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Solar Energy Potentials in Southeastern European Countries: A Case Study

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Abstract- The climate in Southeastern European countries is relatively similar to that of the Middle East and North Africa, where the annual sun irradiation is theoretically high according to SolarGIS data. Today, the photovoltaic systems technology sector is exponentially expanding in the international energy market. The aim of this paper is to study, compare, and analyze this important field in related countries and propose solutions to develop and encourage a solar energy market in Albania, where the economy has been gradually increasing in the last ten years. The potential for a renewable energy sector in Albania is promising, mainly because of the important presence of wind and solar energy resources. An additional objective of this study is to try to apply the results obtained in similar countries in the Balkans to increase the socioeconomic benefits and the creation of job opportunities in the country, as well as contributing to the protection of the environment and economic growth. In this paper, we discuss the importance of exploiting photovoltaic systems in mountainous regions and villages –where public electricity is unavailable – to be widely used in heating, lighting, and irrigation, as well as to support grid systems. In addition, the advantages of photovoltaic technology are introduced and illustrated to motivate public establishments and government-owned electrical sectors to use and develop this technology.

Keywords heating, education, clinics, home lighting, irrigation, mountainous areas, floating solar.

Nomenclatures **Abbreviations**	
AM0	Air Mass zero
AU	Astronomic Unit
c	Speed of light (c = about 3 * 108 m/s)
CSP	Concentrating Solar Thermal Power
EPS	Energy performance certificates
GISS	Goddard Institute for Space Studies
GISTEMP	GISS Surface Temperature Analysis
GWdc	Giga Watts-dc
MERRA	Modern Era Retrospective Analysis for Research and Application
MW	Megawatt
NASA	National Aeronautics and Space Administration
PERC	Passivated Emitter and Rear Cell
PV	Photovoltaic
W	Watts
Le	Radiance
E	Energy
M	Mass
P	Power [W]
E	Energy [kWh]

Greek symbols	
K	Kelvin
θ	Polar angle
φ	Azimuth
$\hbar$	Speed of Plank's constant
ν	Frequency
λ	Wavelength
Ω	Hemisphere
Prefixes	
A	Whole surface
Ph	Photons

1. Introduction

Radiant energy from the Sun constitutes the Earth's primary source of energy. This energy is measured in irradiance, which is the amount of light energy received by a surface per unit area. Put differently, irradiance can be defined as the output of light energy from the sun as it is measured on Earth. With photonic wavelengths ranging from X-rays and gamma rays, this light energy is made visible by means of infrared and radio technology [1].
Today, photovoltaic technology has become one of the world's most important source of power in generating infinite energy. According to [2], "the annual market increased nearly 50% to at least 75 GWdc – equivalent to more than 31,000 solar panels installed every hour – raising the global total to at least 303 GWdc. In 2016, 110 MW of concentrating solar thermal power (CSP) capacity came online, bringing global capacity to more than 4.8 GW by year's end [2] This was the lowest annual growth rate in total global capacity in 10 years, at just over 2%. Even so, CSP remains on a strong growth trajectory, with as much as 900 MW expected to enter operation during the course of 2017."

Photovoltaic cells is a solar-energy technology that converts sunlight into electricity (PV effect) by using semiconductor conductivity widely known as PV cells. Solar cells are configured as a PV panel or a module that can be combined as a PV system operating from watts – from an electricity power output – to several megawatts – from power stations [3].
Figure 1 projects global temperature and precipitation rates in the years leading to 2100, according to various greenhouse gases emission rates. NASA developed these projections by combining historical data with the results from climate simulations using state of the art technology.

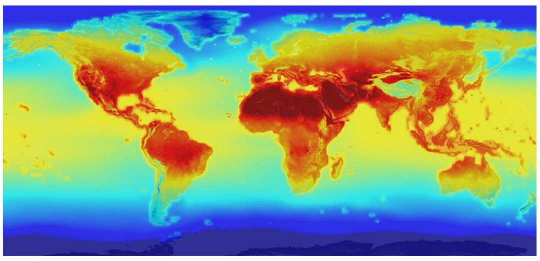


Fig. 1. The new NASA global data set combines historical measurements with data from climate simulations using the best available computer models to provide forecasts of how global temperature (shown here) and precipitation might change up to 2100 under different greenhouse gas emissions scenarios [4].

Figure 2 shows the GISTEMP monthly temperature anomalies in a 1880 to 2018 mean seasonal cycle.

