Interreg Baltic Sea Region

Co-funded by the European Union

ENERGY TRANSITION

PV 4 All

30 March 2023

Atlas on options for small-scale photovoltaics

Output 1.1.

Introduction

The central aim of the project, which was initiated and funded under the Interreg Programme 2021-2027, Priority 3 Climate-Neutral Societies, Objective 3.2 Energy Transition, is to develop models for the increased use of photovoltaics and - as an option - "green electricity" for heat pumps and local heat supply systems. Particular attention will be paid to involving population groups, organizations and companies that have not yet discovered this increasingly cheaper and easier-to-use form of energy, partly because it has been more expensive for a long time.

Small-scale solar PV installations, defined by EIA as having capacity of less than 1 megawatt (MW**)**, are usually located at the customer's site of electricity consumption. These small-scale PV installations are also called behind-the-meter, customer-sited, or distributed generation capacity. (U.S. Energy Information Administration - EIA - Independent Statistics and Analysis). The definition of small-scale photovoltaics is not defined under EU legislation and by the most EU member-states. After the discussion among project partners, 1 MW was considered as too large for the Baltic Sea Region countries, and decision was made to reduce this capacity to 100 kW. Thus, for the purpose of this project we have accepted the following definition:

*Small-scale solar PV installations have capacity of less than 100 kilowatt (kW**)** and are usually located at the customer's site of electricity consumption.*

This Output 1.1. *Atlas on options for small-scale photovoltaics* consists of two parts: Part 1 - a well-founded status report, containing the National situation of generating PV in the participating BSR countries (Chapter 1), Identification & analysis of risks, barriers and success factors for the implementation of small-scale photovoltaics (Chapter 2), Localized analysis – mirror the conditions analysed against the local situation in the BSR countries (Chapter 3), and Specific analysis of potential solutions (Chapter 4). This part is elaborated with consultations and discussions with national and/or regional stakeholders involved in PV development activities.

Part 2 Atlas - contains several typical and/or variable PV project examples from participating project partner countries. The projects described show the variety of small-scale PV plants used and applied for residential, small businesses, farmers, and public institutions. The short Text box and marking of enlisted projects are provided in the map, provided on the project website:

Photovoltaics for All - Interreg Baltic Sea Region (interreg-baltic.eu)

Contents

Part 1: Status Report

1. The national situation of generating PV in the participating BSR countries.

1.1. Germany

The expansion of renewable energies with the goal of climate-neutral energy production is organized and planned in Germany in the Renewable Energies Act (EEG). This also includes the planning of PV expansion in Germany for the coming years. An expansion to 215 GWp is planned by 2030 and 400 GWp by 2040. In 2022, the installed capacity was 67 GWp, resulting in electricity generation of 61 TWh and thus covering 11% of Germany's gross electricity consumption. On sunny summer days, PV electricity covers two thirds of the electricity demand. The development over the past years is shown in the Fig. 1 below.

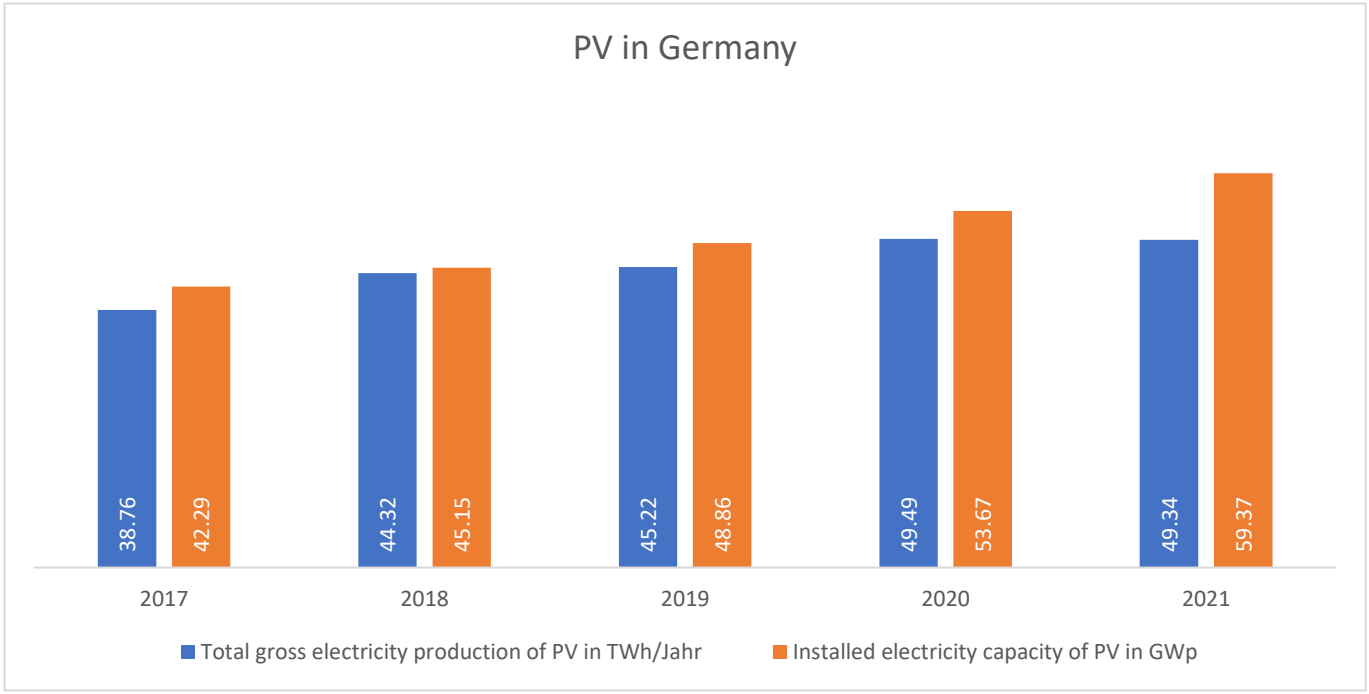


Fig. 1 - PV production & installed capacity in Germany until 2021 (Wirth, 2022, Aktuelle Fakten zur Photovoltaik in Deutschland, Harry Wirth, Fraunhofer ISE, Download von www.PV-fakten.de, Fassung vom 18.12.2022)

To achieve the targets until 2030 and 2040, an annual increase of about 20 GWp is necessary in the coming years. Even if the conditions for PV energy are better in the south of Germany, PV electricity can also be produced economically in the northern part of the country. In the five federal states that make up northern Germany, the installed PV capacity is 10.3 GWp with a population of about 15 million. Large power plants produce PV electricity at costs from 3.1 to 5.7 ct/kWh. Smaller rooftop plants produce at 11-13 ct/kWh. As an incentive for private individuals and companies to install a PV system, a purchase

guarantee has been enshrined in law in Germany, so that electricity produced but not consumed by the company itself can be fed into the public grid and is guaranteed to be purchased.

In total, 43.9 % of the electricity generated (gross) in 2022 was generated from renewable energies (Fig. 2).

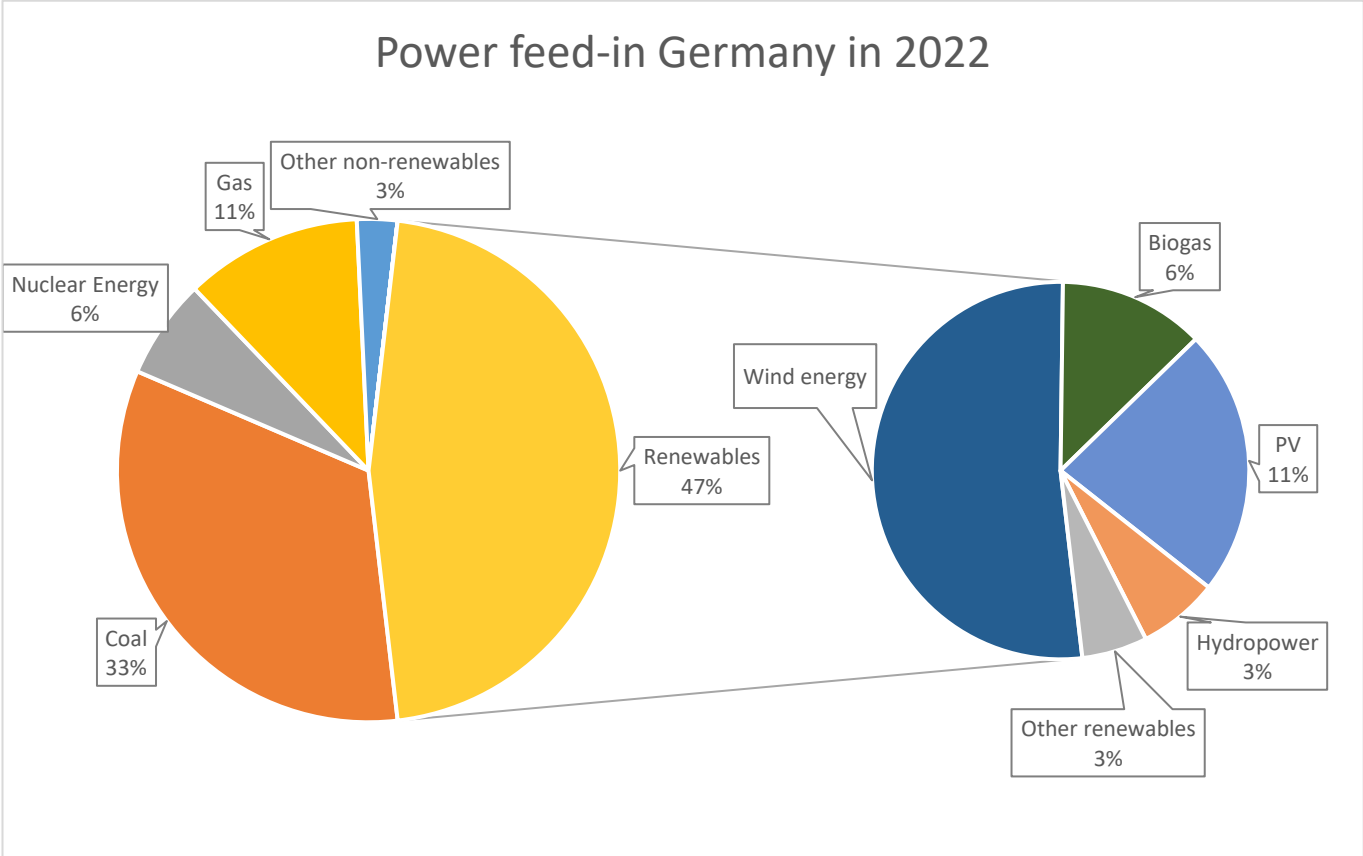


Fig. 1 – Power feed-in Germany in 2022 (Statistisches Bundesamt, 2023 - Stromerzeugung 2022: Ein Drittel aus Kohle, ein Viertel aus Windkraft - Statistisches Bundesamt (destatis.de))

At the moment, more than 2.2 Mio PV powerplants are installed in Germany, mainly in rural areas and around 64 % of those are small scale PVs with outputs below 10 kW.

Focusing on German production capacities, in 2007, a German company recorded the world's largest production volume of PV systems and Germany was one of the leading countries in constructing PV power plants with. However, in the past decade, when the growth in expansion slowed down again, several production plants and companies had to close-down. Nevertheless, there are still various companies active in different parts of the value-adding cycle.

1.2. Finland

In Finland, the utilization of solar energy has been studied and promoted since the late 1970s. However, progress has been relatively slow to adopt solar power compared to other RSR countries until the very last few years. This has been influenced by more challenging conditions due to its northern location and limited sunlight during winter months, prejudices and the low level of subsidies compared to most other EU countries. However, thousands of off-grid solar systems for summer cottages and various technical sites have been in use in all over the country for a long time and 2021 amount of off-grid PV systems was over 50 000.

However, in recent years, there has been a significant increase in interest and investment in solar energy, driven in partly by government incentives and a growing awareness of the need to transition to renewable energy sources.

PV electricity production and capacity began to increase strongly in 2015, installed PV-system doubled until 2018 it started to decrease. The decrease may partially have been caused the reduction of state subsidies, which were 30% in 2015 and only 15% in 2020. PV production 298 GWh and capacity 404 MW in 2021 (Fig. 3, Fig. 4 and Fig. 5).

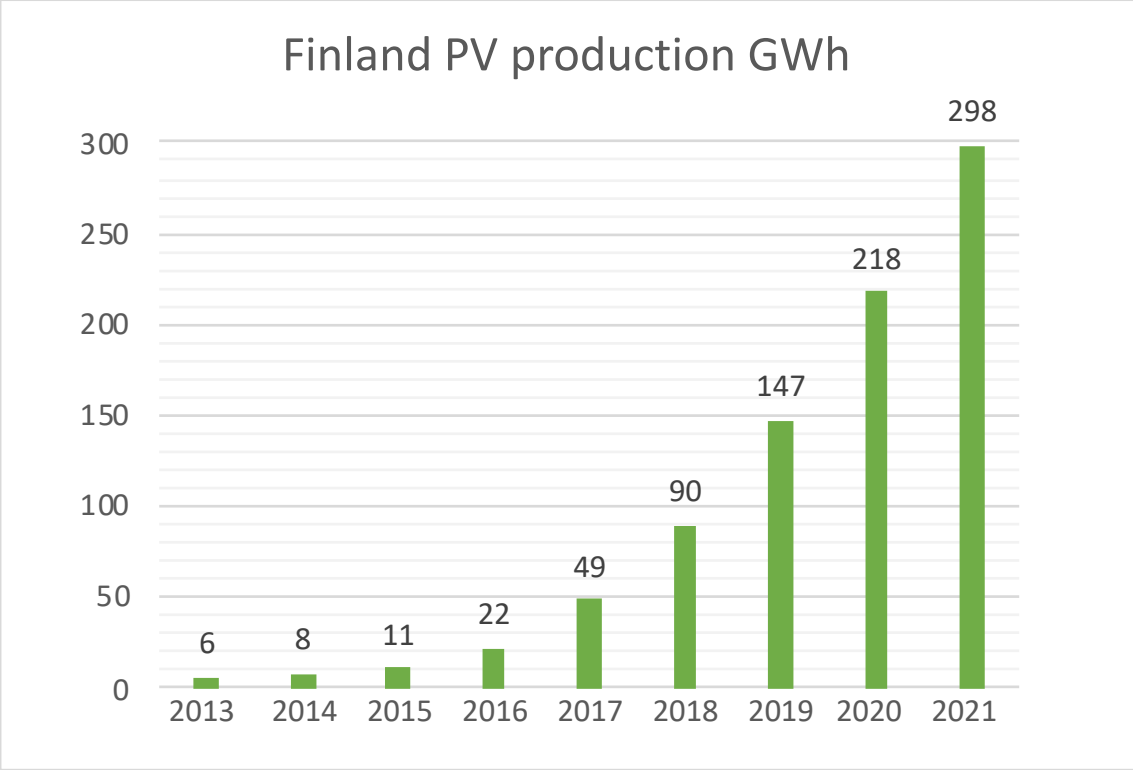


Fig. 3 - Total gross electricity production of PV in Finland

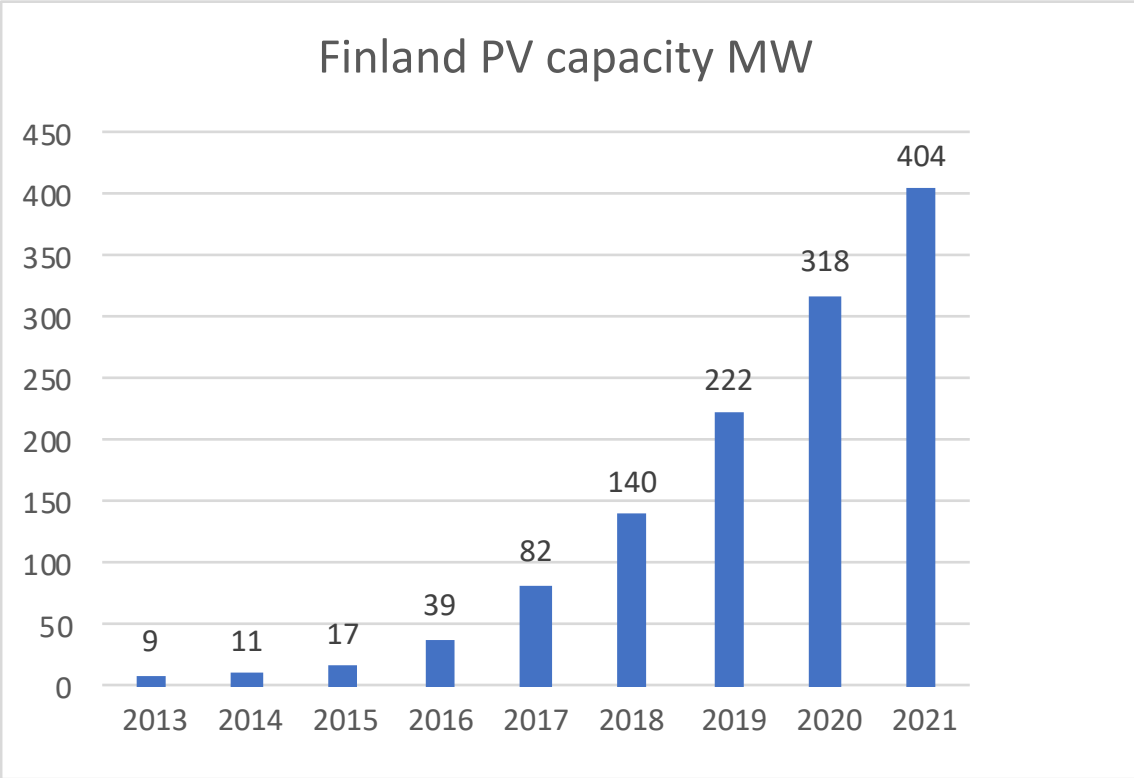


Fig. 4 - Installed electric capacity of PV in Finland

Finland's PV production was only 0.4 % of the total production in 2021 and 0.5% in 2022 but is growing rapidly. In this sector there is a need to raise awareness. The growth of small and medium-sized systems is currently the greatest. At the end of 2021, there were over 40,000 PV systems in Finland and mostly small-scale systems for single family houses. Large scale power plant end of 2022 has been installed only about 34 MW and largest power plant is 10 MW, but dozens of tens or hundreds megawatt scale solar power plants are planned in Finland and will be installed in next few years.

