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Development of Renewable Energy in Kosovo and Impact on Economy

MASTER'S THESIS

to achieve the university degree of

Diplom-Ingenieur

Master's degree programme: Electrical Engineering

submitted to

Graz University of Technology

Supervisor

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Graz, June 2021

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Acknowledgment

First and foremost, I want to make it clear that this Master's thesis would not have been possible without the help of my mentors from the Institute of Electricity Economics and Energy Innovation at the University of Technology in Graz, and all the other professors and colleagues during my entire master's program who helped me directly or indirectly to get this far into my academic studies.

My special thanks go to my supervisor Mr. Karthik Bhat as well as my mentor Prof. Dr. Udo Bachhiesl who gave me the unique opportunity to do this wonderful thesis on the topic "Development of Renewable Energy in Kosovo and the Impact on Economy", which also helped me in doing a lot of research and I have learned a lot of new things, which I am grateful to them.

Furthermore, I really want to thank all the researchers that I have come across during research. They deserve the greatest respect for having made invaluable contributions in the form of scientific publications that have empowered me to better understanding of the topic covered in my master thesis.

Special thanks go to my parents and my girlfriend who helped me a lot in finalizing this goal.

Above all, I would like to thank God for His never-ending grace, mercy, and care during what ended up being one of the toughest times of my life. Studying in Europe was a dream come true for me, but at the same time a tough challenge.

Shpat Memishi

November 2019

Graz, Austria

Abstract

The development of renewable energy and its impact on the economy are the subject of this master's thesis. Given the fact that Kosovo is one of the countries in the region that has invested the least in renewable energy, this topic aims to provide facts that demonstrate the renewable energy potential in Kosovo and beyond, the impact of this potential in the domestic economy.

In the century that we are living in, in most of the countries in the European Union and beyond, the main research in the field of energy production has been focused on renewable energy and, moreover, most investments are being made in this type of electricity production. The reasons are the following: lower production cost, extraordinarily high environmental protection, and greater impact on the country's economic development.

One of the main reasons why renewable energy is considered such important is the preservation of the environment. While many large corporations around the world are trying to minimize global warming, this phenomenon is nowadays the main concern of humanity.

Throughout the topic you will find various facts showing that one of the chief reasons why the capital of Kosovo is one of the most polluted cities in Europe is the production of electricity from coal.

The results show that Kosovo is a country with enormous potential for renewable energy. In cooperation with neighbouring country Albania, these two countries can become a very important factor of electricity stability in the Balkans by investing in renewable energies.

Abbreviations

BMVIT	Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (Federal Ministry of Transport, Innovation and Technology)
EE	Energy Efficiency
EMS	Elektromreža Srbija (Serbian national transmission system operator company)
ERO	Energy Regulatory Office
ETU	Lower Calorific Value
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GJ	Gigajoule
GW	Gigawatts
GWh	Gigawatt hours
H	Ash
HPP	Hydropower Plant
IRR	Internal Rate of Return
KEDS	Kosovo Electricity Distribution Company
KEK	Koorporata Energjitike e Kosoves, (Kosovo Energy Corporation)
KESCO	Kosovo Electricity Supply Company
KFOS	Kosovo Foundation for Open Society
KOSTT	Operator Sistemi, Transimisoni dhe Tregu (Transmission, System and Market Operator)
kV	Kilowatt Amperes
L	Moisture
LCP	Large Combustion Plant
MED	Ministry of Economic Development
MW	Megawatt
NKEC	New Kosovo Energy Company
NPP	New Power Plant
NPPKR	New Power Plan Kosova e Re
NPV	Net Present Value
PPA	Power Purchase Agreement
PV	Photovoltaic

RE	Renewable Energy
RES	Renewable Energy Sources
S	Sulphur
SESA	Strategic Environmental and Social Assessment
T&D	Transmission and Distribution
TPP	Thermal Power Plant
UNDP	United Development Program
WB6	Western Balkans 6

1 Introduction

Several studies show that Kosovo, in the last decade, is facing difficult energy and development choices, which may in future have an impact on the energy supply available to meet basic needs and for economic growth. From an environmental point of view, these choices will have an impact on health of population. The economic point of view will determine the job creation in the energy sector. Kosovo, a new country in the transitional phase, is a member of the Energy Community. [Energy Community, 2019]

As such, it has various obligations and targets to reach. Given these (read: the path Kosovo will choose), this chosen path could make Kosovo have a greater (fundamental) role in the Committee and the European Union.

There is a variety of opportunities that Kosovo could utilize, to ensure that energy development will be sustainable. The World Bank, European Bank, and the individual donor nations are among them. The energy sector in Kosovo is in a very bad condition. The actual Distribution Network was constructed during the last century. As such, it will require significant financial investment as well as investments in terms of capacity support.

The Renewable and Appropriate Energy Laboratory at the University of California, Berkeley[1] has made an evaluation of the benefits and costs in economic, social, and environmental terms of a number of energy scenarios for Kosovo. [University of California, Berkeley, 2012]

This study shows the current energy alternatives that exist in Kosovo today, and what can be created through the wise use of fossil fuel resources, investigation of new energy efficiency, and at last, but not the least important, the investment in the Renewable Energy (RE).

This study will be more concentrated in the Investment in the Renewable Energy. Basically, in the comparison between investment in the renewable energy and traditional energy production today in Kosovo, and its impact on the economy.

Knowing the current economic state in Kosovo today, one of the key components of energy plan for Kosovo should be job creation. Kosovo is among the most economically backward developing countries in Europe where the percentage of unemployment is very high. Given that, it is very important to recognize what kind of investment in the Energy section will generate more jobs.

As mentioned above, Kosovo is a part of the Energy Community, along with the ambition to be the next country in the European Union. Given that, there are some obligations that Kosovo should fulfill. As mentioned above, Kosovo is a country of the Energy Committee, with the aim of being in the European Union as well. To achieve this, there are several obligations that Kosovo must meet such as Renewable Energy, Energy Efficiency, new interconnection lines (high voltage lines between states), a better (easy)market and secure liberalization energy market. In all of them

[1] RAEL is a unique multidisciplinary research group that has been working for decades and focuses on the systems science of clean and sustainable energy systems.

Kosovo has several serious shortcomings. There is some relative progress, but much work remains to be accomplished, especially at the distribution system level.

This study will focus on all above-mentioned facts and will analyze the actual situation to provide a few insights for the future of Kosovo's electricity section.

2 Fundamentals of the Electricity Sector of Kosovo

2.1 Current Electricity Supply Balance in Kosovo

2.1.1 Power Generation

The demand for electricity in Kosovo exceeds the domestic supply capacity. The increase in demand increases the gap between demand and supply. Import costs are often much larger than the costs of internal generation of electricity.

2.1.2 Fossil Fuels (Coal)

Of the generic electricity generating capacity in Kosovo, 95 percent of capacity is generated from lignite. Nowadays the country has two power plants, Kosova A and Kosova B, both using the lignite mines of Mirash and Bardh and recently the Sibovc South-West mines and Sitnica mines. The combined installed capacity of the two power plants is 1,478 MW, and the same would be enough to cover Kosovo's electricity demand if they were perfectly available. [Energy Regulation Office, 2017]

However, due to the aging and non-operation of two Kosova A units, the net operating capacity of these two power plants is significantly reduced. These plants are property and are operated by Korporata Energjiteke e Kosoves (KEK).

Kosova A operates with 5 units (A1-A5). Two of them are no longer operational as mentioned above. The three other units, which were built between 1970 and 1975 have an installed capacity of 610 MW, the first two units 200 MW each, and the third one 210 MW and a net capacity of 350 MW and operates with an efficiency of 26 percent. [KEK, 2019]

The annual electricity production from TPP Kosova A is about 1500 GWh. However, with its poor efficiency, Kosova A consumes 1.7 tons of lignite for a produced megawatt, and has unacceptably high emissions, which exceed 700 mg/m3. For this reason, plans have been made for its decommissioning, whenever it is possible to replace its capacity.

Kosova B operates with two large units (B1 and B2) with an annual installed capacity of 340 MW each, which came into service in 1983 and 1984. Both units are depreciated in capacity of 280 MW and operate at an efficiency of 32%. [KEK, 2019]

From 2005 to 2015 the averaged of annual production of Kosova B in the generator was about 3,750 GW. 2013 is the year when this power plant has achieved record production in its history since its inception, as the value reached 4196,314 GW. Moreover, the Kosova B power plant will not be able to meet the standards set out in the EU Directives for Large Combustion Plants (LCPs), unless it will be rehabilitated.

Table 1 shows the data of the installed capacity of Thermo Power Plant (TPP) Kosova A&B.

Table 1: Capacities of existing TPP Kosova A&B

	Available Capacity		Installed Capacity	First year	Retirement
Name	min (MW)	(MW / h)	(MW / h)	Year	Year
Kosova A1	n.a.	n.a.	65	1962	2007
Kosova A2	n.a.	n.a.	125	1965	2002
Kosova A3	120	130	200	1970	Q4 2023
Kosova A4	120	130	200	1971	Q4 2023
Kosova A5	120	135	210	1975	Q4 2023
Kosova B1	200	260	339	1983	>2030
Kosova B2	200	260	339	1984	>2030

Figure 1 shows photos of TPP Kosova A and Kosova B.

Figure 1: Photo of TPP Kosova A and Kosova B [KEK, 2019]

2.1.3 Hydropower – Current Situation

The other percentage is covered by renewable energy resources (RES), such as hydropower plants (HPP) and wind energy.

In Table 2 it's presented the installed capacity of existing HPP in Kosovo. [KOSTT, 2019]

Table 2: Installed capacity of HPPs

Generating Units	Installed Capacity (MW)	Net Capacity (MW)
Ujmani	35	32
Lumbardhi 1&2	8.08	8
Belaja	8.08	7.5
Decani	9.81	9.5
Lumbardhi Cascade	31.37	30.20
Total	**66.37**	**62.20**

HPP Ujmani is a public enterprise, operated by a public company called “Iber Lepenci”. The plant is directly connected to the transmission network and in 2016 it had a net generation of 114 GWh. The other HPPs are owned by private investors and are connected to several locations in Kosovo's distribution network.

2.1.4 Wind Power

Last year the Kosovo Energy Regulatory Authority accepted the application by a Turkish company Air Energy for a license to generate electricity for the Kitka wind farm having an installed capacity of 32.4 MW. Kitka wind farm with 13 Units each of them 2.5 MW generates 95.600.000 kWh electricity per year.

The first wind power plant that its facilities have been brought into operation with an installed capacity of 1.36 MW is located in Golesh.

However, the power plant was shut down shortly after commissioning According to official Energy Regulatory Office (ERO) data these devices are amortized and therefore are not entitled to the full capacity which at the beginning of the project was foreseen to produce renewable energy from wind.

Golesh's location is known for its good wind conditions, but sufficient studies or measurement values have not been made.

There are other wind energy projects which are going to be built in the future, which will be discussed in the next chapter.

2.2 Transmission System Flows

Total energy flow (GWh) through the electricity transmission (KOSTT[2]) in 2019 is planned to be around 6,073.3 GWh. [Energy Regulatory Office, 2018]

Figure 2 shows the percentage of generation of electricity in Kosovo. The total demand in the distribution network (households, public lighting, small businesses, etc. connected to the voltage level 35 kV, 10 kV and 0.4 kV, distribution losses) is projected to be 4,470.4 GWh. Approximately 95% of energy is generated by the two biggest power plants in Kosovo (Kosova A and B). The other 5% by RES. (Figure 2)

[2] KOSTT J.S.C is electricity Transmission, System and Market Operator of the Republic of Kosovo, a public company with 100% of shares owned by the Republic of Kosovo.

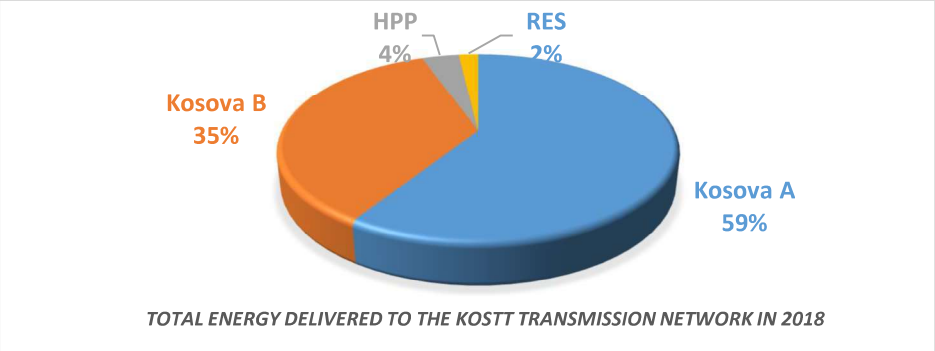


Figure 2: Total energy delivered to the KOSTT transmission network in 2018 (GWh)

Electricity losses in the transmission system were 121 GWh (2% of net energy input). This includes the losses caused by transit.

Figure 3 shows the transmission losses during the period 2006-2016. [Energy Regulation Office, 2017]

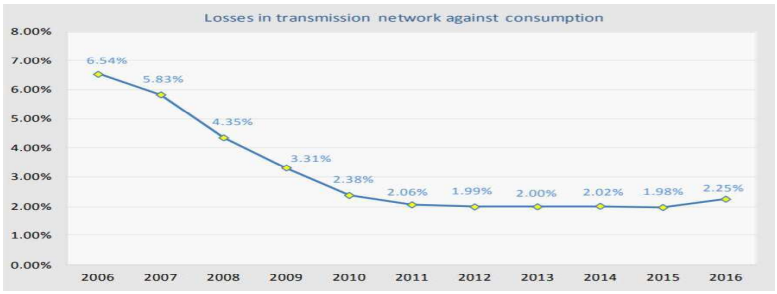


Figure 3: Transmission losses 2006-2016

Figure 4 shows the electricity flow of through connection lines. [Energy Regulation Office, 2017]

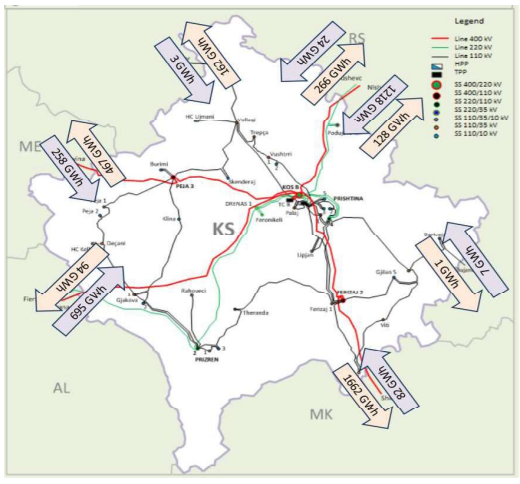


Figure 4: Flow of electricity in the electricity network of Kosovo [Statement of Security of Supply for Kosovo, 2016]

There are three major industrial customers that directly consume electricity distributed by the KOSTT transmission network: Ferronikeli, Trepça and Sharrcemi. The total consumption by these customers in 2018 was 507.2 GWh. The other part of generated electricity (5,566.1 GWh) has been supplied to the distribution system.

The main part of produced electricity goes to the houshold costumers. The other part goes to high voltage, comercial and industrial consumers. A small part of electricity goes to the public lighting and other small consumers. Table 3 shows the electricity consuption by sectors, during the years 2009-2017. [Kosovo Agency of Statistics, 2018]

Table 3: Electricity consumption by sectors (2009-2017)

Years	2009	2010	2011	2012	2013	2014	2015	2016	2017
Houslhold (GWh)	1,768	1,873	2,007	2,084	2,130	2,050	2,133	2,209	2,288
Customers (220-110 kV(GWh)	544.0	700.6	679,5	473.1	487.1	622.9	671.7	306.4	474.9
Comercial GWh	527.9	569.9	634.7	677.0	702.0	710.3	792.3	835.9	868.8
Industrial GWh	227.5	222.6	244.4	240.9	239.4	229.8	262.7	309.6	355.8
Publik Lighting &others (GWh)	132.5	109.9	118.6	136.7	146.3	130.5	131.5	128.4	117.4
Total consamption (GWh)	3,200	3,480	3,684	3,611	3,705	3,743	3,971	3,789	4,105

These data are illustrated in Figure 5, in order to have a clear view of consumption of electricity in Kosovo during this period of time.

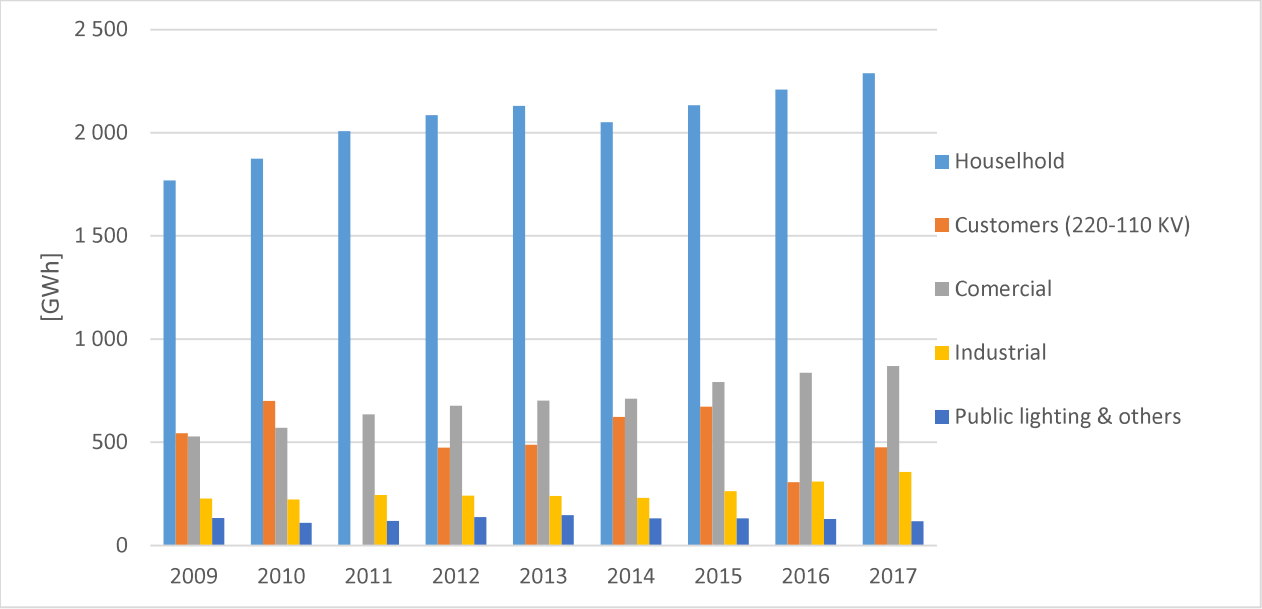


Figure 5: Electricity consumption (2009-2017)

2.3 Demand and Generation Forecast

A study conveyed in University of California, Berkley in 2012 was based on KOSTT calculations. [University of California, Berkeley, 2012]

These calculations show that three forecast scenarios for the period 2011-2020 estimate the total consumption and peak load. „base" scenario, "low growth" scenario and "high growth" scenario. 3.2 % growth of GDP is assumed by "base" scenario. "Low growth" scenario that corresponds to an annual GDP increase of 1.7%, and "high growth" scenario 4.7 %.

The estimates of cost calculations for gross demand (GWh) and peak load (MW) which correspond to these three scenarios are presented in the Table 4 and Table 5.

Table 4: Gross demand forecast scenario 2010-2020 [University of California, Berkeley, 2012]

Overall consumption (GWh)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average Growth
The lower growth scenario	5636	5760	5904	6046	6167	6290	6416	6544	6655	8177	6890	2.21%
The higher growth scenario	5636	6010	6280	6550	6832	7112	7404	7655	7916	8177	8439	4.10%
Base Case Scenario	5636	5916	6144	6323	6499	6674	6853	7035	7210	7381	7530	3.04%

Table 5: Peak load forecast scenario 2010 - 2020

Peak Load (MW)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average Growth
The lower growth Scenario	1126	1145	1155	1175	1195	1215	1240	1260	1280	1300	1320	1.91%
The higher growth scenario	1126	1183	1215	1250	1290	1330	1375	1415	1460	1510	1550	3.41%
Base Case Scenario	1126	1175	1190	1220	1250	1283	1310	1340	1365	1390	1410	2.53%

These data are illustrated in Figure 6 and Figure 7, to have a clear picture of total consumption and peak load in Kosovo during 2010-2020.

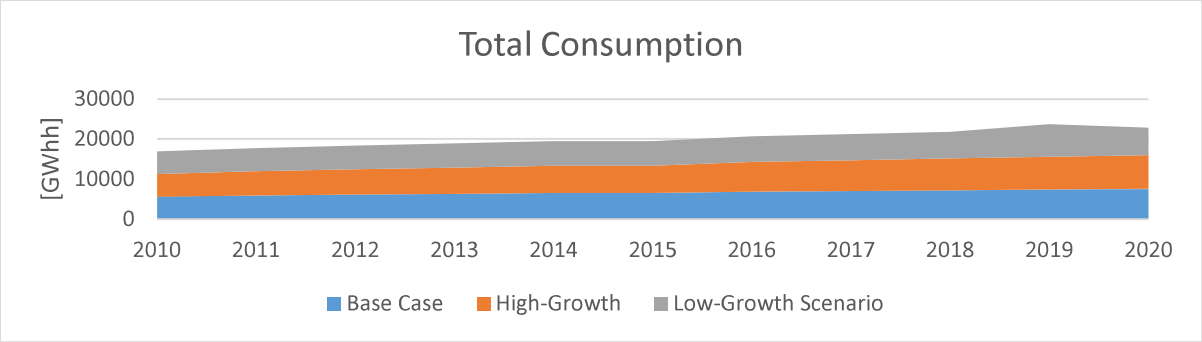


Figure 6: Total consumption

In this study, the base scenario for gross consumption is divided into six categories: residential, industrial, services, distribution, transmission, and commercial losses. The same classification was not possible for high-growth and low-growth scenarios due to lack of data.

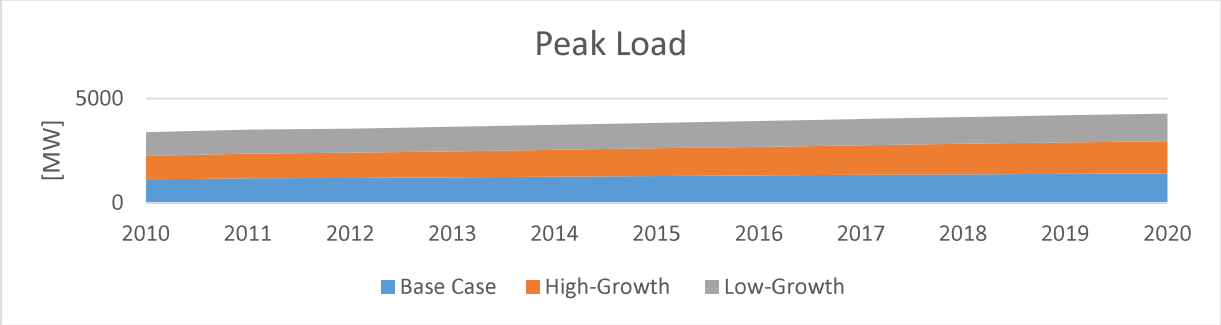


Figure 7: Peak load

Other analyses of this study show that technical losses will drop from 14% to 11% of the overall consumption in the time 2011-2020. Commercial losses will drop from 17% to 1%. Transmission system losses will remain at 2% during this period. In total, sum of technical, commercial and transmission losses will decrease to 14% in 2020.

During the research it is found that the demand of the electricity in Kosovo is higher than the production. Figure 8 shows the electricity demand, generation, import and export in the period 2000-2015. [Ministry of Economic Development, 2017]

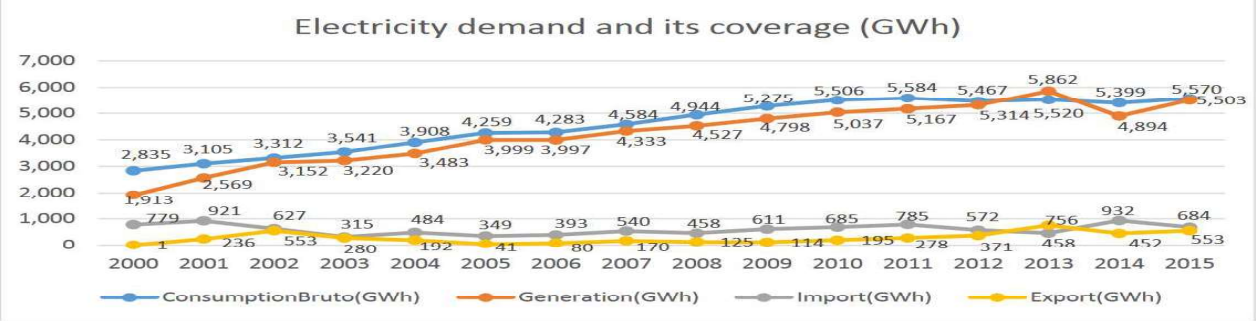


Figure 8: Evaluation of electricity demand and its coverage

To meet the increasing local demand, which potentially being exported to electricity surpluses, and based on the Electricity Generation Adequacy Plan 2017-2026 investments in the following projects are planned between 2017 and 2026: [Energy Regulation Office, 2017]

- The new Kosova e Re power plant with an installed capacity of 1*450 MW is to be constructed and is expected to be operational in 2023.
- The construction of a flexible 200 MW HPP in 2023, which is considered to be very important for balancing and optimizing the work of the energy system
- Construction of small-scale power generation units (mainly) by private investors using these capacities: 140 MW small HPP, 150 MW wind turbines, 14 MW from biomass, and 10 MW in solar energy (photovoltaic).

As of generation forecast, to reach rising energy needs as mentioned above, the government of Kosovo has formulated a five-pronged strategy:

- Investment by the private sector in new lignite-fired power generation
- Power distribution and supply network privatization
- Power Plant “Kosova B” rehabilitation, upgrade of generation electricity to a 600 MW
- Decommissioning of “Kosova A” Power Plant by 2020
- Development of renewable energy sources

Our focus will be more at RES. MED has set some targets for RES through the government's clean and efficient energy program to be integrated into Kosovo's electricity grid. This is also the “base” scenario of the government. Our study for the potential of RES in Kosovo will be discussed in the next chapters.

This program includes new HPP resources, wind, biomass and solar photovoltaic (PV).

MED “base” scenario for RES to be developed by 2025:

- Construction of the HPP "Zhur" with an installation capacity of 305 MW. It is expected that the HPP Zhur will produce 398 GWh per year.
- Development of a further 20 small HPPs to be contributed by 2020 in Kosovo Power Grind with a total capacity of 140 MW.
- Private wind investors have applied for project proposals by KOSTT with a total capacity of 157 MW. One of the projects has already been built. The KITKA wind power plant is a 32.4 MW plant and will generate 95,600,000 kWh of electricity.
- In 2012 there has been started some development of biomass and urbane waste, which fuels the power plant, with a progressive capacity development reaching 14 MW.
- Based on a perception of excessive costs, the MED "base" scenario estimates that the potential for installed solar PV is low. 10 MW is the solar capacity that is predicted until 2020.

The MED "base" scenario for the new generation capacity is shown in Table 6.

Table 6: MED "base" scenario for the new production capacity (2010-2025)

	Unit	Total installed capacity (MW)	In operation mode
New TPP	C1	300	2023
	C2	300	2023
New Renewables Energy Capacity	HPP Zhur	305	2020-2025
	Small HPP	140.3	2020-2025
	Wind	141.0	2020-2025
	Biomass	14	2020
	Solar	10	2020

2.4 Impact - Current Situation

2.4.1 Economic Impact

Kosovo is a small country with 1,836,529 inhabitants. The economy is very fragile. The overall unemployment rate of population is very high. Based on Kosovo Agency Statistics 30.5% of population are unemployed, with youth unemployment by 52.7%. 5.2% of the population is facing extreme poverty. [Kosovo Agency of Statistics, 2018]

The GDP growth rate of 4% registered in 2017 is not enough to be translated into significant change of the current situation. These numbers are taken from government resources. The current situation is even worse. Different studies show that the unemployment in Kosovo is around 40-45 % with youth unemployment by 75%. It is hard to find a country in the World with these numbers, regarding unemployment. [Swiss Cooperation Office Kosovo, 2014]

To cover the needs for electricity, the governmental plan is to build a new lignite power plant. The plans to build a new one has been on for more than a decade. At the beginning it was planned to build Kosovo C, now it is planned to build New Kosovo Power Plant "Kosova e Re". The initial plan was for a power plant with an installed capacity of 2000 MW. [Reuters, 2009]

For the construction of NPP with a capacity of 500 MW, it is foreseen that the power plant will cost 1.3 billion euro. [Gap Institute, 2018]

However, there are a lot of key questions that remain unanswered. Even though, these are huge numbers that will have a significant impact to the Kosovan households and will highly increase the price of electricity. All of these will be an additional economic burden to the Kosovars.

