VATTENFALL

Report

Study about Security of Electricity Supply in Kosovo

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Executive Summary

- **Task 1:**

On the basis of several different regression methods the winter peak power and the electrical energy consumption of Kosovo for the period till 2030 were forecasted (see Table 0-1 and Table 0-2). The result of this forecast has been shown with a confidence interval, which was calculated by taking the standard deviation of the regression data and the Student-t-distribution into account. By means of a forecast of the Kosovan population development the specific power demand and electric energy consumption were evaluated for the years till 2030 and compared with data from other countries.

Scenario	Real peak demand 2010 [MW]	Result 2015 [MW]	Result 2020 [MW]	Result 2025 [MW]	Result 2030 [MW]
High	1,158	1,297	1,510	1,747	2,010
Medium	1,158	1,218	1,411	1,627	1,869
Low	1,158	1,138	1,311	1,506	1,727

Table 0-1 Evaluated load forecast scenarios

Year	$W_{total,sectors}$ [GWh]	$W_{Households}$ [GWh]	$W_{Industry}$ [GWh]	W_{Com} [GWh]	$W_{Lighting}$ [GWh]	W_{losses} [GWh]
2011	5,584	2,615	1,203	814	12	940
2015	6,679	3,137	1,526	942	13	1,061
2020	7,947	3,678	1,939	1,155	16	1,159
2025	9,216	4,220	2,352	1,368	19	1,257
2030	10,484	4,761	2,765	1,581	22	1,355

Table 0-2 Forecasted electrical energy consumption, 2012-2030

Following results were derived from these forecasts:

- The electric energy consumption and in particular the power demand are increased in Kosovo in past 10 years very quickly. One important reason for that is the increase in use of electric energy for heating and hot water supply.
- Due to the fact that energy generation remains stable or even decreases, it is essentially needed to devote prior attention to the rational use of demanded electric energy in the next few years.
- Due to the lack of an extensive gas supply the electrical energy for heating and hot water will remain significant and the increase of the electric energy consumption and especially the winter peak power will continue.
- The forecast of electricity demand on the basis of the development of the consumption of the individual energy sector have shown more than 10% increase in industrial and commercial sector, which is not expected to continue in the same tempo.
- A linear growth of energy demand was forecasted that leads, under consideration of the necessarily growing load factor, to a load development corresponding to the found peak demand development by means of linear regression.
- An exponential power demand development following the trend of recent 12 years would lead to power consumption values of 3.2 to 4GW in 2030,which appears unreal but also shows, in order to characterize, that forecast method has a significant impact on the result of the forecast.

- **Task 2:**

The System Adequacy (ENTSO-E-methodology) was analysed in Task 2. The respective value to be determined and evaluated is the Generation Adequacy calculated from the difference between Remaining Margin (is adequate with the difference of Reliably Available Capacity and Seasonal Peak Load) and Spare Capacity (means 10% of Net Generation Capacity).

This Generation Adequacy value is calculated for the respective reference points and illustrated in clear diagrams. Additionally it will be compared with the available Cross-border Transmission Import and Export Capacities in order to find Transmission Adequacy.

On the basis of the developed forecast of electric energy consumption and the winter peak demand, the consumption values for the summer peak and summer minimum were found. They show that Kosovo urgently needs to take measures to increase significantly the load factor in order to reach more economically beneficial operating hours for new coal-fired units.

In addition to Base and Conservative scenarios taken from Energy Strategy 10 own-created power demand development strategies were evolved, out of which an optimum production strategy was derived by the game theory decision approach. That optimum strategy considers both the particularly large availability of lignite in Kosovo and the EU strategy for the wider use of renewable generation facilities. Overall, it is necessary to expand the generation capacity of Kosovo in compliance with the situation of the neighbouring countries.

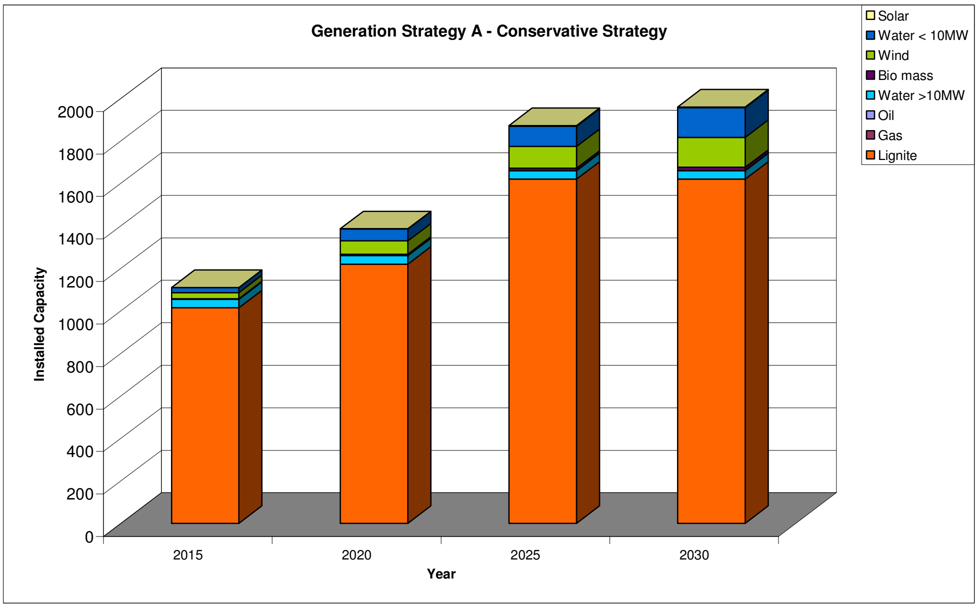

Figure 0-1 Annual generation development of Conservative Strategy

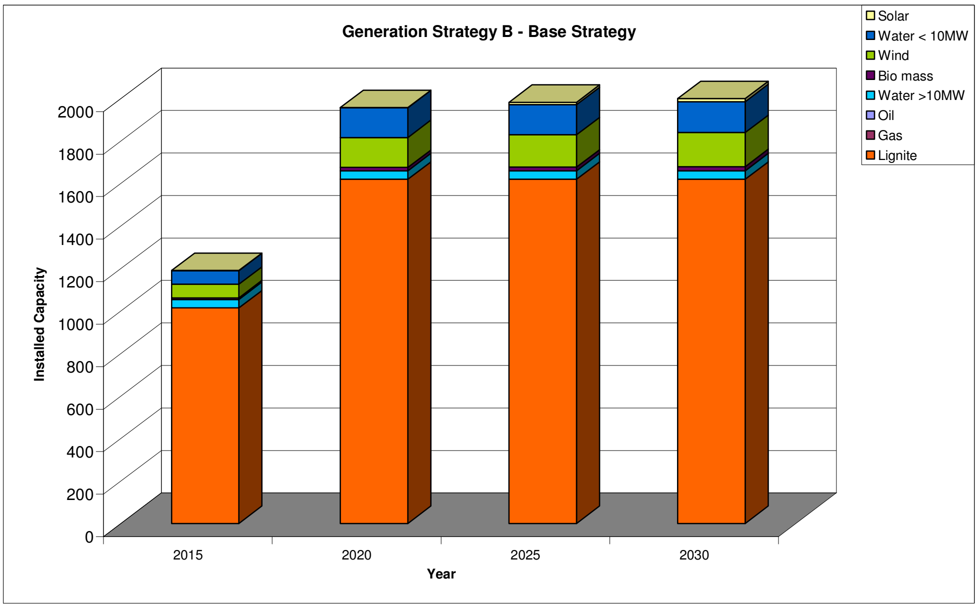

Figure 0-2 Annual generation development of Base Strategy

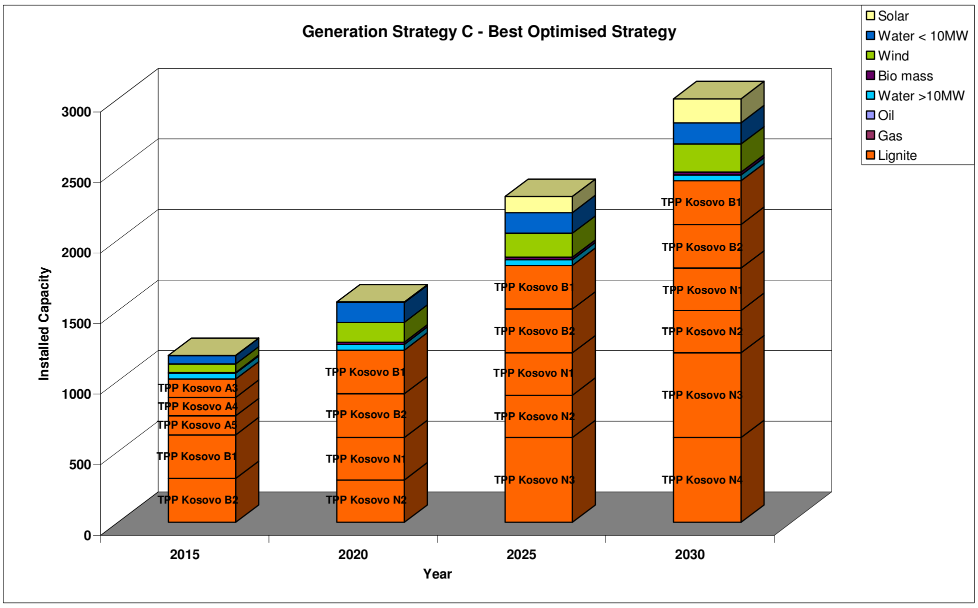

Figure 0-3 Annual generation development of Strategy C

Generation Adequacy analysis has shown that with Base and Conservative Strategies the Kosovan power system remains import dependent. By means of the implementation of Strategy C the system gets export capable in most of the situations. Transmission Adequacy is always granted, that means that generation adequacy is always less than import and export capacity. The Generation Adequacy of the joint Kosovan-Albanian operation strategies shows that the construction of new power plants as per Base and Conservative Strategies does not lead to sufficient results. The power systems remain import dependent. The best optimised strategy makes both power systems being able to export in most of the reference points.

In best optimised generation strategy the following energy price development occurs. The tendency of decreasing energy prices while joining the power systems of Kosovo and Albania can be seen.

Year		2015	2020	2025	2030
Kosovo	€/MWh	31,28	42,91	46,82	48,16
Albania		20,59	24,54	35,66	35,00
Kosovo-Albania		21,49	30,35	37,06	39,51

Table 0-3 Energy generation price development, Best optimised generation strategy, MGS, approach 2

The 400-kV-/ 220-kV-system of Kosovo is designed adequately for the planned extension of generation power and will be, by means of the new 400kV-line from Prishtina to Tirana 2, sufficiently capable for the recommended construction of further lignite units and possible new renewable generation in order to support optimally energy trades. The, in comparison to the (n-1)-transmission capability relatively low net transfer capacity can be increased further by modern protection technology or monitoring. Additionally it rises automatically only due to the construction of new 400kV-lines in the areas of neighbouring TSO.

For granting system adequacy the extension of 110kV- grids has main priority. The conversion of the 400-kV-system preferably planned for power interchange with neighbouring TSO to a transmission system with importance for a quality power supply of Kosovo requires the construction of several 400-kV-/ 110-kV nodes.

Summarising finally it can be stated:

- System adequacy analysis has shown higher security of supply for best optimised strategies for both Kosovan single and Kosovan-Albanian joint operation modes with export possibilities in most of the situations
- Kosovan thermal power plants should be used for base supply, Albanian hydro power plants for covering the peak demand and provision of control power
- Kosovan RES generation development and CO_2 certificate trades could be supported by existing Albanian hydro power plants in joint operation of both countries
- The energy generation costs of joint operation are bit higher than in Albanian single operation but substantially less than in Kosovan single mode.
- However Albanian peak and reserve control power can be sold much more expensive than Kosovan base power
- Therewith both countries earn a high national economic welfare

- **Task 3**

The energy balance curves are defined as the difference of the produced and the demanded energy per year in total. Therefore positive values stand for a surplus of energy with possibilities of export and negative values for the need of imports. The results show big export possibilities of Kosovan power system although generation adequacy analysis has shown that the total system is likely to import in most of the situations. However that results from necessary system reserves remaining unconsidered in that energy balance analysis.

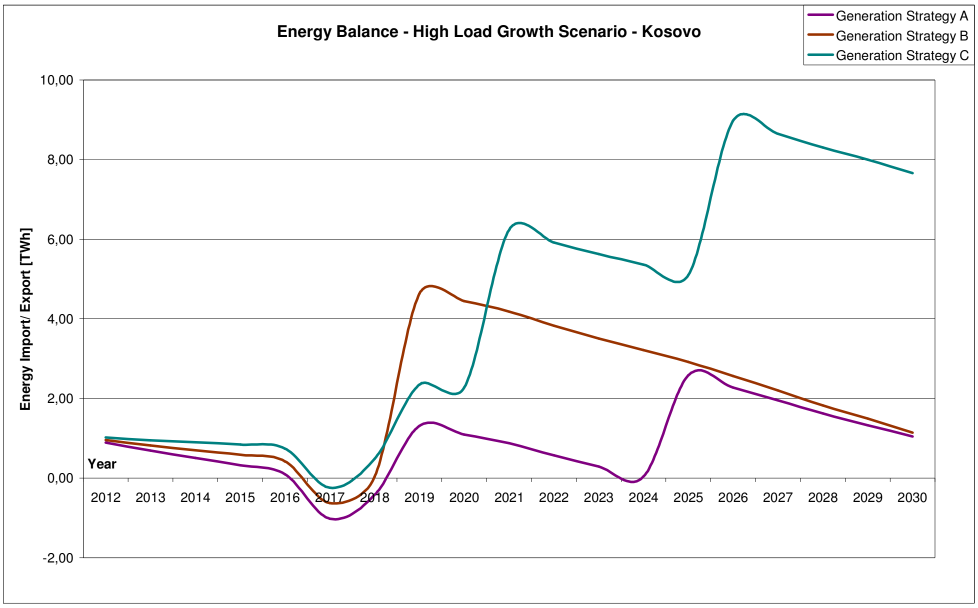

Figure 0-4 Energy Balance of Kosovan power system, HGS

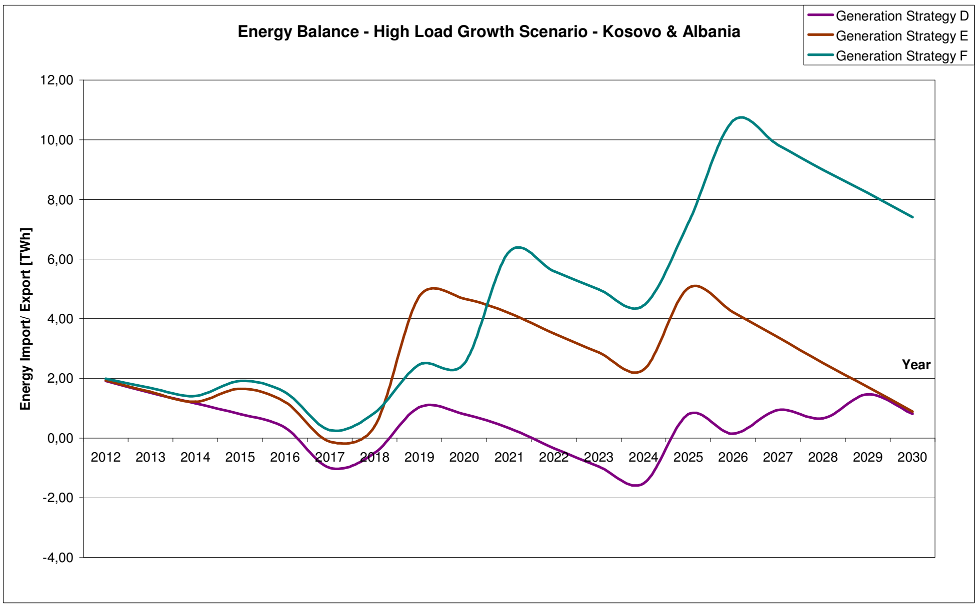

Figure 0-5 Energy Balance of Kosovan and Albanian power system, HGS

The energy balance of the joint power system Kosovo and Albania shows that the merging of both power systems does bring advantages as it can be seen by comparison of Kosovan graphs (see exemplarily Figure 0-4 for High Growth Scenario) with the energy balance curves of joint .operation (see exemplarily Figure 0-5 for High Growth Scenario). The single Kosovan system tends to be more import dependent or less export capable than the joint operation power system.

Additionally the potential of emission of CO_2 per strategy and year is shown. The values are calculated for the total production possible including export. For the covering of energy demand of only Kosovo the gas emission values are lower. Furthermore possible CO_2- savings, which result from the utilisation of renewable energy sources, are depicted (see Figure 0-6).

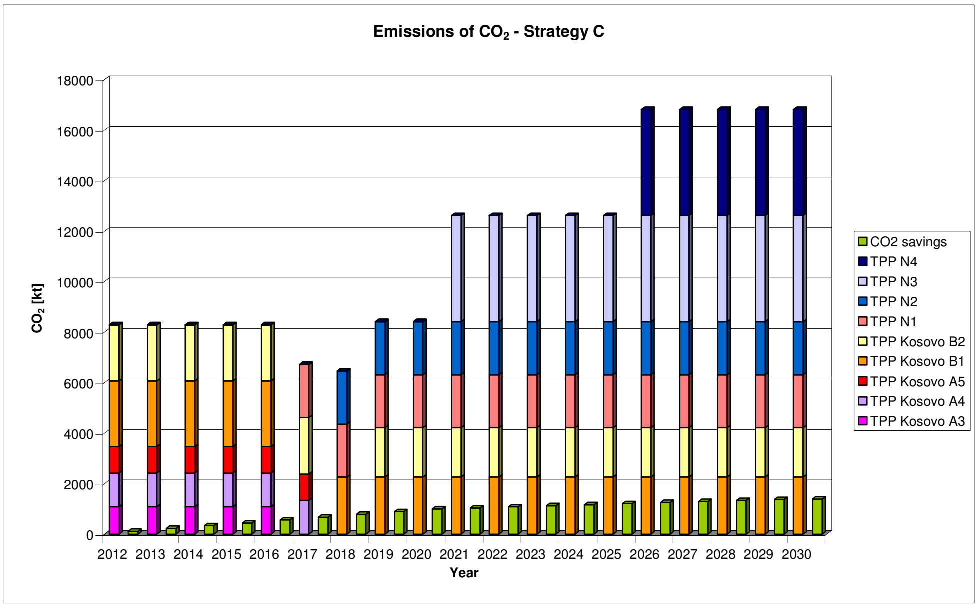

Figure 0-6 CO_2- emissions according to Strategy C

In Figure 0-7 the SO_2-emissions per year are illustrated. Considering all three strategies the sulphur dioxide emissions will decrease tremendously, as state-of-the-art units only emit 20% to 25% of SO_2 per MWh. That means even by doubling the generation from lignite reserves (strategy C) the SO_2-

emissions will only amount in total to the half in comparison with the values before refurbishment and installation of new units, which is from environmental point of view a great improvement.

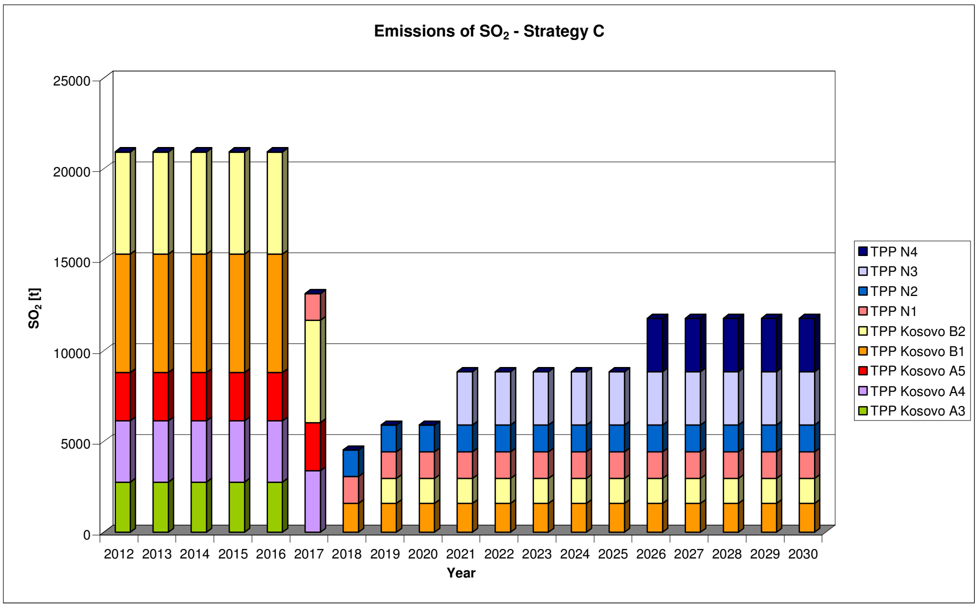

Figure 0-7 SO_2- emissions according to Strategy C

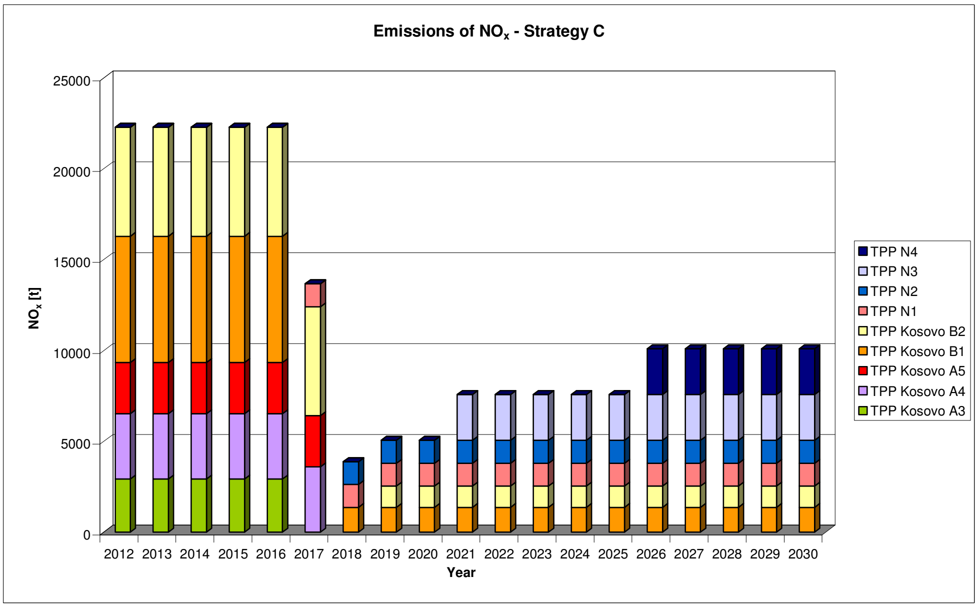

Figure 0-8 NO_x- emissions according to Strategy C

In Figure 0-8 the NO_x-emissions per year are illustrated. Considering all three strategies the nitric oxide emissions will decrease tremendously, just like SO_2, as state-of-the-art units only emit 15% to 20% of NO_x per MWh. That means even by doubling the generation from lignite reserves (strategy C) the NO_x-emissions will only amount in total to less than the half in comparison with the values before refurbishment and installation of new units, which is from environmental point of view a great improvement.

- **Tasks 4 and 5:**

Based on the liberalisation proceeding all over Europe including the basic modification of the energy market possibilities for the creation of an energy market the resulting requirements and mechanisms for

- The control energy market
- The energy exchange
- The OTC-market

are worked out.

According to their responsibilities the European TSO, also on a liberalised energy market, are obliged for ensuring system stability and procurement of

- Primary Control Power (PCP)
- Secondary Control Power (SCP)
- Minute Reserve (MR)

The procurement of PCP, SCP and MR can only be granted and contracted by the TSO, while they buy these energy products on control energy market from potential vendors like power plants or traders. Utilised methodologies (prequalification, tendering and placing) on the liberalised European energy market are described exemplarily.

The joint utilisation of SCP and MR by several TSO for avoiding a contradictive control is an established methodology in the meantime. Possible procedures and international trends are described. Therefore the creation of a control energy market, all-over South-East Europe is recommended in a long-term perspective. For the clear allocation of control energy costs on the respective market participants the creation of a balance group management seems to be necessary.

The modifications of the European energy market performed in the last years have led to completely changed market mechanisms. Besides over-the-counter-trades (OTC-market) this modification is characterised by the creation of nationally and internationally acting energy exchanges with different trading floors and energy products. The creation of an energy exchange according to European Guidelines requires clear market rules for all market participants. To these belong among others the Code of Conduct and the Operation Rules that depict the exchange mechanisms in a very clear way and avoids or at least limits the misuse of the exchange by deceivers.

Additionally to that description four possible options for the creation of a liberalised energy market in Kosovo and beyond are illustrated based on the draft of “The Market Rules” of May 2012:

- Option 1: OTC- market → Future
- Option 2: OTC- market → Future & Spot
- Option 3: OTC- market and Energy Exchange (physical exchange) → Future & Spot
- Option 4: OTC- market and Energy Exchange (physical and financial exchange) → Future & Spot

The utilisation of Renewable Energy Sources (RES) such as wind and solar do not make any contribution for the covering of the increasing energy demand in Kosovo. However the extension of RES is a requirement to be met in Kosovo, too. Nevertheless this requirement is connected additionally with demands to the TSO. Reliable planning basics, credible extension scenarios and investment security are determining for the integration of RES into Kosovan system and therewith the necessary grid extension. Clear regulations for the allocation of energy and compensation costs of RES plus its reimbursement are additional, inevitable prerequisites for the integration of RES.

Regarding market development it can be finally summarised:

- The creation of a joint market in Kosovo and Albania is feasible
- However this can be only a start and for a successful development it has to be territorially extended SEE-wide.
- Having a market means to install an independent market place that is controlled and approved by the state (clearing house). This market place consists of an organisation/ company with the respective legal entity, facility, communication possibility, market software platform and employees with:
    - Defined market products
    - Approved market participants
- It is recommendable to install such a market with 5 to 10 sellers (power plants) and minimum 5 to 10 buyers (suppliers) first. A lower number of actors leads to a non-active market and the goal, a high market acceptance avoiding monopolistic structures and cost reduction will not be reached.
- It is very important for a functioning control energy market to have a sufficient market depth, i.e. to have a huge number of market participants involved. The number of vendors per control power product should not be less than 5 per control power product. The more providers exist in the market the bigger are the selection possibilities by the TSO and therewith the opportunity of an optimum cost

- Market implementation can be started immediately, if:
    - a mutual declaration of intent is signed and
    - an independent market company is founded
- This company defines the tempo of market development.
- But the immediate start of talks with Albanian and further international partners for the creation of a respective acceptance of a market is the base for the realisation of a functioning energy and control power market beyond Kosovo/ Albania within 1 or 2 years.
- Privatisation of distribution, supply, generation etc. does not have any influence on the market.
- In a liberalised market the tariff for the final energy customer is determined by the supplier. The customer itself is free in choice of his supplier, an important characteristic of a liberalised market. The tariff is unilaterally and exclusively determined by the supplier. It defines the tariff under consideration of the market situation and therewith the tariff influences the market success of the supplier.
- Risk factors for a liberalised market do not exist but for its participants, especially the inefficient ones. The higher their efficiency is, the more probable is the viability on the market.
- Necessary investments have to be done for the creation of the required market place as already mentioned above. Stranded costs do arise if the current handling of economic processes in energy production, transmission, distribution and sales is removed stepwise by the new market process. The efficiency of new TPP will become the determining element of market success and therewith for eventual income loss and stranded costs.

Analysing the economic signals it can be stated:

- The costs of energy generation by new TPP are lower in contrast to permanently refurbished TPP
- The costs for energy generation from TPP are lower than for RES
- The utilisation of RES is a climate political strategy all-over Europe and leads to higher prices for the final customers

- Every constraint in TPP generation by RES leads to higher generation costs
- Increasing security of supply leads to
    - A distinct growth of GDP of Kosovo
    - An increase of employees
    - A distinct signal for investors, as no investment without secure energy supply formation.

0 Introduction

0.1 Scope of the study, Terms of Reference

0.1.1 Task 1 – Demand forecast

Forecasting the demand is essentially necessary for the evaluation of Kosovo's future security of electricity supply. This study requires a forecast considering impacts of electricity sector reforms and economic development in Kosovo. The forecast should cover a time frame from 2010 until 2030. A three demand scenario depending on Gross Domestic Product (GDP) growth for different electricity consumer categories (Households, Industries and Services) should be developed:

- Most probable scenario – Medium growth scenario (MGS)
- Low growth scenario (LGS)
- High Growth scenario (HGS).

The scenarios should also take other impact factors such as energy efficiency and reduction of commercial losses into consideration. The forecasting, done for every year within the timeframe, should include on the one hand Kosovo's annual energy demand (in GWh), divided into the respective sectors, and on the other hand its load demand including winter and summer maximum and minimum load (MW), the ratio of monthly peak demand to annual system peak and hourly demand curves for four typical weeks (168 hours for the third week of January, April, July and October).

0.1.2 Task 2 – Evaluation of system and generation adequacy

The objectives of this task are the long term provision of the system and generation adequacy (supply reliability) and information about the necessary amount of new generation units or imports respectively.

Therefore three generation investment strategies have to be developed:

- **Conservative Strategy A:**

This most probable generation scenario takes relevant impact factors into consideration, which can effect a new generation capacity development, available primary resources of the country, GDP, regional energy market, energy price development and other possible uncertainties.

- **Base Strategy B:**

This scenario is based on updated Energy Strategy 2009 - 2018 and extended till 2030 with additionally required installation of new generation capacities (conventional and renewable) and should provide sustainable security of supply.

- **Best optimized Strategy C:**

This generation scenario reflects the optimization and minimization of costs for electricity sector of Kosovo. The study should consider two operation modes of the Kosovan Power System, as self and jointly regulated area with the Albanian Power System respectively.

So, system and generation adequacy in accordance with the ENTSO-E methodology has to be evaluated and recommendations should be given. The Study shall take the following impact factors into consideration:

- Impact of daily and seasonal load curves
- Impact of developments in energy saving (efficiency) and demand side management options
- Current and future installed generation capacity (type of plant, installed capacity, fuel type, year of commissioning, year of decommissioning)
- Impact of developments in renewable resources (HPP, Wind, Solar, Biomass)
- Impact of import and export opportunities
- Impact of possible system constraints
- Impact of different scenarios, e.g. fuel price scenarios and demand growth scenarios
- Impact of CO_2-costs.

0.1.3 Task 3 – Long Term Electricity Balance

This task has to elaborate a forecast about the electric power supply and demand as well as electric power transfers for the period 2010 - 2030 with the ultimate objective of achieving a balanced power system operation. The following issues shall be included:

- Estimation of energy balance for each year based on demand and generation scenarios (Task 1 and Task 2)
- Evaluation of required reserves for fuel level and reserve capacities to achieve the necessary level of security and reliability of supply for each year
- Evaluation of gas emission (SO_2, NOx and CO_2) for each year

- Recommendations for measures to be adopted to secure supply and minimize costs for end users.

0.1.4 Task 4 – Establishment of a competitive market

In this task the long term generation capacity development and its influence on the development of a competitive liquid market in Kosovo and in addition of a coupled market in Kosovo and Albania has to be reviewed. Currently the energy market is not sufficiently developed to provide correct signals for investments in generation. Therefore, an assessment of the development of market parameters in the future is required. Fundamental elements to be considered are:

- Offer and demand
- Non discriminated Third Party Access to the network and cost reflections
- Economic signals (generation and consumers respond toward price signals)
- Sufficient number of buyers and sellers under consideration of the avoidance of any monopoly
- Appropriate treatment of stranded costs and subsidies

From market point of view, import and export should not be seen only as transactions necessary during power shortages or surpluses. Increase of commercial cross-border transactions is the best indicator for an open market development. Therefore, it shall also be evaluated to which extend it might be economically and technically favourable to import electricity for covering the domestic demand.

0.1.5 Task 5 – Assessment of the ability to implement an electricity market for ancillary services

Power systems need ancillary services to maintain the quality of electricity. A market for ancillary services with prices high enough to influence investment decisions has to be described. This market should encourage the construction of power plants that are capable to provide certain ancillary services. It must ensure fair competition and adequate balance risks. So the study has to find answers for ensuring ancillary services in the future and the flexible system operation possibilities in the use of resources.

0.1.6 Task 6 – Weighting to the respective interest of the parties concerned

With reference to Tasks 1-5 barriers and opportunities for the development of new generation capacities have to be identified. Requirements for flexibility and secure operation plus the implementation of Directive 2005/89/EC should be regarded respectively. Analysing from technical and economical point of view the pros and cons of proposed options recommendations for the technically and economically most feasible construction of new generation capacities have to be given.

0.2 Grid topology of Kosovo

0.2.1 General description

The transmission grid of Kosovo consists of 400-, 220- and 110-kV-lines and respective substations. The power generation centre of Kosovo is located in the vicinity of Prishtina, where the power plants of Kosovo A and Kosovo B produce more than 95% of electric power in Kosovo. The power plant Kosovo A is connected to the 220-kV-grid, while the power plant Kosovo B is connected to the 400-kV-grid. Both networks are connected by grid coupling transformers.

The mentioned power plants have redundant grid connections for power infeed to the grid, which represents a very high technical standard of grid connection. Comprehensive reconstruction and refurbishment programmes are planned for the overhead lines and switchgears in the substations within the 400-kV- as well as within the 220-kV-grid. That demonstrates that a large scale of reconstruction and refurbishment measures is still necessary to increase the stability and reliability of the transmission grid.

Nevertheless, the fact that KOSTT changed the maintenance strategy in 2010 from condition oriented to a systematic preventing maintenance, shows that the positive development of fault statistics is not a stochastic issue but the result of comprehensive maintenance works. The respective fault statistic of the last years is shown in Table 0-1.

Year	2007	2008	2009
Number of outages	10	4	0

Table 0-1 Fault statistic of 400-/220-kV-transmission grid of Kosovo

This development of the fault statistic for the 400-/220-kV-transmission grid shows impressively that Kosovo is on the way to reach the standards of western European countries. But this positive development of the fault statistic is not conterminous with a sufficient transfer capacity of the HV-grid in vertical direction.

In order to eliminate transfer bottlenecks in vertical direction, among other measures high-temperature conductors were installed, e.g. to eliminate a bottleneck on the 110-kV-line between substations of Kosovo A and Vushtri. The same measures were realised on the 110-kV-line between the substations of Prizreni 2 and Prizreni 1. Those grid reinforcement projects will require considerable capacities for the next years and lead to significant improvement of technical conditions within the 110-kV-voltage level, as:

- Decrease of fault events
- Improvement of voltage quality
- Increase of the security of supply
- Reduction of grid losses

0.2.2 Transmission interconnections of Kosovo transmission grid with ENTSO-E- system

The determinant interconnection assets of the Kosovan transmission grid into the ENTSO-E-system are the 400-kV- and 220-kV-transmission lines. The 110-kV-lines, considered to be part of the Kosovan transmission grid, do not have an essential influence on the reliability and stability of the ENTSO-E-interconnection of Kosovo and therefore will not be considered further.

The 400-kV-interconnection lines to Serbia, Macedonia and Montenegro guarantee a proper interconnection of Kosovo with the ENTSO-E-system. The thermal transmission capacity of each of these transmission lines amounts to 1,316 MVA and therefore is able to control a blackout of the power plants Kosovo A and Kosovo B in principle even under consideration of the (n-1)-criterion (see Table 0-2).

Transmission interconnection to	Voltage level [kV]	Net Transfer Capacity [MW]	Natural Power [MW]	Nominal Power [MVA]
Serbia	220	100	120	300
	400	450	500	1,317
Montenegro	400	400	500	1,317
Macedonia	400	400	500	1,317
Albania	220	100	120	300
Albania	400	500	500	1,317
Sum	**-**	**1,950**	**2,240**	**5,868**

Table 0-2 Transfer capacity of Kosovo interconnection lines

For this general statement it needs to be assumed, that the entire 400-kV-system of the region comprising Serbia, Bulgaria, Greece and Montenegro is operated following the (n-1)-criterion. Necessary secondary and tertiary control power (minute reserve) is available according to the “Handbook for Operation Management of the ENTSOE-E-grid” (Operation Handbook, OH, [1]) or in case of unavailability it has to be realised by load shedding.

The 400-kV-level is a Europe-wide compound. The system disturbance on October 4th 2006 has shown that SEE was impacted by the failure in German transmission system. Already today there is a big influence of system operation of SEE countries on Kosovo further increasing by the powerful extension of the system.

The import and utilisation of reserve power from the 220-/400-kV-grid area of Austria and Hungary is possible in principle but will lead to significant voltage losses in heavy peak load times due to the relatively weak grid conditions in north-south-direction. Under market conditions the procurement of reserve power is even possible from remote network areas but will lead to voltage drop in case of high system load.

Additionally the 220-kV-connections from Kosovo to Albania and Serbia do stabilise the grid interconnection of Kosovo. The planned 400-kV-overheadline Prishtina – Tirana 2 will lead to a further improvement of integration of the Kosovo grid into the ENTSO-E- system and the stability of the 400-kV-grid in the region not only for Kosovo and Albania but also have positive effects in particular for the grid integration of Serbia, Macedonia, Montenegro and Greece. The integration of the Kosovo transmission grid into the ENTSO-E-system is shown in Annex 1.

Summarising it can be stated that the integration of Kosovo into the ENTSO-E-grid is very good at present from technical point of view and will reach an extraordinary high standard after completion of the new 400-kV-transmission line Prishtina – Tirana 2. Additionally it can be summarised that no technical grid bottlenecks are existing neither for primary, secondary nor tertiary control power. Excellent technical grid conditions do already exist for export and import of electrical energy even without the planned new 400-kV-line Prishtina – Tirana 2.

0.3 Generation topology of Kosovo

0.3.1 General description

The electric power generation capacity of Kosovo is very much dominated by the lignite fired thermal power plants of Kosovo A and Kosovo B. These two power plants together have a total nominal power capacity of 1,513MW. Due to lifetime and maintenance conditions, especially of Thermal Power Plant (TPP) Kosovo A, the available capacity of the units is much below nominal values. Altogether the total average available power capacity of the thermal units only amounts to approximately 900MW.

The Kosovo A units are between 35 and 50 years old and have either already reached or will reach the end of their lifetimes in 2017. Therefore the power production capacity will decrease further without installation of new power plant capacities. Currently the thermal power generation of Kosovo represents about 97% of the total power generation of the country. Beside this an installed power capacity of 32MW is provided by the hydro power plant (HPP) Ujman/ Gazivode. The situation of the generating units as per questionnaire 2012 (according to Vattenfall Power Consult (VPC) site assessment 05-2012) is given in Annex 2.

0.3.2 Short description of main operational characteristics

0.3.2.1 TPP Kosovo A

The Kosovo A Power Plant is located in Obiliq about 15 km next to Prishtina. Kosovo A power plant has five units, which were constructed during the 1960s and the 1970s. The units A3 to A5 actually are in operation. Units A1 and A2 have been out of operation for several years. There are plans existing for refurbishment and re-commissioning of Unit A2. The availability of the Kosovo A units is rather low and ranges between 60-70%.

Kosovo A power plant operates today down-rated (between 100MW to 130MW actual capacity versus 200/ 210MW design capacity) and with efficiency far below design. The units of Kosovo A power plant have (mainly) exceeded their lifetime and large investments and rehabilitation would be needed to bring them close to required environmental standards. Given the limited operation time this is economically not feasible.

In summary it can be noted:

- The units A1 and A2 are stopped, but further operation of Unit A2 is intended by KEK currently under discussion.
- The units A3, A4, A5 (nominal net output capacity 200-210MW) are operated in base load mode with reduced power (100-130MW) due to power equipment limitations. The decommissioning of these units A3 to A5 is planned for 2017, but only in case of respective new, substitutive power units.

0.3.2.2 TPP Kosovo B

The Kosovo B Power Plant is located next to Kosovo A in Obiliq about 15 km next to Prishtina and consists of two lignite fuelled units of 339MW power generation capacity each. Different projects on rehabilitation of mechanical part have been carried out between 2000 and 2002. The aim of specified rehabilitation project was the upgrade of Kosovo B in order to improve the availability and the control characteristics.

Kosovo B power plant operates today slightly down-rated (about 270MW actual capacity versus 339MW design capacity) and with efficiency far below design. The units of Kosovo B power plant will reach their lifetime, but large investments and rehabilitation measures in 2017/ 2018 will bring them to required environmental standards and extend lifetime till longer than 2030.

In summary it can be noted:

- The units B1 and B2 (nominal net output capacity 339MW each) are operated in base load mode with less reduced power (310MW) due to power equipment limitations.
- Large rehabilitation measures are planned for 2017 and 2018, but only in case of respective new, substitutive power units.

0.3.2.3 Hydro Power Plant (HPP) Ujman

The only other important power generation plant outside of KEK is the HPP Gazivoda/ Ujmani (2 units of 17.5MW design power each), administrated by the water company Hydrosystem Ibër-Lepenc. The units 1 and 2 after standard maintenance measures during the last 10 years are operated in manual mode. The nominal net output capacity of each unit is 16MW. The HPP Ujmani units are connected to the 110-kV-grid.

0.4 Energy Strategy of Kosovo

0.4.1 Identified strategic objectives of Energy Strategy

The Energy Strategy review is based on the Kosovo Government Program, a number of Government decisions, and a variety of relevant studies and analysis conducted during the recent years. Particular attention is given to the full compliance with the European Union Acquis.

The accelerated and sustainable economic development of Kosovo will substantially depend on implementation of adequate economic and structural policies and reforms, which will ensure rational utilization of natural and human recourses. Security of supply, promotion of investments in the sector, preserving of environment and further development of the energy market are the main strategic goals of the new European strategy for the EU energy sector. A number of important objectives derive from these goals, including the so called 20-20-20 program. Considering the demand development this program means that following the Kosovan government objective a capacity of 10MW bio mass, 250MW wind, 1MW solar and 150MW small hydro power plants need to be installed to reach 20% renewable supply share in 2020 considering typical operation hours per year expected for the several generation options as per European experiences (see Table 0-3). If these renewable energy development goals cannot be reached in Kosovo, the formation of a joint energy system with Albania will lead to fulfilment of 20-20-20-objective.

Renewable Energy Source	Installed Capacity [MW]	Operation hours per year [h/a]	Produced energy per year [GWh/a]
Small Hydro	150	4,400	660
Wind	250	1,800	450
Biomass	10	5,000	50
Solar	1	1,100	1,1
Total	**411**	**-**	**1,161**

Table 0-3 Example for a possible in-feed to reach the 20-20-20-goal

The following issues are determined as main objectives for Kosovo:

- Secure reliable energy supply: All categories of energy consumers must be able to enjoy efficient and uninterrupted energy supply of an adequate quality.
- Restructuring and development of the energy sector in compliance with the Energy Community Treaty (EnCT): The energy legislation in Kosovo should be in line with the European Union Acquis and the timetable set by the EnCT. Kosovo has to continue reforming its energy industry in order to ensure competition in the energy market under the general principles of open competition, non-discrimination, transparency and equality
- Development and rehabilitation of power generation capacities with private investment is of high priority for Government of Kosovo. Sufficient power generation for domestic consumption, ensuring of reserve capacity and export of electricity will promote sustainable development of the country.
- Development of energy transmission infrastructure: Kosovo has unbundled the transmission function (KOSTT JSC is already incorporated) and is working to enhance its transmission and transformers capacities for domestic supply and connections with the systems of

neighbouring countries, through rehabilitation, reinforcement and expansion of its transmission infrastructure.

- Development of energy distribution infrastructure: It is imperative for Kosovo to drastically reduce energy losses, both commercial and technical, in the power distribution system. Extension and reinforcement of the district heating distribution network is also necessary.
- Promotion of foreign investments in the energy sector: Kosovo aims to cover the majority of its capital requirements for energy sector investments by private sector investment. To attract private capital Kosovo has to complete restructuring of the energy sector and offer a stable regulatory environment within a competitive market context and also use a set of appropriate institutional tools.
- Optimizing the exploitation of all available energy resources, including both indigenous and imported resources: Kosovo has to take advantage of its indigenous abundant lignite resources and plan for their rational utilization for electricity generation, exploiting the cost-competitive advantage of Kosovo's power industry chain in the Energy Community. Moreover, it also needs to utilize rationally all other available energy resources, including hydropower and other Renewable Energy Sources (RES).
- Promotion of environmental protection awareness in energy activities: In accordance with the EnCT, Kosovo is committed to implement the Acquis Communautaire on environment with regard to energy resources exploitation and power infrastructure construction and operation.
- Kosovo plans to promote both energy efficiency and the use of renewable energy as two interrelated sustainable development options that contribute to the overall security of supply and environmental protection.

0.4.2 Generation Investment Scenarios

- **Conservative Scenario**

This Conservative Scenario is deduced from the Base Strategy as described in Energy Strategy 2009-2018 [2] and Generation Adequacy Plan 2011-2020 [3] and represents a reduced development of new generation capacities (see Table 0-4). In contrast to the defined scenario in [3] the conservative scenario within this study considers the commissioning date of TPP units N1 and N2 not until 2017 and 2018 respectively, the commission of the new unit TPP N3 (400MW) for 2025 and HPP Zhur as not constructed and commissioned in the regarded timeframe till 2030.

Generation	First year of operation	Planned Life Time	Installed Capacity [MW]	Net available capacity [MW]	Life Time Extension
TPP Kosovo A3	1970	2017	200	130	-
TPP Kosovo A4	1971	2018	200	130	-
TPP Kosovo A5	1975	2018	210	135	-
TPP Kosovo B1	1983	2030	339	310	2017
TPP Kosovo B2	1984	2030	339	310	2018
HPP Ujmani	1983	>2030	35	32	-
HPP Lumbardhi	1957 (2005)	>2030	8.08	8	-
TPP N1	2017	>2030	300	300	-
TPP N2	2018	>2030	300	300	-
TPP N3	2025	>2030	400	400	-
HPP < 10MW	2012-2020	>2030	56	56	-
Wind	2012-2020	>2030	63	63	-
Bio mass	2012-2020	>2030	7	7	-
Solar	2017-2020	>2030	1	1	-

Table 0-4 Generation development defined in Conservative Scenario

- **Base Scenario**

This Base Scenario is elaborated in [2] and additionally defined in [3]. The generation development for this case is listed in Table 0-5. In contrast to the defined scenario in [3] the conservative scenario within this study considers the commissioning date of TPP units N1 and N2 not before 2017 and 2018 respectively, the commission of the new unit TPP N3 (400MW) for 2019 and HPP Zhur as not constructed and commissioned in the regarded timeframe till 2030.

