Pavilosta Marina and Gas station Energy Audit –

Energy Efficiency Action Proposals

Spring 2022, Teemu Heikkinen CBSmallPorts, SAMK

CB SMALL PORTS
Interreg Central Baltic
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European Regional Development Fund

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2 INTRODUCTION AND SCOPE

This paper presents detailed information, used assumptions, sources and calculations of the proposed energy efficiency actions for Pavilosta Marina and camping (Ostmalas iela 1A k-4) and the separate gas station (Ostmalas iela 8) based on the completed energy audit work and site visit during Feb-May 2022. The completed energy audit concentrated on the electricity consumption issues.

3 PAVILOSTA MARINA AND GAS STATION ENERGY EFFICIENCY PROPOSALS

3.1 SOLAR POWER PLANT

Generally, the solar power production profile and the marina or camping site electricity consumption matches nicely since they both are concentrated in summer months. Based on the earlier study made for a small port in Finland, even 80% of the solar power production can be self-consumed which is always the most economical way. In the case of Pavilosta Marina, the port/camping is open from May to September (five months) which is also the time during which about 70% of the annual electricity use is consumed.

In Latvia the NET settlement system (NETO norēķinu sistēma), which enhance the feasibility of solar power, is in use. Within this system, the monthly net energy is calculated between '*the energy transferred from the networ*k' (=normally bought energy) and *'the energy transferred to the network'* (=excess solar production). The monthly balance is stored for the next month. See the linked document for details. More information on the subject can be found e.g. from the Enefit web pages.

Example of NET settlement system

If, during the month, a user has an excess solar production of 125kWh and they transfer (buy) 100kWh from the network, then 25kWh is stored as monthly balance.

Note that this calculation does not show how much of the solar production user self-consumed. The solar power system production can be seen from the inverter monitoring data of your system.

Feasibility calculations for solar power plant example

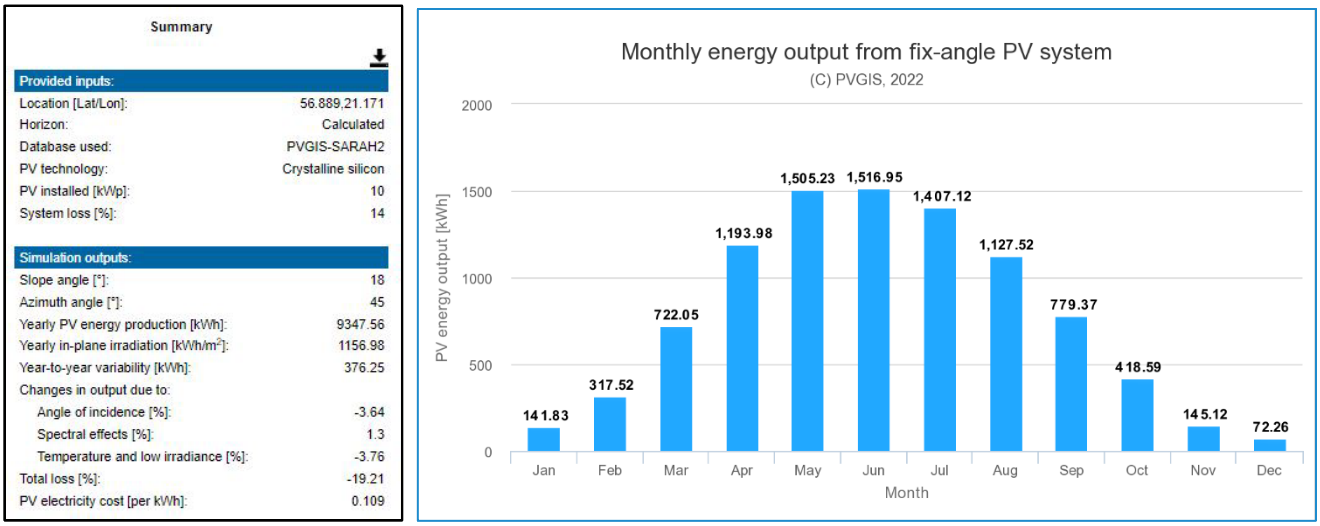
In this example calculation, a 10kWp grid connected solar power plant would be installed on the blue steel framed tarpaulin warehouse within the Pavilosta camping area (azimuth: Southwest, tilt: 20°). The assumptions are that this would be possible from warehouse structural perspective without extra costs and that there would be no shading on the panels caused by trees or other obstacles. Note that even a partial shading of the panel field can have big impacts on the whole plant output. See more about impact of shading on solar panels e.g. from here. Another option for the installation could be a ground installation in a sunny place with proper mounting racks. In both cases, it should be ensured that there is a big enough electricity connection available (fuse/cable capacity) where to connect the system.