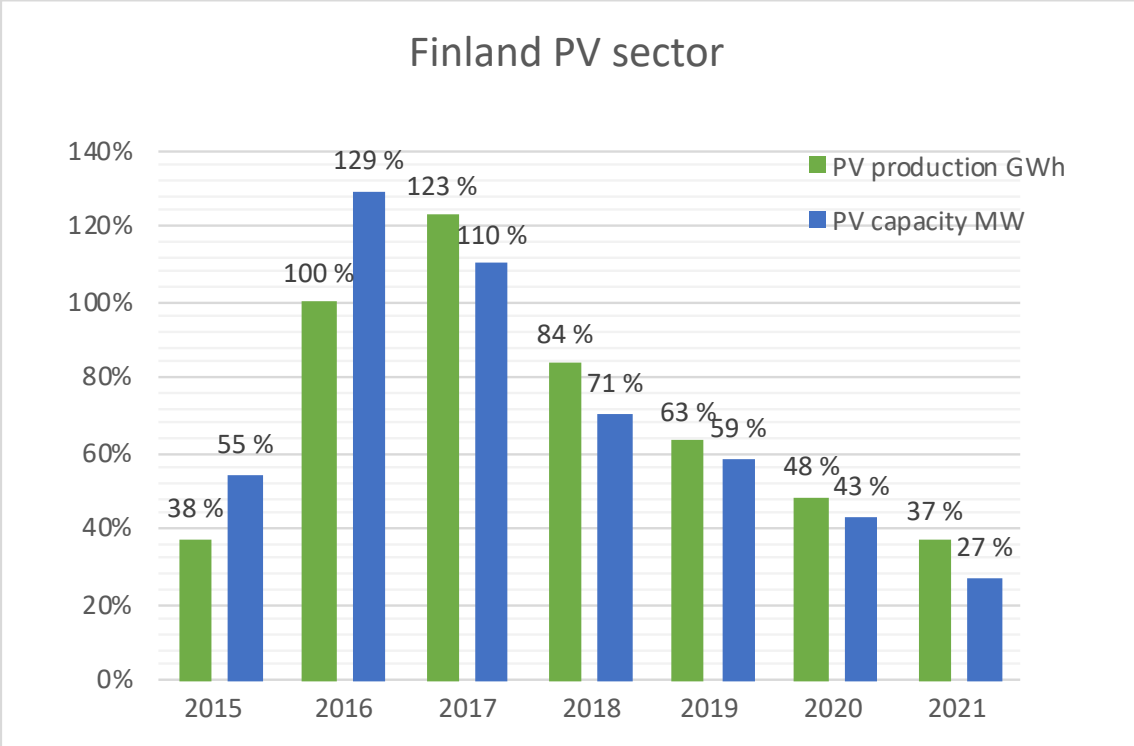


Fig. 5 - Growth of Finland PV-sector

Manufactures in Finland:

- SaloTech: Manufactures PV-modules and partly components are manufactured in Asia.
- Valoe: Manufactures efficient IBC cells (Interdigitated Back Contact) and Valoe develops solar electricity solutions suitable for various environments, such as means of transport or buildings, they design and supply solar module manufacturing lines and factories. They have production facilities in Juva in Finland and Vilnius in Lithuania.

Electricity providers:

- Fortum is a Finnish energy company that provides electricity and heat to customers in the Nordic and Baltic countries. It is one of the largest electricity producers in Finland and its share is approximately 20 % and offering renewable and non-renewable energy options.
- Helen is a Helsinki-based energy company that provides electricity, heat, and cooling to customers in the Helsinki region. It is one of the largest district heating providers in Finland and has a strong focus on renewable energy sources.

- Vattenfall is a Swedish energy company that operates in several countries, including Finland. It primarily operates as an electricity retailer and does not have significant production in Finland.
- In addition, there are several companies in Finland that sell electricity to consumers, such as Oomi, Väre, Lumme, which they purchase from companies producing electricity at hydro and wind power and CHP power plants and from the Nordic electricity exchange.

1.3. Lithuania

Annual electricity production from solar installations is well forecasted: in Lithuanian conditions, an installed solar plant of 1 kW produces between 926 kWh and 1042 kWh of electricity on average. However, this amount of energy varies slightly from region to region in Lithuania, as the amount of light energy per unit area of the earth's surface varies between regions.

The first phase of PV development started with the introduction of feed-in tariffs for solar plants up to 30 kW in 2009 with tariff guarantees for a period of 10 years. However, the feed-in tariff system was scrapped in 2013 and no longer applies to new PV plants. In 2018, net metering was implemented, and electricity consumers were encouraged to become generating consumers - prosumers. In this case, the electricity is produced only to cover its own needs, the surplus is fed into the grid and the grid operator becomes a virtual storage battery. A storage fee is paid to the grid operator.

Total gross electricity production from PV in 2021 was 190.8 GWh and final national electricity consumption was 11149,2 GWh (Fig. 6). Thus, PV makes 1.71%.

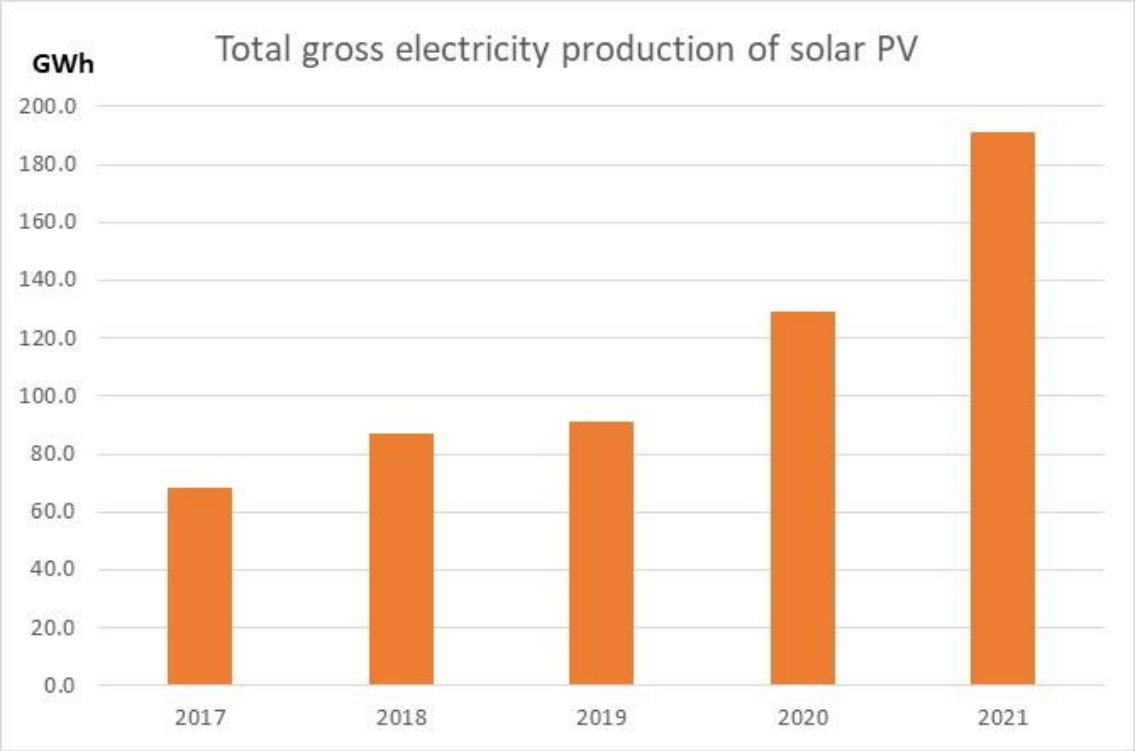


Fig. 6. Total gross electricity production of PV (Renewable energy resources - Oficialiosios statistikos portalas)

As in electricity generation from renewables PV makes 7.3%, wind makes 51.9%, hydro – 14.6%, solid biofuels - 12.3%, industrial & municipal waste – 7.9% and biogas – 6.0%.

Total installed PV capacity in year 2021 has exceeded 250 MW and is still constantly growing (Fig. 7).

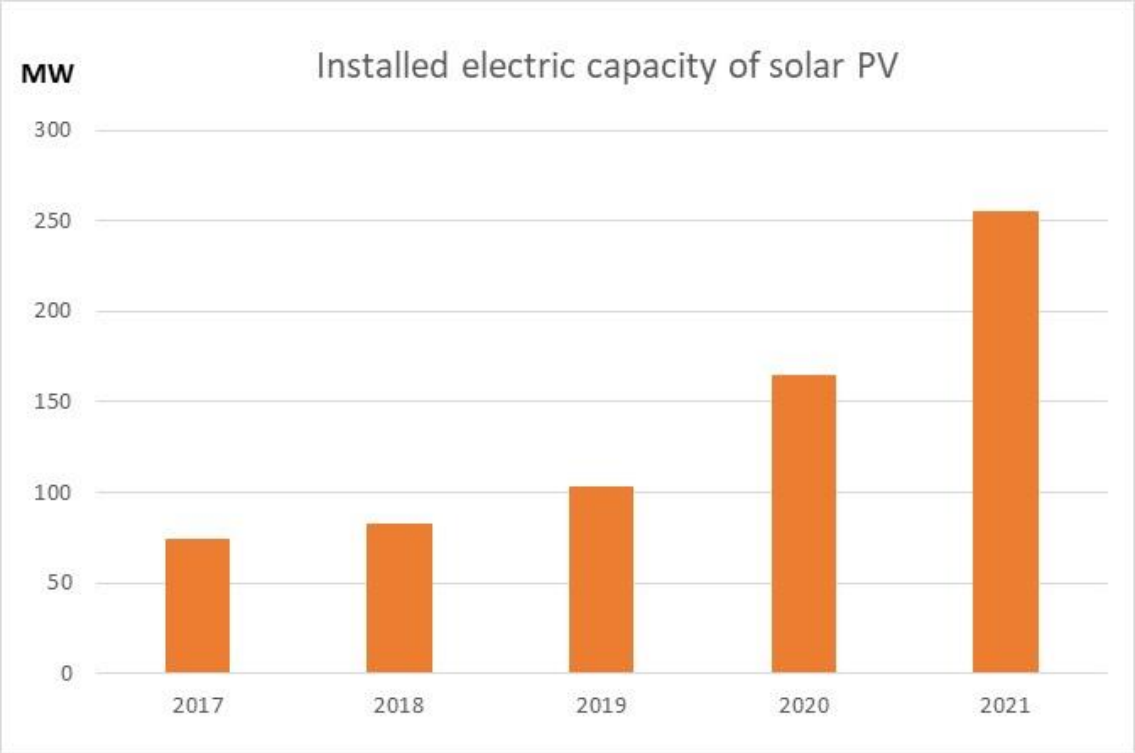


Fig. 7. Installed electric capacity of PV (Renewable energy resources - Oficialiosios statistikos portalas)

There are a few PV panels and systems producers in Lithuania:

- Solitek RnD, UAB – manufacturer of solar panels, belongs to BOD Group; produces Glass Glass and Glass Foil Solar Panels.
- Via Solis, UAB – manufacturer of solar panels and laminated glass; ViaSolis is an international manufacturer of PV glass and a provider of solar energy solutions. The company was established in 2009. Via Solis operates one of the most advanced production facilities in the EU. We merge and utilize the best achievements from PV, glass processing & lamination as well as insulated glass manufacturing industries.
- Intelligent Solar - PV solar panels can be designed and adapted according to specific technical requirements and technical solutions. Intelligent solar factory can manufacture using two main technologies – glass/glass and glass back sheet solar panels.

Main generators with a total installed capacity of 255 MW (the year 2021):

- Households and other (prosumers)- 147 MW
- PV in Industry – appr. 60 MW

- Solar PV parks – 57.3 MW (situation in 2022)

Providers (utilities, private households, industry, PV parks)

- Ignitis: the largest supplier of electricity and gas in Lithuania, where it provides more than 1.6 million people with all key energy services. We are also your partners, ensuring that energy is clear and simple for all our customers, not something that requires extra time and effort.
- ESO: electricity and natural gas distribution, guaranteed supply of electricity and natural gas, property connecting to electricity and gas networks, maintenance and development of electricity and gas distribution networks, security, and reliability of energy distribution assurance. ESO serves 1.6 million customers throughout Lithuania. The company-serviced area reaches 65,300 km².

1.4. Poland

The share of PV and renewables in electricity generation in Lower Silesian Voivodship (Poland) is presented in Table 1

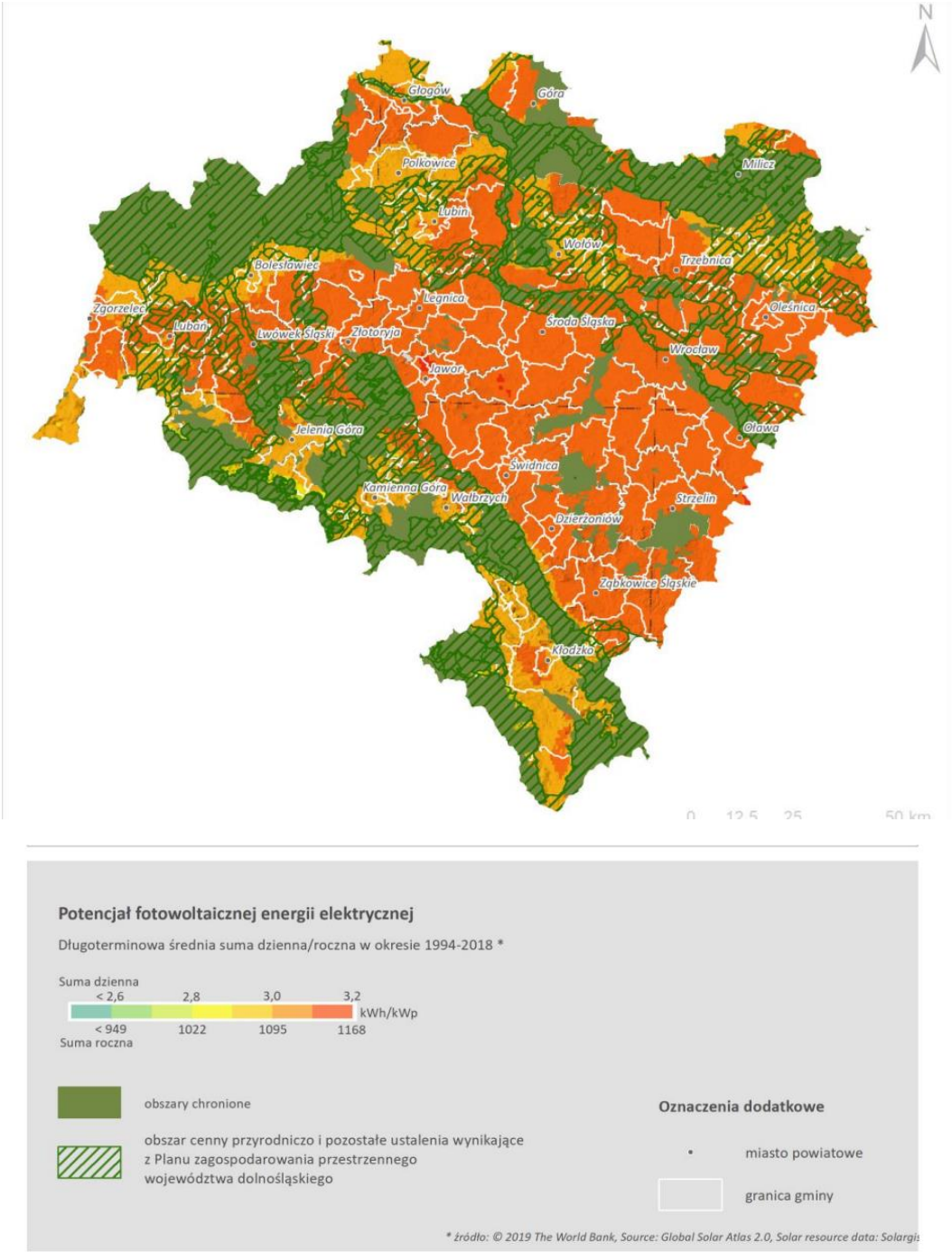
Table 1. The share of PV and renewables in electricity generation in Lower Silesian Voivodship (Poland)

Lower Silesian Voivodeship	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Production of electricity total(GWh)	15774,2	15441,8	14777,5	14816,1	13937,3	13368,0	13350,5	13567,7	12686,1	11047,5	10750,2	10944,6	10219,5	9 917,7	8 513,2	8 706,2
from renewable energy sources (GWh)	207,2	207,5	257,4	272,0	446,7	658,9	703,5	897,0	763,1	1 055,9	1 013,0	708,2	803,5	644,3	769,7	885,1
share of renewable energy sources in total production of electricity (%)	1,3	1,3	1,7	1,8	3,2	4,9	5,3	6,6	6,0	9,6	9,4	6,5	7,9	6,5	9,0	10,2

Energy Strategy of Lower Silesia. The strategy identifies the necessary goals to be achieved. Goal 4 Development of renewable energy sources and technologies of Energy Storage. Due to its location and terrain, the region has varied conditions for the development of wind and solar energy (easy adaptation for a single household) and based on biogas (technology using landfill gas, from sewage sludge and also animal manure). The Lower Silesian province also has good natural conditions for the operation of small and medium-sized hydroelectric power plants, which, in addition to energy production, contribute to: increasing water retention, flood control measures, maintenance of riverbeds, reconstruction and maintenance of hydrotechnical infrastructure, creation of recreation sites, as well as care for historic hydropower facilities.

Activities planned for implementation:

- support for the replacement of heat sources using hydrocarbons, for renewable energy sources energy or connection to system solutions and powered by non-carbon sources.
- stimulating the development of distributed energy by using the potential of the area of the province for the development of renewable energy sources, including wind power, solar power, hydroelectric power, as well as shallow and deep geothermal energy and biogas.



źródło: opracowanie IRT

Fig. 8. Potential for development of photovoltaic electricity in Lower Silesia region

Potencjał fotowoltaicznej energii elektrycznej	The potential of photovoltaic electricity
Długoterminowa średnia dzienna/roczna w okresie 1994-2018	Long-term daily/annual average for the period 1994-2018
Suma dzienna	Daily total
Suma roczna	Annual total
Obszary chronione	Protected areas
Obszar cenny przyrodniczo i pozostałe ustalenia wynikające z Planu zagospodarowania przestrzennego województwa dolnośląskiego	Environmentally valuable area and other arrangements resulting from the Spatial Development Plan of the Lower Silesian region

1.5. Sweden

In Sweden, the number of PV installations has increased rapidly over the last year. From a total of 10 000 installations year 2016, there is now a total number of installations of more than 92,000-year 2021. Most of the installations are smaller facilities with a maximum of 20 kW capacity (80,207-year 2021). Installations larger than 1 000 kW has increased from 3-year 2016 to 59 year 2021 (Fig. 9 – Fig.10).

