THE CHALLENGES OF SUSTAINABLE ENERGY IN SERBIA

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1. The Serbian Energetic – Status and Problems

As a country undergoing reforms, Serbia has gone through a period of great challenges related to market disintegration of socialist Yugoslavia in 1991. This includes not only the bloody war resolution, but international sanctions, hyperinflation, and the NATO bombing of the 1999th. After entering the period of peaceful transformation to a market economy, rule of law and political democracy, Serbian society is still suffering from the problem of late transition, poorly designed and implemented privatization, corruption, lack of power of the new institutions, as well as the serious consequences of the recent global economic crisis. All these effects are visible in the energy sector (Djukic, 2011). However, this situation should soon be changing for the better in terms of open market economy, international competition, and strategic planning of sustainable economic and social future in a spirit of preparation of Serbia's candidacy for EU membership.

1.1. The Losses – Legacy and Changes

The main requirements placed on the country where reform is being implemented are economic efficiency and sustainability of economic sectors. It is known that the former socialist countries were the real energy spendthrifts. Thus, for example, the loss of electricity "on network" (in transmission and distribution) in Serbia in 2001 was among the highest in Europe. It amounted to 19 percent. At that time, Romania and Bulgaria had losses of 12 to 13 percent. Almost ten years later, Serbia is no longer "first" country in Europe by losses. On the map of energy losses have emerged, with something worse indicators: Albania, Montenegro and Former Yugoslav Republic of Macedonia (Fig.1). However, in relative terms, situation is even worse for Serbia. It shows the relative relation between Serbia and advanced nations in the reduction of energy losses. Serbian losses "on network" are, in fact, reduced only by 1 percent (Djukic, 2011, a).

Following all the programs of modernization, reorganization, restructuring, etc., domestic electric power company EPS (Electric Power Industry of Serbia) was split into two companies, and one organizational segment (Public Company for Underground Coal Mining) was extracted from the system in 2004. Regardless of these changes, losses on the network were reduced only by 1%, and losses in the business of EPS are measured in billions of dollars (57 billion dinars or more than 500 million Euros only in 2010). Furthermore, in early 2011, an investigation for abuse of office and misappropriation in some companies was opened[1], worth tens of millions of Euros.

A comparative analyses shows that losses of the electric power industry of Croatia, which is by the heritage and technology similar to Serbian, have been halved during the transition period, and they amount to almost half of Serbian losses. Slovakia, for example, managed to reduce its own losses from 8.8 percent to just 3.5 percent, which, along with Finland, is a record for the EU 27 (Fig 1).

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[1] There is evidence that the usurpation of public funds occurred because of the involvement of the private companies to operate in Kolubara Company that is part of the EPS. Related news, which unfortunately remained at the level of scandal or unconfirmed investigation (due to lack of evidence), were coming in 2005 and 2006 as a result of purchasing electricity from the exclusive suppliers at the international market.

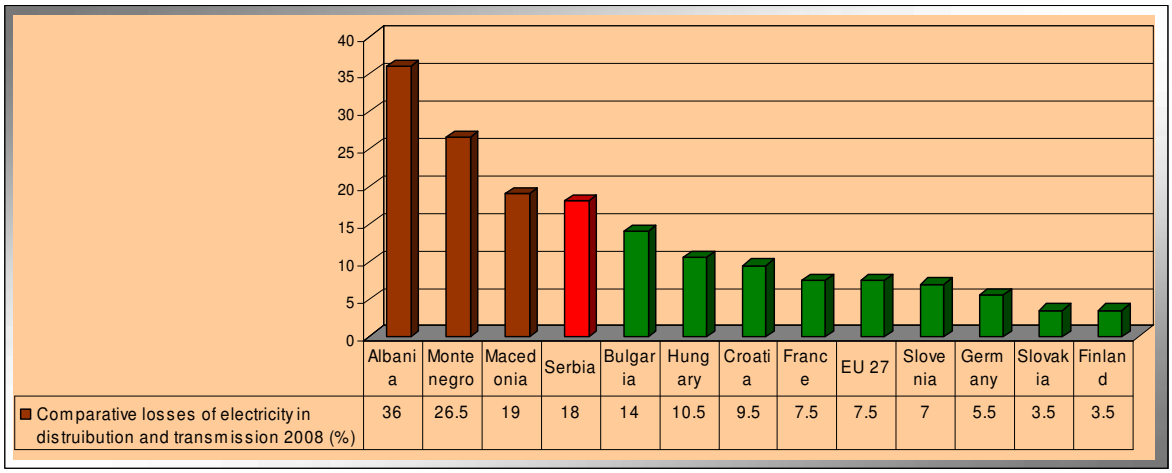

Fig 1. Comparative losses of electricity in distribution and transmission – Serbia, neighbouring countries and some European countries (Source: Eurostat)