At the beginning the project was supported from the World Bank. In September 2018, the World Bank announced that it will withdraw from the project because of green policies and will recommend to the government of Kosovo to invest in RES.

2.4.1.1 Electricity Price

Seeing this poverty in Kosovo, electricity price is very high. Even though Kosovo (with Serbia) has the lowest prices of electricity in Europe in relation to surrounding countries, but if the average income of Kosovars with the average income of European country will be compared, then it will come to a conclusion that Kosovars pay much more euro for kWh in comparison with Europeans. The middle class and the poor population pay approximately 14% of their income for electricity. Poor families pay 30% of their income. An european household pays approximately 6% of their annual income. [European Commission, 2019]

44 percent of Kosovars have problems with electricity bills, in terms of paying them, according to the Kosovo's Agency of Statistics. [Kosovo Agency of Statistics, 2016]

There is a noticeable difference between Kosovo and European Countries when it comes to the price of electricity. A household in Kosovo paid 0.0638 €/kWh in 2018. On the other hand, the price of electricity for a household consumer in Austria was 0.2012 €/kWh in 2018. It is much more expensive in Denmark. A Danish household paid 0.3126 €/kWh in 2018. [Euro Stat, 2019] But the average salary in Denmark is 3163 US dollars (tax excluded). The average salary in Kosovo in public sector is 531 US dollars (tax excluded). It is less in private sector. An employee in private sector is paid 390 US dollar. The average is 460 US dollar. [Kosovo Agency of Statistics, 2018] That means that a Danish household earns 687 % more than a Kosovar. On the other hand, it was mentioned that the unemployment in Kosovo is around 40-45%. In Denmark it was 5.20% in 2018. [CEIC, 2019]

With all these numbers the price of electricity in Kosovo is unaffordable to a large part of the population.

Following, in Figure 9 and Figure 10 it is illustrated the price of electricity in period 2014-2018 in Kosovo. [Euro Stat, 2019]

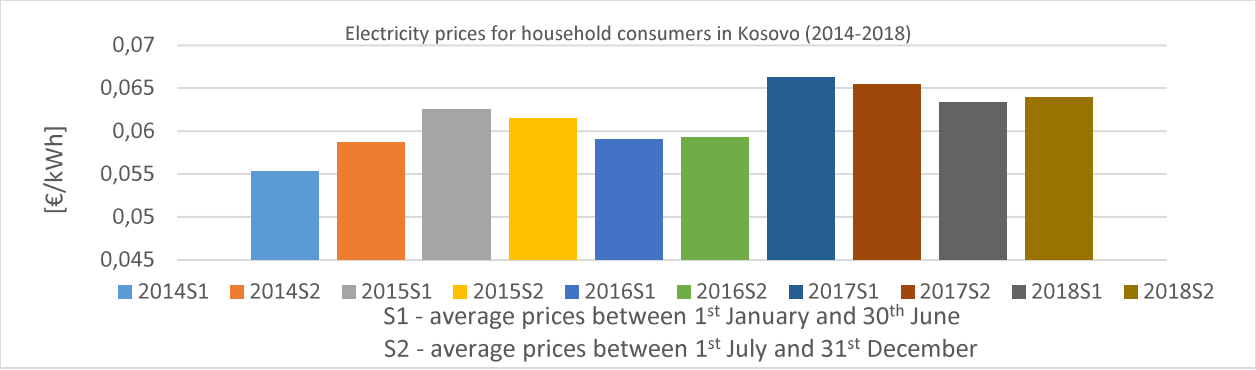


Figure 9: Electricity prices for household consumers in Kosovo (2014-2018)

Figure 9 ilustrates the price of electricity for household consumers. Figure 10 ilustrates the price of electricity for non-household consumers. [Euro Stat, 2019]

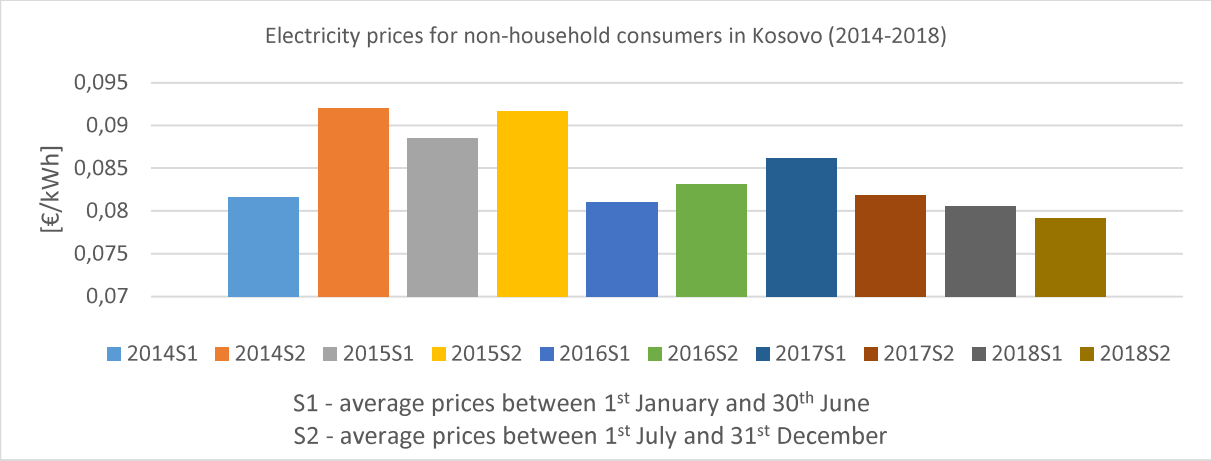


Figure 10: Electricity prices for non-household consumers in Kosovo (2014-2018)

Figure 9 also shows that the price of electricity in Kosovo is increased continuously. The same was not for non-household consumers. Last three years was a significant drop in price of electricity for non-household consumers.

2.4.1.2 Employment opportunities

As mentioned above, Kosovo is a country with poor economy and with a double-digit unemployment rate. Thus, job creation in Kosovo is an especially pressing issue. With 40-45% unemployment rate and with 75% of young population unemployed, Kosovo has the weakest unemployment track in EU.

Two large power plants in Kosovo, Kosova A and Kosova B are two of the companies employing more employees. There are unofficial data about the current employees at Kosova A, but the latest data from 2010 show that 777 people worked there. A document from European Commission in March 2015 estimates that 600 workers are employed in Kosova A. This is the number that would be more appropriate. Kosova A should be decommissioned until 2020.

Regarding employment rate. approximately the same applies to Kosova B. The latest date from 2010 show that 705 workers are employed there. The study from European Commission estimates that normally the power plant would cooperate with 500 workers. There are no data available to indicate whether there has been a reduction in the number of employees. However, even with 500 employees, Kosova B would only produce a GWh per year. This is a very small number if it is compared with other countries. Sibovc mine is currently the main field being exploited. 3249 people are currently employed in the coal production department of the Kosovo Public Power Corporation KEK. [European Commision Liasion Office to Kosovo, 2010]

Based on financial audit reports of KEK in 2017 there were produced around 7.5 million tons of lignite. That means 2308 tons per worker. These figures make Sibovc one of the highest efficiency

mines in the region per worker, but in comparison with central European standards still very low efficiency. Germany for example produces 11,154 tons per employee. Poland at 10105 tons. Thus, it means that there is a very significant number of employees that is not necessary in the mine.

The new power plant „Kosova e Re" (NPPKR) that is planned to be built in Kosovo, in order to cover the energy needs in Kosovo, will create new jobs. Contour Global was the only bidder for this project. Contour Global Executive Vice-President Garry Levesley said that for this project there could be created around 10,000 jobs during the construction and 500 more during operational phase, when the power plant comes online. A study from CEE Bankwatch network in 2016 has found that in Bosnia and Herzegovina (BIH) for the project "Stanari" power plant with an installed capacity twice less than "Kosova e Re" power plant, were needed 800 workers during the building phase. [Reuters, 2015]

Therefore, there is no reason to suppose that a plant with this capacity would need ten times as many workers. The same study says that the same power plant with the same installed capacity in Slovenia "Šoštanj" power plant employed 4,500 employees. [CEE Bankwatch Network, 2016]

Why the same power plant should require two and a half times more employees. There is only one conclusion. Contour Global is the regional prize winner for outrageous claims when it comes to coal plant employment.

2.4.2 Impact on the environment

2.4.2.1 Health impact

Today climate change is an intensively discussed topic and a threat to mankind. There are thousands of seminars, projects and meetings that took place, regarding this topic. This happened just to find a solution. But a much more dangerous factor to the humankind is coal mining. Many more chemicals are released than those responsible for climate change. It also containing mercury, cadmium, beryllium, chromium lead, arsenic, and some other toxins as well as carcinogenic substances. With the burning of coal, there are several processes that precede combustion. Coal must be crushed, processed, and washed. Each year, this releases tones of particulate matter and various chemicals that are harmful to public health and the community's ecosystem. Thus, Prishtina is one of the most polluted cities in the hole world. Last year, December 2018 air quality index reached highs of 456. The index range differs from 0-500. Every level that is higher than 300, is considered "hazardous". All this is caused by coal-fired power plants located 15 km from Prishtina. *"We don't need any more proof, we can see it's coming from the thermal power stations"* said Luan Shllaku, founder of Kosovo Foundation for Open Society (KFOS). [Prishtina Insight, 2018]

Another worrying statistic is that Kosovo has the worst health outcomes in comparison with other Balkan countries. A UNDP study estimates that Kosovo had the lowest life anticipation in Balkans and the highest child and infant mortality rates. Air pollution, heavy metal pollutions are

environmental problems that affect the population's health. According to the same study, people that live in Mitrovica municipality, have the world' s highest levels of blood lead.

Table 7 shows the infant and child mortality, life expectancy, maternal death rates, tuberculosis incidence, immunization rates. [University of California, Berkeley, 2012]

Table 7: Kosovo and neighboring countries health care indicators 2007

Indicators	**Kosovo**	**Albania**	**Bosna**	**Macedonia**	**Serbia**	**EU**
Child mortality (per 1000 live birth)	20.6	7.8	n/a	n/a	7.11	4.56
Life duration in the air we breathe (years)	69	76	n/a	n/a	74	79
Under 5 mortality (per 1000)	69	12.4	n/a	n/a	8.14	5.47
Particulate matter in the air $PM_{2.5} - (AQI)$ $[\mu m/m^3]$	60	n/a	57	55	55	35
Tuberculosis incidence per 100000	52	13.9	60.5	25.7	26.6	15.5
UNDP Human development Index	0.734	0.807	0.802	0.808	0.821	n/a

Analyzing Table 7, one will conclude that Kosovo ranks often by a factor too below the neighboring countries, when it comes to infant and child mortality, life expectancy, maternal death rates, tuberculosis incidence, immunization rates.

2.4.2.2 Resettlement Impact

Last year the government had problems with the residents of two villages because of the exiting mine. To cover the need of the coal, KEK had made plans about extending the Sibovc mine. 1,114 people should be located from the Sibovc village to create space for extending of this mine.

In the located area where the power plant is planned to be built, there are 20 villages. The population density in this area is very high. 304 persons per km^2 is the average population density, higher that Kosovo average, that is 193 km^2.

The territory of the Obliq municipality had to be expropriated by approximately 13%. Most residents of Shipitulla (Dardhishte), Hade and Lajthishte villages should be relocated, to create space for mining of coal. The overall population of the affected area is estimated at around 1,500 families. Not to mention that in addition 330 families should be relocated when the construction of the NPP will begin. According to Strategic Environmental and Social Assessment (SESA) in 2018 from Ministry of Energy and Mining in 2008, most of the community that is located near this area should be relocated. According to the same study it is foreseen that the project-affected should be divided into three categories: [University of California, Berkeley, 2012]

1. Areas directly required for mining, including all ancillary installations
2. Areas that must be moved for safety reasons, such as danger from substations and transmitting lines
3. Areas that are neither planned for mining nor for formal security, but which could be affected in terms of their environmental and social significance, including noise, dust, air pollution and contamination of ground and surface water.

The area planned for mining, is largely an agricultural land, while the remaining area is roads or forests.

The Prime Minister of Kosovo has reached an agreement with the residents, but all of this has a very large financial cost. Only for the resettlement cost for the Kosovo Lignite Power project the government of Kosovo will pay around 33 million of dollars, according to an analysis from World Bank of the new mine, which will supply NPPKR with an installed capacity of 600 MW. Not to mention the amount of money that the government should pay, regarding to create space for the extending of Sibovc mine. These large amounts of money are very high. The citizens of Kosovo should pay these through their taxes. [The Prime Minister Office, 2017]

2.4.3 Political Impact

Kosovo, as mentioned above, is a new country. Since 2006 it has been a signatory to the Energy Community Treaty. Thus, it has various obligations and targets to reach. Given that, these decisions could affect the broader regional role that Kosovo could develop within the European Community and the European Union.

According to the Annual Report Implementation from Energy Community Secretariat in September 2018 the Implementation of the Third Energy Package compliant set of laws adopted in 2016 has not reached the promising targets, when it comes to electricity market opening and competition development. Thus, those missed opportunities are limiting the possibilities for competition development regards electricity markets. [Energy Community, 2018]

Actually, the real problem is a political one. A collision between transmission system operator of Kosovo (KOSTT) and Serbia (EMS) is in fact the main precondition for unlocking cross-border cooperation and integration of the market. Energy Community Dispute Resolution and Negotiation Centre leads the negotiations between KOSTT and EMS and are assisted WB6[3] regional energy market connectivity program. No concrete solution has been found yet.

[3] Western Balkans 6 Chamber Investment Forum (WB6 CIF) is a joint initiative of chambers of commerce and industry from Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, Montenegro and Serbia.

Nevertheless, this should not prevent Kosovo from proceeding to reform its electricity market. It is very important for Kosovo that the certification of the transmission system operator should be finalized in accordance with the deadlines. Third Energy Package requirements include rules for grid and system operation, especially those related to system balancing. Something that is very important for the Third Energy Package and should be implemented by Kosovo is Regulation (EU) 543/2013 on publication of market data and a set of Connection Network Codes.

There are areas that are fully deregulated. The wholesale market is fully disordered, while the retail market remains deregulated for the supply of high voltage customers only. Due to a notable lack of competition, the deregulation of supply prices for medium voltage customers were postponed until 1 April 2019. Kosovo Electricity Supply Company (KESCO) is the only provider for all final customers. There are two other licensed retail suppliers but still inactive in the market. [Energy Community, 2018]

It is very important that the regulator will increase its monitoring of the functioning of the market and to improve competition when it comes to the distribution to the final costumer. New biannual report on the functioning of the electricity market should be a priority for the regulator too.
When it comes to NPPKR, there are several political risks that Kosovo could face in the future. As it was discussed earlier, plans for NPPKR have changed several times. All this, because of valuable energy planning assumptions and because of the election of the values promoted by political events. Whether the cost of NPPKR is subsidized from outside investors, NPPKR will affect the choices for the Kosovo government, in terms of economic value of NPPKR and its impact on electricity rates. So, it is very important that all these factors not to be ignored when establishing an interest rate for this project. There are some reasons why it is so important. At the beginning the project was supported from World Bank. In October 2018 World Bank said that it will no longer support the building of NPPKR. [Reuters, 2018]

One of their argument was, the government was supposed to provide a partial risk assurance, that will guarantee to unlock cheaper loans for this big project.

The government could not still address the real impact that the project will have on the banking system or actual rates in the country. A study from Institute for Energy Economics and Financial Analyses estimates that NPPKR project will require large loans, even though the financial market in Kosovo in relatively small. Same study says that this kind of large loans will drive Kosovo banking decisions for decades to come. [Institute for Energy Economics and Financial Analyses, 2016]

3 Potentials and Projects for the Development of the Electricity Economy of Kosovo

3.1 Fossil Fuels

3.1.1 Coal

Kosovo has an enviable asset of natural resources. With a proven lignite reserve of 14.7 million tonnes, Kosovo represents the fifth largest proven lignite reserves in the world. It is extremely important for the country and is one of the most important factors for energy production in the long term. Moreover, Kosovo's coal, with a consumption of 1,1 €/GJ, definitely has the cheapest quality/price ratio in the region. [The Ministry of Foreign Affairs and Diaspora, 2019]

About 90% of Kosovo's electricity needs are covered by the two thermal power plants Kosova A and Kosova B. Lignite which is available in Kosovo, is also refered as brown coal. This material has the lowest percentage of carbon, but the highest percentage of humid. From a geographical point of view, it is geologically newer than other types of coal, and it is mainly used for electricity generation. Moreover, lignite is unfortunately the most polluting type of coal, when it comes to the process of converting it into usable energy.

Although such in a large extent, the coal is of very poor quality and the use of lignite in electricity generation releases an average of about 6 million tons of carbon dioxide into the atmosphere each year. As mentioned above, Kosovo has planned the construction of a NPP called "Kosova e Re". It is therefore possible that Kosovo could be potentially liable for CO_2 emissions of up to 22.5 million tons over the year. [University of California, Berkeley, 2012]

Figure 11: Coal mine in Kosovo [Mekuli Press, 2019]

3.1.2 Locations

The most important coal basins are:

- Kosovo Basin (extends to the central part of the Republic of Kosovo);
- Dukagjini basin (extends almost in the central part of Dukagjini plain); and
- Drenica basin (Basin of Drenica lies in the middle of the Kosovo basin and Dukagjini basin in the west) [Ministry of Economic Development, 2012]

Kosovo's basin covers approximately 12 billion tonnes of brown coal. The type of the coal in the Kosovo basin is lignite. The proportion of coal to fallow land in the Kosovar basin is 1:185. It has an approximate diameter of 45 metres. In this pond, coal events vary from the surface to a maximum of 310 metres below surface level. The quality of lignite in the Kosovo basin is high, and the average values for the most significant parameters are:

- ETU (low calorific value): 7,300 kJ/kg
- S (sulfur) <1%
- L (humidity): ranging between 45% and 47%.
- H (ash): 18%

A major part of the coal can be found in the very center of the Kosovo basin, where the maximum thickness also reaches 110 m. Furthermore, two excavation sites in the Kosovo Basin are active and are used for the extraction of lignite for power plants in Kosovo and their capacity is 7,000,000 tons per year. According to reports, by 2009, the consumption of coal was about 200 million tons, which represents only 2% of the total coal reserves in the Kosovar basin. Mining Babushi, which also has a certain percentage of coal reserves, is in the southern part of the Kosovo Basin and covers an area of 0.5 km^2. Babushi mine possesses geological coal reserves of 3.7 million tons.

The Dukagjini basin has three coal production series:

- The Mio Pliocene Series, (before the Ponce era)
- Early Pliocene Series (Poncho Epoch)
- Late Pliocene Series (Levantine Age)

More productivity is found north of the Dukagjini (Kline) basin, which has an average coal thickness of 40 meters:

- ETU = 600 to 10,000 kJ/kg
- S = 1.06%
- L = 31 to 69%
- H = 20 to 27%.

The Drenica basin is one of the areas with the poorest potential compared to the other two basins mentioned above. It consists of two coal fields: Skenderaj and Drenica. The Skenderaj coal field spans an area of 5.1 km^2 and has an average depth of 15 m.

The readings for the quality parameters in this coalfield are as follows:

- ETU = 7.300 kJ / kg
- L = 32.46%
- H = 25.60%
- S = 1.58%

3.2 Hydropower Resources

Kosovo is generally considered not to be a country with significant hydroelectric potential, mostly for geographical factors related to its topography. The topography is mainly in the shape of a plateau, with relatively soft terrain and low rainfall. Among the Western Balkans, Kosovo is the country with the poorest water availability - 1,600 m3 of water per inhabitant. On the other hand, Albania has approximately 13,000 m^3 of water per inhabitant. [Balkan Green Foundation, 2019]

There are plans, that in the future Albania and Kosovo will invest a project that will have a big impact in the generation of electricity for these two countries. This issue will be discussed later on in this research.

There are two different hydro resources that can be exploited in Kosovo. An accumulation of decentralized small HPPs that in other words are River runs, and a proposed supply-scale bigger HPP.

Different studies show a potential of an approximately 63 MW aggregated hydropower capacity with a combined annual production of 300 GWh. In the Table 8 are shown HPPs and their possible capacity. [KOSID, 2014]

By 2025 the ERO office has planned an increased development of small-scale HPPs up to 140.3 MW capacity.

Table 8: The proposed small HPP and their capacity

River	HPP	Capacity (MW)	Production (GWh)
Decani	Decani	8	41
Llocani	Mal	3	19
	Llocani	3	14
Bistrica	Batare	2	6
Erenik	Dragash	2	12
	Jasi	2	10
	Erenik	2	10
Peja	Kuqishtë	4	19
	Drelaj	6	30
	Shtupeq	8	37
	Bellaje	5	26
Prizren	Brezovica	2	12
	Recan	2	8
Bajska	Bajska	1	2
Kacandoll	Majnc	1	3
Lepnc	Lepenci	4	19
Deçani+Drini	Mirusha	5	28
Plave	Orcush	6	29
Total		**63**	**323**

Figure 12 shows locations of the proposed small HPPs.

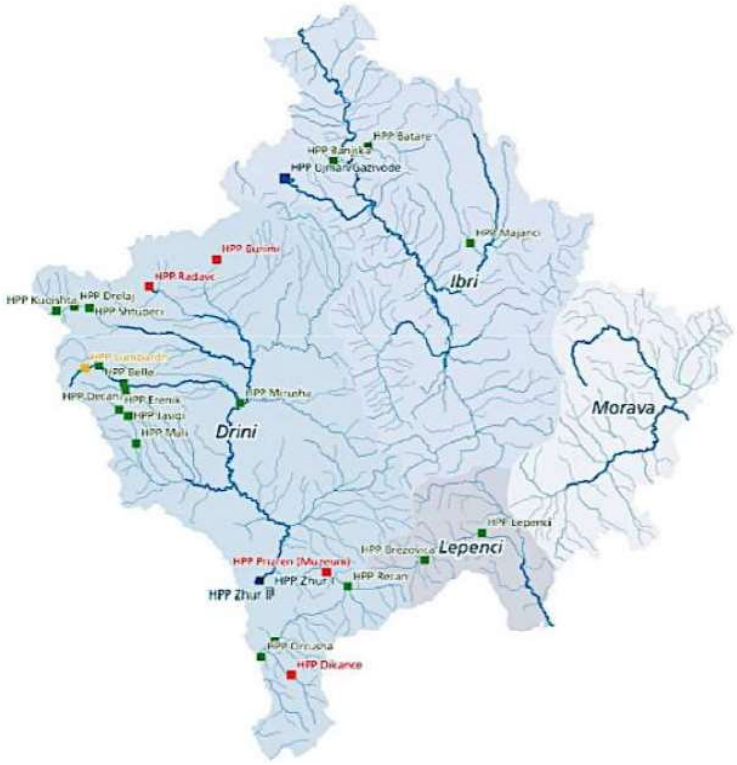


Figure 12: Distribution of the proposed HPP

One of the biggest projects of the MED regarding to the RES was HPP Zhur. The proposed plant at the beginning was planned to be launched at 2016. The primary project had an initial projected capacity of 305 MW and an estimated annual generation of about 400 GWh.

This HPP could have the role of secondary and tertiary reserve in the Kosovo power system. Zhur hydropower potential represented about 43% of the total technically productive capacity to be used in Kosovo. Likewise, it is not that there was any other important hydropower, with similar capacity that could be built.

The period analyzed here included six years of project implementation with 50 years of operational lifespan.

This project was part of the Energy Strategy 2009-2016. A decade later, the project for the HPP Zhur has remained on paper. Moreover, MED has removed this from the 10-year Energy Development Strategy.

Instead, another project has been mentioned. Now with Albanian state, a HPP also in the Sharri region, but in another area, connecting the two states, Kosovo with Albania. In 2018, an agreement was reached that Albania, Kosovo and the European Union will be co-financiers of the project for the construction of a 200 MW HPP.

The energy project is planned to be built in the triangle Albania-Kosovo-Macedonia, in the Dragash area. The Minister of Economic Development Valdrin Lluka said that, the EU will provide a grant of 20 million EUR for the construction of the HPP to be used for electricity balancing in Albania and Kosovo. Lluka also said that this location between these two cities has a strong potential for a HPP. [Balkan Green Energy News, 2018]

3.3 Wind

There are different studies on the wind energy potential. Unfortunately, Kosovo still does not have a wind map or other information that could be used for the further development of wind energy use. Table 9 shows basic data for Kosovo. Analysing these data will give us a clear picture of ecological parameters such as climate, area, location, population, and domestically produced goods.

Table 9: Data of Kosovo

Climate	Under the influence of continental air masses, it happens that winters are with heavy snow, hot and dry summers and also in intermediate periods with Mediterranean and Alpine impacts create regional variety with peak rainfall between October and December
Area land in km2	10887
Position	Southeast Europe, between Albania and Macedonia
Population	1836529 inhabitants
Gross inland output	13,020,000,000 $ per/head: $6,500

According to a 2012 study based on metrology measurements gathered at 10 prospective localities across the country, 3 out of 10 sites had the required wind speed to invest in wind turbines. The highest wind speed from these 3 locations was measured in Budakova. [NEK Umwelttechnik AG, 2010]

Figure 13 shows the modeled wind resource at this location.

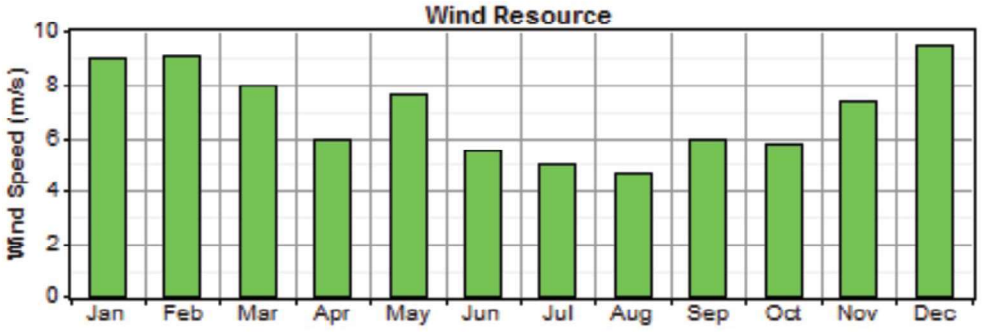


Figure 13: Annual wind speed in Budakova [University of California, Berkeley, 2012]

Based on the mentioned study, Figure 14 shows the potential locations for wind farms in Kosovo.

