.
The Hydropower developer's aim was to *"work for the rapid and rational utilization of hydro power for the benefit of industry and the country"*. Their first goal was to establish *"a practical water law*". The hydropower developers directed their campaign for a new water legislation towards depoliticing the limits for enterprise by precluding direct political influence. The decisive instrument was the move to establish special water courts, which would decide about water-related civil engineering projects. The new water courts would not be peopled only by lawyers - technicians would also be decision-makers. With the First World War, a difficult power supply situation arose in Sweden. It became increasingly clear that the country needed to focus on domestic sources of energy. The agrarian interests gave way under this pressure. In 1918, the Water Law was passed, and brought with it the riparianism principle of reasonable use into Swedish law. If the benefit could be shown to be three times greater than the damage, the newly established

water courts allowed water-related civil engineering projects and regulation of the water flow. If these conditions could not be fulfilled, but the enterprise was of considerable benefit to business or community, water-related civil engineering projects could be permitted by the government. Substantial regulation of water had become possible. Now it was the closing off of water, and not keeping it open, that was given priority.

In the middle of early hydropower development Norway became 1905 a fully independent state after the dissolution of the union with Sweden. This became an important driving force behind the build up of a new electricity system. The question of how to manage the hydropower development became dominating in the political discussions of this newborn state.

The background is to be found in the wave of protests against foreign interests in Norwegian industry. One of the problems was the very weak Norwegian credit institution. Foreign citizens controlled 39 % of the capital stock in Norwegian industry. Shortly after 1905 one estimates that foreigners had purchased Norwegian waterfalls representing 500 000 horse powers. This was the double of the effect used by Norwegian industry at that moment. The motives were investments for new industry, but also a speculation for selling the water falls at a better price. There was a widespread comprehension that speculators, especially foreign, cheated Norwegian peasants because they did not know the dormant values of their waterfalls. The 1909 concession laws ruled that it was only the state, municipalities and Norwegians who where allowed to buy waterfalls without a concession. The law also stipulated about fees on production and electricity production for state and municipalities. Furthermore there were social demands on the construction of the powers stations and dams, for example that the working force should be Norwegian citizens. Another principle introduced was The Reversionary Right. This meant that after 80 years the waterfall would be given to the Norwegian state without any compensation. (The reversionary right is at the moment object for discussions with the EU).

1917 the Norwegian Parliament passed the final concession laws. And they were even more radical. From now on only Norwegian companies could be given concessions. The political struggles over the concession laws were the first in the rebirth, free Norway. But how do we interpret them?

Usually they are understood as a reaction of foreigners purchasing Norwegian waterfalls. They have been explained as tools for a national protectionism after the dissolution of the Swedish-Norwegian union in 1905, and thereby as legal defense against foreign influence. But are there more answers to find? They could also be analyzed as a protest to a quick industrialization process and the need for the state to regulate the utilization of natural resources. Norwegian historians have also showed that the investments did not decrease and foreign interests were given room. Half of the concessions (1906-1910) were given to foreign companies. One can claim this should not be analyzed as a policy of the powerless. The social demands in the concessions on Norwegian labor and sub suppliers, production fees and the reversionary right were signs of an offensive industrial policy. (These concession laws have been formative for the institutional framework of Norwegian oil development).

The Swedish and the Norwegian hydropower systems

The Norwegian hydropower system has been characterized as a decentralized and at the same time a divided system. The Norwegian municipalities and counties produced electricity for domestic needs, as for example lighting and heating. The power demanding industry often owns their own power sources, where they produce their own electricity. The Norwegian state has played an active role in designing this system. Municipalities and counties could buy waterfalls without concessions and from 1911 municipalities had the right to expropriate waterfalls. The state also purchased waterfalls and later sold them to municipalities. Since 1920 nearly every Norwegian power station is built by a county or a municipality. The Swedish power production was very centralized. The state owned Vattenfall produced nearly half of all electricity in Sweden. The combination of a big state power producer and a couple of private power producers has been named "the Swedish system". The state power board was given great freedom of action and its management was put together of industry. Around 1920 both Norway and Sweden had confirmed an institutional framework that would be in function for nearly the rest of the 1900s. There were however great differences: Norway had reversionary right, time limited concessions, social demands on construction works, restrictions for foreign interests, political influence over the conditions when building power stations and rights for municipalities to expropriations of water falls. On the other hand Sweden: there were no fees, no time limits, the allowance was given when one could prove that the value of the power station was three times the damage, and the decisions was to be taken in non-political water courts.

To conclude it is important to point at the difference of level of democrat-ization in Norway and Sweden. In Sweden right to vote for everyone was not yet carried through. In Norway there were full right to vote for men since 1899. A more developed democracy and an active independence policy in different fields can explain the radical hydropower policy in Norway.

Epilogue

During the last years comprehensive changes have occurred in the Norwegian and Swedish hydropower system. Due to liberalization of the electricity market the organizational system have changed. The electricity marked is now characterized by commercialism and internationalization. For example the Swedish state producer Vattenfall has become one of the giants in north European electricity production and by this expanded out of its former national frame. The growth is no longer characterized by harnessing of waterfalls, but by buying greater parts of an expanding European electricity marked. By controlling Swedish hydro- and nuclear power, Lettish hydropower, Lithuanian nuclear power and German and Polish coal generated power production, one has accomplished a heterogeneity that, in perspective of an electricity system logic, can be very rational. Scandinavian electricity marked is by the structural and political changes today commercialized in an open electricity marked. One could call this an institutional revolution of the Scandinavian power systems.

PROBLEMS OF GENERATING UNITS PLANING IN THE ELECTRICITY MARKET ENVIRONMENT

Prof. dr. sci. Ferdinand Gubina

1. Introduction

Power system expansion planning has experienced a drawback in the era of electricity market introduction to electric energy industry. Deregulation has brought about horizontal industry organization structure organizationally decoupling generation from the network in order to eliminate the natural monopolistic mode of operation. Independent system operator (ISO) absorbed that monopolistic characteristic and, additionally, ISO took the responsibility to oversee the needs for development of generation and transmission to ensure satisfaction of the users' needs and security of power system operation. On the other side, regulation of quality of delivered energy and other decisions concerning adequacy of system have been entrusted to a regulator independent from the government. That arrangement was bound to fail with respect to the power system expansion planning since both of these actors lacked the executive power to enforce expansion of energy production units as well as network expansion with growing consumption.

Vertically organized power companies split and converted into horizontal organizations containing generation companies (GENCO), transmission companies (TRANSCO), distribution companies (DISCO), and nonprofit ISO's. To increase competitiveness of GENCO-s in the market, these companies merged gradually to large entities and occasionally abused their market power. Although entering of independent power producers to the electricity market was expected that did not happen apparently due to high investment cost, high investment costs, and long construction times of new generating units, and price uncertainty after that period.

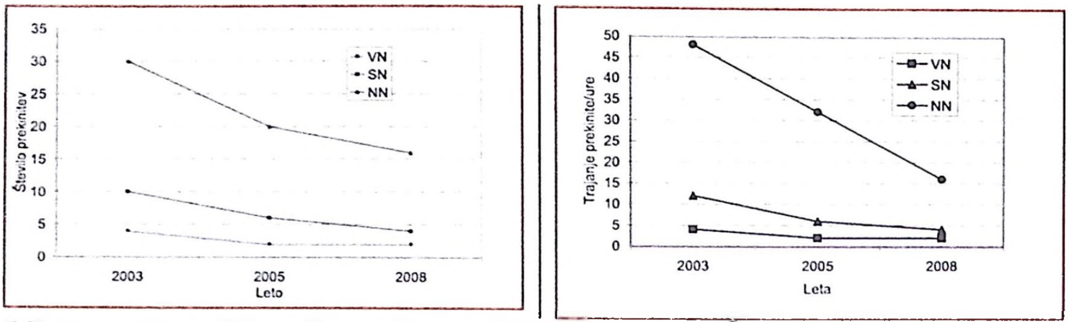
Existing energy market models exhibited even more flaws causing severe perturbations in power system operation including the increased number partial and total black-outs. The power networks operated closer to their limits, but expansion was not following due to lack of investments and long times to obtain new right of ways. Decreasing quality of electricity supply made it inevitable that the governments had to intervene in the power system markets to ensure required electricity quality for their industry and domestic customers.

Prof. dr. sci. Ferdinand Gubina
University of Ljubljana, Slovenija

Following deregulation, privatization of power generating sector quickly entered the scene and, in some cases, created additional problems. A lot of attention of power and other energy companies were drawn to the possibility to buy generation and distribution companies with exception of transmission networks. New generating companies formed buying out smaller enterprises, especially in the economically weaker countries. The monopoly problems and national resentment made governments to interfere in the process. Privatization is therefore still a hot issue due to its application to the basic country's infrastructure supplying electricity to the industry and domestic consumers.
Restructuring of the electricity supply industry has changed the previous paradigm of generation expansion planning based on the least cost and central decision process. Different market participants operate the power system segments and optimize their own profit based on the relatively short-term economic analysis horizon. They tend to evaluate their own expansion strategies in the same scheme. The long-term generation expansion planning is therefore characterized by structural change and strategic behaviors of market participants.

2. Electricity supply requirements

In spite of deregulation and privatization, the basic requirements of electricity supply remained practically the same except for ever increasing quality requirements due to more stringent needs of industry operations. The electricity market does not deal with these problems although it has been initially expected that it will solve all such problems. The growth of electricity demand endangers the balance of supply and consumption, which has to be met at each and every instant. Unfortunately, electric energy can not be stored efficiently to be used in case of temporary production shortage. Therefore, frequency control has to be maintained independently from the energy market by ensuring a solvent power reserve market. Similar appears the need for maintaining the adequate voltage profile across the network and sufficient reactive power reserves, which have to be sufficient and spatially distributed.
Along with others, these tasks remained unchanged from the previous vertically organized system for the ISO to deal with. Moreover, new ones originated from the market control problems as for instance from power balance demonstrated as a difference between contracts and actual use of electricity, measurement and billing, observation of environmental limits, and from an increased need for security check of power flow in the network for potentially critical states detection etc. Their detection requires extensive calculations for each market trading time interval since the networks have been pushed to operate close to stability and security limits.



(NN-low voltage, SN medium voltage and VN high voltage, Število prekinitev= Interruption mumber, Trajanje prkinitev=interruption duration/hours)

Fig. 1. Planned CAIFI and CAIDI for the Slovenian power network

The quality standards represent limitations on operation and additional requirements to expansion planning of production units as well as to the transmission and distribution network expansion and are increasing steadily. For instance, the required adequacy risk indices like loss of load probability (LOLP<10h/a) and energy non served (ENS<0,3%) are pushed down by industry. Similarly, the indices denoting quality of delivered energy on the distribution side, like customer average interruption frequency index f_{CI} (CAIFI) and customer average interruption duration index T_I (CAIDI) are targeted to reach lower values, as shown in example in Fig. 1 for Slovenia.
The black-outs resulting usually in huge economy losses are becoming of primary concern of the power system operation security. They result in lowering the system adequacy due to lack of investments in transmission networks and of nonsystematic planning of generation units. A rush in building the extensive wind parks with a large share in power production and with their volatility of power production became a problem of power system control. Better control centers and more complex means of power system control are sought along with careful expansion planning of new generation units and transmission lines.

3. Effects of electricity markets and privatization process

3.1. Public versus private ownership in the energy sector

Electricity market models used throughout the power industry suffer from various defects resulting in shortage of production and transmission capacities in the long range. The market gives insight into the future energy needs only for a day in advance, while in developed and functioning power exchanges, the forward markets can predict prices for up to six years ahead, a bare minimum in the planning horizon. The generation companies were preoccupied with windfall of profits following the surplus of generation from the regulated era, exploiting the existing infrastructure for financial gain. It took governmental bodies more than a decade and generation shortage situation with spiking energy prices to notice the generation shortage phenomenon and realize the need for action.

For that reason, the idea of *capacity markets* emerged. Their main problem is nature of the power system expansion. It is easy to build simple and cheap gas units what happened, for instance, in the USA after the first power shortages plagued the electricity industry. The operating costs including fuel made them soon unattractive and they were for sale as soon as there were cheaper conventional generating units became available.

Unfortunately, a large time span is needed to implement an expansion plan and to build cost effective generation units. From a country's as well as from a large production company's standpoint, several criteria have to be followed including diversification of fuels to keep the security of power supply satisfied, observation of the environment constraints, and risk management. Large lag times in conventional generation units in construction ranging from five to over ten years plus planned pay back time combined with very high costs of construction, increase the financial risk of the investment in generation projects, which is a high burden even for larger power companies. That is why new smaller independent power producers have refrained from entering the electricity markets.

Moreover, the role of governments was overlooked when designing the electricity markets since the regulator and ISO jointly lack the executive power to enforce generation unit's expansion. Electricity markets operate on a country's given transmission and distribution network infrastructure, transport infrastructure of rail, rivers and on a given energy natural resources. At the end of the day, the government has to ensure that the infrastructure is there for functioning of electricity market at all times regardless of the players in the market. The vital infrastructure in country's economy is therefore of basic importance for well being of a country's economy and population.

Privatization is a code word in many countries when discussing the electricity markets. In many smaller countries it is advertised that energy systems should be privatized immediately after opening the market. It is necessary to emphasize, that the notion that private companies are more effective in electricity markets than the government owned ones is simply not always true since there exist large very successful power companies which are government owned. The company's success in the market depends largely on a good management team and on minimum political interference in its management.

Declared goals of privatization are to increase efficiency of company operations in the market, which eliminates less successful companies. The governments sell some entities to private investors to reduce the public debt. Some governments want to reduce their responsibility at managing and interfering in these entities. Dispersing the ownership and ownership of employees may be another goal of privatization. Another form of partial privatization is a concession for exploitation, and Build - Operate - Transfer system.

Shadow side of privatization may emerge in the following: exploitation of market power, weak interest of private sector for production of goods and services with small profit prospects, reduction of workforce, and attempts to squeeze money from public funding.

The most important appears that the private ownership leads to actions which are contrary to interests of the public. Private companies are interested to optimally use the infrastructure to make profit and in that sense to spend minimum for its maintenance and expansion. If they possess the infrastructure it can happen that they exploit it to its economical limit and then abandon it like an obsolete plant. That should not happen under any circumstance to the energy supply infrastructure. In case it happens, though, the government must intervene and reinvest at least the money obtained at the sale of that particular infrastructure, losing money in long term in that kind of operation. That has happened and has been experienced outside of the area of energy systems, as for instance in the public transport systems, too.

3.2. Role of existing generating units infrastructure in expansion plans

Generating power companies entered the electricity marked with certain portfolio of power plants. They shortly experienced their advantages and deficiencies in biding in the market. It is natural that they tried to improve the portfolio by refurbishing and upgrading their units or closing them down permanently and by acquisition of new ones. Some power plants were obsolete or did not meet the environmental criteria, which required additional funding to meet them. If these plants had to operate they were classified as a stranded investment. Those plants could be helped by giving them an opportunity to sell their energy at a higher price. The difference in price was forwarded into the power system operation costs together with the costs of power system control. That help was extended to them for a certain period to remunerate the capital loss.

In Slovenia, the experience with the 120 MW Trbovlje thermal power plant (TPP) was characteristic. Its burnt coal from a neighboring mine with a high content of sulfur and a very high chimney was built (360 m) along with the sulfur scrubbing plant. It had to be listed as a stranded investment. Since it had chronically mechanical troubles with the turbine it was earlier decided to build a new power plant. However, the public turned against it and the plan had to

be scrapped. After some years, the situation in the marked changed along with the shift in the public opinion and a new power plant is planned with a considerably increased power to 350 MW burning with low sulfur content imported coal or its mixture with domestic coal.
Companies with generating units in bad condition have to make the decision to sell them out, close them down or to refurbish them. Their decision is based on the plant condition and the projected prices in the electricity market. Usually, it is better to refurbish a plant since the electricity prices are ever raising due to lack of new investments. However, the obsolete plant with main components in a bad shape is bound to be shut down. Those with low efficiency grade could be used for a shorter time as peaking units or as a replacement reserve capacity.
Similarly, the power plants using renewable energy sources (RES) have to be predominantly subsidized. Their product has been classified as "green" energy and, in turn, offered in the market to the consumers. There are several system of support of RES in place in the EU, including feed-in tariffs, tradable green certificates coupled with quotas, tendering, and subsidies that are currently used to support implementation of new RES technologies.
Among the most aggravating problem in generation planning is to find a new site for a coal or nuclear power plant due to the local population protest (Not In My Back Yard - NIMBY syndrome). It may be met in case of refurbishment of hydro power plants (HPP), too. In Slovenia, such a case is the Moste storage HPP, which needs urgently to be refurbished and upgraded since its machine house is subject to sliding the plant has low efficiency due to inadequate intake pipe parameters and since the storage was contaminated by toxic byproducts of a nearby steel plant. The process was practically blocked by public opinion mainly due to bad communications with the public and due to particular local interests.
A problem is the potential HHP-s on the Soča River. In reason is that the Soča River is an environmental pearl. Its upper part is a nature protected region. However, utilization of its tributaries is explored for potential HPP-s.
Another problem is the HPP-s on the Idrijca River, where a large Trebuša storage HPP of 200 MW could be built. Although the site has been reserved for that project for decades, it with time became unacceptable due a too high dam and its public rejection. An alternative was offered with two HPP-s and total of 150 MW installed capacity, but was practically stranded by public opinion so far. In turn, unacceptable run of river small HPP-s have been offered by environmentalists as a counter-project.
As a conclusion, the potential power plans should be carefully prepared beforehand by early information properly and gradually presented to the population. It should be showing strengths and weaknesses of the project.

Some prospects for remuneration should be given to the local population solving their local and personal problems, too. The compensation negotiations should encompass all segments of the population, which is normally not interested in power plants, power system needs or power company's plans. Actually, the idea has to be successfully "sold" to the public.

4. Power system planning under uncertainty

Integrated resource planning has dominated in electric power industry before the era of deregulation. Scenarios of resources were compared with respect to the present value of costs taking into account numerous constraints of technical, power system, social and of environmental nature. The WASP program, for instance, utilized probabilistic estimation of system production costs, non served energy cost, and reliability indices. It assessed optimal dispatch policy satisfying exogenous constraints on environmental emissions, fuel availability and electricity generation by some plants, searching for optimum of alternative system expansion policies on the costs basis. The approach yielded the best solution for a company or the whole country with integrated power system.

4.1. Scenarios and parameters

The essential part of generation planning is preparation of credible scenarios of generating units. Although there are usually several production companies, the generation and network planning are of national economy interest, too. The scenarios have to observe the national resources and security of imports of primary energy to ensure diversity of fuels and to exploit available sites. A good insight into the possible generation mix is needed. Conventional generation encompasses fossil fuels (lignite, hard coal, gas, and oil), hydro power with storage hydro and run-of-river hydro, pumped-storage, the nuclear power, renewable generation (other than hydro), wind, photovoltaic, geothermal, biomass, biogas, waste, etc.

The basis for a good generation expansion planning is a long range prediction of load growth. The best approach gives a long range scenario approach separate for industrial segment consumption growth assessed by experts for each of the segment and than observed a whole. The total load growth is usually in the range of (1-3) %/a, lower value for mature economies and upper values for the growing ones.

Fuel	LOW €/GJ	HIGH €/GJ
Gas	4.31	5.54
Coal	1.59	1.65
Peat	2.64	3.12

Tab. 1. Fuel cost scenarios

The future fuel and electricity prices are important to forecast although it is a formidable task due to their daily and long range volatility. The values given in Table 2 nay be used, but they have to be projected changing in the planning time span since the economy of different countries may influence them by having different growth rates.
Another problem may be the question of CO_2 emissions. Sequestration of CO_2 has not found a satisfactory solution yet. The values of the CO_2 emissions can be evaluated in the scope of the EU Emisison Trading Scheme (EU ETS). Although they have been exhibiting a considerable volatility in their first trading phase (2004-2007), in the EU ETS second phase (2008-2012) the national quotas have been much more stringent as to permit CO_2 coupon prices only above the 25 €/tCO_2 mark. Still, these costs are mainly expected to be transferred to the electricity prices.
Similarly, the production costs of different generating units have a wide range as shown in Fig. 2. The cost of nuclear units is the lowest and significantly influences the environment constraints regarding the CO2 emissions. The biogas has different structure, but its technology price still needs some sort of support mechanism to be competitive.

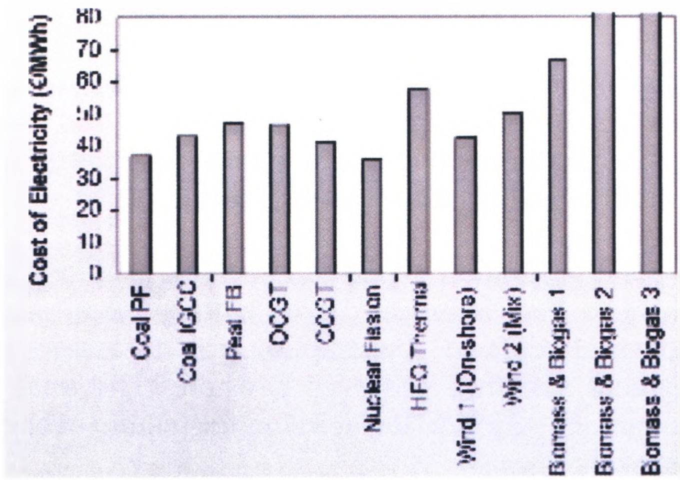


Fig.2 Generation costs

Capital costs of different units are important for composing the scenarios. Table 2 illustrates a set of parameters for different generating units. An important factor is availability of power production of the generating units since it influences the position of a unit within the load diagram. The efficiency of units varies and construction times may vary, too.

Plant Type	Notional Size of Installation (MW)	Plant Life (Years)	Build Time (Years)	Average Efficiency (%)	Capital Cost (€/MW)	Op & Main (€/MW p.a.)	CO_2 Emissions (Tons Co_2/MWh)	Availability (%)	Resource Limited (MW)
Coal PF	1000 (3 x 333)	30	4	37	1,479,200	34,800	0.92	84	-
Coal IGCC	800 (2 x 400)	25	5	48	1,761,321	69,000	0.71	84	-
Peat FB	150	25	4	37	1,223,807	55,200	1.15	87	1000
OCGT	110	20	1	43	518,411	35,000	0.47	92	-
CCGT	390	20	2	56	537,500	50,000	0.36	88	-
Nuclear Fission	1000 (2 x 500)	30	5	-	1,990,758	59,500	0.00	88	-
Wind 1 (On-Shore)	30 (15 x 2)	20	2	-	981,475	34,800	0.00	-	1200
Wind 2 (Mix)	30 (15 x 2)	20	2	-	1,028,775	54,250	0.00	-	2600
Biomass & Biogas 1	10	20	2	-	2,418,750	80,000	0.00	78	70
Biomass & Biogas 2	10	20	2	-	3,386,250	90,000	0.00	78	50
Biomass & Biogas 3	10	20	2	-	4,353,750	90,000	0.00	78	500

Tab.2 Plant parameters and utilization

The minimal construction time figure is given for a nuclear power plant, but its implementation time in practice may be even doubled due to various obstacles like its acceptance in public. The CO_2 emissions are unit dependent and so is the plant life. The costs of construction, operation, and maintenance vary with different power plants and technologies.

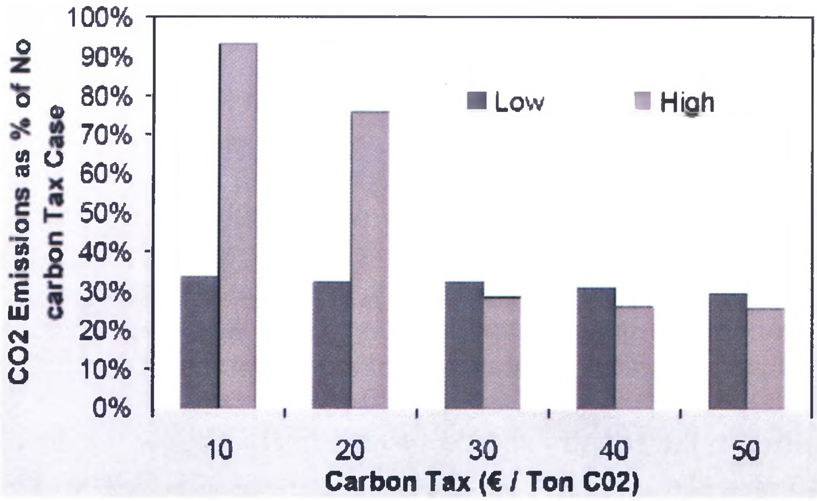


Fig. 3 Effect of Carbon tax

Due to volatility of these parameters, a sensitivity analysis should be performed to get a credible range of scenarios in the optimization process. Fig. 3 shows the influence setting of various CO_2 emission tax on emission itself and Fig. 4 demonstrates the effect of nuclear plant entrance on the CO_2 emissions.
When choosing a scenario, it is important to note that while natural gas based system may result in high volatility in fuel prices, wind generation and biomass may offer limited help to supply consumption. The coal technologies are still important for a supply scenario composition. The green glass house effect revived the nuclear option as a solid part of scenarios contributing to CO_2 reduction significantly. Effect of a nuclear plant in the scenario is demonstrated in Fig.4 regarding the CO_2 emissions.

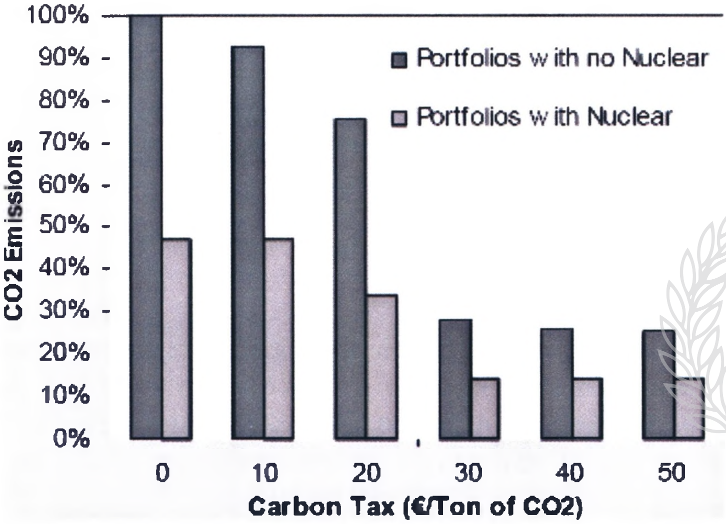


Fig. 4. Effect of nuclear plant on CO2 emissions

Generation companies are facing difficulties, which are significantly impactting their investment planning. Among them are relatively long lead times in generation construction, environmental constraints, lack of suitable locations, inadequate national energy plans, which may grossly underestimate the future energy needs or do not foster sufficient investments in expected national generation mix diversification. Generally, the market participants do not get adequate economic signals from the long term markets, which add to the uncertainties in generation expansion planning of an individual generation company.
The authorities in the country should systematically follow the development of energy demand and mitigate market failures, giving timely incentives to ensure the security of supply and expansion plans implementation. Monitoring

of generation adequacy has been a significant issue for not only the public authorities but also for the market participants.

4.2. Expansion planning models and methods

Generation expansion planning is a complex process which has to take into account the power system operation and maintenance costs, credible development scenarios, estimated energy consumption growth and several limitations, as for instance the environmental limits including emissions and their costs, technical parameters of various generating units, site limitations regarding the inflow of fuel etc. The process has to follow the estimates of reliability of supply as shown in Fig. 5. Both aspects of supply are important, generation adequacy and network adequacy along with security of the network operation.

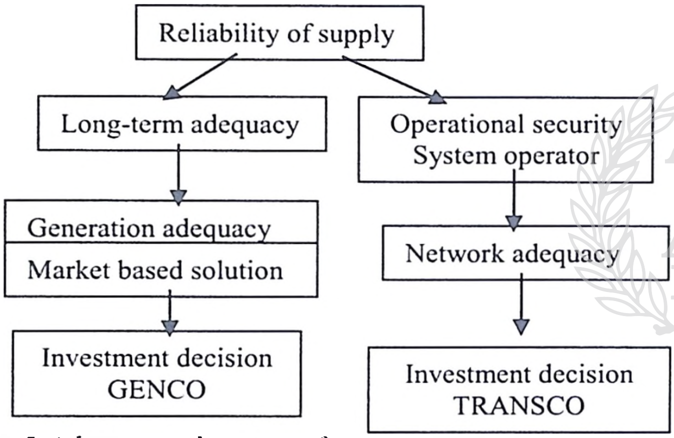


Fig.5 Adequacy planning of a power system

The deregulation and market environment introduced an important new element of risk associated with decisions of the competition in the market and with needed generation adequacy planning. In a competitive auction market for long-term electricity contract, the bidding results critically influence the determination of generator loading priority list, and the expected investment payoff, both of uncertain nature. Moreover, the investor (GENCO) can not obtain full set of information on other competitor's decisions. A Monte Carlo simulation could be used to achieve the profit probability distribution of the GENCO's investment.
For risk management, roles and responsibilities should be clearly defined amongst stakeholders, including regulators, system operators, government and commercial market players. Regulatory uncertainty for investors is created due to a lack of decisions in these areas. Clear and credible long-term policy

decision gives the power to the government to reduce a significant cost caused by this uncertainty.

A risk assessment tool called Conditional value at risk (CVaR) Fig. 6 can be applied to manage the risk of the generation expansion project where the sum of capital investments, operation and maintenance costs of a unit, energy and operational constraints are a basis of generation expansion planning. It is a coherent risk measure based on the standard deviation of normal planning parameters distribution. It gives the investors an intuitive criterion for making an investment decision. Due to its complexity, the model requires solving large-scale programs.

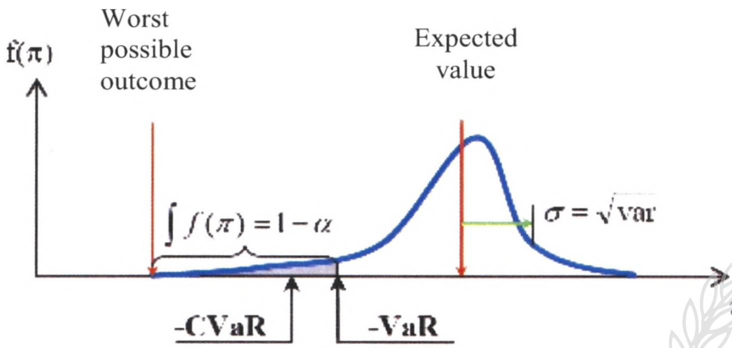


Fig. 6 VaR and CVaR scheme

Using the uncertainties of bids for long-term contracts in the electricity market, the probability distribution of the surplus on bid price over marginal cost are obtained and the distribution of expected generated energy for a given period can be achieved to calculate the profit of a generation company.

A more advanced program of capacity adequacy planning of a power system includes two dimensions in reliability of supply. One is the long-term generation and transmission adequacy, which is concerned with the sufficient and timely investment at proper site with the right technology. The other is the security of system operation in the short-term, which should ensure the continuity and the quality of supply in operation.

The generating companies (GENCO-s) as independent entities in the competitive market environment (agents) could plan for their own generation investment separately. In the process of simulation, they as agents are learning how to behave in the market environment. The decisions are based on the profits of investment which are conditioned by the company's exposure to risk. Reliability index used in this analysis is expected non served energy as this index integrates duration and magnitude of load loss.

The procedure may use a complex-adaptive systems approach to represent agent learning and adaptation as in Electricity Market Complex Adaptive System package (EMCAS) [9]. It deals with the following tasks:

- Utility function characterization of agent objectives,
- Heuristic optimization for unit commitment,
- Demand response functions to reflect the consumer reaction,
- Transmission power flow analysis,
- Complex-adaptive systems approach to represent agent learning and adaptation.

With its simulation capacity and based on appropriate scenarios and model data, the program enables the following:

- Combines engineering techniques with quantitative market analysis where DC load flow is used to simulate the actual operation of the physical system configuration since AC power flow uses to much time;
- The market participants and agents to make individual decisions to maximize own utility profit using multiple objectives including risk exposure where they learn and adapt to results of previous runs;
- Simulation of markets operations with changing rules while analyzing the behavior of both individual agents and the system under different market configurations.
- Studying a market in transient conditions due to agent interactions and analysis of states with no equilibrium and the origins of system problems.
- The studies of power system expansion planning have to compare different scenarios. The results of cost comparison give results like those in Fig. 6. As seen from the figure, the comparison is made in the form of prices depending on their standard deviation. The decisions depend on the accepted company's of degree of price risk exposure.

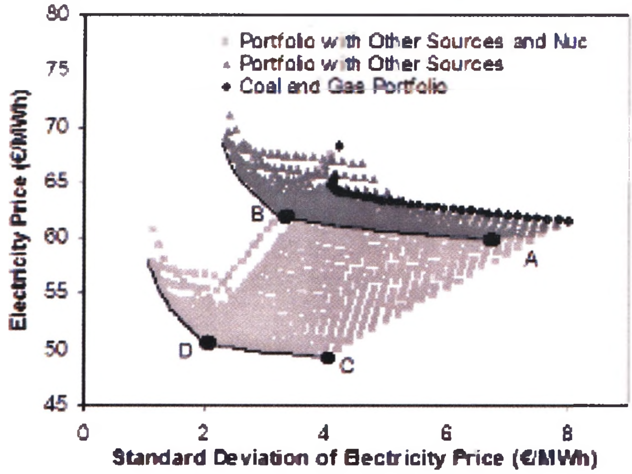


Fig. 6 Comparison of different portfolio scenarios

Profit-driven companies tend often to sacrifice the system security for commercial objectives, therefore coordination and cooperation between the market players and interconnections is needed and, therefore, simulated in the program. To rebuild the responsibility chain of competing companies for reliability and security in power system operation to ensure the balanced and consistent expansion development becomes a complicated task.

5. Social benefit and environment degradation

Expansion planning and its implementation bring about growth of social welfare and, inevitably, some adverse effects to the environment. Firstly, it increases the social benefit by improving the quality of delivered electrical energy to the consumers, especially to the industry which fosters new generation capacity in the field of RES. If a satisfactory level of prices is reached they enable development of new products and services. Centralized point of power system expansion planning may contribute to the best way for risk management in some areas on behalf of welfare of society.

Construction of new power plants brings improvement to social welfare and to the environment by employment of additional workers and by support of the community needs by a new power entity. An investment cycle of series of new power plants may significantly improve the gross national product due to wide range of activities spurred by the expansion plan implementation. In the deregulated market, it introduces new players, which may lead to stabilization of prices and to their lower volatility.

Electricity is of vital importance for industry and society, its application to industrial processes is inevitable and is ever growing. In case of surplus of power after successful investment cycle in a country, electricity may be exported occasionally or under long term contracts, usually with good economic results. The reason for that lies in the fact that it is difficult to obtain new sites for generation units. That is well demonstrated in the French case with their long term exports of electricity.

An important task has to be addresses in the field of efficient energy use. That produces **NegaWats** (Negative Watts), ie. reduction in MW of planned power due to better utilization of energy in transport, industry and in households. Moreover, its potential is in saving a lot of investment costs and, correspondingly, it contributes to nature conservation.

Secondly, the environment should be protected to certain extent against excessive usage. In Slovenia, the Natura 2000 covers the vital parts of territory that should be protected for some reasons to pass on the heritage to our grandchildren.

That is why the adverse effects to surroundings have to be considered by utmost care with the aim to minimize them to the highest degree. Since it is hard to obtain new construction site in Slovenia, the public has to become convinced in need of implementation of the selected and approved scenario. For that purpose, a lot of complimentary studies of environment before and its potential changes after the building of a new generating unit have to be performed. Nature degradation should be carefully assessed. The conesquences of potential dislocation of population, flooding of fertile soil, loss or indigenous flora, waste deposition, risk of soil and air poisoning have to be carefully analyzed and evaluated before and after implementation of the planned projects. Countermeasures have to be devised and all technical possibilities employed to minimize the side effects.
Local population is an important factor in that process. Remuneration scheme has to be modeled for disadvantages for environment changes that the population is potentially exposed to after implementation of a generation expansion plan. It has to be assessed, explained, and clearly laid out to the public. A possible individual treatment should be foreseen, too. Of course, the process must be carefully handled and a sufficient time for that has to be foreseen.