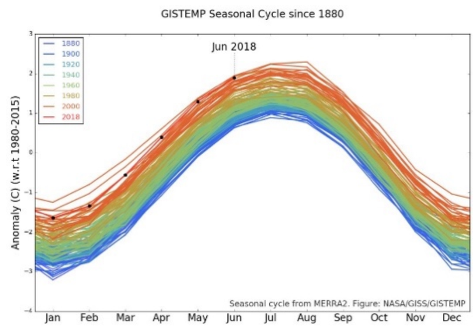


Fig. 2. The GISTEMP monthly temperature anomalies in a 1880 to 2018 mean seasonal cycle (seasonal cycle from MERRA2) [5].

According to the National Aeronautics and Space Administration, Goddard Institute for space Studies "April 2018 was the third warmest April on record," as it was "0.86°C warmer than the average April of the 1951-1980 period; this value is in line with the 1.8°C/century rate of increase of the past 40 years." Table 1 demonstrates the warmer months compared to the average, where the results show that April 2016 and 2018 were the warmest.

Table 1. The warmer months compared to the average value

Month and year	April 2010	June 2015	April 2016	April 2017	April 2018
Warmer than the average value	+0.84 °C	+0.80°C	+1.07 °C	+0.92 °C	+0.86°C

Global warming, or climate change, is defined as the drastic change in temperature over the last few years comparatively to the historical trend, as demonstrated in Table 1. This trend will continue and even worsen if policymakers do not adopt the measures necessary to protect the planet, such as limiting gas emission and minimizing its sources as much as possible and introducing preventative solutions. One solution is to further develop renewable energy technology, expand its use, encourage investment in renewable energy resources and minimize the manufacture of polluting objects.
For solar modules, efficiency is the key metric. Put simply, increasing the efficiency consequently increases the power rating. EPCs pay for this power rating, which charges a number of dollars per watt.

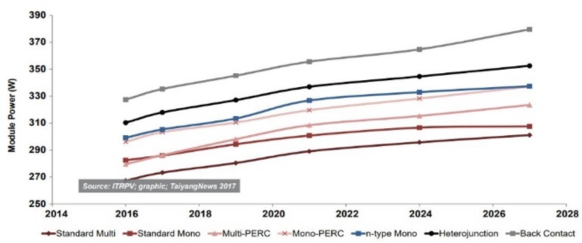


Fig. 3. Power rating of different module technology [6].

Figure 3 presents the power gain potential: over the next 10 years the power ratings of solar modules are expected to increase by an average of approximately 1.3% /year; back contact modules and multi-PERC are expected to record the highest increase – close to 1.6% per year.

2. Literature Review

According to a study by IRENA, published in February 2018, renewable energy systems are rapidly becoming less expensive than conventional power production technology. Therefore, fossil fuel prices have fallen in the last decade and renewable energy technology prices are quickly plummeting thanks to the development of a stronger renewable energy global market. For example, solar PV systems and solar panel technology in Europe has decreased by approximately 80% from 2010 to 2016 (IRENA, 2016c). Consequently, this decrease enables competitive generation prices, even in countries with low-quality solar resources. In June 2017, for instance, a utility-scale solar PV auction in Germany yielded an average cost of 5.6 Eurocents per kWh [7].

An approximation of payback time of different sized photovoltaic panels in different locations was estimated in a paper published by Giovanni Mazzanti. The study takes into account the time required to evaluate the incentive mechanism and the PV market economy. The objective of the published paper is to determine if the PV system is equivalent to grid systems. The assessment demonstrates the fast growth of PV markets in the last decade worldwide and particularly in Italy. This method of PV can be a standard of developing solar energy systems in the world as indicated in the paper. The study estimates that the economic situation could lead to a decrease in the PV market technology. However, the study also foresees a possible delay in the progress of Grid Parity, though, its finalization is inevitable [8].

A series of long-term surface solar radiation (SSR) in Athens is presented in this published work. The measurements of the surface solar radiation were implemented between 1954 to 2012. The study used a record sunshine duration between 1900 to 1953 to rebuild monthly SSR. After having analyzed the data, the results showed that a small change of 0.02 % in SSR was registered. Compared to several studies developed in the Mediterranean area, this Athenian study reported a lower percentage of SSR change. The study also demonstrates that changes in SSR of all-sky and clear-sky conditions after 1994 are largely the result of aerosol load changes, although cloudiness is a partial factor [9].

