SOLAR ENERGY PRODUCTION PROSPECTS IN UKRAINIAN REALITY

by

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Date _____

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LIST OF ABBREVIATIONS

BloombergNEF Bloomberg New Energy Finance

CAGR Compound annual growth rate

EBRD European Bank for Reconstruction and Development

FIT Feed-in tariff

IRENA International Renewable Energy Agency

LCOE Levelized Cost of Energy

PV Photovoltaic

RES Renewable Energy Sources

SPP Solar Power Plants

UARE Ukrainian Association of Renewable Energy

WBGU the German Advisory Council on Global Change

WHO World Health Organization

CHAPTER 1. EXECUTIVE SUMMARY

Today, society is living with advance technology and everyone wants to keep pace with it. Everyone needs electricity, and growing global consumption of energy leads to growing greenhouse emissions and global warming.

The solar power industry, which is the focus of this study, is a good eco-friendly alternative to fossil fuels and coal-related sources of electricity. Ukraine is a lucky country because has better solar irradiation than Germany, while the last has a bigger growth in solar energy capacity.

In this term paper we are talking about the solar energy market as it is in Ukraine and in the world as a whole. There are a lot of key growth drivers of this industry. Year by year the cost of installing solar systems, developing and making a service for them, is falling and becoming more real for citizens.

Solar energy is attractive to enter this market for almost countries. Caxton M. Munyoki came to the conclusion that Kenyan market is moderately attractive to solar power companies in his analysis "An assessment of the attractiveness of solar power industry in Kenya".

On the solar panel market there is a big competition between Chinese producers and European, because first want to cover all market. To enter into the Ukrainian production market of solar panels, the company should introduce good quality with lower price than Chinese producer has. It is a big barrier to enter the solar industry in the world, not only in Ukraine. On one hand, people would rather buy Chinese equipment because it is cheaper, but on the other hand Ukrainian government compensate up to 20 percent of the equipment cost.

CHAPTER 2. INDUSTRY ANALYSIS AND RESULTS

2.1. Industry overview

Introduction

Solar energy is the radiant energy emitted from the sun, which is controlled by using different collecting methods. One of the ways to generate electricity from solar energy is photovoltaic with using photovoltaic or solar cells and they directly convert sunlight into electricity.

Solar energy is a convenient renewable solution toward global environmental problems. Energy taken from the sun reduces the amount of electricity coming from fossil fuels by supplying with clean, renewable energy. As about numbers, the sun produces energy daily which is enough to supply 10,000 times the world's electrical needs. Hence, sun has a big potential in energy industry and our society should use it as much as it possible to be eco-friendly.

It is true that the number of people dying each year from the effects of fossil fuels is high. Besides, about 2 million people (mainly women and children) die annually from illnesses related to indoor air pollution from the use of different types of solid fuels according to the WHO's report where coal-related air pollution deaths have reached 1 million people per year.

Growth drivers

For one thing, environmental pollution stimulates the growth of solar energy, and for another, government incentives and tax rebates to install solar panels create good conditions to consume energy from the sun.

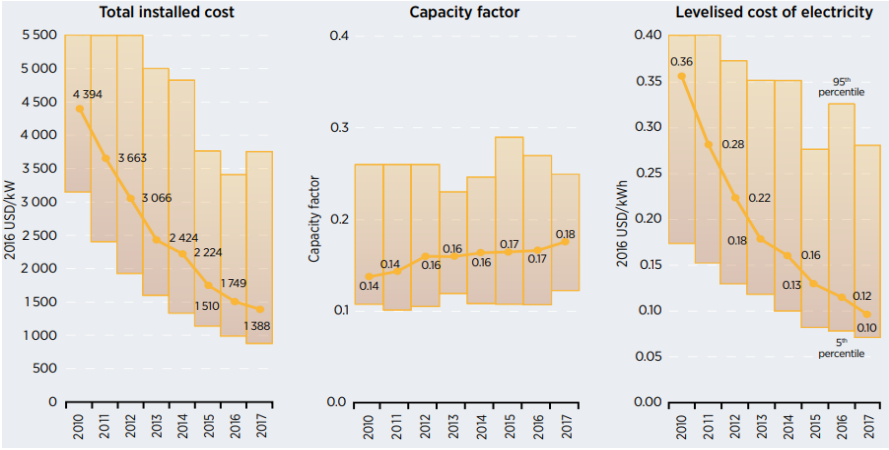
Year by year prices for solar panels are becoming lower and lower while electricity prices are increasing across the world. Moreover, installation cost of solar panel systems and further services also are now cheaper than several years ago. All these factors lead to a significant solar panel market growth.