6. Conclusions

After restructuring of the electricity supply industry, the power systems are operated by several market participants. That has changed expansion planning from the least cost and central decision process to a risk management process where these companies seek their own profit based on the risk management and economic analysis. The long-term generation expansion planning is therefore characterized by structural change and strategic behavior of market participants.
Considering the process of expansion planning in the market environment and in the privatization aspect, the following conclusions may be drawn:

- Analysis of economy strategic development, load prediction, diversification prospects, quality of delivered energy, strategies and risk exposure of companies have to be carefully prepared for scenarios and assessed for the expansion planning decisions;
- The governments should constantly monitor the adequacy of generation and transmission network along wit quality of delivered energy by distribution companies in order to perpetuate the needed expansion activities in the market at the right time since the implementation requires long time and a lot of investment capital.
- Wide spread general notion that private companies are more effective in electricity markets than the government owned ones is simply not true

since there exist large very successful power companies which are government owned;

- The adverse effects to surroundings have to be considered by utmost care with the aim to minimize them to the highest degree. The expansion plans have to be well documented and supported with series of public hearings including involvement of civil society organizations.

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DECISION MAKING PRINCIPLES FOR POWER PLANTS - ECONOMIC, ENVIRONMENTAL AND SOCIAL ASPECTS

Prof. dr. sci. Wolfgang Pfaffenberger

1. The markets for power in the European Union

1.1. The principle of competition

One of the basic principles of the European Union is to promote a common European market and have unrestricted trade of commodities and services between the member countries. When the internal market started most of the member countries had regulation in the market for electricity not compatible with open exchange. Basically in most member countries the supply of electricity was based on local or regional vertically integrated monopolies. In this regime investment in new equipment usually was not the problem because the cost of investment could be shifted easily towards customers.

With the beginning of a new regulation based on an open market the industry began with a high level of capacity by far enough to supply all the electricity needed and be able to cope with unforeseen situations on the supply side.

The regulatory regime allows customers to buy electricity from who ever they want. This regime has been introduced step-by-step and now it is near to completion. Such a regime completely changes the conditions of investment in this market.

1.2. Regulation of the power market

The European Commission has issued a number of directives in recent years that had to be translated into national law in order to create an internal market regulation for all member countries that somehow fits open markets and trade between countries. There is a strict separation between production of electricity, transport, distribution and supply and trade. Whereas transport and distribution are considered monopolistic in nature, they are subject to specific regulation regarding network access and pricing. Production, supply and trade are open markets where the forces of competition should influence the market behaviour of producers and consumers.

This being the basic principle on the other hand a lot of regulation also refers to production activities regarding the energy mix on the one hand and a number of physically conditions regarding production activities.

Prof. dr. sci. Wolfgang Pfaffenberger
Jacobs University Bremen, Germany

1.3. Environmental Regulation

Environmental Regulation for power plants and power installations is part of the general regulation for environmental protection and in addition there are specific rules and regulations for power plant emissions, particularly airborne emissions.
In general every installation that may interfere with nature has to be analysed by a so-called "*Environmental Impact Analysis*" which is a kind of documenttation of expected effects if the installation is realised. In addition, certain interactions with nature have to be analysed on the basis of the directive on the conservation of natural habitats and of wild fauna and flora.
Specifically power plants have to fulfil a number of quality standards regarding emissions of sulphur dioxide, nitrogen oxide, dust and others. The operator has to prove that these standars will be fulfilled during operation. The necessary procedures are explained in more detail in chapter 4 in this paper.
Regarding the emission of greenhouse gases the European Union has started a scheme of special permits for the emission of greenhouse gases particularly carbon dioxide. Operators receive a certain amount of permits and at the end of the year have to prove that the quantity of carbon emitted corresponds to the quantity of permits that the company has available. The system is flexible in that permits can be bought and sold on a market that has been established in the meantime. This system of flexible mechanisms anticipates the procedures that have been envisaged in the Kyoto Protocol for all participating countries. This system will strongly influence the decision-making on the choice of fuel and plant in the future. In addition to the markets for fuel and plants the conditions of this additional market influences all strategic and operational decisions. The price in the market for emission certificates will determine decision making in the same way as the price for fuel or the power plant itself.

1.4. The role of Renewables and CHP

The European Union has set itself ambitious targets regarding the future structure of energy production and energy consumption in Europe in order to comply with greenhouse gas reduction goals on the one hand and goals to reduce the import of fossil fuels particularly oil and natural gas in the future. In order to reach these goals the share of renewable energy in the production of electricity, heat and in the transport sector needs to grow and there will be binding targets for all European Union member countries in the future. To increase energy efficiency it is intended to increase the share of power production in combined heat and power (CHP) mode. This may require additional infrastructure for heat distribution and may also conflict with the

aim of increasing the energy efficiency in buildings 'which in turn will reduce the demand for heat in the future.
In order to increase the share of renewable energy member countries use different instruments on a national level. At present, the Union is working on a directive to increase import and export of renewables between European countries and other countries. This however, requires a certain standardisation of instruments of promoting renewables. The outcome of this political process of negotiation between countries is presently uncertain.

1.5. The role of European rules for national decision making

The market and industry structure in the electricity industry in European countries have been quite different in the past. And also at present there are quite remarkable differences regarding market structure, ownership and the role of government in respect to this industry. National governments have basically the say regarding the energy mix in the power sector (e. g. the decision on nuclear power) whereas the European Union has successfully introduced a number of market rules that are now binding in all European countries. However, the monitoring of these rules is to a large extend with national governments so that there still are lots of differences regarding the implementation of these rules.
To summarize: the introduction of the open market model for the electricity sector has been introduced in Europe on the basis of European regulation and also quite a number of important energy policy measures particularly in the area of environmental regulation have been strongly influenced by European policy makers. On the other hand a lot of national differences remain partly because of socio-cultural differences on the one hand and historic differences in market and industries structure on the other hand. One important difference is for example the strong role of municipal utility companies in some countries like Germany and the much more centralised structure in Britain with private ownership and in France with state ownership.
The basic paradigms of running a utility company and particularly of making strategic and investment decisions for the future have considerably changed during the last ten years in Europe. In the following, we will go into more details of these changes and will explain them from a German perspective.

2. Decision making in the market place

In a market environment, a power plant can only run if the price on the market for a certain hour at least covers the marginal cost of running this plant in this hour[1]. If a sufficient number of other operators exist, the individual operator with his plant will act as a price taker. That is no individual alone can influence the price on the market. All operators have to adjust to the price resulting from all the production plants and the decisions of all operators. Thus, we would expect that the prices on the market follow the merit order of power plants as can be seen from figure 1.

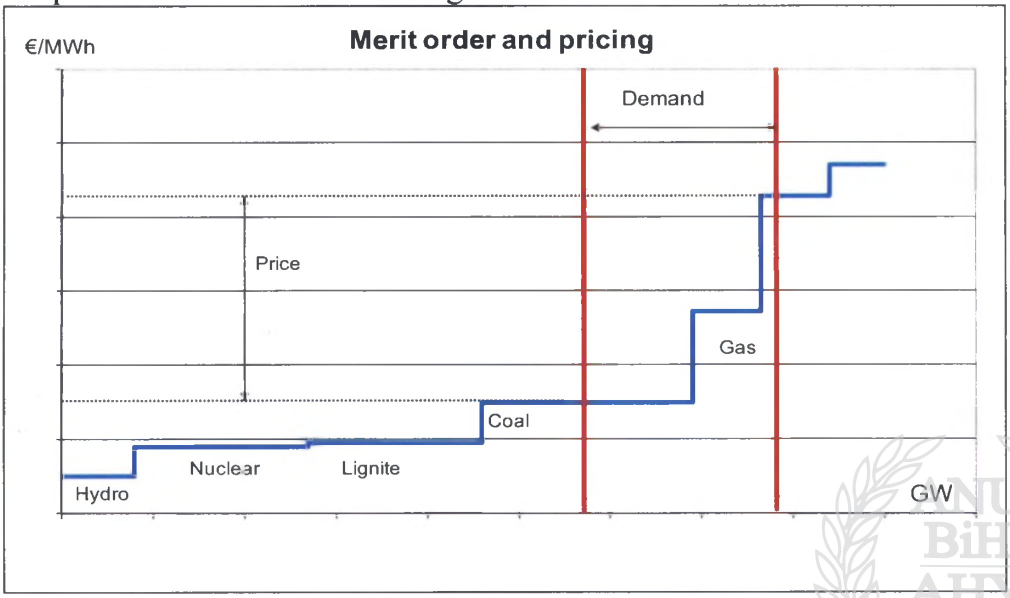


Figure 1: Merit order of power plants

As long as there is an abundance of capacity in the market, we can expect that prices will be largely determined by the short-term marginal cost of running different plants.

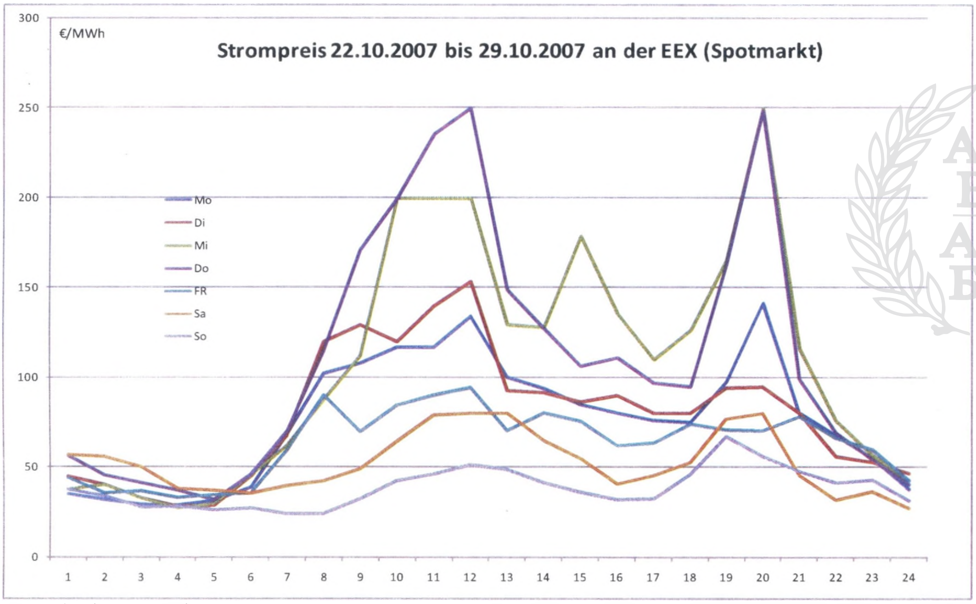
As we know however, this not a long-term solution because in the long run nobody can and will build power plants that do not cover total cost including fixed cost and all capital cost. When the introduction of the market model took place in Europe, there was in fact an abundance of power plant capacity. The newly created markets inherited a lot of capacity from the past constructed under completely different economic conditions. Formerly suppliers had a local or regional monopoly and could therefore plan investment without considering the market price of electricity set by competitors.

In the traditional model of organizing the electricity industry, a lot of the market risks are shifted towards the customer. In the new open market model, the division of risks between the market parties changes and the producer has to take some of the market risks particularly the risk of building power plants that might fail in the market because other competitors with a different cost

[1] The typical wholesale market time slice is one hour.

structure will set the market price in the future. There are of course also risks for the consumers: The consumer can choose between different products and particularly contracts for different periods of time. So there may be differences between the price development on the market on the one hand and the prices negotiated in the contracts on the other hand. Both of these risks however, are typical for market situations in all markets. We have to note however, that the long lifetime of assets in the power industry increases the risk of investment in this industry relative to other industries. Therefore, one of the crucial questions regarding the open market model in the electricity industry is whether under open market conditions there will be enough investment in the long run after the period of transformation from the former monopolistic model to the market model has been completed.

2.1. Price volatility



Price for all days of the week for 24h from October 22 to October 29, 2007, Source EEX

Figure 2: Wholesaleprice for power, EEX Spotmarket, October 2007

It has been observed that in open electricity markets prices can become quite volatile from time to time that is at certain times prices move far away from marginal cost. This situation may only persist for a few hours but involves a great deal of risk for electricity traders. Figure 2 shows as an example the development of the spot market price for electricity at the European Power Exchange for a week in October 2007. The diagram shows the price curve for all days of the week over the 24 hour period.

As can be seen prices are almost the same for all days during off-peak hours during the night (between 22 h and 6 h in the morning). During the day peaks there are considerable differences between the week days particularly in this special week. There was a very strong price increase on Wednesday and Thursday. The explanation in this particularly case was that there was an unplanned outage of a large nuclear power plant during these days that ended on the Friday so that the price differences between the hours became much more moderate again.
This example shows that prices vary strongly depending on the short term availability of resources in the market. If resources are scarce for certain times we can expect strong price increases and there are examples where prices went up to 1,000 € per megawatt hour in the German spot market. Price peaks are beneficial for the producers because for certain hours they increase there income considerably above the level of marginal cost at the same hours. On the other hand such peaks occur at unexpected times and in unexpected intervals so it is difficult to plan for such income in order to make sure that the total cost of a plant can be met.

2.2. Investment decision in a market with volatile prices

In general an investment for a power plant is economically feasible if the plant can cover its total cost during operation. This is the case if there are sufficient hours during which the plant can achieve a positive margin above marginal cost that is sufficient to cover the fixed cost including the capital cost of the plant. In Figure 3 this is explained.

$$\sum_t (p_t - b_t) \geq C_{fix} \qquad \text{for all } t \text{ with } b_t \leq p_t$$

P = expected market price
b= expected variable cost
C_{fix}= fixed cost
t = time index (hour)
Plant can only run if marginal cost can be recovered
Plant has to recover fixed cost incl. of rate of return

Figure 3: Conditions for economic feasibility

Remember that for the plant to be successful two conditions have to be met:

1. A plant can only operate if marginal cost can be recovered, that is the price at a certain hour is greater or equal the marginal cost of this particular plant. This is the general principle, in real operations the problem is somewhat more complex because start up cost has to be considered as well.
2. On the other hand, the plant also has to achieve a surplus above marginal cost in a sufficient number of operating hours to also recover the fixed cost.

In order to analyse the conditions for a particular plant a so called price duration curve of the market is used. This is then compared to the conditions of the plant. The price duration curve itself is a listing of all prices achieved hour per hour in the market place ordered by its level. **Figure 4** now shows how we can find out about the economic feasibility of a plant in a situation with a given price duration curve. The marginal cost of an individual plant determines its potential hours of operation under given prices.

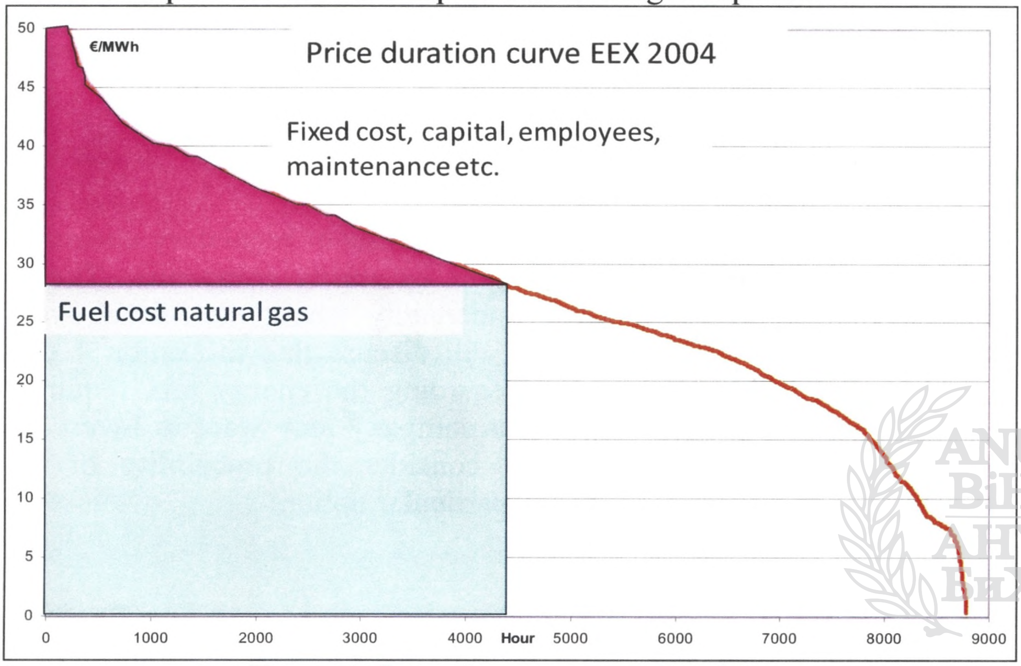


Figure 4: Price duration curve EEX 2004

The sum of all prices achieved during operating hours minus the marginal cost is the contribution of this plant to its fixed and capital cost. If the area above the marginal cost line is sufficient to cover the fixed cost, the plant can be run and investment is meaningful. If the area is too small and the fixed cost cannot be recovered from the market prices, then it does not make sense to invest in such a plant.

2.3. Market risks

There is, of course the problem of finding out about potential prices in the future. Under market conditions, the duration of contracts for power delivery is much smaller than the lifetime of power plants. Thus, market risks can not be reduced by simply having long term contracts. This problem is particularly relevant for highly capital intensive power plants like nuclear plants. There is an automatic tendency in the market mechanism to favour plants with low

capital intensity because the time required for the capital expenditure to flow back is much smaller. This is one of the explanations for the high share of natural gas plants in the United Kingdom, where the market model was introduced much earlier then in most other parts of Europe.
The market risks become smaller, if the number of players in the market gets smaller. An implicit coordination of investment plans can be more easily achieved than if the number of players is very large. To some extent there is a certain contradiction between competition wanted in order to have cost efficient prices and the long term problem of securing enough investment in order to reach the necessary security of supply.

2.4. Regulatory uncertainties

In addition to the market risks there are a number of regulatory uncertainties that may interfere with investment plans by utility companies. The most important one at present is the uncertainty about the future of the environmental regulatory regime. We will discuss this in section 4 of this paper. There are other uncertainties regarding the energy mix required by society or government If for instance a company may want to invest into a nuclear plant, it may also want to consider the probability of future government interference regarding this particular option.

2.5. Priority for Renewables

In order to promote the contribution of renewable energies to the production of electricity, producers of renewable electricity in Germany receive a special status. The production of renewable sources is given absolute priority in the network. Producers from others sources have to adjust their production to the amount of renewables available in the system at any time. With the high share of wind energy in the renewable portfolio and the erratic nature of wind energy the system has to adjust to a lot of short term changes caused by fluctuating inflows of power from wind energy plants. This increases investment uncertainties for potential investors for new plants. We will come back to this aspect in section 3 of this paper.

3. Network restrictions

3.1. Locational decisions and network

A location of a power plant depends on a number of factors like

- available infrastructure for transport of fuel and waste,

- availability of cooling water,
- availability of connection to power grid,
- availability of capacity in the grid to follow production plan for the plant.

Assuming that the physical requirements for a location (transport of fuels and waste, availability of cooling water) are met, in what way do network aspects influence the investment decision? From the point of view of system stability the network operator may have strong priorities for the location of plants in order to avoid network bottlenecks. These preferences must not coincide with the preferences by the producer who will prefer sites with good infrastructure availability plus low transport cost for the fuel. Theoretically, the potential network bottlenecks expressed in money terms should be balanced against the potential economic benefits of the producers in order to find the economic optimum. In practice however, the monetary value of network congestion may not be available and thus, decision making by plant investors may not fulfil the necessary conditions of the network.

In the German case in order to promote competition in the present legal situation plant operators have the right to be connected at any location of their choice and a certain priority will be given to new operators regarding the actual use of the network. This situation has caused a run towards locations with low transport costs for fuel (near the coast) where however, there is not sufficient power demand to use the potential output of these newly planned plants. Potentially there will be overproduction in certain regions and overdemand in other regions. Consequently, there may be bottlenecks in the network that require rescheduling of plants in general and may lead to much lower production in newly planned plants then the operator has envisaged. From this we can conclude that investment plans have to be coordinated with the network operator. The British system has developed solutions for this problem by applying different kinds of charges to newly connected power plants depending on the availability of network capacity. This will give an incentive to investors to plan production sites in conformity to the requirements of the grid.

3.2. National and international trade

As was mentioned in the introduction European policy strives for an open European electricity market where theoretically every customer in any member country can choose his supplier in any other member country. On the other hand there are network restrictions for international exchange of electricity between member countries. These restrictions are twofold:

- The conditions of network access may differ between countries so that the administrative procedures for trade activities are complicated

- Physical capacity may not be sufficient to allow international exchange in the volume required by customers.

Again here, we have a special optimization problem: to expand the network is meaningful as long as the extra network cost is lower than the cost differences for power between different regions. In Europe there are remarkable differences in production cost of electricity depending on the availability of certain cheap sources of energy (especially hydropower and nuclear). These sources are however restricted either by political factors or by natural/physical factors and therefore a re-allocation towards such cheaper sources in the longer run is only possible in a limited way. Yet international exchange of electricity within the given physical restrictions plays an important role between quite a numbers of European countries. The European Union is setting up regulation in order to cope with cross-border bottlenecks between countries.

Instead of exporting/importing power producers in the longer run can also think about setting up new power stations in regions where power prices are higher than in other regions. To give an example power shortages in the Netherlands lead to congestion in cross border transmission between the Netherlands and Germany. As a short-term solution, the transmission capacities are auctioned to interested parties. For a longer term solution German companies have decided to build power plants in the Netherlands.

Investment decisions for a new plant to mainly serve export purposes are not the case in Germany. For such a plant it may be necessary to build individual commercial power lines independent of the general grid in order to make sure that the export contract can be fulfilled without any restrictions from the ups and downs in the general grid. Such plans have been discussed but until now not realised.

4. Environmental regulation

Nowadays there is a very detailed regulation on all aspects of possible interference of power plants with the natural environment. For the erection of new plants or the change of existing plants permission is required. This permission is based on a number of administrative procedures. A potential investor of a new plant has to inform the authorities about a lot of aspects of his project. At a certain stage also a public hearing will take place so that the public can voice their concerns about any possible consequences of the investment planned. In this way the role of NGOs has been strengthened considerably. Often the concerns voiced by such organisations led to additional measures to be taken against unavoidable interference with natural structures that then have to be financed by the investor.

4.1. Command and control type regulation

The Federal Environmental Law (BImSchG) is the basis of all the administrative procedures. All power stations above a certain size are subject to the procedures for permission for building and running the plant. The strictest procedures apply to plants above a size of 50 MW but also smaller plants above 1 MW may need permits but procedures may be simplified. The aim of the law is to make sure that plants are built and operated in such a way that environmental quality can be maintained. In detail that implies:

1. There should be no damaging environmental effects or other dangers or other disadvantages for the general public and the neighbourhood.
2. Precautions should be taken against damaging environmental effects or other dangers or disadvantages especially taking measures corresponding to the state of the art.
3. Waste materials should be avoided, not avoidable waste material should be recycled and not recyclable waste should be deposited without interfering with general well-being.
4. Energy should be used in an efficient way.
5. In addition such plants have to be shut down in such a way that
6. There should be no damaging in environmental effects or other dangers or disadvantages for the general public and the neighbourhood.
7. Existing waste materials should be recycled in an orderly and undamaging way or should be deposited without interfering with general well-being.
8. The restoration of an orderly state of the area used should be granted (§ 5 BImSchG).

These general rules have been specified in great detail for different plants and there are several annexes to the law referring to power plants. These annexes contain detailed emission standards for power plants and the administrative procedures to monitor the actual emissions of plants after beginning of operation. In general measurements of emissions are continuous and just in time so that authorities can interfere immediately if emissions are above the standard. In addition standards may be increased above the values in the general law by local authorities if local conditions require higher standards.

These standards refer to nitrogen oxides, sulphur dioxide, metals like mercury, cadmium and many others, dioxin and similar substances and dust. The standards are defined as a maximum amount of substance per cubic metre of flue gas and are valid for the average of the day. In addition, there are also maximum values for half hour averages.

The introduction of these emission standards first for new plants and later also for all existing plants has led to a dramatic reduction of emissions of the substances mentioned.

4.2. Environmental impact analysis

For power stations also a general environmental impact analysis has to be carried out often in connection with the flora/fauna/habitat impact analysis. These instruments are used as precautionary measures against potential environmental effects of power plants. Therefore, the scope of this analysis is much wider than the emission standard regulation described above. Practically all natural factors that may be influenced by the building and operation of the plant have to be considered. Usually these analyses are carried out by expert institutes. Such an environmental impact analysis has to take care of the special conditions of any special location and therefore is independent of the particular power plant type. So, if the power plant of a certain type has been accepted by the authorities at location A this does not necessarily imply that it also will be accepted at location B.

Besides all the environmental factors possibly influenced by a power plant site, the availability of cooling water is a particularly important aspect. If water from rivers is used for this purpose the environmental impact analysis has to find out whether this could lead to a degradation of water quality in this particular river. This may necessitate the extra investment into a cooling tower or may lead to restricting the operation of the plant depending on the water temperature of the river arriving at the plant inflow. As was already mentioned the public is part of the procedure of an environmental impact analysis. The documentation of this analysis has to be published; afterwards there will be a public hearing. Interested parties can make statements on certain issues regarding the proposal which later on will be debated in a public hearing. At the end the authorities have to make a report also explaining their decisions regarding objections from the public. In this context, the principles laid down in the Federal Law for the protection of nature and landscape play an important role. According to this law, avoidable interference with nature and landscape should not take place. If interference cannot be avoided those causing the interference have to take measures to compensate for this interference. This compensation can take place by direct restitution on the one hand or by taking equivalent measures for instance in other areas. If, for instance for a new site for a power plant it is necessary to cut trees and the living conditions for animals in this untouched region will be changed, the investor will have to finance compensatory measures in another area. This could take the form of planting trees and making sure that the conditions for a wild life will be equivalent to the ones in the area where he wants to build his power plant. It is quite clear that with any project of a large kind negotiations on what kind of compensating measures will be adequate will start. In a densely populated country it will also be sometimes difficult to find adequate other territories where the compensation could take place. Protection of nature restricts the possible scope of industrial activity especially for new sites.

4.3. Energy taxes

Energy taxes depending on the way they are levied have an influence on decision making on power plants. In the German case energy taxes are mostly consumption taxes. With the so-called ecological tax reform in 1999 a tax on electricity was introduced, it has to be paid by the consumer. This tax is therefore neutral to the type of power plant orf fuel. In addition there are also taxes on certain fuels (but not coal); natural gas and oil are taxed and the tax party depends on the degree of efficiency in a particular plant. This is an incentive for higher efficiency possibly by using combined heat and power plants or using highly efficient combined cycle gas turbines.
In general the idea of taxing energy also is to give an incentive to consumers to reduce their consumption by increasing the efficiency of energy use. In the electricity industry in Germany this was not very successful until now because although more efficient equipment is being used continuously there are additional uses for electricity on the other hand so that consumption has risen to some extent. The rise has been relatively be small.

4.4. Regulation of Carbon emissions

As was already mentioned the European Union has introduced a carbon certificate scheme for all combustion units above a size of 20 MW. National governments have to set up a so-called *National Allocation Plan*, which lists the emission certificates granted to operators of energy combustion plants. The bulk of the certificates go to the electricity sector, mainly plants fired by coal or lignite. In the beginning the certificates were allocated free to operators. Although there was a surplus of certificates over emissions in the first period the price of the certificates rose considerably due to a lot of uncertainties with the beginning of the new system and also caused by some regional imbalances (Britain had to buy certificates in order to avoid running high price natural gas plants). In the present phase of the system the number of certificates allocated has been reduced so that the environment becomes a limiting factor for the enterprises. Present regulation in the European Union does not allow auctioning of all certificates to operators. In Germany the decision was made to sell a share of certificates to electricity operators by the government rather than allocating them for free. The price has presently settled at around 20 € / t CO_2 for the coming allocation period.

For the future the Eurolpean Commission now plans to sell all certificates in order to avoid negative distributional impacts that happened in the first phase (freely allocated certificates were considered as valuable assets by the enterprises and they increased their power prices accordingly).
The price of power has been influenced strongly by the new certificate system. As explained above the price of power depends on the marginal cost of the marginal plant at different times of consumption. As the diagram shows the marginal plants in Germany are either coal or natural gas plants, both subject to a price increase due to CO_2. The price for power from coal almost doubles and the price for natural gas increases less but natural gas in itself is much more expensive.

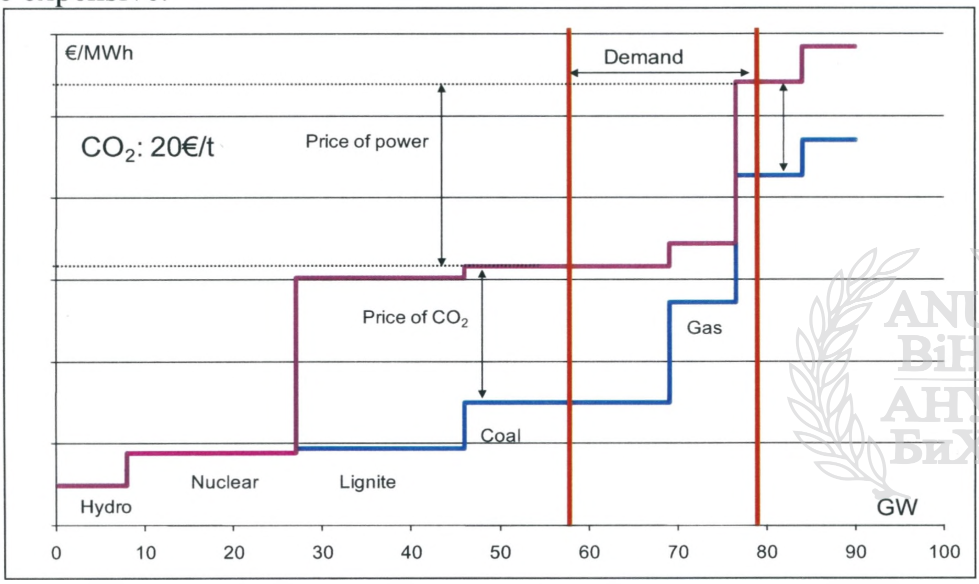


Figure 5: Merit order of power plants with a CO_2 price of 20€/t

It is one of the very important questions of present decision making on power plants on how the future regime for CO_2 certificates will influence investment behaviour. As was explained above the market price for power in the future is uncertain anyway because in liberalised markets the operator of the plant has to take a market risk. The uncertainty about the future price of CO_2 being responsible for about half of the cost of a power plant is a very important determinant of investment decision in the future.
There is a strong incentive in the carbon certificate system to invest into carbon free energy or alternatives with low carbon content. Whether the introduction of a CO_2 certificate system will lead to a revival of nuclear energy has led to controversial debates in recent years; there are also discussions on the possibility of extracting carbon from the flue gas and depositing it safely. However, there are no reliable technological concepts for this available yet.

4.5. Nuclear Energy

Nuclear Energy which accounts for about 30% of electricity produced in Germany is considered as a transitional energy and the parliament has passed legislation to gradually run down the nuclear plans within the next 12 years. The present legislation does not leave any room for new installations. Accordingly, there are no investment plans by German operators in Germany. German companies however, have announced that they might want to invest into nuclear plants in other European countries. The present political debate rather centers on the question whether it makes sense to close down the existing plants, which represent a very high technical standard long time before their lifetime ends. The legislator has decided that plants should not operate longer than the equivalent of 32 years. Permissions for the plant were originally granted for an unlimited life span as long as the plants fulfilled all the security criteria. The companies operating nuclear plants however, accepted the 32 year limit in a political bargaining process. There have been various proposals to change this legislation in order to be able to run the plants for a longer time but political parties are quite reluctant to changes this legislation because they fear repercussions in the public debate.

5. Social acceptance

The instruments described in this paper are instruments developed by parliamentary legislation and used by administrations at different levels. In addition, decision making on power plants may be influenced by social acceptance. Whether plants are accepted by the public or not depends on many criteria outside of the criteria we discussed until now in this paper. In the past it has been common practice for large energy companies to integrate local interests represented by regional stakeholders often in the form of special councils or bodies where regular meetings would inform regional stakeholders about the plans of the companies and the companies would listen to regional concerns. At the same time, it was quite common for companies holding a local or regional monopoly to finance or co finance public projects

This mechanism, which was quite successful in the past has lost a lot of its influence with the rise of grass root level local initiatives who voice their individual concerns directly. The forms of interaction in a democratic society change over time and thereby change the conditions of decision making for large investment.

On the one hand large projects in certain regions can lead to a lot of benefits and often investment wanted by regional bodies in order to attract value creating activities. There will be more jobs, there will be more income, there will be more taxes and all this can lead to an increase of the quality of life in that particular region. On the other hand, there may be regional disadvantages like environmental emissions, noise, additional transport activities etc. All these factors are analysed in the environmental instruments described in Chapter 4 but at the end this may not be convincing for certain interest groups in the region for the planned production site.

On the other hand the possible sites for power plants are quite limited, in Germany due to population density, availability of network connections, availability of access to cooling water etc.

In recent time there is a lot of opposition against new power plants even those replacing old ones on a regional level, particularly against coal fired power plants. The reasons are partly a strong emphasis on reducing greenhouse gases and partly resistance against possible environmental effects of such plants. In a society where the public wants stronger environmental controls than those represented by legislation the climate for investment becomes quite difficult.

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FROM SOCIAL RESPONSIBILITY OF COMPANY TO RESPONSIBILITY FOR TERRITORY

Dr. sci. Alfredo Vičković

Corporate social responsibility and European documents

The notion of corporate social responsibility (CSR)[1] became the focus of interest only after long confinement within the inner circle of economic debate prompted by the European Commission's Green Paper of 18 July 2001 entitled *Promoting a European framework for corporate social responsibility* - a business contribution to sustainable development.[2] This was followed on 2 July 2002 by a Commission communication concerning corporate social responsibility, while on 3 December 2001 the Council of Europe passed a resolution on going beyond the CSR Green Paper, followed on 6 February 2003 by another resolution on CSR. The European Parliament is currently debating the issue again, and is expected shortly to take a position on the Commission's latest communication.

This is a subject that cuts across a range of issues, including corporate competitiveness, social dumping, and the delocalization and globalization of the market, and draws attention to the link - or rather, the bottom line - with the social benefit of economic initiatives.[3] Seen in the light of the national legal system,

Dr. sci. Alfredo Vičković
Zagreb HEP Croatia, Croatia

[1] Translator's note: the Croatian-language original of this paper gives "RSI" as the "English" acronym for corporate social responsibility. However, all the European documents referred to use "CSR," which is therefore adopted in this paper.

[2] There is a direct link between this and Delors' 1993 White Paper on *Economic growth, competition and employment* and with the appeal by the European Council in Lisbon in 2000 to companies'sense of social responsibility regarding best practices for lifelong learning, work organisation, equal opportunities, social inclusion and sustainable development. Back in 1999 the European Commission issued a Green Paper promoting a European framework for social responsibility, which addressed issues such as job quality, social investment, social and eco-labels, the integrated management of corporate social responsibility and other related matters.

[3] Article 41 of the [Italian - trans.] Constitution highlights the limits of freedom of private economic initiative, "which cannot be carried out so as to be contrary to public utility or so as to be detrimental to security, freedom and human dignity." It should be noted that it draws attention to the law establishing programmes and controls "which are appropriate to guide and coordinate public and private economic activity for social purposes." [Quoted from *Unfair Contract Terms in European Law: A Study in Comparative and EC Law*, Paolisa Nebbia, Hart Publishing, 2007, p. 77 fn. 36. Trans.]

there can be no doubt that Article 41 of the [Italian - trans.] Constitution[1] sets out the terms of reference of normative foundations, although these norms are but rarely referred to, remaining effectively trapped in the limbo of good programmatic intentions.

As the European documents indicate, CSR is intended primarily for the corporate world, particularly medium-sized enterprises. However, a closer scrutiny reveals that much energy has been dedicated to promoting CSR in smaller enterprises and to involving public corporations, large enterprises, non-profit organizations, cooperatives and associations. It entails some extremely interesting transitions, which do not however change the appearance of future choices: directing economic and manufacturing entities, be they social or public, to the instruments and trajectories of social responsibility, which thereby open up to all those who may regard themselves, or be regarded, as stakeholders.

The Green Paper notes that "most definitions of corporate social responsibility describe it as a concept whereby enterprises integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis. Being socially responsible means not only fulfilling legal expectations, but also going beyond compliance and investing 'more' into human capital, the environment and relations with stakeholders."

This is an appealing notion, which clarifies the voluntary nature of CSR,[2] but fails to alleviate the suspicion that it is too ambiguous. From the legal perspective, it needs above all to draw the line between fulfilling legal expectations and the process of going beyond compliance, to test the limits of its application, and to study its effective application.

Above all, we view it through different lenses: at the global level, the sources of international law require a minimal overall coverage and set the threshold at the level of fundamental human rights; at the European level, it entails accepting responsibilities that go beyond existing commitments. At first glance, there appears to be no contradiction, but the pragmatic recognition of the existence of pluralist rights has a different impact. Solutions cannot be identical, given the complexity deriving from the structural, economic and cultural divergence between the global, the European and the national levels.

