

Kosovo: Kosovo Power Project
Report of the SFDC External Expert Panel
to the World Bank

János M. Beér

Wladyslaw Mielczarski

Derek M. Taylor

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1. Description of the project

Lignite-fired electricity generation is responsible for 97% of the total generating capacity in Kosovo. At the moment, there are two operating plants, Kosovo A and Kosovo B, both fuelled by lignite from the Mirash and Bardh mines (that will be exhausted this year) and more recently from the Sibovc South West and Sitnica mines. Kosovo A is made up of 5 units, two of which are no longer operational. The other three Soviet designed units, constructed between 1970 and 1975, have a design capacity of 200 MW, 200 MW and 210 MW but a net capacity totalling 350MW and operates with an efficiency of 26%. Kosovo B consists of two 340 MW units which entered into service in 1983 and 1984. Both units have been de-rated to 280MW and operate at an efficiency of 32%. The Mirash and Bardh mines have been producing lignite since 1958.

Demand for electricity in Kosovo exceeds internal supply capacity and, with a growing demand, the gap between supply and demand is expected to grow. The costs of imports are often far in excess of internal generating costs. However, with its poor efficiency, the Kosovo A plant consumes 1.7 tonnes of lignite per MW produced and has unacceptably high emissions, in particular of particulate material (PM) - which exceed 700mg/m³. There are therefore plans for its decommissioning once its capacity can be replaced. Furthermore, the Kosovo B plant will not be able to meet the standards set in the EU's Large Combustion Plant (LCP) Directive unless it is rehabilitated.

The Government of Kosovo has invited private sector investors to invest in the "Kosovo Power Project". This project includes:

a) build-own-operate a new lignite-fired 2 X 300 MW power plant (known as "Kosovo e Re Power Plant - KRPP)

b) rehabilitate-own (or lease)-operate the 2 X340 MW Kosovo B power plant (presently de-rated to 2 X 280 MW)

c) build-own-operate-transfer a new lignite mine called the Sibovc South Lignite Mine (also simply known as the "New Mine")

KRPP will be an extension to the Kosovo B power plant and the two plants will have some common facilities. Both plants will be fuelled by the lignite from the Sibovc South mine.

In parallel to the project, the Government has launched the privatisation of the Kosovo Electricity Distribution and Supply Company (KEDS). In the past, both the transmission and distribution networks in the country have suffered from technical losses that at around 18% are well above what would be expected for a system of its size. This has been compounded with very high commercial losses (close to 25%). It is hoped that the privatisation of KEDS will help to improve the operational and financial efficiency of the system and demand side management and result in reduced losses.

2. The Expert Panel

For the past few years, the World Bank has been active in Kosovo energy sector through the Lignite Power Technical Assistance Project (LPTAP), whose objectives are: (i) to help the Government strengthen the enabling policy, legal, and regulatory frameworks conducive to new investments in the energy sector; and (ii) to assist the Government in attracting qualified private investors to

develop lignite mines and build new capacity for lignite thermal power generation guided by high standards of environmental and social sustainability. To achieve these objectives, LPTAP is financing, *inter alia*, the preparation of the Kosovo Power Project (known in Kosovo as the —Kosova e Re ProjectII).

In 2008, the World Bank adopted a *Strategic Framework For Development and Climate Change* (SFDC). This document establishes the World Bank Group policy on any future participation in coal-based power generation projects. The SFDC outlines the following criteria based on which the World Bank Group could support a particular coal project:

(i) there is a demonstrated developmental impact of the project including improving overall energy security, reducing power shortage, or access for the poor;

(ii) assistance is being provided to identify and prepare low-carbon projects;

(iii) energy sources are optimized, looking at the possibility of meeting the country's needs through energy efficiency (both supply and demand) and conservation;

(iv) after full consideration of viable alternatives to the least cost (including environmental externalities) options, and when the additional financing from donors for their incremental cost is not available;

(v) coal projects will be designed to use the best appropriate available technology to allow for high efficiency and, therefore, lower GHG emissions intensity; and

(vi) an approach to incorporate environmental externalities in project analysis will be developed.

These criteria are applicable for new coal-based electricity generation facilities, and rehabilitation and modernization of existing coal power plants, though the rehabilitation and modernization projects are excluded from complying with criteria (ii) and (v) in cases where rehabilitation projects result in reduction in lifecycle GHG emissions.

In line with the above, *Operational Guidance for World Bank Group Staff on Criteria for Screening Coal Projects under the Strategic Framework for Development and Climate Change* (March 2010), referred to as the Operational Guidance, necessitates the project team to prepare an assessment of project compliance with the six SFDC criteria following the Operational Guidance methodology. Furthermore, the Operational Guidance also requires the engagement of an **External Expert Panel** to evaluate the proposed project's compliance with the screening criteria. The Panel will include three experts in the fields of (a) power systems planning and economics, (b) energy policy including evaluation of low-carbon options for the energy sector, and (c) power technologies. One of the members will be appointed as the Panel Chair.

The three members of the Expert Panel were appointed by the World Bank in July 2011. They are Professor János M. Beér, Professor Wladyslaw Mielczarski and Dr Derek M. Taylor. The Terms of Reference of the Panel, along with the resumes of the Panel members, are available to the public on the World Bank website. Dr Taylor was appointed Chair of the Panel.

The objective of the Panel is to (i) review the concept for the proposed Kosovo Power Project, and (ii) assess the compliance of the Kosovo Power Project with the six screening criteria of the SFDC. When assessing whether the proposed project has passed the screening criteria, the Panel will be guided by the Operational Guidance document referred to above, the project team's assessment of

the application of the SFDC criteria to the Kosovo Power Project, and a large amount of analytical work prepared by various bodies during the last 10 years relating to the energy situation in Kosovo (see reference list in Annex).

In addition to the above, the Expert Panel held meetings with members of the World Bank's project team and two of the Panel (WM and DMT) visited Kosovo where they toured both power plants and met with operational management and staff of the Kosovo Energy Corporation (KEK), visited the lignite mining area and held a number of meetings in Prishtina that are listed below:

Meeting with the Minister for Economic Development and his staff

Meeting with the Minister for the Environment and Spatial Planning and his staff

Meeting with the Energy Regulator and his staff at the Energy Regulators Office (ERO)

Meeting with the Chief Executive Office and his staff at the Kosovo Electricity Transmission System and Market Operator (KOSTT)

Meeting with the Chairman of the Governing Board and the Head of the Geology Department and other staff at the Independent Commission for Mines and Minerals .

Meetings with the Project Manager for the Lignite Power Technical Assistance Project (LPTAP).

Meeting with representatives of Civil Society (including representatives of the organisations KIPRED, GAP, RI-INVEST and FIQ)

Meeting with the members of the World Bank office in Prishtina and a consultant from DH Infrastructure (preparing a report on renewable energies in Kosovo).

This present report describes the assessment of the Kosovo Power Project by the Expert Panel specifically in relation to the six SFDC criteria. However, when studying this report the reader is particularly asked to keep in mind the special situation of Kosovo. It is still very much a post-conflict country with a fragile economy and a rather limited capacity for growth. As with any country in such a situation the supply of secure and affordable energy, in particular electricity, is vital for its future social and economic development and stability.

3. Regional Energy Setting

In November 2002, countries in South Eastern Europe signed a memorandum of understanding with the European Commission with the aim of creating a regional energy market. The objective of this was threefold: 1. Improved efficiency within the sector; 2. Better use of existing infrastructure; and 3. Consistency of approach with the European Union (EU).

In October 2005 the Energy Community Treaty of South East Europe (ECSEE) - also known as the Energy Community Treaty - was signed between the EU and individual South East European countries and entered into force in July 2006. The signatories committed to unbundling of utilities, creation of independent regulatory bodies and development of national and regional market structures. Kosovo is a participant in the Treaty and is therefore committed to meet the environmental standards of thermal power plants and mining and mitigate social impacts as outlined in the various EU Directives.

The region is characterised by a general lack of adequate electricity supply with very few of the national power systems capable of covering their electricity demand. Of the signatories, only Bosnia-Herzegovina, Bulgaria and Romania have adequate supply. The lack of capacity in the region is expected to worsen as the countries move out of recession. Lack of reliable electricity supply is generally a serious problem throughout the region.

The size of the markets in the region, in terms of final energy consumption, varies widely, but most of the markets are small. Kosovo is the smallest market in energy terms closely followed by Albania and Montenegro. Excluding EU Member States, the largest market is Serbia with a final electricity consumption around 5 or 6 times that of Kosovo. Network losses in the region are generally quite large ranging around 10% in Croatia to close to 40% in Kosovo. The countries in the region have low energy efficiencies with high electricity and carbon intensities relative to their EU neighbours. Kosovo and all its neighbours are net electricity importers.

Moreover, the region is characterised by high electricity prices even though in most cases these prices charged to consumers, especially domestic consumer, do not cover the system costs. Partly as a result of this there is a lack of investment in new plant and infrastructure in the region for a greater part of last three decades that will only serve to aggravate the supply shortages in the medium term.

The total electricity generation in the region is a mixture between conventional thermal, hydro and nuclear power. Other than hydro, renewable sources have played a very limited role so far. Albania gets almost all of its domestic generation from hydro power, but is also to a high degree import dependent. This is in particular the case in drought years. Other countries such as Bosnia and Herzegovina, Croatia and Serbia also get a third or more of their generation from hydro power. Kosovo, at the other extreme gets almost all of its domestic generation from thermal plants (lignite) and is also import dependent.