Investments in clean energy in 2018 exceeded USD 325 billion – BloombergNEF. At the same time, investments in solar installations fall down by 24%, but they still retained leading positions.

Generation costs

The following figure tells us that LCOE (see Appendix A) for solar PV systems is falling year by year. It is an additional advantage of renewables, the cost of which will be sooner or later cheaper than fossil fuels and coal-related sources of energy.

Figure 1. Global weighted average total installed costs, capacity factors and LCOE for solar PV, 2010-2017



Sourse: IRENA Renewable Cost Database

Market competitive landscape

According to the Bloomberg Tier 1 List (see Appendix A) for the 1st quarter of 2019 there are the following top 10 worldwide solar manufacturers: Canadian Solar, LG, Hanwha, Risen, LONGi, HT-SAAE, NSP (Neo Solar Power), Seraphim, Astronergy, Talesun. Additionally, the price for solar modules depends on regions, demand orientation (commercial and residential end-use applications) and profitability of module manufacturers.

2.2 Literature overview

Michael Eugene Porter, an American academic, in 1980 said that industry attractiveness is the high potential profitability of an industry that is measured through the long-term return on the capital invested as determined by five forces of competitive pressure.

When we are discussing the industry we want to know how it is attractive to enter this market. Solar energy is attractive for almost countries. For example, the analysis "An assessment of the attractiveness of solar power industry in Kenya" by Caxton M. Munyoki made a conclusion that Kenyan market is moderately attractive to solar power companies.

The reason for author to take this study was because the solar power industry has generated a lot of interest because of the high cost of hydroelectricity. The study employed descriptive census survey to identify the factors that attract investors to solar power industry in Kenya.

Munyoki (2007) found out that two factors, which help to understand what aspects really determine the attractiveness or non-attractiveness of the Kenyan market to solar power companies, are barriers to entry and rivalry in the industry.

The author used Porter's modified model. As a result, strong powers are rivalry among the existing solar power companies, logistics and influence of government policies, bargaining power of buyers and barriers to entry. And the solar power industry in Kenya has the weak bargaining power of buyers, bargaining power of suppliers and weak threat posed by new entrants and power play.

Another solar energy analysis concerns Germany. Ukraine has much less solar power capacity than Germany; however, the geographical position and solar irradiation create better conditions for developing solar energy industry in Ukraine.

According to the "Recent facts about photovoltaics in Germany" compiled by Dr. Harry Wirth, Fraunhofer ISE, Germany is leaving the age of fossil fuel behind.

Germany is highly dependent on energy imports. It creates a risk of political interference by mining and transit countries and the risk of disturbances in raw materials logistics, for example due to low water levels in the rivers.

Figure 2: Development of annually installed PV capacity for Germany and globally, or Rest of World, (RoW), (last year estimated)