The work published by Roberto L. Arantegui and Arnulf Jäger-Waldu introduces the deployment of solar and wind energy in the EU and the leading strategy behind this growth. As one of the largest economies in the world, the EU plans to reach 27% of its energy production from green sources by 2030. In 2016, over 12% of the EU's electricity demand was generated by solar and wind sources – a little less than half of the 2030 target As the authors indicate, the data used in this research is collected from different sources, establishments, government officials and policymakers to support the progress of solar and wind energy, proving once again that grey data is crucial to research in this domain [10].

This paper focuses on solar energy potential and its merits and demerits. The development of modern photovoltaic technology is considered as one of the solutions to meeting the increasing demand for electrical energy production. Researchers explored the fast growth of solar technology and the several technical barriers that persist, mainly a low PV cell efficiency, a low performing balance of systems and economic obstacles, such as the high cost and shortage of funding mechanisms [11].

As indicated in the report [2], solar PV has become the primary source of new power capacity in a number of major economies. In 2017 – a particularly fruitful year for PV systems technology – more capacities of this technology were developed than other power productions, such as fossil fuel and nuclear power [12].

"In the year 2017, 29 countries passed the GW mark with respect to the PV installed capacity. Seven countries now have more than 10 GW of total capacity, four more than 40 GW and China alone represented 131 GW. Germany, which used to lead the rankings for years, lost its leading position in 2015 and now ranks fourth (42 GW), with Japan third (49 GW) and the USA second (51 GW). With more than 111 GW of total capacity, Europe is now significantly behind the Asian leader that runs at least 219 GW, and much more to come in the coming years" [13].

According to IRENA, as of late 2017, hydro power generation capacity remains the most used renewable generation in the world, with 53% (1,152 GW) of the share, while wind energy ranks in second place with 23% (514 GW) of the share, as demonstrated in Fig. 5. Overall, solar energy production ranks in third place, with 18% (397 GW) of the share, while the remaining renewable energy accounts for 6% of all production. Globally, renewable generation capacity amounts to 2,179 GW [14].

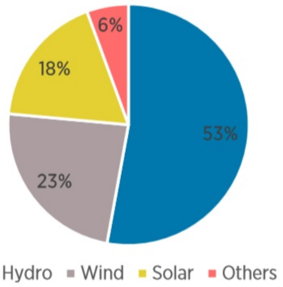


Fig. 5. Renewable generation capacity by energy source.

In 2016, the global solar cell manufacture reached 79 to 84 GW, while it increased to 90 to 95 GW in 2017. Figure 6 shows the global PV cell/module production between 2005 and 2017.

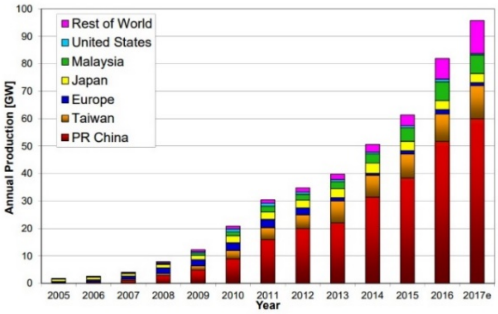


Fig. 6. World PV cell/module production from 2005 to 2017 (estimate) [15-16].

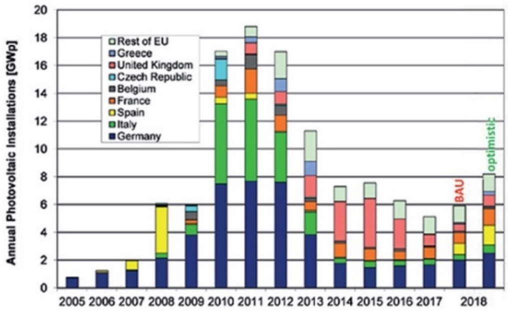


Fig. 7. Annual photovoltaic installation in the European Union [17].

Figure 7 illustrates the annual photovoltaic installation (GWp) in the EU from 2005 to 2018. Up until 2011, there has been an exponential increase, which began to falter afterwards, although the total installed capacity recorded in 2017 was 108 GW approximately. The installation span in the last four years starts from approximately 5.1 to 7.6. We note that the average annual target has decreased comparatively to the growth that occurred from 2010 to 2011. Accordingly, new policies to develop this important sector are needed to increase the annual photovoltaic installation in the European Union [17].

