ANALYSIS OF THE ELECTRICITY PRODUCTION OPPORTUNITIES FROM THE BUILDING OF THE MUNICIPALITY OF DOBRICH

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SUMMARY

This analysis discusses the possibilities of installing a photovoltaic plant on the roof of the administrative building of the Municipality of Dobrich. The aim is to compare the different approaches for the implementation of the project, evaluating the possibilities of 1) building an installation for own consumption only, and 2) an installation to cover the needs of the building and sell the surplus energy. In the first scenario, the investment is fully borne by the municipality, while the second relies on the participation of other stakeholders (municipality residents or else) in the investment process in an energy cooperative based on public-private partnership (PPP).

On the basis of the analyses, it is concluded that the structuring of an energy cooperative is feasible and would be beneficial for both the municipality and the participants in the cooperative. This scenario allows financial risk to be spread, providing a good return for investors relative to current levels of bank deposit rates.

Exemplary models for the participation of the attracted investors are developed within a 10-year investment recovery period. For this period, investors receive annually 1/10 of the value of the investment plus an annual dividend on its residual value. The expected return over the period, depending on the model chosen, is between 27% and 32% on the funds invested.

1. STUDY OF THE CURRENT SITUATION AND PLANNING

The widespread adoption of new technologies by energy consumers creates attractive opportunities, but these also come with the need to solve a number of site-specific applicability analysis tasks.

For decentralised electricity generation, photovoltaic installations are the most widespread due to their affordability. They can be supplied as individual elements or as a finished product for installation. Recently, proposals for combining PV installations with storage batteries for better utilisation of the produced electricity are also gaining ground.

It should be stressed that in order to achieve higher efficiency of decentralised energy production and consumption solutions, it is necessary to apply energy management software solutions, which are available on the market.

In relation to the task for the analysis of possible models for the implementation of a project for the deployment of a photovoltaic installation on the roof of the building of the Municipality of Dobrich, the following sequence of steps is applied:

- Review of data from an available energy audit of the building, collection of data on the building's electricity consumption, discussion of the potential for connection of different end users;
- Based on the data obtained, a joint hourly load profile and a PV power generation profile were prepared for use in the variant analyses;
- a model of financial estimates based on the hourly prices on the Bulgarian Independent Electricity Exchange, Day Ahead platform, for the last 12 months, was developed.

On the basis of the prepared model, simulations were performed for the following variants:

- Dobrich Municipality's stand-alone investment in a photovoltaic installation and storage options;
- leveraged finance model.

To prepare the framework for the analysis, the project team reviewed the preliminary data for the building of Dobrich Municipality and discussed a wide range of issues, including:

- the extent to which there is a change in the loading schedules for the building;

- the current approach of heating the building with natural gas, but also involving air conditioners;
- the condition of the electrical installation in the building and the presence of separate circuit breakers by user group (air conditioners, water heaters, sockets for PC, lighting, etc.);
- use of the water heaters (are they powered on continuously or do they have a switch-on mode);
- whether there is another municipal site in the vicinity (and at what distance);
- whether there are premises with other types of periodic use (e.g. cinema hall, etc.);
- whether there are external users in the building or only the municipal administration is using the premises.

The main data used in this model are:

- 1. Hourly metered consumption data in the building, and
- 2. Energy efficiency audit data.

The hourly consumption metering data is as per the hourly metering reference for the period 01.01.2017 to 31.21.2017[1].

The Energy Efficiency Audit of the Municipal Administration, Sofia Dobrich, was carried out by Buildcontrol Ltd. in 2016.

The survey details the electricity consumers, namely:

- Lighting installation, which is mainly made with incandescent and fluorescent lamps. Mixed lighting is used. Outdoor lighting is available and is considered as a non-impacting consumer.
- Power consumers, the main ones being the equipment in the offices, as well as the outdoor lighting and air conditioners in cooling mode.
- electric boilers
- electric heaters and air conditioners.
- heating pumps and boiler burner for boiler.

The study concludes with the electricity balance shown in Table 1.

[1] Data from 2017 was used due to the fact that there was a problem obtaining hourly load profile data after switching the energy supplier after this period. This year's data is considered representative and reliable as it is not affected by the constraints imposed by the COVID pandemic.

Table 1. Balance of electricity consumption

Electricity Consumption			
System	Winter	Summer	Total
	kWh	kWh	kWh/a
Lighting	7840	5333	13173
Consumers influencing the balance	51957	47676	99633
Consumers not influencing the balance	3321	16997	20318
Domestic hot water	6641	6023	12664
Pumps (heating)	6647		6647
Electrical heating appliances	16340		16340
		Total	168775
		Reference period	168775

Source. Dobrich, Building Control Ltd. in 2016.

The Energy Efficiency Audit recommends a range of energy efficiency measures, but also soft measures such as introducing rules for the operation and maintenance of energy systems and introducing energy monitoring.

The study recommends that "*at the discretion of site management, a dedicated energy efficiency officer could be appointed to directly oversee the implementation of monitoring. This would greatly facilitate the process of reporting the required energy performance*". This recommendation is even more important when deciding to implement any of the PV installation options.