Generation	First year of operation	Planned Life Time	Installed Capacity [MW]	Net available capacity [MW]	Life Time Extension
TPP Kosovo A3	1970	2018	200	130	-
TPP Kosovo A4	1971	2018	200	130	-
TPP Kosovo A5	1975	2018	210	135	-
TPP Kosovo B1	1983	2030	339	310	2017
TPP Kosovo B2	1984	2030	339	310	2018
HPP Ujmani	1983	>2030	35	32	-
HPP Lumbardhi	1957 (2005)	>2030	8.08	8	-
TPP N1	2017	>2030	300	300	-
TPP N2	2018	>2030	300	300	-
TPP N3	2019	>2030	400	400	-
HPP < 10MW	2012-2020	>2030	140	140	-
Wind	2012-2020	>2030	141	141	-
Bio mass	2012-2020	>2030	16	16	-
Solar	2017-2020	>2030	1	1	-

Table 0-5 Generation development defined in Base Scenario.

0.4.3 Lignite mining

Considering exhaustion of the lignite reserves in the existing Bardh and Mirash mines the opening of the new lignite mine in 2010-2011 to secure continuous supply for the existing generation plants TPP Kosova A and Kosova B was an urgent matter as it has a direct impact on the security of power.supply. The “New Mine” in Sibove is assessed at 830 Million tones; an amount, which is sufficient to supply the existing power generation capacities as well as a thermal power generation complex of about 2,000MW for 40 years.

The required increasing production of lignite for new lignite fired power generation units will lead to a rise of power demand for lignite mining. Therefore it is especially important to decrease the specific power demand for lignite mining.

0.4.4 Modernization of transmission and interconnection lines

The main objective of this strategy, as far as the transmission system is concerned, is to establish a sustainable infrastructure being able to handle the increased domestic demand for electricity:

- Development of sufficient transformation capacities 400kV to 110kV and eventual maintenance of the existing transformation stations 220kV to 110kV
- Development of sufficient capacities of the 110-kV-transmission grid
- Provision of secure data collection and control systems for operation of the transmission system

- Construction of the 400-kV-interconnection line with Albania, 400/110kV substation in Peja, Prizren and that of Ferizaj with Gjilan as well as the necessary reinforcement of the 110-kV-lines

1 Task 1 – Demand Forecast

1.1 Forecast methodology

The regression analysis is a statistical analysis method, which is preferably applied to describe the relation between a dependent variable and one or more independent variables mathematically. Result of such regression analysis is a mathematical description, which can be used for a forecast or a development, where they found mathematical relation is projected into the future.

Details of the regression analysis can be found in the respective special literature, which in a comprehensive way describes mathematical method of regression and its projection into the future. However the indication is missing that the result of the regression analysis provides reasonable results for the future, only when the general conditions, under which the regression relation is found, are not changing for the forecast period. For this reason forecasts on the basis of the regression analysis are of higher significance. Mathematically reasonable confidence intervals are also applicable for the forecasted time period, if general assumptive conditions did not change. It has to be remembered that mathematically high accuracy of the calculated forecast values does not procure high accuracy of the forecast itself, so that changes in general conditions might break down every forecast based on regression analysis. In order to avoid such mistakes, all conceivable influencing factors have to be already comprised in the regression analysis. But practically it is difficult to realise, because normally all influencing factors cannot at all be comprised or rather be known.

The linear regression is an analysis methodology for the determination of a regression slope or rather linear function. The regression slope or linear function is indicating, which relation between two or more variables exists.

The essence of utilisation of the regression analysis for the forecast from arbitrary data is that to present the chronological progress of historical data (values from the past) with a mathematical function in such way that the calculated values from this found function and the real historical values show minimal difference. This is achieved by identifying the function, which values have the least standard deviation to the real historical values.

- **Forecast of the electrical power demand of the Kosovo with regression**

The common predominant method of forecasting the electrical power demand development is the determination of the functional relations between time and measured power values by help of the regression analysis.

  - **Potential function**

Generally forecasts are developed using potential function for the past period, which comes close to the historical development of the electrical power. This function will be optimized by the method of the least squares (standard deviation).

These functions have the form:

$$P_t = P_0 \cdot \left(1 + \frac{z}{100}\right)^t \qquad \textbf{Equ. 1-1}$$

whereas:

P_t	Electrical power demand in year t
P_0	Electrical power demand at t=0 for the base year
z	Growth factor in % (change in % from the previous year)
t	Number of years after the basis year

Such long-term forecasts on the basis of such a potential function, leaned onto the interest calculation, are generally indeed very favoured, because rates of growth are commonly used. But most people have no perception of effects of percentage rates of growth. Therefore it is reasonable to compare these forecasts with forecasts based on quadratic functions. The growth appears as a first derivative of the quadratic function.

- **Linear Function/Quadratic Function**

Another possibility is to take the growth of the electrical power demand as basis. The growth of the electrical power demand is often presentable by an easily manageable linear function.

$$\Delta P_t = a_z \cdot t + b_z$$ **Equ. 1-2**

Whereas:

ΔPt	Growth of the electrical power demand between two years as y variable of the linear function
a_z	General slope of the linear function
b_z	General shift function of the linear function
t	Year as x variable of the linear function

Integrating the growth of power demand (ΔP_t) the power demand can be presented as a quadratic function.

$$P_t = 0.5 \cdot a_z \cdot t^2 + b_z \cdot t + P_0$$ **Equ. 1-3**

For the purpose of comparison it is wise to determine the electrical power demand also as a linear function.

$$P_t = a \cdot t + b$$ **Equ. 1-4**

As an outcome there are four precise mathematical results of the development of electrical demand, which can be compared by means of standard deviation regarding their accuracy in relation of the real values and values calculated from the functions.

From these four forecasts a mean value can be formed. This mean value can be used as the forecast and set as a basis for further studies. As the methods, linear regression of the growth and integration of the growth, have the same mathematical base, therefore only three remaining methods will be chosen:

- Linear regression of the growth
- Linear regression of the peak power
- Exponential regression.

For every kind of forecast a confidence interval I_v can be identified. It essentially depends on an accuracy of the regression function, which is characterized by the standard deviation and the value of the Student-t-distribution. Since the confidence interval always appears as positive and negative deviation then in result there are a medium, a maximum and a minimum forecast value.

$$P_t = P_{tm} \pm I_v$$ **Equ. 1-5**

$$P_{t\max} = P_{tm} + \lambda * s * \sqrt{\frac{1}{n} + \frac{(t_p - T)^2}{\sum (t_j - T)^2}}$$ **Equ. 1-6**

$$P_{t\min} = P_{tm} - \lambda * s * \sqrt{\frac{1}{n} + \frac{(t_p - T)^2}{\sum (t_j - T)^2}}$$ **Equ. 1-7**

whereas:

I_v	Confidence interval
P_t	Forecast value
P_{tm}	Medium forecast value
P_{tmax}	Maximum forecast value
P_{tmin}	Minimum forecast value
s	Standard deviation
λ	Value of Student distribution
n	Number of measured points for the regression function
$(t_p-T)^2$	Difference square of forecast year and mean value for the years in regression period
$\sum(t_j-T)^2$	Total of difference square of regression year and mean value for the years in regression period

Another method to forecast the electrical power demand is to take the population development into consideration, as a significant change of number of inhabitants in the area of supply also influences the power demand development. This method contains the forecast of the population development in a combination with the forecast of the specific power demand per inhabitant. Thereby the development of the specific power demand can be estimated, compared with the specific power demand in the past and relations to other countries can be set. The mean value of the development of the specific power demand can also be forecasted on the basis of the data values in the past, thus the development of the power demand can be derived from the population development and the specific power demand development.

It is useful to apply all methods, in order to compare the forecast results and to evaluate them by help of brainstorming leaned on Delphi method.

1.2 Evaluation of existing data

1.2.1 Gross Domestic Product (GDP)

The following data for GDP growth were developed by KOSTT and Ministry of Finance and are listed in Table 1-1. The key assumptions of all three scenarios are described hereinafter.

Scenarios/ Year	2007	2008	2009	2010	2011	2012	2013	2014
Base Scenario	6.3%	6.9%	2.9%	3.9%	5.3%	4.4%	4.9%	5.6%
Low Scenario	6.3%	6.9%	2.9%	3.9%	5.3%	4.4%	3.9%	3.8%
High Scenario	6.3%	6.9%	2.9%	3.9%	5.3%	4.4%	5.7%	7.4%
Scenarios/ Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
Base Scenario	5.8%	4.5%	6.5%	5.9%	5.5%	5.1%	5.6%	6.2%
Low Scenario	3.8%	2.0%	3.4%	2.5%	2.0%	1.4%	2.8%	2.5%
High Scenario	7.8%	7.5%	8.5%	7.7%	7.1%	6.6%	7.0%	8.0%

Table 1-1 GDP development of Kosovo

The Base-case scenario is developed on projections presented in the 2012 budget. It was built for generating budget revenue projections in the mid-term 2012-2014. Moreover, this scenario includes all policies which will be implemented consistently including assumptions about new policies incorporated in the macro-fiscal framework. Government expenditures were planned over the medium term by this framework. As a result, a similar trend of expenditures is also assumed in the years up to 2030. The base scenario assumes a slight increase in exports. Exporting companies are still in the initial phase of their operation and still have not fully utilised their existing capacity. Based on the fact that imports constitute an important part in consumption as well as investment and export, imports are expected to continue to grow at similar trend as previous years. Positive impact on real growth in this scenario is expected to be the export of services, which represents a significant potential for sustainable growth in the future. Based on the structure of population in Kosovo and unemployment it can be expected that services (construction, communication and consulting services, information technology) are important part of economic growth during this time. This scenario also assumes the continuation of remittances from abroad, which are mainly used for consumption with a small participation in investments. Similarly, foreign direct investments are expected to continue the trend of growth as in previous years.

This High Scenario assumes significant changes in government spending in contrast to the base scenario. It takes into account capital expenditures continuously growing primarily on infrastructure development. The main drivers of the demand in this scenario would be export, consumption, private investment potential as well as those of foreign and local investments in companies that are expected to be privatized. High scenario, compared with base scenario, takes into account these key assumptions:

- Commencement of construction of Pristina-Skopje road (€ 600 million)
- Construction of New Kosovo Power Plant, which is supposed to be invested from € 100 million each year
- Privatization of distribution grid was realised in 2012 while investment is expected to begin by the year 2013 and onwards
- Private investments in addition to the current annual investments in Posta dhe Telekomunikacioni i Kosovës (PTK) assuming that PTK will be privatized in early 2013.

Apart from that, high scenario additionally considers further assumptions:

- The significant increase of exports starting in 2013 with an improvement of business climate in Kosovo, investment increase in agriculture, release of raw materials from custom duties and improvement of infrastructure in general

- Significant decline in imports due to the replacement with local products that come as result of increases in domestic production.
- Significant decline in growth rate of consumption resulting from increased income and tendency to save.

The Low Scenario assumes that growth will mainly come from consumption based largely on remittances from the Diaspora. In this scenario, investment growth is expected to be modest. Exports are projected to rise with a low rate due to slight increases of current exporting companies' production. The forecast for the metal price decrease will affect a lower export of metal which constitutes the largest export part. Imports are expected to increase more during this period, mainly to cover consumption which also worsens the trade balance even more. As a result of these assumptions the budget revenues will be lower and therefore the government spending particularly capital expenditures will be reduced. The public debt to finance the budget deficit will increase and therefore will affect further deterioration balance of payments. In this scenario the improvement of business conditions including possible changes in tax policy and investment is not even supposed to increase the existing infrastructure.

1.2.2 Population and households

Year	No. of Households	Population [mill. inh.]	Year	No. of Households	Population [mill. inh.]
2000	n/a	1.700	**2005**	385,521	1.767
2001	n/a	1.721	**2006**	399,308	1.777
2002	n/a	1.737	**2007**	413,816	1.785
2003	360,000	1.748	**2008**	429,099	1.795
2004	372,407	1.757	**2009**	445,217	1.805
2005	385,521	1.767	**2010**	462,235	1.815

Table 1-2 Development of number of households & population Kosovo

1.2.3 Energy demand per sector

Year	Households [GWh]	Industry [GWh]	Commercial [GWh]
2000	1,410	388	280
2001	1,590	450	360
2002	1,650	480	390
2003	1,850	556	450
2004	2,022	612	480
2005	2,140	658	514
2006	2,351	400	550
2007	2,371	633	620
2008	2,335	1,063	617
2009	2,455	1,154	655
2010	2,521	1,295	712
2011	2,615	1,203	814

Table 1-3 Energy demand per sector

1.2.4 Technical and commercial losses

Year	Transmission Losses			Distribution Losses			Total Grid Losses	Commercial Losses	Load shedding	Overall Consumption
	Lines	Transformers	Total	Lines	Transformers	Total				
	GWh									
2000	171	26	197	506	44	550	747	733	552	2,829
2001	196	29	225	534	46	580	805	813	552	3,210
2002	216	31	247	552	48	600	847	880	704	3,373
2003	105	15	120	570	50	620	740	929	649	3,602
2004	146	21	167	588	51	639	806	903	392	3,927
2005	215	31	246	612	53	665	911	951	405	4,230
2006	209	30	239	638	56	694	933	928	718	4,242
2007	205	29	234	646	56	702	936	972	562	4,567
2008	184	26	210	654	51	705	915	710	724	4,939
2009	152	22	174	740	60	800	974	796	381	5,247
2010	114	17	131	724	95	819	950	913	194	5,488
2011	101	14	115	726	99	825	940	784	331	5,584

Table 1-4 Technical and commercial losses in Kosovan Transmission and Distribution Grid

1.3 Load forecast of Kosovo

1.3.1 Influence factors considered

1.3.1.1 Peak load development

Table 1-5 gives an overview of the results of various forecasting methods as well as the mean forecast of three methods and the mathematical accuracy of forecasts. The confidence interval for the mean forecast is shown, too.

Method	Peak demand 2010 [MW]	Standard deviation [MW]	Formula	Result 2015 [MW]	Result 2020 [MW]	Result 2025 [MW]	Result 2030 [MW]
M1	1,158	73.6	$dP_{M1}=1.62t+2.9$	1,344	1,626	1,948	2,311
M2	1,158	75.8	$P_{M2}=0.81t^2+2.9t+500$	1,368	1,654	1,981	2,347
M3	1,158	94.2	$P_{M3}=20.84t+447$	1,093	1,197	1,301	1,405
M4	1,158	83.4	$P_{M4}=504(1+0.0298)^t$	1,216	1,409	1,631	1,889
Mean value	1,158	81.7	$P_{mean}= (P_{M1}+P_{M3}+P_{M4})/3$	1,218	1,411	1,627	1,869
Confidence interval				79	100	121	142
Mean value - Confidence Interval				1,138	1,311	1,506	1,727
Mean value				1,218	1,411	1,627	1,869
Mean value + Confidence Interval				1,297	1,510	1,747	2,010

Table 1-5 Regression possibilities and the respective results

whereas:

M1 Linear regression of peak demand growth
M2 Quadratic regression of peak (integration of M1)
M3 Linear regression of peak demand

M4 Exponential regression of peak demand

For comparison the forecasted power development the values from other sources are listed in Table 1-6.

Year	Result 2011 [MW]	Result 2018 [MW]	Result 2020 [MW]	Result 2025 [MW]	Result 2030 [MW]
Long Term Energy Balance, 2009	1,112	1,317	-	-	-
Generation Adequacy Plan, 2011	1,175	1,365	1,410	-	-
Energy Strategy Kosovo, 2009	1,212	1,543	-	-	-

Table 1-6 Forecasting results from other studies

On the basis of the applied regression function and the consultation of KOSTT experts the following development of the power demand of Kosovo is forecasted (see Table 1-7). The reason for such a high increase till 2030 is probably the increasing power demand for heating and hot water, which is resulting from the lack of national heating gas supply and other substitutes.

Scenario	Real peak demand 2010 [MW]	Result 2015 [MW]	Result 2020 [MW]	Result 2025 [MW]	Result 2030 [MW]
High	1,158	1,297	1,510	1,747	2,010
Medium	1,158	1,218	1,411	1,627	1,869
Low	1,158	1,138	1,311	1,506	1,727

Table 1-7 Evaluated load forecast scenarios

1.3.1.2 Population development

The forecast of the growth of population in Kosovo is obtained by a linear regression of population growth. Integrating this parameter the development of the population in Kosovo can be achieved (see Table 1-8 and Table 1-9).

Year	2001	2010	2020	2025	2030
Growth [Inh/a]	21,000	10,000	-1,600	-6,100	-10,600

Table 1-8 Forecast of the growth of the population (linear regression)

Year	2001	2010	2020	2025	2030
Million Inhabitants	1.721	1.815	1.840	1.818	1.774

Table 1-9 Forecast of population development (integration of linear regression)

It emerges from the forecast of population development that after initially still increasing number of inhabitants of Kosovo, saturation is reached and the number of inhabitants after 2020 decreases again and till 2030 returns to the values from 2010. This forecast in 2030 is associated with an uncertainty of ±200,000 inhabitants.

1.3.1.3 Specific load per inhabitant

The forecast of specific power demand per inhabitant of Kosovo is obtained (see Table 1-10) by identified function of the power demand development and development of the number of inhabitants. The forecast values are based on a function of past data. The real power value from 2010 is higher then this one for 2015. Therefore the standard deviation is used. This mathematical method is used in order to get the total range of possible values. From mathematical point of the value in 2015 can be lower in comparison to 2010, if the growth is low and the trend of the past 25 years and not only year 2010 is taken as basis.

		Actual 2010	Result 2015	Result 2020	Result 2025	Result 2030
Forecast low	**MW**	1,158	1,138	1,311	1,506	1,727
Forecast med	**MW**	1,158	1,218	1,411	1,627	1,869
Forecast high	**MW**	1,158	1,297	1,510	1,747	2,010
Inhabitants	**Mill.**	1.815	1.839	1.840	1.818	1.775
Spec. Power Demand low	**kW/Inh**	0.64	0.62	0.71	0.83	0.97
Spec. Power Demand med	**kW/Inh**	0.64	0.66	0.77	0.89	1.05
Spec. Power Demand high	**kW/Inh**	0.64	0.7	0.82	0.96	1.13

Table 1-10 Forecast of the specific electrical demand

This specific ratio gives the possibility to evaluate and compare the development of the specific power requirements with industrially developed countries (see Table 1-11).

Country		Germany	Bulgaria	Hungary	Croatia
Specific Power Demand (Orientation values)	kW/inh	1.05	0.7	0.7	0.7

Table 1-11 Orientation and comparison values for specific power demand

Assuming a lower increase of the specific power demand (5W and 10W per year and inhabitant) the respective forecast values as per Table 1-12 result.

		Actual 2010	Result 2020	Result 2025	Result 2030
Specific Power Demand increase 5W/a*inhabitant	kW/inh	0.64	0.69	0.71	0.74
Specific Power Demand increase 10W/a*inhabitant	kW/inh	0.64	0.74	0.79	0.84
Forecast (5W/a*inh)	MW	1,158	1,269	1,300	1,313
Forecast (10W/a*inh)	MW	1,158	1,370	1,448	1,506

Table 1-12 Forecast of the electric power demand based on the fore-casted population development and the estimated specific power demand

On the basis of the expert estimation the specific power requirements can also be estimated and thus differ from the mathematical evaluated forecast values. As a result of an expert consultation the developments as per Table 1-10 were agreed to be taken as basis for further calculations.

1.3.1.4 Development of electrical energy structure

Based on this forecasted power demand in chapter 1.3.1.1 the development of electrical energy consumption as listed in Table 1-13 is obtained.

Year		2010	2015	2020	2025	2030
Maximum utilisation hours of peak demand	h	4,855	5,000	5,200	5,400	5,600
Peak power	MW	1,158	1,218	1,411	1,627	1,870
Electrical energy consumption	GWh	5,622	6,090	7,337	8,786	10,466
Number of inhabitants	10^6	1.815	1.839	1.840	1.818	1.774
Specific electrical energy consumption	kWh per year and inhabitant	3,097	3,312	3,987	4,833	5,900

Table 1-13 Development of electrical energy consumption

Considering the development of electric energy consumption over the past 11 years divided into the respective energy demanding sectors (see Table 1-14) the forecasted energy demand per sector results as depicted in Table 1-15.

Year	Sum [GWh]	Households [GWh]	Industry [GWh]	Commercial [GWh]	Street lighting [GWh]	Losses [GWh]
2000	2,829	1,410	388	280	4	747
2001	3,210	1,590	450	360	5	805
2002	3,373	1,650	480	390	6	847
2003	3,602	1,850	556	450	6	740
2004	3,927	2,022	612	480	7	806
2005	4,230	2,140	658	514	7	911
2006	4,242	2,351	400	550	8	933
2007	4,567	2,371	633	620	7	936
2008	4,939	2,335	1,063	617	8	915
2009	5,247	2,455	1,154	655	9	974
2010	5,488	2,521	1,295	712	10	950
2011	5,584	2,615	1,203	814	12	940

Table 1-14 Electrical energy consumption, 2000-2011

Year	$W_{total,sectors}$ [GWh]	$W_{Households}$ [GWh]	$W_{Industry}$ [GWh]	W_{Com} [GWh]	$W_{Lighting}$ [GWh]	W_{losses} [GWh]
2011	5,584	2,615	1,203	814	12	940
2012	5,919	2,813	1,278	814	11	1,003
2013	6,172	2,921	1,361	856	12	1,022
2014	6,425	3,029	1,443	899	12	1,042
2015	6,679	3,137	1,526	942	13	1,061
2016	6,932	3,246	1,608	984	13	1,081
2017	7,187	3,354	1,691	1,027	14	1,101
2018	7,441	3,462	1,774	1,070	15	1,120
2019	7,693	3,570	1,856	1,112	15	1,140
2020	7,947	3,678	1,939	1,155	16	1,159
2021	8,201	3,787	2,022	1,197	16	1,179
2022	8,455	3,895	2,104	1,240	17	1,199
2023	8,709	4,003	2,187	1,283	18	1,218
2024	8,961	4,111	2,269	1,325	18	1,238
2025	9,216	4,220	2,352	1,368	19	1,257
2026	9,469	4,328	2,435	1,410	19	1,277
2027	9,723	4,436	2,517	1,453	20	1,297
2028	9,976	4,544	2,600	1,496	20	1,316
2029	10,229	4,652	2,682	1,538	21	1,336
2030	10,484	4,761	2,765	1,581	22	1,355

Table 1-15 Forecasted electrical energy consumption, 2012-2030

In continuation of this electric energy consumption growth the following development of winter peak power will result (see Table 1-16).

Winter peak	$P_{total,sectors}$ [MW]	$P_{Households}$ [MW]	$P_{Industry}$ [MW]	P_{Com} [MW]	$P_{Lighting}$ [MW]	P_{losses} [MW]
2012	1,275	622	190	169	6	288
2013	1,319	642	201	177	6	293
2014	1,363	662	213	184	6	298
2015	1,407	682	224	192	6	303
2016	1,452	702	235	200	7	308
2017	1,495	721	246	207	7	314
2018	1,539	741	257	215	7	319
2019	1,581	760	267	222	8	324
2020	1,623	778	278	230	8	329
2021	1,665	797	289	237	8	334
2022	1,706	816	299	244	8	339
2023	1,748	834	310	251	9	344
2024	1,789	852	320	259	9	349
2025	1,829	870	330	266	9	354
2026	1,871	888	341	273	10	359
2027	1,909	905	351	279	10	364
2028	1,949	923	361	286	10	369
2029	1,988	940	371	293	10	374
2030	2,027	957	380	300	11	379

Table 1-16 Development of peak demand considering energy consumption and utilisation hours per sector

It is obvious that the herewith developed peak demand corresponds to the forecasted peak demand of High Growth Scenario as per Table 1-7. Additionally a simultaneity factor for the respective sector peak loads needs to be considered, i.e. peak loads of the different sectors do not occur at same time. The assumed utilisation hours per sector are to be seen in Table 1-17. The utilisation hours are assumed on the basis of previous years taking an increasing efficiency of energy supply into consideration. Stable or decreasing utilisation hours might lead to an increase of necessary generation capacity.

Year	T_{max}, [h] Households	T_{max}, [h] Industry	T_{max}, [h] Commercial	T_{max}, [h] Lighting	T_{max}, [h] Losses
2011	4,500	6,700	4,800	2,000	3,470
2012	4,525	6,730	4,825	2,000	3,485
2013	4,550	6,760	4,850	2,000	3,490
2014	4,575	6,790	4,875	2,000	3,495
2015	4,600	6,820	4,900	2,000	3,500
2016	4,625	6,850	4,925	2,000	3,505
2017	4,650	6,880	4,950	2,000	3,510
2018	4,675	6,910	4,975	2,000	3,515
2019	4,700	6,940	5,000	2,000	3,520
2020	4,725	6,970	5,025	2,000	3,525
2021	4,750	7,000	5,050	2,000	3,530
2022	4,775	7,030	5,075	2,000	3,535
2023	4,800	7,060	5,100	2,000	3,540
2024	4,825	7,090	5,125	2,000	3,545
2025	4,850	7,120	5,150	2,000	3,550
2026	4,875	7,150	5,175	2,000	3,555
2027	4,900	7,180	5,200	2,000	3,560
2028	4,925	7,210	5,225	2,000	3,565
2029	4,950	7,240	5,250	2,000	3,570
2030	4,975	7,270	5,275	2,000	3,575

Table 1-17 Assumed sectoral utilisation hours

Taking all available forecasts till 2020 and new ones till 2030 into account two fundamental results can be emphasized:

- The construction of new generation capacity is urgently needed as power demand still continues to increase.
- Measures for reducing the power demand are as necessary as the construction of the new generation capacities and have to start without delay in order to attenuate the steep increase of power demand.

In continuation of the steep growth of specific power demand within the last 10 years Kosovo would have a higher electrical power demand per inhabitant than Germany in 2030. Germany's current specific power demand amounts to 1.05kW/inh. According to the plans of the Federal Government this value has to be reduced by 20%, however a quite demanding goal. Therefore, specific power demand values in a range between 0.85 to 0.90kW/inh are orientation values, which should not be exceeded by an efficient use of electricity in Kosovo till 2030.

Without a significant reduction in the utilisation of electric energy for heating and hot water in the households, industry and other sectors, the power demand of Kosovo in winter will continue to increase noticeably. Alternatives only include the construction of district heating based on coal combining heat and power plus the utilisation of electric heat pumps with optimized load position control, as oil or gas for modern heating or other energy substitutes are still not available in Kosovo. The limitation measures of the power rise are urgently required, as the continuation of such a development trend as happened within the past 10 years, the problems in ensuring the power supply, especially during the winter peak would increase further. The modern development of our society is not characterized by a steady growth of electric energy consumption, but by the efficient use of electrical energy, which is accomplished by measures for reduction of technical grid losses and improvement of the efficiency factor for energy used.

1.3.1.5 Seasonal dependencies

Based on the metered 10-year load data given the mean factors of the last decade for “Winter Peak”, “Winter Low”, “Summer Peak” and “Summer Low” on the one hand and for the quarter year peaks (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec) on the other in relation to winter peak load were calculated (see Table 1-18). By means of these factors the seasonal dependencies of power demand for the forecasted years were evaluated.

Power [MW]	Load Factors [p.u.]	2011	2015	2020	2025	2030
Winter Peak	1.00	1,150	1,218	1,411	1,627	1,869
Winter Low	0.36	414	438	508	586	673
Summer Peak	0.63	724	767	889	1025	1,177
Summer Low	0.22	253	268	310	358	411
January – March	1.00	1,150	1,218	1,411	1,627	1,869
April – June	0.80	920	974	1,129	1,302	1,495
July – September	0.63	725	767	889	1,025	1,177
October-December	0.97	1,116	1,181	1,369	1,578	1,813

Table 1-18 Seasonal dependencies of power demand in Kosovo

Table 1-18 shows additionally that winter peaks mostly emerge in January and summer peaks in July or August, although December and April peaks are still quite high.

If these factors are seen in relation to German seasonal load profiles, it has to be stated that they are quite comparable for “Summer Peak and Low” values. However Kosovo’s factor for “Winter Low” amounts to only the half of the German one (see Table 1-19). That fact confirms the high share of electrical heating and households plus the low share of industrial consumption in Kosovo.

Power [MW]	Load Factors Kosovo [p.u.]	Load Factors Germany [p.u.]
Winter Peak	1.00	1.00
Winter Low	0.36	0.73
Summer Peak	0.63	0.51
Summer Low	0.22	0.26

Table 1-19 Comparison of load factors and profiles

1.3.1.6 Weekly and daily dependencies

For the evaluation of weekly and also daily load curves in the context of an adequate power plant utilisation the metered 10-year values were taken as calculation basis. As per ENTSO-E- methodology the 3rd weeks of January, April, July and October are chosen exemplarily. All figures below show load curves that are normalised to the respective quarter year peak load. The yearly curves are drawn thinly, the mean value more thickly in red. All these graphs can be taken to derive the respective load curve in the forecasted years till 2030.

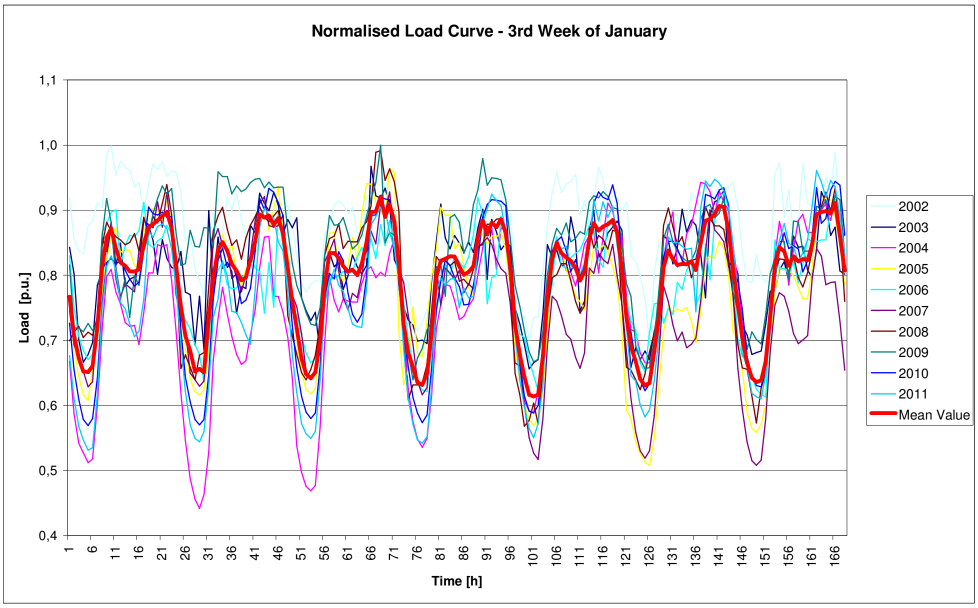

Figure 1-1 Normalised Load Curve, 3rd Week of January; [4]

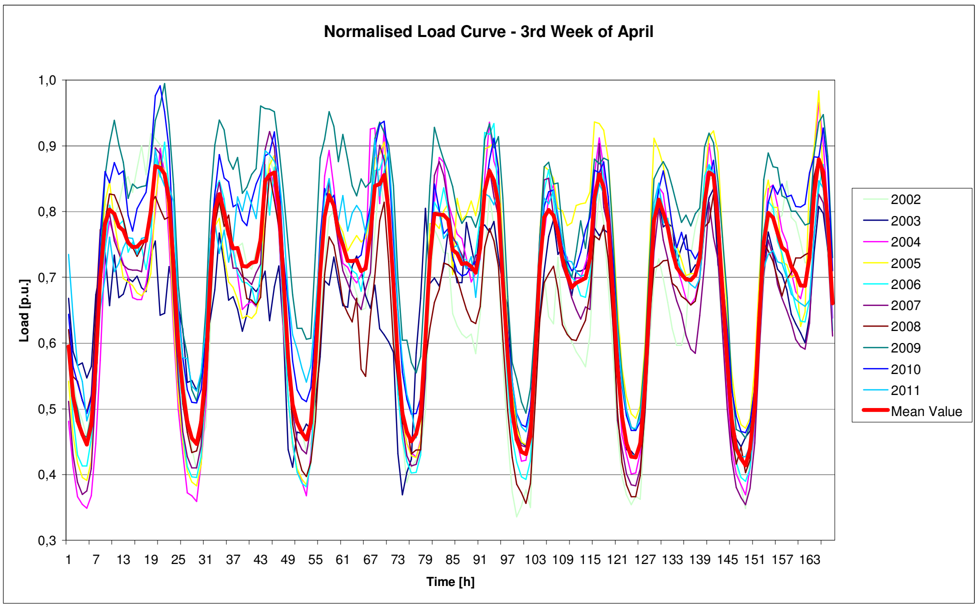

Figure 1-2 Normalised Load Curve, 3rd Week of April; [4]

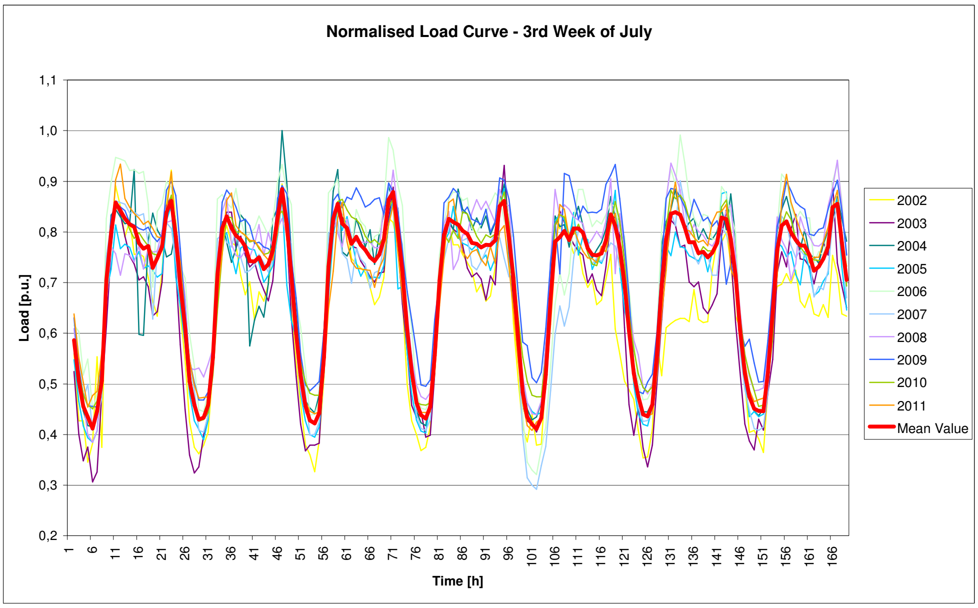

Figure 1-3 **Normalised Load Curve, 3rd Week of July; [4]**

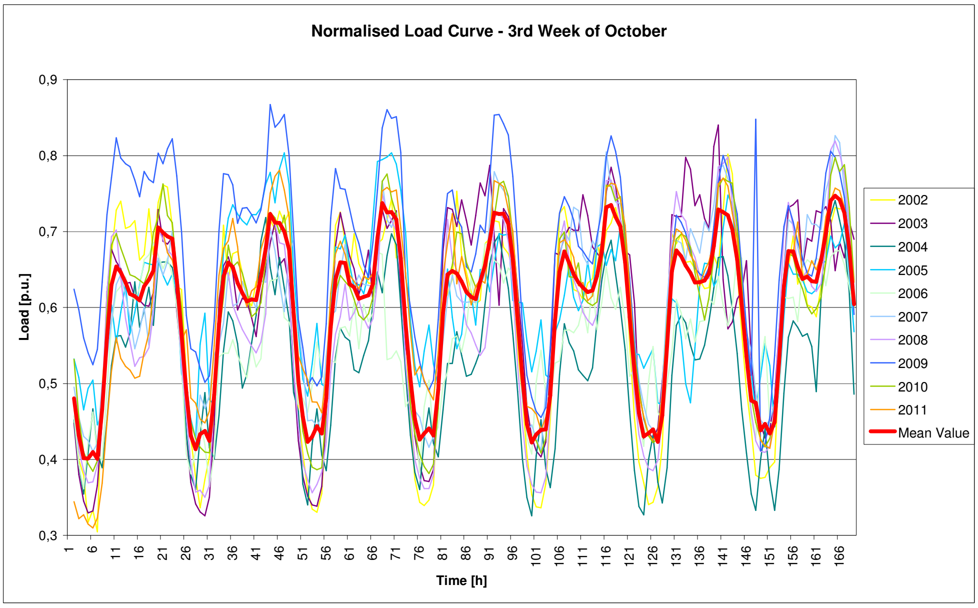

Figure 1-4 **Normalised Load Curve, 3rd Week of October; [4]**

The graphs show a big dependency on household consumption. The colder it gets in winter times (cp. Figure 1-1 and Figure 1-4), the wider and more distinctive the evening peak appears. There is no equalisation characteristic arising from a considerable share of industrial consumption.

1.3.2 Summary of Kosovo's Low, Medium and High Growth Scenarios

The calculated scenarios were developed from the average of several mathematical analyses (linear regression of peak demand, linear regression of growth of peak demand and potential growth). For the evaluation of values received from mathematical investigations they needed to be compared with several important influencing factors like the GDP, the population development and the deriving load per inhabitant.

The GDP average growth rates beginning in base year 2007 are not congruent with the load growth factors per scenario. The average GDP growth amounts to 5.4% for Base, 3.2% for Low and 6.7% for High GDP growth scenario. In comparison to that load growth factors only amount to from 2.8% for Low to 3.0% for High growth scenarios. For a better comparison the base year 2007 was chosen for both calculations (see Table 1-20).

The assumption of independency from load to GDP growth has several reasons. First and foremost it has to be mentioned that typical load curves are very household load dependent as to be seen in Figure 1-1 to Figure 1-4. Maximum peak demand is always in winter evening times (19th to 21st hour), either in late December or beginning January. That shows the significant temperature, household and as a consequence also heating dependencies of load in Kosovo. The maximum peak grew only due to direct heating in winter evenings. Industrial growth is quite low as special subsidies of the government of Kosovo are foreseen for service and commercial economy only.

Furthermore an adaptation and flattening of the steep load curves and concomitant an increase of utilisation hours of maximum demand was assumed. However this can only be reached by necessary energy efficiency programs to be issued by governmental subsidies and legal requirements, as e.g. prohibition of direct heating, the support of utilisation of further types of heating (night storage heating, mini combined heat and power plants or heat pumps per apartment building), containment of energy thefts and energy efficiency measures in the industry.

Year	Low Growth Scenario	Medium Growth Scenario	High Growth Scenario
2012	1,046	1,113	1,181
2013	1,076	1,147	1,218
2014	1,107	1,182	1,257
2015	1,138	1,218	1,297
2016	1,171	1,254	1,338
2017	1,205	1,292	1,380
2018	1,240	1,331	1,422
2019	1,275	1,370	1,466
2020	1,311	1,411	1,510
2021	1,348	1,452	1,556
2022	1,386	1,494	1,602
2023	1,426	1,538	1,650
2024	1,466	1,582	1,698
2025	1,506	1,627	1,747
2026	1,549	1,673	1,798
2027	1,592	1,721	1,850
2028	1,636	1,769	1,902
2029	1,681	1,818	1,956
2030	1,727	1,869	2,010
Growth rate [%][1]	2.82%	2.92%	3.00%

Table 1-20 Peak load development of all scenarios

1 Base Year 2007

Table 1-20 shows the peak load development forecasted from 2012 to 2030 for Low, Medium and High growth scenarios.

Considering the specific power demand per inhabitant and comparing it with German and European situation a range between 0.97kW/inhabitant to 1.13kW/inhabtitant in 2030 seem to be quite suitable under the assumption that Kosovo uses more energy sources than only electricity for heating.

		Actual 2010	Result 2015	Result 2020	Result 2025	Result 2030
Spec. Power Demand LGS	kW/Inh	0.64	0.62	0.71	0.83	0.97
Spec. Power Demand MGS	kW/Inh	0.64	0.66	0.77	0.89	1.05
Spec. Power Demand HGS	kW/Inh	0.64	0.7	0.82	0.96	1.13

Table 1-21 Specific power demand per inhabitant and load scenario

1.4 Load forecast of Albania

The forecast of the electrical power demand and electrical power consumption of Albania is leaned onto the actual values. These data were partially given. Therefore necessary data are calculated by load factors, which were given in a case of medium power demand. Load factor formula goes:

$$Load\ \ factor\,[\%] = \frac{Demand\ [GWh]\cdot\dfrac{1}{8760h}}{Peak\ [MW]} \qquad \textbf{Equ. 1-8}$$

As the values of electrical power demand and electrical power consumption were given just for some years, the values in-between were calculated by the method of linear interpolation. Linear interpolation function is presented as following:

$$f(x) = f_0 + \frac{f_1 - f_0}{x_1 - x_0} \cdot (x - x_0)$$ **Equ. 1-9**

whereas:

f_1 and f_0 are measured points

x_1 and x_0 are respective years.

As of further forecasting from year 2020 to 2030 the potential function with average growth rates is used (see Table 1-22 and Table 1-23).

Year/ Scenario	Growth [%]	2010 [MW]	2015 [MW]	2020 [MW]	2025 [MW]	2030 [MW]
Low	2.57	1,300	1,506	1,675	1,902	2,159
Medium	3.13	1,300	1,536	1,765	2,061	2,404
High	3.6	1,300	1,581	1,854	2,209	2,636

Table 1-22 Electrical power demand, Albania

Year/ Scenario	Growth [%]	2010 [GWh]	2015 [GWh]	2020 [GWh]	2025 [GWh]	2030 [GWh]
Low	2.57	6,489	7,522	8,511	9,748	11,164
medium	3.13	6,489	7,707	8,934	10,484	12,302
High	3.6	6,489	7,895	9,422	11,354	13,681

Table 1-23 Electrical energy consumption, Albania

For the purpose of determining the specific electrical demand population development of Albania is applied (see Table 1-24 and Table 1-25).

Year	Population [Mill. Inh.]	Specific Power Demand [kW/Inh]		
		low	medium	High
2010	3.20	0.41	0.41	0.41
2015	3.25	0.46	0.47	0.49
2020	3.30	0.51	0.53	0.56
2025	3.35	0.57	0.62	0.66
2030	3.40	0.63	0.71	0.78

Table 1-24 Forecasted specific power demand of Albania

Year	Population [Mill. Inh.]	Specific Energy Consumption [kWh/Inh]		
		low	medium	High
2010	3.20	2,028	2,028	2,028
2015	3.25	2,314	2,371	2,429
2020	3.30	2,579	2,707	2,855
2025	3.35	2,910	3,130	3,389
2030	3.40	3,283	3,618	4,024

Table 1-25 Forecasted specific Energy Consumption of Albania

2 Task 2 – Evaluation of Generation and Transmission Adequacy

2.1 ENTSO-E-methodology – Top- down approach

Known ENTSO-E-methodology as Top-down approach is described in detail in Annex 3. Nevertheless Figure 2-1 gives a first overview about the principal approach of this method.

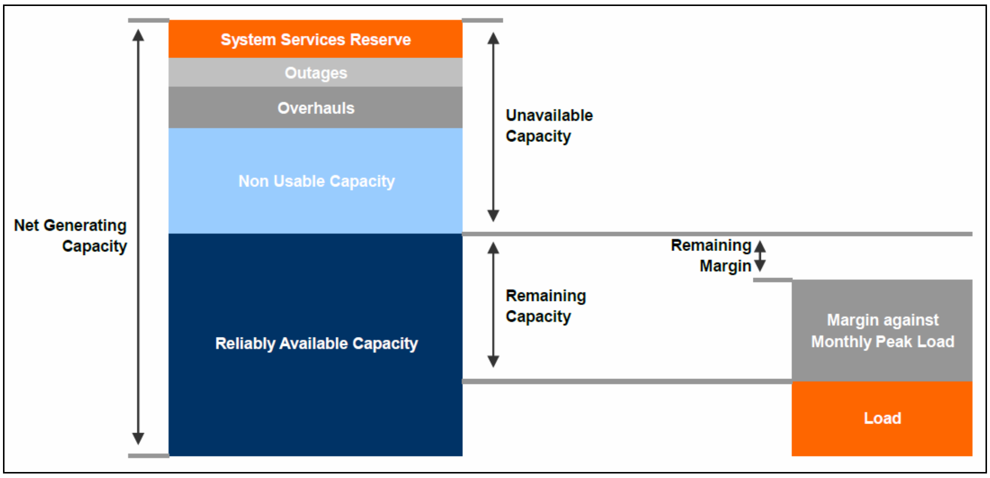

Figure 2-1 Generation Adequacy; [6]

Figure 2-2 as given in [3] shows the adequacy methodology from ENTSO-E more in detail. The respective value to be determined and evaluated is the Generation Adequacy calculated from the difference between Remaining Margin (is adequate with the difference of Reliably Available Capacity and Seasonal Peak Load) and Spare Capacity (means 10% of Net Generation Capacity).

This Generation Adequacy value is calculated for the respective reference points and illustrated in clear diagrams. Additionally it will be compared with the available Transmission Import and Export Capacities in order to find Transmission Adequacy.

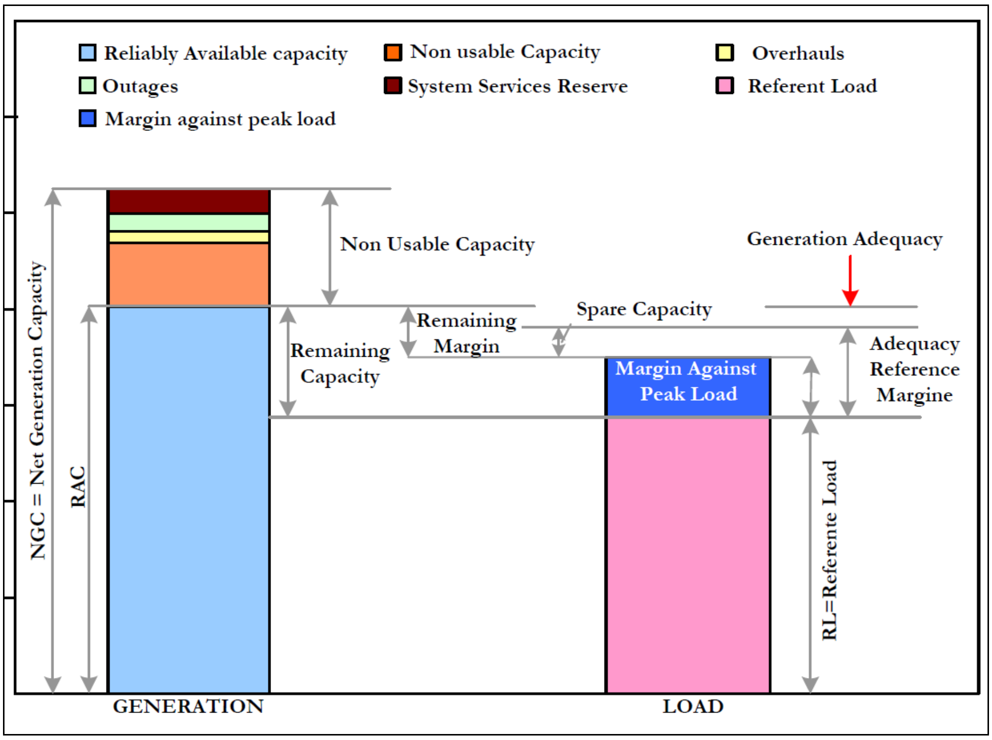

Figure 2-2 Generation Adequacy; [3]

2.2 Balance matrix – Bottom-up approach

This own-developed approach actually foreseen for comparability with ENTSO-E-methodology is taken for the evaluation of best optimised generation strategy in Kosovo and Kosovo and Albania (joint operation), too. In contrast to the top-down approach of ENTSO-E this method takes the forecasted peak demand as basis and cumulates necessary system reserves (primary, secondary and tertiary control power including a total reserve of 10%) to a total sum of necessary generation power (see Table 2-1).

