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Using Ground Source Heat Pumps for Renewable Energy

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ABSTRACT
This paper provides background information on the current energy supply, energy demand, and energy sources in Kosovo. Moreover, it presents the country's current level of applying alternative energy sources. Additionally, this paper focuses on geothermal energy as a renewable energy resource with the potential to contribute to a sustainable use of resources to meet renewable energy and energy efficiency requirements of the European Union (EU), "EU 20 20 by 2020" policy. Hence, a careful analysis is included on how to approach the aforementioned targets through investments in geothermal energy through providing an energy consumption forecast and analysing geothermal energy projects in Europe and specifically in Kosovo. This paper carefully represents the potential usage of geothermal energy in Kosovo, renewable energy source targets, and it addresses the importance of laws, regulations, and reports regarding the utilization of this type of energy. Economic and environmental implications of investing in geothermal energy - geothermal heat pumps for the case of International Village are additionally analysed. Lastly, recommendations and conclusions, for future actions, are derived and addressed to relevant stakeholders, primarily policy-makers, and government representatives.

Keywords: geothermal, renewable, energy, sustainable, targets, heat pumps.

I. RENEWABLE ENERGY SOURCES TARGETS IN KOSOVO

On February 17th, 2008, Kosovo unilaterally declared its independence and since then the vision of the Government of Kosovo (GK) was to create a prosperous democratic state and a society with European values. Throughout this period of transition, the GK did highlight the importance of the "EU 20 20 by 2020." The "20- 20- 20" targets of the "EU 20 20 by 2020" policy refer to a series of demanding climate and energy set forth by the EU Heads of State and Government, which have to be met by 2020, which are:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels.
- 20% of EU energy consumption to come from renewable resources.
- Achieve a 20% decrease in primary energy use through improving energy efficiency.

Directive 2009/28/EC (RES Directive) sets a target of 20% renewable energy in gross final consumption of energy for 2020 [1]. In regards to climate change, in January 2008 the EC proposed binding legislation to implement the 20-20-20 targets – 'the climate and energy package', which was approved by the European Parliament and Council in December 2008 and became law in June 2009. This law creates pressure to improve Energy Efficiency (EE) but does not address it directly: EE is addressed through the EU's energy efficiency action plan. In the case of Kosovo, we find out that the country is not obliged to adhere to the EU's 2020 energy and climate targets because it is not a member of neither European Union nor United Nation (thus not a member of United Nations Framework Convention on Climate Change). However, the country signed the Energy Community Treaty (EnCT), therefore, the GK has moral responsibility against its people and the world to deal with climate change.

A strategic approach addressing climate change and energy sustainability, for the next ten to twenty years, is in place. It incorporates the energy sector, transportation, deforestation, EU 2020, and UNFCCC. In October 2012, the GK set an ambitious Renewable Energy Sources (RES) target at 29.4% of its total energy consumption by 2020. This in line with the country's commitment to become a member of the UNFCCC and to ratify the Kyoto Protocol. Continuing, Kosovo will need to comply with the EU energy acquis in areas of RES, EE targets, climate change, and environmental protection. A key component in addressing this challenge is strengthening the existing regulatory framework and institutional capacities. Kosovo's NEEAP 2010-2018 highlights a target of 9% for EE by 2018 (based on 2010 consumption levels). The Report on the Implementation of the First National Energy Efficiency Action Plan 2010 – 2012 [2] highlights that around 2.2% energy savings have been achieved during the period of the NEEAP, against the 3% indicative saving target [3].

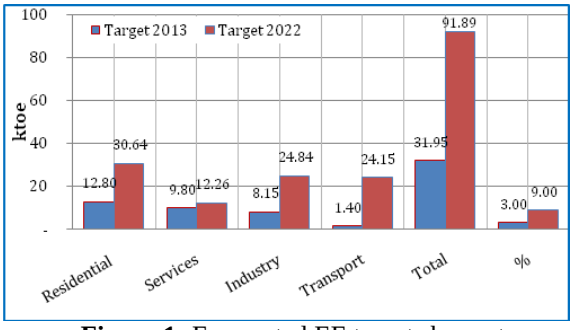

Figure 1: Forecasted EE targets by sectors

The indicative target set at 9% for the NEEAP covers the period 2010-2018 and it amounts to energy savings of 91.89 ktoe (out of 1021.08 ktoe). The objective of 9% was calculated based on the Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing [4]. The energy forecast was made based on a scenario of average annual GDP growth of 3.1% [2].