A number of regional energy studies have been carried out in recent years, most notably the Regional Balkans Infrastructure Study - Electricity (REBIS) and the Electricity Generation Investment Study (GIS). The objective of these studies was to assist the EU, the International Financial Institutions (IFIs) and donor bodies in identifying an indicative priority list of investments in power generation and related electricity infrastructure from a regional perspective.

The results of the analyses undertaken during the studies indicate that diversification of energy supplies is essential for the region and should include local lignite, imported energy (in the form of natural gas, coal and electricity), renewables, hydro and potentially nuclear power (in the event of a high CO₂ price).

The study drew a number of specific conclusions which included:

- Fuel and CO₂ prices have a significant impact on the viability of existing coal and lignite power plants, which require rehabilitation and environmental controls. If it is not cost effective to rehabilitate the plants they should be retired but would need to be replaced by new power plants; hence increasing further the required investment for new capacity.
- From the solid fuel new plants, Kosovo continues to be the least-cost option. Most scenarios used in the study indicate desirable Kosovo capacity in the 4,200 - 4,800 MWs range. This is close to the maximum capacity (5,000 MWs) assumed to be practical within the planning period. Even under high CO₂ prices and significant electricity imports, there is a need for Kosovo plants (2,000-2,500 MW). Moderate CO₂ prices (€5-10/ton CO₂) resulted in an increase of Kosovo plants to the

maximum (5,000 MWs); this was because as the value of carbon credit (i.e. the cost of emitting carbon) increases, existing power plants become less cost-effective and there is need for more efficient plants burning Kosovo lignite.

The study goes on to suggest that a more comprehensive assessment is needed regarding the feasible capacity which could be developed in Kosovo considering all relevant constraints (e.g., ability to transmit the power to the region and beyond, capacity to finance future plants, environmental impacts, energy security considerations, etc.). It also points out that there are other lignite mines in the region which potentially could play a role in the future. However, in the GIS study, other mines did not play an important role mainly because the cost of production of Kosovo lignite is the lowest, though lignite production costs in other countries could be reduced and become competitive. In this context it is worth noting that Kosovo's lignite reserves are the third largest in Europe and by far the largest in the region.

A regional market relies on a good network and strong interconnections. The Kosovo transmission network is an important part of the regional transmission system via interconnections with Serbia, Macedonia, Montenegro and Albania. Kosovo is at the centre of the north-south transmission interface of the South East European market and important for power flows to and from Serbia, Macedonia and Greece. Presently there are 400 kV lines between Kosovo and Serbia, Montenegro and Macedonia and a 220kV line with Albania, with a 400 kV line under construction.

4. The Kosovo Energy Strategy

The latest revision of the Energy Strategy for Kosovo was published by the then Ministry of Energy and Mining (MEM) in September 2009. It covers the period 2009 to 2018. For much of the report, the latest available energy data is from 2007, but this gives an adequate overview of the energy situation in Kosovo.

Total energy supply in Kosovo in 2007 was 2201 ktoe (thousand tonnes of oil equivalent) and was growing at a rate of 3.2% per annum. Coal (lignite) was by far the most important primary source of energy contributing over 56% to total consumption. Oil and oil derivative, all of which are imported, contributed around 30%. The only other major source of energy is biomass - almost exclusively wood - that contributed approximately 11%. The balance was mainly made up by indigenous hydro and imported electricity.

Industry was responsible for around 20% of energy demand with transport and housing each contributing close to 30%. The balance was made up by services (around 15%) and agriculture (around 5%).

Electricity consumption in Kosovo had increased strongly from 2000 (2,864 GWh) to 2007 (4,582 GWh). More recent data indicates that consumption continues to grow to 5,420 GWh in 2009 (KOSTT Annual Report for 2009). The major sources of domestic supply are the lignite-fired power plants Kosovo A and Kosovo B (with 97% of the domestic supply) and a small (3%) contribution from hydro power plants. The balance between supply and demand is met by electricity imports (annually around 10%). The average price of electricity in Kosovo in 2009 was €25.78/MWh while the price of imported electricity was €75.9/MWh.

The Energy Strategy report forecasts that energy demand will increase from its present (estimated) level of between 1400 and 1500 ktoe/year to between 1900 and 2200 ktoe/year in 2018. During the same period, electricity demand is forecast to increase to around 7500 GWh by 2018 and to 8000 GWh in 2020.

The government's energy strategy for 2009-2018 was adopted in April 2010. In brief, the main strategic objectives consist of security of supply, restructuring the sector, developing and rehabilitating generation capacity, developing transmission and distribution, promoting foreign investment, promoting energy efficiency and renewable energy use and developing gas infrastructure. Important factors that influence the strategy include compliance with the European Union *acquis* (which is legally binding on Kosovo through its membership of the Energy Community Treaty) and the very high losses (technical and commercial) in the electricity sector. Much of the focus of the Energy Strategy is on electricity supply and, in particular, on the closure and decommissioning of the Kosovo A power plant, its replacement by new generating capacity and opening of a new mine to provide the lignite for a rehabilitated Kosovo B and the new plant.

To meet the strategic objectives, the Government set out a number of sector reforms, policies and strategies that included:

- (i) development of new power generation capacities;
- (ii) undertaking complete unbundling of Kosovo Energy Corporation (KE JSC) to meet Kosovo's obligations under the Energy Community Treaty and facilitate private participation;
- (iii) developing a sound and comprehensive legal and institutional framework for concessions and/or privatization to strategic investors;
- (iv) concessioning or privatization of power distribution and supply, as well as engaging private sector in existing power generation industry;
- (v) furthering the development of the power transmission and interconnection system;
- (vi) promoting energy efficiency and private investment in developing renewable energy sources; and
- (vii) developing and implementing sound policy for connecting to the regional gas networks and diversify sources of energy supply.

A number of the specific actions proposed/described in the Strategy Paper relate directly to the project under review by the Expert Panel.

Concerning **lignite mining**, it was important to realise the development of a "New Mine" through "significant medium to long term investment, mainly private, with the initial support from the Kosovo Budget in order to avoid delays" while also ensuring "clean coal development by encouraging efficient mining operations", adopting a "social policy framework governing all aspects of resettlement" and supporting the independence of the Independent Commission on Mines and Minerals".

Concerning electricity, to continue the commercial operation: of **TPP Kosovo A** "with regular maintenance until the end of 2017 at latest" (including realization of the project of hydraulic transportation of ash and possible improvement of the "environmental component"); of **TPP Kosovo B** with "revitalization"¹ of the two units in the period 2016-2017; of hydropower plants HPP Ujmani and other small existing plants; and construction of **TPP "New Kosovo" (to replace Kosovo A and help to reduce imports)** through an open, transparent and competitive process and construction of

¹ The rehabilitation/modernisation of the two Kosovo B units to include technical and environmental improvements and life-time extension.

HPP Zhur with concession also through an open, transparent and competitive process. In addition it was planned to increase the capacity of HPP Ujmani, develop new small HPPs and develop new power generation from other renewable sources.

Other specific actions included:

Modernisation of the **transmission system** and its international integration, construction of a 400 kV interconnection with Albania, unbundling of KEK JSC, privatisation of KEK Distribution and development of competition in the electricity market.

Development of favourable business conditions and promotion of heat supply for **district heating** of Prishtina through cogeneration at TPP Kosovo B and promotion of combined heat and power generation throughout Kosovo.

Promote and support Kosovo's connection in regional **natural gas** supply projects, such as the Gas Ring Project for Southeast Europe.

Concerning **oil and derivatives**, regulation and promotion of Liquefied Petroleum Gas (LPG), promotion of the use of biofuels and preparation of plans for achieving the compulsory oil reserves in line with EU Directives.

Putting forward a wide range of measures (eleven in total) were put forward to increase the present modest share of **renewable energies** (RES) in the generation portfolio (to reach a target share for RES of 7% by 2016) and to improve **energy efficiency** (EE) in line with the relevant EU Directives on RES and EE and to ratify the UN Framework Climate Change Convention (UNFCCC) and the Kyoto Protocol as soon as feasible.

Finally, there were a number of measures for ensuring standards for **environment protection and social issues**, including: the adoption of a "Strategic Environmental and Social Assessment (SESA) framework, including public consultation, that will help determine strategic options and inform development plans for future mining and power projects"; to "strengthen legislation and institutional structures for regulating the environmental impacts for future mining and power projects"; and to strengthen water resource management. Specifically, regarding Kosovo A, "to repair and make functional by 2010 the ash handling and disposal system and waste water treatment system for the entire plant" and to install an environmental monitoring system.

5. The Six Criteria and Findings of the Panel

The document "Development and Climate Change: A Strategic Framework for the World Bank Group" (abbreviated to SFDCC) defines the World Bank Group's policy on the issue of development and climate change. It states that "Reflecting the importance of coal for electricity generation in many developing countries, the WBG could support client countries in developing new coal power projects based on the most appropriate technology and analysis of alternatives". The SFDCC also outlines six broad criteria under which the WBG could support its partner countries in developing coal-based power generation projects. These criteria - and the Expert Panel's findings - are each detailed below.

It should be pointed out that, in this case, a part of the project concerns the proposed rehabilitation and modernisation of an existing power plant (Kosovo B). According to the Operational Guidance provided by the World Bank, this specific part of the project is not required to comply with Criterion 2 and Criterion 5 as long as this rehabilitation results in a reduction in the relative intensity of GHG emissions.