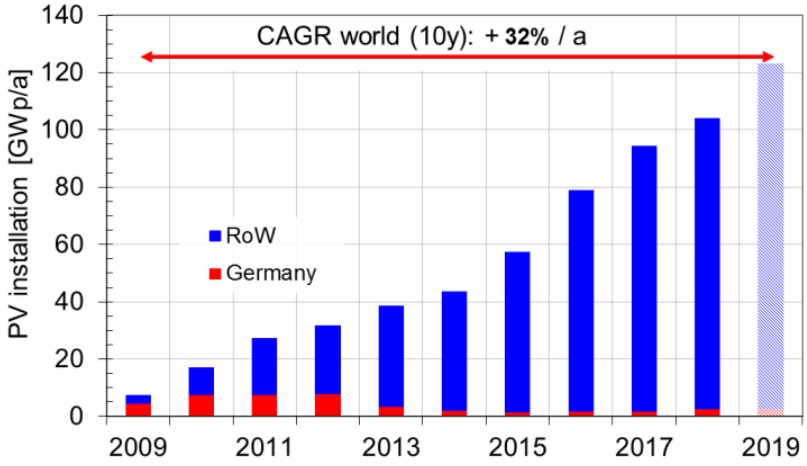


Figure shows the development of installed PV capacity per year for Germany and other countries. For the last 10 years CAGR for the world is 32%. Worldwide PV is reducing the use of fossil fuels for electricity production. Germany's renewable energy sector is among the most innovative and successful worldwide. If Germany wants to avoid new dependencies in energy supply, people need PV production in Germany. A PV production within Germany offers long-term security of supply at high ecological standards and quality.

2.3. Domestic market overview

Solar energy industry is also growing in Ukraine. In 2018 new installed PV systems reached 211.0 MW compared to 2017 according to Global Market Outlook []. There is also a prediction that in 2022 will be 751MW installed additions in PV systems in the table below what is equal to 4% share of the total European capacity additions (in 2018 2% share).

Table 1.Capacity additions of top 10 European solar pv markets in 2017 and 2022

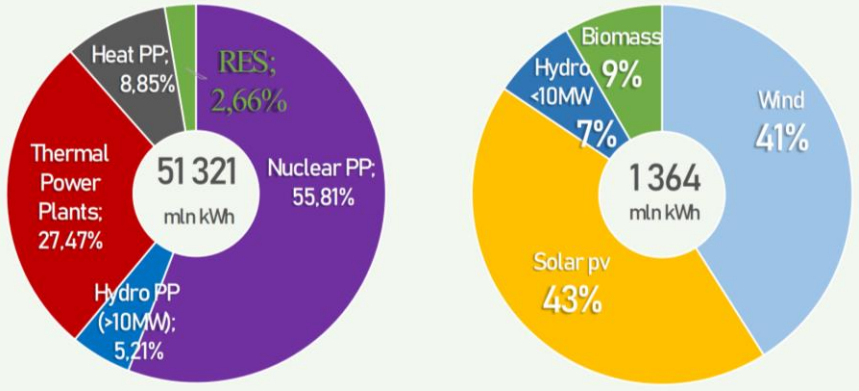
2018		**2022**	
Country	**Capacity additions (MW)**	**Country**	**Capacity additions (MW)**
Turkey	2,588	Germany	3,992
Germany	1,760	France	3,240
UK	954	Turkey	2,250
France	873	Netherlands	1,912
Netherlands	770	Spain	1,849
Italy	409	Italy	1,824
Belgium	285	Ukraine	751 (4%)

Switzerland	260	UK	587
Ukraine	211 (2%)	Poland	551
Austria	170	Greece	543

Source: http://www.solarpowereurope.org Global-Market-Outlook-2018-2022

It is also interesting to look into the distribution between energy generations in Ukraine. Left-side pie diagram below tells us about the all energy industry in Ukraine, and right-side especially about renewables. In Addition, about 43% of renewable energy installed capacity leads to solar PV systems, according to UARE's report. Albeit, there are big competitors such as nuclear and thermal power plants.

Figure 3. All energy sources and renewable energy sources capacity more detailed respectively for Ukraine, according to UARE, as of 01.05.2019



Looking at the Table 2. below, we can say that Ukraine has big potential in solar power systems, both ground-mounted and roof-mounted.

Table 2. Potential of Solar Power in Ukraine, GW. (Source: study by M.Child, D.Bogdanov and C.Breyer "Transition towards a 100% renewable energy system by 2050 for Ukraine", 2016)

	2030	2050
For ground-mounted power plants	16	90
For roof-mounted power plants	5	36

For now in Ukraine works 3100 MW due to feed-in tariff, 2200 MW of which is from solar energy. In 2018 4500 Ukrainian households installed their own solar power stations (in total 7500). Their total capacity is 157 MW.