The annual solar installations in Europe, in 2017, increased by 28% (with Turkey leading the solar market), with a total of solar energy production of approximately 8.61 GW; while in the 2016, the installation increased by only 6%, rising from 5.69 to 6.03 GW according to Solar Power Europe [20]. The top 5 European markets in 2017 are presented in Table 2.

Table 2. Top 5 European Solar Markets 2017 [18].

Country Name	RoE	Turkey	Germany	UK	France	Netherlands
Solar Market	28%	21%	20%	11%	10%	10%

Renewable generation capacity in Europe in 2017 is shown in Table 3.

Table 3. Renewable generation capacity in Europe [14].

Capacity	Global share	Change	Growth
512 GW	24%	+24 GW	+4.8%

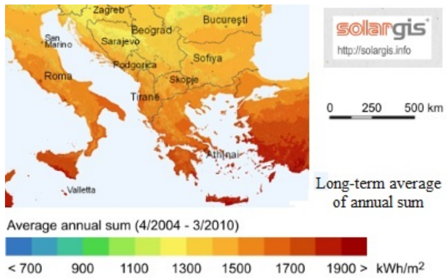


Fig. 8. Map of the average annual download surface solar irradiation in Southeast Europe [19].

Figure 8 shows the long term average of annual sum surface solar radiation in Southeast Europe. Seven different solar radiation scales are explored in the region starting from 700 to 1900 kWh/m^2/year. Accordingly, development of solar energy systems in the region is promising compared to north and central Europe, as indicated in the previous map, as radiation levels are a key factor in increasing the efficiency and economic feasibility of PV systems.
Finally, we quote the paper published by Stefan Dunjic et al. [20]. This paper illustrates the growth, consumption and share of renewable energy in the related countries. Some calculations are done to illustrate the shares for two years, namely 2010 and 2011. Subsequently, these numbers are combined with those from the years 2009, 2012 and 2013 to create a linear trend forecast.
The results show the growth of renewable energy outside of the European Union and its link to the complex political situation in the Balkan countries, including the gas crisis of 2009. Consequently, decision makers developed renewable energy markets to avoid the existing and future energy crisis.

3. Methodology

The sun is at the center of the solar system and consists mainly of hydrogen and helium. Its mean distance from the Earth is approximately 149,600,000 km (the astronomic unit, AU), its temperature (at the center) is about 15.000,000 K and it radiates 3.8*1026 W of energy, of which the Earth receives only 1.7*1018 W. The solar radiation spectrum is introduced in Fig. 4.

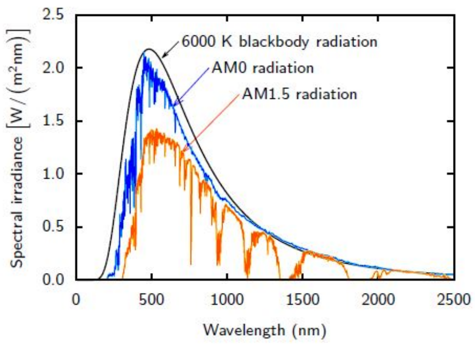


Fig. 4. Different solar spectra [21].

Figure 4 shows the spectrum of a blackbody at 6000 K. But outside the Earth's atmosphere, the spectrum – called AM0 spectrum since the photon travels across no or "zero" atmosphere – is drastically different. AM0 is also illustrated in Fig. 4. The irradiance at AM0 is

$$L_e(AM0) = 1361\, W.m^{-2}$$

The optical air mass refers to the ratio of sunlight through this minimal distance. When the Sun sits at its zenith, the spectrum is AM1. As such, we can calculate the air mass when the sun is at an any angle θ from the zenith using the following formula:

$$Air\,Mass = \frac{1}{\cos\theta} \quad (1)$$

Using Einstein's equation, the difference is converted into energy:

$$E = mc^2 \quad (2)$$

Radiometry is the science concerned with measuring electromagnetic radiation and hence more specifically light. This is particularly important to photovoltaic processes that convert sunlight into electricity, as the "amount of energy" must defined mathematically first. To determine the amount of energy per unit time, we must apply the following formula:

$$P = \frac{dE}{dt} \quad (3)$$

where P is the power and E the amount of energy.
To calculate the total power over the entire surface, we must the apply the following formula:

$$P = \int_A \int_{2\pi} L_e \cos\theta \, d\Omega \, dA \quad (4)$$

The presence of $\cos\theta$is indicative of the importance of the projection of dA on (θ, φ) rather than dA itself. This is essentially a manifestation of the Lambert cosine law. Le refers to the radiance, of which the physical dimension can be expressed as:

$$[L_e] = W.m^{-2}.sr^{-1},$$

Sunlight is a portion of electromagnetic radiation given off by the sun, in particular infrared (700 nm to 1 mm), with a frequency that ranges from 430 THz to 300 GHz approximately, visible light spans (from 380 to 780 nm), and ultraviolet light (10 to 400 nm).

