AN INVENTORY OF RENEWABLE ENERGY POTENTIAL OF REGION OF KARAVASTA, IN ALBANIA

VALBONA LAME-MUDA[1], PELLUMB BERBERI[1], DRIADA MITRUSHI[1], DANIELA HALILI[1], IRMA BERDUFI[1],URIM BUZRA[1],MARGARITA KUQALI[1]

[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania valbona_muda@hotmail.com
[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania pellumb.berberi@gmail.com
[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania driadamitrushi@yahoo.com
[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania topciudaniela@yahoo.com
[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania irmaberdufi@gmail.com
[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania rimibuzra@yahoo.com
[1]Department of Engineering Physics, Faculty of Engineering Mathematic and Engineering Physics, Polytechnic University of Tirana, Albania mkuqali@yahoo.com

Abstract

The Karavasta Lagoon is the largest lagoon in Albania and one of the largest in the Mediterranean Sea. The lagoon is cut of from the Adriatic Sea by a long sandy bar. This study presents a general evaluation of the natural aspects of Karavasta Lagoon area and its surroundings, and offers a feasibility evaluation of local sources of energy friendly to environment. Karavasta Lagoon, as a protected area, is very sensitive on use of conventional technologies for fulfilling of its needs for energy. Uncontrolled human activity for many years has damaged fauna and flora of the region, which makes very important applying friendly technologies based on regional resources for producing needed energy. Solar technologies seem to be very promising. For the solar technologies, the ‘‘initial investment only” cost analysis is performed by considering only the initial costs of purchasing and installing the equipment. Calculations are carried following described by us in previous works mentioned in our literature**.** Two solar technologies are considered: crystalline photovoltaic and flat plate solar collectors.

Production of heat using solar energy results to be very cost effective. Cost of heat is only 0.019 Euro/kWh, five times cheaper than the energy supplied from the grid. Cost of electricity produced by photovoltaic is still high, 0.187 Euro/kWh, but it can be a reliable source of power for water pumping. Karavasta Lagoon results to be one of the most insolated regions in Albania, which make very feasible use of solar collectors for producing hot water or for green houses to produce early agriculture products.

Keywords: *Karavasta lagoon, inventory of energy potential.*

Introduction

The Karavasta Lagoon is the largest lagoon in Albania and one of the largest in the Mediterranean Sea. (Figure 1).The lagoon is situated in the west of Albania in the coast of Adriatic Sea. The lagoon is cut off from the Adriatis Sea by a long sandy bar. The Karavasta lagoon has many pine trees and small sandy islands. The lagoon is famous for the rare Dalmatian Pelican which nests there: In fact 5% of the world's population of this type of pelican is found in this lagoon. Karavasta lagoon is one of important areas in ecological area Divjak's pine forest. Karavasta's lagoon is declared protected natural area and is included in the list of Ramsarit's convention. The protected area involves the surface of National Park (Divjaka's Pine) of 1162 ha, the Kular area of 815 ha and area of lagoon of 3967 ha **[1]**. The geographic position of Karavasta, gives to this a Field Mediterranean climate. One of the main factors that influence this climate is the closeness to the sea.

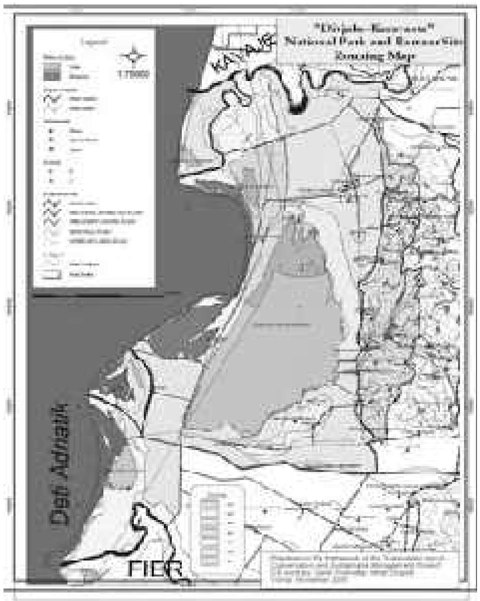

Figure 1 *The Karavasta Lagoon, the largest lagoon in Albania and one of the largest in the Mediterranean Sea, is situated in the west of Albania. Declared protected natural area included in the list of Ramsarit's convention. The protected area involves the surface of National Park (Divjaka's Pine) of 1162 ha, the Kular area of 815 ha and area of lagoon of 3967 ha. The lagoon is famous for the rare Dalmatian Pelican which nests there: 5% of the world's population of this type of pelican is found in this lagoon.*

The region is not very populated and supply of energy from the grid is problematic. The objective of our study is creating a detailed inventory of natural resources of the area demanding a careful protection and whish habitat can be influenced by the use of conventional technologies of energy, local needs for energy to assure a sustainable development of the region minimizing possible damages of local flora and fauna, and a feasible analysis of potential use of local renewable sources of energy supply the needed energy.