Year		2015	2020	2025	2030
Peak Demand	**MW**	1,138	1,311	1,506	1,727
Primary Reserve Power	**MW**	5	6	6	8
Secondary Reserve Power	**MW**	28	33	38	43
Minute Reserve incl. Border-Crossing-MR	**MW**	277		400	400
Required available Generation Power	**MW**	**1,448**	**1,621**	**1,906**	**2,127**
Reserve Power 10%	**MW**	145	162	191	213
Necessary Generation Power	**MW**	**1,593**	**1,783**	**2,097**	**2,340**

Table 2-1 Balance Matrix – Basis; LGS, Generation Strategy A (Conservative Strategy)

The power plant park of Kosovo including its costs per produced MWh is designed by means of this necessary generation power as per Table 2-2.

Year		2015	2020	2025	2030
Oil	**MW**	0	0	0	0
Gas	**MW**	0	0	0	0
Nuclear	**MW**	0	0	0	0
Water >10MW	**MW**	40	40	40	40
Lignite	**MW**	1,015	1,220	1,620	1,620
Installed Conventional Generation Power	**MW**	**1,055**	**1,260**	**1,660**	**1,660**
Bio mass	**MW**	3.2	7.2	11.2	16
Wind	**MW**	28	63	103	141
Water < 10MW	**MW**	24	56	96	140
Solar	**MW**	0.4	1	2	3
Installed Renewable Generation Power	**MW**	**55.6**	**127.2**	**212.2**	**300**
Import / Export	**MW**	**575**	**566**	**485**	**736**

Table 2-2 Balance matrix – Calculation of necessary imports or possible exports; LGS, Generation Strategy A (Conservative Strategy)

2.3 Generation Investment Strategies to be considered

2.3.1 Strategy A – Kosovo, Conservative Strategy

This Conservative Strategy is deduced from the Base Strategy as described in [2] and [3] and represents a reduced development of new generation capacities. It is already described in Chapter 0.4 (see Table 0-4). Figure 2-3 shows the annual development of generation power within this scenario.

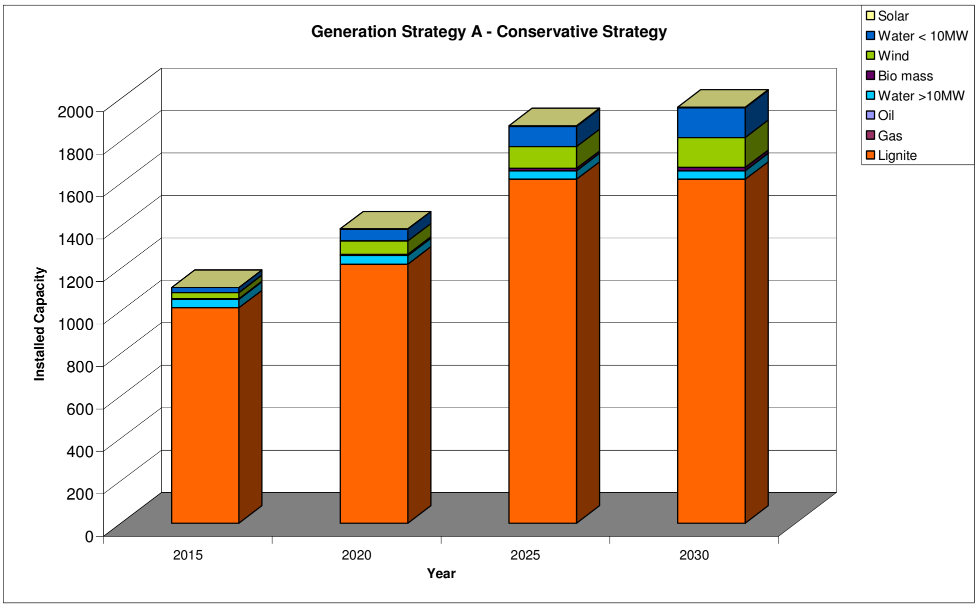

Figure 2-3 Annual generation development of Conservative Strategy

2.3.2 Strategy B – Kosovo, Base Strategy

This Base Strategy is elaborated in Energy Strategy 2009-2018 [2] and additionally defined in Generation Adequacy Plan 2011-2020 [3]. The generation development for this case is described in Chapter 0.4 and listed in

Table 0-5. Figure 2-4 shows the annual development of generation power within this scenario.

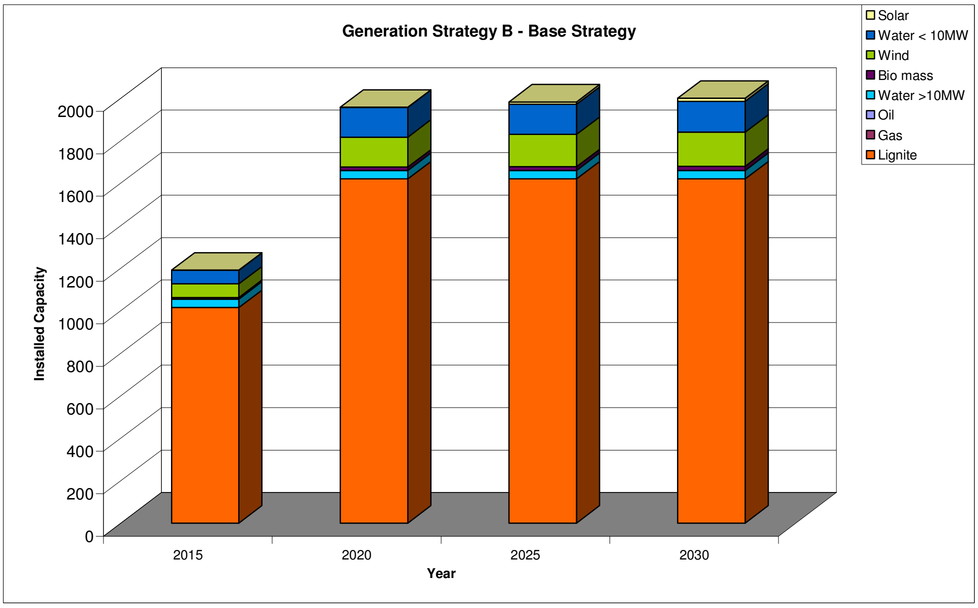

Figure 2-4 Annual generation development of Base Strategy

2.3.3 Strategy C – Kosovo, Best optimised Strategy

2.3.3.1 Load scenarios and generation strategies

Based on the forecast of electrical power demand up to 2030 and the respective confidence intervals of this prognosis (as evaluated in chapter 1), three possible scenarios of load development result:

- Low Growth Scenario (LGS),
- Medium Growth Scenario (MGS) and
- High Growth Scenario (HGS)

that need to be considered in the planning of covering the load demand, as every possibility of this forecast can occur.

Besides profitability, the environmental protection and the general political orientation in energy economy have to be considered while choosing the optimum strategy for covering the electrical power and energy demand. The special situation of Kosovo consists of exceedingly huge lignite deposit available to be mined and converted into electricity affordably. For a wider utilisation of hydro power the natural prerequisites exist, as well. Energy generation by gas can first of all only be regarded after the construction of a powerful gas grid, whose realisation cannot be foreseen at the moment. With the project of a gas line (Project Bergovya) from Russia passing the Black Sea and the Balkan Region to Italy possibilities for a wider gas utilisation might emerge for Kosovo after 2020 in order to reduce the high electrical consumption of population in winter for heating and warm water production.

Energy production by diesel fuel or heating oil is widespread in type of emergency generators but also quite costly and therefore only foreseen in case of outages of public supply for important buildings. A power in-feed from these emergency power systems into distribution grid in cases of temporary shortages is not planned, too.

Renewable energy production is, except the utilisation of hydro power, practically not available. For the utilisation of both wind and solar power plants necessary basic analyses of the respective potentials in Kosovo are missing. Due to the enormous agricultural areas available a certain, reasonable potential for biomass energy generation, still not used, exists in Kosovo, although for its development no forecasts are available, yet. For this renewable generation the political will of government is decisive, as without a so-called “Renewable Energy Act” a renewable generation is not economically realisable in any country. Its characteristic consists of:

- A fixed reimbursement of minimum 20 years according to governmentally determined tariffs
- A prior in-feed with full extent of possible renewable generation into the grid including the reduction of conventional power plants

A lot of countries in Europe have such a Renewable Act and increase the share of renewable in total energy production year by year. However such an act does not exist in Kosovo. Nevertheless it can be assumed that in future a respective legal regulation following the European trend will be concluded. Therefore a more or less extensive renewable generation was considered within the different possible strategies of covering the power and energy demand of Kosovo.

Base of all analysed strategies was the already available forecast as per Energy Strategy till 2020. Prerequisite of every single technically possible strategy is the necessary generation power (see chapter 2.2) consisting of:

- Winter peak demand in the three scenarios LGS, MGS, HGS
- Primary control power
- Secondary control power
- Minute Reserve
- General system reserve
- Export, import

Furthermore renewable power is not considered to be taken for covering of winter peak demand as it is not guaranteed to be available at all times.

The investigated 10 technical strategies show a wide range of generation possibilities easily expandable, if necessary. These ten strategies go from options with dominating lignite generation to those with very high renewable generation (see Annex 4).

2.3.3.2 Methodology for a selection of the optimum generation strategy

In order to find the economically optimised option from all technically possible strategies several methods might be used. In the first and most simple approach one of the three possible but uncertain load development scenarios is chosen. Only for this scenario the optimum solution of generation is determined by contrasting the annual operation costs (OC) of each strategy as per Annex 4 with the load development. The strategy with minimum costs is chosen as optimum (see Table 2-3). Normally this is realised by Delphi-interviews of experts that choose the possibly emerging option in the future. Other development variants remain unconsidered. The uncertainties of the determination of operation costs of every generation option are neglected and only one single, discrete variant of operation costs is expelled, admittedly knowing that operation costs cannot be determined without fault tolerances. Also in that case one discrete variant is chosen from a variety of possible values.

Generation Strategies	GS1	GS2	GS3	GS4	GS5	GS6
Load Scenario				Optimum		
MGS	OC12	OC22	OC32	$OC42 = OC_{min}$	OC52	OC62

Table 2-3 Example for the selection of the optimum strategy by means of Method 1 and MGS load scenario

The advantage of this methodology is the strict limitation of variants to be calculated and therefore the good clarity of results. Nevertheless the problem of load development sensitivity remains unsolved.

The second methodology continues this sensitivity problem and analyses the optimum generation strategy for every possible load scenario. The so found solutions might coincide in best case and lead to one optimum variant, i.e. from the sum of all generation strategies one single becomes apparent independently from load development (see Table 2-4).

Generation Strategies	GS1	GS2	GS3	GS4	GS5	GS6
Load Scenario				**Optimum**		
LGS	OC11	OC21	OC31	**OC41 = OC_{min}**	OC51	OC61
MGS	OC12	OC22	OC32	**OC42 = OC_{min}**	OC52	OC62
HGS	OC13	OC23	OC33	**OC43 = OC_{min}**	OC53	OC63

Table 2-4 Example for the selection of the optimum strategy by means of Method 2 and all load scenario, "stable optimum"

Nevertheless it could be possible, too, that for every of all three forecasted load developments different generation strategies might be optimal (see Table 2-5). In that case the optimum solution needs to be defined by Delphi-interview analysis, as well.

Generation strategies	GS1	GS2	GS3	GS4	GS5	GS6
Load Scenario	**Sub-optimum 1**	**Sub-optimum 2**		**Sub-optimum 3**		
LGS	**OC11 = OC_{min}**	OC21	OC31	OC41	OC51	OC61
MGS	OC12	OC22	OC32	**OC42 = OC_{min}**	OC52	OC62
HGS	OC13	**OC23 = OC_{min}**	OC33	OC43	OC53	OC63

Table 2-5 Example for the finding of suboptimum strategies by means of Method 2 and all load scenario; "non-stable optimum"

Since not only load development is subject to uncertainty but the base data (the operation costs) too, the found result can be analysed concerning its stability in modification of base data (sensitivity analysis). In that way it can be seen, in which range of investment and fuel costs etc. the found optimum solution is stable.

This method is a significant progress in contrast to the first method. Distinctly profound information about the technical-economical relation is acquired. The wider the ranges of basic data are, in that the result of option comparison does not change, the more stable is the found solution and therefore the confidence to this generation strategy.

The third methodology is realised as done in the second approach. However a game-theoretical decision criterion is additionally utilised. The practical usage of the game theory for technical-economical decision is comprehensively described by Muschick and Müller [7].

Classical decision criteria of game theory are:

- Minimax-criterion
- Bayes-Laplace-criterion
- Savage-criterion

Therewith it is the most secure option to choose and use the minimax-criterion. This criterion delivers an optimum decision under the uncertainty of load development. Independent from the really emerging development that variant with the fewest economical loss is chosen. Unfortunately the minimax-criterion is characterised by the fact that strategies with high benefits remain unconsidered, if they cause higher losses in some load scenarios than the found optimum by minimax. Bayes-Laplace is more optimistic in that terms and chooses a strategy that on the one hand facilitates higher benefits but on the other hand is less secure.

In order to receive a game-theoretical decision matrix, in that instead of operation costs benefit elements are listed, the operation costs are depicted as negative costs. Thus the highest operation costs are converted to benefit elements with the fewest benefit.

Generation Strategies	GS1	GS2	GS3	GS4	GS5	GS6
Load Scenario			**Optimum**			
LGS	OC11	OC21	OC31	OC41	OC51	OC61
MGS	OC12	OC22	OC32	OC42	OC52	OC62
HGS	OC13	OC23	OC33	OC43	OC53	OC63
Minmax – OC	Min OC1	Min OC2	**Min OC3**	Min OC4	Min OC5	Min OC6

Table 2-6 Optimum strategy according to Minmax-criterion

Generation Strategies	GS1	GS2	GS3	GS4	GS5	GS6
Load Scenario				**Optimum**		
LGS	OC11	OC21	OC31	OC41	OC51	OC61
MGS	OC12	OC22	OC32	OC42	OC52	OC62
HGS	OC13	OC23	OC33	OC43	OC53	OC63
1/3*∑OCij	OC1	OC2	OC3	OC4	OC5	OC6
Max 1/3*∑OCij				**OC4**		

Table 2-7 Optimum strategy according to Bayes-Laplace

2.3.3.3 Evaluated optimum generation strategy of Kosovo

As a result of economic evaluation of developed 10 generation scenarios strategy 4 is the optimum strategy for covering the load demand under consideration of uncertainty of load development (winter peak). This strategy is characterised by a distinct rise of generation based on lignite power plants. Nevertheless a coincident increase of RES generation is foreseen that leads to savings in coal and CO_2 and guarantees the trend of European energy policy to be regarded. Figure 2-5 shows the development till 2030 in 5-year-steps.

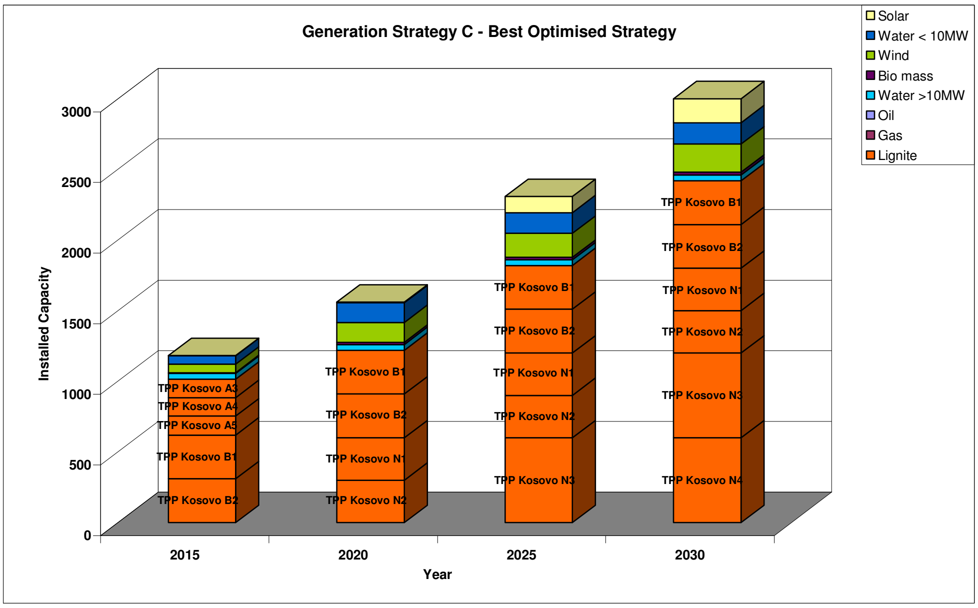

Figure 2-5 Generation development of Strategy C

The evaluated optimum strategy of generation development in Kosovo confirms the planned construction of two new lignite units with a rated power of 300MW each and shows additionally the necessity of erecting two further lignite units with respectively 600MW. With the integration of TPP New Kosovo into the 400-kV-system there are no problems concerning the outage of further 600MW-units. As per European experience in international compound operation and from NTC point of view it can be stated with a high security that the integration of several 600MW-units is no problem for the Kosovan 400-kV-system. Nevertheless the system stability aspect needs to be reviewed. The trip of generators at generator-near short circuits after a too short time period after fault event was the reason for the general limitation of installed power plant capacity by KOSTT in the past. Due to the realisation of several inner and abroad grid projects stability calculations in general and during the grid connection procedures are urgently necessary.

The planned hydro power plant in Zhur is not involved in the optimum strategy and could be substituted by a greater number of smaller hydro power plants. These might be constructed without serious impacts on the environment, if they are benefited by a Renewable Energy Act and a sufficient number of locations is designated.

Table 2-8 shows an overview about the calculations and the most important data of this strategy. In Annex 5 all analysed strategies are listed and the results of profitability calculations and game-theoretical decision are depicted.

This strategy including the construction of two 600MW rated units facilitates Kosovo not only to cover most of its own demand but to participate in the energy market of the Balkan region. Due to the volatile and household dependent daily and annual load curves being characterised by high differences between minimum and maximum the new units should be adjustable between 25 to 100% of rated power. Additionally it needs to be mentioned that the maximum annual operation hours of lignite power plants are decreased by increasing RES generation. This could be counteracted by energy exports especially in cases of bad hydrological situations in South-East Europe (SEE).

Year		2015	2020	2025	2030
Peak Demand	MW	1,218	1,411	1,627	1,869
Primary Reserve Power	MW	5	6	6	8
Secondary Reserve Power 2,5%	MW	30	35	41	47
Minute Reserve	MW	310	310	600	600
Required Available Generation Power	**MW**	**1,528**	**1,721**	**2,227**	**2,469**
Reserve Power 10%	MW	153	172	223	247
Necessary Generation Power	**MW**	**1,680**	**1,893**	**2,449**	**2,716**
Oil	MW	0	0	0	0
Gas	MW	0	0	0	0
Nuclear	MW	0	0	0	0
Water >10MW	MW	40	40	40	40
Lignite	MW	1,015	1,220	1,820	2,420
Installed Conventional Generation Power	**MW**	**1,055**	**1,260**	**1,860**	**2,460**
Bio mass	MW	6	16	18	20
Wind	MW	60	140	170	200
Water < 10MW	MW	60	141	146	150
Solar	MW	1.4	3	113	200
Installed Renewable Generation Power	**MW**	**127.4**	**300**	**447**	**570**
Import / Export	**MW**	**625**	**633**	**589**	**256**

Table 2-8 Strategy 4 and MGS – Forecasted, installed Generation Capacities

Table 2-9 shows the possible development of energy production according to strategy 4.

Year		2015	2020	2025	2030
Coal	TWh	5.25	5.95	7.19	8.83
Gas	TWh	0.00	0.00	0.00	0.00
Oil	TWh	0.00	0.00	0.00	0.00
Water < 10MW	TWh	0.26	0.62	0.64	0.66
Water > 10MW	TWh	0.18	0.18	0.18	0.18
Wind	TWh	0.11	0.25	0.31	0.36
Solar	TWh	0.00	0.00	0.12	0.22
Biomass	TWh	0.03	0.08	0.09	0.10
Winter Peak Import	TWh	0.25	0.25	0.24	0.10
Total generation for Kosovan consumption	**TWh**	**6.08**	**7.33**	**8.81**	**10.45**
Export	**TWh**	**1.04**	**1.62**	**4.10**	**6.17**
Costs per produced MWh incl. Export	**€/MWh**	**49,39**	**51,07**	**51,84**	**51,53**

Table 2-9 Strategy 4 and MGS – Forecasted Energy production

The depicted operation and production costs as per Table 2-9 and Annex 5 can only serve as “orientation values” to be evaluated in detail per power plant project further on. Nevertheless they show qualitatively the influence of different strategies. Although these values are dependent on future price development of technical equipment, such increase was not considered. On the one hand these analyses show quite obviously that due to increasing RES generation the costs per produced energy will increase tremendously. On the other hand it can be seen as well that an appropriate share of RES in the system is possible without essential increases of energy production costs. With costs ranging between 42.93€/MWh and 47.93€/MWh the analysis of this strategy leads to competitive costs first and foremost dominated by lignite power plant investment costs, fuel costs and interests for credits. The fact that both Minmax- and Bayes-Laplace-criteria deliver strategy 4 as optimum proves the stable result averagely being benefit orientated. Sensitivity analysis of parameters (fuel costs, interests, depreciation) lead to the same best optimised strategy.

The result of game-theoretical decisions does not exclude that later on, if load development explicitly occurred, another possibility might be better. The game theory does not allow looking in the future and deciding correctly thereupon. However it grants under conditions of load development uncertainties to find the optimum solution that avoids serious losses. So, by means of game theory it cannot be decided in a better way than by confirmed, secure information. Therefore long-term decisions based on game theory need to be reviewed and if necessary to be corrected, if the real development of load demand is not in the range of forecasted values.

Most important result of realised analysis is the necessity of progressing plans of two new lignite units with 600MW each, first of all for covering Kosovo’s winter peak demand but also under consideration of possible energy exports periods with lower demand without neglecting important generation development of RES.

2.3.4 Strategy D – Joint operation with Albania, Conservative Strategy

This Conservative Strategy is developed under consideration of a joint operation of Kosovo's and Albania's power systems. Additional explanations about activities for joint operation were already given in "Load-frequency control study Kosovo-Albania" [8] by the consultant. It represents a reduced development of new generation capacities and is deduced for Kosovo from the Base Strategy as described in [2] and [3]. The generation development for Kosovo is already described in Chapter 0.4 (see Table 0-4).

The Albanian part is derived from the generation data given by KOSTT. For this conservative assumption the construction times of new HPP were prolonged. Considering a complete state of planning the construction durations were considered with:

- 10 years minimum for HPP with an installed capacity of more than 100MW
- 8 years minimum for HPP with an installed capacity of more than 10MW and less than 100MW
- 5 years minimum for HPP with an installed capacity of more than 5MW and less than 10MW
- 3 years minimum for HPP with an installed capacity of less than 5MW

So, in the following the generation development is depicted. Table 2-10 shows the Albanian development of mostly HPP generation. Finally Figure 2-6 shows the annual development of total generation power in Kosovo and Albania within this scenario.

Year		2015	2020	2025	2030
Oil	**MW**	159	159	159	159
Gas	**MW**	0	0	0	0
Nuclear	**MW**	0	0	0	0
Water >10MW	**MW**	1,443	1,491	1,503	2,271
Lignite	**MW**	0	0	0	0
Installed Conventional Generation Power	**MW**	**1,602**	**1,650**	**1,662**	**2,430**
Bio mass	**MW**	0	0	0	0
Wind	**MW**	60	135	235	435
Water < 10MW	**MW**	90	150	198	238
Solar	**MW**	0	0	0	0
Installed Renewable Generation Power	**MW**	**150**	**285**	**433**	**673**

Table 2-10 Generation development of Albanian power system, Conservative Strategy

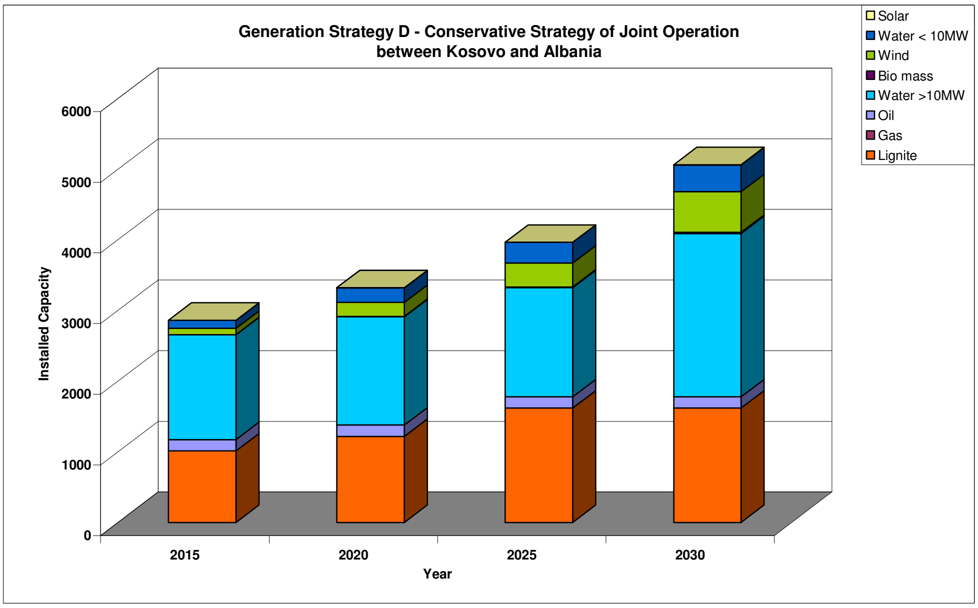

Figure 2-6 Annual generation development of Conservative Strategy D

2.3.5 Strategy E – Joint operation with Albania, Base Strategy

This Base Strategy is developed under consideration of a joint operation of Kosovo's and Albania's power systems. It represents the planned development of new generation capacities and is deduced for Kosovo from the Base Strategy as described in [2] and [3]. The generation development for Kosovo is already described in Chapter 0.4 (see Table 0-4).

The Albanian part is derived from the generation data given by KOSTT. For this assumption the construction times of new HPP were taken as planned by Albanian Ministry and some more wind development was assumed.

So, in the following the generation development is depicted. Table 2-11 shows the Albanian development of mostly HPP generation. Figure 2-7 shows the annual development of total generation power in Kosovo and Albania within this scenario.

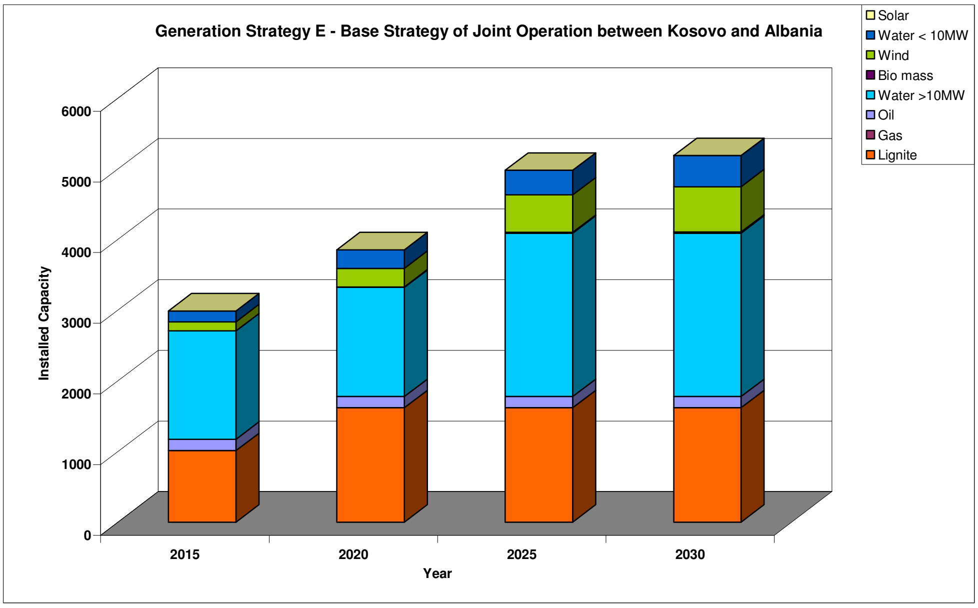

Figure 2-7 Generation development of Base Strategy E

Year		2015	2020	2025	2030
Oil	MW	159	159	159	159
Gas	MW	0	0	0	0
Nuclear	MW	0	0	0	0
Water >10MW	MW	1,491	1,503	2,271	2,271
Lignite	MW	0	0	0	0
Installed Conventional Generation Power	**MW**	**1,650**	**1,662**	**2,430**	**2,430**
Bio mass	MW	0	0	0	0
Wind	MW	100	200	428	500
Water < 10MW	MW	128	207	250	300
Solar	MW	0	0	0	0
Installed Renewable Generation Power	**MW**	**228**	**407**	**678**	**800**

Table 2-11 Generation development of Albanian power system, Base Strategy

2.3.6 Strategy F – Joint operation with Albania, Best optimised Strategy

The best optimised strategy of a joint operation of Kosovan and Albanian power systems is the utilisation of the advantages of both countries, on the one hand the huge amount of lignite reserves and on the other hand the big potential of hydro power generation. The best optimised strategy for Kosovo was developed in chapter 2.3.3 and consists of altogether 2,400MW of installed lignite generation capacity mixed with an adequate quantity of water and further renewable generation capacities (about 430MW). Optimising both systems means having Kosovan lignite generation as base supply and furthermore Albanian hydro power generation as peak supply available.

As done in chapter 2.3.3 the optimum strategy was found by the described balance matrix and the game-theoretical approach using the same possible strategies, but now including Albanian Base Generation Strategy. As in single operation the analysis delivers Strategy 4 to be the optimum one but now with costs being about 1€/MWh in 2015 higher respectively 0.20€/MWh in 2030 less than in Kosovan single operation.

Year		2015	2020	2025	2030
Coal	TWh	6.09	7.32	10.92	14.52
Gas	TWh	0.00	0.00	0.00	0.00
Oil	TWh	0.02	0.02	0.02	0.02
Water < 10MW	TWh	0.51	0.97	0.59	0.56
Water > 10MW	TWh	4.17	4.28	3.47	2.89
Wind	TWh	0.29	0.61	1.08	1.26
Solar	TWh	0.00	0.00	0.12	0.22
Biomass	TWh	0.03	0.08	0.09	0.10
Winter Peak Import/ Export	TWh	0.04	0.10	-0.14	-0.16
Total	**TWh**	**11.15**	**13.38**	**16.15**	**19.40**
Export	**TWh**	**2.71**	**2.78**	**7.31**	**8.10**
Costs per produced MWh incl. Export	**€/MWh**	**50,34**	**51,61**	**51,26**	**51,31**

Table 2-12 Strategy F and MGS – Forecasted Energy production

Therefore, to the already determined generation strategy C the possible and planned hydro power capacity was added. Therewith the following joint generation structure arises as depicted in Table 2-13 and Figure 2-8.

Year		2015	2020	2025	2030
Oil	**MW**	159	159	159	159
Gas	**MW**	0	0	0	0
Nuclear	**MW**	0	0	0	0
Water >10MW	**MW**	1,531	1543	2311	2311
Lignite	**MW**	1,015	1220	1820	2420
Installed Conventional Generation Power	**MW**	**2,705**	**2922**	**4290**	**4890**
Bio mass	**MW**	6	16	18	20
Wind	**MW**	160	340	598	700
Water < 10MW	**MW**	188	348	396	450
Solar	**MW**	1.4	3	113	200
Installed Renewable Generation Power	**MW**	**355.4**	**707**	**1125**	**1370**

Table 2-13 Generation development of Kosovan and Albanian power system, Best Optimised Strategy

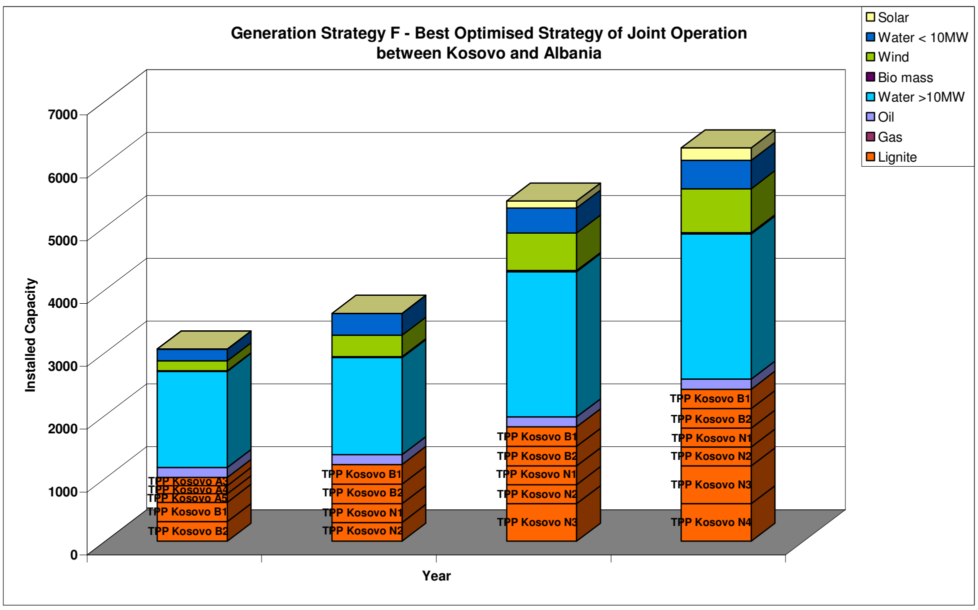

Figure 2-8 Generation development of Best Optimised Strategy F

2.3.7 Assumptions for energy price calculations

In the calculations and analyses of the resulting energy generation prices in the pre-chapters the influencing parameters, listed in the following, were considered for all types and ages of power plants:

- Investment costs
- Fuel costs
- Depreciation costs
- Interest costs
- Employee costs
- Miscellaneous costs

Capital costs, like depreciations and interests, were taken in this first approach also for elder power plants into consideration, although these are not existent anymore for the generation units. Using this methodology the following energy prices were exemplarily estimated for the best optimised generation strategy and the medium load growth scenario (see Table 2-14).

Year		2015	2020	2025	2030
Kosovo	€/MWh	49,39	51,07	51,84	51,53
Albania		54,62	60,98	56,57	59,05
Kosovo-Albania		50,34	51,61	51,26	51,31

Table 2-14 Energy generation price development, Best optimised generation strategy, MGS, approach 1

Due to high investment costs for hydro power plants their depreciation and interest costs and therewith also the energy costs are quite high. Nevertheless the tendency of decreasing energy prices while joining the power systems of Kosovo and Albania can be seen. Going one step further and developing that approach by neglect of capital costs for all old, already existing units delivers the following results for energy price development in the same load growth scenario and generation expansion strategy (see Table 2-16).

Year		2015	2020	2025	2030
Kosovo	€/MWh	31,28	42,91	46,82	48,16
Albania		20,59	24,54	35,66	35,00
Kosovo-Albania		21,49	30,35	37,06	39,51

Table 2-15 Energy generation price development, Best optimised generation strategy, MGS, approach 2

Table 2-15 shows the same tendency as the results of Table 2-14. The energy generation costs of joint operation are bit higher than in Albanian single operation but substantially less than in Kosovan single mode. That proves that used methodology is consistent and delivers good results.

2.4 System adequacy

2.4.1 Generation adequacy

2.4.1.1 Kosovo's power system

The Generation Adequacy of the Strategies A to C shows, that the construction of new power plants as per Base and Conservative Strategies do not lead to sufficient results. The power systems remain import dependent. The best optimised strategy with about 2,400MW of lignite power installed makes the Kosovan power system being able to export in most of the reference points. The results of all strategies depending on the respective load growth scenario are depicted in Figure 2-9 to Figure 2-11.

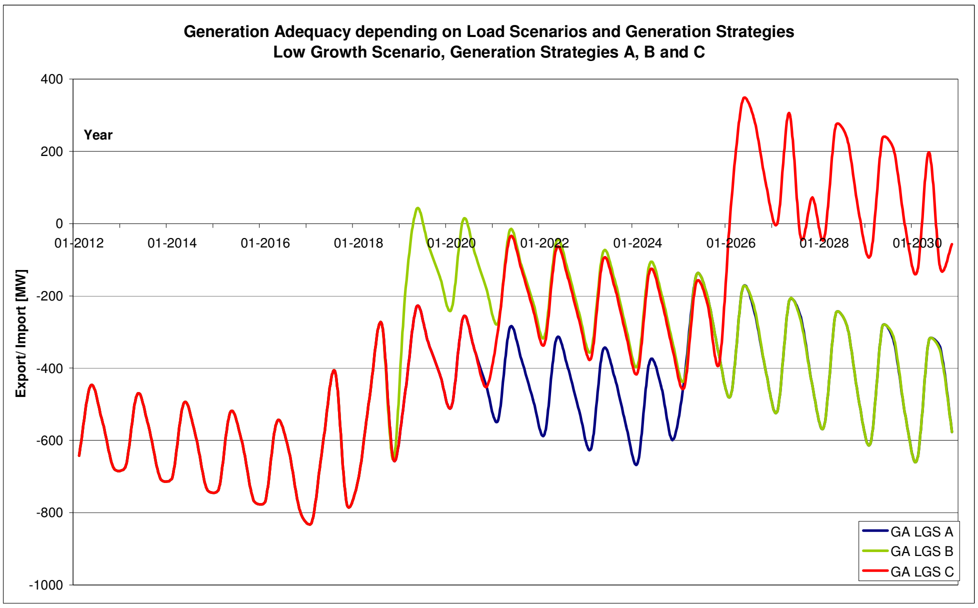

Figure 2-9 **Generation Adequacy, LGS, Generation Strategy A, B and C**

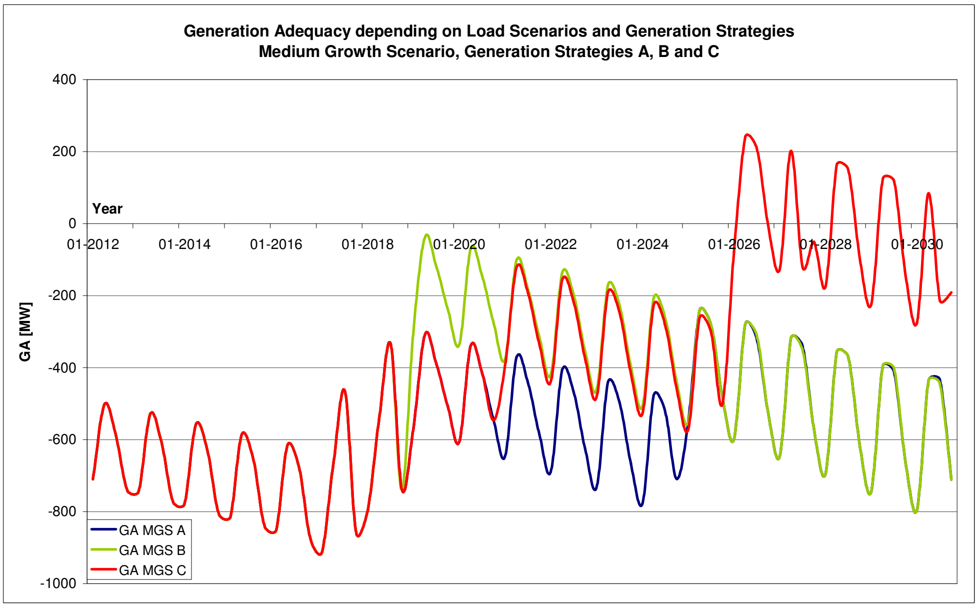

Figure 2-10 **Generation Adequacy, MGS, Generation Strategy A, B and C**

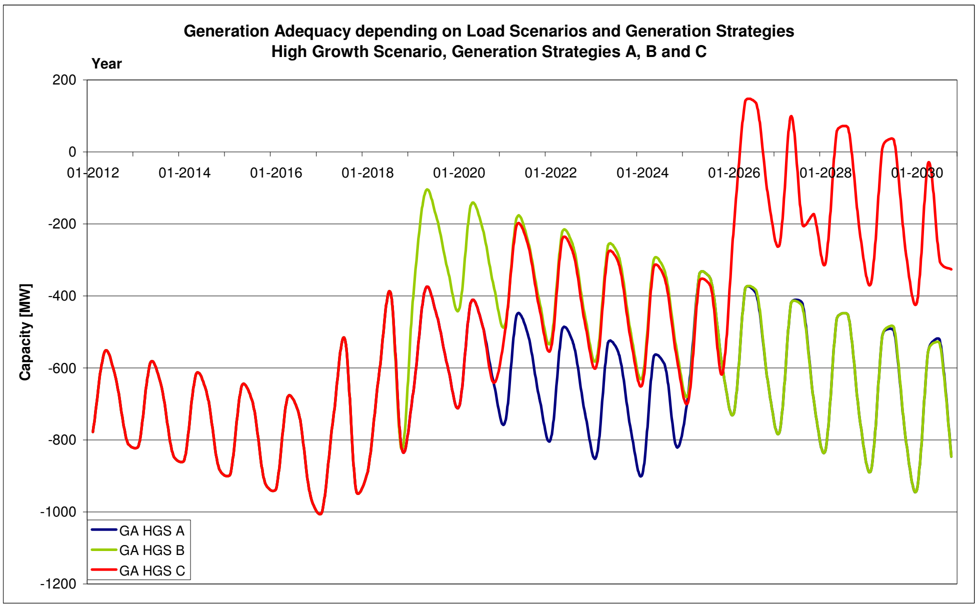

Figure 2-11 Generation Adequacy, HGS, Generation Strategy A, B and C

In Figure 2-12 the assumed power balance for the 3rd Wednesday of January in 2030 is depicted without consideration of control power. Exemplarily the Medium Load Growth Scenario and Generation Strategy C are taken. The load curve was developed from the normalised load curves as per Figure 1-1 to Figure 1-4, the respective load factors from Table 1-18. As it can be seen for that case, the total power system is still capable for export the whole day long, although all generation capacities were assumed not to be in full operation (90% of rated power). However it has to be mentioned that control power was not considered within this graph.

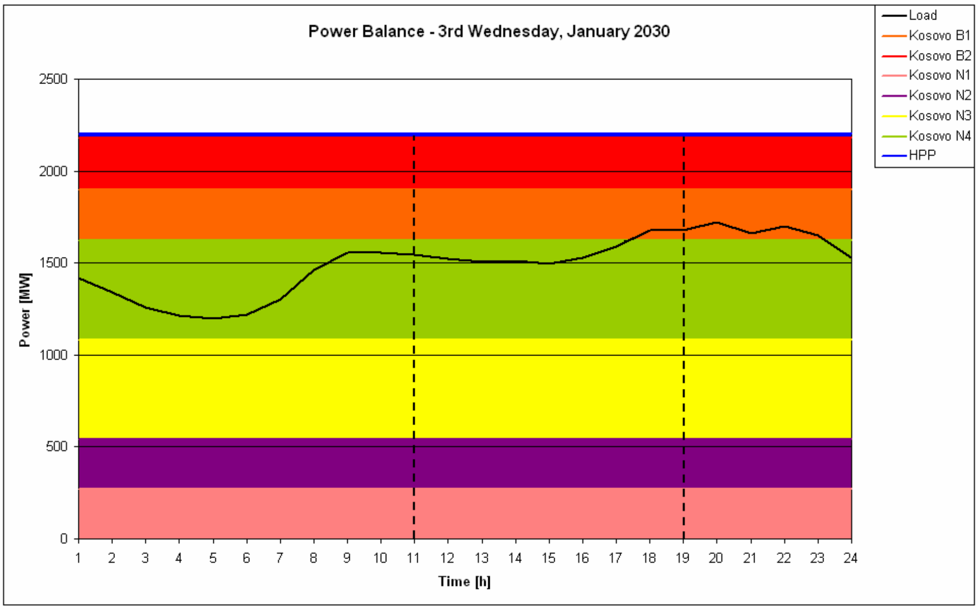

Figure 2-12 Power Balance of Kosovan Power System on 3rd Wednesday of January 2030

2.4.1.2 Joint operation of power systems of Kosovo and Albania

The Generation Adequacy of the Strategies D to F shows, that the construction of new power plants as per Base and Conservative Strategies do not lead to sufficient results. The power systems remain import dependent. The best optimised strategy with about 2,400MW of lignite power installed makes both power systems being able to export in most of the reference points. The results of all strategies depending on the respective load growth scenario are depicted in Figure 2-13 to Figure 2-15.