For the purposes of this analysis, the following aspects of data collection are essential:

- the reported consumption in the period 01.2017-12.2017 is significantly lower than that presented in the energy efficiency audit. This is due to the energy efficiency improvement measures taken in the building and hence it has been assumed to use the annual consumption as the baseline consumption as per the submitted hourly report for 2017;
- other hourly data - PV production profile and pricing parameters - are also needed to build the model. For the purpose of the analysis, data from another site in Bulgaria were used, which were adapted to the solar radiation profile for the location of the town of. Data from PVGIS-5 of JRC[2] at the European Commission were used. The price parameters are based on prices achieved on the Day Ahead platform as mentioned above.

[2] https://re.jrc.ec.europa.eu/pvg_tools/en/

2. PROJECTED LOAD PROFILE AND ENERGY BALANCE FOR DOBRICH MUNICIPALITY

For the purpose of the analysis and based on the assessment of the possibilities for deployment of photovoltaic panels on the roof of the building of the Municipality of Dobrich, two power capacity options were adopted:

- a photovoltaic installation with capacity of 60 kWp, and
- a photovoltaic installation with capacity of 90 kWp.

For the purpose of discussing different options, the effects of a combination with batteries for storing electricity generated by the PV installation and subsequently for feeding it to consumers in the building are analysed here.

The results of the balance sheet calculations of the combination of building load and PV generation are presented in Table 2.

Table 2. Balance calculations and impact analysis

Month	Load Profile Building	Production (option with 60 kWp)	Electricity from grid	Unused electricity from PV	Electricity from PV for own needs	Production (option with 90 kWp)	Electricity from grid	Unused electricity from PV	Electricity from PV for own needs
January	14 572	3 322	12 177	927	2 395	4 983	11 489	1 900	3 083
February	10 550	4 989	6 980	1 418	3 570	7 483	6 344	3 277	4 206
March	10 675	6 235	6 749	2 309	3 926	9 352	6 053	4 730	4 622
April	8 549	7 919	4 457	3 827	4 092	11 879	3 962	7 291	4 588
May	8 147	9 445	3 049	4 347	5 098	14 167	2 707	8 727	5 440
June	10 392	7 939	4 585	2 132	5 807	11 908	3 470	4 985	6 922
July	11 671	9 953	4 512	2 793	7 159	14 929	3 473	6 731	8 198
August	12 417	9 610	4 750	1 943	7 667	14 415	3 651	5 649	8 766
September	9 434	7 297	4 405	2 269	5 029	10 946	3 617	5 129	5 817
October	10 640	4 075	7 608	1 043	3 031	6 112	6 858	2 331	3 781
November	12 292	3 303	9 448	460	2 843	4 955	8 700	1 364	3 591
December	12 153	1 323	11 050	220	1 103	1 985	10 697	528	1 457
Total	131 492	75 409	79 771	23 688	51 721	113 113	71 021	52 641	60 472
Effect analysis									
Reduction of electricity from grid		39%				46%			
Efficiency of the PV for own needs					69%				53%
Additional effect - batteries (# 1)			3%				7%		
Additional effect - batteries (# 2)			5%				13%		

Source: own model

In summary of the analysis of the effects of using different technological solutions, the following conclusions are drawn:

- the deployment of a photovoltaic installation with a capacity of 60 kWp, which is close to the reported maximum hourly consumption in the building (65 kW), leads to:

  - Reduction of the electricity drawn from the grid by about 40%;
  - The efficiency of PV for own use is determined by the coincidence time between

consumption in the building and production from RES and in this case reaches about 70%;

- when installing a battery that allows for the transfer of renewable energy to non-renewable generation hours, electricity drawn from the grid can be reduced by an additional 3 to 5%.

- the deployment of a photovoltaic installation with a capacity of 90 kWp, which is the maximum possible utilization of the roof using a load-bearing frame at different levels, results in:

- Reduction of the electricity drawn from the grid by about 45%;
- The efficiency of PV for own use is determined by the coincidence time between consumption in the building and production from RES and in this case reaches about 55%
- when installing a battery that allows for the transfer of renewable energy to non-renewable generation hours, electricity drawn from the grid can be further reduced by 7 to 13%.

Deploying a rooftop PV system with a larger capacity relative to the maximum loads in the building results in a reduction in the energy draw from the grid, but the efficiency of the PV system is significantly lower. Adding storage capacities makes a noticeable contribution for the higher capacity installation, which, in combination with a more powerful battery, results in a reduction of grid electricity by more than 50%, but the efficiency of the installation remains around 60%, i.e. lower than the 60 kWp capacity option.

Figures 1 to 4 illustrate the different variants of PV installation and battery contribution in winter and summer mode. It can be seen that the low capacity installation makes a small contribution to the building's electricity supply in winter due to the low production from solar energy.