Ukraine is in a stage to improve energy independence from Russian gas while adopting solar and renewables.

2.4 Industry prospects and overall attractiveness

Factors making the industry attractive

To support the idea that the number of installed solar stations in Ukraine is growing let's discuss the main drivers and advantages for owners of these solar stations.

• The government undertakes to redeem fully all surplus electricity produced by solar power plants.

• The level of insolation in all regions of Ukraine exceeds Germany, the leader of solar energy producers. At the same time, a large amount of solar

radiation is combined with relatively low temperatures, which minimizes generation losses due to the heating of solar panels.

• The feed-in tariff (FIT, see Appendix A) for solar power plants is related to the euro, which minimizes the negative impact of inflation. It means that if the national currency fluctuates significantly against the euro, the feed-in tariff adjusts.

• Guarantee of return of investments - currencies and precious metals are not always stable, the real estate market is not stable, and shares flock are also rapidly lose value. At the same time, electricity remains a commodity that is constantly in demand by the consumer. It should be noted separately that the period of operation of the elements of the solar power plant is not less than 25 years.

• The constant increase in the cost of electricity makes investments in the generation of own electricity justifiable. Speaking of cost, it is now possible to talk about the parity of prices between alternative and traditional electricity.

• Ukraine grants a 5% premium on FITs for PV projects built with 30-49% domestically made equipment. Those with a domestic content of 50% or more receive a 10% bonus. To be eligible for domestic content rules, plants must be commissioned before 2025.

Factors making the industry unattractive

Inefficiency. First of all solar station is still an expensive investment, especially when you consider how inefficient they are. According to the National Academy of Engineering, most solar panels are 10 to 20 percent efficient. Hence, the majority of energy from the sun isn't even captured by solar systems.

This inefficiency of solar panels mainly because of the origin of solar stations and due to the fact that they can't move to meet the sun's direct rays. In

opposite to that, modern producers even developing tracking systems to follow the sun.

Oversupply. There is a huge list of solar modules producers in the world. Solar energy industry has a rapid growth across the globe and new manufacturers rushed to produce the panels and equipment needed to generate the electricity.

However, not all companies are able to compete in this market. The large number of companies that jumped into the market created an oversupply of solar panels. The demand is lower than the supply and many of producers becoming bankrupts.

2.5. Main players in Ukraine

One of the Ukrainian solar systems equipment producers is Prolog Semicor Ltd manufacturing monocrystalline silicon ingots, silicon plates, solar modules and synthetic corundum products. Also high-quality solar modules with a rated capacity of 10-300W of their own production. All these elements are used in solar energy industry. The power of this firm is low; the launch of its own line of assembly of solar modules has a capacity of 9MW per year.

The second domestic producer is Kvazar which provides stationary and mobile solar power systems and installations and back-up solar systems. Also producing PV energy products, integrated circuits and silicon plates. The annual solar modules capacity is about 15MW.

On 5th February, 2019 €5 million investment opened a factory by KNESS Group in Vinnytsia to produce solar modules. This factory has the biggest solar panel's capacity among domestic companies – 200MW per year. In Addition, leaders of the company are planning to double their production and open 200MW more solar module capacity till the end of this year.

"The launch of the Kness PV plant is a significant event because with the start of Ukrainian PV modules production, Ukraine will have 100% of its own PV power plant main components," said KNESS CEO Serhii Shakalov.[1]

Its production lines were installed by China's National Institute, which claims to be one of the world's leading renewable energy technology centers.

2.6. The Five Forces analysis

We use The Five Forces analysis on the Ukrainian solar panel market to disclose the attractiveness of the Ukrainian solar panel market from a single investor point of view. The main focus is on the interest in a long-term investment. The stronger the forces, the lower the collective profitability for participating firms.