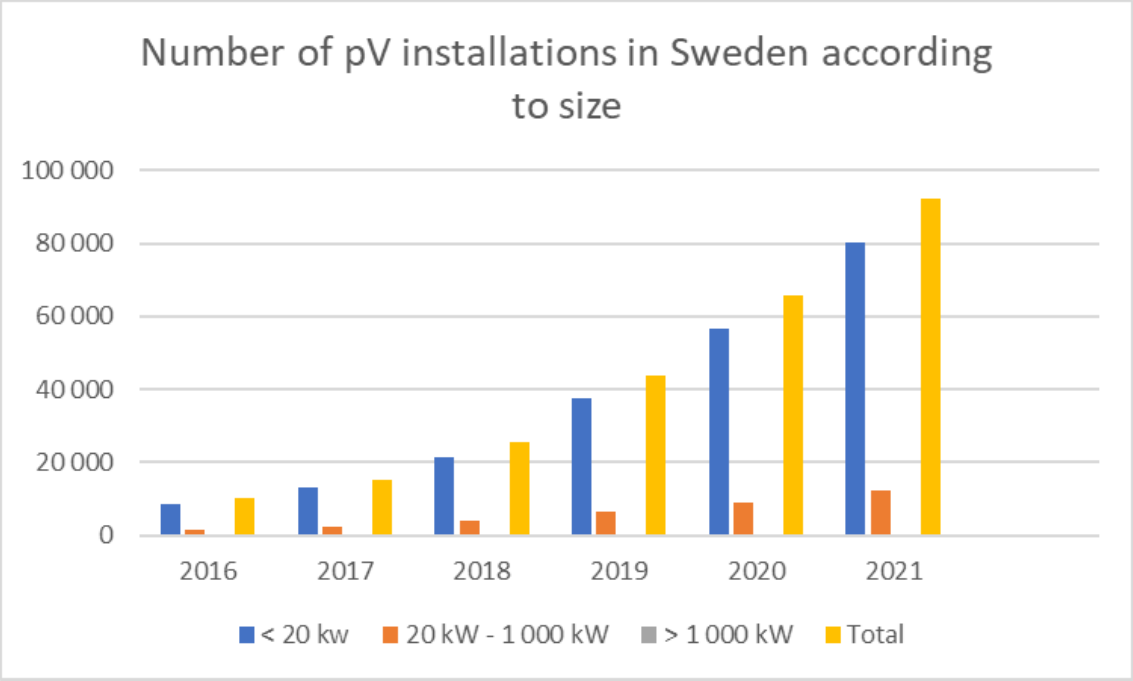


Fig. 9. Number of PV installations in Sweden 2016-2021. Source: Swedish Energy Agency

Seen to total installed electricity capacity, numbers even up compared to number of different installation sizes. The smaller installations and medium installations have about same installed capacity. The total installed electricity capacity has increased rapidly from 140 MW year 2016 to 1587 MW year 2021.

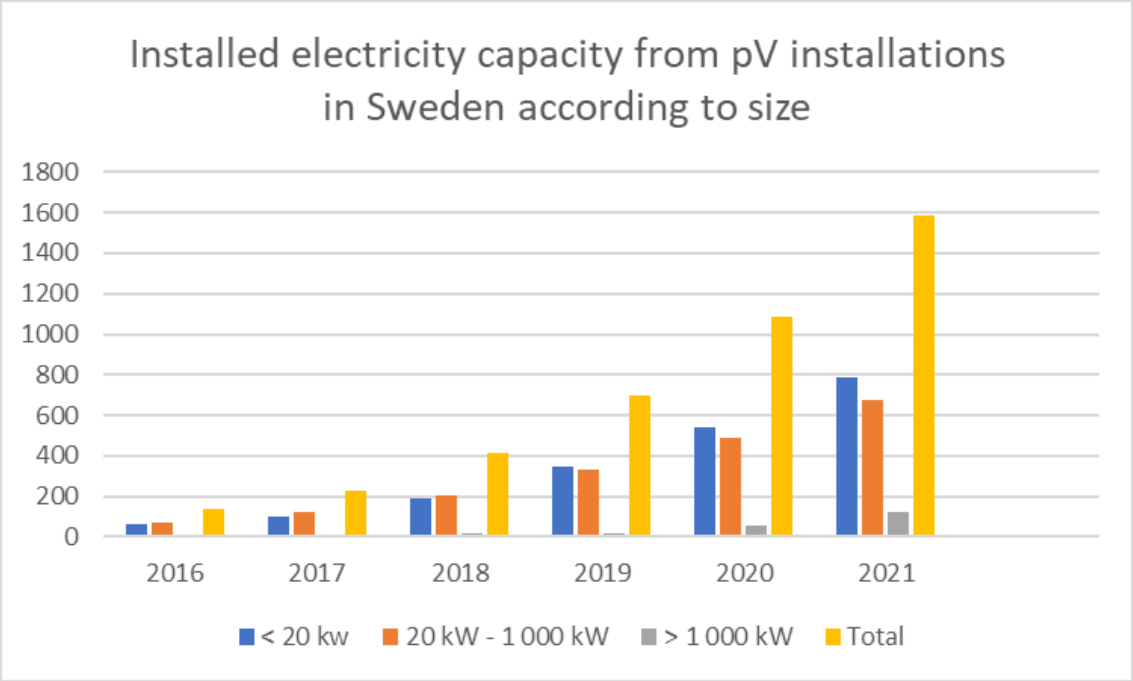


Fig. 10. Installed electricity capacity from PV installations in Sweden 2016-2021. Source: Swedish Energy Agency

Each installed kW PV produces between 800-1100 kWh depending where in Sweden the facility is located and what kind of equipment that is used. Normally it is around 1000 kWh per installed kW. According to Swedish Energy Agency 1,1 TWh electricity was produced from photovoltaics year 2021, which is close to 0,66 % of electricity production (165,5 TWh year 2021) in Sweden and 0,79 % of electricity consumption (140 TWH year 2021). Regarding electricity production from renewables, 1% is accounted for from PV. Main part is generated from hydropower (around 70 %), then wind power (close to 20 %) and biofuels (10 %).

There are some manufacturers and developers for PV panels and systems in Sweden:

Manufacturers with production in Sweden

- Midsummer: Manufactures fully in Sweden roof integrated PVs
- Windon: Manufactures PVs partly in Sweden. Parts are also manufactured in Italy and Lithuania.

Swedish PV companies with production abroad

- SolTech Energy: Develops and sells PV integrated in roofs, manufactured in China.
- Gruppsol: Develops and market PVs for Swedish retails, manufactured in Asia.
- HP SolarTech: Develop and sells PVs, manufactured in Asia.
- PPAM: Do research and development of PVs that are manufactured abroad to their demands.
- Eke-Tech: Development and retail of PVs, manufactured in Hong Kong.
- Exeger: Development of very small PVs that can be used in small equipment as headphones and bags. Manufactured carried out abroad.

Main electricity providers in Sweden are:

- Vattenfall – is a governmental owned energy company with main markets in Sweden (largest), Germany, France, Netherlands, Finland, Norway, Denmark, and Great Britain with 19 000 employees. Photovoltaics has an important role in the energy markets, from small-scale installations to large PV parks. Vattenfall deliver electricity to 900 000 Swedish customers.
- Fortum – is a Finnish energy company where the Finnish government owns over half of shares. Fortum has main markets in Sweden, Finland, Norway, Baltic area, and Poland. Fortum has 885 000 Swedish customers.
- E.ON – is a private German energy company with markets in several companies in Europe. E.ON has around 700 000 Swedish customers.

1.6. Comparison between five project participating countries.

To make clearer the levels of PV development in five countries of the Baltic Sea Region, which participate in PV4All project, here we present the comparison of gross electricity generation (Fig. 11) and installed PV capacities (Fig. 12).

We must bear in mind the difference in ranges of participating countries, still Germany is undeniably the most experienced leader, followed by Poland, then Sweden, Finland, and Lithuania. For better image Fig. 13 a Fig. 14 present gross PV electricity generation and installed PV capacity per capita as for year 2021.

2021	Population	GWh/ca	MW/ca
Finland	5 535 992	5.38296E-05	7.2977E-05
Germany	83 237 124	0.000592764	0.000713263
Lithuania	2 810 761	6.79531E-05	9.07228E-05
Poland	38 179 800	0.000103432	0.000117863
Sweden	10 467 097	0.000100983	0.000151618

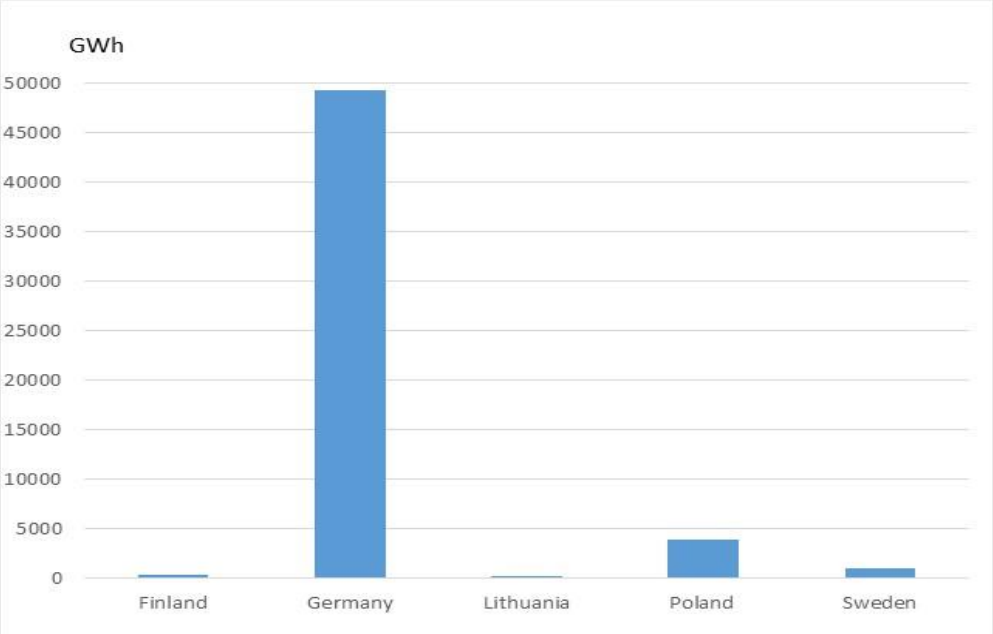


Fig. 11. Gross electricity generation of PV in five countries of the Baltic Sea Region in 2021, GWh

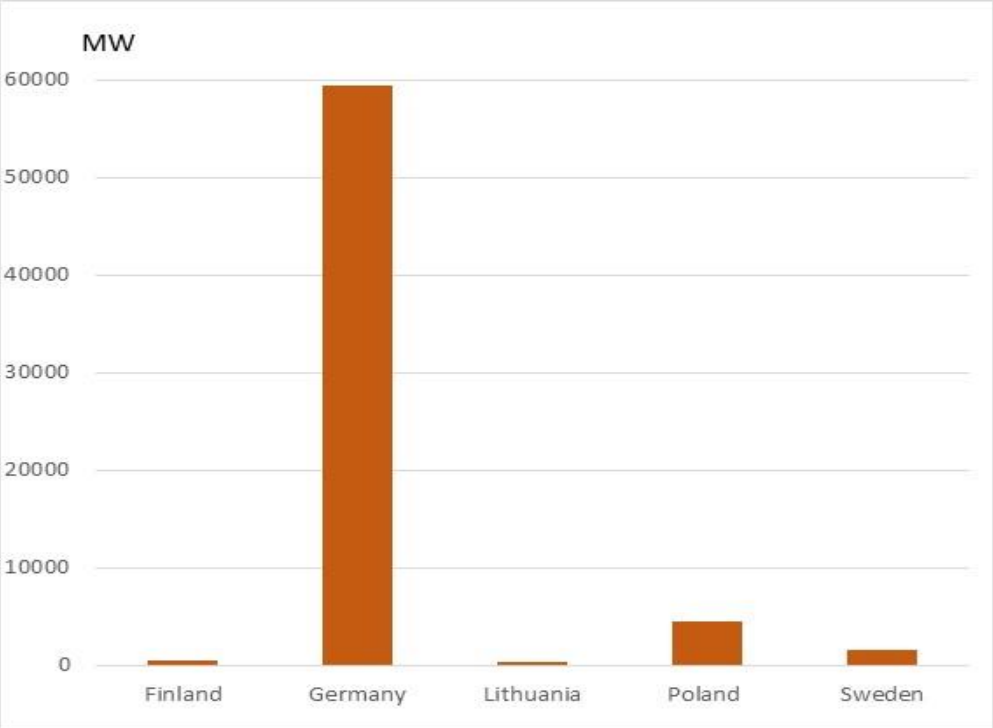


Fig. 12. Installed PV capacity in five countries of the Baltic Sea Region in 2021, MW

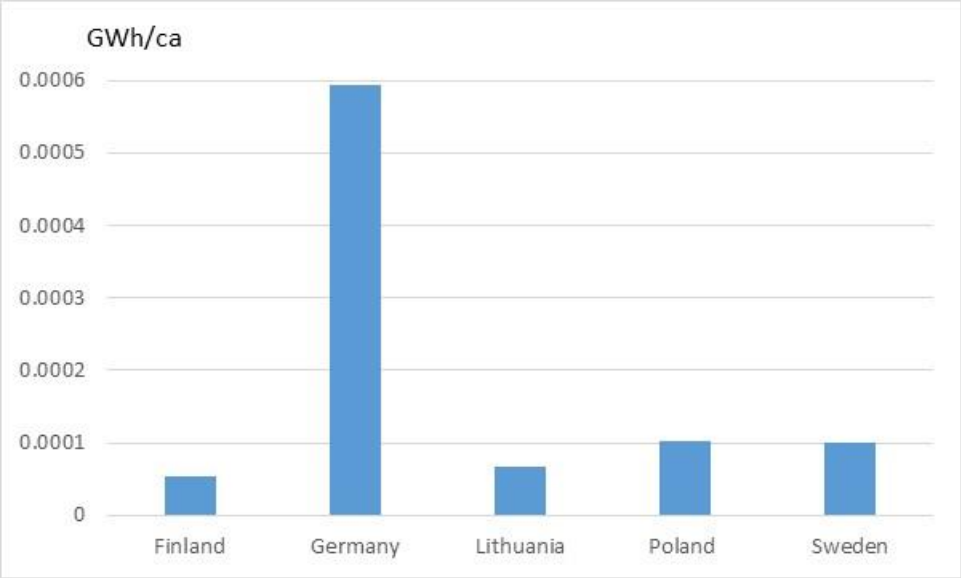


Fig. 13. Gross electricity generation of PV in five countries of the Baltic Sea Region in 2021, GWh/ca

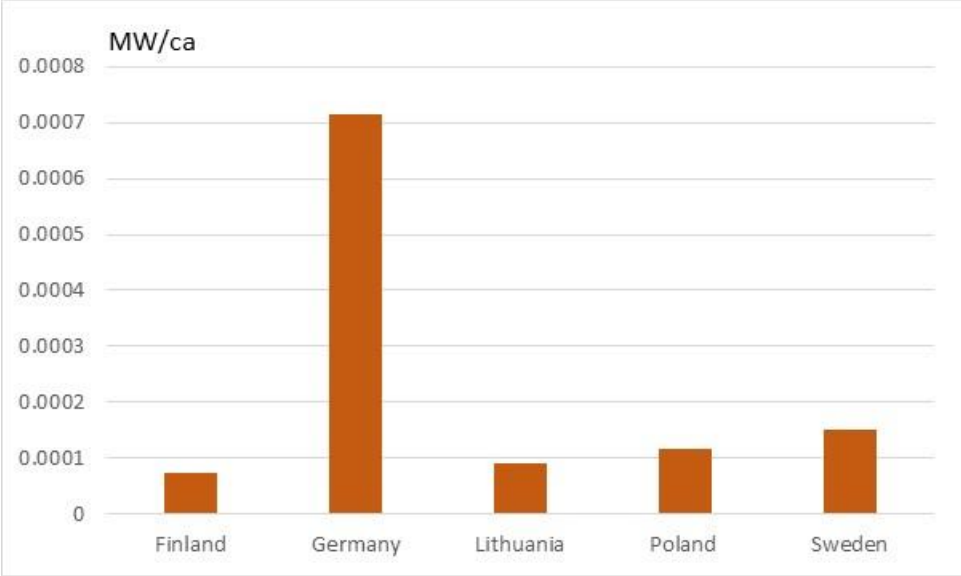


Fig. 14. Installed PV capacity in five countries of the Baltic Sea Region in 2021, MW/ca

2. Identification & analysis of risks, barriers and success factors for the implementation of small-scale photovoltaics

2.1. Germany

Success Factors:

In Hamburg, there is the obligation to build a PV plant on the roof for every building with construction start after January 1st, 2023 (§ 16 HmbKliSchG - „PV-PFLICHT “). For the renewal of roof surfaces, this rule comes into effect by January 1st, 2025. Similar rules apply to the whole country of Germany; The regulations and progress vary from state to state, as everything is decided at the state level. In summary, about half of the federal states have already started with a PV obligation, but to different extents.

In the meantime, PV energy is in many cases a cheaper alternative compared to other forms of electricity generation – especially when externalities of fossil fuels are considered. The reasons for this are the many years of subsidies and preferential purchase of electricity from PV power plants. This has also made a PV power plant economically viable in recent years. Due to the steadily increasing production, the production prices fell (25% price reduction with doubling of production), which resulted in the aforementioned economic efficiency. Another major factor is the feed-in priority of PV energy on the energy market.

Risks and Barriers:

Currently, the biggest barrier to expansion of the PV share in the energy market is probably the shortage of skilled workers. A calculation from 2018 says that 46,500 full-time employees are needed to install 10 GWp. In 2011, 156,000 people were employed in the PV sector in Germany - in 2014, the figure was 49,900. Now the number is around 57.000.

In addition, there have also been supply bottlenecks in the past.

Technical barriers:

In general, the generation profile of PV power fits very well with the load profile of the German power grid. "However, conflicts are increasing with sluggish power plants that can only follow a fluctuating residual load to a very limited extent for technical and economic reasons." Older coal-fired power plants, especially lignite-fired power plants, cannot contribute balancing power in an economically justifiable way. In principle, however, volatile generators with their negligible marginal costs must be given priority. These unresolved conflicts can briefly lead to significant overproduction and high electricity exports with low to negative exchange electricity prices" (Source online available at: Aktuelle Fakten zur Photovoltaik in Deutschland - Fraunhofer ISE).

In the future, with further expansion of PV power plants, the storage of excess electricity will be a challenge.

Financial barriers:

Furthermore, in the past there were subsidies for the construction of plants through the funding institutions of the federal states. In 2023, these subsidies will only be available in Berlin. However, many municipalities continue to have various subsidies for small-scale PV systems in different forms (mainly for balcony power plants).

In the case of research funding, it is also regrettable that, at around €85 million per year, a similar amount is invested in PV research as in research on nuclear energy.

Funding availability:

In addition, KfW (a German development bank) promotes photovoltaic systems with low-interest loans.

Socio-Economic barriers:

Information deficits also occur for many people. Legal frameworks are relatively complex and knowledge about concrete options for action is lacking and not accessible to specific target groups.

The age structure of homeowners in Germany also plays a role in the focus on PV systems on roofs. On average, they are 60 years old in Germany and shy away from long-term investments or are less likely to obtain a loan for financing. People with lower incomes or who live in rented accommodation have more difficult access to their own PV systems. Even if a home is available and the possibility of a loan exists, this represents a financial risk.

Networks, associations, etc., promoting PV development:

National level:

DGS (Deutsche Gesellschaft für Sonnenenergie, German Society for Solar Energy)

--> part of the International Solar Energy Society (ISES)

Bundesverband für Solarwirtschaft (BSW) (Federal Association for the Solar Industry)

--> society of companies, belonging to the solar industry

SFV (Solarenergie-Förderverein Deutschland e.V., Solar Energy Promotion Association Germany e.V.)

--> association for consulting the subject “Solar energy.”

Hamburg:

Hamburger Energielotsen (Hamburg Energy Guides)

--> free advice on the use of renewable energy in buildings and energy-efficient construction, funded by the Hamburg Authority for the Environment, Climate, Energy and Agriculture.