[1] Which reads, in full: "(i) Private economic initiative is free. (ii) Private economic initiative cannot be carried out so as to be contrary to public utilityor so as to be detrimental to security, freedom and human dignity. (iii) The law shall establish programmes and controls which are appropriate to guide and coordinate public and private economic activity for social purposes."

[2] The principal of the voluntary nature of CSR as the European Union understands it does not mean recognizing arbitrary decisions or reducing all decisions and value-judgments to the subjective level - indeed, the Union is very explicit in its opposition to such practices; it means rejecting the notion that there is a standard or comprehensive validation as opposed to the possibility of choosing between different ideal reference points.

It has become clear that even within systems of different scope, there are many points in common between international and European methods and instruments, notwithstanding the increasingly fluid boundaries between these two dimensions. Between European and national legislation, too, there is a convergence around the issue of the level of guaranteed rights, which must be minimal to median, and valid for all European countries, while the level of guaranteed rights within each country may not be altered, and must remain above European legislation.
As we shall see, whatever the circumstances, the effect remains the same, but the legal baseline alters. What is needed, therefore, is to define and analyze entities, to identify thresholds and, in consequence, the "delta" added value that takes into consideration the diverse contexts, legal nature, dimensions, sectors and territories being referred to.[1]
The different approaches that derive from this should cause no surprise.[2] We must get accustomed to living with injustice in a world of diversity while working together in the serious matter of combating discrimination, without resorting to shortcuts or fanciful schemes.[3]
The proposal we believe should follow leads us to the integration of the macro-economic and the macro-social vision and, as noted in one interesting European document, to an understanding of how CSR can become a form of implementation at the micro-economic level of a macro-economic concept of sustainable development.[4]

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[1] Though the fundamental principles are the same, it is the European Economic and Social Council (EESC) that specified, in its Opinion of 8 June 2005 on *Information and measurement instruments for CSR in a globalised economy*, that indicators must respect diversity while taking into consideration the socio-economic, legal and cultural circumstances and the type and size of the business or corporation in various parts of the world and in different sectors.
[2] The EESC Opinion of 8 June 2005 highlights as a problem the fact that since CSR entails going beyond legal requirements, the absence of uniformity between national laws could have damaging consequences. It gives the example of a business generating a moderate amount of pollution, which could receive a high rating in a country without laws governing greenhouse-gas emissions, while another generating the same levels of pollution but based in a country with strict laws on emissions could receive a low rating. The proposed solution does not seem satisfactory: bearing in mind social and environmental standards, it would seem fundamental to take as the starting point the idea that the current European body of norms sets a minimal standard only and that efforts should be made to implement it further.
[3] A recent Code of Ethics issued by Unindustria di Padova in December 2004 made it a requirement to respect human values, and banned the use of juvenile labour and all discrimination against workers and suppliers on the basis of language, race, sex or religion and belief. The document states that the companies concerned are already inspired by these values and seek merely to convey them to civil society..
[4] The reference, once again, is to the EESC Opinion of 8 June 2005

To do this effectively, however, we need to choose a path on which the axis of the principal entity is transposed as it attempts to move within a spectrum privileging the local community and developing its potential within the terms of integrated competitivity: economic, social and environmental.

Towards territorial social responsibility: the example of the Veneto Region

One of the most interesting lines of development in this regard concerns the transition from corporate social responsibility (CSR) to territorial social responsibility (TSR), which is of particular interest for at least two reasons: it comes close to the idea of the network, which has developmental connotations in different areas, and it focuses directly on achieving a goal that is regarded as strategic: competitive responsibility for territory.

This means understanding the way in which a shift of perspective may be achieved, from the individual to the pluralist or collective, in such a way that the actions of individual factors can be coordinated and interwoven.

It is no accident that the most forward-looking ideas are coming from a region like the Veneto, which has a strong social sense and is also marked by the presence of small enterprises and a system of regional subdivisions, with very few large corporations.

Two studies have recently been conducted at the University of Verona by the Governance and Social Responsibility in Companies Research Centre (Ce.R.S.I.) in association with the Avanzi Centre of Milan, both funded by banks keen to study the subject in depth.[1] Though different in content and field of research, they have one feature in common - they attest to the potential of territorial concerns in the future.

The starting-point is a re-reading of CSR as a factor of competitive advantage associated with long-term sustainable development. Territories such as the Veneto region are seeking alternative solutions capable of addressing the inevitable elements of crisis which - as is now clear here and elsewhere - cannot be overcome in an area where production costs are held down, but must be effected by highlighting distinctive factors through identifying new opportunities and enhancing quality.

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[1] The first dealt with *Corporate social responsibility and networked systems. Territory as the place of greater application of Corporate Social Responsibility*; the second with *Corporate social responsibility and the competitivity of local economic systems. Contribution by banks to cooperative credit in altering the development model of the regions of Veneto and Friuli Venezi Giulia*. The first was funded by the local council of Verona by UniCredit Group, and the second by Banca Agrileasing and several cooperative loan banks from the Veneto and Friuli regions.

Corporate social responsibility, and in particular its relationship with the social context, is capable of stimulating the Veneto region by recognizing in its social capital the driving force of development and the creation of added value. This prompts us to turn to a dimension that is almost the converse of CSR, in which the focus is no longer on the individual enterprise negotiating as a separate entity with its stakeholders, including the local community, but rather on the local community itself, entering into various relations with those representing its interests, including economic factors. "In other words, if it is true that corporate social responsibility consists of taking upon oneself the legitimate expectations of stakeholders and seeking to make them the principal objective of the enterprise, one must speculate whether it is possible to speak of a division of responsibility between the corporate system and the territorial, i.e. the local community."[1]

We may follow at least two models which are clearly gaining ground: in the first, we are seeing a transition of business groups and associations from the individual to the plural level, while in the second, there is a veritable exchange of entities from which springs a network of relations and relationships from individual firms to the local community.

In the first model, the shift is from the enterprise maintaining relations with its stakeholders to a system of enterprises entering into relationships with their own local community.

In the second model, the enterprise is no longer the focus of the strategy but merely one of the stakeholders. Instead of the relationship between the individual entity and its interlocutors, a relationship of circular reciprocity is created in which each entity becomes alternately "inside" and "outside."

In the research conducted by BCC, preference was given to the first model, and efforts were made to verify "whether it is possible to imagine that the corporate system, or systems, can and will identify, recognize and take on their own collective responsibility in regard to the local community in which they are based; extract definitions by recognizing this responsibility for shared social goals; calculate their own impact; and whether activating this process will give rise to a powerful circular process that reinforces the system itself."

Generally and specifically, given the nature of enterprise in the Veneto, it would seem helpful to pursue the model in which, rather than each enterprise acting on its own accord in regard to CSR, they become parts of a network, facing and resolving problems of a structural nature hand-in-hand with other enterprises in order to create a system and involve small and medium-sized enterprises with a commitment to social responsibility.

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[1] BCC research, p. 10. Translator's note: original source not provided, and I have been unable to track it down on the internet; this and the following quotations quotation have thus been re-translated from the Croatian.

The final section of this research reveals that "just as it is important for individual enterprises to maintain constructive relations with their stakeholders, so too is it important for the local economic system in regard to the society in which it operates." "A socially responsible local economic system is able to activate a relationship of dialogue and mutual exchange which, repeated over time, creates a climate of general consensus and facilitates transactions. This may be transformed into competitive advantage even for individual enterprises that are part of the system." Clearly, these are neither simple nor linear processes. "The first problem is that we are not dealing with relationships between entities, but between groups of non-homogeneous, unorganized entities." These are, in fact, "local economic systems," which are not legal entities, and which cannot be identified. Another problem that "arises when interests are highly divergent is that the incentive for each individual entity to change is weak, even when the risk is high, since the cause and effect link between direct action and the results it may bring is not recognized" (p. 50). If these may be regarded as the elements of resistance to the corporate system's taking collective social responsibility for the local community, it is important to observe that there are signs of change and early innovative experiments, which should be encouraged and stepped up.

The primary objective of the other research, initiated by UniCredit, was to study CSR in networked enterprises, with special emphasis on enterprises providing public services or serving the general public, such as those providing communications or transport services, energy and water suppliers, health care companies and service companies. There were several very different reasons for the selection of these very enterprises: mainly their modern networking approach, their unavoidable association with the territory, and their very close relationship with their customers or consumers, and in addition, because of their specific relationship with the local community even in the legal sense. "The relationship with the public was very rich and complex, because the enterprises were simultaneously stakeholders in various interests: those of their beneficiaries, but also of their owners or the commissioning authorities (indirectly, through the state administration), and of their own interests as part of the wider social community" (p. 22).

The CSR proposal set out in this study includes an interpretative model on the basis of which the transition is made from the enterprise mapping the network of its own relations with its various stakeholders to increasing the number of networks using the local community as the basis of overall relationships, leading finally to a simplification, and to a reversal of the set of terms of reference forming its starting point, so that the local community is at the centre of everything. In other words, instead of mapping ways for individual enterprises to take social responsibility on a voluntary basis, the aim is for the

territory and the local community to be capable of dialogue with their stakeholders, including the corporate system.
The study emphasizes that the model of networked enterprises does not mean, for the community, "an instrument for interpreting reality; rather, it is a project, work in progress. In other words, a network does not exist or is not created in itself, or rather, it is not said to exist or that when it does exist it will operate in the best possible way. This is why the network needs to be built and maintained."

Some questions needing to be resolved

Both these models fit into the prospect of a greater number of stakeholders, and thus in essence modify certain differentiating features. As is well-known, the CSR system is already a transition from the model of a single stakeholder focusing on meeting its shareholders' expectations to "a model of extended corporate governance whereby who runs a firm (entrepreneurs, directors, managers) have responsibilities that range from the fulfilment of their fiduciary duties towards the owners to the fulfilment of analogous fiduciary duties towards all the firm's stakeholders" (Sacconi, 2005). Territorial social responsibility also alters the nature or even the basic entity of pluralist relations from the individual enterprise to the corporate system and the local community. The multi-stakeholder model is enriched and developed to become the permanent and indispensable foundation of territorial integrity.
Change calls for great attention and innovativeness in raising awareness of just how stimulative the proposed ideas are. The proposal to set up territorial networks based on know-how, capacities, and the principles of ethics and morality dates back a full century, to Weber. Recent sociological studies, too, propose social competitiveness as a cooperative game based on technology, talents and tolerance (Florida, 2006).
In such a broad framework, it is vital to avoid the risk of including philanthropic initiatives within the notion of CSR.[1] The risk may lie in demanding single-mindedness in executive choices. Little has been written, at least in Italy, about interpreting CSR through a territorial key. It may be instructive to refer to some empirical studies,[2] which refer - not by chance - mainly to philanthropic cases in which CSR is "unconscious," "sporadic" and

[1] Philanthropy and charitable work are positive aspects of the policy of an advanced enterprise, but are on the opposite side of the balance sheet from profit.
[2] W. Sancassiani, 2005. "Verso distretti responsabili e nuove identità di territorio" (Towards responsible districts and new ideas of territory), in the periodical *Comuni polvere e polvere di Comunita, Communitas*, no. 3-4, which deals with "the study of 55 enterprises in three manufacturing districts around Modena" (p. 153).

"dependent" on individuals. Recent experience concerns "the purchase of flats for immigrant workers, the construction of clinics, sports and recreation centres, restaurants and cafés within the company at concessionary prices for employees, the purchase of works of art, the purchase of medical instruments for the local hospital structures;" it follows from this that "these are actions characterized by a combination of a strong sense of belonging to the local district (territory) and solid values, pride and sensitivity to one's own personal reputation and that of the company."[1]

In my view, better results are achieved by taking responsibility for relations that are reciprocal in a multiplicity of ways, and which lead to the creation of a synergy of exchange and involvement, avoiding one-sidedness and fragmentation into separate enterprises, separate departments, separate entities and separate measures.

This facilitates a transition from the integration of social and environmental issues into the corporate decision-making process to issues that cover planning local public policy, thus exercising the principles of mutual assistance and sustainable development. It also facilitates breaking out of the scheme of exchange to adopt the networking model, which genuinely takes in a great many actors who thereby avoid incurring unnecessary costs, prevent tasks piling up, and save energy and resources, all the while consciously recognizing their own limits.

The view of social responsibility thereby extends to territory as the proposal of a collective entity that agrees to become the initiating nucleus of the networking structure. The ultimate aim remains the integration of the production strategy of a given territory with social and environmental considerations (to adapt the European Commission's 2001 Green Paper definition of CSR) and to find innovative solutions that will assure the sustainability - and thereby the competitiveness - of its own development. In other words, this strategy links competitiveness with development in an innovatory manner.

The greatest problem is defining what the territory, or rather the territorial community, consists of and how large it is. Later essays, to which I direct the reader, will deal with this question. It will be sufficient here to recall that we cannot simply stay with the transfer of the reference model and, in consequence, ascribe socially responsible choices and conduct to entities that are not corporations, without defining them and identifying the entity that launched the initiative. Just as the initial discourse was of moving from large enterprises to smaller ones, to the non-profit sector, to cooperatives, to local authorities, to multi-utilities, to trades unions, so too the next shift is to the district, to local bodies, to civil society and to the individual citizen. Each

[1] Ibid, p. 155.

time responsibility is focused on these actors, with a concomitant increase in acronyms and buzz-phrases,[1] as well as of experiences. Obviously, major and significant differences emerge between these entities, on account of which the (new) leading CSR actor is confirmed, as is the fact that it serves either as driving force or as overseer.

It is important, therefore, to identify the collective or pluralist entity able to take direct action or merely to be the driving force of the cycle. Whenever local authorities become this entity, there may be multiple activities, in the following categories: promotional (by dissemination of examples of best practice), reflexive (applied within the entity's own structure), or regulatory (depending on the entity's powers). Whenever a group of associated enterprises emerges as this entity, the area of operation corresponds more closely with the willingness of each enterprise. And whenever this entity is a mixed association, its possible impact is the promotion of values and assistance in joining the network.

Particularly in cases when the foundational entity is a local body or mixed association, the strategy may be regarded as the model of deliberative democracy in which "any decision-making procedure is legitimate only if all interests, opinions and positions in society are represented and involved in the decision-making process" (Young, 1999).[2]

There is not time here to consider studies that take as their basic principle the inclusion and active involvement of all those actors that are interested and involved because of decisions being made in a given territory. It is enough to observe that what is in question are decision-making processes for Agenda 21, the experience that is closest - at least as regards sustainability - to the notion of territorial social responsibility. There are similarities between the two ideas: both emphasize adaptability and flexibility; both are based on the action of individual and collective stakeholders; both are geared up to the crisis of transition dictated by globalization and market internationalization; both call for identifying common ground where collective decisions can be made that are imbued with a high degree of ideals.

Yet if we seek to define the direct link between deliberative democracy and TSR, I believe it can be found in the potential for the inclusion of the citizen, even to the point of direct involvement, in the management of the *res publica*, moving on from "negotiation" to "decision-making," from representative democracy to deliberative democracy (Donolo, 2005).

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[1] Such as the social responsibility of the individual district, territorial and institutional social responsibility, civic social responsibility.

[2] Translator's note: original source not provided; the quotation has thus been re-translated from the Croatian.

These are merely initial thoughts as a basis for reflection, needing not only a theoretical component but also specific experience to test their feasibility and impact. In my view, what might make a difference is the possibility of placing all the entities noted in a synergistic relationship. Territorial social responsibility, with all its different degrees of intensity, requires a networking structure with a division into territory, activities, instruments and resources.
But what might its objectives be?

The area of impact of TSR: the ability to attract and provide employment for talent

The aims of TSR do not diverge from those of CSR, although there is a clear polarization of the social and environmental competitiveness of territories. An area that should certainly be privileged is that of education and retraining, which are essential to enhancing the knowledge and abilities of the people living and working in a given territory. This ranges from retraining existing personnel to creating a base of young people setting themselves the goal of on-going lifetime education and training as a permanent modality for self-improvement and innovativeness, following the best guidelines from the European level, particularly the Lisbon strategy.
The Lisbon Strategy of 2000 was designed to drive Europe towards a social model based on innovation, education, and full employment with good job quality. A year later, work began on processes focused on CSR. European documents continued to highlight the importance of on-going lifelong learning: employees opt for on-going education regardless of the specific expertise needed when offering their services, while lifelong learning is about improving and upgrading expertise and know-how, on becoming aware how difficult it is to separate professional matters from those designed for the development and improvement of one's own skills. On the other hand, there are almost no occupations, and those that do exist are in ever fewer areas, where people may be employed without qualifications or finishing their education. On-going, lifelong learning is not merely a defence mechanism; it is a vector of innovativeness and competitiveness. It provides us with an instrument for reflection and the application of new methodologies, for honing our skills, for enhancing our expertise and, thereby, our productivity. Just as a person facing unemployment must necessarily adapt his or her skills, so too it is important for the employed to be provided with analogous, more flexible instruments. This is true of every occupation, but its importance increases exponentially for those occupations and professions that call for a higher level of education and for attention in the context and evolution of productive and financial economic systems.

Attention should also be focused on the culture and well-being of individuals, to ensure that they see themselves as the principal competitive advantage of a given territory. In that area, Veneto has no equal, since all it needs is further to enhance the valorization of its historical and natural heritage.
Research and education and training must go hand-in-hand in a subject such as the one addressed here, and can generate education and training projects specifically aimed at underpinning and developing future social responsibility.
If one agrees with everything that has been set out here, it becomes clear that CSR, and its specific development through TSR, is a multipurpose instrument for applications ranging from creating an identity enabling society to arrive at a social management system, to the choices that each individual acting in society must make in regard to his or her conduct at every level of expertise, skill and occupation within each enterprise as well as within the network of all the region's enterprises.
More broadly still, we may claim that the aims should lie in the community's ability, by means of choices for the future through TSR, to become inclusive, creative, attentive to individual well-being and to the quality and effectiveness of services.

HYDRO POWER, RESERVOIRS AND ENVIRONMENT WITH CLIMATE CHANGE ISSUES IN B&H

Prof. dr. sci. Tarik Kupusović

Summary

The world has been dividing onto those that are becoming globally connected, and those becoming globally isolated. In the first part global and European recent trends in energy, climate change, hydro power and environment were summarized. The rest of the paper presents the B&H challenges, existing situation, plans and possible future of these sectors.

Keywords: Hydro power, Energy, Environment, Climate change, B&H Challenges

1. Introduction

Access to energy and water is fundamental to the daily lives of every human being. Citizens are affected by higher prices for drinking water or wastewater services, threats to the security of energy and water supply, and effects of climate changes. Sustainable, competitive and secure energy and water is one of the basic pillars of our daily life, and our economy.

The nations in Central, Eastern and Southern Europe face triple challenges of the ongoing economic and political transition, continuing vulnerability to environmental hazards, and longer term impacts of global climate changes. Bosnia and Herzegovina additionally faces post-war and complex constitutional challenges.

The future of B&H will depend on the speed at which it will find acceptable solution for all its citizens, all three ethnicities and two entities, which will stimulate economic development. Serbia and Kosovo are a large challenge for International Community, since it has been hard to find acceptable solutions that would provide prospects of faster development, and put the war traumas behind. If Croatia wants to become the EU member, and it obviously wants, Croatia will also have to, by rational measures, dampen the emotional charge related to the issues from the war years, and speedily reform and institutionalize the society in accordance with the European norms. The last issue is even more intensively related to Montenegro, and Macedonia, which still has problems with its ethnic divisions [4].

Prof. dr. sci. Tarik Kupusović
HYDRO-ENGINEERING INSTITUTE, Sarajevo, B&H

And while all of the above mentioned countries were, all together and individually, struggling with their own specific problems, the world and the surrounding countries were moving forward increasingly faster and further. Romania and Bulgaria became new EU members in January 2007. The interest of Russia in its neighbors is spreading to the Balkan region as well, as the traditional Russian interest area. China and Africa are concluding contracts on long-term cooperation regarding infrastructure development and utilization of resources, while India and China are preparing a joint entry on the market of Latin America countries. It is completely clear that the Southeast Europe is not devoting enough attention to these wider trends.
The world has been dividing onto those that are becoming globally connected, and those becoming globally isolated. It is certain that global connecting has no reasonable alternative, but the bulk of countries in the region is preoccupied with their own problems, and is therefore not taking part in it; [4].
It is obvious that this region may not expect very high rates of economic growth.

The reasons are the following:

- traditionalism, which does not allow larger liberalization of economy, which is the condition for long-term explosive growth rates of approximately 10%;
- higher labor costs in relation to other undeveloped countries, which does not attract foreign investment and it leads to avoiding of traditional, work intensive industries and mass, market agriculture;
- unfavorable demographic movements of population, on average becoming older, while younger and more skilful people are leaving for developed countries.

Bosnia and Herzegovina is only at the beginning of the new road, when B&H institutions should take full responsibility for future of its inhabitants of all ethnicities. The following goals are indisputable: EU membership, building of democratic and just country, equality of all peoples, poverty reduction, economic development, cooperation with neighboring countries, etc. The problem is how and when to implement all of this. The capacity to implement the goals was the basic problem in the previous period, burdened by war and its consequences. Unfortunately, the synergic solutions that would eliminate the institutional, legislative and organizational problems in building of B&H into a modern and prosperous country, but at the same time respecting all the specific qualities it has, have not been found yet; [4].

2. Global Energy and Climate Change Challenges

2.1. Energy Challenges

Energy is essential to improving the quality of life and opportunities in developed and developing nations. Therefore, ensuring sufficient, reliable and environmentally responsible supplies of energy, at prices reflecting market fundamentals, is a challenge for all countries and for mankind as a whole.

To tackle this overarching goal, political leaders and intellectual elite have to deal with serious and linked challenges such as:

- high and volatile oil prices;
- growing demand for energy (estimated to rise by more than 50% by the year 2030 compared to 2007);
- increasing energy importing dependence in many countries;
- enormous investment requirements along the entire energy chain;
- the need to protect the environment and to tackle climate change;
- the vulnerability of the critical energy infrastructure;
- political instability, natural disasters and other threats.

The global nature of these challenges and the growing interdependence between producing, consuming and transiting countries, require strengthened partnership between all stakeholders to enhance global energy security. But, leading role in this issue is within leading industrialized countries, organized in G8[1] group, so as countries in possession of the majority of World's oil resources, OPEC[2].

G8 leaders agreed in St. Petersburg (July 2006, Joint statement, [10]) that development of transparent, efficient and competitive global energy markets is the best way to achieve objectives on this score. They recognize that governments and relevant international organizations also play an important role in addressing global energy challenges.

[1] The G8 members are: Germany, France, the United Kingdom, Italy, Japan, the United States, Canada (since 1976) and Russia (since 1998). The European Commission is also represented at all the meetings.

[2] The Organization of the Petroleum Exporting Countries (OPEC) is a permanent intergovernmental organization, created 1960, by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela, later joined by other members: Qatar, Indonesia, Socialist Peoples Libyan Arab Jamahiriya, United Arab Emirates, Algeria, Nigeria, Ecuador. OPEC is made up of thirteen developing nations, whose economies rely on oil export revenues. One of OPEC's primary missions is to achieve stable oil prices, which are fair and reasonable for producers and consumers.

Given political will, the international community can effectively address three interrelated issues: energy security, economic growth and environmental protection (the "3 Es"). Applying fair and competitive market-based responses to the global energy challenges will help preclude potentially disruptive actions affecting energy sources, supplies and transit, and create a secure basis for dynamic and sustainable development of our civilization over the long term.

G8 leaders will pursue energy security through a comprehensive and concerted approach consistent with common environmental goals. Previous year (2007), G8 agreed to enhance work under the Plan of Action for Climate Change, Clean Energy and Sustainable Development and resolved to take forward the dialogue on these issues whose results will be reported at the 2008 G8 Summit in Japan.

G8 leaders reaffirm commitment to the United Nations Framework Convention on Climate Change (UNFCCC) and to meet shared multiple objectives of reducing greenhouse gas emissions, improving the global environment, enhancing energy security, and cutting air pollution in conjunction with vigorous efforts to reduce energy poverty. They also agree to work on improving access to energy in developing countries.

They reaffirm commitment to implement and build upon the agreements related to energy reached at previous G8 summits. They will enhance global energy security through actions in the following key areas:

- increasing transparency, predictability and stability of global energy markets;
- improving the investment climate in the energy sector;
- enhancing energy efficiency and energy saving;
- diversifying energy mix;
- ensuring physical security of critical energy infrastructure;
- reducing energy poverty;
- addressing climate change and sustainable development.

A large-scale use of renewable energy will make a significant contribution to long-term energy supply without adverse impact on climate. The renewable solar, wind, hydro, biomass, and geothermal energy resources are becoming increasingly cost competitive with conventional fuels, and a wide variety of current applications are already cost-effective.

Renewable energy sources are accessed to be cost-effective for both heat and electricity generation, as well as the production of bio-fuels.

Today, renewable energy sources account for 13 % of the world's primary energy demand. Biomass, which is mainly used for heating, is the largest renewable source. The share of renewable energy in electricity generation is

18 %, whilst the contribution of renewables to heat supply is around 26 %. About 80 % of primary energy supply still comes from fossil fuels, and the remaining 7 % from nuclear power; [8].

The real cost of energy production by conventional energy includes expenses absorbed by society, such as health impact and local and regional environmental degradation - from mercury pollution to acid rain - as well as the global negative impacts from climate change. Hidden costs include the waiving of nuclear accident insurance that is too expensive to be covered by the nuclear power plant operators.

Environmental damage should be rectified at source as a priority. Translated into energy generation that would mean that, ideally, production of energy should not pollute and that it is the energy producer's responsibility to prevent it. If they still do pollute, they should pay an amount equal to the damage the production causes to society as a whole, or remediate the full damage. However, the environmental impacts of electricity generation can be difficult to quantify.

An ambitious project, founded by the European Commission - ExternE - has tried to quantify the true costs, including the environmental costs, of electricity generation. It estimates that the cost of producing electricity from coal or oil would double and that from gas would increase by 30 % if external costs, in the form of damage to the environment and health, were taken into account. If those environmental costs were levied on electricity generation according to their impact, many renewable energy sources would not need any support. If, at the same time, direct and indirect subsidies to fossil fuels and nuclear power were removed, the need to support renewable electricity generation would seriously diminish or cease to exist; [8].

G8 welcome the work of interested parties in international mechanisms and programs dealing with renewable energy, including the Renewable Energy and Energy Efficiency Program (REEEP), the Renewable Energy Policy Network for the 21st Century (REN21), the Mediterranean Renewable Energy Partnership (MEDREP), and the establishment of the Global Bio-Energy Partnership (GBEP). G8 will work in partnership with developing countries to foster the use of renewable energy. G8 leaders instructed their experts to work together with other countries, international and regional financial institutions (World Bank, Regional Development Banks, UN agencies, etc.), the private sector and other stakeholders to facilitate technology transfer in the areas of energy efficiency, energy saving, renewable energy and decentralized local sources to reduce energy poverty, thereby improving energy access and enhancing energy efficiency in developing countries.

With the renewable energy, the principal role of public policy is to promote, engage and mobilize action by the private sector [10].

2. 2. Global Challenge of Climate Change

This paragraph builds to a large extent upon the recently published Fourth Assessment Report of the Intergovernmental Panel of Climate Change (IPCC, Valencia, Spain, November 2007), which assesses the latest scientific, technical and socio-economic literature relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation; [19].

Global emissions of greenhouse-gases (GHG)[1] have increased markedly as a result of human activities since pre-industrial times. The increase in emissions has lead to unequivocal global warming, which is evident from observations of increasing air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

Emissions projections from future scenarios indicate that without the tightening of current climate change mitigation policies, global GHG emissions will continue to grow at high pace over the next decades. This increase would cause further warming and induce many changes in the global climate system during the 21st century that would be much larger than those observed today. Unmitigated climate change would thus increase the risk of climate-induced impacts for many climate sensitive and vulnerable systems, including food supply, infrastructure, health, water resources, coastal systems, ecosystems, global biogeochemical cycles, ice sheets, and modes of oceanic and atmospheric circulations.

Reducing the risk of irreversible climate impacts requires thus the mitigation of global GHG emissions aiming at the long-term stabilization of atmospheric GHG concentrations. Achieving this goal translates into the need of reducing emissions to virtually zero over long time-frames. The mitigation challenge is best illustrated by the stabilization scenarios for low stabilization levels, which would e.g. be consistent with the 2^0C temperature increases target of the European Union (See Paragraph 3). These scenarios indicate the need for rapid decarbonisation of the energy system, where global emissions would have to be reduced by more than 50 % by 2050, compared to 1990.

Although there are large uncertainties with respect to the deployment of individual future technologies, there is strong evidence that no single mitigation measure alone would be sufficient for achieving the stabilization of GHG concentrations at low levels. A wide portfolio of technologies across all GHG-intensive sectors is needed for cost-effective emissions reductions. The bulk of these emissions reductions would need to come from the energy sector, with

[1] Carbon dioxide (CO_2); Methane (CH_4), Nitrous oxide (N_20); Sulfur hexafluoride (SF_6); Hydro fluorocarbons (HFC); Perfluorocarbons (PFC); Chlorofluorocarbons (CFC); etc.

the forest and agricultural sectors playing an important role for the cost-effectiveness. Energy-related measures range from energy conservation and efficiency improvements to shifts away from carbon-intensive coal to cleaner fuels (such as natural gas, renewables, and nuclear), as well as "add-on" technologies such as carbon capture and storage. Other important measures include changes in agricultural practices to reduce GHG emissions, and enhancement of terrestrial sink activities in the forest sector.
Reducing the risks of climate change significantly, requires fundamental structural changes of the energy system in the long term, combined with accelerated technology diffusion and early investments over the next few decades. In addition, appropriate and effective investment incentives need to be in place for development, acquisition, transfer, and deployment of new technologies. Achieving a trend-reversal of presently declining trends of R&D expenditures in environmentally friendly energy technologies will thus be central for addressing the climate change challenge; [11].

2.3. Climate Change Challenges on Water Resources

As the recent Intergovernmental Panel on Climate Change Report makes clear [19], water is in the eye of the climate management storm. Global warming and related climate changes are predicted to present significant challenges over the century. These challenges are increasingly better understood and there is growing consensus on their likely scale.
To date, much attention has been focused on the dimensions of temperature and sea level rise. Substantial work has also been done on some of the consequences, such as changes in rainfall and the risk of more, and more intense, floods and droughts. However, not nearly enough work has been done to understand how to cope with the potential impact of climate change on the water environment at a regional, national and local level; [7].
As the same IPCC report has also made clear, "irrespective of the scale of mitigation measures, adaptation measures are necessary". This implies an integrated approach to climate changes that embraces both ***mitigation***, which addresses the drivers of climate change, and **adaptation**, which considers the measures necessary to accommodate such changes. In this context, the challenges of water management will become increasingly important because there is general agreement that the supply of and demand for water resources will be substantially affected by climate change.
The first key message is that, if our global energy habits are the focus for mitigation, the way we use and manage our water must become the focus for adaptation; [7].

One reason for this is that it is widely predicted that relatively small temperature changes of a few degrees Centigrade will influence average river flows and water availability increase by 10 - 40 % in some regions, while, in others, they will decrease by 10 - 30 %. A further message is thus that changes in climate will be amplified in the water environment.

If the challenges of climate change for the world's water are not understood and addressed, we run the risk that the water supplies we provide to the communities of a growing, urbanizing world, the infrastructure we build to serve them and the industries and agriculture that supply and feed them, will prove to be unsustainable.

There are also broader dangers. If we fail to understand the interaction between climate change and water, other climate change strategies may actually aggravate the problems and increase the vulnerability of communities to both natural and manmade calamities.

Adaptation efforts must begin immediately, because both the institutions that we establish and the infrastructure that we build today, lock us into patterns of behavior for many years to come. Unless we act now, we will miss opportunities to ensure a more sustainable long term future.

It is thus important for water managers and water users alike to get to grips with the future that is unfolding. An approach to water resources management that can identify and address the challenges - and uncertainties - is needed. But as important as promoting better, more intelligent, water management, we need to ensure that in all sectors of society, the water challenges are addressed in broader climate change and development strategies.

Although it will be some time before the full extent of the impacts of climate change on water resources become evident and are fully understood, it is important that they should be addressed sooner rather than later, to adapt to a future that many believe has already begun to occur. Moreover, the best way for countries to build the capacity to adapt to climate change will be to improve their ability to cope with today's climate variability. Adaptation on seasonal to inter-annual time scales will be critical in adapting to the impacts of longer term climate change as well. So, another overarching message is that improving the way we use and manage our water today will make it possible to address the challenges of tomorrow; [7].

While this brief focuses on the emerging challenge of adaptation, it is important to recognize that aspects of water use contribute to climate change and that different approaches to water management can help to reduce these impacts. Indeed, mitigating global climate change will require addressing a range of thorny water and development problems, such as tapping more of the world's hydroelectric energy potential in ways that are socially and environmentally responsible, balancing the allocation of scarce land and water resources for bio-fuel production against other key uses, and finding ways to reduce the energy-intensity of desalination and groundwater-based approaches to increasing fresh-water supply.

Hydroelectricity, an important source of renewable energy, depends on reliable water sources. Lower river flows will reduce electricity production and thus supplies too, and power failures will affect the economic and social life of many communities unless new investments are made.

More intense rainfall will increase the cost of flood protection works, as well as that of associated infrastructure such as roads and storm-water drains.

The IPCC does not consider methane generated in reservoirs to be a significant source of greenhouse gases (GHG), noting that "while some GHG emissions from new hydroelectric schemes are expected in the future, especially in tropical settings,..., such schemes are regarded as a lower source of CH_4 emissions, compared to those of other energy sector or agricultural activities". Hydroelectric power is therefore not treated as a separate emission category in the Special Report on Emissions Scenarios. (See IPCC Special Report on Emissions Scenarios, UNEP/WMO 2006); [19].

A related issue is the size of extreme water events such as floods and droughts. There are sound reasons to expect that there will be more powerful, intense storms and floods and longer, more intense droughts. One effect of temperature increases that is often forgotten is the increase of aridity - the ratio between rainfall and evaporation. Since evaporation increases with temperature, aridity will increase in many areas.

As important as the size of extreme events is how often they occur, it is predicted that extreme events will occur more often; floods and droughts that previously occurred once in a lifetime, every 50 years, may now occur every 5 or 10 years; [7].

One way to manage the impact of climate's variability on water resources is to capture and control river flows. Dams can retain and store flows in excess of user requirements and release them when low flows are not sufficient; this can also help to maintain aquatic ecosystems. Peak flood flows can be stored and released later, avoiding flood damage by reducing maximum flows. Both functions are important to sustain human settlements and to avert disasters caused by floods and droughts. Dams also store water as a form of potential energy to generate electricity, without which healthy human life is difficult to sustain, particularly as settlements increase in size.

Since the useful life of large water infrastructure is often measured in hundreds of years, investment that are made today will still be operating under the new climate of the 22nd century, and need to be designed for the future as well as for the present.

Building resilience to manage the impact of variable climates on human activity is not new and has been the day to day business of society's water managers for generations. To satisfy an ever increasing water demand, the construction of new dams might remain an option, but the choice of sites is becoming more difficult as the economic, environmental and social costs are increasing again and again. An alternative option to dam building might be to increase the storing capacity of existing dams, since by increasing the size of dam, one can regulate the water output from the reservoir by a more effective use of inter-annual variability; [17].
The design of expensive water-power and water infrastructure and complex management arrangements needs more than technical capacities. It must be guided by sound information about the water resource. Paradoxically, one consequence of the wide uncertainty about the future impact of climate change is that water managers are still using historic climate data to design water infrastructure and guide their management decisions. This has been aggravated by a worldwide decline in the availability of hard water data over the past two decades. In many poorer countries and countries in transition (including B&H), hydrological information systems have been allowed to decay under pressure to allocate scarce resources to more immediate needs. As a result, we have limited information to support the planning, development and management of the water resources, a situation which cannot be reversed overnight. However, unless a start is made to rebuild the basic systems to provide information about water resources, the danger is that new infrastructure will not achieve their predicted yields.
Many poorer countries cannot even manage their current climate variability, not because the strategies needed are unclear, but because the means to implement them are lacking. They may reasonably ask how they should address tomorrow's climate change if they cannot afford to manage today's floods and droughts; [7].
Many of the impacts threatened by climate change are just extreme examples of challenges that are already addressed on a daily basis across the world. Countries which have established effective institutions and infrastructure to deal with today's climate are better placed to deal with the more extreme variability, which we expect tomorrow.
Being rich certainly helps, but being wise is as important. For poor countries, it is arguably more important to develop and apply water wisdom to the challenges of climate change; [7].