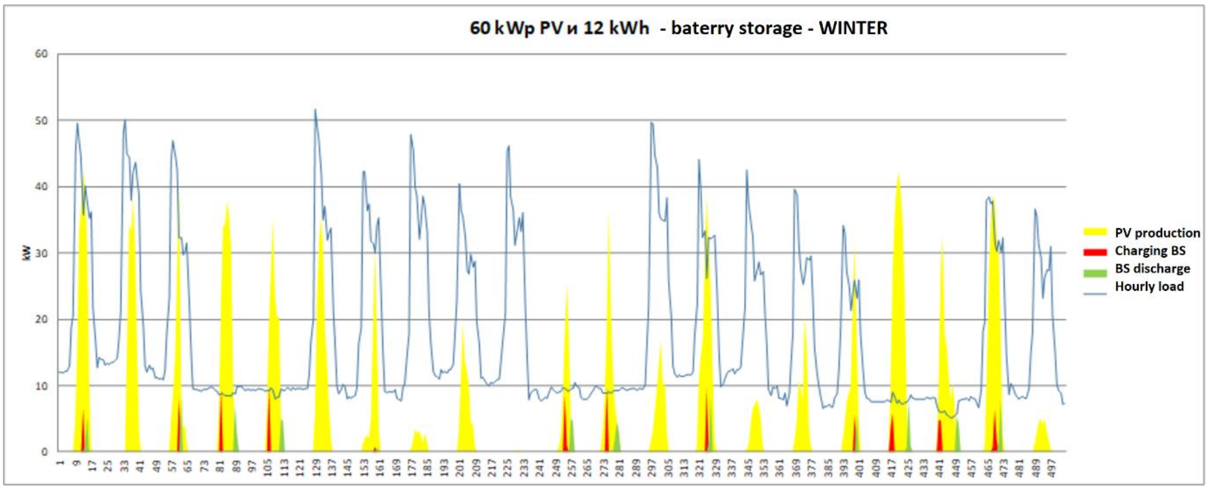
In the summer, both options compact the daily load profile, with the involvement of batteries increasing the efficiency during this period.

Due to the typical mode of operation of the administration, the effect of solar power generation on weekends remains very low even with the use of batteries. It is reported that by using the available hot water heaters as an energy storage buffer, the efficiency of using the PV system increases.

The energy balance analyses also show that the available roof area, even with the use of powerful batteries, is not sufficient to achieve building autonomy and the building must use grid electricity.

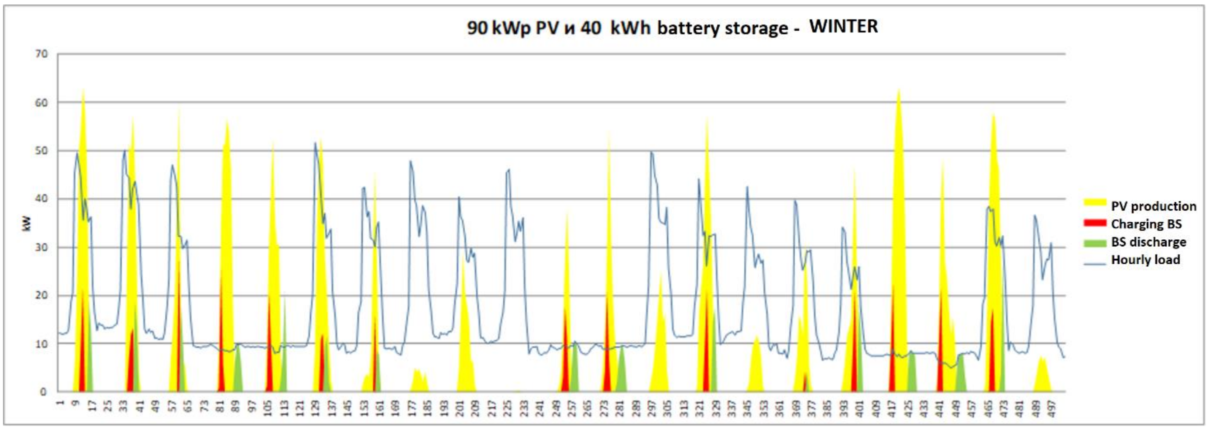
Energy balance estimates of the effect of deploying the PV system with or without batteries are not sufficient to make a straightforward decision for investment in this direction. Therefore, in the next section of the analysis financial assessments of the different options are proposed.

Figure 1. Illustrative sample of the joint operation of a PV installation (60 kWp) and a battery storage (BS), relative to the winter load profile of the building