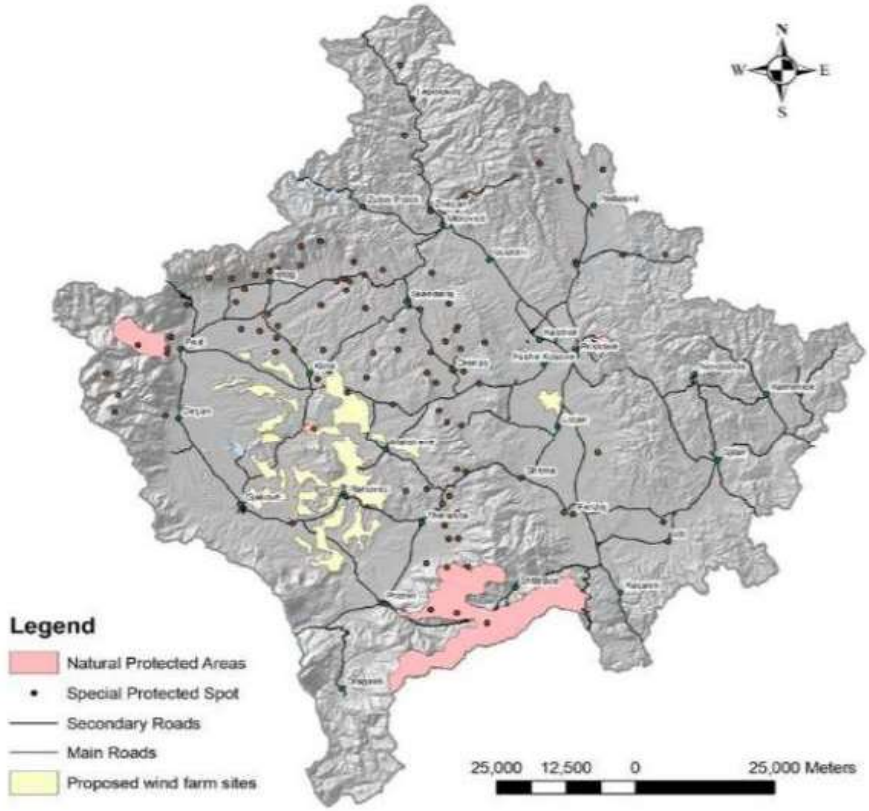


Figure 14: Potential locations for wind farms [University of California, Berkeley, 2012]

3.3.1 NEK Wind Farm Projects

An examination and intensive analysis of the current state of the wind energy potential can be found in the study of "NEK UMWELTTECHNIK AG" company. [NEK Umwelttechnik AG, 2010]

According to this study, undoubtedly there is a big potential for wind energy in Kosovo. It only remains to find investors. Thus, the feasibility study of this company on developing wind power generation in Kosovo, including wind measuring at about 10 locations, serves to create a regional wind map, that could be offered to potential investor or wind energy park operators that could be used as basic information. Furthermore, there were estimates that wind park energy in Kosovo can be developed. What NEK collected from these 10 locations, were sufficient data, to design a map of wind resources and with suitable locations, where future wind turbine project can take place.

The most important measuring indicators identified have been locations, speed of wind and interval of measurements. Figure 15 shows the results of the study.

Name of the Analysis	NEK WIND PARK „ZATRIC" (30 MW) RAHOVEC, KOSOVO	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT	NEK WIND RESOURCE ASSESSMENT, FINAL REPORT
Date	01.04.2012	01.12.2010	01.12.2010	01.12.2010	01.12.2010	01.12.2010	01.12.2010	01.12.2010	01.12.2010	01.12.2010
Locations	Zatric, Rahovec BBZAT	Lypjan BBUT	Lypjan ETEC	Gjilan EBUD	Theranda BBUD	Theranda SDUL	Klina WGJU	Abri e Eperme EABI	Prizren BBZYM	Kacanik SSTA
Height in Meters	35	37	33	33	38	34	44	45	37	37
Sea level in M	1016	1055	733	592	1667	858	578	763	658	578
Wind Speed m/s	7.14.	NA	3.6.	3.3.	7.0.	4.4.	3.8.	4.6.	3.4.	4.1.
Air Pressure			92.87 kPa	94.45 kPa	82.89 kPa	91.49 kPa	94.61 kPa	92.54 kPa	93.71 kPa	94.61 kPa
Air Density			1.141 kg/m³	1.157 kg/m³	1.037 kg/m³	1.128 kg/m³	1.159 kg/m³	1.138 kg/m³	1.149 kg/m³	1.159 kg/m³
Temperature			10.2 °C	11.2 °C	5.68 °C	9.43 °C	11.3 °C	10.1 °C	10.7 °C	11.3 °C
Start	01.02.2011	22.07.2009	22.07.2009	23.07.2009	25.07.2009	26.07.2009	24.07.2009	23.07.2009	24.07.2009	28.07.2009
End	31.01.2012		16.08.2010	16.08.2010	16.08.2010	24.08.2010	24.08.2010	24.08.2010	25.08.2010	25.08.2010
Duration in Mon.			13	13	13	13	13	13	13	13

Figure 15: Location criteria of NEK study [NEK Umwelttechnik AG, 2010*]*

Based on these data, NEK is going to develop and invest in wind energy in a project with an overall capacity of 45 MW, and as a location NEK has chosen Zatriq, a village in the municipality of Rahovec, for further wind measurements. Christoph Kapp, Deputy Director of NEK from Switzerland said: *"We will construct wind park in Zatriq with 15 turbines i.e. windmills 100 m long. Capacity of every individual project is 3.0 MW and the whole wind park will produce 45 MW in total. We have submitted a request for starting of work in Zatriq and we had got temporary license before. We have also submitted a request for connecting a wind park on Kosovo's electricity network and we are very close to the contract signing with KOSTT (Operative System of Market and Distribution Network). We believe that we will get all necessary licenses in following months so we can begin our work in Zatriq".* [SEE Energy News, 2013]

This location has perfect wind conditions and a good, developed infrastructure. At the end of June 2012, NEK has applied for a 45 MW wind farm project at ERO. They are now waiting for the permission to start with a project. Project was fully permitted but was temporarily put on hold due to a PPA which is not bankable. Negotiations with the government to see if realization under the "Strategic Investment Plan" is possible are still going on. [NEK Umweltechnik AG, 2019]

Figure 16 shows the location of Zatriq.

Figure 16: Zatriq location [NEK Umwelttechnik AG, 2010]

Seeing the big potential in wind energy NEK will invest in a second and third big wind farm projects. The second project will be realized in Budakova with an installed capacity of 48 MW. It was intended that the wind farm would start construction in 2015, but due to the problems with required permissions, the project is still in progress. The third project of NEK will take place at Çiçavica and foresees the establishment of 17 wind turbines and a total installed power capacity up to 51 MW.

3.3.2 Wind Farm Project Shtime 1&2

KOSTT, the transmission operator has reported that German company, that for the moment should be anonymous, applied to the transmission grid in 2010 and the total installation capacity of the wind turbine is 127 MW. At the workshop the project results were presented and were estimated as real.

3.3.3 Wind Farm Project Bajgora and Skenderaj

The most promising project that could take place in Kosovo is in Skenderaj and Bajgora. In 2014 an Italian-Kosovo cooperation, made the appropriate measuring. Back than the findings showed a very big potential of a three-digit megawatt range. 2 anemometers [4] have been installed in different locations.

The results were phenomenal. In an acreage of seven hectares in Bajgora the wind speed averaged 9 - 12 m/s. Figure 17 shows Bajgora location.

Figure 17: Windspeed measurement in Bajgora

[4] Gauge for measuring wind rate

3.3.4 Summary of the wind power plant projects

Based on the above projects and the measurement that were made, there is a very huge potential for development of wind energy.

The summary of the above projects that is also written in Table 10 shows a total potential of 371 MW.

Table 10: Potential of wind energy projects

Nr.	Project	Installed capacity (MW)
1	NEK Zatriq	45
2	NEK Budakova	48
3	NEK Çiçavica	51
4	Shtime 1	100
5	Shtime 2	27
6	Bajgora	50
7	Skenderaj	50
Total		**371**

3.4 Solar Energy

3.4.1 Solar Irradiance

Radiation is an important factor, for heating and PV, as it is an additional energy source, even if it is not stable. The sun's position during the winter season is low, and the duration of irradiation is considerably shorter.

Nevertheless, the profit from exposure to radiation caused by windows has a great importance, especially in the equipment that are thermo insulation. Knowing that amount of heat during the winter is low, the solar radiation is very important.

Solar radiation is very dominant during March and April in older buildings with large windows. Sun protection is therefore very important in this time of year. [Solar energy and options of using in Kosovo, 2009]

Abundance and reflection within the air molecule and the varying compositions including dust, steam and humidity are phenomena that describe the weakness of solar lighting from the radiation through the atmosphere. As shorter the length of the wave is, as higher is its distribution.

The spread of energy in the Earth's surface is ultraviolet rays up to 6%, visible light 50% and infrared lights 44%.

The total quantity of radiation varies and depends on the climate, air pollution and geographical position.

2200 kW/m^2 reaches the global radiation in the world, compared to Europe, where it ranges from 800 kW/m^2 in the north to 1750 kW/m^2 in the south.

3.4.2 Solar Radiation in Kosovo

Solar radiation in Kosovo generally oscillates in the range of 1550 kW/m^2 and 1650 kW/m^2. [KOSID, 2014]

In Figure 18 it is shown the solar radiation in South East Europa.

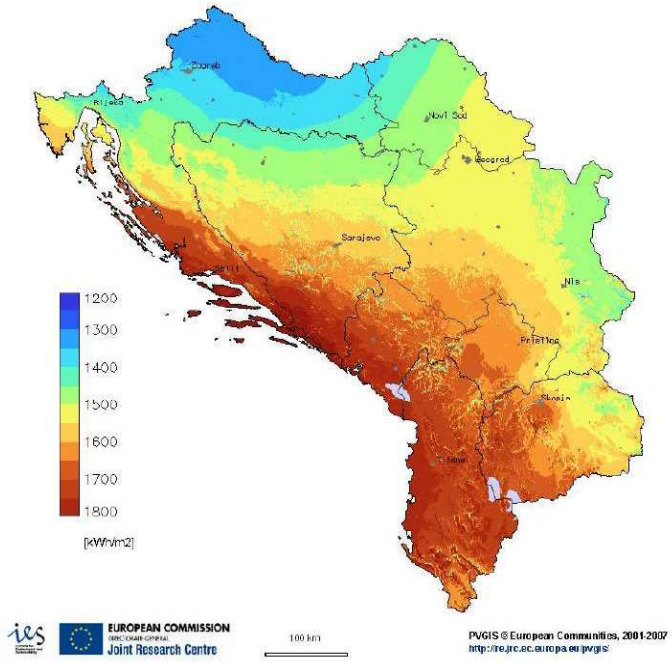


Figure 18: Solar radiation in South East Europa [KOSID, 2014]

Solar radiation in three municipalities in Kosovo can be considered as the average for the whole country.

Hours of sunshine per year in:

1. Prishtina – 2153.2 hours
2. Prizreni – 2131.8 hours
3. Peja – 1974 hours

The average number of sunshine hours per year in Kosovo, taking these three cities as a basis, is 2086.3 hours. [Solar energy and options of using in Kosovo, 2009]

The analysis of these data shows that Kosovo has favorable weather conditions and that these great amounts of sun radiation are useful for electricity generation and the heating of sanitary water.

3.4.3 Jaha Solar

JAHA GROUP continued its investment activities in Kosovo in 2016 in the manufacturing sector. Jaha Group has established the "JAHA SOLAR" unit and has opened a factory for producing solar panels with headquarters in Fushë Kosovë. "JAHA SOLAR" factory was inaugurated on June 2, 2016 with initial capacity from the first production line of 200 MW per year, presenting the latest technology in the production of solar PV panels. Total number of staff engaged within company is around 80.

3.5 Biomass

Several different biomass sources exist in Kosovo. Wood is the most important biomass resource. Livestock waste and agricultural waste comes as an additional contribution. Agricultural biomass in the shape of straw is being produced in many communities by many small farmers. There are difficulties in collecting these resources of biomass and therefore it limits using of these, that can be used for generation of electricity.

The above-mentioned potential arising of biomass reserves is presented in Table 11. [Solar energy and options of using in Kosovo, 2009]

Table 11: Biomass reserves in Kosovo, GWh/y

Type of resource	**Resource**	**GWh/y**
Wood	0.9 mill. m^3	2,812
Livestock	352,000 cattle 152,000 sheep/goats	1,363
Agriculture	0.30 mill. Ton straw	1,200
Solid waste	0.44 mill. ton	1,229
	Total	**6,604**

Based on these data, the theoretical biomass energy potential is assumed:

- Maximum yearly sustainable logging, 30% oak, beech and moisture
- All utilised animal waste and maximum theoretical generation of biogas
- Whole straw used, 15% moisture content
- All recycled solid waste

Therefore, the theoretical annual energy that can be produced from biomass resources in Kosovo is approximately 6600 GWh/yr.

Another study from Rael Berkeley Laboratory in 2012 forecasts an installation of biomass capacity of 165 MW by the year 2020. [KOSID, 2014]

3.6 Geothermal

Regrettably, specific studies on the geothermal potential in Kosovo have not been carried out. Referring to the neighboring countries such as Serbia and Macedonia, it is obvious that there has been a development of using geothermal energy as an energy source. 210 MWh/yr is the estimated potential of energy production from geothermal and there are 14 different geothermal locations which are used as a heating load. Serbia is completely another story. Currently over 60 geothermal systems exist with a temperature of less than 150 °C. Different studies indicate that the approximate energy reserves of geothermal resources in Serbia and Kosovo should be in the region of 800 MW. [University of California, Berkeley, 2012]

3.7 Energy and Grid Efficiency

3.7.1 Facts and Figures

Energy Efficiency (EE) is the optimal measure of energy, when energy is used to complete a certain service, while EE improvement means getting a better usage from what we used before. Thus, that means that we were more efficient, if during the winter season we managed to heat a location the same as the previous year, but we have spent less in terms of all electricity, with all factors remaining unchanged such as price, weather conditions etc.

In the previous chapter it was pointed out that according to the Kosovo's Agency Statistics 44 % of Kosovars had problems with electricity bills, in terms of paying them. Therefore, EE in Kosovo has a significantly impact.

Various studies have identified Kosovo as a non-energy-efficient developing country. In terms of EE improvements, little progress has been made in last 20 years. In the other hand there is a large energy saving potential in Kosovo. In 2010, a United Development Program (UNDP) experiment in the municipality of Dragash revealed a potential saving of 26 GWh per year through EE measurements. Table 12 shows data from consumption and CO_2 emissions from the experiment.

Table 12: CO_2 emission and energy consumption before and after the EE measurements

Before/After/Gains	Energy use GWh/y	CO_2 Emission (Ton/y)
Before measurements	124	41,377
After measurements	98	37,014
Gains	26	4,363
Percentage (%)	21	11

Even though the potential is big, improving efficiency is not an easy objective to achieve. Just the opposite, Kosovo is facing with an increasing demand of electricity. In the first quarter of 2018, the amount of electricity consumed was 1 136.7 GWh of electricity. In relation to the same quarter last year (Q1 2017) the amount of electricity consumed was raised by 2.8%. [Kosovo Agency of Statistics, 2013]

If the energy consumption is separated in different classes, it seems that households are by far the largest consumers of electrical energy with more than 50% only during the first quarter of 2018.

Figure 19 shows the percentage of different consumers in Kosovo during the first quarter of 2018.

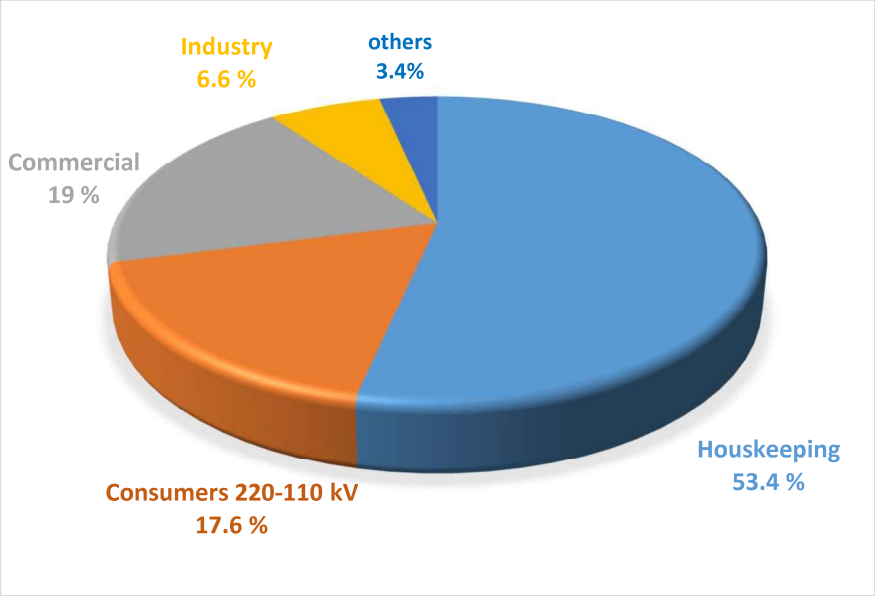


Figure 19: Structure of electrical energy distribution as an average

3.7.2 Energy Efficiency - Improvements Potential

Developed countries have achieved the solution for electrical energy efficiency problem through policies that affect mainly industrial consumers such as businesses. While Kosovo is another scenario. Electrical energy efficiency improvements must be achieved through policies that affect the households. A study from MED shows that the total area of the building stock in Kosovo is 45 million m^2. About 2/3 of the entire building stock consists of residential buildings with a surface of total 35 million m^2 ahead of the private services housing category with about 8 million m^2, whereas public sector properties occupy a surface area of about 2 million m^2.

Table 13 shows the summary of energy saving potentials by category of buildings. [Ministry of Economic Development, 2019]

Table 13: Compilation of the energy saving potentials according to building categories

Building Sector	The total area of the building sector [million m^2]	Total area of building sector [%]	Potential for Energy Saving in Building Sector expressed in Function% of Final Energy Consumption	Building Sector Energy Savings expressed in% of Primary Power Source Supply	Total Potential for Energy Savings [ktoe]	Total Potential for CO_2 Reduction [expressed in Million Tons / Year]
Residents	34.72	76.9%	45%	7.86%	171.74	2236.76
Public Municipal Buildings	2.36	5.2%	32%	0.77%	16.77	35.96
Schools	1.69	3.7%	37%	0.5%	10.9	23.37
Health / Hospital Buildings	0.39	0.9%	37%	0.15%	3.35	7.18
Other buildings	0.28	0.6%	30%	0.11%	2.52	5.4
Central Public Buildings	0.18	0.4%	49%	0.16%	3.6	10.28
Central Hospitals	0.05	0.1%	45%	0.05%	1.12	3.2
Central Government	0.14	0.3%	50%	0.11%	2.49	7.08
Private and Commercial	7.86	17.4%	46%	2.15%	46.95	102.04
Total	**45.12**	**100.0%**	**20.07%**	**10.94%**	**239.05**	**2385.03**

According to this study, and analysing Table 13, the overall energy saving potential in Kosovo's buildings sector constitutes for approximately the equivalent of 11% of Kosovo's primary energy consumption as well as 20.07% of its overall energy demand. The overall amount of saving for the entire building stock represents close to 45% of total energy consumption when the housing and services sectors are added together.

3.7.3 Power Network Efficiency

As discussed in section 2.2, the total demand in the distribution network (households, public lighting, small businesses, etc. connected to the voltage level 35kV, 10kV and 0.4kV, distribution losses) is projected to be 4,470.4 GWh. The electricity losses in the distribution network according to the ERO data are planned to be 1,159 GWh, around 26% of total consumption. Therefore, the inefficiencies of the transmission and distribution network in Kosovo account for a large loss of energy.

A simple calculation estimates that the citizens of Kosovo who are paying their bills bear the additional cost of this 26% waste of energy. This large amount of percentage is both a major inefficiency and raises questions of consumer rights.

4 Development Scenario for the Electricity Sector of Kosovo

4.1 Introduction

In this chapter the focus will be on two potential scenarios.

The first scenario will be the MED scenario, how the government foresees the development of the energy sector in the period 2011-2025, and the second scenario will be the scenario of this study, namely, what is the real potential of renewable energy in Kosovo, based on the findings so far.

Initially, it will be reviewed the government's plan of how it sees the development of energy production in the period 2011-2025.

4.2 "Business as usual" – MED Scenario

As it is discussed in section 2.3, the demand of the electricity in Kosovo is higher than the production. To cover the growing local demand, which is potentially exported to potential electricity surpluses, and based on the generation adequacy plan 2017-2026, the government has drafted a plan with the following investments and projects by 2026. [Ministry of Economic Development, 2017]

4.2.1 Strategy and Investment

As of generation forecast, in order to reach rising energy needs, as mentioned above, the government has formulated a strategy with five priorities.

- Private investment in lignite-fired new electricity generation
- Privatisation of power distribution and electricity supply
- Power Plant "Kosova B" rehabilitation, upgrade of generation electricity to a 600 MW
- Decommissioning of TPP "Kosova A" by 2020
- Development of renewable energy resources

MED also has drafted a plan with the following projects.

- New Power Plant "Kosova e Re" with an installation capacity from 1x450MW
- HPP with installation capacity of 200 MW in 2023
- Building of small-scale power generation plants (mainly RES) using these capabilities: 140 MW small HPP, 150 MW wind turbines, 14 MW from biomass, and 10 MW in solar energy (photovoltaic).
- HPP "Zhur", with an installation capacity of 305 MW.

4.2.2 New Power Plant “Kosova e Re”

The TPP “Kosovo e Re” is the main and the most prominent post-war government of Kosovo project when it comes to the electricity and is expected to become operational in 2023. Initially, it started as a 2000 MW project, and then transformed into a project with an installation capacity of 600 MW. Later this project with one-unit 600 MW, was proposed a project with two 300 MW units, a project that will generate 560 MW net capacity.

The latest version of the NPP was presented on November 2015, from minister of economic development Blerand Stavileci. [The Prime Minister Office, 2015]

The latest project reduces the size of the plant from 600 MW to 500 MW with the net capacity of 450 MW (because 50 MW would be needed to run the plant). On December 18th, Kosovo's government, on behalf of the minister for economic development, Blerand Stavileci, recently announced the signing of a letter of intent with the US investor Contour Global. [MED, 2015]

Figure 20 shows how the NPP “Kosova e Re” will look like in reality.

Figure 20: NPP "Kosova e Re" - 3D Picture [Prishtina Insight, 2019]

According to various studies this project is a huge burden for economic of Kosovo, bearing in mind how poor the country of Kosovo is.

4.2.3 Zhur Hydropower Plant – (300 MW)

One of the biggest projects of the government regarding HPPs is HPP Zhur. At the beginning of the project, the proposed plant was planned to be launched in 2016. The initial project was with an approximate expected capacity of 305 MW and an average of 400 GWh annual production.

As the project was part of the Energy Strategy 2009-2016, a decade later this project has remained on paper. Moreover, the government had removed this from the 10-year energy development strategy.

4.2.4 New Hydropower Plant – (200 MW)

After removing the project of HPP Zhur from the energy development strategy, the Ministry of Economic Development came with another project of HPP. The construction of this project is seen as very important to balance and optimize the work of the energy system.

So far, there are no accurate data about this project. What is public until now, is the news of minister Valdrin Lluka, that in the next years a HPP will be built in co-financing with the European Union and the state of Albania. So far it is known the potential location where this HPP will be built. A location between Municipality of Dragash and Prizren is thought to be the location.

4.2.5 Small Hydropower Plant – (140 MW)

The current installed capacity of small HPP in 2018 was 66.37 MW. Based on estimates of Ministry of Economic Development an additional of 140 MW of small HPP can be installed until 2025. Based on a study in 2006, the monthly changes in hydro resources were calculated using production forecasts covering 20 possible small HPPs. The same study estimates that the installed capacity between 2010 and 2020 will variate linearly between 42 MW to 182 MW. This variation is shown in Figure 21. [AAEESD, 2006]

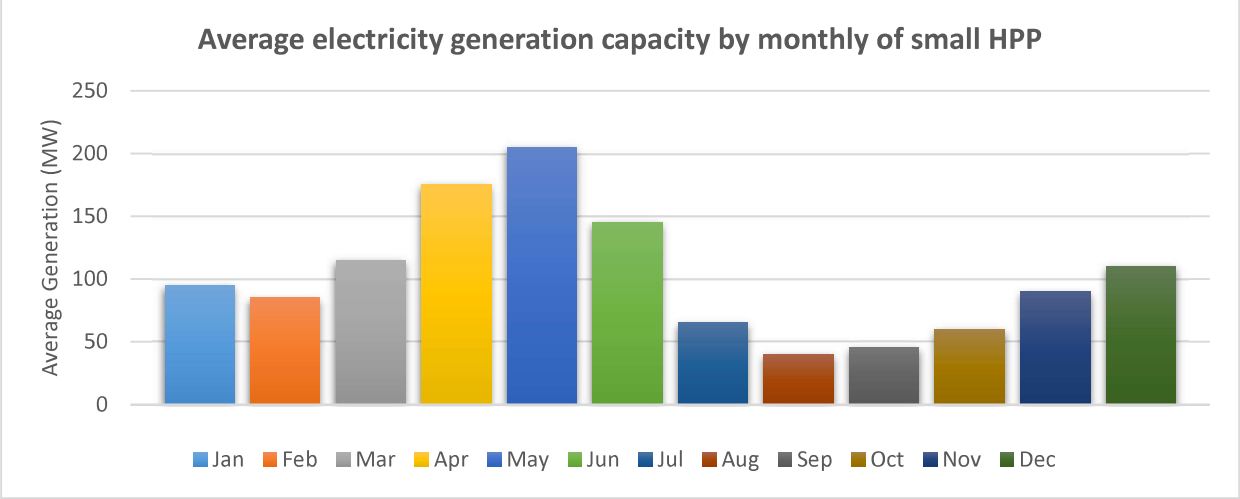


Figure 21: Average electricity generation by small HPP per month

4.2.6 Wind – (157 MW)

Wind private investors have handed in project applications from KOSTT with a total capacity of 157 MW. One of the projects is already build. KITKA wind power plant is a plant with an existing

installation capacity of 32.4 MW which will produce 95,600,000 kWh of electricity. Based on the Generation Adequacy Plan 2011-2020 the presumed capacity ratio of this 157 MW is approximately 25%. [KOSTT, 2018]

4.2.7 Biomass – (14 MW)

In 2012 there has been started some development of biomass and urbane waste, which fuels the power plant, with a gradual capacity expansion reaching 14 MW by 2020. As the main resource of biomass for the scenario is the fermentation gas generator and its capacity factor of approximately 58%. There are different emissions factors of biogas generator, that are presented in the Table 14. [University of California, Berkeley, 2012]

Table 14: Factors of biogas generator emissions

Carbon black oxide (g/kg of fuel)	6.5
Uncombusted hydrocarbons (g/kg of fuel)	0.72
Particle Matter (g/kg of fuel)	0.49
Percentage of fuel Sulphur transformed into PM	2.2
Nitrogen Oxides (g/kg of fuel)	58

4.2.8 Solar – (10 MW)

A perception of excessive costs, MED "base" scenario estimates that potential for installed solar PVs are low. 10 MW is the solar capacity that is predicted until 2020.

Hourly solar resources available to the government use NASA telemetry information for cloud cover and solar radiation indices Figure 22 shows the estimated monthly solar resources. [University of California, Berkeley, 2012]

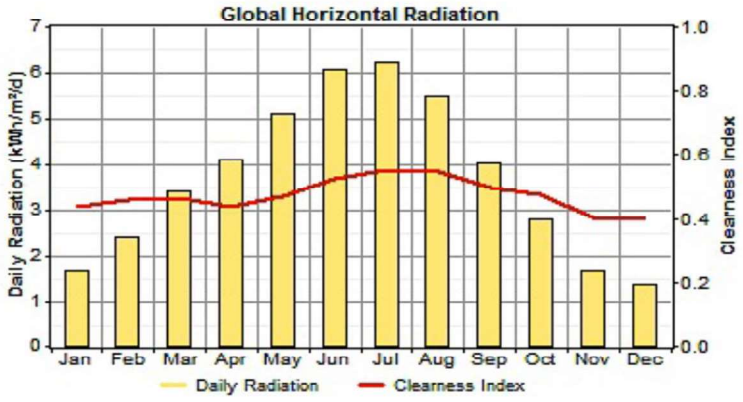


Figure 22: Modeled solar resource for Kosovo [University of California, Berkeley, 2012]

According to these resources, solar PV was modeled as power generation with 13% efficiency. It is estimated that the AC derating coefficient, including conversion of DC-AC conversion efficiencies, age, and pollution losses is about 87%.