2.4. The Clean Development Mechanism (CDM)and Hydro Power

The CDM was established under the Kyoto Protocol of the UN Framework Convention on Climate Changes (UNFCCC) at the 7th Conference of Parties in October 2001. It allows industrialized country Parties to the Protocol to meet their GHG emission reduction targets in part by purchasing "certified emission reduction" credits (CERs) by subsidizing projects in developing country parties.

The mechanism is intended to support the host nation in meeting her sustainable development goals; to transfer new technologies to developing countries; and to lower the cost to developed countries of meeting their emission reduction targets.

Eligibility for participation in the CDM requires the following:

- That a developed country party invests in a project in a developing country in order to reduce GHG emissions from variety of sectoral options,
- To comply with a set of monitoring, verification and validation procedures agreed by the UNFCCC and the CDM board,
- To allow for clear assessment on the "additionality" of a project. "Additional" in that it is an emission reduction activity that would only occur with the extra income obtained by the sale of the CERs.

Annual expected CER generations by project type are:

- Industrial gases 31%,
- Methane capture or combustion 18%,
- Hydro 15%,
- Renewable energy 13%,
- Energy efficiency 12%,
- Fossil fuel switch 8%,
- Land use and other 3%.

Hydro power projects represent approximately one-fifth to one-quarter of all registered CDM projects. Data on CER applications up to September 2007 for hydro projects (updates available on "International rivers" website) show that:

- CERs have been sought for 592 hydro projects for a total installed capacity of 18 GW (this compares to estimates of 1.700 overall planned hydro projects worldwide with more that 135 GW capacity),
- These projects are mainly located in countries with emerging economies: China 371, India 79, Brazil 49;
- The initial buyers of these CERs are from: UK 242, Netherlands 128, Germany 62.

However, the inclusions of hydro power projects in the CDM has been controversial because of the uncertainty over the scale of GHG emitted from reservoirs, and the non-GHG impacts on people and the environment of many hydro projects; [18].

3. EU Energy and Climate Change Policy

Energy landscape of the 21st century is one in which the world's economic regions are dependant on each other for ensuring energy security and stable economic conditions, and for ensuring effective action against climate change. Europe is the world's second largest energy market, with over 450 million consumers. Acting together, it has the weight to protect and assert its interests. The EU has not just the scale, but also the policy range to tackle the new energy landscape. The EU leads the world in demand management, in promoting new and renewable forms of energy, and in the development of low carbon technologies. If the EU backs up a new common policy with a common voice on energy questions, Europe can lead the global search for energy solutions.

Europe acts urgently, because it takes many years to bring innovation on stream in the energy sector. EU also promotes diversity - of energy type, place of origin (in Europe and outside) and transit. In this way, Europe creates conditions for growth, jobs, greater security and better environment, [1].

At a landmark summit in March 2007, European heads of state agreed to move forward with ambitious objectives to slash greenhouse-gas emissions and boost renewable energies by 2020 in a bid to reduce the EU's dependency on imported fuels and "**set the pace for a new global industrial revolution**"; [5].

Latest & next steps:

- **10 Jan. 2007**: Commission presents "Energy and Climate Change Package" including a Strategic Energy Review focusing on both external and internal aspects of EU energy policy;
- **27 Feb 2007:** Commission issues 3rd high level group report: "Helping Energy Intensive Industries Adapt to the Energy and Climate Change Challenges";
- **8-9 March 2007:** EU leaders endorse key points contained in the package, agreeing on a two-year action plan to launch (in 2009) a Common Energy Policy;
- **19 Sept. 2007**: "Third Liberalisation Package" to ensure completion of internal market for electricity and gas proposed by the Commission;
- **22 Nov. 2007**: Commission proposal on Strategic Energy Technology Plan (SET-Plan);

- **23 Jan. 2008**: Commission presented legislative proposals for carbon trading for the period after 2013, along with revised EU state aid rules and a communication on carbon capture and storage (CCS), as part of a larger package on renewable energies and climate change;
- **March 2008**: Commission hopes for endorsement (and financing commitments) from EU leaders for the SET-Plan;
- **By spring 2008**: Second Strategic European Energy Review;
- **2020**: Target date to achieve the objectives.

European Commission opened a wide-ranging debate on a future European energy policy with the publication of a Green Paper on Security of Energy Supply in March 2006.

The need to act at EU level was prompted by mounting concerns regarding high oil and gas prices and worries about Europe's increasing dependency on a few external suppliers, as well as the global-warming crisis.

Central to the summit of March 2007 agreement is a recognition that energy and climate-change policies should go hand in hand. It stressed the need for "decisive and immediate action" on climate-change and underlined "the vital importance of achieving the **strategic objective of limiting the global average temperature increase to not more than 2°C above pre-industrial levels**". To achieve this aim, EU leaders agreed to:

- a **binding target to slash the EU's greenhouse gas emissions by 20% in 2020** compared with 1990 levels. EU leaders agreed that the objective should be pursued "unilaterally" even if there is no international agreement on reducing greenhouse-gas emissions after 2012, when the Kyoto targets expire;
- a commitment to reduce emissions by 30%, provided that other industrialized nations, including the US, commit themselves to comparable emission reductions and that "advanced developing countries" (i.e.: China and India) contribute as well in the framework of a post-2012 agreement.
- To achieve these objectives, the summit endorsed an action plan to be implemented between 2007 and 2009. The plan's main elements include:
- Completing the internal market for electricity and gas;
- a binding target to raise the EU's share of renewables to **20 % by 2020**;
- an obligation for each member state to have **10% biofuels** in their transport fuel mix **by 2020**;
- boosting **energy efficiency** with a target to save **20 %** of the EU's total primary energy consumption **by 2020**. New initiatives here include proposals for an international agreement on energy-efficiency standards for consumer appliances;

- aiming towards "**a low CO_2 fossil fuel future**" with support for "clean coal" technology, using carbon capture and storage deep underground;
- developing a common **external energy policy** to "actively pursue Europe's interests" on the international scene with major supplier, consumer and transit countries, including Russia;
- developing a **European Strategic Energy Technology Plan** to focus R&D efforts on low carbon technologies, and;
- on **nuclear**, the Commission chose to take an "agnostic" stance, leaving it up to member states to decide; [5].

Developing a European energy policy is a long term challenge. This need a clear but flexible framework: clear in that it represents a common approach endorsed at the highest level, flexible in that it needs periodic updating.
The Strategic EU Energy Review would offer a clear European framework for national decisions on the energy mix. It should analyse all the advantages and drawbacks of different sources of energy, from indigenous renewable energy sources such as wind, biomass and bio-fuels, small hydro and energy efficiency to coal and nuclear, and the knock-on effects of these changes for the EU as a whole.
Coal and lignite, for example, presently account for around one-third of the EU electricity production: climate change means that this is only sustainable if accompanied by commercialized carbon sequestration and clean coal technologies on an EU level.
Effective action to address climate change is urgent and the EU must continue to lead by example and, above all, work towards the widest possible action. Europe needs to be ambitious and must act in a integrated manner that promotes own objectives; [1].
The EU is already at the forefront of approaches to decouple economic growth from increasing energy consumption. Its action has combined robust legislative initiatives and energy efficiency programs with encouragement to competitive and effective renewable energy. However, the EU's commitment to fighting climate change is a long-term one.
Action on renewables and energy efficiency, besides tackling climate change, will contribute to security of energy supply and help limit the EU's growing dependence on imported energy. It could also create many high-quality jobs in Europe and maintain Europe's technological leadership in a rapidly growing global sector; [1].
Moreover, the recent energy supply crises have highlighted Europe's growing dependency on external sources of energy. Energy policy security and climate change security have ceased to be abstract ideas. There are two sides of the some coin; [6].

An effective energy efficiency policy does not mean sacrificing comfort or convenience. Nor does it mean reducing competitiveness. In fact, an effective policy in this area means the opposite: making cost-effective investments in order to reduce the waste of energy, thereby increasing standards of living and saving money, and using price signals that would lead to more responsible, economic and rational use of energy. Market-based instruments can be very efficient tool in this respect. Energy efficiency means making more from less; [1]. In the world of global interdependence, energy policy in B&H, however, necessarily has a European dimension.

4. Hydro Power

Hydro power is a mature technology that has long been used for economic generation of electricity.
Global energy use has risen by 70 % since 1971 and continues to increase at the rate of about 2% per year, demand coming from both developed and developing countries. There are many scenarios for future demand and the energy mix that will be needed to meet this.

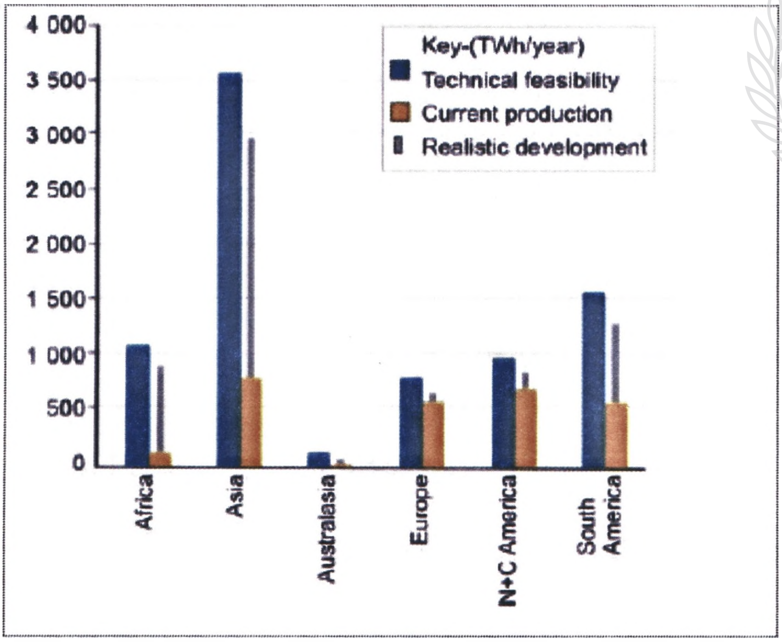

Figure 1 Estimated hydropower development by region
Source: International Hydropower Association

In 2005, renewable energy represented less than one-fifth of total power generation, [16]. Hydro power is the most advanced and flexible of the renewables and represents 87% of this type of energy production. During 2005 alone,

18GW of new hydro capacity was commissioned. Notwithstanding this, the entire renewables portfolio for heat, power and transportation offers an enormous potential. As far as hydro power resources are concerned, the International Hydro power Association estimates that only one-third of the realistic potential in the world has been developed (Fig. 1).
Hydro provides some level of power generation in 160 countries. Five countries make up more than half of the world's hydro power production: Brazil, Canada, China, Russia and the USA. If taking Europe as a benchmark (proportion of production in relation to realistic feasibility), hydro can be expected to see a ten-fold increase in Africa, a three-fold increase in Asia, a doubling in South America, and an increase of about 10% in North America. Just for North America, this would equate to an additional 16 GW of new capacity, of which 11 GW is already identified in Canada. While this expansion will be determined by the needs of the North American market, future development in many less-developed regions will rely more heavily on finding long-term funding mechanisms and appropriate partnerships, thus controlling the rate of progress.
Most of the early hydro power projects were built to provide a primary 'base load' to the power system and this pattern will continue in countries where hydro power occupies a significant share in the power generation mix. As other technologies have been introduced, hydro has tended to evolve into a supporting role - responding to gaps between supply and peak demand.
The challenge is to continuously improve hydro power technology in terms of environmental performance, materials, efficiency, operating range, and costs. From the smallest to the largest, all developments have a footprint, especially evident in the cumulative effect of many small schemes. Smaller-scale hydro plays an important role in remote areas, in community developments, and in maximizing the value of multi-purpose infrastructure - applicable in both developed and developing countries. Large schemes will continue to be the most environmentally benign in supporting grid systems and powering industrial and urban centers; [16].
The least-cost option for producers desiring additional capacity is almost always to modernize existing plants, when this is an option. Equipment with improved performance can be retrofitted, often to accommodate market demands for more flexible, peaking modes of operation. Most of the 807 GW of hydro equipment in operation today will need to be modernized by 2030. There are many recent cases of incremental hydro power, both where current capacity has been added to, and where existing infrastructure has been reworked, resulting in entirely new hydro power facilities.
Development of hydro has a long-term economic advantage. With annual operating costs being a tiny fraction of the initial capital cost, hydro's

autonomy from the fuel price is a distinct advantage. The flexibility of storage hydro (using reservoirs) also makes it a compelling partner to ensure security in mixed power systems. Another driver for hydro development is the increasing need for water management. Multi-purpose hydro reservoirs can bring security of water supply as well as power.

Storage hydro and, in regions where the quantity of water is limited, pumped storage can solve a plethora of system challenges. It can follow load fluctuations, so that fossil-fuel plants can continue to operate at their best efficiency. Wind power produces a variable and intermittent supply and hydro can provide the firming capacity to ensure both security and quality in the system. The characteristics of geothermal plant are well suited to base-load operation; hydro's flexibility can support it by meeting peaks in demand. Similar synergies with solar, bio-generation and marine power will develop as these technologies move into larger-scale deployment. In many regions where there is a diverse mix in the power system, storage hydro and pumped storage ensure total system security and maintain the quality of supply; [16].

Today, small-scale hydro power plants are generally accepted as renewable and sustainable sources of energy [13]. There are different classifications of small-scale plants (in B&H, it is generally accepted that they are plants up to 5 MW). Both large-scale and small-scale plants may be of different types. These are river plants, especially in cases when dams and reservoirs are primarily constructed for water supply and irrigation purposes. However, on small watercourses, mainly the run-of-river hydro power plants, which use relatively large heads with relatively small discharge, have been built.

Their advantages include: source renewability, lack of any adverse emissions and other types of pollution, "free" raw material and in certain cases the closeness of users. Disadvantages are the following: without dams and reservoirs, the electric power is produced according to the regime that varies, generally inversely proportionate to the size of the watercourse. If a really environmentally friendly small-scale hydro power plant is to be built, then the environmental flow must be satisfied - the guaranteed quantity of water that will always flow through the watercourse between the intake and turbine hall -which causes the additional significant reduction in exploitable flow, especially during dry periods. Run-of-river plants on small watercourses produce, "less valuable", "base" energy, due to impossibility to guarantee the delivery to the system, in accordance with the needs, since the run-of-river plants deliver electric energy depending on the quantity of water available. On the other hand, storage hydro power plants usually cover the "peak" part of their electricity needs, and due to uniquely large speed of putting into operation they are the only efficient way to maintain the voltage and frequency in the network during abrupt consumption changes. The price of generated kWh from a small-scale hydro power plant may be defined by law. (That is generally the case in B&H as well, due to the political orientation to promote this type of production). Still, the utilization value of such kWh is smaller than for the one from thermal power plant, and that value is even smaller than the value of kWh of the storage or pumped storage hydro power plants, which may store energy for the shortage periods.

Scattering of a larger number of small-scale hydro power plants in relatively inaccessible areas, may be a strategic advantage in crisis situations, but also a major disadvantage in an ordered and regulated electric power system, due to large costs of transmission lines and voltage transformation, as well as access roads.

Due to savings in designing, construction and assemblage, the exploitation coefficients are smaller than with large-scale hydro power plants ("off-shelf" turbines that are close to optimum ones are used, while with large power plants they are optimized for each individual scheme). Shortly, the price per installed kW is still double in comparison to the large-scale hydro power plants, and it ranges from $ 2000 to 5000, and even $ 8000 in the world. It has almost the same disadvantage as the large-scale power plants, and even most of the renewable sources, which is large initial investment, and this means that it is necessary to wait usually about 10 or even more years for the power plant to pay off and become profitable.

In order to replace production of one medium-scale hydro power plant of let's say 100 MW, it would be necessary to build approximately 100 small-scale hydro power plants in the same number of locations, and make transmission lines from all these locations to the electric power system, maintain equipment (200 small power generators) and guard the structures, and change the flow regime at length of approximately 200 km of small watercourses. If we presume that there will be equal production in GWh, large-scale hydro power plants still may have several times larger capacity to fulfill the needs of power system, in terms of daily and seasonal differences in demand.

However, the advantages of small-scale hydro power plants often still prevail over other alternative sources, and their development will continue with large intensity, which will lead to additional decrease in prices per unit of production. The positive role of small-scale hydro power plants in the future is very important and certainly unquestionable, but they cannot replace the conventional hydro power plants with reservoirs; [13].

In terms of climate change, hydro power tends to have a very low greenhouse gas footprint. As water carries carbon in the natural cycle, scientists have investigated the extent to which a new reservoir might accelerate carbon emissions. In some very shallow tropical reservoirs, this may be the case, and the factor would need to be taken into consideration in the life-cycle analysis of such schemes. In contrast, many reservoirs around the world have been monitored to test their emissions, confirming that hydro power is one of the cleanest methods of power generation; [16].

Today we can also hear the ideas that hydro power which uses water reservoirs is not renewable. It is true that reservoirs have their lifetime and in some cases, this lifetime was overestimated. Filling up of reservoirs does not reduce the natural hydro power potential, but only the flexibility in hydro power plant's operation. The total volume of water is still the same, which can, at the same overall head, produce the same amount of energy; [13].

Population growth in emerging markets is both a driver and a constraint. The demand for land and water resources increases with population growth. However, water management is key to sustainable development. Many future projects will be multi-purpose, climate-mitigation structures, for drought protection and flood mitigation, in addition to power generation. By storing water, freshwater reservoirs increase water security; by maintaining reserve storage capacity, reservoirs can absorb peak flows during flood events; and, by employing hydro power generation in place of fossil-fuel technologies, a significant offset of greenhouse gas emissions can be achieved.

Finding the right balance is fundamental. Sustainability criteria demand that economic decisions incorporate environmental stewardship and social justice.

Sustainability assessment is applicable to both existing schemes and new developments. Europe and North America tend to have the most advanced regulatory frameworks. While comprehensive assessment is necessary, much superfluous bureaucracy is created in the development of new projects and the periodic re-licensing of existing installations. The high administration costs are a significant burden, especially for smaller companies and smaller countries. In Europe, both the Water Framework and Emissions Trading Directives are in need of clarification regarding hydro power. For the transition countries and the developing world, regulations relating to the Kyoto mechanisms need to be better understood. In addition, financial institutions must standardize their policies to avoid unnecessary duplication and inefficiency; [16].

Many economically feasible hydro power projects are financially challenged. High up-front costs are a deterrent for investment. Also, hydro tends to have lengthy lead times for planning, permitting, and construction. When life-cycle costs are examined, however, hydro often has the best performance, with operating costs being low in comparison with the capital investment. The development of more appropriate financing models is a major challenge for the hydro sector, as is finding the optimum roles for the public and private sectors.

The main challenges relate to creating investor confidence in hydro power and reducing risk. Green markets and trading in emissions reductions will

undoubtedly provide incentives in some areas. In developing markets, interconnection between countries and the formation of power pools will build investor confidence. Feasibility and impact assessments carried out by the public sector, prior to tenders from the developers, will ensure greater private-sector interest in future projects.
Unfortunately, investment often only materializes when the need becomes urgent - when the lights go out. Unless policymakers are better informed, much of the investment will be targeted at quick-fix solutions. The avoidance of such unsustainable development is a major challenge; [16].

5. Large Dams and Environmental Protection

Worldwide, many countries rely on hydro power for a substantial portion of their electricity. In developing countries, rapid urbanization and continued population growth will ensure increased demand for electric power for decades. Thus, energy planers are likely to continue seeing hydroelectric projects as a promising resource. With large dams continuing to be developed, it is important to find sites that minimize environmental effects.
In the world (but here as well), we are very often witnesses to large media and public campaigns against hydro power plants with reservoirs, which go that far to say that hydro power plants are the enemy no. 1 to environment. It is also interesting to observe that not even closely the same level of attention is given to unheard-of production of plastic bags, bottles and other indestructible throwaway packaging, which, in case of B&H, largely ends up on the banks of rivers and reservoirs.
From an environmental standpoint, all large dams are not alike. The site largely determines the amount of possible environmental damage from a proposed project. While dams at good sites can be environmentally very friendly, those at unfavorable sites often will be problematic, even if all available mitigation measures are properly implemented. Examples of adverse environmental effects that cannot be fully mitigated include:

- Irreversible biodiversity loss, if critical natural habitats not occurring elsewhere are submerged or left dry;
- The pre-dam ecological balance of a river, in terms of species composition or fish migrations, cannot be fully restored with fish ladders facilities; and
- Some cultural property (including sacred sites) cannot be adequately salvaged before reservoir inundation.

Furthermore, ideal mitigation measures may not be carried out due to limited budgets, tight construction schedules, conflicting priorities, and/or weak implementing agencies.

Thus, the single most important environmental mitigation measure for a new hydro project is good site selection, to help ensure the proposed dam will be relatively benign.
Possible adverse environmental and related social effects of large dams and reservoirs are [14], [15]:

- Loss of natural habitats and wildlife;
- Involuntary displacement of people;
- Water quality deterioration;
- Hydrological changes downstream;
- Water-related diseases;
- Damage to fish species and other aquatic life;
- Floating aquatic weed proliferation;
- Loss of cultural property;
- Greenhouse gas emissions;
- Salt water intrusion;
- Effects of complementary works (access roads, transmission lines, quarries and borrow pits);
- Effects of induced development (irrigation, urban, industrial, more dams, if flow regulation from one dam makes others on that river more economical).

While some effects occur only during construction, the most important effects usually are due to the long-term existence and operation of the dam and reservoir.
Worldwide, the proportion of sites available for hydroelectric generation that have been developed is roughly 15 %. This means that many developing countries have numerous, and varied, choices for hydro project sites; [15].
Large hydroelectric projects typically are connected to a national or regional power grid. Thus, government or private sector planers have the opportunity to identify those sites that would be the least damaging from an environmental standpoint, especially in relation to the amount of electric power or other economic benefits generated.

6. B&H Challenges

6.1. Environmental aspects of hydro power in B&H

The most common argument given by those who strongly oppose the construction of (new) hydro power plants is that the developed "West" has realized how much the hydro power plants are "bad" and that is why today it is impossible to build even one hydro power plant there. For most of the highly developed countries it is true that there will be no new hydro power schemes. Why? Primarily since all hydro power plants that could be built have already been built a long time ago. We can look at the Table 1 which presents an overview of hydro power potential in selected countries and how much this potential has been used (the most developed European countries have been selected, which have either significant or large share of hydro power in power system, as well as several countries outside of Europe, or those to which hydro power is the most important source in the power system); [13].

	Gross potential (TWh/year)	Technically usable (TWh/year)	Economically usable (TWh/year)	Installed (TWh/year)	Degree of potential utilization (%)	Share of hydro power in the power system (%)
Germany	120	25	20	24.8	124.0	4.0
Latvia	7.2	4	3.9	4.3	110.3	75.3
France	200	72	71.5	72	100.7	15.0
Switzerland	144	41	35.5	34.5	97.2	56.0
Belgium	0.6	0.45	0.4	0.385	96.3	0.5
Italy	150	69	54	51.6	95.6	19.5
Ukraine	45	23.5	19	15.9	83,7	9.2
Japan	717.6	135.5	114.3	95.6	83.6	9.0
Albania	40	15	6.4	5.3	82.8	98
USA	4485	528	376	309	82.2	9.0
Slovakia	10	6.6	6	4.75	79.2	17.5
Ireland	1.4	1.18	0.95	0.725	76.3	5.0
Sweden	200	130	90	68.3	75,9	47.7
Paraguay	111	85	68	51.3	75.4	99.5
Austria	150	54	53.7	37.5	69.8	65.0
Canada	1332	981	536	350	65,3	61.3
Norway	560	200	180	116.5	64.7	99.4
Finland	46.5	20	19.7	12.2	61.9	19.0
Slovenia	12.5	8.8	6.1	3.7	60.7	29.6
Croatia	20	12	10.5	6.1	58.1	46
Serbia and Montenegro	?	27	27	12	44.4	32.0
B&H	68.6	24	22	8.9	40.5	48
Europe	3220	1225	775	567	73.2	

Table 1 Share of hydro power in selected countries

It is interesting to see that France, Germany, Italy and Switzerland are at the top of the table (Latvia and Belgium are less interesting in this sense, due to small number of water resources). Germany and France have built the plants

by which they use almost entire technically usable potential, exceeding the amount that was assessed as cost-efficient.
If we analyze other developed countries as well, we will see the correlation between the level of economic development (standards) and utilization of hydro potential. B&H is at the bottom of the European list with utilization of only 55% of the average potential utilized in other European countries. It is even slightly behind all other neighboring countries, although it has significantly larger potential.
It is interesting that one such a large country like Brazil, can satisfy over 95% of its electricity needs from hydro power plants. Norway practically produces all its energy in hydro power plants. The orientation of these countries is obviously to rely primarily on hydro energy in the future as well. One more interesting thing is that the Alpine, record-large dams are a type of tourist attraction in Switzerland, and that the Swiss people are very proud of them. Economically speaking, in countries with appropriate natural resources, hydro power plants had a decisive development role [13].
Today however, the approach to planning, construction and management of reservoirs must be drastically changed, as it indeed has started to change, but somewhat too slow. Namely, today we are aware of many environmental disadvantages of large hydro power plants, about which we learned from numerous examples in the past. Large dam is not an end in itself, but it represents a way to achieve optimum use of water resources (flood control, creation of water reservoirs for dry periods, water supply, irrigation, navigation, fish-farming, recreation and, of course, electricity production). Reservoirs are one of the basic tools for solving of water management problems in every basin. In this matter, it is important that they can be used for all of the above mentioned purposes, which are applicable under the conditions given.
Approximately 45,000 large dams have been registered in the world today. Most of these dams have been successfully implemented, but some problems have also occurred that may be put into categories from "environmental problems" to "failures" (loss of function) and even "disasters". 142 "failure" cases have been registered [13], including one of our local dams - Idbar, downstream from Konjic, which has not been torn down, but it has also never started to operate due to instability of its right wing (since the adequate bottom outlet has not been foreseen, during the reservoir testing, water from the reservoir had to be released through the opening made by explosive).
When talking about failures, the most frequent concern is related to tearing down of dams. The largest enemy of dams is water, and the most common reason why dams are torn down is inadequate sizing of overflows and operational problems with them (34 %), problems with foundation engineering and stability of slopes (30 %) and inadequate infiltration regime through the

foundations (20 %). One of these three reasons is responsible for 84% of damages, while the remaining 16 % is caused by other problems; [13]. It is interesting that the significant problems caused by seismicity, or earthquakes, have been registered only with two dams in the world, but one of them did not suffer any significant damage. Still, the most common concern of the public, when dams are in question, is related to the danger of earthquakes.
The significant reason for "animosity" of the public toward the hydro power plants may also be the feeling that they are somebody else's property, and that the others (minority) benefit from, while the majority (at least of local population) is damaged by them, what unfortunately often has been truth. Absolutely nothing has been done in B&H on raising of public awareness and promotion. The access to these structures was (and still is) forbidden, as well as taking of photos, therefore the people see them as imposed and undesirable foreign body. In all EU states, the practice is exactly the opposite. Hydro power plants are open for the public, local and foreign tourists etc. Large boards have been placed, which present all more important data and interesting facts about the plant, the brochures and souvenirs may be bought, and all tourists may take as many photos as they want. In addition, by presentation of important facts, the awareness of the people is raised, and they realize that the electricity without hydro power plants would be more expensive, and cuts in electricity supply more frequent. In this way, people no longer have fear of the unknown, and they understand that they personally benefit from these plants, and they start to see them as "their own"; [13].
One of the more important arguments of those who are against construction of new hydro energy schemes, is that B&H has a "surplus" of energy, since it "exports" electricity, and new hydro power plants are therefore not necessary. It should be right away emphasized that B&H has a "shortage" of energy, since it imports oil and gas, which must be paid by something, and the electricity "surplus" largely exists because of heavy losses inflicted on industrial production. Such situation may not last for long and the electricity needs in B&H will certainly grow. In addition, we should bear in mind that B&H has deficits in foreign trade in almost all fields, and that „surplus" in one field (electricity in this case) can certainly not be considered as unnecessary! In the trade-economy equation, there must be a "surplus" somewhere, which can cover the numerous "shortages".
As it has already been mentioned earlier, the main problem in acceptance of hydro power plants are large dams and reservoirs that they make. From the aspect of environmental protection, the most important fact is that, no matter for how long they last, the dams are not everlasting, and hence there is the issue of sustainability. In the eyes of the public, the largest problems are the loss of quality of water in the reservoirs so as loss of natural water sources,

loss of land and landscapes. If all main negative impacts of reservoirs are simplified, they come down to the size of artificial lakes, in other words the area and storage capacity taken by them.

No.	Name	Watercourse	Basin	Storage capacity 10^6 m^3	Area (ha)	Purpose
Black Sea Basin (Sava River Basin)						
1.	Jajce II	Vrbas	Vrbas	3.5	47	E
2.	Bočac	Vrbas	Vrbas	52.7	233	E
3.	Modrac	Spreča	Bosna	88	1675	WS,C,O
4.	Snježnica	Rastošnica	Bosna	20.6	103	WS
5.	Bajina Bašta	Drina	Drina	355	1030	E,C,WS,O
6.	Zvornik	Drina	Drina	89	1380	E
7.	Višegrad	Drina	Drina	161	890	E
8.	Hazna	Hazna	Adjoining the Sava Basin	0.7	12	C,R
9.	Vidara	Vidara	Adjoining the Sava Basin	2.9	46	C,WS
10.	Drenova	Vijaka	Adjoining the Sava Basin	9.5	132	C,WS,O
Sava Basin				762.90	5548	
Adriatic Sea Basin						
1.	Jablanica	Neretva	Neretva	318.0	1440	E,C,I,O
2.	Grabovica	Neretva	Neretva	21.1	134	E
3.	Salakovac	Neretva	Neretva	68.1	370	E
4.	Mostar	Neretva	Neretva	10.9	161	E
5.	Rama	Rama	Neretva	487	1550	E,C,I,O
6.	Svitava	Krupa	Trebišnjica	44	1000	E,C
7.	Tribistovo	Ružički stream	Trebišnjica	5.0	70	WS
8.	Klinje	Mušnica	Trebišnjica	1.7	26	I,WS
9.	Alagovac	Alagovac	Neretva	3.6	70	WS
10.	Vrba	Vrba	Trebišnjica	14.6	77	WS
11.	Bileća	Trebišnjica	Trebišnjica	1280	2764	E,C,I,O
12.	Gorica	Trebišnjica	Trebišnjica	15.0	171	E
13.	Popovo polje	Trebišnjica	Trebišnjica	5.4	86	E,WS,I
14.	Mandak	Mandak	Cetina	1.8	35	K,WS,I
15.	Lipa	Brda-Lipa	Cetina	2.3	230	E,WS,I
16.	Buško Blato	Ričina	Cetina	800	5670	E,WS,I
Adriatic Sea Basin				3078.5	13854	
TOTAL (both basins)				3841.4	19402	

Index: C - Flood control; I - Irrigation; O - rising the level of low water
E - Energy; WS- Water supply; R - Recreation

Table 2. Overview of artificial lakes in B&H

In addition to the above mentioned existing reservoirs, different water management plans have foreseen 35 additional reservoirs with the storage capacity of 3.473 x 10^6 m^3 and area of 14.340 ha. These include 24 artificial lakes/reservoirs in the Black Sea Basin (ΣV= 2.352 x 10^6 m^3, ΣP = 10.070 ha), and 11 in the Adriatic Sea Basin (ΣV= 1.120 x 10^6 m^3, ΣP = 4.267 ha); [14].

Most of these planned reservoirs will be used, among other things, for electricity production. In certain cases, some land areas and parts of watercourses with special residential, agricultural, landscape, ecological and other values would be covered by water. Almost all planning documentation based on which these reservoirs have been defined, is more than 20 years old. In the meantime, many criteria and conceptions have significantly changed, and it would therefore be for the best to first make new water management plans (better to say River Basin Management Plans, in compliance with the EU Water Framework Directive), new studies regarding the usability of parts of watercourses that have not been used yet, new spatial plans, and the like, in order for the most favorable sustainable solution to be defined, taking into account all available data, standards and criteria, as well as the facts known today; [13].

As it is no longer acceptable to build too large reservoirs, it is also hardly acceptable to cover entire watercourses with water and turn them into lake steps. Although other human or tourist activities, such as rafting for example, cannot in economic terms be competitive to electricity production at the same river reach, this does not mean that the entire river should be covered with water, and in that way the possibility to practice rafting eliminated. On the other hand, this should not mean that nothing can be built, since, as we saw, there will be the shortage in electricity, and alternatives to hydro power plants are mainly more expensive, dirtier and less flexible.

Through development of new planning documentation, taking into account all interests (not to build anything may not be anybody's serious interest), the solutions acceptable for all could be found. If realization of projects for a long period of time would continue to prolong, it might come to the point that there will be no one on the B&H side to implement them, nor will there be anyone to implement them for.

In both B&H entities, the environmental laws have been passed, which are harmonized with the EU standards, and which prescribe the obligation to develop the Environmental Impact Study, for hydro power plants as well (including the existing ones). Such studies must identify the problems, establish the environmental management measures and monitoring, as well as measures for mitigation and compensation.

For example, expropriation compensations would have to be acceptable for inhabitants that have to move. This does not mean only financially acceptable, but also socially acceptable, through compensation of lost land, employment and the like. In addition, the common "minimum flow" (the quantity of water that must be released in order to supply other users, including environment as one of the key users, previously usually neglected), will have to be redefined as "environmental flow", which will certainly be larger than the one from pre-

vious practice, whose release causes the decrease in production of electricity. Aiming at preservation of acceptable water quality, we will have to implement adequate measures. Further on, structures such as artificial spawning sites, fish ladders, selective intakes, discharges of turbid currents, compensation tanks etc. will become the common structures within new hydro power plants.
All this implies additional costs and reduction of profit, with aim to preserve existing (pre-dam) environmental conditions, what was largely neglected in the past; [14]. As a result, aiming at environmental sustainability, costs of construction will be larger, and the impact on cost-efficiency of such schemes might cause delay in the realization of some of these schemes for the time when, after other energy sources become more expensive, they will again be acceptable.
The activities of non-governmental organizations in B&H, which are on average against building of new reservoirs, sometimes have such unpleasant formulations like "there is no common sense in that", they are "monstrous, or half-crazy, or crime plans, crumbs of projects worth millions" and those who support the construction are called "yes-men of energy lobby" etc. However, in one serious brochure [9], recently promoted in the Academy of Arts and Sciences of B&H, the "Greens" say: "It is very important for the movement against construction of dams not to become so radical to develop into a movement which is against construction of any dam. It is in the first place necessary to request the transparency of the project, involvement of all interested parties during the entire process, from the planning to designing phase, and possibility to directly give recommendations for improvement and correction of designs, where that is possible. In cases when the project may cause maximum negative impacts on people and environment, project abandonment should be requested".
The developed countries have constructed their hydro power plants during the period when they did not have to fulfill even much less strict environmental management conditions. Countries in development will construct their plants in future, under much stricter conditions.
Unused natural resources cannot pull us out of poverty. Only through improved, rational and sustainable management, natural resources in B&H can gain value, which is B&H' only chance toward sustainable development.

6.2. Hydro Power Situation in B&H

Use of hydro energy potential in B&H started in 1895, when first hydro power plant was constructed on the Pliva River, with installed capacity of 7 MW, which was at the time the largest in Europe. Until 1917, several hydro power plants were built: "Plava voda" (Blue Water) /Travnik, "Kanal-Una" (Una

Channel)/Bihać, "Krušnica"/Bosanska Krupa and "Hrid"/Sarajevo, which, together with smaller thermal power plants, satisfied the electricity needs at that time. In the period between two world wars, until 1939, small-scale hydro power plants "Fojnica", "Ljuta", "Bugojno" and others were built, 16 small-scale hydro power plants in total, with total installed capacity of 10.7 MW and production of 48 GWh. More intensive construction started after the World War II. The dynamics was different, depending on the possibilities and consumption growth.

Hydro power situation in B&H today is shown in Table 3; [4].

Federation of B&H - existing hydro power plants		
Elektroprivreda B&H [1]		
Name	HPP Power House output (MW)	Expected annual production (GWh)
Jablanica	175	771
Grabovica	114	334
Salakovac	207	410
Small scale HPP B&H	13	65
Total EP B&H	509	1580
Elektroprivreda HZHB		
Čapljina	400	200
Rama	159.4	650
Mostar	71.6	247
Jajce I	58	233
Jajce II	28	157
Peć Mlini	30	82
Total EP HZHB	747	1569
Total F BiH	1256	3149
Elektroprivreda RS - existing hydro power plants		
Višegrad	315	1038
Bočac	110	307.5
Trebinje I	180	535.4
Trebinje II	7.6	12.5
Dubrovnik I (50%)	108	695.6
Small-scale and industrial hydro power plants	14.1	72
Total EP RS	734.7	2660.9
Total B&H	1990.7	5809.9

Table 3 Overview of the existing hydro power plants (HPP) in B&H

[1] Currently in B&H power sector there are three major producers and distributors of electricity, public utilities - Elektroprivredas (EPs): Elektroprivreda B&H (EP B&H), Elektroprivreda HZHB (EP HZHB) and Elektroprivreda RS (EP RS). Each EP has its own generation and distribution facilities and is in charge of generation, distribution and supply on its territory.