The electromagnetic spectrum is defined in terms of energy, wavelengths or frequency, of which the latter two are related by the following equation [22]:

$$\lambda = \frac{c}{v} \quad (5)$$

where c is the speed of light (2.998 * 108 m/s).

As Albert Einstein concluded in 1905, under Plank's law, light travels in quanta of energy with the size expressed as follows:

$$E_{ph} = hv \quad (6)$$

where h is the speed of Plank's constant. The unit of wavelength is expressed in meters (m), very often in microns (denoted by µm and equal to 10-6 m) or in nanometers (denoted by nm and equal to 10-9 m). These quanta are called photons. In terms of classical mechanics, it can be said that light shows the behavior of particles. Refer to references for more details [21].

PV cell technology has improved gradually over the last decade and the infinite power generation sector has a significant application worldwide, mainly due to its low cost (dropping cost of silicon solar cells), the high-efficiency of solar cells and a global shift towards renewable energy sources. Hence, research priorities include:

- Reducing the PV panel cost and increasing its conversion efficiency.
- Reducing the cost of battery storage for PV power systems.
- Innovating a new generation of solar photovoltaic technology.

4. Renewable Energy Sector Overview of Albania, BiH and Kosovo

The Western Balkan countries have an obligation to meet a set of specific renewable power generation targets by 2020. The targets involve different renewable sources, namely hydro, wind and solar, and also take into account the total energy consumption. BiH has set the highest percentage, 40%, closely followed by Albania at 38%, Montenegro at 33%, Serbia at 27%, Kosovo at 25% and finally Macedonia at 21% [23].

Progress towards these targets varies across countries: while Macedonia has nearly reached 95% of its set goal, Kosovo has only progressed by 17.74%. Serbia has recorded the second highest progress at 81.28%; BiH comes in third place at 77.54%, closely followed by Albania at 74.06% and Montenegro at 65.72%. Table 4 introduces the RES target fulfillments (Albania, BiH, and Kosovo).

Table 4. RES target fulfillments (Albania, BiH, and Kosovo) [23].

RES 2020	**Albania (38%)**		**BiH (40%)**		**Kosovo (25%)**	
RES	Target (MW)	Reached 2015	Target (MW)	Reached 2015	Target (MW)	Reached 2015
RES						
Hydro	2,324	1,797	2,700	2,150	240	71.94
Wind	30	0	33	0.3	150	1.35
Solar	50	0	16.2	8.2	10	0.15
Biomass	5	0	35.7	1	14	0
Total MW	2,409	1.797	2,784.9	2,159.5	414	73.44
Percentage (%) reached	74.60%		77.54%		17.74%	
Sources	IRENA 2017 (Table 4.2);		NREAP, IRENA table 4.4		NREAP	

4.1 Solar Potential in Albania

Located between latitudes 39°38' - 42°38' and longitudes 19°16' - 21°04', Albania is a western Balkan country with significant renewable energy potential from hydro, wind and solar resources. It is surrounded by the Adriatic and Ionian seas at the West, Macedonia to the East, Kosovo to the Northeast, Montenegro to the Northeast and Greece to the South [24]. Its solar irradiation potential is promising, as the sunshine irradiation varies from 1200 kWh/m2 in the Northeast (Bajram Curri, Kruje, Kukës, Peshkopi, and Pukë) up to 1600 kWh/m2 in the Myzeqe area. In the Northwest, the quantity of solar irradiation varies from 1500 kWh/m2 up to 1700 kWh/m2 a year, as recorded in the following cities: (Durrës, Kavaja, Fier, Volorë, Vlora, Saranda, Tirana, and Berate) (Fig. 9) [25-26]. Solar radiation varies regionally, with the lowest daily average of 3.2 kWh/m2 being recorded in the Northeast and a high of 4.6 kWh/m2 in the Southwest. Hence, the average daily solar irradiation in Albania is about 4.1 kWh/m2; these statistics show that solar energy in Albania is available and considerable. The average sunshine is of 2400 hours/per year, while the Western regions receive more than 2500 hours (Fier has a record of 2850 hours) [25].