1.2. Energy Efficiency

According to some measures and comparisons that were made after 2000, it turned out that Serbia has a huge disadvantage from energy efficiency, not only for EU countries, but for the majority of those in the region. As for the OECD countries, in 2005 Serbia was four times lower energy efficient than they. However, Serbian gross domestic product (GDP) per capita expressed in foreign currency has grown slightly faster since 2000, not only in real terms, but also due to appreciation of the Serbian dinar exchange rate. This is why the dollar GDP has been growing faster than the real one, expressed in dinars, i.e. measured by the internal purchasing power of dinar.

So there has been rapid growth of income expressed in Euro or dollar. In this way, Serbia is artificially made closer to previously mentioned countries. Energy efficiency is still increased, as previously increased in countries in transition, which not so long ago became part of the European Union. However, it appears that a key reason for increasing their energy efficiency was the price of energy, especially electricity.

Electricity price in Serbia even today is among the lowest in the region. Here is one illustration. If the Serbian GDP is shown based on the present exchange rate relations (for example, official market dinar-Euro relation), it could be noticed that the GDP declined in 2009 and 2010 (slightly more than in real terms). The total GDP is just under 29 billion Euros, and measured per capita it is just over 4,000 Euros. Given the volume of economic activity, if the energy consumed per unit of product is measured (for example, 100 Euros per unit of product in Serbia and the EU), it leads to data that the energy intensity of Serbia, measured by primary energy consumption per unit of product, is 3.1 times higher compared to the average of EU countries.

However, one should bear in mind that purchasing power of gross domestic product unit indicator (100 Euros) is not the same in Serbia and the EU. Namely, if the Serbian GDP is expressed by purchasing power parity (PPP), it seems that, when compared in such a way, the energy efficiency in Serbia is slightly less than three times lower than the one in the EU (more precise, in 2008, the Serbian GDP would be 37 percent of the one in the EU). In this case, the comparison of the energy efficiency shows that the primary energy consumption per capita in Serbia is 1.6 times higher than in the European Union.

That is, naturally, followed by the problem of unfavourable structure of consumption, particularly of electricity. Serbia currently consumes the most electricity for heating. It is still highly unsustainable “solution”, giving the dominant way and costs of obtaining this final form of energy. Electricity production in Serbia is highly carbon intensive, since more than two-thirds of electricity comes from combustion of lignite of poor quality, with

outdated technology and inefficient purification systems. The fact that Serbia is not an urgent issue with CO_2 emissions per capita, is only because of the fact that its industry, due to the collapse that has happened over the last two decades, is still at a level that does not exceed half the volume of 1989. However, energy consumption per capita is growing faster than per unit of production, so that the problem of limited carbon dioxide emissions, in light of the EU practises, will already occur over the next 5 to10 years.

2. Main Economic-Environmental Problems

During the winter time, two thirds of the Serbian towns (where natural gas has not been implemented yet), look like "smokehouses", due to excessive usage of local lignite and high concentrations of soot and dust. For example, along the corridor Kolubara–Obrenovac (area located 40 km south-west of Belgrade) power plants are operating on lignite, as well as their ash and lignite mines. In the area of 26 miles as the corridor extends, pollution affects the quality of air seriously, which results in a high incidence of respiratory diseases and respiratory tract in the region (Markovic, Pavlovic, 2006). In the mentioned article, it is also stated that the lignite-fired power plants in Serbia are not equipped for continuous monitoring of emissions of waste into the atmosphere, making it difficult to assess environmental risks.

The problem of ecological sustainability of Serbian energetic, as elsewhere in the world, can not be solved outside the economic context, i.e. energy market issues, and economic energy prices. In this sense, energy prices policy is an important segment of the strategic orientation towards sustainable energy.

However, the market price of electricity in Serbia ranges from 5 to 14 eurocents per kilowatt hour (depending on the monthly consumption, and the dinar-Euro relation), which is well bellow the European average. In contrast to electricity, natural gas for households, together with the value added tax, costs about 40 eurocents per cubic meter! It is already very close to the European average. The highest relative energy prices are those of quality oil products, which currently exceed the final price of 1.3 Euros per litre! This means that energy costs for citizens of Serbia, whose average monthly salary during the first half of 2011 is about 350 Euros net, are a relatively high family budget item, so they simply resort to reduce the consumption. However, it does not contribute significantly to raising energy efficiency, primarily due to high losses in manufacturing and transportation, lack of transparent pricing, and poor organization and corruption in still monopolized energy sector.