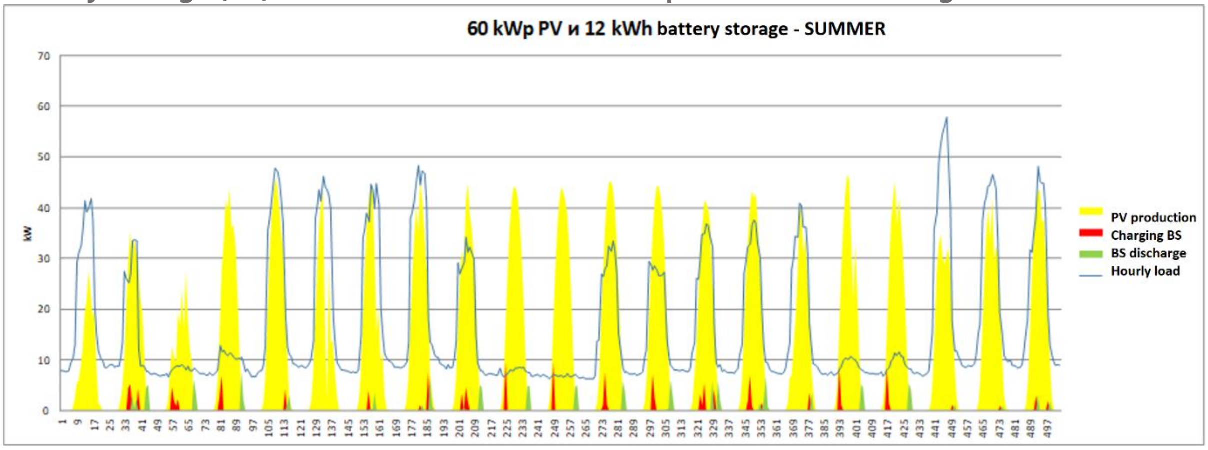
Source: own model

Figure 2. Illustrative sample of the joint operation of a PV installation (90 kWp) and a battery storage (BS), relative to the winter load profile of the building



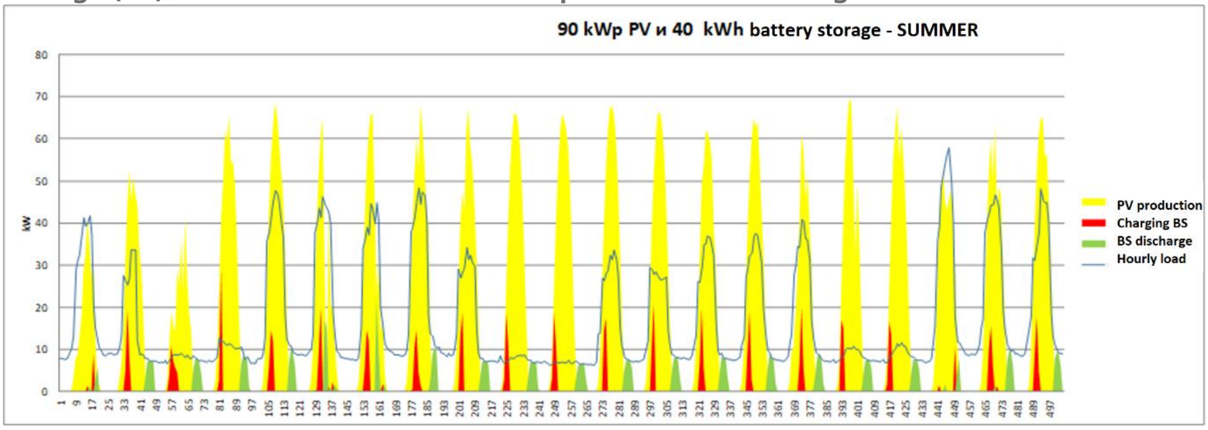
Source: own model

Figure 3. Illustrative sample of the joint operation of a PV installation (60 kWp) and a battery storage (BS), relative to the summer load profile of the building



Source: own model

Figure 4. llustrative sample of the joint operation of a PV installation (90 kWp) and a battery storage (BS), relative to the summer load profile of the building



Source: own model

3. DEVELOPING SCENARIOS FOR THE USE OF RENEWABLE ENERGY IN A DECENTRALISED SYSTEM

Meeting the needs of end users for electricity generated from renewable energy sources will increasingly be based on decentralised solutions. In this context, the following three categories of renewable electricity producers are now clearly emerging:

- those that build generating capacity in order to sell electricity from renewable energy on the market (utility installations),
- those that use the energy produced from renewable energy only for their own consumption, without selling it (a subset of this category are consumers who use only their own sources or "off-grid"),
- those whose aim is both to satisfy their own consumption and to sell the surplus energy produced (Prosumers).

These three categories differ in terms of the process of connection to the grid, their possible role as users of the grid, and their status as commercial participants in the electricity market. For example, for sites with self-consumption installations that operate in parallel with the grid and are not 'off grid', it is necessary to determine an optimal connection scheme and to investigate the supply voltage values of existing consumers, which is best done using specialised software.

In Bulgaria, combining consumers into a common group for electricity production and consumption is still an exception.

For now, the following examples can be offered:

- for pooling users to cover common costs - such as condominiums or users with space in commercial buildings like large shopping centres;
- pooling of consumers who have a common energy installation - such are available in condominiums, where the energy produced is sold and the amounts received are used to cover the common costs;
- pooling of a RES producer and a remote consumer through the grid - these are examples of targeted RES contracts.

Considering the general trends, the two main scenarios for the realization of an investment plan for the deployment of a photovoltaic installation on the roof of the building of the Municipality of Dobrich are:

- realization of own investment initiative with funds of the Municipality, and

- implementation of a joint investment initiative between the Municipality and small private investors.

For the investment analysis, a financial model has been developed for both scenarios that takes into account the current prices for network and system services as well as the prices for the supply of active electricity.

For the purposes of statistical coverage of price factors in final prices for consumers in the European market, the European Commission uses three main groups:

- Taxes and levies;
- Networks;
- Energy.