Criterion 1: *There is a demonstrated development impact of the project, including improving overall energy security, reducing power shortage or increasing access for the poor.*

The Expert Panel agreed that this project complied with this criterion. The new plant would more than compensate for the loss of capacity that would result from the closure of the Kosovo A plant and make a contribution to reducing the gap between demand and supply in the country. In the most recent EBRD-World Bank Business Environment and Enterprise Performance Survey (BEEPS), electricity supply was seen as the major obstacle to doing business in Kosovo. Ninety-one percent of the 270 firms responding to the questionnaire in 2008 found supply to be an important obstacle and nearly half of these indicated that it was a severe obstacle. The new plant, together with a rehabilitated/modernised Kosovo B, should result in increased system reliability and fewer power shortages for the country. The project would therefore increase energy security in Kosovo, but at an increased cost of electricity generation relative to the costs of electricity generation from the existing already amortised plants. On the other hand, the alternative supply of electricity would likely be more expensive and/or, for example in the case of diesel generated electricity, more polluting. The new mine would guarantee continuing supply of fuel to the new and rehabilitated plants in an economical way.

Criterion 2: *Assistance is being provided to identify and prepare low carbon projects.*

The Expert Panel agreed that the project complied with this criterion. Based on the results of an Assessment Study on Renewable Energy Resources in Kosovo financed by the European Commission, a follow up study on renewable energies has been carried out with the support of the WBG. There has also been a prefeasibility study for small hydro power plants in Kosovo and a WBG supported updating of an existing feasibility study for a hydropower plant at Zhur. Most recently a report by DHInfrastructure assesses alternative technologies to lignite for the generation of electricity in Kosovo and the comparative costs of these technologies. Assistance in the form of grant funding is being provided for studies on carbon capture and storage (CCS), for a more detailed assessment of wind potential and for studies on solar power and water heating. There are feed-in tariffs in place for electricity generated from hydropower plants and from wind turbines and a small number of private sector projects have had their applications for licences approved. An investment credit is proposed to be provided by the World Bank for further work on energy efficiency improvements and renewables.

Criterion 3: *Energy sources are optimized, looking at the possibility of meeting the country's needs through energy efficiency (both supply and demand) and conservation.*

The Expert Panel agreed that - subject to certain reservations - the project complied with this criterion. The reservations concern the need for increased effort to reduce energy demand and the technical and commercial losses related to electricity supply. While energy efficiency measures are unlikely to alter the need for new power generating capacity, they should be important elements of Kosovo's energy strategy.

There appears to be little doubt that the Government of Kosovo is making considerable efforts to improve energy efficiency in the country from both the point of view of supply and demand. On the supply side, the new project would result in considerable improvements in the efficiency of electricity generation and consume significantly less fuel per unit of electricity produced than the present plants meaning a more sustainable use of indigenous resources. Also, emissions of air pollutants including CO₂ would be reduced directly proportionately with the reduction in fuel consumption. On the demand side, there are a number of projects and actions that have been implemented in Kosovo, ranging from awareness raising to improving the energy efficiency of many public buildings.

However, it is felt that increased effort could be made in future to reduce electricity demand by such measures as encouraging the use of solar water heaters and by energy conservation through regulations to bring about improvement in the energy efficiency of the private housing stock. Of course, such actions come at a not insignificant cost and take time to implement, especially in poorer regions. In addition, much greater efforts need to be made to cut down on the technical and commercial losses associated with electricity distribution and supply. The planned privatisation of the distribution network should play an important role here. Having to pay for electricity consumed, or to pay more for the electricity, should have a noticeable impact on demand. Studies have shown that price elasticity is no more than 30% so the expected reduction in response to a reasonable price increase, while significant, would certainly not be sufficient to remove the need for the new generating capacity. However, together with the other demand side efficiency measures it could slow down demand growth sufficiently for renewable energy to make an important contribution to filling future supply gaps in the coming decades.

Criterion 4: *After full consideration of viable alternatives to be least cost (including environmental externalities) options, and when the additional financing from donors for the incremental cost is not available.*

The Expert Panel agreed that the project meets this criterion. This is based on the existing and growing supply gap between domestic demand and production combined with; the need to close the Kosovo A plant (to reduce environmental pollution and to meet new European norms and regulations); the present grid structure; and the cost of any reasonable alternative sources. New lignite-fired capacity and the rehabilitation/modernisation of Kosovo B supported by the opening of the new mine would be the least cost option for Kosovo. Renewable energies should play an important role in the future energy mix with the construction of the Zhur hydropower plant and additional renewable capacities being provided by wind power, small hydro, biomass and biogas. It is felt that more could be done to better evaluate the potential for wind power in Kosovo, the work to date being insufficient to completely rule out wind as a potentially important supply source for the future. Furthermore, more efforts need to be made to introduce natural gas into the region and, eventually, into Kosovo. This could play an important role, if only as back-up power to renewables. However, greater use of renewables and gas would likely require a more regional approach to energy markets and more interconnections with neighbouring countries than are presently available. Environmental externalities are discussed in more detail in Criterion 6 (below) and their costs described in the recent report by DHInfrastructure (see Section 6a of this report).

Criterion 5: *Coal projects will be designed to use the best appropriate available technology to allow for high efficiency and, therefore, lower GHG emissions intensity.*

The Expert Panel agreed that the project meets this criterion subject to certain modifications. These modifications specifically relate to achieving the highest possible efficiency for the new plant. Given the required total capacity of the new plant, two units of 300 MW each would be the preferred option relative to a single larger unit, especially in the interest of grid stability and supply in the event of unscheduled outages. Also, when such a base load plant has to perform back up operation for intermittent renewables (wind or solar) a smaller, 300MW plant, will perform cycling duty at lower cost than would a 600 MW plant. (Such costs occur because cycling duty causes reduced efficiency, require more frequent maintenance and result in reduced life of the plant). The new plant part of the project should be "best appropriate available technology" which would result it in being significantly more efficient than either of the existing plants. **The Expert Panel believes that efforts should be made by the Government to encourage bidders to provide a plant with the highest possible efficiency rather than simply meet a minimum efficiency level (as required in the present draft Request for Proposals).** In other words, a decision on which private sector bidder to accept should not be based on price alone but should also be closely linked to the efficiency of the

proposed plant. Furthermore, the Panel believes that it would be best not specify to that the plant should use either pulverised coal (PC) or circulating fluidized bed technology (CFB) technology but leave this to the individual bidders to propose. Domestic lignite from the new mine would clearly be the preferred fuel. However, given the high moisture content of the lignite, the use of advanced lignite drying techniques might offer economic opportunities for improving plant efficiency. While higher efficiencies could be achieved in larger units, in supercritical units and using hard coal as opposed to lignite, with the possible exception of supercritical units, none of these options presents a realistic alternative in Kosovo - at least at this time.

Criterion 6: *An approach to incorporate environmental externalities in project analysis will be developed.*

The Expert Panel agreed that the project meets this criterion though better monitoring capabilities are required in the future, especially for carbon dioxide and other GHG, to better quantify the expected benefits. There is an urgent need to improve the environmental monitoring capabilities in the country and, in particular, around Prishtina, the plants and the mine. It is very important that baseline emissions be established as soon as possible and it is expected that this work would form an important part of the project-specific environmental and social impact assessment (ESIA) that is being funded and will start soon. The increased efficiency of the new plant relative to the existing plants and the rehabilitation of Kosovo B will result in less consumption of lignite and significantly fewer emissions of PM, NO_x, SO_x and carbon dioxide per unit of electricity produced than the existing configuration. Calculations provided by the Ministry for Economic Development indicate that after the start up of a new plant, the closure of Kosovo A and rehabilitation of Kosovo B, coal consumption would reduce by around 27% for each unit of electricity produced, PM emissions would be reduced by over well over 90%, SO_x and NO_x by around 80% and CO₂ by approximately 25%. However, the cost of the emissions need to be factored into any future analysis of the project. This is particularly important for carbon as the price of emission allowances under the EU's Emission Trading Scheme (ETS) may be expected to rise steadily - or even quickly - as full auctioning becomes a requirement and the cap on emissions is lowered. The recent study by DHInfrastructure does examine a sufficiently broad range of possible carbon prices to assess the external costs of the different options. However, it is recommended that the World Bank continue to examine how a changing carbon price would impact on the economics of lignite-fired power plants in Kosovo and on future electricity prices. The project analysis should include, where possible, the potential cost of health impacts of the power plant, though these would be expected to decrease significantly from the present levels with the reduced emission of pollutants in future and to factor these into future studies of alternative technologies.

6. Discussion on specific issues

a. Alternative technologies to lignite for electricity production in Kosovo

There have been several studies conducted for and by different organisations that have concluded that lignite-fired generation would be the least cost option for Kosovo, and others in the region, to meet energy supply and security needs. However, until recently, there had not been an attempt to a detailed systematic comparison and evaluation of the costs of the alternatives taking properly into account the environmental externalities associated with each option. This situation has now been rectified by the Background Paper "Development and Evaluation of Power Supply Options for Kosovo" prepared for the World Bank by DHInfrastructure. This new paper, which can be downloaded from the World Bank's web site, analyzes the cost of the alternatives that could be available to Kosovo to meet energy consumption and peak demand in the period until 2025.

