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Congratulation!

Edmond

Hajrizi, Rector of UBT and Chair of IC - BTI

Përmbajtja

A Review on Energy Generation from the Sun and the Earth

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Abstract. The earthen and solar thermal capacities are enormous, though only a small part of it is at concrete disposal. In layman's terms, the immensity of the thermal energy is not attainable in its totality to human beings' science and tools.

Dimensionally, thermal contours encompass an expanse, be it an area, a region, or a spatial sector, that entails thermal dynamism on the Earth's body of soil or in space. If the thermal dynamism (activity, energy, or source) is not present on the surface of the Earth proper, *thermal dynamism* can refer to the superficial space or area that coincides geographically with the underground thermal reservoir or with the thermal resources hovering above in the sky.

Keywords: thermal energy, classification, solar energy, Earth, Sun

Introduction

Technically, the thermal exploitation is limited to the places in which the pertinent devices can be made operational in harmony with the geological or spatial configurations. Thus, for example, carriers are employed to extract the heat in the shape of steam or water from the depths.

On another note, by way of an alternative, the solar energy can be transformed into thermal energy, as it can be converted, auxiliarily, into electrical energy. These configurations, amongst other operational potentialities, comprise processes evolving around the thermal sources.

The sources in question, and their intrinsic aspects, are not exploited sufficiently as the energetic possibilities are virtually limitless. In effect, just a small portion of the potential energy in question can be utilized because it is scientifically, physically, and technically inaccessible to the human beings.

Energy expenditures

According to the estimations, the worldwide energy utilization or expenditure will, in all likelihood, increase 1.5% yearly through to 2030 (Hasan, Mahlia, and Nur, 2012; Mekhilefa, Saidurb, and Safari, 2011).

The expenditure of gas and oil natural stocks, among other pertinent factors, has called for different solutions that appertain to renewable energies (Handbook of Energy and Economic Statistic of Indonesia, 2010). We can mention here various types of energy such as biomass, solar, hydropower, or wind.

Energy generation from the Sun

Hsieh (1986) claimed that the Sun converts four million tons of hydrogen into helium per second. In 2009, the solar radiation input surpassed by 11,300 times the worldwide energy utilization (W. Shepherd, W., and Shepherd, D. W., 2014).

Solar energy moves with a velocity of 186,000 miles per second. At this speed, it reaches the Earth (93 million miles of distance) in a bit over than eight minutes (Promotion of Renewable Energy, Energy Efficient and Greenhouse Gas Abatement, 2003).

Solar source

In simple terms, solar power stems from the Sun. It can be transformed into electrical energy, in the process. It is considered by many, as the most eco-friendly and plentiful renewable energy resource.

Solar devices are capable of rendering useful the power stemming from the Sun for diverse utilizations. The most common employments in this sense are heating (of water, etc.) and electricity. If profitable technologies are employed in all senses, this configuration could become more viable at a later stage from an economic point of view and lucrative from a financial point of view compared to some other energetic resources. Besides, it is available in many regions around the globe.

These parameters may render it more attractive for the politics of different governments in the world.

Energy generation from the Earth

Four to five centuries ago, people started digging mineshafts and mines more meaningfully while searching for deposits of precious and semi-precious metals and stones. As they went deeper, they could experience a sensate heat growing gradually. In all likelihood, they had already presumed beforehand that the depths of the Earth were much hotter by the sheer presence of the visible lava domes or hydrothermal springs, amongst other indicators.

Until now, humankind has not been able to go deep into the Earth. As a matter of fact, the maximum depth that was reached is only 12 kilometers (Kola Superdeep Borehole SG-3, which was drilled in 1989).

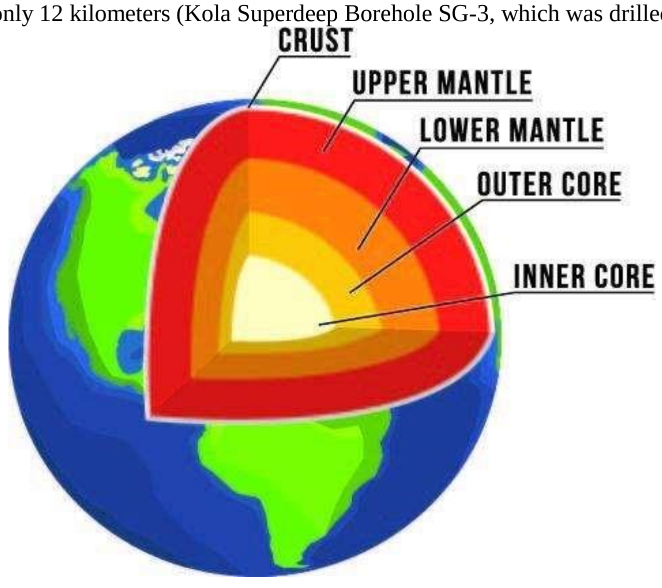

Figure 1. The Earth’s crust, upper mantle, lower mantle, outer core, inner core (SEA GRANT, 2018).

The mid-term and long-term projections for innovative tools and technologies may usher further advancements into the depths of the Earth that are beyond range as of now. In that case, further renewable energy sources would become available.

Conclusion

There is room, in abundance, for the thermal energy to be increased at the expense of the other energy sources. For example — within the renewable energy sources context — by 2003 only 1.6% of the total electricity came from thermal resources (Fridleifson, 2003).

And what is more, if compared to the utilization of the non-renewable energies, thermal energies are prospectively more advantageous from an environmental point of view while displaying huge potential, among other advantages. In such cases, a significant number of issues can be remedied on a local or regional scale.

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Challenges, stability and reliability of the energy network after the continuous integration of renewable energy sources

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Abstract. For the sustainable economic and social development of the country, based on the contemporary demand for electricity, the uninterrupted supply of sufficient quantity and quality of electricity is a necessary requirement, especially for countries that are still developing, such as Kosovo. Some of the main requirements that must be met in order to have quality and uninterrupted supply are: the right voltage, the availability of energy according to demand and high reliability of supply. Considering these requirements, the demands for qualitative and efficient energy from the users of electricity have increased recently. However, in recent times the use of energy from other forms has started to increase. Renewable energy sources now represent the group of sources from which electricity is being produced. Every day there is an attempt to integrate renewable sources as much as possible into the energy network. Of course, the integration of renewable resources will have its own impacts on the points where they are connected to the network. For this reason, one of the main challenges of different operators is to ensure a stable and reliable network and in compliance with the technical standards of operation.

Therefore, this paper will try to address the challenges and integration technologies for renewable energies in the grid. The problems of grid stability with renewable energy sources and their solution will be addressed in this paper. The second part of paper then continues with the integration of RES in the electricity network of Kosovo, with the changes that must be made in the current network of Kosovo for the integration of these sources. The challenges of RES in Kosovo are an integral part of this paper where the obstacles or challenges encountered in the development of projects for distributed generation from renewable sources in Kosovo are categorized.

Keywords: Energy, Renewable sources, Stability, Voltage, Frequency

1 Introduction

Economic and social growth at the same time has resulted in demand for increased energy, or higher consumption. Since ancient times, people have used the resources made available by the earth to survive and produce energy. Nowdays, the sources from which electricity is generated are divided into two main groups: non-renewable energy sources and renewable energy sources.

Growing numbers of distributed power sources, like photovoltaic panels, biogas plants, and wind farms, are continually increasing requirements on the distribution grids. Some of the main requirements that must be met in order to have quality and uninterrupted supply are: the right voltage, the availability of energy according to demand and high reliability of supply. But, is the existing network properly designed to accept without any problem the continuous integration of renewable resources into the network? A number of questions need to be answered in order to create a reliable and powerful energy system that will be able to meet the requirements of the changing energy system. However, most power energy infrastructures specifically distribution ones, were never built to handle too many distributed generators, power swings, intermittency issues, and even power flow reversals. Therefore, in order to enable the integration of renewable sources in the network, the electric networks are passing through the phase of transition from traditionally simple networks to advanced and smart networks. In energy system most of the complexities happens because of the interconnections of different types of generators, transmission lines, transformers, and different loads.

2 Renewable energy in power system

2.1 Stability and reliability of the electricity network

The main requirements that must be met in order to have quality and uninterrupted supply are: correct voltage, availability of energy on demand and reliability. Evaluation of the performance and reliability of power system infrastructure lately is becoming more complex due to the large number of network components, complex different network topology and component interdependency.

The concepts of reliability, security, and stability are interrelated with each other and can be considered and treated from different perspectives. A power system that is reliable has enough generation, demand response and network capacity to supply customers with the energy that they demand. For there to be stability, the energy generated must be equal to the energy consumed by the customers. Carson W. Taylor states about stability: "I may not be able to define stability, but I know it when I see it". [1]. In order power system to remain stable, it needs to respond to volatility in voltage and frequency disturbances, as two of some of the most important parameters of the electrical system. This means that energy production and consumption must always be balanced. This balance ensures safe and stable operation of the network at a constant frequency of 50 [Hz]. The frequency in this interconnected network must be kept constant at all times.

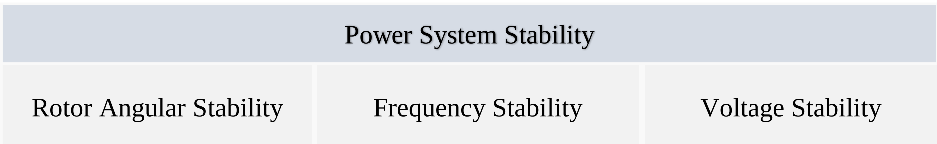

Figure 1. Power System Stability

Generally, an electrical network is safe if:

- The generation capacity is greater than the load
- The transmission elements are not overloaded
- The voltages in all nodes are within the limit
- The network is able to withstand generator failures
- The network is able to withstand transmission line losses
- The network does not lose stability during short circuits [2]

It should be mentioned that costs and profitability play a major role in the application of reliability concepts and their technical implementation. The two aspects of a relatively cheap and high-reliability electricity supply at the same time are often in direct conflict with each other and present the network operator and planner with a number of challenging problems. The general planning problem in electrical networks is how to compare different alternatives for network development based on network costs. Socioeconomic losses in the form of customer costs are reduced as reliability increases [1].

2.2 Renewable Energy Sources (RES)

Today people primarily use fossil fuels to heat and power homes and the elements that needs supply. It's convenient to use coal, oil, and natural gas for meeting the energy needs and demand, but one thing is sure that one day these sources will run out and we will have a limited supply of these fuels on Earth. So, it is understable that the world should move to other sources of creating energy.

Renewable energy uses energy sources that are continually replenished by nature: the sun, the wind, water, the plants and earth's heat. Different technologies of renewable energy turn these sources into usable forms of energy like electricity. These sources have a huge potential to provide energy services for the world.

Figure below presents the used sources of renewable energy worldwide. According to figure there are different types of renewable energy such as: hydropower, solar energy, wind energy, geothermal energy. Increasing the use of renewable energy sources is a key component of national energy policies supported by many countries.

Renewable Energy Sources

Further developing and exploiting renewable energy sources using modern conversion

Renewable Energy Sources

Wind Energy	Solar Energy	Hydro Energy	Geothermal Energy	Bioenergy

Figure 2. Renewable Energy Sources

Distributed generation in the smart energy grid would provide the platform for the usage of renewable resources and adequate emergency power for major metropolitan load centers and would protect against the complete outage of interconnected power systems due to induced events from human and environmental disasters and would provide the ability to divide interconnected energy systems into smaller clusters or regions.

2.2 Integration of renewable resources in the power network

It is known that in the electrical energy systems, the energy always flows from the large power plants which are connected to the transmission system and then through the distribution system the electricity flows to the consumers. When electricity generation is distributed, the power flows irregularly from one point to another within the distribution system, therefore we can say that it can lead to the effective malfunction of the system in general and the weakening of its protection.

It is therefore reasonable for grids to evolve so that a managed demand is supplied by distributed RES generation. Naturally, this evolution can be achieved with the use of electronic power interfaces, which will significantly increase the effectiveness of RES. From what was said above, we can conclude that the integration of RES with the electricity grid would help control energy flows and also ensure supply reliability.

The word integration in the energy term when it comes to renewable sources and the grid means the physical connection of the generator to the grid, always based on the appropriate adaptation and control of the electricity system to have a safe operation of the system so that the source of this energy to be used optimally. The integration of renewable energy generators is fundamentally similar to that of fossil energy generators and is based on the same principles, but renewable energy sources are often variable and geographically dispersed. [3]

Given that the technologies used to produce electricity from renewable sources are small in size and capacity, it is quite suitable for distributed energy generation systems, since many small plants are connected to the distribution network and produce electricity in places where there is demand. Then the use of these technologies would significantly reduce the need for centralized power generation and high-voltage transmission lines, as well as transmission and distribution costs. [4]

2.3 Stability and reliability of the energy network after the continuous integration of renewable energy sources

All electric grids in the world are different from each other and the optimal solutions for addressing integration of renewable energy sources integration vary accordingly. Integration of RES it will have impact in grid in different aspects, but if checked technically the impact will be seen in:

Frequency - The frequency of a system will change from its standard value if an imbalance in active power occurs as a result of an event or fault that can happen in power system. For example, a sudden change in load or a loss of generation can create problems regarding frequency. For this reason, the balance of the system it should be taken always in consideration because the frequency of the system should be kept within an acceptable range. But, in a system that is very dynamic, both generation and demand can change, which change can lead to an imbalance between the total generation and total demand. This imbalance will create frequency deviation. If the deviation is outside of the acceptable range, it will affect the power system's operation, reliability, efficiency, and security, as well as degrade load performance, overload transmission lines, and lead to protection failures.

Variability in generation: If we check the generation of electricity by wind and sun, the uncertainty and variability in generation can pose challenges for grid operators. This variability in generation sources will require additional actions to balance the system from the unbalances that can occur. In these cases, power forecasting from RES can help reduce the uncertainty of variable generation.

Voltage regulation – Voltage issue regarding RES can face two problems: voltage rise or voltage drop. Integration of RES shows bidirectional power flows in the distribution network and it will cause voltage rise at the receiving ends while RE generates more power than the load demand. Voltage can also drop if RES generation is unable to meet customer load demand especially at the peak hours when load demand is high.

Protection issues - The relay settings need to be changed as per the changing fault level in the power systems where RES are connected. Continually evolving and adding RES in grid will make a complex task to calculate and to validate protection setting that would be appropriate for relay trip in case of faults. The highly variability nature of renewable sources results in different network topologies that of course causes variation in fault levels. With integration of DG (distributed generation) the fault current and accordingly the protection system will be affected. There are some choices to mitigate the negative impacts of DG on the protection system like: restricting DG capacity and installing fault current limiter.

4. Stability and reliability of Kosovo electricity network with integration of RES

4.1 Power system of Kosovo

One of the biggest challenges of human civilization, especially of countries that are still developing, as is the case of Kosovo, is electricity and sufficient energy sources. The production capacities of electricity in Kosovo are mainly from thermal power plants which make up 91.41% of the installed capacity, or 89.29% of the net capacity and the rest are hydropower plants and other renewable energy sources like wind power plants and solar panels. Its electricity generation is almost entirely dependent on two ageing lignite plants: Kosova A and Kosovo B. Kosovo has an estimated reserve of coal equaling 12.5 billion t, which ranks Kosovo as the country with the second largest lignite reserves in Europe and fifth largest reserves in the world. [5]

It can be said that the entire production of electricity in Kosovo is based on fuel, therefore it is necessary that the energy production strategy also takes into consideration the production of energy from renewable sources. The Energy Strategy of the Republic of Kosovo for the period 2017-2026 in special focus, in addition to the security of stable supply of electricity, also set as an objective the diversification of sources of electricity. Creating an appropriate legal and regulatory framework, a friendly environment for private investments and a favorable market for promoting the development of electricity generation through renewable sources in Kosovo has been the goal of the newest energy strategy [5].

4.2 Stability and reliability of Kosovo electricity network

In Kosovo, the demand for energy is currently quite high. There is a vital need for stable, base-load generation in Kosovo that can meet demand. Electricity shortages can occur when generation and import capacity do not meet demand or when there is a service failure at one of Kosovo's aging power plants.

Europe is facing an energy and climate crisis. Rising energy prices in Europe in late 2021 and 2022 have increased the urgency also in Kosovo to invest in sustainable domestic energy production and reduce dependence on expensive imports. Our dependence on imported fossil fuels, can never deliver the energy security Europe needs. For this reason, Kosovo needs to open roads and to develop necessary strategies that will support RES integration, that will use energy efficiency measures or find any other solution that will cover energy demand. There are some of the basic challenges facing the energy sector in Kosovo that affect the stability and reliability of network. The main challenges include: rehabilitation of existing plants, insufficient generation capacities to cover the peak demand in the winter season, lack of secondary and tertiary power reserves in the system due to lack of flexible generators and underuse of potential renewable energy resources. To achieve the goal of a reliable supply of electricity and required capacities for a stable power system, significant works need to be done:

- To create sufficient generation capacities
- To increase the use of renewable energy sources for the production of electricity and to identify Kosovo potential for each type of this group
- To decrease technical and non-technical losses
- Decrease energy consumption through energy efficiency measures

If we check in the terms of stability, Kosovo electricity network is a complex system that contains many elements. Regarding voltage and frequency stability the system operates in accordance with the values set in the operation standards of the electrical network. Also having in consideration the production side that works with its maximum capacities, transmission side for providing and improving the capacities, the heavily investments from distribution company on the rehabilitation of the existing network, on distribution network digitalization, on reducing electricity losses, and improve the security of supply and overall service quality, it can be concluded that all the mechanisms involved in the energy sector do their best to maintain the stability and reliability of the electrical network.

4.3 The development of renewable energy in Kosovo

Experts in the field of energy in Kosovo consider that despite the great need for alternative sources of energy, Kosovo does not have the capacity to replace energy production from coal to renewable resources such as wind, sunlight, water and others. However, despite this, the tendency for the development of renewable energy sources in recent years is increasing. Such a tendency has also been observed in the development of photovoltaic or solar energy and the wind energy in Kosovo during the last years. The generation from RES built in recent times is mainly connected to the distribution network for direct supply of individual consumers (commercial and industrial) to meet their needs and do not directly contribute to the overall transmission system. [6] It can be said that the capacities of solar energy in Kosovo are modest in terms of meeting the requirements for the construction of solar plants that produce electricity with sufficient quality and quantity for connection to the transmission system. But this energy can be used in small plants for individual needs with connection to the electricity supply system and for thermal energy for the preparation of hot sanitary water.

In term of hydropower, Kosovo is not a country with great hydropower potential mainly for geographical reasons related to the topographic aspect - the relief is mainly in the form of a plateau characterized by relatively soft terrain and little rainfall. In the Western Balkan region, Kosovo is the poorest country in terms of available water resources – 1,600 cubic meters of water per capita. [7]

In terms of wind energy, Kosovo is doing better. Wind energy is one of the fastest growing, cost-effective and high efficiency of electric power generation in country.

Kosovo has now completed one of the largest wind turbine projects in Selac, respectively in Mitrovica, where the installed capacity is 102.6 [MW].

A transformer substation with a capacity of 120 [MW] was built near the village of Bajgora to convert the wind farm’s electricity to 110 [kV]. [8]

Statistics for renewable energy sources connected to transmission and distribution network of Kosovo:

The table presented below shows the main hydropower plants connected to the transmission network in Kosovo [9]:

Table 1. Hydropower plants connected in transmission network of Kosovo [9]

Hydropower plants	Installed capacity [MW]
HPP Ujmani	17.5
	17.5
Lumbardhi I	4.04
	4.04
Lumbardhi II	5.4
Belaja	5.29
	2.79
Deçani	6.66
	3.15
Total	**66.37**

The table presented below shows the main hydropower plants connected to the distribution network at the level of 35 or 10 [kV] in Kosovo [6].

Table 2. Hydropower plants connected in distribution network of Kosovo [6]

Hydropower plants	Installed capacity [MW]
HC Dikanci	4.02
HC Radavc	1
HC Burimi	0.95
HC Hidroline- Albaniku III	4.27
HC Brod II	4.8
HC Restelica 1&2	2.28
Hidroenergji (Lepenci 3)	10
EKO Energji (HC Binqa)	0.6
HC Brezovica	2.1
Total	**30.02**

The table presented below shows the main wind turbines connected to transmission network in Kosovo. Both of them are connected at 110 [kV] side of transmission grid.

Table 3. Wind turbines connected in transmission network of Kosovo

Wind Turbines	Installed capacity [MW]
KITKA	32.4
SELAC	102.6
Total	**135**

While the other table below shows the total installed capacity in [MW] of solar panels connected to the distribution network at the level of 35 or 10 [kV] in Kosovo [10]:

Table 4. PV connected in distribution network of Kosovo

Solar Energy	Installed capacity [MW]
Solar – Led Light Techn.	0.102
Solar - Onix	0.505
Solar – Eco Park	3
Solar - Frigo Food	3
Solar – Green Energy	3
Solar – Eling	0.480
Total	**10.087**

Figure 3. a) Eco Park, Madanaj- Kusar, Gjakove, 3,000 [kW] dhe
b) Solar Green Energy, Novoselle, Kamenice, 3,000 [kW] [10]

The total solar PV installed capacity by end of 2020 is 20.9 MW, and when converted to energy it represents a modest share of 0.04% of total electricity consumption in Kosovo [10]. Total installed capacity by project type is presented in below graph:

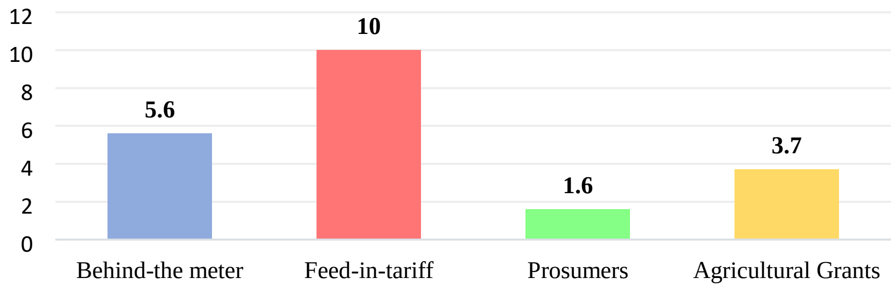

Figure 4. The total solar PV installed capacity by type in Kosovo [10]

4.4 Changes in the existing power system of Kosovo for the integration of RES

The main aspects of the capability of the electric power system that affect the integration of energy production based on renewable energy are.

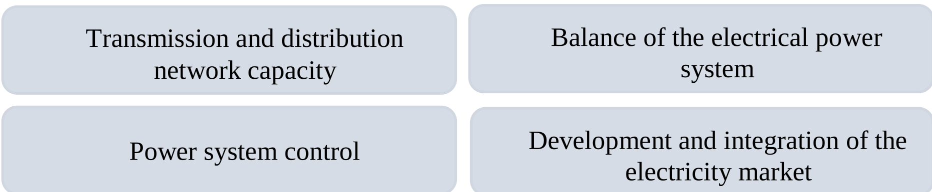

Figure 5. Influencing aspects for integration of RES in the existing network

The existing transmission network managed by KOSTT has enough capacity to integrate the candidate production capacities from RES, so the only problem for OST remains the lack of power system control reserves to compensate for variable and unpredictable production of solar generation. However, for the distribution network managed by KEDS, numerous analyzes must be made which determine that the current dimensioning of the electrical network sufficiently supports the installation capacities of RES. In order to ensure the stability and reliability of the network after the integration of RES, then before the integration of renewable resources in the electric network or at the point where they will be connected, *some changes must be made*, such as:

Bidirectional flow of energy - Initially, the existing electricity network of Kosovo must enable the two-way flow of energy, that is, from the generator to the consumers and vice versa with the end users who contribute to the supply of electricity. Through the twoway flow of energy, it is possible to ensure the stability of the network.

Creation of efficient mechanisms - Efficient network management mechanisms should be established, aimed at reducing peak loads, improving network flexibility, responsiveness and security of supply to cope with increased systemic variability. **Improvement of interconnection of networks** - If the installation power of RES is large (eg if their connection is made to the transmission network) then it is necessary to improve the interconnection of networks at the regional, national and international level, with the aim of increasing network balancing capabilities, reliability and stability. **Balancing and controlling the power** - The balancing ability of the energy system is one of the main limitations for the integration of RES in the existing network of Kosovo precisely because of the nature of uncertainty and fluctuation of output power. Therefore, changes must be made in the existing network, in which case the addition of mechanisms or systems that enable power balancing and control must be made. **Energy storage** – Changes must be made to the existing network in order to introduce energy storage capacity to store the electricity generated by RES which is variable energy when the energy supply exceeds the demand and aims to increase the flexibility of system and security of supply.

Addition of reserve capacities - From the point of view of system planning and operation, with the increasing penetration of production from renewable sources, electricity systems need additional reserve capacity to provide energy for the system at times when RE sources do not produce enough to meet demand.

Installation of additional voltage control devices – A main criterion for connecting RES in power system is the influence on the grid voltage during normal operation. RES to be connected are required to keep the voltage rise within an acceptable range. In order to check the voltage, in the cases where the need arises, additional devices must be installed in the existing network of Kosovo that enable even the smallest voltage fluctuations to be recorded.

Installation of directectional protections – Accepting the integration of RES in the existing network of Kosovo may cause unwanted impacts on the protection systems, mainly due to changes in the load flow and the increase in the contribution of shortcircuit currents that may occur in the network. Therefore, in order to ensure safe and selective protection, the impact of RES on protection systems must be considered in planning the operation of the network, considering the installation of new directional relays as well as the development of new directional protection algorithms.

SCADA system installation - In order to be able to monitor the key parameters from the generation of electricity through RES such as voltage, currents, frequency, active power, then it is necessary to install the SCADA system in all existing power stations and those that will be installed in the future [11].

4.5 Challenges of renewable energy in Kosovo

Although every day more and more works are being done on the drafting of supporting policies, there are still many challenges for the development of renewable resources in the electricity network of Kosovo. All these challenges must be addressed effectively and at the right time, and which require concise legal foundations as well as promotion schemes and development strategies.

There are several obstacles to the development of projects for distributed generation from RES in Kosovo. These obstacles or challenges are divided into three categories:

I. **Policies and regulation** - which include the following categories: Long administrative and permit delays, arbitrary restrictions imposed on prosumers, special requirements for municipal consent, sometimes dysfunctional institutional and regulatory environment, lack of skilled labor.
II. **Balancing responsibilities** - According to Article 22 of Law no. 05/L-085 for Electricity in Kosovo, the Transmission System Operator (OST) is specifically responsible for the organization and development of the electricity balancing market [11]. Meanwhile, prosumers with on-site renewable energy projects below 400 [kW] do not face special balancing responsibilities.
III. **Financing** - generally high interest rates and lack of investment loans are among the main financial obstacles faced by people who want to install renewable plants.

Conclusion

For human life, for the fulfillment of needs and for the further development of the country, it is important that the energy sector be developed with the right steps. In the case of Kosovo, the number of RES connected to the electricity network is always increasing, which means that the tendency for their use in the coming years will be at good levels. RES in Kosovo will help on improving the energy supply, increases economic growth, and reduces CO2 emissions. But as explained in the chapters above RES can have a positive and negative impact on the power grid stability and reliability. For this reason, in order to have only a positive impact on the network from the integration of renewable sources, then numerous analyzes must be made which determine that the current dimensioning of the electrical network of Kosovo sufficiently supports the installation capacities of RES. Our country Kosovo has an urgent need to develop a sustainable path of energy development, from which it can be seen that RES are an integral part of this path.

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Component dimensioning for a combined photovoltaic and heat pump system installed in a residential building

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Abstrakt. The intermittent nature of renewable energy sources has attracted much interest in the integration of storage devices towards the deployment of micro-grid systems. In fact, these devices can be placed in the system decoupling energy production from consumption mainly by storing the extra energy produced by RES during the day for eventual use at night. However, for stand-alone systems, calculating the optimal size of power generation systems and storage devices is required for continuous power supply. The energy sector faces a continuous increase in PV battery energy storage systems. These systems are applied to increase the rate of self-consumption of home photovoltaic systems. The energy generated by the PV system can also be used for space heating and domestic hot water to contribute to the decarburization of the heating sector. Sectorial coupling of energy and heat can be achieved using heat pump systems. The combined system is capable of providing renewable energy for the heating and electricity needs of households. Therefore the Dimensioning of the various system components greatly affects the economics of PV with combined power and heat.

Kwey words: PV system, heat pump, components, residential building

1 Introduction

Currently in Kosovo, the demand for energy comes primarily from the household consumer, who is the largest consumer. Until now, the energy consumed for heating homes has been generated from fossil fuels. Therefore, residential households can play a major role in the decarbonisation process [1]. The increase in the number of PV systems in Kosovo enables an increase in the production of renewable energy in the residential sector. To use this energy in the heating sector, the heat pump can be applied. The heat pump increases the self-consumption rate of residential PV generators [2]. Further increase in the self-consumption rate of PV can be achieved by installing battery energy storage systems [3]. Integrated households combine a PV generator and a heat pump for combining energy with heat. An optimization of the component sizes of integrated houses can increase their economy.

Capital intensive components such as PV generator, heat pump and thermal storage units play a major role in profitability. In addition, the thermal and electrical load profile of the residential house as well as the solar radiation profile must be considered to determine the efficient dimensions of the component. This is why an optimization of the component size is necessary to increase the economy of the system. [4]

This paper analyzes the economic optimization of integrated families. In addition, the impact of feed-in tariffs (FIT) for PV systems on the optimal size of the integrated house components is also investigated. Also, the leveled cost of energy (LCO Energy) is calculated, to enable a cross-sectorial comparison and a complete economic treatment [4]. Analysis of the PV/T system on a long-term basis showed that the electrical and thermal performance can be related to four dimensionless parameters. These include PV/T performance characteristics, consumption, average ambient temperature, insulation and heat pump performance.

2 Methodology

To find the optimal system configuration for an integrated facility with a combined heat and power system, a detailed model is essential. The presented model of an integrated house has a PV and a heat pump to combine the electrical and thermal system.

3. Photovoltaic systems

There are many renewable energy sources, such as the use of energy from the Sun, which for one hour radiates enough energy to cover the energy consumption used by people for a year. Now with the technologies we have, it is a smart and correct solution to produce electricity from solar radiation.

The benefits of producing electricity from solar radiation are many such as:

- The photovoltaic plant provides green energy.
- Solar energy is undeniable and reasonably priced.
- The implementation of photovoltaic plants is suitable for integration with the distribution network.
- Remain in working condition for long periods and without technical maintenance.
- Photovoltaic energy is flexible and the range of energy produced by them varies from a few microwatts to megawatts.
- The plant does not produce noise, for this reason it is the ideal solution for urban areas and collective facilities.
- The supporting and mounting structures have "zero" environmental impact and do not alter the physical condition of the terrain. • They are static, they have no moving equipment, and therefore they have very few unplanned shutdowns and need supervision.
- Increasing security of electricity supply and diversification of energy sources.
- Support and liberalization of the electricity market.

3.1 General data of the object

The general data of the facility, which also includes electricity costs, are of particular importance because they also determine the required consumption, which in fact represents the design basis of the system [5]. 1. The facility does not have any PV system installed

2. The object is connected to the network
3. The facility has a generator in case of a power outage from the grid
4. The facility does not have a battery system installed
5. The building has good insulation in the windows and walls that are in contact with the outside environment
6. The facility does not have a central cooling system, there are only individual air conditioners in each space.
7. The facility has a central heating system installed (a diesel boiler)
8. The area that can be used for the installation of photovoltaic panels is 500m2 (this area does not include the area that must be left between the series of panels for maintenance or cleaning of the photovoltaic panels and an area that for technical reasons cannot be photovoltaic panels are installed).

Table 1. Monthly and annual electricity consumption from the facility

Month	Monthly electricity consumption, year 2020 (kWh)	The price of electricity on average, calculating the two tariffs	The price of electricity during a month
January	19426	0.07€/kwh	1359.82€
February	21026	0.07€/kwh	1471.82€
March	21006	0.07€/kwh	1470.42€
April	23066	0.07€/kwh	1614.62€
May	24006	0.07€/kwh	1680.42€
June	28867	0.07€/kwh	2020.69€
July	31957	0.07€/kwh	2236.99€
August	28732	0.07€/kwh	2011.24€
September	21585	0.07€/kwh	1510.95€
October	21357	0.07€/kwh	1494.99€
November	20187	0.07€/kwh	1413.09€
December	19598	0.07€/kwh	1371.86€
TOTAL	275813kWh		19656.91€

3.1.1 Photovoltaic panels

The photovoltaic panel that will be used has the following technical characteristics: Solar panel - Jaha Solar SHPK, JSP 270W with technical data as follows [5]:

Table 2. Technical data for solar panels

Polycristaline	
Maximum Power (Pmax)	270 Wp
Voltage at Maximum Power (Vmpp)	32.38 V
Current at Maximum Power (Impp)	8.37A
Open Circuit Voltage (Voc)	38.24 V
Short Circuit Current (Isc)	8.87 A
Panel Efficiency	16.42 %
Power Tolerance (Positive)	2%
Panel Dimension (H/W/D)	164.8x99.8x3.5 cm
Weight	17.5 kg
Price	0.191 €/Wp

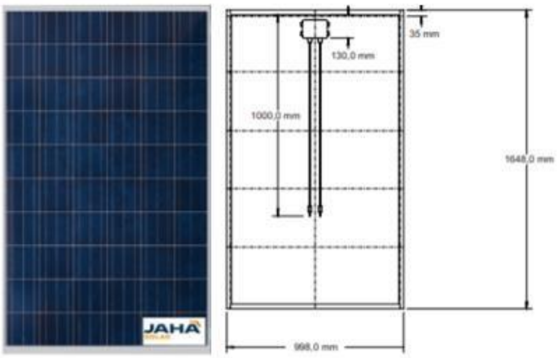


Figure 1. Dimension of the photovoltaic module used in the system.

Based on the technical data for the panel, their number has been appropriated in function of the surface of the object that we have at our disposal. The gross surface of a PV is ≈ 1.67m^2, while the surface of the building is ≈ 500m^2 that can be used for the installation of PV, then the number of panels we will install:

$$N_p = \frac{S_{totale}}{S_{panelit}} = \frac{500m^2}{1.67m^2} = 299.4\, panele \approx 300\, panelePV$$

The total installed capacity is:***300*0.270Wp=81kWp***

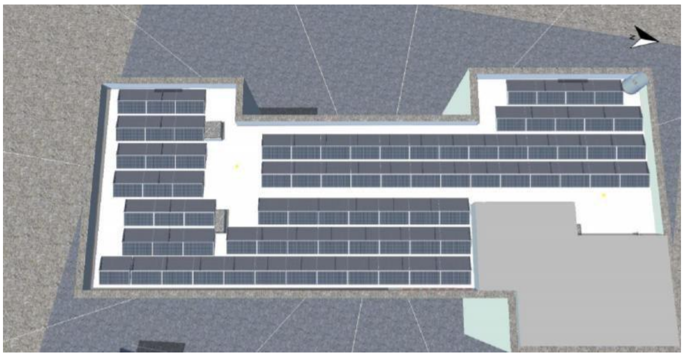


Figure 2. View from the terrace of the building after PV installation

A PV system with a capacity of 81kWp as well as the inverter has been installed and based on the installed power we have a total of 7 inverters with 12kW each of the Kaco Blueplanet 10.0 type with technical data as follows:

Figure 3. Kaco Blueplanet species invertor

Tab. 3 Technical data of the inverter

Blueplanet	**10.0 TL3**
Max. recommended PV generator power	**12 000 W**
MPP range	470 – 800 V
Operating range	200 – 950 V
Rated DC voltage / start voltage	653 V / 250 V
Max. no-load voltage	1 000 V
Max. input current	2 x 11 A
Max. short circuit current Isc max	2 x 16 A

Number of MPP tracker	2
Connection per tracker	1

Below is the electricity generation for one year for 1kWp from the PV system that we have installed.