The national mandatory overall target for the share of energy from RES in gross final energy consumption in the year 2020 is 25%. This target is determined in the Ministerial Council of the Energy Community Decision D/2012/04/MC-EnC on the Implementation of the Directive 2009/28/EC and Amendment of Article 20 of the Energy Community Treaty. Administrative Instruction No. 01/2013 on Indicative Targets of Renewable Energy Sources determines annual and long-term targets for energy generated from renewable energy sources and consumed in the electricity, heating, and transport sectors by 2020 [5]. According to National Renewable Energy Plan (NREAP) Kosovo will aim at a higher target which corresponds to 29.47% of expected gross final energy consumption in 2020 [6]:

Target 1: Electricity generation: 10.13%
Target 2: Transport: 2.1%
Target 3: Heating and Cooling: 17.24%

NREAP defines targets for three sectors (electricity generation, transport, and heating and cooling sector) [6]:

Target 1: 25.64% of RES in gross final consumption of electricity
Target 2: 10% of RES in final consumption of energy in transport
Target 3: 45.65% of RES in gross final consumption of heating and cooling.

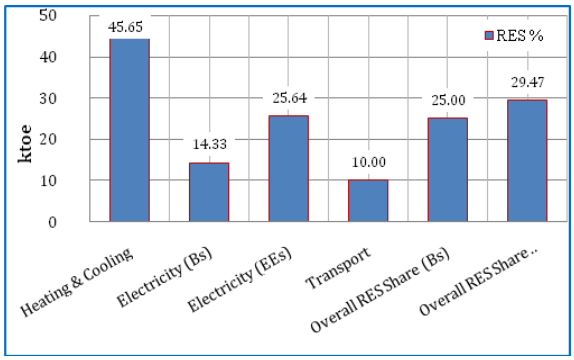

Figure 2: Forecasted RES targets

EEs - EE scenario; Bs - Baseline scenario
Coal, petroleum products, and biomass represent the primary energy products in Kosovo. Petroleum products and electricity present the most consumed energy products. Households represent the sector that consumes the most energy. The following figures and tables provide a detailed picture of primary energy products, consumption by source, and utilization by sector [7].

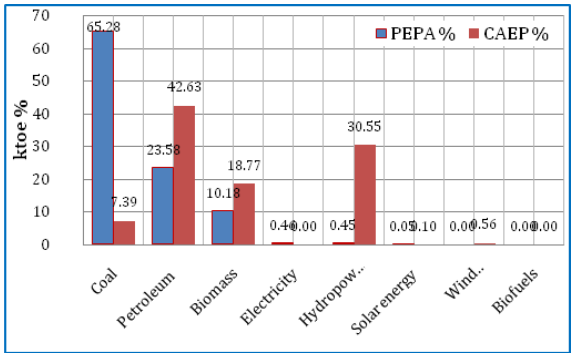

Figure 3: Primary Energy Products Available (PEPA) and Consumption of all Energy Products (CAEP)

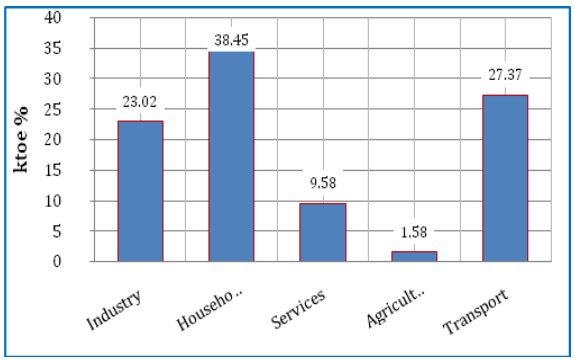

Figure 4: Utilization of energy sources in all sectors in 2014

Table 1: Forecasted consumption of all energy products in 2013 (ktoe).