This approach is also used in this analysis under the following specific assumptions:

- the group "Taxes and levies" includes the general burdens, such as VAT and excise duty, but it is possible that an additional burden will arise, formed as a "Liability to society", as it was until 2021 in our country;
- The Networks group includes prices for the transmission of electricity through the electricity transmission and distribution network and access prices for non-household customers. The prices set in Decision No C-19 of 01.07.2022 were taken as the basis for the analysis. These prices are expected to increase;
- The Energy group includes market-determined prices for active electricity, which are most commonly associated with hourly prices on the Day-Ahead Market Platform, as well as the trading service, which includes load profile administration and supply balancing.

The assumed level for the commercial service price of BGN 25 per MWh is based on data from market supply in 2022, and a proprietary forecast has been prepared for market prices for active electricity.

Typically, price level forecasts for supplies and services are based on an analysis of historical data for 2 or more years. In the electricity market, the last 3 years have been marked by the strong influence of non-systemic factors, such as:

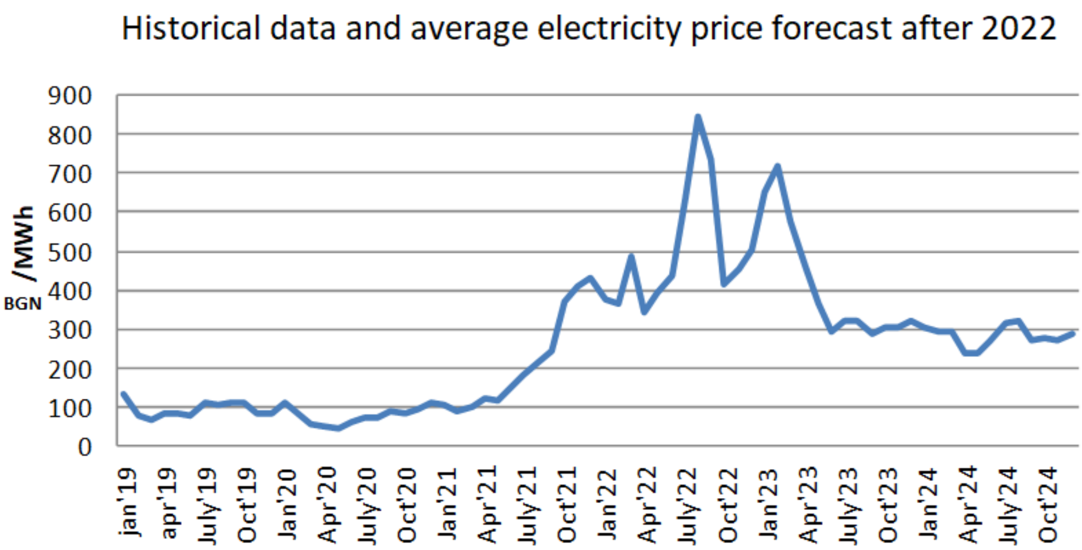
- Rapid carbon price growth in 2019;
- strong decline during the 2020 COVID pandemic and strong growth during the 2021 economic recovery;
- overlay of gas supply crisis and war in Ukraine in 2022.

These factors make estimates of expected prices over the next 10 years conditional, but the expectation is that they will decline in 2023-2024 relative to current prices, but remain at higher levels than those achieved in 2019 when accounting for:

- continued dependence on gas supplies until at least 2030, and
- the need for high prices to maintain the interest of private investors to carry out the necessary renewable energy projects that underpin the energy transition.

As a result of the above, an own forecast is developed, presented in Figure 5, which assumes an average annual wholesale electricity price of €140 per MWh.

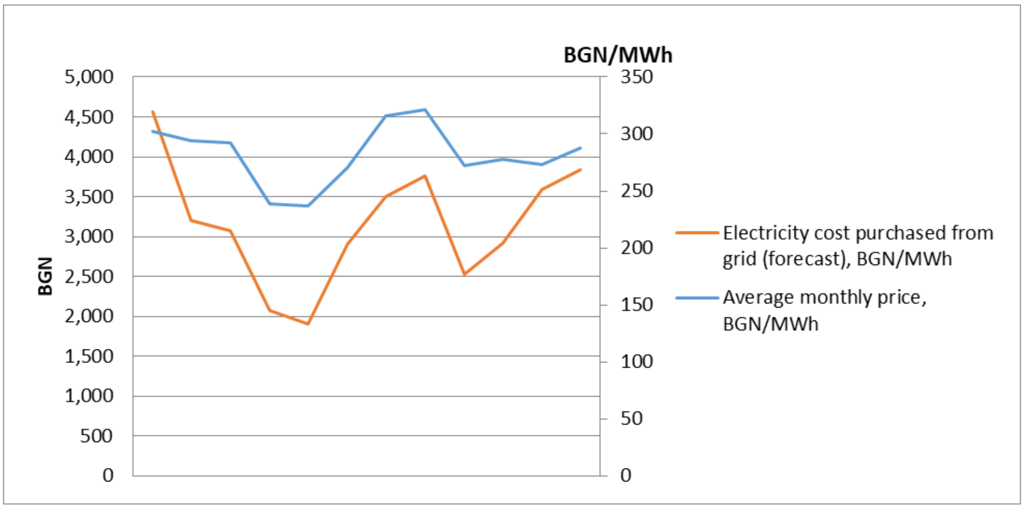
Figure 5. Basis for determining the forecast electricity price



Source: historical data from IBEX and own model

In addition to forecasting an average annual electricity price, the forecast model was also used to produce a forecast hourly price profile that follows the market price profile in 2019. The result is presented in Figure 6.