Table 4. Energy generation from the PV system

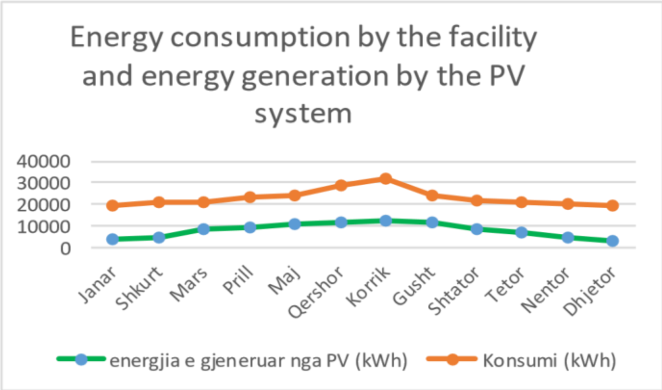
Month	Radiation coef-ficient per month	Capacity of the installed system kWp	Energy generated by the system kWh
January	45.88	81	3716.28
February	58.24	81	4717.44
March	104.16	81	8436.96
April	115.2	81	9331.20
May	133.92	81	10847.52
June	144.90	81	11736.90
July	155.62	81	12605.22
August	143.84	81	11651.04
September	108.00	81	8748.00
October	88.35	81	7156.35
November	55.50	81	4495.50
December	38.13	81	3088.53
Total		Totali	**96530.94kWh**

The energy spent for one year before the installation of the PV system was 275.81MWh, while the PV system will generate electricity for a year ≈ 96.5MWh from which it results that we have installed a PV system ≈30% of the total electricity consumption from the facility.

Based on the data obtained, we have built a diagram for electricity costs after PV installation.

Table 5. Consumption and generation from PV

Month	Consumption (kWh)	Generation from PV (kWh)	The difference (kWh)
January	19426	3716.28	15709.72
February	21026	4717.44	16308.56
March	21006	8436.96	12569.04
April	23066	9331.20	13734.8
May	24006	10847.52	13158.48
June	28867	11736.90	17130.1
July	31957	12605.22	19351.78
August	28732	11651.04	17,080.96
September	21585	8748.00	12837
October	21357	7156.35	14200.65
November	20187	4495.50	15691.5
December	19598	3088.53	16509.47



If we analyze the graph and the table.3 we notice that there is no need to install a battery system because in no case do we generate more electricity from the PV systems than the consumption.

Table 6. LCEO of the PV system

Premeasurement and precalculation of PV system					
nr	Product	Unit	amount	Product price	PRICE (€)
1	Solar panel Jaha Solar LLC, JSP 270W	pcs	300	0.191(€/Wp)	15,471.00
2	Kaco Blue Planet 10.0 inverter12kW	pcs	7	3000 (€)	21,000.00
3	Cables and connectors	set	7	1000(€)	7,000.00
4	Equipment assembly	set	1	12000(€)	12,000.00
5	Unpredictable material	set	1	5000(€)	5,000.00
6	Metal constructions	set	1	10000(€)	10,000.00
7	System grounding	set	1	2000(€)	2,000.00
				Total=72,471€	

Table 7. Project cost

t	Investing	Maintenance	Energy generated	(1+r)^t	NUM €/vit	DEN kWh/vit
1	51,971.00	500,00	96,530.94	1.04	75,889.84	92,818.21
2	0.00	500,00	96,530.94	1.08	540.80	89,248.28
3	0.00	500,00	96,530.94	1.12	562.43	85,815.65
4	0.00	500,00	96,530.94	1.17	584.93	82,515.05
5	0.00	500,00	96,530.94	1.22	608.33	79,341.40
2	0.00	500,00	96,530.94	1.08	541.92	89,248.28
3	0.00	500,00	96,530.94	1.12	562.43	85,815.65
4	0.00	500,00	96,530.94	1.17	584.93	82,515.05
5	0.00	500,00	96,530.94	1.22	608.33	79,341.40
6	0.00	500,00	96,530.94	1.27	632.66	76,289.80
7	0.00	500,00	96,530.94	1.32	657.97	73,355.58
8	0.00	500,00	96,530.94	1.37	684.28	70,534.21
9	0.00	500,00	96,530.94	1.42	711.66	67,821.36
10	0.00	500,00	96,530.94	1.48	740.12	65,212.84
11	0.00	500,00	96,530.94	1.54	769.73	62,704.66
12	0.00	500,00	96,530.94	1.60	800.52	60,292.94

Total				Total	85,480.87	1,242,870.37

P	81	kW	**LCEO=0.06877698Euro/kWh**		
En Gh	96530.94	kWh/vit			
Investing	49,971.00	€			
Maintenance	6000	Euro / 10 vite			
r	0.03				

Based on the calculation, it turns out that after approximately 12 years we will enter the market and return the investment.

3.1.2 Heat pump

The system of the researched facility has an Eco Flam MAX 12 type boiler installed, 100-130 kWh of thermal energy, 19L/h consumption, or 0.1461 L/kWh. The boiler worked during the winter period 8 hours every day approximately 150 days/year. Then how much thermal energy have we spent and how much oil within this period.

Energjia termike = 130kW * 8h * 150 =156000kWh energji termike brenda nje viti.
Nafta e shpenzuar:156000*0.1461=22,791.6 [l] ≈ 23000€/ vit

We have installed a system with a heat pump so that during the winter period we have heating with a heat pump and during the summer for cooling the environment. We will have the oil boiler as a backup system. Based on the data and the energy demand of approximately 130kWh of thermal energy, we have chosen the heat pump with technical data:

Table 8. Heat pump data

Thermo pomp Daikin UATYQ-ABAY1	
Power	55kw
Capacity	190000BTU
Voltage	400/3+N/50 ±5 %
Réfrigérant	R410A
Dimension HxLxP	1.799x2.712x2.263 mm
Cop	-25ºC – 1.89
	-15 ºC – 2.11
	-5ºC – 3.05
	5ºC – 3.5
	20ºC – 3.89
	35ºC – 3.75
Price	17,500€

From these data we can get an average device performance coefficient of 2.5 from which it follows that this device will generate thermal energy within an hour of approximately 137kWh which meets the demand.

Table 9. LCOE of the heat pump

Premeasurement and precalculation of the heat pump system					
nr	product	Njësia	Sasia	Çmimi i produktit	Çmimi
1	Daikin heat pump 55kw	pcs	1	27,500€	27,500€
2	Round metal pipe ϕ70	m	130	10€	1300€
3	Metal turn ϕ70	pcs	20	7€	140€
4	Assembly of the device with all parts	suite	1	2000€	2000€
5	Fine non-calculating material	suite	1	1000€	1000€

6	Circulating water pump	pcs	1	750€	750€
				Total	32,690€

Working hours for a year for the heat pump:

$$h_{pt} = 280[ditë]\ x\ 8[h] = 2240[h/vit]$$

The consumption of electricity from the pump in this case will be:

$$E_{vit} = 2240[h]x55[kW] = 123200[kWh]$$

The total cost of electricity from the heat pump in one year will be:

$$K_{totale} = 123200[kWh]x0.07€ = 8.624€$$

During this period we will save:

$$Perfitmi_1 = 23000€ - 8624€ = 14376€$$

Air conditioners have been installed in the existing facility, which will not be used, so electricity will be saved by about 15%. or €2896/year. Therefore, the benefit of installing the heat pump will be:

$$P_{totale} = 2896€ + 14376€ = 17272€/vit$$

The return of the investment will be realized for a period of 2 years.

Summary

A detailed, transient simulation of the system operation of a building along with the electricity production of the rooftop PV installation is done to shed light on the effect of the installation size on the system performance between the electricity consumed and the electricity generated produced by the PV system. An analysis of electricity demand from the power grid was presented in a comparative way, to find the periods during the year that rooftop PV electricity could support the energy supply process away from fossil fuel dependence. To this end, the economic viability of installing rooftop PV panels was examined under different electricity price and equipment financing scenarios. These results can be used in the more rational design of net metering tariffs to support the further expansion of rooftop PV systems.

Electrification of buildings, together with the installation of rooftop PV panels on new and existing houses, based on private investment or mortgage extensions, is a viable option that can strongly support the energy transition based on private investment at the lowest level. We start from the fact that the energy spent for a year before the installation of the PV system was 275.81MWh, while the PV system will generate electricity for a year ≈ 96.5MWh from which it follows that we have installed a PV system ≈30% of the total consumption of electricity from the object.

Also, the installation of a heat pump system so that during the winter period we have heating and during the summer for the cooling of the environment, we manage to save about €17,272/year. The return of the investment will be realized for a period of 2 years. The heat pump is the most efficient way to produce thermal energy, where, depending on the type and utilization coefficient, they reach 70-80% of the energy from the environment. So not only do they save a lot during work, but they are also ecological.

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Egypt Energy Transition

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Abstract: As sharing views, experiences and facilitating the exchange of knowledge in the field of energy efficiency are mainly the aim of the conference, sharing Egypt energy transition experience will be a value added specially in the area of environmental impact of energy efficiency. Negative environmental impact on air, water and land, caused by different forms of electricity generation will be discussed and how producing and using electricity more efficiently can reduce both the amount of fuel needed to generate electricity and the amount of greenhouse gases and other air pollution emitted as a result will be explained. How electricity from renewable resources such as solar, geothermal, and wind generally does not contribute to climate change or local air pollution since no fuels are combusted will be measured. Transition to renewable energy in Egypt and the Situation in 2014, actions taken to overcome Generation shortage, upgrading transition, transition to renewable energy, investment opportunities in green projects, preparation for EGYPT's hosting of COP27, how Egypt is an Energy Hub for International Interconnections and Corridors integrated, sustainable energy strategy to 2035, and other interactions will be discussed in details in this paper.

Keywords: Egypt, Energy, Transition, Efficiency, Environment, Pollution, Electricity, Generation, Pollution, Renewable, Climate Change.

1 Introduction

1.1 Environmental impact of energy

Energy and environmental problems are closely related, since it is nearly impossible to produce, transport, or consume energy without significant environmental impact. The environmental problems directly related to energy production and consumption includes air pollution, climate change, water pollution, thermal pollution, and solid waste disposal. The emission of air pollutants from fossil fuel combustion is the major cause of air pollution. Burning fossil fuels is also the main contributor to the emission of greenhouse gases. Diverse water pollution problems are associated with energy usage. One problem is oil spills. In all petroleum-handling operations, there is a finite probability of spilling oil either on the earth or in a body of water. Coal mining can also pollute water. Changes in groundwater flow produced by mining operations often bring otherwise unpolluted waters into contact with certain mineral materials which are leached from the soil and produce an acid mine drainage. Solid waste is also a by-product of some forms of energy usage. Coal mining requires the removal of large quantities of earth as well as coal.

1.2 Environmental impact of electricity generation

Electricity generation is the process of generating electric power from sources of primary energy. After electricity has been generated, a system of electrical wires carries the electricity from the source of generation to our homes and businesses. These lines can be found overhead or sometimes in the ground, and, combined, transmission and distribution lines make up what is commonly called "the grid." Transmission and distribution are two separate stages or systems on the grid. An electric power **sys**tem or electric grid is known as a large network of power generating plants which connected to the consumer loads**.** Electricity transmission lines and the distribution infrastructure that carries electricity from power plants to customers also have environmental effects. Most transmission lines are above ground on large towers. The towers and power lines alter the visual landscape, especially when they pass through undeveloped areas. Vegetation near power lines may be disturbed and may have to be continually managed to keep it away from the power lines. These activities can affect native plant populations and wildlife. Power lines can be placed underground, but it is a more expensive option and usually not done outside of urban areas. Although electricity is a clean and relatively safe form of energy when it is used, the generation and transmission of electricity affects the environment. Nearly all types of electric power plants have an effect on the environment, but some power plants have larger effects than others. (USEIA last updated 6/ 2021).

2 The effect of power plants on:

2.1 The landscape

- All power plants have a physical footprint (the location of the power plant). Some power plants are located inside, on, or next to an existing building, so the footprint is fairly small. Most large power plants require land clearing to build the power plant. Some power plants may also require access roads, railroads, and pipelines for fuel delivery, electricity transmission lines, and cooling water supplies. Power plants that burn solid fuels may have areas to store the combustion ash. Many power plants are large structures that alter the visual landscape. In general, the larger the structure, the more likely it is that the power plant will affect the visual landscape. . (US EIA 8/5/2022)

2.2 Fossil fuel, biomass, and waste burning power plants

In the United States, about 60% of total electricity generation in 2020 was produced from fossil fuels (coal, natural gas, and petroleum), materials that come from plants (biomass), and municipal and industrial wastes. The substances that occur in combustion gases when these fuels are burned include:

- Carbon dioxide (CO_2)
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Nitrogen oxides (NOx)
- Particulate matter (PM)
- Heavy metals such as mercury

Nearly all combustion by products have negative effects on the environment and human health:

- CO_2 is a greenhouse gas, which contributes to the greenhouse effect.
- SO_2 causes acid rain, which is harmful to plants and to animals that live in water.
- SO_2 also worsens respiratory illnesses and heart diseases, particularly in children and the elderly.
- NOx contribute to ground-level ozone, which irritates and damages the lungs.
- PM results in hazy conditions in cites and scenic areas and coupled with ozone, contributes to asthma and chronic bronchitis, especially in children and the elderly. Very small, or fine PM, is also believed to cause emphysema and lung cancer.

- Heavy metals such as mercury are hazardous to human and animal health. (US EIA 8/5/2022)

2.3 Some power plants also produce liquid and solid wastes

Ash is the solid residue that results from burning solid fuels such as coal, biomass, and municipal solid waste. *Bottom ash* includes the largest particles that collect at the bottom of the combustion chamber of power plant boilers. *Fly ash* is the smaller and lighter particulates that collect in air emission control devices. Fly ash is usually mixed with bottom ash. The ash contains all the hazardous materials that pollution control devices capture. Many coal-fired power plants store ash sludge (ash mixed with water) in retention ponds. Several of these ponds have burst and caused extensive damage and pollution downstream. Some coal-fired power plants send ash to landfills or sell ash for use in making concrete blocks or asphalt.

2.4 Nuclear power plants produce different kinds of waste

Nuclear power plants do not produce greenhouse gases or PM, SO_2, or NOx, but they do produce two general types of radioactive waste:

- Low-level waste, such as contaminated protective shoe covers, clothing, wiping rags, mops, filters, reactor water treatment residues, equipment, and tools, is stored at nuclear power plants until the radioactivity in the waste decays to a level safe for disposal as ordinary trash, or it is sent to a low-level radioactive waste disposal site.
- High-level waste, which includes the highly radioactive spent (used) nuclear fuel assemblies, must be stored in specially designed storage containers and facilities.

3 Power plants reduce air pollution emissions in various ways

Air pollution emission standards limit the amounts of some of the substances that power plants can release into the air. Some of the ways that power plants meet these standards include:

- Burning low-sulfur-content coal to reduce SO_2 emissions. Some coal-fired power plants co fire wood chips with coal to reduce SO_2 emissions. Pretreating and processing coal can also reduce the level of undesirable compounds in combustion gases.
- Different kinds of particulate emission control devices treat combustion gases before they exit the power plant: Bag-houses are large filters that trap particulates.
- Electrostatic precipitators use electrically charged plates that attract and pull particulates out of the combustion gas.
- Wet scrubbers use a liquid solution to remove PM from combustion gas.
- Wet and dry scrubbers mix lime in the fuel (coal) or spray a lime solution into combustion gases to reduce SO_2 emissions. also results in lower SO_2 emissions.
- NOx emissions controls include low NOx burners during the combustion phase or selective catalytic and non-catalytic converters during the post combustion phase. (EIA) 6/2021.

4 Transition to Renewable Energy in Egypt

4.1 The Situation in 2014

Egypt’s power outages continue to intensify. Analysts say that while the current crisis has been expected since the Mubarak era, it will take at least a couple of years to reverse the situation.

Massive power outage hits Egypt: Officials say nearly 50% of the country’s electricity cut for several hours. Cairo trains halted during rush hour.

Major power outage hits Cairo and governorates: Electricity blackout hits large areas of Cairo and other towns on Thursday morning; minister blames ‘technical problems’, 4 Sep. 2014.

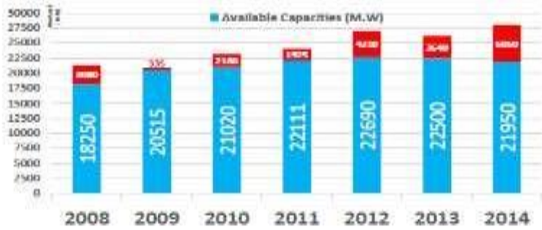

Fig. 1. Available and needed capacities (M.W) during the period 2008-2014

Source: Ministry of Electricity & Renewable Energy 2022

Challenges lead to the Importance of setting a new strategy of electricity Sector is clearly indicated from figure (1). The available capacity (MW) increased only by 4700 MW (26%) during the period 2008-2014, from 18250 to 21950 (MW).The needed M.B in 2008 was 21330 (3080 MW shortage). The corresponding value in 2014 was (6050 MW shortage) where about 28000 M.W was needed. Fuel shortage and load shedding are indicated figure (2), massive electrical power outage was expected.

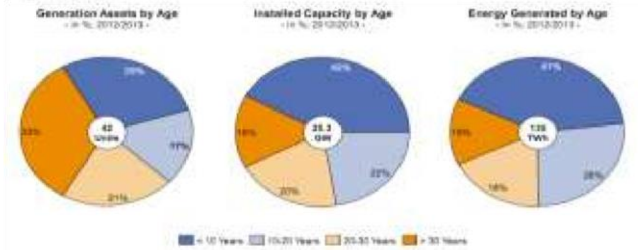

Fig. 2. Thermal generation capacity by age 2012/2013 by age

Source: Ministry of Electricity & Renewable Energy 2022

Generation Assets by age indicated that about one third of them 33% exceeds the age 30 years while 54 % of them are more than 20 years old. Meanwhile installed capacity by age indicated that only 36% of them are more than 20 years old, and 16% of them are more than 30 years old. Energy generated by age indicated that one third of them 33% and 15% are respectively more than 30 and 20 years old. Massive electrical power outage is indicated. Low availability factor of power plant is indicated.

4.2 Actions Taken to Overcome Generation Shortage

4.2.1 Upgrading Generation Power Plant:

Energy is considered as a national security and the political leadership has placed the issue of electric energy within its main agenda as it is the main pillar for development in various fields of economic and social life. An Immediate action has been taken to overcome generation shortage.

- **Fast Track Plan:** Added Capacity: 3636 MW Installed in 8.5 Months, total cost 2.7Billlion $.Egypt Contracted with (GE, Siemens, Ansaldo, Energia) for immediate installation.
- **Completion of under construction Power Plant:** Added Capacity: 4250 MW total cost 3.3 Billion $ from Sep. 2009 – March 2017.
- **3 Mega Project Power plants:** Added Capacity 14400 MW installed in 2.5 years.
- **Energy Efficiency:** plans ended at 2015 with cost of 6 Billion Euro added Capacity 1840 MW without using an Extra Fuel.

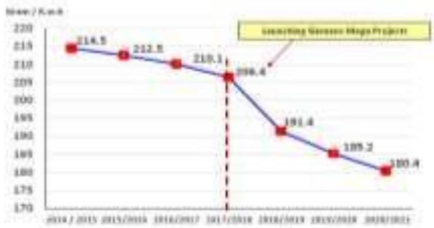

Fig. 3. Reduction in CO2 Emissions **Fig. 4.** Fuel consumption 2014/2015 - 2020/2021 **Source: Ministry of Electricity & Renewable Energy 2022**

Figure (3) indicates reduction in CO2 Emissions in 2020/2021comparing to 2014/2015 is about 21% Figure (4) indicates that the reduction in Fuel consumption in 2020/2021 compared with 2014/2015 is about 16%. Less reduction in Fuel consumption during the period 2014/2015 to 2017/2018 equal 3.78% while the corresponding value from 2017/2018 to 2020/2021 is 13% almost three times. May be due to launching Siemens mega projects is behind.

Fig. 5. Installed Capacities Added from the End of 2014 till the End of 2021

Source: Ministry of Electricity & Renewable Energy 2022

Figure (5) indicated that 1965 mw is added from wind and solar projects owned by private sector, 1840 mw by conversion of simple cycle to combined cycle, 14400 mw from mega power projects in Burulus and Beni Swif, total of 7936 mw (completed under construction 4050 mw + S. Helwan 1950 mw + Walidea Assiut 650 mw + West Cairo 650 mw + NREA projects 606 mw + Assiut Barrage 32 mw) and fast track plan 3636 mw. Total Capacities Added About (29.8 Giga watt). Equivalent to 14 Times the installed capacities from the High Dam.

Fig. 6. Generation performance during the period from 2014 to 2022

Source: Ministry of Electricity & Renewable Energy 2022

Load shedding, Load and available power are shown in figure (6) no load shedding appeared since June 2015, it reached 6000 mw in summer 2014. Peak load was 33.8 GW in August 2021.During 7 years total investment cost of the Generation Power Plants over national Grid exceed: 22 billion$.

4.2.2 Upgrading and Strengthening the National Grid

4.2.2.1 Upgrading the extra high voltage main transmission network

Investigate the impact of the growing demand on the transmission system infrastructure by 2025 and define the corresponding grid development measures. Set a target network topology as a guideline for the short term transmission planning phase. Electricity Sector took An Urgent Majors to Upgrade Transmission Network to Keep Pace with the Generation Capacities increasing and the new Technology Added from Different source of Generation.

Table 1. Total Ultra & High Voltage Substations Capacities

Development Since 2014			
Voltage	2014 MVA	2021 MVA	Added MVA
500 KV	9800	42300	32500
220 KV	40278	67553	27275
66 K.V	44397	63773	19375

Fig. 7. Total Ultra & High Voltage Substations Capacities
Source: Ministry of Electricity & Renewable Energy 2022

- **Situation for 500 KV:** There were 10 Substations with total capacity 9800 MVA in 2014, adding 21 Substations with total capacities 32500 MVA by end 2021 to get 31substation with total capacity 42300 MVA, about 230% of the existing in 2014
- **Situation for 220 KV:** There were 40278 MVA in 2014 adding 27275 MVA to get 67553 MVA by end of 2021
- **Situation for 66 KV:** There were 44397 MVA in 2014 adding 19375 MVA to get 63773 MVA by end of 2021

Table 2. Total Ultra & high voltage transmission lines

Development Since 2014			
Voltage	2014 KM	2021 KM	Added KM
500 KV	3078	7203	4125
220 KV	17360	21396	4036
66 K.V	19300	21003	1703

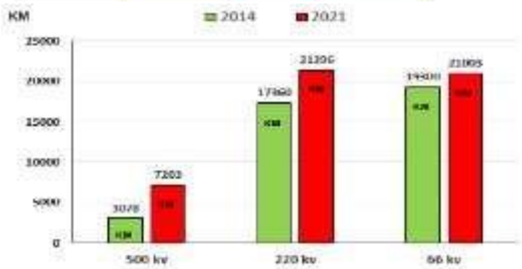

Fig. 8. Total Ultra & high voltage transmission lines

Source: Ministry of Electricity & Renewable Energy 2022

- **Situation for 500 KV;** There were 3078 MVA in 2014 adding 4125 MVA to get 7203 MVA by end of 2021
- **Situation for 220 KV:** There were 17360 MVA in 2014 adding 4036 MVA to get 21396 MVA by end of 2021
- **Situation for 66 KV:** There were 19300 MVA in 2014 adding 1703 MVA to get 21003 MVA by end of 2021.

5 Transition to Renewable Energy

5.1 Integrated Sustainable Energy Strategy to 2035

- Targeting 20% Renewable Energy from peak load by the year 2022 Targeting by the year 2035:
- 42% Renewable Energy from total installed capacity.
- 18% Improvement in Energy Efficiency.

Table 3. Egypt Energy Mix by 2035

Source	Percentage
PV	21.13
Wind	14.04
CSP	5.52
Hydro	1.98
Conventional	57.33
100 %	

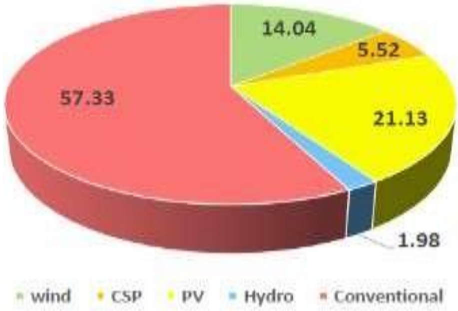

Fig. 9. Egypt's Energy Mix by 2035

Source: Ministry of Electricity & Renewable Energy2022

2035 Strategy has been revised and excluding coal option from the Energy Mix and replaced it by

Renewable Energy using (BOO) Scheme. As indicated from table (3) and figure (9)

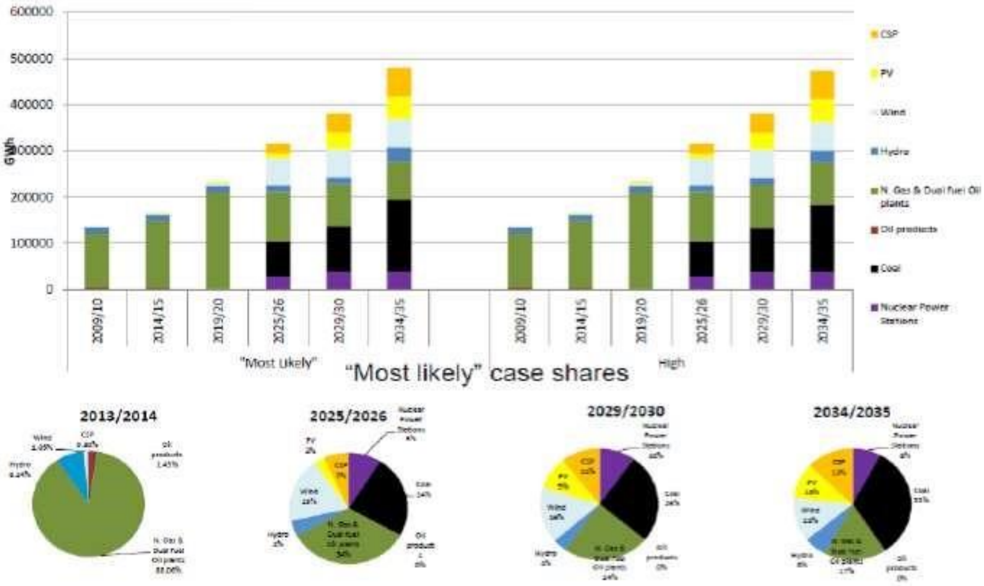

Fig. 10. Egypt's energy Mix by 2035

Source: Ministry of Electricity & Renewable Energy 2022

- Electricity production by plant type is indicated in figure (10). 88% of the electricity production in 2013/2014 was N Gas & dual fuel oil plants. Electricity production by that plant sharply declined to 34% in 2025/2026 and 24% in 2029/2030 and expected to be 17% in 2034/2035, with about 81% reduction during the period 2013/2014 to 2034/2035.
- Both PV and CSP electricity production plant is supposed to start with small percent in 2025/2026 and expected to continue increasing till the year 2034/2035. PV is supposed to start with 3% to reach 9% and 10% in 2029/2030, and 2034/2035 respectively. The corresponding CSP values are 7%, 11%, and 13%, respectively.
- Oil product as an electricity production plant was 2.45 % in 2013/2014 and disappeared with no expectation till 2034/2035.
- Coal as an electricity production plant was 24%, 26% and 33% in the expectations related to the three years 2025/2026, 2029/2030 and 2034/2035 respectively.
- Hydro as an electricity production plant was 8.14% in 2013/2014 and expected to be 4% in both 2025/2026 and 2029/2030, and 65 IN 2034/2035
- Wind as an electricity production plant was .05% in 2013/2014 and expected to be 19% in 2025/2026, 16% in 2029/2030 and 11% in 2030/2035.
- Nuclear as an electricity production plant is expected to start with 9% in 2025/2026 to be 10% and 8% in the years 2029/2030 and 2030/2035 respectively.

6 Preparation for EGYPT's hosting of the 27th Conference of parties on Climate Change COP27

The Energy Wealth Initiative (EWI) seeks to establish a green energy transition platform for Egypt to:

- Accelerate the deployment of renewable energy to lower the cost of energy supply and develop the regional market for decarbonized fuel.
- Accelerate the retirement of inefficient Fossil Fuel plants to abate carbon emissions and free up Egypt's domestic gas resources for sale at global energy price, here by improving the balance of payments.
- Invest at scale in renewable energy, storage and infrastructure, underpinned by ambitious GHG emission reduction commitments to access climate finance from MDBs, private sector and donors.
- Support a just translation (so that the EWI benefits are shared, while protecting vulnerable Regions and people) and develop local supply chains and grids strengthening for renewable energy equipment.

7 Egypt is an Energy Hub

For International Interconnections and Corridors:

- Egypt /Jordan Interconnection 450 MW, March 2021 A framework agreement was signed between Egypt /Jordan to increase interconnection capacity to 1000 M WW.
- Egypt / Sudan: Interconnection (300 MW). (Existing + Strengthen Connection) (Phase 1 In April 2020 Energized with exchange up to 80 MW and will reach 300 MW in the next year (Phase 2 Intended to be raised to 1000 MW
- Egyptian /Libyan Interconnection 150 MW (Existing + under Study Strengthen Connection) Egypt / Saudi Arabia to Allow Exchanging of 3000 MW Egypt, Cyprus and Greece Egypt has the following potentials:
  - Excellent location between three important continents (Europe–Africa–Asia) - Existing interconnection with neighboring countries.
  - Huge renewable energy potential (wind-solar).
  - Electrical energy surplus.
  - Strong extra high voltage transmission network - Strong local manufactured electrical systems.

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Energy transition and energy insufficiency in the country

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Abstract:

While the West is facing electricity shortage due to resources, the need for consumption has increased the demand in the market. With the trend of increasing demand and even higher consumption, the need for maximum utilization of natural resources has led governments to undertake intensive actions in order to ease the burden on the electric power system. While the EU has accelerated the process of its energy transition after the new challenges that the new world order is facing, Kosovo is doing its best to align the energy market with Albania on one hand, and to create the necessary infrastructure for the generation of energy from renewable sources on the other hand. This is intended to be achieved through the 2022-2031 Energy Strategy, which gives special importance to renewable energy sources for improving energy supply and reducing the level of pollution from power plants. This paper will address the energy transition process, through which the energy insufficiency in the country will be overcome, while scientific views will be given on the possibilities and capacities available from these sources. In addition, the issue of energy insufficiency will be addressed as a potential threat in relation to international agreements, specifically with the European Network of Transmission System Operators (ENTSOE).

Keywords: Transition, energy insufficiency, energy strategy, renewable resources, ENTSO-E, power system.

Introduction

Developed countries are facing energy insufficiency to cover their internal consumption and import needs are increasing. The sustainable development of the economy, on the other hand, is getting harder, because the energy dependence on imports endangers the proper functioning of the economy market itself. This has made it necessary to look at all alternatives so that the insufficiency is covered with complementary methods, which would ensure the coverage of the gap between consumption and production. Accelerating the energy transition plan, on the other hand, is being seen as an opportunity that would have a positive impact on such situations, especially in times of crisis, when securing energy imports on international markets has become very challenging for countries that, in terms of budget capacities, are limited, therefore, the insufficiency for them, including here in Kosovo, implies the undertaking of more drastic actions, that of reductions, which by effect have a direct impact on the local economy [1].

This scientific paper addresses the steps taken so far to enable energy stability, including energy coverage, and will focus on the importance and contribution of the energy transition to the proper functioning of the energy system as a whole. The energy transition that Kosovo has already started, supported by institutional and geo-political policies, including here the cooperation with Albania for energy exchange, is enabling the increase in consumption at the country level to be balanced [2]. Consequently, the energy effect is resulting in a stable supply of electricity. But this does not mean nor does it guarantee long-term energy stability, without the creation of new generating capacities, which would be made available to cover local consumption, especially at peak times, when consumption demands exceed domestic production. The support of internationals, on the other hand, is a good opportunity for the country to further accelerate the energy transition process, towards the generation of electricity from renewable sources, which by their role, apart from contributing directly to the energy system, at the same time they enable the reduction of the emission of greenhouse gases and carbon dioxide [1] [2].

Materials and methods

Kosovo, 22 years after the war, is still facing significant problems in the energy power system, even though the power supply has improved and stabilized significantly compared to the first years after the war when power cuts, systematic reductions and the noise of individual diesel generators were part of everyday life. The improvement of this situation has had a direct impact on a series of actions undertaken such as: regular maintenance and repair of units in TPP Kosovo A and B, investments in the transmission and distribution network, direct investments in the opening of the southwest mine of Sibovci, the re-functionalization of existing small hydropower plants, the privatization of the distribution and supply network, the reduction of technical and non-technical losses, the most favorable prices in the regional electricity market and the improvement of the legal and regulatory framework [1].

Despite the large investments in this sector and the improvement of the situation in the electricity system, Kosovo still remains an importer of electricity and faces major problems from the point of view of providing the necessary capacities to cover the maximum demand for energy (peak), which is especially needed during the winter season. A special problem is the fulfillment of the requirements of the necessary reserve capacities and the regulation of the stability (balancing) of the electric power system as a whole.

For sustainable economic and social development of the country, based on the contemporary demand for electricity, the uninterrupted supply of sufficient quantity and quality of electricity is a necessary requirement. For this very reason, the regular supply of consumers in Kosovo (individual, commercial and industrial) with qualitative and quantitative energy represents a great challenge for all parties involved in this issue. The solution to this complex problem is not simple, quick and easy, because it depends on many factors [3].

In this paper, the alternatives and real possibilities of Kosovo for meeting the demand for electricity are analyzed, including the environmental aspects of each alternative. Previous studies carried out by the European Commission, the World Bank and other donors have concluded that the production of electricity from lignite in Kosovo is the least expensive option compared to other options so that the entire country can meet the needs of own for energy supply [4] [5]. The most sustainable and cost-effective solution is the construction of new generating capacities based on local lignite reserves, followed by the construction of modest capacities from renewable energy sources (RES). Kosovo has significant potential for the use of renewable energy sources as a secondary source of energy in the country. Unfortunately, this sector is not so developed in the country, and consequently Kosovo relies on imported energy to cover the needs during the intervals of the day. The country has faced many challenges in attracting and enabling investments in this field, despite the existence of legal infrastructure.