SoliSolar Hamburg

--> Initiative for small-scaled solar-systems for tenants and house owners

2.2. Finland

Risks and barriers:

In Finland's PV-sector are no barriers to connect micro producers to the electricity grid. Recently biggest barrier is lack of components and skillful installers mostly situation is caused by due to high demand. Small and medium size installation company's order backlog is moderately long and recruiting employees is the only way to shorten installation deliveries. It is not possible to carry out installations on the roofs of the buildings all year round due to the snow situation, so most of the installations are aimed to be carried out between March to November. Otherwise, ground and wall mount installations are possible to do during wintertime, only requires more precise schedule planning.

There is still lack of awareness about the benefits of small-scale solar electricity and how the technology works, as well as prejudices due to Finland's long and dark winter season and because in practice PV systems production is exceptionally low or almost nothing between November and February.

To address these barriers, the Finnish government has taken some steps to support the deployment of small and medium-scale PV installations. For example, there is a national energy and climate strategy that includes a goal to increase the share of renewable energy in the country's energy mix. Additionally, there are some national support schemes available for small and medium-scale installations, such as some subsidies for energy efficiency and renewable energy projects. However, there is still room for improvement in the regulatory and incentive framework to further support the deployment of small and medium-scale PV installations in Finland specially for residential and micro-scale system.

There is some uncertainty around the regulatory framework for PV installations in Finland, particularly with regards to net metering and the remuneration of self-consumed electricity. This can create uncertainty for citizen and make it challenging to accurately assess the profitability of small and medium-scale PV installations.

Technical barriers:

The PV panels on the roof are sensitive to weather conditions, and the amount of snow in Finland in winter reduces the energy yield and the return on invested capital.

Connecting the plug-in system to the network can be challenging due to technical and regulatory reasons, which can slow down their implementation process and is not yet authorized.

Finland receives plenty of sunlight during the summer months, which makes it an attractive place to install solar power systems. Similarly, in the summer months, electricity consumption drops considerably, so storage is needed to improve the balance between consumption and production, but electricity storage technology (ESS) is expensive and not yet very cost-effective. Or alternatively, the single house owners should be getting higher price of the excess electricity produced to the grid to make it profitable to sell it to the electricity companies.

Financial barriers:

The initial cost of installing a small-scale solar power system can be high, which can discourage citizens from investing in the technology.

Small PV systems purchased for households are not supported in terms of equipment, only the part of the work can be deducted in taxation, so-called household deduction, which is limited to €2,250 per year per person.

When improvement energy efficiency in apartment buildings, PV systems installation on the property are also supported. The condition for receiving the support is a significant improvement in the energy efficiency of the entire building, so installing a PV system alone is not enough to achieve the target.

The existing incentive schemes for small-scale PV installations in Finland are not sufficient to offset the high installation costs, which can discourage potential purchasers of PV systems.

Success factors:

The Finnish government should implement political measures that encourage the introduction of small-scale solar electricity. For example, the government should support households that install solar panels with the goal of increasing the share of renewable energy in the country's energy mix.

The development of photovoltaic technology has made solar panels even more efficient and cost-effective and therefore encourages the increase of photovoltaic systems in Finland. Citizens' awareness of the benefits of solar energy has increased, which has increased the demand for small solar power plants. Increasing this awareness will have a significant impact in the future.

Cooperating between various of stakeholders, including the government, industry, and academia, will help promote the introduction and may improve the availability of subsidies and financing, which would help also influence the successful implementation of small-scale solar electricity in Finland. Overall, a combination of supportive policies, technological development, public awareness, strong solar resources, cooperation, and access to finance will contribute to the success.

Networks, associations, etc., promoting PV development:

All Finnish provinces (18) offer consumers, municipalities and companies free regional energy advice funded by the Energy authority and organized by Motiva, which includes advice and training related to renewable energy such as solar electricity and energy efficiency to raise awareness among citizens, which the advisory organizations do in close cooperation. The Central Finland Energy Agency (CFEA) is one of these advisory organizations and associated partner in the PV4All project.

Finnish energy authority (Energiavirasto) regulates and promotes operation of the electricity and gas markets, emission reductions, energy efficiency and the use of renewable energy. Energy authority enforce Finnish and European energy and climate policies and the goal is to promote cost efficient achievement of climate goals and efficient operation of the energy market. The Energy Authority governs the feed-in tariff scheme for renewable energy subsidies, arranges auctions for renewable energy

subsidies and transport infrastructure projects, as well as collects wind power charges. The Energy Authority also provides energy advice for consumers, municipalities, and enterprises, as well as carries out impact assessments on renewable energy policy actions and prepares related reports and statistics.

Suomen aurinkoenergiayhdistys (Sary). The Finnish solar energy association's goal is to grow a stable and reliable group of operators in the solar energy industry. The association aims to educate its members so that the systems purchased from them are of high quality, safe and work in accordance with sales promises. According to the association, more than 10% of the electricity consumed in Finland is cost-effectively produced with solar energy using current technology. In the coming years, the technology will develop, and the profitability of solar energy will improve. In the future, it makes sense to produce a larger part of the necessary energy from solar. In any case, solar energy will be a significant part of the renewable energy-based energy system of the future in Finland as well.

Suomen Lähienergialiitto (Lähienergia) Finnish Clean Energy Associations goal is to make the use of renewable energy as easy as possible for Finns as well as to help clean energy industry to grow. The association has extensive stakeholder networks in Finnish communities and companies which operating in the field of renewable energy. The association to do lobbying work also in the direction to of the Finnish government and EU to increase renewable energy consumption and production.

2.3. Lithuania

Risks and Barriers. Although there are no barriers to generating consumers to connect to the grid, the problem is that the bigger players do not help households to install solar PV plants. According to the Energy Minister, entrepreneurs are only looking at attractive sites, where it is profitable. 4.8 GW of capacity has been reserved by business, while the so-called 'breakthrough package' was half that amount - just 2 GW. In total, the state has earmarked 4 GW for the future development of solar power plants. By comparison, the solar and wind power plants already operating in Lithuania generate a total of 1.1 GW of electricity. Future capacity was to be divided in half between businesses and household energy consumers.

There is a problem with the electricity grid capacity, and either additional distribution options should be sought or more investments should be made in their development. However, solar and wind capacity can be accommodated in one grid. Both the sun and the wind, especially with the emergence of batteries, are perfectly compatible with each other.

Technical barriers:

- Insufficient grid capacity.
- Lack of PV panels and inverters due to equipment supply bottlenecks and lack of kit parts.

Financial barriers:

- Limited funds for support

- Only equipment is supported, and there is no support for work, so payment can be not transparent (financial actions performed in cash)

Funding availability. Several banks and other financial institutions are providing loans for the development of renewable energy projects with rather similar conditions, which are:

- Annual interest rate 4.9 %/a, in some institutions between 4.9 and 9.9 %.
- Fixed administration payment – appr. 50 Eur (after application for installation of PV).
- Loan sum between 3,000 and 20,000 Eur, in some banks between 4,000 and 30,000 Eur.
- Payment periods between 6 months and 7-10 years.
- No initial deposit is required.

Networks, associations, etc., promoting PV development:

Ministry of Environment of the Republic of Lithuania - responsible for providing support for the implementation of renewables via the Environmental Project Management Agency (EPMA)

Ministry of Energy of the Republic of Lithuania - responsible for a capacity mechanism is a measure designed to ensure the adequacy and reliability of the power system.

The Environmental Project Management Agency (EPMA) under the Ministry of Environment of the Republic of Lithuania - administrates state support for PV projects and acts as an advanced environmental investment management center. Project “Installation of facilities for the production of electricity from renewable energy sources” in connection to the 4th priority according to the Operational Programme for the European Union funds’ investments “Promotion of Energy Efficiency as well as Production and Use of Energy from Renewable Sources”.

Lithuanian Solar Energy Association (LSEA) - the Association aims to develop solar energy, to create favorable conditions for the use of solar energy in Lithuania and to educate the public about solar energy technologies. LSEA is a member of „SolarPower Europe“ to ensure that more energy is generated by solar than any other energy source by 2030 and to lead our members to make solar the core of a smart, sustainable, secure and inclusive energy system to reach carbon neutrality before 2050. LSEA is part of the Photovoltaic Technology Cluster.

Lithuanian Solar Energy Development Association (LSEPA) - is a non-profit organization, that unites companies, which are active in the solar energy sector and aims to promote environmentally friendly solar energy solutions among businesses, individual consumers, and public and educational institutions, to facilitate solar energy development and to develop safety and efficiency standards for the sector, based on the world's best practices.

Lithuanian Renewable Energy Confederation - which was established by the Lithuanian Biomass Energy Association LITBIOMA, the Lithuanian Wind Energy Association, the Lithuanian Biogas Association, the

Lithuanian Renewable Energy Resources Association, and the Lithuanian Solar Energy Association. The president of Confederation is the registered lobby for renewable energy.

Lithuanian Association of Thermal Engineers (LTERA) –the main activities of the Association are the development of the qualifications of thermal engineers and the assessment of their professional knowledge. Currently, there is great interest in the development of heating alternatives using solar and heat pump technologies.

All major developers of PV plants are strongly promoting PV projects as well as acting as qualified advisors. Most of them also provide project design free of charge.

2.4. Poland

Risks and Barriers. Photovoltaic installations continue to increase in Poland. Over the past 2-3 years, not only owners of single-family homes, but also more and more owners and boards of directors of companies and cooperative boards have decided that they need to install photovoltaics and heat pumps. The year 2022, among other things, due to the outbreak of war in Ukraine, which left its mark on the economy, further problems with the supply of components from the Far East and the increasing impoverishment of society, as well as the situation in the installation and heating industry itself, was a tough year for society. There were huge increases in gas and electricity prices in 2022. The public became increasingly interested in renewable energy sources. A PV installation of up to 50 kW can be set up in 1 month. For PV installations of more than 50 kW, there is a need to obtain a building permit for PV installations and for connection conditions. These procedures usually take up to a year of time. This is one of the barriers for investors of medium-sized PV installations. For owners of single-family houses, despite the subsidies, a considerable barrier is the cost of investment. When renewable energy sources became more and more popular, the market in Poland was flooded by a wave of companies without the required competence in this complicated subject. And so small companies, previously installing, for example, gas boilers, significantly underestimated prices, and then performed installations that did not meet the necessary standards. Large capitals, on the other hand, wishing to transfer their experience from photovoltaic panels, often overprice, as they usually use the know-how of subcontractors, or have an inflated "greed factor."

The main barriers to the development of renewable energy sources in Poland:

- limited opportunities for entrepreneurs to finance investments,
- legal regulations of support,
- administrative and procedural difficulties,
- problems with the operation of industrial networks.

Main risks associated with the development of renewable energy sources in Poland:

- High initial costs,

- Long payback period.

The current situation in the coal market will have far-reaching consequences in terms of how Poles look at a heat pump. Until now, coal boilers have been treated as a technology that, despite its many drawbacks, guarantees that the home will be warm in winter. Now the roles are reversing. People stop thinking - What if there is no electricity? - they just think - What if I cannot buy coal?" - Kamil Dorocinski - CEO of ONEPOWER Sp. z o.o. - said for TOP-OZE.pl.

Subsidies certainly have an impact on the popularity of heat pumps, but certainly the most for their promotion has been done by... recent increases in coal and gas prices. Until now, the pump has been treated as a slightly more expensive to operate solution that guarantees convenience and ecology. Now it has turned out that pumps are the most economical for this. Clean Air, My Heat or My Electricity is an additional incentive to choose a pump. Rather, however, not treated as a decisive factor in choosing a particular heating technology.

"At the moment, opportunities for the development of Polish renewable sources are identified with the implementation of hydrogen technologies. Limitations of grid connection capacities, outdated electricity infrastructure and lack of adequate support systems are just a few reasons why RES development without hydrogen will be impossible or exceedingly difficult. Poland's distributed and renewable energy industry is primarily betting on offshore wind turbines, photovoltaic farms, and energy storage in various forms (not only lithium-ion batteries, but primarily hydrogen). The latter will perfectly complement and stabilize the energy mix while relieving some of the burden on Polish grids." - Bartosz Firmanty - Innovation Director at EkoEnergia Polska Sp. z o.o. - said for TOP-OZE.pl.

The electricity and heating market is very dynamic. New photovoltaic installations are constantly increasing. The greatest dynamics are recorded by heat pump installations. More and more households and companies are also installing energy storage.

2.5. Sweden

Risks and Barriers. There are not really any larger barriers other than administrative for installing small-scale PVs if the facility is connected to the electricity grid via an electricity central (normally in a house or building). There are many retail companies selling smaller PV systems complete with installations. This includes both smaller private companies with a few employees and the larger energy companies as Vattenfall and E.ON. Between year 2020 to 2021, 26 000 new PV facilities were installed and 90 % of them were smaller facilities up to 20 kW. This number is highly likely to go up for 2022. The larger energy companies have web pages where you can go in directly and order your PV facility for your home and see what the price will be at once. Most of the smaller companies will ask you to contact them for dimensioning the facility and price including installation.

Though, for small-scale PV facilities using electric plug to put in an electricity wall socket for connection to the electricity grid, there are great barriers. They are not allowed at all in Sweden by the authority that approves electrical equipment, Elsäkerhetsverket.

The question of storage of electricity will increase as more PV facilities are installed. Now there are no problem on a national level seen to production of electricity compared to the current demand of electricity. But on a local level it could be a challenge to balance the electricity system, for example when an urban district decides to go for 100 % electricity supply from PVs. If it is a demand outside the city district, the electricity from PVs can be used elsewhere but in future there might be so many PV facilities installed that the production on a sunny day exceed the demand largely on a local level. Then some kind of storage of electricity is probably needed. Today an electricity grid owner could not deny a private person to connect PV to the grid.

Technical barriers:

Small-scale PV:

- The rules of building permits have changed a few years ago that a private person don´t need a building permit to install a PV facility if the PV installation follow the level of the roof. But there are some exceptions to this, for example if the buildings are marked for cultural interest (also single-family houses) or if the area is of military interest (could be villages) in planned areas. Large PV facilities for electricity production of market interest need permits.
- If you need a building permit for the PV facility it could be quite a lot of work with different drawings and calculations to be carried out.
- Even if you don´t need a building permit for the PV facility you will need to register the new facility to your electricity grid owner and report that you start your installation. An authorized electrician needs to do all the electricity work connecting the facility to your electricity central in your home. When everything is done, the electrician needs to report to the grid owner that it is ready to start. Before you get the ok from the grid owner, you cannot start the facility for production of electricity. The time for approval from the grid owners varies and can take from days to months.

Plug-in PV:

Plug-in PV with a electrical plug that you plug in an electrical wall socket are not allowed. This is due to:

- The electrical capacity can be too large in the building electricity net compared to what the net in the building is dimensioned to. For example, when connecting plug-in PV facilities in series to a wall socket, other wall socket in the building can receive more ampere than dimensioned for and the net can take fire.

- If electricity power is shut down in the building and plug-in PV that are producing electricty are connected, there are still electricity in the net and an electrician working on the net in the building can get an electrical shock.
- The electrical plug on the PV is not safe to touch, it lacks mechanical protection to not get an electrical shock.

According to Elsäkerhetsverket, Germany is the only country in EU that has a decided standard and legislation in place for using plug-in PV.

Financial barriers:

One could always want that investment support from the government could be larger than decided but there are really no financial barriers other than applies for all investments of the same amount to be done.

Funding availability.

Several banks and other financial institutions are providing green loans to private persons. These loans might have a slightly lower interest rate but not much.

The larger energy companies as Vattenfall, Fortum, E.ON offer financial solutions when buying complete PV installation from them but it is normally the available banks in Sweden they are cooperating with.

Networks, associations, etc., promoting PV development:

The Swedish Energy Agency is a governmental authority working with different kind of energy sources where renewable energy and solar energy is an important area. The agency provides annual statistics for photovoltaics in Sweden.

The Swedish Tax agency is a governmental authority working with taxes for companies, public organizations, and private persons in Sweden. The grant that is valid for 20 % of PV installation costs and 50 % of battery installation costs is administrated by the tax authority. The grant is directly regulated by the seller of the product but paid by the tax authority and balanced in the yearly tax declarations.

There are a few organizations working with solar energy on basis of being business network associations for solar energy in Sweden:

Swedish Solar Energy Association – is a trade association with 280 member companies. The association is working with shaping, creating opinion, and develop business for solar energy. They work with:

- Meetings with decision makers, authorities, and institutions.
- Industry development in collaboration with actors from all parts of society.
- Participation, on behalf of our member companies, in the creation and development of standards.
- Opinion formation - for example through debate articles at local, regional, and national level.

- To contribute in various contexts with expertise to raise the general level of knowledge about solar energy.

Swedenergy – is a non-profit industry and special interest organization for companies that supply, distribute, sell, and store energy. The organization has a total of 400 members, which includes state-owned, municipal, and private companies as well as associations within the energy sector. Swedenergy monitors and promotes the interests of its members and the Swedish energy sector in general.

Solar Region Skåne – is an interest member organization with aim that the region Skåne in Sweden will be a leading region and area of solar energy use. The vision is to limit the climate impact in the region and strengthen the energy supply by contribute to an increased expansion of renewable solar power in Skåne. The organization work with education and information about solar energy, bring together different stakeholders and improve conditions for solar energy. Members come from the industry, municipalities, academia, research, and private individuals and are about 60 in total. Solar Region Skåne is associated partner in the PV4All project.

3. Localized analysis – mirror the conditions analysed against the local situation in the BSR countries.

3.1. Germany

As mentioned before, there is a legal solution for creating more new PV plants on Roofs. Therefore, we will focus on the conditions of other small-scale solutions.

For small-scale PV there are different funding opportunities in Germany also considering the variety of small-scale solutions:

1. PV Plants on roofs of private houses:

   Depending on the self-used PV electricity, the rest of the generated electricity flows into the public grid and the producer receives a feed-in tariff (this tariff raised in July 2022). The amount depends on the size and the time of commissioning of the system.

2. Balcony Power Plants

   Since 2023, plug-in PV in Germany are exempt from VAT (Source: Mini-PV-Anlagen: Balkonkraftwerk Förderung 2023 - Finanztip). Three states and 23 cities in Germany currently have subsidies for balcony power plants. Especially in cities, there is a high potential for installing small scale.