THREAT OF NEW ENTRY

Entry barriers are high but it mostly depends on existing competitors that are still in the market. Thus, the threat of new entrants is LOW.

Economies of scale. It is one of the most significant barriers to market entry. Companies with a big share of the whole market will benefit of economies of scale, managing to minimize their costs per unit of energy both produced and distributed. Prolog Semicor company can compete with KNESS Group since the last is a new company and not well-known.

Capital requirements. It is not a secret that financial investment in R&D must be extremely high in solar energy industry in order to develop solar panels

[1] https://www.pv-magazine.com/2019/02/07/kness-group-commissions-module-factory-in-ukraine/

in an efficient way that competes with KNESS Group. Technological equipment and plants create unrecoverable expenditures which consequently increase risks to enter the renewable energy industry.

Product differentiation. There are two main types of solar panels, monocrystalline and polycrystalline. Manufacturer may create product identification, but mainly customers focus on competitive prices. Brands are not important in this sector, and we may see that from the big variety of "made in China" panels which are not well-known but have competitive prices for Ukrainians, are also popular in our market.

Switching costs. To start a new production of solar panels it took high operational costs. Big manufacturers are able to lower switching costs for solar electric power generators.

Access to distribution channels. In Ukraine we have a lot of firms distributing solar panels. In most cases top energy producers already own most of distribution channels. It might create a high barrier to have own distributional channels for new domestic companies. But through the fact that the Ukrainian market of producing solar panels is small, it is easier to distribute own products for new players in Ukrainian market.

Cost disadvantages independent of scale. For firms which produce solar panels there is no difference in location and they have equal access to raw materials.

Government policy. Most of financial resources invested in renewable comes either from the private sector or from corporations. The Ukrainian government has a nice option that the use of equipment supplied by the national producers provides an additional increase to the FIT.

POWER OF SUPPLIERS

KNESS company produces the whole solar panel at the finish of the production but still should use imported details. The head of the company is explaining that fact in the way that we have in Ukraine producers of all components for solar panels but the price does not explain the quality of that elements. According to that factory in Vinnytsia has to import details from abroad, for example, from China.

There is also a lack of information which components do domestic producers using in manufacturing solar panels.

The solar modules' components are expensive and even if Chinese dealer of such elements, which implement the lowest price, increases the price, factory of producing solar panels in Ukraine stands behind loses.

There is a small number of firms which are producing solar panels in Ukraine. Hence, we may expect the power of suppliers could be described as powerful. For example, Chinese manufacturers (low labor costs) mass produce large quantities of low priced solar panels, undercutting the domestic manufacturers of solar cells for different countries, even in Ukraine, and lowering switching costs for solar electric power generators.

Concentration of suppliers' industry. As I said, in our country we have a highly concentrated market because we have only 3 firms which are producing solar panels.

Switching costs. Companies which produce renewable energy mostly invest in specialized equipment. And suppliers' component require specific investment

in supporting products and services, which can lose its value if suppliers is changed.

Forward integration. To compete in this industry Ukrainian company need to acquire the necessary resources and competencies, which can cost long time and big money. Extension to industry support suppliers' business model.

Industry importance for suppliers. Suppliers profit depend much on the whole renewable energy and consequently it represents an important customer for them. Each company is interested in protecting their sustainability when apply new prices and assistance in many fields such as R&D.

THREAT OF SUBSTITUTES

The biggest substitute for renewable energy is electricity generated in fossil-fuel or nuclear power stations. They are more economical that renewable sources of energy. The cost for solar power, especially for important technologies, and other renewables has decreased over the years. This decrease caused by increased competition when China entered this industry in 2012 and started rapid growth in production solar panels and other equipment.

The relation renewable-fossil is now about 15% to 85% in a long-term perspective reaching a 50% to 50% relation in 40 years time; WBGU's World Energy Vision 2100.

Solar energy is still more expensive than other resources such as nuclear power; hence, the threat of substitutes would be high. Solar energy industry continues to improve. On the other hand, the threat of substitutes could be described as low, as the solar industry supply the energy and long term income thanks to the revenues of selling the energy to the government. There are no

close substitutes that satisfy those two needs, as, for example, a wind power turbine may be too expensive for a household.