As a signatory of the Energy Community Treaty, Kosovo had objectives to reach a certain percentage of RES energy in the total energy consumption by 2020. The National Plan set Kosovo a target of 25%, while an internal Administrative Instruction (UA 01/2013 of MZHE) had set an even higher target of 29.47%.

The total installed capacity for energy from RES in Kosovo is currently around 250 MW, while the draft energy strategy envisages the development of new wind and photovoltaic RES capacities, to reach a total installed capacity of RES- of at least 1400 MW (including here 100 MW of the capacity of self-producing consumers) until 2031, with the possibility of increasing this target if such a thing is possible [1] [2].

Considering the trends in this sector, this aim seems very ambitious in terms of energy generated by RES. To encourage the use of RES, Kosovo, through the Energy Regulatory Office, has developed a support scheme of "feed-in" tariffs for energy from water, wind, photovoltaic energy and biomass. These fees may be changed on an annual basis by ERO [6].

Figure 1 shows the participation of generators in the production of electricity during 2020.

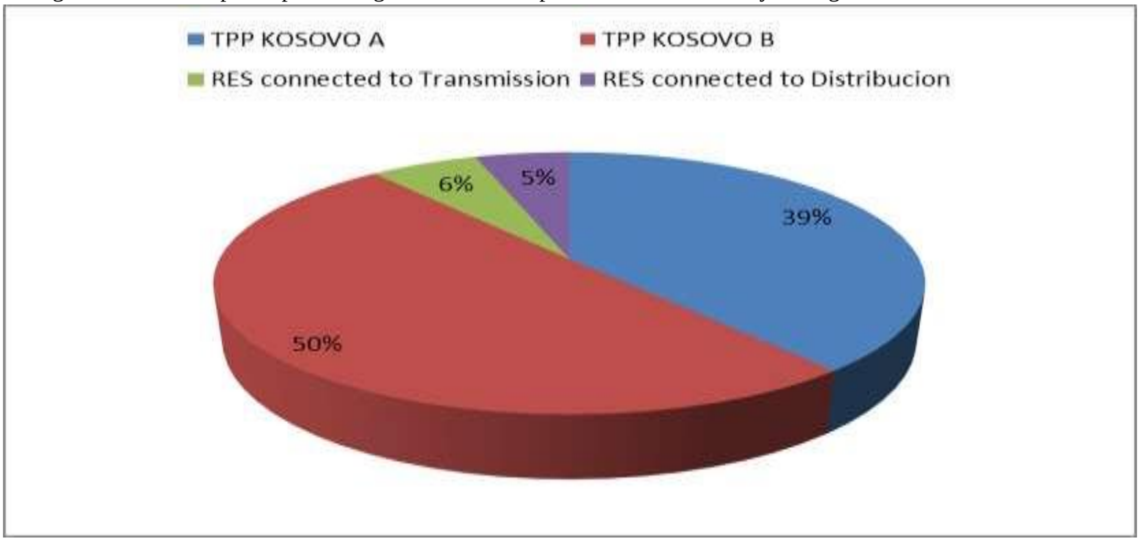

Figure 1. Participation of generators in electricity production during 2020.

Results and discussion

Removing barriers to the efficient operation of the market through market integration with Albania until 2023, integration into the pan-European market area until 2023 and the gradual removal of the Wholesale Supply Agreement, starting in 2025 at the latest, will have a direct impact on the proper functioning of the energy sector in the country, because through the undertaking of such steps, energy stability will be achieved, thus influencing the reduction of energy insufficiency, as a result, local consumption will be met through local capacities production, having no need for import [2]. This will also have an impact on sustainable economic development, because through cooperation and the creation of a common market, generating capacities will be able to be exchanged in case the need arises. Meanwhile, with the surplus created by the new capacities, it will be possible to offer them in the foreign market, thus creating financial stability for the country, as additional opportunities for new investments in the energy sector will be created. Such actions, as much as they may seem very ambitious, there is a serious institutional and international attitude to fulfill these objectives, since in addition to the local institutions that have taken the commitment to increase the coverage by RES, the international factor itself is being a strong important supporter in this direction. However, it should be borne in mind that Kosovo continues to depend on natural reserves of lignite, which also constitute the highest level of resource used for electricity generation, which means that the complete transition from coal reserves to renewable sources, will take time and of course large capital investments to enable such a transition [1] [2].

Conclusion

The energy situation in the country continues to be serious. This was highlighted even more during the current energy crisis, which showed the many problems in energy generation, considering that Kosovo continues to depend on the production of electricity through TPP Kosovo A and PP Kosovo B, which due to their age have reached a rather large lifespan and as a result their depreciation has reached the critical point, when not infrequently, they go out of operation precisely because of obsolescence.

The investments planned through the draft energy strategy of Kosovo aim to reduce the dependence on energy production through TPP Kosovo A and B, to rehabilitate them and gradually switch to energy production from RES, which in terms of impact, will have a directly positive effect also in relation to nature.

In addition, the common market with Albania and the new policies of the energy sector will reduce the services dissatisfaction in relation to the consumer and increase energy stability in the country. Ideally, the reliability of an energy system from the point of view of consumers means an uninterrupted supply of energy from the generation, transmission and distribution systems. Renewable energy ultimately transforms from an ideal and vision for the future, to a pressing demand for policymakers' desks.

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Environmental protection through the application of new technologies

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Abstract: In recent years, global warming is becoming an essential and very important issue in terms of daily national and international policies. All these issues are closely related to the general developments on the planet and are also closely related to the development of science and technology. The increase in population has increased the need for more products and with this the development of industry and the development of technology. This rapid development many times and continuously has had impacts in various aspects on the increase of pollution in the living environment, air, land, and water. Using of various information technology devices and mass communication tools has a significant impact on our daily life and also on the environment. The technological changes in IT that have occurred in the last 20 years have caused millions of units to be thrown away as useless equipment without the possibility of recycling.

The need for the production of construction materials, energy production, the use of fossil materials, etc. condition the emission of a large number of gases in the air such as CO_2, SO_2, NO_x, and other greenhouse gases which directly affect global warming and the destruction of the Ozone layer in the atmosphere. Even other daily activities such as construction, agricultural activities, use of various chemicals to increase yield, hygiene, and health, all together contribute to the pollution of air, soil, and water and thus to global warming.

Keywords: Environment, Global Warming, Industry, New Technologies, Pollution.

Introduction

When we talk about the environment, we must mention some factors that directly affect the environment, respectively the environment that surrounds us. Starting from the increase in the number of inhabitants, which has reached almost 9 billion inhabitants to exist in life we need a high utilization of natural resources and with this also a high utilization of energy, the creation of waste and garbage, which, in one way or another, all affect the increase in environmental pollution. Considering the needs for housing and the rapid development of the construction industry and taking as an example only the increase in the needs for the production of cement which in 2020 has reached 5000 Mt/year [1] and with this the release of CO_2 only from cement production has reached 2350 Mt/year. Due to the daily needs, the production of energy has also increased a lot and in the year 2020 it has reached 500 EJ/year [1] and that most of this energy is produced by fossil fuels, which also results in the production of CO_2.

The development of science and technology has caused, however, the amount of energy, fuel, and the use of raw materials to decrease and with it the reduction of the production of greenhouse gases and the smaller use of human resources and sustainable development.

While the impact of technology on the environment was very negative, the concept of environmental technology can save our planet from the damage that has been done. As technology is a choice it is also part of the problem.

1.1. New technologies

Recently, the negative impact of technologies on the environment is a global concern due to climate change. This has influenced the development of new environmental technologies which are intended to help solve some of the biggest environmental concerns we are facing as a society during these years. This is aimed at shifting toward sustainable development, and a low-carbon economy. Technologies that help the environmental issue are also known as green technologies or clean technologies and refer to the development of new technologies that aim to preserve, monitor, or reduce the negative impact of technology on the environment.

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2 ºC, preferably to 1.5 ºC, compared to pre-industrial levels [4]. The above-mentioned agreement has led almost every country in the world to strive to combat climate change by keeping the increase in global average temperature to less than 2°C above pre-industrial levels. The focus on the positive impact of technology on the environment will be as a result of the development of new environmental technologies such as renewable energy, smart technology, and electric vehicles and through them the reduction of greenhouse gases.

Environmental pollution in Kosovo, cement factory

2.1. Production of CO_2, SO_2, and NOx as a by-product of cement production and environmental pollution During the production of cement, materials with a carbonate composition were used as raw materials, which decompose into CaO and CO_2 during baking. Raw material enters into the rotary furnace where the temperature is about 1250-1350 ºC and is transformed into the mid-cement product called clinker. Content $CaCO_3$ in the raw material is 74%-76% and $MgCO_3$ is about 2 to 3%. The Rotary furnace caries following chemical reactions [8]:

$$CaCO_3 + heat \rightarrow CaO + CO_2 \qquad (1)$$

$$MgCO_3 + \text{heat} \rightarrow \text{MgO} + \text{C} \qquad (2)$$

If we start calculation from the atomic masses of these compounds we will have:

$$CaCO_3 + \text{heat} \rightarrow CaO + CO_2$$

(3)

$$100gCaCO_3 \rightarrow 56gCaO + 44gC$$

(4)

Otherwise expressed in tones would be:

$$100tCaCO_3 \rightarrow 56tCaO + 44tCO_2$$

(5)

For our calculations, we perform material balance as a condition that the capacity of the furnace is 100 tons per hour, for ten months per year, and 30 days per month with 24 hours. So, the annual amount of $CaCO_3$ within a year which is processed is:

$$mCaCO_3 = 100\ \frac{t}{h}\ X\ 30day\ X\ 24h\ X\ 10month\ X\ 0.76 = 547.200t \qquad (6)$$

Since we will have the annual amount of carbon dioxide that is released from the raw material:

$$mCO_2CaCO_3 = \frac{547200 \times 44}{100} = 240.768t \qquad (7)$$

In the same way, can be calculated the amount of carbon dioxide released from the Magnesium Carbonate ($MgCO_3$).

The total amount of carbon dioxide:

$$\sum mCO_2 = mCO_2CaCO_3 + mCO_2MgCO_3 = 250.196,57t \qquad (8)$$

From equation 10 we can see that within a year during the processing of raw material in the rotary furnace it will be released 250.196,57 ton/year of CO_2.

In this case of the emission of gases in this plant, so chemical reactions can write as the following:

$$C + \frac{1}{2} O_2 \rightarrow CO$$

(9)

$$C + {}^{1}2\ O_2 \rightarrow CO_2$$

(10)

$$S + O_2 \rightarrow SO_2$$
(11)

Table 1. Composition of fuel

Parameter	Unit	Value
Dynamic viscosity on 800ºC	Pa s	45.1
Flashing point	ºC	176
Content of coke	%	9
Sulfur content	%	2.8
Carbon content	%	87.5
Volatile matter	%	11.48
High calorific value	MJ/kg	41.6
Low calorific value	MJ/kg	40.5

In consideration that the capacity of the fuel within an hour is 2.85 t/h, and petroleum coke 2, 55 t/h we will have:

$$12tC + 32tO_2 = 44t\ CO_2 \quad (12)$$

From Table 1 we can see that carbon in oil composition is 87.5% and knowing that within an hour we consume 2,55t/h of fuel, we will find the annual amount of carbon dioxide released.

$$mC_{Fuel} = 2{,}55\ \frac{t}{h} \times 0{,}875 \times 24h \times 30day \times 10month = 16.065t \quad (13)$$

So, the annual amount of carbon that is derived from fuel ($m_C$fuel) is 16065t.

Now we will calculate the amount of carbon from petroleum coke. From table 2 we can see that the composition of carbon in petroleum coke is 85.5%, knowing that within an hour we will consume 2.85 t/our petroleum coke, in the same way, we will calculate the amount of carbon from the petroleum coke.

$$mC_{petrol\ coke} = 2{,}85\ \frac{t}{h} \times 0{,}855 \times 24hour \times 30day \times 10month = 17.544{,}6t \quad (14)$$

So the annual amount of carbon that is derived from petroleum coke ($m_{petrolcoke}$) is 17,544.6 tonnes. By collecting equations (13) and (14) we will have the total amount of carbon.

$$\sum mC = mC_{mazut} + mC_{petrolcoke} = 16.065t + 17.544{,}6t = 33.609{,}2t \quad (15)$$

From equation (15) we can see that the total amount of carbon (mC) which is derived from mazut and petroleum coke, and which serves as fuel for ripening the clinker is 33.609,6 tons. By burning this amount of carbon, we will have the amount of carbon dioxide that is produced during a year.

$$mCO_2 = \frac{33609{,}6t \times 44t}{12t} = 123.235{,}2t \quad (16)$$

The total amount of quantity of CO_2 that is produced from the plant within a year is:

$$mCO_2 = mCO_2Raw\ material + mCO_2fuel \quad (17)$$

Equivalent to:

$$\sum mCO_2 = 250.196{,}57\ t + 123.235{,}2\ t = 373.431{,}77\ tone\ per\ year \quad (18)$$

From equation (18) we can see that the cement factory will release 373.431,77 tonnes CO_2 per year.

Table 2. Composition of petroleum coke

Parameter	Unit	Value
Humidity	%	0.68
Ash	%	0.65
Sulfur content	%	4.57
Carbon content	%	85.5
Volatile matter	%	11.48
High calorific value	MJ/Kg	20.34
Low calorific value	MJ/Kg	19.89

From table 2 we can see that the composition of sulfur in mazut is 2.8 % the annual amount of sulfur dioxide (SO_2) emit (released) from mazut is:

$$mS_{fuel} = 2{,}55t \times 0{,}028 \times 24hour \times 30day \times 10month = 514{,}08t \quad (19)$$

From table 2 we can see that the percentage of sulfur in petroleum coke is 4, 57%, and knowing that within an hour we will spend 2.85 t petroleum cokes we will have:

$$mS = 2{,}85 \times 0.0457 \times 24hour \times 30day \times 10month = 937{,}764t \quad (20)$$

The total amount of sulfur dioxide (SO_2) emitted from the cement factory is:

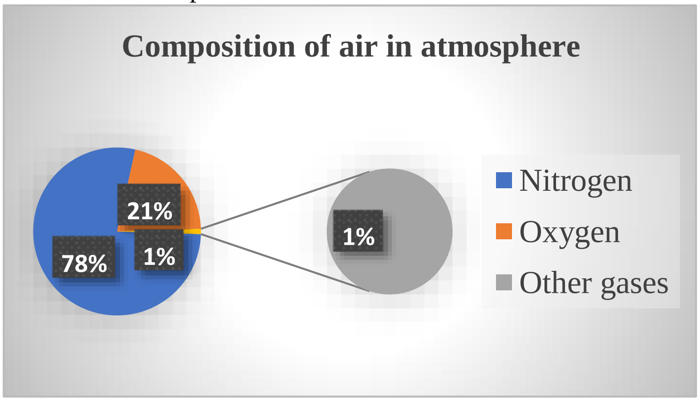
$$\sum mS = mS_{fuel} + mS_{petrolcoke} = 514{,}08t + 937{,}764t \quad (21)$$

$$\sum mS = 1451{,}8t \quad (22)$$

The total amount of SO_2 released within a year.

$$mSO_2 = \frac{1451{,}8t \times 64t}{32} = 2903{,}7t \quad (23)$$

Table 3. Composition of air in the atmosphere



NO_x generally includes NO and NO_2, and it causes serious problems not only in the environment but also in the human body owing to chemical reactions in the atmosphere. Typically, it causes adverse environmental effects such as photochemical smog, acid rain, global warming, fine dust, and soil contamination due to nitrate, which in turn can cause diseases in the respiratory tract and heart due to lung damage. NO_x is mainly generated from nitrogen present in the air during cement production under high-temperature combustion conditions and also when the nitrogen contained in the fuel is oxidized. In addition, the nitrogen present in the feed material combusts, or pre-existing free radicals react with the nitrogen in the air [12].

From table 3 we can see that the composition of Nitrogen (N_2) in the air is 78 % of the annual amount of oxides of Nitrogen (NO_x)[13] emitted (released) from a rotary furnace are:

$$2N_2 + O_2 \rightarrow 2NO + 2N$$

(24)

$$N + O_2 \rightarrow NO + O$$

(28)

During the experimental measurements we came to the following results:

Table 4. Amount of NO_x per month

Mar-18	NO_x (mg/m^3)	Apr-18	NO_x (mg/m^3)	May-18	NO_x (mg/m^3)
1	574	1	513.77	1	572.67
2	554.15	2	529.92	2	563.4
3	584.73	3	461.96	3	562.37
4	588.88	4	440.51	4	527.25
5	586.12	5	450.75	5	502.93
6	582.84	6	444.23	6	475.79
7	577.73	7	466.7	7	461.35
8	563.47	8	475.72	8	464.45
9	570.56	9	485.47	9	470.02
10	565.02	10	493.59	10	478.47
11	553.64	11	493.94	11	478.99
12	553.87	12	500.39	12	478.79
13	519.01	13	500.06	13	486.25
14	522.76	14	499.12	14	494.64
15	521.31	15	502	15	497.14
16	518.84	16	50.13	16	494.14

17	516.73	17	508.64	17	490.06
18	513.34	18	506.22	18	484.64
19	496.18	19	499.21	19	480.65
20	498.01	20	496.83	20	476.1
21	487.71	21	490.47	21	474.58
22	484.91	22	489.95	22	472.93
23	490.97	23	490.1	23	473.45
24	495.61	24	491.63	24	472.73
25	499.79	25	495.69	25	472.21
26	498.23	26	495.41	26	473.58
27	498.23	27	493.89	27	474.64
28	500.11	28	492.66	28	478.25
29	502.38	29	492.63	29	480.59
30	503.06	30	491.81	30	485.26
31	501.81			31	486.74

2.2. Methods of reducing NO_x emissions in cement kilns

NO_x reduction in cement kilns is achieved by limiting the nitrogen oxidation reactions that generate NO_x. The reduction of nitrogen oxides in the cement industry is carried out in two ways:

- → Primary methods
- → Secondary methods.

Reduction by primary methods is mainly carried out by optimizing the process and equipment such as:

- → Flame cooling
- → Operation under reducing conditions.
- → Operation of Low NO_x burners where technology allows.

Primary methods achieve only a marginal reduction of nitrogen oxides and their impact is limited. Sharrcem's technology is relatively old and there is no preheater equipped with a calciner that enables the operation of low NOx burners or the creation of a reducing atmosphere in the preheater furnace system. The only option allowed by the factory technology is the installation of a flame cooling plant.

This system includes an atomized water line that sprays at the top of the burner as well as the corresponding pump and reservoir. The system also communicates with SCADA (Supervisory Control and Data Acquisition), the factory's automatic control system to be activated when the process is interrupted.

Secondary methods

Secondary NOx reduction methods include selective non-catalytic and catalytic methods. Mainly in the cement industry, the selective non-catalytic method (SNCR) is used.

The non-catalytic selective method consists of injecting urea or ammonia solutions at certain points of the furnace-preheating system where the temperature range is suitable for injection and the reduction reaction has the maximum yield.

Using this method, a reduction of several hundred mg NO_x/m^3 can be achieved. The selection of solution for injection is determined by the profile of temperatures in the preheater, technical conditions as well as the availability of reducing solutions in the country or region. Technical conditions and availability determine the need for a plant for the preparation of solutions or the provision of ready-made solutions from the market. Currently, ammonia solutions with a concentration of about 10% and urea with a concentration of about 25% are used.

SNCR installations are very expensive and have a high operational cost. The installation of this technology exceeds 1 million Euro and the operational costs are approximately 1 EUR/t of clinker. The process of determining the plant, selection, and installation is relatively long as it requires the engagement of highly specialized companies in this field.

Conclusions

With the purchase of the latest technology by the Sharrcem LLC Factory in Hani Elezit, the amount of air pollution has been reduced and the allowed parameters of environmental pollution have been kept under control. Air pollutants are introduced into the atmosphere from various sources which change the composition of the atmosphere and affect the biotic environment.

The concentration of air pollutants depends not only on the quantities that are emitted from the sources of air pollution but also on the ability of the atmosphere to absorb or disperse these emissions. Sources of air pollutants include vehicles, industry, indoor sources, and natural resources. There are some natural pollutants, such as natural fog, particles from volcanic eruptions, pollen grains, bacteria, and so on.

Dust, noise, safety risks, landscape alternation by using raw materials, air emissions, and energy and water consumption are issues related to our day-to-day performance. For this reason, Sharrcem LLC is committed to actions that reduce the operational impact on the environment. Sharrcem LLC complies with all national regulations on environmental protection in the Republic of Kosovo. Some recommendations made to us are:

- → Treat the discharge water of the extraction and processing industry, even though the industrial water in Sharrcem LLC is recirculated in addition to water for sanitary needs,
- → In continuous identification of polluted areas above the maximum allowed values and drafting programs for their rehabilitation,
- → Implement standards on maximum permissible values of pollutants,
- → Improvement in the continuous technological process,
- → Functioning of the national system for air quality monitoring and,
- → Undertaking legal measures and sanctioning these activities following the law on environmental protection.

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Formulation of the Low-Voltage Ride-Through Curve for Wind Power Integration into Albanian Power System

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Abstract. The aim of this study is to formulate a Low-Voltage Ride-Through (LVRT) curve fitting for the Albanian Power System (APS) by studying short circuit scenarios and times of short circuits in power grid after integration of 50 MW wind power plant. This LVRT curve may help to smooth the effects of operation actions in the wind turbines on the APS. The power system was modeled based on its real technical parameters using Power System Simulation for Engineering (PSS/E) software. It is seen that the formulated LVRT curve prevented the decoupling of the Wind Turbines (WT) and grids during faults, reduced voltage dip, and the system recovered the stability shortly after the fault cleared.

Keywords: Wind power, LVRT curve, Renewable energy, Power system.

Introduction

Many countries have shifted their attention to exploiting renewable energies to reduce the dependency on conventional power generation (thermal units). Based on the Global Wind Energy Council publication for the year 2021, the total installed capacity worldwide was 837 GW, and the installed wind power capacity in 2021 was as high as 96.3 GW [1]. According to the International Renewable Energy Agency (IRENA) estimates, Albania could install around 600 MW of wind and solar power by 2030. Renewable energy (wind and solar) potential in Albania is estimated at over 7 GW [2].

The Republic of Albania's energy sector is almost renewable and has one of the largest shares in the region. Hydropower represents 95% of the country's installed power capacity. The Albanian government has launched the National Renewable Energy Action Plan to diversify energy resources, where wind energy is an important part. The connection of wind power to power systems may face several technical challenges. To overcome these challenges in many countries are developed several standard operating procedures to connect the wind farms with power grids. Consequently, the LVRT curve has become an important subject for wind power engineers and researchers. The LVRT is a practice in making continuous connectivity of WTs during the grid faults [3].

The aim of this study is to formulate a Low-Voltage Ride-Through (LVRT) curve appropriate for the Albanian Power System (APS) by studying short circuit situations and times of short circuits in power grid after integration of a 50 MW wind power plant.

The paper is organized as follows. In Section II, the Power System Simulation for Engineering (PSS/E), the power system under study description, and the simulation method are discussed. The simulation results are discussed in Section III. Finally, in Section IV, a summary of the main conclusions and findings of this paper is presented.

Materials and methods

PSS/E software

The PSS/E software is a power system simulation tool projected for studies of transmission, generation, and distribution systems in steady-state and dynamic situations. PSS/E has been extensively used by many scholars in studies of power flow, short circuits, contingency analysis, transient stability, harmonics, etc. [4], [5], [6], [7], [8], [9], [10].

The single-line diagram (SLD) of the APS is shown in Figure 1 [11]. The generation units are modeled as GENSAL (Salient Pole Generator Model), their exciters are ESST2A and EXPIC1, and the turbine governors are IEEEG3. Based on the PSS/E libraries, the wind turbines are modeled as WT4G1 and WT4E1 [12]. The technical parameters of the APS studied in this paper are real.

The Power System Description

The Albanian transmission system consists of 110 kV, 150 kV, 220 kV, and 400 kV voltage levels. The APS is synchronized with the European Network for Transmission System Operators for Electricity via 150 kV and 400 kV transmission lines to Greece, 220 kV and 400 kV to Montenegro, and 220 kV and 400 kV to Kosovo.

According to the Energy Regulatory Authority, the total electricity consumption of Albania reached 8,414,836 MWh, at the end of 2021. The total electricity generation was mainly dependent upon hydro resources, while wind and solar are in the first steps of installation [13].

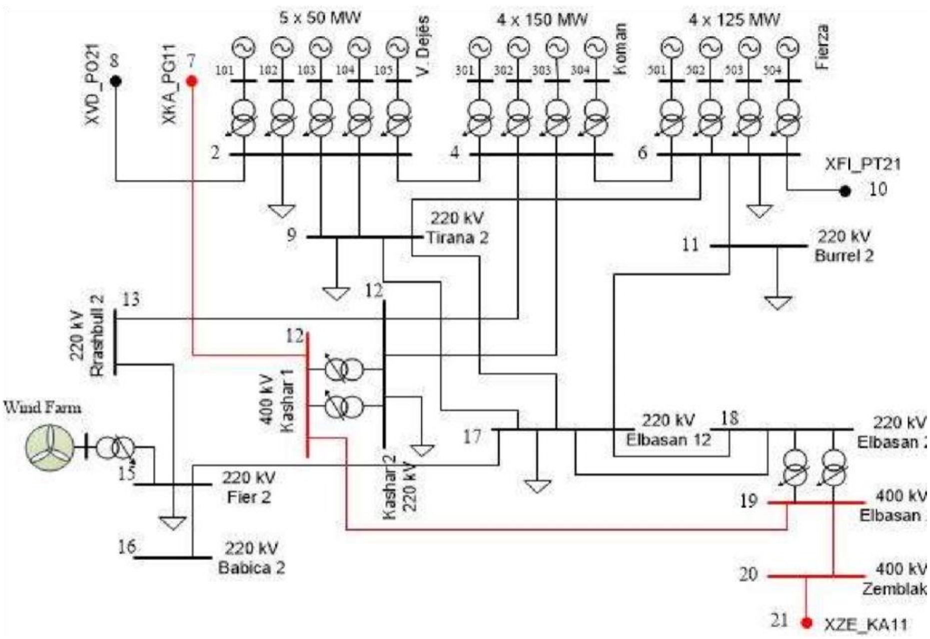

Fig. 1. The SLD of the APS.

The APS shown in Figure 1 comprises exactly 13 buses at 220 kV voltage level, 5 buses at 400 kV voltage level, 13 generators (hydro generators) of 1350 MW installed capacity, 11 electrical loads of 1148.23 MW and 290.23 MVAr, 24 branches (220 and 400 kV), 4 three-winding voltage transformers, 13 two-winding voltage transformers, etc. The main power generation capacities are concentrated in the north of the country. The wind farm suggested and studied in this research work is connected at 220 kV (Fieri substation) voltage level.

Results and discussions

An onshore wind farm with a 50 MW installed capacity is discussed in this study and the low-voltage ride-through (LVRT) curve for the proposed wind farm integrated into the Albanian Power System is formulated based on simulations results. The Fier (Bus 15) substation is chosen as the connection point, as depicted in Figure 1. The wind turbine considered in this study is Type 4. The Type 4 WTs are variable speed with full converter interface.

The voltage was raised from 0.69 kV to 35 kV through a dedicated transformer and was then raised again from 35 to 220 kV through a substation.
According to the results obtained from simulations, when the bus 15 fails, the terminal voltage of the proposed wind farm is almost 7.7 kV/ 0.035p.u, thus, the WTs will be capable to connect the power system within a period.

Table 1. The terminal voltage during a fault at Bus 15.

Bus fault	Transmission line tripped	Terminal voltage (p.u)
15 Fier	Fier 15 – 13 Rrashbull	0.035
15 Fier	Fier 15 – 17 Elbasan 12	0.035

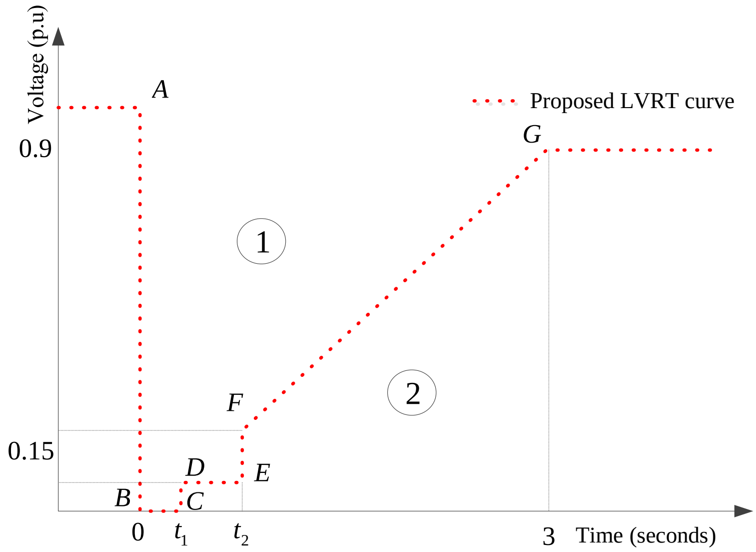

Fig. 2. The proposed LVRT curve.

The stable voltage recovery time (VRT) is related to the fault clearing time (FCT). It is a well-known fact that the longer the FCT, the longer the stable recovery time [14]. If the FCT is too long, the voltage collapse may be occurring, and as a consequence, the power system cannot return back at its normal operation. Therefore, it is needed to consider whether the terminal voltage of the WTs can recover its stability during fault when plotting the LVRT curve [14].

The maximal fault time is accepted to be 0.625 seconds for simulations and the terminal voltage is observed. Based on the voltage behavior the LVRT curve is formulated. In Figure 2 is shown the proposed LVRT curve in this research paper. There are two zones; The Zone 1, where WTs remain connected to the grid and Zone 2, where WTs are disconnected. Throughout the simulations we have determined the points AB-C-D-E-F-G. The simulation processes are as follows:

Step 1 - The faults happen at the time t □0(A-B).
Step 2 - The time duration when the voltage is 0 p.u (B-C).
Step 3 - The minimum voltage magnitude for several fault durations (D-E).
Step 4 - The LVRT curve is retained according to international grid codes (F-G).

Table 2. The influence of fault clearance times on wind farms connected to PCC.

Bus fault	Name	Voltage (kV)	Fault Clearing Time (seconds)					
			0.1	0.15	0.2	0.25	0.5	0.625

Bus 9	Tirana 12	220	□□□□□□
Bus 11	Burrel	220	□□□□□□
Bus 12	Tirana 22	220	□□□□□□
Bus 13	Rrashbull	220	□□□□□□
Bus 15	Fier	220	□□□□□□
Bus 17	Elbasan 12	220	□□□□□□
Bus 18	Elbasan 22	220	□□□□□□
Bus 14	Tirana 21	400	□□□□□□
Bus 19	Elbasan 21	400	□□□□□□
Bus 20	Zemblak	400	□□□□□□

To conduct this research several faults in different time periods are carried out. Table 2 shows when different buses of the grid fail, and whether in the Point of Common Coupling (PCC) the voltage will recover to 90% of its nominal value within three seconds. Based on the results, the wind farm continue to operate in grid-connected for 0.1 seconds in the time when a fault occurs, this is, point C in Figure 2. The minimum voltage should be 0.121 at point D, and the length of time should be 0.625 seconds from D to E. All points are linked to shape the proposed LVRT as in Figure 2.

Figure 3 shows several simulation scenarios to observe the voltage behavior at the PCC for different length of time. Based on the voltage variation is structured the LVRT curve.

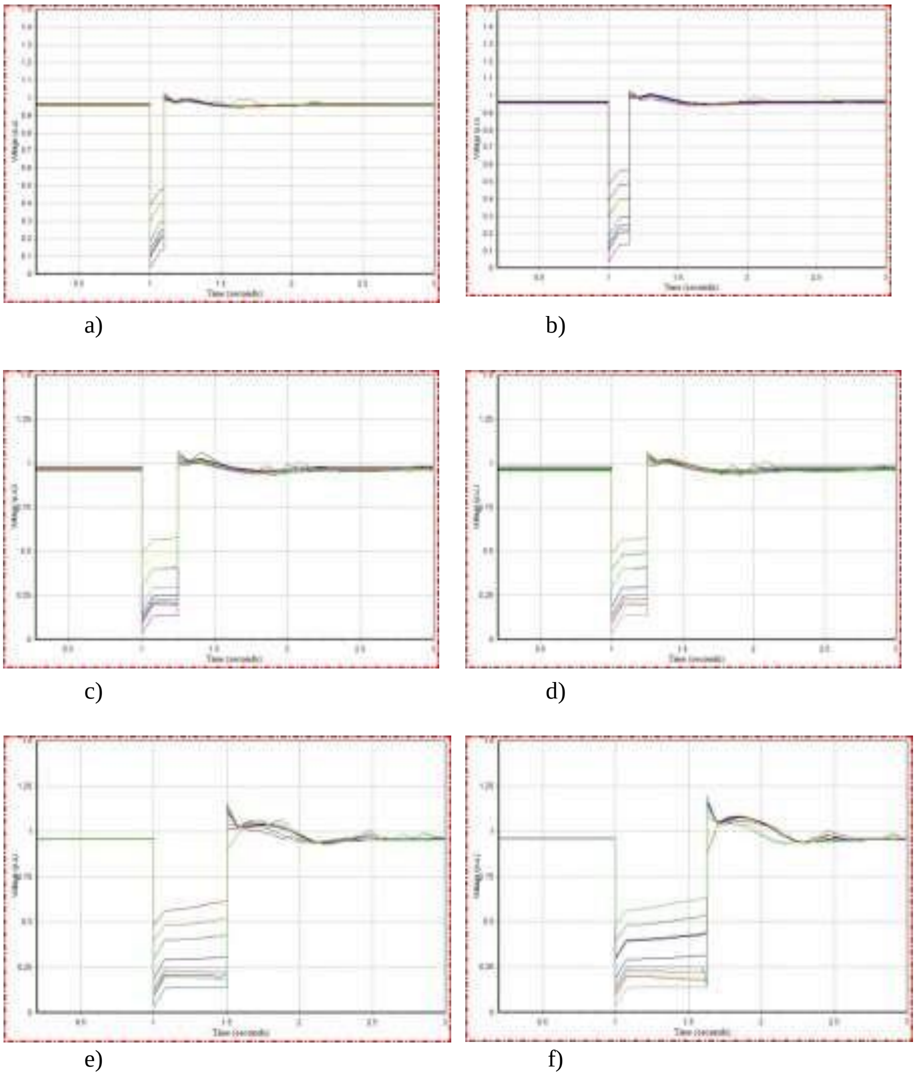

Fig. 3. Simulation fault scenarios: (a) 0.1; (b) 0.15; (c) 0.2; (d) 0.25; (e) 0.5; (f) 0.625 seconds.

Conclusions

In this paper is presented a study on a 50 MW wind power farm integrated into Albanian Power System (Fieri substation) aiming to formulate the LVRT curve. In order to formulate the LVRT curve several short circuit scenarios and short circuit times are considered. The proposed LVRT curve prevents the wind turbine disconnection from the grid during faults (3-phase short circuit in this case), reduces the voltage dip, and the system recovers its stability in a short time after the fault is removed. This research paper may be a reference for power system engineers in the future.