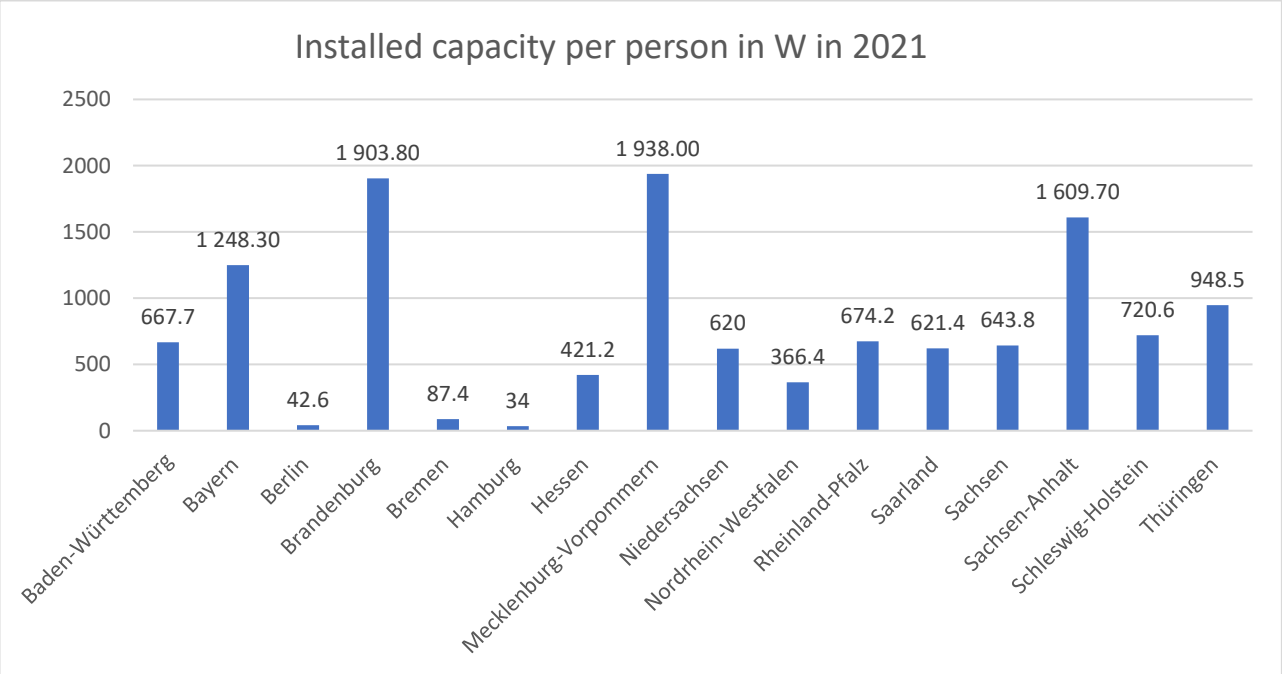


Fig. 15 - Installed capacity per Person by federal states (Fraunhofer ISE, 2022; https://energy-charts.info/charts/installed_power/chart.htm?l=de&c=DE&expansion=p_inst_states&year=2021&chartColumnSorting=default)

Here, too, there still are obstacles:

Also, when it comes to small-scale PV plants, there are barriers to expansion:

For one thing, the outside surface of a balcony where the power plant is mounted belongs to the building owner and a tenant is not allowed to mount a corresponding plant without permission. Many landlords do not see the need, are worried about possible damage to the building and therefore refuse to give their permission. Furthermore, there is no clarity about possible legal consequences of damage, should a plant cause damage by falling, for example. Furthermore, there are difficulties because a certain plug is necessary for the installation and the registration of the PV modules is relatively complex.

Particularly in the area of balcony power plants, facilitations are currently foreseeable in Germany, which will also affect access in cities: with the VDE, one of the most influential technology organizations in Europe has demanded the following changes (Source: VDE schlägt einfachere Regeln für Balkonkraftwerke vor):

- Introduction of a de minimis limit of up to 800W (already implemented in the Netherlands) and corresponding European "Regulation for Generators". Installations up to 800W would thus no longer be "grid-relevant".
- Mini-generation plants may use any type of meter. Currently, balcony power plants may not be connected to meters without a return flow meter.
- Simplified registration only with the Federal Network Agency
- Toleration of the Schucko plug for feed-in up to 800W.
- The VDE recommends that mini power plants be tested by an independent testing institute so that the customer can put a safe device into operation at home.

In addition, there are various approaches to utilizing the potential of PV energy in urban areas. Here, a potential of at least 59 GWp was determined. This refers to the dual use of already sealed surfaces in the city, such as car parks, sports facilities, or public squares, where PV systems not only generate energy but also provide shade or rain protection and can be combined with light or installed with charging infrastructure for e-mobility. (Urbane Photovoltaik - Fraunhofer ISE)

Urban photovoltaics is particularly necessary for the necessary decentralization of the energy transition. There is a high demand for electricity in cities and it is precisely here that renewable energies are not yet widespread.

3.2. Finland

In Finland, support for installing a photovoltaic system in single-family houses is only available if the property's energy efficiency improves by 44%, which includes all the measures taken after the construction time. The amount of support is €4,000/house. The same support is also possible for apartment and tenant buildings, in which case the support is €4,000/apartment and energy efficiency improve must be 32%.

The level of support is good, but the system is complex and requires a good knowledge of construction and energy technology to evaluate the effects of the measures. Installations PV system alone is not enough, so to receive support, other measures must also be taken to achieve efficiency.

An individual can deduct 40% of the work for the installation of the solar electric system in taxation, the so-called the household deduction is a maximum of €2,250/person/year.

Now, there are not any subsidies for individuals to receive direct from in Finland government for the purchase of solar power systems, and this is an especially important development point of change to encourage citizens to purchase systems. It should be noted that the prices of equipment have decreased, and the price of electricity is higher than before, which makes the purchase of solar power systems more economically profitable and the possibility to sell excess electricity also increases the attractiveness of purchasing equipment.

The law which implemented 2022 enables the so-called the establishment of energy communities, and for example, a larger PV system can be installed in apartment buildings and the electricity produced by it can also be distributed to the residents. The distribution can be based on the number of shareholders' shares, or the apartment area (m^2) owned. Some electricity companies offer already online services where is possible to establish and register an energy community.

Business Finland is a government organization that grants energy aid, which is paid based on the actual costs reported by the organization. The subsidy for the installation of solar electricity for enterprises is 15%. The investment costs of the project must be 30,000 euros, and there is no upper limit on the size of the project.

The Finnish Food Authority grants agricultural energy investment support for renewable energy production equipment, such as solar power investments. The condition of the support is that the energy produced is consumed to agricultural production. The amount of the subsidy is 50% of the acceptable costs at least 7,000 euros, so the minimum investment must be 14,000 euros.

3.3. Lithuania

New and favorable opportunities for the wider use of solar energy are offered by the possibility, provided for in the RES Law, to give a portion of the solar electricity produced but not consumed to the electricity distribution network operator and then to recover it, the so-called "double metering" system. It is particularly useful for facilities with low electricity consumption at weekends or in summer. Excess electricity generated at these sites can be fed back into the grid and recovered in the event of a shortfall. This greatly facilitates the efficient use of solar electricity. So far, this system only applies to plants up to

50 kW, but the Ministry of Energy and the Seimas are currently discussing the possibility of raising this limit to 100 kW.

The following support measures are implemented:

1. In Lithuania, people living in individual houses or apartment blocks can benefit from support for installing solar power plants.

The process of obtaining support is straightforward and anyone planning to install a solar power plant has a good chance of getting it and covering more than 30-35% of the total cost of installing a solar power plant.

The support is €323 per installed kW for purchasers installing a new solar power plant (both panels and inverter/converter) and €241/kW for those wishing to expand an existing plant by adding panels only.

The support is valid up to an installed capacity of 10 kW, but you can install a solar power plant with more capacity. The maximum grant is €3230. So, if you install a 15-kW solar power plant, you will receive support, but it will be capped at your "ceiling" of €3,230.

Call for support for solar power plants is announced several times a year and applications take about a month to be accepted. In 2022, applications for Solar PV Support will be accepted several times a year. Applications are accepted for about one month after the announcement. The solar power plant must be installed after you have submitted your application. If you install it before the application deadline, you will not be granted support.

It will take between 9 and 12 months to install the solar plant after the publication of the grant. You will have 9 months to install the plant. Often this deadline is extended due to long installation queues and can be a year or more. So, you will be able to carry out the selection of contractors, the power uprating (if necessary) and other preparatory steps even after the confirmation that you have received support.

Although the Ministry of Energy plans to allocate a total of €16 million for the period 2019-2022. This is about €4 million annually, but as the practice in both 2021 and 2022 shows, the support budget can be increased. That is, it looks more at how many people have applied and if the number of people willing to install exceeds the budget, the budget is increased. For example, in March 2022 alone, almost 15,000 people applied for support for solar power plants - a record number of applicants so far. The support in Lithuania is distributed by the Environmental Project Management Agency (EPMA) of the Ministry of the Environment.

The requirements for the equipment to be installed:

- Must be new (unused), comply with EU standards and eco-labels normally required for such equipment.
- solar PV panels must have a 10-year product warranty and a 25-year 80% efficiency guarantee.

- the inverter must be covered by a 5-year product warranty.

2. Business support. Eligible applicants are industrial enterprises (micro, small, medium, and large).

The applicant shall be an industrial enterprise which has been active for at least 3 years before the submission of the Project Implementation Plan (hereinafter referred to as the 'PIP') and whose average annual revenue from its production in the last two financial years before the submission of the PIP is at least EUR 300,000 in the case of an industrial enterprise which is a large enterprise and EUR 145,000 in the case of an industrial enterprise which is a micro-enterprise, a small enterprise or a medium enterprise.

Funding will not be granted to an applicant that produces renewable energy in remote solar parks. The project activities shall be implemented in the region of Central and Western Lithuania. The duration of the project activities shall not exceed 18 months. Amount of support: between EUR 20 000 and EUR 300 000 per applicant.

Amount of own contribution:

- At least 20 % for micro, and small enterprises.
- At least 30 % for medium-sized enterprises.
- At least 40 % for large enterprises.

3. There is also support for public buildings, where the support rate for PV plants is 80%.
4. In December 2022, the pilot support bid was initiated for batteries up to 10 kW.

Environment Project Management Agency (APVA) informed that the Solar PV support is available to residents who purchase and install an iron phosphate electricity storage device or a lithium-ion electricity storage device and use it to store their own electricity. The solar battery compensation is granted for a 0.5 kWh to 10 kWh installation.

The applicant may also purchase an electricity storage device with a capacity of more than 10 kWh, but the compensation will only be granted for a capacity of 10 kWh.

The draft currently foresees that solar electricity storage installations will also be subject to certain technical requirements, such as the solar panel must be:

- new (unused),
- comply with EU standards, and
- may be required to provide certificates of conformity upon request from the APVA.

Support for batteries up to 10 kW:

- 450 €/ 1 kW for lithium iron phosphate electricity storage installation.
- 391 €/ 1 kW for an installed lithium-ion energy storage unit.
- 1 mill. € Total amount available for funding (during the 1st bid).

3.4. Poland

1. Subsidies for photovoltaics in blocks - applications from February 1, 2023

The government on November 28, 2022, announced a new program for subsidies for photovoltaics in blocks of flats. The program is aimed at housing communities and cooperatives. Subsidies are to amount to 50% of the cost of investment in photovoltaics. Acceptance of applications for subsidies for photovoltaics in multi-family buildings will start on February 1, 2023.

2. My Current 2023

Recall that a new edition of the My Current program, which was created specifically to subsidize photovoltaic installations, started on December 15, 2022. It aims to increase the share of photovoltaics in national electricity production.

Subsidies under the My Current program in 2022 and 2023 are available to:

1. applicants billing for electricity produced in the so-called net-billing system, and for applicants billing for electricity produced in the so-called net-metering discount system, who have not benefited from the subsidy for photovoltaic micro-installation, provided that they switch to the so-called net-billing system for billing electricity produced. The amount of subsidy in the form of grants is:

   - only for PV micro-installation - up to 50% of eligible costs not more than PLN 6 thousand,

   If a PV micro-installation with an additional element is submitted for subsidy, the subsidy will be:

   - to PV micro-installation up to 50% of eligible costs, not more than PLN 7 thousand,

   - to energy storage up to 50% of eligible costs, not more than 16 thousand zlotys,

   - to heat storage up to 50% of eligible costs, not more than PLN 5 thousand,

   - to EMS / HEMS up to 50% of eligible costs, not more than PLN 3 thousand.

2. applicants accounting for electricity produced in the system of discounts so-called net-metering, who have benefited from funding for photovoltaic micro-installation, among others, from the My Current program (in previous calls), if they switch to the system of accounting for electricity produced, so-called net-billing. The amount of subsidy in the form of grants is:

- for a PV micro-installation for which at least one additional element indicated in the points below will be purchased and installed - up to 50% of the eligible costs (entered in the already paid application) not more than PLN 3,000,

- to energy storage up to 50% of eligible costs, not more than 16 thousand zlotys,

- to heat storage up to 50% of eligible costs, not more than PLN 5 thousand,

- for EMS / HEMS up to 50% of eligible costs, not more than PLN 3 thousand.

All those who have applied only for PV micro-installation will be able to submit a supplementary application for additional elements, without having to withdraw the application already submitted. For already paid applications, eligible costs will be recalculated against the new subsidy level.

3. Clean Air 2023

A subsidy for photovoltaics under the Clean Air program is offered to those who have replaced an old stove and installed a photovoltaic micro-installation before April 1, 2022. Note, the program offers support for photovoltaics only to those who have replaced an old stove. These people can take advantage of a subsidy of 5,000 to 9,000 zlotys without switching to the less financially favorable net-billing system. The condition for receiving the subsidy is the timely submission of the application, i.e., before 6 months after the first investment expenses were incurred.

To sum up, the Clean Air program is aimed at eliminating the so-called "fossil fuels" and encouraging thermo-modernization of homes, and only additionally one can apply for subsidies for photovoltaics.

Let us add that the Clean Air program currently offers grants of:

- up to PLN 30,000 for the basic subsidy level,

- PLN 37,000 for the increased level,

- PLN 69,000 for the highest level.

The amount of subsidy you can get for an air heat pump with increased energy class A+ is PLN 14,100 (including documentation), adding to this PLN 5,000 for photovoltaics, the subsidy for the pump + photovoltaics will be more than PLN 19,000. However, first you must bear the cost of the entire investment, and only then apply for a subsidy.

From January 3, 2023, new solutions enter the program, viz:

- increasing income thresholds,

- increase in the amount of financial support,

- the income threshold for basic subsidy will increase to PLN 135 thousand, and the maximum amount of subsidy will be PLN 66 thousand,

- with increased subsidy, the income threshold will increase from PLN 1564 to PLN 1894 per person in a multi-person household and from PLN 2189 to PLN 2651 in a single-person household. The maximum subsidy will increase from PLN 47 thousand to PLN 99 thousand.

4. subsidies for photovoltaics - Czyste Powietrze Plus.

This is a program that complements Czyste Powietrze and assumes replacement of the heat source or thermal modernization of the building with the possibility of prepayment for families with lower incomes. Czyste Powietrze Plus differs from the existing Clean Air rules primarily in that it will be possible to obtain prepayment of up to 50% of the amount covered by the program within a short period of time. To receive the prepayment, it is necessary to apply to the Provincial Fund for Environmental Protection and Water Management. Applications can be submitted from July 15.

All previous limits for heat pumps, gas boilers, pellet boilers, photovoltaics or thermal modernization do not change. In the new program, only the total amount you can receive and the time when the subsidy for replacing a pellet boiler, photovoltaics and thermal modernization is paid out changes. For this program, too, you can additionally benefit from a subsidy for photovoltaics in the amount of 5 thousand to 9 thousand zlotys.

How much subsidy in the Clean Air Plus program?

- Up to PLN 30 thousand - this is the basic level of subsidy, for people with an annual income of up to PLN 100 thousand,

- up to PLN 37 thousand - is the increased level of subsidy - counting the average monthly income per person up to PLN 1564 in a multi-person household and up to PLN 2189 in a single-person household.

As of January 25, 2022, people whose monthly income per member in a multi-person household does not exceed PLN 900 and PLN 1260 for single-person households can receive up to 90% support.

5. subsidies for photovoltaics 2023 in regional programs.

It is worth knowing that in addition to the nationwide heat pump subsidy programs, there are also regional programs. Support programs for this type of investment are really a lot, but subsidies for photovoltaics from municipalities is often quite a breakneck road. Therefore, it is worth carefully studying the rules of the program, as in this case the conditions for taking advantage of subsidies can sometimes be very restrictive and complicated.

3.5. Sweden

The Swedish government supply grants for private investments of PV facilities. A private person receives 20 % of the installation cost for labor and material with a maximum grant of 50 000 SEK (about 5 000€) per year. There is also a grant for storage of electricity where a private person receives 50 % of the installation cost for labor and material for a battery. This grant will add up to the PV grant where it

combined can have a maximum of 5 000€ per person per year. If there are two persons in the household, it will be 10 000€.

In Sweden there are the possibility for a small-scale producer of electricity to sell the excess electricity, not used in the building where the PV facility is located. To make this easy and worth to carry on with, there is the possibility to become a micro producer for small-scale facilities. There are a few economic benefits to be a producer of electricity from a small-scale facility.

1. To be a micro producer the law states that the electricity producer could have an overall safety fuse of maximum 63 ampere for the current connection point to the grid and the feed in capacity from the facility to the grid could be of maximum 43,5 kW. If the electricity producer is below these limits, no fee for grid connection from the grid owner to the facility owner is allowed. For small-scale facilities above the limits, it is up to the grid owner to decide the cost for connecting the facility to the grid. This differ for different grid owners what the costs are and at what size of the facility the grid owner starts to charge a fee.
2. As a producer of renewable electricity, you are entitled to a tax reduction. The tax reduction is 0,6 SEK (0,06€) per fed in kWh to the grid (not used in the own building) and valid for maximum 30 000 kWh per year. This means a maximum tax reduction of 1 800€ per year is possible.
3. The electricity that is fed into the grid is allowed for the small-scale producer to sell to an electricity trading company. Up to 40 000 SEK (around 4 000€) is allowed to sell for each year without paying tax. Income above 40 000 SEK will be calculated for tax.
4. You don´t have to pay VAT for selling electricity up to a net value of 80 000 SEK (around 8 000€) per year.
5. You don´t need to pay tax for electricity produced from a facility below 500 kW.
6. You will receive an exceedingly small amount for grid enhancement from the grid owner for produced electricity.

There are the same rules about taxes and VAT as for private persons that can apply to small companies that want to install a PV facility on their building. For larger energy producing companies there is no public support of interest. There is a national system with renewable certificates for renewable electricity production but the target for the renewable production are almost already met so the economic compensation from the certificates is very low.

4. Specific analysis of potential solutions

4.1. Germany

Plug-In PV:

In 2018, a big step forward was made for Germany by finding a new regulation for the connection of plug-in solar technology. An important building block here was a study that showed "that it is possible to feed in up to 3.5 amps (approx. 840 Wp, equivalent to 2 PV panels) with plug-in solar devices in every household with circuit breakers without any safety concerns". (**Microsoft Word - Testbericht.Stecker-Solar-Geräte.v20mv_SK (pvplug.de)**). In addition, tireless public relations work was necessary to change the standard. With this step, Germany is following, among other things, on the "Resolution of the European Parliament on small-scale electricity and heat generation" (**2012/2930(RSP) - 12/09/2013 - Resolution on microgeneration - small-scale electricity and heat generation (europa.eu)**. Annually, such a power plant in Germany currently produces about 160kWh. At the end of 2021, there were about 190,000 installed balcony power plants in Germany.

An important task now is to inform people about this and to get subsidies underway so that low-income people also have access to balcony power plants. Here lies not only the obvious potential of saving carbon. At current electricity prices, balcony power plants have an annual savings potential of €200 and thus pay for themselves after just 3 years. Especially for people whose electricity bills are paid by the state, there is also a savings potential here from the state's point of view, if a balcony power plant is installed and explained to people receiving social benefits, there is the possibility for these people to also benefit from the savings themselves, so that several advantages result (shared values).