Coal	Petroleum	Biomass	Electricity	Solar	Bio-fuel
107.38	602.39	259.02	403.95	1.93	3.34
7.75%	43.46%	18.69%	29.14%	0.14%	0.24%

Source: Energy Regulatory Office, Annual Report 2012.

In terms of electricity, about 97% of power generation capacity in Kosovo is located in two lignite-fired thermo-power plants: 50 year old Kosovo A – 3 operation units and 30 year old Kosovo B – 2 operation units, see table 2 [8].

Generation unit	Capacity of Units (MW)			Set in operation
	Installed	Net	Min/Max	
A3	200	182	100/130	1970
A4	200	182	100/130	1971
A5	210	187	100/135	1975
B1	339	310	180/260	1983
B2	339	310	180/260	1984
TPP Kosovo	1288	1171	660/915	

Table 2: Generation Capacity of Kosova A and Kosova B [8]

Limited alternative energy sources have been utilized for the purpose to meet energy demand: a few small hydropower plants (hydropower plant Ujmani capacity of 35 MW and few small HPPs with total installed capacity of 11.68 MW), one small wind farm in Golesh with installed capacity of 1.35 MW, and biomass (mainly firewood). Around 3% of total electricity production in 2010 came from renewable energy [9].

Regarding energy used for heating in the household sector, we find out that the main energy sources for space and water heating in Kosovo are electricity (in towns), coal and biomass (in villages, together accounting for over 80% of heating consumption. Kosovo also has three district heating systems, Pristina, Mitrovica and Gjakova with total installed capacity of 183.5 MW or 3% of Kosovo's heating demand [8]. The units are running on imported heavy oil fuel as their prime fuel. Heat consumption and billing are mostly unmetered and based on the pre-assessed heating area of each customer (in square meters). The high consumption of unmanaged and unregulated firewood results in forest degradation, giving rise to adverse environmental, economic and health impacts. In this context, it is worth mentioning that the country's annual contribution to climate change is as follows:

- Lignite, used as a primary source to generate electricity, contributes with 5.8 mil tons of CO_2 into the atmosphere.
- Vehicles, contribute with an additional 5.5mil tons of CO_2.
- Deforestation, as subject to unregulated logging of forests, is weakening the process of naturally absorbing CO_2.

Finally, the problem addressed in this paper is the 29.47% RES generation in the country by 2020 and the 9% EE target and how investments in geothermal energy project can help address energy security, reduce public and private expenditures on energy, reduce environmental impact, and improve the overall wellbeing of Kosovo's citizens. In this context, "The International Village", a private initiative of investing in RES by focusing on geothermal energy will be analyzed. Relevant lessons learned will be derived and scenarios of how to increase the usage of geothermal energy will be presented.

To begin with, continuous work is being prepared in order to develop and adopt legislation and regulation relevant for supporting and promoting expedited development of RES – Renewable Energy Sources. The Law on Energy Efficiency was approved by the Assembly of Kosovo on June 23, 2011. In addition, a number of related laws and secondary legislation have been and are being drafted [10]; continuing with the development of numerous strategic documents which are in agreement with the EU Acquis Communautaire [11, 12].

The Energy Strategy 2009 – 2018 is the core document that sets the basis for creating an appropriate legislative framework and a favorable market for promotion and development of RES in Kosovo [11]. As stated above, this document is in accordance with the EU criteria and its objectives rely on attaining effective management of the current energy resources while protecting the environment. Emphasis is given on improving the security of energy supply following European standards and expanding the variety of the energy resources that are currently being used. The strategy itself aims to encourage a coherent utilization of energy, promote energy effectiveness, promote the growth of the renewable energy sector, and introduces ways to minimize possible negative impacts on the environment in harmony with the accepted standards. This document includes information about geothermal, hydro, wind, biomass, solar, and gas energy. Therefore, the purpose of this paper is to emphasize the necessity of a detailed study on the future potential of these energy sources, in particular, geothermal energy.