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Integration of Photovoltaic Energy in the Electricity System of Kosovo

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Abstract

Small-scale electricity generators such as photovoltaic (PV) systems are generally connected to the grid in primary or secondary distribution and are considered distributed. Often, these small-scale renewable generators cannot be connected directly to the grid. Generation technology requires the use of an integration between the generator and the utility distribution network. This paper describes the most common issues and challenges encountered during the grid integration of small-scale photovoltaic power systems. The main problems and appropriate solutions are also highlighted in this paper. These include technical issues and power quality issues as primary issues and economic and research issues as secondary issues. Grid-connected photovoltaic systems have grown dramatically in recent years due to increased global interest in renewable energy sources and increased energy demand. As a consequence, new and modern control strategies must be implemented to improve the efficiency, reliability and stability of grid-connected PV systems. To achieve this, the entire PV system must be tested under different weather and grid conditions. However, the large variety of PV system devices and control algorithms, in addition to the destructive nature of many types of scenarios and faults, make practical PV system testing very difficult, very expensive, and in many cases impossible. The simulation results show that the model is reliable, stable and suitable for the study of grid-connected PV system.

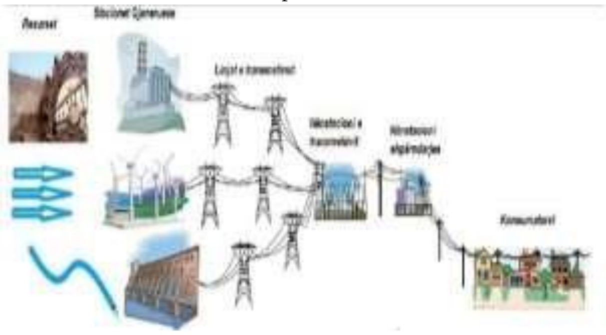
INTRODUCTION

Electricity generators such as photovoltaic (PV) systems are generally connected to the grid in primary or secondary distribution. Often, these renewable generators cannot be directly connected to the grid, so integration between the generator and the distribution network is required. The paper deals with the most common issues and challenges encountered during the grid integration of photovoltaic systems related to appropriate technical solutions and energy quality issues as primary issues and secondary issues and research and economic ones. In recent years, equipment for generating electricity from renewable sources has begun to be installed. Of course, these types of energy have their own advantages, but they also have challenges in their integration into the network and coverage of consumption.

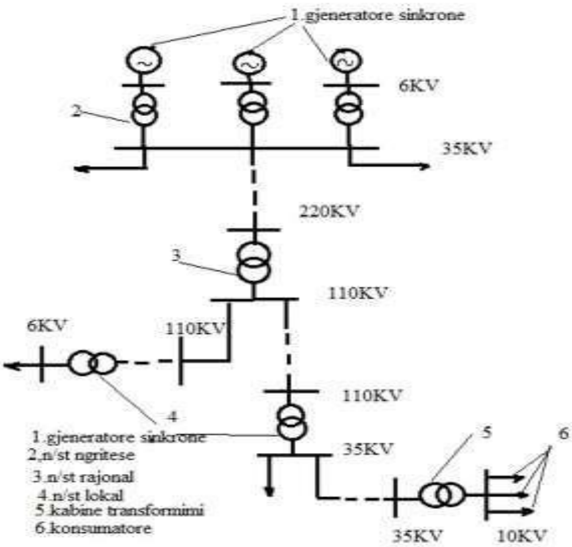
1.Electricity System of Kosovo

The Electricity System of Kosovo consists of:

- Generation
- Transmission
- Distribution
- Consumption



- **Generation:** Current electricity in Kosovo is produced from fossil materials in thermal power plants, but also from renewable sources.
- **Transmission:** The purpose of the transmission network is to transmit electrical energy from the generation units to the substations of the distribution system.
- Distribution: The distribution system is the part of the electric power system that connects distribution substations with consumers.
- **Consumption**: The electrical system loads are industrial, commercial and household.

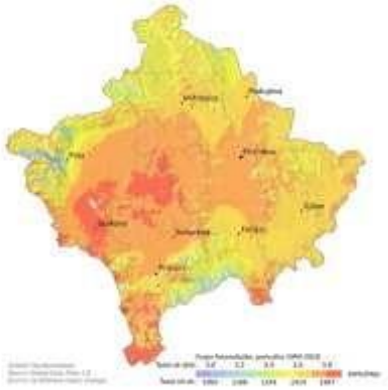


Electricity transmission and distribution scheme.

2. Integration of Photovoltaic Energy in the electricity network of Kosovo

Of all the renewable energy sources in Kosovo, photovoltaic energy turns out to be the source with the highest utilization potential. Kosovo during a year has approximately 270 sunny days and the greatest energy potential is in the central part of Kosovo.

PV-grid integration is very important as it optimizes the construction of the energy balance, improves the economics of PV systems, reduces operating costs and provides added value to the consumer and the grid. This integration is now a practice in many countries of the world, because there is a growing demand for the use of renewable energy sources against fossil sources. Currently, advanced inverter devices that convert PV direct current to alternating current for the grid can be used to help control voltage and make the grid more stable. (Stenclik. Derek, D. P. 2017)



2.1 The Impact of Photovoltaic (PV) Systems Integration

Photovoltaic systems can have some negative impacts on the electrical network, especially if the level of penetration is high. These impacts depend on the size and location of the photovoltaic system. Listed below are some of the negative impacts on the network (Davud Mostafa Tobnaghi, R. V. (2016) :

- **Reverse power flow** (This reverse flow results in network overload and power loss).
- **Power losses** (they are minimal at approximately 5% penetration, but if the penetration level rises, the losses will also rise).
- Difficulty in voltage control (All voltage regulation devices such as capacitor banks and voltage regulators are designed to operate in unidirectional power flow systems)
- **Imbalance between Phases** (Inverters used in small residential PV systems are in most cases single-phase, so if these inverters are not evenly distributed between phases, an imbalance occurs.
- **Power quality problems** (are one of the main impacts of PV with a high level of penetration in distribution networks)
- **Increased reactive power** (PV system inverters operate at uniform power factor due to the IEEE 929-2000 standard, and that Small Residential System owners in incentive programs only earn from output per kilowatt hours)
- **Electromagnetic interference problems** (High frequency switching of PV system inverters can result in interference with neighboring circuits such as capacitor banks, protection devices, converters and DC links resulting in malfunction of these devices).

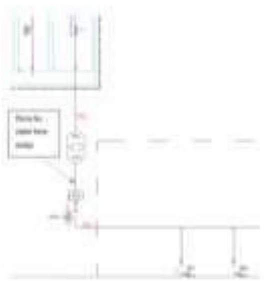
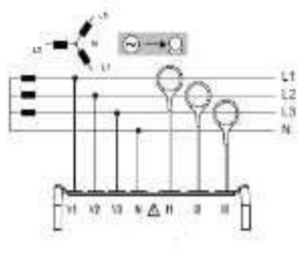
2.1.1 Impact on the network of the "Eko-Park" photovoltaic park

The Photovoltaic Project is located in Gjakova and has an installed capacity of 6 MW. In this project, 3 types of photovoltaic panels from the manufacturer Canadian Solar and 2 types of inverters from the manufacturer

Huawei were used. (Srinivasan M, R. R. 2016)

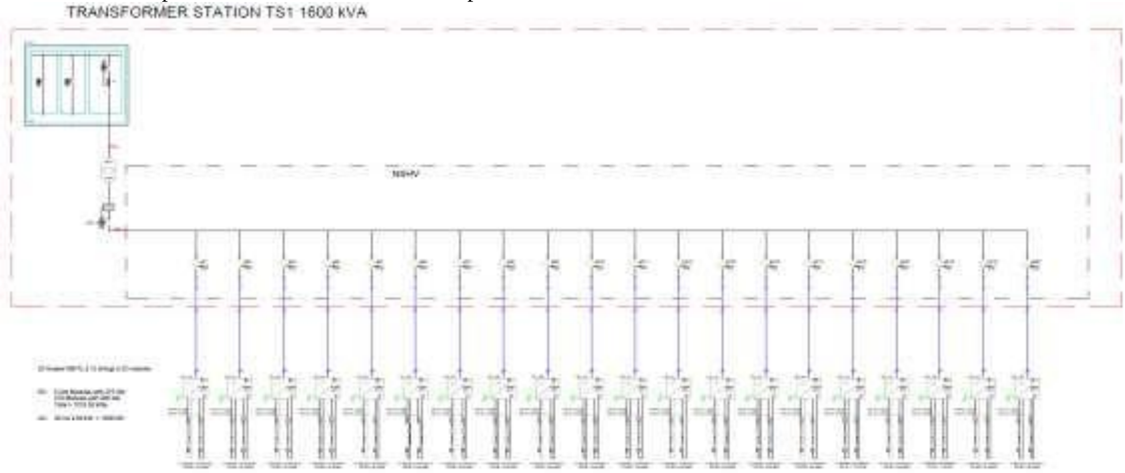
The project has a total of 21792 modules and 80 Inverters.

The measurements were made with the PEL 102/103 instrument.

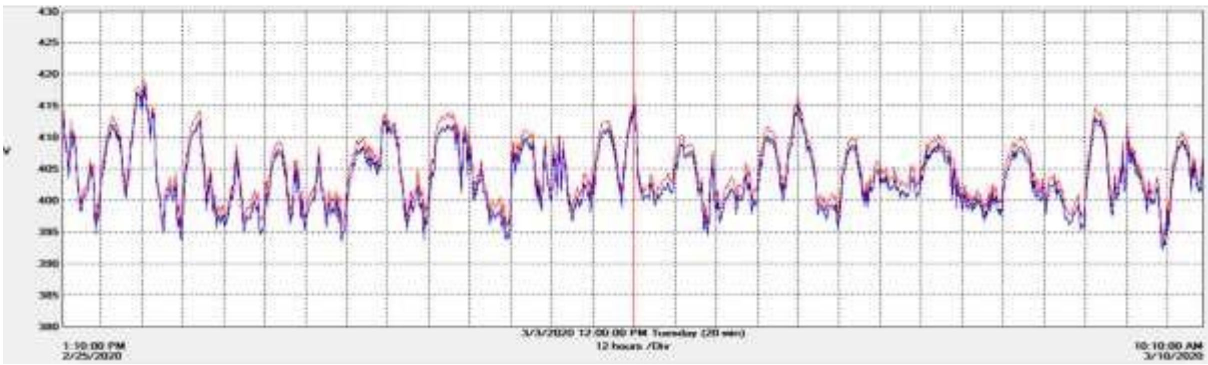




PEL Instrument 102/103 The point where the instrument is placed The method of realization of measurement

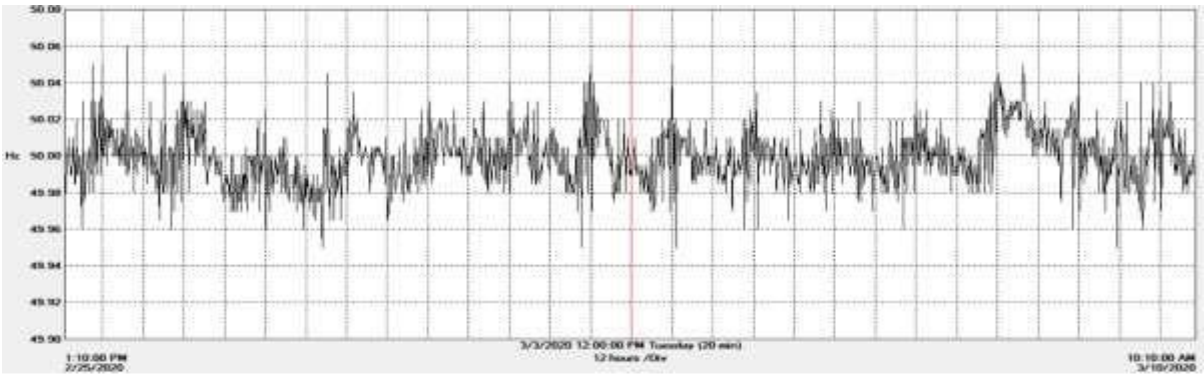
Unipolar connection scheme of the panels with the 0.4/35 kV transformer



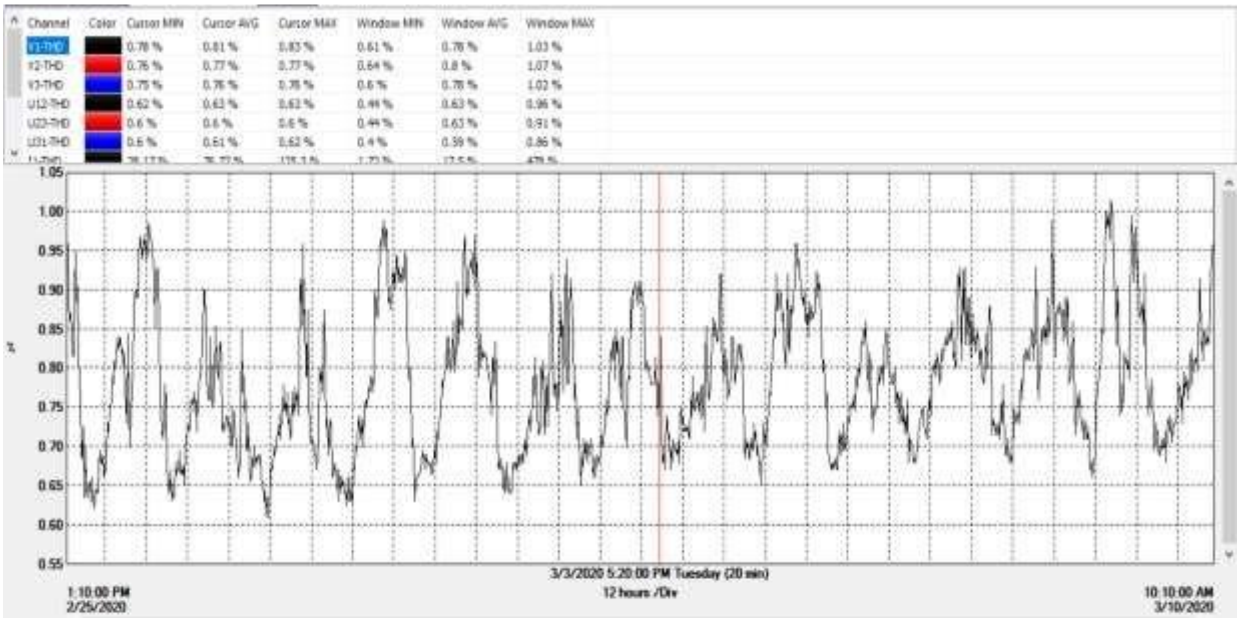
Voltage fluctuations



Frequency fluctuations



Percentage of harmonic distortion between phase 1 and neutral



Conclusion

In this paper, problems of grid integration and problems with power quality in the PV power grid are presented. To minimize impacts such as voltage fluctuations and intermittent problems, electrical equipment is a viable option. Moreover, energy storage can help in dispatching these resources, since when there is excess energy and there is no demand then the energy can be stored and the use of the excess energy can be shifted to the desired time. Also with the use of LC filter it has been seen that fluctuations in PV systems can be reduced. It is also shown how the output of active or reactive power can be controlled to enable the best operation of the network. From this paper we can conclude that with the use of the technologies described in this study, a good integration of these technologies can be achieved and that in the future this technology is expected to be further developed as renewable energy sources are expected to have great growth in the future.

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Investments, the increase of electricity capacities in Kosovo, and the possibilities of energy stabilization

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Abstract. The investment of 200 million dollars in the energy sector means solving the problem of energy supply in Kosovo: the increase in the quality of the energy consumed as well as its quantity, as well as the integration of renewable sources in the network are the first and most important effects related of this investment, but definitely and fortunately they are not the only ones. Yet, we should not be satisfied with having for the first time such a big budget for energy investments. The growth and expansion of production capacities from coal should follow first since our country has large reserves of coal. Repairs in the existing blocks of existing coal power plants to increase efficiency, the installation of filters such as in the EU countries to reduce the emission of CO2 gases, as well as the reduction of technical and commercial losses, would complete the general scheme of necessary investments. In this case, the challenges of transforming the conventional grid into an intelligent one must be overcome. In this case, we must overcome the challenges of the transformation of the conventional grid into an intelligent grid. The way to achieve this is straight forward and short: the production of batteries with large capacity with the possibility of storing energy for a long time, and the possibilities of building artificial dams as a suitable source for storage and use of energy in times of crisis. These are the most suitable alternatives for our geographical position, while any further advancement of the system is appropriate.

As an additional alternative, it can be the increase of cogeneration capacities for supplying the citizens with heat as much as possible. The advantages of using renewable energy and cogeneration are the reduction of heating costs and at the same time the reduction of electricity use.

All the above alternatives or others not mentioned here should be thought of and put into operation in a relatively short time. If the energy system is not intervened in time, we will have a tough winter in terms of energy, tougher than the previous one.

Key words: Energy sector, Thermal power plant, New Kosovo, Energy crisis, Energy Storage.

Introduction

The recent reductions in electricity in the summer season made us think about the long-term solution to the electricity problem, when we know that in Kosovo in the winter the electricity needs are much higher than in the summer. This is because the heating of buildings is necessary and unavoidable during the winter months, while in Kosovo the ventilation and natural cooling of residential buildings is more pronounced.

Since the insulation of residential and industrial buildings has been seen as an important first step towards increasing efficiency and saving electricity, a project which has had the same goal has been financially supported by the American government. As a continuation of this project, the American government in cooperation with the government of Kosovo have approved the program of 200 million dollars, which aims at the sustainable development of energy.

But how can this project be used to solve the long-term problem of electricity!?

The solution to the electricity crisis in Kosovo should be sought in the construction of new capacities, such as the construction of a new coal power plant and the increase in the use of renewable energy sources.

The obsolescence of the existing power plants in Kosovo has made it necessary to send the units frequently for overhaul. As a result of this and the lack of additional capacities, we come to the chain problem leading to the energy crisis. The lack of coverage of electricity consumption leads to an increase in the need to import energy. With the increase in electricity prices in the market and the lack of finance for import, it is impossible to cover the total consumption. This is because Kosovo imports energy based on the concept of a day ahead, on the other hand, energy is exported at night when the demand is below the generation level.

Electricity capacity in Kosovo

Kosovo's electricity production is almost entirely dependent on two coal power plants: Kosovo A (5 units with

800 MW installed) and Kosovo B (two units with 678 MW installed). The current capacity of these power plants is a total of about 915 MW. These aging power plants contribute to air pollution, and Kosovo B is the highest dust emitter of all coal-fired power plants in the Western Balkans. [6]

As for hydropower plants, we have the Ujman Hydropower Plant with a generating capacity of 35 MW, as well as several small hydropower plants such as Lumbardhi (8.3MW), Dikanca (2.6MW), Radaci (0.65MW), Burimi (0.64MW). In addition to these, Kosovo also has two wind parks (Wind Park in Bajgora and Kitka) with a combined installed capacity of 137.4 MW [10].

Regarding the generating capacity from solar energy according to the latest report 'Security of Electricity Supply in Kosovo: Assessment of Photovoltaic Generators in Kosovo prepared by DT Global for USAID in Kosovo, the total installed capacity of solar energy by the end of the year 2020 was 20.9 megawatts which represents 0.04% of the total electricity consumption in Kosovo.

So, the total installed capacity in Kosovo is 1,537 MW, of which 84% is lignite-based. The three units of the "Kosovo A" Thermal Power Plant that are still in operation are at the end of their technical lifespan - two of the units were put into operation more than 50 years ago. This results in a higher probability and frequency of unplanned outages. Both power plants, Kosovo A and B, must be renovated to meet the required emission standards. [9]

By 2021, capacities of 137 MW of wind generation units have been commissioned in Kosovo, resulting in a wind share of 9% of installed capacity. Even hydro-energy is an essential element of the electric power system with a participation of 6.5% of the total installed capacity [9].

As for the heating sector, biomass provides about half of the required energy [9].

All types of electricity sources that contribute to energy production in Kosovo are presented in Table 1.

Table 1. Energy capacity in Kosovo [9]

Fuel	Name	Year of commissioning	Installed capacity, MW	Available capacity, MW
Lignite	Kosovo A3	1970	200	138
	Kosovo A4	1971	200	138
	Kosovo A5	1975	210	138
	Kosovo B1	1983	339	305
	Kosovo B2	1984	339	305
Wind		-	137	-
Water		-	101	-
Solar photovoltaic		-	10	-
Biomass		-	1.2	-
Total		-	1537	-

The current consumption of Kosovo is brought to 750 MW, while during the peak hours and in some cases during the winter season, the consumption goes up to 1280-1300 MWh. Considering that renewable sources do not offer guaranteed production at the time when we need electricity, Kosovo during the winter and during peak hours has a great lack of electricity, which must be imported to meet the current needs.

Kosovo's energy challenge

The constant increase in energy demands and the ever-increasing demands of electrical equipment for more power, such as air conditioning systems, cause the power grid to turn to reserves in order to be able to supply the necessary energy. In such a condition, voltage problems may occur. Since voltage collapses have already occurred several times around the world in the recent past, it is currently of significant importance to thoroughly analyze the stability of the voltage in an electricity grid. The most crucial factors that can lead to voltage instability or voltage collapse in the electrical network are load rapid fluctuations and the lack of reactive power. On the other hand, without this increase in demand for energy and electrical equipment, our country has a lack of energy supply even during the summer and much more during the winter [1].

In order to boost employment, increase development, reduce poverty, and improve the life of the population, Kosovo needs affordable and safe energy. The country's current electricity system is outdated, inefficient and insecure – posing major challenges to economic growth and development. Frequent power outages hinder investment and damage production, education, and health services. Many citizens still burn firewood and coal for heating and cooking, which causes air pollution that then causes breathing problems and other health problems. Without a reliable and stable supply of electricity, foreign and local companies are reluctant to invest and create jobs in Kosovo.

Electricity consumption in Kosovo for 2019 was 3.96 billion kWh [8]

Due to the lack of good planning and investments over the past decades, the energy sector in Kosovo today faces major challenges, including:

- Dependence on old lignite-fired power plants, which do not guarantee regular electricity supply, nor proper flexibility of the power system, and in turn cause greenhouse gas (GHG) emissions and pollution.
- High energy consumption (and therefore high energy costs) relative to GDP and population, due to a number of factors, including high network losses, inefficient buildings, and inefficient equipment (e.g., for space and water heating), both in the residential and commercial and public sectors.
- High dependence on individual household heating systems, with electricity or inefficient wood or coal burning equipment, which significantly increases both the need to import electricity, as well as high greenhouse gas emissions and air pollution during cold months.
- High concentration of the market, both at the wholesale and retail level.

- The vulnerability of the system's high import dependence during the heating season was particularly highlighted during the post-pandemic energy crisis in 2021, which was further exacerbated by the war in Ukraine in 2022, causing fluctuations and extremely soaring prices in the natural gas and electricity market, unseen before. As a result, Kosovo had to pay exceedingly high prices to import electricity. This energy crisis proved that Kosovo's electricity system needs a deep transformation to become more stable, more independent, and more flexible.

The possibility of solving the energy problem in our country

In order to solve the energy problem in the country, measures should be taken to raise the awareness of the citizens about the energy efficiency and to increase the energy capacity in Kosovo.

Kosovo has very large lignite resources, amounting to 12.5 billion tons, which are claimed to be the second largest reserves in Europe and the fifth largest in the world. The lack of oil and natural gas infrastructure means that Kosovo is fully dependent on the production of energy from coal to ensure the country's energy sustainability. [6] Figure 1 shows some of the main goals of Kosovo's strategy regarding to avoiding future energy crises.

Figure 1: Main goals of the Kosovo Energy Strategy (2022 – 2031).[9]

In order to increase the electricity capacity in Kosovo, we must consider the conditions derived from the European Union:

- Coverage of at least 35% of electricity consumption by RES by 2031.[9]
- Development of new wind and photovoltaic RES capacities, to reach a total installed RES capacity of at least 1400 MW (including here 100 MW of self-generating consumer capacity) by 2031, with the possibility of increasing this target if such a thing is possible.[9]

System reliability and security of supply will be guaranteed through the unified operation of the power system. This requires appropriately sized supply and reserve capacity, reliability, flexibility, and efficiency of generating units, grid elements and integrated markets.[9]

Two options which have been proposed and which would help Kosovo in the development of a sustainable energy are the construction of a new coal power plant (the so-called New Kosovo Power Plant or TCKR) and the construction of a reversible hydropower plant (Zhuri Hydropower Plant).

TCKR would be a key asset in strategic terms since it would cover almost half of the energy demand in the country and would be a long-term source of thermal energy for space heating in the surrounding municipalities. TCKR will at the same time address the solution of a number of problems of the energy sector, but also more broadly in Kosovo, such as the security of electricity supply, the direct impact on sustainability and economic development, as well as the significant improvement of social and environmental aspects.[7]

TCKR is supposed to have a capacity of five hundred megawatts, which will cost nearly 1.3 billion euros and have a lifespan of 40 years.

On the other hand, the Hydropower Plant of Zhuri is probably the greatest possibility of using renewable energy potentials. It has been calculated that the generating capacity of the Zhur Hydropower Plant would be 305 MW.[7]

System reliability and security of supply will be guaranteed through the unified operation of the power system. This requires appropriately sized supply and reserve capacity, reliability, flexibility, and efficiency of generating units, grid elements and integrated markets.[9]

The ultimate goal of the current version of the Energy Strategy is the use of cleaner energy, targeting around 400 MW of renewables in the system by 2026, in line with EU targets.

Kosovo does not have generating units for flexible and quick response to serve as reserve capacities of the system. To enable increased participation of renewable capacities, flexibility is a key issue in the electricity sector. Currently, only the energy reserve capacity for keeping the frequency under control ("frequency containment reserve", FCR) (primary reserve of 5 MW) is provided by the power plants in Kosovo. Other auxiliary services (+/-
25 MW aFRR and +143/-90 MW mFRR) are provided by the electricity system of Albania. For this purpose,

Kosovo will install at least 170MW of energy storage capacity through batteries in its energy system by 2031. Investing in energy storage will not only help improve the flexibility of the system and the integration of variable renewable energy sources but will also be necessary to meet ENTSO-E's energy reserve requirements, and to some extent help reduce electricity imports [9].

Investments and their use in solving the energy problem

The World Bank is committed to helping Kosovo address its electricity shortage through a comprehensive strategy that includes increased energy efficiency, development of renewable energy sources, integration into regional energy markets, and support for a new energy production that is reliable, sustainable, and affordable for citizens. Although electricity supply options in Kosovo are extremely limited, due to the modest availability of accessible renewable resources, outdated and unsafe lignite power plants, supply interruptions in neighboring countries (especially during high peak demand, which limits Kosovo's ability to import electricity) and the lack of any source of natural gas or infrastructure to import gas. In recent years, the demand for electricity has exceeded the supply several times - a problem that is expected to worsen with the closure of one of the largest coal power plants (Kosovo A), which provides nearly a third of the country's electricity production. These investments should be used for the rehabilitation of existing capacities to produce electricity and the development of new capacities.

As an example, we can take the project of changing the filters in the Kosovo B coal power plant, which is a sixtyfour million project supported by the European Union and KEK (Kosovo Energy Corporation).[11]

Germany invests over sixty million Euros in solar energy in Kosovo, this investment will ensure clean energy supply for Kosovo.[12]

The world's global energy investment is expected to grow by 8% in 2022 to reach $2.4 trillion, with growth expected to be mainly in clean energy, according to a new report from the International Energy Agency.[13] Turkish investments from 2009 to 2019 have been around 450 million euros, where the energy sector makes up 31 percent of all investments, amounting to around 39.5 million euros.[14] In order to meet the current and future energy shortages in Kosovo, through the Options Study, improvements in economy or efficiency, demand management, construction of small hydropower plants and other renewable sources, power exchange have been taken into account. with Albania, importing electricity from neighboring countries and additional production from thermal power plants.

The draft of Kosovo's Energy Strategy gives positive signals for renewable sources and energy efficiency, but key information is still missing. The Strategy states that Kosovo will build 1400 MW of wind and solar energy by 2031. But it is not clear why this figure was chosen and how much potential Kosovo has in general. The strategy has some information on budgetary implications but lacks implementation measures. For example, for the electrification of the heating sector, the reduction of distribution losses, what measures are planned for energy efficiency, how 1400 MW of solar and wind energy will be attained, etc. [15] For more than a decade, successive Kosovo governments planned to build a new 500 MW (about 450 MW net) lignite-fired power plant, New Kosovo. The controversial project was eventually canceled in 2020 after concession holder ContourGlobal withdrew.[16]

Global investment is expected to grow by 8% in 2022, with growth expected to be driven primarily by clean energy, according to a new report from the International Energy Agency.[17]

Conclusions

The purpose of this paper was to present the current state of the electricity system of Kosovo and the possibility of solving the energy crisis in Kosovo, Investments in our country and their possibility to solve the energy problem in Kosovo. Electricity from coal power plants is foreseen as primary, as sustainable, and stable energy, the possibility of energy supply with quantity and quality, while energy from RES as secondary energy.

Since TC Kosovo A and TC Kosovo B are outdated, it is foreseen to replace the filters in the thermal power plant Kosovo B, the project of which is expected to begin implementation in 2024, where a fund of 76.4 million euros has been provided necessary means for the finalization of this project of revitalization in Kosovo B provided by the EU and KEK.

Necessary and inevitable for the possibility of sustainable and sufficient electricity supply will be the construction of a new thermal power plant, such as TCKR, which would cover half of the energy demand in the country and have a direct impact on economic development. TCKR is supposed to cost nearly 1.3 billion euros. The amount for the construction of this TC is 6 times greater than the 200 million dollars of investment for solving the energy problem.

In addition to the need for the development of new production capacities, there is also the need for building energy storage systems. Storing renewable energy and using this energy to mitigate the peak load can be achieved through the implementation of a large-capacity battery project, as well as through the construction of a reversible hydropower plant.

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Main Tests of Power Transformer TR_2 in the Substation 35/10 kV “Xerxe”

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Abstract. One of the most important devices in the power system is the power transformer, which supply with suitable voltage all consumers. A thorough analysis of the operation failures of power transformers in the power system, would help to understand the impact of faults on their processes and daily operations. Given that the performance of this device is quite important then it is vital to prevent faults which may occur in it. Transformer failures in power systems not only reduce the reliability of the power system, but also have significant effects on the quality of electricity which is delivered to consumers connected to the network. This paper generally deals with the transformer, its characteristics and phenomena that may occur during its operation, while in a more specific way it deals with the ways of testing of transformers. Inspection . and diagnostic testing will always be a key factor in determining the operating condition of the transformer and help to select the appropriate corrective measures to ensure reliable operation which would then result in extending the life of the transformer. For this reason, the paper is focused on the importance of transformer testing, as a result of which the numerous faults that can occur in this device can then be prevented.This paper will discuss the techniques and types of testing applied in the testıng of transformers ın the Kosovo Dıstrıbutıon System, case study – Transformer TR_2 in Substation 35/10 [kV] “Xerxa”. The working methodology for the preparation of this paper is based on the practical knowledge and scientific research about worldwide experiences for the testing of oil power transformers.

Keywords: Oil type transformers, Testing of transformers, Commissioning of transformers, Type of testing.

Introduction

Transformers increase the voltage starting from 110 kV to approximately 1000 kV for long transmission lines with very small losses. They then reduce the voltage in the range of 0.4 kV to 34.5 kV for distribution and finally electricity can be safely used by consumers [1].

If we know the fundamentals of transformer theory, design, and operation, these principles can be applied to maintenance, testing and commissioning.

Operation tests are intended to check the design features of the equipment against the specified standards. This may include failure tests to assess the extreme capabilities of the equipment.

Commissioning is the last phase of the final project cycle, in which the objective is to verify the performance of new equipment/systems/processes according to the purpose of design and demand as well as the level of service of those equipment [2].

The aim of testing, commonly referred as a predictive maintenance is to detect aging or wear in components so that preventative maintenance can be performed before ultimate failure occurs.

There are a number of site tests that are considered good predictive maintenance practices and these tests are also useful for diagnosing transformer trouble, which should be performed periodically [3].

Transformers are exclusively used in power systems to transfer power by electromagnetic induction between circuits at the same frequency, usually with changed values of voltage and current [4, 5].

Every transformer that is manufactured undergoes some form of factory testing. For power transformers, these tests are quite extensive and 5% of test failures do occur.

Test requirements are spelled out in a number of industry standards and specifications [6, 7].

The type of transformer that we will discuss in this paper is the power transformer, the one that is mostly used in power systems.

This paper treats testing for transformers, with special emphasis in Kosovo distribution system. It has been analyzed testing of distribution transformers with installed capacity 2x8 MVA in SS 35/10 kV, "Xerxa".

The paper is structured as follows: Testing of oil type power transformers are presented in section 2; Tests performing in oil type transformer TR_2 with installed capcity of 8 MVA in SS 35/10 kV "Xerxa" are presented in section 3 and Conclusions of this paper are summarized in section 4.

Testing of oil type Power Transformer

Testing of power transformers is one of the most important actions that can be performed on this device, because it serves as a way to eliminate many defects that can occur in transformers and as a preventive measure for the greatest damage that can be caused as a result of anomalies that may appear in it.

There are various tests performed on power transformers. Some of the tests are performed on the premises of the transformer manufacturer before the transformer is delivered and installed, while other tests are performed in the field.

The main tests of power transformers, performed also in our case study, include:

- Inspection
- Measurement of insulation resistance
- Measurement of winding resistance
- Transformer ratio test
- Dielectric test, Mesaurement of strength of the oil, etc.

Inspection

Various external and internal influences can affect the life expectancy throughout the life cycle of a transformer. Diagnostic monitoring and inspection will always help to determine the operating condition of the transformer and help to select the appropriate corrective measures to ensure reliable operation which would then lead to the extension of the life of the transformer. The main purpose of transformer inspection is to ensure that the internal and external parts of the transformer and its accompanying elements are in good condition and suitable for safe operation at all times. Transformer inspection includes:

- General external inspection of all transformer elements
- Oil leakage inspection
- Inspection for any cracks or holes in the transformer elements
- Inspection of ancillary equipment
- Corrosion inspection

Insulation resistance test - IR

One of the most important tests performed on a transformer is the insulation resistance test. Insulation resistance tests are performed to determine the insulation resistance from the individual windings with earthing or between individual windings. Insulation resistance tests are usually measured directly with Megaohmmeter (Fig.1) or can be calculated from the measurements of applied voltage and leakage current. This type of transformer testing is commonly known as the Megger test. This test determines the quality of insulation inside the transformer. Some changes in test results are natural, depending on the humidity, cleanliness and temperature of the insulation, but to pass, the insulation must demonstrate a resistance at a higher value.

Fig.1. Insulation resistance measured directly with Megaohmmeter

Measurements of winding resistance

Winding resistance measurements are an important diagnostic tool for assessing potential transformer damage resulting from poor design, mounting, handling, adverse environments, overloading, or poor maintenance [1].