Off-Grid PV:

Off-grid systems are not subject to registration in Germany and are therefore less expensive to purchase than other PV solutions. Off-grid PV provide a good solution for several areas of application. For example, for charging stations for electric cars or for buildings outside of the grid-structure (like weekend houses). PV energy is generated decentral, and the distribution of the charging stations is logically decentralized. Direct storage of solar energy in cars also increases efficiency.

The system consists of a standard connection of PV modules, which form the "Off-Grid System" with specially designed inverters and storage.

The core of the system is a so-called "charge controller", which manages the charging and discharging of the batteries and thus also protects them.

Second-hand PV:

In Germany, the first PV systems that were installed with subsidies from the EEG (“Erneuerbare Energien Gesetz”, Renewable Energies Act) will soon reach their technical life expectancy and extensive

replacement measures will take place to increase economic efficiency and yield. This offers great potential – especially in combination with plug-in PV and stand-alone solutions. The older, replaced models may not have the same economic efficiency as new modules, but they are still fully functional. In addition, they have a significantly better carbon footprint, are cheaper to buy and still perform well. In Hamburg, the company 2ndlifesolar specializes in recycling PV systems. A concrete example of a recycled and installed system of 98.2 kWp illustrates that in addition to the lower purchase costs compared to a new system, 243 tons of carbon could be saved.

With the help of various partners, the company offers an all-round service. This includes appraisals of old modules, quality checks regarding sensible further use or disposal, as well as transport and installation. Even defective modules remain in the value chain, thanks to the reprocessing of the raw materials used.

One-Stop-Shop (OSS):

As mentioned before, there is a potential to improve the access to information on PV. In Hamburg, there is already an institution set up for this purpose (Hamburger Energielotsen, Hamburg Energy Guides). The Hamburg Energy Guides represent Hamburg's independent energy advice service, which is available to all building owners, homeowners, tenants, and tradespeople at various points in the city. Private individuals as well as tradespeople can obtain free initial advice here to identify and unlock energy-saving potential of their building or apartment and learn about the possibility to use renewable energies including solar energy. We define this form of counselling here as one-stop-shop counselling, because the energy guides are the central point of contact for questions about energy-efficient building and planning and are paid for by subsidies from the Hamburg Authority for the Environment, Climate, Energy and Agriculture to provide independent advice. However, the energy guides and their consultations have a limited capacity, which makes outreach work into specific neighborhoods or to individual target groups, for example, almost impossible. It is therefore difficult to reach people who are educationally disadvantaged. One potential therefore lies in the knowledge and consultation services of these energy guides. Existing offers for people in structurally weak areas can be used as a multiplier and thus expand the reach of the energy guides. There is a big potential here to involve more people in the energy transition.

Business Models:

Rental PV

In the meantime, there is also a possibility for people who are investment-shy and do not have the means to invest to profit economically from the purchase of a PV system and thus contribute to climate-neutral electricity generation. There are companies that specialize in a rental model. In this case, a private roof is made available, and the company finances the construction of the system and purchases all of the electricity used. Through the rental model, the homeowner pays a monthly fee to the company, which includes the entire electricity consumption. This monthly rent is lower than the general electricity costs. After 20 years, the tenant can take over the system for the symbolic price of one euro.

Tenant Flow Model

The tenant flow model is a contract for electricity supply between tenant and system operator or third party as full supplier, therefore in full responsibility.

This model is a possibility to use the roof of a building or a neighborhood for the generation of PV electricity and to offer this to tenants against payment. Systems built after Jan. 1, 2021, may also be used for tenant electricity if they are connected in a building complex/ensemble. The electricity supplied in the tenant flow model must be 10 percent cheaper than the basic supply tariff.

4.2. Finland

Plug-In PV:

Finnish Energy authority has not defined the legislation allowing the connection of plug-in systems, so the connection is not allowed.

Second-hand PV:

Second-hand PV systems are not yet available in Finland, but there are many suppliers abroad from which it is possible to order used modules. The supply of used PV systems will increase in the future as the number of systems installed in Finland increases and ages.

Off-Grid PV:

Off grid PV systems is mostly preferred in countryside, especially in second houses and cottages. Finland is a large and rather sparsely built country, so a comprehensive electricity grid is not available everywhere, or it is not profitable to build. With current technology that includes electricity storage and, for example, a wind turbine, the solution is also possible for the buildings that are in residential use all year round.

One Stop Shops (OSS):

There is plenty of unbiased information about solar electricity available in Finland. The Energy Authority finances, and Motiva organizes regional energy counseling in all 18 Finnish provinces. The staff of the regional energy counseling organizations are well trained and knowledgeable about the requirements and profitability of solar power systems. Counselors are available on weekdays. In addition, Aurinkoenergiayhdistys and Lähienergialiitto provide information and training related to the production of solar electricity and renewable energy.

Many suppliers of solar power systems offer turnkey services. The service providers apply for the necessary permits, ensure the suitability of the building or object for the installation of the PV system, make measurement and installations and notifications to the authorities.

4.3. Lithuania

Plug-In PV

Mini PV-Systems, which are solar panels that can be mounted to the balcony railing or set up on the terrace or garage, and the generated electricity can be fed in via a socket with a plug-in system (inverter + AC connection cable) and used for the personal use. Though such systems are extremely popular in e.g., Germany, in Lithuania, the idea is not only viewed with suspicion, but without permission, it is also subject to fines. However, some plug-in PV solutions become possible and is coming with support for storage batteries. The pilot funding for batteries was launched in 2022 (support 300 €/1 kW installed of battery with full cost 1000 €/1 kW installed, i.e., appr 30%), and it was a great success, while 1,000,000 € was disseminated in half a day after announcement. Such support makes plug-In and Off-grid more attractive.

Off-grid PV

Until 2009, solar power plants in Lithuania were installed by enthusiasts Off-grid only, i.e., operating independently of the electricity grid, and were installed on farmsteads, farms, summerhouses, and remote telecommunications sites. The installation of PV plants on a larger scale started in September 2009, when the State Commission for the Control of Prices and Energy adopted Resolution No O3-117, which provided for a feed-in tariff for the purchase of electricity generated by PV plants. However, the public was unhappy that the high incentive tariff was putting money from the State budget into the pockets of businessmen, but neither the Ministry of Energy nor the State Energy and Price Control Commission stopped this process. The law was in force until the first quarter of 2013.

Since then, the construction of commercial solar power plants in Lithuania has stopped. Many PV installers and equipment sellers have gone bankrupt. People only installed Off-grid solar plants for their own needs. This development of PV energy in Lithuania took place until the legalization of net metering in the spring of 2015. Afterwards, those wishing to install Off-grid PV plants did not receive such favorable subsidies from the State, but they could and still can apply to the Lithuanian Environmental Investment Fund (LAAIF) for partial reimbursement of the cost of the PV equipment. Support is also available from Local Action Groups (LAGs) or the Young Farmers Settlement Program. It should be notified that Off-grid PV plants only work with batteries, but they offer relative energy independence as they operate completely independently from the electricity grid.

Grid-connected solar power plants will continue to be complemented by Off-grid plants with battery power reserves. Grid-synchronized plants allow savings, while Off-grid or islanded solar micro-plants with battery storage provide a kind of energy independence, optimum self-consumption of the energy produced (redirecting excess energy to e.g. water heating), and the possibility to have electricity right here, right now, i.e. with no need to develop projects, wait for a favorable renewable energy law, or fear changes to the same law, to the detriment of the owners of the solar plant.

Second-hand PV

As it was mentioned before: “The requirements for the equipment to be installed - must be new (unused), comply with EU standards and eco-labels normally required for such equipment.”

In Lithuania, the practice of green energy generation is shorter than the lifetime of PV plants, so there has been speculation in the social sphere about where to put them when they fail. Experts ensure that although Lithuania does not yet have many worn-out PV plants, the infrastructure to recycle them is already in place. In Lithuania, there is an "Electronics Producers and Importers Organisation" (EGIO) which manages this waste following the WEEE Directive. If the panels are no longer working and the warranty period has expired, owners can either call electronics equipment managers to take away the equipment free of charge, or they can take them to bulky waste collection sites themselves. Legal entities may be subject to additional charges for the collection or delivery of such waste.

However, since only 10 kW PV are supported for households, there are ones, which install more capacities, and in this case, there are possibilities to use second-hand not used or very little used panels, which were disassembled in Lithuania and/or other EU countries for some reason and are being sold with discount and without guarantee.

One-Stop-Shop (OSS)

There is plenty of information on all levels of supporting institutions on possibilities to install PV plants, support measures, funding, etc. in Lithuania. Besides, all major developers of PV plants are strongly promoting PV projects as well as acting as qualified advisors. Most of them also provide project design free of charge. Thus, here we can state, that all these companies act as One Stop Shops.

4.4. Poland

PV plug and play

The PV plug and play kit, also known as photovoltaics to the socket, is a complete, prefabricated photovoltaic installation for the home, which only requires connection to a contact in the apartment or house to produce electricity from the sun. Installation of such a photovoltaic system does not require a special team, as the whole thing has been developed so that even people without much knowledge of renewable energy or electrical installation can carry it out. The whole essence of PV plug and play is that the kit is already configured and has all the necessary components for operation. For it to start producing energy for us from the sun, all we need to do is mount it in the desired location and connect the wires. The procedure is like assembling furniture purchased from popular furniture chains.

Do energy operators allow such a solution in Poland?

As far as formal issues are concerned, Commission Regulation (EU) 2016/631 of 14.04.2016, (with which, among other things, the procedure for notification of photovoltaics to the grid is associated) sets out the requirements for installations with a capacity of more than 0.8 kW. For smaller sets, the regulations are not precise - especially when it comes to such an unusual design as a photovoltaic for a socket.

So, do you need to inform the operator that you are using such a solution? To avoid possible problems, it is worth contacting the DSO. Until the regulations are clarified, the further path will depend on the operator itself. However, some of them (e.g., Enea) treat plug-and-play PV similarly to off-grid PV and do not require any procedures.

When considering the purchase of plug-and-play PV, one must keep in mind that it is a relatively young solution. The first such home DIY photovoltaic kit was presented by Fraunhofer CSE in 2016. Because of this, in Poland they are not as widespread as in Germany, for example.

Capacity	0,8 kWp	0,75 kWp
Tariff	~ 4.200 zł	~ 3.700 zł
Annual profit (at optimal assembling)	~ 800 kWh	~ 750 kWh
Annual savings	~ 640 zł	~ 570 zł
Payback	~ 7 years	

Plug-and-play PV is still a novelty on the photovoltaic market. In Poland, the solution is so far not as popular as, for example, in our western neighbors, which affects the availability and cost of the kits. However, the ease of use and minimal paperwork associated with photovoltaics to the socket in a short time may win it many fans. Especially now when electricity prices are rising at an alarming rate.

Off grid solar kits

Off grid solar kits are built with mono or polycrystalline panels. They are fully self-contained, photovoltaic sets. In their case, excess energy is stored in batteries instead of going to the distribution grid, which is the case with many standard photovoltaic solutions. It is therefore a solution that allows users to become independent of the power grid.

Off-Grid sets do not require any notification to the power grid company. Off-Grid photovoltaic systems are fully self-contained and do not return excess energy produced to the power distribution grid. Excess energy is stored in batteries.

In Poland, it was not until November 5, 2021, that the Metered Law created a legal framework for the development of modern technologies, enabling the integration of distributed energy, and abolished previous barriers to the operation of energy storage, such as double counting of grid fees. A decree of the Minister of Climate and Environment, containing implementing regulations for the law, was promulgated in the Polish Official Gazette. Currently, storages are not subject to registration and are treated as generation units. The Meter Law has made the electronic registration of energy storage facilities above 50 kW mandatory. This will allow monitoring the development of storage technology in Poland. This means that we are just beginning the adventure with energy storage. Find out this process has been going

on in the German market as of 2013. Add that it began with the introduction of a support program for the purchase of energy storage.

Second-hand PV

Disposing of photovoltaic panels when they wear out or become damaged is not complicated at all in Poland. The Polish law on electro-waste also takes photovoltaics into account, and panel recyclers are already operating in our country.

Photovoltaic panels, like any object, wear out over time. Manufacturers of photovoltaics most often state that their lifespan is 25-30 years. This does not mean that after that the panels simply stop working - studies suggest that today's photovoltaics can last up to approx. 50 years. However, it is a natural feature of the panels that their efficiency decreases over time, and after about 25 years will be only about 80 percent of the initial efficiency. At that point, it is best to replace the panels with new ones and dispose of the old ones in accordance with regulations - they must not go to the regular trash.

It is worth remembering that we are talking about averaged values - the service life of a particular panel depends on many factors and can decrease, for example, due to damage or a manufacturing defect. Lifespan, on the other hand, can be extended by taking care of photovoltaics and performing regular maintenance.

Photovoltaics are subject to the same disposal regulations as other electro-waste. It is explicitly listed in one of the appendices to the Law on Waste Electrical and Electronic Equipment. The regulations clearly indicate that the owner of the panels must recycle them. This means that photovoltaics should go to a specialized plant for their disposal.

Importantly, according to the law, the photovoltaic manufacturer is obliged to take back used panels free of charge. The electro-waste can be picked up at the point of sale (where the customer delivers it) or at the place where the equipment is delivered (the manufacturer comes to pick up the waste himself). This is explained in Article 37 of the Law.

The owner of photovoltaic panels has several options for their disposal. No paperwork is required for this. The possibilities are as follows:

- contact the distributor of the panels and arrange to pick up the used equipment on site,
- on your own, deliver the dismantled panels to any point of sale of any photovoltaic distributor,
- on your own, deliver the equipment to one of the specialized photovoltaic recycling companies.

From photovoltaics, the recycling process recovers primarily glass and aluminum - the dismantled components can be reused. Silicon is also recovered, which can later be used to manufacture new PV panels. In addition, small amounts of other materials, including silver and plastic, are also found in PV installations.

One-Stop-Shop (OSS)

In Poland, there is a lot of information at all levels of institutions, associations, companies about the possibility of installing power plants, support programs, financing, etc. Companies operating in the market

strongly promote PV projects. In Poland, companies involved in photovoltaics, mostly provide comprehensive services, i.e., help to obtain financing, all documentation, design, consulting services, installation and, in the final phase, disposal.

Recently, several initiatives have emerged to facilitate the formation of energy communities, engaging in sustainable energy initiatives, but above all representing the interests of the resident. This is how the idea of establishing One Stop Shops, energy communities that support local communities in working together on the energy transition, came about.

One Stop Shops (OSS) form the basis of the UP-Stairs project, aimed at breaking down barriers to the formulation of energy communities. In March 2022, a document "Framework for legal support to citizens" was prepared to support residents, during the formation of collective actions such as transferring surplus energy to other members of the energy community, and to help familiarize them with the activities of One Stop Shops.

According to the analysis conducted, for the purpose of the document, the most important barriers that occurred during the creation of One Stop Shops are:

- lack of or incomplete regulations related to energy communities.
- energy community as a new, unknown structure.
- the inability to obtain funding for the creation of collective activities.
- the difficulty of gaining the trust of residents, who may perceive OSS activities as hindering or, due to a lack of previous experience, may be afraid of what joining an OSS entail.
- the need to establish a legal entity, which may involve a difficult administrative process.

So far, individual One Stop Shops have learned several lessons that should help not only the currently established service points, but also those that will be established in the future. It has been noted that a major challenge is finding properly educated as well as experienced service personnel. In addition, they noted the need to consider a wider audience for OSS services, so as not to exclude any group that could potentially be interested in them.

In the case of the creation of more one-stop shops in a region, the need to link them into a single network was noted. This will make it possible to collect data and share the effects of activities between different points, which in turn will help to improve imperfections and allow consistency in their activities, despite their different goals and structures. It is also important to note that OSS activities should focus on residents, for whom public consultations and information events should be held regularly.

Each region where a One Stop Shop is established has advantages that can contribute to its success. In the case of OSSs in Ireland and Austria, a big plus is that the residents of Cork and Upper Austria have a high environmental awareness. In contrast, One Stop Shops in Barcelona and Asenovgrad are fostering a growing interest among residents in renewable energy sources and increased energy efficiency. For all the emerging service points, an important aspect is also that they are intended to help the region/country move toward energy decarbonization or, in the case of Austria, even toward energy neutrality.

A significant advantage of each of the OSSs is also expected to be that their activities will relate to the needs of the residents of the respective regions, e.g. in the Asenovgrad Municipality, the service point's activities will support groups particularly vulnerable to energy poverty, while in Barcelona special attention will be given to the development of RES, mainly by increasing the number of photovoltaic panels, which will be able to cover a significant part of the energy demand due to the high solar insolation found in the country.

Source: https://energia0.pl/efektywnosc-energetyczna/item/842-one-stop-shop

4.5. Sweden

Plug-In PV

Plug-In PV are not allowed in Sweden by national electricity authority Elsäkerhetsverket.

Second-hand PV

Second-hand PV have not yet started to be a market in Sweden. It is likely to start in coming years when new PV panels will be more efficient than today, and people would like to have the most updated equipment.

Off-grid PV

Off-grid PV systems including batteries are available in Sweden but are not a noticeably big market. The electricity grid is well built out and covers permanent living areas. However, there are remote summer houses, hunting cabins and other smaller facilities located outside the ordinary electricity grid. For these places an Off-grid solution could be an interesting option. In the region of Skåne, the most populated region in Sweden, it is not many of these facilities where a possible Off-grid solution would be an option. In the north of Sweden there are likely to be more of them.

One Stop Shops (OSS)

In Sweden there is something called Energy Advising Service. Each local authority will receive a grant from the government to employ a local energy advisor. The size of the grant depends on the number of inhabitants in the local authority. The local energy advisor can give advice to citizens and companies about PV. The energy advisors are objective and neutral and cannot market in certain brand of PV or a certain company for installation of PV. They will give advice about PV in general and what to think of when buying an installation of PV. There are also 15 regional energy agencies in Sweden, who coordinates the local energy advisory service on a regional level. The energy agencies could direct interested persons and companies to a local energy advisor for further information.