In brief, the study examines the current and future demand-supply balance in Kosovo, the different power supply options and alternatives and their costs and identifies a least-cost supply plan. It also

examines a number of sensitivities - including demand and environmental, construction and fuel costs. In addition to domestic lignite, two thermal options are covered by the study - natural gas and fuel oil. The renewable options include both moderate-sized hydro (specifically the planned Zhur plant) and small hydro plants, wind, solar photovoltaic (PV) and manure-based biogas and wood-based biomass². As electricity imports are presently critically important for Kosovo, possibilities of increasing transmission links with neighbouring countries were also examined. Increased energy efficiency, for which there is considerable potential in Kosovo, was taken into account in the demand forecasts and in the sensitivity analyses.

In summary, the main findings of the supply options report are as follows:

- i) Kosovo needs a mix of both base load and peaking capacity in order to meet its demand reliably and at lowest cost. This will mean a mix of thermal and renewables, not any single option by itself. Hydro and renewables can provide some of the firm capacity, but there would be a 600 MW capacity gap by 2017-2019 that can only be met by fossil-fuel fired thermal plant.
- ii) The study assumes a least cost supply mix would include the 305 MW Zhur hydropower plant that would serve as a peaking plant, 395 MW of installed renewable capacity (small hydro, wind, biomass and biogas³) and approximately 600 MW of thermal capacity. The least cost supply plan also assumes significant reduction in technical and non-technical losses⁴ and improvements in end-use efficiency⁵. Three different types of new thermal plant were assessed - lignite, natural gas and fuel oil. The report concludes that the power supply plan based on new lignite plant is the least cost thermal option for Kosovo.
- iii) The lignite option is the least expensive thermal option even when the relatively higher environmental costs of lignite are priced in. The levelised electricity cost (LEC) - including environmental externalities - for the new lignite plant has been calculated at €81.42/MWh compared with €89.78/MWh for natural gas and €161.45/MWh for fuel oil. The most important

² In brief, **the least cost supply plan** assumes: new 600 MW thermal plant built by 2017; the retirement of Kosovo A in 2017; Kosovo B rehabilitated during period 2017-2018; 305 MW Zhur hydro plant commissioned in 2017; 60 MW of small hydro (with capacity factor of 53%) installed by 2015; 250 MW of new wind capacity installed between 2016 and 2021; 20 MW of new biomass and 70MW of new biogas generation installed between 2022 and 2023. Renewables to be dispatched first. In addition, new 400kV lines to Albania (by 2012) and Macedonia (by 2018) to increase import capacity.

³ A study by Mercados Energy Markets International (2009) would indicate that around two-thirds of the other renewables potential could come from **wind turbines**, though a study carried out by NEK Technologies concluded that there were very few areas with wind speeds exceeding 6 m/s, a minimum needed for commercial potential in the region, and that the potential in Kosovo was at best "moderate". The renewable capacity would not include **solar PV**. An earlier study had estimated solar PV potential at 77 MW but this would be achievable only at very high costs (over €250/MWh). Data available to date suggests that **geothermal energy** is not viable due to low water and soil temperatures.

⁴ In the study, **technical losses** are assumed to decline from 16.6 percent of gross energy supplied in 2010 to 8.0 percent in 2025. **Non-technical losses** are assumed to be reduced from 24 percent to 5 percent at a uniform rate over the 5 years from 2013 to 2018.3 It is also assumed that the reduction in non-technical losses will reduce demand, as customers reduce consumption of the kWh for which they pay.

⁵ In line with the new Law on **Energy Efficiency** and the draft National Energy Efficiency Plan for the period 2010-18, the supply options study assumes uptake of energy efficiency measures in its demand forecast and consequent sensitivity analysis.

environmental parameter for the thermal option is the price of carbon⁶. The study calculated that the cost of generating electricity from lignite would surpass that of the cost of generating electricity from gas if the carbon price (in €/tonne of CO₂) is 55% higher than that assumed in the base case (the IEA forecast carbon price). Lignite plan (coupled with the Zhur plant and other renewables) is also the least cost option under a reduced electricity demand, with significantly higher lignite fuel costs (increases of up to 70%) and higher (by 25%) lignite plant construction costs.

The supply options report also points out that even if 475 MW of renewable capacity (305 MW from Zhur and 170 MW from other sources) could be built by 2017, there would be a remaining gap between supply and demand for firm base-load capacity which averages around 600 MW in the period 2017-2019 and grows to around 1000 MW by 2025.

In terms of cost, the least expensive generating option, if environmental externalities are not taken into account, would be lignite-fuelled thermal plant (€50.05/MWh). However, when environmental externalities are taken fully into account small hydro appears to have the lowest cost at €53.60/MWh, though this could increase to over €63/MWh when capacity penalties are taken into account. The other renewables have somewhat higher costs: biogas and biomass (between €90/MWh and €99/MWh); Zhur hydro plant (€96.40/MWh) and wind (€101/MWh to €119/MWh). Solar PV had costs ranging from €251/MWh to €270/MWh so was not included in the supply power plan. For details of all the assumptions and the operating characteristics of the various plants, please see the DHInfrastructure report.

b. Size of new plant

There are two main contradicting rules relating to setting a size of new power plants:

- A unit should be large as energy efficiency of a larger unit is usually greater than a smaller one
- A power generating unit should be small because in such a case it allows for more flexible transmission network operation and does not require large power reserve.

Because, the first rule has been discussed in details in the beginning of the report, in this section the attention will be given to operation of power generating units in transmission networks. The planning of system operation is usually called “commitment and dispatch” of power generating units and it aims at the balancing of energy production with demand, which significantly varies in every hour. The relation presenting demand for power as a function of time is called “power profile”. A typical relation of maximum power demand, usually happens during evenings, to low demand during night hours is as 3:1 and must be balanced by flexible power production.

One of the main tasks of the power control centre is to ensure the adequate level of the power reserve to cover outages of generating units. There are three categories of power reserves:

- Primary reserve installed directly on the shaft of the power generation unit. The primary controller increases and decreases the input of steam to a turbine to keep shaft speed at the synchronous level. This reserve is set up usually as about 5% of the maximum power of a generating unit.
- Secondary reserve is implemented by control signals sent by Grid Control Centre to compensate deviations of a system frequency caused by outages and the rapid increase of

⁶ the study assumes €15/tonne as starting point, then growing in pace with the IEA forecast to roughly €23/tonne by 2025, and €26/tonne by 2030

power loads. The necessary amount of secondary reserve is usually about 10% of the maximum power of a generating unit.

- Spinning reserve is the unused power of the generators which is connected to the power system and rotate synchronously with other power units. This reserve can be treated as some kind of spinning stand-by resources ready to be used in minutes. The general rule of power system operation states that the minimum level of spinning reserve should cover the loss of a largest power unit in the system.

Operation rules relating to the required amount of spinning reserve have significant influence on the maximum size of a generating unit, which can be connected to the transmission network. The larger the generating unit, the more spinning reserve is required. Considering two possible options of generating units proposed for Kosovo, 2 X 300MW or 1 X 600MW, and taking into account the power system operating characteristics and the number and size of units presently in operation, the two smaller units are advisable. The power system in Kosovo has maximum demand only about 1000MW. Moreover, assuming that the future structure of the power generation in Kosovo will consist of 2 units of 300MW in the power station B and 2 units of 300MW in a new power station, it will be possible to ensure the level of spinning reserve only for a smaller unit of 300MW. If larger units such as 600MW were installed, the power control centre would have difficulties to ensure the adequate level of power reserve and load shedding is the only possible way to balance demand and supply in the case of disturbances. However, analyzing the future structure of the power system supply, load shedding as a tool for system balancing should not be taken into account, because it has negative impact on the economy and comfort of customers' living.

c. Efficiency and Emissions

Commercial technology options for the replacement of Kosovo A power plants burning Kosovo lignite include:

- pulverized coal combustion in sub critical or supercritical steam plant, and
- circulating fluidized bed combustion in sub critical steam plant.

It is important that the replacement plant has maximum affordable operating efficiency because of the effect of efficiency on the emissions of all pollutants including CO₂ as soon as the plant is operational, and, in the longer term, when the plant is likely going to be equipped with carbon capture and storage (CCS).

Increasing generating efficiency is the most cost effective way of controlling emissions. Higher efficiency enables maintaining output at reduced coal input and hence at reduced emissions of the pollutants SO_x, NO_x, particulate matter (PM) and CO₂ without any flue gas treatment.

Measures to increase power plant efficiency in Rankine cycle steam power plant include use of advanced steam parameters (pressure and temperature) and steps reducing waste gas heat loss (see Annex 3).

As steam pressure and temperature are increased to beyond 221 bar (22MPa) and 374C the steam becomes "supercritical". Use of supercritical steam increases the energy conversion efficiency due to the higher pressure and higher mean temperature of heat addition. Pulverised coal (PC - for which the coal is very finely ground) supercritical plants show efficiency advantages of about 2.9 percentage points over PC sub-critical plants.