Natural resources of the region

A biotic aspects. The Divjak-Karavasta region for its variety and ecological characteristics represents one of the most beautiful areas of Albania. Its area includes a belt of littoral sand, a coastal forest (Divjaka forest) the Karavasta Lagoon, Agricultural lands and Divjaka Hills. Karavasta Lagoon, situated near the sea, has a typical field Mediterranean Climate. The area is known for its mild climate, due to both low relief and also the important influence of warm air masses from the sea. From June to September the weather is hot and dry, while from October to May is cool and wet.

We used two sources of data: ground insolation measured by local existing meteorological net and database of NASA surface meteorology and solar energy. Radiation parameters were compared with data from the Baseline Surface Radiation Network**. [2]** The parameters evaluated are: solar radiation, air temperatures, air humidity, wind and rainfall.l

Solar Radiation: Solar Radiation is a principal factor of the climatological regime. Average annual global solar radiation on Karavasta Lagoon is about 1560 kWh/m^2. The global radiation varies from 54 kWh/m^2 in January, to 218 kWh/m^2 in July. About 130 sunny hours are observed in January while in July about 390 hours. Average annual number of the sunny hours observed is about 2770. Table 1 shows monthly distribution of mean daily insolation on a horizontal surface

Table 1. *Monthly Averaged Insolation Incident On A Horizontal Surface (kWh/m^2/day)*

Karavasta (LU)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22-year Average	1.99	2.85	4.20	5.24	6.55	7.57	7.66	6.62	5.08	3.44	2.12	1.60

Air temperatures- Average monthly air temperature in Karavasta Lagoon varies from $t = 7.0^0 C$ in January, which is the coldest month of the year to $t = 23.5^0 C$ in August, which is the hottest month. Average for the multi-annual air temperature period is $t = 15.3°C$. The absolute maximum temperature recorded is $t = 41.5°C$ and the minimum temperature recorded is $t = -10.5°C$. Karavasta Lagoon area is one the hottest region in Albania. Annual average number the hottest days for the air temperature $t > 30^0 C$ observed is $35°C$. Annual average number of cold days, air temperature $t < 0.0^0 C$ is small, about 2-3 in a year. Table 2 shows monthly averaged air temperature at 10 m above the surface of the earth

Table 2 *shows monthly averaged air temperature at 10 m above the surface of the earth (°C)*

Karavasta	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
22-year Average	6.68	7.20	9.60	13.0	17.7	21.6	24.6	24.8	21.2	17.1	12.0	7.83	15.3

Air Humidity: Air Relative Humidity J_0 depends on the periods of the year. Monthly average of the Relative Air humidity in Karavasta Lagoon area varies from $J_0 = 63\%$ in July to $J_0 = 14\%$ in January. Annual average of Relative Air humidity for the multi-annual period is $J_0 = 68\%$. Air Humidity Deficit Δl_0 varies from $\Delta l_0 = 3.0 mb$ in January, which is the coldest month of the year to $\Delta l_0 = 2.5 mb$ in July, which is the hottest month. Annual average of the Air Humidity Deficit for the multi-annual periods is $\overline{\Delta l}_0 = 6.6mb$. Table 3 shows monthly averaged air temperature at 10 m above the surface of the earth

Table 3 *shows monthly averaged air temperature at 10 m above the surface of the earth (%)*													
Karavasta	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
22-year Average	68.2	64.7	63.1	61.8	59.2	55.8	50.6	52.0	55.8	60.3	66.9	69.6	60.7

Wind: Wind velocities depend on the periods of the year. The highest values in the Karavasta Lagoon area are observed in winter when the cyclonic activity is more intensive. In this season the average wind velocity varies between $\overline{V} = 3.2 - 3.5m/s$. Summer is characterized by relative low wind velocities, because of the anticyclonic weather. The average velocity of the wind differs from $\overline{V} = 2.5$ *to* $2.7\, m/s$ in this season. The maximal average wind velocity in Karavasta Lagoon Area is $v \succ 4.0m/s$. Technology for wind energy has tremendously advanced the last years leading to: large turbines, lower noise levels etc. the developments of new types of turbines have therefore resulted in larger and higher turbines. Table 4 shows monthly averaged air temperature at 10 m above the surface of the earth