Part 2: Atlas (Selected projects)

1. Germany

Country	Germany 01
Title	“2ndlifesolar”; recycling and reuse of retired PV/solar panels
Address	Hamburg, Germany
Type of energy	Self-sufficiency for production by using recycled PV-panels
The purpose of installation	Reuse of old panels to create new systems by much lower costs
Technical aspects	377 panels on a total area of 625m^2 to produce up to 97.6 kW$_p$/a 40% self-sufficiency, power-storage is planed
Economic aspects	Pilot project for utilization of recycled panels (2020) In comparison to every year’s power costs, 8000€ profit, counting in feed-in tariff. next step is providing power for e-mobility to reduce CO_2 up to 32t/a
Short description and interesting details	First every build “Recycling PV-System” on HME’s (big local waste disposal company) rooftop. This company does reuse, repair and disposes retired systems in a real circular economy, without export to other countries.
One- max. two photos, if available	

Country	Germany 02
Title	“Frisen-Haus” Ottensen
Address	Hamburg, Germany
Type of energy	PV panels on rooftop for tenant flow
The purpose of installation	Self-sufficiency in power for renters and feed-in tariff usage
Technical aspects	4 rows of PV-panels, able to produce 7000kWh/a. smart meter tool provides monitoring capability
Economic aspects	12000€ investment for approximately 24% self sufficiency 80% of produced power is used directly.
Short description and interesting details	This project is directed towards the 50 artists, working in this structure. Combined with a renovation of the rooftop, the 8.3kW system was mounted in 2016. A smart meter tool was implemented, to show off the current power supply and usage.
One- max. two photos, if available	 

Country	**Germany 03**
Title	"Handwerkerhof Ottensen; PV on new building for craftmanship
Address	Hamburg, Germany
Type of energy	PV panels on rooftop for tenant flow
The purpose of installation	Self-sufficiency in power for craft companies, to reduce costs
Technical aspects	114 panels on rooftop; 260Wp per module by "Solarworld" 29,64 kWp installed capacity, initialized by "Solaroffensive Hamburg"
Economic aspects	Reducing energy costs for small craft companies
Short description and interesting details	This newly build community building for small/medium craft companies was planned to supply itself with power by implementing 144 polycrystalline PV-panels. the initiator of this project, "Solaroffensive Hamburg", plans to get at least 5000 roofs equipped with PV/solar panels.
One- max. two photos, if available	 

Country	Germany 04
Title	PV system for middle class business
Address	Hamburg, Germany
Type of energy	PV panels on rooftop for self-usage and feed-in tariff usage
The purpose of installation	Self-sufficiency for office and e-mobility
Technical aspects	140m^2 of PV panels with a capacity of 13,6 kWp; estimated yield of 9.5 MWh/a
Economic aspects	Total investment (PV and company cars) 200,000 € Reducing fuel expanses, by converting into e-mobility, because they made half of the energy-costs. (Only 3,75€ /100km). Independency for charging company cars
Short description and interesting details	Build in 2009, roofer company “Heinz Kopp” invested in a PV system with 13,6 kWp to operate his offices and company cars. Use of vacuum tube collectors to produce energy for his cars, this arrangement safes up to 15 t CO_2 per year. In addition, a roof insulation and new heating systems does provide savings of 1.5 t CO_2 per year.
One- max. two photos, if available	

Country	Germany 05
Title	solar research building with partial self-sufficiency
Address	Berlin, Germany
Type of energy	PV panels, installed on facade and rooftop
The purpose of installation	Self-sufficiency in power and for feed-in tariff usage
Technical aspects	60 monocrystalline 240 W PV-panels (14,1kWp) on roof+ 73m^2 (8kWp) facade-panels. At first, 40kWh storage using discarded car batteries for testing purposes, afterwards battery system by Lion Smart. Heating with power-based air water heat pump and het recovery system by ventilation
Economic aspects	Usage of recycled car batteries with > 80% nominal capacity. Successful test, even under unfavorable weather conditions. ➔ Self-sufficiency only with PV-usage Annual power consumption is lower than power gain with PV. Consumption: 12400kWh Gain: 13,306 kWh (11,578 kWh/a roof / 5,047kWh/a facade).
Short description and interesting details	A research building, build to investigate the possibilities of solar usage for daily life and e-mobility. The building was built for test families to simulate a daily consumption and to test out “new” strategies of power storage and facade design. After the testing phase, the building was used for public events and as working space.
One- max. two photos, if available	 

Country	Germany 06
Title	"SoliSolar"- Initiative for small-scaled solar-systems for renters and house owners
Address	Hamburg, Germany
Type of energy	Micro Solar PV for balconies, walls, and roofs.
The purpose of installation	reducing energy costs with self-made power
Technical aspects	Maximum of two panels with 300W each for private use. Approximately 300kWh per year; no storage, only direct use
Economic aspects	Total investment 600 € per module; state support depends on location of use., with lifespan of at least 20 years. Estimated payback is 5 to 8 years, but with current situation, it could be lower. (90-110€ per year energy-cost reduction) Production costs for systems are reached in less than one year.
Short description and interesting details	Energy transition in small steps; with micro systems for everyone. Small-scaled, permission free and legal opportunity to produce power for everyday use, organized by local, non-profit initiatives. mounted on balconies, rooftops, or walls with direct connection to power grid. orientation should be south or southwest/southeast for best results over the day.
One- max. two photos, if available	 

Country	Germany 07
Title	“Sonnenhöfe” Wilhelmsburg
Address	Hamburg, Germany
Type of energy	PV panels on rooftop for tenant flow
The purpose of installation	Self-sufficiency in power for renters and feed-in tariff usage
Technical aspects	Newly build complex with 198 panels on rooftop by “Winaico” 823 kWp/a installed on 329,3m2 for electricity and feed-in tariff.
Economic aspects	65500€ total invest; 49,2% self-sufficiency for renters, to lower the costs for electricity. 50,8% for feeding into local power grid.
Short description and interesting details	Build in 2014, this apartment building powers itself with PV-panels. The installation degree of ~10° in full south orientation does make this system very effective, by achieving 42,4 kWh. In addition: This building does provide energy for the apartment next to him as well. The combination of PV and a combined heat and power plant helps to decrease the energy costs for the future.
One- max. two photos, if available	

2. Finland

Country	Finland_01
Title	**Berry and honey farm**
Address	Haapamäki, Finland
Type of energy	16,6 kWp photovoltaic system, installed on roof 20 modules east and 20 modules west direction
The purpose of installation	Electricity production for freezers and refrigerators.
Technical aspects	Installed PV capacity 16,6 kWp; Module type 415 Wp 40 pcs, manufacturer Trina. Inverter Solis 15 kW. Annual electricity generation appr. 760 kWh/1 kWp installed.
Economic aspects	Total investment 14 900 € and estimated payback time 10 years.
Short description and interesting details	The farm grows strawberries, raspberries, and other berries. Honey is also produced. Modules have installed on the roof, east-south slope 132 pcs and north-west slope 36 pcs. The electricity production time is in summer about 15 - 17 h.
One- max. two photos, if available	Installation in spring 2023

Country	Finland 02
Title	**Dairy farm**
Address	Kyyjärvi, Finland
Type of energy	52 kWp PV-system
The purpose of installation	Electricity for milk cooling and milking robots.
Technical aspects	Solar PV with installed capacity 52 kWp; Module type 310 Wp x 168 pcs. Annual electricity generation appr. 810 kWh/1 kW installed.
Economic aspects	Estimated payback during installation (2020) was 8-10 years, in current conditions and electricity prices could be 6-7 years.
Short description and interesting details	1 milking robot which operating 23 h/day and 1 h for washing. Milk must be cooled + 4 °C and in summer season fans cooling building. Modules have installed on the roof, east-south slope 132 pcs and north-west slope 36 pcs. The electricity production time is in mid of summer about 15 - 17 h.
One- max. two photos, if available	 

Country	Finland 03
Title	**3,8 kWp PV-system of three single eco houses**
Address	Helsinki Finland
Type of energy	3,8 kWp photovoltaic system installed on the roof.
The purpose of installation	Electricity production for single house consumption.
Technical aspects	Installed PV capacity 3,8 kWp; Module type 270 Wp 14 pcs, manufacturer SolarWatt. Inverter Fronius 3,7 kW. Annual electricity generation appr. 890 kWh/1 kWp installed.
Economic aspects	Total investment 7 100 € per house and estimated payback time 8-10 years, which depend on the price of electricity. Several installs at the same time give some price benefits.
Short description and interesting details	Modules have been installed on the roof, south slope angle about 40°. The orientation of the houses and the roofs are designed to optimize the production of solar energy. Houses are very energy efficiency, solid wood construction and ecological. Geothermal heat pump, low temperature floor heating and energy-efficient ventilation.
One- max. two photos, if available	

Country	Finland 04
Title	**Hybrid system**
Address	Kuopio, Finland
Type of energy	10 kWp PV, 6 kW solar heating, electric energy storage 28 kWh and 9 kW geothermal heat pump
The purpose of installation	Electricity production, energy storage and heating for single house and electricity for electric vehicle. The goal is to be self-sufficient as possible.
Technical aspects	Installed solar PV capacity 10 kWp; Module type 310 W x 9; Manufacturer – SolarWatt. Annual electricity generation appr. 800 kWh/1 kW installed. Solar thermal heat pipe 6 kW installed on the south wall. Geothermal heat pump 9 kW and backup bio boiler with wood fuel
Economic aspects	Invested without subsidies, all costs about 32 000€. Estimated payback 12 – 15 years, which depends on price of electricity.
Short description and interesting details	The system was built little by little, in three years. 1. solar heat 2. solar electricity 3. geothermal heat 4. electricity storage. This way the investment costs have been spread over several years.
One- max. two photos, if available	 

Country	Finland 05
Title	**4,8 kW residental PV system**
Address	Keuruu, Finland
Type of energy	Single house PV-system
The purpose of installation	Electricity production, for single house heating and electricity consumption
Technical aspects	Installed PV capacity 4,92 kWp; Module type 410 Wp 12 pcs, manufacturer SpolarPV. Inverter Steca 4,8 kW. Annual electricity generation appr. 840 kWh/1 kWp installed.
Economic aspects	Invested without subsidies, all costs about 6 000€. Estimated payback 7-9 years, which depends on price of electricity.
Short description and interesting details	Modules have been installed on the roof, south slope angle about 27°.
One- max. two photos, if available	

3. Lithuania

Country	**Lithuania 01**
Title	**Micro PV on a terrace house**
Address	Kaunas, Lithuania
Type of energy	PV combined with heat pump air-to-air
The purpose of the installation	Electricity and cooling/heating supply for household.
Ownership	Private
Technical aspects	Micro solar PV with installed capacity 2.79 kW; Module type 310 W x 9; Manufacturer – Solar Fabrik. Annual electricity generation appr. 1000 kWh/1 kW installed. Heat pumps of A+ energy efficiency class for heating and cooling. Annual energy consumption for cooling is 219 kWh/a, and for heating 840 kWh/a. Manufacturer SAMSUNG.
Economic aspects	Total investment 3000 €; state support for PV household consumers is 332 €/kW, thus total compensation was 926 €. The estimated payback during installation (2019) was 8-10 years, in current conditions and electricity prices could be 3-5 years. Investment into heat pumps 840 € x 2 = 1680 €.
Short description and interesting details	The single-family (3 persons) terrace house has a total area of 80 sq.m. and a roof area - of 40 sq. m. The installed PV panels were oriented towards the south, and this is the reason, why only 3 lines, 3 panels each, could be installed and the total capacity is 2.79 kW only. Installation degree – 17°. Annual yield between 2550 and 2790 kWh/a, and monthly output varies from approximately 4.2 kWh in January to 460 kWh in June. Solar PV covers appr. 25% of total annual household demand. 2 Heat pumps produce cooling in summer and heating when it is not too cold during autumn/spring periods. The PV capacity covers annual energy consumption both for heating and cooling.
Photos	  Owners photo

Country	**Lithuania 02**
Title	**Carport with solar PV**
Address	Šiauliai, Lithuania
Type of energy	PV on top of a carport
The purpose of the installation	Carport with a shed with power generation
Ownership	Private (business)
Technical aspects	Solar PV with a capacity of 9.45 kW on the roof of the carport with dimensions: 7.70 m. x 6.30 m.
Economic aspects	Total investment 13,200 €.
Short description and interesting details	The company owner of the project is involved in the installation of PV plants, and also in the installation of such carports and has installed this one as an example on the company premises. BAUER (Germany) panels “glass-glass” are used. Guaranteed efficiency of 87% for 30 years. Inverter – Solis, the installation angle is 10-12 degrees. The construction is made of aluminium.
Photos	 ©Ecoenergas.

Country	**Lithuania 03**
Title	**PV-based electric vehicle charging station**
Address	Kaunas, Lithuania
Type of energy	PV for vehicle charging station
The purpose of the installation	Solar PV feeding vehicle charging station
Ownership	Municipal DH company
Technical aspects	A PV solar power plant with an installed capacity of 20 kW was installed on the roof of the office building, with an annual electricity generation of 17,000 kWh. This accounts for most of the electricity consumed annually in the company's main office building. The vehicle charging station can charge the batteries of two electric vehicles at the same time. The charging station has a medium speed and a charging capacity of up to 22 kW.
Economic aspects	The investment into PV was 23,000 €, The average payback period of the solar plant is 10-12 years. After this period, the plant will continue to operate to reduce electricity costs. The lifetime of the solar panels is about 30 years. The investment in the charging station was 5,400 Eur.
Short description and interesting details	It was estimated that the photovoltaic plant will generate most of its electricity in April and August when it will generate more than 2,000 kWh of electricity per month. In May and June, electricity production exceeds 2,500 kWh. In the autumn-winter period, electricity production is between 149 and 800 kWh per month. Most of the electricity is consumed in the company's main office building, while the rest is fed into the electricity grid through net metering. The installed charging station uses part of the electricity generated by PV. The station was installed to use advanced future technologies. The station is designed and built to be comfortable and easy to use, to look aesthetically pleasing and to withstand vandal attacks. In the meantime, the charging station is free of charge for electric vehicles. The station was commissioned by Kauno energija and installed by the Kaunas company Elinta.
Photos	  AB Kauno energija

Country	**Lithuania 04**
Title	**Mini PV with hybrid inverter and EV charging in town private house**
Address	Kaunas, Lithuania
Type of energy	PV combined with standard and hybrid inverters
The purpose of the installation	Electricity, hot water preparation, cooling/heating for household purposes, EV charging for a private car. In the future plans to install an electrical battery (about 10 kWh) with a possibility to operate partly as ***Off-grid PV***
Ownership	Private
Technical aspects	Mini solar PV with installed capacity 12.98 kW; a few module types (installation in different places of the roof during different installation periods) 240 W x 8; 280W x 8; 320W x 8; 460W x 6; 500W x 7. Annual electricity generation appr. 900 kWh/1 kW installed. Electric heater for hot water preparation – 3.5 kW. Heat pump air-to-air (manufacturer Hisense) 5 kW of A+ energy efficiency class for heating and cooling. Annual energy consumption for cooling is 510 kWh/a and for heating 1540 kWh/a.
Economic aspects	Total investment 12500 €; state support for PV household consumers is 332 €/kW, thus total compensation was 3320 € (only up to 10 kW PV installation). The estimated payback during installation (2020) was 10-12 years, in current conditions and electricity prices could be about 5-6 years. Investment into heat pumps 1640 €.
Short description and interesting details	The single-family (2 persons) private house has a total area of 120 sq.m. and a roof area - of 150 sq. m. The installed PV panels were oriented towards the south (6,92 kW), west (2,56 kW) and east (3,5 kW). Installation degree – 28°. Annual production is between 9,650 and 10,910 kWh/a, and monthly output varies from approximately 10 kWh in December to 1420 kWh in June. PV covers appr. 35% (direct consumption) of total annual household demand; 18% of total annual domestic hot tap water preparation (hot water storage tank with electric heater). Solar iBoost+ is installed next to the hot water tank. When activated it intelligently controls and adjusts the level of energy flowing to the immersion heater in line with the export levels as they rise and fall); 6% of total direct electric vehicle home charging. Heat pumps produce cooling in summer and heating when it is not too cold during autumn/spring periods.
Photos	  Owners photo

Country	**Lithuania 05**
Title	**Mini PV on countryside private house**
Address	Kaunas reg., Lithuania
Type of energy	PV combined with heat pump air-to-water
The purpose of the installation	Electricity and heating supply for household.
Ownership	Private
Technical aspects	Mini solar PV with installed capacity 15.40 kW; Module type 385 W x 40; Manufacturer – Energetica. Annual electricity generation appr. 1000 kWh/1 kW installed. Heat pumps of A+ energy efficiency class for heating. Annual energy consumption for heating is 12,000 kWh/a. Manufacturer Daikin.
Economic aspects	Total investment 14,000 €; state support for PV household consumers is 332 €/kW, (maximum compensation to 10 KW) thus total compensation was 3320 €. The estimated payback is 3-5 years. Investment into heat pump 3,200 €.
Short description and interesting details	The single-family (4 persons) private house has a total area of 120 sq.m. and a roof area of 56 sq. m. with cars covered port area - of 57 sq. m. The installed PV panels were oriented towards the east. Installation degree – roof 36°, cars port - 14°. Annual yield between 12,000 – 13,000 kWh/a, and monthly output varies from approximately 50 kWh in January to 2,000 kWh in June. Solar PV covers 100% of total annual household demand. Heat pumps produce heating and hot water during the whole year.
Photos	 Owners photo

Country	**Lithuania 06**
Title	**Mini PV on the cultural centre of the village community**
Address	Kėdainiai reg., Lithuania
Type of energy	Solar PV with a standard inverter
The purpose of the installation	Electricity for electrical equipment of a cultural centre, for space cooling/heating with air-to-air heat pump.
Ownership	Community
Technical aspects	Mini solar PV with an installed capacity of 11.4 kW; Module type and number 380W x 30. Annual electricity generation appr. 820 kWh/1 kW installed (9350 kWh). The annual energy consumption of the cultural centre is about 8000 kWh/a generated from PV and supplied by the power grid.
Economic aspects	Total investment was 18,500 €; state support for PV and modern heating system installation was 14,800 €. The estimated payback during installation (2021) was 11-13 years, in current conditions (with higher electricity prices) could be about 6-7 years.
Short description and interesting details	The cultural centre has a total area of 160 sq.m. and a roof area - of 210 sq. m. The installed PV panels were oriented towards the south (18 plates) and east (12 plates). Installation degree – 45°. Annual production is between 7,500 and 8,500 kWh/a, and monthly output varies from approximately 25 kWh in December to 1350 kWh in June. Solar PV covers appr. 31% (direct consumption) of total annual equipment in a small cultural centre; for electrical equipment and cooling/heating heat pump (air to air). Electricity is consumed for cultural community activities, children's employment activities, artistic self-activity, the demonstration of home crafts and some educational activities, etc.
One- max. two photos, if available	 

Country	**Lithuania 07**
Title	**Mini PV at a small farm**
Address	Kėdainiai reg., Lithuania
Type of energy	Solar PV with a standard inverter
The purpose of the installation	Electricity for electrical equipment in a small cattle farm; for electrical equipment in the farmer's garage/workshop; for grain drying equipment during the grain harvesting season; and for household purposes
Ownership	Private
Technical aspects	Mini solar PV with installed capacity 9.88 kW; module type and number 380W x 26. Annual electricity generation appr. 1000 kWh/1 kW installed (9,8800 kWh). Total annual energy consumption in a small farm is about 32,000 kWh/a from PV and power grid.
Economic aspects	Total investment 9,500 €; state support for PV of the small farm was 369 €/kW, thus total compensation was 3,646 €. The estimated payback during installation (2021) was 9-12 years, in current conditions (with higher electricity prices) could be about 6-7 years.
Short description and interesting details	The farmer's garage/workshop has a total area of 210 sq.m. and a roof area - of 250 sq. m. The installed PV panels were oriented towards the south. Installation degree – 36°. Annual production is between 9,000 and 9,500 kWh/a, and monthly output varies from approximately 30 kWh in December to 1750 kWh in June. Solar PV covers appr. 19% (direct consumption) of total annual equipment in a small cattle farm; for electrical equipment in the farmer's garage/workshop; for grain drying equipment during the grain harvesting season; and for household purposes.
One- max. two photos, if available	 Owners photo