Circulating Fluidized Bed (CFB) plants can comply with environmental emissions regulations without flue gas treatments for sulphur capture and for NO_x reduction. Because of the easier preparation of

the fuel feed (crushed instead of finely ground), CFB is amenable to the use of lignite and co-firing with biomass⁷. The limiting factor for co-firing with biomass, in addition to the availability of sustainable biomass, is its high alkali content which reduces the softening temperature of the lignite ash and can cause increased fouling of boiler tube surfaces. However the combustion temperature in CFBC is sufficiently low to avoid slagging of heat exchangers. There are many 300MW size sub critical CFB units in operation, and there is now an offer of a 300 MW CFB with supercritical steam on the market.

d. Lignite Drying

Coal drying is part of coal preparation and grinding for PC combustion and for crushing for CFB combustion. It is also integral to the thermodynamic design of the plant. Drying improves crushability or grindability of the coal and assists ignition and flame stability, and can also improve the plant efficiency.

For high moisture sub-bituminous coal or lignite, furnace gas withdrawn from the top of the boiler combustion chamber is used as drying agent. When the furnace gas is reintroduced into the boiler transporting the dried pulverized lignite and the vapour through the burners, the plant efficiency is unaffected. If, however, boiler exit flue gas is used for lignite drying and low pressure bleed steam from the steam turbine is used for feed water heating, the plant efficiency increases. Comparison of measurement data for the alternative systems of furnace gas and flue gas-drying of a lignite with 47% initial moisture dried to 25% shows 4.9% relative efficiency improvement for flue gas coal drying. [1,2]

When waste heat extracted from the hot cooling water leaving the steam condenser is used for fluidized bed coal drying, the plant efficiency increases and water use of the plant is reduced [3]. For example, the calculated benefits for 300MW gross power generation and a 20% lignite product moisture are: 5.5% relative improvement in plant efficiency and 740 litre/min cooling tower make up water saved, at the expense of a 10 MW parasitic load increase on account of the energy requirement for the fluidized bed dryer. [Note: These numbers are purely illustrative, as they are not based on a Kosovo site-specific engineering study].

Further improvement of the plant efficiency can be gained by dewatering high moisture coals prior to combustion [2,4]. The temperature of the vapour leaving a steam-fluidized coal dryer is raised by compression, and used for further drying by means of a tubular heat exchanger immersed in the coal dryer. Coal-moisture is removed in the form of liquid water; the boiler is fired by dried coal, and the water vapour content of the flue gas is reduced to the sum of the residual moisture of the dried coal and the combustion products of the hydrogen in the coal.

Coal dewatering increases the heating value of the coal; the energy consumption by the thermo-compressor represents about 25% of this heat gain. The net improvement in efficiency of dewatering lignite from 47% to 25% moisture is estimated at a relative 7% compared with the case when the flue gas contains all the coal moisture.

⁷ Co-firing biomass is a near term low cost option of adding renewable energy to high efficiency coal based electric power generation. Deployment barriers of co-firing include the handling (storage, feeding and grinding) of the biomass, the requirement of pelletization to make it capable of feeding into pulveriser mills, the restriction of temperature and O₂ content of the inlet gas in the mill circuit to prevent ignition of the high volatile woody biomass in the mill or the transport pipeline to the burners. Industrial practice shows that up to about 15% by thermal content biomass co-firing in coal based power plant does not have detrimental effect on efficiency or availability of the coal plant.

e. Carbon Capture and Storage (CCS)

Coal as an energy source has the attraction of broad availability, low cost, and economic utilization by mature technologies. Use of Kosovo's indigenous lignite helps its energy independence and improves the country's balance of payments.

Coal use represents a challenge of reducing emissions of air pollutants including CO₂. In response to this challenge, a number of technologies capable of mitigating emissions of the pollutants SO_x, NO_x and particulates have been developed and are in commercial use. CO₂ emission has the potential of being reduced by increased efficiency of the plant, however the flue gas will still contain a lot of CO₂.

Carbon dioxide capture and geological storage (CCS) is the key enabling technology for the significant (up to 90%) reduction of CO₂ emission from coal-based (and gas-based) power generation.

CO₂ capture from pulverized coal combustion (PC) involves post-combustion cleanup, through the separation of CO₂ gas. Chemical absorption with amines is presently the only commercially available technology (though others, such as chilled ammonia, are under development or being evaluated). The CO₂ is first captured by the amine from the exhaust gas stream in an absorption tower. The absorbed CO₂ must then be stripped from the amine solution using large amounts of steam, and regenerating the solution for recycle to the absorption tower. The recovered CO₂ is cooled, dried, and compressed to a high pressure (>136 atmospheres) supercritical fluid. It is then ready to be transported by pipeline for either long-term storage in underground rock or for use (i.e. for enhanced oil recovery, if this option is available).

Application of post-combustion CO₂ capture reduces the electrical output of the power plant by a relative 20 to 30% (dependent upon the efficiency of the plant without CCS), due to the removal from the steam turbine of significant amounts of low pressure steam for the amine solvent recovery system and the power consumption of the CO₂ compressors⁸. To maintain constant net power output, the coal input, and the size of the boiler, steam turbine/generator, and emission control equipment all need to be increased. While these modifications can be possible when applying CO₂ capture to new units that are being planned and designed, they are not readily available for existing units.

Therefore, the efficiency of the plant, new or existing, that is to be equipped now or in the future with CCS, has to be high to be capable of dealing with this 9.5 percentage point efficiency reduction.

Full CO₂ capture can also more than double a plant's water demand, primarily due to the need to cool the exhaust gas before entering the CO₂ absorber.

While there are several successful applications of CCS mainly with enhanced oil recovery CCS is not yet commercially available for large-scale coal-based power plants. It is estimated that the development of novel, less energy intensive CO₂ capture systems and several full scale demonstrations, will lead to CCS to be commercial by 2020-2025.

It is most likely that during the lifetime of the new Kosovo plant CCS will become commercially available and that economic and legislative pressures will require CCS deployment. This would require any new thermal power plant to be retrofit with carbon capture technology. There is need, therefore, for the new plant to have the highest affordable thermal conversion efficiency and to be

⁸ The thermal energy required to recover CO₂ from the amine solution also reduces the efficiency by 5 percentage points. The energy required to compress the CO₂ to a supercritical fluid is the next largest factor, reducing the efficiency by 3.5 percentage points. All other energy requirements amount to less than one percentage point.

built "CCS ready". i.e. with increased availability of water supply, and sufficient space for the future CO₂ capture and compression plants.

f. Grid issues

The Kosovo transmission grid includes: three main levels of voltages: 400kV, 220kV and 110kV. The network is relatively in a good technical condition as over 40% of 400kV lines, 48% of 220kV lines and 33% of 110kV lines have ages between 0-25 years. The networks with a voltage level of 110kV, representing about 45%, have ages between 35-50 years.

Outages in transmission networks are kept on a relatively low level, except for transformers of 220/110kV. The statistics provided shows the great efforts to reduce a number of faults and the transmission network reliability increases every year.

Thanks to investment in new substations and reconstruction of some transmission lines, the transmission capacity increased from 930MW in 2008 to 1250MW at the end of 2009. The increase of the transmission capacity was observed in the 4th quarter of 2009. It indicates that the current transmission capacity is on the level of over 1200MW, while the maximum demand is on the level of 1023MW for the 1st quarter of 2010.

The investment in infrastructure for control and monitoring embraces SCADA/EMS and telecommunications including 200km of optical ground wire cable. Such cables provide the protection to the electricity network and allow for the transmission of telecommunication signals. The Transmission System Operator (TSO) plans to install a "back bone" network with SDH equipment that operates with high capacity up to STM-4.

The transmission grid control centre is well equipped with a modern synoptic map of the Kosovo power system and interstate power connections. The computer systems installed in the control centre allow for the efficient control of the power flow in the Kosovo transmission network.

g. Choice of mine site

Lignite reserves in Kosovo are located in two large basins - "Kosova" and "Dukagjini". The Kosova Basin is the larger of the two, with reserves in excess of 10 billion tonnes. It is also the area closest to the existing and planned new power plant and an area of it is presently being exploited to provide fuel for these plants.

Based on the quantities of reserves in place and the ease of exploitation, the zones of the Kosova Basin were assessed as falling into one of three "priority" areas for development. The first priority comprised Zone C (Sibovci) and Zone D (Dardhishte) as having the most suitable surficial exploitation conditions. Further, based on analysis of the lignite combined with economic, social and environmental factors, Zone C was identified for future development.

The area to be mined is the "Sibovci South" field which is the part of Zone C immediately adjacent and to the north of the present mining area. It has an added advantage insofar as it is the closest field in the Kosova Basin to the site for the new plant and can use much of the existing mining infrastructure. It is expected that much of the overburden from the new mine could be used to backfill the existing pit left by the mining to date. One small village will need to be relocated during the development of the new mine. Work has already started on the south-western part of the new mine.

There appears to be a general acceptance by civil society that lignite mining needs to be continued in Kosovo and the Expert Panel agree with this assessment. Also the selection of the new mining area was done with the technical knowledge and support of the State's Commission for Mines and

Minerals and approved by the Ministry of the Environment and the Kosovo Assembly. The choice does not seem to have been challenged by any of the stakeholders. The Panel therefore has no recommendations to make on the choice of site

h. Concerns of Civil Society

Like nearly all coal-fired power projects, the plans for a new lignite-fired power plant in Kosovo - especially one so close to Prishtina - has been the centre of an animated debate with the civil society in Kosovo. However, there are very few, if any, significant challenges to the continuation of using lignite-fired power generation or even to the construction of a new plant, especially as it is to replace the Kosovo A plant that is presently the source of much of the airborne pollution in the country. This is understandable as there is little possibility of replacing a significant portion of the lignite-fired generation, which produces 97% of the country's electricity, by other sources in the short to medium term. Given the fragility of the economy in Kosovo it is vital that any replacement energy system improves the security of electricity supply while any negative impacts on the economy are kept to a minimum.