4.2.9 "Business as usual" – Summary of Potential

Based on this scenario, the entire energy production from renewable energies by 2026 is expected to be 1225 GWh. Comparing the data in section 2.2, it is estimated that by 2025, 12% of total net generation is expected to be covered from RES. 10% of total net generation will be from HPPs and the rest. Wind + solar + biomass will be 5%. Figure 23 shows the potential of RES in numbers from "Business as usual" scenario.

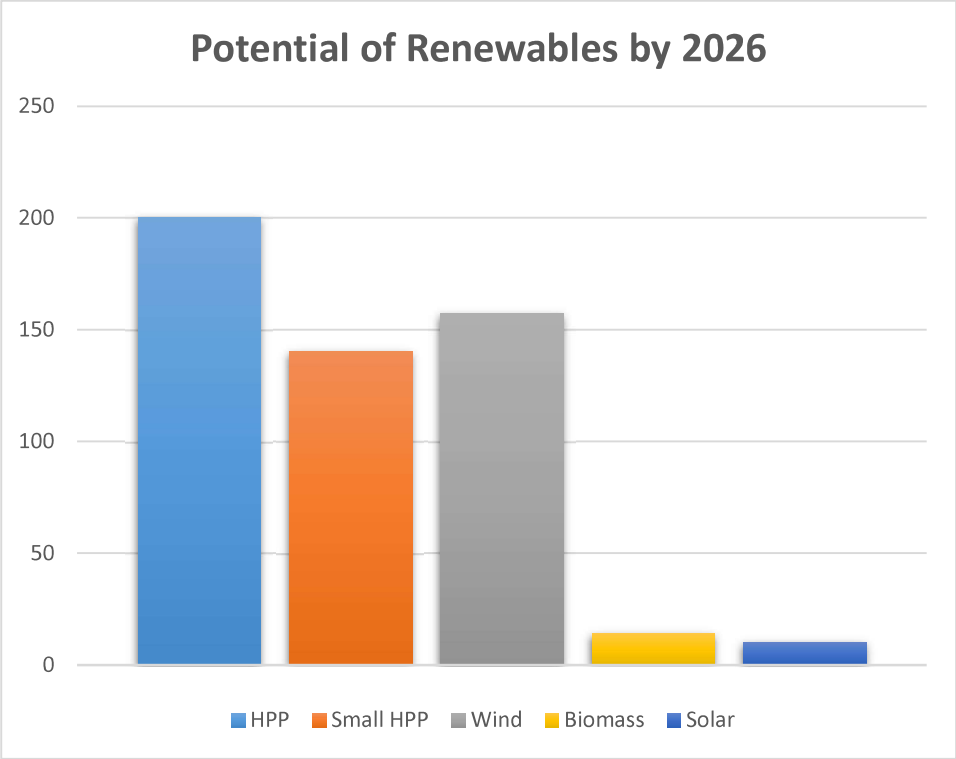


Figure 23: Potential of RES by 2026

- 200 MW HPP by 2026
- 140 MW new small HPP by 2026
- 157 MW Wind by 2026
- 14 MW Biomass by 2026
- 10 MW Solar (photovoltaic) by 2026

Until 2026 it is estimated that the installed capacity from RES will be 521 MW.

4.3 "Low Carbon and Renewables" – Research Scenario

As emphasized above, this study will show two scenarios. The first one was the "Business as usual" scenario, a government scenario. The second scenario will be the study scenario based on the findings.

4.3.1 Strategy and Investment

The study, based on the findings so far, that foresees Kosovo to meet electricity supply needs, should focus on investments in RES and T&D Los preventions. Compared to the government's plan, the findings show that there is far more potential in renewable energy, especially in the Wind Energy, Solar Energy, Biogas and Geothermal. In the following part these assumptions will be detailed.

- TPP Kosova A – decommissioned as soon as possible
- TPP Kosova B – remain at service through 2025, and undergo to efficiency improvements
- New Power Plant "Kosova e Re" should not be constructed
- Small HPP – same capacity as it was defined by the government model in section 4.2
- HPP with 200 MW, as it was mentioned in the government scenario in section 4.2
- HPP "Zhur" should not be constructed
- Wind power plant with a combined total capacity of 371 MW
- Solar PV with an installed capacity of 75 MW by 2025
- Biomass with the capacity development reaching 165 MW
- Geothermal – the installed capacity could easily be up to 300 MW

4.3.2 TPP Kosova A

In this scenario it is thought that TPP Kosova A should be decommissioned as soon as possible.

As pointed out in section 2.1, TPP Kosova A operates with 5 units (A1-A5). Two of them are no longer operational. The three other units, which are built between 1970 and 1975 have an installation capacity of 610 MW. There are two units of 200 MW each, and the third one 210 MW, with a net capacity of 350 MW operate with an efficiency of 26 %.

The oldest power plant in the Balkans "Kosova A" it is not going to be repaired as it was planned from the government. Nor will it close in 2023 as the decision of the government says. Preliminary preparations are needed to carry out its decommissioning during the year 2023. No concrete steps by the government are done which leaves us hopping that the this is going to happen in 2023. Anyway, year 2023 is far away when it comes to decommissioning this power plant. It should be

closed as soon as possible, knowing that the TPP Kosova A is in bad condition and being the worst one-point source of pollution in Europe.

On the other hand, environmental pollution in Kosovo exceeds the allowed european norms, while the results of the Kosovo Environmental Protection Agency show that only in Prishtina these values are exceeded by 3 to 6 times more than allowed. Power plants are the main environmental pollutants in Kosovo, especially TPP Kosova A. Thus, TPP Kosova A should be closed as soon as possible.

4.3.3 TPP Kosova B

Rehabilitation of TPP Kosova B should take place as soon as possible with EU environmental standards.

TPP Kosova B is the largest power station in Kosovo. It operates with two large units (B1 and B2) with an installation capacity of 340 MW. Both units are depreciated in capacity of 280 MW and operate at an efficiency of 32%. Thus, TPP Kosova B will not be able to meet the standards set out in the EU Directives for Large Combustion Plants (LCPs), unless it will be rehabilitated.

4.3.4 New Power Plant "Kosova e Re"

The main topic in the last decade in terms of energy development in Kosovo is the NPP “Kosova e Re”.

In section 4.2.2 was explained the history of this power plant, so in this chapter it won’t be necessary to go into the details again. The focus will be mainly on discussing whether this power plant should be built or not. The government insists that the building of the NPP “Kosova e Re” will solve the problem of Kosovo's energy supply. Mathematically it may even be. But taking into consideration all the details about the construction of this power plant that have been provided by the government so far, it may conclude that the cost of this power plant is irreplaceable for the citizens of Kosovo, and as such should not be built. Later, it will be elaborated in more details this stance of the study.

4.3.5 Small Hydropower Plant

Small HPP capacity is projected to remain the same as estimated in the government version.

4.3.6 New Hydropower Plant – (200 MW)

HPP in corporation with Albanian state with 200 MW installed capacity will remain same too, as it was mentioned in the government scenario in section 4.2.

4.3.7 Hydropower Plant "Zhur"

As stressed out in section 3.2 and 4.2.3 HPP Zhur is the biggest project of MED regarding the HPPs. Initial project was planned to be launched in 2016 having an installed capacity estimated at 305 MW with an annual generation of approximately 400 GWh.

It was planned that this HPP could have the role of secondary and tertiary reserve in the Kosovo power system. It was estimated that Zhur's hydropower potential represented about 43% of the total technically productive capacity to be used in Kosovo. The period analyzed here included six years of project implementation with 50 years of operational lifespan.

Today this project has remained only on paper. Moreover, MED has removed this from the 10-year energy development strategy.

Anyway, there are pliantly of reasons why this project should not take place. HPP Zhur diverts the waters of three rivers: Bushtricë, Caje and Orgjot. Consequently, this will have a devastating impact in the Kukës area that is located in Albania. The entire water flow of this area will go to the construction of HPP and the remaining water will be just Dragash sewage.

A study from Balkan Green Foundation estimates that HPP Zhur project needs to be removed from all plans, because, in their opinion, the project has major problems such as financial feasibility as well as political legitimacy and has a significant environmental impact and the amount of energy produced by the HPP would not be sufficient to justify the investment. They also estimate that this type of HPP would be operating only in peak periods (4-6 hours) per day. In feasibility terms, the profitability of the investment would take about 50 years and in addition would lose about 3 kW of energy during the low tariff, for one kWh energy earned during the peak hour. [Balkan Green Foundation, 2019]

4.3.8 Wind Power Plant – (371 MW)

So far, only foreign investors and various international organizations that defend green policies in terms of electricity production have made wind speed measurements in different locations in Kosovo.

In section 3.3.1 was mentioned a study from NEK Umweltechnik Company. A study with an examination and intensive analysis of the current state of the wind energy potential. The company has made wind measurements in 10 locations, and the first purpose of the company was to create a regional wind map that could be offered to potential investor or wind energy park operators that could be used as basic information. Furthermore, there were estimates that wind park energy in Kosovo can be developed. Results were sufficient data to design a map of wind resources and with suitable locations where future wind turbine project can take place.

Based on their results, NEK is convinced that there is a huge potential of wind energy in Kosovo, and they decided to invest in three projects in different locations in Kosovo. Village of Zatriq, an area in the municipality of Rahovec is the first location for the wind power ülant with an installation capacity of 30 MW in Zatriq. Budakova is the second location, where a wind power plant with an installation capacity of 48 MW will take place. The third project of NEK will be at Çiçavica with an installed capacity of 51 MW.

There are more projects from different investors that have applied to KOST that were mentioned in section 3.3. One of them is the wind farm project Shtime 1 and 2 from an anonymous German company with an installed capacity of 127 MW. Another one is a promising project in Bajgora and Skenderaj from a Kosovo-Italian cooperation that made measurement and showed a very big potential of a three-digit megawatt range. The average wind speed in a 7-hectare area in Bajgora was 9 - 12 m/s. The proposed project from this corporation is 100 MW.

Based on the findings so far, the potential of wind energy in Kosovo can reach up to 371 MW.

4.3.9 Solar Energy – (75 MW)

The production of solar panels is aimed at promoting and supporting the interest of renewable energy, and this enables the production, sale and installation of solar PV panels.

The establishment of Jaha Solar Factory, besides the initiative of a new business spirit in Kosovo, has also created jobs for new staff, and has built a bridge of cooperation and partnership with non-governmental (non-profit) institutions such as USAID, GIZ, who honored the inauguration with the presence of their representatives in Kosovo.

Jaha Solar offers solar PV panels which have high performance and high quality and meet the most advanced standards. Solar panels have standard life assurance and productivity guarantees which makes them the desired product for buyers from different countries of the world.

Jaha Solar has successfully passed the ISO 9001:2008 Quality Management System Certificate from TÜV NORD CERT.

TUV NORD has certified the "JAHA SOLAR" factory for these activities:

- Production of PV panels
- Sale and installation of PV systems

Latest projects:

- SGE project, 3 MWp (Kamenice, Kosovo)
- Brickos project, 1.17 MWp (Kamenice, Kosovo)
- Eco Solar System, 996 kWp (Podgorica, Montenegro)
- Albi Mall, 550 kWp (Prishtina, Kosovo)
- Invicta, 416 kWp (Podgorica, Montenegro)

PV market development in Kosovo has lot of potential for several reasons:

- Good solar irradiance (around 1300-1350 kWh/kWp)
- Lower investment costs due to technology development
- Predicted higher electricity price due to construction of new TPP (Coal)
- New support schemes for small to medium rooftop projects.

Based on the findings so far, the potential of wind energy in Kosovo can reach up to 75 MW

4.3.10 Biomass – (165 MW)

There are different types of biomasses available in Kosovo, with wood making the largest contribution. As an additional contribution is agricultural and livestock waste. Agricultural biomass in the form of straw is manufactured in many communities by many small farmers. Different difficulties appear in collecting these resources of biomass and therefore it limits using of these, that can be used for generation of electricity.

Based on different studies, there is more potential than the government has planned. Research by the Rael Berkeley laboratory in 2012 predicts an annual installed biomass capacity of around 165 MW by 2020. The same study assumes a fermentation gas plant with a 58% capacity factor with an overall annual energy generation of ~830 GWh/year, corresponding to only 14% of the assumed potential resources.

4.3.11 Geothermal – (300 MW)

Geothermal mapping in the area close to Kosovo shows a large potential to produce geothermal energy.

Unfortunately, in Kosovo there is no specific measurement available, but neighboring countries like Macedonia and Serbia are already investing in geothermal energy production.

Based on the findings so far, this scenario assumes an installed capacity of 300 MW. But there is much more potential. With the right investment the real potential capacity can reach up to 800+ MW in combination with Serbia.

4.3.12 "Low Carbon and Renewables" Scenario – Summary of Potential

Figure 24 shows the potential of RES in numbers from "Low Carbon and Renewables" scenario.

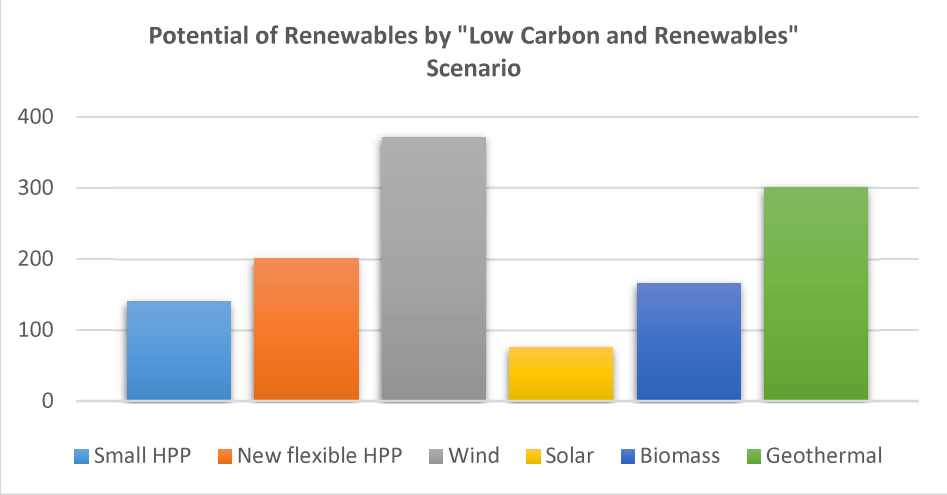


Figure 24: Potential of RES by "Low Carbon and Renewables" Scenario

- 140 MW new small HPP by 2026
- 200 MW HPP by 2026
- 371 MW Wind by 2026
- 75 MW Solar PV by 2026
- 165 MW Biomass by 2026
- 300 MW Geothermal
- Decommissioning of TPP „Kosova A" as soon as possible
- Rehabilitation of TPP "Kosova B" by 2020

Until 2026 it is estimated that the installed capacity from RES will be 1251 MW.

4.4 Impact of "Low Carbon and Renewables" Scenario

4.4.1 NPP "Kosova e Re"

In section 4.3.4 it was concluded that NPP "Kosova e Re" should not be constructed for several different abovementioned reasons.

Cost of this power plant is irreplaceable for the citizens of Kosovo, and there are more reasons why this power plant should not be built. In the following part it will be discussed in detail all of them.

4.4.1.1 Misuse of public money

Since 2006 over 20 million euro have been spent only for project new Kosovo project partners. [Balkan Green Foundation, 2019]

In 2006, the World Bank engaged transaction advisors for the first time, whereby 12 million € were spent until 2011, of which 4 million euro were covered from the budget of government of Kosovo.

In 2011, the government engaged consular companies where they spent 3.9 million euro. From 2012 to 2015, through several service contracts, the MED has engaged three different project managers and support staff for a value of approximately 200,000 euro.

On May 2019, MED has announced a tender with a reference value of 4 million € for the purchase of consultancy services for the NPP “Kosovo e Re” project. With this tender, the costs for consultants of the project "Kosova e Re" will reach over 20 million euro.

4.4.1.2 Legal problems

The agreement that government and Contour-Global had signed, namely commercial agreements for the construction of TPP Kosova e Re is in violation of Kosovo and EU laws.

Following, these are the agreements signed by the government of Kosovo and Contour-Global contains elements of State Aid: [Balkan Green Foundation, 2019]

- New Kosovo Energy Company (NKEC) is obliged to buy 100% of NPP “Kosova e Re” production capacity, even if the market does not require it.
- Because NPP “Kosova e Re” has priority over NPP “Kosova B”, Kosovo's electricity market will be closed for 20 years blocking the development of any competition with the minimum chance of liberalizing the energy market.
- All charges for using the system will be charged to NKEC and not Contour-Global.
- KEK is obliged to provide coal, giving Contour-Global competitors less efficient coal for a higher price.
- The land, where NPP “Kosova e Re” is going to be build was given for use to Contour-Global only for 10 euro.

4.4.1.3 NKEC Company

The government of Kosovo has established a new public company named New Kosovo Electric Company (NKEC). The first and the only mission of NKEC that is under the contract for construction of the Contour Global thermal power plant is the purchase of all available energy from this power plant on the condition of "get or pay". In other words, NKEC is committed to acquiring the entire production capacity of the NPP at a price of 80 EUR per MWh. (Power purchase Agreement, Recital F, pg. 7). This price is twice as high as the price that KEK is paying today. The contract guarantees the Contour-Global that the entire generated electricity is going to be bought by the NKEC. NKEC is obliged to buy electricity from Contour-Global in the price of 270 mil. EUR per year.

At the other hand NKEC will sell the generated electricity to Kosovo Electricity Distribution Company (KEDS) at a market price, and if there is a difference between the market price and this price, the same difference will be subsidized by the Kosovo budget.

This obligation has been guaranteed by the government for the next 20 years. 20 years burden on citizens and businesses. Kosovo will be released from this obligation in 2043.

NKEC will start purchasing electricity from Contour Global in 2023. This means that the company that is now established will not play a part in the market of energy. In other words, for the next four years, the government of Kosovo will pay from public money high salaries to board members of this company, and other expenses completely needless. Based on some calculations from Balkan Green Foundation, Kosovar taxpayers will pay about 100,000 euro per year only for NKEC staff salaries. The NPP “Kosova e Re” construction is expected to extend for four years. During these four years, Kosovar taxpayers will pay about 400,000 euro only to NKEC staff. [Balkan Green Foundation, 2019]

Based on the current laws in the Republic of Kosovo, such contracts as Contour Global would have to be voted in the Assembly of the Republic of Kosovo. The creation of expenditures at a time when the project guarantee is necessary to be voted in the assembly is neglect by the authority of the assembly.

4.4.1.4 Price of Electricity

Until today a Kosovan household has paid 18.75 euro per month for electricity. The same household would have to pay 35.94 euro per month or 92% more expensive electricity bill if NPP “Kosova e Re” will be built.

Today, the average monthly price for electricity is 6 cent/kWh. After the construction of NPP “Kosova e Re”, the average monthly price is expected to be 11.5 cent/kWh.

4.4.2 Job Creation

Kosovo as mentioned above is a poor country with a large percentage of unemployment, which reaches up to 60%. Creating new jobs is much more significant in these circumstances.

In the previous chapters the high potential of generating electricity through renewable energy has been discussed. Consequently, in Kosovo, but also the region, is developing new projects for generation of electricity through renewable sources, respectively wind and solar energy.

The turkish company "Air Energy" has invested in the Dardana Municipality region at a 35 MW capacity in a Wind Power Plant and now this plant is operational. Numerous other projects mentioned in the previous chapters are already in the phase of obtaining permission from the competent authorities of the Republic of Kosovo.

Unfortunately, there is little data about the number of employees these companies are employing. Consequently, to describe the possibilities of exploiting the potential of renewable sources, namely wind and sun, as a reference point will be the different studies that have been carried out by various companies or organizations at local or international level.

A study by Deutsche “Gesellschaft für Internationale Zusammenarbeit” (GIZ) is based on the EU's energy market, in particular, wind energy market.

In order to reach the most accurate generation of jobs from renewable sources, this study has divided into three emerging supply networks that are directly concerned by the development of repetitive energy:

- Manufacturing of devices and components
- Planning and installing
- Operation and servicing

Also, according to the same study, it is estimated that analyzing the labor market in the EU, there are two types of employment:

- Direct employment, and
- Indirect employment

Direct employment implies jobs at wind generator manufacturers and in the manufacturing sector of other components. In this group are also the employees in the planning offices and in the service companies that are specialized in maintenance, operation, and other services.

The concrete industry, steel industry, transportation of equipment, financial services, generate jobs that can be classified as an indirect employment.

The same study, for calculation of new jobs has received a study by Feder Ministry of Transport, Innovation and Technology (BMVIT), where 129 companies of wind operating energy in 6

different regions in Austria have been asked. Results show that these companies employ 173 people on a full-time basis for a combined capacity of 1010.6 MW, or 0.17 jobs per MW.

In the previous chapter it was emphasized that the potential of wind power in Kosovo is 371 MW. A simple mathematical calculation shows that 371 MW would result in 63 new permanent jobs in operating companies. Potential of wind energy generation for countries of the region has been taken from the GIZ study. Table 15 shows the exact number of permanent jobs in operating companies.

Table 15: Permanent employment in Operating Companies

operational corporations Basis 0.17 Jobs per MW			
Nr.	**Country**	**MW**	**Jobs**
1	Kosovo	371	63
2	Albania	1367	236
3	Serbia	1733	300
4	Bosnia and Herzegovina	648	112
5	Montenegro	118	20
6	Macedonia	377	65
	Overall	**4614**	**796**

The BMVIT study continues with the number of jobs that would be created by operations, repair, and maintenance and the result of this study indicates that for 1 MW of installed power, 0.54 new jobs would be created. Consequently, Kosovo with a potential of 371 MW would be able to create 200 new jobs in operating, repair, and maintenance sector.Table 16 below shows the new generated jobs in each sector for each country in Balkan. The potential of wind power in other Balkan countries is a reference from the GIZ study.

Table 16: Permanent Jobs for the operation, repair, and maintenance

Operating, maintenance and servicing Basis 0.54 Jobs per MW			
Nr.	**Country**	**MW**	**Jobs**
1	Kosovo	371	200
2	Albania	1367	738
3	Serbia	1733	936
4	Bosnia and Herzegovina	648	350
5	Montenegro	118	64
6	Macedonia	377	204
	Overall	**4614**	**2492**

In addition, work during the construction of a wind power plant results in primary and secondary effects, otherwise known as input-output analysis.

This method is used by the BMVIT study to evaluate the economic effects. The purpose of this method is to determine the direct and indirect impact of its economy of the country. Direct effects are considered those effects that immediately create economic sectors. Generators, propellers, installation companies and construction firms can be included in this group. In the second group can enter companies supplying the manufacturing, chemical industry which supplies fiberglass, mechanical engineering, and transportation. All these groups provide employment and additional income.

Based on the above-mentioned data, BMVIT estimates that for 1 MW, 6.4 new jobs can be generated. Based on this, Kosovo with a capacity of 371 MW will be able to create 2374 new jobs because of primary and secondary effects.

Table 17 shows the exact number of primary and secondary employments in other Balkan countries.

Table 17: Primary and secondary employments effects

Direct and indirect employment effects Basis 6.4 Jobs per MW			
Nr.	**Country**	**MW**	**Jobs**
1	Kosovo	371	2374
2	Albania	1367	8749
3	Serbia	1733	11095
4	Bosnia and Herzegovina	648	4147
5	Montenegro	118	755
6	Macedonia	377	2413
	Overall	**4614**	**29533**

All these findings would be feasible if the government of Kosovo would create conditions for the promotion of foreign investment in the country, especially in the renewable energy sector.

The geographic position of Kosovo, which is in the middle of the Balkans, with modern highways is connected through all countries bordering Kosovo, like Albania, Macedonia and Serbia. Its population is young, averaging 25 years of age. The average salary in Kosovo is 460 US. The total number of students in university education during the academic year 2018/2019 was 104,606. All these data guarantee an extraordinary security both infrastructure and professional to produce some components of wind generators or other parts of a wind turbine.

5 Development Scenario for Kosovo's Electricity Sector based on RETScreen Calculations

5.1 RETSreen Program

RETScreen is a software system for clean energy management for the feasibility analysis of projects in the fields of energy efficiency, renewable energies and combined heat and power generation as well as for the ongoing analysis of energy performance.

RETScreen enables professionals and decision-makers to quickly identify, assess and improve the technical and financial feasibility of potential clean energy related projects.This software platform for decision intelligence also enables managers to easily monitor and verify the actual performance of their plants and helps to identify additional energy conservation/production opportunities.

RETScreen is managed by CanmetEnergy Varennes Research Center.

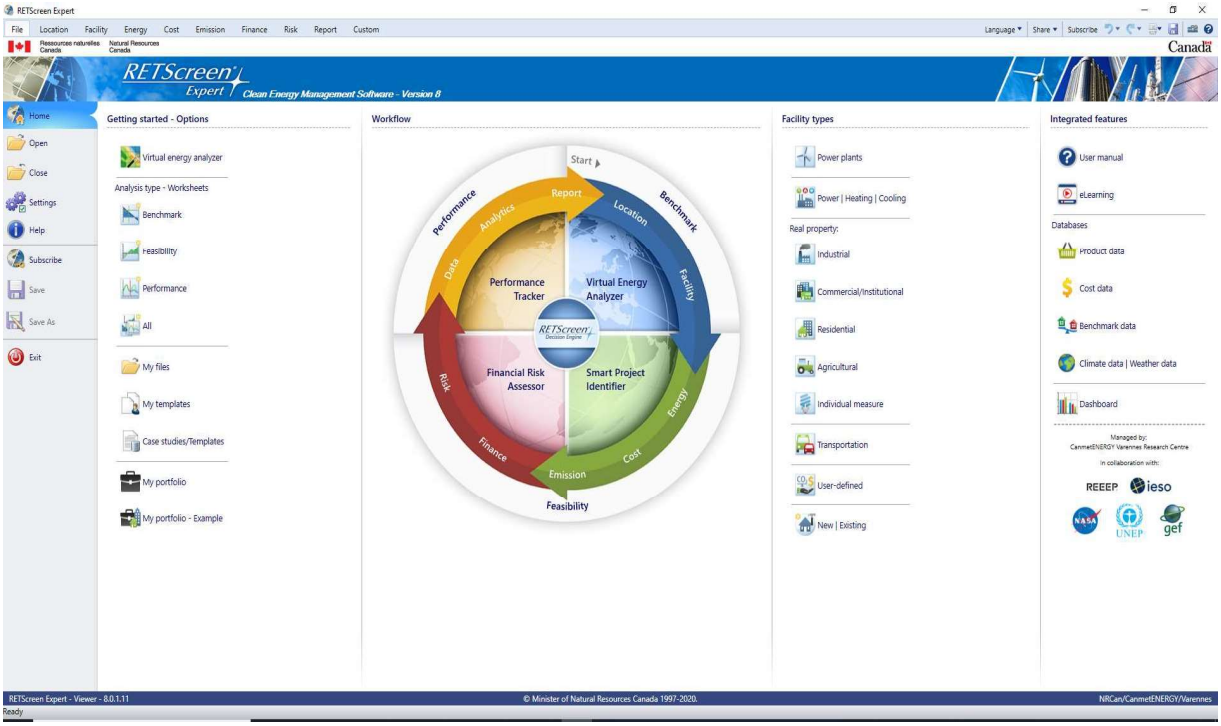


Figure 25: RETScreen display [Government of Canada, 2020]

5.2 Projects Analyses - RETScreen

Based on the data[5] collected during the thesis, case studies were built using RETScreen for each of the power plant types for an in-depth technoeconomic analysis.

[5] All papers reviewed in this master thesis, available in the chapter "References"

The first case study modeled using the RETScreen is the TPP "Kosova e Re" project. Based on the data achieved, the ecological and financial aspects of the project are analysed.

The second case study modeled in this study is the proposed wind power plant in Kitka mountain, municipality of Dardana. Similar as the case study TPP “Kosova e Re”, the environmental aspect of the project and the financial side will be analysed.

The last case study modeled in this thesis is the solar PV power plant in municipality of Dardana, where the reduced amount of CO_2 and financial aspects will be thoroughly analysed.

Finally, in order to get a better overview of the potential that renewable energies offer, always on the basis of the collected data, and to make a comparison between the project of TPP "Kosova e Re" and the potential of electricity, a combined project of wind and solar energy is going to be modulated.