The GK has planned to draft, during 2014, the Second Mid-Term Action Plan for Energy Efficiency and also approve the Action Plan for Renewable Energy Sources, a draft of which for the period 2011 – 2020 has been completed. Moreover, the GK has also drafted the National Mid-Term Energy Efficiency Plan 2013-2015. Related to EE

and RES, the GK has also developed the District Heating Strategy 2011-2018, which specifies that the use of lignite, fuel, and wood for heating should be minimized [12]. Instead, it emphasizes the use of RES such as solar energy, communal waste, and wood waste. However, the document does not elaborate geothermal energy in any context besides the fact that it mentions that a study undertaken in 2008 by the EU in Kosovo concluded that there are no underneath geothermal sources which could be used as energy sources, for which purpose no measurements are done.

In 2013, the Ministry of Economic Development of Kosovo forecasted energy consumption for 2022 to be 1701.84 ktoe [7]. This amount is calculated based on three targets: economic growth (GDP), the number of households, and consumption of energy.

The following figures and table provide detailed data for: Forecasted energy consumption for all sectors (ktoe); Forecasted energy consumption by geothermal energy product (ktoe) and Forecasted consumption of geothermal energy products in the household sector (ktoe); Gross final energy consumption – the difference between two scenarios and RES targets related to heating and cooling [13].

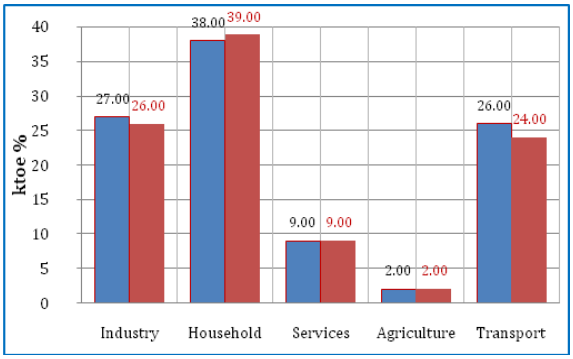

Figure 5: Forecasted energy consumption for all sectors (ktoe) 2013-2022

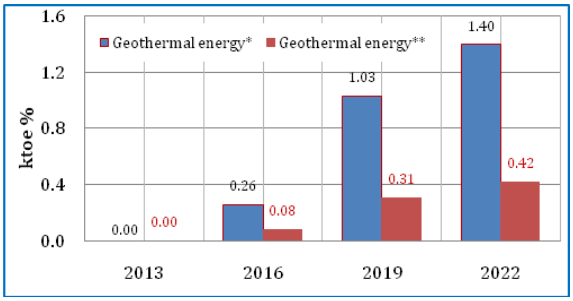

Figure 6: Forecasted energy consumption by geothermal energy product (ktoe)* and Forecasted consumption of geothermal energy in the household sector (ktoe)**

The Ministry of Economic Development of Kosovo foresees two scenarios related to final energy consumption:

- the BS 'baseline scenario', and
- the EES 'energy efficient scenario'.

The average annual growth rate of energy consumption is calculated at 3.88% for the first scenarios, and 2.89% for the second scenario [6].

Table 3: RES targets related to heating and cooling

RES	MW_{th}	MWh	Ktoe
Thermal Solar Energy	70	150,000	12.9
Biomass			284.05
Geothermal Energy (Thermal Pumps)	10	15,000	1.29
TOTAL	80	165,000	298.24
Share of Renewable Energy for Heating and Cooling in Total Renewable Energy (%) – Baseline Scenario		68.9	
Share of Renewable Energy for Heating and Cooling in Total Renewable Energy (%) – EE Scenario		58.51	
Contribution of Renewable Energy for Heating and Cooling in the GFEC (%)		17.24	

Source: Ministry of Economic Development. (2013). NREAP Action Plan 2011 – 2020.