However, the different NGOs have already urged the Government to take a number of steps to reduce the level of pollution and the dependence on lignite. These included greater use of district heating, improvements in energy efficiency by implementing more efficiency measures particularly targeted at private housing (including better insulation of buildings and improved lighting management), reducing commercial and technical losses from the transmission and distribution system and to make greater efforts to increase the share of renewable energies in the energy mix. (in particular wind, solar and geothermal). There has also been a suggestion that Kosovo "fuse" its energy system with that of Albania (which presently relies almost exclusively on hydro-power) with priority being given to the construction of the new 400kV link. In a broad sense the Expert Panel feels it could endorse these various proposals.

There are also a number of complaints by Civil Society concerning a perceived absence of transparency in the preparation of the country's energy strategy and energy market model, about certain aspects of the privatisation of the energy sources and infrastructure (possible creation of a monopoly and absence of future competition in the sector) and also a perceived lack of opportunity for civil society to be properly involved in the above processes. The Expert Panel has not had the opportunity to be involved in the detailed discussions/negotiations with the local people so could not give a definitive view on this. However, the Panel would encourage openness and transparency through fully developed consultation processes and the involvement of society in the various processes whenever this is possible.

7. Recommendations

Following on from its review of all the available documentation, its meetings in Kosovo and staff from the World Bank, the Expert Panel has a number of recommendations concerning energy that it would like to present to the Government of Kosovo. While the members of the Panel have a relatively limited knowledge of the situation in Kosovo, they do have a wide knowledge and experience of energy policy and technologies in other parts of Europe and elsewhere in the world, in particular in countries relying heavily on coal for their power supplies. These recommendations should be interpreted in that context.

a. The proposed project (new plant, rehabilitation of Kosovo B, new mine development)

The Expert Panel recommends that, subject to the comments and recommendations here and elsewhere in this report (in particular Sections 5 "Criteria" and 6 "Discussion") that the Government of Kosovo go ahead with the proposed project as quickly as possible. The Panel feels that the

improvements in energy security and reduction in pollution that will result from the successful completion of the work would have medium and long term benefits for the people of Kosovo. At this time, they can see no suitable alternative way of achieving this objective at a comparable or reasonable cost.

b. Supply side energy efficiency

The Expert Panel recommends that the new plant that is going to replace Kosovo A be equipped with the highest affordable power generation efficiency, because of the proportionately reduced pollutant and CO₂ emissions with higher efficiency. As the new plant is going to operate for the next 30 to 40 years during a period in which CCS should become commercially available and legally required, the power plant would have to be built "CCS ready" i.e. highly efficient to reduce the energy penalty of future CCS application, and with sufficient space for the post combustion CO₂ capture and compression plants.

The Expert Panel recommends that two 300MW units, as opposed to one 600 MW plant, be the preferred option because of the limited size of total capacity of the electricity generating park in Kosovo, and the higher flexibility of the smaller plants, for example for cycling duty.

A Circulating Fluidized Bed (CFB) plant is capable of complying with emissions regulations for SO_x and NO_x without additional flue gas treatment. 300MW CFB with sub critical steam is now commercial with several plants in operation. A 300 MW CFB plant with supercritical steam has been recently offered by major manufacturer; there is, however, no operational experience to date with such a plant. For similar reasons, the possibility of a 300MW plant with pulverized coal (PC) combustion in a supercritical steam cycle was also discussed and eventually discarded by the Panel.

Taking into account the above discussion, the Panel agreed that the choice of the technology and the design conditions should be left to the bidders with the addition, if possible, of an incentive to achieve higher efficiency.

c. Demand side energy efficiency.

Any new energy strategy or policy should first look at reducing the demand for energy through energy saving and improvements in energy efficiency use.

Greater efforts need to be undertaken to reduce both the technical and commercial losses in the grid system. Studies have shown that the "commercial losses" - mainly resulting from non-payment or theft - exceed the total output of the Kosovo A plant. According to the Energy Regulator, in 2009 the total - commercial plus technical - losses exceeded 40% and were close to 70% in the Mitrovica district. Eliminating such losses would result in a very significant reduction in demand and demand growth.

In a climate such as Kosovo's, heat losses during winter and ever growing demand for air conditioning in summer will increasingly dominate energy demand. While some steps have been taken to improve the energy efficiency of public buildings, it is vital that improvements are made in the thermal insulation of private buildings by improved building standards and their enforcement.

d. Solar thermal water heating

A large part of present energy demand in Kosovo is for water heating. In a country with close to 300 days of sunshine each year, solar water heating for both public and private buildings should be encouraged. A study on the potential of this source of energy in Kosovo - including the possibility of manufacturing some of the equipment in the country - should be undertaken.

e. District heating

The latest estimate of the population of the city of Prishtina is around 200,000⁹ people, but this figure is expected to significantly increase during this decade. A large part of the existing apartment buildings are connected to the district heating system. The major part of the existing district heating is supplied by heavy fuel oil boilers and heat supply is already insufficient during cold weather conditions. It is expected that this increase in population and greater focus on the construction of low-energy buildings in line with EU requirement, will lead to an increased demand for district heating supplies.

Studies have shown that connecting Kosovo B to the Prishtina district heating (DH) system could save on the use of fuel oil and fuel oil imports and reduce demand on the electric power network. From an environmental point of view a CHP project would be greatly beneficial relative to the present system with significant reductions in both SO_x and CO₂ emissions¹⁰. In addition, it is expected that less water might be needed to be cooled in the cooling towers of the Kosovo B plant. For these reasons, the payback period would be short (approximately 4 years). Cogeneration is strongly encouraged within the European Union as an instrument for GHG emission reduction so that investment in a co-generation system would be in line with EU Regulations.

Additional to the reduction of pollutant emissions because of higher generating efficiency, the use of CHP has further health benefits by the replacement of wood fired domestic heating. Combustion by-products of incomplete combustion of wood products which are emitted at low heights in densely populated areas, contain mutagenic polycyclic aromatic hydrocarbons.

f. Regional co-operation

Great regional co-operation on all aspects of energy is the main objective of the Energy Community Treaty. In a region in which most countries already suffer from energy shortages, there are many incentives for closer co-operation. Kosovo is very well placed in this regard with four neighbours with whom it already has power linkages and also links to Bulgaria, presently a source of electricity imports. Kosovo owns a relatively small power system and the regional cooperation should allow for gains resulting from the economy of scale and synergy of interconnected power systems.

The Kosovo transmission network has relatively strong interstate connections with other power systems in neighbourhood. There are power tie lines to Serbia of 400kV, 220kV and 110kV, two power lines to Macedonia of 400kV and 110kV, one strong 400kV power line to Montenegro and one 220kV line to Albania. A new power line of 400kV to Albania is under construction. There are no lines to Bosnia and Herzegovina.

The current interstate power exchange is very high with import and transits of about 30% of the total energy flow. The interstate power exchange capacities in most European countries are below 10%. From this perspective the Kosovo power system is well connected to other power systems. It can be a basis for the development of future regional cooperation.

New quality to the regional cooperation will be brought by the commissioning of a new tie line with Albania, a country which relies as heavily on hydro as Kosovo relies on lignite. Establishing a single electricity market between the two countries should increase the predictability and security of supply and the stability of the electricity grids. This option should be actively pursued in parallel to the new plant. The main current activities to construct a new power line to Albania should be associated with the efforts to achieve more cooperation with other countries and the development

⁹ Preliminary estimate from the 2011 Census

¹⁰ The low sulphur and the very high calcium oxide (CaO) content of the Kosovo lignite ash is very favourable to decreasing SO₂ emission during combustion. This can be especially advantageous in CFB combustion.

of a regional electricity market. Extension of the market to Macedonia and Montenegro could be pursued and, eventually, to Serbia. Development of a gas grid in the region should also be foreseen and studied further. Such cooperation can be based on the common rules for international power exchange developed by European Network Transmission System Operators (ENTSO) and the European agency, ACER. Also, the other regulations developed by the European Commission can be applied for the power exchange with other countries.

The opening up of new natural gas pipeline routes through the Caucasus would make the increased use of gas in Kosovo more attractive than a network having to rely simply on Russian gas. A regional gas grid would accelerate the introduction of renewable energies as it could provide the necessary back-up generating capacity. This possibility should be studied further.

As the European Union pursues its policy towards reducing to near zero GHG emission from the power sector by 2050, it is unlikely that any Member State would be allowed to continue to operate with unabated fossil-fuel power plants. As Kosovo has aspirations to join the EU but also expects to continue to rely heavily on fossil fuels for its energy supply, efforts will need to be made to reduce emissions from its lignite power plants, probably using carbon capture and storage (CCS). Given that the geology of Kosovo does not appear attractive for storage of large quantities of carbon dioxide, co-operation on possible future storage sites with neighbouring countries, in particular Albania, should be studied.

g. Need for future capacity

Kosovo suffers from energy shortages and presently needs to import around 10% of its annual electricity supply. This percentage will increase annually until the new plant comes on line. However, unless other new capacity is constructed, further shortfalls will occur after Kosovo A is shut down. Meeting future energy demand requires long term planning and investment, especially if it is to be done efficiently and at reasonable cost. Lead times for the construction of new plant are long, so efforts should already be underway to identify and prepare for the new capacities that will be required in both Kosovo and the region within the next 10 years. In the medium to longer term, Kosovo will need to invest in more renewable energy sources to reduce its GHG emissions. A regional gas grid would be a key element in either providing electricity with lower emissions than lignite or in providing back-up capacity for renewables.

