# STRATEGY OF FINANCIAL INCENTIVES FOR DEVELOPMENT OF SOLAR POWER PLANTS IN THE REPUBLIC OF SERBIA

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***Abstract***: *Money can be invested in many ways, from building new factories to investing in new government issued bonds, which offer many different combinations of expected risk and return. There is no free money. With the physical process from the sunlight which is called photovoltaic or photoelectric conversion, it is possible to produce two products as outputs: electric energy and hot water. Results of investing in solar power plants create symbiosis on the plan of realization of economic and social effects. The basic resource (sunlight), is free, which is a great comparative advantage in comparison to wind, tides and all other conventional sources and the process of their transformation into electric energy. Investments refer to technical and technological structures (panels, inventors, distribution network and accumulators for storing electricity and hot water). Developmental orientation must be directed toward the result and not the size of the inevitably generated profit. Location, as seen through the number of sunny days in a year, as well as micro localities (households) determines the process of decision making. We are on the verge of developing a sunlight-based technology (transformation of photon light into electricity), which will help the efficiency of future power plants grow much more and will not have time restrictions or harmful impact.*
***Keywords****: solar plants, strategy, financial incentives, sustainable development.*

## Introduction

Nathan S. Lewis states in his work, regarding cost effective solar energy use that more energy from sunlight strikes the Earth in 1 hour than all of the energy consumed by humans in an entire year. Solar energy resource dwarfs all other renewable and fossil-based energy sources combined. From this we can conclude that sunlight energy is somewhat infinite, and that it is the future of renewable energy sources. However, the important aspect of it is its cost effectiveness and how it will contribute to economies and compete against low-cost and base-loadable fossil-based electricity that has always been a formidable competitor for electrical power generation.

Results of investing in solar power plants create symbiosis of the plan of realization of economic and social effects. The basic resource (sunlight) is free, which is a great comparative advantage in comparison to wind, tides and all other conventional sources and the process of their transformation into electric energy.

Effects of investing in solar power plants, regardless of their true power and size, would be multiple for Serbia. We think that those could be the following: socioecological, economic, and economic-ecologic, substitution of consumption of current sources that are being used and their reduction to level of sustainability.

Commitment for solar power plants will cause a risk-free supply of money and changes in the behaviour of the banks, funds, markets and personal assets. The general goal should be to have at least 50-60% of electric energy produced from sustainable sources.

## Solar energy in production, supply and use

Solar energy is used to produce electric and thermal energy. There are two ways that this can be done. One is through solar thermal energy which is the conversion of solar irradiation into heat. Typically, the systems use solar collectors and concentrators to gather solar radiation, store it and use it for heating air or water in domestic, commercial or industrial plants. Fig 1 represents a diagram which shows the path of sunlight irradiation conversion into mechanical energy. Solar energy is collected through a solar collector and then stored in a storage unit from which it is transferred to a boiler that creates heat. The latter is further distributed through a heat engine into mechanical energy. The leftover from boiler is returned to a storage unit and the heat engine rejects part of heat that is enough to create mechanical energy. These systems are more likely to be seen in use in industrial processes.

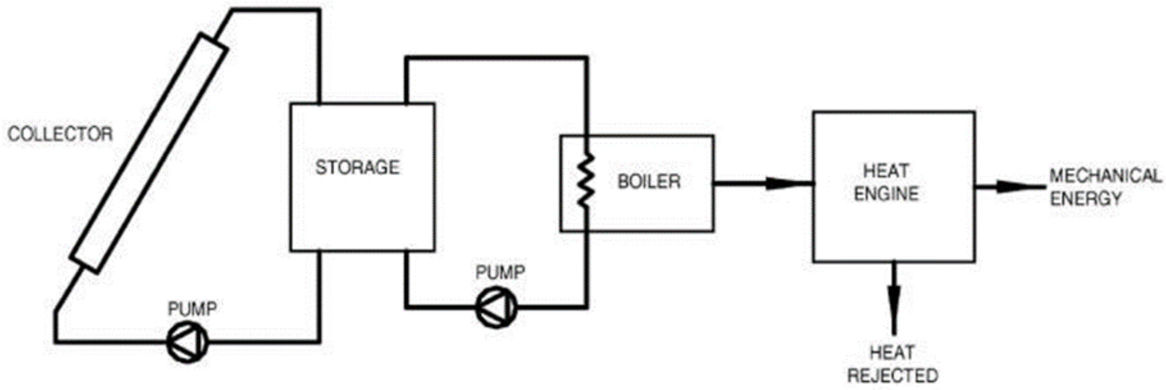


Figure 1 Schematic of solar thermal conversion system
Source: https://bit.ly/2Y8BN2M (29.10.2021)