II. GEOTHERMAL ENERGY PROJECTS

2.1 GEOTHERMAL ENERGY PROJECTS IN EUROPE

Among all energies, geothermal is the most reliable, with a load factor of more than 90%. However, it is a capital-intensive technology that needs 5-7 years to become operational from the start of the permitting process until commissioning [14].

The following figure provide a detailed number of geothermal power plants in Europe; GeoDH capacity installed in Europe (MWth) and GeoDH systems in Europe [15]. With 53 systems under development, the most advanced market in the next few years is Germany. Moreover, GeoDH – Geothermal District Heating projects are being developed in other countries across Europe, including new markets (Bosnia-Herzegovina, Croatia, Norway, and Spain). Moreover, cogeneration geothermal plants are functional and operative in Iceland, but also in Germany and Austria with intermediate temperatures driving binary turbines. In the future, cogeneration can help geothermal energy become more economically attractive/efficient by recovering waste heat which is then distributed through district systems for heating and cooling purposes.

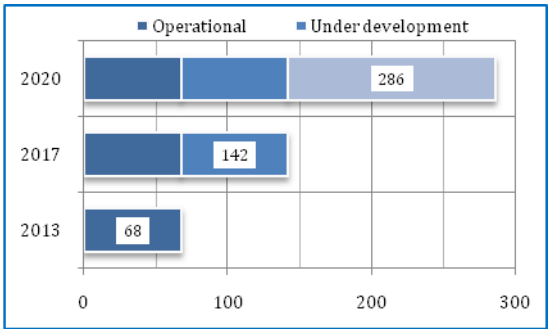

Figure 7: Number of geothermal power plants in Europe

Albania has numerous geothermal energy of low enthalpy resources located in different areas. Thermal waters reach temperatures with values up to 65.5°C and are usually located in several deep oil and gas wells as fountain outputs (temperature can vary from 32°C to 65.5°C). Moreover, the assessment of this type of energy is still being studied [16].

In Serbia, geothermal waters are highly popular considering that approximately sixty spas use geothermal waters for recreational purposes, sports, and balneology. Out of 74 MWt installed energy, 36 MWt are used in balneology while the other 38 MWt for other purposes. Serbia is considered to be one of the top countries in the world that use geothermal energy. Serbia uses approximately 10% of its real geothermal potential [17].

Another country that is characterized by a great practice of geothermal energy use is Macedonia. However, in the last 20 years, Macedonia has faced a stagnating period in the development of its great geothermal potentials resulting in geothermal energy usage decline. This energy is mainly used for greenhouse and space heating. In 2006, from 21 ktoe, the yearly usage is minimized to 9 ktoe (110 GWh). Overall, geothermal energy consumption results around 0.4 to 0.5% in the final energy consumption [18].

2.2 GEOTHERMAL ENERGY PROJECTS IN KOSOVO

As defined in the Renewable Energy Sources - RES Directive 2009/28/EC, "geothermal energy is the energy stored in the form of heat beneath the surface of the solid Earth" [19]. Hence, geothermal energy is a highly distributed (low carbon), a sustainable resource with the capacities to produce continual base-load energy [19]. Because of its characteristics, geothermal energy has the capacity to increase its potential use and contribute to a sustainable use of resources in accordance with the EU targets for renewable energy in 2020. The existing usage of geothermal energy resources differs from country to country. Geothermal energy sector develops when a country implements suitable financial, technical, and regulatory regimes.

Benefits of geothermal energy are in accordance with the European Union target 20:20:20: it is renewable and sustainable; it generates continuous and reliable power; it provides clean and safe energy; it conserves fossil fuels to be used for other applications and it avoids importing energy.

In addition, suggestions are provided on how to increase the geothermal energy production in Kosovo to levels that are comparable with other EU countries. The goals for this paper are:

- Forecast the usage of geothermal energy in Kosovo for the period 2013 – 2022.
- Demonstrate how geothermal energy contributes to an eco-friendly environment by analyzing a local developed geothermal project.
- Show how central and local level governments can use public-private partnerships to develop geothermal energy projects.