Systematic resolution of these difficulties is only possible by long-term strategies measures aimed at meeting the energy needs of the economy and citizens, in a way that improves the quality of environment and, with a necessary social balance, contributing to overall economic and social development. This commitment was adopted in the Sustainable Development Strategy (2008), with the relative delay, after many crucial changes in the economic system and economic structure, such as inefficient privatization, shutting down numerous companies, lack of successful restructuring, etc. One of the promising measures could be implementing on environmental taxes. For example, in the EU, every 10 Euros of fee per tonne of CO_2 emission leads to an increase in production costs in the lignite-fired power plants for about 1 eurocent per kWh. At the same time, one percent increase in production from renewable sources, means increasing price by nearly 1 percent.

The European Union has committed to increase the share of renewable energy sources from 8 percent in 2005 to even 20 percent in 2020. Serbia, officially, has a somewhat larger share of renewable sources in total energy consumption, but it's only due to the high share of hydropower in electricity production (26 to 29 percent average per annum, depending on the hydrological situation). In 2008, for example, that share in the total energy consumed in Serbia, according to the Ministry of Energy and Mining, was 13 percent. However, renewable sources, according to EU standards, do not include large hydropower plants, but only those up to 10 MW. Considering that in hydro energetic of Serbia dominate large hydropower plants, inherited from the socialist period, according to the EU methodology, the share of renewable sources in the total energy consumed in Serbia is less than 2 percent.

Despite this unfavourable structure of energy production, Serbia still has significant untapped hydro potential, especially suitable for small (mini and micro) hydropower plants.

In any case, Serbia has committed to, firstly, the environmental upgrading of existing energy capacity (modernization of the oil refinery, desulphurization and denitrification of output coal-fired power plants); secondly, increasing natural gas imports from Russia (investment in new pipeline construction) and, thirdly, increased use of renewable energy sources (Djelic et al. 2009).

3. The Challenges of Fossil Energetic

Serbian Oil Industry (NIS) is privatized on January 2008, when the Russian company "Gazprom Neft" bought 51 percent shares of NIS. A year later, representatives of Russia and Serbia signed a contract to build a new gas pipeline by the name "South Stream" (from Russia to Austria and Italy) which will partially pass over the Serbian territory. Once this new gas pipeline is completed (scheduled for the year 2015), it will be annually exported via its route from Russia 43 billion cubic meters (Bm^3) of gas to Serbia, Northern Italy and Austria, and 10 Bm^3 to Greece and Southern Italy [Energy View of BSEC Countries, 2008]. In this way, the Balkan and Apennine peninsula will be fully supplied with gas from Russia and secured from the consequences of the current political turmoil in the countries of North Africa.

In mid-2010, the project of revitalization of the Pancevo oil refinery (the city located 15 km east of Belgrade), worth 470 million Euros, was initiated. Upon completion of the works, scheduled for 2012, about 4.5 million tons a year of "Euro 5" quality fuel, with minimum sulphur content, will be getting out of the refurbished refinery, what is totally in accordance with the EU requirements (http://www.mre.gov.rs).

As for revitalization of Serbian coal-fired power plants, the initial steps were made in 2004, when the German companies had revitalized the old Thermal Power Plant (TPP) "Kolubara". Regarding this, in early 2011, Serbia was visited by delegation of several Japanese companies. Local officials have been negotiating a project of gas desulphurization of the major TPP "Nikola Tesla" in Obrenovac of more than 3.000 MW power. The two technologies for removing SO_2 from the gas emission were compared: technology with the use of limestone (the final product obtained is gypsum) and technology with the use of ammonia (the final product is ammonium sulphate – one-component nitrogen fertilizer). Although limestone-gypsum technology is widely applied in the world, we believe that ammonia–ammonium sulphate solution is better one for the Serbian thermal power plants. This technology eliminates the problem of creating gypsum landfill and reduces the amount of waste water.

Anyway, the town of Obrenovac, which is located 30 km west of Belgrade, is the leading city in Serbia in implementation of solar energy. Only in 2010, in this town three large solar collector systems were installed, and a public mobile phone charger, whose batteries are charging power from solar cells.