Name	HPP Power House output (MW)	Expected production (GWh/year)	Specific investment EUR/kW	Construction duration (year)	Earliest year of commissioning
Federation of B&H					
Elektroprivreda B&H					
Small-scale HPP EP B&H	34.2	126.6	1493	2	2009
Unac	71	250	963	3	2012
Ustikolina	59	255	1396	4	2013
Vranduk	22	103.2	2111	4	2013
Glavatičevo	171.8	295	1048	5	2014
Bjelimići	100	306.4	1660	5	2016
Vrhpolje	68	157.4	1562	4	2016
Čaplje	7.7	56.8	2845	4	2016
Konjic	121	290	1074	5	2016
Total EP B&H	654.7	1840.4			
Elektroprivreda HZ HB					
Mostarsko Blato*	60	167	1200	4	2010
PHPP Vrilo	52	92	1149	5	2011
PHPP Kablić	52	73	1437	5	2012
Han Skela	8.5	36	1500	5	2015
Vrletna Kosa	25	63	1500	5	2013
Jajce II -extensión of HPP Ugar Mouth	15	60	1500	5	2014
Small-scale HPP HZ HB Basin T-M-T	19.9	127.7	1881	2	2010
Lištica Basin	7	27.7	1832	2	2011
Gornja Cetina Basin	12.7	30.7	1650	2	2015
Total EP HZ HB	252.1	677.1			
Total F BiH	906.8	2517.5			
Elektroprivreda RS					
Small-scale HPP on the territory of RS	212	650	1750	2	2009
Buk Bijela	132	450	2121	4.5	2013
Foča	56	199	1512	4	2012
Dabar	160	271	1049	4.5	2013
Bileća	36	117	1417	3.5	2013
Dubrovnik II	152	159	1153	4	2015
Nevesinje	60	101	2027	5	2013
Krupa	49	140	1528	5	2015
Banja Luka low	37	187	2316	5	2019
Novoselija	16	70	1559	2.5	2019
Ključ	49	2011	2998	4	2019
Total EP RS	958	2555			
TOTAL B&H	1865	5072			

* under construction

Table 4 Hydro power plant candidates in B&H

Average annual precipitation on the territory of B&H is 64 km³, of which 59% runs down the watercourses, or 38 km^3. Behind 26 dams (5 rock- and earth-fil-

led dams, 20 concrete dams and one constructed from blocks), are reservoirs with total storage capacity of 3,85 km^3, or approximately 10% of total runoff volume.
With its hydro energy potential, B&H is at eleventh position in Europe (without the European part of Russia, behind Norway, Sweden, France, Italy, Austria, Island, Spain, Switzerland, Serbia and Montenegro), and in front of Germany, Portugal, Finland and Ukraine, which have similar potential. A large part of other European countries has much smaller potential than B&H.
The annual electricity consumption in B&H has decreased from 13.8 TWh (1991) to approximately 11 TWh in 2000. The share of production from hydro and thermal sources is approximately equal today, while in the period before the war the share of hydro energy varied from 25 to 40%. Approximately 10% of produced electricity is exported to neighbouring countries, whose needs for import are approximately 4 times larger than that.
The total capacity of pump-reversible plants is 660 MW. The total capacity of hydro power plants in B&H, if entire potential would be used, could be between 5600 and 6800 MW. Usable hydro potential is estimated to 22 TWh per year, and the potential used today is approximately 40%.
The Table 4 shows hydro power plant candidates in B&H, according to the existing plans of Power Companies (Elektroprivredas) in B&H [4].
Unused potential for small-scale hydro power plants is approximately 2.500 GWh per year. Studies from the period 2000-2002, identified approximately 140 small-scale plants from 1 to 5 MW. By the Law from 2002, the state guarantees the price of kWh from small-scale hydro power plants (with capacity up to 5 MW) in the amount of 7.74 pfenings, which creates conditions for implementation of plans on construction of approximately 10 new small-scale hydro power plants every year.
In addition to public Power Companies (Elektroprivredas), new projects will be managed by several other, private companies from both entities, as well as foreign concessionaires. For some reason, the larger part of them is not willing to give even basic data about plants in operation, therefore, during a short research period it was not possible to get the updated picture of current situation. It would be useful to see what is the situation like for the entire B&H, and there is not obvious reason why this data should be (treated like) a secret. Such practice reminds of the common (unnecessary) secrecy associated with large projects before the war, which partially lead to an aversion of a large part of the general public toward hydro power plants. If such practice continues with small-scale hydro power plants, can soon be expected similar reaction of the public towards them, since, as it can be seen, they are not completely friendly to environment. Naturally, issues will be raised that, if the data is kept a secret, something must be wrong with it!

6.3. Accents from Medium Term Development Strategy 2004-2007 for Energy Sector

The major goals of the energy sector reform are:
1. Stimulate national and international investment;
2. Ensure a more reliable supply of energy, at lowest prices;
3. Join the international market through a single market of electric power and gas in B&H;
4. Enhance cost-effectiveness and rational use of energy sources and improve energy efficiency;
5. Implement liberalization and introduce competition and transparency;
6. Ensure protection of environment in accordance with national and international standards;
7. Protect interest of the system users;
8. Increase the use of renewable energy sources;
9. Meet the conditions of the European Energy Charter Agreement, as well as other international contracts and agreements.

(Just to remember)

7. Conclusion and Recommendations

7.1. Conclusions

- Energy needs in the world, and in the region, including B&H, will grow during the forthcoming 50 years;
- In the foreseeable future, it is realistic to expect constant rising of prices, and then final exhaustion of fossil fuel resources, which are largest environmental polluters;
- Alternative energy sources, toward which we aspire, will not be able to replace the conventional sources during the forthcoming 50 years;
- Small-scale hydro power plants, as generally accepted as sustainable and renewable energy sources, will play a very important role in the power system, especially in the distanced areas, close to isolated users. Nonetheless, it is not realistic to expect, even with full use of their potential, that they could supersede or replace their large "cousins";
- The developed countries, whose standard is considered to be a model toward which all other countries aspire (e.g. USA, Japan, Switzerland, Austria, Italy, Germany, France, Norway, or Sweden) have entirely, or almost entirely used their available hydro potentials;
- The utilization of hydro potential in B&H is at the bottom of the European list, including the neighbouring countries, which, due to deficits in the

available resources, present potential market for possible surplus in electricity production in B&H. Production of electricity is one of rare economic fields in which B&H will still be able, for certain period of time, to produce “surplus”;

- Hydro energy, although not being ideal as it was considered 20-30 years ago, will remain one of the most important sources for electricity production and not as much because of quantity as because of the quality that lies in the simple flexibility during satisfaction of peak needs;
- New hydro power plants will have to be built in environmentally friendly manner, for which there is the know-how, as well as legislation. The existing hydro power plants will also gradually have to satisfy the newly set environmental criteria;
- There is a clear correlation between the development of a certain country, and level of utilization of its hydro potential and management of other natural resources. Accordingly, B&H can be pulled out of poverty through improvements in management of water and other natural resources.

7.2. Recommendations

- Promotion of importance of hydro power plants, their opening for the public, and fair dissemination of information about positive as well as negative aspects of their operation, is not only desirable but indispensable for development of new hydro power schemes. Without this development, we would all loose an important component of modern life - we would have to get used to frequent power shortages, and even more frequent power cuts, due to breakdowns in parts of the network;
- It is especially necessary to conduct an environmentally concerned review of conceptual designs for hydro power utilization of parts of basins, in cases where there is a large opposition of the public (e.g. „Gornja Neretva" (Upper Neretva), „Gornji horizonti" (Upper Horizons) Trebišnjice, gornja Drina (Upper Drina), Banja Luka and others). This would imply development of new studies in accordance with the environmentally sustainable principles, paying special attention to all stakeholders and providing public consultations. In this way, it would be possible to find solutions that could, although they do not have optimum level of energy usability, satisfy all stakeholders, which would put an end to the stalemate, and create preconditions for real environmentally sustainable development.

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THERMO-ENERGY POTENTIAL OF BOSNIA AND HERZEGOVINA - TODAY AND PROJECTIONS FOR THE FUTURE

Prof. dr. sci. Zdravko N. Milovanović and Prof. dr. sci. Izet Smajević

Brief resume of the works

Thermal power capacity of Bosnia and Herzegovina is based on significant domestic sources of primary energy. Bosnia and Herzegovina with its small area is emboded with important amounts of lignite and brown coal reserves. All forecasts estimate that exploatable reserves of coal in BiH present reliable base for planning of electricity production from coal according to current rate of 65%:35% to the other resaurces - at least for the next 50 years, taking into account also expected grow of electricity consumption in BiH of 4% per year. Coalmining in BiH dated from end of 19 Sentury, and the full development reached at the end of eighties of last sentury. The most important reserves of coal are located in so called coal basens: Tuzla (coalmines: Kreka, Banovici, Djurdjevik and Ugljevik), Srednja Bosna (coalmines: Kakanj, Breza, Zenica and Bila), Bugojno (coal mine Gračanica), Livno-Duvno (coal mine Tušnica), Gacko (coal mine Gacko), Miljevina (coal mine Miljevina) and Doboj-Banja Luka (coal mine Stanari). There are some minor geological reserves on other locations, but they haven't been properly explored (Ramići, Lješljani, Mesići, Čelinac-Kotor Varoš, Bukovac-Bušletić near Doboja, Mrkonjić Grad-Šipovo, Ozren-valley of Spreča, Majevica-mineral coal and other). Coal will keep its leading role as basic fuel for electricity generation in the next 20 years, not only in Bosnia i Herzegovina but also in the World. Bosna i Hercegovina posseses important reserves of coal, and preciase amounts must be identified by additional investigations on coalmines. Existing technology in thermal power plants in Bosnia and Herzegovina is to be modernized, which is particularly important for new coal-based power plants to be constructed. Thus, clean coal technologies must be applied, and adopted to the specific domestic coal combustion behaviours. At this, particular attention should be focussed to the environmental issue.

Key words: *thermal power capacity, coal reserves, degree of exploration, qualitative characteristics, water supply, stag and ash disposal, environment protection*

Prof. dr. sci. Zdravko N. Milovanović
University in Banja Luka, B&H

Prof. dr. sci. Izet Smajević
University of Sarajevo;
Public Electric Utility Elektroprivreda B&H d.d.-Sarajevo, B&H

1. Introduction

Thermal power capacity (TPC) includes the sources of primary energy that can be transformed into secondary and useful energy sources (heat, mechanical and electrical power) by energetic-technological processes that are technically possible and financially justified. Among other, these are energetic processes in thermal power plants, nuclear power plants, thermal power plants - heating plants, industrial power plants, heating plants and other plants and engines for direct and indirect transformation of primary into other forms of energy. Needs for electricity are increased in the World, at least for two reasons: grow of enhabitants and requirements for growth of GPD. Consequently, growth of needs for electricity is faster than growth of inhabitants, Figure 1.

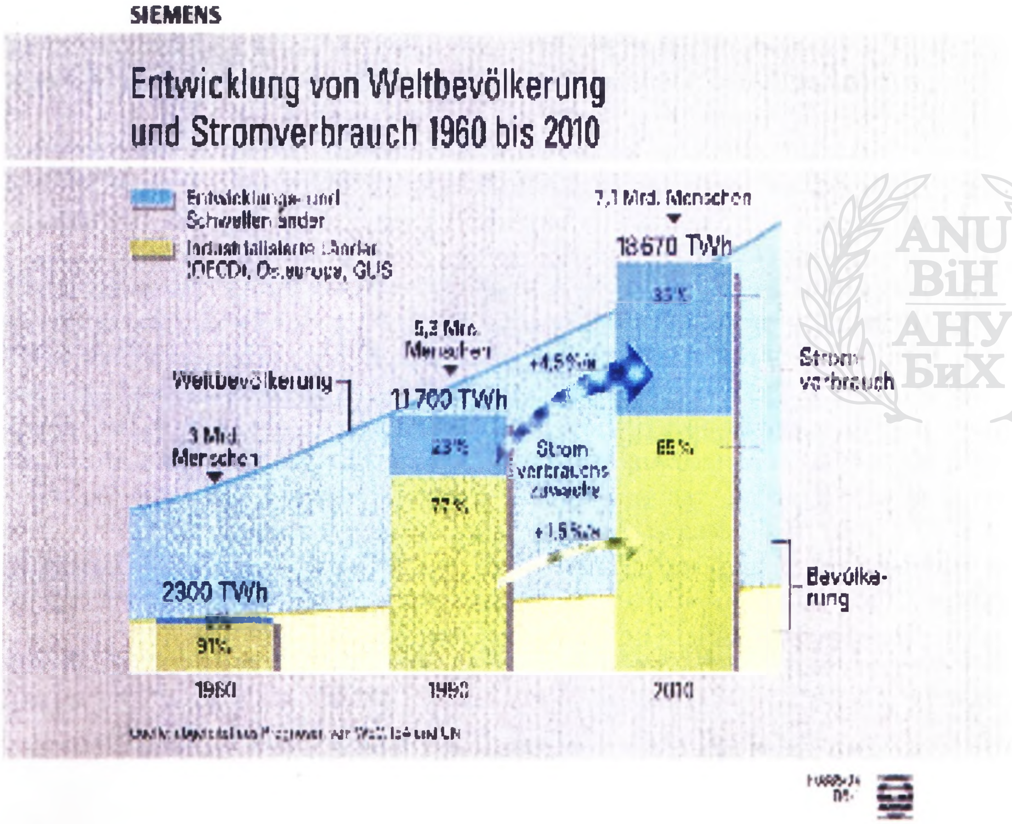


Figure 1. Global increase of needs for electricity

It is evident that fulfilling those needs requires building of new energy capacities, Figure 2. In the case of fossil fuels based power plants, the reserves of fossils are being exhausted, accompanied by emissions of sulphur and nitrogen oxides, as well as carbon dioxide as the most influent green house gas. Bosnia and Herzegovina has no documented reserves of oil and natural gas. Minor reserves of uranium have been discovered, which could be used as possible fuel in nuclear thermal power processes. The available sources of primary energy as basis of TPC are being used for production of electric power, technological steam and electric power in industrial power plants and for production of heat energy in heating plants and households. For this reason, significant reserves of unconventional sources of primary energy should be added to the coal reserves, such as: energetic wood and other biomasses, geo-thermal energy, solar energy and wind energy. It is necessary to emphasize the importance of rational exploitation of biomasses from forestry and agriculture, which will present important parts of the economy in the future development of Bosnia and Herzegovina.

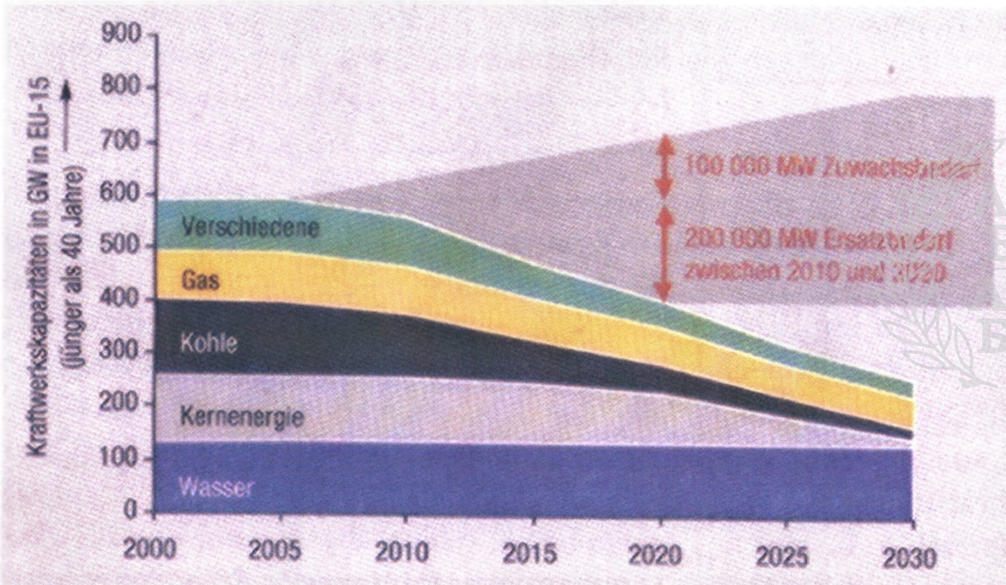


Figure 2. Till 2020 new 300 GW of new electricity capacities are required in EU 15, [1]

From all fossils, Bosna and Hercegovina posseses important reserves of coal. Coal is the most embedded fosils in the World, and it is important that large reserves of coal in the World lay in the no politicly risky regions. In comparison to other fosils; gas and oil, it results in more convenient and a stable price of coal, Figure 3. For that reason, the most part of electricity in the world today is produced on the base of coal.

From 1990., share of coal in total electricity generation is 39%, and all forecasts show that coal will keep this role for the next 20 years, Figure 4. Share of coal in total electricty generation in some countries of EU is much larger (Germany, Poland, ...), and also in Bosnia and Herzegovina.

Sustainability indicators of existing Bosnian coal-based power plants, namely time and energy availability, efficiency, reliability as well as environmental issue, are far behind of that in developed countries, [3, 4]. The main reason is oldness of the power plant equipment, and bed combustion process inside the pulverised coal fired boilers. Generally, coal fired in Bosnian thermal power plants are low-valuable domestic coal types with low and variable heating value, high percentage of moisture or ash, high percentage of sulphur and unfavourable carbon/hydrogen ratio in some cases, as well as expressed slagging and fouling behaviours due to unfavourable ash composition. Besides, design solutions of the pulverised coal fired boilers are not convenient for the temporary operation conditions. All mentioned influents to a lower reliability, availability, efficiency, power range variability, and environment issue of most Bosnian coal fired power plants, including high nitrogen and sulphur emission and CO_2 emission as well, [5]. These shortcomings could be overcome in two ways; either by continuing of the reconstruction the existing coal fired thermal power units or by building up the new ones.

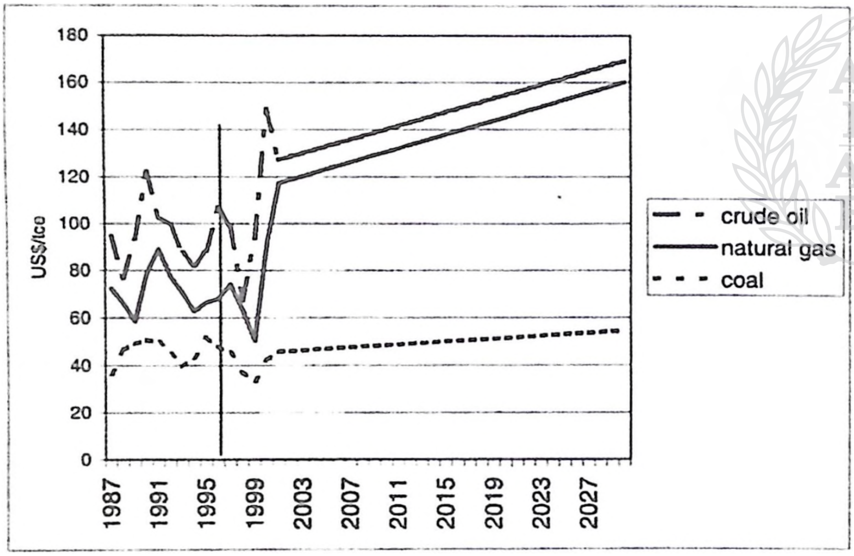


Figure 3. Actual and projected international fuel prices, 1987- 2030., [2]

Whatever of the mentioned approaches is selected, more information on domestic coal types combustion behaviours are required, to identify specific problems of combustion of domestic coals, and then to undertake appropriate measures.
Taking into account that secure and economical production of electricity is basic precondition for further sustainable development of energy power sector of Bosnia and Herzegovina, as well as the fact that liberalized electricity

market in Europre requires environmental friendly electricity production, then modernization of the coal based power system in BiH is necessary.
A number of factors influents to the decision making regarding modernization of reminder of coal-based power units in BiH and building the new ones. Particular attention is to be focused to the present condition of energy power stations, longterm forecast of consumption and production of electricity - both in BiH and the region, environment issue and prices on the liberalized market (price of electricity, fuels, CER etc.).
There is no doubt that electric power, neither today nor in the near future, can fully rely on unconventional power sources. However, it should be taken in consideration that in the developed industrial country about 60% of total energy is used in low temperature conversion (<100°C). This exactly emphasizes possibility and need for increased exploitation of restorable power sources with aim of increased environment protection and decrease of consumption of classic primary sources and electric power. Energetic capacities on alternative primary sources, as well as savings in power consumption can be considered a new classic energy source that has appropriate value in capacity of construction of new power structures based on classic primary sources.

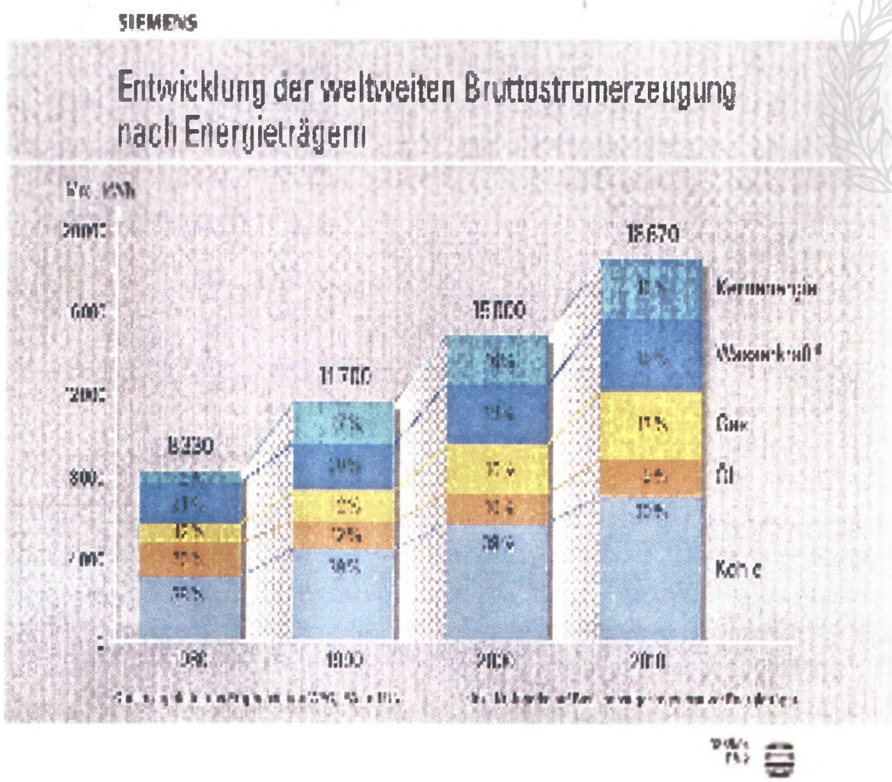


Figure 4. Share of coal in total electricity generation in the World is 39%

Concrete plans and programs for construction of new thermal power structures should be based on reliable data about fuel characteristics, cooling water, stag and ash disposal, as well as requirements in terms of environment protection. Besides that, it is necessary to accurately define the consumption need for electric and heat power, i.e. it is necessary to assess the need for construction of power networks. All the above said has to be defined by special research studies and based on them preliminary designs will be produced for each power structure together with obligatory feasibility studies. So far on the level of the entity the following studies have been realized: Feasibility Study for TPP Stanari of 420 MW installed power and TPP-HP Doboj (reconstruction of the existing heating plant in Doboj, with installation of new power block of power of 34,8 MWe in condensing regime), Preliminary Feasibility Study for TPP Gacko II (variant solution). These solutions have been harmonized with the phase Spatial Plan of the entity.

2. Reserves and investigations of coal in B&H

2.1. Previous and current situation

Bosnia and Herzegovina with its small area is emboded with important amounts of lignite and brown coal reserves. All forecasts estimate that exploatable reserves of coal in BiH present reliable base for planning of electricity production from coal according to current rate of 65%:35% to the other resaurces - at least for the next 50 years, taking into account also expected grow of electricity consumption in BiH of 4% per year.
Coalmining in BiH dated from end of 19 Sentury, and the full development reached at the end of eighties of last sentury. The most important reserves of coal are located in so called coal basens: Tuzla (coalmines: Kreka, Banovici, Djurdjevik and Ugljevik), Srednja Bosna (coalmines: Kakanj, Breza, Zenica and Bila), Bugojno (coal mine Gračanica), Livno-Duvno (coal mine Tušnica), Miljevina (coal mine Miljevina) and Doboj-Banja Luka (coal mine Stanari). There are some minor geological reserves on other locations, but they haven't been properly explored (Ramići, Lješljani, Mesići, Čelinac - Kotor Varoš, Bukovac - Bušletić near Doboja, Mrkonjić Grad - Šipovo, Ozren - valley of Spreča, Majevica - mineral coal and other). Coalmine Kamengrad, in basen Kamengrad, works with a smaller capacity after 1990, while coalmine Mostar, in basen Mostar, is closed. Till 1990., almost all coalmines in BiH were organized into the unique company „Titovi rudnici uglja“ - Tuzla, as an exlusive coal supplier of TPP Tuzla and TPP Kakanj. Only coal mine Gacko and coalmine Ugljevik, which supply TPP Gacko and TPP Ugljevik, respec-

tivlly, were incorporated into unique electricity utility of Bosnia and Herzegovina EP B&H. Till 1990, coalmines in BiH had 31.000 employees, and annual production were reached 18 million tones. During 1992/1995, the production was reduced to 10÷15%. In 2007, it was produced 9,852 million tones or 54,3% of production in 1990, with 15.250 employees. Only coal mine Gacko and coalmine Ugljevik reached the same production as in in 1990.. In December 1995., according to Dayton peace agreement, energy sector in B&H were reorganized, resulting in three electricity utility; JP EP B&H (Sarajevo), with TPP Tuzla and TPP TE Kakanj; EP HZ HB (Mostar) without thermal power plants, and EP RS (Trebinje) with TPP Gacko and TPP Ugljevik.
Today, except Gacko and Ugljevik, there are 14 coalmines companies in B&H, with 27 production capacities, of which 11 are underground coalmines. Some of the coalmines are closed or work with very small capacity (Mostar; Kamengrad; Miljevina; Dobrnja; Bukinje). TPP Tuzla uses coal from coalmines Kreka, Banovići and Đurđevik, while TPP Kakanj is mainly supplied with coal from coalmines Kakanj, Breza and Zenica - and partially from Bila, Gračanica and Livno.
Almost all mentioned coalmines have problems in their dealings. Especially big problem is for underground mining. The attention should be focused on revitalization of the coalmines from one side, and on reorganization and restructuring from the other side.

Some forign partners have worked out two studies for coalmines in FBiH:

1. Fisibility Study on coalmines Srednja Bosna and Tuzla, Marston&Marston Inc., St. Louis, St.Missouri, USA, 06. 2000. god; sponsored by USTDA;
2. Program of modernization of coalmines in FBiH, DMT-Montang Consalting, Essen, Njemačke, 06. 2002.god; sponsored by MfWuMEuV des Landes Nordrhein-Westfalen

Both studies suggested reorganization of the coalmines, by their joining into one holding company, or by their including with thermal power plants into energy power system of JP EP BiH. By this, it would be ensured longterm and reliable supply of TPP Tuzla and TPP Kakanj under condition of liberalised electricity market.

2.2. Potential for further development of coal sector - coal reserves

Table 1 presents preview of coal reserves in B&H [7, 9, 10, 16], based on the data from the coalmines. Quality of coal, first of all calorific value, is key factor for defining the price of the coal on the coalmine in EUR/tone or EUR/GJ. However, some of the data presented in Table 1 differ siginificantly from some earler data, and also from the data on geological reserves issued by Ministry for energy, industry and mining. Thus, data from Table 1 should be taken with causion. For that reason, it is necessary to reinvestigate coal reserves in BiH and confirm real reserves, so that potential investors have no dilemmas regarding investing in this sector.

All data about coal reserves in BiH are based on standards from 1979 - from period of ex-SFRJ. In above mentioned studies it is emphasized that those standards are reliable and even stricter then in some countries today, so they are relevant. It is indicative for example that above mentioned Study on coalmines Srednja Bosna and Tuzla, Marston & Marston Inc., based on own approach to the economy of the coalmines, has affirmed that there was available 465.3 million tone of balanced and 335 million tone of exploitable reserves of coal in F.BiH in 2000, with exploitable losses of 28%, that is much differ relating data given in Table 1. Explanation for this lies in the fact that Marston&Marston did not include in their consideration coal reserves from coalmines which are not interesting as energy potential for TPP Tuzla and TPP Kakanj (Livno, Kongora, Bugojno, Kamengrad, ...), which directly reduced real coal reserves. The mentioned confirm emergency of checking the data on coal reserves, and also a scientific approach in determination of exploitable losses, to define precisely exploitable reserves before serios planning and building new coal-based power plants. It must be taken into account also that this checking will take certain time andfund.

The basic thermal power capacity of EPRS is based on reserves of brown and lignite coal. Reserves of these coals are mostly located in four major coal basins: Ugljevik, Gacko, Stanari and Miljevina. Relatively small geological reserves of coal can be found in some other locations, but the degree of exploration is low (Ramići, Lješljani, Mesići, Čelinac-Kotor Varoš, Mrkonjić Grad-Šipovo, Ozren-valley of Spreča, Majevica - mineral coal and other). On some coal deposits not even basic characteristics have been determined, such as chemical composition of coal and mineral admixtures (ash), not to mention special characteristics needed for the selection of firebox types for combustion boilers, air protection plants (electric filters, FGD, DENOx), transport, clinker and ash disposal, and especially clinkering and abrasion characteristics of coal and its ash. After a feasibility study is finished, estimated or calculated coal sources are classified as “probable” or “proved” coal reserves.

No.	Name of coalmine and type of coal	COAL RESERVES (000 t)								
		Balance $(A+B+C_1)$	Non balance $(A+B+C_1)$	Potential $(C_2+D_1+D_2)$	Total geological	Exploatable $(A+B+C_1)$	H_d (GJ/t)	Moisture (%)	Ash (%)	Sulphur total (%)
BOSNIA AND HERZEGOVINA										
Total lignite (L) in BiH		*1.412.973*[7]	*414.929*[7]	*1.386.488*[7]	*3.214.390*[7]	*1.004.593*[7]				
		1.498.602,22	*422.538,51*	*1.547.729,44*	*3.468.870,18*	*1.033.561*				
Total brown coal (B) in BiH		*1.102.718*[7]	*206.834*[7]	*1.101.689*[7]	*2.411.241*[7]	*648.039*[7]				
		1.201.295	*214.315*	*1.156.022*	*2.571.632*	*751.175,08*				
Total in BiH		*2.515.691*[7]	*621.763*[7]	*2.488.177*[7]	*5.525.631*[7]	*1.652.632*[7]				
		2.699.897,22	*636.853,51*	*2.703.751,44*	*6.040.502,18*	*1.784.736,08*				
Preview of some coalmines										
1	Gacko (L)	338.333	65.979	100.000	504.312	297.000	10,11	37,45	16,61	1,55
2	Ugljevik (B)	285.117	25.092	119.700	429.909	73.271	13,174	31-33	18-32	3,3-6,3
3	Stanari (L)	108.395,226	32.615,516	9.622,927	150.633,669	58.710	7,735-10,465	52-48	15,6-4,0	0,14-0,19
4	Miljevina (B)	21.204	15.846	40.130	77.180	19.08	11,7-14,8	18,27-23,22	21,98-28,73	2,37-2,39
5	Kreka (L)	743.954	322.833	59.407	1.126.194	456.008	11,31	38,7	13,06	0,61
6	Banovići (B)	194.085	13.935	0	208.020	162.429	16,18	16,09	24,14	1,74
7	Đurđevik (B)	60.183	4.963	0	65.146	54.524	17,95	9,42	25,77	2,30
8	Kakanj (B)	256.536	56.525	127.604	440.665	204.839	12,5-16,07	5,7-9,16	35,49-42,75	1,4-3,85
9	Breza (B)	49.244	23.928	0	73.172	28.098	14,428	6,61	30,99	2,54
10	Zenica (B)	179.843	59.931	721.369	961.143	131.000	17,619	12,58	22,32	3,65
11	Bila (B)	26.808	10.373	25.354	62.535	16.091	14,503	15,84	24,65	4,69
12	Gračanica (L)	10.657	0	0	10.657	10.657	10,746	32,43	17,06	2,95
13	Tušnica (L)	76.201	1.111	0	77.312	68.528	11	39	13	2,23
	(B)	16.274	0	1.865	18.139	11.433	15	16,5	18	4
14	Kamengrad (B)	112.001	3.722	120.000	235.723	68.671	13,003	22,60	24,19	4,08
15	Bugojno (L)*	14.651	0	1.280.105	1.294.756	12.893	11,36	32,88	19,43	2,45
16	Kongora (L)*	206.411	0	0	206.411	129.765	7,38	35,06	27,50	1,25
Total BiH lignite (L)		*1.051.874 + 446.728,226*	*323.944 + 98.594,516*	*1.339.512 + 208.217,443*	*2.715.330 + 654.945,669*	*677.851 + 355.710*				
Total BiH brown coal (B)		*894.974 + 306.321*	*173.377 + 40.938*	*996.192 + 159.830*	*2.064.543 + 507.089*	*677.885 + 73.290,08*				
Total BiH		*1.946.848+ 753.049,226*	*497.321 + 139.532,516*	*2.335.704 + 368.047,443*	*4.779.873 + 1.162.034,669*	*1.355.736 + 429.000,08*				

Table 1. Preview of coal reserves in BiH, [7, 9, 10,16]

Based on internationally accepted recommendations (JORC, 1999), the coal reserves in basins of Republic of Srpska can be classified in the following manner:

- Category A and B of balance reserves corresponds to “calculated” coal resources; Category C_1 of balance reserves corresponds to “estimated” or “calculated” coal resources, depending on a deposit degree of exploration;
- Category C_2 of reserves corresponds to “assumed” coal resources.

The coal reserves are presented in Table 2 in accordance with exploration categories for the four significant mining basins. It is important to notice that the balance reserves amount to above 735 million tons and together with approximately 270 millions tons of potential reserves it totals in more than one billion tons of coal for potential exploitation. The factor of loss has to be taken in consideration in order to get efficient reserves.

x 10^3 t

Coal basin	Balance reserves				Potential reserves C_2+D_1	Surplus balance reserves $A+B+C_1$
	A	B	C_1	$A+B+C_1$		
Ugljevik	24.541	82.824	177.752	285.117	119.700	25.092
Gacko	45.752	166.278	126.303	338.333	100.000	65.979
Stanari*	5.115,6	32.913,7	71.365,8	108.395,2	9.622,9	32.615,5
Miljevina	1.893	6.791	12.520	21.204	40.130	15.846
Total	79.301,6	299.359	294.535,7	753.049,2	269.452,9	139.532,5

*An Elaborate was prepared for Stanari coal basin [10] and it has been approved by the Commission for technical control - revision (record no. 165/2005 dated August 23rd 2005)

Table 2. Balance reserves of major coal basins

When it comes to the total balance and potential reserves, lignite coal (Gacko, Stanari) is more represented than brown coal (Ugljevik, Miljevina). Data on the coal reserves are given based on the latest valid solutions issued by authorized governmental bodies for verification of coal reserves and based on official documents on certain coal mines. All verifications were carried out before 1991 (apart from Stanari coal basin), and no additional exploration were done recently due to the war activities, but taking in consideration that there was no major coal production, these data can be considered sufficiently correct. Degree of exploration of the coal reserves in certain locations are presented within Table 2. It can be concluded that a half of coal reserves have been explored, which means that additional investments are required in direction of promotion of reserves to higher exploration categories. As presented in Table 3, degree of balance reserves exploration ranged from

37,6 % (Ugljevik) to 62,7 % (Gacko) or about 50 % for the four coal basins together. Degree of deposits exploration in general amounts to 64,8 %, and ranges from 27,5 % (Miljevina) to 83,7 % (Gacko).
However, exploration of some coal deposits in individual mining basins is very different. For example, exploration of balance reserves in the deposit of "Ugljevik -Istok" is 53,1 % with high participation of C_1 reserves category (46,9 %), even though the coal from this deposit is foreseen for "TPP Ugljevik II". On the other hand, exploration of balance reserves in "Mezgraja" coal shaft amounts to 78,3 %, and this deposit is foreseen for supply of TPP "Ugljevik III". "Peljave - Tobut" deposit as well has only determined coal reserves of C_1 category (38,15 x 10^6 tons).