Energy prices and fees

- Fixed monthly fee for all three electricity meters together is 140 €. It was assumed that these would not be affected and thus they are not considered in following calculations.
- Energy transfer price is 0.04422 €/kWh. This solar energy producer must pay for all energy transfer from and to network. So excess energy "network storage" causes some transfer costs in both directions.
- Energy price 0.16814 €/kWh. This is paid for the energy needed in addition to own production and "network storage".
- MPC (OIK) price 0.00932 €/kWh
- VAT 21%
- All above together: (0.004422 + 0.16814 + 0.00932) x 1.21 = 0.26823 €/kWh =~ 0.268 €/kWh
- In all the price of saved kWh is 0.268 €/kWh (note here the VAT 21% is included)

Estimated solar power production and savings

In below solar power plant production estimation (Figure 1), the [European commission JRC's open PVGIS]() online software was used. SW can be used easily to estimate the performance of different kinds of solar power plant/panels installation options.



Summary	
Provided inputs:	
Location [Lat/Lon]:	56.889,21.171
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed [kWp]:	10
System loss [%]:	14
Simulation outputs:	
Slope angle [°]:	18
Azimuth angle [°]:	45
Yearly PV energy production [kWh]:	9347.56
Yearly in-plane irradiation [kWh/m²]:	1156.98
Year-to-year variability [kWh]:	376.25
Changes in output due to:	
Angle of incidence [%]:	-3.64
Spectral effects [%]:	1.3
Temperature and low irradiance [%]:	-3.76
Total loss [%]:	-19.21
PV electricity cost [per kWh]:	0.109

Figure 1. Production estimations for shade free 10kWp PV system with slope of 18° and azimuth angle of 45° (southwest). 'Yearly PV energy production' would be 9347.56 kWh.

Figure 2 graph shows the average monthly consumption of the marina/camping site and estimated monthly solar power production of the example 10kWp system.

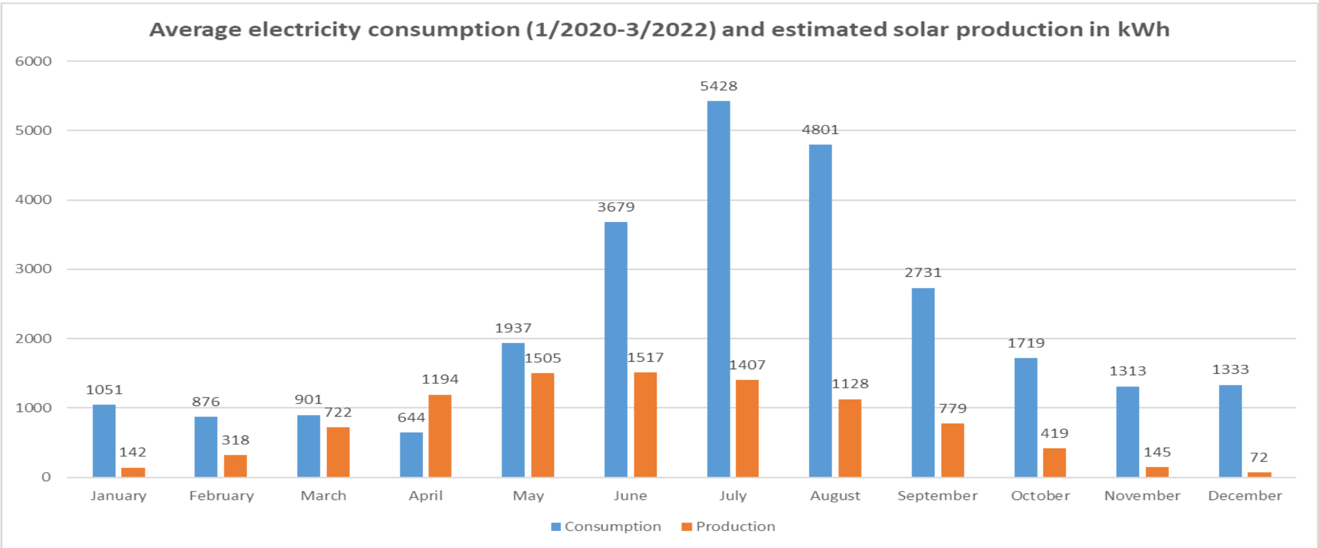


Figure 2. Measured average monthly electricity consumptions and estimated solar plant production.