Additionally, the above-listed goals were addressed through a research methodology that was both qualitative and quantitative in nature. Secondary research was performed through desk research, which included the following research activities:

- Laws and regulations were reviewed and evaluated with respect to the project goals.
- A number of documents were reviewed, such as government strategies, academic writings, and specific Kosovo energy efficiency related reports published by different Kosovo governmental and non-governmental organizations operating in Kosovo.

A number of best practices for developing geothermal energy project were reviewed and analyzed. Relevant lessons learned were derived from the identified case.

Primary research was performed through interviews with central and local level government officials were conducted in order to identify what are Kosovo's institutions doing in meeting the EU energy standards; what is specifically being done related to alternative energy sources; and is the government supporting private investments in alternative energy source, specifically geothermal energy projects.

Besides the secondary research activities and the interviews done with the project stakeholders, considerable time was spent going through the documents of one locally developed EE geothermal projects, The International Village.

2.3 GEOTHERMAL ENERGY - GROUND SOURCE HEAT PUMPS

Public-private partnerships are seen as promising alternatives in increasing the financial

potential of the local level governments to initiate and implement additional public projects and also as ways to stimulate private sector involvement in developing geothermal projects. Such initiatives not only support municipalities in increasing their overall municipal level funds, but also support them in becoming more environmentally cautious regarding climate change. Lastly, PPPs – Public Private Partnerships in geothermal energy projects enable local authorities to increase their level of investments and overall well-being of citizens.

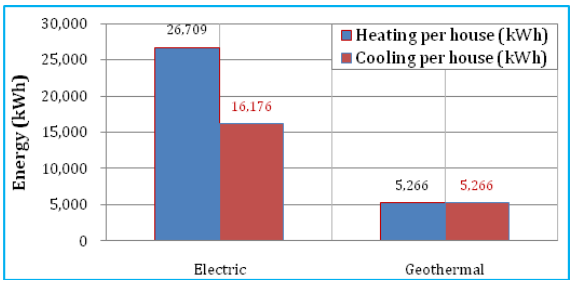

Figure 8: Energy requirements for Electric energy vs. Geothermal energy per house

The International Village undertook a renewable energy project with the objective to save its long-term operational budget and become environmentally friendly. It has analyzed two scenarios for its heating and cooling needs for the 110 houses, each with average space of 315.64 m^2, and total space of 34,720.40 m^2, in the residential complex - both electric versus geothermal energy.

Table 4: The International Village: Energy requirements - electric energy vs. geothermal energy

House type:	A (420 m^2)		B (330 m^2)		C (260 m^2)	
No of houses	26		28		56	
Energy:	Elec.	Geo.	Elec.	Geo.l	Elec.	Geo.
kW (Heating)	17.1	3.1	12.5	2.5	10.1	2.1
kW (Cooling)	10.9	3.1	7.5	2.5	5.9	2.1

The season is calculated from 01 October to 30 March for winter (2,160 hours) and from 01 April to 30 September for summer (2,160 hours). Thermal analysis is based on specific heat consumption q (kWh/m^2year), t_i=18°C average design temperature within the room, t_e= -15°C outdoor design temperature and based on Unified Construction Code of Kosovo for Pristina city, with the Excel program ThermoCalc, see figure 9 [20].

The ten year calculated heating energy with electrical energy, and with geothermal energy and energy savings in MWh/10years are illustrated in figure 11 and 12.

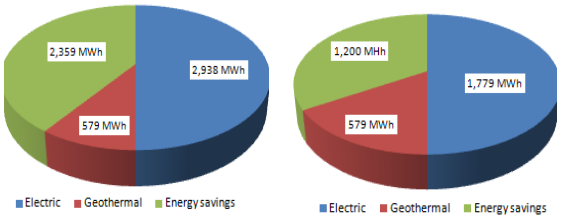

Figure 9: Spending heating energy – electric energy vs. geothermal energy

a. Heating energy consumption MWh
b. Cooling energy consumption MWh

In the following figures and table are given: the Approximate project cost with electric energy (€), Approximate project cost with geothermal energy (€) and RES target and EE target in the ktoe for Kosovo Village.