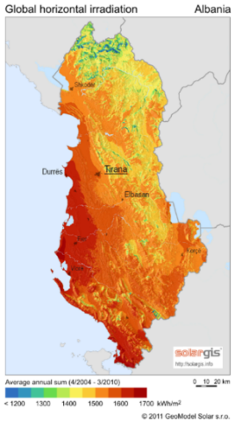


Fig. 9. Solar irradiation map of Albania, SolarGIS 2011.

Thus, the irradiation and PV electricity potential in Albania is promising. There is great potential to expand grid-based PV systems throughout Albania for heating, lighting, irrigation, telecommunication, medical, and education-related purposes. It can also be expanded in villages and mountainous areas (Korab, 2764 m, Maja Jezercë, 2694 m, Radohima, 2568 m, Tomorr, 2416 m, Maja e thatë, 2406 m, Shkëlzen, 2404, and Koritnik, 2393m, ASL, etc) [27]. The PV systems market developed rapidly in Albania over the last ten years thanks to political stability in the country and relative economic growth.

As demonstrated in Fig. 10, the hot season in Koplik in Northwest Albania [27] started June 14th and ended September 9th and averaged a daily high of 82°F. With a recorded high of 90°F and a low of 70°F, August 4 was the hottest day of the year. The cool season started November 21st and ended March 11th and averaged a daily high below 57°F; the coldest day of the year was January 13, in which temperatures reached a low of 34°F and a high of 49°F.

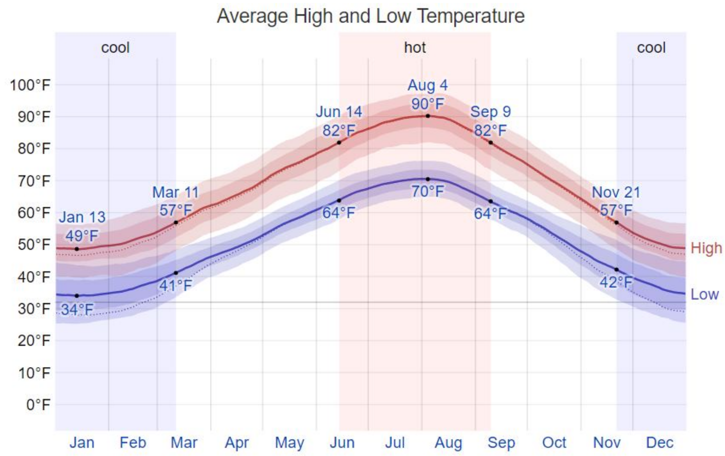


Fig. 10. The daily average high (red line) and low (blue line) temperatures [28].

The average hours of annual sunshine in Tirana is 2544 [29]. Albania is a country heavily defined by its location. It is a small predominantly mountainous country in Southern Europe, facing the Adriatic and lonian seas within the Mediterranean Sea. Table 5 introduces some geographical statistics for Albania:

Table 5. Some statistics about Albania [30].

Item	Description
Continent	Europe
Location	Southeast Europe; Western part of the Balkan peninsula; surrounded by the Adriatic Sea and Ionian Sea to the West, Macedonia to the East, Greece to the South and Montenegro and Kosovo to the North
Coordinates	41°00′N 20°00′E
Area	28,748 km^2
Coastline	362 km (225mi)
Population	3,038,594 (#137)
Population density	110.91/km^2
GDP (PPP)	$33.90 billion
GPD per Capita	$11,900
Climate	Mild temperate: winters are cool, cloudy and wet, while summers are hot, clear and dry, although interior regions are usually cooler and wetter

The territory located in the Western coast is influenced by a maritime weather, where the temperatures in winter barely dip below zero, while summers are warm. The Eastern region is influenced by continental air masses; it is not rare to record temperatures below zero during the winters (the coldest temperature recorded was - 26°C). The valley of Albania in the summer is hot, averaging 35°C. The climate of the country has a Mediterranean character and is distinguished by a great number of sunny days, approximately 290 days a year, in the North and in the East, and about 325 days in the South and Southwest [31]

In 2015, there was a 2% loss in high voltage transmission and a 31.3% loss in distribution in Albania. The Albanian power sector needs a new policy to address problems and set future energy targets. Table 6 shows the transmission and distribution losses in Albania, 2014 and 2015 [32].