Figure 6. Forecast profile for monthly wholesale prices and forecast costs when purchased from the grid



Source: own model

It can be seen that in order to determine the baseline parameters for the construction of a forecast financial model and to discuss alternative investment options, a number of assumptions have to be made that are related to possible changes in different directions. In addition, their impacts differ depending on the capacity in which the investor is considered - producer, seller or consumer of own production. Table 3 provides a qualitative assessment of the impact of possible changes in baseline parameters on the business model of the Municipality as a consumer and the Municipality as a seller of electricity in the market. An assessment under the status quo without renewable energy investments is also included.

Table 3. Analysis of the impacts of the underlying financial assumptions

Admission	Current state, without RES	Use of RES for own needs	Sale of electricity from RES
Imposing of surcharges	Increases costs	Increases savings from own needs	Does not affect sales revenue
Increased cost of network services	Increases costs	Increases savings from own needs	Does not affect sales revenue
Increase in commercial services	Increases costs	Increases savings from own needs	Reduces sales revenue
Increase in the wholesale price of electricity	Increases costs	Increases savings from own needs	Increases sales revenue
Wholesale electricity price reduction	Reduces costs	Reduces savings from own needs	Reduces sales revenue
Higher investments in renewable energy than planned	No relation	Reduces savings from own needs	Reduces sales revenue
Improved optimization in load management	Reduces costs	Increases savings from own needs	Increases sales revenue

The emergence of many identical RES capacities	Reduces costs	Reduces savings from own needs	Reduces sales revenue

Source: own analysis

Despite the conditionality of the qualitative analyses, the following conclusions can be drawn from the table:

- In the position of a fully market-dependent consumer, the Municipality has very limited possibilities to counter negative market trends;
- The Municipality's position as a consumer of renewable energy for its own needs poses the least risks, which should encourage efforts to acquire this type of installation;
- The risks of the Municipality's position as a consumer and especially as a seller should be considered and steps taken to mitigate their impact.

In relation to the latter, conservative estimates of investment and market price growth have been assumed in modelling the scenarios below. On the other hand, the earlier a project comes to fruition, the less the impact of the latter factor will be.

The resulting financial estimate of the Municipality's electricity costs, cost savings, and estimated annual revenues from sales of free electricity are shown in Table 4.

Table 4. Simulation model results for the PV contribution

			PV (60kWp)			PV (90kWp)		
Month	Average monthly price, BGN/MWh	Electricity cost purchased from grid (forecast), BGN/MWh	Electricity purchased from grid after PV	Electricity for sell	Saved electricity (produced by own PV)	Electricity purchased from grid after PV	Electricity for sell	Saved electricity (produced by own PV)
January	302	4,568	3,780	324	788	3,552	652	1,016
February	294	3,196	2,153	401	1,042	1,955	923	1,241
March	292	3,078	2,070	609	1,008	1,872	1,220	1,207
April	238	2,076	1,164	694	911	1,026	1,358	1,050
May	237	1,904	770	891	1,133	678	1,811	1,226
June	270	2,899	1,284	463	1,616	951	1,170	1,948
July	316	3,502	1,470	752	2,032	1,158	1,832	2,344
August	322	3,762	1,495	575	2,268	1,191	1,693	2,571
September	272	2,527	1,197	565	1,330	997	1,312	1,531
October	278	2,916	2,151	243	766	1,950	547	966
November	273	3,591	2,728	155	863	2,499	436	1,092
December	288	3,836	3,506	43	330	3,391	114	444
Total		37,855	23,768	5,715	14,087	21,219	13,067	16,636
Net services costs, BGN/MWh	97.12							
Market services costs, BGN/MWh	25							
Total energy costs/ income BGN/y		53,913	33,510	5,123		29,892	11,751	
Saved energy costs			20,403			24,021		

Source: own analysis

For the preliminary profitability analysis for the two scenarios considered, the following assumptions are made about the investment required, which are derived from a review of commercial proposals for similar capacity plants[3] and batteries[4] :

- 60 kWp installation - 95 000 BGN, delivery and installation;
- 90 kWp installation - 145 000 BGN, delivery and installation;
- battery with a capacity of 24 kAh - 18 000 BGN, delivery and installation;
- battery with a capacity of 40 kAh - 27 000 BGN, delivery and installation.

The investment in a PV installation includes panels, support frames, inverters, wiring, a panel with protections and a power meter, and the batteries are Li-ion with an 80% discharge allowance.

Two scenarios for a rooftop PV project are described below, along with the results of the financial assessments for each.

3.1 Scenario for a photovoltaic installation for own use

This scenario has the highest prevalence and is being applied to more and more industrial sites primarily to satisfy their own PV needs.

This proliferation is due both to the simplified procedures for grid connection and building permits, and to the possibilities of obtaining financial support.

There are already dozens of applications in industrial sites of photovoltaic installations for their own needs, but due to the variable nature of the energy produced by them, they are used partially by combining them with contracts for the purchase of part of the surplus energy produced. In these projects, on-site generation can typically cover less than 20% of consumption.