4. Renewable Energy Sources

The transition to a sustainable energy system, based on renewable energy sources, is of high importance for many reasons. Firstly, reducing consumption of fossil fuels has serious environmental and health benefits. Secondly, it reduces energy dependency and conflicts related to energy resources on a global level. And thirdly, market development of renewable energy sources and creation of new industries create promising opportunities for economic development (Luethi, 2010), particularly in rural and remote areas.

Technically exploitable potential of renewable energy sources in the Republic of Serbia is substantial, and estimated at 4.3 million tonnes of oil equivalent (toe) per year. Out of that, 63 percent is biomass, 14 percent – untapped hydropower potential, 14 percent – solar energy, 5 percent – wind energy, and 4 percent – so far discovered geothermal energy resources.

4.1. Biomass

The total energy potential of biomass in the Republic of Serbia is estimated at 2.7 million tonnes of oil equivalent per year. It consists of about 1 million toe of the residues in forestry and wood processing industry (Glavonjic et al. 2009), and about 1.7 million toe of residues in crop production, livestock breeding, wine production, and primary processing of fruits. Biomass energy potential in livestock production, which is suitable for biogas production, has been estimated at 42,000 toe. In recent years, the production of biodiesel from rapeseed, soybean and sunflower has started. In Serbia, for the biodiesel production is installed equipment capacity of 145 000 t/yr. However, production of biodiesel is practically stopped. Procedure regulation for mixture of biofuels and mineral oil are needed (Gligorijevic et al. 2009).

In mid-2010, the Government of Serbia adopted a so-called Biomass Action Plan (BAP). The plan is drafted in co-operation with the Dutch government and Dutch projects of biomass and bio fuels implementation. The aim of the Action Plan is to define strategy for the use of biomass. Accordingly, the main objectives of the Action Plan are revision of current policies and the creation of sustainable modes of production and consumption of biomass energy in Serbia. At the same time, one of the main challenges of BAP is to identify issues in the implementation of biomass energy, and to define actions to overcome them (Van Erp, 2009). Although primarily focused on short-term actions (by the end of 2012), BAP includes recommendations concerning the long term.

4.2. Hydro Energy

The energy potential of small water streams in Serbia, suitable for construction of small hydro power plants (SHPP), amounts about 0.4 million toe per year, or about 10 percent of overall renewable energy sources potential.

Investment opportunities for small hydropower plants are as follows:

- Revitalization of old and out of operation SHPP (30 locations),
- Building up new SHPP:
  - 900 locations (5 to 10 MW each)
  - 39 locations (2 to 5 MW each).

According to the Agreement between the Energy Ministries of Serbia and Italy, signed in March 2010, it was planned to build 14 small hydropower plants on the Serbian rivers Drina, Ibar and Sava, a total capacity of about 590 MW. Electricity produced from these hydropower plants would be exported to Italy, where the electricity price is four times higher than in Serbia. As regards Serbian rivers, the largest hydro energy potential has Drina River (Sandic, et al. 2009). There is a plan for eight new hydropower plants, a total power of 830 MW, to be build up through the Join Venture project (http://www.eps.rs).

4.3. Wind Energy

Wind energy potential in Serbia is estimated at about 1,360 megawatts, based on available analyses and studies. It is concluded that the best chance of setting a wind farm has an area of Eastern Serbia. Along the valley of the Danube River, downstream from Belgrade, during the cold period of the year, blows very strong east wind, called the “koshava”. Koshava strikes may be stronger than 20 meters per second. According to the feasibility studies done so far, modern windmills of individual power of 3MW, in “koshava area” of Serbia, could produce electricity at a cost of 0.05 Euros per kilowatt hour. If it would be invested 62 million Euros in a wind farm of 45 MW power, with the electricity price of 11 Eurocents per kilowatt hour, it would result in internal rate of return of 14.7 percent and 7-years payback time (Kragic, et. al., 2009). For this reason, by mid 2010, nine permits for the construction of nine wind farms were issued, a total capacity of 1,390 MW. Still, there is none modern windmill in Serbia yet. Integration of wind power in the transmission system is currently the most important technical issue. The main problem to be solved is to determine maximum power of wind generator installation at

the regional level and at the level of the system as a whole, and to thus preserve the safety of the transmission system (Subotic, et al. 2011).