Table 6. Transmission and distribution losses in Albania, 2014 and 2015

Country	Transmission losses (%)		Distribution losses (%)	
Albania	2014	2015	2014	2015
Loss	2.1	2	37.8	31.3

The renewable power capacity additions in Albania 2015/2016 is presented in the following table. As indicated in the table, the use of renewable energy in these related countries is still modest.

Table 7. Renewable power capacity additions in Albania 2015/2016 [2].

Country	Hydro	Wind	Solar	Solid biomass	Biogas	Geothermal	Total
Albania	5.0	0.0	0.0	0.0	0.0	0.0	5.0
FYROM of Macedonia	25.7	0.0	1.9	0.0	4.0	0.0	31.6
Bosnia and Herzegovina	83.8	0.0	9.0	0.3	1.0	0.0	94.0
Montenegro	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 8. Daily average solar radiation in (kJ/m^2) [33]

City Name	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Peshkopia	9813	11584	13952	15127	17192	19225	20704	19815	18838	14189	1261	11566
Shkodra	10857	12316	14119	15771	17425	19253	20836	20069	18855	14450	12977	12235

Durres	13205	13523	14347	17604	18637	20228	22277	23199	20305	17750	15347	14677
Tirana	12066	13292	14243	16007	18555	20538	21598	21896	19854	16564	13604	13250
Vlora	14239	13894	13733	17726	19207	21376	22926	24093	23217	19791	17799	15347
Saranda	12868	15445	16633	18511	20405	22758	23443	24101	23237	17390	16857	14820

Table 8 introduces the average solar irradiation for the main cities in Albania. The data shows that solar energy is promising, especially in spring, summer and autumn.

Recently, Albania implemented the “Country Program of Albania” under the Global Solar Water Heating Market Transformation and Strengthening Initiative by the Government (a cooperation between the Ministry of Energy and Industry, the Ministry of Environment and the UNDP) which began in 2010 [34].

4.2 Banja floating solar plant in Albania

In the past decade, the use of renewable energy resources, particularly solar energy, in Albania has increased. For example, in September 2016, Norwegian Statkraft hydropower and wind company officially opened Banja hydropower cascade plants along the Devoll River in southeast Albania. Banja Lake as shown in Fig. 11 is located in Cerrik Municipality in the Elbasan province, 65 Km Southeast Albania's capital Tirana. Table 9 presents some statistics of the Banja hydropower plants.

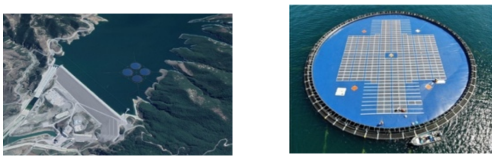
Table 9. Some statistics of the Banja hydropower plants [35]

Production Power (MW)	Dam height (m)	Total Volume Covering an Area
700 GWh 256	80	391 billion litres 14 Km^2

Fig. 11. General view of the Banja Lake in Albania [36-37].

Norway's Statkraft is entering the final stage of its second hydropower plant along the Devoll River, Moglice. Both projects form part of the comprehensive Devoll Hydropower project, which is estimated to cost €535 million for a total capacity of 256 MW. The aim of the investment is to boost electricity generation by 20 percent in the country [35].

Statkraft has relied on Ocean Sun AS, a Norwegian floating solar technology developer, to construct a floating solar plant with a maximum capacity of 2 MW (4 floating units with a capacity 0.5 MW) in the Banja Lake, as demonstrated in Figs 12, each costing about EUR 2.3 million or $2.6 million [38].



(a) (b)

Fig. 12. The floating solar plant park will consist of 4 floating units (a) of 0.5 MW each (b) in the Banja Lake in Albania [39].

In addition, KESH is also developing new generation projects in the field of renewable and sustainable energy systems, such as wind and PV systems. The first project deals with the the installation of floating PVs on Vau i Dejës Reservoir, with a capacity of 12.9 MW, in 2019 [40].