8. Summary and Conclusions

The Government of Kosovo has invited private sector investors to invest in the "Kosovo Power Project". This project includes:

a) build-own-operate a new lignite-fired 2 X 300 MW power plant (known as "Kosovo e Re Power Plant - KRPP)

b) rehabilitate-own (or lease)-operate the 2 X340 MW Kosovo B power plant (presently de-rated to 2 X 280 MW)

c) build-own-operate-transfer a new lignite mine called the Sibovc South Lignite Mine (also simply known as the "New Mine")

KRPP will be an extension to the Kosovo B power plant and the two plants will have some common facilities. Both plants will be fuelled by the lignite from the Sibovc South mine.

In 2008, the World Bank adopted a *Strategic Framework For Development and Climate Change* (SFDCC). This document establishes the World Bank Group policy on any future participation in coal-based power generation projects. The SFDCC outlines a number of criteria, based on which the World Bank Group could support a particular coal project. In line with this Framework, operational guidance was developed that requires the engagement of an **External Expert Panel** to evaluate the proposed project's compliance with the screening criteria. The three members of the Expert Panel were appointed by the World Bank in July 2011.

In carrying out its task, the Panel took into account the World Bank project team's assessment of the application the SFDCC criteria to the Kosovo Power Project and a large amount of analytical work prepared by various bodies during the last 10 years relating to the energy situation in Kosovo. In addition, the Panel held meetings with members of the World Bank's project team and two of the Panel (WM and DMT) visited Kosovo where they toured both the Kosovo A and Kosovo B power plants, visited the lignite mining area and held a number of meetings with government officials, agencies, operators and representatives of the Civil Society.

This report is the outcome of all the analyses and discussions carried out by the Expert Panel. It assesses the projects compliance with the six screening criteria in the light of the regional energy situation and the present and expected future development of the electricity market in Kosovo. It also makes a number of very specific observations and recommendations concerning the proposed project.

It is the unanimous view of the Expert Panel finds that the project complies fully with the screening criteria developed in the SFDCC. However, the Panel did raise concerns over the need for increased effort to reduce energy demand and the technical and commercial losses related to electricity supply (in the context of Criterion 3), suggested modifications to the project specifically related to achieving the highest possible efficiency for the new plant (Criterion 5) and pointed to an urgent need to improve the environmental monitoring capabilities in the country and, in particular, around Prishtina, the plants and the mine (Criterion 6). They note that the part of the project concerning the proposed rehabilitation and modernisation of an existing power plant (Kosovo B), is not required to specifically comply with Criterion 2 and Criterion 5 as long as this rehabilitation results in a reduction in the relative intensity of GHG emissions.

A critical issue in the work of the Panel was the possibility of alternatives supply options for the supply of electricity in Kosovo over the next 10-15 years. These options have been studied by a number of organisations in recent years, most recently by DHInfrastructure for its background paper "Development and Evaluation of Power Supply Options for Kosovo", which looked at the different costs for the potential options, including their environmental externalities. It is clear from the studies carried out that renewable energies could make an important contribution to future electricity supply in Kosovo. The Zhur hydropower plant will be a key element as would the development of small hydro plant, especially as the latter could be most economically competitive. Wind power could also play an important role, though more work will be needed to better assess its potential and a lot of effort will be required to build it up from its present very low level and to properly integrate it into the grid. However, even taking fully into account the renewable potential and expected improvements in both end-use efficiency and the presently very sizeable technical and commercial losses, there will still be a very important supply demand gap and need for base-load generation that could only be met by thermal power plants in the foreseeable future. The Panel is unanimous in agreeing that lignite-fired generation would be the most appropriate option to fill this gap. Furthermore, they agree that 2 X 300 MW units would be preferable to a single 600 MW unit.

The Panel had long discussions on the possible thermal efficiency of the proposed new plant and strongly recommends that the Kosovo government should encourage as high a level of efficiency as

reasonably achievable in its competition for the new plant. One of the obvious benefits of this would be to reduce to as low a level as possible the emissions of carbon dioxide from the new plant. In addition, it was urged that a new plant should be "carbon capture and storage (CCS) ready" so that it could be retrofit with carbon capture technology in the future. This could be very important if Kosovo becomes a member of the European Union and subject to the Emission Trading System (ETS), especially if the price of carbon increases significantly during the lifetime of the plant.

The Panel encourages the Kosovo Government to make every effort to improve the efficiency of energy use in Kosovo and to reduce demand by improving the energy efficiency of public and private buildings, promoting solar water heating, greater use of sustainable biomass (where available) and biogas and by reducing the technical and commercial losses. However, it is still expected that a supply-demand gap could reappear early in the next decade and that plans should already be being made to cover this gap. Renewables could play an increasingly important role in doing this, but to realise their full potential will take improve interconnections with neighbouring countries and a more comprehensive regional approach to energy policy, which could eventually include the introduction of natural gas into Kosovo.

Annex 1: List of key documents reviewed by the Expert Panel relating to compliance with SFDCC

1. Energy Strategy of the Republic of Kosovo (2009-2018), September 2009.
2. Draft Request for Proposals for the Kosovo e Re Project, issued 10 August 2010.
3. Technical Background Paper Energy Sector for the Donors Conference, 2008.
4. Strategic Environmental and Social Assessment, ERM Italia, 2008.
5. Regional Balkans Infrastructure Study—Electricity (REBIS) and Generation Investment Study (GIS), prepared by PwC Consortium (PricewaterhouseCoopers LLP, Atkins International plc, MWH), 31 December 2004, updated 2007.
6. Project Appraisal Document on a Proposed International Development Association Grant in the Amount of SDR 5.8 million (US\$ 8.5 million equivalent) to the United Nations Interim Administration Mission in Kosovo for the Benefit of Kosovo for a Lignite Power Technical Assistance Project, World Bank, September 2006.
7. Project Appraisal Document on a Proposed International Development Association Grant in the Amount of SDR 3.8 million (US\$ 5.5 million equivalent) to the United Nations Interim Administration Mission in Kosovo for the Benefit of Kosovo for an Energy Sector Clean-up and Land Reclamation Project, World Bank, May 2006.
8. Studies to support the development of new generation capacities and related transmission—Kosovo UNMIK, prepared by Pöyry Consortium (Pöyry, Cesi, Terna, and Decon), August 2007.
9. Study for Decommissioning of Kosovo-A Power Plant, Final Report, prepared by Evonik Industries, 15 March 2010.
10. Economic and Technical Feasibility of the Rehabilitation of Units of Kosovo A Power Plant, European Agency for Reconstruction Contract 04KOS01/03/007, prepared by A3i Consortium

(Application Européenne de Technologie et de Services, AEA Technology plc, Allplan, Iberdrola S.A.), Task Report, September 2005.

11. Scoping Statement for Environmental Assessment for Rehabilitation of Thermal Power Plant Kosovo B, Final Report, prepared by Advanced Engineering Associates International et al, 6 April 2010.
12. Kosova "B" Investment Requirements and Rehabilitation Feasibility Study, prepared by PA Government Services for USAID, August 2010.
13. Improvement of District Heating in Kosovo, KfW. February, 2009.
14. Development and Climate Change, A Strategic Framework for the World Bank Group: Technical Report, World Bank Group, January 2009.
15. Criteria for Screening of Coal Projects under the Strategic Framework for Development and Climate Change, Operational Guidance for World Bank Group Staff, March 2010.
16. Generation Sizing in View of the Technical and Commercial Requirements of the Kosovo Power System, prepared by KOSTT, February 2010.
17. Generation Planning and Unit Sizing, prepared by Parsons Brinckerhoff and PricewaterhouseCoopers, March 2010, and Unit Sizing, prepared by Parsons Brinckerhoff and PricewaterhouseCoopers, April 2010.
18. MEM Report on Energy Efficiency. November 2007. Update May 2008.
19. Prefeasibility Study for Identification of Small Hydro Power Plant in Kosovo. Albanian Association of Energy and Environment for Sustainable Development. May 2006.
20. Energy Regulatory Office. Kosovo. Annual Report 2009.
21. Letter from Minister Pula requesting funding for Carbon Capture pre-feasibility study from specialized funds in the World Bank. Dated: 5May 2010.
22. Equipment Required for the Opening of Sibovc South West Mine. Recommendations for the Government. USAID. May 2008.
23. Energy Sector Technical Assistance Project I Study. World Bank Group. September 2002.
24. Private Sector Participation in Kosovo Power Distribution – Key Issues Report. International Finance Corporation. February 2010
25. Kosovo Energy Strategy - Management Briefing Note, November 2009
26. Kosovo Energy Sector PER. December 2009.
27. Kosovo Lignite Power Initiative – Economic Analysis. 2006.
28. Feasibility study of converting Kosovo B into combined heat and power plant, KfW (report expected in June 2011)

29. Water Security for Central Kosovo - Iber River Basin and Iber Lepenc Water System. Water resources, water demands and program of measures towards water security. Draft Final Report. SCE, March 2011.
30. Water Supply from the Iber Lepenc Hydro System for the Proposed Kosovo C Power Plant. Evaluation of the hydro system and water availability assessment. Pre-feasibility Study, BCEOM Consortium, 2008.