Second way energy is produced from sunlight is by usage of photovoltaic (PV) systems. Photovoltaic systems use solar panels that contain solar cells that convert energy in the photons of sunlight into electricity by means of photoelectric phenomenon found in certain types of semiconductors such as silicon and selenium. These systems are more likely to be in use for powering households, many remote industrial process and isolated industrial applications such as traffic lights, telecommunication instruments and geographical-position systems (GPS). Standalone systems are the systems which are not connected to the grid and energy produced by the system is usually matched with the energy required by the load. They are usually supported by energy storage systems such as rechargeable batteries to provide electricity when there is no sunlight. Grid connected systems are the systems which are connected to the public grid. They can take in energy from the grid when there is not enough power generated from the panels and they can supply power to the grid when there is enough power production in the system. Fig 2 shows how PV systems work. Sunlight is gathered via panels and converted into electricity which then powers home electric units. In addition, it can be connected to the grid where excessive electricity is distributed. The focus of our paper will be on PV systems, due to their lower price, easier installation process and higher need in the region of our focus.

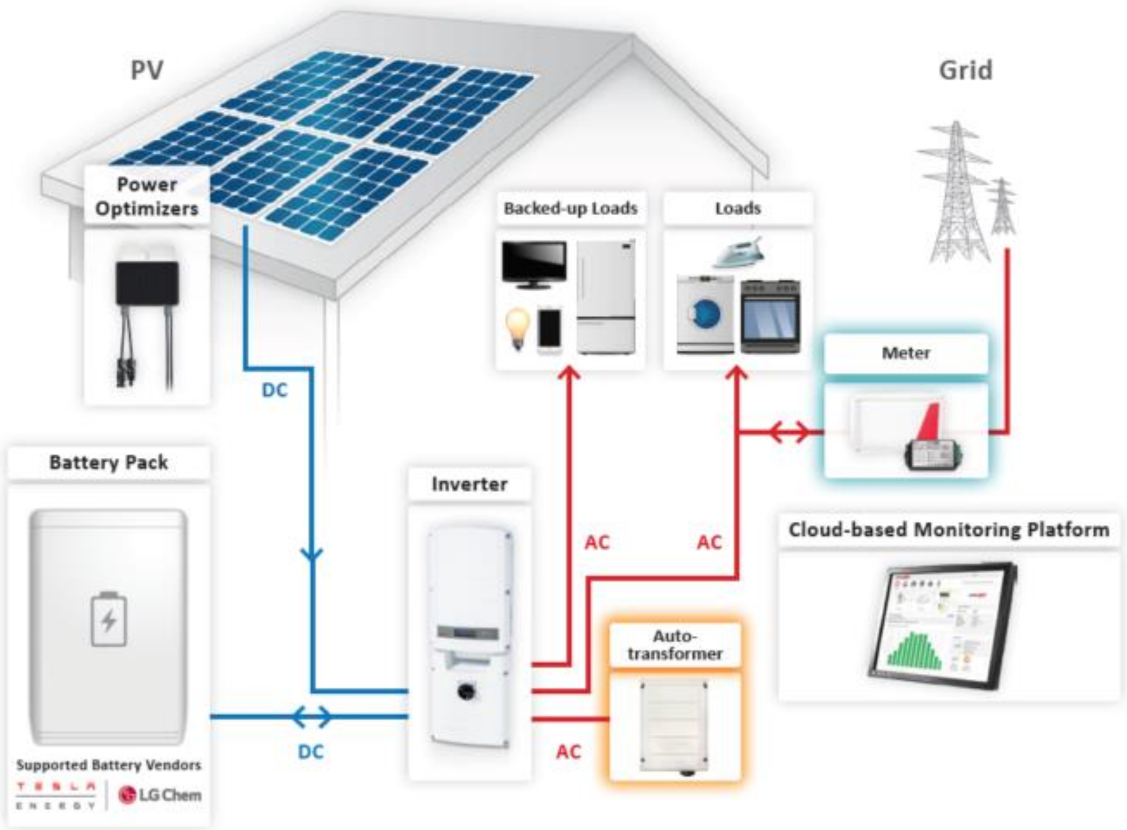


Figure 2 Schematic presentation of PV system
Source: https://bit.ly/2ZGKVf7 (29.10.2021)