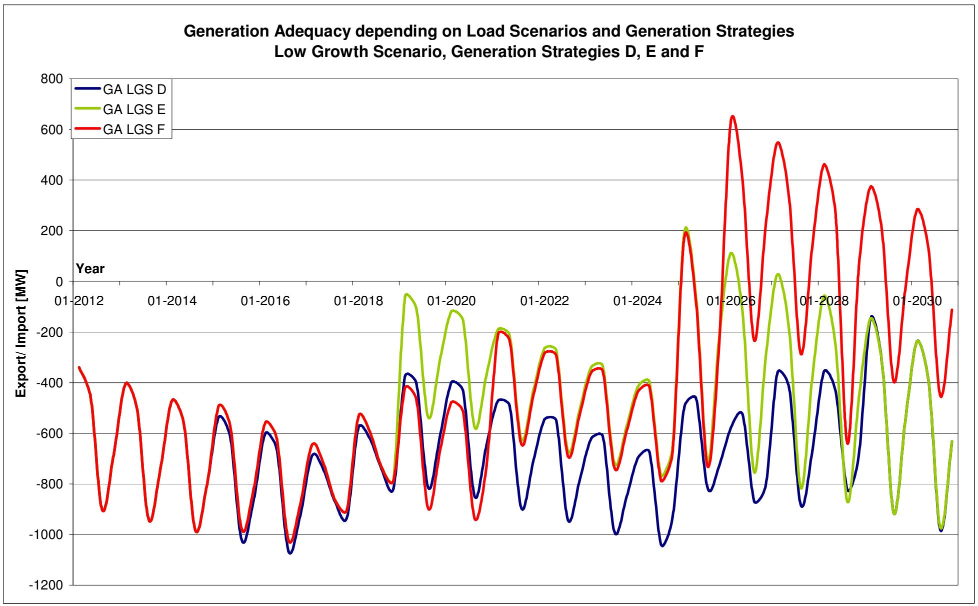

Figure 2-13 Generation Adequacy, LGS, Generation Strategy D, E and F

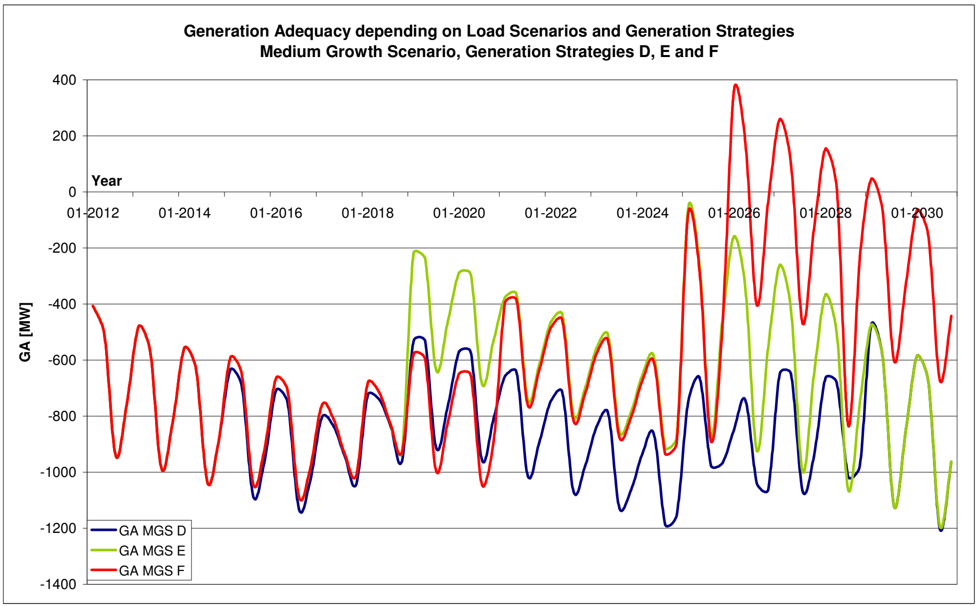

Figure 2-14 Generation Adequacy, MGS, Generation Strategy D, E and F

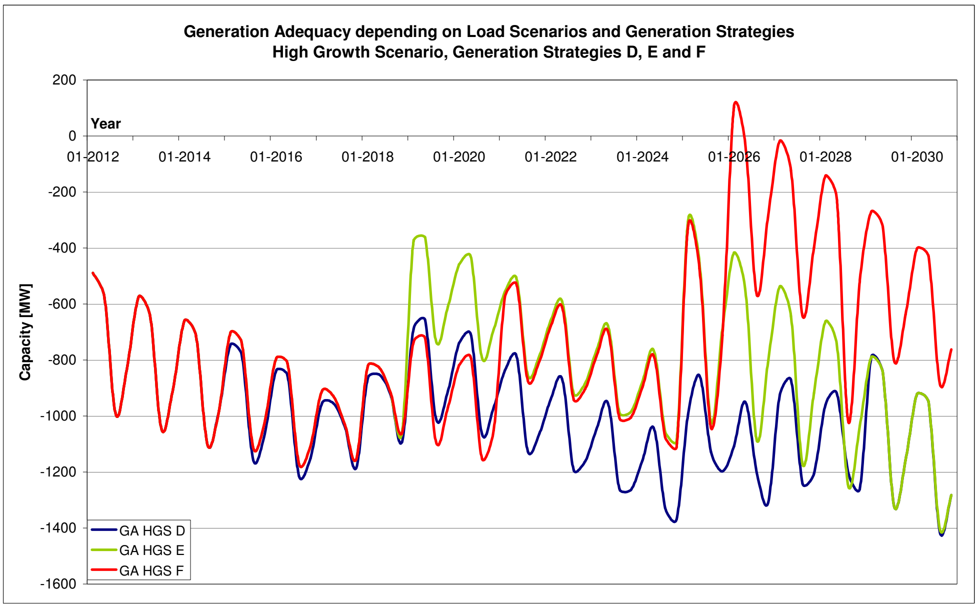

Figure 2-15 Generation Adequacy, HGS, Generation Strategy D, E and F

2.4.2 Transmission adequacy

2.4.2.1 Brief outline of current grid situation

The electricity grid is characterised by a quite well developed transmission system (400kV and 220kV) from structural point of view. Its technical state in terms of an independent assessment was not available. The maintenance measures realised in the last years and as a consequence thereof the decrease of grid faults and outages make the grid to be in an ordinary state.

The 110-kV-grid does not fulfil the n-1-criterion in winter peak cases in some regions. Due to relatively high distances at 110-kV-level and high loads in particular regions voltages may amount to less than $0.9*U_N$ that are not compensable by voltage control of 110-kV-transformers. Associated with high loads at medium and low voltage level this might lead to insufficient voltage qualities at the customers.

Extending the 110-kV-grid to (n-1)-secure systems voltage problems are remedied and grid losses are reduced automatically. Exceptions might occur, if already in the overriding systems voltages are too low or reactive power is not compensated sufficiently at the customers.

Medium and low voltage grids are mostly obsolete and not adapted to the load flows in winter peak. Often these are definitively responsible for high grid losses and the inadequate voltage quality at customers.

2.4.2.2 International compound operation

As lignite will have a dominating importance for power supply of Kosovo in the next 30 years, the main area of generation will be in the region of Prishtina probably. This region is very well interconnected into the European compound grid by powerful 400-kV-transmission lines to Macedonia, Montenegro and Serbia. The integration will be strengthened further by the planned 400-kV-overhead line to Albania (Tirana 2). Indirectly the new 400-kV-line from Montenegro (Podgorica) via Tirana 2 to Elbasan in Albania will have a sustainable, positive influence on Kosovo's system integration because of closing a 400-kV-ring from Prishtina via Podgorica and Tirana 2 back to Prishtina. Additionally by further planned measures in 400-kV-grid in Macedonia (coupling to Greece), Serbia (coupling to Macedonia) and Greece all 400-kV-lines of Kosovo are closed to ring structures in the southern Balkan region and will reach high standards concerning reliability and transmission capability without any grid extension measures necessary in Kosovo.

Figure 2-16 shows schematically the 400-kV-connection of Kosovo with the neighboured transmission system operators in Albania, Macedonia and

Serbia. The planned, new overhead line to Albania to be in operation in 2015 is shown dashed. As per Fichtner Study [9] the construction of a 400-kV-south-ring in Kosovo is recommended, shown dashed as well. Furthermore Kosovo has 220-kV-overhead lines to Serbia (Krusevac) and Albania (Fierze).

Figure 2-16 **400-kV-integration of KOSTT in SEE; [10]**

For the development of an energy market there are excellent prerequisites after commissioning of the 400-kV-line to Albania from grid point of view. But even without that line the current transmission situation is sufficient (see Figure 2-17). Base for this evaluation of grid conditions for energy trades are Net Transfer Capacity (NTC)-values published for all trans-boundary transmission lines.

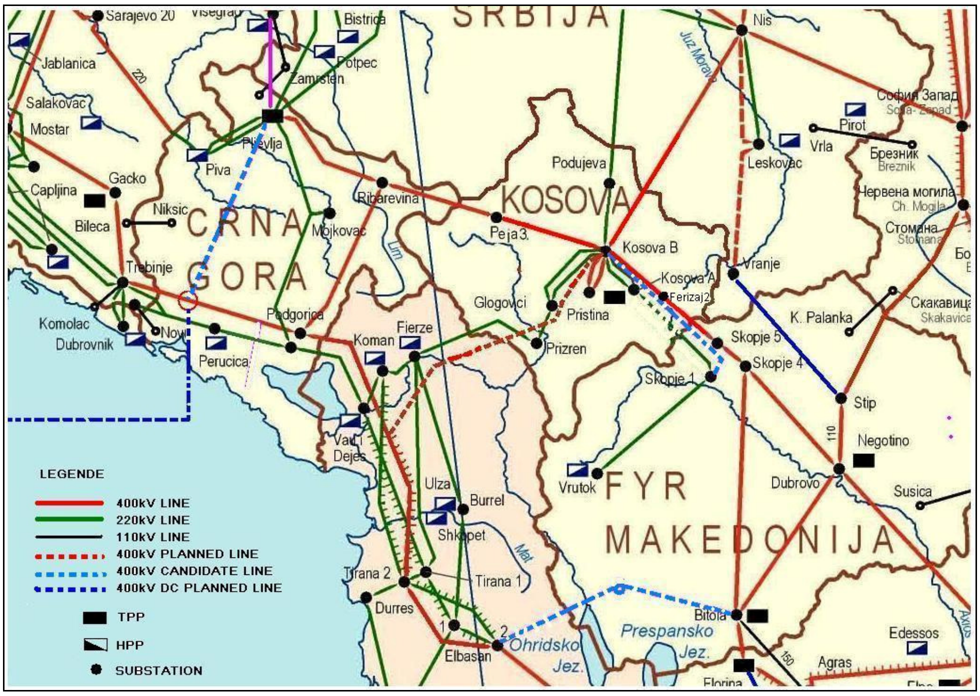

Figure 2-17 Extract of 400-kV-/220-kV-grid of Southern Balkan region; [11]

Table 2-16 gives an overview about different transmission capacities of 400-kV- and 220-kV lines in Kosovo. Therewith five of its types are depicted:

- Thermal transmission capacity
- (n-1)-transmission capacity
- Net transfer capacity
- Natural transmission capacity
- Monitoring transmission capacity

For the real and practical system operation the (n-1)-transmission capacity is critical, as this capacity ensures that

- in cases of a fault of one 400-kV-line the respectively available demand can be taken over by neighboured lines
- coincidently the available thermal capacity of these lines is not exceeded
- the voltages in all grid nodes range between acceptable values

As all lines are cross border lines this (n-1)-transmission capability needs to be agreed with the neighbouring TSO. The (n-1)-transmission power is the maximum permissible one under normal operation conditions. In Table 2-16 this value is determined with 70% of thermal capacity as first orientation value. This (n-1)-transmission capacity does not only grant the mastery of outages of neighboured lines but also the outage of the biggest unit (300MW) in Kosovo without impacts on the supply of customers, if necessary minute reserve is available.

Thermal capacity is not the maximum permissible transmission capacity. In winter operation a by 10% to 20% higher load can be admitted, if all necessary prerequisites are met (400-kV-line monitoring). This monitoring is successfully utilised in Germany. The most important criterion is the thorough adaptation of such an operation mode with grid protection. The overload protection generally has to be abandoned. The parameterisation of short circuit protection needs to be realised in that way that line disconnections due to overload are excluded.

NTC-values for all European countries are given in a country matrix as per ENTSO-E [12]. For Kosovo the figures are missing. For orientating calculations, absolutely necessary for long-term assumptions, the NTC of a control area can be determined between 30% and 40% of thermal transmission capacity to the neighbouring TSO. Fichtner study [9] indicates the NTC of Kosovo after commissioning of the line to Tirana 2 with 1,200MVA, but refers providently that "[…] Therefore a direct NTC between two countries cannot be determined.". KOSTT itself states that NTC amounts to 1,740MW according to [3] after commissioning of the new line to Albania.

The overview in Table 2-16 shows that with an according optimisation of transmission capacity the calculated NTC-value seems to be a reliable assumption, safely available in winter peak, without infringing the (n-1)-criterion and under the condition dynamic overhead line rating (temperature monitoring) in winter time.

Line	Voltage [kV]	Thermal TC [MVA]	(n-1)-TC [MVA]	NTC[2] 2020 [MW]	Natural TC [MW]	Maximum Winter TC [MVA]
Prishtina – Nis	400	1,317	1,015	495	550	1,450
Prishtina – Krusevac	220	300	231	110	120	330
Prishtina – Podgorica	400	1,317	1,015	440	550	1,450
Prishtina – Skopje	400	1,317	1,015	440	550	1,450
Prishtina – Tirana 2	400	1,317	1,015	550	550	1,450
Prizren – Fierze	220	300	231	110	120	330
Total	**-**	**5,868**	**4,522**	**2,145**	**2,440**	**6,460**

Table 2-16 Different Transmission Capacities of Transmission lines in Kosovo

If cross-border load flows do flow due to missing consistency of 400-kV-system via integrated 220-kV-lines or these do overtake parallel load flows, the 400-kV-transmission capacity is determined by the transformer capacities in 400-kV-/ 220-kV- substations and mostly seriously limited. In that scope the missing line from Montenegro (Podgorica) to Elbasan via Tirana (Albania) is a bottleneck, restricting the high technical transmission capability of 400-kV-lines. That concerns further 220-kV-lines in the Southern Bal-

[2] NTC- values taking higher load capacity in winter under lower out temperature into consideration

kan region. An extension planning of Kosovo's 400-kV-grid can only be optimal, if neighboured transmission grids and its extensions are considered.

The stated NTC power increases automatically without any construction of additional 400-kV-lines in Kosovo only by the elimination of 220-kV-bottlenecks in the Serbian, Macedonian, Albanian and Greek transmission grids. Further possibilities of NTC increases can be realised by the refurbishment and optimisation of grid protection in SEE plus the implementation of a temperature depending grid operation (monitoring by dynamic overhead line rating).

Summarising it needs to be stated that after completion of the 400-kV-line Prishtina – Tirana 2 under consideration of forecasted winter peak development until 2030 all tasks in the scope of an international compound operation can be fulfilled from grid's point of view and optimal prerequisites for energy trades are given.

The importance of the 220kV-lines to Fierza (Albania) and Krusevac (Serbia) is in future very high but only until there are no substations in South, West and North Kosovo between 400-kV- and 110-kV-grid.

2.4.2.3 Calculation of Transmission Adequacy

As described in Annex 3 the Transmission Adequacy as consequence of generation adequacy is calculated with:

$$0 \le (RC - ARM) \le EC$$ **Export** **Equ. 2-1**

$$0 > (RC - ARM)$$
$$|RC - ARM| \le IC$$ **Import** **Equ. 2-2**

whereas:

RC Remaining Capacity

ARM Adequacy Reference Margin

EC Export Capacity

IC Import Capacity

- **Kosovo's power system**

All results are listed in Annex 8. For the regarded strategies A and B, the Conservative and Base strategies, Kosovo's power system is import dependent for all years and reference points. In every case the import capacity, the net transfer capacity of about 1,950MW, will not be exceeded. In Strategy C, the best optimised one from technical and economical point of view, generating capacity likely to be available on the power system can be exported in the years after the commissioning of TPP N4 for some of the reference points without any constraints concerning the possible export capacity.

Year	2015	2020	2025	2030
ARM	291.75	341.78	434.81	531.83
RC	-293.88	2.24	172.48	615.90
Export/Import	**Import**	**Import**	**Import**	**Export**
Transmission Adequacy	-585.63	-339.53	-262.33	+84.07
	NTC fulfilled	**NTC Fulfilled**	**NTC fulfilled**	**NTC fulfilled**

Table 2-17 Transmission Adequacy, Generation Strategy C, MGS, Reference Point 2

Year	2015	2020	2025	2030
ARM	246.50	289.35	374.36	462.38
RC	-407.13	-125.37	73.56	249.12
Export/Import	Import	Import	Import	Import
Transmission Adequacy	-653.63	-414.72	-300.80	-213.26
	NTC fulfilled	NTC Fulfilled	NTC fulfilled	NTC fulfilled

Table 2-18 Transmission Adequacy, Generation Strategy C, MGS, Reference Point 3

- **Joint operation of power systems of Kosovo and Albania**

All results are listed in Annex 9. For the regarded strategies D and E, the Conservative and Base strategies, both power systems in total is import dependent for all years and reference points in most of the situations. In every case the import capacity, the net transfer capacity of estimated about 2,000MW, will not be exceeded. In Strategy C, the best optimised one from technical and economical point of view, generating capacity likely to be available on the power system can be exported in the years after the commissioning of TPP N4 for some of the reference points without any constraints concerning the possible export capacity.

Year	2015	2020	2026	2030
ARM	649.56	729.41	1,011.92	1077.20
RC	0.24	76.09	1,192.64	916.50
Export/Import	Import	Import	Export	Import
Transmission Adequacy	-649.32	-653.32	180.72	-160.70
	NTC fulfilled	NTC Fulfilled	NTC fulfilled	NTC fulfilled

Table 2-19 Transmission Adequacy, Generation Strategy F, MGS, Reference Point 2

Year	2015	2020	2026	2030
ARM	557.45	623.19	884.86	934.27
RC	-485.56	-422.25	481.77	262.33
Export/Import	Import	Import	Import	Import
Transmission Adequacy	-1,043.01	-1,045.44	-403.08	-671.95
	NTC fulfilled	NTC Fulfilled	NTC fulfilled	NTC fulfilled

Table 2-20 Transmission Adequacy, Generation Strategy F, MGS, Reference Point 3

2.5 Conclusion

Figure 2-18 shows the best optimised strategy for Kosovo's power plant park..

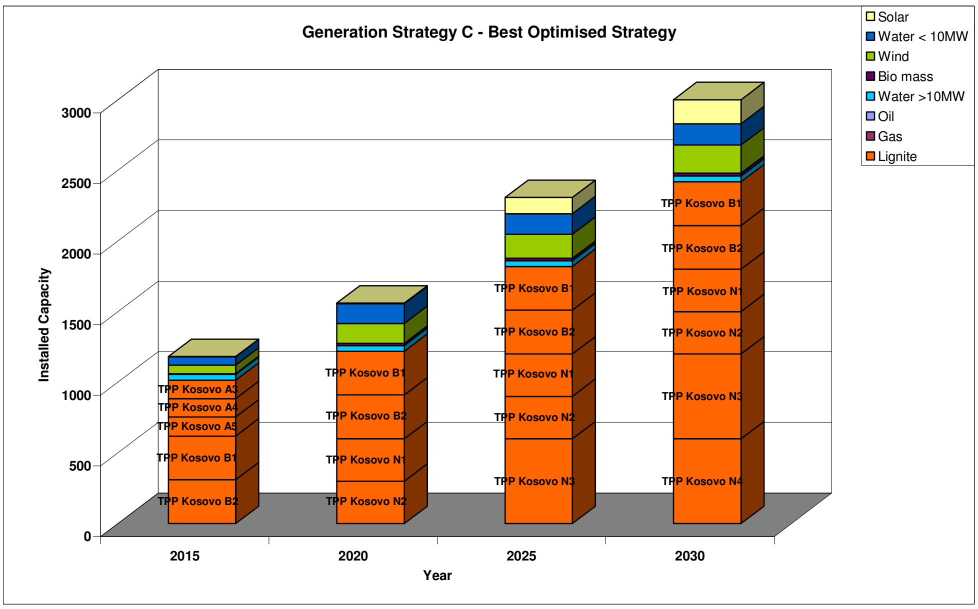

Figure 2-18 Generation development of Strategy C

The evaluated optimum strategy of generation development in Kosovo confirms the planned construction of two new lignite units with a rated power of 300MW each and shows additionally the necessity of erecting two further lignite units with respectively 600MW.

The best optimised strategy of a joint operation of Kosovan and Albanian power systems is the utilisation of the advantages of both countries, on the one hand the huge amount of lignite reserves and on the other hand the big potential of hydro power generation. The best optimised strategy for Kosovo was developed in chapter 2.3.3 and consists of altogether 2,400MW of installed lignite generation capacity mixed with an adequate quantity of water and further renewable generation capacities (about 430MW). Optimising both systems means having Kosovan lignite generation as base supply and furthermore Albanian hydro power generation as peak supply available. Therefore, to the already determined generation strategy C the possible and planned hydro power capacity was added. Therewith the following joint generation structure arises as depicted in Figure 2-19.

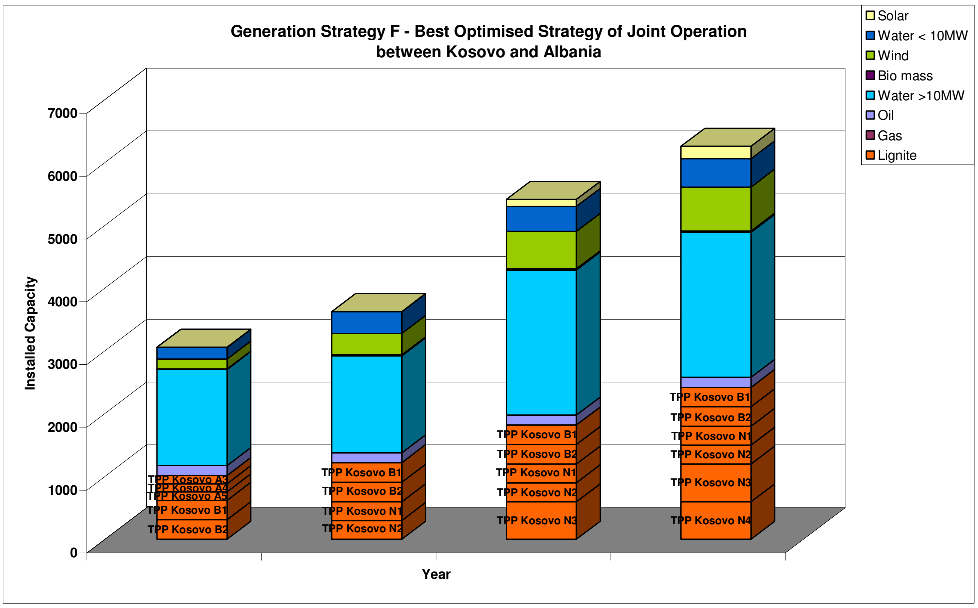

Figure 2-19 Generation development of Best Optimised Strategy F

Generation adequacy analysis has shown that fulfilling these optimised strategies, especially the joint operation between Kosovo and Albania, leads to higher securities of supply for both countries. The base and conservative generation strategies show big import influences for both the Kosovan and the Kosovan and Albanian power systems for most of the situations. The evaluated best optimised generation strategies C and F are much better and make the power systems being able to export energy in some of the situations.

Prices for generated energy develop as listed in Table 2-21. The energy generation costs of joint operation are bit higher than in Albanian single operation but substantially less than in Kosovan single mode.

Year		**2015**	**2020**	**2025**	**2030**
Kosovo	**€/MWh**	31,28	42,91	46,82	48,16
Albania		20,59	24,54	35,66	35,00
Kosovo-Albania		21,49	30,35	37,06	39,51

Table 2-21 Energy generation price development, Best optimised generation strategy, MGS, approach 2

The 400-kV-/ 220-kV-system of Kosovo is designed adequately for the planned extension of generation power and will be, by means of the new 400kV-line from Prishtina to Tirana 2, sufficiently capable for the recommended construction of further lignite units and possible new renewable generation in order to support optimally energy trades. The, in comparison to the (n-1)-transmission capability relatively low net transfer capacity can be increased further by modern protection technology or monitoring. Additionally it rises automatically only due to the construction of new 400kV-lines in the areas of neighbouring TSO.

For granting system adequacy the extension of 110kV- grids has main priority. The conversion of the 400-kV-system preferably planned for power interchange with neighbouring TSO to a transmission system with importance for a quality power supply of Kosovo requires the construction of several 400-kV-/ 110-kV nodes.

Summarising finally it can be stated:

- System adequacy analysis has shown higher security of supply for best optimised strategies for both Kosovan single and Kosovan-Albanian joint operation modes with export possibilities in most of the situations
- Kosovan thermal power plants should be used for base supply, Albanian hydro power plants for covering the peak demand and provision of control power
- Kosovan RES generation development and CO_2 certificate trades could be supported by existing Albanian hydro power plants in joint operation of both countries
- The energy generation costs of joint operation are bit higher than in Albanian single operation but substantially less than in Kosovan single mode.
- However Albanian peak and reserve control power can be sold much more expensive than Kosovan base power
- Therewith both countries earn a high national economic welfare

3 Task 3 – Long Term Energy Balance

3.1 Energy Balance Calculation

The energy balance curves are defined as the difference of the produced and the demanded energy per year in total. Therefore positive values stand for a surplus of energy with possibilities of export and negative values for the need of imports.

The graphs in Figure 3-1 to Figure 3-3 show big export possibilities of Kosovan power system although generation adequacy analysis has shown that the total system is likely to import in most of the situations. However that results from necessary system reserves remaining unconsidered in that energy balance analysis.

Generation units	Operation hours	2015 [MW]	2020 [MW]	2025 [MW]	2030 [MW]
TPP Kosovo A3	5,500	130	0	0	0
TPP Kosovo A4	6,750	130	0	0	0
TPP Kosovo A5	5,100	135	0	0	0
TPP Kosovo B1	7,300	310	310	310	310
TPP Kosovo B2	6,300	310	310	310	310
HPP Ujmani	3,000	32	32	32	32
HPP Lumbardhi	5,000	8	8	8	8
TPP N1	7,000	0	300	300	300
TPP N2	7,000	0	300	300	300
TPP N3	7,000	0	0	600	600
TPP N4	7,000	0	0	0	600
Biomass	5,000	60	141	145.5	150
Wind	1,800	60	140	170	200
HPP < 10MW	4,400	6	16	18	20
Solar	1,100	1,4	3	113	200
Produced Energy [TWh]		**7.07**	**9.58**	**13.99**	**18.37**

Table 3-1 Energy generation analysis, Strategy C

Table 3-1 shows exemplarily for the years 2015, 2020, 2025 and 2030 the assumptions concerning maximum operations hours of the different power plants including the possible generation power per power plant. Finally the totally produced energy is depicted.

Year	T_{max} [h]	LGS		MGS		HGS	
		P [MW]	W [TWh]	P [MW]	W [TWh]	P [MW]	W [TWh]
2012	4,900	1,046	5.12	1,113	5.46	1,181	5.79
2013	4,950	1,076	5.32	1,147	5.68	1,218	6.03
2014	4,975	1,107	5.51	1,182	5.88	1,257	6.26
2015	5,000	1,138	5.69	1,218	6.09	1,297	6.49
2016	5,050	1,171	5.91	1,254	6.33	1,338	6.76
2017	5,100	1,205	6.15	1,292	6.59	1,380	7.04
2018	5,150	1,240	6.38	1,331	6.85	1,422	7.33
2019	5,175	1,275	6.60	1,370	7.09	1,466	7.59
2020	5,200	1,311	6.82	1,411	7.34	1,510	7.85
2021	5,225	1,348	7.04	1,452	7.59	1,556	8.13
2022	5,300	1,386	7.35	1,494	7.92	1,602	8.49
2023	5,350	1,426	7.63	1,538	8.23	1,650	8.83
2024	5,375	1,466	7.88	1,582	8.50	1,698	9.13
2025	5,400	1,506	8.13	1,627	8.78	1,747	9.44
2026	5,450	1,549	8.44	1,673	9.12	1,798	9.80
2027	5,500	1,592	8.75	1,721	9.46	1,850	10.17
2028	5,550	1,636	9.08	1,769	9.82	1,902	10.56
2029	5,575	1,681	9.37	1,818	10.14	1,956	10.90
2030	5,600	1,727	9.67	1,869	10.46	2,010	11.26

Table 3-2 Energy Demand of Kosovo

The produced energy in Table 3-1 is compared with the needed demand in Table 3-2. The curves in Figure 3-1 to Figure 3-3 result from that.

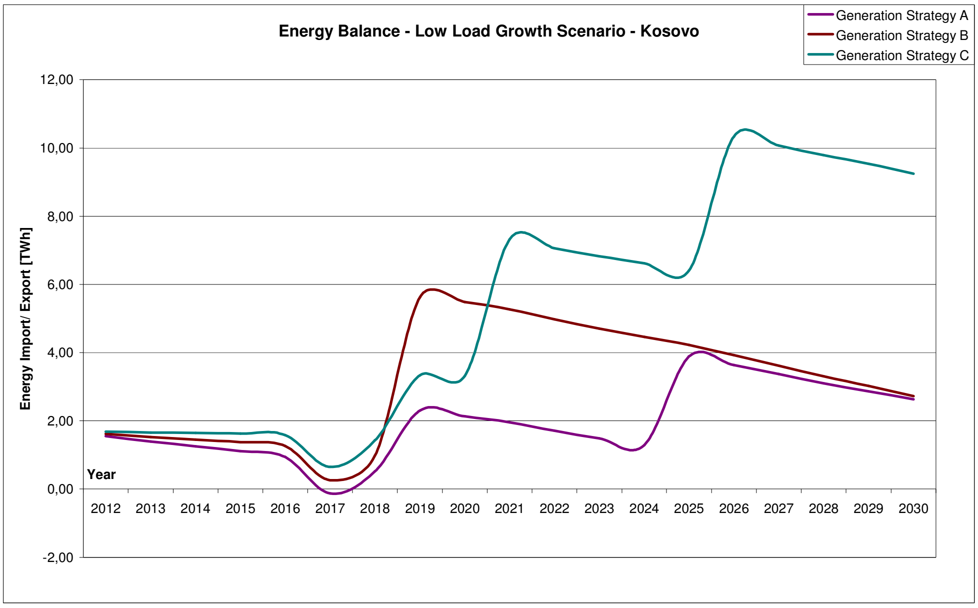

Figure 3-1 Energy Balance of Kosovan power system, LGS

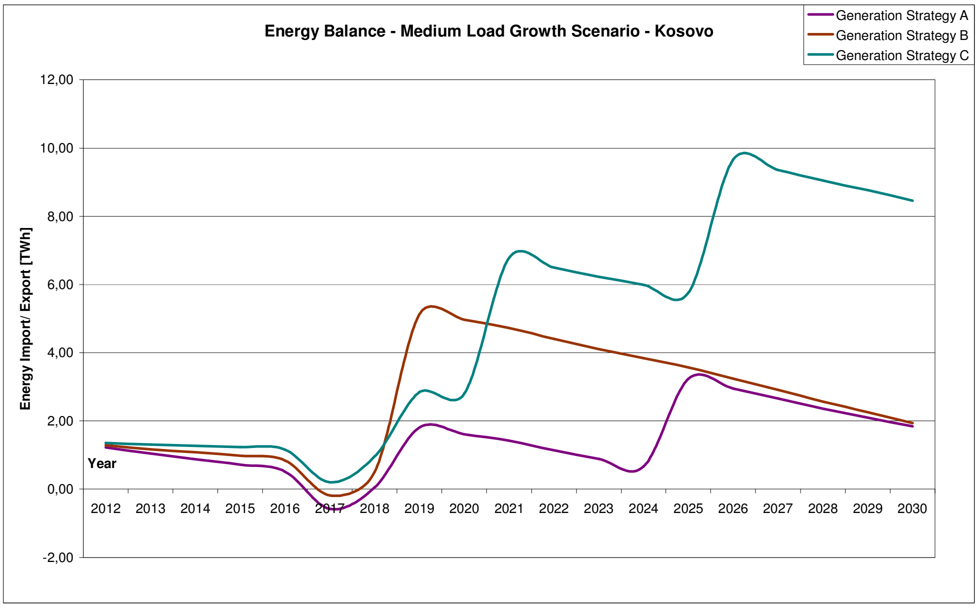

Figure 3-2 Energy Balance of Kosovan power system, MGS

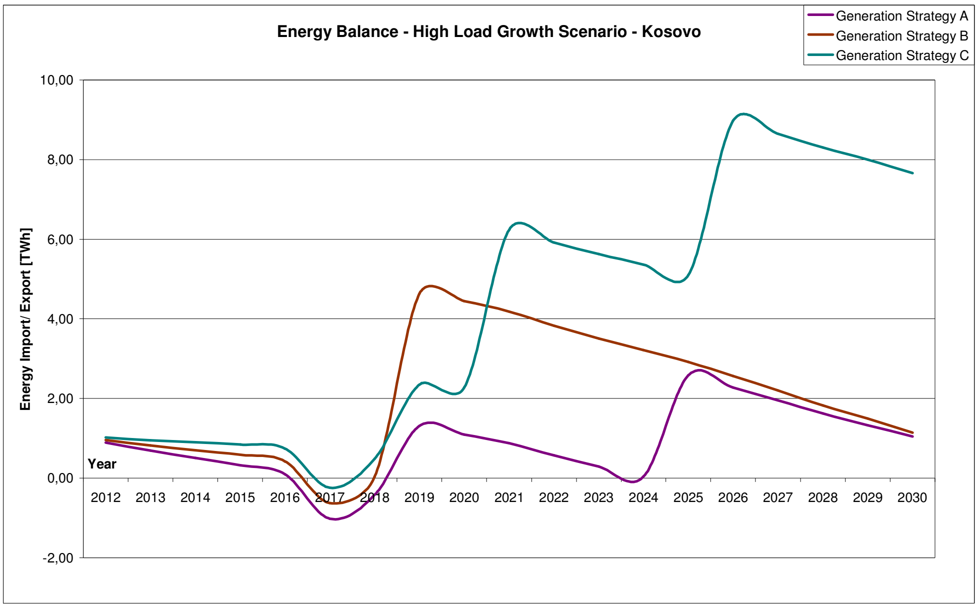

Figure 3-3 Energy Balance of Kosovan power system, HGS

Figure 3-4 to Figure 3-6 show the energy balance of the joint power system Kosovo and Albania. Merging both power systems does bring advantages as it can be seen by comparison of Kosovan graphs above with the energy balance curves of joint operation depicted below. The single Kosovan system tends to be more import dependent or less export capable than the joint operation power system.

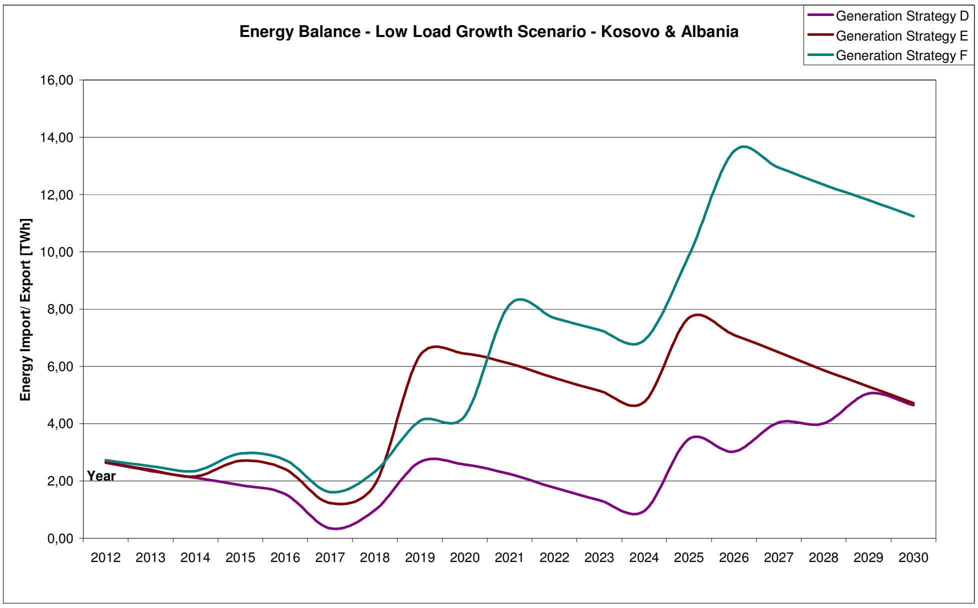

Figure 3-4 Energy Balance of Kosovan and Albanian power system, LGS

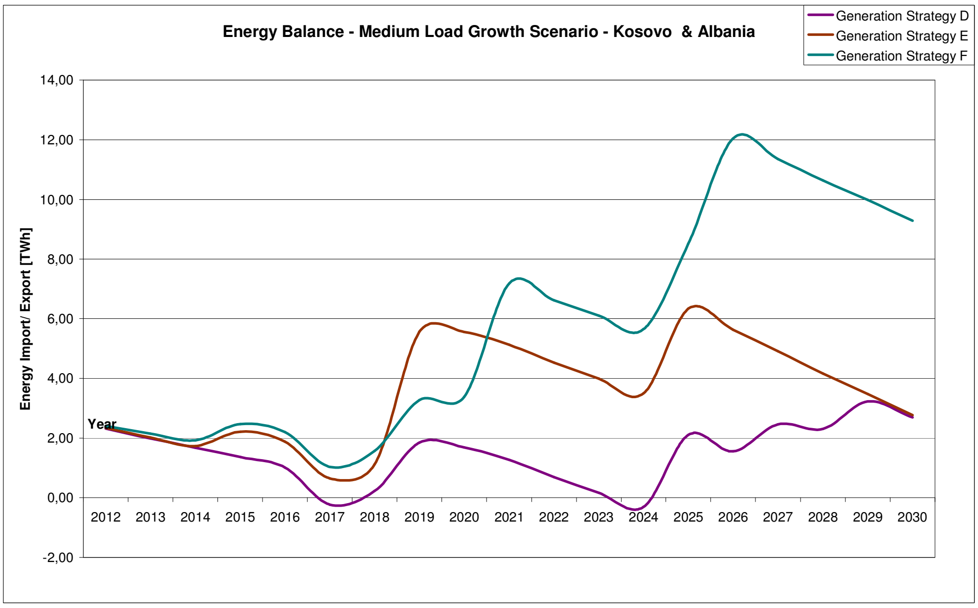

Figure 3-5 Energy Balance of Kosovan and Albanian power system, MGS

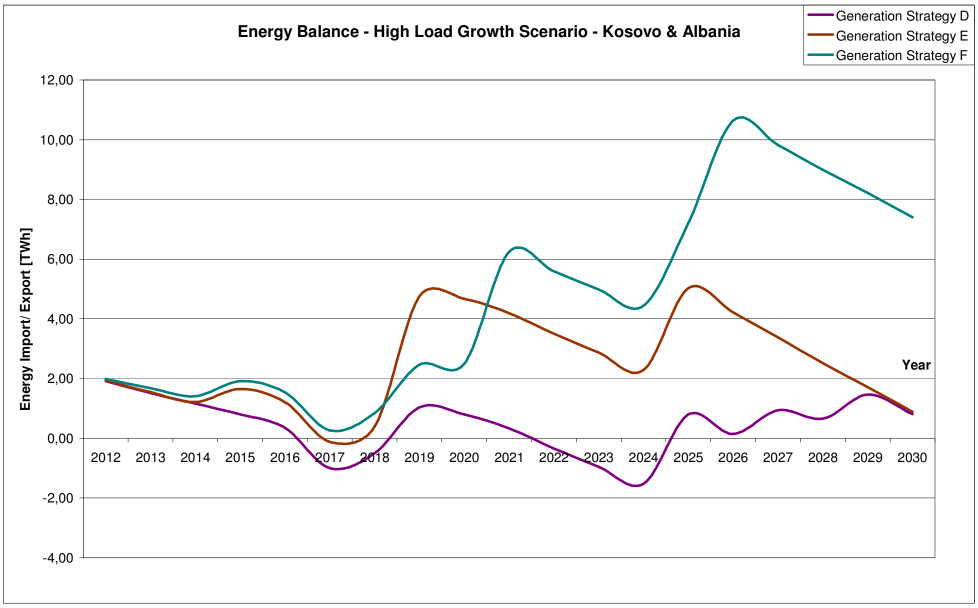

Figure 3-6 Energy Balance of Kosovan and Albanian power system, HGS

3.2 Evaluation of gas emissions

In order to evaluate the gas emissions by lignite units the following amount in kg per MWh of energy output as per Table 3-3 were taken. The emission data for the new lignite units in Kosovo N1 to N4 plus the completely refurbished units B1 and B2 from 2017/ 2018 were assumed on the base of state-of-the-art facilities in Germany. By means of these emission data and the possible energy production including exports the total CO_2- (in kilotons), SO_2- and NO_x- (respectively in tons) emissions per year were calculated. For the covering of energy demand of Kosovo only the gas emission values will be lower than depicted in the following figures.

Gas emissions [kg/MWh]	CO_2	SO_2	NO_x
Kosovo A3-A5	1,523	3.85	4.09
Kosovo B1 and 2, 2012-2017/ 2018	1,143	2.88	3.07
Kosovo B1 and 2, 2017/ 2018-2030	1,000	0.7	0.6
Kosovo N1-N4	1,000	0.7	0.6

Table 3-3 Gas emission parameters per energy output

Figure 3-7 to Figure 3-9 show the potential of emission of CO_2 per strategy and year. It can be seen that the values for CO_2 still increase till 2030, although new or refurbished power plants with much lower emission parameters (CO_2: between 10% to 30% less) will be in operation then. However it has to be pointed out that installed capacity is depending on the strategy up to three-times higher than in current situation. Additionally possible CO_2-savings that result from the utilisation of renewable energy sources are shown in Table 3-4 and Figure 3-7 to Figure 3-9.

Year	2012 [kt]	2013 [kt]	2014 [kt]	2015 [kt]	2016 [kt]	2017 [kt]	2018 [kt]	2019 [kt]	2020 [kt]	2021 [kt]
Strategy A	45	89	134	179	224	268	313	358	413	469
Strategy B	114	227	341	454	568	681	795	908	995	1,005
Strategy C	114	227	341	454	568	681	795	908	996	1,038
Year	**2021 [kt]**	**2022 [kt]**	**2023 [kt]**	**2024 [kt]**	**2025 [kt]**	**2026 [kt]**	**2027 [kt]**	**2028 [kt]**	**2029 [kt]**	**2030 [kt]**
Strategy A	469	526	583	640	697	754	811	868	925	998
Strategy B	1,005	1,014	1,023	1,032	1,041	1,050	1,059	1,069	1,078	1,084
Strategy C	1,038	1,081	1,123	1,166	1,208	1,251	1,294	1,336	1,377	1,392

Table 3-4 CO_2- savings due to utilisation of RES

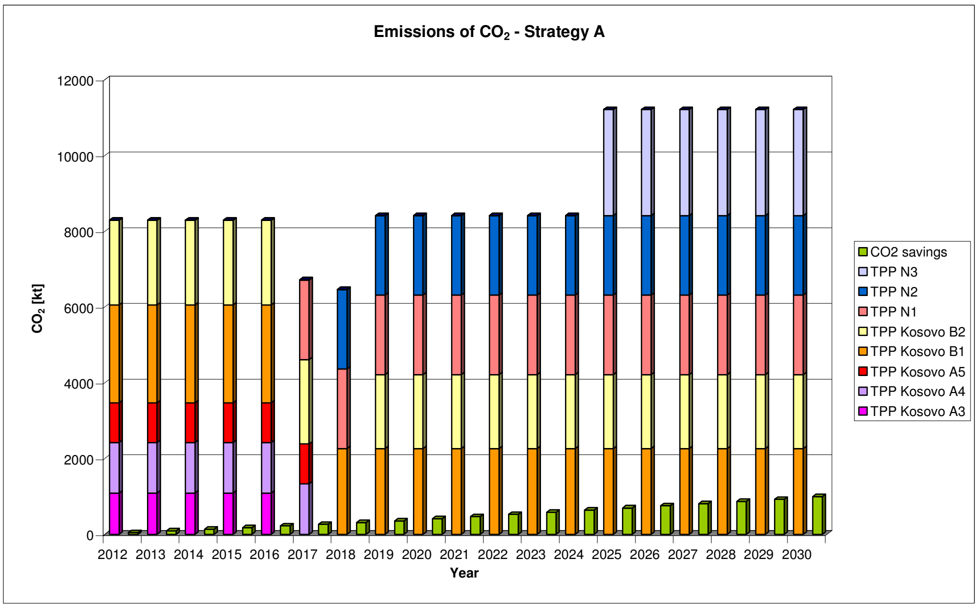

Figure 3-7 CO_2- emissions according to Strategy A

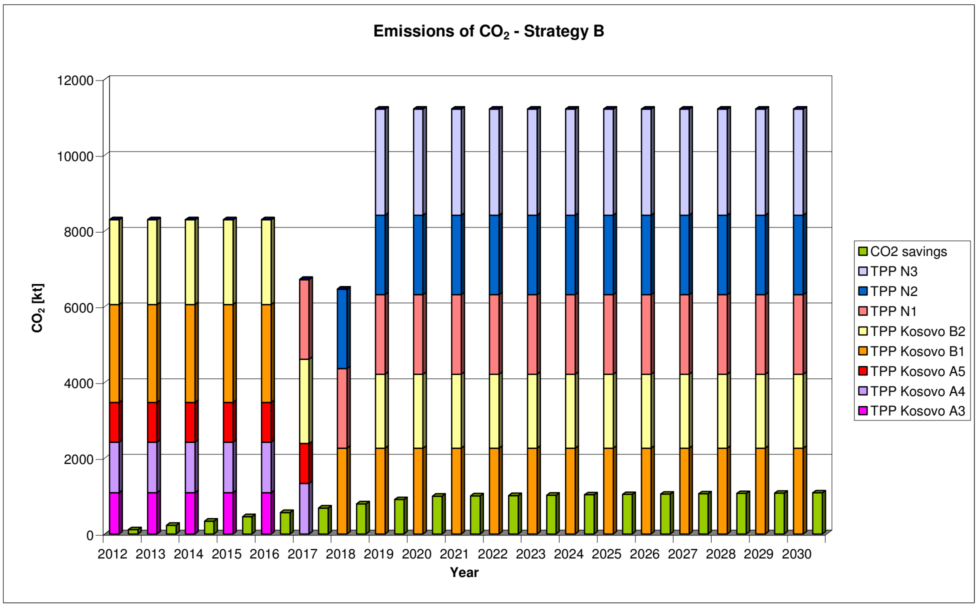

Figure 3-8 CO_2- emissions according to Strategy B

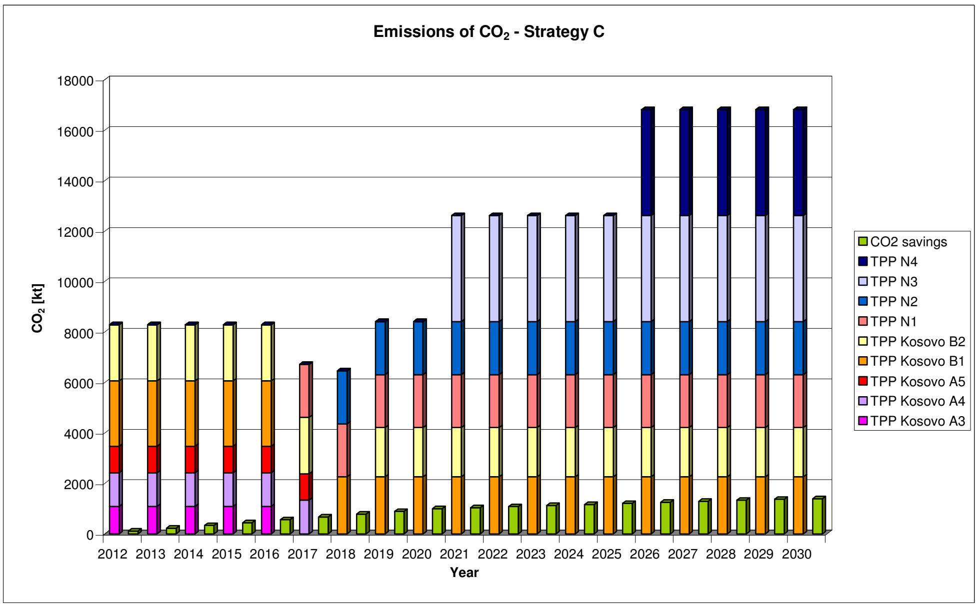

Figure 3-9 CO_2- emissions according to Strategy C

In Figure 3-10 to Figure 3-12 the SO_2-emissions per year are illustrated. Considering all three strategies the sulphur dioxide emissions will decrease tremendously, as state-of-the-art units only emit 20% to 25% of SO_2 per MWh. That means even by doubling the generation from lignite reserves (strategy C) the SO_2-emissions will only amount in total to the half in comparison with the values before refurbishment and installation of new units, which is from environmental point of view a great improvement.