Transformer winding resistance testing are taken by passing a known DC current through the winding in which the tests are being carried out and by measuring the voltage drop across each terminal [1].

The main reason of this test is to check for large differences between windings and open points which may be in the windings. The winding resistance test is a test that ensures that each circuit in the transformer is properly connected and that all connections are well tightened.

The winding resistance in transformers will change due to loose connections or deteriorated contacts in the tap changer. Resistance measurements are made step by step and readings are compared with each other to determine if they are within the norms. For widing resistance, the results should not differ by more than 1% compared to the reference measurement. In addition, the differences between phases are usually less than 2-3%. The resistance should differ by no more than 2% from the values obtained in the same branch of the other phases, or from the manufacturer's data. Whereas if any unacceptable value is observed then it can be implied that the change in this value may be as a result of loose connections or deteriorated contacts in the voltage regulator.

Winding resistance measurements are performed to assess possible damage to the windings or contact problems, such as from bushing to windings, from windings to tap changer.

They are also used to control the widing number regulator (OLTC) as they can indicate when the OLTC contacts need to be cleaned or replaced.

Failures can be detected without opening the OLTC space. OLTC (On load tap changer) is regulator of the number of turns under load. Further in the paper we will use it only as OLTC.

To measure the resistance of the windings, it must be charged until the transformer core passes into saturation. Then the resistance of the windings is calculated from the ratio of voltage and current. Testing is performed with voltage and direct current.

Here we distinguish 2 types of measurements:

- **Static measurement of winding resistance** - which is accomplished by measuring the winding resistance for each OLTC position and comparing it with factory measurement data.
- **Dynamic measurement of winding resistance** - is performed as an additional measurement to analyze the transient process during the change of OLTC positions. This measurement is not often applied in the field.

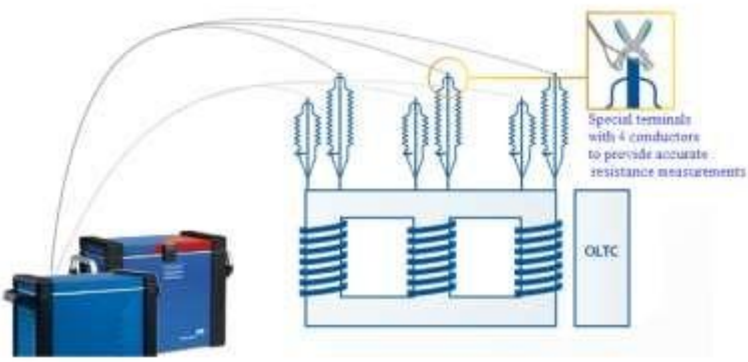

Fig.2 Measurement of winding resistance - Scheme of connections with OMICRON

During winding resistance measurements the transformer core can remain magnetized. Therefore, it is recommended to demagnetize the nucleus after performing measurements and
tests. [8]

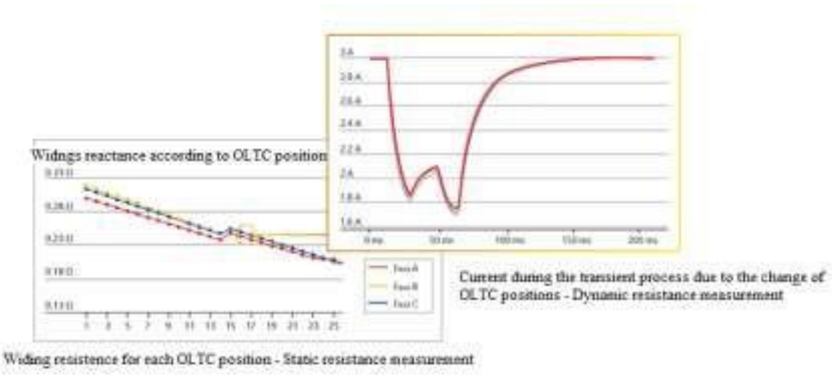

Fig.3 Winding resistance depending on the number of turns

Transformation ratio test

Transformation Ratio Tester (TTR) is a device used to measure the transformation ratio between windings (Fig.4). Ratio measurements are performed at all tap changer positions and are calculated by dividing the reading induced voltage by the value of the applied voltage.

Fig.4 OMICRON CPC 100

When transformation ratio test is performed on three-phase transformer, the ratio is taken in one phase at the same time as a three-phase TTR until the three-phase ratio measurements are completed. The measured ratio changes must be within 0.5%.

Dielectric test

Transformer oil (also known as insulating oil) is a special type of oil which has excellent electrical insulating properties and is stable at high temperatures. Transformer oil is used in oil-filled electrical transformers to insulate, to stop the crown from the corona and discharging, and dissipate the transformer heat (i.e. act as a coolant).

Transformer oil is also used to protect transformer cores and windings - as they are completely immersed in the oil. Another important property of insulating oil is its ability to prevent oxidation of paper insulation made from cellulose. Transformer oil acts as a barrier between atmospheric oxygen and cellulose - avoiding direct contact and thus minimizing oxidation.

The dielectric strength of transformer oil is also known as the Breakdown Voltage (BDV) of transformer oil. A low value of BDV indicates the presence of moisture content and accompanying substances in the oil. BDV is an important transformer oil test, as it is the main indicator of oil health and can be easily performed on site.

The permability voltage is measured by observing the voltage, between two electrodes immersed in oil, separated by a specific gap. To measure the dielectric strength of the transformer oil, the device must be taken at the location where the transformer is located. The oil is kept in a container in which a pair of electrodes are fixed with a gap of 2.5 mm. Slowly the voltage between the electrodes increases. The rate of voltage rise is controlled at 2 kV/s and the voltage at which the arc between the electrodes begins to appear is transmitted. This means at which the dielectric strength of the transformer oil is broken. This measurement is made 3 to 6 times in the same oil sample, and the average value of these measurements is taken.

Dry and pure oil gives results of dielectric strength, better than oil with moisture content and other accompanying impurities. The minimum permability voltage of the transformer oil or the dielectric strength of the transformer oil in which this oil can be safely used in the transformer is considered to be 30kV. [8]

Fig.5 Equipment for testing and Measurement of dielectric strength of oil

Tests performing in oil type transformer TR_2 with installed capacity of 8 MVA – SS 35/10 kV "Xerxa"

Continuously increasing the reliability and performance of transformers is a challenge in itself especially for electricity distribution companies. Power outages are always undesirable and companies tend to always keep the duration of power outages to a minimum. Diagnosing and eliminating possible defects in time so that we do not have power outages is one of the main reasons for examining the condition of power transformers.

Fig 6 Power transformers in the distribution network, SS 35/10 kV "Xerexa"

In order to avoid major breakdowns of transformers, KEDS - Distribution Comapany in Kosova, conducts several maintenance and testing processes:

- Transformer inspection process
- Transformer testing process o Winding resistance test o Insulation resistance test o Transformation ratio test
  - o Dielectric test - strength of oil
- Transformer maintenance process

Transformer TR_2 in NS 35/10 [kV] "Xerxa"

This SS 35/10 [kV] "Xerxa" can supply from two substations: "Gjakova 1", 110/35 [V] and "Rahoveci" 110/35/10 [kV]. So if in case of any breakdown occurs in any of the 35 [kV] overhead lines, then supply will be from the another 35 [kV] feeder.

This substation has 2 transformers 35/10 [kV] and both transformers located in SS 35/10 [kV] "Xerxa" are 8 [MVA], which means that the total installed capacity in this substation is 2x8 [MVA] = 16 [MVA]. This capacity is enough to supply all 10 [kV] feeders of this substation.

The data of transformer TR_2 in SS 35/10 [kV] "Xerxa" are as follows:

Table 1. Data of TR_2 in SS 35/10 [kV] "Xerxa"

Description	Information
District	Gjakova
Substation	35/10 [kV] Xerxa
Transformer	TR_2
Transformation	35/10(20) [kV]

Producer	Konçar
Connection group	Dyn-5

Table 2. Electrical parameters of transformer TR_2

Volatge				
Windigs	**Voltage L-L**	**Volyage L-N**	**Insulation, Level L-L**	
Primary	35.000 kV	20.207 kV	70 kV	
Secondary	10.500 kV	6.062 kV	50 kV	
Current				
Current in primary side primare		**Current in secondary side**		
132.000 A		440.000 A		
Short circuit Impedance				
u_k [%]	**Installed capacity**	**Nominal voltage**	**Position OLTC**	**Position DETC**
6.70%	8.000 MVA	35.000 kV	-	3

Table 3 Voltage in different regulator positions

Regulator position	Voltage in primary side
1	36750.0 V
2	35875.0 V
3	35000.0 V
4	34125.0 V
5	33250.0 V

The transformer TR_2 of this substation has two voltage regulators (Tape changers):

- Primary side regulator which has 5 positions which change the voltage by 2.5%
- Secondary regulator which has 2 positions: 10.5 [kV] and 21 [kV]

So based on the position of the regulator, this transformer can also transform the voltage from 35 [kV] to 20 [kV].

Inspection of transformer TR_2 in SS 35/10 [kV] "Xerxa"

So as mentioned above the first process that a transformer goes through is the transformer inspection process.

After inspecting all the elements of the transformer TR_2, the following conclusions are drawn, presented in the following table:

Table 4 Transformer inspection results

No.	Parts and equipments in transformer	Good conditions	Bad conditions	Remarks
1	Tank and radiators	✓		
2	Insulators in primary side 35 [kV]	✓		
3	Insualtors in secondary side 10 [kV]	✓		
4	Buhollc's relay	✓		
5	thermometer	✓		
6	Silicagel	✓		
7	Voltage regulator (Tape changer)	✓		
8	Oil level	✓		
9	Fans	✓		
10	Transformer grounding (earthing)	✓		
11	Busbars and cables connected to transformer	✓		
12	Thermovision camera inspection	✓		

From the presented notes it means that the transformer elements are in good condition, no oil leakage has been noticed from any part of the transformer and that it can be further continued with its electrical testing.

Winding resistance test

This test is performed by means of advanced equipment which displays all the results in the specified reports [9].

For the primary side of winding the following results are obtained:

Table 5 Results of winding resistance measurements (primary side)

DC – Resistance of priamry winding									
Testing current				1.0 A					
Winding temperature				15 °C					
Temperature correction - factor (K)				1.24					
Type of voltage regulator (Tape changer)				DETC					
	A (A - B)			**B (B - C)**			**C (C - A)**		
Pos.	**Rmesur**	**Rdev**	**Rcorr**	**Rmesur**	**Rdev**	**Rcorr**	**Rmesur**	**Rdev**	**Rcorr**
3	1.063 Ω	0.08 %	1.283 Ω	1.078 Ω	0.098 %	1.301 Ω	1.066 Ω	0.087 %	1.287 Ω

For the secondary side of winding the following results are obtained:

Table 6 Results of winding resistance measurements (secondary side)

DC – Resistance of priamry winding									
Testing current				3.0 A					
Winding temperature				15 °C					
Temperature correction - factor (K)				-					
Type of voltage regulator (Tape changer)				-					
	A (a_1 –n_1)			**B (b_1 – n_1)**			**C (c_1 – n_1)**		
Pos.	**Rmesur**	**Rdev**	**Rcorr**	**Rmesur**	**Rdev**	**Rcorr**	**Rmesur**	**Rdev**	**Rcorr**
3	30.902 mΩ	0.065 %	30.901 mΩ	30.796 mΩ	0.086 %	30.796 mΩ	30.712 mΩ	0.071 %	30.712 mΩ

Transformation ratio test

Transformation ratio test verifies that the transformer windings have the required number of windings in order to produce the required voltages in them. Like the winding resistance test, this type of testing is performed by means of advanced equipment which displays all the results in the specified reports. According to the standards, the tolerance in the measured ratio should usually be within 0.5% of the estimates given in the transformer table.

Table 6 Results of Transformation ratio test

		Phase A		**Phase B**		**Phase C**	
Pos.	**Nom. Ratio**	**TTR**	**Devijation**	**TTR**	**Devijation**	**TTR**	**Devijation**
3	5.7735	5.7768	0.11%	5.7781	0.08%	5.7851	0.20%

Insulation resistance test

This test determines how is effective the dielectric (insulation) in resistenc of current flow, which means that this test is a simple indicator of insulation dryness. Because each transformer is unique in several ways, it is difficult to describe an acceptable value of insulation resistance, but that it is measured in Mega-Ohm. Realisation such a test at regular intervals can detect imminent insulation failures and prevent costly transformer repairs, which is the reason why this test was performed on transformer TR_2 of SS 35/10 [kV] “Xerxa”.

Table 7 Results of Insulation resistance test

Resistance of insulation	MV-Tank	LV-Tank	LV-MV
15 sec	7.55 GΩ	10.37 GΩ	4.99 GΩ
60 sec	9.21 GΩ	15.21 GΩ	9.86 GΩ

Dielectric test - strength of oil

For an oil sample, this measurement is done 3 to 6 times and at the end the average value of the measured values is obtained.

Table 8 Results of Dielectric test

ODS	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average value
[kV]	60.5	62.3	60.4	59.8	64.2	63.5	61.78

Since the minimum voltage of such a test is estimated to be 30 [kV], then for the oil of this transformer we can say that it is in good condition.

Conclusions

Testing and commissioning of transformers are of great importance and from this paper it can be concluded that continuous monitoring and diagnostics of transformers increase their stability, safety and longevity.

In order to track the performance of each transformer it is necessary to maintain a database of all power transformers of a power system. In this way all failures or faults that have occurred during the operation of the transformers since the beginning of their operation would be possessed.

Insepction contributes greatly to obtaining records, routine tests, creating a safe database that serves the companies.

As a result, after the main tests performed for 8 MVA power transformer we can conclude that the transformer is in good condition, the values obtained are within the allowable limits and that the transformer can continue to operate to enable the supply of 10 [kV] outputs of NS.ghout its life.

From this paper it is concluded that the execution of all type of tests treated in this paper and the commissioning steps to oil type power transformers on a periodic basis is a necessary process, which contributes greatly to the goals set by professionals in this field.

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Mathematical modelling and simulation of a sanitary hot water for a Dormitory using T*SOL software

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Abstract. Electricity is a necessary prerequisite for a sustainable economic development of the Republic of Kosovo. Therefore, efforts are constantly being made to improve the service to consumers and encourage the construction of new energy capacities. Participation of energy consumption in household is still dominant - about 41.4% of the total consumption in Kosovo, 15% of this energy used for domestic hot water.

In this study, using T*SOL software a model of a sanitary hot water has been developed and simulated for a Dormitory nr.8 at student city of Prishtina, Kosovo.

The mathematical model is calculated based in demand, means how many liters of hot water are needed for this Dormitory, for this it is necessary to know the number of beds. Based on this the daily average sanitary hot water consumption is 5400[l], knowing that the average sun duration for the city of Pristine is 5.44[h], while the average horizontal irradiation is 3.79[kWh/m²] per day.

Two different simulation approaches have been considered, based from simulation, for this system that serv for sanitary hot water, the temperature from 45˚C to 60˚C: the average total solar fraction for Dormitory nr.8 is 54%, the average solar contribution is 51506 kWh, the average CO_2 emissions is 12495.5 kg per year.

Keywords: Renewable Energy, Solar Thermal Energy, Domestic Hot Water, Saving Electricity, CO_2 Reduction.

1 Introduction

In Kosovo, electricity generation capacities are: Power Plants, Hydro Power Plants, and Renewable Energy Sources (small hydro power plants, wind power plants and photovoltaic panels). Around 93%[11] of the primary energy is provided by fossil fuels, while participation of renewable resources is symbolic.

With the recent increase in energy costs many scientists have been looking for renewable energy sources. One of the biggest sources of energy that was available to use is solar energy in the application.

Solar thermal technology is used extensively in all regions of the world to provide hot water, to heat and cool space, to dry products and to provide heat, steam or refrigeration for industrial processes or commercial cooking.

In Kosovo, the first Solar collectors were installed in a number of premises of the Kosovo Clinical University Centre and the Student Centre in Pristine, funded by the national budget (during 2008-2009)[1], and in three other public premises – part of the project for the implementation of energy efficiency measures, funded by the European Commission (during 2010), nowadays these investments have increased significantly. Table1: The first Solar collectors, installed in Kosovo, all of them are social institutions.

Table 1. The first Solar collectors, installed in Kosovo

Social Institutions	Date	Area	Type of the collector
The Pediatric and Neonatology Clinic	13 .02.2009.	100m^2	Flat plate collectors
The Neuropsychiatric Clinic	01 .07. 2009	100m^2	Flat plate collectors
The Internal Medicine Clinic	27. 01.2010	150m^2	Evacuated tube collectors
Student Centre	2010	133m^2	Flat plate collectors

The studied solar system is located in Student Center of Pristine, Kosovo. This system is providing sanitary hot water for Dormitory nr.8.

Fig. 1. The student center of Pristine

2 Mathematical model

The f-chart method was developed in 1976-1977 by Klein and Beckman [3]. This method is based on the results of many numerical experiments (simulations) of different solar systems. These results served as the basis for correlations to calculate dimensionless variables.

This method is used to estimate the annual thermal performance of active heating systems for building, where the minimum temperature of energy delivery is near 20°C.

It is clear that the demand for sanitary hot water varies from object to object. This variation depends on whether the building is individual or collective, school institutions or religious buildings, etc. In some sectors, sanitary hot water is necessary for example in residential buildings, in dormitories, while in others it increases the quality of life, for example in medical education institutions etc.

2.1 Hot water demand calculations

To calculate how many liters of water are needed for a building, it is necessary to know the number of inhabitants and the type of building Tab.2.

Table 2. Schedule for hot water demand

Type of building	Specific Daily Hot Water Demand in **liters** per day at 60°C
Domestic residential houses	40 per person
Educational institutions such as colleges and boarding schools	5 per student
Hotel, Hostel	20 per bed
Restaurants, Cafeterias and similar eating places	5 per meal
Laundries	5 per kilogram of clothes
Dormitories	15 per bed
Health institutions such as Hospitals, Health Centers, clinics and similar, medical facilities	15 per bed

2.2 Average Radiation on sloped surface – Isotropic Sky

Using the isotropic diffuse assumption, the monthly average radiation incident on the collector can be estimated. A collector is to be installed in Pristine, latitude L=42º39’N at a slope of 45^0 to the south. The results for Average daily total radiation for 12 months on the tilted surface presented in the Table 3. Energy quantities are in mega joules per square meter. It is difficult to put limits of accuracy on them, they are probably no better than ±10%.

Table 3. Results for Kosovo city Pristine with latitude L□ 42□39' N

Month	H [MJ/m²]	H_0 [MJ/m²]	K_T	H_d/H	R_b	$□_g$	h_{ss} [□□]	h_{ss}' [□□]	H_T [MJ/m²]
January	**5.911**	**13.818**	**0.428**	**0.467**	**2.524**	**0.7**	**69.581**	**90.998**	**10.911**
February	**8.79**	**18.914**	**0.465**	**0.426**	**1.938**	**0.7**	**77.879**	**90.601**	**13.885**
March	**12.27**	**26.301**	**0.467**	**0.462**	**1.442**	**0.4**	**87.791**	**90.11**	**15.074**
April	**15.52**	**33.931**	**0.457**	**0.471**	**1.07**	**0.2**	**98.706**	**89.567**	**15.476**
May	**18.88**	**39.461**	**0.478**	**0.45**	**0.859**	**0.2**	**108.095**	**89.111**	**16.724**
June	**22.28**	**41.7**	**0.534**	**0.397**	**0.777**	**0.2**	**112.897**	**88.887**	**18.642**
July	**23.19**	**40.504**	**0.573**	**0.362**	**0.812**	**0.2**	**110.717**	**88.988**	**19.865**
August	**20.53**	**35.874**	**0.572**	**0.363**	**0.973**	**0.2**	**102.614**	**89.375**	**19.682**
September	**14.94**	**28.844**	**0.518**	**0.412**	**1.277**	**0.2**	**92.025**	**89.899**	**16.91**
October	**10.11**	**21.062**	**0.48**	**0.411**	**1.756**	**0.2**	**81.119**	**90.442**	**14.299**
November	**6.322**	**14.918**	**0.424**	**0.472**	**2.349**	**0.2**	**71.776**	**90.895**	**10.575**
December	**4.982**	**12.266**	**0.406**	**0.493**	**2.739**	**0.4**	**67.145**	**91.111**	**9.306**

Calculation of the boiler volume

The capacity of this dormitory is 300 beds. To calculate how many liters of sanitary hot water are needed for this building, the number of beds (300) should be multiplied with 15 liters of water Tab.3. and with 1.2,[3].

$$G = 300 \cdot 15 \cdot 1.2 = 5400\,(l) \qquad (1)$$

Calculation of the collectors' number

Where:

G=5400*[l]* - the volume of the boiler,

T_{min}=12°C - the temperature in the boiler entry (of water supply),

T_{max}=60°C - the temperature at the exit of the boiler,

C_p=1.16[Wh/kgK] - specific capacity of water, h =0.776 - utilization coefficient[8],

p=2.33[m²] - effective area of the collector,

q=4.746[kWh/m²day] - the capacity of sunlight,

$$Q = \frac{G \cdot Cp \cdot (T\max - T\min)}{1000} = \frac{5400 \cdot 1.16 \cdot (60 - 12)}{1000} = 300.67 [kWh/day] \quad (2)$$

Collector area:

$$S = \frac{Q}{q \cdot \eta} = 81.64 [m^2] \quad (3)$$

The number of collectors:

$$n = \frac{S}{p} = 35 \text{collectors.} \quad (4)$$

3. Development of the model for Dormitory

In order to obtain results for a solar thermal system, the input data is necessary (Location -Pristine, Latitude - $L = 42^\circ 39' N$, Slope - 45°, and other data shown in Tab.4). This model is used for both Domestic Water heating and ambient heating of the building, but in the case of the present work it will only be used for Domestic Water Heating.

The two dimensionless groups are:

$$X = F_R U_L \frac{F'_R}{F_R} (T_{ref} - T_a) \Delta t \frac{A_C}{L} \quad (5)$$

Table 4: Prishtina's meteorological data

Month	$\bar{H}_T$ [MJ/m²]	$\bar{K}_T$	ρ_g	Ta [°C]
January	10.911	0.428	0.7	0.20
February	13.885	0.465	0.7	2.57
March	15.074	0.467	0.4	6.60
April	15.476	0.457	0.2	11.15
May	16.724	0.478	0.2	15.64
June	18.642	0.534	0.2	19.72
July	19.865	0.573	0.2	22.21

August	19.682	0.572	0.2	22.15
September	16.91	0.518	0.2	16.32
October	14.299	0.48	0.2	11.54
November	10.575	0.424	0.2	6.26
December	9.306	0.406	0.4	1.2

$$Y = F_R(\tau\alpha)_n \frac{F_R'}{F_R}\frac{(\overline{\tau\alpha})}{(\tau\alpha)_n} \bar{H}_T N \frac{A_C}{L} \qquad (6)$$

3.1. How the model works

In F-chart method, the system's performance is expressed in terms of f, which is the fraction of the heating load supplied by solar energy during each month [3]. The relationship between f and the dimensionless variable X and Y is:

$$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3 \qquad (7)$$

If monthly values of X are multiplied by a water heating correction factor Xc/X in

Equation (6.1), the f –chart for liquid-based solar space and water heating systems (Equation 6.4) can be used to estimate monthly values of *f* for water heating systems (all temperatures are in degrees Celsius).

$$\frac{X_c}{X} = \frac{11.6 + 1.18T_W + 3.86T_m - 2.32\bar{T}_a}{100 - \bar{T}_a} \qquad (8)$$

The energy contribution for the month is the product of f_i and the monthly hot-water load L_i. The fraction of the annual heating load supplied by solar energy F is the sum of the monthly solar energy contributions divided by the annual load.

$$F = \frac{\sum f_i L_i}{\sum L_i} \qquad (9)$$

3.2. Results

Table 5. Monthly and Annual Performance for Infectious diseases Clinic

Month	L [GJ]	Xc	Y	f	fL [GJ]
January	18.09	3.846	0.581	0.296	7.173
February	16.34	3.653	0.422	0.422	9.241
March	18.09	3.31	0.802	0.483	11.73
April	17.51	2.934	0.823	0.518	12.16
May	18.09	2.55	0.89	0.583	14.13
June	17.51	2.213	0.992	0.666	15.63
July	18.09	2.005	1.057	0.716	17.38
August	18.09	2.01	1.047	0.71	17.23

September	17.51	2.498	0.9	0.592	13.9
October	18.09	2.897	0.761	0.477	11.58
November	17.51	3.339	0.563	0.308	7.238
December	18.09	3.762	0.495	0.233	5.653
Annual	213			0.501	143.0

4. Modeling and simulation of solar water heating systems

For this case, we have used TSOL 2018 software, to gained data for: solar fraction, solar contribution, CO2 avoided, collector temperature, financial analysis etc. The schematic of the simulated system is shown in Figure 2.[7].

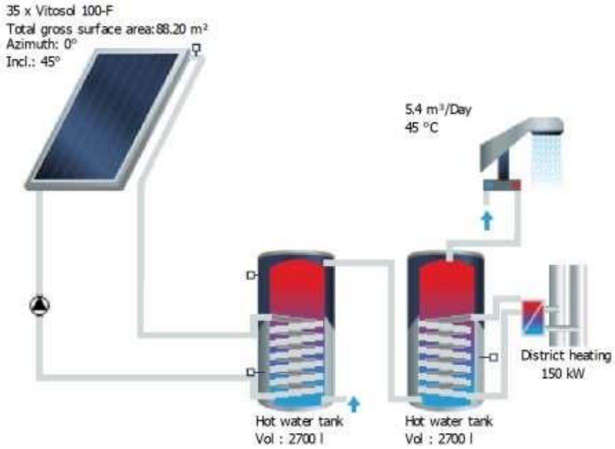

Fig. 2. *The DHW system for the Dormitory 8*

Table 6. The results of studied parameters

Parameters / *Object* / *Months*		Solar contribution to DHW [kWh]		DHW solar fraction [%]		CO2 emissions avoided [kg]		E-SL to tank [kWh]		Energy from Auxiliary heating [kWh]		Savings District heating [kWh]	
		45°C	60°C	45°C	60°C	45°C	60°C	45°C	60°C	45°C	60°C	45°C	60°C
Dormitory nr.8	Jan	2884	2905	42	30	670	675	2922	2930	4055	6826	3102	3124
	Feb	3242	3283	41	29	753	762	3188	3233	4716	7884	3486	3530
	Mar	4121	4245	66	48	957	986	4151	4264	2145	4578	4481	4565
	Apr	4885	4950	57	41	1142	1157	4908	4968	3675	7156	5287	5357
	May	5522	5642	58	41	1365	1395	5556	5670	3960	7992	6320	6459
	Jun	5926	6082	61	43	1497	1537	5977	6120	3778	7992	6932	7115
	Jul	5891	6263	82	60	1497	1592	6078	6410	1277	4200	6931	7368
	Aug	3464	4657	100	95	880	1183	3740	4851	0	220	4075	5478
	Sep	3834	4555	95	79	946	1125	4013	4681	182	1228	4378	5206
	Oct	3453	4770	83	61	1066	1140	4459	4771	929	3001	4935	5279
	Nov	3407	3407	57	39	796	796	3370	3388	2608	5237	3684	3687
	Dec	2305	2320	39	28	535	539	2293	2305	3572	6046	2479	2495
	Year	**49933**	**53079**	**62**	**46**	**12104**	**12887**	**50655**	**53593**	**30896**	**62360**	**56038**	**59663**

5. Konkluzion

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The aim of this works was to study a solar domestic water heating system, and replacing the electric water heating system with solar water heating system for student centre is proposed, to develop a numerical model based on the f-chart method and to compare results obtained from the model with data obtained from TSOL software.

Application of solar thermal energy in Kosovo nowadays is very symbolic. The first solar collectors were installed during 2008-2009, while nowadays, especially in social institutions, this situation is better, including the student center!

As a general conclusion it can be suggested that for sanitary hot water temperature from 45˚C to 60˚C: the average total solar fraction for dormitory is **54%,** the average solar contribution is 51506 kWh, the average CO_2 emissions avoided is 12495.5 kg, and the average Savings District heating is 57850.5 kWh.

As suggested, if solar water system is to be installed, first step is simulate the system using the software with default conditions. The computing time will be very small, but we will have very accurate data about the solar contribution, solar fraction, CO2 emissions, financial analysis etc.

The results obtained from this investigate highlight the positive aspects of the use of solar energy to heat domestic sanitary water.

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NZEB and Photovoltaics in Kosovo. Grid connected PV plants with storage system vs. PV plants without storage

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Abstract. Considering the increase of global warming and the contribution of energy sources, the minimization of energy consumption in residential buildings, including electrical loads and heating system, is a critical issue. Buildings are at the forefront of this issue due to their high energy consumption. Integrating renewable energy systems into buildings has become a common practice. Netzero energy building design promotes the energy transition from fossil fuel-based technologies by coupling renewable systems such as photovoltaic (PV) plants with heat pumps for heating and cooling. In other words, the net energy received from the grid is zero over a year. This work aims to align a ZEB under construction in Italy, in the regulatory, climatic, and technological context of Kosovo.

Two types of these buildings can be supposed, which can be grid-connected or non-grid-connected. In those that are not connected to the grid, an energy storage system should be installed so that when there is no generation at peak hours, the stored energy is used to supply electrical loads on demand. So, this type of building must be equipped with a system of batteries that help its operation. Thus, more and more, in the future, these types of buildings will be present, which will help preserve the environment, as well as reduce carbon emissions. In this context, the exact size of PV plants plays a central role in the perspective of determining self-consumption schemes. The design objective concerns the minimization of exported and imported energy through an optimized size of the PV plant and the integration of electrochemical energy storage.

Keywords: Photovoltaics, NZEB, Storage Systems, Sustainable Economy, Energy Independence, Renewable Energy.

Introduction

Near Zero Energy Buildings (NZEB) are highly efficient buildings with extremely low energy demand, which is met by renewable energy sources. Such buildings produce as much energy as they consume, calculated annually. To achieve net zero energy goals, NZEBs must first significantly reduce energy demand by using energy efficient technologies and then use renewable energy sources to meet the remaining demand. Another term used is the term "island energy system" which describes buildings which are independent of energy suppliers. In order for the production and consumption of electricity to be balanced in such a building not only during the day (24 hours), but also in the four seasons of the year, a large capacity storage system (battery) and a powerful renewable energy source are needed. Although there has been great progress in the field of energy efficient buildings in recent years, people still tend to have different views and concerns about nZEBs, often related to investment and maintenance costs**.**

Figure 1. Near Zero Energy Building - nZEB

Near-zero energy building types

Based on the way of meeting its energy needs, the nearly zero energy building (nZEB) can be divided into two types:

- connected to the network and
- off-grid(standalone).

The near-zero energy building (nZEB) connected to the utility network (electricity network, district hot water or other central energy distribution system) uses these other energy sources to balance its energy needs. It can use the utility's energy when local renewable resource generation does not meet its needs. However, it must feed back into the grid the equivalent of the energy withdrawn on an annual basis in order to maintain the building's zero energy status. The off-grid near-zero energy building (nZEB) is a grid-independent building that requires additional on-site generation potentials combined with significant energy storage technology.

Photovoltaic system with a battery pack at a house as nZEB

For a better understanding of the dimensioning of a photovoltaic system with a battery pack, we have taken a case study for a residential building in the municipality of Suharek, respectively in the village of Mushtisht.

Figure 2.Model of a house

Energy consumption analysis

First, we analyze the energy performance of this residential house to see if it meets the conditions for operation as a nZEB object, the objective is to analyze the consumption of electricity and thermal energy in order to know how many photovoltaic panels are necessary for our object, as well as their dimensioning should also be done in order to adapt the insulation material since it is known that they should also be zero energy. The selected object has P+1, which is therefore located in an area suitable for maximum solar radiation and unobstructed radiation.

Thermal analysis of the object

In the thermal analysis of the object, the thermal coefficients of heat transfer for the support of the object were analyzed. Calculating the necessary coefficients and a comparison was made with reference values of the coefficients, so that the object would contain the technical norms to be a nZEB object.

Table 1. Calculation of thermal coefficients for external walls.

	External Walls			
No.	**TYPE OF MATERIAL**	**δ [cm]**	**λ [W/mK]**	**R_λ [m²K/W]**
1	Plaster from CementLime Mortar	5.00	0.87	0.06
2	Hollow Block	30.00	0.47	0.64
3	Styrofoam - Strong Foam	15.00	0.04	3.75
4	Facades	0.40	1.40	0.00
			ΣRλ =	4.45

Internal wall heat transfer resistance: Rb = 0.13 [m²K/W]

External wall heat transfer resistanceHeat transfer resistance: : Rj= 0.04 [m²K/W]

Rk=Rb+ΣRλ+Rj= 4.62 [m²K/W]

Heat transfer coefficient: k=1/Rk= [W/m²K] 0.35

The same as for external walls, thermal coefficients are calculated for internal walls, floors, ceilings, etc.

So, based on the reference values, it can be seen that for the object, all levels of insulation have been designed in the values necessary for the object to have as little thermal loss or loss of thermal energy as possible. While after the calculations of the results, we extract the data for the necessary thermal energy and for the type of heat pump that will be used for this facility:

The heat pump needed for the object turns out to be Q=16 kW, Vitocal 200-S.

Table 2. Values of coefficients for some types of insulation.

Type of insulation	U values	Reference Values
External Wall	0.35	0.3
Tiles on the ground (floor)	0.5	0.5
External windows	1.4	1.4
External doors	1.6	1.6
Roof	0.35	0.3

Figure 3. Heating pump

Electrical analysis of the object

As for the electrical analysis, we calculate the annual consumption, which is expected to be around 25,000 kWh/year, it can also be seen from the following diagram where the data is presented in percentage according to the electrical expenses used for this residential object.

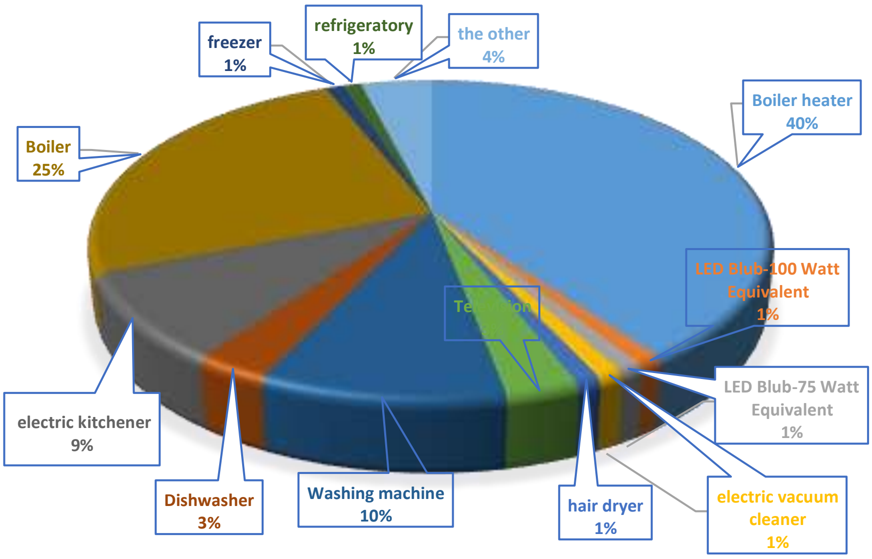

Figure 4. The electrical expenses of the equipment

The devices that are expected to be used are devices that have a very low energy consumption (A+++) and also in this object the implementation of the Smart Home system is foreseen.