We briefly described different ways of solar energy production and how it is used. A great issue regarding solar energy is its supply, and particularly, the logistics of it. That can best be described through a supply chain from the first to the last step. Fig. 3 shows the supply chain of solar energy.

In our work, the emphasis is on the financial part, so it is important to say something about the production cost and final cost of produced goods.

Essentially, we have to include the price of facilities, equipment, maintenance, electricity use, labour and materials just in the production process, followed by the supply chain costs, which include sales, marketing, administrative labour, taxes and R&D. Based on information from nrel.gov, the price of c-Si module in 2015 was $0.67 per W and it is projected to go as low as $0.18 in 2025. Once we add an overhead cost to this, we get a minimum sustainable price.

Speaking of retail pricing, according to nrel.gov, the cost of a residential PV system (22 panel system) in 2010 was $7.53 per kW and in 2020 it dropped to $2.71 per W. This is due to the reduced cost of installation labour, taxes, module prices but there are higher costs of module upgrades and system updates.

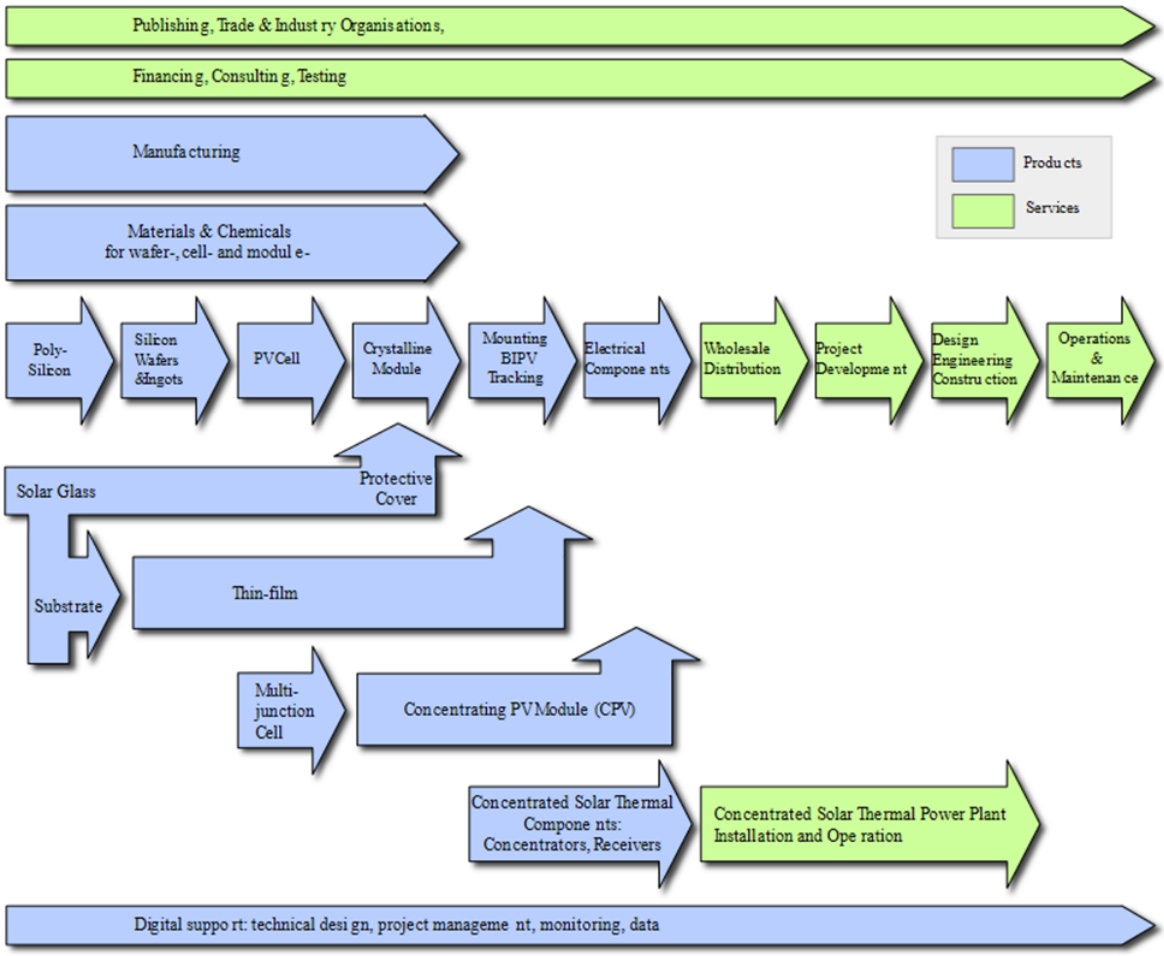


Figure 3 Solar Value Chain

Source: https://bit.ly/3w4QeRG (29.10.2021)

There are distinct segments within the whole eco-system of solar power, starting from the manufacturing of equipment and module production, all the way to the installation and operation. Among them are also activities that span the whole lifecycle such as consulting and financing, as well as promotion and training. The main products of the manufacturing process are polysilicon, wafers, cells, modules, mounting and tracking systems and electrical components. Services include project development, wholesale distribution, design, engineering, construction and maintenance.

**Ecologic dimension and level of substitution of solar energy**

Ecologic dimension is achieved in terms of the degree of dominant technologies. There is almost no pollution in the production of panels or inventors and accumulators or any other structural elements necessary for the functioning of the installed capacity. The processes of production, storing, and distribution are ecologically clean.

We can distinguish the modern trends of other "green" technologies from the solar one.

There are many different methods for sunlight conversion into energy, but one thing they have in common is their need for big land usage and water usage for cooling down the systems and cleaning the panels. Other than this, we do not know much about its impact on the development of wildlife.