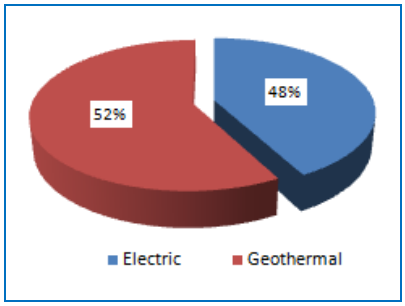

Figure 10: Cost implications

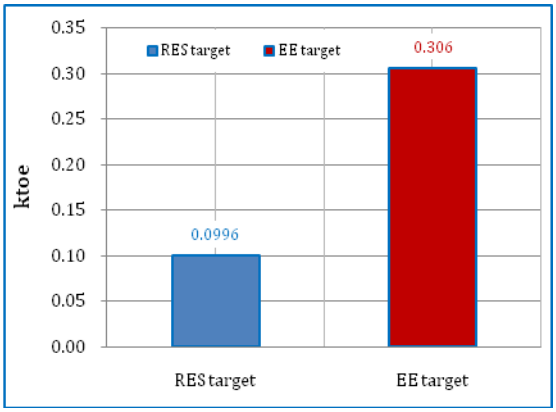

Figure 11: RES target and EE target

Electric energy vs. Geothermal energy Based on the results presented above (energy requirements for electric vs. geothermal energy per house, cost implications electric vs. geothermal energy, heating and cooling energy savings we can calculate the Return on investment for project physical infrastructure, shown in the following figure 12.

The heating and cooling energy needs for Kosovo Village is used from a Ground Source Heat Pump (GSHP). GHP is a cost-effective tool that lowers the level of carbon emissions if it is planned

for heating in a properly planned building. The Coefficient of Performance "CoP" plays a vital role in the efficiency of a GSHP. The First Law of Thermodynamics indicates that "energy can neither be created nor destroyed" [21].

However, a proper installation containing a GSHP, for every unit of electricity consumed is capable of producing around four units of heat [22]. As stated below, "the heat pump is not creating this energy, but merely separating a medium temperature from the ground into warmth (which can be used for heating) and cold (which can be returned to the ground)" [22].

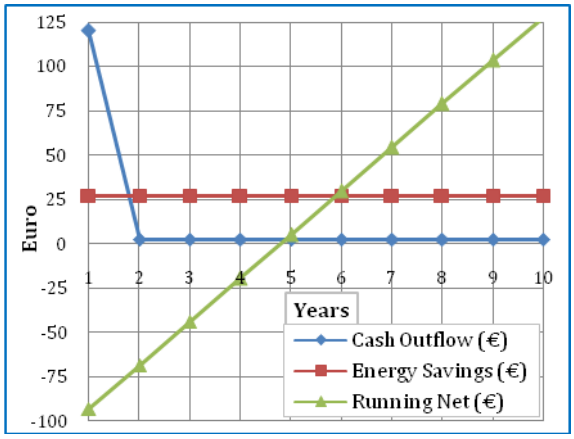

Figure 12: Return on investment for project physical infrastructure

The geothermal heat pump is not generating this energy, but only dividing a medium temperature from the ground into warmth that can be used for heating and cold that can be returned to the ground. In our case - Kosovo Village coefficient of performance is CoP=5.20.

From the above case we can derive the following analysis:

- Annual contribution to RES target for households: 0.0996 ktoe
- Annual contribution EE target for households: 0.3060 ktoe.

From the above table we also find out that thirteen (13) such paired investments projects (Kosovo Village) are needed to be undertaken, throughout 2013 and 2022, so that the country, especially the GK, achieves to reach the national RES target of 1.29 ktoe (15,000.70 MWh) ktoe by 2020. Continuing, an additional ninety six (96) such paired investments are needed to be undertaken, throughout 2014 and 2018, so that EE target of 30.64 ktoe 356,342.20 MWh) is achieved.