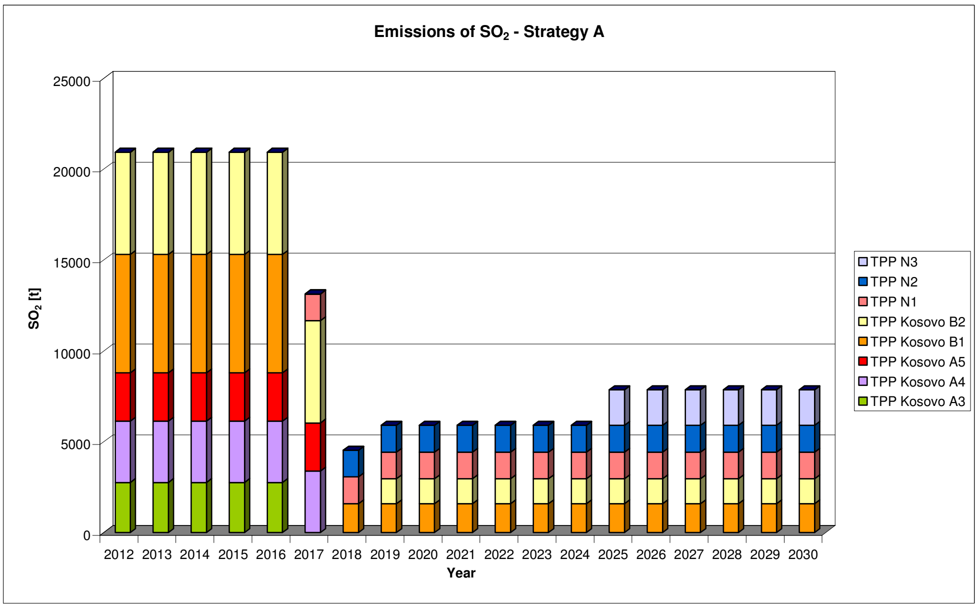

Figure 3-10 SO_2- emissions according to Strategy A

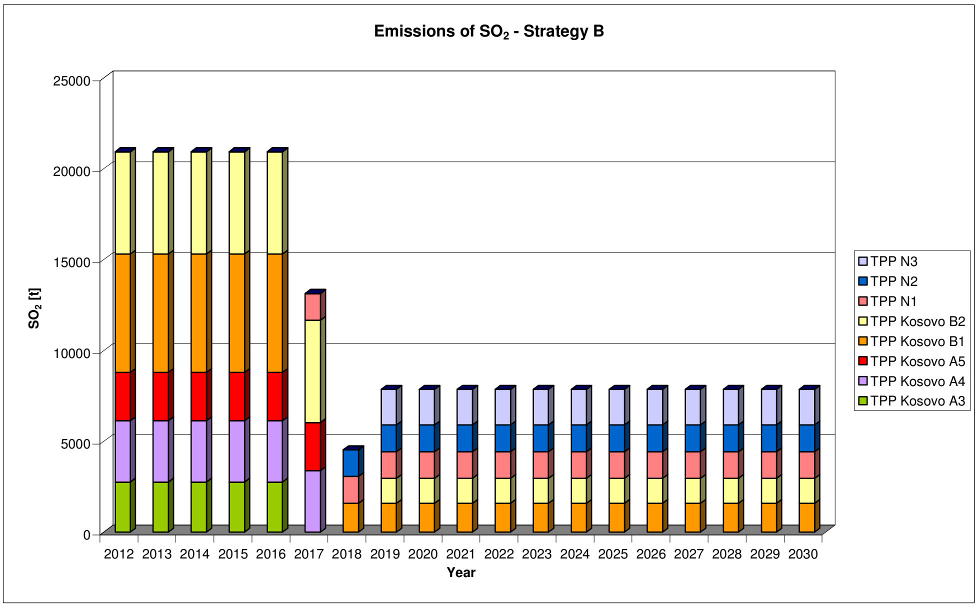

Figure 3-11 SO_2- emissions according to Strategy B

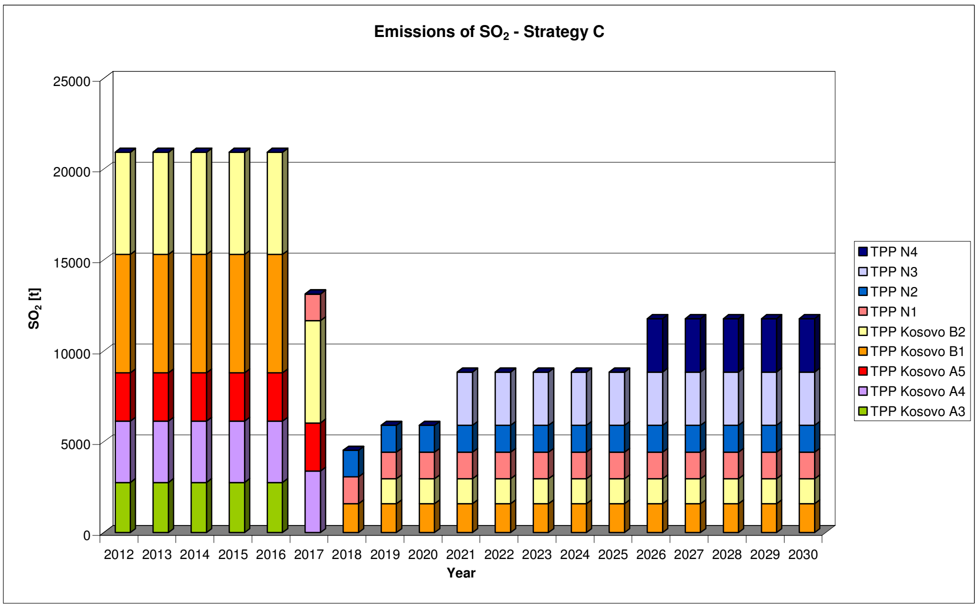

Figure 3-12 SO_2- emissions according to Strategy C

In Figure 3-13 to Figure 3-15 the NO_x-emissions per year are illustrated. Considering all three strategies the nitric oxide emissions will decrease tremendously, just like SO_2, as state-of-the-art units only emit 15% to 20% of NO_x per MWh. That means even by doubling the generation from lignite reserves (strategy C) the NO_x-emissions will only amount in total to less than the half in comparison with the values before refurbishment and installation of new units, which is from environmental point of view a great improvement.

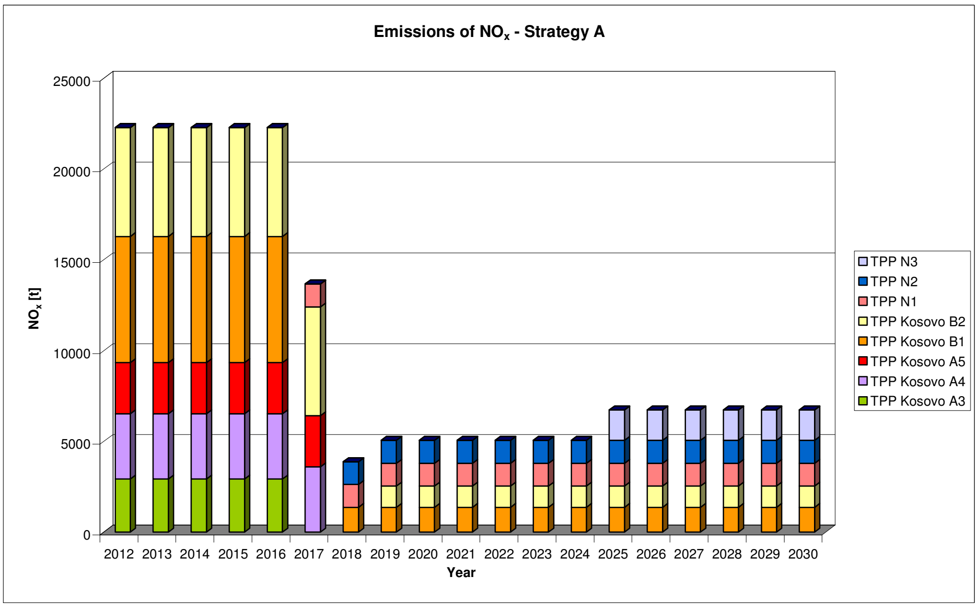

Figure 3-13 NO_x- emissions according to Strategy A

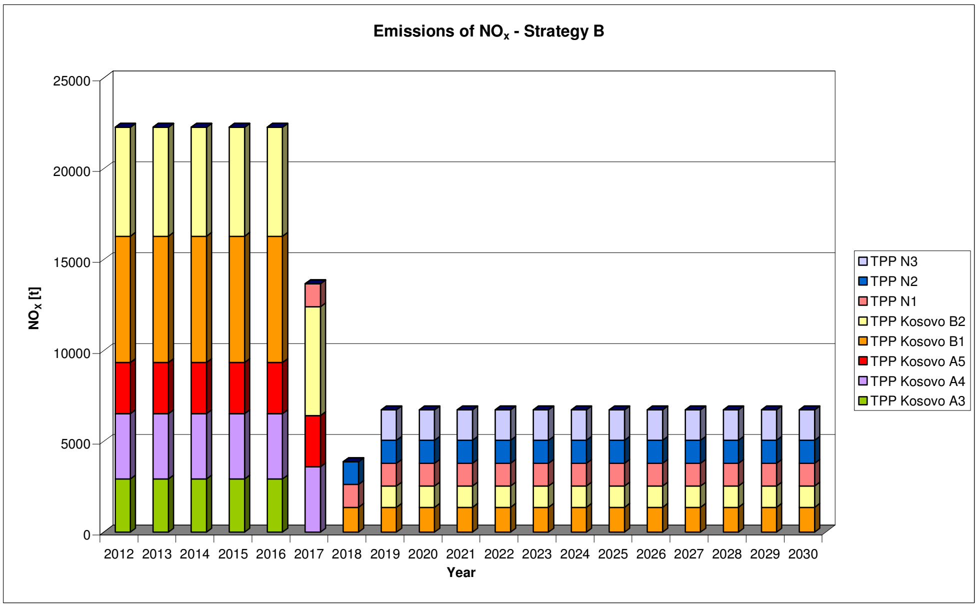

Figure 3-14 NO_x- emissions according to Strategy B

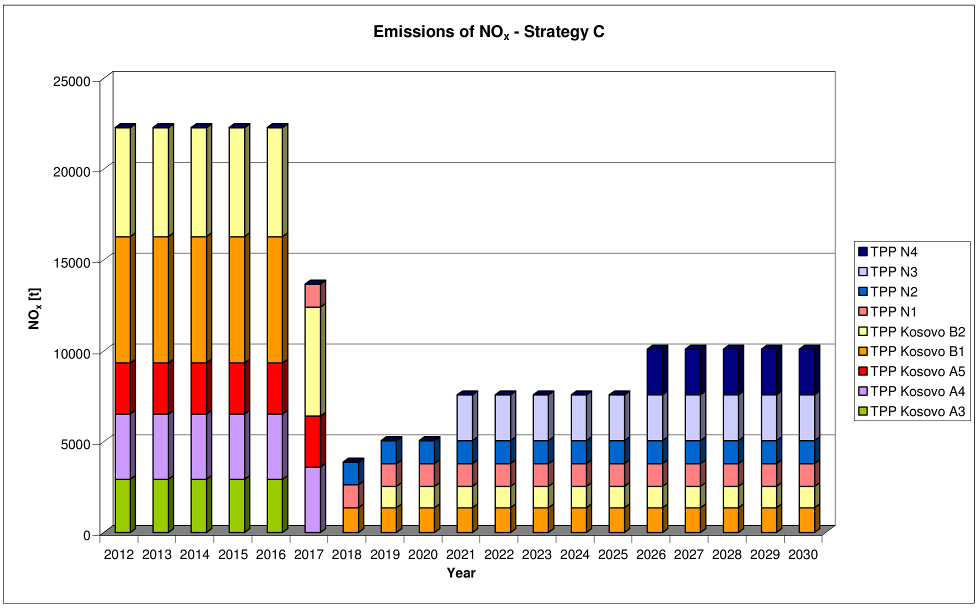

Figure 3-15 NO_x- emissions according to Strategy C

As per European legislation the smoke gas of power plants needs to fulfil hard restrictions concerning its several components. Therefore it has to be cleaned respectively the components dust, sulphur dioxide and nitric oxides have to be eliminated with a ratio of at least 95%. Limit values to be observed amount to 200mg per standard cubic meter for sulphur dioxide and nitric oxides plus 10mg per standard cubic meter for dust.

In order to meet the tough requirements, elaborate procedures and facilities are necessary. The share of smoke gas cleaning amounts to about 30% of investment costs in Germany. Furthermore for the operation of such facilities process energy is needed that reduces the power plant efficiency by 2 to 3 percentage points. For the elimination of dust from the smoke gas big electrical filters are required. Sulphur dioxide is generally absorbed by spraying of lime milk into the smoke gas. Gypsum (calcium sulphate) is the result, which can be sold to the gypsum industry. Nitric oxides are eliminated from the smoke gas by spraying of ammonia.

Carbon capture and storage (CCS) refers to the technology attempting to prevent the release of large quantities of CO_2 into the atmosphere from fossil fuel use in power generation and other industries by capturing CO_2, transporting it and ultimately, pumping it into underground geologic formations to securely store it away from the atmosphere. It is a potential means of mitigating the contribution of fossil fuel emissions to global warming. Although CO_2 has been injected into geological formations for various purposes, the long term storage of CO_2 is a relatively new concept. The first commercial example was Weyburn in 2000.

An integrated pilot-scale CCS power plant was to begin operating in September 2008 in the eastern German power plant Schwarze Pumpe run by Vattenfall, in the hope of answering questions about technological feasibility and economic efficiency. CCS applied to a modern conventional power plant could reduce CO_2 emissions to the atmosphere by approximately 80-90% compared to a plant without CCS.

Capturing and compressing CO_2 may increase the fuel needs of a coal-fired CCS plant by 25%-40%. These and other system costs are estimated to increase the cost of the energy produced.

4 Task 4 and Task 5 – Market implementation, Design of a competitive electrical energy market

4.1 General remarks

Along with the beginning liberalisation of the electricity market the unbundling was succeeded especially in the member states of the European Union. That means the absolute monopoly of the integrated compound companies taking responsibility for generation, sales, trading as well as transmission and distribution networks was broken (see Figure 4-1).

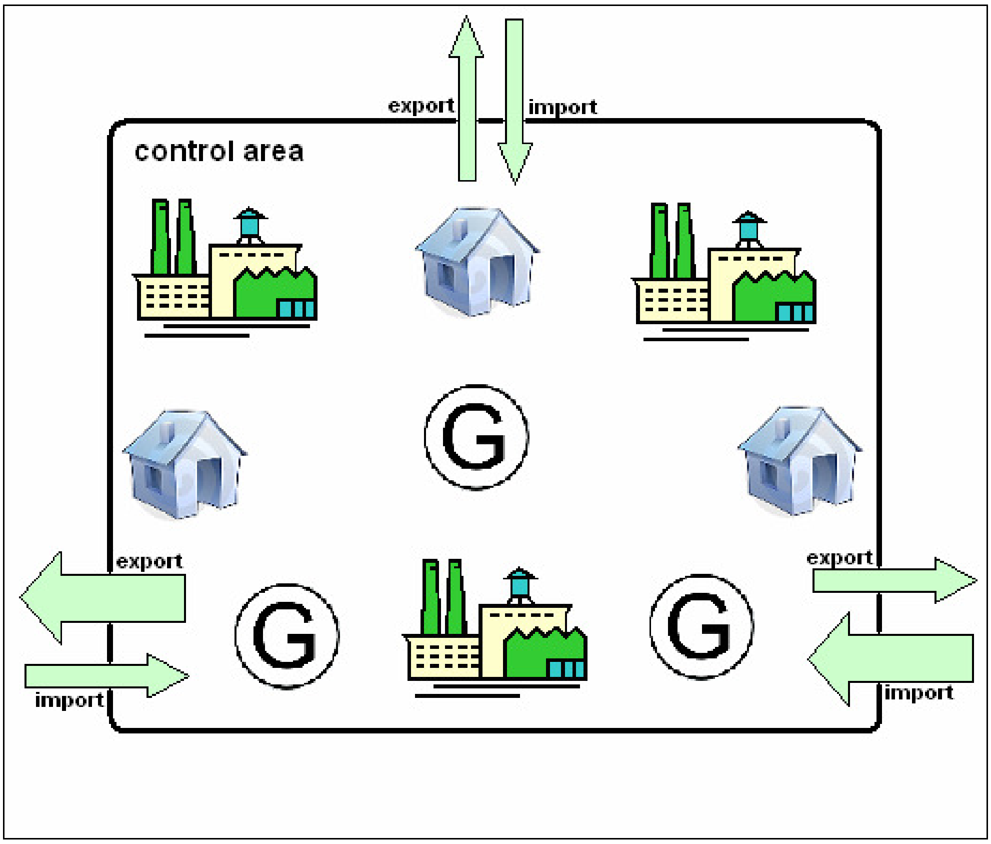

Figure 4-1 Energy market before Unbundling process

The unbundling did change the nature of electrical power supply significantly. Many suppliers and traders do independently place the product of electrical energy on the market. Power generators do offer its products on the independent power market, which are acquired by respective customer groups for their own needs or for resale e.g. to industry or households (see Figure 4-2).

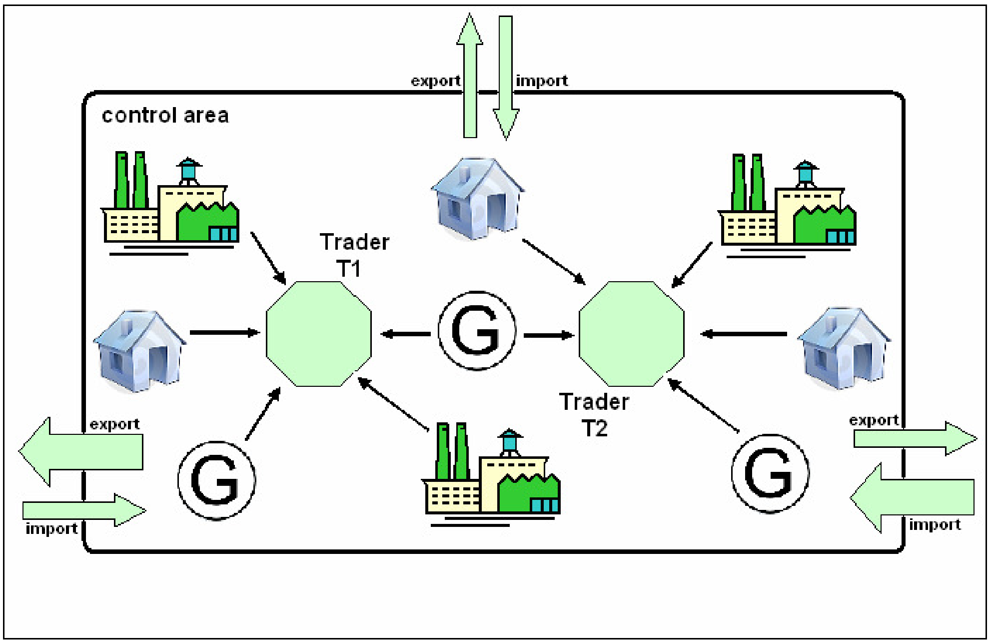

Figure 4-2 Energy market after Unbundling process

Out of this kind of handling of the product electrical energy follows the necessity for establishing of various market portals. These are on the European electricity market among others:

- Control energy market of TSO's for procurement of primary and secondary control power and minute reserve power necessary for system balancing
- OTC-market

- Independent power stock exchange with its products
    - Spot market (day-ahead auction, intra-day-trading)
    - Market for futures (weekly, monthly, quarterly and yearly futures)

For the establishment of a complex regional electricity market in South-East Europe in which Kosovo and Albania are to be involved the mechanisms of the electricity markets already existing should be used and therewith the European energy law and legal framework will be implemented. That means further that an electricity market will be established involving a huge number of market participants (power suppliers and traders) within South East Europe, as any well performing market needs many market participants. Within this study the requirements and the mechanisms of auction of the control energy market and the power exchange will be elaborated.

The liberalisation of the electricity market did require a system ensuring the balance between generation and consumption and therefore the system security even under conditions of a huge number of market participants involved. This means that the differences between power in-feed and power consumption need to be quantifiable, in order to ensure a fair distribution of costs to causers by the TSO. That fact required the necessity to establish the system of balance groups, balance group contracts and balance group responsible parties (see Chapter 4.2.9).

The integration of renewable energy generation units into the electrical energy compound supply system has significant consequences for system security of the transmission network. Based on this fact essential preconditions and requirements for network connection and system management for power generation units will be further described, which should be enforced by the TSO (see Chapter 4.4).

4.2 Control energy market of TSO

4.2.1 Control energy market in Kosovo (in SEE)

A control energy market in Kosovo is still not implemented. Primary and secondary control is mainly realised by Kosovo's power plant operator KEK. Tertiary reserve is not covered by Kosovo's generators. Such services will be provided from generators abroad.

4.2.2 Procurement of control energy in a liberalised energy market

Assuring system stability in their control areas European TSO are obliged to have control power and energy available. Control energy is the most exactly regulated energy product at European Energy Exchange. Control power has to fulfil the following main tasks (see Figure 4-3):

- Primary Control Power (PCP, positive/ negative): It acts for the quick frequency stabilisation after disturbances of power balance between in-feed and load in the European compound operation. PCP is utilised automatically and peripherally plus provided by all countries participating solidarily in the synchronous compound. The amount of the respective share depends on the net energy generation of the country.
- Secondary Control Power (SCP, positive, negative): It acts for the settlement of exchange power to the set points in that control area with the disturbance of power balance. SCP is activated automatically and centrally by a load frequency controller.
- Minute reserve (MR, positive/ negative): It acts for the "removal" and support of SCP. It is activated manually by the responsible TSO.

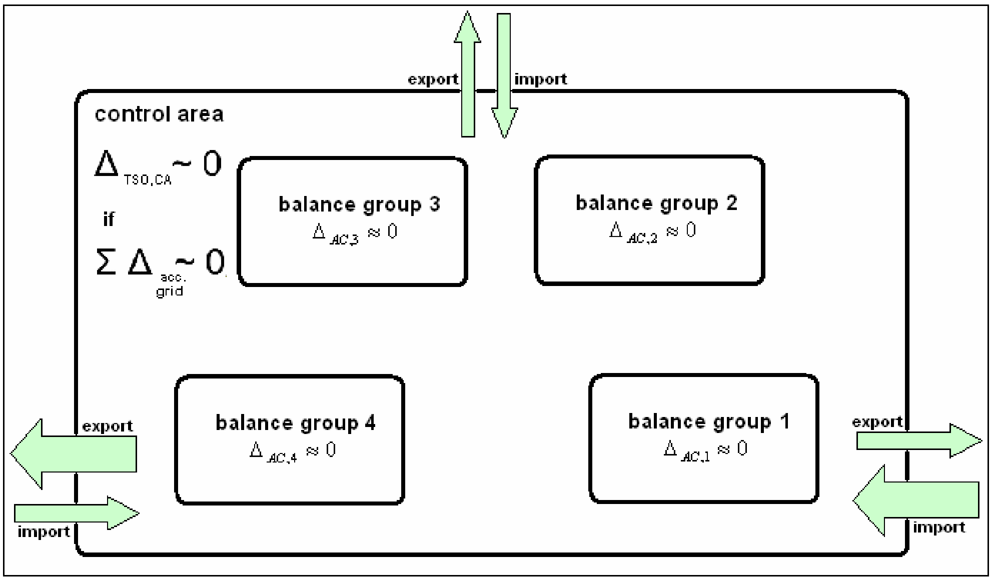

Figure 4-3 Assuring system stability of a control area by utilisation of PCP, SCP, MR and energy exchange

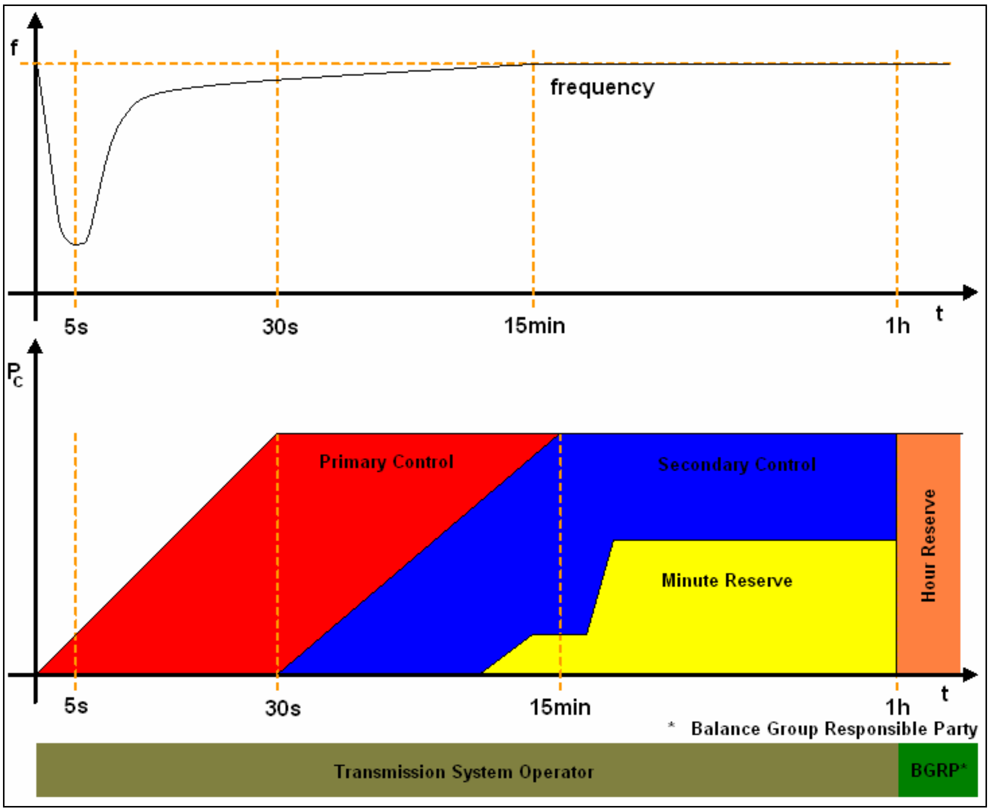

Figure 4-4 Chronology of PCP, SCP and MR utilisation and their influence on frequency behaviour

The chronological sequence of PCP, SCP and MR utilisation is described in Operation handbook [1] of ENTSO-E in detail. Figure 4-4 shows this chronology of activities and the respective responsibilities for procurement and utilisation.

In the following chapters the existing control and compensation energy market is described exemplarily with its different types without giving sample solutions for Kosovo's control energy market. Therefore it is essential to know that German TSO have to handle two control circuits for ensuring of system stability within their responsibility:

- System balancing between generation and demand of energy within the control area, i.e. the TSO assures the compensation of all balancing groups in the control area by utilisation of PCP, SCP and MR as far as these balance groups are not balanced by their respective balance group responsible parties.
- Assuring of system balance of their RES balance group assigned by the legislator

The control power/ energy necessary for system balancing (conventional control) is procured and billed completely separately from RES power reserve. This procedure is necessary for a clear cost allocation of conventional control and RES control costs.

According to statutory provisions (EnWG [13] and StromNZV [14]) the German Grid Agency as national regulator has to set requirements for all TSO for their market operation and ordering of control power (PCP, SCP and MR). The procurement for all 4 TSO is realised within one common tender.

4.2.3 Procurement procedures

4.2.3.1 Procurement of primary control power

The procurement of PCP can take place in a weekly tendering process as in Europe, but all other time cycles are possible, e.g. monthly. The product PCP is tendered by means of a power price and a product. The determination of a minimum volume, e.g. 1MW, is recommendable. Table 4-1 contains exemplarily for the period 2012-02-06 to 02-12 the total demand for PCP of all German TSO structured into one product.

Product	Total demand Germany [MW]
NEGPOS_00_24	527

Table 4-1 Demand of Primary Control Power of all German TSO for the timeframe 2012-02-06 to 2012-02-12; [15]

4.2.3.2 Procurement of Secondary Control Power

The procurement of SCP can take place in a weekly tender separated into negative and positive SCP plus into high (HT) and low tariff (NT). So, four products are offered with a power price (primarily relevant for the placing of an order):

- Product 1: negative SCP – HT
- Product 2: positive SCP – HT
- Product 3: negative SCP – NT
- Product 4: positive SCP – NT

The minimum volume should be determined in advance, e.g. 5MW. Table 4-2 shows exemplarily for the timeframe 2012-02-06 to 02-12 the demand of all TSO separated to the 4 mentioned products.

Product	Total Demand [MW]	Demand of Secondary Control Power [MW]			
		50Hertz	Amprion	TenneT	Transnet BW
NEG_HT	2,114	447	748	625	294
NEG_NT	2,114	447	748	625	294
POS_HT	2,084	448	697	561	378
POS_NT	2,084	448	697	561	378

Table 4-2 Demand of Secondary Control Power of all German TSO for the timeframe 2012-02-06 to 2012-02-12; [15]

4.2.3.3 Procurement of Minute Reserve

Minute Reserve should be tendered every day, divided into positive and negative MR plus 6 4-h-blocks, i.e. 12 products following that example in Table 4-3:

Name	Period	Neg/Pos	Name	Period	Neg/Pos
Product 1	00:00-04:00	negative	Product 7	00:00-04:00	positive
Product 2	04:00-08:00		Product 8	04:00-08:00	
Product 3	08:00-12:00		Product 9	08:00-12:00	
Product 4	12:00-16:00		Product 10	12:00-16:00	
Product 5	16:00-20:00		Product 11	16:00-20:00	
Product 6	20:00-24:00		Product 12	20:00-24:00	

Table 4-3 Example for MR product structure

In Table 4-4 an example (2012-02-08) for the total amount of MR of all German TSO separated into 12 products is depicted. The vendors have to offer like with PCP and SCP a power price (primarily placing relevant) and an energy price. Again a minimum volume (e.g. 15MW) should be determined.

Product	Total Demand [MW]	Overall share [MW]
NEG_00_04	2,158	2,158
NEG_04_08	2,158	2,158
NEG_08_12	2,158	2,158
NEG_12_16	2,158	2,158
NEG_16_20	2,158	2,158
NEG_20_24	2,158	2,158
POS_00_04	1,737	1,737
POS_04_08	1,737	1,737
POS_08_12	1,737	1,737
POS_12_16	1,737	1,737
POS_16_20	1,737	1,737
POS_20_24	1,737	1,737

Table 4-4 Demand of Minute Reserve Control Power of all German TSO for the 8th of February 2012; [15]

4.2.4 Prequalification and tendering processes

4.2.4.1 Prequalification

Potential vendors (power plants, traders etc.) for the different forms of control power/ energy can participate in a prequalification process providing the evidence of fulfilling the requirements necessary for system balance. Besides technical competences the correct and proper provision of control power under normal, operational conditions and the economical capability have to be guaranteed. The prequalification process has to take place in that control area the concerning technical unit (TU) is connected to (connection-TSO). After successful prequalification the prequalified TU receives a corresponding prequalification confirmation from the connection-TSO that will be accepted by all German TSO as evidence of a successful prequalification. For TUs procuring and providing SCP the vendor has to install a control system connection to the load frequency controller of that TSO he wants to offer the SCP.

Following that process a frame contract separated per type of control power between the vendor and the regarding TSO has to be concluded as a prerequisite for participation in tendering of control power. After a successful tendering and the confirmation by the TSO the vendor is obliged to make its control power in the contractually concluded timeframe available. The TSO refunds the control power available with a power price for both positive and negative control power. After the demand of shares or the complete power, the TSO refunds the generated energy with an energy prices agreed during the tendering process.

4.2.4.2 Provision of primary control power

The provider of PCP has to guarantee on the one hand that its offered control range per TU amounts to at least ±2% of its rated power but minimum ±2MW. On the other hand it has to be ensured that the control range is higher than the measurement tolerances and sensitivity ranges plus measurable with the existing instruments. The prequalifying party submits the adjustable control band available in the regarding TU. The offered primary control power has to be activated within 30s and available for 15min at every quasi-stationary frequency deviation of ±200mHz. The TSO refunds the power provision by the power price set in the tender (see Table 4-5).

Product	Power price [€/MW]	Tendered Power [MW]	Acceptance
NEGPOS_00_24	2,304	5	Yes
NEGPOS_00_24	2,312	5	Yes
NEGPOS_00_24	2,320	5	Yes
NEGPOS_00_24	2,328	5	Yes
NEGPOS_00_24	2,332	7	Yes
NEGPOS_00_24	2,304	5	Yes
NEGPOS_00_24	2,312	5	Yes
NEGPOS_00_24	2,320	5	Yes
NEGPOS_00_24	2,328	5	Yes
NEGPOS_00_24	2,332	7	Yes
NEGPOS_00_24	2,332	6	Yes
NEGPOS_00_24	2,333	5	Yes
NEGPOS_00_24	2,333	7	Yes
NEGPOS_00_24	2,333	7	Yes
NEGPOS_00_24	2,335	6	Yes

Table 4-5 Results of tendering positive/ negative PCP in the time period 2012-02-06 to 02-12; [15]

Table 4-6 shows medium and limit power prices for PCP in the same time-frame.

Product	Medium Power Price [€/MW]	Limit Power Price [€/MW]
NEGPOS_00_24	2,349.20	2,400.00

Table 4-6 Medium and Limit Power Prices for Primary Control Power in the timeframe 2012-02-06 to 2012-02-12; [15]

4.2.4.3 Provision of secondary control power

Due to design related, different technical possibilities a distinction between hydro and thermal power units concerning SCP provision has to be done:

- Thermal power units providing SCP during the contracted product timeframe have to be connected to the grid synchronously rotating and ensuring power delivery
- Hydro power units being able to start-up and deliver the contracted, prequalified SCP within maximum 5 minutes plus sticking to power gradients of 2% of rated power can remain in standstill but operable on responsibility of the vendor. Nevertheless the TSO can instruct a rotating provision.

The respective vendor has to describe the concept of implementation of its technical units into vendor's central grid control and into the secondary control circuit of the TSO under consideration of technical and organisational minimum requirements stated in the prequalification papers. The vendor submits this concept to the TSO within the prequalification process. For the single selection at least the following information per TU have to be provided online:

- Actual generation values per single TU
- Actual set point per single TU
- Delivered SCP per single TU
- Status information “Secondary Control ON/ OFF) per single TU
- Power range with maximum and minimum limits of the actual available SCP control band per single TU
- SCP requirement (set point) by TSO
- ¼-h-values of the set point for load covering per single TU

The TSO refunds the SCP with a power price for both positive and negative SCP. After the demand of shares or of the complete power, the TSO refunds the generated energy with an energy price agreed during the tendering process. Table 4-7 shows medium and limit power prices of negative and positive SCP in high and low tariffs respectively. In Table 4-8 examplarily single offers including power and energy prices are depicted.

Product	Medium Power Price [€/MW]	Limit Power Price [€/MW]
NEG_HT	723.75	1,378.00
NEG_NT	10,867.02	17,989.00
POS_HT	3,875.14	3,984.00
POS_NT	3,495.38	5,617.00

Table 4-7 Medium and Limit Power Prices for Secondary Control Power in the timeframe 2012-02-06 to 2012-02-12; [15]

Product	Power Price [€/MW]	Energy Price [€/MWh]	Offered Power [MW]	Acceptance of Bid
NEG_HT	350	0	10	yes
NEG_HT	362	5	10	yes
NEG_HT	374	8	20	yes
NEG_HT	377	27	5	yes
NEG_HT	386	10	15	yes
POS_HT	24	90.04	28	yes
POS_HT	27	94.30	5	yes
POS_HT	29	99.68	28	yes
POS_HT	30	94	5	yes
POS_HT	30	105	5	yes
POS_HT	34	92.48	28	yes
POS_NT	294	300	25	yes
POS_NT	294	330	5	yes
POS_NT	295	163.70	60	yes
POS_NT	295	329.30	70	yes
NEG_NT	1,521	6.90	50	yes
NEG_NT	1,522	6.90	50	yes
NEG_NT	1,522.50	6.90	40	yes
NEG_NT	1,523	6.90	40	yes

Table 4-8 Tender results for Secondary Control Power; [15]

4.2.4.4 Provision of minute reserve

The vendor of MR has to state the place of fulfilment with the belonging connection-TSO for every single TU used for provision and procurement of MR. For TU not directly connected to the grid of the connection-TSO additionally all participating system operators (mainly DSO) need to be mentioned. Every vendor has to deliver MR in full amount for every prequalified TU within 15 min after demand by telephone call. After completion of the requirement the MR has to be reduced within 15 min. The energy availability of MR has to amount to 100% during the total offer timeframe. Possible energy restrictions of every single TU for the provision of MR have to be submitted to the TSO.

The tendering process is realised in 6 time slices per 4 hours. The TSO refunds the MR with a power price for both positive and negative MR. After the demand of shares or of the complete power, the TSO refunds the generated energy with an energy price agreed during the tendering process (see Table 4-9). In Table 4-8 exemplarily single offers including power and energy prices are depicted. The utilisation of MR confirmed within the tendering process is realised by the chronology of orders by the TSO increasingly sorted by the energy price.

Product	Medium Power Price [€/MW]	Limit Power Price [€/MW]
NEG_HT	523.61	582.00
NEG_NT	1,395.51	1,525.00
POS_HT	113.10	589.00
POS_NT	288.75	300.00

Table 4-9 Medium and Limit Power Prices for Minute Reserve Power in the timeframe 2012-02-06 to 2012-02-12; [15]

Product	Power Price [€/MW]	Energy Price [€/MWh]	Offered Power [MW]	Acceptance of Bid
NEG_00_04	4.80	89	15	yes
NEG_00_04	4.80	510	20	yes
NEG_00_04	4.99	38	10	yes
NEG_04_08	6.50	6.20	15	yes
NEG_04_08	6.50	6.20	15	yes
NEG_04_08	6.50	6.20	16	yes
NEG_08_12	0.114	0.11	10	yes
NEG_08_12	0.115	0.11	10	yes
NEG_08_12	0.115	0.11	10	yes
NEG_12_16	0.11	11	15	yes
NEG_12_16	0.11	11	25	yes
NEG_12_16	0.11	11	15	yes
NEG_16_20	0.103	0.11	10	yes
NEG_16_20	0.103	0.11	10	yes
NEG_16_20	0.103	48.52	40	yes
NEG_20_24	0.01	0.11	10	yes
NEG_20_24	0.011	10.27	40	yes
NEG_20_24	0.012	0.11	10	yes
NEG_20_24	0.05	89	15	yes
NEG_20_24	0.05	840	10	yes
NEG_20_24	0.052	247	10	yes

Table 4-10 Tender results for Minute Reserve Power; [15]

4.2.5 Total process of procurement of control power and energy

The procedure for procurement of the different types of control energy from prequalification up to billing process is shown in Figure 4-5.

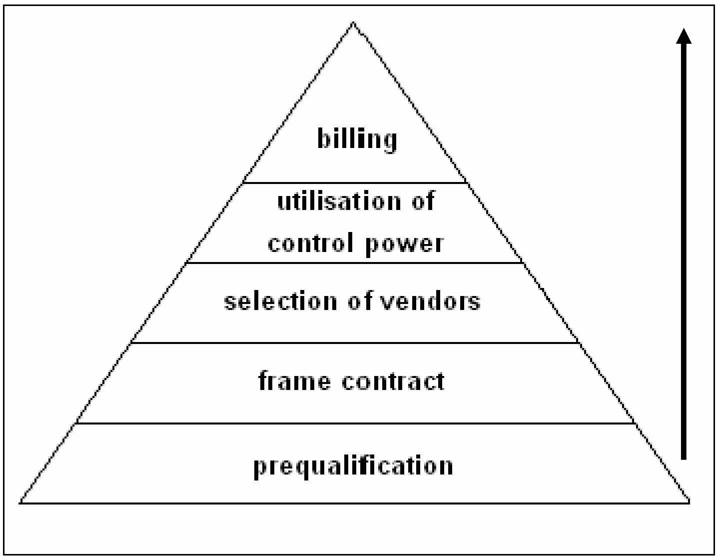

Figure 4-5 Procedures for procurement of control energy

In case that the system balance cannot be ensured by utilisation of tendered secondary control and minute reserve, the German TSOs use the Energy Stck Exchange EEX for procurement of additional negative or positive control energy for balancing of the total balance groups located in their control area including of the renewable energy balance group. This procedure is exemplary shown for the RES balance group in Figure 4-6.

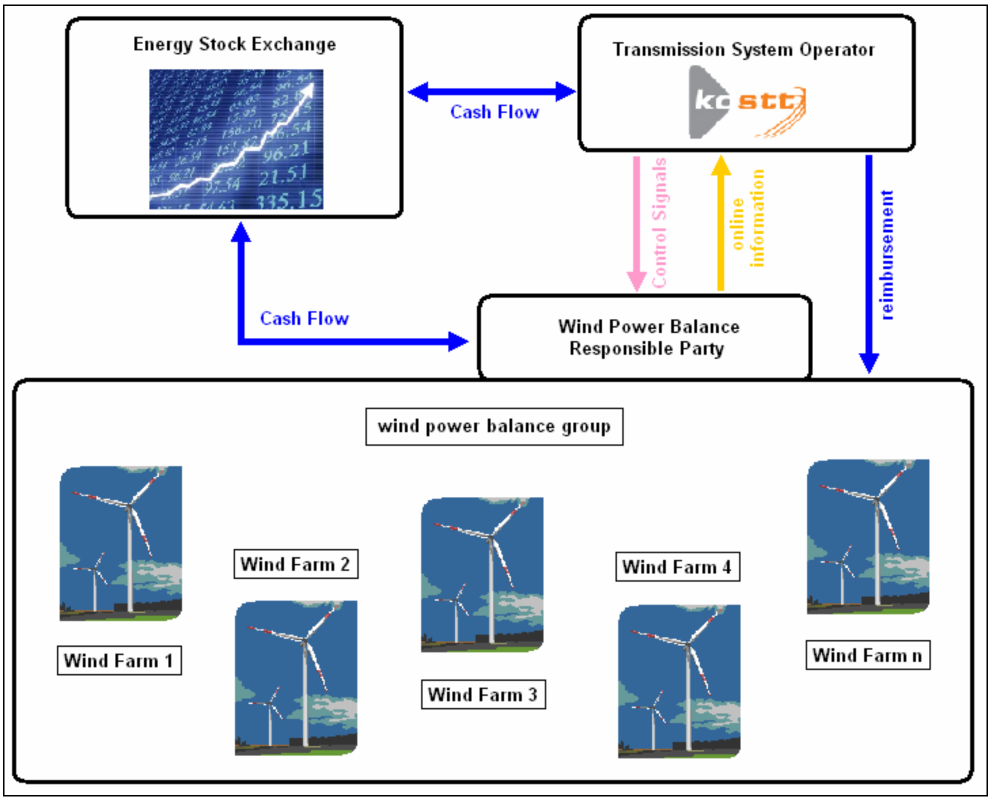

Figure 4-6 Procurement of compensation energy for RES balance group at energy stock exchange

4.2.6 Joint utilisation of control power within a synchronous compound operation

In order to avoid that several TSO do control against each other and for reduction of secondary control and minute reserve needed the joint dimensioning and mutual temporary help between the TSO has proven to be very useful. Furthermore cost optimisation can be achieved for all TSO involved by mutual utilisation of Merit-Order-Lists and the related coordinated use of secondary power and minute reserve.

The example in Figure 4-7 shows that in case of lack of secondary control power of -10MW in control area 1 and a simultaneous surplus of secondary control power of +6MW in control area 2 the surplus of control power in control area 2 can be used to overcome the lack of control power in control area 1. Therefore it is necessary to realise the provision of the respective actual values to ensure that both load frequency controllers get a correction signal and therewith the activation of secondary control power at load frequency controller of control area 1 will be reduced by 6MW as per example.

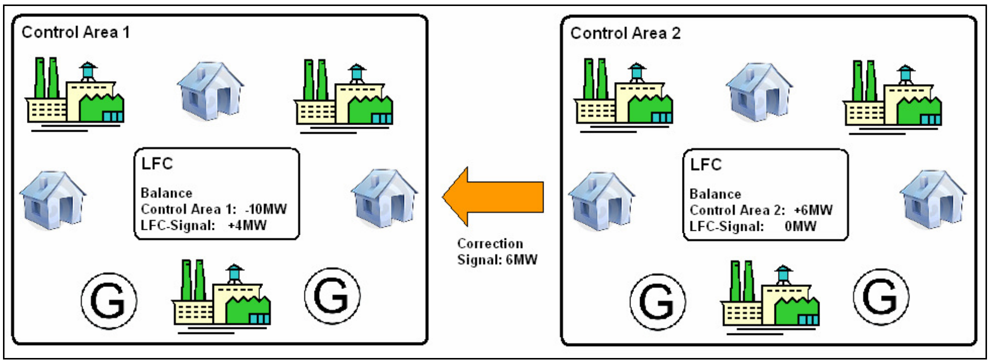

Figure 4-7 Coordinated utilisation of secondary control power in case of simultaneous surplus and lack in several control areas; Option 1

A further option of coordinated utilisation of secondary control power is to be seen in Figure 4-8. In this case a mutual support regarding secondary control power takes place that way that the demand of secondary control power in one control area (control area 1) exceeds the amount available.