Degree of exploration		Ugljevik	Gacko	Stanari*	Miljevina
Exploration of balance reserves	$\frac{A+B}{A+B+C_1}$, %	37,6	62,7	35,8	40,9
	C_1 u $(A+B+C_1)$, %	62,3	37,3	65,838	59,1
*An Elaborate was prepared for Stanari coal basin [2] and it has been approved by the Commission for technical control - revision (record no. 165/2005 dated August 23rd 2005)					

Table 3. Degree of exploration of major coal basins

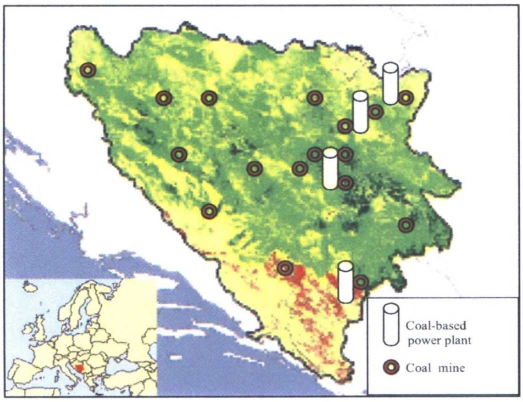
Investigation drilling carried out in the period of 1946 - 1993 determined the borders of spreading and the quality of coal layer in Stanari lignite basin, and at the same time defined litological composition and geometric characteristics of attached litological members. All major morphological factors in the wide area of Stanari coal basin have been separated and outlined based on inspection of the available litological profiles of drill holes, with consultation of geological and hydro-geological basements (geological and hydro-geological map, geological and hydro-geological profiles) and grain size testing. *Elaborate on classification, categorization and calculation of coal reserves of Stanari coal basin - condition on December 31st 2004* has been produced for the area of Stanari coal basin by the National Institute for Geological Research "Geozavod" Zvornik, which was approved by the Commission for technical control - revision (record no. 165/2005 dated August 23rd 2005), and after that the competent ministerial body verified the coal reserves and quality by a corresponding document. Balance coal reserves of A+B category in Ostružnja deposit have been classified as "calculated coal resources". Balance reserves of C_1 category and reserves of C_2 category have been classified as "estimated coal resources" as there haven't been and coal quality testing. "Calculated coal resources" in Ostružnja deposit (reserves of A+B category can be classified as "probable coal reserves". Exploitation reserves can be roughly estimated based on assumed exploitation loss of 10%. Therefore, in total this brings us to 27,3 millions tons of the "probable coal reserves" and 24,57 millions tons of exploitation coal reserves. The estimated resources amount to 18,58 millions tons of coal.

The current power complex of Gacko consists of Gračanica Mining Site and the thermal power plant with one block of installed power of 300 MW (Mine and TPP Gacko) which it's been operational since 1983. Total power capacity of this basin is based on major reserves of lignite coal. The confirmed balance reserves amount to 338,33 millions tons, and refer to a deposit of opened type Gračanica Mining site 17.500.103 tons, and the future Gacko Mine deposit. The coal deposit is quite well explored, and its characteristics are demonstrated through the coal layers as follows: major, thickness ranges from 11 to 25 m, then first foothill of about 13 m and second foothill of about 10m, as well as roof series of about 40m. Geological reserves and coal quality in Gacko coal basin are confirmed with the condition on December 31st 1987 (decision no. 06-310-478/88, dated October 12th 1988). Further construction of thermal power blocks in Gacko, first of all the Mine and TPP Gacko II, is based on the explored coal reserves. Detailed mining-geological investigation works have been carried out with regard to the planned construction of TPP Gacko, and a detailed Study on selection of the location for the second phase of Gacko Mine has been prepared and revised. Based on this Study, it is possible to start preparation of the preliminary design and the investment program for opening of a uniform mining site - Gacko planned for the future coal supply of power block TPP Gacko I. Technical design TPP Gacko 2x300 MW was prepared during the construction of TPP Gacko I, which provided technical solutions for thermal power block TPP Gacko II. A number of infra-structural structures were built during the first block construction and these structures will serve for the second construction phase. Realization of the Preliminary Feasibility Study is ongoing by NERS in order to provide the economical-financial estimate of the possible variant solutions for the project realization of Gacko II, through a joint investment, which would enable qualitative coal characteristics that would provide reliable work of the constructed power block (TPP Gacko I) for the long time period of 30 years, including revitalization, as well as provision of the required technology and equipment for the mine that will permanently provide the defined coal quality needed for designing of a new boiler for a new block, better adapted to the real coal characteristics. According to the available

data, it is possible to notice relatively well exploration of Gacko coal basin: degree of exploration of balance reserves is 62,7%, and participation of category reserves in the balance reserves amounts to 37%.
Exploration of coal reserves in Miljevina coal basin is insufficient and amounts to 41 %. Degree of exploration of the entire "Miljevina" deposit is even lower and amounts to only 27%. However, taking in consideration the exploration started in 1991 and 1992 the exploration degree is much more favourable. Namely, during these detailed geological investigations in the eastern part of the basin (Debelo Brdo - Daničići) 25 drill holes or 4803,5m were successfully drilled, and a geological map was made in scale of 1:2500 on the area of approximately 6 km^2. Out of 25 drilling holes, coal is found in 21 of them, and thickness of the coal layer ranges from 1,4 to 20,54 m. The samples from these drill holes were sent to Tuzla before the war, but the results have never been delivered to "Miljevina" Mine, and it would be useful to actualize this issue. Based on the above said, a major part of potential reserves (40,1 x 10^6 tons) could be promoted into balance reserves.
The adopted legal regulations and other measures for protection of coal reserves from further devastation has created conditions for further exploitation of the existing surplus balance reserves, including modern processes of coal gasification as well. The mentioned measures should be provided within the strategy for development of power, i.e. power utility, as it was included in the Spatial Plan of both entities in Bosnia and Herzegovina.

3. Quality of coal in Bosnia and Herzegovina

The most recent estimates assume that 60% of the coal in Bosnia and Herzegovina is lignite and 40% is brown coal. According to the heating power, Bosnian brown coal is similar to sub-bituminous coal. The coalmines map of Bosnia and Herzegovina with the existing coal-based power plants marked is given in Figure 5.
Characteristics of Bosnian lignite and brown coals widely varies from one coal basin to the other, and even amongst different coalmines within the same coal basin. Generally, Bosnian coal types are low valuable coals, with high content of CaO in ash, high content of sulfur and low net calorific value. Thus, calorific value of Bosnian coal is between 7 and 21 GJ/kg, Figure 5. Research into specific problems of combustion of domestic coals, being carried out at Mechanical Engineering Faculty of University in Sarajevo [5], is to be resulted in a reliable database of Bosnian coal combustion behavior, accentuated to the ash deposition characteristics and pollutant emissions under different combustion conditions, Figures 6 and Figure 7.



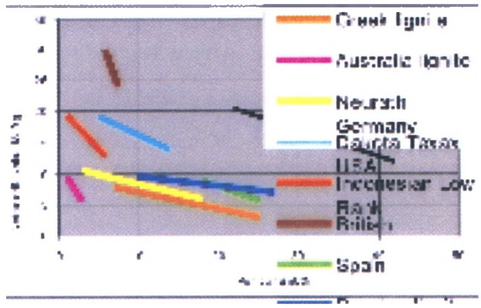


Figure 5. Left: Map of coalmines of Bosnia and Herzegovina; Right: Average calorific value of Bosnian coals in comparison with some world coal types

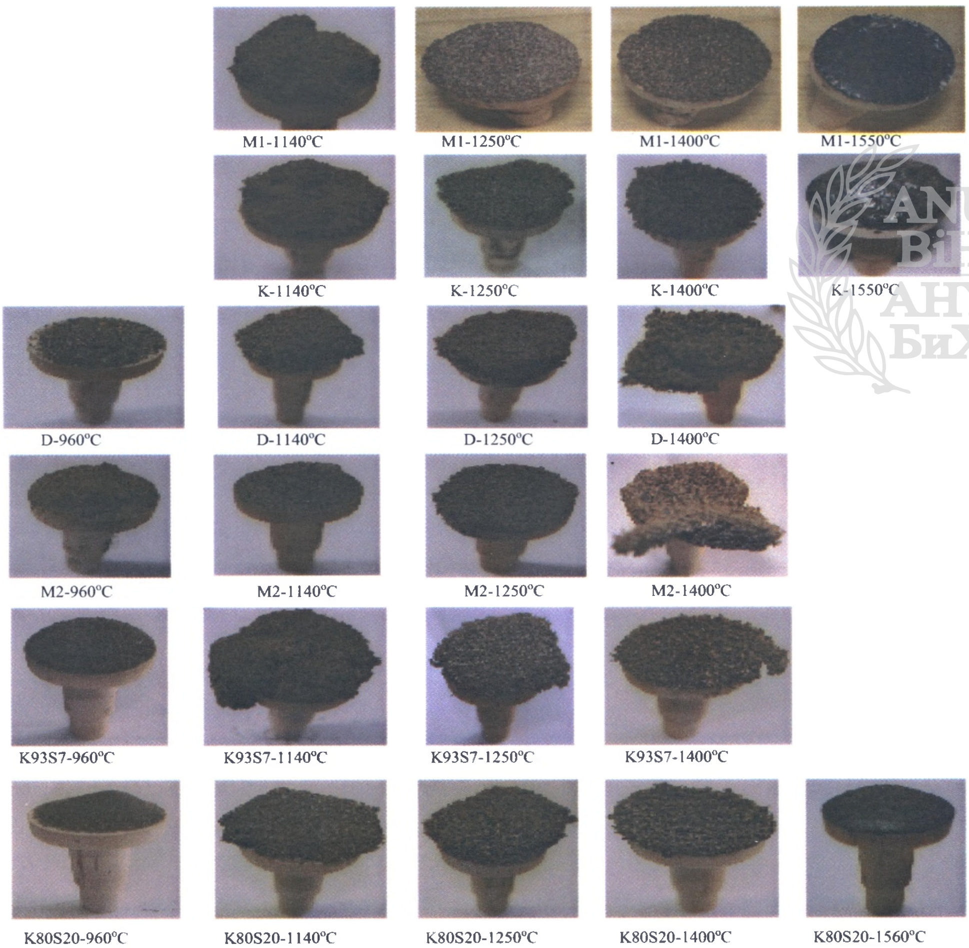


Figure 6. Ash deposit samples for the coal types tested, [5]

The aim is sustainability improvement of coal-based electricity production in Bosnia and Herzegovina, responding to the requests of liberalized energy market. Co-combustion behaviors of domestic coals and biomass – predominantly wooden residues, are being tested also within this research. This part of research presents first tests of co-combustion of domestic coal and biomass aimed to application in power plants, which offers opportunities for further reducing carbon dioxide emission and achieving better energy efficiency. Therefore, the research is presented as precondition for adoption clean coal technologies in Bosnia and Herzegovina.

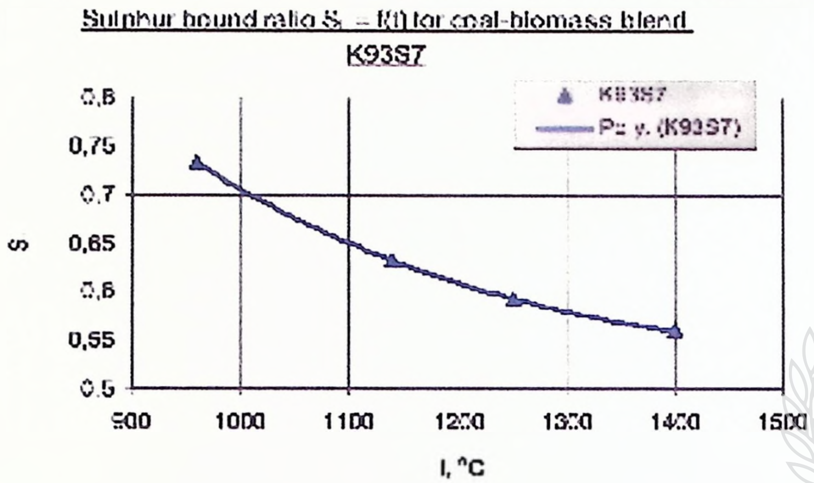


Figure 7. Sulfur bound ratio in the test facility as function of temperature for coal-biomass blend K93S7, [5]

Different variants of basic characteristics of coals in some mining basins are presented in Table 4. Majority of the characteristics refer to the average conditions defined for designing of boiler plants, taking in consideration exploitation conditions in mines and contouring of a corresponding deposit. In general, it can be said that the thermal power capacity of EPRS is based on the coal of predominantly low quality. The coal heating capacity ranges form 6.000 to 13.000 kJ/kg. Higher quality can be expected only in „Mezgraja" deposit of Ugljevik basin, which exploitation would partly be carried out with mining method. The coal quality decrease is contributed by ballast materials (humidity and ashes) and major sulphur content in coal, ash (A^r=7 do 8 %) and extremely low content of total sulphur (S_t=0,18%), and particularly combustible sulphur 0,06 %. Heating capacity of this coal decreases high content of humidity, about 50 %.

Location of coal - sample definition and characteristics		Coal characteristics								
		H_d^r, kJ/kg	W^r, %	A^r, %	S_k^r, %	S_g^r, %	C^r, %	H^r, %	N^r, %	O^r, %
TPP UGLJEVIK I „Bogutovo selo" Mining Site	Guaranteed composition (GC)	10476	33,0	25,0	5,4	4,8	27,2	2,2	0,6	7,2
	Improved composition (IC)	12142	33,0	18,0	6,3	5,6	31,7	2,5	0,7	8,5
	Aggravated composition (AC)	8792	33,0	32,0	4,5	4,0	22,7	1,8	0,5	6,0
TPP UGLJEVIK II „Ugljevik Istok" Mining Site	Guaranteed composition (GC)	10479	31,0	18,8		3,3	27,2	2,6	1,1	9,2
	Improved composition (IC)	12326	31,0	14,8		3,9	31,2	2,2	1,3	11,0
	Aggravated composition (AC)	8788	31,0	22,3		2,5	23,0	2,3	0,8	7,9
GACKO Mining basin	Ministry decision dated December 31st 1987	10110	37,45	16,61	1,55	-	-	-	-	-
TPP GACKO I „Gračanica" exc. Site	Project (GC)	10362	40,0	12,0	-	0,5	30,6	2,4	0,5	14,0
	Project (IC)	11618	35,0	8,0	-	1,0	33,7	2,7	0,6	18,0
	Project (AC)	9106	44,0	16,0	-	0,1	35,8	2,1	0,5	11,5
TPP GACKO I - boiler reconstruction	Guaranteed composition (GC)	7437	41,8	16,65	-	0,75	22,78	2,05	0,5	9,52
	Improved composition (IC)	8285	40,5	17,41	-	0,68	24,08	2,66	0,5	12,90
	Aggravated composition (AC)	6690	39,95	19,14	-	0,61	20,54	2,02	0,5	8,68
TE GACKO II Study on selection of the Mine location	Average composition	7014	37,72	21,8	-	0,4	-	-	-	-
	Bottom limit	8417	34,00	17,5	-	0,4	-	-	-	-
	Upper limit	5611	43,0	26,6	-	0,4	-	-	-	-
STANARI MINE	Average value	9310	50,04	7,41	0,18	0,06	28,82	2,54	10,80	
MILJEVINA MINE Project for new power plant "Maglić"	Deposit average	12620	18,28	28,74	2,39	1,42	38,73	3,48	0,49	11,79
	Upper limit	13280	18,41	-	2,68	-	-	-	-	-
	Bottom limit	10362	18,53	36,10	2,08	0,85	28,97	2,66	0,31	16,99

Table 4. Summary of coal characteristics,[9]

Aggravation of the coal quality in Gacko basin is particularly typical, comparing to the coal required by the design for TPP “Gacko I” and comparing to the verified reserves according to the decision of the B&H Ministry of energetics for conditions on December 31st 1987. Changes in the coal quality can be easily noticed by comparison of the data in Table 4. The coal heating capacity has decreased for about 3000 kJ/kg, and ash content in the coal has increased from 12 % to 17 - 22 %

An important coal characteristic is chemical composition of ash. Chemical analyzes for the considered coal types are presented in Table 5. This parameter also shows aggravation of ash composition comparing to the design requirement, particularly content of CaO which has a dominant role when heating surfaces of boilers are clinkered and dirtied. This kind of condition was notices in TPP "Ugljevik", and it was particularly distinct in the case of TPP „Gacko". The installed capacities of these thermal power blocks have decreased due to very clinkering features of these coals, in spite of introduction of radical cleaning procedures of heating surfaces.

Locations and definition of coals composition		**Chemical analysis of ash, %**									
		SiO_2	**Fe_2O_3**	**Al_2O_3**	**CaO**	**MgO**	**SO_3**	**P_2O_5**	**TiO**	**Na_2O**	**K_2O**
TPP UGLJEVIK I „Bogutovo selo“ Mining Site	GC	33,9	18,3	16,6	10,35	3,6	13,9	0,28	0,43	1,45	1,05
	from	17,3	11,0	7,7	3,65	2,65	5,5	0,12	0,17	0,55	0,22
	to	41,8	28,8	24,1	29,8	6,6	28,1	0,64	0,7	2,09	1,75
TPP UGLJEVIK II „Ugljevik Istok“	GC	17,1	11,0	4,9	36,2	3,25	25,6	0,18	0,23	1,03	0,5
TPP GACKO I PK -project-	GC	12,5	5,5	6,4	58,0	2,6	12,8	0,23	0,21	0,80	0,28
TPP GACKO I - reconstruction project-	GC	9,79	2,12	2,41	72,78	1,98	10,34	0,11	0,19	0,05	0,33
	IC	9,22	3,6	6,0	64,43	1,7	13,53	0,4	0,18	0,61	0,33
	AC	6,73	1,85	2,37	79,46	1,33	7,61	0,1	0,08	0,35	0,12
Study for TPP GACKO II	average	20,35	6,05	11,35	47,27	1,26	12,11	0,2	0,43	0,37	0,55
	from	6,0	3,0	4,0	35,0	0,8	6,0	0,0	0,15	0,2	0,1
	to	30,0	11,0	15,0	80,0	3,5	18,0	0,5	0,75	0,7	0,8
STANARI	average	48,99	0,85	32,22	8,64	4,10	3,22	0,05	1,04	0,11	0,89
MILJEVINA	average	40,33	5,71	19,21	19,37	0,79	10,31	0,39	0,62	0,93	0,60

Table 5. Chemical analyses of coal ash from Table 4.[9]

Brown coal:

(1) Ugljevik I - design (SC)
(2) Ugljevik I - real coal, average for 29 samples
(3) Ugljevik I - design (waeker content)
(4) Ugljevik I - design (better content)
(5) Ugljevik II - design (better component)
(12) Miljevina

Lignite coal:

(6) Gacko I - design (GC)
(7) Gacko - Study, deposit
(8) Gacko I - reconsruction (GC)
(9) Gacko I - reconstrction (IC)
(10) Gacko I - reconstruction (AC)
(11) Stanari - deposit cross section

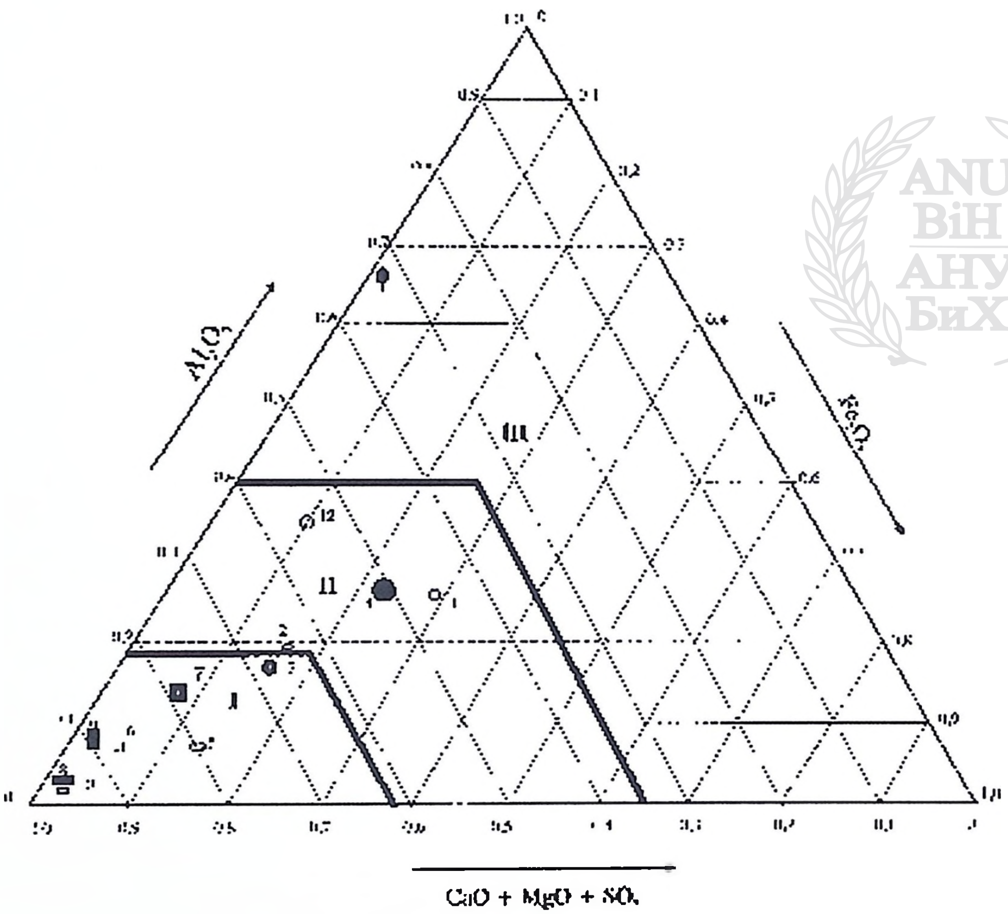


Figure 8. Characteristics of clinkering features of coals in Table 4. according to Altman diagram, [9]

Worse quality of coal is evident and that determines the need for further exploration of their characteristics with aim of additional definition of reaction features (kinetic and dynamic parameters) of coal in the process of combustion in space and fluidized layer. The above mentioned is needed, in order to enable competent selection of a furnace or types of boilers in the process of designing of future thermal power plants, then impact parameters related to environment protection, taking in consideration high content of sulphur and ash in the considered coals (apart form Stanari lignite). This will ensure correct selection of a plant for separation of ashes, sulphur and nitrogen for flue gases, including the possible selection of boilers with fluidized combustion, as well as clinkering features of the subject coals types with known methods based on ashes chemical composition and special process testing for creation of ashes and determination of temperature for initiation of clinkering in laboratory and plant conditions.
Analysis of chemical composition of our coals through clinkering method (R_s), dirtying factor, silicate modulus (K_{SiO2}) and base factor (K_1=B/A), and based on practical experiences it can be concluded that these coals fall under the group of extremely or moderately inclining to clinkering (apart from Stanari coal). Triple diagrams of condition and particularly Altman triangle is practical for assessment of clinkering features. When composing Altman triangle, the portions of some components are calculated from data on complete chemical composition of ashes (Table 5) which sum amounts to 100% with appreciation of the relation $Al_2O_3+Fe_2O+(CaO+MgO+SO_3)=1$. This kind of diagram has been constructed for the subject types of coal and is presented in Figure 8. All analyses of coals from the basins of Ugljevik, Gacko and Miljevina fall under the group of extremely (I) or moderately (II) clinkering coals. The lignite coal from Stanari is not inclined to clinkering (item 11 in group II on the diagram). All coal samples from Gacko Mine and "Ugljevik-Istok" Mining Site for TPP "Ugljevik II" are very inclined to clinkering and dirtying of a boiler heating surfaces (group I in Altman diagram).

4. Analysis of needs and possibilities of utilisation of thermal energy potential in B&H

4.1 Current situation

Approximately 80% of produced coal in Bosnia nad Herzegovina is delivered to 4 existing coal-based power plants - with 9 units, of total capacity of 1765 MW_e, and annual production of 15039 GWh, Table 6.

Although some of the power units was recently reconstructed and modernized (TPP Tuzla unit 4 and 5, TPP Kakanj units 5 and 7, TPP Gacko), present park of thermal power plants in Bosnia and Herzegovina is worn, both thank to the year of commissioning and technology applied. The most recent unit in the park is TPP Kakanj unit 7 - 230 MW, commissioned in 1988. Equivalent MW of TPP Tuzla is 27.46 years old, and TPP Kakanj 22.66 years, taking into account modernized units also.

Thermal power plant	*Generator*	*Comissioned*	*Power installed (MW)*			*** Possible production*
			No.	*Generator Power*	*Station Power*	
TUZLA	*G3**	*1966*	1	100	100	462
	*G4**	*1971*	1	200	200	1078
	G5	*1974*	1	200	200	1078
	G6	*1978*	1	215	215	1103
	total		4		715	3721
KAKANJ	*G5**	1969	1	110	110	627
	G6	1977	1	110	110	478
	G7	1988	1	230	230	1227
	total		3		450	2332
GACKO	*G1*	1983	1	300	300	1412
UGLJEVIK	*G1*	1985	1	300	300	1521
Total TPP in BiH			9		1765	15039

Table 6. Existing thermal power plants in BiH

4.2 Forecast for electricity demands and development of park of thermal power plants in BiH till 2020

Current consumption of electricity in Bosnia and Herzegovina, arranged according to companies and category of consumers, is given in Table 7.
Considering total electricity consumption in Bosnia and Herzegovina in 2006, Table 7, and taking into account a realictic estimation of annual grow of electricity consumption of 4% in the next 10-12 years, total consumption in BiH in 2020 is expected to be 19000 GWh. Therefore it is necessary to provide preconditions for fulfilling sach demands. Taking into consideration also opportunities for export of electricity, it is possible only by investing into Energy power system of Bosnia and Herzegovina, in three basic components: Production (including coalmines), high voltage lines for electricity transmittion and distribution system. With completion of reconstruction and modernization of remaining power units, construction of

new coal-based power plants is crucial point, Table 8. It must be emphasized here that it is planned to shut down only one unit in BiH till 2020: TPP Tuzla unit 3 - 100 MW.

No	Category of consumers	Consumption MWh		
		MH EP RS a.d. Trebinje	**JP EP HZ HB d.d. Mostar**	**JP EP BiH d.d. Sarajevo**
1	Direct ≥110kV	*199.520*	1875.030	542.897
2	35 kV	*87.650*	173.800	337.992
3	20 (10) kV	*325.990*	126.115	540.829
4	110, 35, 20(10) kV	613.160	2.174.945	1.421.718
5	Householders	1.502.180	672.611	1.742.175
6	Other 0,4 kV	465.640	231.210	637.419
7	Public light	41.220	21.019	59.592
8	Low voltage 0,4 kV	9.320	924.840	2.439.186
9	Net consumption	2.622.200	3.099.785	3.860.904
10	Transfer losses	42.070	69.730	159.000
11	Distribution losses	7.010	260.812	404.000
12	System losses	153.650	330.542	563.000
13	Gross consumption	3.463.540	3.430.327	4.423.904
14	Total BiH-(RS+FbiH)	(3.463.540+7.854.231) = 11.317.771 MWh		

Sources : Annual report 2006.: EP RS, EP BiH, EP HZ HB

Table 7. Electricity consumption in BiH by consumers

Additionally, for purpose of diversity of electricity sources and flexibility of energy power system, as well as some other effects like improving environmental issue, it is recommended working out Fisibility Study of construction of a Combined Cycle Gas Turbine (CCGT) in TPP Kakanj - Kakanj A 100 MW. Certain activities on this study, including detail thermal calculations of one option of such unit in TPP Kakanj, are already done, TPP Kakanj CCGT 100 MW (70 MW GT+30 MW PT), [3].

It must be emphasized here that new thermal power plants in Bosnia and Herzegovina have to be based on state-of-the-art technologies, so called clean coal technologies, adopted as far as combustion system is concerned to the specific domestic coal behaviours. Only by this approach, with needed level of reorganization of energy power sector, electricity utilities in Bosnia and Herzegovina will successfully meet chalanges of incoming open European electricity market.

No	Name of TPP	No and power of generator (MW)	Power installed (MW)	Annual production (MWh)	Year of comissioning
1.	TPP Stanari	1x410	410	2916	2012
2.	TPP Gacko 2		Table 9		2013-2015
3.	TPP Ugljevik 2	1x300	300	1601000	2014-2017
4.	TPP Tuzla, unit 7	1x370	370	2047000	2013
5.	TPP Kakanj, unit 8	1x250	250	1260000	2013
6.	TPP Bugojno 1	1x300	300	1630000	2013
7.	TPP Kongora	2x275	550	3000000	2013
8.	TPP Tuzla B-1	1X500	500	2640000	2017
9.	TPP Bugojno 2	1x300	300	1630000	2017
10.	TPP Kamengrad 1	1x215	215	1190000	2017

Table 8. Preview of planned construction of new coal-based power plants in BiH till 2020

Thermal power potential based on coal, as a non-renewable source of energy and big and valuable national treasure, deserves to be valued as such. On the other hand, that is also constant source of energy during entire year and it does not depend on hydrologic conditions, and it just partially depends on meteorological conditions. Besides power utility company, on usage of this potential, other important society subjects have rights (industry and households, including town heating on domestic energy fuel independent on import problems). Certainly, national consensus has to be achieved through creation and implementation of a long term strategy for development of energy-power in Bosnia and Herzegovina, which is now pending (completed preliminary plan, on bases of which public discussion is going on).

Further analyses of possibilities for usage of coal potential starts from assumption that the largest part of coal will be used for production of electric power in Thermal Power Plants (TPP) and TPP-HP or industrial power plants. Planning to build thermal power facilities is possible if based on available balances, and in a long term based on potential coal reserves, calculating production life span of these facilities foreseen to be 40 years. Based on detailed calculations and analyses, included in Table 9 are installed powers and possible production of electric power on verge of TPP that are already constructed (600 MW, 2.993 GWh), TPP planed for construction until year 2020. (min. 1084,8 MW, min. 5718,8 GWh), as well as TPP which construction is possible under certain conditions after year 2020 (1.120 MW, 5.963 GWh).

Thermal Power Plant		Power on generators		Available power on output TPP, MW	Annual production on output TPP for 5740 h/year, GWh
		Installed, MW	Available, MW		
TPP Ugljevik I		300	285	266	1.521
TPP Gacko I		300	267	246	1.412
Total of TPP constructed		600	552	512	2.933
Planned power plant construction until year 2020.					
TPP Stanari (Figure 9)		420	410,30	388,80	2.232
TPP-TO Doboj	Condesation operations	34,8	34,8	31,50	180,8
	Toplification operations	27,5	27,5	24,77	142,2
TPP UgljevikII		300	300	279	1.601
TPP Gacko II	Option I	330	330	297	1.705
	Option II	2x330	660	594	3.409,6
	Option III	2x250	500	450	2.583,0
Total of new TPP until year 2020 (with option I for TPP Gacko II)		1084,8	1075,10	996,30	5.718,8
Possible thermal power plant construction after year 2020					
TPP Miljevina I		110	110	101	580
TPP Ugljevik III		300	300	279	1.601
TPP Gacko III		300	300	279	1.601
TPP Ugljevik IV		300	300	279	1.601
TPP Miljevina II		110	110	101	580
Total thermal capacity		1.120	1.120	1.039	5.963
Ovreral thermal energy capacity		2.455	2.407	2.233	11.681,8

Table 9. Complies of installed power and possible production of electric power on output of some existing and planned TPP

From Table 9 one can notice that it is possible to reach overall construction of complete mentioned thermal power capacity up to installed power of 2455MW in 11 energy blocks in four TPP, including TPP Stanari and TPP-HP Doboj. That is not particularly imposing number, only 86% of presently installed power TENT A+B in Obrenovac and probably with lower economic effects.

Inclusion of already noted TP facilities in average life span plans of development and certain programmes of construction need to be based on serious and comprehensive research, studies and design works. In deed, based on executed and required span of research, for each power facility, adequate technical documentation with feasibility studies or construction feasibility has to be completed. Certain financial means for this purpose should be put aside in yearly investment plans. This kind of documentation should be adequate for relevant government bodies for planning and making decisions on construction and realisation of finances.

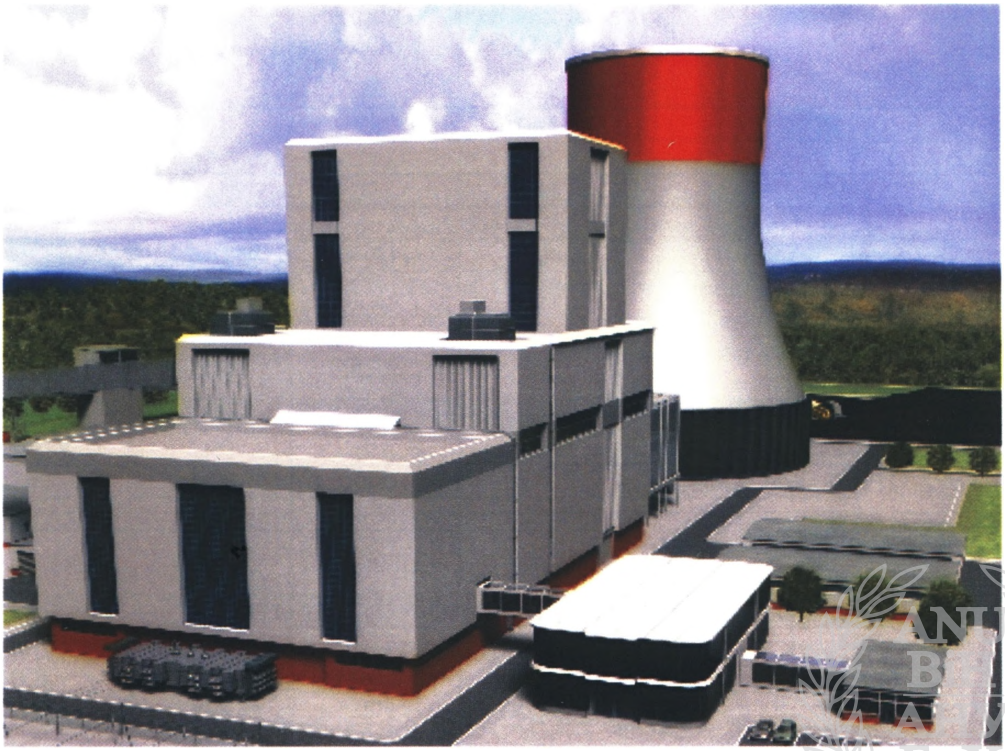


Figure 9. Planned facility for construction -TPP Stanari power 420 MW, [12]

Besides highlighted need to calculate quality characteristics of coal, it is necessary to pay attention to technologic conditions which might be limiting factors for development of thermal-energy in coal pools here. In this case it is primarily meant to provide enough water for cooling, disposal of huge amount of coal ash from TPP, adequate protection of environment, and preservation of air quality in particular.

Providing water to thermal-energy facilities which will be constructed until year 2020 is mostly resolved.

Cooling TPP Stanari is resolved by using dry cooling towers and providing technical water from wells in area around TPP. TPP-TO Doboj has at their disposal water from river Bosna, which completely fulfils all technical and ecological criteria.

Providing water for new energy blocks 2 x 300 MW in Ugljevik (TPP Ugljevik III and IV) is not possible to resolve safely from surrounding area. Therefore it is necessary to think about other solutions and provide required amount of water from river Drina or river Sava which has been discussed during design of TPP Ugljevik I. One of the excepted solutions also needs to include water production company bases. Alternative to a solution above, which figures water cooling systems with wet cooling towers, is consideration for introduction of cooling systems with dry cooling towers. It is clear that the last solution hinders economic block (rising of pressure in condensation systems) so at the same time technical-economic analyses for both possible solutions has to be completed.

For TPP Gacko III with installed power 1 x 300 MW it is possible to find solution for water supply within surrounding water streams, it is considered to go towards rising of dam "Klinja" for 2 meters or building new accumulation "Gračanica". In any case with these solutions it is necessary to pay attention to energetic values of Gornji Horizont potential.

Supply of untreated water for future TPP Miljevina I and II is possible to provide by building smaller accumulation on river Bistrica which runes through Miljevina. Up till now, for this location there has not been any study documentations completed so, this should be done in foreseeable future.

Disposal of linker and ash becomes, for our conditions, more and more important factor in investment and running costs of thermal power plant, but the problem is not any smaller from perspective of environment protection, spread of dry ash, water and ground pollution caused by seepage from land fill, as well as provision of land, including parts of agricultural land, to be used for storage of large quantities of linker and ash.