Lastly, it will be illustrated how investments in renewable energy can achieve a very large reduction of carbon dioxide, and with almost the same investment it will be able to generate almost the same amount of electricity through the renewable energy.

5.3 Case study 1: Coal Power Plant “Kosova e Re”

The "Kosova e Re" coal power plant represents, as mentioned in the previous chapters, the biggest project of the government after the end of the war.

5.3.1 Data Inputs

In the following sections there will be a step-by-step modulation of the project TPP "Kosova e Re" based on the data provided in the previous chapters.

Data such as ***location, type of technology, type of fuel*** used for the selected technology and many other data, all of which can be incorporated into the model via the RETScreen program.

5.3.1.1 Location

The RETScreen program allows to select the location where the project will be built. Depending on the selected location, the program calculates all-natural parameters that may influence the work of the project.

Figure 26: Location of power plant "Kosova e Re"

As it is shown in Figure 26, TPP “Kosova e Re” will be constructed near the thermal power plant "Kosovo B". Finally, RETScreen will automatically generate data such as latitude, longitude, climate zone, etc.

5.3.1.2 Facility

In the “Facitity” section, RETScreen allows to choose the type of power generation technology and the installation capacity of the technology. (Figure *27*)

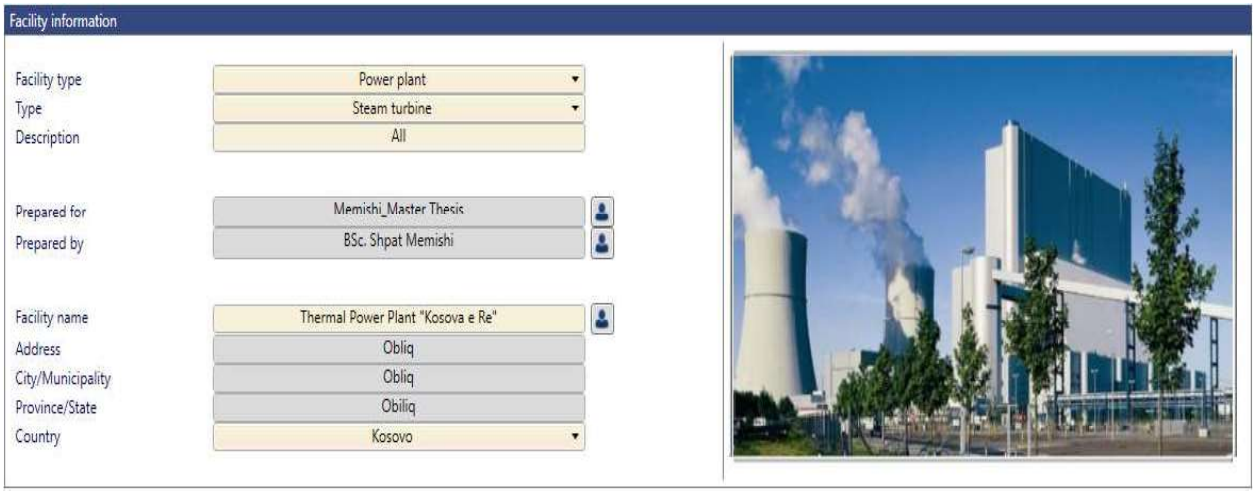


Figure 27: Facility information – Steam Turbine

5.3.1.3 Benchmark – Price of Electricity per kWh

Based on the type of technology and the selected location, RETScreen automatically provides the type of fuel used for the respective technology and its price per kWh. As it is shown in Figure 28, the fuel for steam turbines is lignite, and its prices range from 0.063 €/kWh to 0.114 €/kWh.

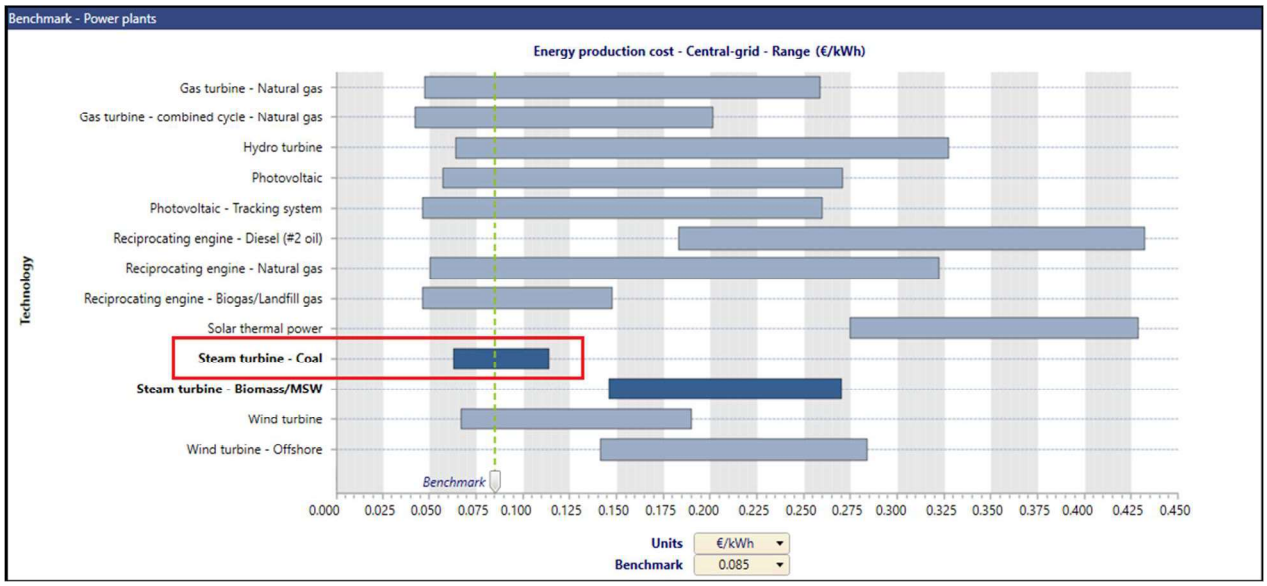


Figure 28: Benchmark - coal

5.3.2 Data Input – TPP "Kosova e Re"

5.3.2.1 Fuel Definition and Electricity

In the following it is necessary to choose the fuel for our case, its price per ton and the export price for the electricity generated by the new power plant "Kosova e Re". (Figure 29)

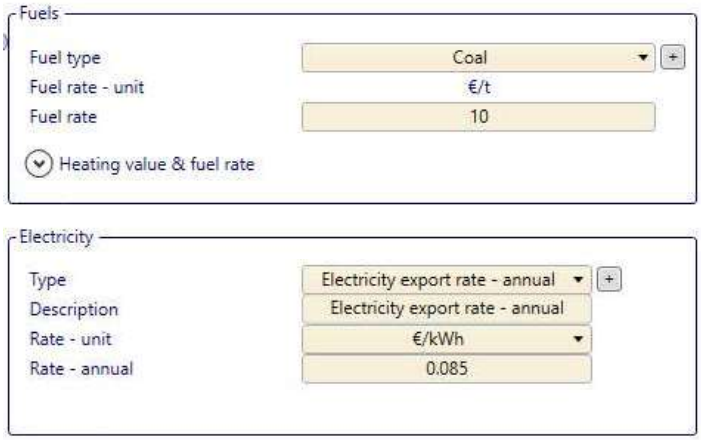


Figure 29: Fuel and electricity price

It is very important to underline that the export price of electricity in the current study is estimated at 8,5 cents/kWh, always being based on the market price currently prevailing in the north-eastern Balkans. Later, it will be shown how the government of Kosovo has guaranteed the investor Contour Global a price of 11.5 cent/kWh, so that the project of TPP "Kosova e Re" becomes highly profitable.

5.3.2.2 Steam Turbine Settings

Figure 30 shows the main parameters of the steam turbine in the case of “Kosova e Re” power plant.

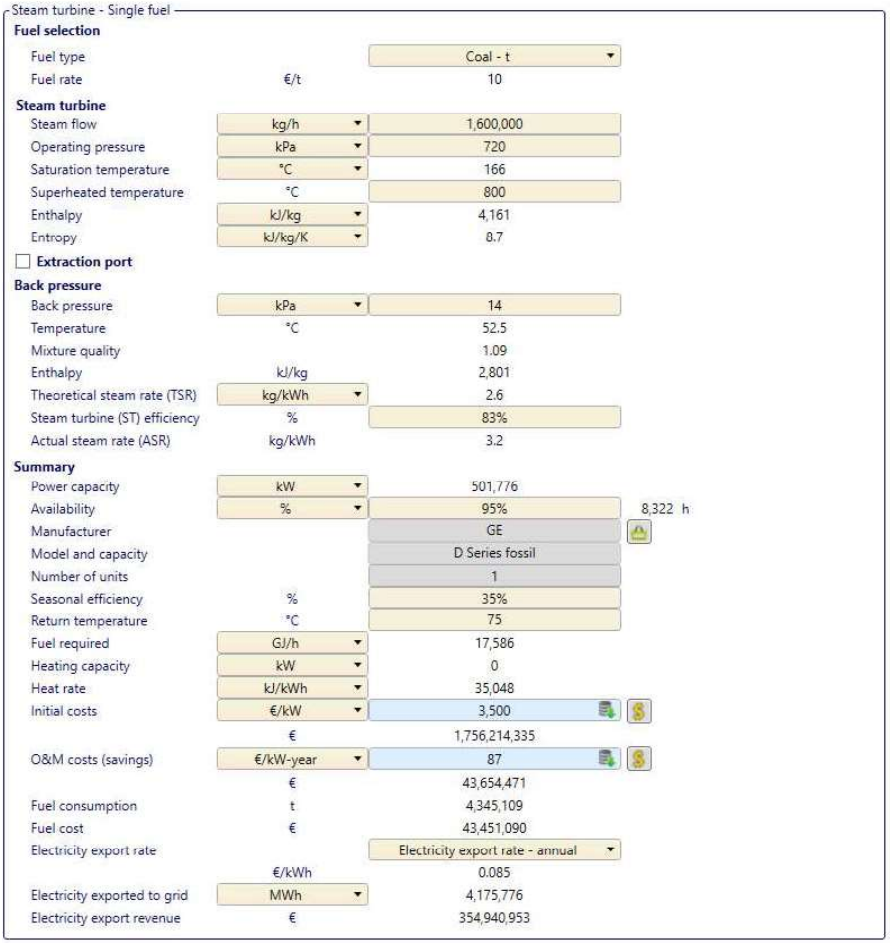


Figure 30: Steam turbine settings

The steam turbine type in this case is the GE model, D series. Turbine capacity will be a generator of 500 MW. Seasonal efficiency will be 35%.

The energy generated by this generating unit for one year will be 4,175.776 GWh. The price for this project based on calculation with RETScreen will be discussed in the next chapter.

5.3.3 Financial Parameters

The following data that are shown in Figure 31, are taken from a study by the Institute of Energy Economics and Financial Analysis from 2016.

Project`s life is expected to last 40 years. The agreement signed between the government and Contour Global stipulates that the interest rate will be around 20%. [Institute for Energy Economics and Financial Analyses, 2016]

Financial parameters		
General		
Fuel cost escalation rate	%	2%
Inflation rate	%	5%
Discount rate	%	9%
Reinvestment rate	%	9%
Project life	yr	40
Finance		
Incentives and grants	€	
Debt ratio	%	80%
Debt	€	1,404,971,468
Equity	€	351,242,867
Debt interest rate	%	20%
Debt term	yr	25
Debt payments	€/yr	283,971,047

Figure 31: Financial parameters of TPP "Kosova e Re"

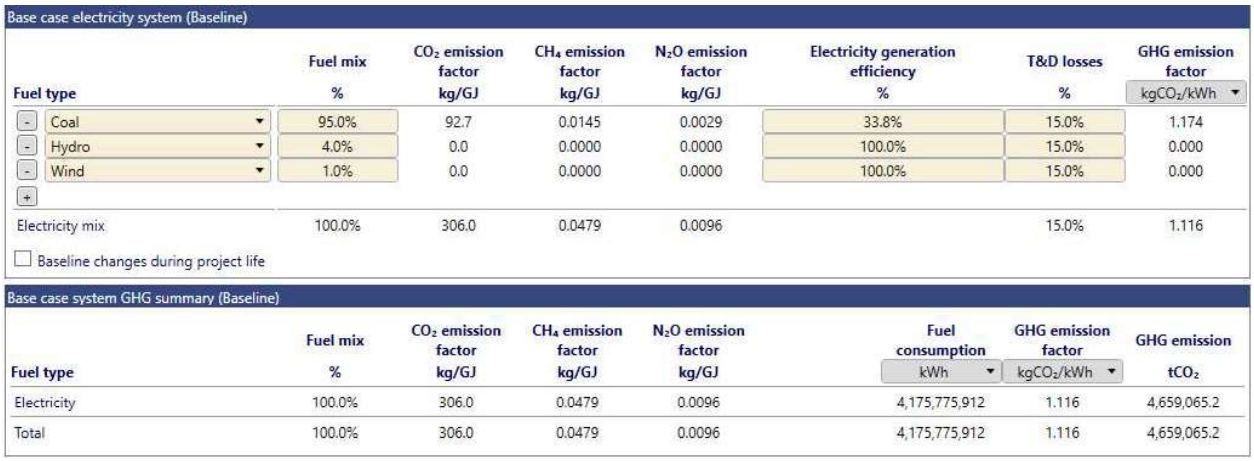
5.3.4 Emission Analysis

5.3.4.1 Current Situation

As mentioned in the previous paragraphs, 95% of the electricity is generated by the two power plants Kosova A and Kosova B. The remaining percentage is covered by RES. The current situation of the environment pollution is by no means good. Prishtina, the capital of Kosovo, is one of the most polluted cities in Europe. Following, RETScreen illustrates the amount of CO_2, released from the power plants in Kosovo throughout a year.

Based on the current situation regarding the way in which electricity is produced, i.e. during one year in Kosovo with 95% of the electricity generated by the power plants 4.6 million tCO_2 is being released.

These calculations are shown in detail in Figure 32.



Base case electricity system (Baseline)

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Electricity generation efficiency %	T&D losses %	GHG emission factor $kgCO_2/kWh$
Coal	95.0%	92.7	0.0145	0.0029	33.8%	15.0%	1.174
Hydro	4.0%	0.0	0.0000	0.0000	100.0%	15.0%	0.000
Wind	1.0%	0.0	0.0000	0.0000	100.0%	15.0%	0.000
Electricity mix	100.0%	306.0	0.0479	0.0096		15.0%	1.116

Baseline changes during project life

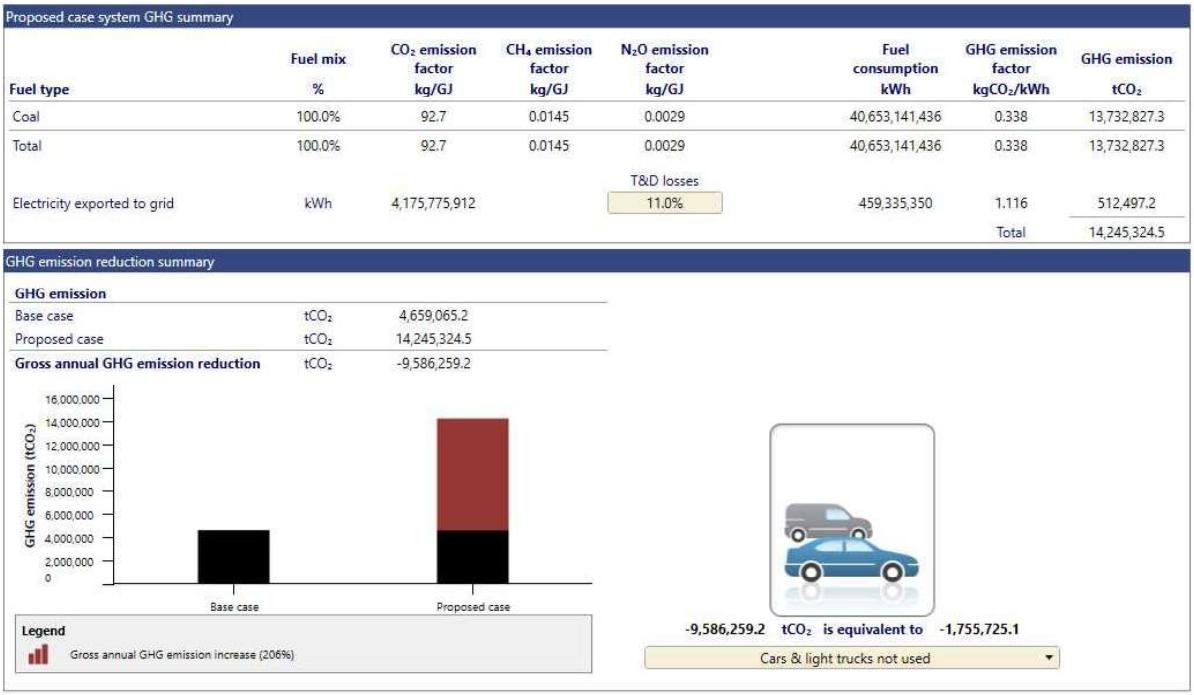
Base case system GHG summary (Baseline)

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Fuel consumption kWh	GHG emission factor $kgCO_2/kWh$	GHG emission tCO_2
Electricity	100.0%	306.0	0.0479	0.0096	4,175,775,912	1.116	4,659,065.2
Total	100.0%	306.0	0.0479	0.0096	4,175,775,912	1.116	4,659,065.2

Figure 32: CO_2 emission – base case

5.3.4.2 Emissions with TPP "Kosova e Re"

In Figure 33 it is illustrated the amount of CO_2 released by the construction of the TPP "Kosova e Re".



Proposed case system GHG summary

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Fuel consumption kWh	GHG emission factor $kgCO_2/kWh$	GHG emission tCO_2
Coal	100.0%	92.7	0.0145	0.0029	40,653,141,436	0.338	13,732,827.3
Total	100.0%	92.7	0.0145	0.0029	40,653,141,436	0.338	13,732,827.3
				T&D losses			
Electricity exported to grid	kWh	4,175,775,912		11.0%	459,335,350	1.116	512,497.2
						Total	14,245,324.5

GHG emission reduction summary

GHG emission		
Base case	tCO_2	4,659,065.2
Proposed case	tCO_2	14,245,324.5
Gross annual GHG emission reduction	tCO_2	-9,586,259.2

Figure 33: CO_2 emission – proposed case

According to RETScreen calculations, it can be seen that the TPP "Kosova e Re" with a capacity of 500 MW will release 14.2 million tCO_2 annually.

Figure 33 shows that the situation regarding air pollution will only worsen. Even in alarming numbers. Based on the findings, in section 3.1.1 it was mentioned that, if the TPP "Kosova e Re" would be established, Kosovo could be responsible for the release of about 20 million tCO_2. RETScreen predicts almost the same amount of released carbon dioxide. According to the calculations with RETScreen it can be concluded that during one year in case of construction of the TPP "Kosova e Re", Kosovo will be responsible for the release of 18.9 million tCO_2.

5.3.5 Cost Analysis

5.3.5.1 Initial Cost Analysis and Annual Savings

In section 2.4.1 based on the data provided by the government, it was stated that the construction of the TPP "Kosova e Re" has a total value of 1.3 billion euro. It was also mentioned that this number is likely to be much higher than the one indicated by the government. According to RETScreen calculations, the initial costs alone will be approximately 1.7 billion euro. (Figure 34)

Costs | Savings | Revenue			
Initial costs			
Initial cost	100%	€	1,756,214,335
Total initial costs	**100%**	€	**1,756,214,335**
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M costs (savings)		€	43,654,471
Fuel cost - proposed case		€	43,451,090
Debt payments - 25 yrs		€	283,971,047
Total annual costs		€	**371,076,608**
Annual savings and revenue			
Electricity export revenue		€	354,940,953
GHG reduction revenue		€	0
Other revenue (cost)		€	0
CE production revenue		€	0
Total annual savings and revenue		€	**354,940,953**

Figure 34: Initial costs and savings – TPP “Kosva e Re”

RETScreen has also calculated the profits that the TPP "Kosova e Re" will generate through the sale of the produced electricity. As mentioned above, this model estimates the price of electricity

sales at 8.5 cent/kWh. On this basis, RETScreen assumes that the revenue from the sale of electricity by the TPP Kosova e Re will be 354.9 mill euro.

On the other hand, the government has given Contour Global an assurance that in the next twenty years the public company NKEC will purchase 100 % of the production capacity of TPP „Kosova e Re", even if the market does not require it, at a fixed price of 11,5 cent/kWh, just to make the project economically viable. In this case, the profit of the TPP "Kosova e Re" generated from the sale of the electricity produced would amount to 480.2 million euro.

5.3.5.2 Yearly Cash Flow

According to the calculations of RETScreen and based on the selling price of electricity with 8.5 cent/kWh, it can be concluded that the TPP "Kosova e Re" project would be less profitable. The calculations of RETScreen show that the net cash flow for the first year is going to be -16.1 million euro. (Figure 35)

Yearly cash flows - Year 1		
Annual costs and debt payments		
O&M costs (savings)	€	43,654,471
Fuel cost - proposed case	€	43,451,090
Debt payments - 25 yrs	€	283,971,047
Total annual costs	**€**	**371,076,608**
Annual savings and revenue		
Electricity export revenue	€	354,940,953
GHG reduction revenue	€	0
Other revenue (cost)	€	0
CE production revenue	€	0
Total annual savings and revenue	**€**	**354,940,953**
Net yearly cash flow - Year 1	**€**	**-16,135,655**

Figure 35: Net yearly cash flow – 8.5 cent/kWh

Figure 36 shows that the break-even point of the project will be reached after the end of the 17th year of the project. Consequently, the investor would take 17 years of the project, to break even the initial investment based on the parameters set by the government.

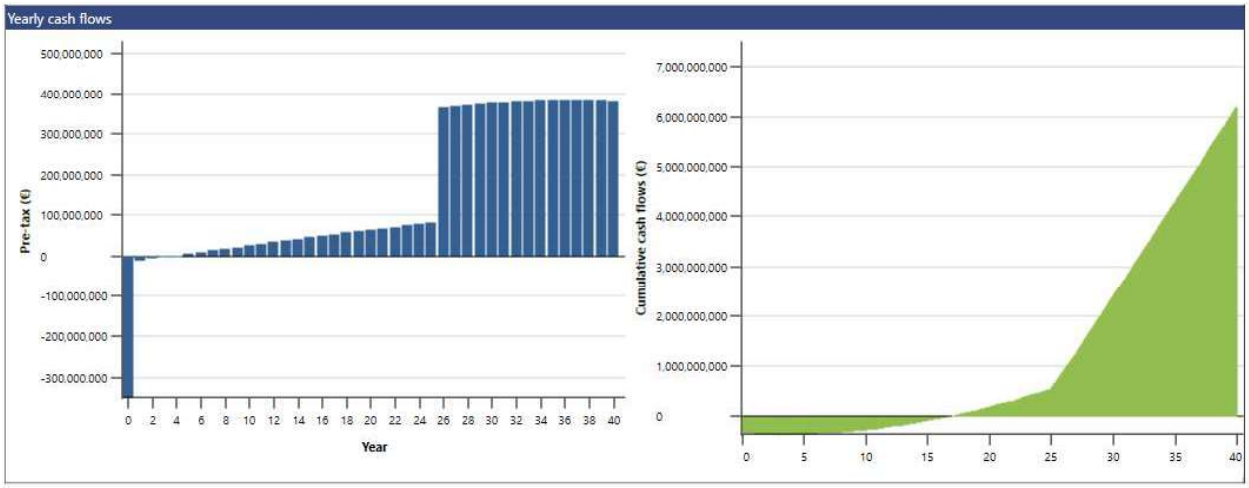


Figure 36: Yearly cash flow and break-even point – (8.5 cent/kWh)

To radically change this situation, the government has assured the investor Contour Global that it will buy 100% of its production capacity at a price of 11.5 cent/kWh. To see the difference, the export price of electricity it is going to be changed from 8.5 to 11.5 cent/kWh. Figure 37 shows that the difference will be enormous.

Yearly cash flows - Year 1		
Annual costs and debt payments		
O&M costs (savings)	€	43,654,471
Fuel cost - proposed case	€	43,451,090
Debt payments - 25 yrs	€	283,971,047
Total annual costs	**€**	**371,076,608**
Annual savings and revenue		
Electricity export revenue	€	480,214,230
GHG reduction revenue	€	0
Other revenue (cost)	€	0
CE production revenue	€	0
Total annual savings and revenue	**€**	**480,214,230**
Net yearly cash flow - Year 1	**€**	**109,137,622**

Figure 37: Net yearly cash flow – 11.5 cent/kWh

In Figure 37 it can be seen that the net cash flow for the first year will not only be positive but will also reach a very high value of 109.1 euro.

Figure 38 shows that the break-even point of the project with the price of 11.5 cent/kWh would be at the beginning of the third year.

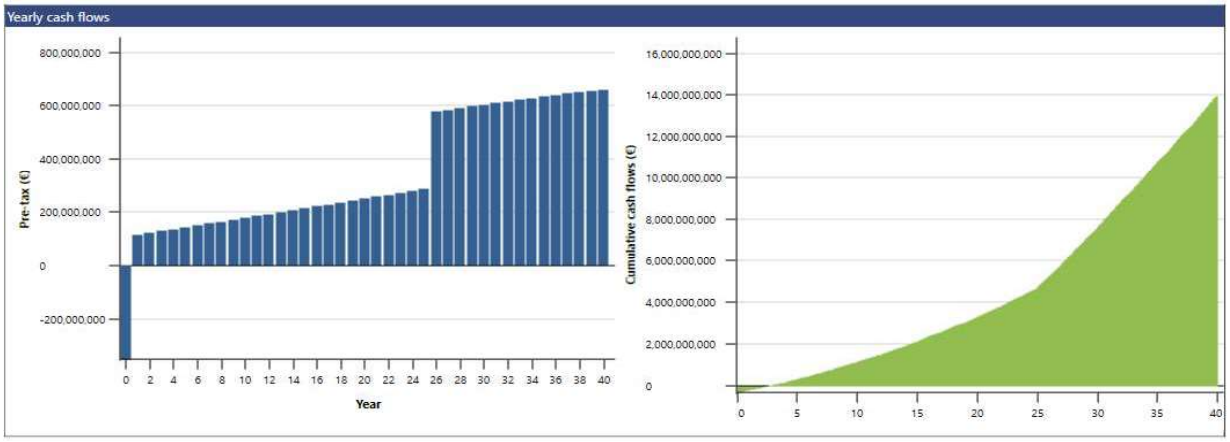


Figure 38: Yearly cash flow and break-even point – (11.5 cent/kWh)

Thus, the TPP "Kosova e Re" project is only profitable at a price of 11.5 cent/kWh, a price that would be prohibitive for the citizens of Kosovo.

5.3.6 Sensitivity and Risk Analysis

In order to get an even clearer picture of the financial aspect of the TPP "Kosova e Re" project and to assess the feasibility of this project, a more detailed analysis of the potential risks that the project may involve is given below and it is shown how sensitive the project is in terms of the financial parameters.

First of all, it is important to keep in mind that the Net Present Value (NPV) of the project calculated by RETScreen will be 190.1 million euro. NPV is the present value of all future cash flows, estimated at the discount rate, in the current currency. The net present value refers to the internal rate of return (IRR). The net present value is therefore calculated at a point in time 0, which is the intersection of the end of year 0 and the beginning of the first year.

In the following the NPV is compared with various economic parameters that may have a significant impact on it.