Both options can also be used together. In this case a linkage between control areas 1 and 2 takes place in a first step, i.e. control area 1 gets energy from control area 2. After that control area 1 has to compensate the remaining difference. If no sufficient control power will be available in control area 1 (limit reached), available control power will be activated in control area 2 and delivered to control area 1 using the actual value signal interchange (see Figure 4-9).

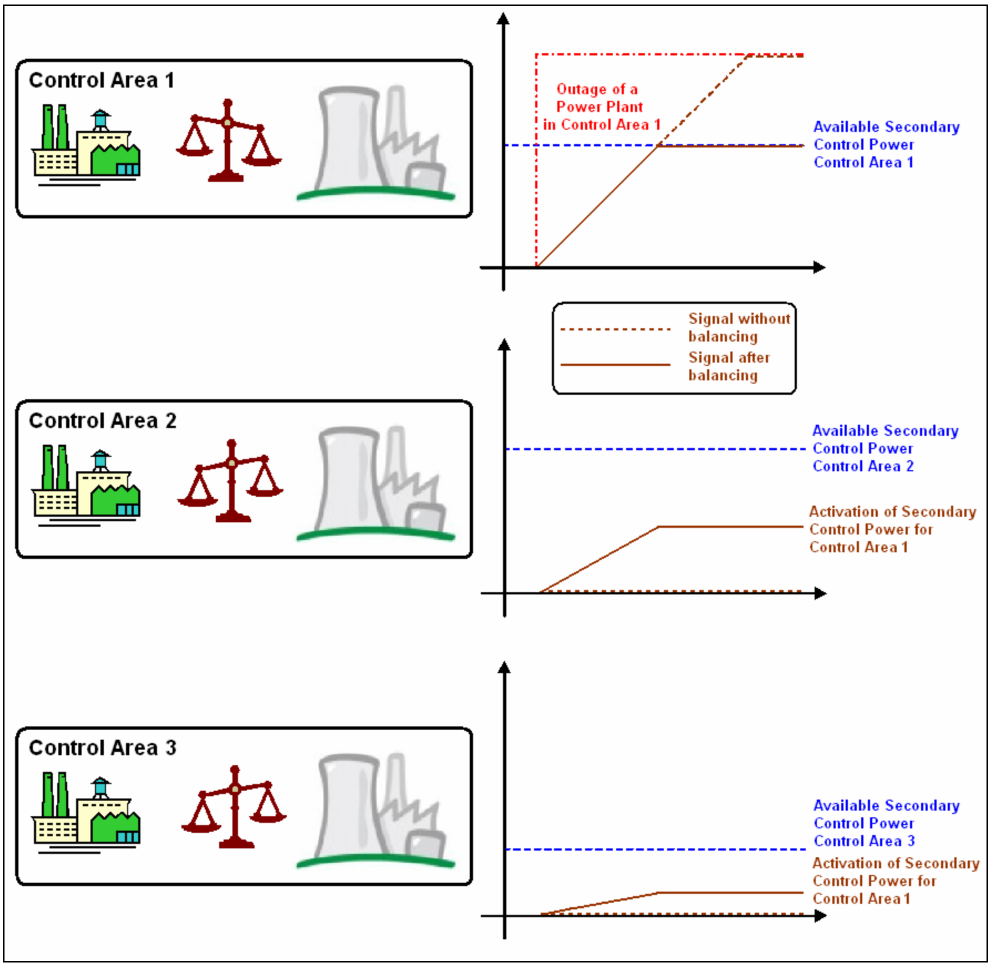

Figure 4-8 Coordinated utilisation of SCP; Option 2

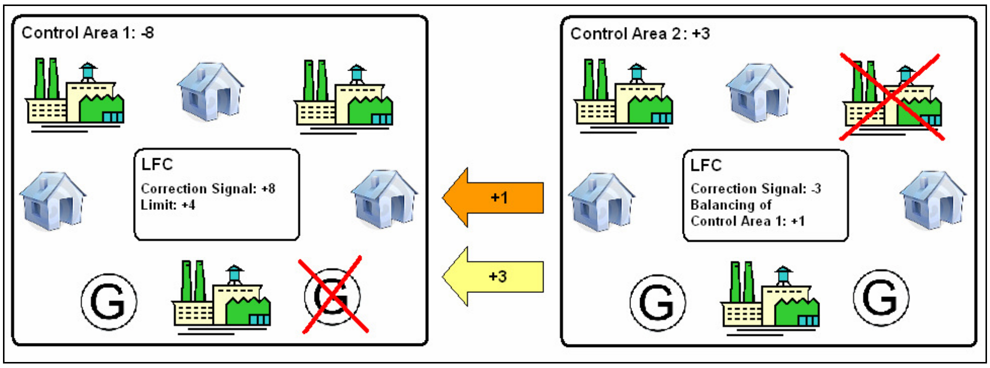

Figure 4-9 Joint utilisation of options 1 and 2; [16]

4.2.7 Billing of exchanged energy

The coordinated utilisation of secondary control power and minute reserve power requires a respective billing process for energy amounts interchanged in order to ensure respective harmony and balance (see an example in Figure 4-10). The billing is done based on avoided activation of control power (opportunity costs).

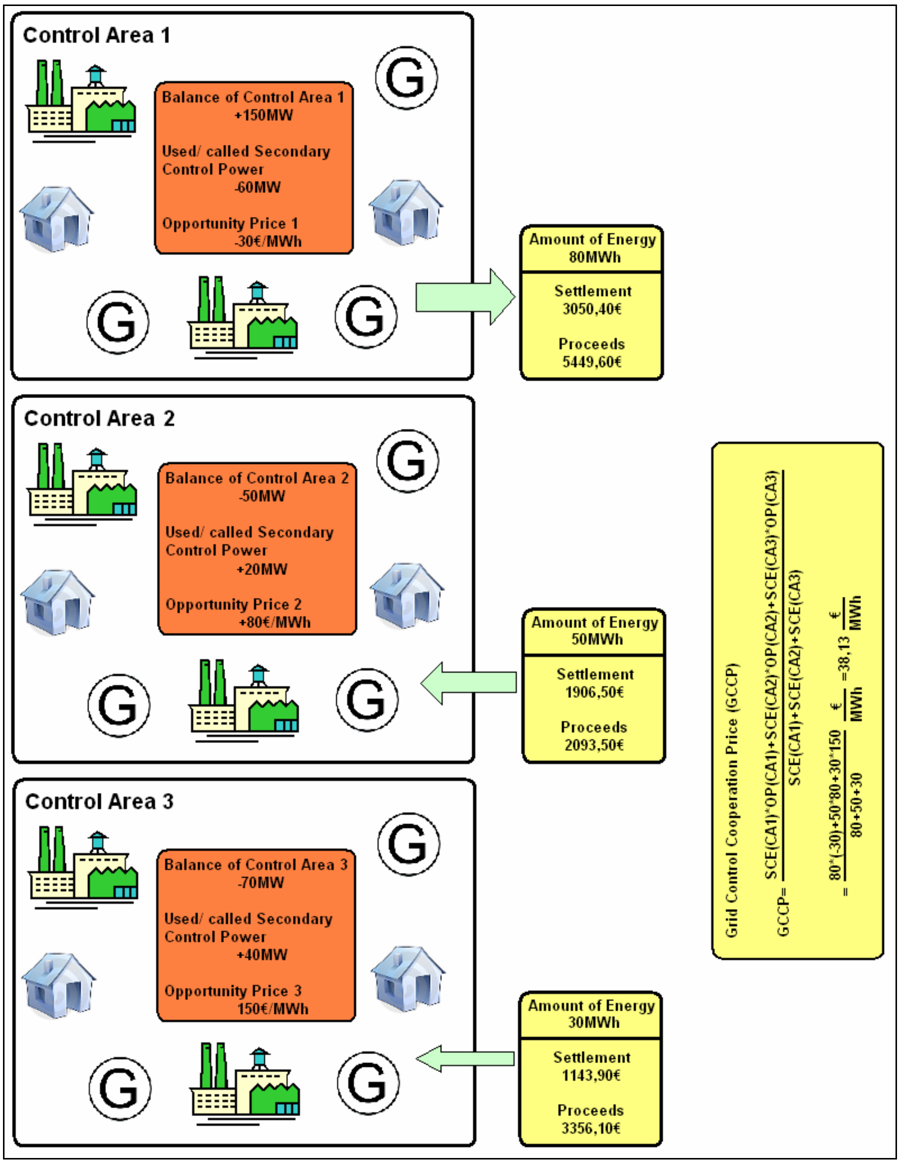

Figure 4-10 **Billing of exchanged energy**

4.2.8 International outlook

The TSO’s involved in the network control cooperation reached a significant saving effect for procurement and utilisation of secondary control power. Furthermore less control power transfers are necessary within the network to ensure the required system balance.

The results achieved in Germany with the coordinated utilisation of secondary control power caused to happen that TSO’s from Denmark, Netherlands, Belgium and Switzerland have expressed their interest to take part in the network control cooperation and already joined this cooperation. Further negotiations for participation are started with the Czech TSO CEPS. The first phase of participation foresees the utilisation of the module 1 “avoidance of control against each other”.

However existing bottlenecks between the TSO’s involved can lead to limitations for the network control cooperation, since the TSO’s are currently not willing to keep transmission capacities for the network control cooperation. In such cases exclusively free capacities on the existing bottlenecks can be used, which is not contracted for other reason. Nevertheless it remains as a fact that the utilisation of the network control cooperation can save control energy.

Therefore a Europe wide utilisation even within regions is a contribution for a common European energy policy and does require the utilisation of potential of all TSos participating in the network control cooperation.

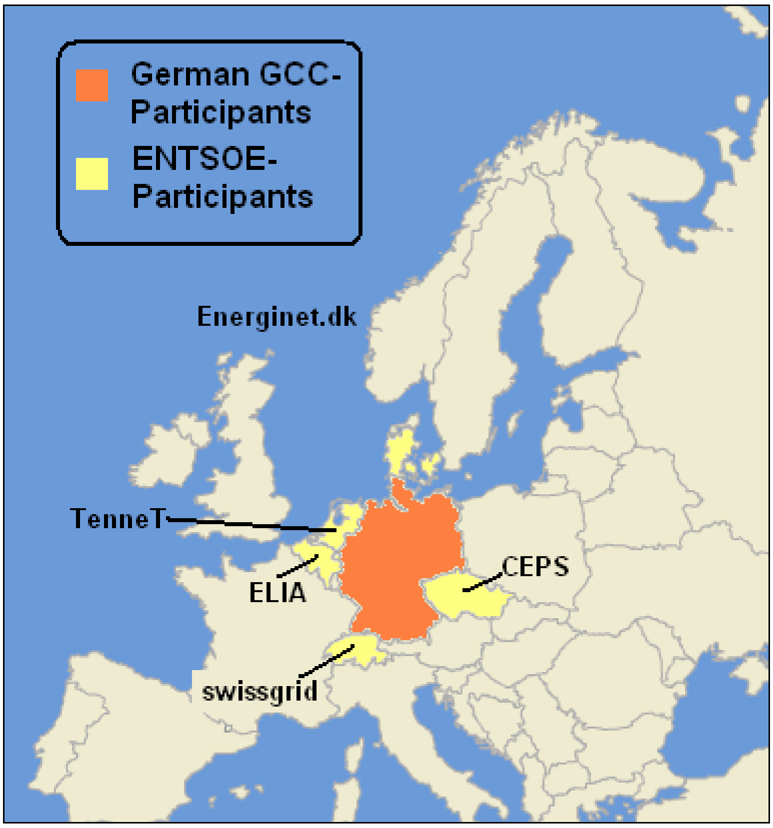

Figure 4-11 Utilisation and extension of the network control cooperation; [16]

4.2.9 Balance group management

4.2.9.1 General remarks

The balance group management is characterized by assigning an independent balance group to every market participant (balance group responsible party) who can be a generator, trader or supplier of electrical energy. The balance group responsible party is obliged to create a power schedule based on a time frame ($^1/_4$-, ½ - or 1- hour) one day ahead and to submit this schedule to the TSO to date being agreed with the TSO, as well.

The daily date of submission shall be selected in a way to give enough time to the TSO to create the overall plan for the following day. Times between 11 a.m. and noon have proven to be adequate. The balance group responsible party is in charge of balancing the differences between the power schedule and the real physical in-feeds and out-feeds of its balance group (see chapter 4.4.5, especially Figure 4-35).

Therefore the balance group responsible party uses contracted generator capacities. In order to determine the costs for this power necessary for balancing the balance group it is necessary to establish a system considering these circumstances. Power schedules and the related physical in-feeds and out-feeds need to be allocated to each other for each ¼-, ½- or 1- hour value for necessary billing of balance groups and creation of allocation of costs. That process guarantees the determination of deviations to schedule for every balance group.

That means hourly values for forecasted power in-feed [MW] schedules including energy amounts [MWh] and real physical in-feeds [MW] schedules including energy amounts [MWh] are mandatory for reliable performance of a revision safe billing process.

A causer equitable allocation of costs for control energy to the balance group responsibles (market participants) is only possible by establishing a respective balance group management. The following pre-conditions need to be implemented:

- Signing of balance group contracts
- Respective hard- and software solutions

4.2.9.2 Balance group contract

The contract for establishment of a balance group within the control area of KOSTT shall include the following aspects:

- Processing of energy schedules to other or from other balance groups
- Balancing of remaining deviations of the balance group by KOSTT
- Rules and regulations for handling of balance group balancing and balance group execution, e.g. for data interchange, power deliveries and billing of the balance group
- Rights and duties of the balance group responsible and the TSO KOSTT in relation to the balance group

The following conditions shall be clarified within a balance group contract:

- Definition of pre-conditions for establishing a balance group
- Definition of the balance group
- Duties and obligations of the balance group responsible
- Duties and obligations of the TSO KOSTT
- Cross border transactions and Congestion Management(CM)
- Implementation of legal rules
- Operational handling of schedules for in-feed of the balance group
- Handling for schedule changes
- Metering and measurement value detection
- Billing of the balance group
- Payment conditions
- Financial standing and security services
- Regulations for handling of faults with impact on handling the balance group contract
- Consideration of economic clauses, confidentiality, data protection, contract duration, regulations for abrogation of contract, etc.

4.2.10 Conclusion

The reservation of a sufficient amount of control energy by the TSO within the control area, the TSO is responsible for, is mandatory for system security of the national network as well as of the synchronous connected European networks.

The frame conditions for the necessary amount of control power and the controllability follow from Operation Handbook (OH) of ENTSO-E and the additional national regulations to be determined. It can be experienced that the frame conditions for the control energy market are more and more regulated by the EU and by national regulation authorities.

It is very important for a functioning control energy market to have a sufficient market depth, i.e. to have a huge number of market participants involved. The network control compound (chapter 4.1.6), which is gaining more and more acceptance all over Europe, is an innovative concept for necessary cost reduction in terms of reservation and utilisation of control power and control energy.

The concept of an international control energy market should be basically considered when establishing new control energy markets. The establishment of a joint control energy market consisting of Kosovo and Albania only might be not sufficient considering the requirements currently valid. Therefore it is highly recommended to form an entire control energy market all over South-East-Europe.

The establishment of a control energy market „Kosovo-Albania“ could be an initial step provided that respective necessary preconditions are available. Therefore it is either necessary to find the respective bidders and potential sellers of control power or to establish them on the market.

Under conditions of a liberalised power market a balance group management is considered to be necessary in order to ensure a definite allocation of costs accruing at KOSTT for control energy to the several market participants, a very practical solution with good experiences in the EU.

The implementation of necessary legal, technical and economical frame conditions is mandatory for a functional control energy market and the related necessary system security of national and international networks.

4.3 The Energy Exchange within a liberalised energy market

4.3.1 The European Power Market

Starting with the liberalisation of the European power market long term power delivery contracts were more and more substituted by short term delivery contracts. Therefore power and power future exchanges were established. The Scandinavian power market (Denmark, Sweden, Norway and Finland) was already liberalised in 1993 when the first European power exchange NordPool was established. The Amsterdam power exchange (APX) was established in 1999 followed by the European Energy Exchange (EEX) in Frankfurt and the Leipzig Power Exchange (LPX) in 2000. EEX and LPX did merge in 2002 forming the biggest power exchange in Europe EEX located in Leipzig. With the liberalisation of the Austrian power market the Energy Exchange Austria (EXAA) was formed in 2001.

In the meantime many power exchanges do exist on the European power market having very different trading volumes. Scandinavian power exchange NordPool was the market leader until 2010, but was ousted from its leading position by the Leipzig stock exchange EEX. EEX reached its position due to its European orientation and cooperation with other European exchanges. Further power trading places in Europe are (Figure 4-12):

- Amsterdam Power Exchange (APX) – Netherlands
- Borzen Power Market Operator (BPMO) – Slovenia
- Energy Exchange Austria (EXAA) – Austria
- Gestore del Mercato Elettrico (GME) - Italiy
- Nordic Power Exchange (NPPEX) – Scandinavia
- Operador del Mercado Eléctrico (OMEL) – Spain
- Polish Power Exchange (PolPX) - Poland

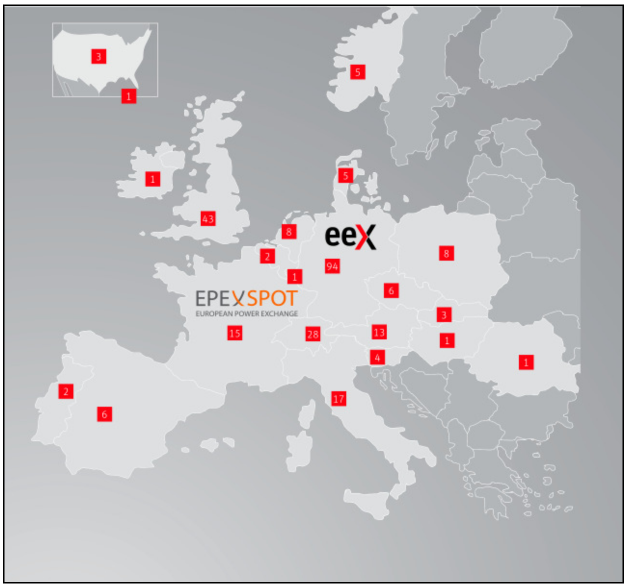

Figure 4-12 Trading sites of Energy Exchanges in Europe; [17]

One example for the European orientation of power exchanges is the unification of Spot and future markets of European Energy Exchange AG (EEX) and Powernext SA in November 2009. Therefore the two subsidiary companies EPEX Spot SE (for Spot-market) and EEX Power Derivatives (for future market) were founded.

Under these circumstances it was of significant importance for the European power market that EEX AG has transferred its clearing activities already in 2006 to a subsidiary company called European Commodity Clearing AG (ECC). ECC takes over this task for other European power exchanges.

Besides trades at energy exchanges there is another marketplace, the so-called Over-the-counter (OTC). So, the wholesale market for the product energy is combined out of the exchange and the OTC market (see Figure 4-13).

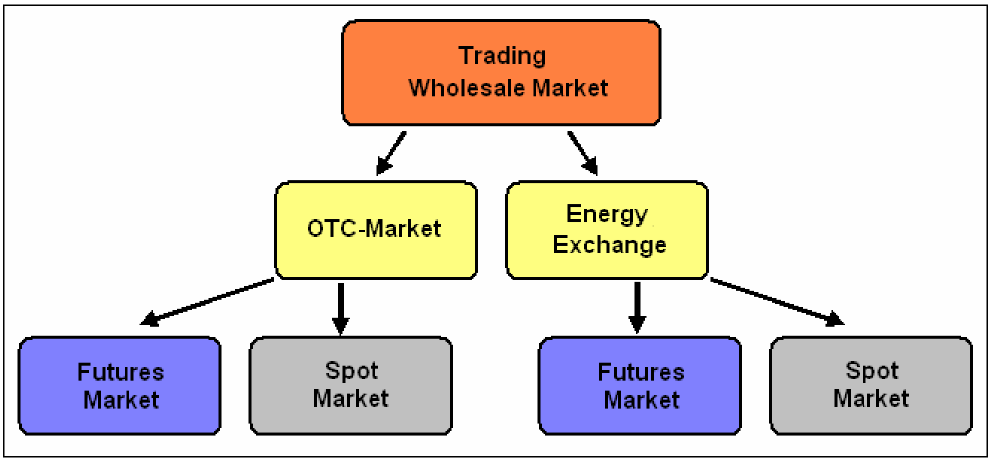

Figure 4-13 Wholesale Energy Market

4.3.2 Energy Exchange in Kosovo (in SEE)

Kosovo's energy market is characterised by deficits especially with the covering of peak load and the outage of generation in TPP Kosovo A or B. So, meeting the demand implies imports necessary that are not realised by an exchange but by bilateral agreements with neighboured TSO. Approaches for short and medium term implementations of an energy market in Kosovo are described in the draft of "Market Rules" by KOSTT from May 2012 [18]. As per Figure 4-14 the designed scheme describes exclusively an OTC- market on that future products are traded. That means for the first stage that an implementation of a spot market or an energy exchange is not foreseen.

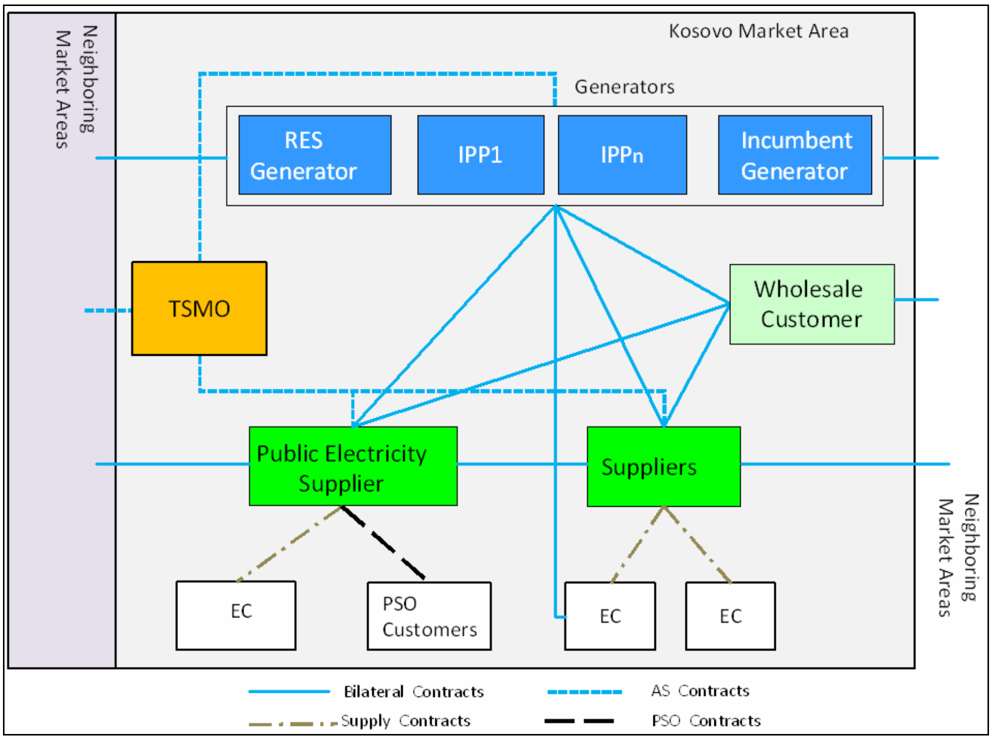

Figure 4-14 Market Scheme Kosovo; [18]

4.3.3 Energy Trades at Energy Exchange (EEX Derivatives Market)

4.3.3.1 General issues

The behaviour of electricity customers is time-wise different and characterised by so-called load profiles. Using respective procurement strategies the responsible power trader does supply the customers demand. Therefore different power products are available for power traders at the exchange to meet the load profile requirements. Figure 4-15 and Figure 4-16 show possible procurement strategies for industrial customers.

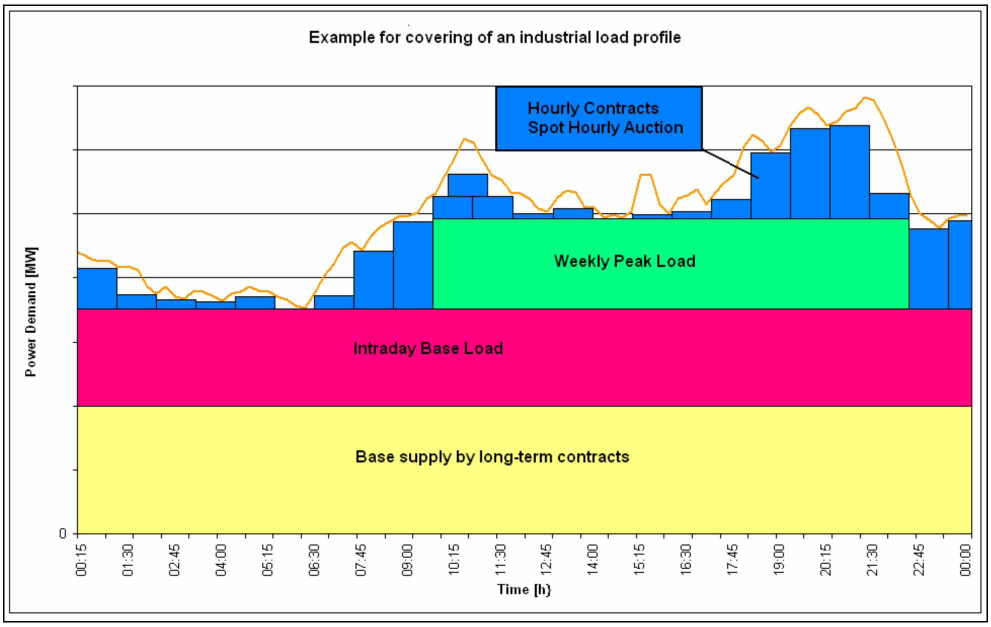

Figure 4-15 Supply of an industrial load profile (option1)

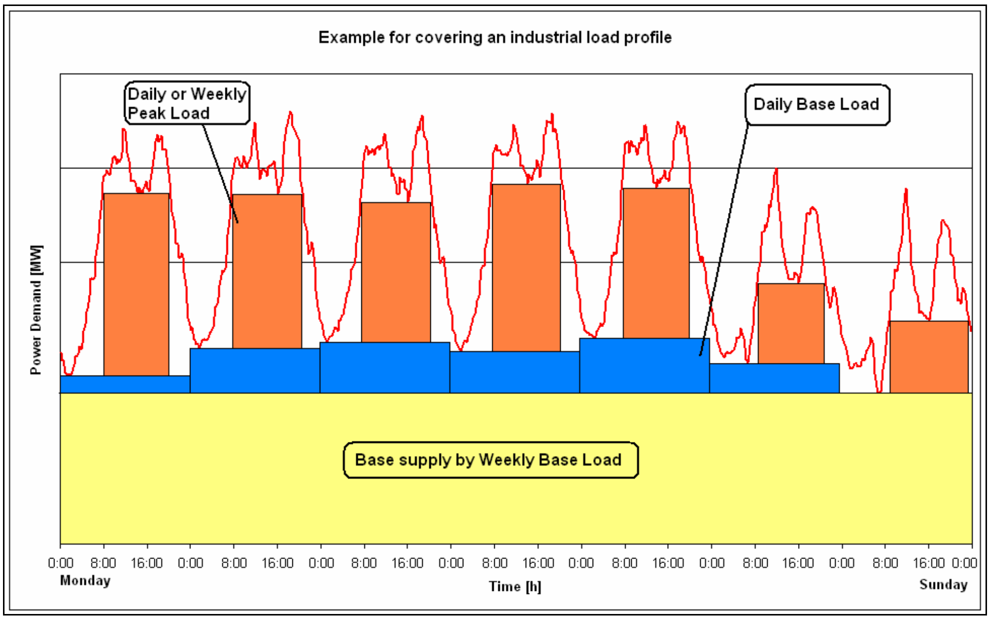

Figure 4-16 Supply of an industrial load profile (option 2)

Based on the power plant portfolio available at the power market several marketing alternatives for power products arise (see Figure 4-17):

- Future and option market
- Spot market
- Control energy market

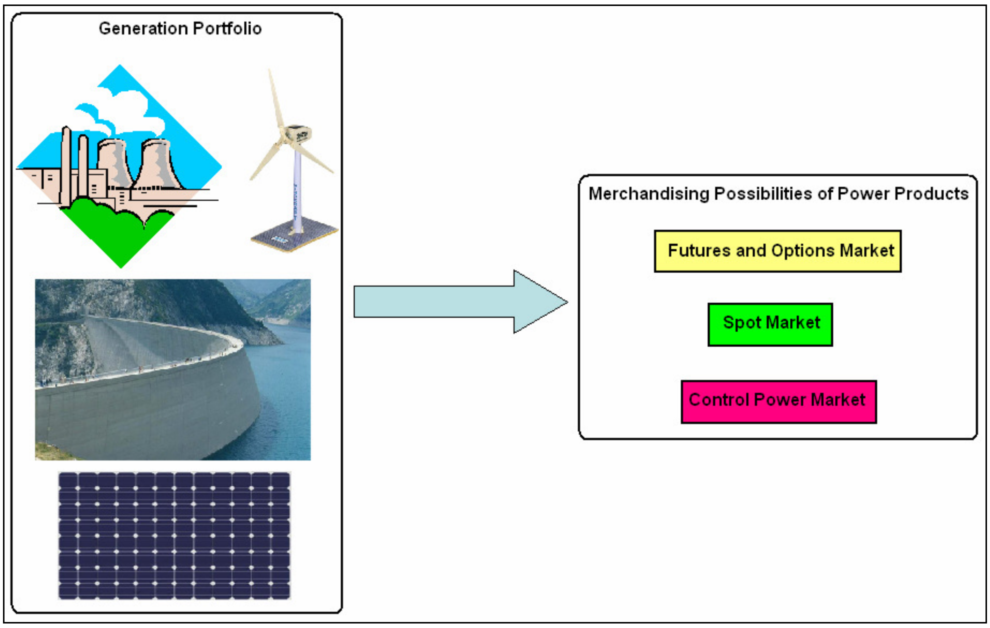

Figure 4-17 Power products and their marketing options

Within the following considerations the market mechanisms of Spot, Future and Option Market will be described. Figure 4-18 shows in a simplified manner the scheme of a power market.

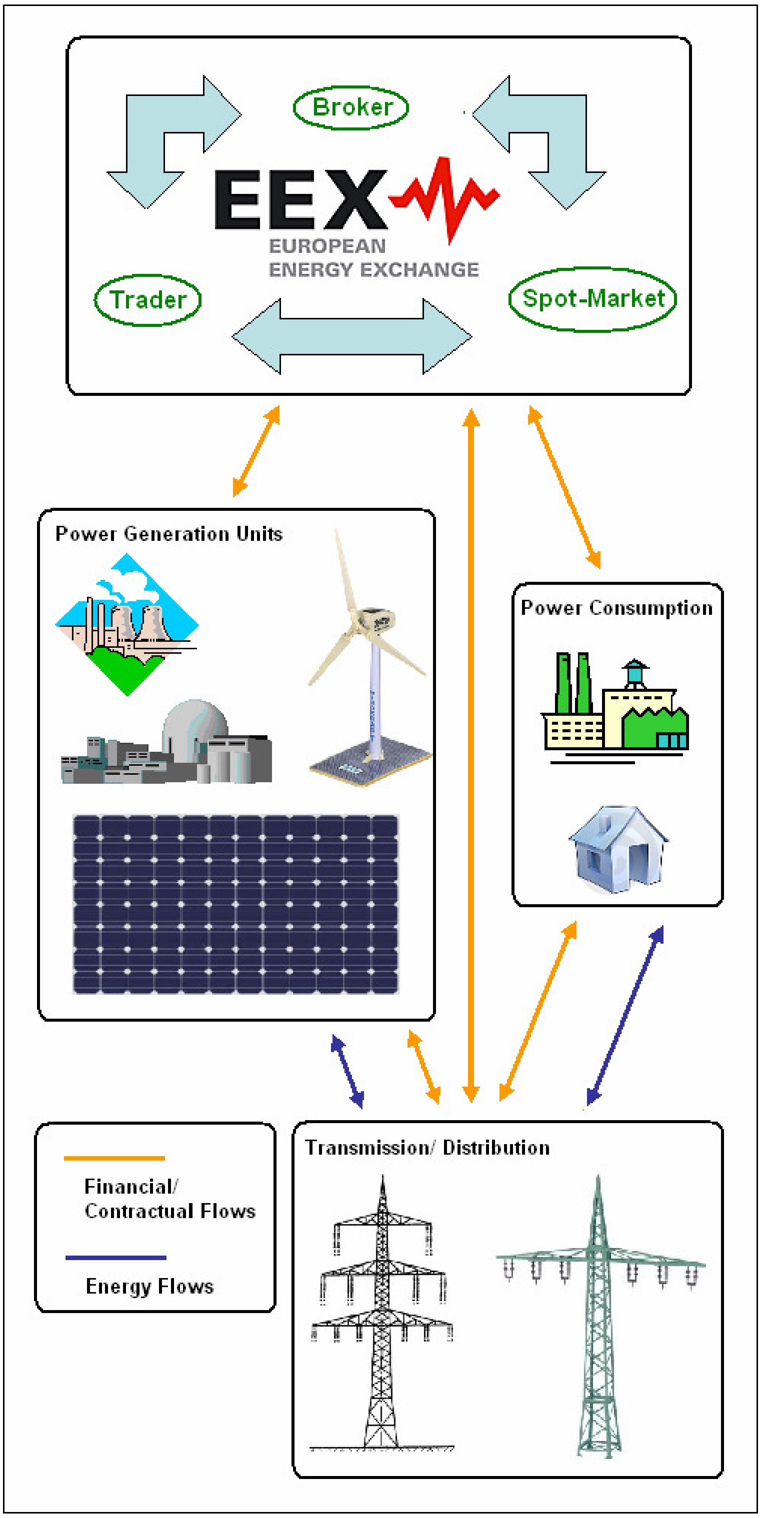

Figure 4-18 Scheme of a power market

4.3.3.2 Products at EEX Derivatives Market

The integration of the European power spot markets has significant progress within the last years. This became possible due to the trusting relationship between the power spot markets and their participants. But it needs to be mentioned, that the success at the power spot markets does attract imposters, who try to misuse the power market and get influence to the power prices using contacts to exchange participants or available infrastructures.

Existing power spot markets like EPEX SPOT SE situated in London have developed operation rules which new exchange participants have to fulfil before getting accredited. The Market Surveillance is an institution independent from the exchange permanently supervising the markets of EPEX SPOT and checking the compliance of market and behavioural rules (see Figure 4-19).

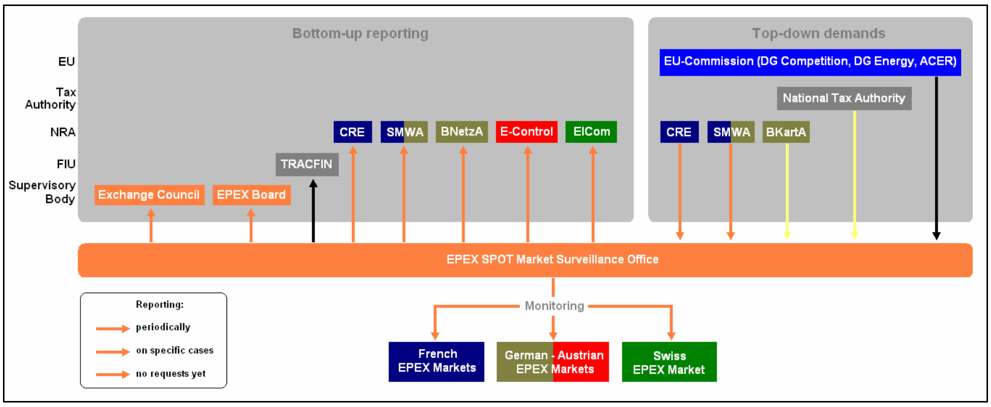

Figure 4-19 Market Surveillance and their integration into supervising and energy regulatory authorities; [17]

It is generally accepted to fix market rules (Code of Conduct; Annex 10) and operation rules mentioned above (Annex 11) in contracts. Agreed contracts can only get operative along with the signing of this trading agreement, which is an essential precondition to make trading at the power spot exchange possible. Two different trading processes are possible in general at the European power spot market, which are

- The auction
- The continuous trading

Considering the development of the European power spot market it seems to be sensible to integrate many exchange participants within a power spot market Kosovo/ Albania to be established. Along with this it has been proven at the European power market that the efficiency of the exchange does increase significantly along with a growing, innovative and profitable European power spot market. Furthermore a high level customer service for exchange participants will be ensured.

When forming a new power exchange acting at the European market it will be necessary to ensure its characteristics to develop a special documentation consisting of market rules, the Code of Conduct and the operation rules. Respective frame conditions are to be defined for the trading process auction (day-ahead-auction) in order to ensure a uniform acting of all exchange members. In accordance with the criteria proven at the European power spot markets the following parameters should be determined:

- Contact parameter describing the minimum volume to be offered and traded at the power spot market. A minimum volume of 1MW has proven as feasible value. Considering the dimensions of the control areas the power spot market is acting in even smaller contact parameters would be possible.
- The minimum rate change defines minimum price change in €/MWh. A very typical value is 0.1€/MWh but values below this are possible as well.

- The Price range does define the minimum (-€/MWh) and maximum (+€/MWh) where the exchange orders need to be placed in-between. The prices even for separate hours or units do not need to be equal but within the price range defined
- The base value determines the delivery intervals for the following day usually a 24h interval.
- Delivery location describes the transmission network and control area where deliveries shall take place
- Auction time defines the times when day-ahead-auctions can take place. Daily auctions have proven to be practicable, seven days per week at noon over the whole year.
- Publication time of auction results should lay expeditious to the auction time (appr. 1 hour)
- Order types describe time base of exchange orders, where single hours and standardised block offers are possible. Single hour offers could include several price/quantity combinations for each hour of the next day. Within the French, Austrian, Swiss and German control areas there are 256 types. Standardised block offers are possible as per Table 4-11.

Block	Time [hour]		Block	Time [hour]	
	from	to		from	to
Base load	1	24	**Off Peak 1**	1	8
Peak load	9	20	**Off Peak 2**	21	24
Night	1	6	**Business**	9	16
Morning	7	10	**Middle Night**	1	4
High Noon	11	14	**Early Morning**	5	8
Afternoon	15	18	**Late Morning**	9	12
Evening	19	24	**Early Afternoon**	13	16
Rush Hour	17	20	**-**	-	-

Table 4-11 Standardised Block offers, day-ahead auction

Standardised block orders must include two following hours as a minimum. Furthermore the maximum volume for block offers and a maximum number of block offers per trading participant can be defined.

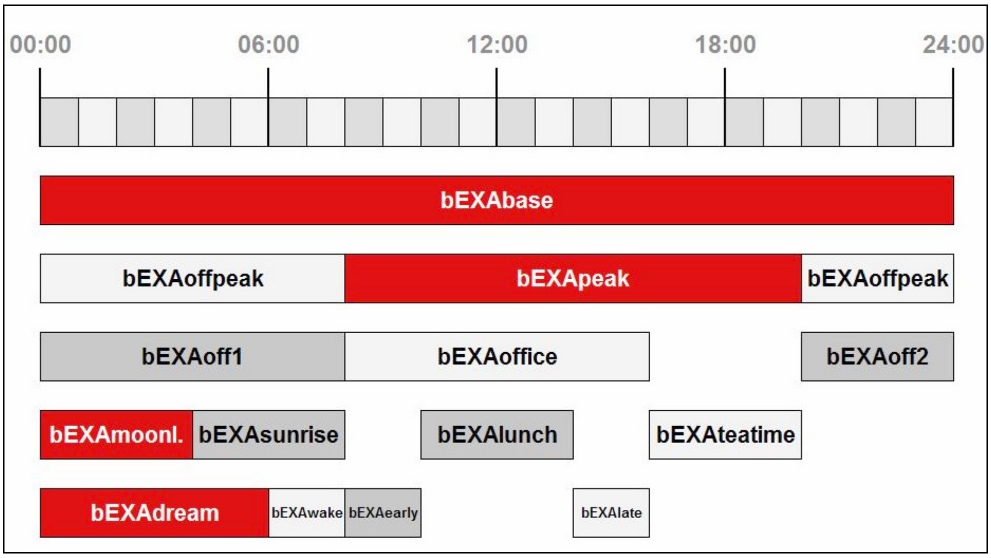

Figure 4-20 Trades with block products; [17]

For the trading process of continuous trading (intraday market) frame conditions need to be defined as well in order to ensure that all exchange members base their trading activities on the same trading rules. Contact parameter describes the minimum volume to be offered and traded at this power spot market with a proven feasible minimum volume of 1MW. Smaller and bigger values are even possible. Minimum rate change determines the minimum price change in €/MWh. Typically 0.01€/MWh is used, but other determinations are possible. The Price range does define the minimum (-€/MWh) and maximum (+€/MWh) where the exchange orders need to be placed in between. The French, German and Swiss market have price ranges of -9,999€ to +9,999€.

The base value defines the delivery intervals for the same and the following day. It stood the test on the European power spot markets that single hours or block offers can be traded minimum two hours down to 45 minutes ahead of delivery. Regarding the next day the trading can start for all hours e.g. at 3 p.m. Furthermore standardised block offers are possible with minimum two hours in the respective block as per following example in Table 4-12:

Block	time [hour]	
	from	To
1	1	24
2	9	20

Table 4-12 Standardised Block offers, intraday market

Delivery location describes the transmission network and the control area respectively where the delivery shall be done. Trading time defines the time periods when intraday trading shall be possible. Continuous trading for seven days per week over 24 hours has proven to be the best way. Order types describe the respective trading orders with the following typical types:

- Limit- Orders and Market Sweep Orders with definition of possible execution conditions
- All- or- none
- Immediate- or- Cancel
- Fill- or- kill
- Hidden quantity.

For the further extension of the European power market so-called market coupling contracts are intensifying to be agreed, e.g. for trading procedure of daily auction.

The clearing and the processing of the auction is done by a power spot exchange responsible at the same time for transfer of contract information regarding processing and delivery to other participating power spot exchanges.

Within the market coupling contracts tradable contracts, clearing, processing, opening and closing of order book, delivery process, admissible offers and expression of quantities are to be regulated among other things.

4.3.3.3 Energy trades at forward market

The forward market is characterised by the fact that finalised order have to be fulfilled by the respective contract partners in an agreed timeframe. So future price risks are reduced and long-term delivery obligations are ensured. As per definition it is a matter of future orders, if the supply/ the delivery of the base values is shifted by minimum two days, i.e. the realisation may happen earliest two days after the business conclusion (Art. 38, paragraph 2 of Commission Regulation (EC) No 1287/2006 of 10th of August 2006). All other exchange orders are spot market orders. On forward market e.g. a power plant can sell its future generation for the momentary market price and ensure a base margin for this future energy. Another possibility is that a power supplier (e.g. a DSO) buys its future energy amount already today.

Speculative participants cannot be excluded on the forward market, as well. Important trading places are located in Scandinavia, Switzerland, France, Germany, the Netherlands and Austria.

- **Products at forward market**
    - **Energy Futures**

The energy futures are differentiated to their physical and financial realisation. The difference lies in the fact that the point of delivery of physical futures is located in a definitely agreed timeframe. With financial futures the contract partners agree that the price difference between the fixed energy price and the market price available at date of delivery will be compensated.

The trades on forward market can be realised by the following futures:

- Phelix- Base- Week- Futures (Cash compensation)
- Phelix- Base- Year-/ Quarter-/ Month- Futures (Cash compensation)
- Phelix- Peak- Year-/ Quarter-/ Month- Futures (Cash compensation)

By participation of several exchanges from different countries these further futures are possible e.g.:

- Kosovo- Base (physical delivery)
- Kosovo- Peak (physical delivery)
- Albania- Base (physical delivery)
- Albania- Peak (physical delivery)
- Macedonia- Base (physical delivery)
- Macedonia- Peak (physical delivery)
- Greece- Base (physical delivery)
- Greece- Peak (physical delivery)

For guaranteeing these futures the delivery period, the load profile, the point of delivery, the contract volume, the tradable delivery periods, the time for payment and the quotation have to be concluded contractually.

- **Energy options**

On forward markets the trade with different energy options is common. Month-, Quarter- and Year- options can be traded. Buying options the buyer purchases the right of energy acquisition (Call) or sales (Put) at concluded prices and a certain time point (on last day of auction) or in a timeframe (until the last day of auction).

With a “Call” the buyer is ensured against too high energy prices and is able to trade falling market prices likewise. A “Put” protects the seller against falling market prices but can profit by increasing market prices.

Prices for "Put" and "Call" have different influencing factors like to be seen in Table 4-13 and Table 4-14:

Influencing factors on high prices of a "Call" option	Influencing factors on low prices of a "Call" option
High price of base value	Low price of base value
Low exertion price	High exertion price
Long remaining term	Short remaining term

Table 4-13 Influencing factors of a „Call" option

Influencing factors on high prices of a "Put" option	Influencing factors on low prices of a "Put" option
Low price of base value	High price of base value
High exertion price	Low exertion price
Long remaining term	Short remaining term

Table 4-14 Influencing factors of a „Put" option

With the acquisition of energy options it is common that the buyer is obliged to pay an options premium. If the buyer does not make use of this option this premium remains at the seller.

- **Distinction between option and future**

The determination of a clear distinction between Futures and Options are necessary for the functionality of an energy exchange. Only due to this differentiation it can be assured that the mutual rights and obligations between the seller and the buyer resulting from the contract are clearly regulated.

With the implementation of a forward market considerable rights and obligations including the Clearing have to be determined. At the EEX trading floor and other sites clear regulations apply concerning the distinction between futures and options. So, futures are firm forward businesses and the owner of Long and Short positions are obliged to realise this business. Regarding the option the owner of the short position has the right to, but is not obliged to, realise the business (see Table 4-15 and Table 4-16).

Buying option (Call)		Selling option (Put)	
Buyer	Seller	Seller	Buyer
Right but no obligation to buy the base Value for the determined price	Obligation to sell for the determined price, if the buyer should exercise his option	Right but no Obligation to sell the base value for the determined price	Obligation to buy for the determined price, if the seller should exercise his option

Table 4-15 Rights and obligations in Options

Exertion of		Assignment of	
Buying option (Call)	**Selling option (Put)**	**Buying option (Call)**	**Selling option (Put)**
Long position in futures	Short position in futures	Short position in futures	Long position in futures

Table 4-16 Exertion of Options on Futures

By means of the mentioned options premium the seller receives, the risk of non-exertion of the option (Long position in futures) is settled. For the buyer there is only the risk of loosing the already paid option premium.