Figure 5. Energy efficienc

Dimensioning of the photovoltaic system

Dimensioning is relatively simple in the case of grid-connected plants as it is assumed that the public grid will be able to absorb the energy generated at all times. This is very different for standalone systems: here the consumption must be determined as accurately as possible and then the PV generator and storage must be dimensioned according to the radiation conditions at the plant location.

Dimensioning of the PV generator

We will supply the building with the photovoltaic system in order to be independent from the electricity grid. So, based on our calculations, we will need to supply with electricity during the time of operation of the heat pump for the purpose of heating the building and sanitary water with a nominal power of 3.6 kW and the electricity consumption of household appliances. If the utilization coefficient of the installed power is c = 0.6, then it is determined that the simultaneously used power is P_mnj=3 kWh.

The total power (in hours) usable by the building's systems is:

$$P_{h.mp} = 3.6kW * 7h = 25.2kWh \quad (1)$$

$$P_{e.pomp} = 3kW * 24h = 72kWh \quad (2)$$

$$P_t = P_{h.mp} + P_{e.pomp} = 25.2kWh + 72kWh = 97.2kWh \quad (3)$$

From the above calculations, it results that the total number of panels needed is 32, of which 17 solar panels are needed to cover the peak demand and 15 solar panels.

Dimensioning of Batteries

Because a voltage of 48 V is generated at the output of the inverter, in our case we will have to realize the circuit of 2 batteries in series, divided into 12 parallel pieces. So these batteries should be 24 [V], since we have 2 batteries connected in series, the voltage should be 48 [V], while we have 200 [Ah], since we have them separated by 12 pieces in parallel, in order to obtain the amount necessary for the consumption of electrical energy from the network to become 0, on average per day we need to store the electrical energy of approximately 60 kW, which energy storage is achieved through this combination of configuration Solar panels + Battery + Inverter.

$$P = V * [VA] = [W] \quad (7)$$

$$I = \frac{P}{V} = \frac{7000W}{48V} = 145.83[A] \quad (8)$$

We need batteries to supply us for time t=16 [h] with load P=7000 [W] therefore:

$$P = I * t = 145.83[A]16[h] = 2334[Ah] \quad (9)$$

$$t_{batteries} = \frac{Q}{I} = \frac{2334}{200} = 12\ batteries\ in\ parallel \quad (10)$$

PV plants with storage system vs. PV plants without storage

The table below shows the value of investments (with and without batteries) based on the required amount of photovoltaic panels for the case study.

Table 3. Value of investments for PV plants with storage system.

PV plants with storage system						
Before Investment				After Investment		
Type of expenses	[kwh/year]	Price	Total expenses	Price	Total expenses	The difference in €
Electrical appliances	25000.00	0.06	1,500.00 €		- €	1,500.00 €
Electric boiler	17640.40	0.06	1,058.42 €		- €	1,058.42 €
Total	42640.40		2,558.42 €		- €	2,558.42 €

Table 4. Value of investments for PV plants without storage system.

PV plants without storage system	
Before Investment	After Investment

Type of expenses	[kwh/year]	Price	Total expenses	Price	Total expenses	The difference in €
Electrical appliances	25000.00	0.06	1,500.00 €	0.06	525.00 €	975.00 €
Electric boiler	17640.40	0.06	1,058.42 €	0.06	952.58 €	105.84 €
Total	42640.40		2,558.42 €		- €	1,080.84 €

In the tables below, we have presented the amount of electricity consumed by the facility and the coverage of that amount for one year by solar panels with and without batteries, and the return on investment in both cases has also been presented.

Table 5. System cost (PV with batteries)

System Cost		Amount	Price	Total
Photovoltaic system **with** batteries	Set	13	2,800.00 €	36,400.00 €
Heating Pump	pcs	1	7,500.00 €	7,500.00 €
Grand Total				43,900.00 €

Table 6. System cost (PV without batteries)

System Cost		Amount	Price	Total
Photovoltaic system **without** batteries	Set	6	1,400.00 €	8,400.00 €
Heating Pump	pcs	1	7,500.00 €	7,500.00 €
Grand Total				15,900.00 €

Table 7. Return of investment (PV with batteries)

Investment value	43,900.00 €
Total savings per year	2,558.42 €

Return (in years)	17

Table 8.Return of investment (PV without batteries)

Investment value	15,900.00 €
Total savings per year	1,080.84 €
Return (in years)	15

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PVsyst & PVSol Software Testing

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Abstract. This paper deals with a theoretical, numerical as well as an appliedempirical analysis of photovoltaic systems of renewable solar energy for electricity generation. The analysis has been applied in 2 case studies of the solar photovoltaic system installed in Ferizaj.

The PV system analyzed has two different PV systems with an installed capacity of 20.1 kWp and is monitored by device "SolarWeb" by measuring the concrete on-line electricity generation values. The generated electricity from this PV system is for Self-consumption and that can be defined as the share of the total PV production directly consumed by the PV system owner.

The software simulation and analysis of the PV-system system has been carried out by applying four different software packages in order to establish the differences in their calculated outcome results and the degree of compatibility with the measured energy generation thru the Solarweb Measurement system. Various operating regimes of the PV system have been simulated for solar electricity generations by applying the PV-Syst Version 6.81, HelioScope, PVGIS-5 as well as PVSOL Premium 2021 software's package for this case study and relevant results have been obtained and analyzed. These obtained simulation results have then been compared with the real measured values of generations of the photovoltaic system that have been monitored during the case study.

Keywords: Photo-voltaic Systems On-Grid, efficiency of PV systems, solar radiation, solar cell, solar panel, invertors

1 STUDYINGCASE

1.1 Description and the placement of the photovoltaic system on the grid of "Ferizaj"

Ferizaj is located in the south-eastern part of Kosovo, about halfway between the cities of Pristina and Skopje. It is some 230 kilometers north-east of Tirana, 55 kilometers north of Skopje, 300 kilometers west of Sofia, 35 kilometers south of Pristina and 300 kilometers east of Podgorica. [1]

Photovoltaic system with an installed power of 20.1kWp, where the solar energy generated by the photovoltaic system is placed on the distribution electrical grid 400V.

In this study case we have made analysis and comparison only for installed power of 20.1kWp On Grid.

In the 1st picture it is presented the placement of the photovoltaic system. [2]

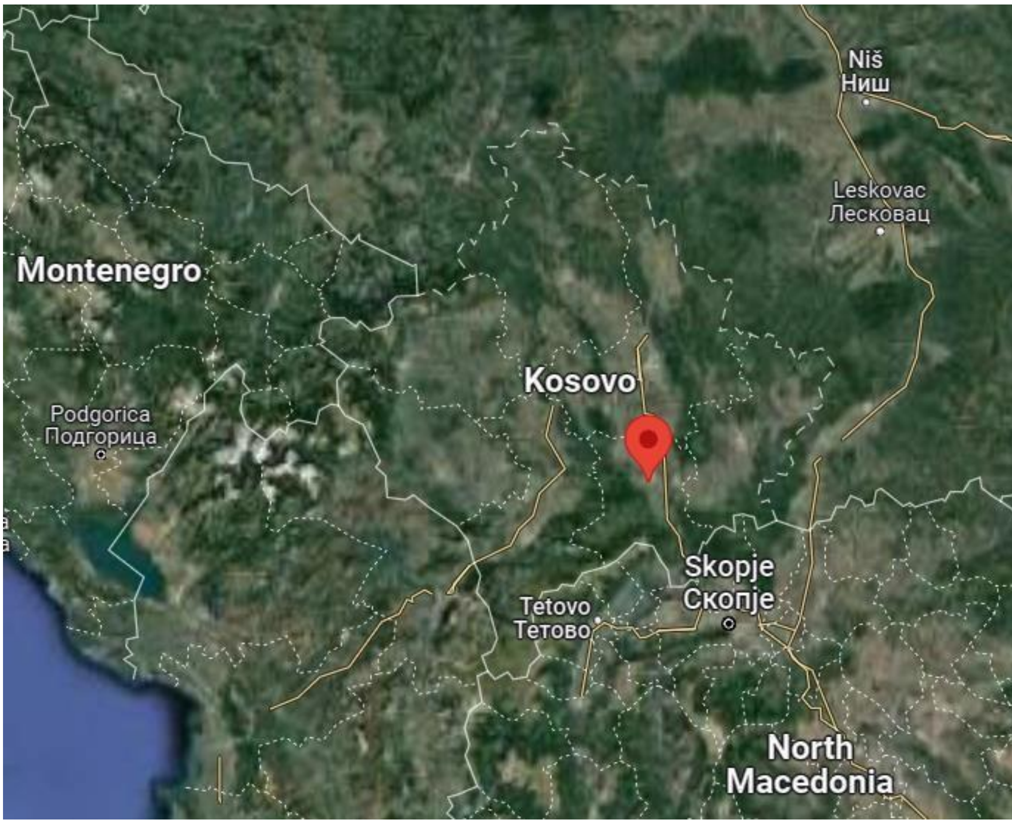
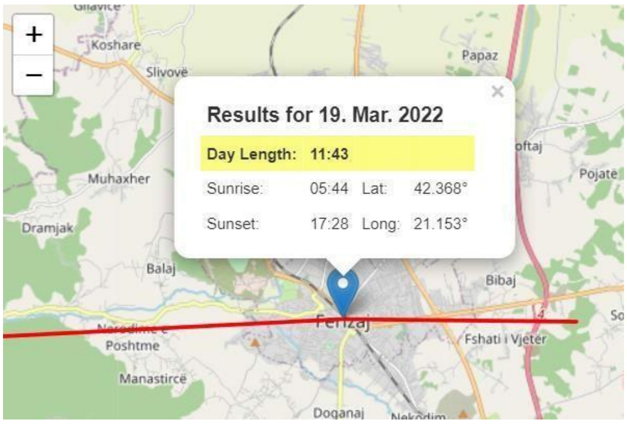
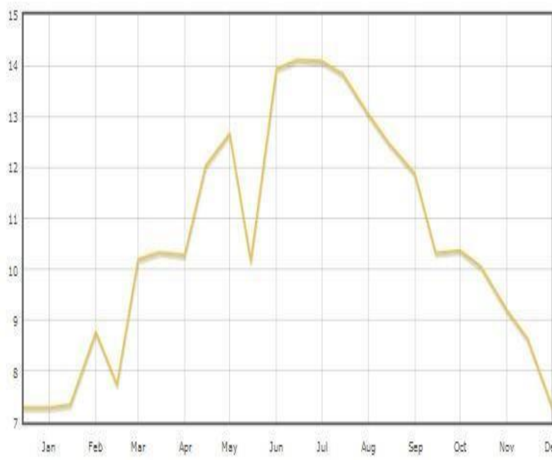


Figure 1. The placement of the reviewed photovoltaic system

In the 2nd picture it is presented graphic for hours with sun during a year in the

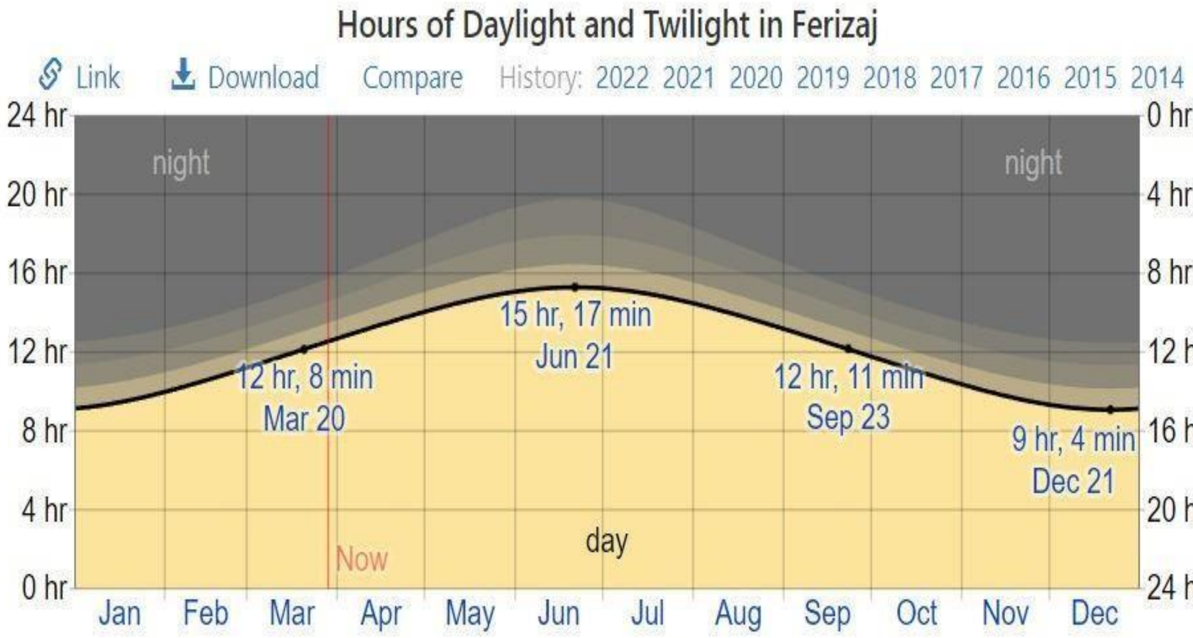




placement of the photovoltaic system. [3][4]

Figure 2. The location of the PV system and the graphic of hours with sun during a year in Ferizaj

Figure 3. Hours of Daylight and Twilight in Ferizaj [5]



The number of hours during which the Sun is visible (black line). From bottom (most yellow) to top (most gray), the color bands indicate: full daylight, twilight (civil, nautical, and astronomical), and full night.

Hours of	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daylight	9.5h	10.6h	12.0h	13.4h	14.6h	15.2h	14.9h	13.8h	12.4h	11.0h	9.8h	9.1h

In the 3rd picture it is presented the diagram of the average temperature in the placement of the photovoltaic system on grid within a year. [5]

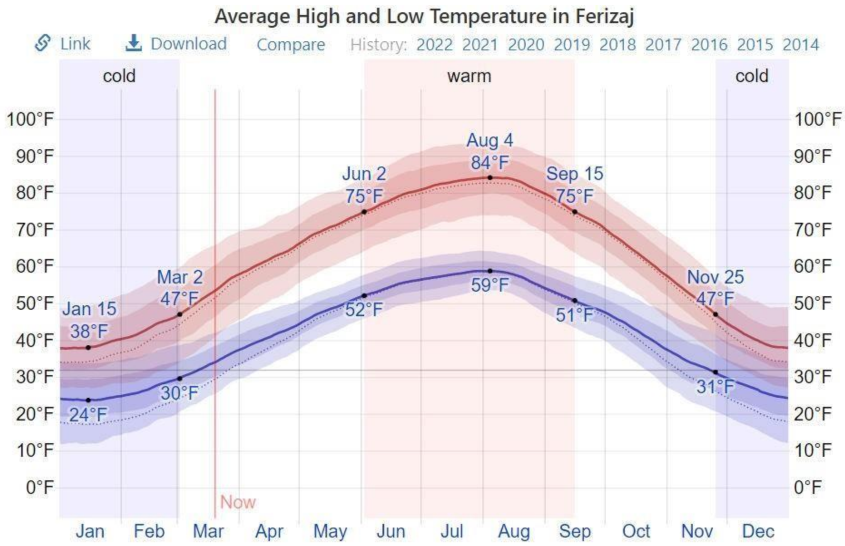


Figure 4. The yearly average temperature

1.2 Solar Energy-Ferizaj

The average daily incident shortwave solar energy experiences extreme seasonal variation over the course of the year.

The brighter period of the year lasts for 3.1 months, from May 18 to August 21, with an average daily incident shortwave energy per square meter above 6.4 kWh. The brightest month of the year in Ferizaj is July, with an average of 7.4 kWh. The darker period of the year lasts for 3.6 months, from October 30 to February 16, with an average daily incident shortwave energy per square meter below 2.9 kWh. The darkest month of the year in Ferizaj is December, with an average of 1.7 kWh. [5]

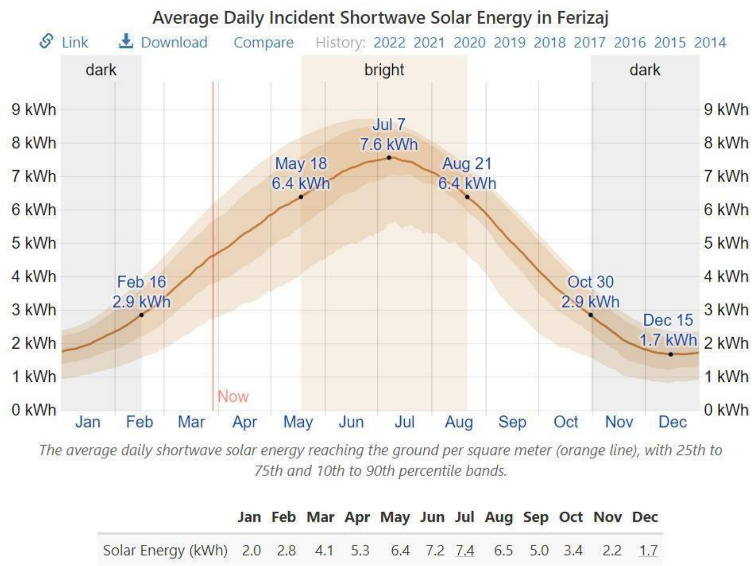


Figure 5. Average Daily Incident Shortwave Solar Energy in Ferizaj

1.3 Configuration of the photovoltaic system On Grid in Ferizaj

Table 1. Characteristics of Photovoltaic System

Description 1	**Description 2**	**Value and Unit**
System Type	ON-Grid	
The panel of mono-crystalline type	AE Solar-A335	P_M=335W
Maximum power Voltage		U=34.02V
Maximum power Current		I=9.85A
Open-Circuit Voltage		U=41.49V
Short-Circuit Current		I=10.49A
Module Efficiency		19.90%
Dimensions of panel		1690x996x35mm
Three phase inverters	Fronius Symo 20.0-3-M	P_I=20 kWac

Panels linked in series	20	
Panels linked in parallel	3	
Total number of inverters	1	
Total number of panels	60	
Power of PV		21.1kWp
The surface of the photovoltaic system	Approximately	$120m^2$

1.4 Input data of the photovoltaic system on grid

1.Installed power of the PV-system, P =20.1kWp.

2.Panel`s angle **Φ**=*30⁰*

3.The number of inverters is 1, *P=20kVA*

4.The number of panels in series is 20 with 3strings parallel and the power of the panel P= 335W.

5.Ferizaj's map with yearly radiation 1400kWh/m² [7]

In the 4th picture it is presented the algorithm of the software package from which we gain the exit results from the operation of the photovoltaic system applied in Ferizaj.

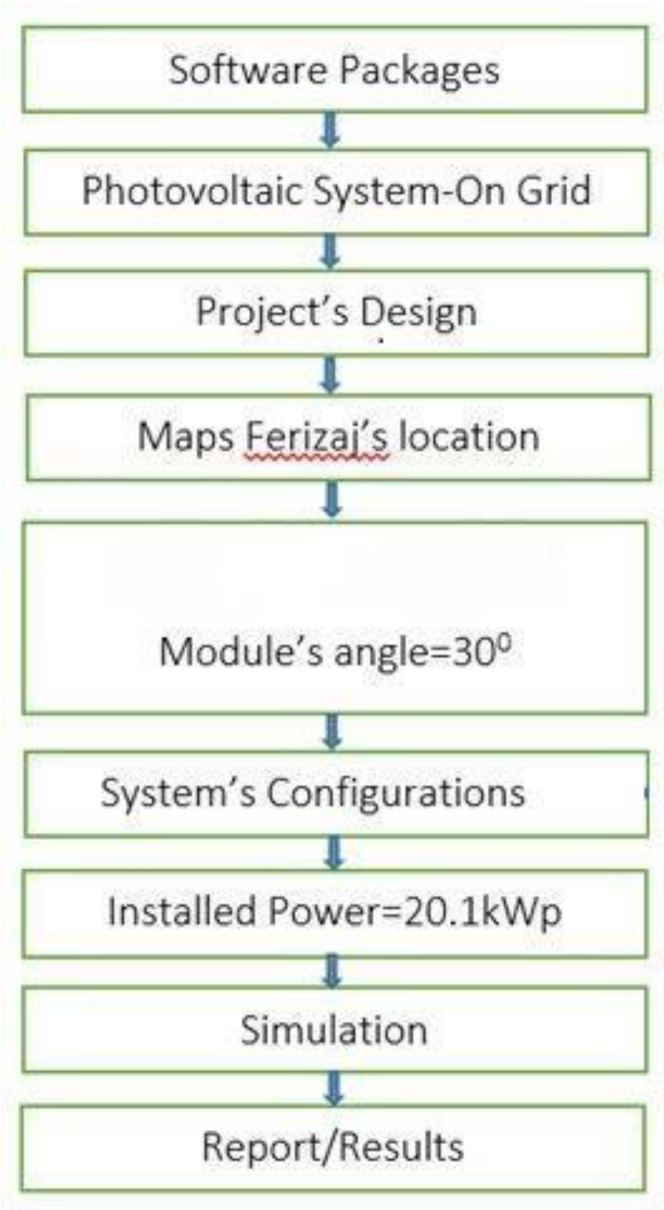


Figure 4. Algorithm of the software package

2 FINAL RESULTS

In the second table are presented the final results simulated in different work regimes as well as the real values measured and monitored of the photovoltaic system on grid applied in
Ferizaj.

Table 2. The final results for the period of July − September

The final results for the period of July − September								
Simulated PV system with the software package								
	Solarweb	Solarweb	PV-Syst6.81	PV-Syst6.81	HelioScope	HelioScope	PV-SOL	PV-SOL
	South-East	East	South-East	East	South-East	East	South-East	East
	[kWh]	**[kWh]**	**[kWh]**	**[kWh]**	**[kWh]**	**[kWh]**	**[kWh]**	**[kWh]**
July	2,873.25	2,286.87	3,301	3,255	3,089.00	2,934.55	2,998.2	2,828.4
August	2,809.26	2,322.58	2,851	2,751	2,612.00	2,481.4	2,582.1	2,403.5
September	1,796.31	1,872.72	2,064	1,943	1,972.00	1,873.4	1,871.1	1,733.3
Produced energy	**7,478.82**	**6,482.17**	**8,216**	**7,949**	**7,673.00**	**7,289.35**	**7,451.4**	**6,965.2**

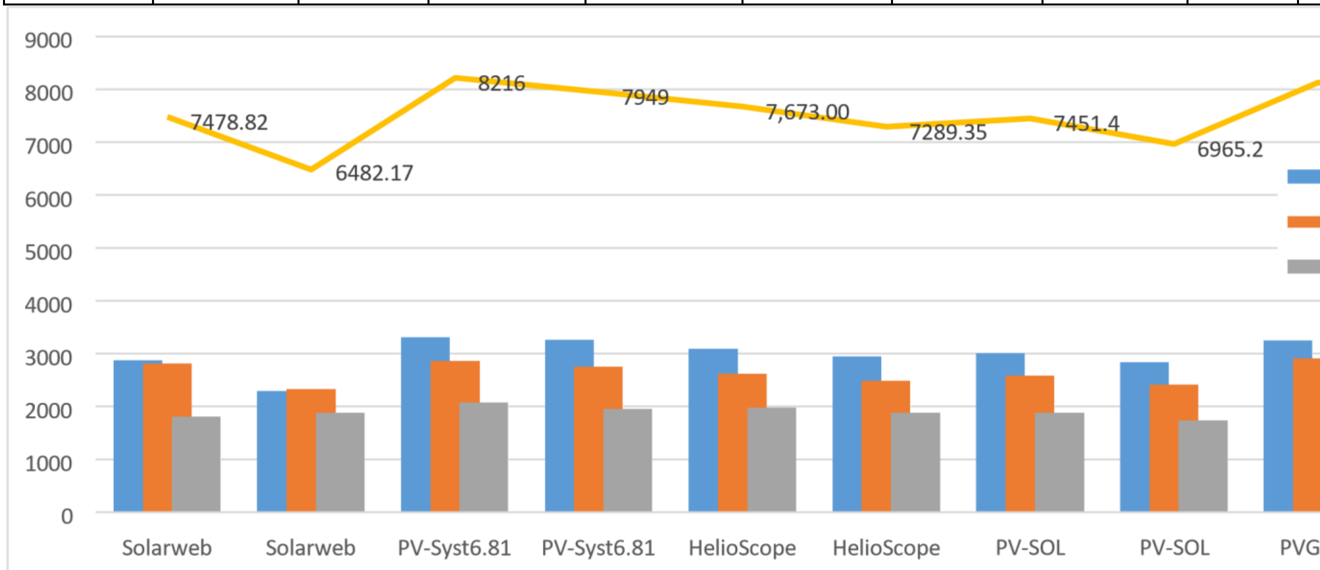


Figure 6. Differentiation Diagram for energy

2.1 Detailed diffraction of losses of the photovoltaic system On Grid

In the addressed studying case the panel of the mono−crystalline with a projected power of 335Wp the loss of the power due to the temperature will be 5.12%. In this calculation it is considered an average temperature during the warm period of the year. Nevertheless, on the cases of a specific project usually are estimated the maximum and minimum losses during an entire year.

The losses of global incident in coll. plane 3.64%, IAM Factor on global is 4.38% loss.

PV loss due to irradiance level 6.65% and module quality loss are 1.22%. Mismatch loss, modules and strings 1.1% and Ohmic wiring loss 0.86%. Inverter loss during operation 2.18%, Inverter loss over nominal inverter power 0.25%, Inverter loss due to power threshold 0.01%.

In conclusion the loss estimation of the system for the worst case scenario, taking in consideration all the calculated loses is 25.41%.

3 CONCLUSION

In this paper are addressed and analyzed the theoretical, numerical, empirical and applicative part of the photovoltaic system of renewal sources for the generation of electrical energy. Numerical analyzes of the photovoltaic system of the generation have been conducted by applying numerical software package and programs in order to simulate different working regimes of these generating systems from the renewal sources.

The generated energy from the studied PV system is for self-consumption.

Photovoltaic systems generate solar energy only during the day and that depending on the solar radiation respectively from the solar hours in the applied locations. Correspondingly, in the examined case during the period of July−September where in average is 6h in a day. For the location and the exploitation of the PV system addressed in this studying paper, the yearly energetic potential of solar radiation during the day contains the value of 4kWh/ m² in a day. Solar radiation differentiates during the year depending on many factors such as the location of system application respectively relevant geographical coordinates, season or the seasonal application period including the time periods day−night, average temperature, as well as the other factors that are resumed with the average solar radiation for a specific selected time period of application. The highest values of solar radiation are registered during the month of July and August whereas the lowest are in December and January, along with the solar radiation energy that differs from one day to another, furthermore even within a day due to the climatic changes and the differentiation of the weather – clear or cloudy.

Based on the STC− Standard Test Conditions for the solar radiation panels AM1.5 serves as a standard spectral distributor and it corresponds with an angle of 48.2° between the positions of the sun and zenith which contains intensity of the solar radiation value 1000 W/ m² and a cellule temperature of 25°C.[12][14][15] Solar generation of a panel is decreased in a cellule temperature above 25°C and it is increased below 25°C. Minimal effective cellule temperature it is equal with the temperature of the environment +25°C. Usually a mono – crystalline panel contains a coefficient of the temperature of −0.45%/°C which means that per each grade °C above 25°C the output power will be reduced for 0.45%. Poli−crystalline panels in the reviewed study contain a coefficient of temperature −0.45%/°C where the losses of the power in the environmental temperature of30°, which at this point the panel reaches it from 55° will be 12.3%.[9][10][11][13].

This conclusion shows that the efficiency of solar energy usage is a function of the used technology with the yearly distribution of the solar energy radiation potential. According the real values of the study case CO_2 Emissions are reduce for 11,460kg/year

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SCADA system in control and automation of distribution system

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Abstract. The power system is a very complex system because it consists of many interconnected elements. For this reason, there was a need to create automated systems that would enable the power system to be monitored and controlled remotely. One of the systems that enables such a thing is the SCADA system. The importance of having such an integrated system in the electricity network is very great therefore given the importance of this system in the power system then it is important to know the types of this system, the ways of its realization and the advantages. This paper generally deals with the SCADA system, the characteristics of this system and the equipment related to this system. This paper is an attempt to bring realization and application of the SCADA system in the distribution network of Kosovo. The overview of SCADA system implementation, the evolution, the data acquisition process and the using of SCADA in the distribution network will be described within this paper..Therefore, the purpose of this paper is to present in more detail the digitization of substations through the SCADA system. This paper will discuss the types of SCADA system equipment (elements) in the Kosovo Distribution System and their installation in power substations, connection between the control center and the power substation. The working methodology for the preparation of this paper is based on the practical knowledge and scientific research about world-wide experiences for SCADA system software.

Keywords: SCADA, distribution network, control system, automation system, Remote Terminal Unit.

Introduction

The purpose of the power system is to operate on the basis of technical parameters and to offer consumers a quality and uninterrupted supply of electricity. However, the challenges to stick to this goal are many, because in recent years this system is going through the phase of transition from traditionally simple networks to advanced and smart grids. Managing of the electric power system, its maintenance, control and monitoring are the main challenges of the companies that operate with the power system.

SCADA (Supervisory Control and Data Acquisition) is system control and data acquisition, whose basic function is monitoring, commanding and real-time data collection from all power substations.

SCADA (supervisory control and data acquisition) has been around as long as there have been control systems. The first SCADA systems utilized data acquisition by means of panels of meters, lights and strip chart recorders. The operator manually operating various control knobs exercised supervisory control. These devices were and still are used to do supervisory control and data acquisition on plants, factories and power generating facilities [1].

A SCADA (supervisory control and data acquisition) is an automation control system that is used in industries such as energy, oil and gas, water, power, and many more. A SCADA system works by operating with signals that communicate via channels to provide the user with remote controls of any equipment in a given system. It also implements a distributed database, or tag database, that contains tags or points throughout the plant. These points represent a single input or output value that is monitored or controlled by the SCADA system in the centralized control room. The points are stored in the distributed database as value-timestamp pairs. It's very common to set up the SCADA systems to also acquire metadata, such as programmable logic controller (PLC) register paths and alarm statistics [2].

SCADA implementation thus involves two major activities: data acquisition (monitoring) of a process or equipment and the supervisory control of the process, thus leading to complete automation. The complete automation of a process can be achieved by automating the monitoring and the control actions [3].

Automating the monitoring part translates into an operator in a control room, being able to "see" the remote process on the operator console, complete with all the information required displayed and updated at the appropriate time intervals. This will involve the following steps [3]:

- Collect the data from the field.Convert the data into transmittable form.

- Bundle the data into packets.
- Transmit the packets of data over the communication media.
- Receive the data at the control center.
- Decode the data.
- Display the data at the appropriate points on the display screens of the operator.

Automating the control process will ensure that the control command issued by the system operator gets translated into the appropriate action in the field and will involve the following steps [3]:

- The operator initiates the control command.
- Bundle the control command as a data packet.
- Transmit the packet over the communication media.
- The field device receives and decodes the control command.
- Control action is initiated in the field using the appropriate device actuation.

The monitoring and controlling method of the power system has a great weight in the managing of the distribution of electricity from the production to the load. This is also the main reason why SCADA is considered as part of the extraordinary modernization of the network by increasing operational efficiency. In order to understand the work of this system, its typical components, the general mode of operation and the ways in which a substation is controlled through it are given and explained in detail.

In an electric power distribution company, the basic functions of a SCADA system include monitoring and controlling the network, storing historical data, creating reports, and many other functions for special application in substation automation.

Taking into account the development trend of new and smart technologies used around the world and based on the importance of having a system that would monitor and control the distribution network, then it was decided that the SCADA system should be implemented in distribution network. The realization of such a system was more than necessary considering that one of the main goals of the Distribution system operator, which is providing of their their customers with high quality uninterrupted electricity supply. Remote network monitoring and control will go a long way toward achieving this goal. This paper is an attempt to bring the realization of the SCADA system and the elaboration of the application of such a system in the distribution system of Kosovo.

The paper is structured as follows: Elements of the SCADA system in the distribution network are presented in section 2; Installation of SCADA system equipment in power substations are presented in section 3; The connection between control center and substation is presented in section 4; Main control center and SCADA system software is presnted in section 5; The results of the implementation of the SCADA system in the distribution system are presented in section 6 and finally Conclusions of this paper are summarized in section 7.

Elements of the SCADA system in the distribution network

After the detailed analysis of all the data collected from the field and after the detailed analysis of all devices that are in the substations and that will be interconnected with the SCADA system, should continue with the definition of the devices that will be installed through electrical substations to enable remote control and monitoring. In order to enable the proper operation of a system such as SCADA in the distribution network, there are a large number of devices and materials which are connected to each other. The most important devices of the SCADA system in the distribution network are as follows:

- Remote Terminal Unit (RTU)
- Communication system
- Main Station (Master Station)
- Human Machine Interface (HMI)

RTU (Remote Terminal Unit)

RTU (Remote Terminal Unit) represents an electronic device controlled by a microprocessor that makes the connection between objects with the SCADA system. Its main task is to control and receive data from equipment at a remote location and transfer this data back to a main station.

Fig.1. Different types of RTUs [4, 5]

An RTU uses input modules (analog or digital) to collect field data and then monitors digital and analog parameters whose data it then transmits to the control center. In addition, this device contains configuration software to connect data streams to data production streams and above all to define communication protocols. So the hardware part of this system consists of digital inputs, digital outputs, memory, communication interface and the supply part of the device. The supply of this equipment to the substations is done with DC voltage so that there is no interruption in communication with it due to the lack of AC voltage.

Communication system

The communication system refers to the communication channels established between the field equipment and the main station. The communication system represents the interface between the SCADA communication network and the internal RTU. All messages from the main station are received and interpreted by the communication subsystem and the required action is initiated within the RTU. The communication channel also carries the control commands that are sent from the control center to the field equipment to keep the power system stable and secure.

Such a thing is even better defined through different communication protocols. Multiple protocols are available for communication within SCADA systems. Protocols are the methodology used to summarize data for transmission between SCADA system components. In Distribution systems, the speed of critical data transfer is sometimes a matter of milliseconds, which makes it necessary to use technologies and protocols that help in this aspect.

One of the most important communication protocols is IEC61850. This standard is an international standard that defines communication protocols for intelligent electronic devices in distributional substations. The IEC 61850 protocol is used for communication between the relays and the RTU, in cases where the relays located in the substations support such a communication protocol. Other important protocols for the communication part are OPC, DNP3, Modbus, etc.

- **Ethernet Switch** - Represents a device in an electronic network that connects other devices together. The optical fiber cables coming from the relays are placed in the ports of this switch, enabling communication with the relays. Since each relay placed in the substation has its own unique address, then each relay connected to this "switch" can be identified by its address.