In a monthly level, the match looks very good and only April would have some excess solar power production. However, it needs to be noted that during a day there usually is electricity transfer in both directions: to and from the network. In practice, during the night all used energy comes from the network and, during the day, some part is covered by the own solar power production, and during more sunny and low consumption hours, there can be also power transfer to network.

With a detailed analysis, it looks like in annual basis about 80% of the produced energy would be self-consumed and not more than 20% would be transferred to network. For this 20% of the produced energy, transfer fees should be paid. Based on study on solar power production rules of Latvia, the daytime excess production e.g. on March-April could be used (computationally) in gas station (same owner/in same electricity bill). The 20% is also used through monthly NET settlement system so in computational sense all 100% would be self-consumed but for this 20% of energy one should pay the transfer fee when transferring it to and from the network. Equation for annual saving would be then:

'Production [kWh]' **x** *'Price of saved Energy [€/kWh]'* **-** *(20%* **x** *'Production [kWh]'* **x** *'Transfer price with VAT')* ***x2***

--> 9300 kWh **x** *0.268 €/kWh* **- (***0.2* **x** *9300 kWh* **x** *0.05351 €/kWh***)** ***x****2 =* ***2293 €***

In all this would make annual energy savings worth of c. **2290 €**.

Payback time (simple) and sensitivity analysis

If the investment cost of the solar power plant would be 12 000€ and there would be no need for loan money (no interest costs) or other maintenance costs etc. the payback time would be then 12 000 / 2290 = **5.2 years.**

Even with slightly higher investment costs and lower energy price or some interest costs, this would make a rather feasible investment. Obstacles (trees, buildings etc.) that cause shading can affect to production figures significantly and increase the payback time. Generally, a solar plant investment is feasible if the payback time is less than 10 years. It is anyhow producing clear financial value from the beginning of use unlike many other investments.

Note. NET settlement system lowers also the costs of the mandatory procurement components (MPC or OIK) part, but it was more difficult to estimate and was not considered in this calculation. Also, it remained unclear if using of NET settlement system costs something.

3.2 Changing halogen lamps to LED lamps

Example of LED lamps that could be used for replacing the existing 35W halogen lamps. https://www.any-lamp.com/multipack-10x-philips-master-value-ledspot-gu10-par16-3-7w-285lm-36d-940-cool-white-best-colour-rendering-dimmable-replaces-35w-8719157027243

Figure 3. Picture of a roof of one of the camping cabins with halogen lamps.

The technical data and price information of the above linked 3.7W LEDspot GU10 is used in lamp change calculations. Input power 3.7W and price 54.79€ for 10 lamps.

Consumption profile assumptions for the lights in calculations are:

- There are 100 lamps to be replaced (estimate, exact number was not calculated)
- Lights are used only during five months (May to Sep)
- They are used i.e. switched on in average 2 hours/day

- Calculation concerns the four older camping cabins build in 2008

Energy consumption in year before

- 100 lamp **x** 35W/lamp **x** 5 month **x** 30 days/month **x** 2 h/day = **1050 kWh/year**

Energy consumption in year after

- 100 **x** 3.7W **x** 5 **x** 30 days **x** 2 h/day = **111 kWh/year**

Thus, energy saving would be 939kWh and if the price of electricity is 0.268€/kWh the saving/year would be 251.7€

Payback time of the investment would then be:

- 10 x 54.79€ / 251.7€/year = 2.2 years

All in all, this makes the lamp change a good energy efficiency measure. Of course, these changes can be made in phases like one cabin at a time and old lamps can be reused in other cabins. Note that LED lights are generally more long lasting than halogen lamps which also saves costs in terms of maintenance work needs.