The highest energy potential in the USA is in the southwestern parts (Death Valley and Mojave Desert) because they are really close to equator and have many sunlight hours per year, and almost no cloudy days. This area is known for its autochthonous species – the Agassiz desert tortoise, an ecological-engineer species that digs burrows, which are used by other species to hide from the high heat. The dust emissions from the large solar facilities can compare to CO2 release by conventional energy production sources, photosynthesis, and water usage of desert plants, whereas heat emissions could alter the sex ratios in animal species whose sex is determined by the incubation temperatures.

From this, we can conclude that there is yet a lot to learn about solar energy harvesting impacts on the environment. In some cases, it has shown that the shades provided by solar panels in large-scale power plants have a positive impact on biodiversity in dry and desert-like areas, where certain species have started migrating and cultivating the soil.

Solar energy has shown a great potential. In the past, its cost was high and so were its levels of substitution to conventional energy sources. However, in the past 10 years, the price of production, sales and installation of solar power plants has dropped to as low as 90%, which has had a global impact of going from 40GW to 578GW on a global scale.

In our work, we will focus on where Serbia is located within that scale.

At this moment, the Republic of Serbia has an installed capacity 10MW of solar energy harvest compared to 4,4 GW that comes from conventional sources (charcoal burning). That is below 1% scale.

Serbia has a great potential amongst European countries. The Southern parts of Serbia get enough sunlight hours per year, which gives us an advantage in comparison to some countries, like Germany for example, which have an installed capacity of 50GW coming from solar harvest.

A plan exists for Serbia to start investing into solar energy in order to reduce its conventional energy production and move on to "green". It is said that it would take between 8GW and 10GW of renewable energy to substitute for the current 4,4GW of conventional energy production.

Recent events have shown that we are moving in a good direction. A plan to construct another conventional power plant "Kolubara B" has been cancelled. A call for auction has been set for building a new 400MW power plant. The Al Pack Company is already building a 1,1MW solar plant. EMS (electric networks of Serbia) is already preparing new grid networks that will be capable of taking and distributing energy from solar plants to the grid. The Government is subsidizing households and farms with incentives to go solar for powering their necessities.