Fig.2. Ethernet Switch

- **Router** - All RTUs have decentralized architecture and modular design and each of these RTUs is connected to an Ethernet LAN station and a router to communicate with the SCADA. A router is connected to two or more data lines from different networks. Since the switches are connected here on two ports, when a data packet arrives on one of the lines, the router reads the network address information in the packet to determine the final destination. Then using the received information the router directs the information for the other line in this case to the SCADA.

- **Relays or IED (Intelligent Electronic Device)** - One of the most important devices in the SCADA system is the relay, which is a device that is designed to disconnect the power switch when there is a short circuit or other abnormality that is incompatible with parameters set in the relay. The main signals from the substation are received through the relay which also has the communication port where the cables are placed to enable communication with them.

Fig.3. Different types of protective relays

- **Fiber optic cables** – The SCADA system installed in the distribution network uses fiber optic cables to transmit data. Fibers are used instead of metal wires because signals are distributed along them with less loss. Fiber is also immune to electromagnetic interference, a problem that affects most other types of cables.

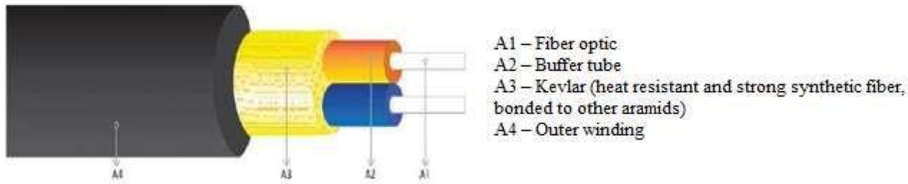

Fig.4. Fiber optic cable

- **Motion and Fire Sensors** - Motion sensors are placed in substations to detect moving objects and the movement of people. While fire sensors are sensors that detect smoke or heat. This device responds to the presence of smoke, fire or extremely high temperatures in the substation. When the sensor detects the presence of smoke or fire, it will send a signal to the SCADA system.

Main Station

Another very important component of the SCADA system is the main station, which represents a collection of computers, peripheral devices and appropriate input and output systems, that enable operators to monitor the state of the distribution system. In systems that are large, the main station consists of multiple servers and computers. The main station displays the received data and also allows the operator to perform remote control tasks.

Human Machine Interface (HMI)

Human-machine interface (HMI) refers to the interface required for interaction between the main station and operators or users of the SCADA system. HMI software is a computer system that processes data and allows an operator to manage and control the system remotely. All the information collected by the RTUs at different points is received in the control center in the SCADA system software.

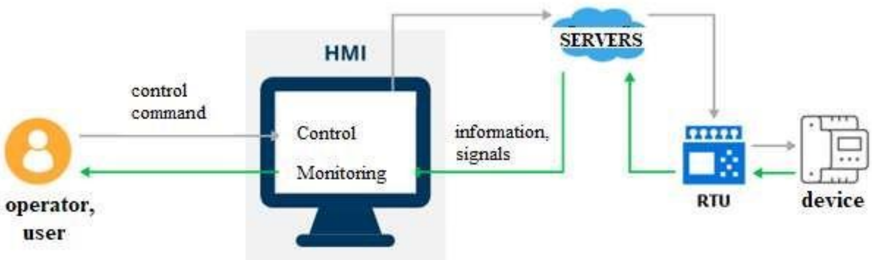

Fig.5. HMI (Human Machine Interface)

HMIs provide operators at the control center with information gathered from multiple RTUs located at various points. This information is presented in the elements presented graphically in the section of different schemes and in the section of alarms in the form of messages. The signals received in this system are numerous and are categorized into two groups:

- **Analog signals** - Analog data includes all continuous, time-varying signals from the field. Examples are voltage, current, power, temperature, etc.
- **Digital Signals** - Represents a discontinuous signal that changes from one state to another in discrete steps, usually represented in binary, or two levels, low and high. In an distribution system, the digital signal can be considered the position of the cricuit breaker, which can have two positions (on or off).

Installation of SCADA system equipment in power substations

The SCADA system in Kosovo distribution system already hasb been implemented in all 35/10 kV and 110/10(20) kV substations, where the distribution operator is also part and in real time they monitor and control the electrical network. So from the control center the monitoring of the entire medium voltage level network 35 [kV], 20 [kV], 10 and 6 [kV] can be done.

In order to receive the correct signals in the SCADA system, it is necessary that the existing equipment in the substations be suitable for this integration. The changes in electrical equipment for the implementation of the SCADA system begin after the most important equipment related to the proper operation of the SCADA system has been defined, after the definition of the communication protocols, after the order of the necessary materials [6].

Fig.6. Photo during SCADA system installation [6]

The changes in the equipment of the substations have been many, but they mainly include:

- Adjusting the positions of disconnectors of busbars, lines and earthing for each alcove
- Adjusting the positions of the circuit breakers
- Circuit breakers spring tuning link
- Replacement of circuit breakers
- Changing redirectors
- Changing the batteries

While the installation of the SCADA equipment begins at the moment the necessary changes are made to the equipment of the electrical substations, which then pave the way for the installation of the necessary equipment for the operation of the system. In order to install the SCADA in the substations, the following works were done:

- Installation of fiber optic cables
- Installation of the RTU and its panel
- Installation of router and internet switches
- Installation of fire and motion sensors
- Installation of limit switches
- For the openings without relays, but from which the positions of the busbar disconnectors must be taken, installation of the cables up to the RTU has been done

- Installation of cables from the redirector to the RTU panel

The connection between control center and substation

The main device in the SCADA system installed in the power distribution system of Kosovo is the RTU (Remote Terminal Unit) through which data is transmitted and received. The RTU receives all field data from the relay, processes the data and transmits the relevant data to the system. The system collects information (such as failures), transfers the information back to the control center and then notifies the control center operators that a failure has occurred, performing the necessary analysis and control, such as determining whether the failure (fault) is critical or not and displays this information in a logical and organized form. At the same time, the RTU distributes the control signals received from the control center to the field equipment.

Fig.7. The connection between control center and substation

Main control center and SCADA system software

The entire distribution network is managed by the main control center. The main control center has many operator workstations and several supervisory/engineering workstations. All workstations have the ability to transform into another type of workstation. The control center receives real-time and non-real-time information from all RTUs installed throughout the distribution network and from all other smart devices. In this center there is also a very large wall screen (video wall) which enables the system to be seen very clearly.

Another important part of the system is the software that enables substation control. When designing the software for a SCADA system, the various field/device signals must be considered in terms of what information will be monitored and what equipment will be controlled. The SCADA system also has software integrated into it, which enables the presentation of signals and the entire system connected to SCADA, in this case the single line diagrams (schemes) of the substations.

The possibilities offered by the software used by operators and other responsible persons are numerous and these possibilities can be divided into two categories:

- **The possibility to monitor the data** – the data that can be monitored in real time are many and include the position of the elements of the alcove (busbar, line, earthing, circuit breaker), the values of the currents for each phase, values of voltages, active power, reactive power, apparent power, energy, power factor, frequency, relay parameters, etc.
- **Ability to command (control)** – devices that are remotely controlled are circuit breakers and protective relays. So the circuit breakers can be turned on and off remotely. The moment a feeder is out of function due to any breakdown or fault, operators stationed at the control center will receive such information in real time. The information will immediately be transferred to the teams that are in the field. After the adjustment, the feeder will be connect immediately through SCADA.

Based on the list of substation signals, all messages that are recorded in the SCADA are stored in the system archive and such data can be used for various analyzes that serve for better decision making. The same applies to all analog-digital easurements. All the values of these measurements are stored in the SCADA archive. Based on this, real-time decisions can be made, improved analysis techniques can be implemented that affect the daily activities of the workforce.

The results of the implementation of the SCADA system in the distribution system

Modern SCADA systems are contributing and playing a major role in the distribution system towards achieving:

- New levels in the reliability of the distribution network
- Proactive problem detection and resolution - higher reliability
- Meeting the necessary requirements for energy quality - increasing customer satisfaction
- Making strategic decisions in real time

The operator of the distribution system with the realization of this system aims to:

- Prevent any problem or fault presented in the field
- React quickly and accurately to the problems presented in the field
- Accurately control the equipment and the installed electrical network from a distance
- Reduce the duration of interruptions
- Increase the efficiency and quality of workers
- Reduce technical losses by applying different techniques
- Provide electronically network status information as requested by any authorized entity.
- Monitor and control the system from a control center and reduce dangerous maneuvers from the point of view of protection and safety at work.

Conclusions

The main motivation for accepting the automation of the power distribution system in developing countries as in the case of Kosovo, is to improve the operational efficiency of the distribution system. SCADA systems make it easier for operators to control large and small processes. This impact is clearly seen in the response quickly and accurately to the problems presented in the field, in reducing the duration of interruptions, in increasing the efficiency and quality of the workers, in reducing technical losses by applying various analysis techniques, etc.

From this paper it is concluded that the realization of the automation of the power distribution system, the integration of SCADA systems can make the power distribution system to function normally and stable in supplying of costumers with electricity. Better information, real-time network monitoring and control, increased system efficiency, increased customer satisfaction with electricity supply, improved service reliability, more accurate decision making are just some of the features of the automation of the power distribution system that are noticed every day during the works performed in the distribution system.

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System Protection Coordination Study for Electrical Distribution System

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Abstract

The power system of Kosovo is a compact and integrated structure in hierarchical aspect. It plays an important role in the process of transmission and distribution energy to the consumers. Based on this importance analysis is necessary in order to estimate the medium- and long-term plans of production of electric energy and development of the power generation plants.

The connection of wind farms the topology of distribution network, which will lead to the change of current detected by relay protection, and the sensitivity and scope of protection will be affected. Cases were examined where three-phase current was short-circuited in different nodes of the system. The case of disconnection of the switch after the operation of the relay protection was considered, and in this case the high-voltage equipment is protected.

Coordination is necessary to achieve fault identification and fault clearing sequence, without good protection coordination, the protection system will lose selectivity, reliability and sensitivity. In this work, defense coordination is designed for the NS Gjilani 110/35 kV system using the conventional technique of system simulation in ETAP software for validation when connection wind farm Koznica with capacaity 45.6MW.

This paper presents an overview on optimal overcurrent relay coordination in protection system and protective relays. Efforts have been made to include all methods used for the coordination of overcurrent relays.

Keywords: Connection, Wind power plant, Protection, Selectivity, Short circuit current, Improvement, Power system

1. Introduction

Renewable sources in the power system play a very significant role, affecting the supply of clean energy to consumers, as well as their positive environmental impacts. Given the European policies for meeting the standards for renewable energy production, then the need for discussion and treatment in this area relies on the capacity of each country to achieve its objectives.

Nowadays, many countries have been promoting the employing of renewable energy in order to produce electricity by distributed generation (DG). DG is a kind of natural energy such as solar energy, wind energy, biomass, and etc., used in the power industry with different technologies.

2. Power system network

Power system network consists of different components like generators, transformers, circuit breakers, current transformers (CT), voltage transformers (VT), cables etc. which are interconnected in a complex manner to provide power supply from source to the end consumer.

3. Relay coordination

A coordination study requires selection of all protective devices in the network right from the power supply to the downstream load side. In the coordination process comparative study to be made on the all the protective devices operating time in response to the different level of fault current in the network and the direction of fault current flow in case of directional overcurrent protection. The objective, of course, is to design a selectively coordinated electrical power system. The numerous data of the power system network are required to be collected and analyzed for appropriate application of the relay grading margins for relay coordination.

Power protection involves using protective devices to insure that in the case of a short circuit or any electrical fault, system components are not damaged and as little of the system is taken down as possible. In order to provide adequate protection for the circuit, these fault conditions must be simulated and analyzed.

The objective of the protection coordination study is to verify that all protective equipment in the system such as relays, breakers, fuses, etc., are properly coordinated and are sized according to the protected equipment.

The electrical protection coordination study is a study or analysis to determine the setting of protection relay and circuit breaker. Its main purpose is to obtain an optimal compromise between protection and selectivity. The study includes determining fault clearing time and coordination of upstream electrical protective equipment. Proper coordination and disruption clearing times can help reduce damage to electrical equipment and protect workers from harm. Study and analysis of coordination of protection equipment is one part of the electric power system

Selectivity of the protection is mainly based on the selection of proper grading time and current. The grading time is the time difference between two consecutive stages of protection. The relay operating time during a heavy fault current condition should not be delayed and at the same time proper margin to be maintained to ensure selectivity. The grading margin principles are used in achieving the desired relay coordination in the power system network.

Overcurrent protection is selected based on the network configuration i.e. radial system or ring main system. With time and current grading, the coordination of the protection relays can be achieved easily.

The benefits of a protective equipment coordination study include:

- Improved system and facility reliability
- Reduces the cost impact of a disruption
- Improved equipment protection
- Increased operating efficiency
- Assist in operations and help prevent unnecessary downtime

- Prevent damage by identifying underrated equipment
- Prevent breakdown by identifying overloaded equipment

Consequently, the over-current protection is the actual most widely applied form of protection. Overcurrent (OC) relay is generally employed as backup protection. But in some conditions it could be the mainly protection provided. A relay needs to get satisfactory chance to protect the sector under its prime protection. Just if the main protection does not crystal clear the failing, the back-up protection must trigger tripping.

Circuit breakers are generally located so that each generator, transformer, bus, transmission line, etc., can be completely disconnected from the rest of the system.

4. Setting of Relay Protection

This point describes the analyzed cases of relay protection behavior in some cases of faults. The first analyzed case is when short circuit current is calculated for faults at Gjilani 3 of substation Gjilani 110/35kV.

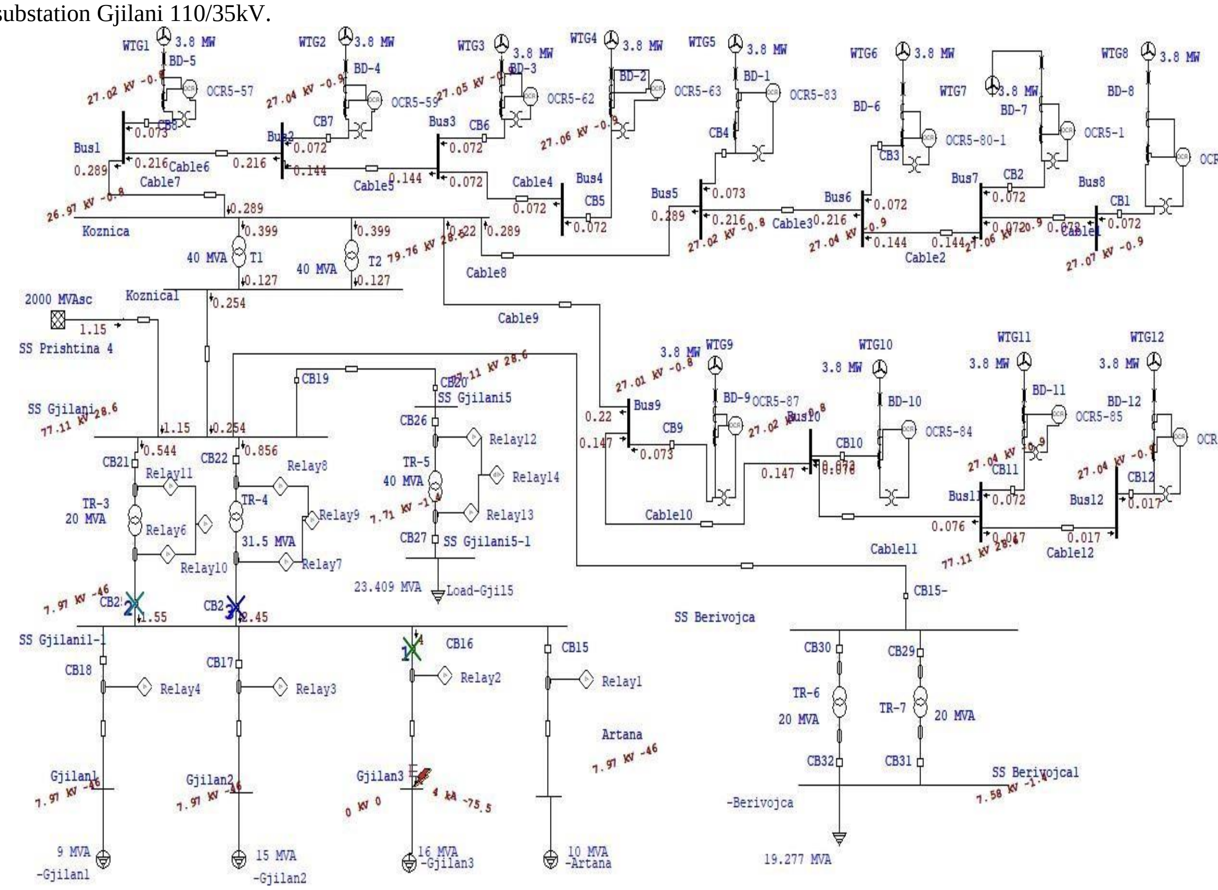


Fig.1. Coordination of relay protections in SS Gjilan 110/35 kV/kV, when the short circuit is in Gjilani 3.

In this case is presented insertion calculation for the Gjilani 3, where is seen the operation of the relay protection on the disconnection of the circuit breakers. First, the relay 2 reacts and trips the CB16 circuit breaker, then relay 10 responds which trips the CB25 circuit breaker and in end relay protection 7 -react and trips the CB28 circuit breaker.

In continue in Table 1. is presented Sequence Operation Event summary report when short circuit is at busbar Gjilni 3.

Project: Koznica- Wind farm	ETAP 12.6.0H	Page:	1
Location: Koznica		Date:	29-06-2022
Contract:		SN:	
Engineer:	Study Case: SM	Revision:	Base
Filename: Koznica		Config.:	Normal

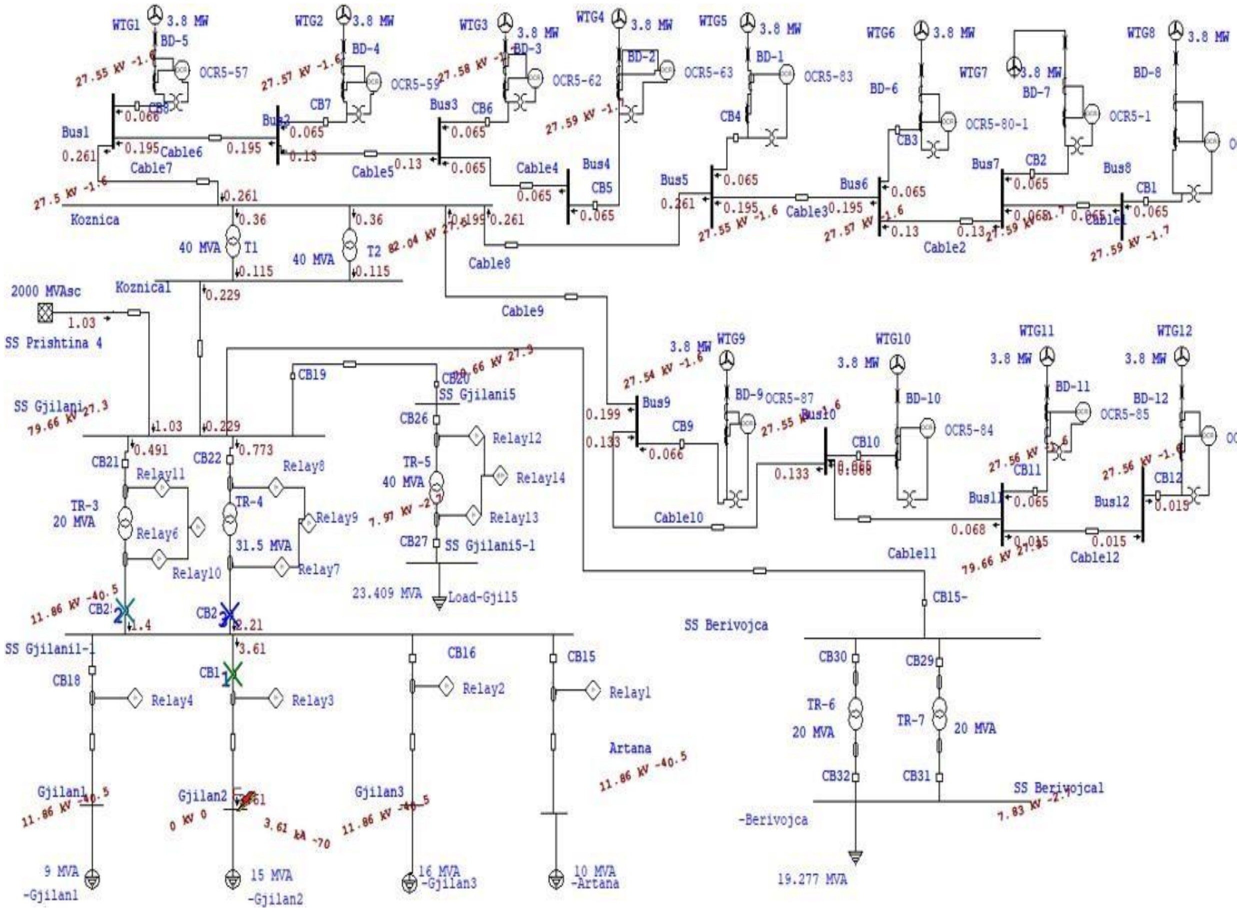
Sequence-of-Operation Event Summary Report

Symmetrical 3-Phase Fault at Gjilan3.

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
10.0	Relay2	3.999	10.0		Phase - OC1 - 50
20.0	CB16		10.0		Tripped by Relay2 Phase - OC1 - 50
505	Relay10	1.553	505		Phase - OC1 - 51
515	CB25		10.0		Tripped by Relay10 Phase - OC1 - 51
553	Relay7	2.446	553		Phase - OC1 - 51
563	CB28		10.0		Tripped by Relay7 Phase - OC1 - 51
743	Relay11	0.544	743		Phase - OC1 - 51
803	CB21		60.0		Tripped by Relay11 Phase - OC1 - 51
844	Relay8	0.856	844		Phase - OC1 - 51
904	CB22		60.0		Tripped by Relay8 Phase - OC1 - 51
1832	Relay6	1.553	1832		Phase - OC1 - 51
1842	CB25		10.0		Tripped by Relay6 Phase - OC1 - 51
1854	Relay9	2.446	1854		Phase - OC1 - 51

Table 1. Sequence-of-Operation Event Summary Report when short circuit in “Gjilani 3” busbar.

Below is presented case when short circuit is in Gjilani 2 busbar and the action of relay protection



Fig,2. Coordination of relay protections in SS Gjilan 110/35 kV/kV, when the short circuit is in Gjilani 2 busbar.

In this case is presented the action of relay protection for the Gjilani 2, where is seen the operation of the relay protection on the disconnection of the circuit breakers. First, the relay 3 reacts and trips the CB17 circuit breaker, then relay 10 responds which trips the CB25 circuit breaker and in end relay protection 7 -react and trips the CB28 circuit breaker.

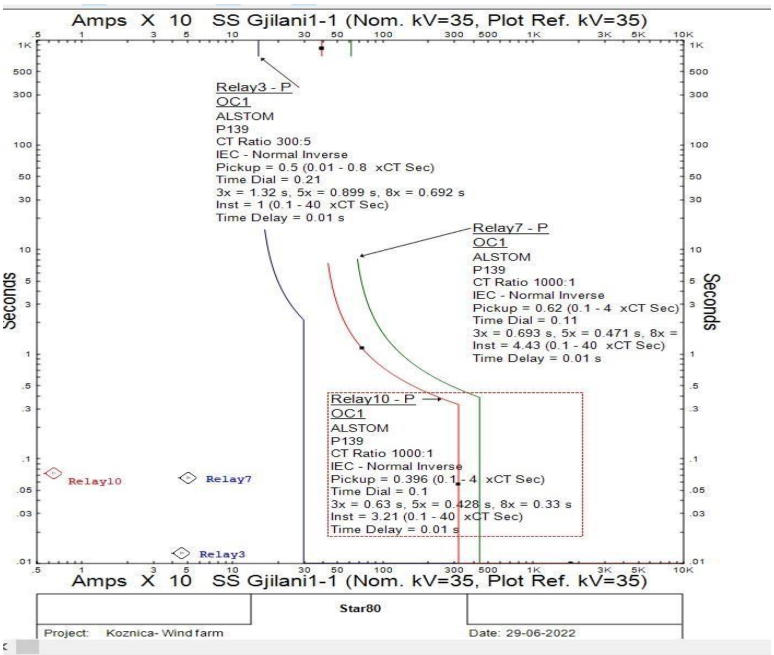


Figure 3. The response of relay protection 3, 10 and 7 when short circuit at Gjilani 2 .

The below is presented case when short circuit current in Gjilani 1-110/35 kV busbar and action rankings of relay protection

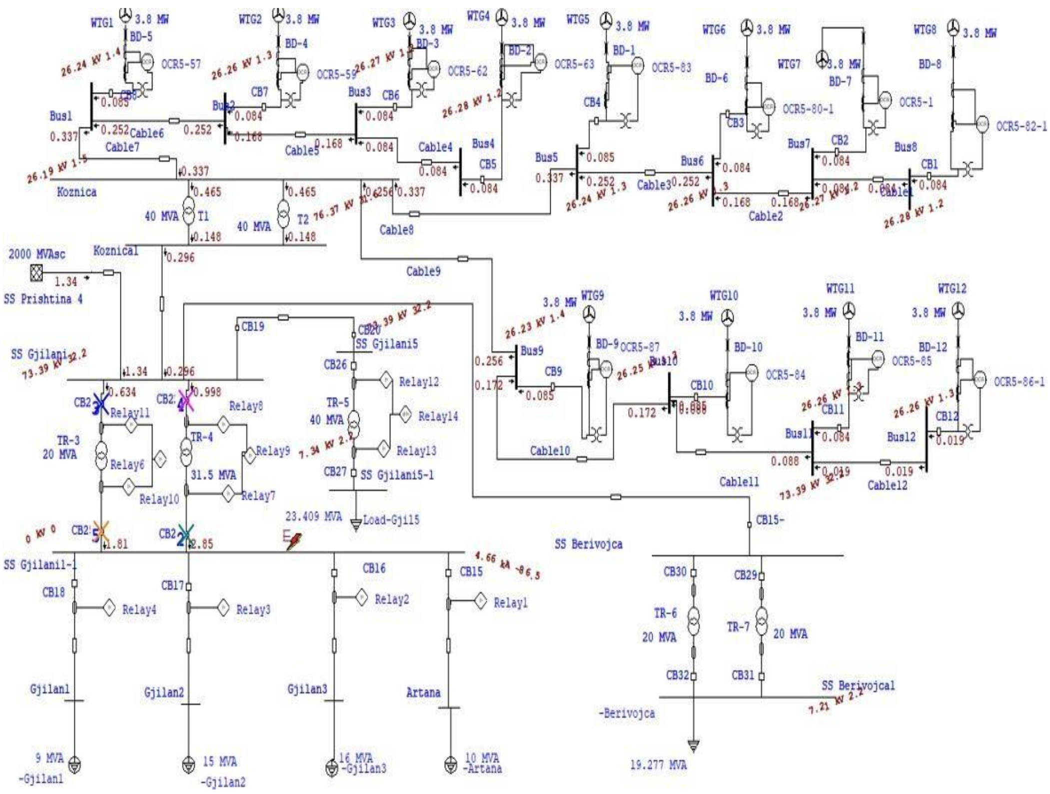


Figure 4. The situation when short circuit current in Gjilani 1 busbar and action rankings of relay protection

In this case is presented insertion calculation for the Gjilani 1, where is seen the operation of the relay protection on the disconnection of the circuit breakers. First, the relay 10 reacts and trips the CB25 circuit breaker, then relay 7 responds which trips the CB28 circuit breaker, relay protection 11 -react and trips the CB21 circuit breaker and in end react relay 8 responds which trips CB22

5. CONCLUSION

Coordination is a systematic application of current actuated devices in a power system, which in response to a fault or overload will remove only a minimum amount of equipment from service. The objective of relay co-ordination is to minimize the equipment damage. In line with the objective the foremost aim is to achieve proper selectivity and speed without sacrificing sensitivity and fast fault clearance time.

Current setting and time multiplier setting of all relays are considered as optimization parameters. Identification of fault and subsequent isolation of faulted section is achieved through appropriate relay coordination study. A coordination study provides data useful for selection of instrument transformers, protective relay characteristics and settings, fuse ratings, and other information pertinent to provision of optimum protection and selectivity in coordinating these devices.

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Sources of Surface Water Pollution in Lake Radoniq

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Abstract. This study aimed to assess the status of the water quality of lake Radoniq. To create knowledge about a water environment that can be used for human life and economy and to meet the needs of drinking water, for irrigation of lands for industry and to give management suggestions based on anthropogenic impact and ecological conditions. The evaluation of the anthropogenic impact on this river was done through physico-chemical, microbiological analyzes and the determination of trace metals. Samples were taken from the Lumbardhi Deçan and lake Radoniq in four periods of 2021 and analyzed for pH, EC, Alkalinity, Total Hardness, Dissolved Oxygen, Iron SAA, inorganic forms of N and P, and total suspended solids , etc.

The environmental risk assessment was done by comparing the results achieved with international standards. The methodology during laboratory analysis is based on ISO standards. The results of the research showed a pollution in the Lumbardh river of Deçan as a supplier of the Radoniq lake as a result of anthropogenic and ecological impact as some parameters had values higher than the standard values.

From the results of the water analysis done during 2021 in Lumbardhin i Deçan, we notice an increase in parameters such as: Turbidity, dissolved oxygen, nitrates, phosphates, $KMnO_4$ expenditure. This increase in parameters is expressed especially in the part where it is inhabited by the population and pollutes the water with uncontrolled spills. Significant control of water quality along the river flow and in the lakes is required.

Keywords: water, parameters, lake, analysis, anthropogenic.

Introduction

Water is the second most important necessity for the existence of life after air. As a result, water quality has been extensively described in the scientific literature. The most popular definition of water quality is "is the physical, chemical and biological characteristics of water" [1, 2]. Water resources are very important for human life and economy and are the main source of meeting the needs for drinking water, land irrigation and industry. The lack of water is considered as a limiting factor of the socioeconomic development of a country.

It is estimated that Kosovo has limited water resources, therefore the protection, preservation and monitoring of their quality is one of the biggest environmental challenges facing our society. Sustainable management of water resources, protection of water and improvement of water quality require special commitment from all responsible factors. Lumbardhi i Deçan has an average flow during the year of $5 m^3/s$ and collects mainly water from nearby sources. The water from Lumbardhi i Deçani is brought to the lake by means of a return structure which returns the water to an open concrete channel with a length of 7.4 km. The water-bearing capacity of the channel is $15 m^3/s$. The lake covers an area of almost 7.5 km^2 and has a depth of 52 m. The water inlets of Lumbardhi and Deçan are the main source and regulator of water in the Radoniq lake. The water of the lake is intended for use as drinking water and for irrigation of lands in agriculture.

Human pressure, generally high is added to other factors (flooding, sedimentation/erosion and intensive urban activities), causing a range of changes in water quality, often in a negative sense.

On the other hand, phreatic waters are closely related to underground waters and the latter to surface waters, strongly influencing their quantity but especially their quality. In plain areas (as is also the case of Lumbardhi) the transfer of deteriorated qualities to the water of the River is fast, being almost the only important source. In urban areas, the demand for water has increased continuously, due to population growth, industrial and agricultural development and the demand for irrigation. An increase in freshwater pollution can be observed due to inadequate uncontrolled water discharge, especially in developing countries [3]. Water quality requirements are a function of the type of food, processing conditions and methods of final preparation at home (cooked/cooked products) [4]

Chemical pollution with an anthropogenic source is caused by urban activity that includes waste produced by daily life in housing, work, traffic, as well as by technological activity that includes industrial production [5]. Water quality and its scarcity are increasingly recognized as one of the most important environmental threats to humanity [6]. Water quality is discussed through a broad review of their common important attributes including physical, chemical and biological parameters. *Turbidity* is a measure of the ability of light to pass through water. It is caused by suspended material such as clay, silt, organic material, plankton and other particulate material in the water[7].

Likeability, viscosity, solubility, smells and chemical reactions are affected by *temperature* [7]. Thus, sedimentation and chlorination processes and biological oxygen demand (BOD) depend on *temperature* [3]. Most people find water at temperatures of 10-15°C more pleasant [7, 8].

pH is one of the most important chemical parameters of water quality. It is a dimensionless number that indicates the strength of an acidic or basic solution [9]. In fact, the pH of water is a measure of how acidic/basic the water is [8,10].

Iron (Fe) and Manganese (Mn) do not cause health problems, they give a noticeable bitter taste to drinking water even in very low concentration [7, 3].

Alkalinity of water is its acid-neutralizing capacity and available from the total of all titratable bases [7]. Measuring the alkalinity of the water is necessary for the amount of lime and soda water that is for softening the water.

Dissolved oxygen (DO) is considered to be one of the most important parameters of water quality in streams, rivers and lakes. It is a key test of water pollution [7]. The higher the dissolved oxygen concentration, the better the water quality. ETC. The assessment of microbial water pollution in the Radoniq lake is a very important parameter. One of the most useful indicators of water quality can be the presence or absence of living organisms [7, 11]. Human bodies maintain a normal population of microbes in the intestinal tract; a large part of which consists of coliform bacteria [12].

Material and Methods

Taking, preserving and analyzing water samples

Water sampling and storage was carried out in accordance with standard methods according to Directive 75/440/EEC for surface water. The amount of water sample for analysis depends on the number of parameters that are determined and the amount of 2 dm^3 is sufficient. Water samples are placed in glass or polyethylene containers, which are previously cleaned with the same water where the sample is taken.

All containers are marked with the place of collection, time, water temperature, air temperature and the name of the person who took the sample for analysis. Some parameters, such as temperature, pH value, dissolved oxygen, electrical conductivity, etc. are determined in the field, at the place of sampling. Samples should be stored in a dark place at a temperature of 3-4 ^{0}C to avoid changes.

The following devices were used to determine the chemical parameters in the laboratory: Spectrophotometer, turbidimeter, etc.

Assessment of lake water quality from a microbial point of view

The water is tested for the presence of faecal coliform bacteria and total coliform bacteria. These organisms are mainly used as pollution indicators. In addition to the physico-chemical evaluation, a bacteriological one was also done during 2021, and the values were taken as the average of these four minimum and maximum study periods of measurement results.

The water samples for this study were taken at different points. For the analysis of total coliforms, the membrane filter technique with porosity (Ø 0.45 μm) was used with the nutrient medium Violet Red bile - Agar, a product of Merck. For coliforms of faecal origin, the nutrient medium - Endo Agar - Less was used. For these analyses, a quantity of water of 100 ml is required, where we then put these in the incubator at a temperature of 37 ºC for 24 hours, and then the reading is done.

Results and Discussions

The experimental research was carried out for the characterization of the water of Lumbardh as a supplier of the Radoniq lake, mainly those samples taken in the four annual periods of 2021 where the relevant results of the analysis are presented in the tables below.