Annex 2: Additional useful references (for section 6d)

1. Dolezal, R., Large Boiler Furnaces, Elsevier, New York 1957.
2. Buki, G., Power Stations (in Hungarian) University of Technology, Budapest 2004
3. Levy, E.K., N. Sarunac, H. Billigen and H. Caram, Use of Coal Drying to Reduce Water Consumed in Pulverized Coal Power Plants. DOE Report DE-FC 26-03NT41729, 2006
4. Elsen, R.O., Planning and construction of the lignite drying pilot plant at Niederaussem VGB Power Tech 6/2001

Annex 3: Increasing efficiency of power plants

Measures to increase power plant efficiency in Rankine cycle steam power plant include use of advanced steam parameters (pressure and temperature) and steps reducing waste gas heat loss. (Fig1)

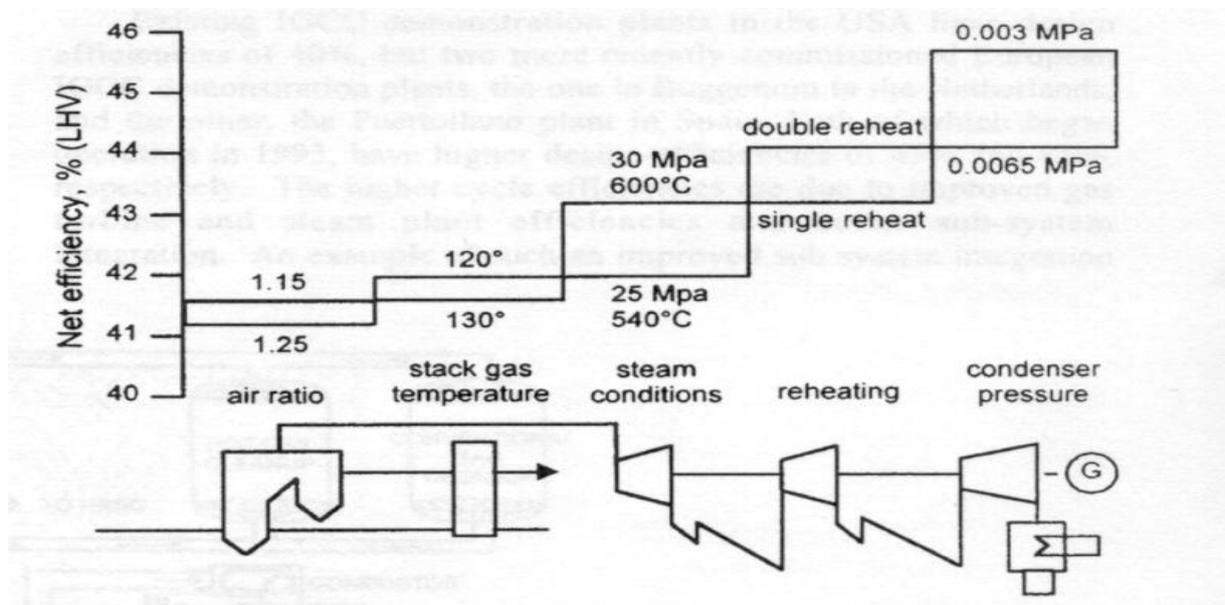


Fig 1 Effect of various measures for improving the efficiency of pulverized coal fired power generating plant (Schilling VGB)

Pulverized coal combustion in supercritical steam plant

As steam pressure and temperature are increased to beyond 221 bar (22MPa) and 374C the steam becomes supercritical, it does not produce a two phase mixture of water and steam and it does not have a saturation temperature or an enthalpy range of latent heat. Instead, it undergoes gradual transition from water to vapour with corresponding changes in physical properties such as density and viscosity.

Use of supercritical steam increases the energy conversion efficiency due to the higher pressure and higher mean temperature of heat addition. Armor et al (EPRI) reviewed the performance and history of pulverized coal supercritical units in the USA and in Europe where most of these PC/SC units were operating since the 1930s. There are about 160 such plants in the US. These plants show efficiency advantages of about 2.9 percentage points (between 41.5 (LHV) for PC/SC and 38.6%(LHV) for sub-critical) amounting to a 7.5% relative advantage of supercritical over sub critical units, without increased outages. (Fig.2)

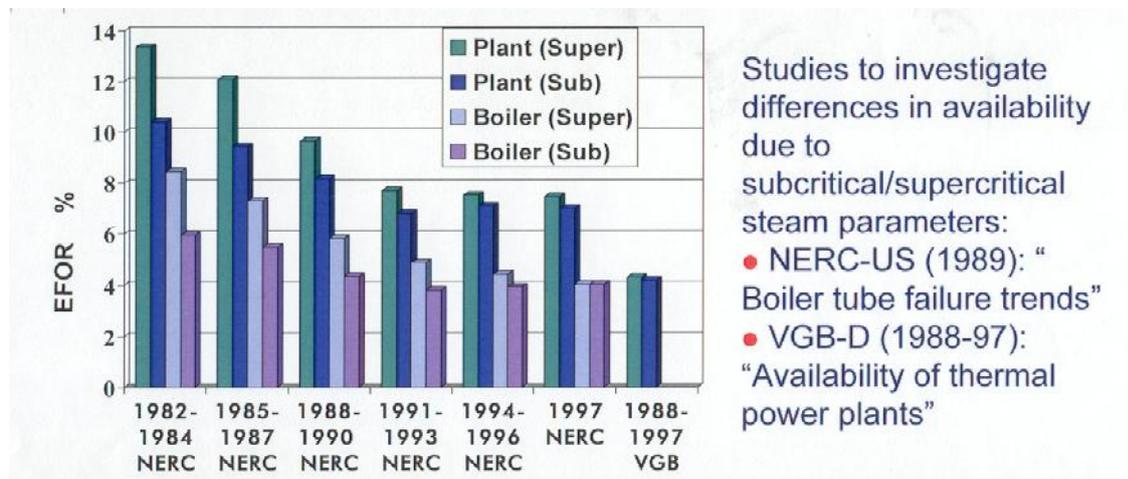


Figure 2 History of forced outages of supercritical and sub critical plants

Circulating Fluidized Bed combustion in supercritical steam plant

In fluidized combustion crushed mm size coal is combusted in a hot bed of sorbet and coal ash particles that are suspended in motion (fluidized) by air blown in from below through a series of nozzles. CFB operates at gas velocities high enough to entrain the solids which are then separated from the flue gas and recycled to the lower part of the vertical furnace to achieve good carbon burnout and sulphur capture by SO₂ sorbent at the relatively low temperature of below 900C. The limestone (CaCO₃) fed with the coal is calcined in the CFB to produce lime (CaO) which reacts with SO₂ to form calcium sulphate (CaSO₄) which is thermodynamically stable at CFB temperatures. Also, the NO_x emission is low partly because of the low temperature, and it is also reduced by staged combustion that can convert NO_x to molecular nitrogen (N₂). Hence, CFB plants can comply with environmental emissions regulations without flue gas treatments for sulphur capture and for NO_x reduction. Because of the easier preparation of the fuel feed (crushed instead of finely ground) CFB is amenable also to the use of lignite and the co-firing with biomass. The limiting factor for co-firing with biomass, in addition to the availability of sustainable biomass, is its high alkali content which reduces the softening temperature of the lignite ash and can cause increased fouling of boiler tube surfaces.

Annex 4: Oxy-fuel combustion and CCS

When oxygen, instead of air is used as oxidant for combustion, the mass flow rate of combustion products is significantly reduced and the flue gas CO₂ concentration is greatly increased. In order to avoid unacceptably high temperatures in the boiler, combustion products, mainly CO₂ are recirculated from the end of the boiler to the combustion chamber. This restores the furnace gas temperature to air combustion levels resulting in an O₂ volume concentration of about 30%, compared to 21% for air blown combustion. This difference is due to the higher specific heat of CO₂ than that of the replaced nitrogen, and also, to CO₂'s high radiative emissivity. Flue gas recirculation (FGR) increases the CO₂ concentration in the flue gas to beyond 90%, the complement being N₂, due to air leakage and about 3% O₂ required for complete burn out of coal. This makes the flue gas ready for sequestration after the removal of condensables but without energy intensive gas separation. If avoidance of corrosion in the compressor and pipeline requires further exhaust gas polishing, the five-fold reduced flue gas volume leads to strongly reduced capital and treatment costs relative to those for an air blown combustion plant.

The presently available Cryogenic Air Separation process consumes a significant fraction of the generating plant's output and reduces its efficiency by 6.4 percentage points. The development of membrane type oxygen processes with greatly reduced energy requirements are urgent R&D targets

Pilot plant studies of Oxy/Combustion are in progress in Germany by Vattenfall, in the Canada, in the UK, in Queensland Australia and in S Korea. The construction of the 30 MW thermal pilot plant at Schwarze Pumpe in Germany is an important milestone for the Vattenfall project. It has been in operation since the middle of 2008 and is the necessary scale-up link between initial engineering and successful operation of the future 250—350 MW electricity demonstration.

While Oxy/combustion is a most promising clean coal technology and is suitable for lignite combustion, the time-line of development does not allow its deployment in the Kosovo A power plant reconstruction project.