**Technical and technological characteristics of solar power plants**

The photovoltaic array is a key component of a photovoltaic power generation system. In the design of a photovoltaic power generation system, the manufacturer of the photovoltaic panels usually provides the parameters of the photovoltaic array, including the open circuit voltage, short circuit current, peak voltage, peak current and maximum power. Applying these parameters to the corresponding mathematical model can directly yield the operation parameters of the photovoltaic array. The characteristic equation for the output of the photovoltaic battery component is:

$$I_L = I_{ph} - I_0\{exp * \left[\frac{q(U_{oc} + I_L R_S)}{36AkT}\right] - 1\}$$

In equation (1), IL is the current flow through the load; Iph is the photo production current; Io is the reverse saturation current of the photovoltaic cell; Rs is the equivalent series resistance; q is the electron charge; Uoc is the open circuit voltage; A is the P-N junction ideal factor; K is the Boltzmann constant; T is the absolute temperature.

Given the Isc, Uoc, Im and Um of the given model of photovoltaic cells under standard conditions, we can obtain the current–voltage curve and power-voltage curve, which were used as the photovoltaic battery output characteristic.

The output power of a photovoltaic power station is related not only to the features of the photovoltaic battery, but also to the intensity of solar radiation that reaches the surface of the photovoltaic cells. The illumination model describes the intensity of solar radiation over a certain period. The intensity of naturally occurring solar radiation depends primarily on the geographic position of the photovoltaic power station. Using the latitude, longitude and altitude of the given location, the intensity of solar radiation in the region can be roughly determined:

$$R_r = f(\alpha, \beta, h)$$

In equation (2): □RT is the actual solar radiation intensity, kW/m2; α is the longitude of the□ photovoltaic power station site; β is the latitude; h is the altitude, m.

**Economic and social dimensions of solar power plants**

When we speak about social and economic dimensions, we cannot bring too much certainty on the table. The fact is that we are still far away from any large-scale impacts, but what we can do is make conclusions and predictions based on the low scale impact that we have.

The biggest reason for not having much information is the fact that many countries and places with best potential still have no programs and solutions for building solar power plants.

We know that if we are to harvest solar power, we need places with a lot of sunlight. It is true that for example Sweden can invest in large scale plants, however the annual amount of sunlight they get is much lower than if we would take Egypt or any other northern African country.

Therefore, we can conclude that if world is going to go fully green and invest in solar power plants, certain measures must be taken by developed countries to help countries with potential to create such conditions and invest in their building up. The result would be a huge number of power plants in the equator area and a solution for grids and export to supply countries in higher demand. It sounds like utopia, but it is a solution.

There have been many case studies that have shown what impacts solar power has on social and economic life of population and our planet.

It is important to say that every transition has its dangers in certain aspects and so does the transition from conventional to renewable energy sources. The most important factor and a base of energy systems nowadays is its infrastructure; its durability means that it can exert influence for many decades. In their natural state, coal, oil, and natural gas are buried in places that are difficult to exploit, difficult to transport, and hard to use. It is only the vast, industrialized, large-scale deployment of drills, mines, pipelines, storage facilities, railroads, tankers, refineries, and distribution systems that render fossil fuels seemingly cheap and abundant for consumers. Many renewable energy systems rely on large-scale manufacturing facilities, long-distance grids, and a proliferation of consumer appliances. Take away key aspects of energy infrastructure, and the energy system can come crashing down quickly, bringing numerous other systems down with it.

On the other hand, the social dimension has its positive sides that are seen in ecological and non-contaminating aspects. The production of solar energy first and foremost has low scale to no impact on global warming because of no residual gases in energy production, which also applies to economy since it reduces the economic cost of production and subsidies for pollution. We can give the example of the US which is a leader in renewable energy production and consumption. At this very moment 2.3% of the total output of energy consumed in the US comes from solar harvest. It is a fact that fossil fuel expenditure also includes healthcare costs, and environmental degradation, and it is estimated that the true cost of fossil fuels is $5.2 trillion a year globally. These numbers would be very much lower with cleaner production. It can reduce the amount of $CO_2$ in the air and air pollution, resulting in cleaner air especially in big cities like Beijing and cutting down healthcare expenditures and growing health issues.