In the case of small systems or the use of RES with small capacity, their adaptation to the existing system is simplified. However, for existing sites, when integrating RES with a capacity of more than 30 kW, a conformity assessment of the design parts is required - at least for the structural, electrical and HVAC parts, and for larger systems a complete design project is necessary.

In case of multifunctional use of the PV installation and when more stakeholders (other users or investors) are involved, the organisation of a command and control centre is recommended.

[3] For example: https://pvsolars.net/product/50-kw-фотоволтаична-соларна-система-за-би/
[4] For example: www.byd.com/energy

The application of this scenario for the construction of a rooftop photovoltaic plant on the building of the Municipality of Dobrich is considered under the assumption of financing entirely at the expense of the Municipality. Estimates of the payback period of the investment on a linear basis, excluding maintenance and control costs for the two capacity options, are:

- 60 kWp installation

- payback period of 3.7 years on account of cost savings and sales of surplus energy;
- with the addition of a rechargeable battery, the payback period increases to 4.2 years due to the higher investment and low battery involvement in load utilisation;
- with active management of existing boilers as an energy buffer - payback period of 2.9 years.

- 90 kWp installation

- payback period of 4.1 years on account of cost savings and sales of surplus energy;
- with the addition of a rechargeable battery, the payback period remains 4.1 years due to the battery's higher involvement in load utilisation;
- with active management of the available boilers as an energy buffer, the payback period reaches 3.2 years.

A 90 kWp installation is more expensive and its effective use for own purposes is lower, resulting in a longer payback period. In total, the investment can be recovered in 3 to 4 years, but the municipality will continue to bear with the cost of purchasing the additional energy from the grid. Thus, if the investment is on a borrowing basis, the payback period increases and the burden on the municipal budget during the payback period is substantial.

The following scenario of shared investment burden is therefore considered.

3.2. Scenario with participation of Dobrich Municipality and other stakeholders

Possible options for "sharing" the rooftop PV plant on the Dobrich Municipality building include extending the range of users by connecting neighbouring sites, using the opportunity of direct cable supply, or involving small investors in financing the project and then sharing the profits.

The practice of combining consumers into a common group for electricity production and consumption is already developing in the "after the meter" model, where the management of production and consumption in the group is carried out by intelligent systems. This is a variant of the Energy Cooperative, which manages the project independently, and for which it is necessary:

- Developing a financial-technological model of production and distributed consumption;
- Development of a project for the distribution of the generated electricity to each consumer in the cooperative, including the provision of metering facilities;
- Developing rules for the operation and control of energy flows.

After a review of the municipal users close to the Dobrich Municipality building (e.g. an art gallery), it was concluded that their connection does not lead to an increase in the efficiency of use of the PV installation, as they have a similar load profile.

This analysis therefore gives priority to the option of small investor participation in financing. In this model, the guiding principle is the existence of a commercial interest – the investors in new renewable energy installations should be able to distribute the revenues generated by the electricity production from these installations in accordance with the share of investments made. Thus, investors participate in a cooperative with cash contributions when building a PV installation.

In this model, the generated electricity is sold to the grid through a trader who is licensed under the Energy Act.

The essential thing in this model is that the Municipality of Dobrich is the initiating party, committing itself to the overall organization of the investment process, the implementation of the project, raising capital and organizing the payment of principal and dividends.

The estimate of the investment payback period is again made on a linear basis without taking into account maintenance and control costs. For each PV capacity option there is a specific model for the participation of the investors involved, and a 10-year payback period for their investment is considered. In this period, investors receive annually 1/10 of the investment value plus an annual dividend on the residual value of the investment:

- 60 kWp installation. Participation of the attracted investors with BGN 40 000, at a dividend of 6%, and Municipality's self-participation with BGN 55 000.

  - the payback period for the Municipality's share is 2.7 years on account of the cost savings, and could be reduced to 2.2 years with active management of the existing boilers as an energy buffer;
  - during the investment recovery period, investors receive a total return of 27% on

their investment.

- Installation with a capacity of 90 kWp. Participation of the attracted investors with 90 000 BGN, at a dividend of 7%, and Municipality's self-participation with 55 000 BGN.

- the payback period for the Municipality's share is 2.3 years on account of the cost savings and can be reduced to 1.9 years with active management of the existing boilers as an energy buffer;
- during the investment recovery period, investors receive a total return of 32% on their investment.

Table 5 shows the annual investment recovery and dividend payments to small investors.

Table 5. Investment recovery by year

Year	Investment 40 000 BGN		Investment 90 000 BGN	
	Principal, BGN	Dividend, BGN	Principal, BGN	Dividend, BGN
1	4000	1123	9000	2751
2	4000	1123	9000	2751
3	4000	1123	9000	2751
4	4000	1123	9000	2751
5	4000	1123	9000	2751
6	4000	1123	9000	2751
7	4000	1123	9000	2751
8	4000	1123	9000	2751
9	4000	1123	9000	2751
10	4000	1123	9000	2751

Source: own analysis

It can be inferred that the participation of attracted investors is more effective in the case of higher PV installation capacity, as higher sales provide them with a higher dividend.