RIVALRY AMONG EXISTING COMPETITORS

In the case of renewable energy factors which influence the rivalry within an industry can vary much from country to country due to specific factors which every country have. As we in Ukraine, new changes in law for feed-in tariff create a framework at which big solar stations are more likely to earn profit. And we should adjust to them.

Industry growth. As I said growth of the solar market is driven by increase in environmental pollution. Also last year not only represented a strong growth compared to 2017. The growth of solar in Ukraine is mainly being driven by the generous FIT scheme.

Storage costs. As there is a huge demand for solar panels and they are manufacturing in Ukraine almost for order, there are nor huge storage costs.

Lack of differentiation. As I told there are two main types of solar panels but foreign companies invest a lot in R&D, so they create new types of solar panels, which make the solar panel market differentiable. But among different firms solar panels may not differ a lot. Companies' strategy cannot be remarkably differentiated, and they are forced to steal customers from their competitors.

Exit barriers. Energy production and production solar panels are very specified productions and need specialized asset. That represent very high exit barriers what can lead to competition among companies even if they earn low or even negative returns on investment.

POWER OF CUSTOMERS

This is the ability of buyers to influence prices of the firm's outputs, customers can force down prices, bargain for higher quality or more services and play competitors against each other. Buyers want to buy the best offerings available by paying the minimum price as possible.

The solar panel is mostly undifferentiated; there are not big differences between solar panels of the different solar companies, besides the quality of the different solar panels do not vary much. Moreover, homeowners buy solar panels just once in their live and there is no strong brand loyalty. The power of buyers is medium.

CHAPTER 3. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Solar panel market in Ukraine has both positive and negative effects if an investor wants to enter the market. A huge growth potential in long-term in all the world and the expectation that the solar energy would be the main energy source in about 10 years providing big growth opportunities in the market.

As I said at the beginning, important factor focus on reduction of CO_2 emission. Hence, governments across the globe are promoting renewable sources of energy, supporting heavy installation of home solar systems.

Such an idea to create a full-cycle company to produce energy (beginning with production panels and silicon crystalline plates, and ending with transfer energy from panels to houses) is unlikely in Ukrainian reality.

After all, developers have traditionally selected tenders from suppliers that offer the best conditions. "Many components are imported. Creating a competitive manufacturing facility requires hundreds of millions of euros in investment. The players are not ready for that.

The costs of solar energy have been falling. Oil-fuelled electricity generation has two big competitors: Solar thermal electricity and solar photovoltaic electricity in sunny countries.

Since the beginning of 2019, the share of renewable energy in total electricity production in Ukraine has increased by 1.7 times and in the second quarter amounted to 3.3%. This was reported by the Ukrainian Renewable Energy Association.

Every month this year in the newspaper we may find chapter about the solar generation in Ukraine. And in almost every region in Ukraine we have new big solar plant and a lot of small domestic solar stations at the roofs. Moreover, we have foreign investors that are building new stations on Ukrainian ground. I

also would like to add that Ukrainian cities have like a little competition: which region open the biggest number of solar stations on the roofs.

I also had limitations of the study about the data because new company KNESS even do not know the prices for their panels. Even they do not have a report for the last sales.

Recommendations

A more detailed analysis of market shares and solar powers profitability may be necessary in order to determine how these aspects affects the investment decisions to operate in Ukraine.

To make any recommendations I want to pay attention to the last news in solar energy sphere in Ukraine according to local source Ukrinform. There are some interesting news as follows.

UDP Renewables, a member of the UFuture Investment Group, has commissioned a new 33.1 MW Scythia-Solar-2 solar power plant in Melitopol. The Scythia-Solar-2 SES covers an area of 50 hectares and is equipped with more than 91,000 solar panels from producer JA Solar. The plant will produce nearly 42,000 MWh a year and it is enough to provide 13,300 households with electricity.[2] Picture 1. from Appendix C.