4.4. Solar Energy

On an annual basis, the average value of solar radiation on the territory of the Republic of Serbia ranges from 1,200 kilowatt hours per square meter in the northwest, up to 1,550 kilowatt hours per square meter in the southeast. Consequently, solar power in Serbia has the energy potential of 0.7 millions toe per year on average. It is used most for heating water in households, hotels and sports centres. Solar energy is also widely used in passive sun houses. The number of passive sun houses, built during the last 20 years, in the former Yugoslavia is about 1,300 (Lovric, 2011). By glazing of the south side, improving thermal insulation and construction of thermal storage in buildings, can be saved 1/3 up to 9/10 the necessary heat. This has been achieved in a sun house in the village Boljevci (Posavina region). The current consumption of 15 kWh of electricity per square meter per year of this house is far lower than 40 kWh which is the world average for the energy-efficient house (http://www.altenergija.org/en/stories/sun-house).

In recent years, the use of silicon solar cells is rapidly increasing in Serbia, mostly for traffic signalization, but also for the lighting of some strategic facilities (Djukanovic, 2004). One of these buildings is a monastery of the Serbian Orthodox Church by the name of Hilandar, located on Holy Mount in northern Greece. Lately, the energy needs of the Monastery have increased due to the increased number of pilgrims and electrical appliances. Because of that, new solutions are currently considered, for the current diesel generator system to be supplemented with 40 kW solar cells system (Nikolic, et al. 2011).

Creating the conditions for market development of solar cells is of great importance for the economy and environment. One smart way is installing the photovoltaic (PV) systems on schools. Accordingly, in June 2009, the Energy Efficiency Agency of Serbia has selected three representative secondary schools: the Secondary Technical School “Mihajlo Pupin” from the town of Kula, the Secondary School of Technical Engineering “Rade Koncar” from Belgrade, and the High School from the town of Varvarin, to be the partners in the project of photovoltaic system, funded by the Government of Spain. Total project costs amount to 120,000 Euros, not including the value of solar cells of peak power of 16 kW. The consultant of the project, the company NIPSA from Madrid (Spain), will provide all the additional equipment, which will allow direct access to the transmission network of Electric Power Industry of Serbia (EPS). Over the next 12 years, according to the Decree of the Serbian Government, EPS will buy up electricity produced by the solar cells systems, at a price of 23 Eurocents per kilowatt hour (http://www.altenergija.org/eng).

In the period to come, it is necessary to increase activities in order to further promote the implementation of solar cells. An excellent example is the public solar charger of mobile equipment, called “Strawberry Tree”. It is the invention of a group of students of technical faculties of the University of Belgrade. “Strawberry Tree” experienced the world promotion in October 2010, when it was installed at the City Square in the town of Obrenovac. In addition to its main function, public solar charger of mobile phones will have an important educative role amongst young, to understand the importance of the implementation of renewable energy sources.

The latest news is a project of the first photovoltaic power plant, of which cornerstone was laid in late June 2011, on Mount Zlatibor (Western Serbia). According to the investors, the Electric Power Industry of Serbia and Dunav Insurance Company, a solar power plant of 5 MW power, worth 15 million Euros, should reach full capacity before the end of 2012 (http://www.dunav.com).

4.5. Geothermal Energy

Geothermal energy can be used in a value of about 0.5 million toe per year. More than 60 Serbian municipalities have natural hot water sources in their territory. Water temperature often reaches 40 degrees Celsius. Only six local municipalities have geothermal sources warmer than 60 degrees Celsius. That potential allows the use of

geothermal water for the treatment of diseases, heating houses and work space, heating greenhouses in agriculture, and in fishery. In spite of that, geothermal power in Serbia is now used mainly for spa-therapeutic purposes, and very little for space heating.

Economically, the use of geothermal energy in Serbia, in addition to space heating, is most suitable for agriculture, drying grain, and vegetable crops. In this regard, significant geothermal sites are located in northern Serbia (Vojvodina), as well as in the valley of the Sava River, west of Belgrade (Macva region). Based on local geological, hydro geological and hydro thermal features, thermal power of the Macva region is calculated at about 360 MW. This makes it one of the most attractive hydro-geothermal sites in Europe (Milivojevic, et al., 1996).