3.3 Optimizing the hot water use

At the time of the field visit, the water system was not in operation due off-season time, therefore the water flows of different faucets could not be measured. This could be done also afterwards by the client for example using simple flow rate meter e.g. like this. Good reference flow rate values are: shover 12L/min, handwashing tap 6L/min and kitchen tap 12L/min. Flow rates bigger than needed waste water when faucet is used fully open and naturally produces more wastewater for later handling.

Figures 4, 5 and 6. At the time of the field visit (27.4.2022), the 800L boiler temperature was set to 75°C and water consumption so far through this meter had been 478m^3

Hot water system and settings

Another issue was the temperature settings of the electric hot water boilers. At least in the service building 800L boiler, the heating temperature was set to maximum of 75℃ (Figure 5). 55°C is enough for hot water to be bacteria wise safe to use. Temperatures higher than this just increase the heat losses of the boilers and can additionally increase the unnecessary heat load for the space they are located. This may again cause additional discomfort or need of cooling energy. It also looked like there was no mixing valve installed between the boiler and faucets. The purpose of this feed mixing valve is to mix hot and cold water so that that it comes out of the faucet at a comfortable and safe temperature. I.e., the hot water from the faucet cannot be burning hot. Additionally, if hot water is fed straight to the faucets, it causes additional heat losses through the pipeline. In this case the hot water pipeline was also not properly insulated for heat losses.

All in all, there was about 2000 litres (7 boilers of different sizes) of electricity boiler capacity in use. Most of the boilers were installed so that also clients or guests can easily adjust them by themselves which is usually not a good thing. This way they can be easily left in a higher temperature setting. As a guiding figure, heating of 2000 litres of water from 55 to 75 degrees would consume about 47 kWh of energy.

Up to date water consumption figures

To our knowledge, the service house (figures 4-7) was taken into use in 2019. Therefore, by spring 2022 it had been used maximum of three seasons. If the water meter (figure 6) was new at the time of commissioning of the service house, the average water consumption of the service house solely has been about 160m^3. This has rather big contradiction to the average water consumption figures of 100m^3 (for whole camping area) we were told. It might also be that there has been big increase in water usage during last couple of years. Anyhow, it is good to check that the actual water consumption is known, follow the consumption regularly and find reasons and make possible actions when changes are detected.

Figure 7. Service building in Pavilosta Marina. Picture by Pavilosta Marina.

Energy use and costs of the wastewater treatment

Moreover, the costs of wastewater purification consist of the running costs of own pre purification system, system maintenance costs and the costs of tank emptying services. Naturally savings in water usage would decrease also these costs.

In conclusion, no detailed saving calculations for water use optimization were made since too little information was available for making them.

3.4 CHECKING REGULARLY ELECTRICITY TRADER CHANGE OPTIONS

It is economically wise to follow the electricity market prices and compare the current offers of different energy traders, especially at times when there are more rapid price changes, to which each trader may react differently.

Due to the foreign language (Latvian), we were not able to find a proper way to compare the current offers, but we heard earlier in the Roja workshop that there should be at least five trader options in Latvia and the changing of your electricity supplier should be easy to do.

3.5 GAS STATION ELECTRIC HEATERS

When using separate electric heaters, like in case of Gas station personnel room, the thermostat within the heater should be used properly by setting it to the desired temperature. Also, the personnel should be advised on its usage. This way the situations where the heater is on and heating even if there is no need for it, could be avoided. Same advice applies also to customers using the heaters in cabins.

Advice and guidance do not cost anything, but there can be some savings in electricity costs here and there. E.g. if during a year 1kW heater is needlessly ON for a month 24/7 the cost for it would be

- Energy saved: 30 day x 24h/day x 1kW = 720 kWh
- Saved costs: 720 kWh x 0.268€/kWh = 192.96€ I.e. **about 190€**

3.6 GAS STATION LIGHTING TO LEDS

Based on the lighting plans (2005) received from the client the lighting of the Gas stations was

Gas station lighting (electric plans 2005)			
	Pieces	W	Total (W)
Outdoors	6	28	168
Shop	12	18	216
Personel	2	60	120
Toilet	1	60	60
			564

During the field visit it was not checked whether the lighting has been updated since. If not, there would be good and easy way to cut down the lighting electricity costs by changing all the current lighting to LEDs if not yet done.