Table 1. Determination of physico-chemical parameters in the river channel and lake, during the year 2021

Parameters		26.02.21	10.06.21	25.09.21	18.12.21
Temperature	º C	6.6	12.3	22.3	7.8
Turbidity	NTU	7.6	11.7	9.5	8.5
pH value	-	8.27	7.85	7.85	7.8
Electrical conductivity	µS/cm	224	194	194	218
Suspended solids	mg/dm^3	117.4	134	114.3	102.8
M-alkalinity	$mval/dm^3$	22.5	21.5	21.5	22
Total solidity	º dH	7.14	6.86	6.86	6.82
Calcium solidity	º dH		5.88	5.88	5.88
Magnesium salidity	º dH		0.98	0.98	0.94
Dissolved oxygen	mgO_2/dm^3	10.4	8.5	9.7	10.1
Iron	mg/dm^3	0.025	0.04	0.023	0.02
Manganese	mg/dm^3	0.054	0.043	0.033	0.028
Aluminum	$mgAl/dm^3$	0.025	0.02	0.01	0.03
Chlorides	$mgCl^-/dm^3$	4.33	4.25	4.32	4.35
Ammonia N-NH_3	mgN/dm^3	0.05	0.007	0.017	0.023
Nitrites N-NO_2^-	mgN/dm^3	0.0063	0.0075	0.0059	0.0038
Nitrites N-NO_3^-	mgN/dm^3	1.2	8.7	5.8	2.1
Sulphates	$mgSO_4/dm^3$	13	15	15	18

Phosphates	mgP/dm^3	0.08	0.10	0.09	0.07
Wastage $KMnO_4$	mg/dm^3	6.11	9.52	7.52	4.84

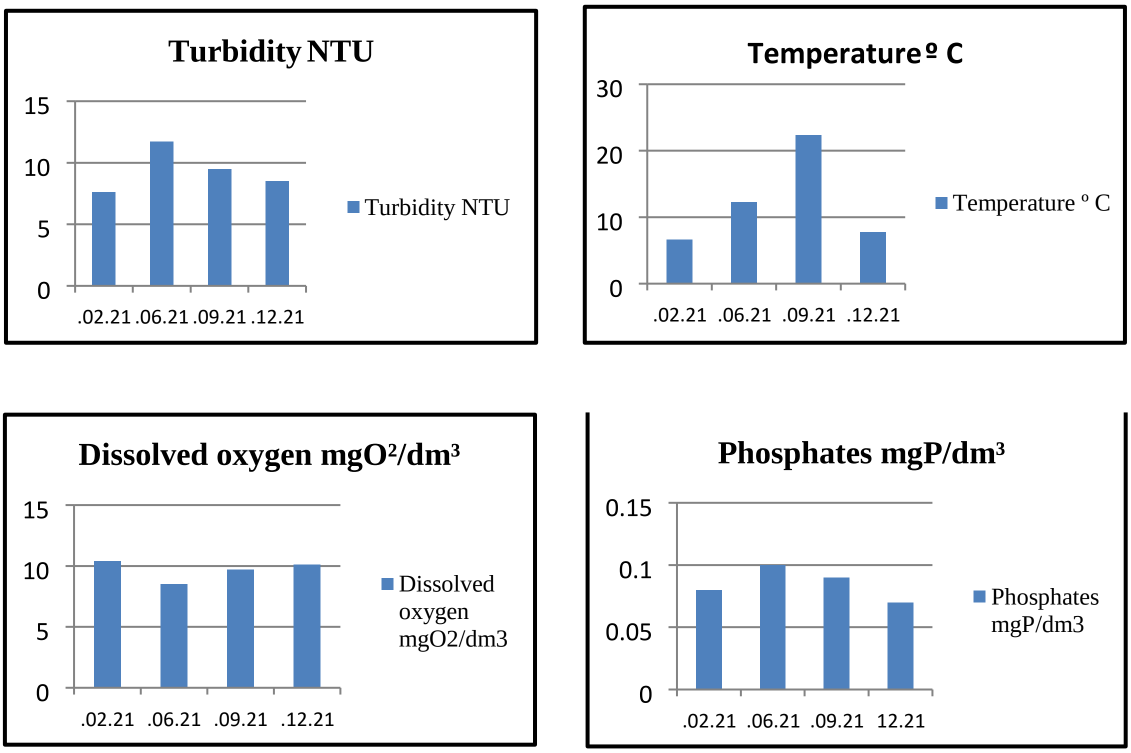
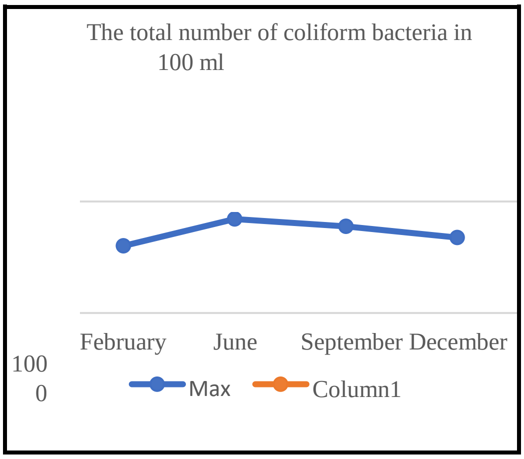


Fig.1. Graphic representation for parameters **:** Turbidity; Temperature; Dissolved oxygen and Phosphates

Table 2. Microbial parameters in the water of Lake Radoniq

	The total number of coliform bacteria in 100 ml			**Coliform bacteria of fecal origin in 100 ml**			**The total number of live bacteria in 1 ml**		
	min	max	avg	min	max	avg	min	max	avg
February	38	42	40	57	73	65	62	75	68

June	65	78	72	75	above 100	87	100	300	200
September	62	68	65	72	65	68	75	100	87
December	48	53	21	66	72	69	64	76	70



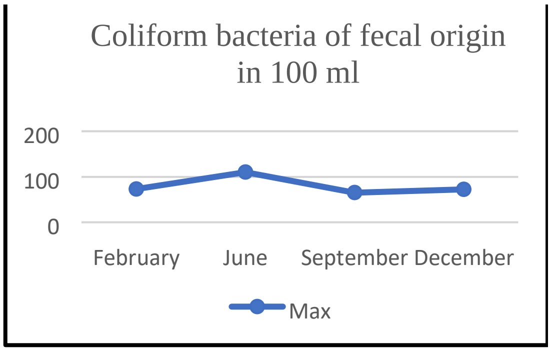


Fig. 2. Graphic representation for: total number of colif. bac. in 100 ml and Colif. bac. of fecal origin in 100 ml

From the results of the water analysis carried out during 2021 in Lumbardhin i Deçan, we notice an increase in chemical parameters such as: Turbidity, dissolved oxygen, nitrates, phosphates, wastage $KMnO_4$. This increase in parameters is especially expressed in the part where it is inhabited with uncontrolled population and spills.

Temperature: depending on the months of the year, the water temperature also varies, which is more than normal in February and January we have a drop in temperature, while in other months there is a gradual rise.

Turbidity: As for the turbidity of the water, it shows an increase during the months of June and September, that is, when we have the flow of large amounts of water. The pH value ranges from 7.8 to 8.27 and indicates that the water belongs to the moderately soft water category.

Nitrates and Phosphates appear with a gradual increase, especially during the spring months, that is, at the time of artificial fertilizers being thrown on the cultivated lands around the river and during the rains, the fertilizers penetrate into the water. Wastage $KMnO_4$: Due to the large flows of water and uncontrolled spills that are made in Lumbardhi of Deçan, we have an increase in organic matter, i.e. in populated areas and uncontrolled discharges that can affect the deterioration of water quality. Regarding the bacteriological analysis of the water, it results in the presence of coliform bacteria of fecal origin, which is a consequence of uncontrolled discharges.

Conclusions

Lumbardhi i Deçan as the only source of water supply of the "Radoniq" Lake, which has multiple uses: for the irrigation of the agricultural lands of the villages of Hasi in Prizren and after water treatment, the cities of Gjakova, From the analytical data determined from the water samples, we can conclude that the water of Lake Radoniq is of a fairly good quality, but that the population living along the river, the channel and around the lake should be made aware of the preservation of the environment. which is affected. in the lake of Radoniq itself. Rahoveci and some villages of Prizren are supplied with drinking water.

Permanent control of water quality along the course of rivers and in lakes is required.

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Kliton The development of sustainable mobility in Prishtina.

2025 scenario vs 2030 scenario.

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Abstract. Mobility and transport are experiencing one of the most eruptive revolutions. Innovations in digitalization and alternative energies, established in previous decades, are unleashing their potential on the streets, forming the bases of smart mobility. Smart mobility is one of the core subjects of any smart city. It involves optimizing transport and communications in order to consolidate new standards of sustainability, efficiency, safety and air quality.

A city's transport network is its lifeblood and, to build a smart city, we need to think seriously about smart mobility, which will define the future of urban development. Due to increasing congestion and related side effects which include pollution, accidents, and waste of time in general, there is an immediate demand for smart mobility in almost all cities. So, different solutions merge and interrelate in smart mobility. Many of these solutions are based on IT and they include a vehicle navigation system, e-parking, e-ticket, info-mobility signalization, demand-responsive transport, car sharing, bike sharing, public transport live tracking. All of these evolve into specific benefits, such as improved health regarding to a massive decrease in CO_2 emissions, thanks to air quality, fewer traffic accident victims or reduced traffic congestion. In this document, it aims to demonstrate a systematic of smart cities and mobility, also analyzing the current condition of the smart capital Pristina with regard to smart mobility, showing the different challenges that Kosovo is facing in this respect. An evolutionary scenario of the capital will be proposed, with a 3- and 7-year vision, analyzing local regulations on the basis of European ones and illustrating the benefits that intelligent mobility generates at an environmental, economic and social level.

Keywords: Smart mobility, Smart City, Smart Mobility Technology, Transport, Pollution, Traffic Congestion, Smart Future, Renewable Energy, Energy Saving.

1 Introduction

There have been many definitions of a smart city given over the years. Smartness in the context of smart cities includes monitoring, control, and optimization to bring in efficiency and bottom-line benefits as well as environmental improvements. A city can be defined as "smart" when social capital and modern information and communication infrastructure fuel sustainable economic development and a high quality of life. In other words, a smart city uses digital technologies or information and communication technologies to enhance quality and performance of urban services, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens.

Mobility is the ability and potential of passengers to travel and freight to be transported.

The sustainable Mobility is focusing on the following four goal:

- Safety: Drastically reduce fatalities, injuries, and crashes.
- Green: Minimize the environmental footprint of mobility (greenhouse gas emissions, noise, and air pollution).
- Access: Connect all people, including women and communities, to economic and social opportunities.
- Efficiency: Optimize the predictability, reliability, and cost effectiveness of mobility.

Smart mobility is the promotion of sustainable mobility that guarantees seamless access to different modes of mobility and enables people or cargo to get from one place to another in a way that is safe, clean, and most efficient. One of the greatest environmental challenges we face today lies in mobility. People need a seemingly infinite network of vehicles and transportation systems to uphold societies and economies, Cars, Busses, Trains, Trucks, and other modes of transport each leaving their indelible mark on the environment.

Smart mobility is one of the main pillars that characterizes smart cities and maintains their sustainability as a way to deal with continuously growing world urbanization and its expected impacts on public health, congestion, and accelerated global climate change. Mobility is now being seen as an information service with physical transportation products, rather than a transportation product with additional services [1][2][8].

2 Present situation of Pristina

In order to make the right (policy) choices for the future in Pristina, it is essential to have a clear understanding of the present situation, in terms of urban transport and mobility statistics, trends and data. Trafiku Urban (TU) is the public transport company owned by the Municipality of Prishtina. It operates with 15 lines in the urban area. Lines are operated through a public-private partnership. In 2016 the Municipality of Prishtina purchased 51 new buses for the city, produced by Iveco, in an attempt to modernize the fleet. Additionally, the app called Trafiku Urban (Android and iOS) developed by Appbites through the municipality of Prishtina allows you to see the realtime location of buses on lines 1, 3, and 4, as well as the bus stops they pass through [1][2].

3

The “EasyPark Mobile Prishtina” application enables you to find parking spots, to park your car quickly and easily. You can control parking sessions using intuitive and smart menu options and location services. For using and taking advantage of these and many others services You need to download the application on your smart phone, register yourself in to the application service in order to use many of its easy-touse features like: searching destinations and free parking spots; starting, stopping and adjusting parking sessions; one-click parking payments using a credit or debit card, finding the location where you left your car, and much more [2].

The main problems that Prishtina faces are related to the public transport network in terms of the lack of integration of services and tickets, as well as poor connections in some parts of the city, The prevalence of illegal taxis competing with registered firms as well as bus operators, lack of cycle and pedestrian infrastructure and route networks, a lack of safe pedestrian crossing, High levels of traffic congestion and delays due to heavy traffic on main roads, long-term parking activity in the city centre and many spaces unregulated or not managed effectively [1].

3 2025 scenario vs 2030 scenario

Innovative design and integration of urban mobility solutions as part of all major city development proposals will help ensure that the most sustainable and efficient modes of transport are delivered to help influence future travel behavior. Effective landuse planning is important to the delivery of long-term sustainable transport solutions. It is essential that new development makes proper provision for sustainable transport, including walking as well as good access by public transport. It is important to ensure that schemes delivered have an impact in terms of reducing congestion, improving road safety or promoting different forms of sustainable travel across the city. The Plan is based on the development of a new transport model and evaluation of different options for improving the current traffic, transport and parking situation, with a view to encouraging behavioral change and a shift in modal transport towards more sustainable alternatives [1].

3.1 2025 Scenario

Walking & Cycling - Our approach is to develop local pedestrian and cycle schemes. To develop quality walking and cycling routes between major attractors, residential areas across the city and other places of interest which will provide a high-quality environment for pedestrians and cyclists and one that is safe, convenient and pleasant to use. To develop a new citywide bike hire scheme, thus the provision of high quality bikes for hire on an hourly or daily basis, supported by dedicated cycle parking stations across Pristina [1].

Developing a Parking Policy for Pristina - this policy includes establishing new residential parking schemes to control parking activity in residential and community areas, inspection the price of parking tickets, introducing new parking regulations where necessary and enforcing these regulations effectively, functionality of app 'Easy Park Mobile Prishtina. To establish a Park & Ride (P&R) concept, whereby remotely located car parks on the approach to the city are linked by an attractive public transport service with the key urban centre. [2]

Taxi Pit Stops - establishment a series of 'pit stops' in the city centre in accessible locations where they do not impede other road users. Car Sharing companies – these companies of electric vehicle on rental bases and the vehicles are made available at strategic locations within the city. This allows for a greater utilization of vehicles and is accompanied by construction of charging station at parking places [6][7].

3.2 Scenario 2030

Construction of rings - In order to have a complete and efficient system of traffic so as to keep transit traffic outside the city, we propose the construction of Outer and inner Rings so that a large number of vehicles will use these roads and in this way congestion in the city will be reduced. New routes - Development of a scheme of new bus routes throughout the city to provide an attractive network of public transport services, convenient, fast and reliable, including the modernization of public transport vehicles.

Information system – Development of a new public transport information system with real-time information on the vehicles, online and on the bus stops, integration of ticket system enabling the purchase of bus tickets through street bus tickets and e-tickets through Buss App, reconstruction of bus stops to increase the quality of pub-lic transport and ensure accessibility for all. Development of Speed Management Plan - Implementation of speed cameras and monitoring of speed limits, including also red-light speed cameras at the signalised junctions to reduce incidences of speeding, lower number of accidents and make more stable traffic flow. Pristina Rapid Transit Services In the longer term, it is proposed to establish a new rapid transit connection extending between to the southern part of Pristina and the city centre, providing a new high capacity public transport link to the urban centre. A tram-train system is proposed for this connection. Tram-train is a light-rapid public transport system which enables trams to run through from an urban tramway network onto main-linerailway. Vehicles can be operated in two transport modes, as a street tram serving urban city centres, as well as a commuter train making use of the existing rail network. This dual operation provides greater flexibility, additional services and routes, and better connections for passengers.[1]

Electrical vehicle Implementation of the appropriate infrastructure within its surface to enable the operation of electrical vehicles, this includes the construction of battery charging station in parking lots or appropriate places so that users have easier access to charging electric cars [1][5][4].

5

4 Conclusions

These scenarios outlines how the Prishtina transport system can achieve its green and digital transformation and become more resilient to future crises. The result is predicted to substantially cut transport emissions by 2030 and contribute to the EU goal of climate neutrality, delivered by a smart, competitive, safe, accessible, and affordable transport system.

So, in this paper we propose different solution paths to help Prishtina move towards sustainable , smart and resilient mobility system and to direct it to structural changes required to achieve sustainable mobility.

The implementation of these scenarios to achieve green goals and sustainable mobility requires a strong financial component. To implement the proposed actions in the proposed timeline, external financial assistance will be necessary. According to the Economic and Investment Plan for the Western Balkans, a certain amount of money will be funded to mobilise to boost economic growth and support reforms. A significant amount will be concentrated on upscaling transport and energy connectivity, on the green transition – in particular, the decarbonization– and on digital transformation, which the region should fully utilise to make its transport smarter and more sustainable.

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Impact of Building Envelopes and Climatology on renovation of public buildings stock in Kosovo in terms of energy efficiency, sustainability environmental and socio-economic Improvement.

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Abstract

Building Envelopes, Climatology and sustainability environment with standards criteria application for the building stock refurbishment for renovation of the public buildings in Kosovo plays e positive role in the terms of energy efficiency and also have impact on social-economic aspects and better quality of life.

Therefore, the renovation of existing buildings in public sector is an inevitable step to improve the energy performance of the public buildings, also has to increase the comfort and in general the quality of life and activity in them, creating a sustainable environment. Knowing that these buildings are big consumers of energy, then precisely with their renovation lies the potential of great energy savings.

Potentially Increasing the Energy Building Performance (EBP), can be achieved the better sustainabilty and durability of this building stocks, consumer can save the energy and the internal condition for living will be better also and health conditions.

During the Energy application measures on renovation of the building stocks, also we find a lot challenges and barriers to the sustainabilty and better condition for life.

Keywords: [Building Envelopes and Climatology, Sustainability environment, Energy Building Performance (EBP), Energy consumers, Energy efficiency in public buildings].

1.Introduction

Building Envelopes and Climatology in the Building has direct impact from the construction or renovation sectors of the buildings stocks in Kosovo in terms of energy efficiency, were sustainability environmental has a long historical period after using and improving the better solutions or tips for renovation where was used for this category of buildings and apartments in the Republic of Kosovo. However, knowing that these buildings are big consumers of energy, then precisely with their renovation lies the potential of great energy savings can be realized using the better methodology and better materials of insulation and reconstruction, where the only focus is on saving the energy consumption**.** The old stock of existing buildings, which were built after the second world war and until 1970/80, did not take into account the insulation of buildings, and for this reason not only in Kosovo, but also in Europe and around the world, also this building stock are the largest consumer of primary energy in Kosovo, although not yet a member of the EU, has pledged to reduce energy expenditure as well as the emission of CO2 and greenhouse gases in the atmosphere, alongside EU member states, and in accordance with policies, legislation, strategies and the goals emerging from the European Commission and EPBD directives, as a leading organization in Europe dealing with climate changes and global warming issues.

The present paper discuses about the Impact of Building Envelopes and Climatology on renovation of public buildings stock in Kosovo in terms of energy efficiency and were we see the benefits of this sustainabilty buildings in the points of the social-economics and environmental benefits.

Around 40% per cent of the EU buildings are over 50 Years Old and also 75 per cent of the building stocks in energy Inefficient and normal renovation of existing Buildings has the potential to load the significant energy savings –reducing the potential of EU's total Energy consumption by the 6% of the reducing $C0_2$ emissions. So the concept of the Building Sustainability is directly impacted from the amount of the Energy Measures especially in the Building structure, as Improving the Envelope of the buildings stocks impact from the Climatology conditions and term of references with policy regulation in the field of Energy Efficiency.

Regarding of this sustainabilty of the buildings has become the very important issues Concerning the construction industry in the twenty –first of century (Dobson *at al.*2013).For the next 30 years the economic ,environmentalist and other scientist has to find the ways for the reducing the energy bills and energy consumption at to determinate the real measures for the sustainable facilities.

The same conditions and measures would be improving and in Kosovo Construction sector, because the great benefits that sustainable facilities offer the environment of the building capacities and their occupants. Old buildings and non-refurbishment are still the problems of achieving the targets on increasing energy efficiency. Kosovo has lagged in fulfilling the goals and obligations deriving from both the Stabilization and Association Agreement and the Energy Community, which are also admitted into the Ministry of Economic Development.

1.1 Description models of buildings envelope

Sustainable construction is one of the most important points of sustainable development and this includes the use of building materials that do not harm the environment, energy efficiency in buildings and their good management. In the context of sustainable development, sustainable construction should provide well-designed building structures that will be financially, economically and ecologically acceptable.

Building Envelope support is main intervention to achieved the Energy and construction goals were stables are:

Reduction of heat losses from the building improving protection its external thermal.

Increasing the heat benefits through the orientation and use of solar energy.

Use of renewable energy sources in buildings (biomass, radiation energy, geother-mal energy etc.)

CO_2 emissions caused by the increasing use of fossil fuels in the housing sector have been ever increasing. The idea of taking measures to increase energy efficiency in the housing sector is to reduce the consumption of all forms of energy in buildings. This results in the reduction of CO_2 emissions and other harmful gases in the environment.

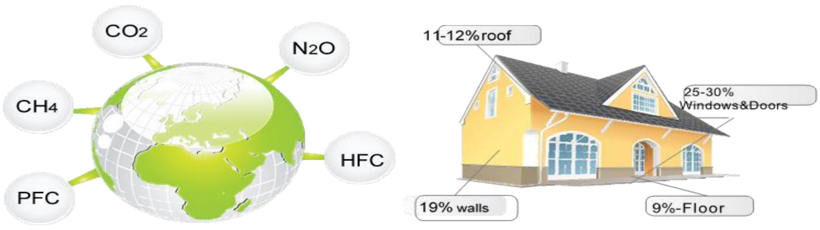


Fig 1-Description of the gas emissions and Building envelope energy losses

(Building Energy Efficiency, IFC –World Bank Group)

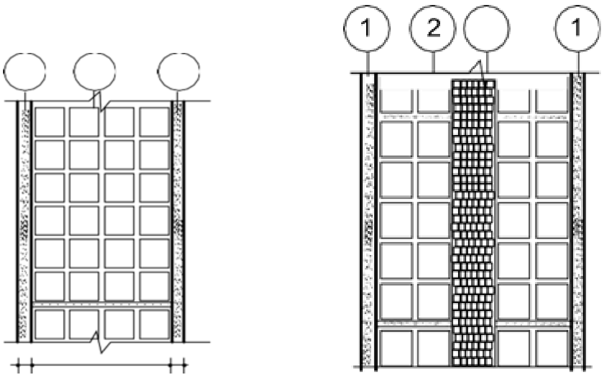
Schematic description of the Buildings Envelope and its terminology means a lot of the duties and replicable measures which must be used for the more energy efficiency and sustainability in the public building sector. Renovation of the buildings stock s has a lot of the costs, but reducing the energy bills will consist with the better living conditions health, economic impacts due to the society increased the more sustainabilty and environment in the such case studies which can be good examples for the further studies. Examples for the (non- insulation walls and insulation walls) we can find Example for the Walls were Thermal transmissions coefficient so the envelope is very important for saving energy in the building. Thermal insulation of buildings is done with materials with high thermal insulation properties (with coefficient of thermal conductivity Th_c=0.029-0.044 (W/m0K). Some of the most used materials in the thermal insulation of buildings are polystyrene, panels with mineral wool or glass. The most used thermal insulation material in our country is polystyrene but in some cases would be used other insulation materials with standards and criteria from the EU –catalogs and EE – standards which has to be more comfortable and sustainable Buildings.

Very important issue is there and that the compatible envelope materials must with declaration of the standards criteria and with the minimum of the thermal bridges formatting ore to avoid this loses.

1.2- THERMAL INSULATION OF THE BUILDING

If we compare structures with and without thermal insulation, we see that in thermally insulated structures we have a significant improvement in terms of heat transmission. The transmission coefficient for the case with thermal insulation has a value almost two times smaller than that without thermal insulation. In this case, the amount of heat lost from the walls decreases by about 50% of energy and heating transfer.

In old buildings, the most useful is external thermal insulation. Internal thermal insulation is recommended only in cultural and very old buildings where, due to the preservation of the architecture of the external facades, external thermal insulation cannot be used.



k= 1.655 (W/ m^2K) k=0.879(W/m^2K)

Fig 2- Examples for wall without & wall with insulation (brochure –IFC) thermal

Conditions

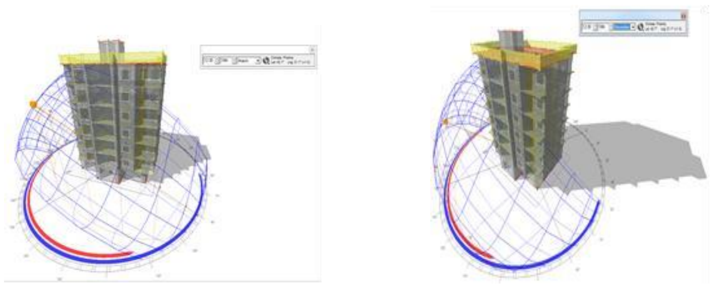


Fig 3-3D Orientation Of Building (author) 3D model designed Autodesk **Ecotect** Analysis is a Software or Device that enables Building Designers to create simulations about the energy performance of objects in the early stages of object design. this program enables us to orient our real 3D model that we created different directions to the parcel and also add the surrounding objects such as flats, trees and in this way we can precisely determine which areas of the building have less lighting and thus architects can look for more favorable technical solutions to increase the level of comfort in interior spaces (Pallaska, 2020).

The primary purpose and role of this program is to maximize energy conservation in objects through passive methods of improving the energy performance of the object **1.3-Example-** from section analyses we can use the example from the building audit of 19 Buildings and the material of building insulation. The example from the cutting section of the drawing detail shows the material and insulators between the ground and the floor for a given object or building surrenders using the appropriate software. Regarding the level of clean lines, we see that there is no high level of dirt in these objects.

Orientation depends: We can see that South-East is 5 objects or 26.3%, East-West is 7 objects or 36.8%, North-South is 5 objects or 21.1% and North-West 3 objects or

15.8%. (Pallaska, 2020)

2.Research limitations/implications -Literature review - European Energy Comity and European Commission has issued new objectives that aim for the Europe to be the first climate-neutral continent in the world by 2050. With this reason, the renovation of existing buildings is one of the goals that must be met to achieve this objective. because more than 40% of energy expenditure comes precisely from the construction sector. Therefore, the renovation of existing buildings in public sector is inevitable step to improve the energy performance of the public buildings, also has to increase the comfort and in general the quality of life and activity in them, creating a sustainable environment. Knowing that these public buildings are the big consumers of energy, then precisely with their renovation lies the potential of great energy savings.

In this regarding the (Bentley ,2002) and Climate changes (Stern ,2006)has impact on sustainabilty changing concerns peak of the oil the satisfaction of the buildings occupants also are the factors that influence the police makers to see the benefits in this sector. In this regard, (Hodges , 2005) argue that the benefits of building envelope translate to the sustainabilty and to the green practices in facility management and Well-Strengthened were the imperative is the reduction of energy consumption.

According to the Dobson et.al (2013) the benefits are mainly economic and social . **3.Used Methodology**

We can improve one sample of the modules used for the study simplifications or simulations in the different formats and applications in the practice as the good practices for future and sustainabilty in the public buildings 19 of them examples in Kosovo as (Schools. Kinder gardens, Municipality, Health centers, Courts and other public buildings).

To achieve the results of this study we held face to face to the Construction Engineers and more than 5 facility managers, from companies around in Kosovo were we give the opinion from the semi structural interview and that names we coded, so the results and analyses we put in the data chart Wizard, using the SPSS –software for calculation. So this results we compare before and after the measures in the building envelope of the buildings such as schools, kinder garden, public municipal and other. Methodology used for this research paper is comparative qualitative with hypothesi**s** which is used for the further determination of this problem is based on calculation forms with applicable Software creating the Building Certificate Performance and classification for each category of building. Where after the analyses this results would be compare with the region state and other in the field of energy efficiency statement. My research also obtained for aims to explain the barriers and challenges in the field of energy efficiency in existing buildings especially in Public sector in Kosovo. Also and Climatic conditions commonly affecting energy use may also differ over time. Such conditions from climate changes may be the likely impact of one or several plausible factors, such as:

a) weather conditions, such as degree days or Heating degree days' example regarding the annually temperature degrees in Kosovo are near (1955-2095 HDD days)

3.1-Policies and Regulation part impact in EE of Buildings

Regarding the Policies and regulation process for Energy Efficiency measures are regular references given from the: from: **Article 1**

Methodology for calculating the national indicative energy savings target[2] ANNEX I – Energy Efficiency Kosovo Fund[1] which there is potentially implemented in :

(From, 2016)-The calculation of the indicative targets of energy saving is based on the methodology specified in the Action Plan for energy efficiency as to calculate the average value of annual consumption must be used official data available on annual energy consumption by all consumer's reference terminal for five (5year) period. This final energy consumption shall be the amount of energy distributed or sold to final customers during the five-year period, not adjusted for degree days, structural changes or production changes.

On the basis of this annual average amount of consumption, the national indicative energy savings target shall be calculated once and the resulting absolute amount of energy to be saved applied for the entire period.

b.Quality of housing	2.6032	0.82946
c.Quality of life	3.6250	1.18275
d. Enterior Quality of air	10.6111	14.08622

The national indicative three-year energy savings target shall:

consist of 3 % of the annual average amount of consumption referred to above;

be measured after the ninth year of application of this Administrative Instruction;

be the result of cumulative annual energy savings achieved throughout the three-year application period of this Administrative Instruction**;**

be reached by way of energy services and other energy efficiency improvements. This methodology for measuring energy savings ensures that the total energy savings prescribed by this Administrative Instruction are a fixed amount, and thus independent of future GDP growth and of any future increase in energy consumption. Kosovo is envisaged to use the top-down approach, which means that the quantity of energy saved

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[1]Article 1

Methodology for calculating the national indicative energy savings target

ANNEX I

is calculated using energy saved at the national or sector specific l level as the starting point.

Table 1.3.3-Descriptive Statistics

Mean Std. Deviation

3.2- Energy savings calculation with SPPS program; after the questionaries' Interview shall be determined by measuring and/or estimating energy consumption, before and after the implementation of the energy measure, while ensuring adjustment and normalization for external conditions commonly affecting energy use ere can be used the statistics, Descriptive statistics - Quality of housing.

Standard regression position R2 = .517, coefficient F = 8.027, and p- value = .004 which means that it is statistically.

b. Dependent Variable: Quality of life

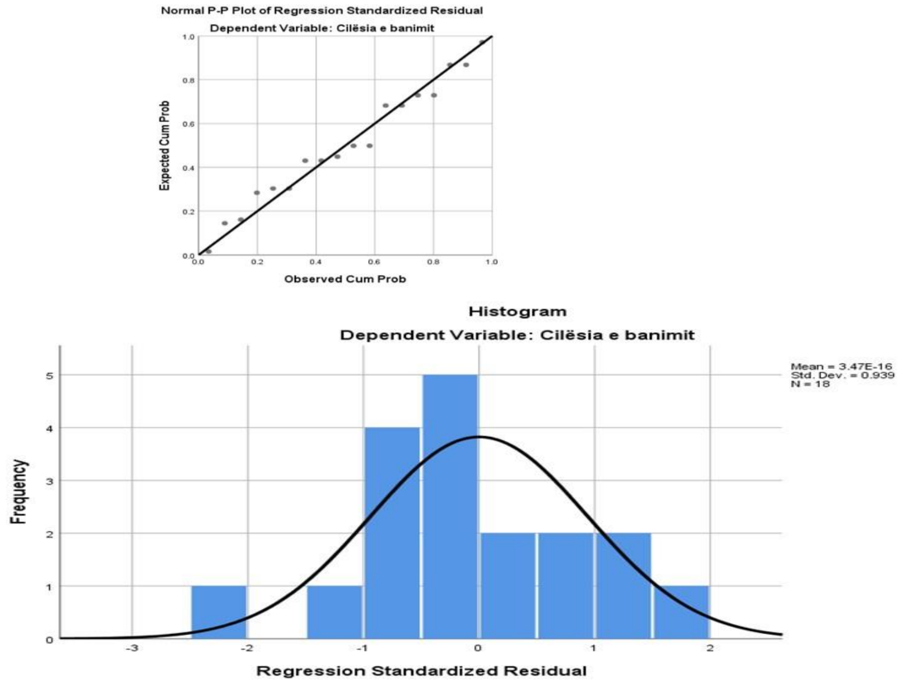

Fig 4- Housing Histogram - Linear Quality of life the quality of life or housing and efficient investments (test from the SPSS –calculation) – author

Temperature during winter is considered to be cold for 5 of the facilities or 26.3%, while on average it is cold for 14 of the facilities or 73.7%.

4.Integration phase and implementing process after the building envelope. We have obtained to analyze the number of 19 facilities that are part of the energy investment program, as an investment by the World Bank in the middle, from the group of 149 MED targeting Republic of Kosovo in years to come from (2018-2023), according to Energy Efficient Strategies of the Republic of Kosovo 2017-2026

During this research level or phase or implementing process envelope at the whole buildings we achieved the results as bellow this Example :

Paired Sample T-test method which enables us to see if there was a difference or decreased specific energy consumption after EE measures [kWh/ m[1] year]. The following table shows the differences in specific energy consumption before EE measures [kWh / m^2 year] and specific energy consumption after EE measures [kWh / m^2 year], where in the former case we have an average of 285.46 [kWh/m^2year] with a high standard deviation of 75.39[kWh /m^2], whereas in

[1] (Pallaska, 2020)

the case of EE measures we have a lower average of **169,644** [kWh /m^2 year] and a standard deviation half lower than before the measures of **49.33** [kWh /m^2 year] (Pallaska, 2020)[2]

5.Conclusions –Results

From the this research paper we conclude that : after the implementing procedures with building renovation regarding the Building Envelopes and Climatology on renovation of public buildings stock in Kosovo in terms of energy efficiency we arrived to acchivied that:

- Impact after the measures implementation using the building envelope, standard orientation of the House building stocks using the Ecotect program software can be achieved the best results in the environmental sustainability and energy savings due to the 40%.

- Envelope buildings stock in Kosovo in terms of energy efficiency, sustainability environmental and socio-economic Improvement is one of the most important issues regarding the better living conditions, inside air conditions and control of air pollutants.

- From the Kosovo Energy Efficiency Found, MCC and other banks Loan is excepted for the next 5 years up to 2027, to achieved or to implemented the amount or target of 149 Public Buildings stocks which are Prepared to be refurbished with the standards and EE-measures applicable in Kosovo.

- The components and insulation materials used for this building envelope must fulfill the standards and in the end for each building from the audit reports must be created The Energy Certificated Performance of Buildings (ECPB), depends of area, year of construction , orientation and construction materials.

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