The difference between options and futures shows also an impact on the clearing. In contrast to futures only the seller of an option has to deposit a security. That is due to the fact that only the owner of a short position contracted an obligation and in case of its default the Clearing House has to balance it by the payment of market related premium.

Taking over these regulations for the implementation of a new trading place (e.g. in Kosovo/ Albania or SEE respectively) a big compatibility to existing European trading places is reached.

- **Securities of futures and options**

The security of energy trades needs to have the highest priority at the energy exchange. Only by guarantees of determined security criteria it was possible to extent the energy trades over more exchanges. In 2004 already about 338TWh were sold, but in 2011 and despite difficult market relations this number grew up to 1,075TWh.

Concerning futures the security is ensured by a deposit of a base security (additional margin) to be realised by exchange participants at the opening of a position. The amount of that additional margin can be determined individually and has to be deposited in the so-called Clearing House. That Clearing House has to deposit its base security in the European Commodity Clearing AG (ECC). The ECC located in Leipzig realises in the meantime the Clearing for all businesses, among others for EEX, the British-Dutch Exchange APX-ENDEX, the Hungarian HUPX, the French Powernext SA and EPEX Spot SE.

As already described before, the options are ensured by options premiums to be paid by the buyer, whereas the seller needs to deposit a premium margin and the additional margin. The amount of securities to be paid depends on the positions held in options and the underlying futures. The exact calculation procedure needs to be determined in a guideline.

4.3.3.4 Trading hours

Trading hours for the respective trading place have to be determined. Experiences on the European energy market have shown that a coordinated approach of determining the trading times proved itself. Figure 4-21 shows exemplarily possible trading times. The exact determination of trading times at the implementation of a new exchange with its trading floor is influenced by territorial aspects, e.g. trading times on neighboured floors.

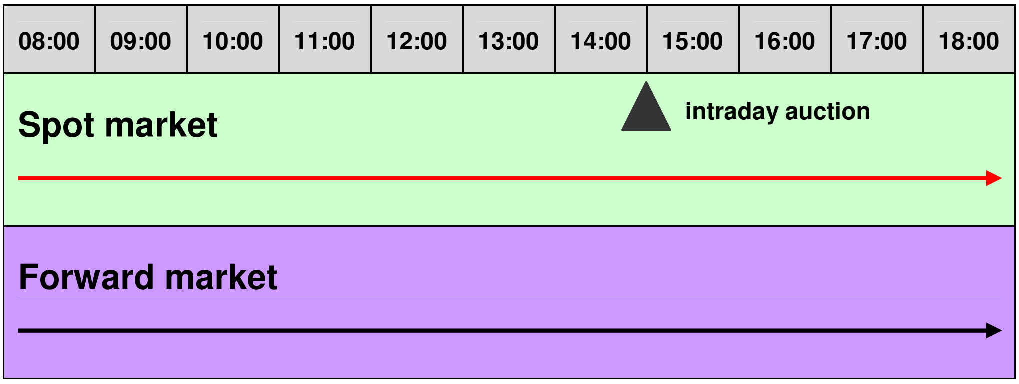

Figure 4-21 Example for trading times on spot and forward market

4.3.3.5 Market surveillance

The most efficient possibility for allocation of the product energy is the trade on a respective market. A prerequisite is that market mechanisms work and fair prices are the basis of this exchange. However, the accomplishment of such fair prices cannot always be seen as self-evident because some participants could get advantages on costs of others. That is why it has to be the purpose of every responsible participant to have the guarantee of manipulation free market behaviours. This task has to be ensured by mandatory market surveillance at state-proved exchanges. The legislator is obliged to implement the legal basis for the creation of such a market surveillance as independent exchange organ. Only with that a steady monitoring of trade behaviour and the adherence of regulations can be guaranteed.

The main priority lies in the realisation of maximum security for all participants. Within the framework of implementation of an energy exchange with simultaneous determinations of the trading floor it is essential to regulate the tasks and authorities of the market surveillance. In these rules mandatory for all market participants the monitoring structure, the tasks, the authorities, the activities and the team of the market surveillance need to be described clearly and unambiguously. Besides mentioned issues it is necessary to fix the legal provisions for exchange trades. Among others belong to these rules:

- Tasks and authorities of the Exchange Controlling Institution
- Prohibition of insider businesses
- Prohibition of Market manipulation
- Prohibition of wrong or irritating signals
- Prohibition of artificial price levels
- Prohibition of other acts of deception
- Procedures of initiation of sanctions
- Determination of types of sanctioning

These sanctions in case of an infringement against the rules of the market surveillance should be clearly regulated and contain financial sanctions up to the exclusion the exchange.

4.3.4 "Over-the-counter" Trading

The over-the-counter- (OTC)-trades (see Figure 4-22) is realised either directly between buyer and seller or indirectly via a mediator, the so-called broker. In contrast to trades at the energy exchange the OTC-trade is concluded by bilateral contracts. Individual and standardised products are traded.

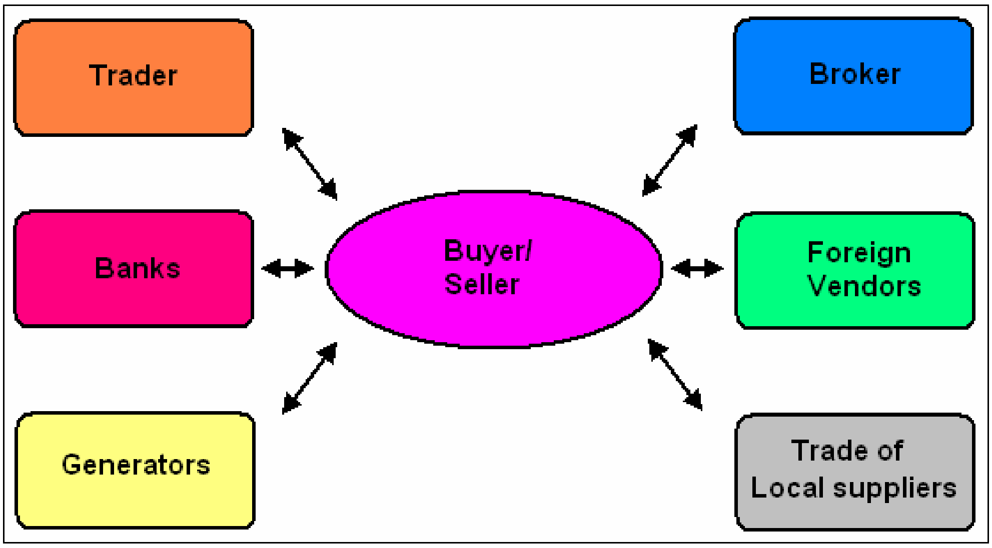

Figure 4-22 Participants in OTC-market

OTC- trades are realised by internet, telephone or direct contact between buyer and seller. The OTC- market is certainly non-transparent concerning price determination, participants and liquidity. Furthermore there is a big competition risk.

A prerequisite of OTC-trades are trade frame contracts between the regarding partners. On European energy market there are more orders with a higher volume on OTC market than at the exchange. Nevertheless the attempt of an extent of exchange orders still insists, i.e. the development of a European energy interior market. Already today the price at the exchange sets the standard for the OTC-trades. Additionally brokers are able to register their OTC-trades at the energy exchange. That means that the exchange confirms the order at the trading organisation that is responsible for the clearing (see Figure 4-23).

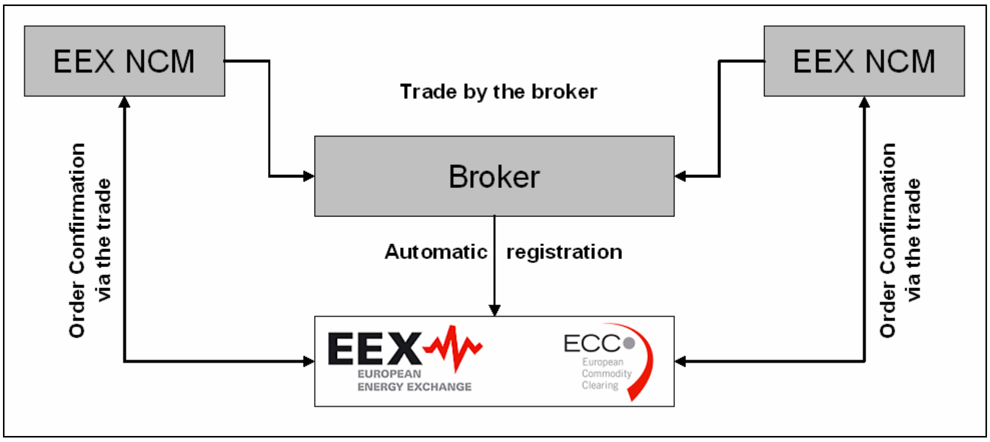

Figure 4-23 Procedure between EEX and OTC; [17]

4.3.5 Conclusion

4.3.5.1 Wholesale market

The liberalisation of the energy market is connected inextricably with the issue that monopoly enterprises supplying an allocated area do not exist anymore. Until the liberalisation of European energy market in 1998 there were no or only low risks trading the product energy. With the liberalisation a wholesale energy market was built (see Figure 4-24). In this context it has to be noticed certainly that the implementation of a liberalised energy market is quite differentiated from country to country.

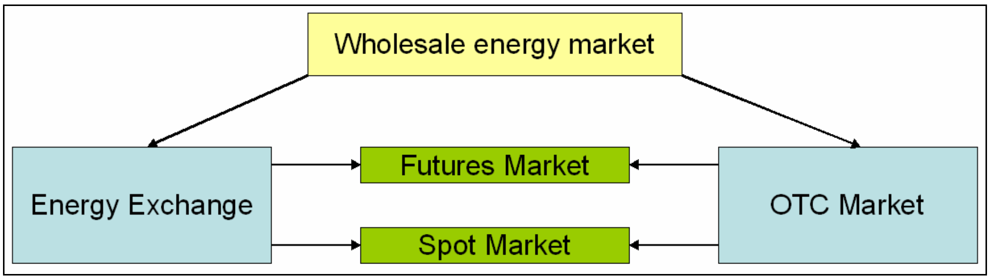

Figure 4-24 Wholesale energy market

Considering the still existing criteria of power supply of customers there is no liberalised market in Kosovo. That is justified essentially by the fact that Kosovo's power supply is nearly exclusively realised by KEK. Assuming that it is useful to implement this trading place by two steps:

- Creation of an Off-market trade (OTC)
- Creation of an energy exchange

Still OTC-market is dominating, but EU trend is that exchange gets more and more important. A recommendation for the proportion between the types cannot be given, as it depends on the respective market participants.

As per experience on the European energy market the first step should be the creation of an OTC-market considering a possibly parallel implementation of prerequisites for an exchange. Therefore it is important, independent whether OTC- or exchange market, that the respective traders get knowledge about the energy price influencing factors (see Figure 4-25).

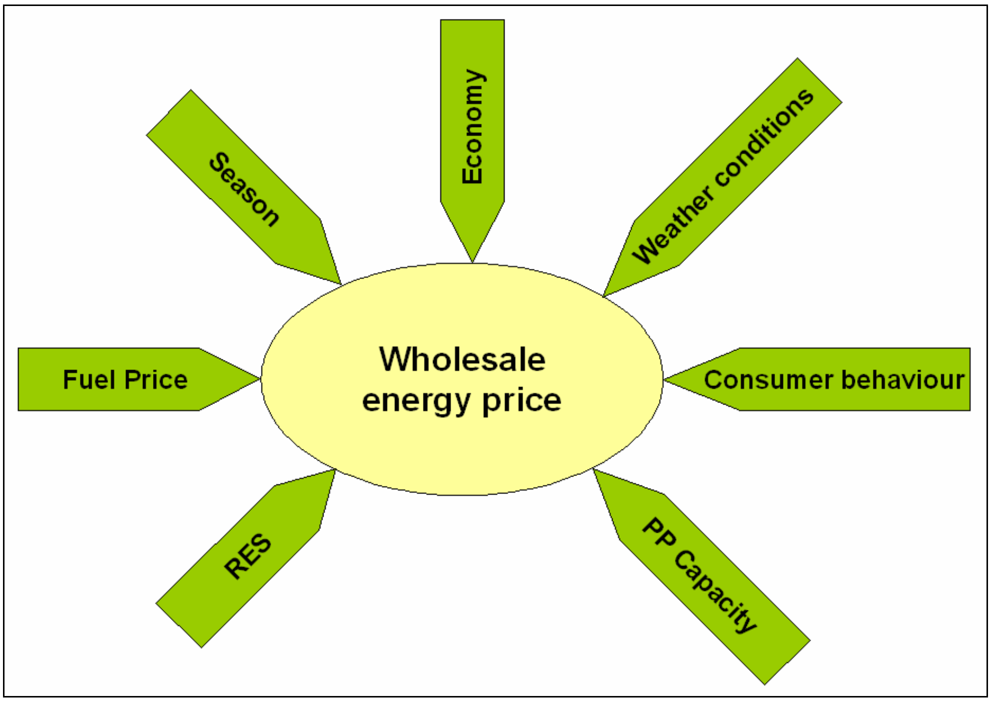

Figure 4-25 Energy price influencing factors

For the implementation of an OTC- or exchange based market in Kosovo or the total Balkan region one of the following 4 options is possible:

- Option 1: OTC-market → Future, Figure 4-26
- Option 2: OTC-market →Future & Spot, Figure 4-28
- Option 3: OTC-market & Exchange (physical market), Future & Spot, Figure 4-29
- Option 4: OTC-market & Exchange (physical and financial market), Future & Spot, Figure 4-30

Option 1 describes an OTC-market exclusively with future trades and one block size as per customer load graph. The trade itself is realised without any mediation of brokers but only between buyers and sellers.

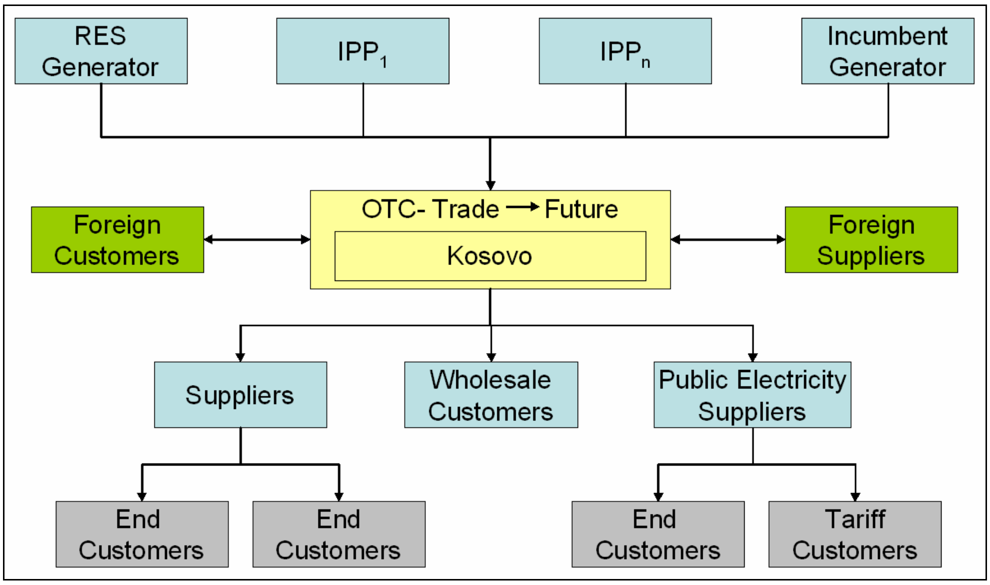

Figure 4-26 Energy Trade in Kosovo, Option 1; [18]

The draft of “Market Rules” elaborated by KOSTT from May 2012 might be realisable in that type. So it can be ensured that the TSO can fulfil its responsibility concerning system stability. Nevertheless this procedure does not correspond to the requirements necessary for an energy market liberalisation. The total independency of system operators (control energy market, OTC trades and Exchange trades) is not sufficiently assured by this organisation structure. Grid operators in a liberalised energy market are but one of many market participants. Regulations concerning grid connection or utilisation exclusively need to be agreed between the respective operator and customer by connection and utilisation contracts (see Annex 13 and Annex 14).

For ensuring system stability by KOSTT the creation of a balance group management system containing respective contracts and responsible parties between the TSO and market participants might be a possible solution. So it can be granted that deviations between demand and in-feed are quantifiable per balance group. Therewith a cause-related assignment of costs emerging to the TSO from system control can be realised. Every market participant in the control area of KOSTT independent whether power plant operator, energy trader and supplier, can be assigned to a respective balance group by the implementation of a balance group management. At the moment there is no market, no participants and therewith no balance group management in Kosovo existing. Time schedules need to be created in a certain raster to be agreed with the TSO (quarter-, half or one-hourly raster) and to be submitted to a determined point of time (11 a.m.) to the TSO by the balance group responsible party (BGRP) for the following day. The BGRP is responsible for balancing the differences between the actual, physical in- and out-feeds. The BGRP is allowed either to use already contracted power plant capacity or to mandate the TSO for balancing its balance group. A billing system has to be created that grants the cost assignment to the BGRPs ensuring that for every balance group its respective deviation to the schedule can be determined.

For the functionality of such audit-proof billing procedure of balance groups quarter-, half- or one-hourly values are essential for:

- The foreseen power in-feed [MW] with schedules including amount of energy [MWh]
- The actual, physical in-feed [MW] including real energy amounts [MWh]

Summarising it can be recommended for the future design of a liberalised energy market in Kosovo or SEE to take care for a strict, contractual separation between system operators and market participants. Therefore the contract structure as depicted in Figure 4-27 should be realised.

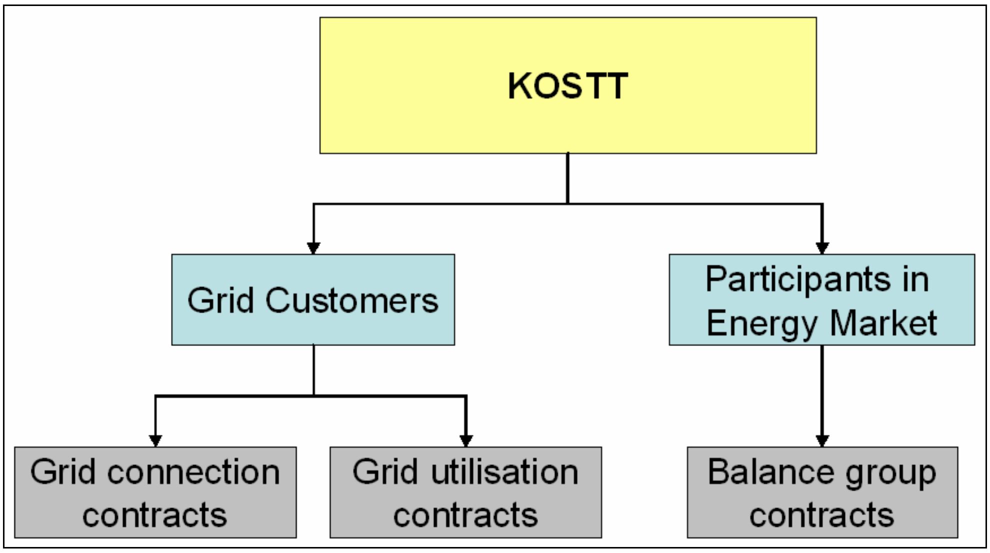

Figure 4-27 Contract structure

Based on the conditions on Kosovo's energy market the procedure from draft version of market rules might be the way to a consequent implementation of a liberalised market. A progression is absolutely recommendable. So, the implementation of Option 1 (see Figure 4-26) into the draft [18] is the next development step.

In a next stage the extension of Option 1 by a spot market connected with the implementation of trade blocks (see Figure 4-28) is possible. The admission of brokers as mediators between sellers and buyers could be realised, but is not stringently required. The location of the OTC trading place should be in Kosovo for Option 1 and 2.

Options 3 (see Figure 4-29) and 4 (see Figure 4-30) contain the creation of an exchange including the necessary determination of the respective exchange trading place. Option 3 contains exclusively a trade with physical fulfilment at the exchange or at the OTC market by all market participants, if necessary by the participation of brokers. For the consequent establishment of a high efficiency the creation of trading floors might be useful. Furthermore energy trades have to be realised on the basis of products with respective duration times.

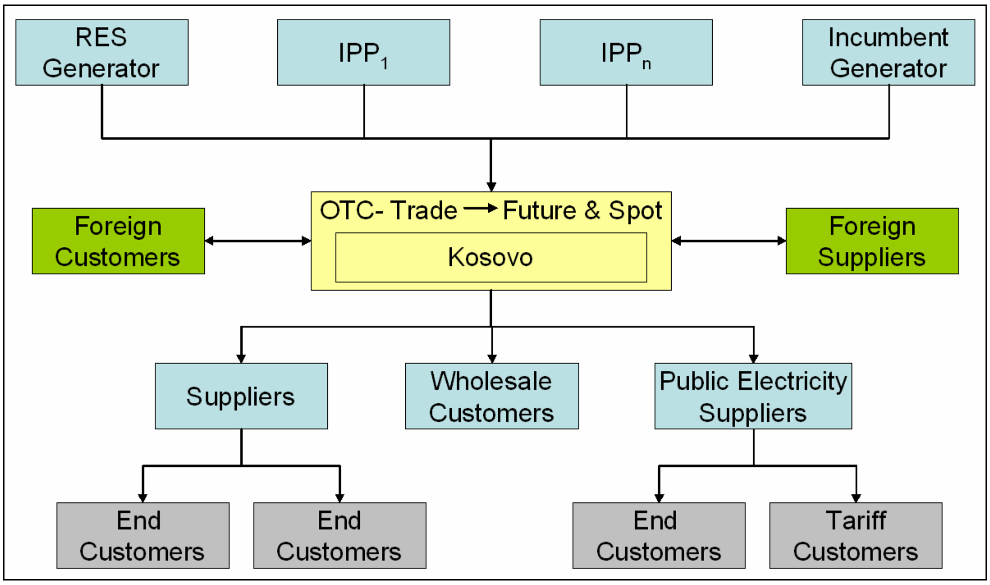

Figure 4-28 Energy Trade in Kosovo, Option 2

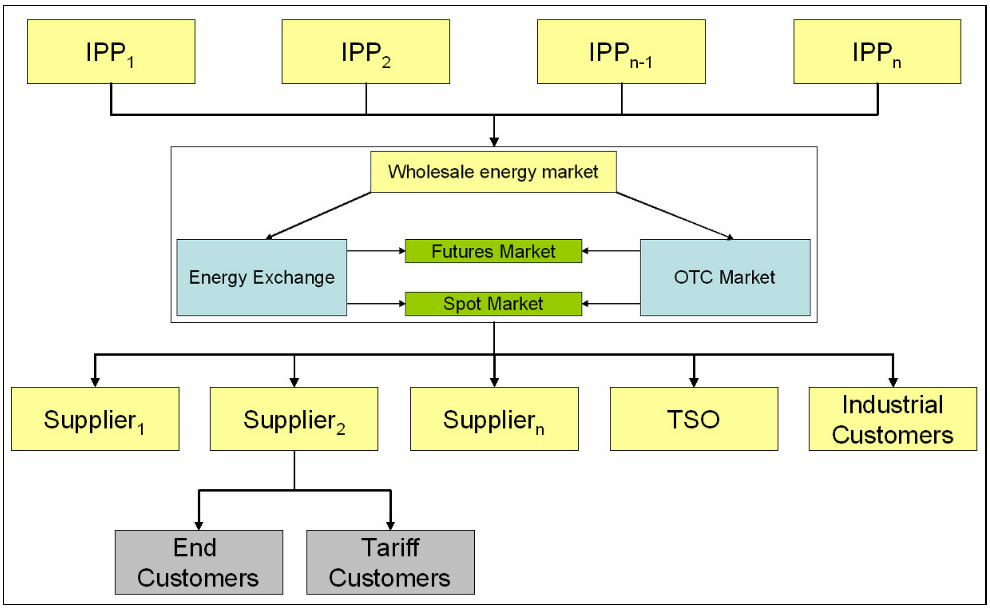

Figure 4-29 Energy Trade in Kosovo, Option 3

Option 4 contains as well physical as financial fulfilments. The implementation of all criteria and possibilities is essential for a European Energy Exchange (as e.g. offered by EEX; see Chapter 4.3.3 of this study).

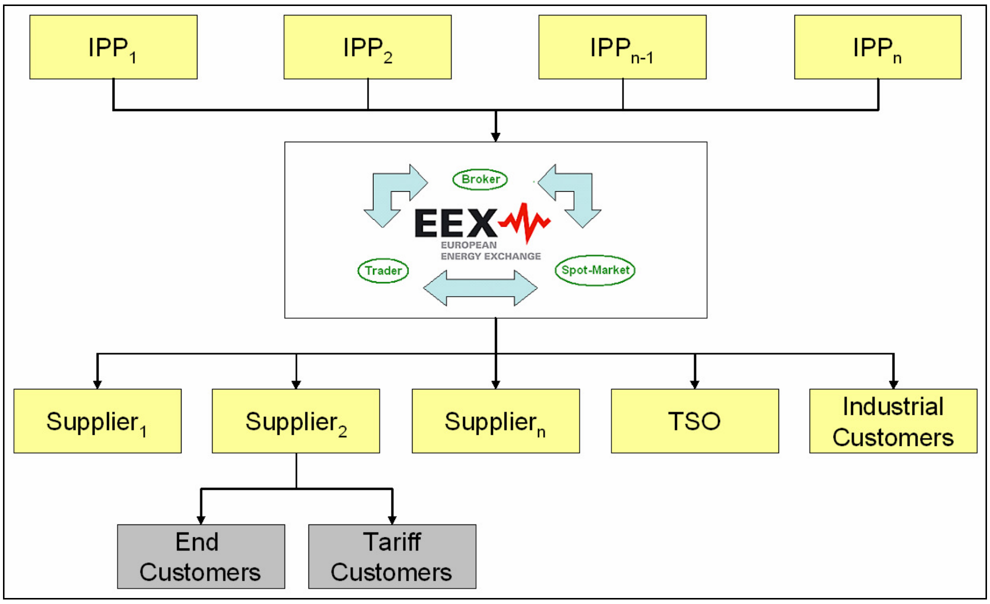

Figure 4-30 Energy Trade in Kosovo, Option 4

The retention of an OTC-market should be determined by the European frame conditions existing in that moment of realisation of Option 4. The location of the Exchange market place is of secondary importance. Depending on the participating actors a territorially central location is recommendable. Furthermore it is important that the TSO are exclusively market participants. So, it can be consecutively stated that the location of the market place is not at the TSO or any other market participant, but has to be independent from all market participants.

4.3.5.2 OTC-market

If an OTC- market is built, the enterprise responsible for provision and trades should form a separate department "Supply and Trading". This organisational department needs respective IT-solutions in order to have a quick overview about trade occurrences of all European trading places. This energy-trading-floor is permanently manned with a respective expert staff.

Big trading enterprises do not only fill their staff with energy traders but also with meteorologists, mathematics, physicists and engineers. So these enterprises guarantee that the complexity of that market can be analysed and understood from every point of view and at every point of time. Additionally the prerequisite for an OTC- market is the existence of a respective energy market place and a balance group system for allocation of bought and sold energy amounts. So it gets possible to create a bilateral trade without further frame conditions and to conclude freely tradable orders. The billing of deliveries can take place bilaterally as well. Basic of the billing is the contract price agreed between the partners. As already mentioned, the OTC-trade contains risks (e.g. outage of buyer or seller) to be evaluated before contract conclusion. A limiting system regarding the amount of energy trades can be useful minimising the risk. A further essential prerequisite for OTC-trades is the availability of a sufficient number of market participants in order to receive a high volume at respective price volatility of energy products. It is recommendable to install such an OTC-market with 5 to 10 sellers (power plants) and minimum 5 to 10 buyers (suppliers) first. A lower number of actors leads to a non-active market and the goal, a high market acceptance avoiding monopolistic structures and cost reduction will not be reached. In OTC-market so-called broker do trade. It is their task to join buyers and sellers and make the necessary communication platform available (hard- and software). On this platform the orders are concluded. A frame contract regulating the specific requirements to enterprises is indispensable.

These contracts should contain besides national regulations general points of contract law:

- Type of traded energy product (e.g. base load, peak load etc.)
- Duration of energy product (see Table 4-17)
- Type of application, confirmation of feed-in schedule management
- Determinations for non-fulfilment of the order by acts of nature or non-considerations of contractual agreements of the partners
- Rights in case of non-adherence of contractually fixed supplies or capture, e.g. remuneration
- Stop of deliveries in case of default in payment
- Possibilities of dismissal by suppliers or buyers

Product duration	Base load	Peak load	Middle night
Day	24h	12h	3h
Week	7 days, 168h	5 days, 60h	7 days, 21h
Month	30 days, 720h	20 days, 240h	40 days, 90h
Quarter	92 days, 2,208h	80 days, 960h	92 days, 276h
Year	365 days, 8,760h	320 days, 3,840h	365 days, 1,095h

Table 4-17 Possible product durations

4.3.5.3 Energy Exchange

While OTC-market exclusively consists of bilateral energy sales, the energy exchange is an organised, state-controlled market for different energy products. These products are traded in timely limited amounts. Pooling of offers and demands within this energy exchange guarantees a high liquidity. In contrast to OTC trading sellers launch their offer at the respective exchange and buyers choose from different products depending on their load profiles. Energy prices are directed to offers and demands, just like on other markets.

Based on load forecasts traders use the energy exchange to buy energy partially in advance in order to be independent from short-term price fluctuations (future market). The optimisation of short-term procurement and commercialisation of energy products is realised by the market participants within the spot market.

The origination of an energy exchange is connected to several conditions to be contracted between the exchange and the users. Furthermore, general rules for the utilisation of an exchange should be described basically. There is the possibility to realise the implementation of this exchange in different options. Annex 15 shows general rules for the utilisation of an exchange with spot and futures market.

The implementation of an energy exchange is inextricably (indissolubly) connected to a consequent liberalisation of the power market and requires the pooling of energy offers and demands. A sufficient liquidity of the energy exchange can only be guaranteed by meeting these demands. Based on the known structure of Kosovo's power industry these requirements can only be met restrictedly. On Kosovo's power market only one participant is acting at the moment (KEK). Additionally the amount of TPP generation is not sufficient for a power trade. So, there is a necessity to open the market to further sellers. Furthermore, based on described load forecast in Task 1 (see Chapter 1.3) it can be deduced that the extension of new generation capacities has to be forced essentially. Considering the load demand of 1,869MW in 2030 it is necessary for the realisation of an exchange and a control energy market within the scope of liberalisation to rethink the foreseen power plant construction program. The realisation of a generation capacity of minimum 3,000MW including the construction of RES seems to be essential in order to both meet the demand and to realise an exchange trading and a control energy market in Kosovo and beyond.

4.4 Utilisation of renewable energy sources within Kosovo's transmission system – Requirements to system stability

Renewable energy sources are currently not used in Kosovo in significant amounts. But the development of renewable power generation is absolutely necessary to ensure a stable electrical power supply of the Kosovo industry and population considering the increasing demand and the current lack of generation capacity. Furthermore the utilisation of renewable energy sources offers possibilities to fulfil the demand for decentralised power supply e.g. for rural areas in a better way.

Nevertheless the main aspect for utilisation of renewable energy sources is climate protection. Beside wind and solar power biomass based power generation can be used for production of electrical energy. The installation and extension of renewable energy utilisation requires the implementation of legal, technical and organisational conditions in order to ensure efficient operation of renewable energy generation units within the electrical energy system of Kosovo.

4.4.1 Renewable energy sources and system stability

Ensuring system stability for the entire electrical energy supply system is the unique characteristic of the electrical transmission system against all other infrastructure systems.

The operation of renewable energy generation units within the electrical energy supply system leads to new requirements for the TSO due to the fact that renewable energy generation units especially wind and solar units have stochastic and fluctuating in-feed characteristics and therefore are not able to substitute thermal base load power plants with its high reliability and predictability.

That implies that e.g. wind power units need a backup for substitution of power by thermal power plants in case of low wind. On the other hand in-feed reduction of wind power units in times of low demand within the system and high wind and therefore high wind power generation needs to be possible

Furthermore a stable and secure system operation requires a minimum utilisation of thermal power plants („must-run-units“), in order to make the necessary short circuit power available in the network and to have sufficient opportunities for necessary reactive power balancing and therefore to operate the system within the admissible voltage limits.

Additionally it needs to be considered that in case of certain faults within the transmission network causing a significant voltage drop within a wide network area might lead to significant outages of wind power in-feed, which is difficult to be balanced by preserved control energy.

Considering the facts mentioned above the following criteria shall be considered to ensure system stability for integration of renewable energy generation units into the Kosovan networks:

- The transport capacities (power capacity and power direction) of the networks need to be adjusted to the changing generation structures. That implies a compatible proceeding in decision preparation for erection and substitution of generation capacities (power capacity, power gradients and plant locations) to avoid significant impacts to system stability.
- The integration and commissioning of renewable generation units in networks ≤ 110kV leads to changing in-feeds (load flows) from the transmission network. This causes new energy transport requirements which can only be ensured by consequent enforcement of in-feed management. This management need to consider the necessary minimum remaining conventional generation („must-run-units"), online data provision for all generation units within the control area and interactions between all generation units of the control area
- Enforcement of requirements to renewable generation units regarding:
    - Voltage support
    - Provision of reactive power
    - Fault ride through capability
    - Limitation of reactive power consumption from the network after fault clearing
    - Provision of short circuit power
- The future integration of renewable generation units into the networks of Kosovo can only be successful, if it becomes a part of a future reliable power supply with a sufficient supply quality. In order to reach this aim, the networks, especially ≥ 110kV, need to be technically developed in a coordinated way and the erection and operation of renewable generation units need to meet the requirements of system security. Basically it is very important that there will be no differ-

ences regarding technical requirements between conventional and renewable generation units.

4.4.2 Renewable energy sources and grid extension measures

Reliable engineering bases and development scenarios and investment security are essential for the integration of renewable generation units into the networks of Kosovo and the related necessary network extension. Therefore a step-by-step procedure is recommended to reach this demanding objective target including the following steps:

- Step1: Renewable generation development scenarios within the networks of Kosovo
- Step 2: Impacts of development to the Kosovo networks
    - Network extension and their costs
- Step 3: Consequences for the system of electrical energy generation
    - Requirements for balancing energy
    - Cost consequences
    - Other effects like control behaviour of conventional power plants

4.4.3 Technical requirements to wind power plants

The intended integration of renewable generation units especially wind power units into the networks of Kosovo leads to strong requirements for network operation and system management. Resulting from this it would be an asset to regulate the network connection of renewable generation units to the Kosovo networks within a defined network connection procedure.

This procedure can be implemented either in a legal regulation or in network connection rules of the network operators.

Network connection contracts (Annex 13) and network utilisation contracts (Annex 14) shall include the specific requirements for the network interfaces between the renewable generation unit operator and the respective network operator respectively the utilisation of the respective network and the related rights and duties to be agreed. Figure 1 to Figure 3 in Annex 13 show the procedure of a network connection process as an example.

Furthermore it is important that several distributed wind parks can be consolidated to wind park clusters. That would offer the opportunity to integrate the wind power units with its stochastic generation behaviour into the system management of KOSTT in an optimised way.

The Wind-park-Cluster-Management System (WCMS) has the mission to pool the geographically distributed wind parks and to image and control them as one big power plant with in-feed in several network nodes in order to optimise the system management and to minimise the demand for compensation and control energy necessary. Using new state-of-the-art technology for active and reactive power control even higher wind power capacities can be integrated into power supply systems.

Depending on generation unit topology the following system levels are to be considered:

- Single wind power units
- Geographic, network topologic and control related consolidation of single wind parks
- Several wind parks consolidated to a wind park cluster

For state-of-the-art wind parks having respective wind park controllers installed the following control and operation management strategies are already feasible:

- Reactive power in-feed as per setpoint value
- Maximum value limitation as per setpoint value
- Minimum value limitation as per setpoint value
- Following maximum gradient limitations as per setpoint value
- Power output limitation in case of overfrequency

Along with the opportunities mentioned, extended strategies like schedule demand (time flexible demand of maximum values), voltage control within the high and extra-high voltage network and provision of control power are feasible.

Based on these opportunities control and operation management strategies for wind power units can be deducted, like:

- Reactive power in-feed
- Generation management
- Schedule management
- Voltage control on high and extra-high voltage level
- Preservation of reserve power
- Ability for primary control

4.4.4 Forecasting methods of wind power in-feed

The detailed development of power schedules for the in-feed of wind power units is an essential precondition for integration of such units into transmission or distribution networks. This is only possible if wind velocity prognoses are available for reference units or reference areas.

In case of non availability of suppliers for such services own wind prognosis systems need to be established by the wind park operators in close cooperation with KOSTT (Figure 4-31). Experiences made for instance in Germany have proven the advantages of using several independent prognosis systems or methods of different suppliers and to make the forecast for power and energy in-feed of wind power units out of a levelled average value.

The electrical power to be generated using wind energy is equivalent to air density r, the flow through area A (measured vertically to the wind direction) and the cube of wind speed v as follows:

$$P = \frac{r}{2} \cdot A \cdot v^3 \text{ [W]}$$

Following this equation unsteady wind conditions (wind blasts) lead to enormous variations of power output of wind power units (e.g. wind speed of 4 m/s correlating to 40 W/m² flow through area while wind speed of 8 m/s correlating to approximately 310 W/m² flow through area).

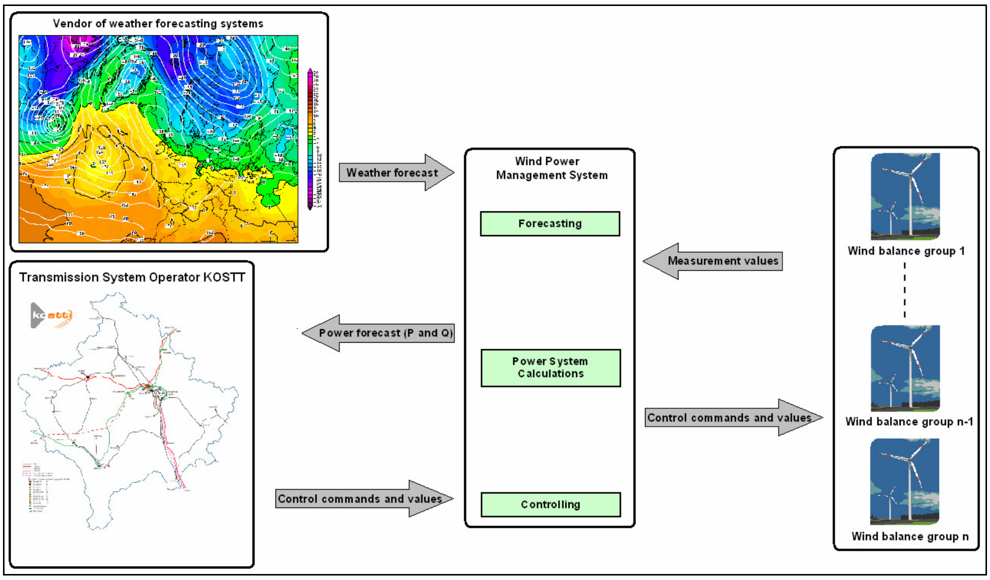

Figure 4-31 Wind prognosis system

Therefore it can be seen that a proper forecast of wind speed, which has cubical influence on the power forecast, is of essential relevance for the forecast accuracy.

Wind forces are to be categorised as follows:

Wind force	Category	Wind speed [m/s]	Energy content [W/m²]
0	calm	0-0.2	0-0.005
1	Light air	0.3-1.5	0.02-2.0
2	Light breeze	1.6-3.3	2.5-20
3	Gentle breeze	3.4-5.4	25-95
4	Moderate breeze	5.5-7.9	100-300
5	Fresh breeze	8.0-10.7	310-740
6	Strong wind	10.8-13.8	760-1,580
7	Near gale	13.9-17.1	1,610-3,000
8	Fresh gale	17.2-20.7	3,050-5,350
9	Gale	20.8-24.4	5,400-8,750
10	Fule gale	24.5-28.4	8,850-13,800
11	Storm	28.5-32.6	13,900-21,000
12	Hurricane	>32.7	>21,000

Table 4-18 Wind categories

As written in official websites of ISET-Institute of Kassel University [19]:
An important component of modern forecasting and energy management systems is the clear description of relevant information and compatibility of users' information and communication technologies (ICT). Developed calculation models for determination of actual and expecting wind energy feed-in are summarized to a total system, the wind power management system (WPMS). This system for operation inside ICT-periphery of different system and wind park operators is modified by coherent interfaces. The input data, therefore the measured wind park data and forecasted meteorological parameters, are converted and committed to forecasting and transformation modules, which accomplish the following computations:

- The determination of actual wind power feed-in for the whole control area plus for different grid regions and sections
- The preparation of next-day wind supply for the control area and grid regions, based on forecasted, meteorological parameters
- The calculation of expected near-term wind power feed-in for a forecast horizon of 1 to 8 hours for the control area and sections, based on forecasted, meteorological parameters and measured wind power data.

The post processor is an optional modul that undertakes the conversion of base data (XML-format) into the respective interface formats to the control centre. Additionally a graphical user interface offers a various and clear presentation of wind power in-feed plus further important information.

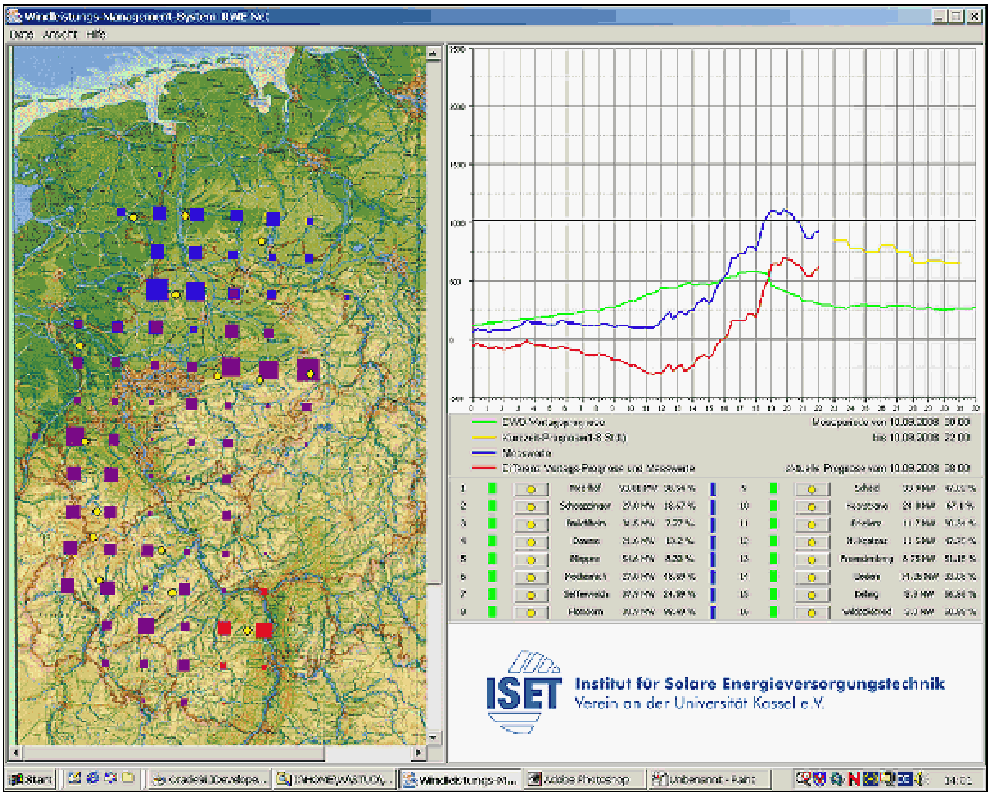

Figure 4-32 Graphical user interface of WPMS

Figure 4-32 shows a possible graphical user interface of WPMS. This surface consists of several windows depicting all information of wind energy feed-in in a clear form. The main window shows a map of the control area with the related wind power installed, departed in plan areas. The size of these areas stands for rated wind power installed; the colour illustrates the actual amount of wind power feed-in for that region. The window on the upper right side shows graphs of actual wind energy feed-in (blue graph) and the respective forecasts (next-day forecast the green graph, short-time yellow one) plus the forecasting error (red graph) of the control area respectively its grid regions. Optionally these information can be tabularised. Furthermore the status of online measuring and the amount of fed in wind power of the representative sites are shown.

Figure 4-33 Wind measurement mast

The same institute has been working since October 2009 to November 2011 on the research project "Wind power utilisation in the inland - development of new potentials in forested low mountain ranges". In this time period and the following years the basis for the development of new procedures for evaluation of wind conditions in big hub heights at forested sites of uplands shall be realised. By a high wind measurement mast (see Figure 4-33) and state-of-the-art measurement methods enormous data for these sites shall be received. The planned infrastructure will be a Europe-wide unique basis for the analysis of wind characteristics in complex areas up to big heights. Results of these projects can be useful for the wind power integration in Kosovo's transmission system.

4.4.5 Acquisition of renewable energy

For balancing of shortages and surpluses of supply within the RES balance group online capturing of generated power is a requirement to be enforced by KOSTT against all operators of RES. For billing of generated renewable energy RES operators have to provide measurement data with a high accuracy. The provision of RES power and energy data shall be regulated within the grid connection contract or/ and within the law by support of RES.

By means of online-capturing of power values in kW or MW (depending on size of WPP) the TSO is able to compensate the stochastic in-feed, especially caused by wind power plants, with that sufficient quality necessary for system balancing (see Figure 4-34 and Figure 4-35). The energy capturing in kWh should be realised by remote meters.

Figure 4-34 shows the real in-feed in the control area of German TSO 50Hertz Transmission GmbH on 1st and 2nd of April 2012. These values fluctuate between 150MW (2nd April 2012 10 p.m.) and about 3,000MW (2nd April 2012, 1 a.m.). The installed capacity within that control area of all wind power plants in total amounts to approximately 11.8GW.