As it can be seen from Table 4, our coals (apart from lignite from Stanari) have relatively large content of ash. If only balance quantities of coal were to burn with 20% excavation and other losses (exploitation reserve), land for storage of 125 million tones of linker and ash is needed.

In respect to this, it is necessary for above mentioned problems to be considered and researched thoroughly and find adequate solutions so that hindrance to exploitation of thermo power potential of coal, including usage of existing and taking upon new technologies for ash consumption as a row material for civil engineering and construction, cement industry etc.

In any case that is excepted practice which is implemented in well developed industrial countries.

Burning of fossil fuels in thermo blocks has important impact on material and energy exchange with surrounding area. Beside other contestants in this exchange (industry, motor transport etc.), thermal power also provides considerable factor in hindering natural balance to circular processes in biosphere. Impact to this balance does not refer only to emission of polluting masteries (sulphur oxides and Nitrogen, heavy particles) but also on increase of CO_2 and decrease of O_2 in atmosphere.

5. Environment issue

5.1 Legal framework / legislative and regulations /

Bosnia and Hercegovina is already ratified or aims to retify the following contracts, protocols and conventions:

1. Contract on Energy policy and protocol of energy policy on energy efficiency and environmental issue / signed on 14 June 1995, ratified in 2000;
2. Framework Convention of United Nations on climate change / ratified in 2000;
3. Convention on border-crossing transports of dangares waste and its disposal / ratified in 2000
4. Convention on protection of Mediterannean Sea from pollution / ratified in 1998 /
5. Kyoto Protocol

Bosnia and Herzegovina ratified on 27. July 2006 Agreement on establishment of energy community, which should prepare SEE region, so and BiH, for functioning of energy sector according to the EU principles which basic elements are given as follows:

<u>AQUIS communautaire on energy</u>, for purpose of Agreement, signifies:

Directive 2003/54/EC of European Parliament and Council on common rules of internal market of electricity,

1. European Parliament and European Parliament and Council on commen rules of internal marketof natural gas, and
2. Regulation 1228/2003/EC of European Parliament and Council on conditions of approaching to the net due to overbording exchange of electricity.

For implementation of this Chapter, European commity will adopt the measures which will adjust the measures AQUIS communautairea described in this Chapter, taking into consideration institution framework of this Agreement and specific situation of every contractual party. According to the Anex, every contractual party is obligated to implement this Chapter nine monthes after entering into force of the Agreement latest.

<u>AQUIS communautaire on environment, every contractual party will implement:</u>

1. Directive of Council 85/337/EEC about evaluation of effects to environment of certain public and private projects, and completed by Directive of Council 97/11/EC and Directive 2003/35/EC of European Parliament and Council after entering into force of the Agreement.

2. Every contractual party will implement Directive of Council 1999/32/EC on decreasing of sulphur content in certain liquid fuels and supplemental Directive 93/12/EEC from 31. December 2011.
3. Every contractual party will implement Directive 2001/80/EC of European Parliament and Council about limitation of certain pollutants into air from large facilities for combustion till 31. December 2017.
4. Every contractual party will implement article 4(2) of Directive 79/409/EEC of Council about saving of wild birds upon entering into force of this Agreement.

AQUIS communautaire for renewable resources:
Every contractual party will submit to the European committee their plans of implementation of Directive 2001/77/EC of European Parliament and Council on promotion of electricity from renwables in internal electricity market and Directive 2003/30/EC of European Parliament and Council on promotion of utilisation of biofuels and other renewable fuels for transport, within one year from the date of entering into force of this Agreement. European committee will expose plans of every Contractual party to the Ministry Council for adoption.

5.2 Projection of effects on environment of new thermal power plants in BiH

Environmental issues have significant influence to the trend in coal consumption today. Improving the existing and introducing the new advanced combustion technologies in coal-fired systems are required to increase efficiency and improve environmental issues. Energy power system of Bosnia and Herzegovina is based on coal; however, sustainability of the coal-based power plants is still lower in comparison with those ones in industrialized countries. The problem is basically addressed to the combustion of domestic coals.
Taking into account above mentioned, in modernization of existing and construction of new coal-based thermal power plants in Bosnia nad Herzegovina, particular attention should be focussed to the environmental issue.
According to the prevailing opinion today, antropological carbondioxide as green house gas is main contributer to the global warming and climate change. This problem could be escalated in future, and basic tool for mitigation of global warming is construction and utilisation of high-efficient energy technologies. Coal is an important contributer to the CO_2 emission. In Figure 10, CO_2 emission from TPP Tuzla in 2007 is given, [6]. Generally, Bosnia and Herzegovina should identify present situation about CO_2 and other emissions from their power plants as well as project the future emissions for period till 2030, to be able to define their emission quotas, which will be base for the

coming negotiations, and thus avoid situation that those emission quotas to be limiting factor in future development of coal-based power sector in B&H.

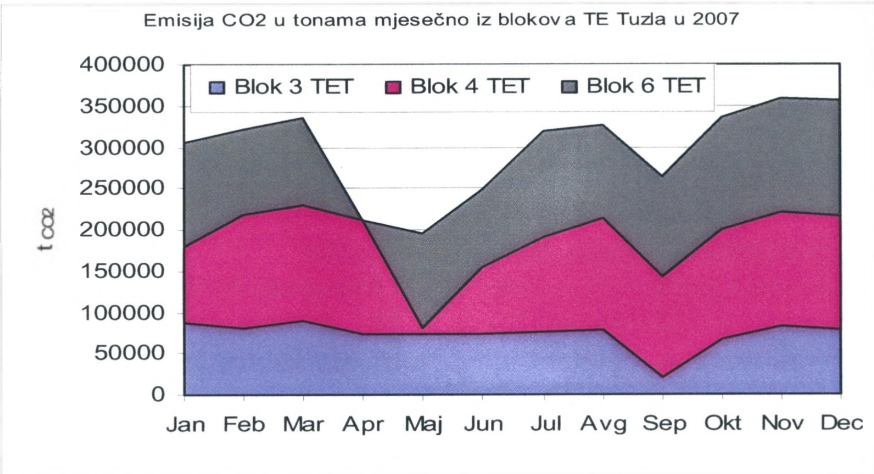


Figure 10. TPP Tuzla, CO_2 emission in 2007 [t/month]

In this line, it is necessary to elaborate several scenarios of development of thermal energy power sector of BiH; some of emissions from thermal power plants in BiH according to one of those scenario – *Scenario 1*, are given in Figures 11-16. This *Scenario 1* includes operation of existing power plants TPP Tuzla and TPP Kakanj till their shuting down as well as operation of the following new thermal power plants to be commissioned till 2020:

- TPP Tuzla unit 8, 370 MW, comissioning 2013, coal: blend of lignites Kreka;
- TPP Kakanj unit 7, 250 MW, comissioning 2013, coal: blend of coal from Srednja Bosna basen with 70% of Kakanj coal per mass;
- TPP Kongora, 2x275 MW, comissioning 2013, coal: Kongora coal;
- TPP Bugojno, 2x300 MW, comissioning 2013/2017, coal: Bugojno coal;
- TPP Tuzla B1, 500 MW, comissioning 2017, coal: blend of Kreka lignite and Banovići brown coal with 70:30 mass ratio;
- TPP Kakanj A, 100 MW, comissioning 2017, Combined Cycle Gas Turbine (CCGT), fuel: natural gas.

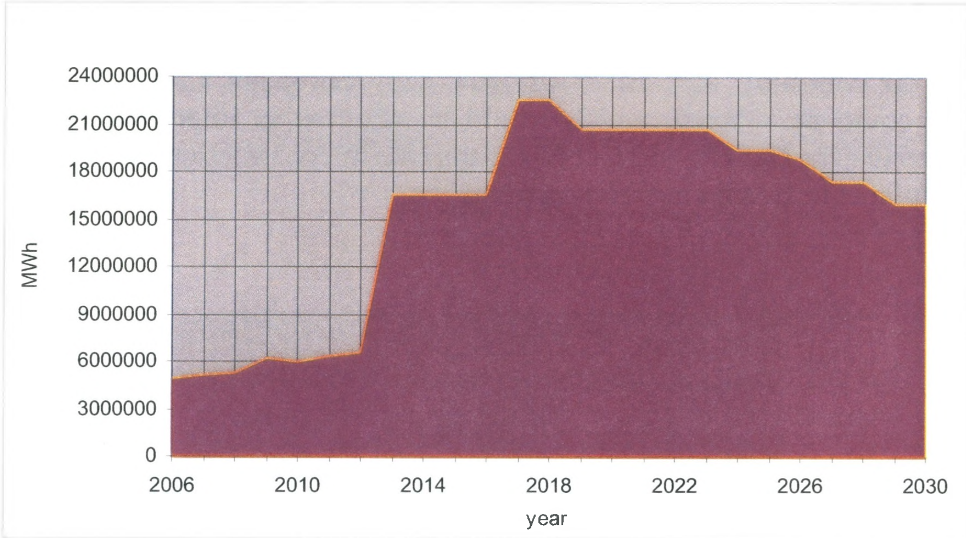


Figure 11. Annual electricity production in TPP in period 2006 - 2030, Scenario 1

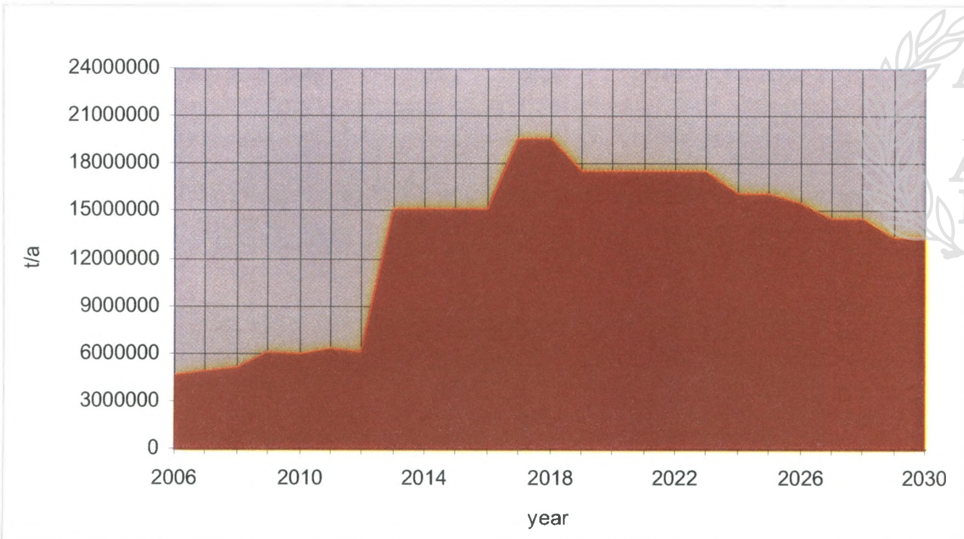


Figure 12. Annual coal consumption in TPP in period 2006 - 2030, Scenario 1

In emissions calculation performed according the CORINAIR methodology, it was used net efficiency of the new power plants in condensing regime of 43%, and net efficiency of CCGT unit in condensing regime of 58%. Emission limit values for SO_2 and NO_x were taken from EU Directive 2001/80/EC, [8]; thus emission limit values for SO_2 is 200 mg/m_n^3 normalised at 6% O_2 in dry flue gas, while for NOx is also 200 mg/m_n^3 normalised at 6% O_2 in dry flue gas - both for coal-based power plants, and 50 mg/m_n^3 for NOx normalised at 15% O_2 in dry flue gas - for CCGT units. However it must be emphasized here that with a good forecast of future emission limit values based on comming agreement of BiH with European Comission, those values could be relaxed, which would be resulted in important savings in investments for DeSOx and DeNOx measures in construction of new thermal power plants in Bosnia nad Herzegovina.

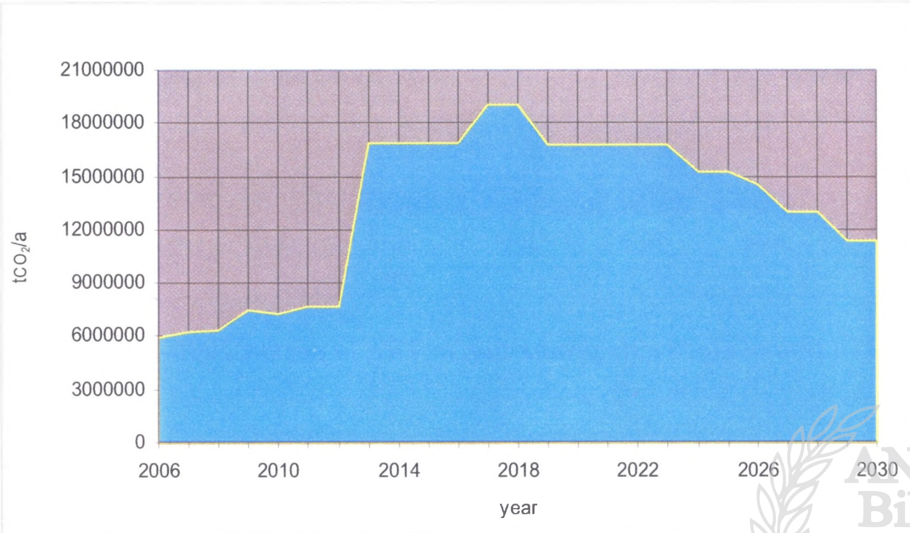


Figure 13. Annual CO_2 emission in tones from TPP in period 2006 - 2030, Scenario 1

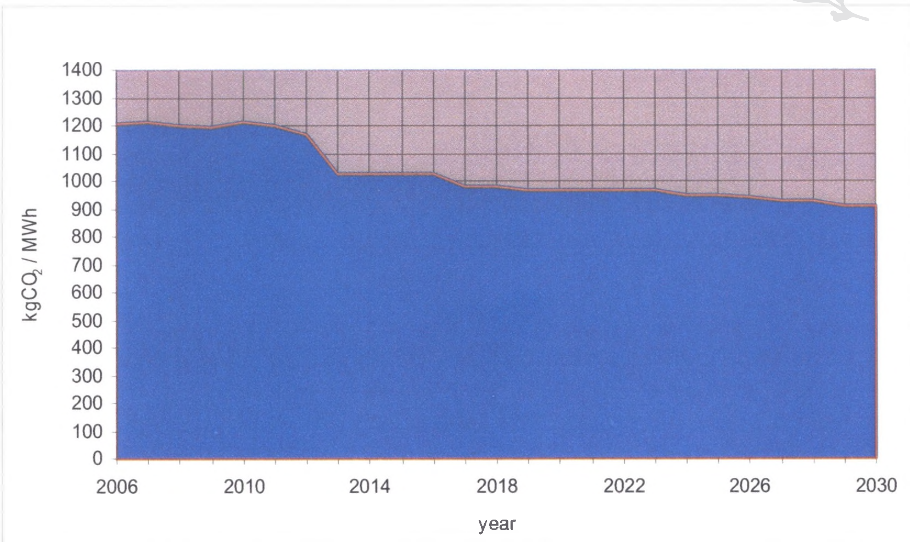


Figure 14. Specific CO_2 emission in kg/MWh from TPP in period 2006 - 2030, Scenario 1

Exploitation of a thermal power facility is unavoidably followed by certain environment impacts; therefore it is necessary to analyze this aspect in all phases of preparation of documents for these kinds of facilities, including pre-investment documentation, which aim is to make preliminary decisions in terms of further project development. Within a preliminary feasibility study for construction of any planned thermal power facility, the basic task and aim of all analyses regarding environment protection, is to present all potential impacts of a planned structure over environment and to provide the necessary protection measures that will keep harmful effects of a thermal power plant work within the permitted limits. The Law on Spatial Planning defines measures and activities in the field of spatial and urban planning and construction for environment protection parallel with energetic development. In accordance with that, construction of these kinds of structures (which are a part of energetic infrastructure) is done in accordance with the Spatial Plan, as well as based on the development plant of that very power infrastructure. In that sense, the first step has to be selection of the most favourable micro-location for construction of a TPP having in consideration ecological, technical and financial criteria.

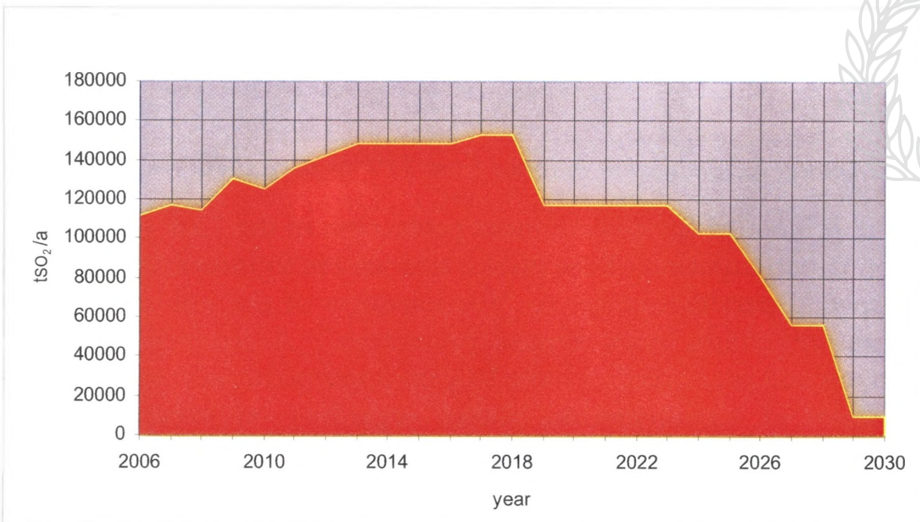


Figure 15. Annual SO_2 emission in tones from TPP in period 2006 - 2030, Scenario 1

Analysis of environment protection from harmful impacts of the subject structure presents multidisciplinary approach to the analysis of the existing condition of environment quality, the analysis of a new structure contribution and includes the following parts: detailed monitoring of the existing environment condition; definition of criteria and basements for the environment impact analysis; identification of types and quantities of polluting substance emitted to environment based on technical solutions of certain systems of a TPP; analysis of the existing environment pollution and determination of the location ecological capacity; analysis of the new facility contribution and total level of pollution after being put in operation; presentation of the measures for mitigation of the TPP harmful environment impact in normal run and in a case of an accident and presentation of a system for environment quality monitoring.

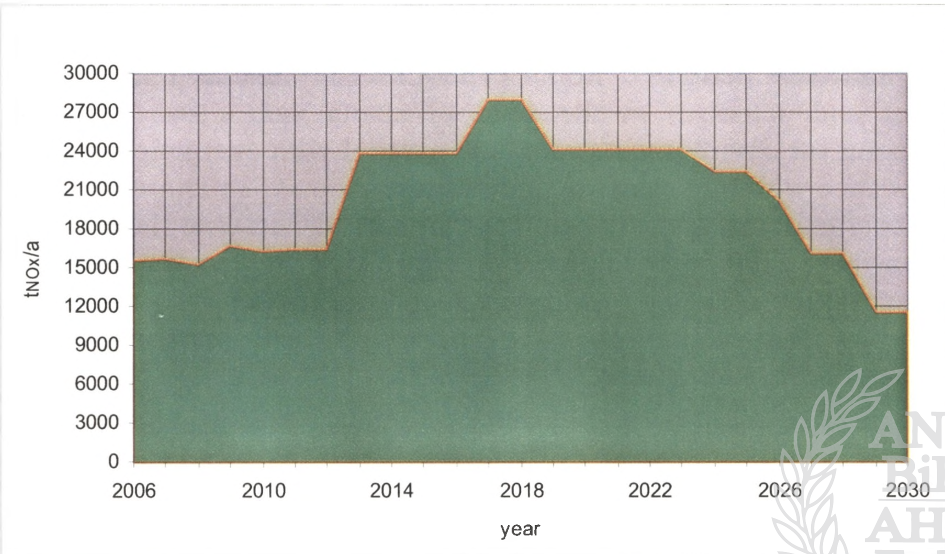


Figure 16. Annual NO_x emission in tones from TPP in period 2006 - 2030, Scenario 1

One of the principles for environment protection in the Law on Environment Protection is participation of the public and access to information, Article 10, and the special part that refers to "Participation of the public and access to information regarding environment protection". According to Article 10, every citizen and organization have to gain appropriate access to information in possession of administration bodies regarding environment protection, including information on dangerous substances and activities in their communities as well as the possibilities of participation in decision making process. In that sense participation of the public is foreseen in the process of adoption of a certain project through an Environment Impact Study, or in the course of preparation of a Feasibility Study. Taking in consideration modern legislation on environment protection in the course of preparation of conceptual solution for a thermal power plant the proposed technical solutions have to encompass all necessary protection measures which will enable that this facility is acceptable from the point of view of economy as well as ecology.

Although 753 millions of balance and 270 millions tons of potential reserves of coal of mainly lower quality with increased content of ashes and sulphur in the coal material, that is major national good, and the strategy of energy development, especially power utility development depends on it. The current level of the built thermal capacities amounts to 600 MW, and there are another 1120 MW for further construction of thermal capacities, under certain conditions.

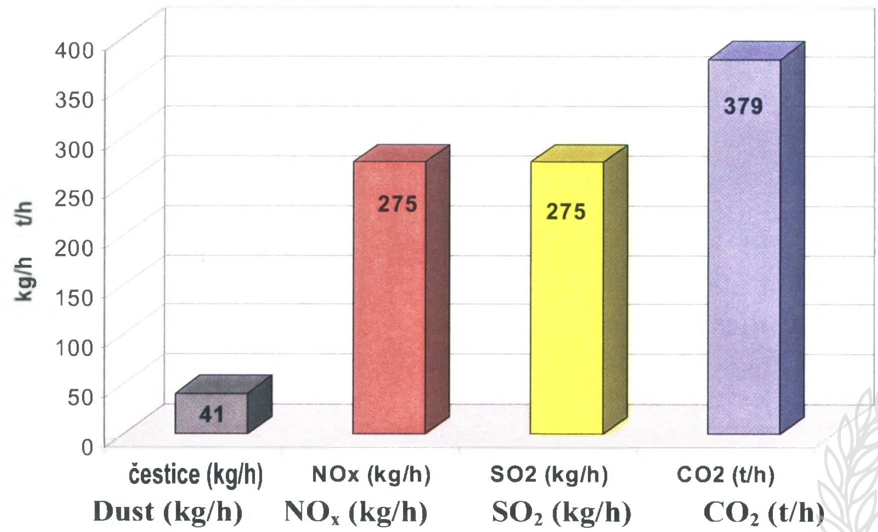


Figure 17. Emission mass flows of TPP Stanari (full load and design coal), [12]

It is necessary to additionally increase the exploration of coal reserves in general (with exception of Stanari lignite deposit) in order to create favourable condition for rational exploitation of this energy potential, with the final aim to promote coal reserves into higher exploration categories. Parallel to this activity it is necessary to increase the definition level of qualitative characteristics of coal on the majority of coal locations (preparation of coal for combustion: grinding capacities, kinetic and dynamic parameters in space and fluidized layer, clinkering features of coal (ashes), as well as features related to environment protection).
Feasibility studies have to be prepared for all potential thermal power plants, and these studies would be a basement for their inclusion into spatial planning documents and they would define opened issues for every facility that requires precise answers based on additional programmed exploration and study-designing working out. Several feasibility studies have been produced in the past years ([11], [12] and [17]). It has been proven that from technical point of view, it is necessary to determine all conditions for potential locations that could become limiting factors for the development of thermal

power. First of all, this refers to solving of problems related to water supply (TPP Stanari), disposal of big quantity of clinker and ashes (TPP Gacko II) and protection of the living environment (TPP Ugljevik II).

6. Conclusions

Coal will keep its leading role as basic fuel for electricity generation in the next 20 years, not only in Bosnia i Herzegovina but also in the World. Bosna i Hercegovina posseses important reserves of coal, and preciase amounts must be identified by additional investigations on coalmines. Existing technology in thermal power plants in Bosnia and Herzegovina is to be modernized, which is particularly important for new coal-based power plants to be constructed. Thus, clean coal technologies must be applied, and adopted to the specific domestic coal combustion behaviours. At this, particular attention should be focussed to the environmental issue. Only by this approach, with needed level of reorganization of energy power sector, electricity utilities in Bosnia and Herzegovina will successfully meet chalanges of incoming open European electricity market. Finnaly, several scenarios of development of coal-based power sector in BiH are to be elaborated to be able to define the emission quotas which will be base for the coming negotiations, and thus avoid situation that the emission quotas to be limiting factor in future construction of thermal power plants in BiH.
The concept of "sustainable development" means exploitation of natural goods in a manner that enables satisfaction of the present generations needs without endangering the future generations possibilities to use these goods satisfy the needs of their development. This concept was declared the basement of the 21st century development policy ("Agenda"), and it should be applied in all countries that long for preservation or improvement of the life quality of their citizens. As for developed countries, provision of technological development requires engagement of additional finances and additional activities that would enable preservation of the natural environment from further exhausting and degradation, or even contribute the revitalization. Having that in consideration, it is necessary to apply the model of integrated techno-economical and ecological analysis of acceptability for construction of the facilities that represent wide interest for the society development, but also represent possible polluters of the environment. Ecological criteria become equally important factors in decision making process in these analyses as well as in Studys. This is a crucial issue when it comes to a facility located in preserved area in ecological sense, which has to be maintained to the same extent after the construction and during the facility operation.

Here in Bosnia and Herzegovina, there is no organized and qualified institute or any other similar scientific-research institute or designing organization. We are suggesting the Power Institute to be formed and adequately equipped. This institute would study the problems of energy and gather and train young scientists and professional staff and would be responsible for connections with professional institutions in other developed countries. In that sense, it is necessary to give stimulus to Faculties of Mechanics, Electrical Engineering and Mining for more active researches of energy problems both through scientific-teaching process and scientific-researching work.

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GENERATION EXPANSION PLANNING CHALLENGES IN COMPETITIVE MARKET IN BOSNIA AND HERZEGOVINA

Prof. dr. sci. Mirza Kušljugić

1. Introduction

The *Generation Expansion Planning* (GEP) task is defined as a problem of determining *What, When* and *Where* of new generation units should be built over a (long-range) planning horizon in order to *efficiently* and *reliably* satisfy future energy demand. The GEP is part of a wider National Energy Planning process which is a strategic planning task for any country. The GEP problem is characterized by uncertainty associated with the input data (i.e. forecasted power demand, economic and technological characteristics of new generating technologies, trends in fuel and electricity prices, construction lead times and government regulations). It also presents a planning challenge since its solution requires simultaneous consideration of several (often conflicting) technical, economic, environmental, social and political objectives. The GEP objectives depend upon the structure of power industry and differ for power companies operating in a traditional industry, characterized by a *regulated monopoly,* and companies operating in a *competitive market* environment.

The aim of a traditional power company, operating as a regulated monopoly, has been to provide an adequate supply of electric energy to its consumers at *minimum costs*. Due to energy self-sufficiency concept local fuel sources were primarily used. Various GEP models have been developed to fulfill this corporate aim, incorporating optimization algorithms and deterministic/probabilistic production costs simulation. Most GEP problems have been modeled as a single-objective optimization problem, considering only the total utility costs (*utility least-cost approach*). The purpose of a least-cost GEP model was to determine generation units to be constructed (size, type and location) and time of their integration into the system so that the total costs (fixed and operational) of the company are minimized.

A long-term GEP problem is a constrained non-linear discrete dynamic optimization task. Its nonlinearity originates from the production costs models and the set of nonlinear constraints. Several optimization methods have been used to solve the GEP problem:

Prof. dr. sci. Mirza Kušljugić
University of Tuzla, Tuzla, B&H

- Traditional approaches such as linear, mixed-integer, non-linear, decomposition schemes and dynamic programming
- Meta-heuristics approaches such as simulated annealing, tabu search, evolutionary algorithms, particle swarm optimization and
- Combinations of traditional and meta-heuristics approaches.

One of the most used GEP algorithms in regulated monopoly industry has been Dynamic Programming (DP) approach. Many utilities use as GEP decision supporting tools commercial software packages based on DP. The most frequently used and best proved conventional GEP package in public sector is The Automatic Wien System Planning (WASP). WASP software was originally developed in the United States for the needs of the International Atomic Energy Agency (IAEA). WASP is determining least-cost expansion plan within pre-specified reliability criteria. It uses heuristic tunnel-based technique to deal with so called "curse of dimensionality" troubles in the dynamic programming routine (L1). It has been used for long-term GEP with the time horizon of up to 30 years. Modifications of dynamic programming algorithm incorporate expert systems techniques.

In order to include the impact of Demand Side Measures (DSM) on generation expansion (as a supply side measure) Integrated Resource Planning (IRP) method has been developed. DSM includes alternatives such as *efficient energy use* and *demand side management* (i.e. shaving of peak load). The objective of IRP optimization problem is minimization of the costs to the utility and society.

GEP has been totally redirected through the introduction of deregulation of electric power industry due to market based competition among generating companies. Competition in electricity market is primarily realized through a wholesale market, where generation and supply market participants compete for their market shares. Therefore not only are future demands within a given region uncertain but due to competition with other generation companies the utilities' market share is uncertain as well. Deregulation also attracted private investors which brought to power industry both their own investment preferences and *maximization of profit business philosophy.*

In addition, today's power industry is faced with evolving regulations concerning its environmental impact, especially regarding greenhouse gas emissions. In response to these environmental concerns many countries adopted a *sustainable development* concept, systematically subsidizing generation from *renewable energy resources* and efficient energy use measures. This trend accompanied with improvements in technologies for small generation units, which price per MW is no longer much more expensive than that for large units, provided opportunity for small private investors to enter power markets. Finally, due to very uncertain future fuel price trends a concept of (national) *energy security* has recently (re)emerged as important planning criteria in today's industry.

Due to the above described changes in power industry modern corporation's needs for optimization models in GEP decision making process have substantially changed. The GEP problem solution in today's industry requires simultaneous consideration of several, often conflicting, objectives (i.e. maximization of the system reliability, minimization of total costs, minimization of impact on environment, promotion of economic development, support for renewable energy generation and DSM, etc.). In *perfectly competitive markets* the problem of GEP has been reformulated from being cost minimization to profit maximization. Therefore the GEP decision makers need decision support tools which explicitly model tradeoffs among objectives, recognize uncertainty and account market prices and profits of generators. These GEP tools are classified as market-oriented tools. *For a perfect competitive market, under a well designed reliability, the result of least cost planning matches the market oriented planning.*

At the moment an intensive power system planning activity is undertaken in Bosnia and Herzegovina (B&H) by different stakeholders using various planning methodologies and GEP models. Problem with application of a coherent GEP methodology in B&H is caused by the fact that its electricity market is in a process of transition with structural characteristics of both regulated and deregulated markets. In order to contribute to ongoing discussion regarding approaches to GEP this paper addresses this issue both from theoretical and practical point of view. First a review of GEP models and solution methods, which have been used in different power systems for GEP both in regulated and market environments, is given. It is followed by a short presentation of restructuring and deregulation process both in developed and developing countries is given. Since B&H power system will be operating integrated with neighboring South East Europe (SEE) power systems and later with EU power markets a review of EU energy policies and SEE power market structures is presented as well. Especially the results of SEE GEP study (Generation Investment Study) and their implications on GEP in B&H are reviewed. Than an analysis of power market in B&H, with identification of major challenges for GEP process and their implications on the selection of GEP models, is elaborated. Finally, recommendations for necessary steps which should be taken for a successful market implementation as well as a proposal of GEP methodology are given.

2. Generation expansion planning in competitive markets

In the last three decades trend to introduce market based principles in almost all modern economic activities has been predominant. Process of introducing market principles is usually called market *liberalization* or *deregulation* or simply market reforms. In many countries deregulation of traditionally "state controlled" sectors (air transportation, telecommunications, banking, railway transportation and electric power) has also been or is being implemented. The main objective of the deregulation process is introduction of market based competition and eventually transfer of the sector control from state to private companies. Main reasons for initiation of deregulation process are:

- Lack of finances for new investment projects
- Economic in-efficiency of state controlled industries
- Poor technical performances.

Infrastructure sectors (i.e. telecommunications, gas and water supply systems and electric power sector), which are characterized by intensive capital investments, economy of scale and natural geographic monopoly, and hence difficulties to attract private investors, present a challenge for market reforms. These sectors were traditionally controlled by the national governments. Even after the market implementation the government influence is evident through monitoring function of regulatory bodies which should enable proper market function and prevent eventual monopolistic operation.
In spite of evident problems in reforming infrastructure sectors numerous industries, like air transportation and airport management and in the network industries telecommunications, have been successfully reformed. In all these sectors reforms initiated positive competition pressures and resulted in better consumer satisfaction and lower prices. Because of these results the reforms have attracted support of political decision makers, too.

2.1. Deregulation and restructuring of electric power industry

Electric power sector deregulation seems to represent to most difficult reform task among the infrastructure industries. Main reason for this difficulty lies in the following characteristics of this industry:

- Evident economy of scale of large generation units, which represents substantial entry barrier for new market players
- Specific technical characteristics of Electric Power System (EPS), which give preference to centralized control versus decentralized coordination (i.e. inability to store energy, need for demand and supply to match at all time etc.)

- Luck of substitutes (for many users electricity has no substitute)
- Electricity is a standard product (switching to another supplier cannot produce better "electricity" so in the well functioning markets prices are inevitably driven down to the short term marginal cost, which is too low a level to justify new investments).
- Impact of technological innovations, like increased competitiveness of smaller production units, is not yet sufficient to trigger fundamental changes in business models of Electric Power Companies (EPC).
- Environmental impact, especially on greenhouse gas emissions, of electric power system is substantial and the market will not deliver the necessary emissions reductions.

These characteristics of electricity mean that perfectly wholesale and retail market in electricity is not possible. The key question is: "Are economically efficient wholesale electricity markets possible?" Since generation makes up to 50% of retail bills the idea behind electricity market introduction was that generation could be transformed from a monopoly to a competitive market, which would result in price reductions. The other key assumed advantage was that investment risk would be transferred from consumers, where it generally falls in a monopoly market, to the shareholders of the generation companies. It was supposed to force a generation company to invest only in profitable options.

In spite of evident difficulties, in the last 30 years deregulation reforms have been initiated both in developed and developing countries and countries in transition. Based on the acquired experience in the developed countries a theoretical "standard" model of electricity market has been developed and implemented in the market design. In the advanced industrialized world the results of deregulation, when implemented properly, have generally confirmed the theory that markets for power can allocate resources more efficiently than had state-dominated systems. The experience in England and Wales in particular has been successful. In developing and transitional countries the experience with electric power markets has been quite different. It is mainly because the deregulation has been implemented partially - market forces operate only at the margins of a system that remains dominated by the state. Experts attribute this gap between theory and practice to poor rule of law, week market institutions and influence of "politics". In transition economies politics determines character and speed of the reforms. In these "systems in transition", with mixed state-controlled and market-driven mechanisms it is very difficult to model power system market operation and GEP.

2.2. Generation Expansion Planning in perfectly competitive markets

In perfectly competitive power markets a company is expected to look for maximization of its profits. The power system behavior is determined by the economic market equilibrium which is result of interaction of the market participants. The following business factors heavily influence the market position of a company:

- Ownership structure
- The technology mix
- Technological and managerial capacity
- Company's perception of risk

In addition, external factors such as behavior of competitors, regulatory issues and economic factors also influence market behavior of a company.
In competitive power markets the price of energy is affected by the following exogenous and endogenous factors:

- Availability and costs of the primary energy resources
- Ratio between installed generation capacity and load demand
- Power generation technologies and efficiency
- Availability and reliability of generation-transmission system
- Demand elasticity with respect to price
- Energy exchange/trade with bordering systems
- Limitations of interconnection network
- Market arrangements
- Strategic behavior of the market players, especially of generation companies.

Modeling of short term market efficiency has been in main focus of researchers. In modeling of market equilibrium in competitive markets the following approaches have been proposed: microeconomics theory, theory of non-cooperative games, mixed complementary problems and mathematical programming with equilibrium constrains.
Long-term investment performance modeling in competitive market has attracted less interest of research community. Modeling of GEP in competitive markets is a complex problem due to conflicting business interests of generation companies. The investment objective of each generation company is to maximize profits, which is correlated, interlinked and in conflict with investment objectives of competing generation companies. In this interaction among generation companies a problem of extreme over/under investment in power market can arise. If the power

market has to function well it has to bring benefits to its consumers. Thus the role of market regulator is to prevent such over/under investment situations through coordination among generation companies, providing long-term market information. Overall objective of the regulator is to achieve security of energy supply through *an equilibrium investment solution*. The solution of this problem is based on its decomposition into two problems. The main problem of the regulator is to evaluate the market prices and generation capacity stability in a long-term sense, based on (indicative) investment strategies of individual generation companies. The sub-problems correspond to investment strategies of individual generation companies, which aim to maximize their profits using information supplied by the solution of the main problem. An equilibrium investment solution is found through an iterative solution of the main problem and the sub-problems.