It is said that with every new technology created, which replaces an old one, at least 1% more new jobs are created than those that are lost. Having said that, we conclude that construction of solar power plants would bring new jobs in production, service, distribution, logistics and many other fields known to man. Every new job will have both social and economic effects, on the wellbeing of employees and the total GDP growth due to lower costs of maintenance in comparison to fossil-based energy production. It is also said that solar power plants can provide new and better conditions for existing industries to function, like heating systems, cooling systems, water heating, steam production etc. Also, there is an idea where at plant locations in specific areas sheep and cow farms could be created since panels create shade which would give animals more time to spend in the fields resulting in higher yield in meat and dairy production.

All in all, there are things yet to be discovered and yet to be calculated to see where investing in solar power will take us.

**Sources of financial means for investing into solar power plants**

a. Personal funds

When speaking of personal funds, it is important to say that they depend on the type and size of power plant invested in. Small scale house powering power plants that are usually used by families for water heating and heating systems tend to have higher percentage of personal fund investment than mid or large-scale plants that require higher investment. The way things usually work is that families sometimes pay fully out of their own pocket for the solar systems in their households or in part by relying on government subsidies. It is rare to hear that families in Serbia take loans for investing in solar systems on their households.

b. Government subsidies

In 2016 the Serbian government brought regulations on incentive measures and the power purchase agreement – PPA of electricity, alongside the procedure to be a privileged producer. It is also said that these subsidies and incentives will go in accordance with the inflation in the Eurozone.

To put it in numbers, solar power stations have 1400 hours of stimulation per year maximum. Those on the ground get 9 cents and those on the rooftops up to 30 KW have the right to get 14,6 cents minus total capacity times 80. Systems installed on buildings 3 capacity up to 5MW will receive 12,404 cents minus 6,809 times the amount of capacity in MW.

We also have an example form this year where government has placed a public call for subsidizing agriculture and farms with 10.000-25.000 Euros for agricultural holdings and 12.500-200.000 Euros for small and medium enterprises. Subsidies will be given in 50-40-10 ratio where 50% is government subsidy, 40% is the loan and 10% comes from personal funds. These subsidies will serve for procurement and installation of solar panels and generators with the purpose of achieving energy efficiency.

c. Credit arrangements

ProCredit Bank is giving affordable interest-free loans toward sustainable and renewable energy projects. These loans are determined for up to 84 months return period for mobile and fixed solar systems of up to 120KW. It is an investment type of loan without any amount limitations and down payment necessities, and they can be used in combination with other incentives.

These loans are realized in partnership with the following producers of solar systems: Volta Technology, Alu Markom - com, Energize, Patez Wind, Conesko etc.

d. National and provincial development funds

The national development foundation of the Republic of Serbia has deployed incentives for application of energy efficiency and improvement for ecological aspects of self-production of solar energy.

The amount of irreversible grants cannot be less than 75.000 RSD (642 EUR) for entrepreneurs, respectively 250.000 RSD for businesses or bigger than 12.500.000 RSD (107.000 EUR) for other larger business entities. The repayment period of these incentives will be up to 10 years for businesses with a one-year grace period and up to 8 years with one-year grace period for entrepreneurs. The repayment period cannot be made in less than 2 years from the time given including the one-year grace period. In case that loan has been repaid in less than 2 years, the client is obligated to also pay back irreversible grant.

The interest rate with currency clause will be 1% with bank warranty and a 2% yearly collateral.

In addition to the Republic there is also a Provincial foundation that provides affordable loans with low interest rates. These loans can range from 500.000 RSD (4.285 EUR) to 100.000.000 RSD

(857.000 EUR). When taking the loan? interest rate is formed without taking VAT into consideration. Interest rates vary from 1% to 3% depending on development sector and area. Every loan taker must provide at least 20% of loan amount of self-funds. Repayment periods are up to 7 years and with a 24-month grace period.

e. Ecological funds

There are various EU, private and state ecological funds with means necessary to help ease starting solar companies, as well as household energy efficient systems, building eco grids etc.

f. Innovation fund

Republic of Serbia Innovation fund has a Mini Grants Program.

The Mini Grants Program is aimed at private young enterprises which are engaged in the development of technological innovations with a clear market need. This Program is designed to support the survival of companies during the critical phase of research and development and to allow the Serbian entrepreneurs to grow effective business capacities through which they will launch their innovations on the market.