Country	**Lithuania 08**
Title	**Mini PV in a small motorcycle repair and parts manufacturing company**
Address	Kėdainiai reg., Lithuania
Type of energy	Solar PV with a hybrid inverter
The purpose of the installation	Electricity for electrical equipment in a small motorcycle repair and parts manufacturing company; for space heating and cooling, charging an electric car, etc. There are plans to install electric storage battery.
Ownership	A private company (small business)
Technical aspects	Mini solar PV with an installed capacity of 29.6 kW; module type and number 400W x 74. Annual electricity generation appr. 1050 kWh/1 kW installed. The annual energy consumption of the company is about 41,000 kWh/a using solar PV and from the power grid. Part of PV is on-ground.
Economic aspects	Total investment was 33,500 €; state support for PV small company's consumers is 369 €/kW, thus total compensation was 10,922 €. Estimated payback in current conditions (with higher electricity prices) could be about 4-5 years.
Short description and interesting details	The company office and garage workshop have a total area of 250 (150+100) sq.m. The installed PV panels were oriented towards the south. Installation degree – 45°. Annual production is between 9,500 and 11,000 kWh/a, and monthly output varies from approximately 150 kWh in December to 5,000 kWh in June. Solar PV covers appr. 38% (direct consumption) of total annual electrical demand, used by the equipment in the company garage/workshop, cooling/heating heat pump and charging of an EV.
One- max. two photos, if available	 Owners photo

Country	**Lithuania 09**
Title	**Medium PV in the biofuel boiler house**
Address	Jonava, Lithuania
Type of energy	Solar PV with standard inverters
The purpose of the installation	Electricity for biofuel boiler house, for electrical equipment in the boiler house and small share for local office rooms, cooling with air-to-air heat pump.
Ownership	Municipal (district heating company)
Technical aspects	Solar PV with installed capacity 77 kW; panels type and number: 315W x 244. Annual electricity generation appr. 950 kWh/1 kW installed (73,150 kWh). Annual energy consumption in boiler house from PV and power grid appr. 217,000 kWh/a.
Economic aspects	Total investment 78,500 €; state support for PV was 18,940 € (246 €/1kW). The estimated payback during installation (2021) was 7-10 years, in current conditions (with higher electricity prices) could be about 2-4 years.
Short description and interesting details	The boiler house has a roof area - of 1210 sq. m. The installed PV panels were oriented towards the south. Installation degree – 18°. Annual production is between 65,000 and 70,000 kWh/a, and monthly output varies from approximately 240 kWh in December to 11000 kWh in June. Solar PV covers appr. 3% (direct consumption) of total annual equipment in a biofuel boiler house; for electrical equipment and a very small part for cooling with a heat pump (air to air). Approximately 98% of electricity from solar PV is directly used in the boiler house (without electricity storage service in electrical networks).
One- max. two photos, if available	 UAB ,,Jonavos šilumos tinklai"

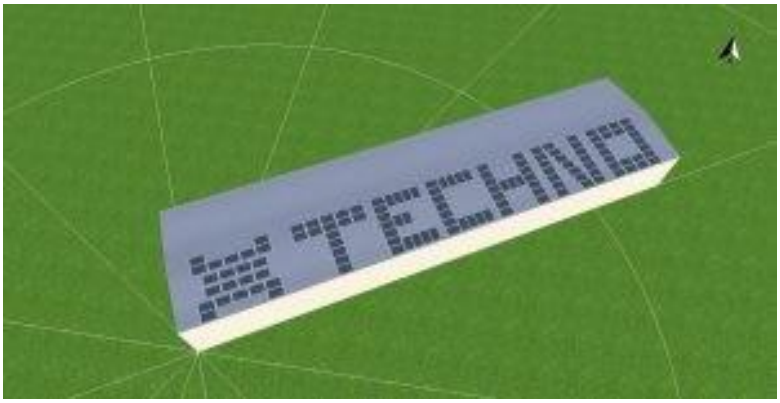
Country	**Lithuania 10**
Title	**Lights over pedestrian-cycle path**
Address	Birštonas-Gelažūnai, Birštonas Municipality, Lithuania
Type of energy	Off-grid PV with batteries
The purpose of installation	Lightening of recreational bike path.
Ownership	Municipal
Technical aspects	21 such luminaires are installed on the cycle-pedestrian path leading to Gelažūnai. With solar panels, ~40 W each.
Economic aspects	The value of the works is EUR 12898.78.
Short description and interesting details	On the way to Gelažūnai village, modern luminaires can be seen on the roadside. Birštonas municipal administration has announced that the municipality has started using solar-powered luminaires to illuminate its cycle and pedestrian paths. This installation took place in 2020. New route with 50 new luminaires on the pedestrian and cycle path from the Norfa shopping centre to the entrance of the Birštonas Urban Management Authority's territory in Škėvonys village was later installed in 2021. According to the Birštonas Municipality's this project was "financed under the programme measure "Creation and improvement of infrastructure for young people for leisure and wellness" of the "Community Initiated Local Development Strategy 2015-2020 for the rural area of the municipalities of the Alytus district and Birštonas".
One- max. two photos, if available	  Photos by Lukas Kazakevičius

Country	**Lithuania 11**
Title	**PV on historic heritage building**
Address	Kaunas, Lithuania
Type of energy	Solar PV with standard inverters on special building
The purpose of installation	Lightening and other needs of the building
Ownership	State owned
Technical aspects	124 units of Sharp NUJC330 330W monocrystalline panels were installed with total installed capacity 40.92 $kW_{p.}$ The system is equipped with 2 inverters - 22.5 kW, and unidirectional electricity meter.
Economic aspects	The installation of PV on cultural historic building was fully subsidized by the state.
Short description and interesting details	The historic building of state theatre was established in 1892. In 2003, the renovation of the theatre's facade started, in 2007, a reconstruction plan was prepared and approved, and in 2008 the reconstruction of the basement and the refurbishment of the auditorium cloakrooms started. Over the last decade, many works have been carried out, including the installation of a ventilation system and a fire alarm, the renovation of the heating system, and the renewal of the sewerage network. In 2021-2022, installation of PV project was performed with simultaneous introduction of innovative lightening (at night). The requirement for historic building was that solar panels should not be seen from below.
One- max. two photos, if available	 Photo by D. Biržietis 

4. Poland

Country	Poland 01
Title	**Photovoltaic installation**
Address	Lubin, woj. Dolnośląskie
Type of energy	Photovoltaic installation
The purpose of installation	Reducing energy charges.
Ownership	Private
Technical aspects	A 5.4 kWp installation consisting of 18 pieces of high-end photovoltaic panels by Heckert Solar.
Economic aspects	In addition, a grid inverter was used which produces electricity for household use.
Short description and interesting details	By connecting the inverter to the Internet, it is possible to constantly monitor the installation via a computer/tablet. This is a very convenient solution.
One- max. two photos, if available	 

Country	Poland 02
Title	Wroclaw University of Economics
Address	A dormitory of the Wroclaw University of Economics
Type of energy	Photovoltaic system
The purpose of installation	Investing in your own photovoltaic system will bring tangible economic benefits, contribute to reducing the carbon footprint on the environment. Photovoltaic technology is the answer to specific problems like overpricing and environmental pollution
Ownership	State
Technical aspects	The flat roof with roofing felt received 40 kWp, i.e., 117 photovoltaic panels. The photovoltaic system was protected according to the high standard of Multisun. The safety index is influenced using low-voltage technology from the manufacturer of the SolarEdge inverter, high-end protection and arresters from the manufacturer DEHN, and automatic fire circuit breakers. The whole project has been checked and approved by a fire expert.
Economic aspects	By producing its own energy, the University of Economics will gain savings of up to PLN 26,000 on its electricity bill annually.
Short description and interesting details	This is a pilot project commissioned by the Wroclaw University of Economics. The photovoltaic system was built on one of the dormitories in the city centre, a 10-minute drive from the Central Railway Station.
One- max. two photos, if available	

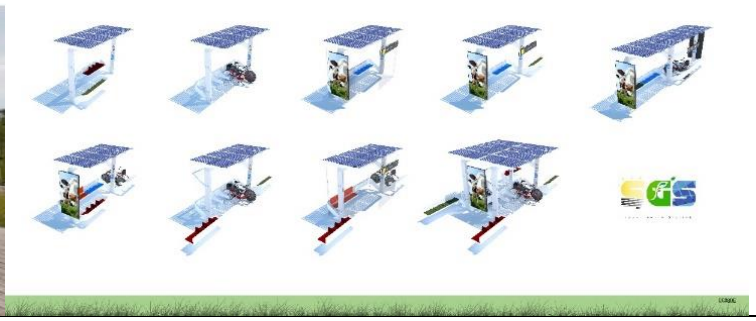
Country	Poland 03
Title	Photovoltaic system
Address	Święta Katarzyna (gmina Siechnice)
Type of energy	Photovoltaic system
The purpose of installation	Another interesting project in Lower Silesia. This is a photovoltaic installation in the village of Swieta Katarzyna (Siechnice municipality).
Technical aspects	The system consists of 129 photovoltaic modules of 310 W each and a grid inverter.
Economic aspects	Energy independence (the energy produced by the panels covers part or all of your electricity needs). Savings in the form of smaller electricity bills. Independence from rising electricity prices. The ability to amortize investment costs and write off the tax base.
Short description and interesting details	At the request of the client, the installation was designed and made in the form of the name and logo of the company for which it will produce electricity. Despite the complicated layout of photovoltaic modules. The installation took about a week, and the results of the work are shown below.
One- max. two photos, if available	 

Country	Poland 04
Title	Photovoltaic system
Address	Pałac Jedlinka
Type of energy	Photovoltaic system
The purpose of installation	Reducing energy charges.
Technical aspects	A photovoltaic installation of about 150 kWp was installed on three roofs of the Jedlinka Palace in Jedlina Zdrój
Economic aspects	The photovoltaic installation will allow you to reduce the cost of your business by lowering the amount you pay for electricity. An additional advantage is the protection against the increase in the price of energy from conventional sources and the reduction of negative impact on the environment.
Short description and interesting details	Installing the photovoltaic panels was quite a challenge, especially since the entire work was supervised by a conservationist.
One- max. two photos, if available	

Country	Poland 05
Title	Photovoltaic system
Address	Oleśnica
Type of energy	Photovoltaic system
The purpose of installation	Reducing energy charges.
Technical aspects	Power - 40 kWp Panels - QCELLS Q.PLUS BFR-G4.1 270 W. Inverter - FRONIUS ECO 27.0 WEB/LAN, FRONIUS SYMO 10.0-3-M light Construction - TRIC
Economic aspects	Over the course of a year, the energy produced will save at least 20,000 zlotys from the bill, which means a return on investment in just about 7 years, and that's without subsidies.
Short description and interesting details	Another interesting project carried out in Lower Silesia. This time the implementation for a business client in Olesnica.
One- max. two photos, if available	

5. Sweden

Country	Sweden 01
Title	**Smart Green Station**
Address	Mölle, Sweden
Type of energy	PV (Off-grid)
The purpose of installation	Small multidisciplinary (resting, meeting, playing area, charging station, public service stop) facility with off grid electricity user possibilities combined with internet communication facilities (wifi).
Technical aspects	Smart Green Station develops interactive and climate-smart, with multiple options such as bus stops, bicycle parking and resting facilities that are at the same time a meeting place for opportunities. The installation is of off-grid character and is possible to use anywhere. The PV charge batteries which in turn supply electricity for different user purposes at the station. A basic meeting point, gives space for 4-8 people in its area, comprehending an area of 2 by 2 meters and a solar-panel roof with height in between 2,40 and 2,70 meters. Power source is composed by 2 solar panels of 445-470 wats each. The dimensions of each panel are 2,12 by 1,052 meters by 35 mm. The battery back-up system has a storage capacity of 1kW, capable of supplying electricity up to 4 days without sunlight. Hence, the power obtained can be used in our stations to charge different devices, it would be included in the station a 230V plug, two USB 5V ports and an inductive charging point. The plug will allow the charge of electric bicycles and scooters, while the rest will be used for mobile phones, drones, and other smaller devices. The station is using an internal feeding system of 5, 12, 15, 24 and 48 V to supply internal services such us a smart screen, environmental sensors, and lighting of the station.
Economic aspects	The investment cost differs from case to case and station to station but is market competitive. The estimated cost of a standard station (the one previously described) would be around 180000-200000 SEK, having in mind that the price may vary depending on the needs of the client, always looking for the most optimal price for the client.
Short description and interesting details	Smart Green Stations are equipped with solar panels, internet connection and charging points (USB sockets, plugs, etc.). The different stations are interconnected and can communicate between each other through cloud wireless communications, where visitors can use this data and get educated through an online platform.

One- max. two photos, if available	 

Country	Sweden 02
Title	**Energy Advisory Service**
Address	Lund, Sweden
Type of energy	PV
The purpose of installation	To give objective advise of PV equipment and installations.
Technical aspects	The local energy advisor could give objective counselling to private persons and companies for about PV equipment and installation of PV facilities. The energy advisor is not allowed to market any particular brand of PV equipment or company for installation. The energy advisor could give advice about what PV facility to install and how it could be designed.
Economic aspects	The energy advisory service on a local level in Sweden, is funded by the government. The local authorities have the possibility to apply for funding for a grant to employ a local energy advisor. The size of the grant depends on the number of inhabitants in the local authority.
Short description and interesting details	The regional energy agencies in Sweden (15) coordinates the local energy advisory service in local authorities. In Skåne region it is the Energy Agency Southern Sweden.
One- max. two photos, if available	ENERGIKONTOR SYD

Country	Sweden 03
Title	**PV on farm house (source:www.energiengagemang.se)**
Address	Tomelilla, Sweden
Type of energy	PV
The purpose of installation	A sustainable option for energy supply and increasing the degree of self-sufficiency on electricity
Technical aspects	Size: 380 square meters Number of panels: 224 Installed capacity: 64.96 kW. Yearly production: 58 000 kWh Yearly consumption: 114 000 kWh Degree of self-sufficiency: 51 %
Economic aspects	Having the degree of self-sufficiency of 51 % really supports the economy in installing the PV facility. When more electricity is produced than consumed, the over production is sold on the market.
Short description and interesting details	The facility was built already in 2016. The agriculture company that installed it is part of the challenge “Fossil free Sweden” and installed PV on at least one roof per year up to 2020.
One- max. two photos, if available	 © Jonas Weissglas / EnergiEngagemang

Summary

Atlas on options for small-scale photovoltaics in five project participant countries – Germany, Finland, Lithuania, Poland, and Sweden - is provided under this report. The report is also supplemented with several typical and/or some exceptional small-scale PV examples in above mentioned countries, as well as the map, providing locations with basic information on the presented examples.

Chapter 1: The national situation of generating PV in the participating BSR countries provides national statistical data and actual situation regarding background and development in photovoltaics field during the recent years. Statistics shows the success of PV development in all five participating countries; however, all countries deal with some difficulties.

Chapter 2: Identification & analysis of risks, barriers, and success factors for the implementation of small-scale photovoltaics presents Success factors, such as being cheaper alternative compared to other forms of electricity generation due to the many years of subsidies and preferential purchase of electricity from PV power plants, and the feed-in priority of PV energy on the energy market in Germany. In Finland see implementation of political measures that encourage the introduction of small-scale solar electricity and increasing the awareness to have a significant impact in the future. A combination of supportive policies, technological development, public awareness, strong solar resources, cooperation, and access to finance will contribute to the success. The public became increasingly interested in PV plants in Lithuania, Poland, and Sweden.

Every participant also encounters several risks and barriers for development of PV plants.

In Germany these are the shortage of skilled workers and unresolved conflicts with power plants that can only follow a fluctuating residual load to a limited extent for technical and economic reasons. Funding is available via low-interest loans from German development bank. There is also socio-economic barrier, such as information deficits for many people due to a big number of elderly homeowners.

In Finland, the main barrier is lack of components and skillful installers mostly situation is caused by due to high demand. There is still lack of awareness about the benefits of small-scale solar electricity and how the technology works. There is some uncertainty around the regulatory framework for PV installations, particularly with regards to net metering and the remuneration of self-consumed electricity. The PV panels on the roof are sensitive to weather conditions due to big amount of snow in winter, which reduces the energy yield and the return on invested capital. Connecting the plug-in system to the network can be challenging due to technical and regulatory reasons, which can slow down their implementation process and is not yet authorized. The existing incentive schemes for small-scale PV installations in Finland are not sufficient to offset the high installation costs, which can discourage potential purchasers of PV systems.

In Lithuania, main barriers come from the fact that the bigger players do not help households to install solar PV plants. According to the Energy Minister, entrepreneurs are only looking at attractive sites, where

it is profitable. There is a problem with the electricity grid capacity, and lack of PV panels and inverters due to equipment supply bottlenecks and lack of kit parts. Though support schemes are sufficient, there are limited funds of support, and only equipment is supported.

In Poland for PV installations of more than 50 kW, there is a need to obtain a building permit for PV installations and for connection conditions. These procedures usually take up to a year of time. This is one of the barriers for investors of medium-sized PV installations. The main barriers are limited opportunities for entrepreneurs to finance investments, legal regulations of support, administrative and procedural difficulties, and problems with the operation of industrial networks.

And in Sweden for really small-scale PV facilities using electric plug to put in an electricity wall socket for connection to the electricity grid, there are great barriers. They are not allowed at all in Sweden by the authority that approves electrical equipment, Elsäkerhetsverket. On a local level it could be a challenge to balance the electricity system, for example when an urban district decides to go for 100 % electricity supply from PV. Plug-in PV with a electrical plug that you plug in an electrical wall socket are not allowed.

Support comes from several networks, associations and other promoting bodies on national and regional levels in all countries.

Chapter 3: Localized analysis – mirror the conditions analyzed against the local situation in the BSR countries shows local conditions in five countries, which promote development of new small-scale PV solutions. There are different funding solutions, such as feed-in tariff and exempt from VAT (Germany), big variety of state subsidizing as in Lithuania, Poland and Sweden. In Finland situation is more complicated as the system is complex and requires a good knowledge of construction and energy technology to evaluate the effects of the measures, since support to family houses is only available if the property's energy efficiency improves by 44%. There is also support for businesses, communities, etc. in the most countries.

Chapter 4: Specific analysis of potential solutions. Opportunities for such potential solutions for development of small-scale PV. ***Plug-in PV***, which are supported and very popular in Germany, possible, but not supported and thus not so popular in Lithuania and Poland and forbidden in Finland and Sweden. ***Off-grid PV*** are possible and can be used for various applications in all countries under this study. ***Second-hand PV*** are already used in Germany, have certain potential in Finland, Lithuania, and Sweden, maybe Poland as the technical age of installed panels has not yet finished here. ***One-stop-shops***, with various success, are developed and operating in all five countries under investigation. Germany, which have the most extensive experience, also suggests such business models as ***Rental PV*** and ***Tenant Flow Model***.

Part 2 of this output provides 31 good practice project examples, typical and/or with variety of applications in five partner countries. These examples are also implemented in the map, available at the project website.