2.3. Multi-criteria decision making methods in Generation Expansion Planning

In order to grasp conflicting nature of trade-offs among different objectives of the GEP process and to select satisfactory compromise solutions the decision makers need the aid of multi-objective models. In multi-objective models the concept of optimal solution in single-objective models is replaced by the concept of the non-dominated solutions. The concept of non-dominated solutions is also known as Pareto optimum, non-inferior optimum and efficient solution. Non-dominated solutions are feasible solutions for which no improvement in any objective function is possible without sacrificing at least one of the other objective functions.

Multi-criteria decision making methods can be classified into *multi-objective* (multi-criteria) decision making and *multi-attribute* decision making groups. In multi-criteria methods the alternatives are not pre-determined and decision problem is solved using multi-objective linear or non-linear programming models. In multi-attribute methods the alternative candidate solutions are evaluated using combination of analytical tools. The most commonly used multi-criteria methods in planning studies in electric power industry are: utility function, tradeoff analysis, analytical hierarchy process (AHP), TOPSIS and PROMETHEE (L3).

3. Deregulation and restructuring in EU

The general objective of deregulation reforms in developed industrialized countries (i.e. the EU members) is introduction of competition and diversification of suppliers in order to decrease energy prices. Diversification of suppliers, especially of natural gas, is very important for energy dependent countries of the EU. Therefore the EU energy policy aims to increase security of energy supply in the future. Currently the EU energy needs are supplied form: oil (36.8%), gas (24%), coal (18.2%), atomic energy (14.4%) and renewable sources (6.4%) (L4). The EU countries produce 2/3 of their current energy needs. However by 2030 it is expected that this relation will be reversed. In order to avoid *energy dependency* the EU has adopted common energy policy aiming to increase energy mix and diversify energy sources. In order to realize the designed energy policy the EU aims to develop strategic partnership relations both with energy producers and energy (especially gas) transit countries. The South East Europe is seen as an important transit route for natural gas (and oil) pipelines from the Central Asia region and Turkey.

It is expected that natural gas will take more prominent role in the future energy needs of the EU. Currently the EU imports 1/2 of its gas needs (from Norway, Algeria and Russia). The half of the EU gas import comes from Russia. The natural gas use in the EU will be increased in households' consumption, in industry and especially in electric energy production. It is expected that between 2002 and 2030 the natural gas consumption for electricity production in the EU will quadruple. According to Austrian Energy Concern OMV by 2030 the EU will import 80% of its natural gas needs. With expected decrease in gas production in the North Sea (in Great Britain and Norway) the EU dependency on gas supply from Russia is expected to increase. Therefore, Russia will become dominant gas supplier for the EU. Europe's growing dependence on Russian energy and recent Russia's apparent willingness to use its energy power for political ends has fueled speculations that Moscow will use the "energy weapon" to try to influence future foreign or economic policy of the EU. All these issues have led Europeans to begin to plan more seriously for their future and to make energy policy a higher priority within the EU. Especially the EU intends to make use of the fact that European market is geographically close and secure market for the Russian gas. The EU is also a potential investor for modernization and development of the Russian energy industry. Therefore, the energy relationship between the EU and Russia is and will be one of mutual dependence. This situation of interdependence and conflicting interests at the same time between the EU and Russia will substantially determine their future political relations. Since South East Europe region is an important transit corridor for oil and gas supplies to the EU it is expected that conflicting interests of these "superpowers" will collide there and substantially influence the energy policies of countries in the region.

3.1. The EU Energy Policy

Although the EU 27 member states have ceded some sovereignty and competencies to the EU's institutions, they have retained the responsibility for energy policy. Decisions regarding long term energy priorities continue to be taken by the individual member states. Despite the lack of common European energy policy the European Commission (EC) has used its existing competencies in competition and environment and consumer protection policies to increase its influence over member states' energy policies. The proposed Treaty on a European Constitution would elevate energy policy to a "shared" competency.

In 1991 the EU launched the Energy Charter Declaration, an initiative intended to promote energy cooperation and diversify Europe's energy supply (L). The Declaration was followed by the Energy Charter Treaty (ECT) and that entered into legal force in 1998 and the Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA) which was signed in 1994, which established a framework of rules and agreements to promote international energy cooperation. Bosnia and Herzegovina, among more than 50 countries, ratified the Charter in 2000 and participated in the Review of Energy Charter process which was concluded in 2004. The Treaty and Protocol seek to create a level playing field of rules regarding *promotion of foreign energy investments, free trade in energy materials, freedom of energy transit through pipelines and grids, real-cost reflecting prices, promoting energy efficiency and providing mechanisms for addressing disputes.*

In March 2006, the European Commission (EC) released a "Green Paper" (L8) detailing continent's energy challenges and outlining broad policy options for a comprehensive EU-wide energy security strategy. The paper called on member states to complete the process of opening their energy markets, dismantle protectionist policies, and create a single European electricity and gas market by mid-2007. Other priorities included measures to encourage efficient mix of energy fuels to foster an integrated approach to climate change, to develop new energy efficient technologies, and to create a coherent external energy policy. In a January 2007 follow-up to the Green Paper, the Commission unveiled a series of more specific policy actions that were officially recommended to EU member states at the European Council summit in March 2007. In the area of sustainability the Commission proposes a 20% EU-wide reduction in carbon emissions compared with 1990 levels by 2020. It also urges EU member states to seek international agreement on a 30% reduction target by 2020 in a post-Kyoto Protocol carbon emissions treaty. To attain these goals the Commission envisions a series of measures to increase the use of bio-fuels and other renewable energy sources, with the target to produce 20% of energy from these sources by 2020, and to improve energy efficiency by 20% by 2020. Detailed analysis of European energy policy is elaborated in (L9).

3.2. The EU Electricity and Gas Directives

The EU Council of Ministers adopted a Directive concerning common rules of the internal electricity market (Directive 96/92/EC) in December 1996 and on gas (Directive 98/30/EC) in June 1998. These were superseded by Directives 2003/54/EC (electricity) and 2003/55/EC (gas) of June 2003. At the heart the Directives aim to transform electricity and gas industries from a monopoly basis to a one operated on competitive principles by making wholesale and retail competitive markets.

The 1996 Directive established rules in the following areas: generation, transmission and distribution, unbundling and regulation. It also had potentially significant implications for ownership and international trade. For the construction of new plants the Member States could adopt two options: *tendering and authorization*. Under tendering procedure generation expansion planning would continue to be centrally planned. An official body would determine the amount of capacity that needed to be built and the specifications bidders would need to meet. The lowest bid would win the tender. It is expected that winning bidders would be given a *long-term Power Purchase Agreement* (PPA) as a guarantee of volume and price of sales that would allow finance for the construction of the plant to be obtained. Under authorization anyone could build a plant, whenever and wherever they wanted providing it complies with legal regulations. From the point of competition authorization procedure enables free entry and free exit and contributes to market development.

The Directives also required Member States to open their market for large users and distributors. To enable generators and retailers to get their power to final consumers there were measures to ensure all competitors would be able to get non-discriminatory access to the network. There were three options: negotiated third party access (TPA), regulated TPA and the Single Buyer. Transmission and Distribution System Operators (TSO and DSO) would determine who would get access to the networks. They also determine the development of the network. Some corporate separation *(functional unbundling)* of the network and generation/retail activities was required as well. Even though the Directive did not require privatization, if the spirit of the Directive was to be followed and competitive markets introduced into generation and retail, in the countries where electricity industry was dominated by a single nationally-owned company new private companies

have to be brought in. For markets to be truly competitive no company would have to have a market share of no more than about 25 per cents.
The Directive was deficient regarding creating competitive markets in four areas: it did not require provision to break up dominant companies, it did not require creation of the whole sale market and retail market opening and there was no requirement for sector regulator.
In 2001 the EC introduced new Directive that accelerated market opening. In addition to the previous four areas the new Directive had provision on *security of supply*. Under the new Directive authorization would be the rule for generation expansion capacity. Member states could also use tendering procedure to promote "infant" technologies and to meet environmental objectives. It also specified that all consumers should be allowed retail competition by 2007. Regulated TPA was defined as the only option for transmission and distribution networks access. The methodologies for calculating network tariffs had to be approved by the regulatory body. Unbundling requirements were substantially strengthened: *legal separation* between TSO and DSO activities and generation or retail activities of integrated companies was required. The Directive also encourages international trade promoting construction between national systems. The member states were required to designate *a sector regulator* that had to have a competence to set at minimum network charges. It also committed the Commission to set up a European Regulators Group for Electricity.
The previous Directive had little explicit discussion on security of supply which was left to be dealt with under "*public service obligation*". It allowed Member States to impose public service obligation "to ensure security of supply and consumer and environmental protection which free competition, left to itself, cannot necessarily guarantee". The new Directive also acknowledged there was a risk that relaying on market signals might not be enough to ensure there was sufficient generating capacity. So the Directive allows Member States, in the event that sufficient generation capacity is not built on the basis of authorization procedure, the possibility to contribute to security of supply through the launching of a tendering procedure. This will require authorities to monitor the supply and demand balance sufficiently far in advance (at least six years ahead) to take remedial measures is a shortage appears probable. However this provision distorts the investment signals that exist in the markets and might prevent efficient market functioning.
From 2008 the Energy Security of Supply Directive has entered into force. The Directive is concerned with technical security of the electricity system and contained measures in the following areas: network security (adequate reliability standards of transmission and distribution networks), maintaining balance between demand and supply, network investment. Directive requires

to set-up an autonomous regulatory body. It also requires that owners of the network have no effective connection with companies that sell or produce electricity. To counter the risk that the savings in transmission operation will be at the expense of system reliability regulators are introducing performance standards. The Directive is also concerned with the security of supply peaking capacity. Detailed analysis of implementation of the above mentionned Directives in individual EU member states and how far efficient markets have been created in the EU is available in (L8).
For GEP consideration the following EU Directives and Regulations are also important:

- Directive 97/11 EC of March 3 1997 on the assessment of the effects of certain public and private projects on the environment
- Directive 2001/77/EC of September 27 2001 on the promotion of electricity produced from the renewable energy resources in the internal electricity markets
- Directive 2001/80/EC of October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants
- Regulation (EC) 1228/2003 of the European Parliament and The Council of June 26 2003 on condition for the access to networks for cross-border exchanges of electricity
- Directive 2006/32/EC of April 5 2006 on energy end-use efficiency and energy services repealing Council Directive 93/76/EEC

4. Energy community in south East Europe treaty

In developing countries and countries in transition electric power markets usually did not operate on economic principles. State subsidies were usual practice, both to demand and supply side. Reliability of systems was lower than in developed countries. Therefore main reason for deregulation reform was introduction of sound economic principles in operation of the sector. The reforms were mainly initiated to attract foreign investors thus providing necessary finances for investment in reliability and quality improvements.
Prior to the reforms the initial economic and technical conditions in transitional countries were different too. There had been no experience in operation of their economies in market environment. Majority of electric power systems in transition countries are relatively small systems (i.e. in this aspect Bosnia and Herzegovina is a typical example since its system had in 2006 the minimum load of 800 MW and maximum load of 2000 MW). This fact was emphasized by the load decrease during transition due to the restructuring of energy intensive industries. In energy "self-sufficient" transition countries the load decrease resulted in an excess of generation capacity (i.e. this recently

has been characteristic for Bosnia and Herzegovina system). Experience shows that "standard market model", which has been successfully implemented in much bigger systems of developed industrialized countries, is not automatically applicable to these systems. All this calls for precautions regarding complexity of the market design and timing of its implementation in these countries (L9). High social and financial costs of restructuring of power industry (in Bosnia and Herzegovina especially of the coal mining sector) in countries in transition suggest *phased and incremental introduction* of market mechanisms. All the above said indicate that short term (economic and social) strategic interests of countries in transition might require short term adaptation of the "standard" market model. Especially a delay in privatization process has been shown to be a right decision.

4.1. Power Sector in South East Europe

The countries of South East Europe (SEE) have no available major energy resources, with the exception of low calories coal - lignite. In general they are, in different degrees, dependent on the import of energy. This energy dependence is forecasted to further grow in the years ahead since an intensified economic development activity in the industrial sector is expected. General picture of the energy sector in SEE could be described by the following facts (L10):

- Generation plants and industrial energy end-use is technologically obsolete with very low energy efficiency.
- Thermal power plants are major sources of air pollution. CO_2 emission per GDP/pc is more than twice greater that the world average.
- The average energy consumption in households per square meter is 2 to 2 ½ times bigger than the average consumption in developed EU countries.
- More than half of the population for heating of houses and cooking uses wood and low calories lignite.

In order to secure the necessary energy supply for economic recovery and growth the countries of the region will have to modernize their power sectors and expand available local production. To realize necessary development project the region will have to mobilize required financing. Major part of it is expected to come in the form of foreign investments. Electric power generation represents a prime candidate for these activities. However, as a consequence of the socialist type economy, the regional electric power sectors had been operated on non-economic principles. They also were under a heavy political influence, mainly protecting "national" interests. Additionally, small size of individual national electric power markets might not be

attractive to foreign investors. In order to overcome possible problems in securing necessary financing for modernization and development the EC and the World Bank (WB) proposed and supported integration of national power markets and sector reform in line with the EC Directives and Regulations and EU energy policy.(L11, L12). Integration of the national power markets with free electric energy trade among the countries in the region in its core has the idea of *optimization of future generation expansion investments*. In order to support power industry financial viability tariff reform and improved payment discipline would also be required. Social safety net should be strengthened, too.
Implementation of the suggested reforms required realization of the following activities:

1. Existing thermal power plants had to be revitalized and modernized in order to increase their efficiency and decrease environmental impact
2. Enormous specific energy consumption per unit of industrial production had to be decreased
3. Efficiency of household energy end-use had to be improved and more efficient means of heating should be provided
4. In order to facilitate cross-border electricity trade within the region and with the EU, and thus improve security of supply and decrease costs, a common regional energy market had to be established
5. Future investment in new capacities should be evaluated considering regional perspective in order to achieve optimal allocation of new capacities
6. Supply of primary energy sources (mainly of natural gas and oil) should be secured through participation in international projects.

Activities 1 to 3 are primarily national responsibilities. Activities 4 to 6 require political and technical cooperation on the regional level and integration of the region into European energy market.

4.2. Energy Community of South East Europe Treaty

Signing of the Energy Community in South East Europe (ECSEE) Treaty on October 25th 2005 by Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Romania, Serbia and Montenegro and United Nations Interim Administration for Kosovo represented a major step forward in development of a regional energy market (for electricity and gas) in SEE. ECSEE Treaty represents *a legal commitment* to a process which started in 2003, as a Stability Pact initiative, following the signing of the Athens Memorandum under which countries in the SEE region agreed to develop a regional energy

market and to undertake reforms required to support this. Turkey has signed the Athens memorandum but not ECSEE Treaty. Nevertheless it will participate in the regional market. ECSEE Treaty calls for implementation of EU *acquis communautaire* on energy, environment, competition and renewable energy sources so the signing parties agreed to implement EC Directives and Regulations regarding electric power sector.
A number of significant challenges remain to be addressed if a regional power market is to be successfully implemented (L13). Chosen market design is an interim trading period, based on bilateral contracts between generators and eligible consumers, following which more sophisticated arrangements may be introduced, providing technical/institutional capacity permits. For the moment there will be no day-ahead market (except in selected countries) and real time balancing arrangements will not be market based. Cross border transmission tariff mechanism should be cost reflective. Dilemma regarding implementation of environmental regulations on regional or bilateral level should be resolved soon.

4.3. GEP in South East Europe - Generation Investment Study (GIS)

Adequate generation capacity is required in SEE in order that regional power market competition ensues. Therefore significant investments are required in power generation and transmission expansion and a framework is needed to support mobilization of required financing. In order to coordinate investments plans of individual countries the WB and the EC co-managed preparation of Generation Investment Study (GIS) on a regional base (L14). The objective of the study was to identify investment requirements to maintain capacity balance and to support market liberalization. GIS considered *regional based least cost* options for rehabilitation of existing capacities and construction of new lignite and gas fired plants and new hydro capacities to meet power demand in SEE over the period 2005-2020. WASP program was used in the analysis.
Under different scenarios, depending on future gas prices and influence of least-cost option of import of electricity from Ukraine/Russia, the following generation expansion candidates in B&H have been identified: rehabilitation of remaining production units in thermal power plants (Tuzla G6, Kakanj G7, Gacko and Ugljevik) and ongoing construction of TPP plant in Stanari as well as eventual construction of hydro power plants. However GIS represents an indicative GEP and some of identified investments might not be realized (L15).

5. Deregulation and restructuring in Bosnia and Herzegovina

Structure of electric power sector of Bosnia and Herzegovina (B&H) has been heavily influenced by the recent war. Presently three public electric power utilities, which are responsible for generation and distribution/supply, operate in B&H, namely:

- Electric Power Company of Bosnia and Herzegovina (Elektroprivreda B&H - EPB&H)
- Electric Power Company of Republika Srpska (Elektroprivreda Republike Srpske - ERS)
- Electric Power Company of Croatian Community Herzeg- Bosnia (Elektroprivreda Hrvatske Zajednice Herceg-Bosna - EPHZHB)

In Brčko District of B&H a separate distribution company – Elektrodistribucija Brčko, is responsible for distribution and supply of electric energy in this part of the country. Structure of electric power system is shown on Figure 5.1.

The structure of electric power industry in B&H is a result of the Dayton Peace Agreement between national political stakeholders. Such a complex electric power system presents substantial technical and economic challenge for planning and operation.

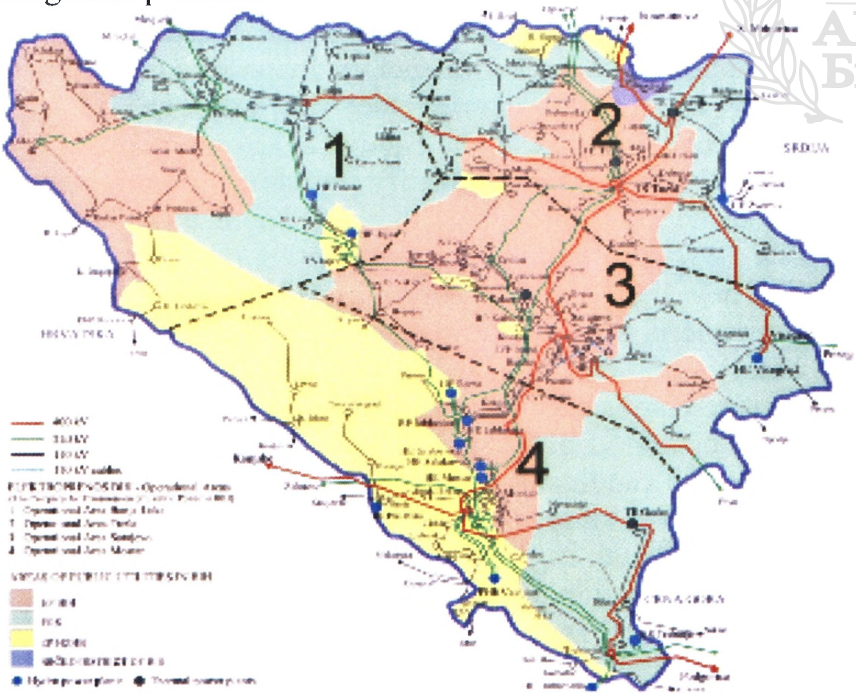

Figure 5.1 Structure of electric power system of Bosnian and Herzegovina

5.1. Reform and development documents

In 2000 necessary reforms were initiated in order to deregulate electricity industry and to increase its efficiency. Basic deregulation planning document "Bosnia and Herzegovina Power Sector Restructuring and Privatization Analysis and Action Plan" (L16), prepared by the PA Consulting in 2001, put forward recommendation for power sector restructuring and unbundling of electricity sector. It was initiated by the representatives of International Community (IC) and funded by the USAID. This illustrates the fact that reforms were "imposed" upon national political decision makers. IC substantially supported post-war reconstruction and modernization of electric power sector in B&H. This has been realized through consecutive Power Programs (Power 1-4 programs), led by the World Bank and supported by the other International Financial Institutions - IFI ((EBRD, EIB, KfW) and donors (EC,USAID, DFID, Canada, Spain, Norway, Italy, Switzerland and Japan). Power 3 and 4 programs, with the total funding of $496 millions, aimed to support the restructuring and reform processes in electric power sector.
The main objectives of the reforms were:

- Integration of electric power system of B&H
- Implementation of market oriented reforms
- Integration with SEE regional electricity market and with European Union power market.

Bosnia and Herzegovina does not have Energy Development Strategy at the national level (the EU supported project "B&H Energy Strategy" for a moment has been suspended). The only official B&H documents which to some extend contain segments of strategic policies in power sector are "Poverty Reduction Strategy Policy - PRSP", adopted by the Council of Ministers as Medium Term Development Strategy for 2003-2007, and the European Partnership which are setting goals for creating a competitive environment for electricity market and its integration into regional market. Instead of energy development strategy the legal framework for reform process has been Action Plans for Power Sectors Restructuring, adopted by the Parliament of Republic Srpska in 2003 and the Parliament of Federation of B&H in 2005. These documents established legal and institutional framework to support liberalization of electricity industry.
The reform process has been intensified following ratification of Energy Community Treaty, which entered into force on July 1 2006. So far the following main results in the transition to competitive market in B&H have been achieved:

- Power market regulators (State and Entities' regulatory commissions) have been established and *regulatory framework* is being developed (the Grid Code and Market rules are adopted, cost reflective Tariff Methodology and Third Party access rules are in place, etc.)
- Initial progress has been achieved in *industry restructuring* through establishment of a separate transmission company (TCO)
- Independent System Operator (ISO), responsible for system control, has been established. The ISO represents B&H in regional ITC mechanism (Inter TSO Compensation) and recently became associated member of ETSO (European Transmission System Operators)
- Functional unbundling of electric power companies (legal separation of generation and distribution/supply functions), that is required under the EC Treaty, is being implemented (in Republic Srpska legal separation has already been implemented).
- Since January 1st 2008 all non-household consumers are eligible buyers

5.2. Challenges to energy sector reforms implementation in B&H

Electric power market in B&H represents a typical *"market in transition"* with all deficiencies which characterize an unfinished market reforms. Additional problems in B&H, which present barriers for further implementation of the liberalization reforms, identified in (L17) are the following:

- There is no integrated state driven action plan for implementation of the reforms
- There is a big disharmony between growing international obligations and capacities of responsible state institutions for their implementation
- Neither Energy law nor Efficient Energy end-use law exist at the state level
- No Energy Efficiency agency/center exits at any government level
- No energy statistics is collected at the state level
- Mechanism for energy balance at the state level does not exist.

Additional obstacle for an efficient reform implementation presents "shared" responsibility in energy sector of the governments in B&H. Ministry of Foreign Trade and Economic Relations - MOFTER, established in 2004, is formally responsible for energy policy formulation in the energy sector. However, the entity ministries (Ministry of Energy, Mining and Industry of the Federation B&H and Ministry of Economy, Energy and Development of Republika Srpska) are *de facto* in charge of the entity energy sectors. In general, the main reason for these B&H specific problems is an *absence of* *political agreement* to implement reforms which will result in an *integrated and functioning B&H electricity sector from technical and economic aspects.* The following factors also present obstacles for development of efficient electricity market:

- According to current institutional setting there are three regulators operating in B&H. The entity regulators, among other responsibilities, are in charge of regulating generation companies. This *asymmetric regulatory structure*, combined with the absence of a mechanism for energy balance at the state level, has created problems regarding provision of energy balances (i.e. the energy balance of Aluminum Plant for 2008 was provided late in December 2007)
- *Public service responsibility* of power companies is not clearly determined. This fact creates situation where ISO has problems to secure secondary services (i.e. operational reserve and loss covering/allocation services) on a competitive base.
- Integrated energy market does not exist and ISO has not developed the market operator function. This fact creates conflicting interests between public companies' commercial interests (which prefer to export surplus energy) and interests of local consumers.
- Restructuring of the mining sector in FB&H has been delayed due to a lack of financial means (especially for financial consolidation and mitigation of social consequences of restructuring process). This endangers economically efficient operation of related TPP in a competitive market environment.
- Unfinished transition to market (with indication to revise reform process in transmission function)

Detailed analysis of power market in B&H is available in (L18).

6. Generation expansion planning challenges in Bosnia and Herzegovina

Economic development of B&H is dependent on establishing effective electric power sector. B&H is one of the few countries in the SEE region with potential for export of electricity. Therefore participation in an effective and integrated regional electricity market, based on SEEEC Treaty, is seen as an opportunity for economic growth and social progress in the state.
The main benefits of creating an efficient power sector through implementtation of the designed reforms are the following (L17):

- Increasing attraction of the sector for foreign investments
- Strengthening state level authorities
- Integration of the energy sector within the country creating single B&H energy market
- Integration of the energy sector in regional end EU markets.

6.1. Generation Expansion Indicative Investment Plans in B&H

Since 1990s there has been no major investment in B&H in new generation capacities. Through the restructuring (*financial consolidation and corporatization of the companies, with payment levels reaching above 90%, and rehabilitation and modernization of the existing generation capacities*) the public electric companies have created a solid base for investments in new capacities. A large private sector interest to invest in expansion of generation capacities in B&H, in order to meet growing electricity supply need of the country and electricity deficit within the region, has been shown as well.
ISO has developed Indicative Power System Expansion Plan for 2007-2016. In (L19) the following new generation capacities were analyzed using least-cost WASP GEP software for the period until 2020:
Thermal power plants at the existing mining facilities (total capacity app.1530 MW):

- EPB&H TPP Tuzla, G7 (450 MW)
- EPB&H TPP Tuzla, G8 (450 MW)
- EPB&H TPP Kakanj, G8 (450 MW)
- ERS TPP Gacko, G2 (330 MW)
- ERS TPP Ugljevik, G2 (300 MW)

Thermal power plants at new coal mine sites (total capacity app. 1750 MW):

- TPP Stanari (410 MW, in construction by EFT company)
- TPP Bugojno, G1 (350 MW)
- TPP Kongora, G1 (275 MW)
- TPP Tuzla B, G1 (500 MW)
- TPP Kamengrad, G1 (215 MW)

Hydro power plants:

- Total capacity of 746 MW in HPP in EPRS is analyzed.
- Total capacity of 654,7 MW in HPP in EPB&H is analyzed
- Total capacity of 252.1 MW in HHP in EPHZHB is analyzed

Additional investments of 1.624 billion KM for modernization and expansion of the existing coal mines and construction of new coal mine sites were identified in (L19). In the same study necessary investments for modernization of the existing TPP in order to achieve environmental requirements regarding emission of greenhouse gases are estimated to be 368 million KM.

In (L19) an analysis of potential electric energy production from Renewable Energy Sources (RES) is analyzed as well. The following potential generation capacities are considered:
Small hydro power plants with capacity less than 5 MW (total estimated capacity app. 460 MW):

- Total capacity of planned small HHP in Republika Srpska is estimated to be 212 MW
- Total capacity of planned small HPP in Federation B&H is estimated to be 177 MW
- EPB&H plans consider construction of 34.2 MW (EPB&H is in a process of constructing 29 mini hydro power plants in Konjic Municipality)
- EP HZHB plans consider construction of 39.6 MW.

Wind power plants

- Real potential of wind generation (in southern part of B&H) until 2015 is estimated to be between 400 and 600 MW
- Gas fired thermal power plants.
- Evaluation of a 300 MW combined-cycle gas fired power plant was considered.

6.2. Generation Expansion Investment Options

No state-wide uniform and transparent procedure exist for construction of new generation plants in accordance with recommendation from EC 2003/54. Major part of future investments is expected to be provided by international investors. Different approaches for investment models have been identified, namely:

- TPP Stanari is being constructed as a Build-Own-Operate (BOO) concession
- Rehabilitation and capacity expansion in TPP Gacko and Ugljevik are being structured as joint ventures between EPRS and strategic investors
- HPP Buk Bijela is planned to be constructed as a joint development project between electric power companies of Republika Srpska and Republic of Serbia.
- In Republika Srpska financing for HPP is planned to be secured by international investors, including IFI.
- According to the proposal of the Government of Federation B&H (L20) generating capacities' expansion in FB&H is planned to be developed according a "strategic partnership model", based on combination of Build-Operate-Transfer (BOT) and Partnership in Production Ownership

models. This proposal is currently under consideration for approval in the Parliament of FB&H.

- Development of small HPP in both entities is based on BOT concessions.

6.3. Generation Expansion Planning Challenges

Biggest challenge for efficient GEP in B&H presents the fact that no comprehensive B&H energy development strategy exists. Un-coordinated investments in expansion of generating capacities among the entities of B&H could only result in a distorted market with suboptimal economic decisions. It is also difficult to apply any GEP methodology if state level coordination is not achieved. Planned "coordinated" approach to development of energy strategy that recently has been agree among the entity prime-ministers and the chairman of the Council of Ministers, in power sector cannot guarantee efficient control of investment decisions.

Second biggest challenge is unclear decision regarding development concept. Current political decision makers base their strategic plans on a big export of surplus energy (each electric power company in B&H in their development documents stated that they aspire to become "a leading company" in the SEE region). However the real importance of each of them in the region does not justify such ambition. Generation of electric energy in B&H in 2006 amounted to 13,749 GWh (56% produced bay Thermal Power Plants - THP and 44% by Hydro Power plants - HPP). In the same year consumption amounted to 11,521 GWh resulting in the net electricity surplus/export of 2,126 GWh. According to (L19) average electric energy consumption per year in B&H from 2005 until 2020 is expected to grow by 3.4% per year. Average increase of consumption on transmission grid is expected to grow by 3% per year. Based and these estimations the electric energy consumption in B&H on transmission grid is expected to increase from 11.3 TWh in 2005 to 17.6 TWh in 2020. Depending on development scenarios it is expected that the maximum load of B&H system will be in a range between 2660 to 2960 MW with load factor between 66% and 68%. In (L19) the scenario with most optimistic expansion plans estimated export to maximum 6.000-7.000 GWh (which is equivalent to a capacity of 1.000 MW in new TPP). These figures are characteristics of a rather small power system. I accordance with the stated political decisions all EPC submitted GEP which are substantially above the expected needs of B&H market. Opponents to these policies prefer "sustainable" development concept (including intensified energy efficiency programs and RES) with much more moderate generation expansion. They also emphasize that sustainable development will rationalize exploitation of local reserves of coal.

Third challenge to aggressive expansion plans is the fact that, according to (L14), there are more competitive electric energy production options in SEE. Especially potential of Kosovo coal reserves (with estimated coal price of 2 KM/GJ) which could be the base for more than 5.000 MW of feasible production in TPP, presents the competitor that B&H future generating TPP plants cannot compete with. Therefore detailed feasibility studies of candidate generating capacities first must find potential market for new export electricity production.

Finally overwhelming influence of political decision makers on energy policies, and especially on GEP, presents a danger that energy sector might be used for short term political benefits. Influence of political decision makers (in theory of electricity liberalization called "*political economy*") on reforms in power sectors in transition countries is rather a rule than an exception. And it is not always destructive (i.e. successful reforms in Slovenia, which had been designed and implemented by its government, presents a good example). However, due to complex governance structure of B&H influence of political economy is likely to be a major obstacle to development of efficient electricity market and optimal generation expansion strategy.

7. Conclusions and recommendations

Stated objective of all political decision makers in B&H is intention to position electric powers sector as important economic development driver. It is expected that this industrial sector should provide FDI, transfer of technologies, energy security, development of industries in its supply-chain (down-steam mining industry and up-stream energy intensive industries) and supporting industries (construction industries and eventually R&D), export and creation of new jobs. Potential for realization of this vision is seen in natural resources (coal and hydro-potential) of the country and favorable position in the region regarding balance of electric power demand/supply. Therefore introduction of market mechanisms in electricity trade in SEE region and integration of B&H power sector in regional and EU markets is seen as a development opportunity. In order to optimally exploit this comparative advantage, B&H stakeholders should efficiently plan use of its natural resources and develop adequate B&H research and planning capacities. Most critical element of power system development planning process is GEP.

In GEP in B&H the following external factors have to be considered:

- Electricity will be freely traded in the regional and the EU market

- Capable competitors exists in SEE market (i.e. Kosovo coal based TPP) and only most competitive generating units will be able to export electricity (for indicative least cost GEP see GIS study)
- Option outside the regional energy resources (i.e. imported high quality coal, gas and import of electricity from Ukraine/Russia should be considered as well).

Various internal factors (in this paper referred to as challenges) should also be considered as well. In order to overcome challenges and barriers to efficient GEP the following recommendations are proposed:

- Restructuring of electric power industry should be completed. In FB&H restructuring and modernization of the mining sector is prerequisite for developing efficient electric power industry.
- Energy law and Efficient Energy end-use law should be adopted at the state level.
- B&H Energy Efficiency Agency should be established.
- Energy Development Strategy and integrated state driven action plan for its implementtation should be adopted. Capacities for its regular up-date and fine-tuning should be developed.
- Capacities of state institutions in energy sector should be strengthened in order to enable B&H to fulfill its international obligations. Energy statistics at the state level should be collected.
- Efficient realization of GEP strategy requires building of wide social consensus which only could be realized through a *transparent and inclusive planning process*. Therefore procedures for involvement of scientific institutions, non-governmental organization and public in general should be developed.

Providing the suggested recommendations have been realized the following GEP process could be implemented:

- Sustainable development concept should be the base for GEP. Planning of generation expansion for export should be done on a market base. In the absence of state-level energy strategy entity-level strategies could determine strategic direction for sector development (i.e. L20).
- Electric power companies, both public and private, should be treated as *competing market players*. Each of them will have to develop its strategic development plans, incorporating generation expansion investment plans (i.e. L21). Initially these plans will be considered as indicative generation expansion alternatives.

- State level regulator (SERC) and ISO will be responsible to analyze these plans, mainly from reliability criteria, using appropriate GEP models and methodologies. The result of these analyses should be information regarding an optimum investment strategy. Initially least-cost GEP models, like WASP, could be used.
- Entity regulators will be responsible for authorization of GEP for internal B&H market. The least-cost option alternatives will be preferred.
- Investment risk for GEP which objective is electricity export should be bored by the electric power companies. Authorization of these generating capacities will be performed only from procedural aspects.

Based on the methodology explained in 2.2 this approach should lead to an equilibrium investment solution.

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CONCLUSIONS

All matter presented at the International Scientific Colloquium "Decision making principles in building of electric power sources" including discussions and suggestions of all Colloquium participants, was subject of careful analysis which has been done by all invited lecturers and Commission for conclusions of Academy of Sciences and Arts of Bosnia and Herzegovina.

Based on the analysis, next conclusions have been formulated:

General:

I. Energy is the basic precondition for the development of the humanity and a vital interest for society as a whole. Demand for energy is cons

II. tantly increasing, with the increase in the demand for electricity exceeding that of the demand for other forms of energy.

III. Decision making in the realm of developing electrical energy sources is the sovereign right of every state.

IV. Adequate and continuous education and development of scientific and research work is a precondition for competent knowledge and professionals existence, as well as for making of valid decisions in the area of electrical systems development.

V. Building of new electrical energy sources must lead to an increase in social welfare and the preservation/improvement of the environment.

VI. It is necessary to define "general social interest" in legal terms.

Particular:

- Reforms in the electrical energy sector imply considerable potential advantages, but also the risk of significant potential losses if they are not fully and appropriately conducted.
- It is very important for electrical energy reforms to have strong political support.
- Adequate coordination and harmonisation of the development process in the electrical energy sector is possible only if a development strategy for the electrical energy sector is adopted on the B&H state level.
- The basis for good planning of development of electrical energy sources are analyses and projections of economic development in the country and long-term projections of the increase in electrical energy consumption.
- Investment in production capacities for the sole purpose of exporting electricity is justified only if it does not interfere with the security of providing of electricity to own consumers and if long-term export contracts ensuring economic justifiability exist.

- In defining development plans for electrical energy sources in B&H, it is necessary to take into account the provisions of the Energy Community South East Europe Treaty and EU policies.
- Before deciding to build new electrical energy sources, it is necessary to consider a number of concrete solutions including all the repercussions on the environment and the population (population displacement, flooding of arable land, destruction of rare flora, waste disposal, resources depletion, land and air pollution), and choose the solution minimising such undesirable effects.
- Plans for the construction and reconstruction of new electrical energy sources must be negotiated with local communities in a timely manner and must contain methods of resolving individual and collective problems of the population with a view to bringing them certain advantages.
- Study for the development of an environmentally acceptable electrical energy sector in the whole of Bosnia and Herzegovina should be done by experts from Bosnia and Herzegovina in cooperation with other international experts.

The existence of a large number of very successful electrical energy companies in state ownership disproves the widely held belief about the greater efficiency of private companies on the electrical energy market.

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