As for the production of electricity from geothermal sources, currently the best prospects has Vranje spa (southern Serbia). In this area, hot water temperature in the existing wells, at a depth of 1,600 meters, amounts 120 ºC. According to estimates based on a new research made by Canadian companies, a geothermal power plant could be built at that spot. That power plant would have an output of 25 to 50 MW and would function on the principle of binary cycle (Geothermal Power Plant in Vranje, http://www.altenergija.org)

5. Instead of Conclusion: To Sustainability – Between the Market and Renewability

Serbia today is definitely adjusting to organize economic life in accordance with standards of the European Union. It is not only the official institutional approach, but also demand resulting from the association process, just before candidacy for European community of nations. In this context, significant economic changes that have been made at the level of the economy as a whole, require a far more determined and consistent approach to energy reform in Serbia. This reform requires changes as follows:

• On the one hand, market reforms, integration into the European market, as well as the internalization of externalities in the pricing policy. Serbian energy sector has much more to act in accordance with market requirements which are arising from regional and international competition, and the need to rationalize and reduce production costs.

• On the other hand, "ecologisation" of energy, switch to cleaner forms of energy, raising energy efficiency, and shift, as much as possible, to renewable sources and greater use of "green kilowatts".

The year 2010 can be considered a turning point for Serbia when it comes to implementation of the renewable energy sources. Namely, on January 1st, 2010, entered into force the long-awaited Decree on Measures of Incentives for the Production of Electricity Using Renewable Energy and Combined Production of Electrical and Thermal Energy (hereinafter: Decree). By the adoption of this Decree, official bodies of Serbia gave "the green light" to private investments in renewable energy sources, after decades of "yellow light", i.e. verbally supported, but in fact banned.

This Decree stipulates in detail the incentives for the production of electricity using renewable energy sources, as well as for the purchase of energy produced in such a way – *Feed-in Tariff* (*FIT*) (Table 1). Energy facilities that produce electricity from renewable sources are also defined, as well as the contents of the contract for the purchase of energy, and amount of reimbursement to the buyer of that energy.

The Decree will be applied in the period January 1st, 2010 – December 31st, 2012. The rights and obligations of the buyers and the privileged producers of electricity from renewable sources will be specified in a written contract for the next 12 years, according to the Serbian Law on Energy. The main goal of the Decree is to reduce consumption of fossil fuels. Other goals include: reducing greenhouse gas emission, reduction of fossil fuel import, the development of local industry and job creation. The planned capacity for the construction by the end of 2012 amounted to at least 45 MW from small hydro power plants, 45 MW from wind plants, 5 MW from

photovoltaic plants, 2 MW from biomass plants and 5 MW from biogas plants, a total investment of about 200 million Euros.

Table 1. Feed-in tariffs in Serbia

Type of power plant	Installed capacity (MW)	Feed-in tariff (€c/kWh)
Hydro power plant	0,5 to 10	10,3 – 5,9
Biomass power plant	0,5 to 10	13,8 – 11,4
Biogas power plant	0,2 to > 2	16,0 – 12,0
Landfill and sewage gas power plant		6,7
Wind power plant		9,5
Solar power plant		23
Geothermal power plant		7,5
Fossil fuel-fired CHP plant	0,2 to 10	10,4 – 7,6
Waste-fired power plant	1 to 10	9,2 – 8,5

Source: Decree on Measures of Incentives for the Production of Electricity Using Renewable Energy and Combined Production of Electrical and Thermal Energy (www.mre.gov.rs)

However, for acceptable solutions of energy future, it is necessary to review all possible scenarios concerning sustainability. Sustainable energy in Serbia would have to be *far cleaner, more efficient, and increasingly renewable and perspective*. This is not an easy task, given the situation of quite old thermo power plants and limited financial capacity to fund new facilities of cleaner and more efficient energy. This task becomes more urgent, not only in the light of environmental sustainability and requirements related to the lower emission of carbon dioxide and other greenhouse gases, but especially when it comes to the structure of production and consumption of energy.

Given the current direct parameters, parity prices are not very favourable for alternative such as renewable energy. Therefore, it can be felt some kind of "tiredness" in some EU countries which promote renewable energy, mainly with taxpayers' money. How long and at what cost will taxpayers tolerate such a spending? On the other hand, there is an irrefutable fact of the necessity of more pressing energy transformation to renewable, cleaner and abundant sources.

These issues, unfortunately, are not on the top of the Serbian government agenda during the crises. More than anything, there is concern about the unstable, expensive, "dirty" and technologically obsolete "classic" energetic. However, strategic issues of sustainable energy future for Serbia should not be overshadowed by the everyday problems of the economy and energy. In any case, Serbia will have to make far more effort in both directions of economic and political activities: on the one hand, in more efficient, more cost-efficient, safer and more consistent market-oriented energy, and on the other hand, in a cleaner and more renewable energy. For all of that, Serbia will need capital, human resources, technological and other kind of knowledge in the decade to come.

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