5.3.6.1 Initial Costs (i.e. NPV) vs. Debt Interest Rate

First of all, it will be illustrated how a possible increase in the initial cost, or the debt interest rate will affect the value of the NPV. In previous chapters it was mentioned that the debt interest rate for this project is estimated at 20%. With this value of the debt interest rate, and with an initial cost of 1.7 billion euro, the NPV as I mentioned above, will be around 190 million euro. Assuming that the initial value of the project will increase by 12%, which can happen very easily, the NPV would drop below zero, reaching even at -202.4 million euro, which means that the project would be extremely unprofitable. (Figure 39)

Debt interest rate		Initial costs €				
		1,317,160,751	1,536,687,543	1,756,214,335	1,975,741,126	2,195,267,918
%		-25.0%	-12.5%	0.0%	12.5%	25.0%
15.00%	-25.0%	1,466,069,164	1,155,298,750	844,528,335	533,757,920	222,987,505
17.50%	-12.5%	1,223,230,633	871,987,129	520,743,626	169,500,122	-181,743,381
20.00%	0.0%	975,263,340	582,691,954	**190,120,569**	-202,450,817	-595,022,202
22.50%	12.5%	723,763,487	289,275,459	-145,212,569	-579,700,597	-1,014,188,624
25.00%	25.0%	469,863,553	-6,941,131	-483,745,814	-960,550,497	-1,437,355,181

Figure 39: Initial costs vs. Debt interest rate

A study by the Institute of Energy Economics and Financial Analysis on this project states that the debt interest rate for this project will be at least 18% and it is assumed that this number might be even higher given the economic situation in Kosovo. [Institute for Energy Economics and Financial Analyses, 2016]

Let's assume that there would be an economic crisis in Kosovo, which means a 12.5% increase in debt interest rates compared to what was predicted for this project. Even with the same value of the initial costs, NPV would be below zero, respectively -145.2 million euro. If the initial costs were to increase by 12.5%, the NPV would be -579.7 million euro.

Figure 39 also shows that if the debt interest rate were to increase by 25 %, even if the initial cost were to decrease, NPV would still be below zero. This is another fact about the risk that this project may entail.

5.3.6.2 Initial Costs (i.e. NPV) vs. Debt Term

Another important parameter that can influence the reduction or increase NPV, is the duration of the debt. In the description of the financial parameters of this project it was mentioned that the loan will be reimbursed in 25 years. Therefore, assuming that the initial price remains the same and the investor would have to repay the loan in 25 years, the NPV would not change. Let us assume that for the same value of the loan term, the initial price of the project increases by 12.5%. This would mean a reduction of almost 400 million euro in NPV. So, the value of the NPV under these parameters would be -202.2 million euro. All these data are shown in Figure 40.

Debt term		Initial costs €				
		1,317,160,751	1,536,687,543	1,756,214,335	1,975,741,126	2,195,267,918
yr		-25.0%	-12.5%	0.0%	12.5%	25.0%
19	-25.0%	1,120,113,775	751,684,128	383,254,482	14,824,836	-353,604,811
22	-12.5%	1,040,597,956	658,915,673	277,233,390	-104,448,893	-486,131,176
25	0.0%	975,263,340	582,691,954	**190,120,569**	-202,450,817	-595,022,202
28	12.5%	922,316,842	520,921,041	119,525,239	-281,870,563	-683,266,365
31	25.0%	879,879,256	471,410,523	62,941,790	-345,526,942	-753,995,675

Figure 40: Initial costs (i.e. NPV) vs. Debt term

In section 4.4.1.3 it was mentioned that the government of Kosovo through the company NKEC, based on the agreement reached with Contour Global, is obliged to purchase 100% of the capacity

produced by TPP "Kosova e Re", even if this does not correspond to the needs of the market. Based on these calculations, it turns out that the main reason for this is the reduction of the number of years of loan repayment, so that Contour Global can maximize the NPV.

5.3.6.3 Initial Cost (i.e. NPV) vs. Fuel Cost

It is evident from Figure 41 that fuel costs are very sensitive when it comes to the impact on net present value. It does not matter whether fuel costs rise or fall, even with the small increase in initial costs, the net present value will be below zero. (Figure 41)

		Initial costs ▾				€
Fuel cost - proposed case ▾		1,317,160,751	1,536,687,543	1,756,214,335	1,975,741,126	2,195,267,918
€		-25.0%	-12.5%	0.0%	12.5%	25.0%
32,588,317	-25.0%	1,122,422,154	729,850,768	337,279,383	-55,292,003	-447,863,389
38,019,704	-12.5%	1,048,842,747	656,271,361	263,699,976	-128,871,410	-521,442,795
43,451,090	0.0%	975,263,340	582,691,954	**190,120,569**	-202,450,817	-595,022,202
48,882,476	12.5%	901,683,933	509,112,547	116,541,162	-276,030,224	-668,601,609
54,313,862	25.0%	828,104,526	435,533,140	42,961,755	-349,609,631	-742,181,016

Figure 41: Initial costs (i.e. NPV) vs. Fuel cost

Thus, it is very important for the investor to keep the value of the initial costs at the forecast level, otherwise the NPV will become negative.

5.3.6.4 Impact of Financial Parameters on NPV

From Figure 42 it can be seen the influence of each parameter separately on the NPV.

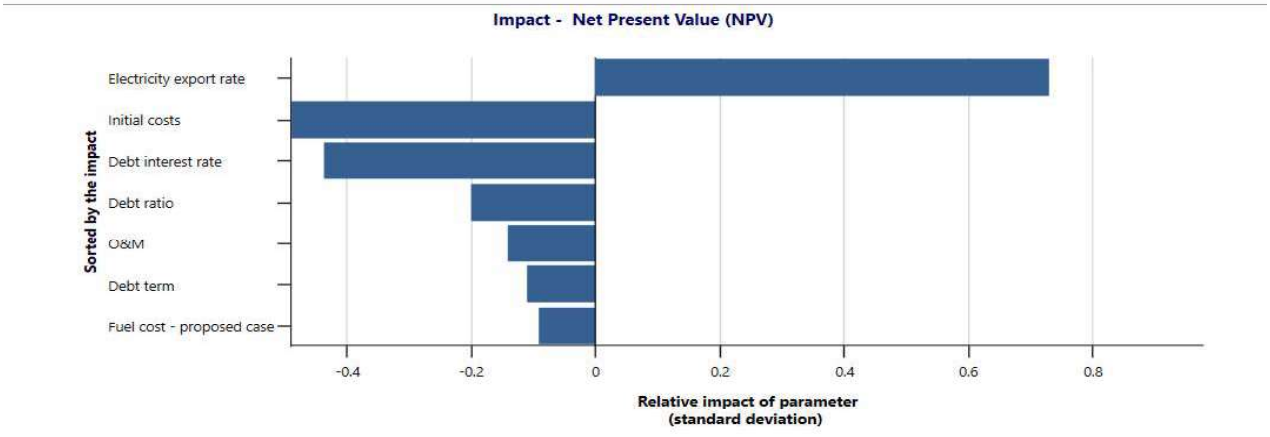


Figure 42: Impact of financial parameters on NPV

As shown in Figure 42, almost all financial parameters have a negative impact on the NPV. The most significant negative impact has the initial cost of the project. As mentioned above, if there is a small change in the initial cost, the NPV is reduced to alarming figures. After the initial cost comes the debt interest rate, and finally the fuel costs, which has the lowest negative impact on the NPV.

Most importantly, in this case, the impact of the selling price of electricity must be taken into account. Thus, if the price of electricity is higher, the NPV will increase in very large numbers. This justifies Contour Global conditional investment in Kosovo to guarantee the electricity price per kWh at 11.5 cent/kWh for the next 40 years.

5.4 Case Study 2: Proposed Wind Power Plant

5.4.1 Data Inputs

In this section, based on the conclusions drawn in section 4.3.12 on wind energy potential, an energy park project with an installation capacity of 371 MW is going to be modelled.

5.4.1.1 Location

The location is the same location where the KITKA wind farm is already operating. As mentioned in the previous project, RETScreen generates all parameters that influence the performance of the wind turbines based on the chosen location. (Figure 43)

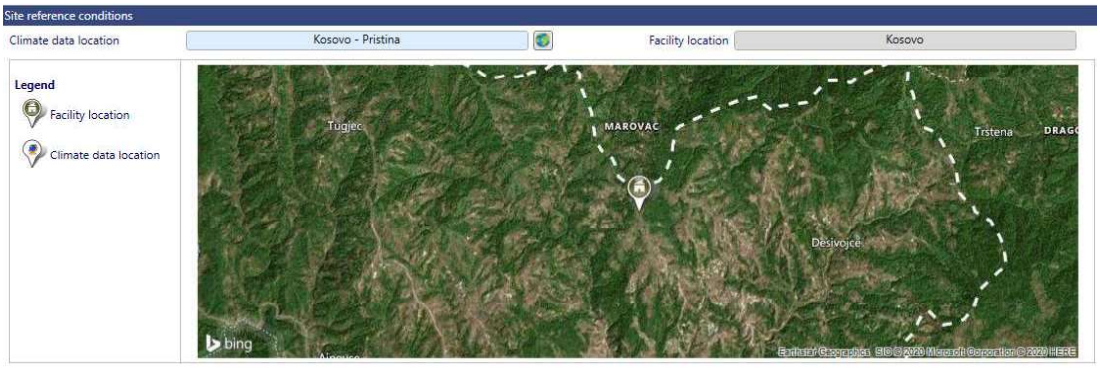


Figure 43: Location of wind farm project

Figure 44 shows the climate data of the selected location. In this case RETScreen has automatically generated e.g. wind speed or air temperature. It is important to note that RETScreen has calculated

these data at a height of 10 m above the ground. These data are not suitable for our project. Since the height of the tubes in this project will be 110 m, other data are required.

Month	Air temperature °C	Relative humidity %	Precipitation mm	Daily solar radiation - horizontal kWh/m²/d	Atmospheric pressure kPa	Wind speed m/s	Earth temperature °C	Heating degree-days 18 °C °C-d	Cooling degree-days 10 °C °C-d
January	-1.1	81.2%	47.74	1.57	95.4	1.3	-2.7	592	0
February	1.1	71.6%	48.16	2.47	95.1	1.7	-1.4	473	0
March	4.9	64.7%	52.08	3.65	94.9	2.0	3.1	406	0
April	9.3	64.2%	60.30	4.75	94.6	2.0	8.4	261	0
May	14.5	64.5%	65.41	5.66	94.9	1.6	14.0	109	140
June	18.5	63.7%	61.50	6.21	94.9	1.3	18.6	0	255
July	20.5	59.2%	48.05	6.55	95.0	1.4	21.8	0	326
August	20.5	59.7%	44.33	5.76	95.0	1.1	21.9	0	326
September	16.0	65.4%	52.80	4.44	95.2	1.1	16.3	60	180
October	10.9	71.7%	57.04	3.10	95.2	1.2	10.2	220	28
November	4.2	79.0%	64.50	1.79	95.2	1.4	3.7	414	0
December	0.0	82.0%	58.59	1.29	95.1	1.5	-1.4	558	0
Annual	**10.0**	**68.9%**	**660.50**	**3.94**	**95.0**	**1.5**	**9.4**	**3,093**	**1,253**
Source	Ground	Ground	NASA	Ground	Ground	Ground	NASA	Ground	Ground
Measured at					m	10	0		

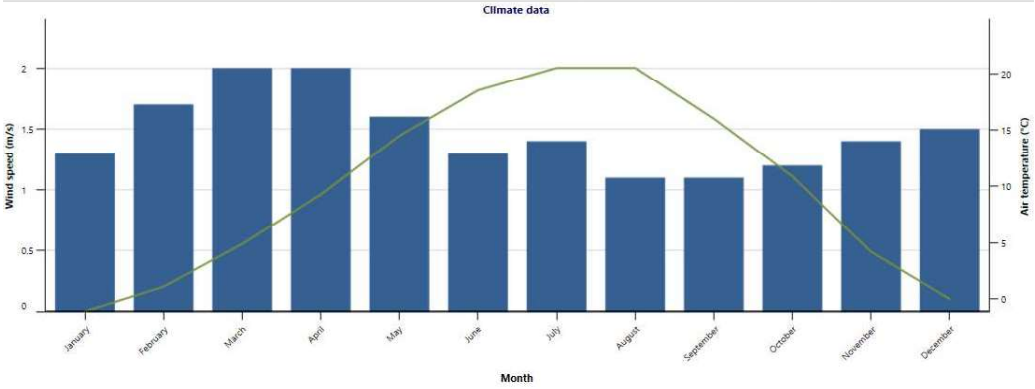


Figure 44: Climate data conditions (Height 10 m) - RETScreen

For this purpose, RETScreen provides access to the global wind atlas, where it is shown that the average wind speed at 100 meters is 7.89 m/s. (Figure 45)

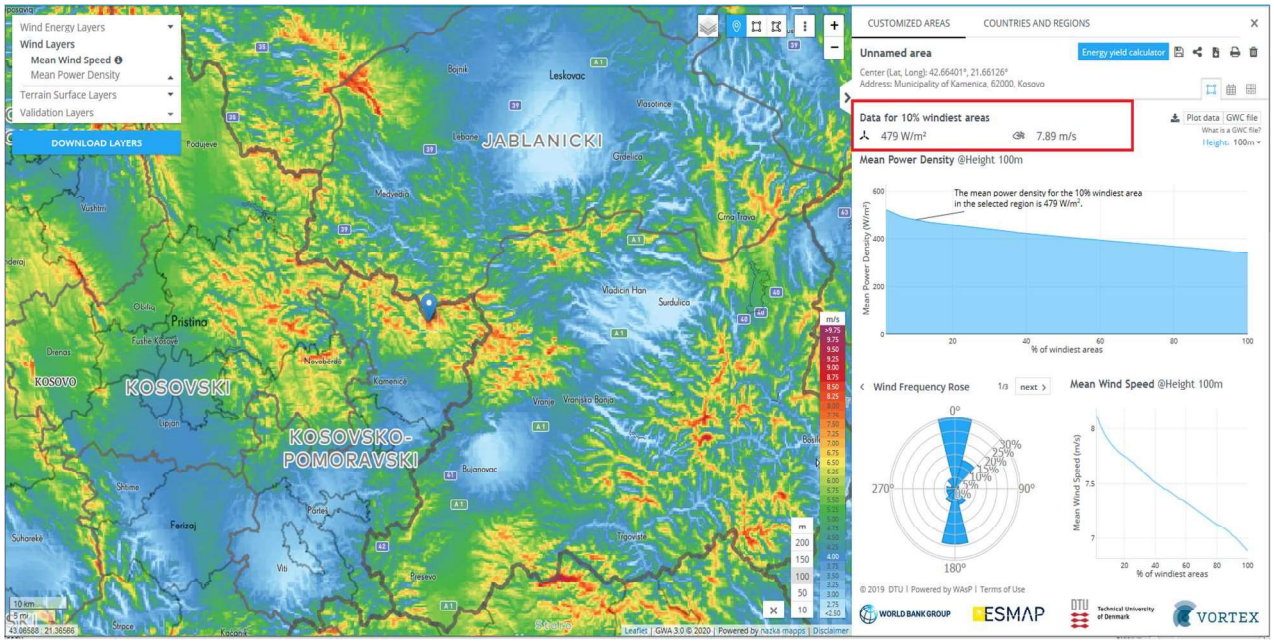


Figure 45: Wind speed (Height 100 m) - Global Wind Atlas

5.4.1.2 Facility

Similar to the previous chapter, in the "facility" section it is possible to choose the type of technology that will be used to generate electricity. (Figure *46*)

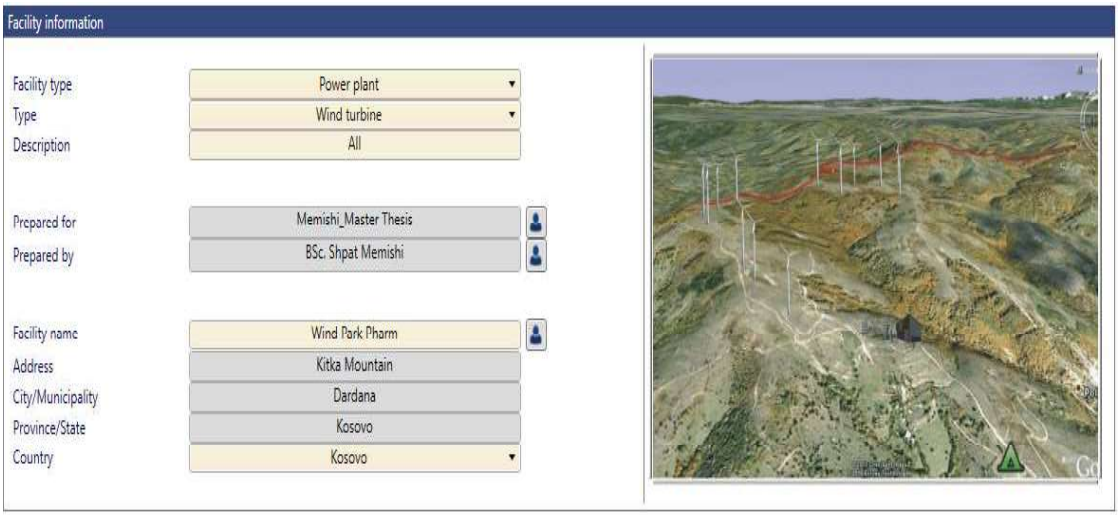


Figure 46: Facility information - wind power plant

5.4.1.3 Benchmark – Electricity Price per kWh

From Figure 47 it can be seen that RETScreen automatically provides wind energy prices per kWh. As shown in Figure 47 the wind energy prices range from 0.067 €/kWh to 0.19 €/kWh.

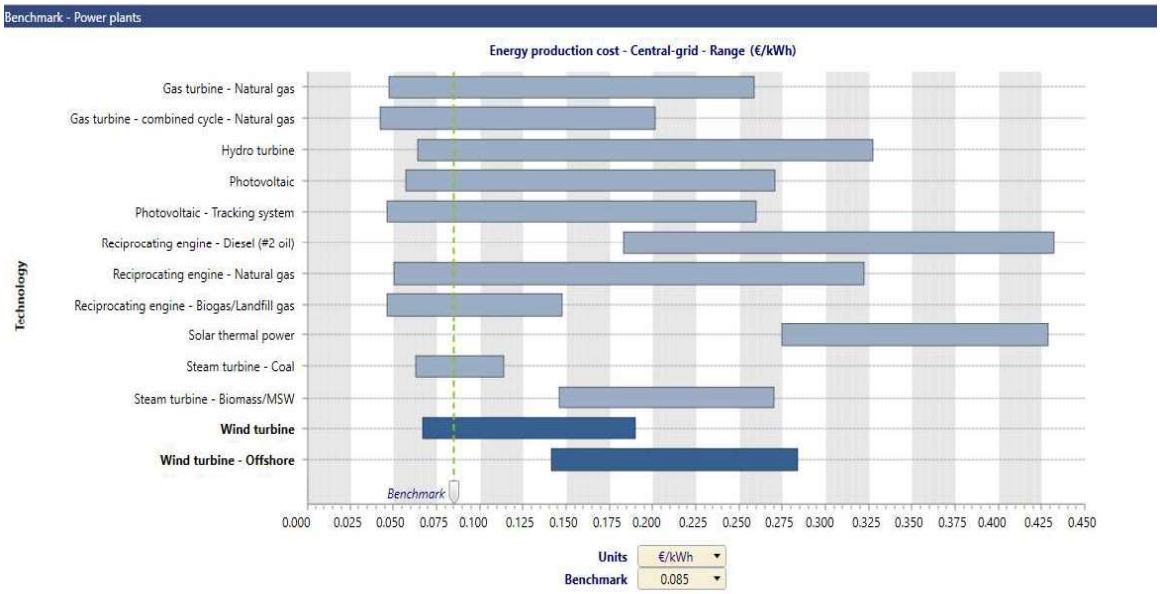


Figure 47: Benchmark – wind turbine

5.4.2 Data Input – Wind Farm Project

5.4.2.1 Electricity Price

Regarding the tariffs for wind energy, Europe's highest tariff is 16.11 cent/kWh and the lowest is 5.89 cent/kWh. Kosovo has a tariff value of 8.5 cent/kWh, Macedonia 8.9 cent/kWh, Montenegro 9.6 cent/kWh and Slovenia 9.5 cent/kWh. Serbia has a lower value of 2.3 cent/kWh.

In Figure 48 it is illustrated that the sale price for this project will be 0.085 €/kWh.

Figure 48: Electricity export rate

5.4.2.2 Wind Farm Project Settings

In order to obtain accurate calculations of electricity production throughout the year, RETScreen allows to set the wind speed for each month. Other data, such as humidity and air pressure, are automatically generated by RETScreen. In Figure 49 it can be seen all these data that were mentioned so far.

	Wind speed	Atmospheric pressure	Air temperature	Climate Data Kosovo - Pristina			Electricity export rate	Electricity exported to grid
Month	m/s	kPa	°C	m/s	kPa	°C	€/kWh	MWh
January	7.0	95.4	-1.1	1.3	95.4	-1.1	0.09	101,959
February	9.1	95.1	1.1	1.7	95.1	1.1	0.09	114,590
March	10.7	94.9	4.9	2.0	94.9	4.9	0.09	135,530
April	10.7	94.6	9.3	2.0	94.6	9.3	0.09	128,705
May	8.6	94.9	14.5	1.6	94.9	14.5	0.09	115,646
June	7.0	94.9	18.5	1.3	94.9	18.5	0.09	91,543
July	7.5	95.0	20.5	1.4	95.0	20.5	0.09	101,121
August	5.9	95.0	20.5	1.1	95.0	20.5	0.09	76,106
September	5.9	95.2	16.0	1.1	95.2	16.0	0.09	74,955
October	6.4	95.2	10.9	1.2	95.2	10.9	0.09	88,226
November	7.5	95.2	4.2	1.4	95.2	4.2	0.09	103,875
December	8.0	95.1	0.0	1.5	95.1	0.0	0.09	116,219
Annual	**7.8**	**95.0**	**10.0**	**1.5**	**95.0**	**10.0**	**0.09**	**1,248,475**

Figure 49: Climate data

As mentioned above, these measurements were taken at a height of 100 meters. As it is evident from Figure 49, the average wind speed during the year is 7.8 m/s, and during the same period a total of 1,248,475 GWh of electricity will be produced.

The turbine type to be installed will be the GE series, specifically GE Wind 3.6 - 137 with a height of 110 m. The entire energy park will contain 103 units. The installation capacity will reach the value of 371 MW, as predicted for the wind energy potential in Kosovo. (Figure 50)

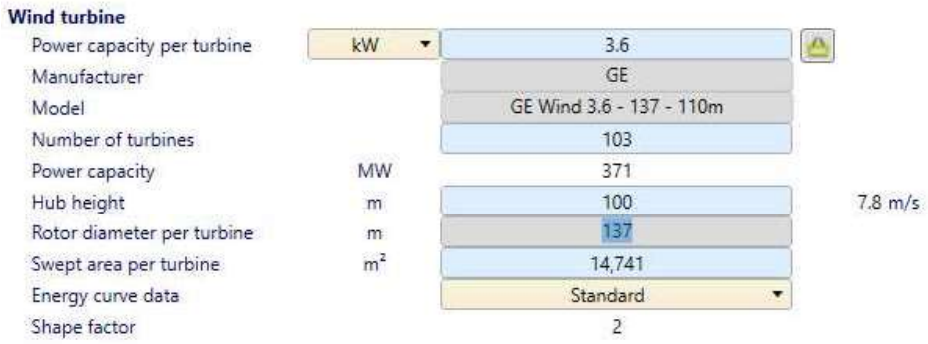


Figure 50: Wind turbine settings

Figure 51 shows the maximum output capacity of wind turbines along different wind speeds.

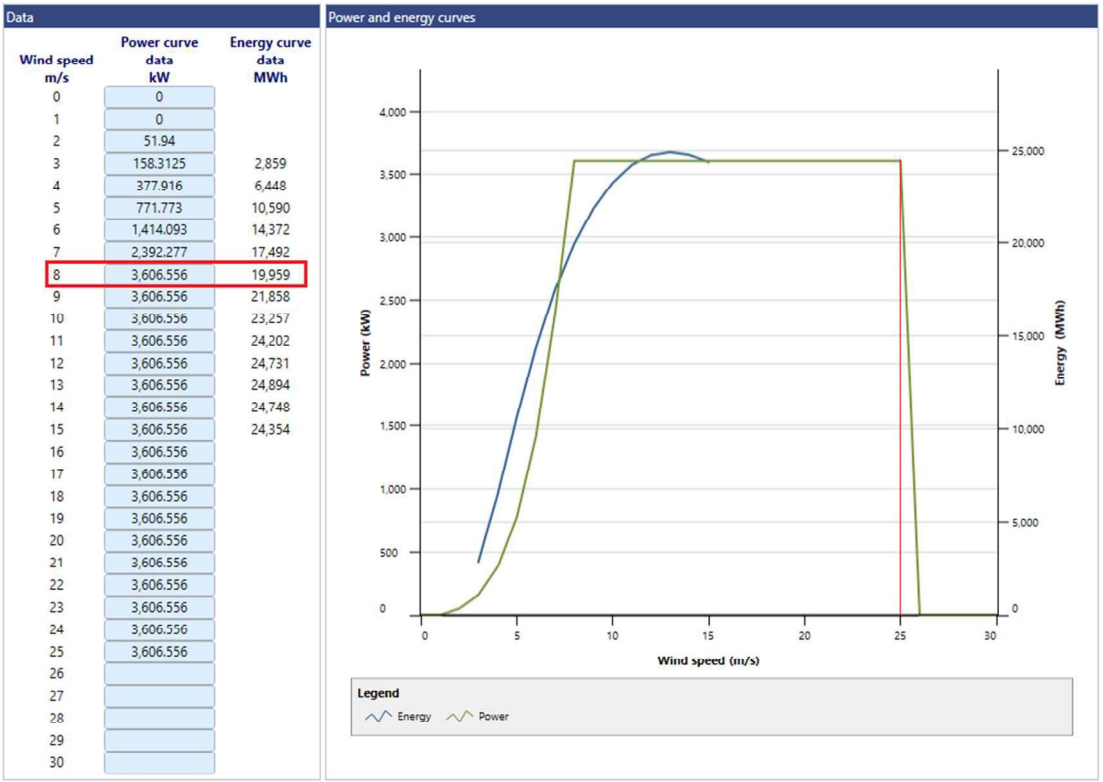


Figure 51: Power and energy curves

The cut-in speed of the specific turbine used in the proposed project was found to be 2m/s, while the rated speed at which the turbine generates the rated power is 8 m/s and generates rated power until the cut-out speed of 25 m/s.

5.4.3 Financial Parameters

In contrast to the TPP project "Kosova e Re", the interest rate on debt capital for this project will be only 7 %, which the interest rate is generally observed in the country of Kosovo. The reason for assuming of the national interest rate for the project is mainly due to limited data, and it is assumed that low carbon technologies, mainly to improve the deteriorating air quality in the country would benefit from a lower interest rate. (Figure 52)

Financial parameters		
General		
Fuel cost escalation rate		2%
Inflation rate	%	5%
Discount rate	%	9%
Reinvestment rate	%	9%
Project life	yr	30
Finance		
Incentives and grants	€	0
Debt ratio	%	70%
Debt	€	648,900,000
Equity	€	278,100,000
Debt interest rate	%	7%
Debt term	yr	15
Debt payments	€/yr	71,245,732

Figure 52: Financial parameters

5.4.4 Emission Analysis

Figure 53 shows the emissions resulting from the second study.

Wind Farm Park GHG summary

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Fuel consumption kWh	GHG emission factor $kgCO_2/kWh$	GHG emission tCO_2
Wind	100.0%	0.0	0.0000	0.0000	1,233,569,872	0.000	0.0
Total	100.0%	0.0	0.0000	0.0000	1,233,569,872	0.000	0.0
				T&D losses			
Electricity exported to grid	kWh	1,233,569,872		0.0%	0	1.116	0.0
						Total	0.0

Figure 53: GHG emissions - wind farm

5.4.5 Cost Analyses

5.4.5.1 Initial Costs and annual savings

RETScreen calculations assume that the initial costs for the wind farm project will be 927 million euro.