Advantages of floating solar photovoltaic (PV) [41]:

- Opens new opportunities for boosting solar generating capacity
- Uses existing electricity transmission systems at hydropower sites
- Close to demand centers
- Improves energy yield due to the cooling effects of water and the decreased presence of dust
- Suitable for rural and desert communities
- Reduces evaporation from water reservoirs
- Improves water quality due to decreased algae growth
- Reduces or eliminates the shading of panels by their surroundings
- Easy installation and deployment in sites

Disadvantages of floating solar:

- Expensive
- Limited use

Socioeconomic benefits [42-45, 51]:

- Creates job opportunities
- Encourages graduate engineers and technicians to work in the PV systems field
- Develops a solar energy market
- Keeps and protects the environment
- Supports the education sector
- Enhances clinics in rural and mountainous areas
- Decreases migration from rural and mountainous areas to urban centers
- Expands the PV water pumping system in irrigation
- Increases the number of small businesses
- Increases tourism to rural and mountainous areas
- Improves the living conditions of rural populations

Recommendations:

- Expanding the use of solar water heating panels
- Expanding the use of solar energy in the irrigation sector
- Eliminating taxation for all green energy technology
- Investing more in renewable resources
- Learning from the experience of leading countries in solar energy in the region
- Teaching about renewable energy in universities, institutes and schools
- Increasing community awareness of the importance of solar energy
- Motivating residential consumers to use PV systems widely
- Creating new photovoltaic farms
- Improving solar energy policies and regulations
- Developing technical standards for interconnection.

Lessons learned [2, 46-51]:

- Prioritizing the most efficient PV modules
- Comparing the efficiency metrics for different suppliers (greater electricity generation)
- PV modules certification – there are several various standards to selecting the best module
- PV module output – over time, the efficiency of the PV module decreases. Customers must select the best PV panels, taking into account the inspection for panel degradation and its warranty
- Expanding customer's use of PV technology, such as solar ovens, solar cellphone chargers, solar powered tents and backpacks, etc.
- Focusing on the growth of solar energy technology market
- Broadening the use of solar energy, especially in the field of heating
- Addressing the lack of investment in renewable energy
- Addressing the scarcity of scientific research in the field of renewable energy in Albania
- Designing and installing PV systems or solar farms, while ensuring a solid design and installation and high quality components to enhance the system's performance
- Ensuring a PV system exploitation and the good use of PV components to increase the longevity of the system

5. Discussion

Expanding the use of renewable energy resources requires more investments, governmental support, enhancement from international or regional renewable energy agencies, donors and customers. Developing countries need regional and international support to raise awareness of the importance of the application and optimal exploitation of renewable energy resources. According to the analysis of ground-based observations and satellite data collected by NASA, 2016 ranks as the warmest year on record, reaching 0.99°C as indicated in Fig. 13, while in 2017 reached of 0.9 °C [52]. The first of half of 2016 set a record as the warmest months globally, according to statistics which date back to 1880. Therefore, policymakers should prioritize the preservation of the planet by reducing heat emission as well as visible and invisible environmental pollution. Several steps to reduce heat emission and pollution include:

- Increasing the use of renewable energy resources and decreasing the use of finite energy production systems
- Recycling environmental pollutants
- Improving waste management plans
- Leaving your car at home twice a week
- Designing homes supported by renewable energy generation systems, such as solar or wind energy
- Increasing investments in the field of renewable energy production
- Raising awareness about climate change

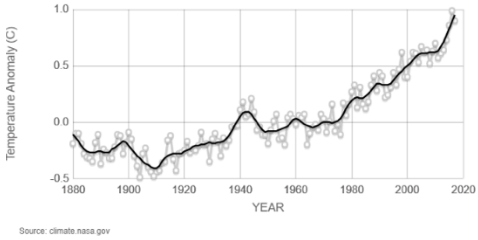


Fig. 13. Global land-ocean temperature index [52].

By studying the renewable energy sector in Albania, we found that this sector is developing by the day, but it requires greater support from donors and leading countries in the field.

6. Conclusion

This paper illustrated the renewable energy sector in the Southeastern European Countries. Solar energy in this area is explored and analyzed. We focused on the PV systems sector in Albania as a case study of this study where, we introduced warmer seasons, monthly temperature, and renewable generation capacities by energy source. The map of the average annual download surface solar irradiation in the related area is presented. The top of five European solar market are introduced. We discussed and analyzed the solar potential in Albania and the development of PV market as well. This paper concentrated on new floating solar projects in two different areas in Albania: Banja Lake and KESH. Finally, we touched on socioeconomic benefits of this study, some recommendations are included as well. The lessons learned were taken into consideration at the end of this study.

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