In Zhytomyr region there are 310 private solar power plants, some of which were installed by residents through a regional program, receiving

[2] https://www.ukrinform.ua/rubric-technology/2747672-u-melitopoli-zapustili-sonacnu-elektrostanciu-potuznistu-33-mvt.html

compensation for their Ukrainian equipment. In particular, it provides for the possibility to receive compensation from the regional budget, namely 20% of the cost of equipment, but within 50 thousand UAH. [3] Picture 2. from Appendix C.

The Norwegian company Scatec Solar has started construction of the 148 MW solar power plant "Progressivka". It will be located in the Mykolaiv region.

The project will be implemented in collaboration with PowerChina Guizhou Engineering Co. Ltd., which will provide financing, engineering and construction (EPC) services. Scatec Solar will be an equity investor and will provide EPC management, operation and maintenance as well as asset management services.

The plant, located in the south of Ukraine, will provide clean energy to about 76,000 households and help prevent about 150,000 tons of carbon emissions a year.[4]

Also in the Dnipropetrovsk region there is a Pokrovska solar power plant with power of 240 MW, which is the second largest power plant in Europe, has been put into operation.

Pokrovska solar station will produce 400 million kWh of green electricity annually, which is sufficient to provide with electricity 200,000 private homes or apartments. Thanks to the operation of the station, CO_2 emissions into the

[3] https://www.ukrinform.ua/rubric-technology/2731496-na-zitomirsini-vstanovili-310-privatnih-sonacnih-elektrostancij.html

[4] https://www.ukrinform.ua/rubric-technology/2714485-norvezci-pocinaut-buduvati-sonacnu-stanciu-na-mikolaivsini.html

atmosphere will be reduced by 420,000 tons per year, which is comparable to emissions of more than 200,000 cars. [5] Picture 3. from Appendix C.

Hence, we have a good platform for solar station owners. Both roof and ground mounted. European investors more and more are going to give their money for Ukrainian solar energy development.

For future research for me it is interested to find out how many times do people click on the button to choose the Ukrainian production solar panels when serving the webpages with a huge number of solar panels all round the world. It may be affected due to the incentive to install domestic modules to earn more money with higher FIT. Moreover, it should be a good idea to compose a questionnaire for Ukrainian manufacturers and ask them about that five forces which I discussed in part 2.6.

Ideally, domestic generating installations should be used to cover their own electricity needs. Instead, as Minister of Energy and Coal Industry of Ukraine Ihor Nasalik points out, the construction of private SES in Ukraine has grown into a "highly profitable business, which creates additional financial burden on other consumers and worsens the regulatory quality of electricity in the network."

To finalize, our government need to implement the right conditions for starting any solar generation for both ground and roof stations. Also look into the experience of countries-neighbors who are using auctions in solar purchasing and selling to the government.

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[5] https://www.ukrinform.ua/rubric-economy/2809685-na-dnipropetrovsini-zapustili-se-odnu-potuznu-sonacnu-elektrostanciu.html

According to the fact that by technology, solar PV and biofuels provide the largest numbers of jobs, we should think about that to make the unemployment rate lower.

All around the world more than 31,000 solar panels installed every hour according to Renewables Global Status Report. This number is huge. We have the ground to think about.

President of Ukraine Volodymyr Zelensky has signed amendments to the Law of Ukraine "On Alternative Energy Sources" that allow domestic SPP with a capacity of up to 30 kW which are installed to sell electricity at a "green" tariff.

Amendments to the Law of Ukraine "On Alternative Energy Sources" allow to apply a "green" tariff for electricity produced by private solar power plants with a capacity of up to 30 kW and abolish the condition of placing such installations only on the roof or facades of buildings or other structures.[6]

[6] https://www.ukrinform.ua/rubric-economy/2755363-prezident-pidpisav-zakon-pro-zelenij-tarif-dla-domasnih-elektrostancij.html

REFERENCES

Austin. J. (1991). The Boundaries of Business: The Developing Country Difference Harvard Business Review. July - August 1991.