RETScreen has also calculated the profits that this project will generate by selling the produced electricity. As already mentioned, this model estimates the price of electricity sales at 8.5 cent/kWh. On this basis, RETScreen assumes that the revenue from the sale of electricity by the wind farm project will be 104.8 million euro. (Figure 54)

Costs | Savings | Revenue			
Initial costs			
Initial cost	100%	€	778,680,000
Total initial costs	**100%**	€	**778,680,000**
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M costs (savings)		€	19,281,600
Debt payments - 15 yrs		€	59,846,415
Total annual costs		€	**79,128,015**
Annual savings and revenue			
Electricity export revenue		€	104,853,439
GHG reduction revenue		€	0
Other revenue (cost)		€	0
CE production revenue		€	0
Total annual savings and revenue		€	**104,853,439**

Figure 54: Initial costs and savings – wind farm park

5.4.5.2 Net Yearly Cash Flow

According to RETScreen`s calculations and based on the sale price for electricity of 8.5 cent/kWh, it can be concluded that the wind farm project would be a profitable project. Based on RETScreen calculations, the net cash flow for the first year will be 25.7 million euro. (Figure 55)

Yearly cash flows - Year 1		
Annual costs and debt payments		
O&M costs (savings)	€	19,281,600
Debt payments - 15 yrs	€	59,846,415
Total annual costs	€	**79,128,015**
Annual savings and revenue		
Electricity export revenue	€	104,853,439
GHG reduction revenue	€	0
Other revenue (cost)	€	0
CE production revenue	€	0
Total annual savings and revenue	€	**104,853,439**
Net yearly cash flow - Year 1	€	**25,725,424**

Figure 55: Net yearly cash flow - year 1

Figure 56 shows that the break-even point of the project will be reached after the end of the 7th year.

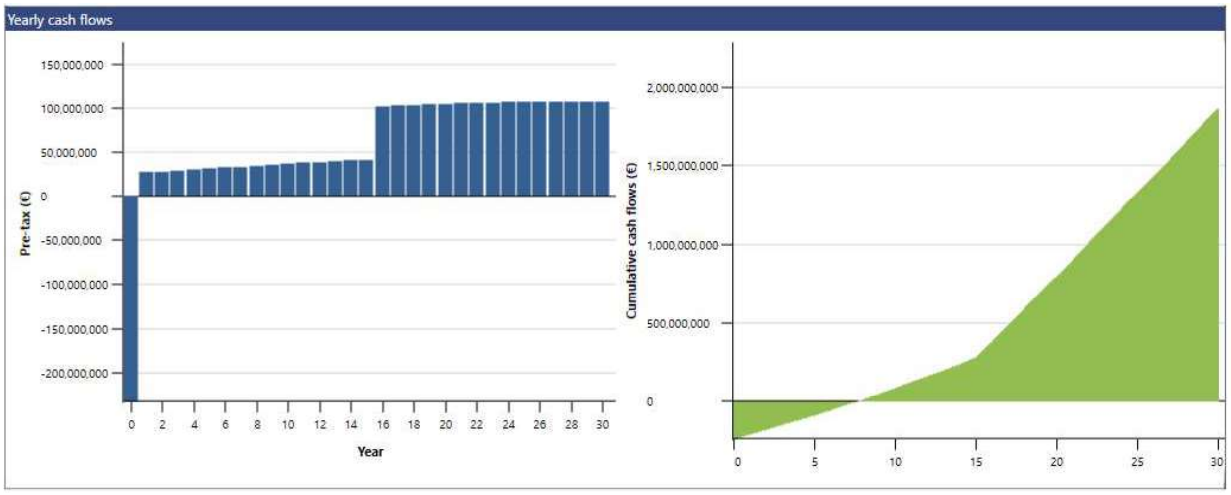


Figure 56: Yearly cash flow and break-even point (without incentives and grants)

Everything that has been said so far is based on the investors' own investments. It is very important to mention that the project of TPP "Kosova e Re" at the beginning was supported by the World Bank. In September 2018, the World Bank announced that it will withdraw from the project because of green policies and recommend to the government to invest in RES.

On such a basis, if the World Bank or another financial organisation would help a potential investor with a grant, then this project would be much more profitable.

To notice the difference, we are assuming that the World Bank will help the investor with a grant of 50 million euro. In this case, the break-even point of the project will be reached at the beginning of the ninth year. (Figure 57)

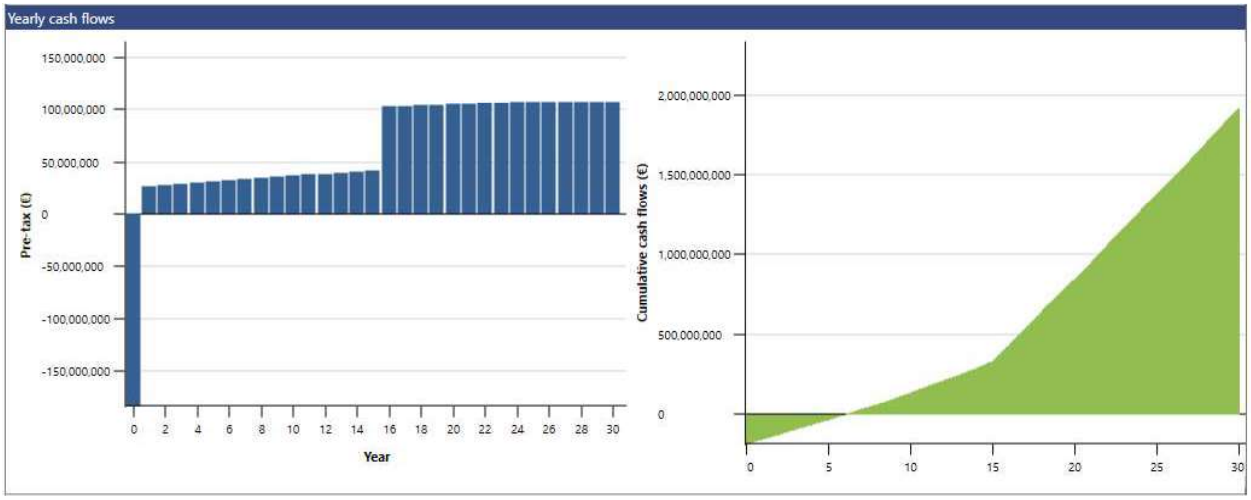


Figure 57: Yearly cash flow and break-even point (with incentives and grants)

5.4.6 Sensitivity and Risk Analyses

The analysis of sensitivities and risks regarding the renewable energy project will be carried out in the next chapter within the combined wind and solar energy project.

5.5 Case study 3: Proposed Solar Photovoltaic Power Plant

5.5.1 Data Inputs

In this chapter, based on the conclusions drawn in section 4.3.12 on solar energy potential, a solar energy park project with an installation capacity of 75 MW is modelled.

5.5.1.1 Location

In section 4.3.9 it was mentioned that one of the projects in the field of solar energy, a project implemented by the company "Jaha Solar", was the SGE project, located in the Municipality of Kamenica. The same location will be used during the experiment. (Figure 58)

	Unit	Climate data location	Facility location	Source
Latitude		42.7	42.6	
Longitude		21.1	21.7	
Climate zone		5A - Cool - Humid		Ground+NASA
Elevation	m	576	540	Ground – Map
Heating design temperature	°C	-9.9		Ground
Cooling design temperature	°C	30.2		Ground
Earth temperature amplitude	°C	21.4		NASA

Figure 58: Location of the project

5.5.1.2 Facilitiy

In the “Facitity”, RETScreen allows to choose the type of power generation technology and the installation capacity of the technology. (Figure 59)

Figure 59: Facility

5.5.1.3 Benchmark – Price of Electricity per kWh

Based on the type of technology and the selected location, RETScreen automatically provides the selling price of electricity with a price range from 0.057 €/kWh to 0.21 €/kWh. *(*Figure 60)

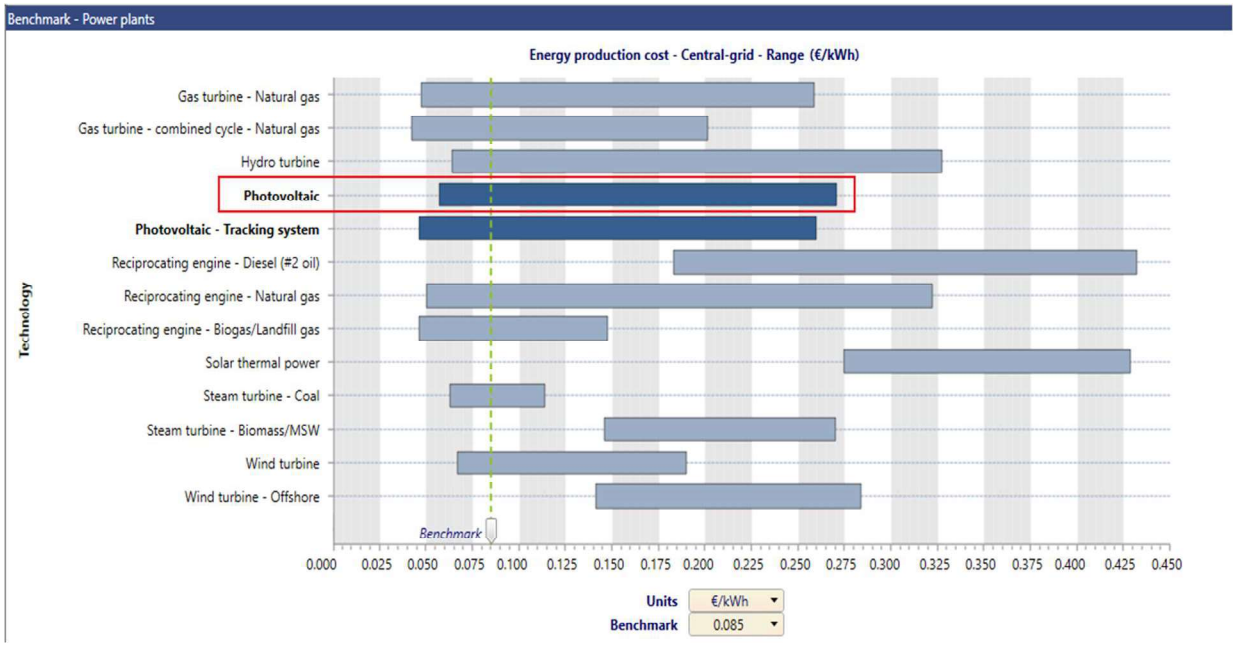


Figure 60: Benchmark - PV

5.5.2 Data Inputs – Photovoltaic Project

5.5.2.1 Electricity Price

The export price of electricity generated by solar energy varies depending on the size of the project. The price per kWh varies from 0.0855 to 0.135 €/kWh. As shown in Figure 61 the price for this project will be 0.0855 €/kWh.

Figure 61: Electricity export rate

5.5.2.2 Data Input

The energy setting for the PV project are as shown in Figure 62.

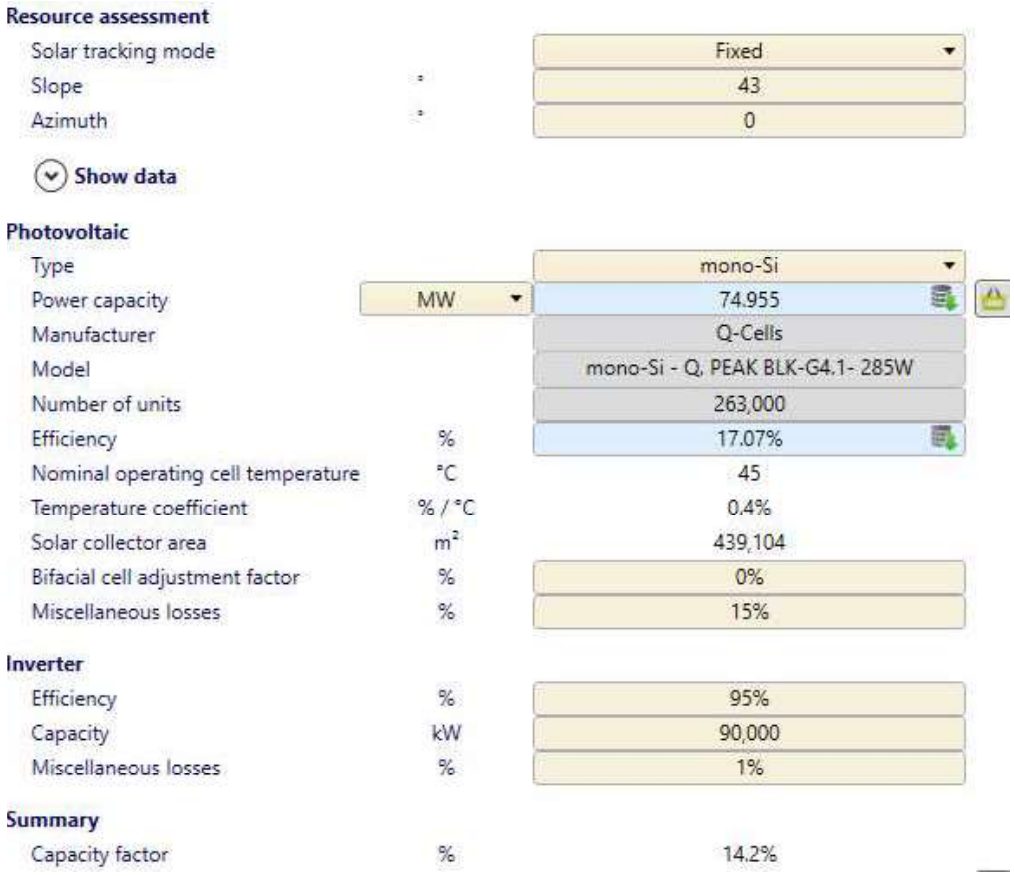


Figure 62: PV project settings

As it is shown in Figure 62, the selected cells belong to the Q-Cell type. The model in this case is Q-Peak Blk-G4.1 with an installed capacity of 285 W per unit. The energy park will have 263,000

units, which means that the total installed capacity of this energy park will be 75 MW, as forecasted in section 4.3.12 regarding to the potential of solar energy.

The total energy produced during one year with this installed capacity will be 93,379 GWh.

5.5.2.3 Financial Parameters

The financial parameters will remain the same as in the wind farm project.

5.5.3 Emission Analyses

Similar to a wind energy project, not a single gram of carbon dioxide would be released in a solar energy project, as shown in Figure 63.

Proposed case system GHG summary

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Fuel consumption kWh	GHG emission factor $kgCO_2/kWh$	GHG emission tCO_2
Solar	100.0%	0.0	0.0000	0.0000	93,379,214	0.000	0.0
Total	100.0%	0.0	0.0000	0.0000	93,379,214	0.000	0.0
				T&D losses			
Electricity exported to grid	kWh	93,379,214		0.0%	0	1.116	0.0
						Total	0.0

Figure 63: GHG emissions – PV

5.5.4 Cost Analysis

5.5.4.1 Initial Costs and Annual Savings

RETScreen calculations assume that the initial costs for the PV project will be 89.9 million euro.

RETScreen has also calculated the profits that this project will generate through the sale of the produced electricity. As mentioned above, this model estimates the price of electricity sales at 8.55 cent/kWh.

On this basis, RETScreen assumes that the revenue from the sale of electricity will be 7.6 million euro. (Figure 64)

Costs | Savings | Revenue			
Initial costs			
Initial cost	100%	€	89,946,000
Total initial costs	**100%**	€	**89,946,000**
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M costs (savings)		€	749,550
Debt payments - 15 yrs		€	6,912,911
Total annual costs		**€**	**7,662,461**
Annual savings and revenue			
Electricity export revenue		€	7,968,125
GHG reduction revenue		€	0
Other revenue (cost)		€	0
CE production revenue		€	0
Total annual savings and revenue		**€**	**7,968,125**

Figure 64: Initial costs and savings – PV

5.5.4.2 Yearly Cash Flow

According to RETScreen's calculations and based on the sales price for electricity of 8.55 cent/kWh, the solar energy project is a profitable project. Based on calculations, the net cash flow for the first year is going to be 305,664 euro. (Figure 65)

Yearly cash flows - Year 1		
Annual costs and debt payments		
O&M costs (savings)	€	749,550
Debt payments - 15 yrs	€	6,912,911
Total annual costs	**€**	**7,662,461**
Annual savings and revenue		
Electricity export revenue	€	7,968,125
GHG reduction revenue	€	0
Other revenue (cost)	€	0
CE production revenue	€	0
Total annual savings and revenue	**€**	**7,968,125**
Net yearly cash flow - Year 1	**€**	**305,664**

Figure 65: Net yearly cash flow (8.55 cent/kWh) - year 1

Figure 66 shows that the break-even point of the project is reached after the end of the 15th year.

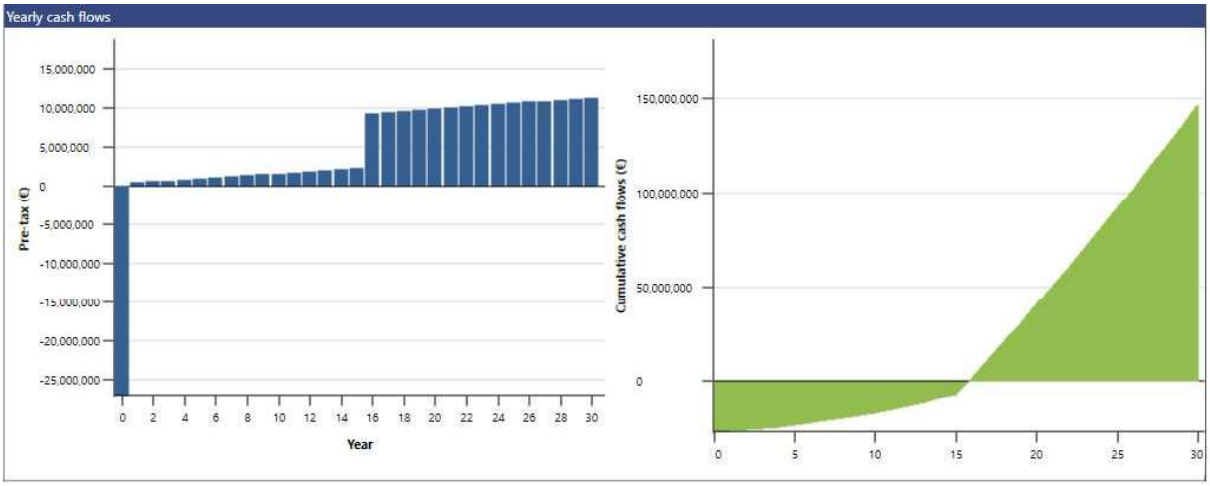


Figure 66: Yearly cash flow and break-even point – (8.55 cent/kWh)

In the introduction of case study 3, it was described that the export price of electricity fluctuates between 8.55 cent/kWh and 13.5 cent/kWh. Initially, it was decided that as an export price would be received at the minimum value, i.e. 8.55 cent/kWh. Figure 67 shows how the financial aspect of the project changes at a price of 13.5 cent/kWh.

Yearly cash flows - Year 1		
Annual costs and debt payments		
O&M costs (savings)	€	749,550
Debt payments - 15 yrs	€	6,912,911
Total annual costs	**€**	**7,662,461**
Annual savings and revenue		
Electricity export revenue	€	12,581,251
GHG reduction revenue	€	0
Other revenue (cost)	€	0
CE production revenue	€	0
Total annual savings and revenue	**€**	**12,581,251**
Net yearly cash flow - Year 1	**€**	**4,918,790**

Figure 67: Net yearly cash flow (13.5 cent/kWh) - year 1

Therefore, as it is shown in Figure 67, the annual cash flow has increased enormously, reaching a value of 4.9 million euro.

When it comes to the break-even point of the project, it is noticeable that there is also a significant difference. The break-even point of the project with a price of 13.5 cent/kWh compared to the previous case, is now at the beginning of the fifth project year. (Figure 68)

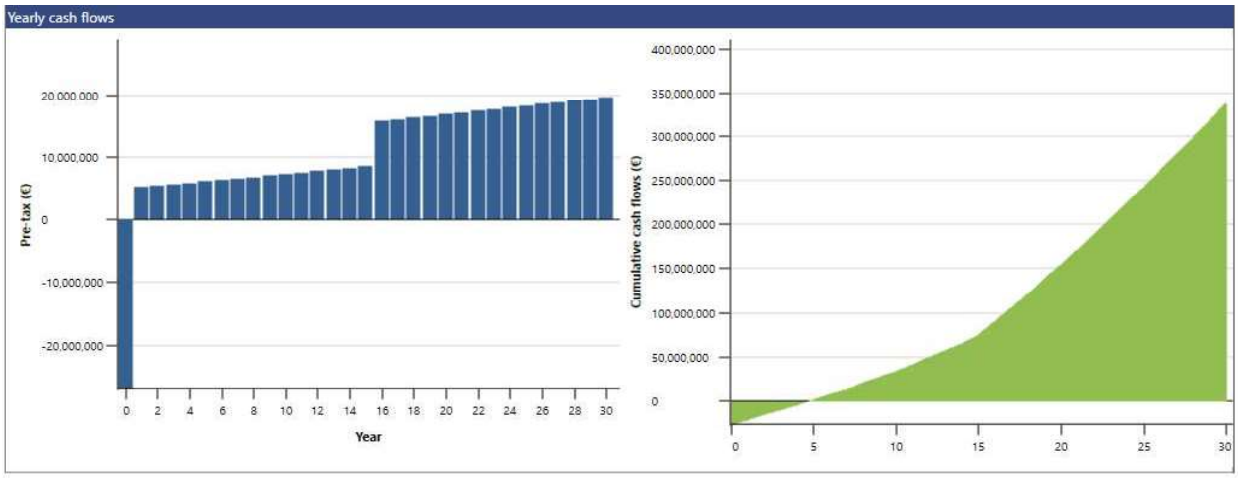


Figure 68: Yearly cash flow and break-even point – (13.5 cent/kWh)

5.5.5 Sensitivity and Risk Analyses

As already mentioned, the analysis of sensitivities and risks related to the renewable energy project will be carried out in the next chapter within the combined wind and solar energy project.

5.6 Coal vs. Renewables for Kosovo – RETScreen

In the fourth chapter of the master thesis the scenarios of the development of the electricity sector were analysed. The first scenario was the Kosovo government's scenario, in particular the way the government foresees the development of the energy sector, with special emphasis on major projects, and the government's focus on renewable energy. The second scenario was the scenario of this study, focusing on the potential of renewable energy in Kosovo, based on various studies.

The main purpose of this study was to prove that there is a high potential of renewable energy in Kosovo and, consequently, the government of Kosovo should abandon the project of TPP "Kosova e Re". First because of its high cost, then, in case of the construction of this power plant, about 20 million tCO_2 would be released, and mainly, because of the high of electricity price. All these assumptions were based on the findings.

In the fifth chapter were carried out three different projects within the RETScreen software. In order to get a better overview of the potential of renewable energies, always based on the collected data, and to make a comparison between the project of the TPP "Kosova e Re" and the potential of RES, finally a combined project with wind and solar energy is modulated.

5.7 Wind and Photovoltaic: Case study 2 + Case study 3

5.7.1 Generating Capacity

As already mentioned in section 5.4.2, the wind farm project will have an installed capacity of 371 MW, while the installation capacity of the solar park, as stated in section 5.5.2, will be 75 MW.

5.7.2 Electricity Price

The electricity export price will be 8.5 cent/kWh.

5.7.3 Financial Parameters

The financial parameters of the combined wind and solar energy park project will remain the same as the financial parameters of these two projects analysed in the previous chapters.

The reason for this is that Kosovo is one of the countries that have invested the least in renewable energy, and therefore various financial organizations support renewable energy projects in Kosovo. The financial parameters for the combined project are shown in Figure 69.

Financial parameters		
General		
Fuel cost escalation rate		2%
Inflation rate	%	5%
Discount rate	%	9%
Reinvestment rate	%	9%
Project life	yr	30
Finance		
Incentives and grants	€	0
Debt ratio	%	70%
Debt	€	608,038,200
Equity	€	260,587,800
Debt interest rate	%	7%
Debt term	yr	15
Debt payments	€/yr	66,759,326

Figure 69: Financial parameters

5.7.4 Initial Costs, Annual Savings, and Yearly Cash Flow

RETScreen calculations assume that the initial costs for the combined project will be 868.6 million euro. (Figure 70)

Profits that this project will generate through the sale of the produced electricity at a sales price of 8.5 cent/kWh will be 112,.7 million euro. These calculations are shown in Figure 70.

Costs | Savings | Revenue			
Initial costs			
Initial cost	100%	€	868,626,000
Total initial costs	**100%**	€	**868,626,000**
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M costs (savings)		€	20,031,150
Debt payments - 15 yrs		€	66,759,326
Total annual costs		€	**86,790,476**
Annual savings and revenue			
Electricity export revenue		€	112,774,967
GHG reduction revenue		€	0
Other revenue (cost)		€	0
CE production revenue		€	0
Total annual savings and revenue		€	**112,774,967**

Figure 70: Initial costs and savings – combined project

As it illustrated in Figure 71 the project would be profitable. Based on RETScreen's calculations, it is perceptible that the net cash flow for the first year is going to be 25.9 million euro. (Figure 71)

Yearly cash flows - Year 1		
Annual costs and debt payments		
O&M costs (savings)	€	20,031,150
Debt payments - 15 yrs	€	66,759,326
Total annual costs	€	**86,790,476**
Annual savings and revenue		
Electricity export revenue	€	112,774,967
GHG reduction revenue	€	0
Other revenue (cost)	€	0
CE production revenue	€	0
Total annual savings and revenue	€	**112,774,967**
Net yearly cash flow - Year 1	€	**25,984,491**

Figure 71: Net yearly cash flow (combined project) - year 1

Figure 72 shows that the break-even point of the project will be reached after the end of the eighth year.

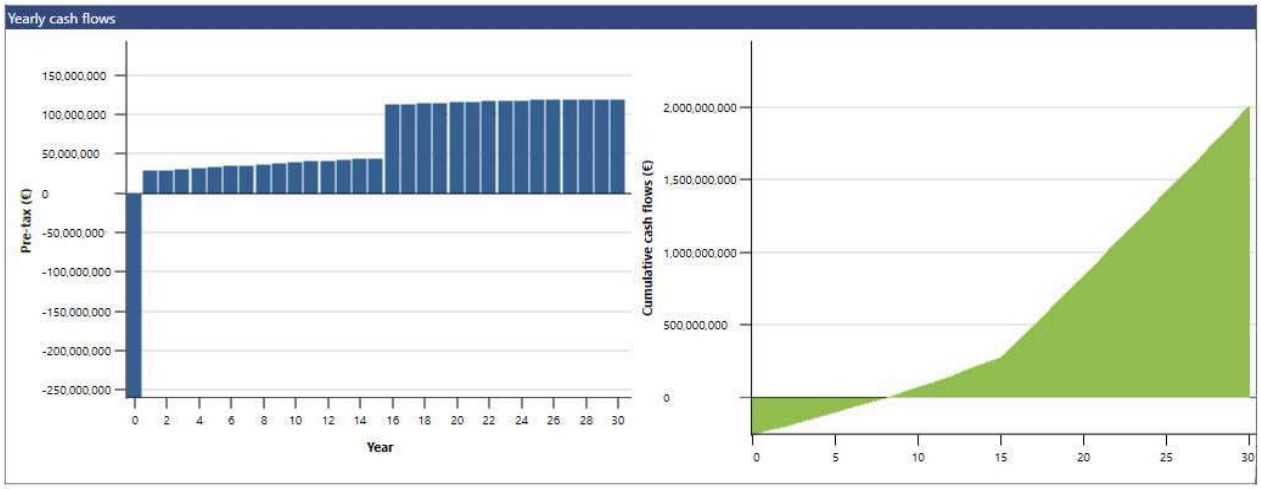


Figure 72: Net yearly cash flow and break-even point – combined project

5.7.5 Sensitivity and Risk Analyses

Similar to the analysis of the financial sensitivity and potential financial risks of the TPP "Kosova e Re" project, the same financial parameters affecting the NPV of the combined wind and solar energy park project are analysed.

5.7.5.1 Initial Costs (i.e. NPV) vs. Debt Interest Rate

As Figure 73 shows, it is highly likely that the combined renewable energy project will be financially viable. Even if the initial cost of the project increases by 25% with an unchanged debt interest rate, the NPV will be 3.4 million euro.