III. CONCLUSIONS

The Republic of Kosovo is rich in thermal and mineral water springs. So far, there has been little research to identify and study the potential of these resources. Based on various data and information gathered in the past years, Kosovo has approximately thirty thermal and mineral water sources. "Banja e Pejes", "Banja e Kllokotit", and "Banjksa" are typical thermal baths located in Kosovo. Besides healing (human health) aspect, Kosovo's thermal waters can be utilized for thermal power generation. However, we still do not know the possible potential of these waters. The temperature that characterizes both thermal and mineral waters varies between 17.4^{o}C and 50^{o}C. The following table represents the characteristics of thermo-mineral sources identified in Kosovo [23].

Based on the Legal and Regulatory action – RES Kosovo as well as on the Energy consumption forecasts it can be concluded that according to Energy Regulatory Office of Kosovo (ERO) 2014, which set feed-in tariffs ("feed-in") of electricity produced from BRE, the utilization of geothermal energy in Kosovo is not favoured. According to ERO, the electric energy produced from using water has the price of 63.3€/MWh, wind 85.0€/MWh, from biomass 71.3€/MWh, and from solar panels/photovoltaic 136.4€/MWh [24].

Table 5: Mass flow and the temperature of thermo-mineral sources of Kosovo

Nr.	Area	Mass flow (l/s)	Temperature (^{o}C)
1.	Banja e Pejes	4.0	48.9
2.	Banja e Kllokotit	10.0	32.0
3.	Banjska	2.5	50.0
4.	Banja e Runikut	15.0	24.8
5.	Burimi i Runikut	5.0	23.0
6.	Studenica	1.0	25.0
7.	Uglari	6.0	25.0

Source: Environmental Protection Agency, The State of Water in Kosovo, Pristina, 2010.

Lack of data regarding the future opportunities of utilizing geothermal energy, the high cost of conducting proper research, and the expensive technology of using these types of resources has resulted that in the short term plans of Kosovo for energy, geothermal energy will be not included within the renewable resources that can be used. This represents an investment that private businesses cannot undertake without financial aid from the Government of Kosovo.

From Figure 9 we can see the quantity of thermal energy (the difference between heating with electric and thermal energy for a 10-year period) which courses with the case of using heat pumps for

heating -2,359 MWh/10years and for cooling - 1,246 MWh/10years.

In figure 10 it can be seen that the price of investment for heating equipment with geothermal energy is significantly higher (58%) compared to those with electric energy (42%). But according to figure 12, the return on investment is five years and it is characterized with energy savings during its utilization, because the costs for geothermal energy during operation are much lower and geothermal pumps are also used for cooling. Hence, the consumption of electric energy gets reduced and as a result, we achieve the National Renewable Energy Plan (NREAP) Kosovo Target 3: 45.65% of RES in gross final consumption of heating and cooling and 20% of EU energy consumption to come from renewable energy resources.

Finally, the continuing trend of low cost of electricity makes RES uncompetitive and EE improvements unattractive to the end users. Hence, the GK should offer more incentives which would foster the development of alternative and efficient energy projects. In the case of geothermal energy, the following recommendations could be considered: Develop a database of geothermal projects; Increase public awareness of geothermal energy; Establish cooperation with the University's, offices and other specialized institutions; Customs and VAT exemptions; Low-interest credit lines and 'feed in' tariffs for geothermal energy; Analyze private investments cases in order to calculate cost implications for RES and EE targets; Undertake PPPs - GK and Municipalities should consider PPPs as a highly promising investment modality.

ACKNOWLEDGEMENTS

The key developments regarding EE and RES targets in Kosovo include a general well-established legal framework, set targets for up to 2022, and donor investments on related projects and activities. However, there remains much to be done, especially by the Government of Kosovo. Further actions should be taken in order to further push the legislative basis, investment in concrete projects, and stimulation of private sector to consider EE and RES investment options. In addition, awareness should be raised amongst the general public on the importance of climate and energy sustainability targets.

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