Churchill, G. A. (1987) Marketing Research: methodological Foundation. Dryden Press. International Edition.

M.Child, D.Bogdanov and C.Breyer "Transition towards a 100% renewable energy system by 2050 for Ukraine", 2016

Recent Facts about Photovoltaics in Germany
https://www.ise.fraunhofer.de/en/publications/studies/recent-facts-about-pv-in-germany.html

An Assessment of The Attractiveness of Solar Power Industry in Kenya, 2007 Caxton M. Munyoki
http://erepository.uonbi.ac.ke/bitstream/handle/11295/21318/Munyoki_An%20Assessment%20of%20the%20Attractiveness%20of%20Solar%20Power%20Industry%20in%20Kenya.pdf?sequence=2

https://www.pv-magazine.com
http://euea-energyagency.org
https://www.kyivpost.com
https://www.irena.org
https://ua.energy
https://ua.boell.org
https://www.saveonenergy.com
https://rentechno.ua
http://www.solarpowereurope.org/wp-content/uploads/2018/09/Global-Market-Outlook-2018-2022.pdf
https://www.ukrinform.ua
http://www.ren21.net

APPENDIX A
TERMINOLOGY

LCOE

The levelized cost of energy (LCOE). It is an economic assessment of the average total cost to build and operate a power-generating asset over its lifetime divided by the total energy output of the asset over that lifetime. The LCOE can also be regarded as the average minimum price at which electricity must be sold in order to break-even over the lifetime of the project. [https://howlingpixel.com/i-en/Advanced_energy_economy]

Measures lifetime costs divided by energy production. Allows the comparison of different technologies (e.g., wind, solar, natural gas) of unequal life spans, project size, different capital cost, risk, return, and capacities.

Bloomberg Tier 1 list

Historically, the Bloomberg Tier 1 list is a reliable source of information on the investment attractiveness of solar power companies. Investors often use it to find out if the solar panels they use in their projects are reliable guarantees and whether the company that is expected to last 25 years or maybe even longer.

Bloomberg, as a bank, defines investment attractiveness as follows: will banks offer non-recourse loans for solar energy products.

FIT

The feed-in tariff exists in most European Union countries, with Germany having a two times lower solar panel rate than we have of 8 euro cents per kilowatt.

It is an obligation of the government to buy the surplus of the produced electricity in home stations. The feed-in tariff in Ukraine is legally fixed by 2030. This time is enough not only to fully redeem the money invested in solar energy, but also to generate significant profits.

A favorable legal framework that really stimulates investment in alternative energy, the feed-in tariff, by which the state purchases all electricity produced by the SES, is one of the highest in Europe.

APPENDIX B
CALCULATIONS

Using the above table we may calculate approximately how much power do we need every day. On average Ukrainians need 8-10kW per day, hence there is a trend to install at least 10kW capacity solar system.

Table 1. Electricity demand and power (source: http://ecodrive.ua/)

Electricity demand			
Type	**amperage (A)**	**high-voltage (V)**	**power (W)**
2 AA batteries	0,2	1,4	0,28
MP3 player	0,2	3	0,6
radio	0,25	9	2,25
battery flashlight	0,5	10	5
portable speaker system	1	5	5
smartphone	1	5	5
SLR camera	0,9	8,4	7,56
portable tv	0,95	13,5	12,82
netbook	1,6	19	30,4
car fridge	5	12	60
a laptop	3,5	19	66,5

Table 2. Measurements of electricity

Value	Symbol	Name
1W	W	watt
10^3W	kW	kilowatt
10^6W	MW	megawatt
10^9W	GW	gigawatt

APPENDIX C
VARIETY OF SOLAR STATIONS IN UKRAINE

In the following part there are the most popular solar energy systems in Ukraine, both ground-mounted and roof-mounted.

Picture 1. Melitopol solar station with power 33MW

Picture 2. 310 private solar power plants in Zhytomyr region

Picture 3. Pokrovska solar power plant in Dnipropetrovsk region