Table 4 *shows monthly averaged air temperature at 10 m above the surface of the earth m/s*													
Karavasta	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
10-year Average	4.38	4.57	4.46	4.22	3.59	3.56	3.60	3.65	3.61	3.91	4.43	4.66	4.05

Rainfall: The rainfalls in Albania have a Mediterranean regime. Albania belongs to the subtropical Mediterranean climate. It is characterized by mild winters with abundant precipitation and hot, dry summers. The average annual precipitation is about 948.5 mm. The highest precipitation is recorded in the clod months (October – March). The richest month in precipitations is November (140.3 mm), while the purest are July (25.7 mm) and August (32.3 mm). Compared to the temperature, the falls regime the last years can be easily distinguished from previous one. Table 5 shows monthly averaged air temperature at 10 m above the surface of the earth

Table 5 *shows monthly averaged air temperature at 10 m above the surface of the earth mm/day*													
Karavasta	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual Average
22-year Average	2.95	2.92	2.42	2.48	1.54	1.18	0.91	1.08	2.24	2.84	4.36	3.67	2.37

Figure 2 shows graphically annual distribution of above-mentioned climatological parameters

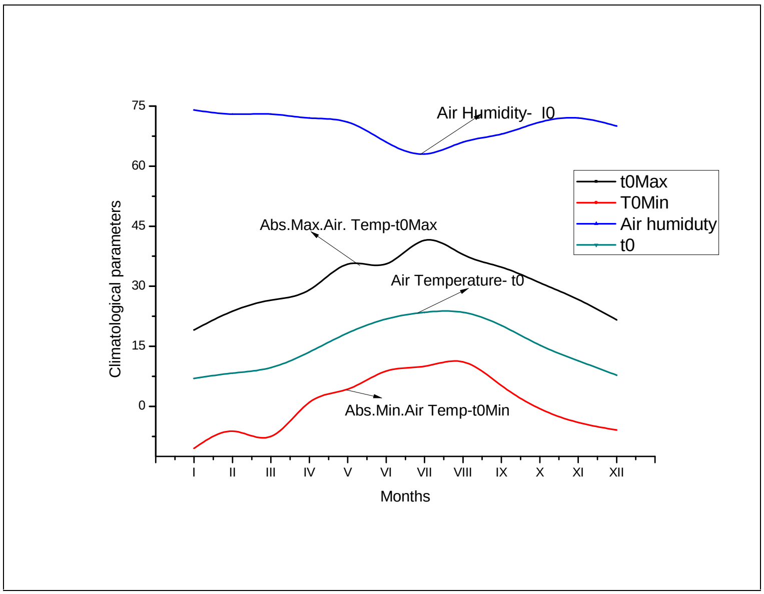

Figure 2*. Variation of climatological parameters during the year.*

Biotic aspects: Uncontrolled human activity for many decades of the XX century and on has damaged very much the general values of Karavasta Lagoon natural environment. This activity includes urban and industrial discharge, untreated hydrocarbons, without taking hydro technical measures for maintain the hydraulic communication channel between the lagoon system and the Adriatic Sea in optimal condition wetlands reclamation without criteria. The impact of climate change in the limniological and hydro morphology regime in deltaic coastal Karavasta system is intensive. The hydroclimatical factors such as the wind, floods of Semani and Shkumbini Rivers, wave refraction, sea currents and others have their relevant impact.

Resources and cost analysis of electricity. Heat produced by solar technologies.

The life cycle cost analysis looks at the economics over the life of the product. Determining the cost of materials and systems used in a house is a challenging task. Prices can be significantly different from year to year and depend on location, manufacturers, vendors, market fluctuations, etc. In order to compile the most accurate and realistic prices for the case study house designed, every effort was made to get up-to-date pricing from local vendors for the solar technologies. Evaluating the financial payback time for changes to house components or systems that affect the electricity demand can be done with several methods. The simplest method is the aptly named ‘‘simple payback” method. However, this is simply the initial cost of the item divided by the annual cost savings due to the change. The results from the simple payback period method are presented because the method is still largely in use. For the solar technologies, the ‘‘initial investment only” cost analysis is performed by considering only the initial costs of purchasing and installing the equipment. Calculations are carried following described by us in previous works **[3]** and **[4].**