		Initial costs				€
Debt interest rate		651,469,500	760,047,750	868,626,000	977,204,250	1,085,782,500
%		-25.0%	-12.5%	0.0%	12.5%	25.0%
5.25%	-25.0%	446,239,133	353,639,878	261,040,624	168,441,369	75,842,114
6.13%	-12.5%	424,815,207	328,645,298	232,475,389	136,305,480	40,135,571
7.00%	0.0%	402,799,216	302,959,976	**203,120,735**	103,281,494	3,442,253
7.88%	12.5%	380,211,725	276,607,902	173,004,079	69,400,256	-34,203,566
8.75%	25.0%	357,073,979	249,613,866	142,153,752	34,693,638	-72,766,475

Figure 73: Initial costs (i.e. NPV) vs. Debt interest rate

The NPV would remain positive even if the debt interest rate were to increase by 25% and the initial cost by 12.5%.

NPV would only fall below zero if the initial price of the project were to rise by 25% and the debt interest rate were to increase by more than 12.5%, representing the worst-case scenario. (Figure 73)

5.7.5.2 Initial Costs (i.e. NPV) vs. Debt Term

Regarding the duration of the debt, the net present value would remain the same for the estimated duration of the loan repayment, even if the initial cost were to increase by 12,5 %. Even if the investor were forced to repay the loan for a shorter period, the NPV would still be in surplus. (Figure 74)

Remove analysis		Initial costs				€
Debt term		651,469,500	760,047,750	868,626,000	977,204,250	1,085,782,500
yr		-25.0%	-12.5%	0.0%	12.5%	25.0%
11	-25.0%	392,539,079	290,989,815	189,440,551	87,891,288	-13,657,976
13	-12.5%	397,876,778	297,217,130	196,557,483	95,897,836	-4,761,811
15	0.0%	402,799,216	302,959,976	**203,120,735**	103,281,494	3,442,253
17	12.5%	407,330,850	308,246,881	209,162,913	110,078,944	10,994,976
19	25.0%	411,495,533	313,105,679	214,715,824	116,325,970	17,936,115

Figure 74: Initial costs (i.e. NPV) vs. Debt term

The worst-case scenario would be if the initial value of the project increases by 25% and the debt duration decreases by at least 12.5% (Figure 74)

5.7.5.3 Initial Costs (i.e. NPV) vs. Electricity Export Rate

In section 5.5.2.1 it was said that the selling price of electricity generated by solar energy varies between 0.0855 €/kWh and 0.135 €/kWh. On this basis, the lowest possible price was obtained as the selling price for the electricity generated by the combined project.

		Initial costs				€
Electricity export rate		651,469,500	760,047,750	868,626,000	977,204,250	1,085,782,500
€/MWh		-25.0%	-12.5%	0.0%	12.5%	25.0%
63.75	-25.0%	44,018,923	-55,820,318	-155,659,559	-255,498,800	-355,338,040
74.38	-12.5%	223,409,070	123,569,829	23,730,588	-76,108,653	-175,947,894
85.00	0.0%	402,799,216	302,959,976	**203,120,735**	103,281,494	3,442,253
95.63	12.5%	582,189,363	482,350,122	382,510,881	282,671,641	182,832,400
106.25	25.0%	761,579,510	661,740,269	561,901,028	462,061,787	362,222,547

Figure 75: Initial costs (i.e. NPV) vs. Electricity export rate

As shown in Figure 75, if the electricity price increases by 12.5%, the net present value would remain positive even if the initial value of the project were to increase by 25%. The investor will have a more favourable case if the investor finds a potential buyer with a 25% increase of

electricity price. In this case, even if the initial price of the project were to increase by 12.5% or 25%, the NPV of the project would be higher than the NPV calculated based on standard parameters.

The worst-case scenario, which is highly unlikely considering the electricity market in the Balkans, would be if the selling price of the electricity fell by more than 25% and the initial value of the project were to increase by at least 12.5%. (Figure 75)

5.7.5.4 Impact of Financial Parameters on NPV (Graph)

Similar to the previous case, the influence of each parameter on the NPV can be seen separately in Figure 76.

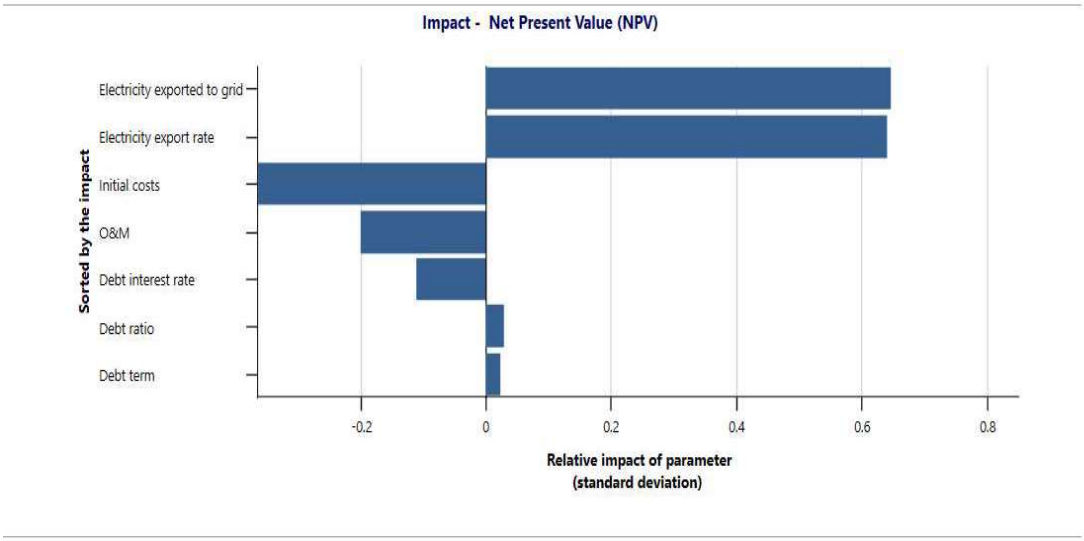


Figure 76: Impact of financial parameters on NPV

Impact of financial parameters on the NPV is lower, compared to the TPP “Kosova e Re”. Initial costs, debt, interest rate, operation and maintenance costs have a negative impact on NPV. As mentioned above, the loan term and interest rates have a positive impact on the net present value.

The main positive effects on the NPV are the amount of electricity produced and its price. The more electricity is produced and the higher its price, the higher is the NPV. (Figure 76)

5.7.6 Comparisons

5.7.6.1 Costs and Generating Capacity

TPP "Kosova e Re" with an installed capacity of 500 MW would cost 1.7 billion euro, generating 4,175.776 GWh for one year.

The combined project of wind and solar energy park with an installation capacity of 446 MW will cost 868.6 million euro and generate 1,326.764 GWh of electricity during the year.

From these figures it can be deducted that that the combined project generates 63% of the electricity generated by the TPP "Kosova e Re" with the same amount of investment, although with a very significant difference. The price of electricity in case of construction of the TPP "Kosova e Re" will be 11.5 cent/kWh, a price that would be prohibitive for consumers, while in case of investments in renewablenergy, i.e. in the combined project of wind and solar energy, the price of electricity would be 8.5 cent/kWh, i.e. 26% cheaper than the former price.

5.7.6.2 Emission Analyses

To compare the two projects, the TPP "Kosova e Re" and the proposed project, it is necessary to illustrate the amount of carbon dioxide that would be released if the TPP "Kosova e Re" would be constructed.

TPP "Kosova e Re" GHG summary

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Fuel consumption kWh	GHG emission factor $kgCO_2/kWh$	GHG emission tCO_2
Coal	100.0%	92.7	0.0145	0.0029	40,653,141,436	0.338	13,732,827.3
Total	100.0%	92.7	0.0145	0.0029	40,653,141,436	0.338	13,732,827.3
				T&D losses			
Electricity exported to grid	kWh	4,175,775,912		11.0%	459,335,350	1.116	512,497.2
						Total	14,245,324.5

Figure 77: GHG emissions - TPP "Kosova e Re"

Therefore, for one year the TPP "Kosova e Re" would release 14.2 million tCO_2 based on RETScreen calculations. (Figure 77)

In the following paragraphs it is illustrated what will happen in relation to the release of carbon dioxide with the combined project.

Thus, Figure 78 shows that the RE combined power plant would not produce any CO_2 emissions.

Proposed case system GHG summary

Fuel type	Fuel mix %	CO_2 emission factor kg/GJ	CH_4 emission factor kg/GJ	N_2O emission factor kg/GJ	Fuel consumption kWh	GHG emission factor $kgCO_2/kWh$	GHG emission tCO_2
Wind	93.0%	0.0	0.0000	0.0000	1,233,569,872	0.000	0.0
Solar	7.0%	0.0	0.0000	0.0000	93,194,449	0.000	0.0
Total	100.0%	0.0	0.0000	0.0000	1,326,764,322	0.000	0.0
				T&D losses			
Electricity exported to grid	kWh	1,326,764,322		0.0%	0	1.116	0.0
						Total	0.0

Figure 78: GHG emissions – combined project

5.7.6.3 Summary

As a conclusion, through a graphic presentation to illustrate the main differences between the TPP "Kosova e Re" and the combined renewable energy project.

Figure 79 shows the production capacity of these two projects based on their installation capacity.

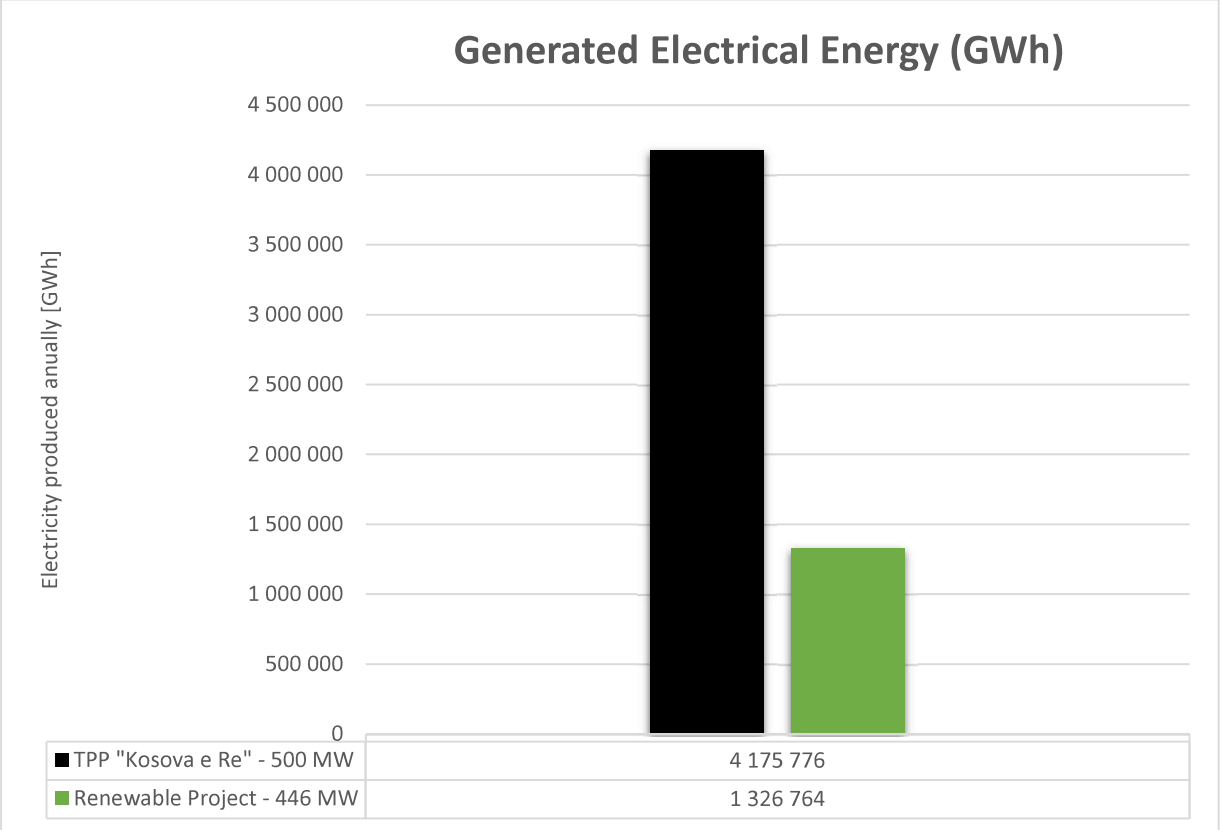


Figure 79: Generating capacity TPP "Kosova e Re" vs. Combined project - in GWh

Analysing Figure 79 and considering that the combined renewable energy project is half the cost of the TPP “Kosova e Re”, it can be concluded that the combined project generates 31.77% of the electricity produced by the TPP "Kosova e Re", although as said, with a very significant difference in investment.

It was already mentioned that the combined renewable energy project costs half the price of the TPP project "Kosova e Re". Figure 80 shows the initial price and net present value (NPV) of the two projects.

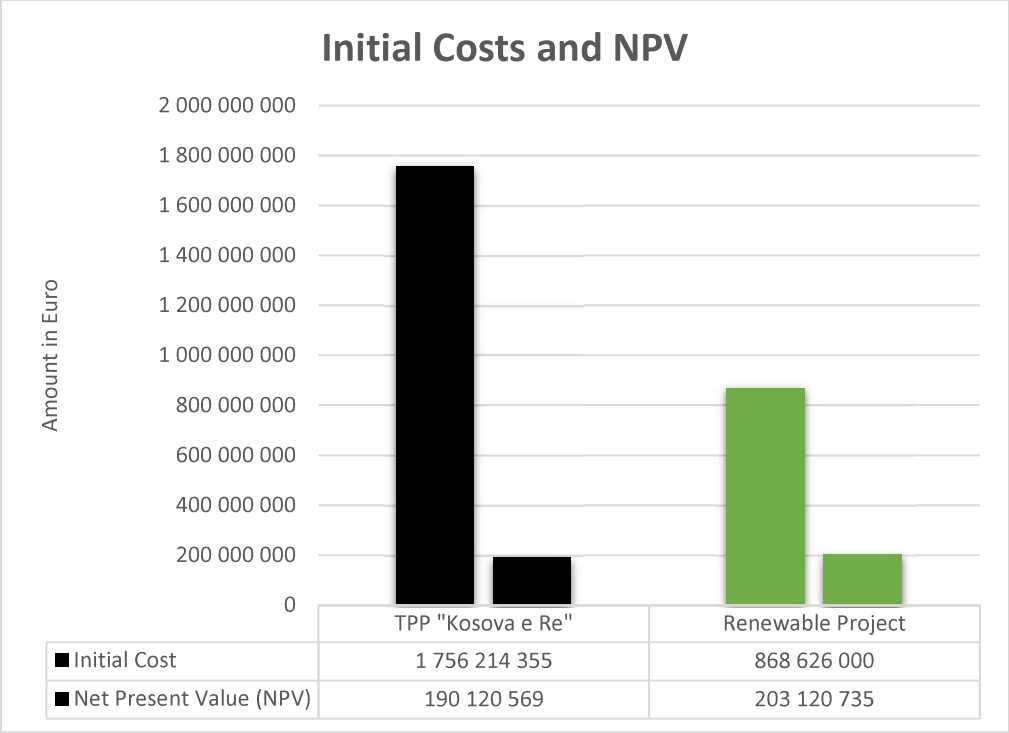


Figure 80: Initial costs and net present value - TPP "Kosova e Re" vs. Combined project

It is also noticeable that the net present value of the renewable energy project is 6.4% higher than the net present value of the TPP "Kosova e Re".

Another very important factor that should be considered in this project is the amount of carbon dioxide that is released respectively reduced in these two projects.

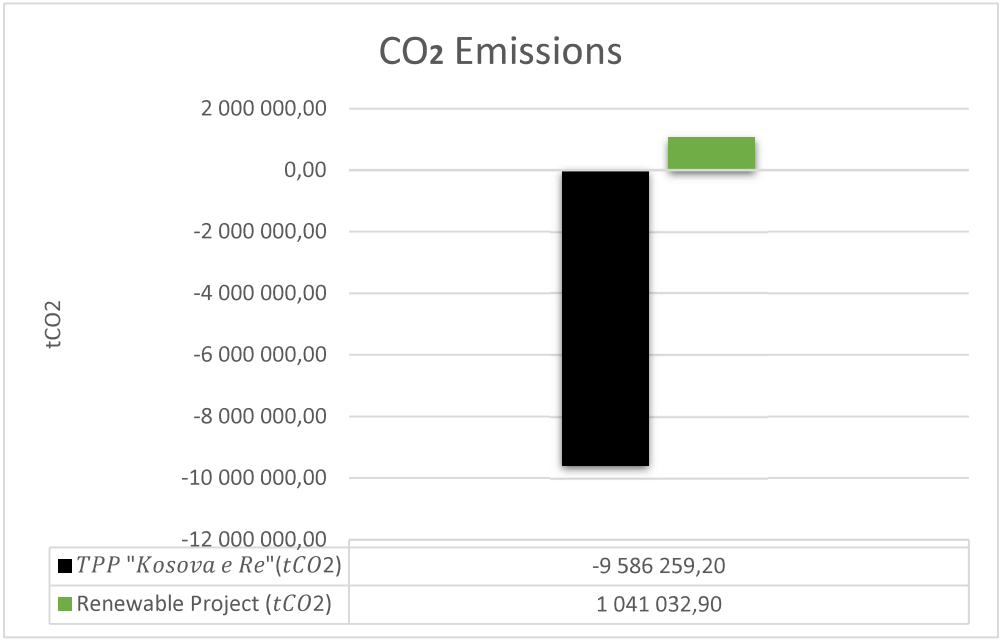


Figure 81: CO2 emissions - TPP "Kosova e Re" vs. Combined project

Based on Figure 81 the GHG emission reduction of CO_2 caused by TPP "Kosova e Re" with a capacity of 500 MW will be -9.5 million tCO_2 annually.

On the other hand, based on RETScreen calculations, the amount of carbon dioxide reduction, if the government decides to invest on the combined project will be 1.014 million tCO_2 annually.

Finally, from an economic point of view, a very important parameter that is always taken into consideration at the beginning of a project is the project's break-even point.

The graph below shows a comparison of the break-even point between the TPP "Kosova e Re" and the combined renewable energy project.

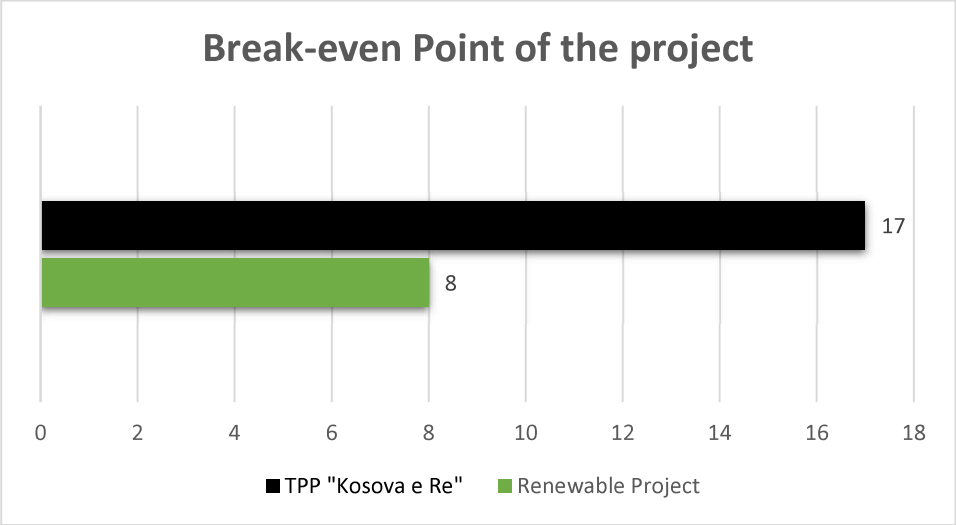


Figure 82: Break-even point of the projects - TPP "Kosova e Re" vs. Combined project

As shown in Figure 82, even at this point there is a very big difference between these two projects. In the case of the TPP "Kosova e Re", the investor could only start making a profit after the 17th year of the project's duration. The case of the renewable project is quite a different story. After the end of the 8th year, i.e. half earlier than in the case of TPP "Kosova e Re", the investor would start to generate his profit.

6 Discussion and Interpretation of the Results

Kosovo is still a country in the transitional phase and continues to pursue conservative policy when it comes to deciding which path should follow for the country's energy development. While in the European Union the trend towards electricity production from renewable sources is constantly increasing, the main orientation of the government of Kosovo continues to be the production of electricity from fuels, namely from coal. Still, the percentage of electricity production from fuels is very high in Kosovo. More than 90% of electricity production continues to be produced from fuels. As a result, Kosovo is one of the most polluted countries in the World.

This study aimed to determine that there is a big potential of RES in Kosovo. The First part of the master thesis was focused on the previous work done by different domestic and international publishers. We are based also on the official data that found on the websites of the institutions of the Republic of Kosovo, namely their publications. The second part of the master`s thesis is written on the basis of the models designed in the RETScreen program, in particular, a comparison between the main project of the government of Kosovo, regarding the energy sector the thermal power plant "Kosova e Re", and some renewable energy projects.

Based on this, the next objective was to determine that path that the government of Kosovo has chosen for energy development, whose main orientation is the construction of new power plants, is completely wrong and contrary to the aims and obligations that Kosovo has taken on by signing of the Energy Community agreement in 2006.

During this study, we were focused on comparing two possible options, the government's option, and the option we propose, based on the results we found during the research and calculations on RETScreen. As stated above, the government's plan is mainly focused on the construction of new power plants, namely the Power Plant "Kosova e Re". The government has already signed an agreement with an American company for the construction of this power plant. And what is mentioned in the preceding chapters is that the construction of this plant will be a tremendous economic burden and almost unbearable for the citizens of Kosovo. Besides the very high cost that the construction of this plant would entail, which is estimated to be worth of 1.3 million dollars a staggering increase in the price of electricity is to be expected. From the findings so far, it turns out that the price of electricity per kWh in the current level of 6 cent/kWh will reach the value of 11.5 cent/kWh, or translated in percentage, 92% more expensive.

It is evident that the amount of electricity produced by the TPP "Kosova e Re" is extremely higher than the amount that would be produced by the renewable energy project. But let us take a break and look at some facts, that are extremely important to emphasize. As already mentioned, based on the data provided by the government, the price for the "Kosova e Re" power plant will be 1.3 billion euro. However, RETScreen calculations show something completely different. RETScreen predicts that a project with the parameters of the TPP "Kosova e Re" will cost at least 1.7 billion euro. On the other hand, the combined renewable energy project with wind and solar energy based

on RETScreen calculations will cost approximately 800 million euro. This is half the price of the TPP "Kosova e Re". Moreover, another very important fact is the pollution of the environment. At the current state of the electricity sector, Kosovo is already one of the most polluted countries in the world. Last year, air quality was the worst in the 20 years after the war. In December 2018, the air quality index reached 456. Any value of this index over 300 is considered as “hazardous”. Conversely, the number of people who die in Kosovo is among the highest in the region. Various articles show that a very high percentage of these people die from cancer or other chronic illnesses. It is up to us to make the connection between these two facts. Due to the rehabilitation of the Power Plant "Kosova B" and moreover the construction of the TPP “Kosova e Re” the level of air pollution will only worsen. According to RETScreen calculations, if the TPP "Kosova e Re" is constructed and CO2 emissions remain at the current level, Kosovo would be responsible for emissions of 18 million tCO_2 during the year. Various studies indicate that this figure could reach the value of 20 million. Finally, with the current capacity of electricity generation, with the two main thermal power plants and the small renewable power plants, almost all the renewable energy demands are covered. Therefore, the project of TPP "Kosova e Re" with an installation capacity of 500 MW is completely unnecessary. What the government should do is to continue to invest in renewable energy or to provide simplified procedures for private investors to facilitate the application process for licenses. The government should also focus on energy efficiency, mainly, put pressure on the private operator that privatized the electricity distribution network to invest in improving the electricity grid, reducing electricity losses, in order to reduce the amount of electricity production.

New jobs have also been promised, if this power plant is built. The experience of the neighboring countries has shown that these new job promises are inflated and are not accurate at all.

These and many other facts presented in the writing of the thesis prove that the path chosen by the government of Kosovo is completely wrong.

It is extremely important, both financially and environmentally, switch from energy production through fossil use, to the production of electricity by exploiting renewable resources. From construction of new HPPs to wind energy parks, increasing the usage of solar energy through solar panels, etc.

Findings from this study suggest that there exists a low-carbon path for Kosovo. This path incorporates the use of energy efficiency, the use of large and small hydropower, solar energy, biomass and, most importantly, the use of wind energy. Furthermore, based on the findings, more than 35% of the electricity demand of the country, could be provided by renewable sources. These statistics surpass the goals and obligations that Kosovo must meet in order to respect the agreement with Energy Community.

With appropriate investments in this sector, more than 60% of new jobs will be created, compared to investments in thermal power plants.

Furthermore, if two Albanian states, Kosovo and Albania, were to cooperate in drafting a common plan in terms of energy production through renewable sources, besides fulfilling the requirements of consumers for electricity, would also be transformed into an energy power in the region. The good news is that this collaboration has just begun. An agreement has already been reached for the construction of a 200 MW HPP. This cooperation should continue regarding investments in solar energy. Albania has an enormous potential in terms of solar energy. It has a favorable geographical position in the Mediterranean basin. It also has very favorable climatic conditions for solar energy utilization. The high intensity of solar radiation, the duration of this radiation, the temperature and humidity of the air, Mediterranean climate with mild winters and humid hot and dry summers, define a very large energy potential of solar energy.

The findings also indicate that if it is decided not to construct the “Kosova e Re” Power Plant, and to invest in renewable resources or finding different investors, the number of new jobs will be much higher than in the government's plan, the air quality will be significantly improved and consequently the quality of life, in terms of healthy living. The price of electricity will not achieve an enormous value and will be comparable with the countries of the region, always considering the monthly economic incomes. Ultimately Kosovo will be able to save large sums of money, which can be invested in other projects that will improve the lives of its citizens.

7 Recommendations

Based on what we said in the previous chapter and the findings that are listed in the above chapters, and most importantly, based on the calculations of RETScreen, we will present recommendations on how the government of Kosovo could act in the framework of electricity production by using renewable resources.

These recommendations will be divided into two groups. The first group includes urgent recommendations that the government must take at the earliest possible moment. In the second group there are listed the steps that the government must take for a long-term plan, regarding the generation of electricity from renewable sources.

7.1 Urgent Recommendations for the Electricity Sector of Kosovo

- The immediate termination of the contract with Contour Global, thus canceling the Government's decision to construct the NPP "Kosova e Re"
- Decontamination of Kosova A power plant as soon as possible
- Strict programs about energy efficiency
- Completion of rehabilitation of "Kosova B" as soon as possible and placement of new filters
- Reducing losses in the network, namely, trying to reach 6%
- Condition the Turkish company "KESCO" to invest in improving the network of electricity distribution
- Removal of HPP “Zhur” from the energy development plan

7.2 Long-term Recommendations for the Electricity Sector of Kosovo

- Reconsider the 2017-2020 energy development plan, namely the renewable energy sector
- Establish local companies, with local and international experts, or engage private companies to formulate a new development plan regarding a real renewable energy potential, specifically:
    - Wind energy
    - Solar energy
    - Hydro
    - Geothermal
- Continue cooperating with the state of Albania. Establish a common set of experts and formulate a joint plan on the possibility of new investments in the construction of hydroelectric power plants and solar panel parks.
- It is extremely important to prepare a wind map showing the corresponding wind zones and corridors. It is crucial to have such a map, because in case of interests from foreign investors

to invest in wind energy, it would be of great help for them, to have a picture of where the regions are, where the real potential capacities in this sector of energy are, etc.

- Given the fact that there are foreign investors waiting for years to get a permit, it is extremely important to simplify the licensing procedures for potential investors. It is also important to draft a document that shows where the investors are legally entitled to build wind or solar parks. It does not mean that if a location meets the climatic conditions, it also meets the legal requirements.
- Development of a strategy regarding the use of newly recruited professional staff, namely the students who graduated in different universities in particular departments of Renewable Energy.

8 Appendix

8.1 List of Figures

8.2 List of Tables

9 References

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