The Mini Grants Program is set to grant up to EUR 80,000, or up to 70% of the total approved project budget. Also, a minimum of 30% of the total approved project budget is to be provided by the applicant from other private sector sources, independently of the innovation fund.

The Project duration is up to 12 months.

g. The Development Agency of Serbia

Serbia has a support program for small and medium-sized enterprises for procurement of equipment.

The Ministry gives irreversible funds for micro, small and medium-sized enterprises, as well as to entrepreneurs for procurement of energy efficient improvement and ecological aspects of production with the goal of earning financing of equipment.

Up until now the most that was given for procurement of equipment was 2.200.000.000 RSD (18.857.500 EUR) in 2019. That year 953 agreements were conducted, worth 2.900.000.000 (24.857.60 EUR). In 2020, the Program was implemented with a smaller budget due to the Pandemic with 363 agreements and 993.000.000 RSD (8.511.500 EUR).

The Program has included all industrial branches, and in recent years public calls have mostly been including the sector for environmental protection and renewables.

h. Dominant sources of financing from EU funds and support programs: Horizon 2020, Cosme, IPARD, WB EDIF etc.

The European Union has a goal to bring developing countries striving for EU membership to a certain level of environmental awareness and mindfulness and to have them reach a certain level of renewable energy production. With that said, the EU has established certain foundations and funds to help those countries, as well as itself, with affordable loans, funds, grants etc.

One of those programs is called Horizon. Horizon Europe is the EU's key funding program for research and innovation with a budget of €95.5 billion. The program facilitates collaboration and strengthens the impact of research and innovation in developing, supporting and implementing EU policies while tackling global challenges. It supports creating and better dispersing of excellent knowledge and technologies.

COSME program is another EU established program for direct funding or bank loan guarantees. It serves the purpose of establishing competitiveness amongst small and medium-sized businesses, and promotion of green technologies. This program has a €2.3 billion budget.

The IPARD II PROGRAM of the European Union is the Instrument for Pre-Accession Assistance in the Field of Rural Development for the programming period 2014 to 2020 - achieving European standards and raising competitiveness. The total budget is €229,970,558. IPARD has a goal to also help farm landlords to improve their energetic sustainability and efficiency. For that they have divided €101,386,667.

The World and European banks are also big benefactors of solar investments with affordable interest rates and loans.

## Diversification of investment through households

Diversification of household investments is seen through one's ability to redistribute excessive energy. Every household that invests in solar systems for personal uses and generates excessive amounts of electric energy has/will have an option of selling that excessive energy through the grid to EDS/EPS (electro distribution of Serbia/Elektroprivreda Srbije).

At this moment EDS has fid-in tariffs for electricity obtained from renewable energy sources that were brought in 2013. These fid-in incentives imply that EDS will in a timeframe of 12 years pay higher tariffs for electricity obtained from renewable energy sources in order to help owners break even with their investments sooner. Buyout price for energy produced from solar is from 12.4 to 12.6 RSD (0.11-euro cents). The price of fid-in tariffs is added on the electric bills of tax payers in a monthly amount of 153 RSD (1.31 EUR) in total.

Other options will include but not be limited to creating a higher-level storage unit on the level of neighbourhood, village or a town where excessive energy would be stored and then shared in times of lower sunlight emission. In addition, Inc. can be formed where one local community can sell excessive energy to another that is not yet using renewable or is not yet connected on the grid. It can also sell it to the EDS or function as a separate electricity producer where households would be able to sell shares and have a yearly dividend.

## Expected economic effects

It is difficult to speak about expected economic effects in terms of numbers, since it is still difficult to recall what deductions and what expenses will the future hold. It is a fact that Serbia needs a safe and stable market-based energy system. Ecologization is the way Serbia should intend to take. $CO_2$ emissions and lignite burning and emission cost Serbia 700-800 million Euros on average each year. With the growth of the renewable sector, the costs of these pollutants would go down. It is a fact that the cost of services and maintenance of renewable resources will not and cannot overgrow expenditures that we have at this moment. In Serbia we have a unique tariff system for accounting electricity bills, which has 3 zones and 3 subzones under each zone. This means that electric bills can get high if energy utilization goes up high and moves from lower to higher zones where the price for kwh is enormous. It is questionable how the state will deal with this since self-production of electricity will not give it the leverage to charge for electricity but only to impose certain taxes or try to raise the prices of equipment and maintenance through market manipulation.