The model is advantageous for the Municipality, as after two years the reduced electricity bills will have an effect for at least 2 more decades. Therefore, the Municipality can make an additional commitment to the investors to guarantee a minimum amount on an annual basis after the second year.

Finally, it should be noted again that the analysis is based on a conservative estimate of annual wholesale prices of 140 € per MWh. If current market prices are applied, dividends to investors exceed 12% and the cost recovery period for the Municipality is less than 1 year.

4. STRUCTURING AN ENERGY COOPERATIVE TO ATTRACT SMALL INVESTORS

Electricity supply development concepts have evolved in recent years and, in addition to a centralized generation-transmission-distribution-consumption system, various close-to-consumption generation options, or decentralized system concepts, are increasingly applied.

The availability of grid infrastructure and the still low share of renewables limit and hinder the application of decentralised system concepts, but they are becoming increasingly relevant in view of unpredictable free market prices, but also in view of low-emission economy policies that are accompanied by incentives.

The widespread development of decentralised system concepts is associated with the implementation of Energy Cooperative or Renewable Energy Community models, with European legislation already in place and national legislation under discussion.

A renewable energy community, according to an EU directive[5] , is a legal entity that owns and develops renewable energy projects, is based on open and voluntary participation, and is independently and effectively controlled by its members who are located in the vicinity of renewable energy projects owned and developed by that community.

The Renewable Energy Community does at least one of the following - generates, consumes, stores or sells electricity, heat and cooling energy from renewable sources and/or shares within that community renewable energy produced by community-owned projects, including through virtual net metering.

A "prosumer" can be defined as an end-user of electricity operating on its own premises or on other premises located within the same district who generates renewable electricity for its own consumption and who may store or sell the renewable electricity it generates. There may be co-operating prosumers – these should be at least two co-operating producer-consumers located in the same building or in a multi-family residential building.

It is the sale of electricity that involves serious regulatory issues that need to be further developed in national legislation to take into account the specificities of renewables and to account more fairly for the energy produced and consumed by energy communities and prosumers.

Three new concepts are now being worked with - the renewable energy community, the user of own renewable electricity (prosumer) and net (virtual) metering.

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[5] EU Renewable Energy Directive 2018/2001 https://bit.ly/2FHtr6o

The establishment of commercial communities can also be implemented under the current legislation, as the specifics of RES generation and consumption should be further developed for specific cases with changes to the Energy from Renewable Sources Act and the Energy Act, including by refining the interaction with grid operators and the metering of commercial electricity generation.

A new aspect is net (virtual) metering, which is evolving in parallel with the development of smart grids and digitalisation in consumers.

Net metering is the ongoing reconciliation of electricity produced and consumed by a producer-consumer at the same renewable energy generation site, owned by the producer who is at the same time a consumer.

Virtual net metering is net metering where at least one of the sites where the energy is consumed is different from the site where the energy is produced.

In this way, consumers who do not have the necessary roof space for solar power generation, for example, may still be part of a renewable energy project that is implemented through an installation at another connection point. In this case, the energy produced can be offset against their consumption as if it had been produced at their site, but with the appropriate grid access charges.

Through virtual net metering, energy flows can be managed and surplus electricity can be used more efficiently, including at times and places other than generation.

In the Bulgarian legal framework the forms of association are fully permissible and used for the needs of Energy Communities, for example there are such under the Condominium Act, but the most common are tripartite contracts with the participation of a consumer, a producer (or investor) and a trader.

It should be recognised that there is still a lack of ready-to-use contractual models for cooperation. Due to the still nascent model of energy cooperation, the analyses within the research projects point out that at this stage, the leading role of a Cooperative Initiator around which the individual actors join, is crucial.

Often the Initiator is driven by broader goals than commercial gain and includes in its strategy support for new renewable energy projects, support for the application of innovative technologies, addressing social issues, etc. This is the reason why in most cases of cited energy cooperatives local municipalities play a leading role. In these cases, the specific role of municipalities covers:

- Funding or guarantees for new projects;
- Creating an enabling environment, including requiring investors to set targets for citizen participation in projects;
- Provision of information;
- Procurement of community-generated energy;

- Cooperative membership;
- Providing administrative assistance and other non-financial resources to citizens.

The main source of funding for Energy Cooperatives is the investments made by their founders.

5. CONCLUSIONS AND RECOMMENDATIONS

1) The implementation of stand-alone measures for the deployment of RES installations for own needs has a limited effect and is linked to the sale of electricity through the grid. The efficiency of the investment depends on the possibilities to manage the loading profile on site. In this case a contract with a third party electricity trader is needed.
2) Scenarios operating in the form of an "Energy Cooperative" allow for the distribution of financial risk to multiple actors, providing attractive returns for investors compared to current levels of bank deposit rates.
3) If steps are taken to implement such a project in conditions of still too high wholesale electricity prices, the profitability of the project will be significantly higher and the Municipality can offer better conditions to investors.
4) It is recommended that the Municipality offer a guaranteed level of dividend on the investment after the period of recovery of its deductible.
5) It is recommended that investors be given assurances that at higher market prices, their dividends will also be increased.
6) It is recommended that when planning an investment in renewable energy and attracting small investors, the municipality should set up its own unit to control and manage energy flows in the building and to communicate with traders and investors.