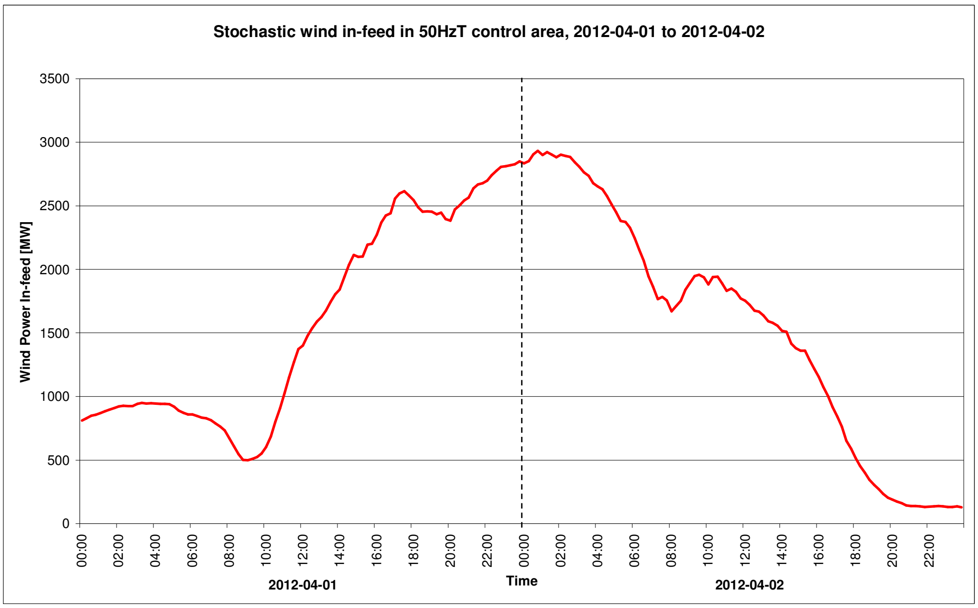

Figure 4-34 Example for Stochastic Wind power in-feed; [20]

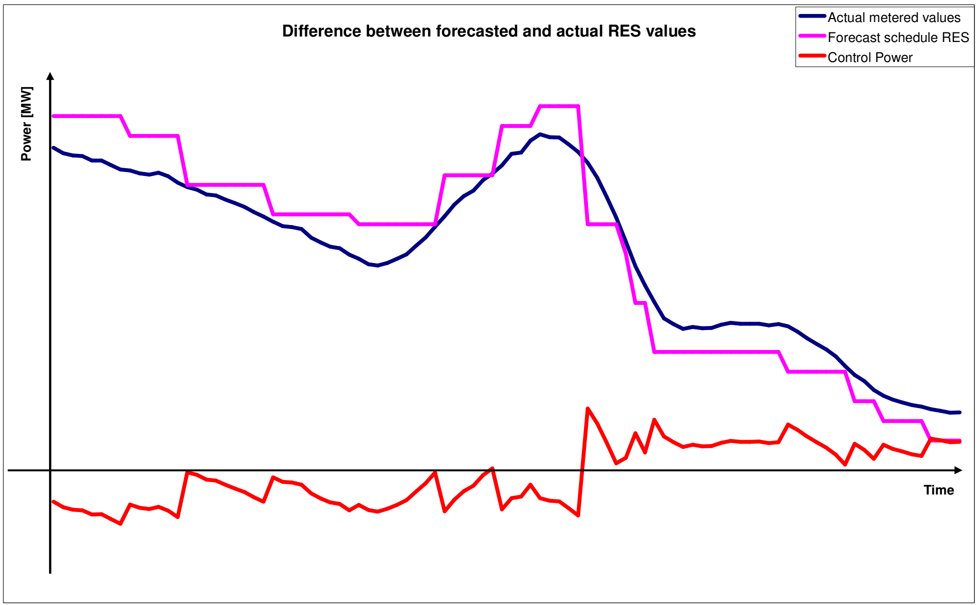

Figure 4-35 Difference between the RES forecast and real in-feed including the necessary control energy; [20]

Obvious rules for the allocation of energy and compensation costs to the respective RES are:

- Reimbursement and allocation of costs of generated renewable energy are an inevitable prerequisite for integration of RES into the transmission and distribution systems.

5 Task 6 – Weighting to the respective interest of the parties concerned

5.1 Introduction

5.1.1 Directive 2005/89/EC

The European Parliament and the Council of the European Union have established the Directive 2005/89/EC concerning measures to safeguard security of electricity supply and infrastructure investment. Among others some of the most important measures to be emphasized are listed below:

Member states shall ensure:

- A high level of security of electricity supply by taking the necessary measures to facilitate a stable investment climate and by defining the roles and responsibilities of competent authorities.
- An adequate level of generation capacity
- An adequate balance between supply and demand
- An appropriate level of interconnection between Member States for the development of an internal market and a certain degree of competition
- A regulatory framework within which Member States are to define transparent, stable and non-discriminatory policies on security of electricity supply compatible with requirements of a competitive internal market for electricity.
- The monitoring of security of supply issues in particular, the supply-demand balance, the level of expected future demand and envisaged additional capacity being planned or under construction, the quality and level of maintenance of the networks, measures to cover

peak demand also and to deal with shortfalls of one or more suppliers.

- The need for regular maintenance and if necessary renewal of the transmission and distribution networks to maintain the performance of the network.
- The degree of diversity in electricity generation.
- The importance of removing administrative barriers to investments in infrastructure and generation capacity.

When promoting electricity from renewable energy sources, it is necessary to ensure the availability of back-up capacity, in order to maintain the reliability and security of the network.

Any measure adopted should be non-discriminatory and should not place an unreasonable burden on the market actors, including market entrants and companies with small market shares. It should be also taken into account, before measure adoption, the impact of the measures on the cost of electricity to final customers.

5.1.2 General remarks concerning the development of an electrical energy system

Decisions concerning the development of an electrical energy system of a country are based on three columns (see Figure 5-1):

- The development of load
- The available resources (energy carrier, economic clout)
- The political frame conditions (energy strategy, environmental protection)

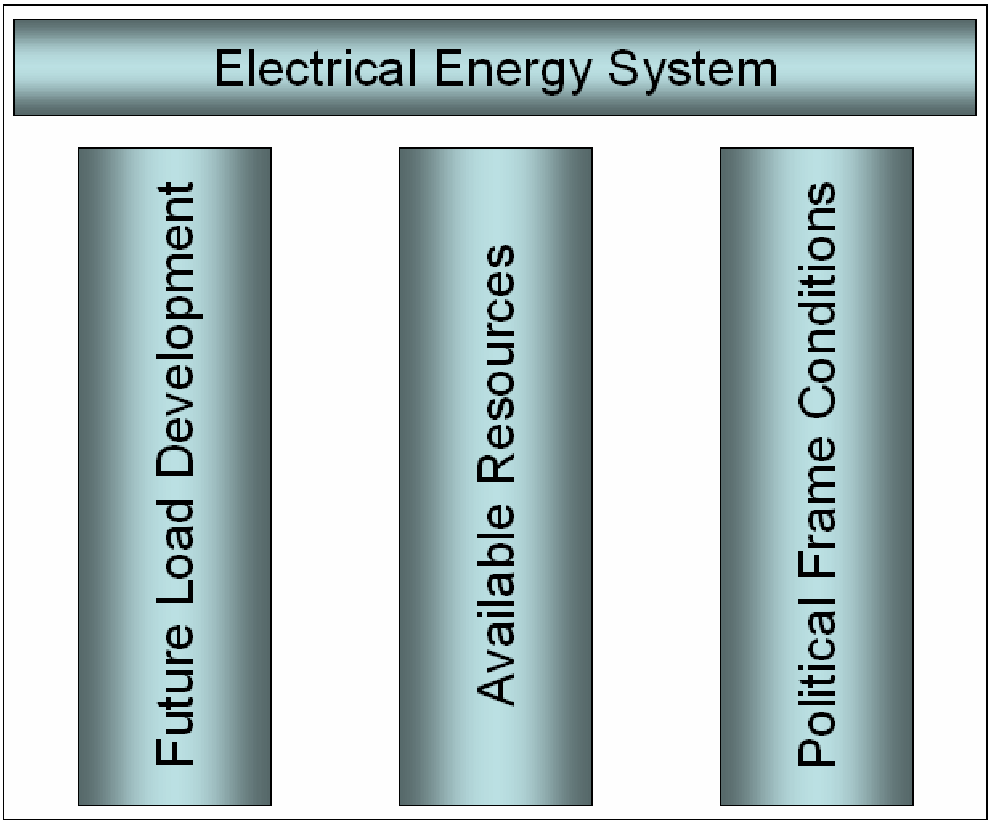

Figure 5-1 Three columns of development

However, in the existing global world it cannot be the only way to make such decisions just from the single point of view of the own country but to consider the general, political and economical development of the region including global development tendencies. Regarding its size, geographical and political situation Kosovo is to a special degree reliant on the European Energy Policy and therefore needs to create its energy political decisions generally compliant to European Union Directives.

5.1.3 Development and future meeting of demand

The growth of winter peak demand in Kosovo between 2000 and 2011 was extraordinarily high (see Table 5-1). The value nearly was doubled within 12 years and therefore requires urgently measures for the effective utilisation of electrical energy.

Year	Peak Load [MW]	Year	Peak Load [MW]
2000	653	**2006**	916
2001	763	**2007**	933
2002	723	**2008**	967
2003	759	**2009**	1072
2004	811	**2010**	1158
2005	898	**2011**	1150

Table 5-1 Real peak load development, 2000-2011

A special issue to be considered is the absence of powerful gas supply and combined heat and power units in bigger cities. Therefore electrical energy had to be taken and the winter peak load grew too fast. A continuation of this trend will lead to a permanently inefficient power system. So, in order to stop that tendency two emphasised measures should be implemented:

- Homogenisation of daily and annual load curves, i.e. shifting of high demand consumption to weak load times
- Reduction of peak load

The found forecast of peak load development till 2030 (see Table 5-2) considers the special conditions in Kosovo concerning warm water and heat production plus requires measures for efficient energy utilisation (among others the reduction of grid losses).

Year	Low Growth Scenario	Medium Growth Scenario	High Growth Scenario
2012	1,046	1,113	1,181
2013	1,076	1,147	1,218
2014	1,107	1,182	1,257
2015	1,138	1,218	1,297
2016	1,171	1,254	1,338
2017	1,205	1,292	1,380
2018	1,240	1,331	1,422
2019	1,275	1,370	1,466
2020	1,311	1,411	1,510
2021	1,348	1,452	1,556
2022	1,386	1,494	1,602
2023	1,426	1,538	1,650
2024	1,466	1,582	1,698
2025	1,506	1,627	1,747
2026	1,549	1,673	1,798
2027	1,592	1,721	1,850
2028	1,636	1,769	1,902
2029	1,681	1,818	1,956
2030	1,727	1,869	2,010

Table 5-2 Peak Load Forecast till 2030

5.1.4 Resources and economic power

It is important in terms of a functioning integration into the economical region of EU and the developing energy market in the Balkan region to consider neighboured power systems having the energy export as important option for extension of generation capacity in mind.

Complete covering of the demand, high security of supply and energy exports are on the one hand strategic energy economical objectives and the requirement of successful economical development but on the other hand the stimulus of such a successful development, too. Covering the demand does not only mean security of supply for Kosovo but also to develop Kosovo in Southern Balkan to a region with high supply standards considering energy exports as a strategic objective.

Important prerequisites for the development of an export orientated energy production and a supply structure meeting the demands are first of all the huge lignite reserves of Kosovo. Additionally the long-term experience concerning energy generation from lignite needs to be mentioned.

The limited economic power of Kosovo regarding the development of a modern, powerful, lignite based power plant park can be overcome by the support of private investors or the European Union. Therefore the future generation development is associated with attractive conditions and incentives for potential foreign investors. Important aspects of such a regulation by incentives are:

- The increasing energy demand comprehensively analyzed; even the Low Growth Scenario requires urgent constructions of new facilities.
- The general situation in Southern Balkan that is characterized by obsolete power plants and absent generation capacities but well extended transmission systems granting good possibilities for attractive energy trades.
- The fact that Albania as important neighbour uses a large share of renewable in-feed being increased by the planned constructions of new HPP gives the possibility of regionally exemplary rates for RES and to see the lignite itself not as dominating future strategy but as a system securing supplement in the mid-term. However, lignite power plants ensure the sustainable long-term extension of RES by granting security of supply.

- The impact of dry periods on the Albanian power system might be completely compensated on the one hand and on the other due to supply of hydro power in cases of water surpluses the lignite energy generation can be operated CO_2 optimized.
- The excellent controllability of Albanian hydro power plants and new Kosovan lignite units grant the integration of modern wind and solar power plants without problems for system security.
- New and state-of-the-art lignite units in connection with Albanian hydro power plants can be placed optimally both on control energy and OTC-market.

5.1.5 Political Framework

The necessary political frame conditions for the extension of a state-of-the-art power supply can be defined as follows:

- Investment security for investors by a clear and long-term affirmation regarding power generation by lignite
- Liberalisation of Energy Market
- Participation in the establishment of an Energy Exchange in the Balkan Region
- Evaluation of RES potential in Kosovo
- Evaluation of CHP potential in bigger cities
- Integration of RES by a special Renewable Energy Act
- Involvement of neighboured regions into the development of Kosovan energy production both as potential customers and as investors (RES, TPP, etc.)
- Cooperation with Albanian TSO OST concerning the design of a secure future power supply free from seasonal influences that is characterised by the utilisation of regional resources and an exemplarily high share of RES generation reaching and exceeding European climate objectives.

- Design of a price policy containing the components:
    - Security of Supply
    - Economical efficiency
    - Environmental Protection
    - Efficient energy utilisation

  in an equitable way.
- Creation of development and promotion schemes for the extension of LV- and MV- networks as contribution for the reduction of grid losses and improvement of power quality at the customers.

5.2 Recommendations

5.2.1 Energy Strategy

In full compliance with EU energy strategy (see Directive 2005/89/EC in Chapter 5.1.1) that orientates on own measures per country and additionally considering the three columns of development of a power system it is unavoidable to extend Kosovo's own generation capacities. Intensifying both energy demand increase and growing wear of existing power plants make new constructions necessary.

The analysis within this study has shown that the best optimised strategy (C and F as per Chapters 2.3.3 and 2.3.6), either in single Kosovan or joint Kosovan-Albanian operation, gives the respective best opportunities concerning meeting the demand, energy prices, export possibilities and effects on the RES and economical development.

In Figure 5-2 and Table 5-3 the assumed generation development is shown including all years of interest. The following assumptions were made:

- Realisation of planning process for the two new lignite units “TPP New Kosovo N1 and N2”
- Subsequent begin of planning for the further units “TPP New Kosovo N3 and N4”
- Construction duration of minimum 5 years per unit
- Planning and construction delay of TPP N4 of about 5 years due to huge requirements and time pressure within all projects necessary
- Zhur will not be constructed as Kosovo and Albania cannot agree on water utilisation of Drin River but may provide similar product within frame of common electricity market
- Shut-down of Kosovo A by 2018
- Total refurbishment and lifetime extension of Kosovo B in 2017 (B1) and 2018 (B2)
- Adequate growth and support of RES generators

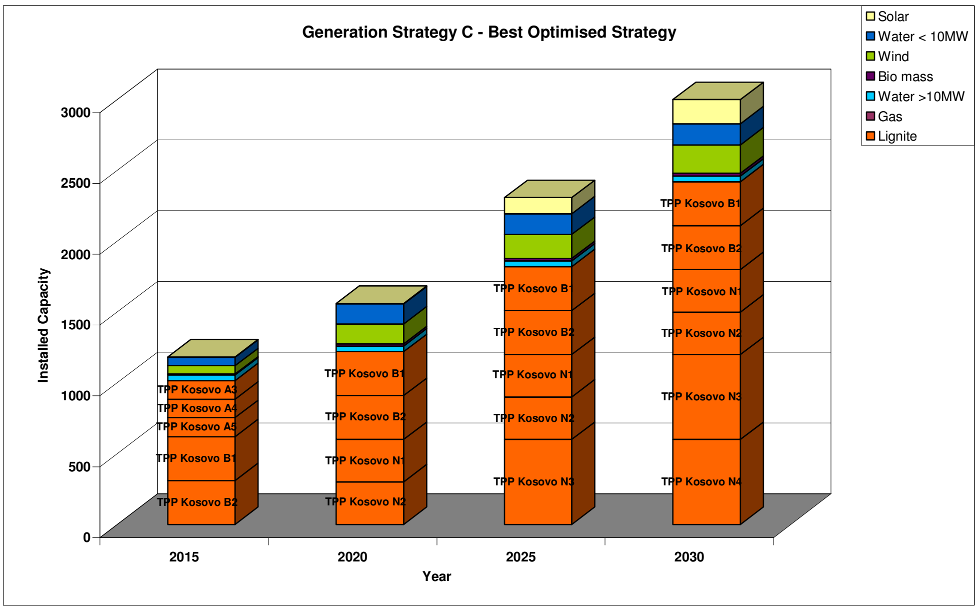

Figure 5-2 Kosovan share in generation development as per Strategies C and F

Generation units	2015	2017	2018	2020	2021	2025	2026	2030
TPP Kosovo A3	130	**0**	0	0	0	0	0	0
TPP Kosovo A4	130	130	**0**	0	0	0	0	0
TPP Kosovo A5	135	135	**0**	0	0	0	0	0
TPP Kosovo B1	310	**0**	310	310	310	310	310	310
TPP Kosovo B2	310	310	**0**	310	310	310	310	310
HPP Ujmani	32	32	32	32	32	32	32	32
HPP Lumbardhi	8	8	8	8	8	8	8	8
TPP N1	0	**300**	300	300	300	300	300	300
TPP N2	0	0	**300**	300	300	300	300	300
TPP N3	0	0	0	0	**600**	600	600	600
TPP N4	0	0	0	0	0	0	**600**	600
Biomass	60	90	105	141	142	146	146	150
Wind	60	90	105	140	146	170	176	200
HPP < 10MW	6	9	10,5	16	16,4	18	18,4	20
Solar	1,4	2,1	2,45	3	25	113	135	200
Oil	0	0	0	0	0	0	0	0
Gas	0	0	0	0	0	0	0	0
HPP Zhur	0	0	0	0	0	0	0	0
Total	**1,182**	**1,106**	**1,173**	**1,560**	**2,167**	**2,307**	**2,935**	**3,030**

Table 5-3 Kosovan share in generation development as per Strategies C and F

All in all it can be stated that an agreed common strategy concerning the development of electrical energy generation in Kosovo and Albania leads to a secure offer of generation capacity in Southern Balkan, facilitates the energy trades by an increasing supply and therefore improves the security of supply. The advantages of a joint control area were already described in the report „Joint Control Area Kosovo and Albania".

The aspect of creating a regional attractive mixture of conventional generation from lignite and a high share of renewable energy generation is economical, environmentally attractive and supports the security of supply. The integration of further neighbours into such a regional development concept is for Kosovo, with its huge lignite reserves, an important economic-political opportunity. The close cooperation with Albania might have an exemplary impact influencing possible investors.

The construction of the proposed lignite units is therefore not only a strategy regarding the development of Kosovan energy system but also a basis for a successful cooperation with neighbouring power systems and a successful position on power market. The geographical position of Kosovo, the energy demand development, the important huge lignite reserves and the very good integration into the 400-kV-system are objective locational advantages for power plant investors. Nevertheless new lignite units give also to wind and solar power generators the possibility for better integration into the energy system, as the weather related fluctuation can be compensated by powerful, well controllable lignite units and Albanian hydro power plants and remain invisible for the customers.

5.2.2 Environment strategy

Especially in countries which have sufficient lignite reserves it is meaningful for utilisation and gives an independence from other countries. However besides the industrial benefits environmental issues have to be taken into account. These plants generate a number of residues, wastes and large amounts of emissions. Main emissions are from CO_2 – carbon dioxide, SO_2 – sulphur dioxide and NO_x – nitric oxides. But in building new lignite power plants also new state-of-art facilities and measures are implemented as they considerably reduce the pollutants. It is believed that benefits are far more beyond the potential negative impacts.

As it can be seen in chapter 3.2 the calculated values for the assumed emissions per year in Strategy C for CO_2 , SO_2 and NO_x till the year of 2030 are shown.

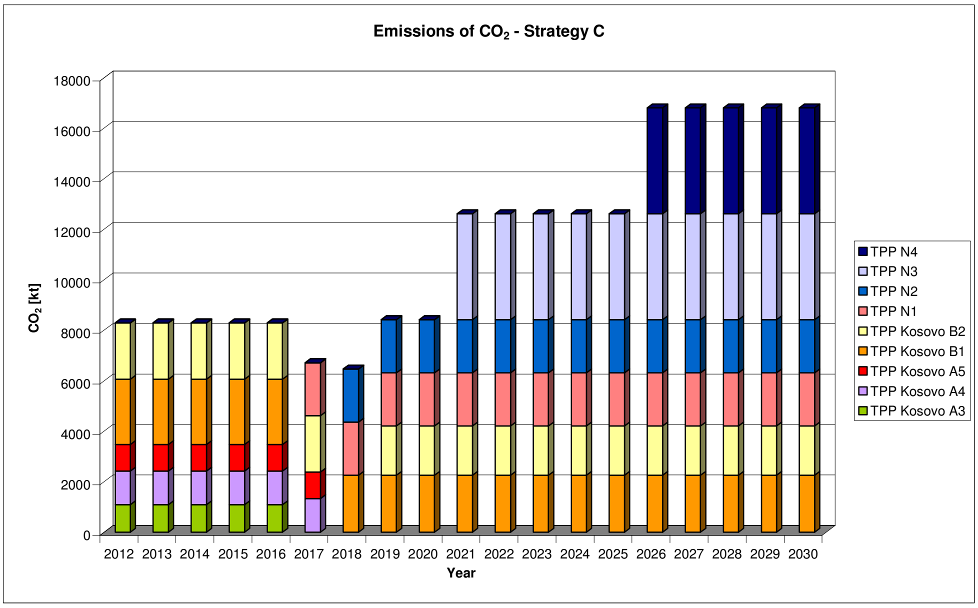

Figure 5-3 Annual CO_2-emissions in Strategy C till 2030

In Figure 5-3 it can be seen that values for CO_2 are increasing despite the new technologies and refurbishment measures of elder plants Kosovo B1 and B2. However this is also understandable due the greater number of power plants. There is an increase in the year 2021 and 2027, when the new power plants should come in operation. The usage of renewable energy sources contributes to lower emissions of CO_2.

As far as SO_2 is concerned, as already mentioned in Chapter 3.2, there will be a great decrease in emission, due the state-of-art units, which are emitting 20% to 25% of SO_2 per MWh in contrast to elder units. In strategy C there is a doubling of lignite generation units but the emission is half as it was before operating of the new units and refurbishment of the old ones. Decrease will happen only due to refurbishment measures and construction of state-of-the-art units (see Figure 5-4).

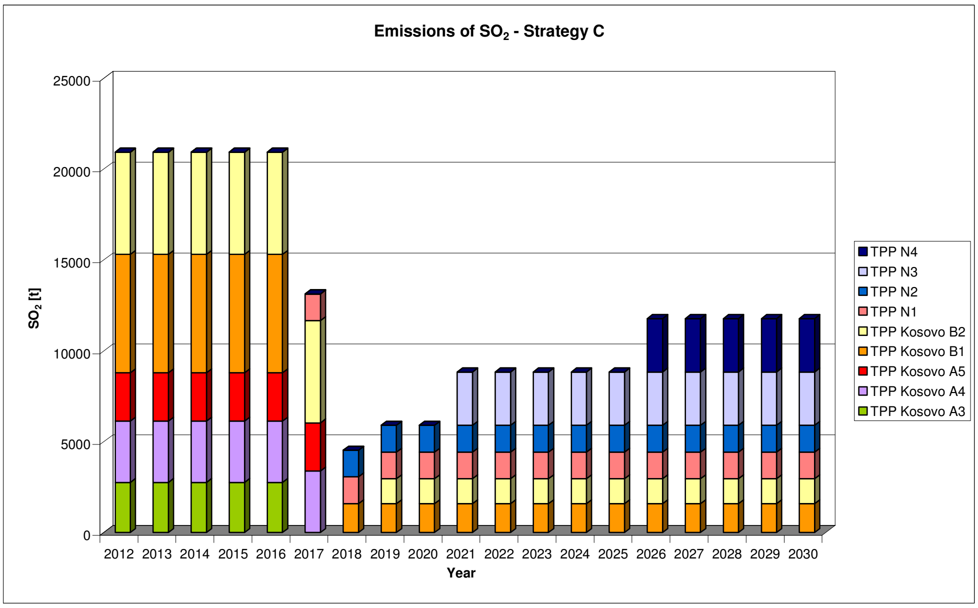

Figure 5-4 Annual SO_2-emissions in Strategy C till 2030

Similar conclusion as for SO_2 can be drawn for NO_x. State-of-art units emit 15% to 20% of NO_x per MWh in comparison with old units. In a case of NO_x in strategy C the total amount will be less than a half of amount before the new and refurbished units. This can be seen in following Figure 5-5.

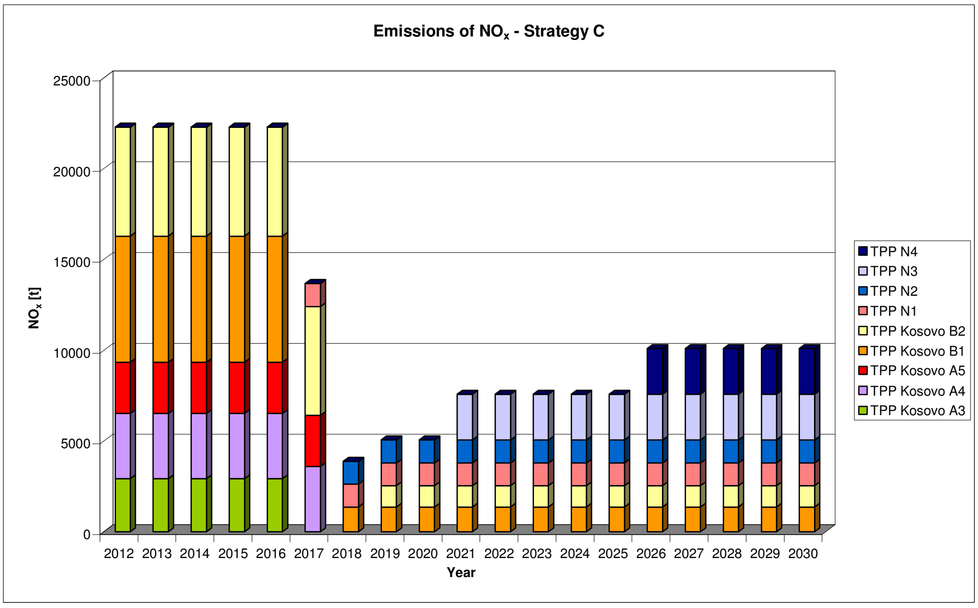

Figure 5-5 Annual NO_x-emissions in Strategy C till 2030

In regard to European legislation the smoke gas of power plants needs to fulfil hard restrictions concerning its several components. These are increasing the investments costs to about 30% in Germany. Also such facilities are reducing the power plant efficiency for about 2-3%. There are several processes, variations in equipment and techniques that can be used to reduce emissions from combustion installations for energy generation:

- Primary measures – Integrated measures to reduce emissions at source or during combustion, including:
    - Fuel-supply measures
    - Combustion modifications.

- Secondary measures: End-of-pipe measures, i.e. those that control emission to air, water and soil:
    - Techniques to reduce sulphur oxide emissions
    - Techniques to reduce nitrogen oxide emissions
    - Combined techniques to reduce sulphur oxide and nitrogen oxide emissions
    - Techniques to reduce heavy metal emissions
    - Techniques to reduce other pollutants arising from the combustion of fossil fuels
    - Techniques to control releases to water
    - Techniques to control releases to land
    - Cooling techniques
    - Emission monitoring and reporting
    - Management systems.

- **Sulphur oxides SO_2**

Emissions of sulphur oxides result mainly from the presence of sulphur in the fuel. Besides the use of low sulphur fuel the techniques are mainly wet scrubber (reduction rate 92 – 98%), but with high costs, and spray dry scrubber desulphurisation (reduction rate 85 – 92%). Dry sorbent injection is used mainly for plants with a thermal capacity of less than 300 MWth.

Limit emissions for SO_2 are 200mg per standard cubic meter. In the following Figure 5-6 the wet scrubber principle is depicted. The basic principle is that the smoke gas is sprayed by the lime. The final product containing about 90% solids as gypsum can be used for plaster, cement and wallboard. The possibility of selling gypsum might contribute to an overall reduction of the total operation costs.

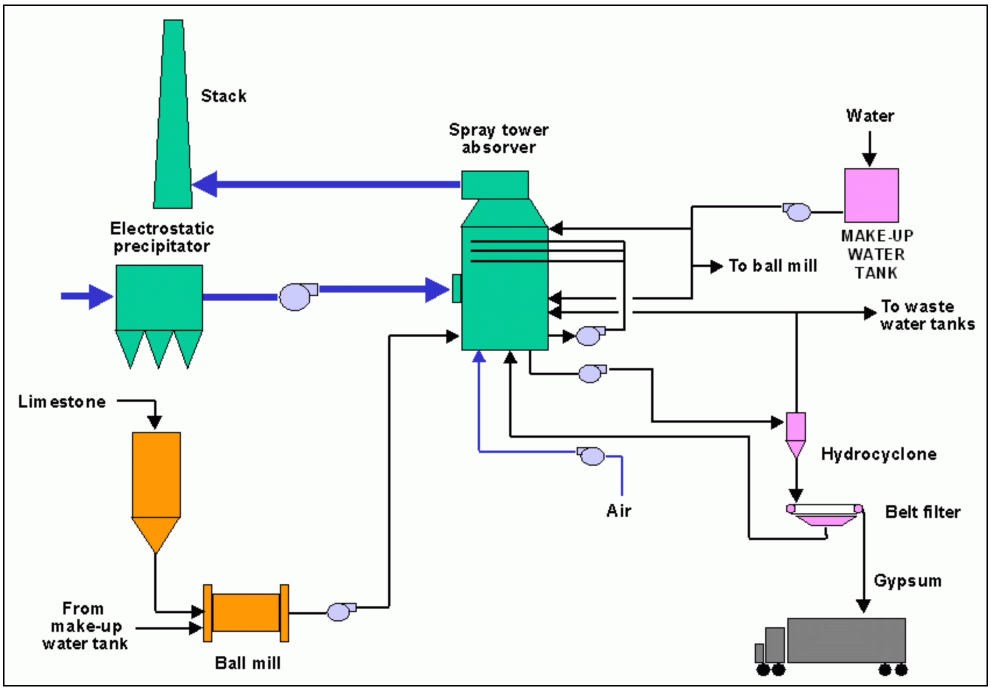

Figure 5-6 Principle of wet scrubber technique; [21]

- **Nitric oxides (NO_x)**

The principal oxides of nitrogen emitted during the combustion of fossil fuels are mainly nitric oxide (NO) and nitric dioxide (NO_2). The emission limits are given in the Table 5-4.

Size	50-100MW	100-300MW	300-500MW	>500MW
Existing plant	600	600	600	500 200 (from Jan 2016)
New plant	400	200	200	200

Table 5-4 Nitric Oxides - Emission limits-European Union, [mg/sm³]; [22]

Techniques to reduce nitric oxides are divided into primary and secondary measures. Primary measures have been developed to control NO_x-formation and/ or reduction in the boiler, whereas secondary measures are end-of-pipe techniques to reduce NO_x-emissions. There are many primary measures (combustion modifications) that are done in such a way to suppress nitric oxides formation in combustion installations. All these measures aim to modify operational or design parameters of combustion installations in such a way that the formation of nitric oxides is reduced or already formed nitric oxides are converted inside the boiler before their release. Secondary measures are end-of-pipe techniques to reduce the nitric oxides already formed. They can be implemented independently or in combination with primary measures. Most flue-gas technologies to reduce NO_x-emissions rely on the injection of ammonia, urea or other compounds, which react with the NO_x in the flue-gas to reduce it to molecular nitrogen.

- **Dust emissions**

Particulate matter (dust) emitted during the combustion of solid or liquid fuels arise almost entirely from their mineral fraction. The emission limit for new power plants amounts 5 to 10mg/ 20 mg per standard cubic meter depending on the installed capacity. For de-dusting emissions from new and existing combustion plants the use of an electrostatic precipitator (ESP) or a fabric filter (FF) is necessary, whereas a fabric filter normally achieves emission levels below 5 mg/sm³. Cyclones and mechanical collectors as a pre-cleaning stage might be taken, as well.

- **Carbon capture and storage – CCS**

Carbon capture and storage (CCS), as already explained in Chapter 3, refers to a set of technologies designed to reduce carbon dioxide (CO_2) emissions from large-point sources such as lignite-fired power plants.

CCS technology (or sequestration) involves capturing CO_2 and then storing it in a reservoir instead of allowing it to be released into the atmosphere, where its accumulation contributes to climate change and greenhouse effect. In the nature CO_2 is removed from the atmosphere and stored in vegetation, soils or oceans. Forests and agricultural lands store carbon dioxide in the natural environment and the oceans exchange massive amounts of CO_2 from the atmosphere by natural processes. Figure 5-7 shows possibilities of storing CO_2.

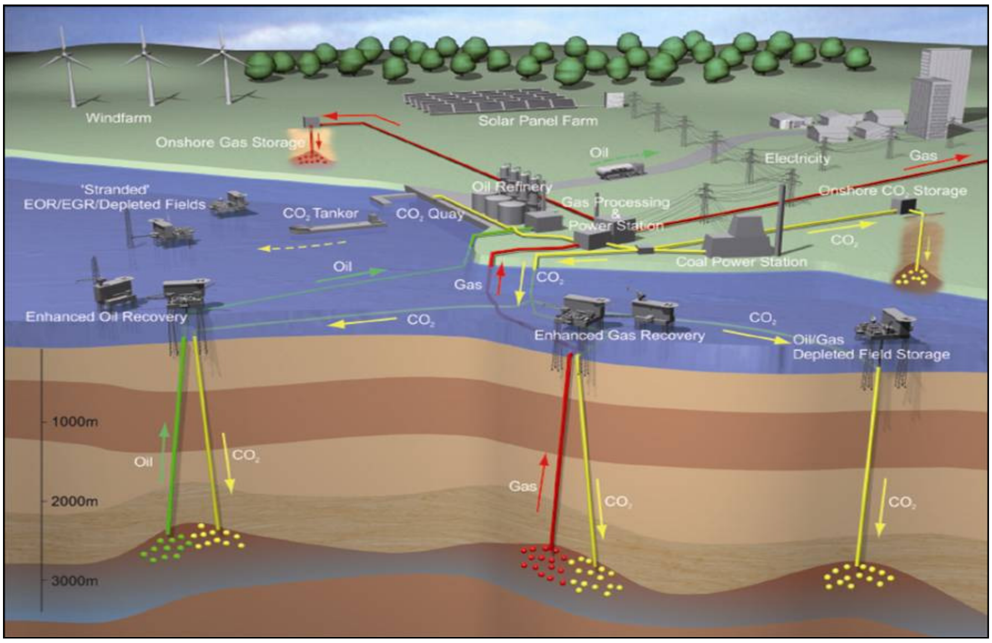

Figure 5-7 CCS storage possibilities; [23]

An integrated CCS system would include three main steps:

- capturing and separating CO_2
- compressing and transporting the captured CO_2 to the sequestration site share and
- sequestering CO_2 in geological reservoirs

There are three different types of technologies:

- Post combustion capture: This process involves extracting CO_2 from the flue-gas following combustion of fossil fuels or biomass.
- Pre-combustion: This process separates CO_2 from the fuel by combining it with air and/ or steam to produce hydrogen for combustion and a separate CO_2 stream that could be stored.
- Oxy-fuel combustion: This process uses oxygen instead of air for combustion and produces a flue-gas that is mostly CO_2 and water, which are easily separable, after that the CO_2 can be compressed, transported and stored. This technique is still considered to be developmental.

Although CO_2 has been injected into geological formations for various purposes, the long term storage of CO_2 is a relatively new concept. The first commercial example was Weyburn in 2000.

5.2.3 Mining strategy and its environmental impact

The Energy Strategy of the Republic of Kosovo stated that in the long term lignite will remain the main energy source for production of electricity in Kosovo. Present day lignite mining sector is the outcome of capital investments realised several decades ago. Those investments included the development of today existing Bardh and Mirash mines with total lignite reserves of 300 million tons and the construction of Kosovo A and Kosovo B.

Lignite reserves in Kosovo are located in two large basins “Kosova” and “Dukagjini”. Geological lignite reserves are assessed to amount 12.5 billion tons (including all categories of reserves). Table 5-5 presents a summary on lignite reserves.

Basin	Surface [km²]	Reserves [Mt]			
		Explored		Exploitable	
		T	t_{ce}	T	t_{ce}
Kosova	274	10,091	2,597	8,772	2,521
Dukagijini	49	2,244	782	2,047	464
Other	5	106	22	73	19
Total	**328**	**12,441**	**3,761**	**10,892**	**3,004**

Table 5-5 Kosovan lignite reserves; [2]

Kosovo’s lignite has low sulphur content. Therefore only a relatively low concentration of lime (calcium oxide) for absorbing sulphur during the combustion process is necessary. The ratio between lignite and overburden is pretty favourable, a fact that makes exploitation of these mines with open cast mining competitive and attractive. The development of a new lignite mine “New Mine” seems to be the most acceptable option from the economic, social and environmental point of view. Geologic lignite reserves of the “Dukagjini” basin are estimated at 2,244 million tons. Opening of the new mines at this location could be planned and possibilities for developing new power generation capacities explored.

Considering the exhaustion of lignite reserves in the Bardh and Mirash mines the opening of the new lignite mine has been planned in order to secure continuous supply for the existing power plants Kosovo A and Kosovo B and for potential expansions of generation capacities. The “New Mine” in Sibove, is assessed at 830 Million tons, an amount which is sufficient to supply the proposed power plant park with about 2,400MW installed lignite capacity in total as per Strategy C for the next 40 years.

Any use of fossil fuels is associated with intervening in nature, both the degradation of raw materials to energy use and the disposal of waste products. Lignite mining has a severe impact on the environment. It leaves huge areas behind, where the ecosystem is permanently destroyed. Besides that there are also social issues as many villages and towns need to be removed. Open-pit mining requires large amounts of water for coal preparation plants and dust suppression. In order to meet this requirement mines acquire (and remove) surface or ground water supplies from nearby agricultural or domestic users, which reduces their productivity. These water resources (once separated from their original environment) are rarely returned after mining, creating a permanent degradation in agricultural productivity. This also lowers the groundwater level to a level below the deepest pit bottom. Emerging dust can be dangerous for the people who are working and for the surroundings.

Thereafter, the mining companies in Germany are obliged to rehabitate the surface of mines by the end of their use, i.e. to restore natural habitats for flora and fauna. A special company, responsible for the recultivation, was found, the Lausiter- und Mitteldeutsche Bergbau-Verwaltungsgesellschaft (LMBV). The reclamation is always in accordance with established criteria for use of state planning goals. In addition to economic aspects equal importance is given to the nature protection and landscape conservation and recreation. Thus, new and valuable habitats and ecosystems as well as lakes, forests or fields for agricultural use will be created. Hereinafter some recultivation possibilities are mentioned exemplarily.

- In the region “Lusatian Lakescape” (Lausitzer Seenland), between Berlin and Dresden, a lake district is flooded by rain and river water and therefore touristically developed out of closed open pit mining areas. Altogether 23 artificial lakes form a unique landscape. In few years 10 lakes will be connected by canals. The total complex is depicted in the following pictures (Figure 5-8 to Figure 5-10).

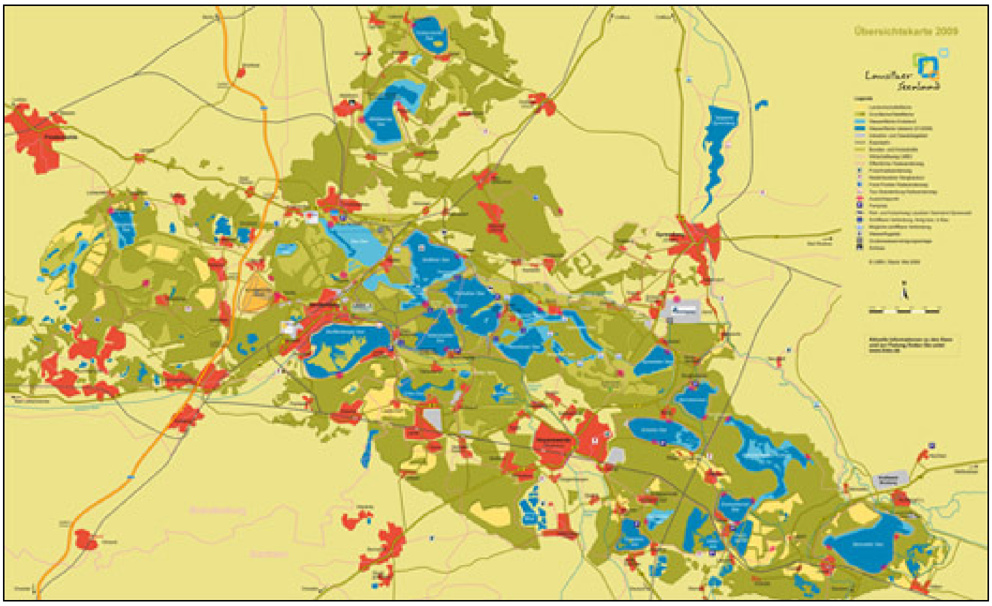

Figure 5-8 Overview Map „Lusatian Lakescape“; [24]

Figure 5-9 Overview about a part of Lusation Lakescape; [25]

Figure 5-10 Sailors in front of TPP Boxberg on Lake "Bärwalder See"; [26]

- Another example is Ferropolis, the city of steel. Five disused bucket wheel excavators, continuous bucket dredgers and stackers, each up to 130m long and 30m high, are located on a peninsula in the lake Gremmin, the former coal mine Golpa-Nord.

Figure 5-11 Ferropolis, city of steel; [27]

Nowadays it is a living museum but also provides a breathtaking setting for all kinds of activities, events, festivals and much more.

- For the former open pit mining area in Meuro between the cities of Cottbus and Dresden a very interesting re-use possibility was found. From 1960 to 1999 altogether 300 million tons of lignite were exploited there (see Figure 5-12). The utilised areas are nowadays recultivated again. In the flooded part there will be the Lake "Großräschener See". In the refilled part there is since 2000 the Eurospeedway Lausitz (see Figure 5-13) in operation arranging a lot of motorcycle and car races on the one hand but concerts and festivals on the other hand, too.

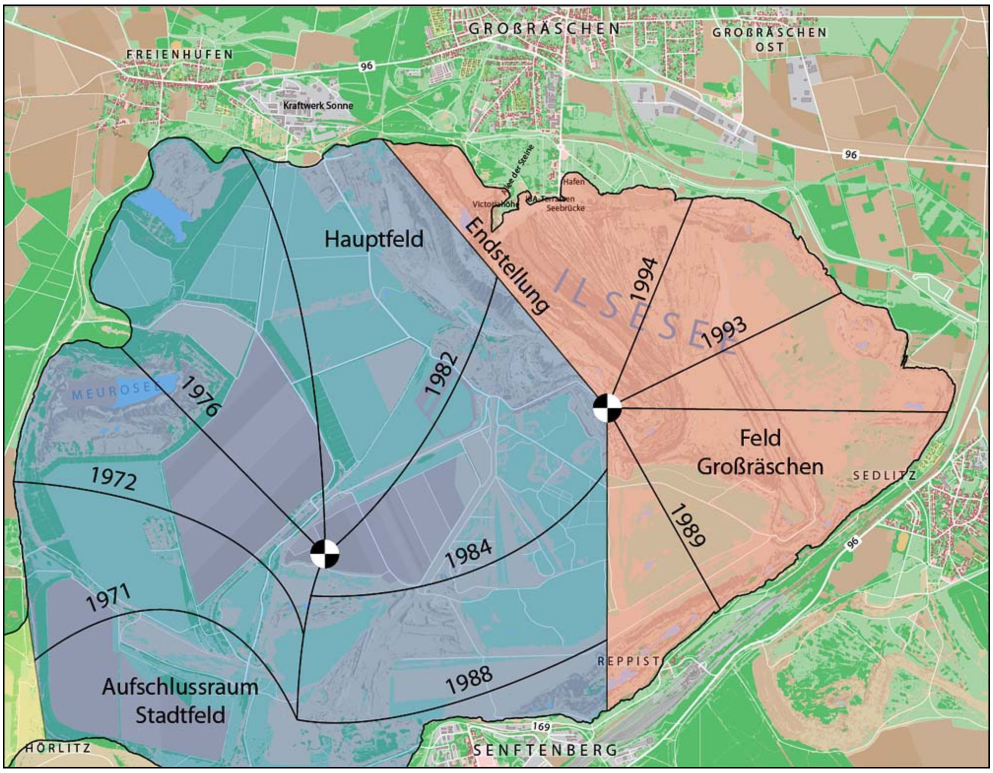

Figure 5-12 Open Pit Mining Area Meuro; [28]

Figure 5-13 Eurospeedway Lausitz; [29]

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List of abbreviations

APX	Amsterdam Power Exchange
BKartA	Bundeskartellamt Federal Cartel Office
BNetzA	Bundesnetzagentur German Federal Grid Agency
BPMO	Borzen Power Market Operator
CCS	Carbon Capture and Storage
CRE	Commission de Régulation de l'Énergie France Energy Regulation Commission France
ECC	European Commodity Clearing AG
E-Control	Energie-Control Austria
EEX	European Energy Exchange
ElCom	Eidgenössische Elektrizitätskommission Schweiz Swiss Electricity Commission
EnCT	Energy Community Treaty
ENTSO-E	European Network of Transmission System Operators for Electricity
EPEX	European Power Exchange
EU	European Union
EXAA	Energy Exchange Austria
FIU	Financial Intelligence Unit
GDP	Gross Domestic Product
GME	Gestore del Mercato Elettrico
HGS	High Growth Scenario (Load)
HPP	Hydro Power Plant
ICT	Information and Communication Technologies
ISET	Institut für Solare Energieversorgungstechnik ISET
KEK	KorporataEnergjetike e Kosovës
KOSTT	Operator Sistemi, Transmisioni dhe Tregu

LGS	Low Growth Scenario (Load)
LPX	Leipzig Power Exchange
MGS	Medium Growth Scenario (Load)
MR	Minute Reserve
NPPEX	Nordic Power Exchange
NRA	National Regulatory Agency
NTC	Net Transfer Capacity
OH	Operation Handbook
OMEL	Operador del Mercado Eléctrico
PCP	Primary Control Power
PolPX	Polish Power Exchange
PTK	Posta dhe Telekomunikacionii Kosovës
RES	Renewable Energy Source
SCP	Secondary Control Power
SEE	South-East Europe
SMWA	Sächsisches Ministerium für Wirtschaft, Arbeit und Verkehr Saxonian Ministry for Economy and Traffic
TPP	Thermal Power Plant
TRACFIN	Traitement du renseignement et action contre les circuits financiers clandestins Treatment agency for information and action against illegal financial circuits
TSO	Transmission System Operatot
VPC	Vattenfall Europe PowerConsult GmbH
WCMS	Wind Park Cluster Management System
WPMS	Wind Power Management System
WPP	Wind Power Plant