It is important to say that goals are hard to set up in our current environment and that they can easily change. The goal is to go fully green until 2050 by substituting 4.4GW of current power production with 8-10GW from renewable. This depends a lot on our day to day routines and uses. There was a big project called "South Stream" which was supposed to set Serbia as a regional hub of natural gas until it was cancelled. There is a fear that great projects such as this one can also go in different directions from the expected, which sets us a step back in our movement towards becoming green.

However, if we imagine that all goes as planned, we should be expecting to have new jobs created which would add up to at least +1% to those that will be discredited. New skills methodologies and sustainability of production and industry will emerge. GDP growth and rise of living standard should be expected. New jobs will require new skill sets that will put those with proper knowledge at disposal and would give them the ability to have a higher-paying job due to lack of knowledge.

## Conclusion

New trends in sustainability and renewable sectors bring a lot of changes to various undeveloped fields. The high demand for renewable energy is growing every day and new ways and solutions are being invented. We are witnessing strivings to create a better world, through a balance between economic and social factors of the environmental protection. Sustainability, first and foremost, needs determination of the people to convert their existence to new and better ways. We intend to stop thinking that we are rulers of this planet, and that we are only its habitants and that the planet is our master. We must not become a virus and make our planet raise temperature (referral to global warming) and kill us just like our bodies do when we have viral infections. We must not live with the belief that natural resources can be replenished easily. That process can last for millions of years. We need to reprogram our habits that are destructive towards nature.

It is shown that costs and benefits of going green and sustainable are bearable and that it is only up to our intentions how we will put funds and resources to use. Many different organizations and funds have raised awareness in this matter by taking away significant amounts and putting them at the disposal of governments and organizations to use, under ISO standards, in order to improve our energy consumption, sources of energy and with it – the quality of life.

The growing population has growing energy needs. Expanding the use of old resources will bring only more and more harm. Luckily, we will run out of them at one point. By that time we need to be ready to take on whatever may come in order to fulfil our needs. With incentives and subsidies that world financial organizations and governments are forming, we are in the right track, and hopefully we will be ready when the time comes.

It is necessary for our country to make changes as well, as fast as we can because pollutions and growing concerns for our habitats can become our worst nightmares easily. The IMF, the World Bank, local banks, innovation funds, ministry and government have already taken actions in this direction and we are overwhelmed with financial sources, however, the question is whether people are willing to acquire knowledge and learn how to put it to use.

The situation in which society finds itself in the world and in our country today is very specific. The Covid pandemic is affecting all activities. In addition, there is a psychological component based on concerns for health and work, because there are significant reductions in business, changes in lifestyle and work, etc. (Carly, 2020). It has been observed that stress at work during a pandemic has a direct negative impact on commitment (Zandi et al., 2020). Employee care during COVID19 affects perceived job security and increases employee commitment (Filimonau et al., 2020). Especially during the months-long crisis period that results from the spread of the COVID19 pandemic, motivation should be developed, success rewarded, and positive thinking encouraged, in which top management plays a key role (Hongwei & Lloyd, 2020).

The analysis of the research proved similar work productivity and job satisfaction of women and men employed in education before the pandemic; the results also revealed that women were less productive and less satisfied with work than men after the outbreak of the pandemic (Feng & Savani, 2020). The results of research on the relationship between the gender and the attitudes of temporary employees, relying on gender role theory, showed that temporary employees have more positive attitudes towards working for a client organization compared to male employees. The results also indicated that education and, to a limited extent, age, acted as a moderator of the relationship between gender and employee attitudes (Selvarajan, et al, 2015).

Based on the obtained results, collected by a direct survey of employees at different levels in state and private banks on the territory of Southern Serbia, it was determined that the fear for job security in the current epidemiological situation is the same for both sexes, which differs from the previous research. The assumptions, i.e. hypotheses from which we started, turned out to be incorrect, i.e. based on data processing and analysis of results, we found that only one of the four hypotheses we set was confirmed – that about satisfied and productive workers.

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