Two solar technologies are considered: crystalline photovoltaic and flat plate solar collectors. Table 6 shows Monthly averaged direct normal radiation, annual average, months with maximal and minimal radiation and life cycle cost of electrical energy produced by photovoltaic for interest zone (Karavasta Lagoon). Table 7 shows Monthly averaged direct normal radiation, annual average, and months with maximal and minimal radiation and life cycle cost of heat produced by solar collectors in Karavasta Lagoon. While electrical energy produced with photovoltaic energy continues to have cost higher then electrical energy supplied by the national grid, cost of the heat produced by solar collectors is much cheaper than the cost of the heat produced using an electric heater. Actual cost of electrical energy supplied from the grid in Albania is 0.1 Euro/kWh. In Table 8 are shown monthly averaged direct normal radiation, cost of heat energy, annual cost of hot water produced by electric system, annual cost of hot water produced by solar collector system and cost saved every year due to use of solar technologies for producing hot water for domestic use in Karavasta Lagoon The mean variation of cost of hot water by solar technologies for all regions of Albania considered is 15.2%. Karavasta Lagoon results to be one of the most insolated regions in Albania, which make very feasible use of solar collectors for producing hot water or for green houses to produce early agriculture products.

Table 6 *Monthly averaged direct normal radiation, annual average, months with maximal and minimal radiation and life cycle cost of electrical energy produced by photovoltaic for Karavasta lagoon*

Region	Location Latitude / Longitude Degree	Mean height over sea level m	Average daily insolation kWh/m^2/day				Average annual insolation kWh/m^2/d	Average Cost of energy €/ KW h
			Max	Month	Min	Month		
Karavasta	40.933/19.7	67	8.32	June	6.68	December	7.62	0.187
Average cost for Albania								0.240

***Table 7** Monthly averaged direct normal radiation, annual average, months with maximal and minimal radiation and life cycle cost of heat produced by solar collectors in Karavasta Lagoon (Lushnje)*

Region	Location Latitude / Longitude Degree	Mean height over sea level m	Average daily insolation kWh/m^2/day				Average annual insolation kWh/m^2/ day	Average Cost of energy €/ KW h
			Max	Month	Min	Month		
Karavasta	40.933/ 19.7	67	8.32	June	6.68	December	7.62	0.019
Average cost for Albania								0.024

Table 8 *Monthly averaged direct normal radiation, cost of heat energy, annual cost of hot water produced by electric system,* annual cost *of hot water produced by solar collector system and cost saved every year due to use of solar technologies for producing hot water for domestic use in Karavasta Lagoon*

Region	Average annual insolation $kWh/m^2/day$	Average Cost of energy €/ KW h	Annual cost of hot water Electric system Euro/y	Annual cost of hot water Solar collector system Euro/y	Cost saved every year Euro/y
Karavasta	7.62	.0.019	519	83	436
Average cost for Albania		0.024	519	105	414

Conclusions

Karavasta Lagoon, as a protected area, is very sensitive on use of conventional technologies for fulfilling of its needs for energy. Uncontrolled human activity for many years has damage fauna and flora of the region, which makes very important applying friendly technologies based on regional resources for producing needed energy. Solar technologies seem to be very promising. Production of heat using solar energy results to be very cost effective. Cost of heat is only 0.019 Euro/kW h, five times cheaper than the energy supplied from the grid. Cost of electricity produced by photovoltaics is still high, 0.187 Euro/kWh, but it can be a reliable source of power for water pumping.

Literature

[1] Study on assessment of renewable energy sources potentials in Albania, Co plan Institute for Habitat Development 2007, http://www.co-plan.org, Visited June 2012

[2] Surface meteorology and Solar Energy, A renewable energy resource web site (release 6.0) http://eosweb.larc.nasa.gov/cgi-bin/sse/sse.cgi, Accessed 10 May 2012

[3] Regional Distribution of Life Cycle Cost of Electrical Energy Produced by Photovoltaics in Albania, *Daniela Halili, Pellumb Berberi, Driada Mitrushi, Valbona Muda-Lame,Ohrid 2012*

[4] Regional Distribution of Life Cycle Cost of Heat Produced by Solar Collectors in Albania *Daniela Halili, Pellumb Berberi, Driada Mitrushi, Valbona Muda-Lame*

[5] Mapping the Potential for Decentralized Energy Generation Based On Res in Western BalkanS, BIBLID: 0354-9836, *11* (2007), 3, 7-26

[6] Hido E. 2006,"Evaluation of solar energy potential in Albania"project Co-PLAN 2007