POWERUP
The catalyst for social innovation in the energy market

Guidelines on renewable energy production business case:

How to do, what to take into account

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Executive summary

The POWER UP project promotes the emergence of local energy market players with a socio-ecological agenda. By providing energy services at the local level in 5 pilot cities in Spain, Czech Republic, Italy, Belgium and The Netherlands, the project explores ways to fight energy poverty. Engaging vulnerable households in co-designing these new business schemes around renewables production and energy efficiency is a cornerstone of the project.

Any local authority wanting to install solar energy on their own assets or windturbines on municipal ground, needs to go through a series of (sometimes lenghthy) steps. In order to facilitate the process and learn from other, we share experiences from the five POWER UP pilots. This report can guide them thanks to very practical insights. It is divided into two sections:

- Part 1 (chapters 2 and 3) provides accessible information on the technical, economic and legal aspects of renewable energy projects for both beginners and more advanced local energy market players such as municipalities and energy communities: This section focuses on solar and wind projects, i.e. the technologies represented in the POWER UP pilot cities. The general guidelines are complemented by country-specific examples from the pilot countries.
- Part 2 is for those who are interested in having a deeper look, you can find more details in the second part of the report (chapters 4-7) on the installations used in the pilot cities Valencia, Roznov, Eeklo, San Giuseppe Vesuviano and Palma Campania (UCSA) and Heerlen.

Check out the other public reports of the POWER UP project on **www.socialenergyplayers.eu.**

01

Introduction

This report covers the economic, technical and legal aspects related to the set-up of renewable energy installations by energy communities.

Chapter 2 focuses on the case of an energy community realizing PV panels on the roof of a residential, public or other building. For more practical insights, you can find the description of a step-by-step approach to the screening of a building's solar potential in chapter 2.5.

Chapter 3 describes the main aspects regarding the realization of wind projects. As these are technically, legally and financially quite complex projects, this report only provides a first overview of a standard approach. More detailed information is needed if your energy community wants to advance on this.

In chapters 4 to 8, you find more information on the economic, technical and legal side of the POWER UP projects in Valencia (Spain), Roznov (Czech Republic), Eeklo (Belgium), UCSA (Italy) and Heerlen (The Netherlands).

02

General guidelines on solar plant installations

2.1

The role of solar energy in the renewable energy transition

Solar energy is an important pillar of the renewable energy transition. Compared to other renewable energy sources, solar energy is cheaper and easier to install, making it one of the most accessible ways to spur the transition to a fossil-free energy system. The production potential is huge and can trigger massive energy savings, emission reductions, and – as the POWER UP project strives to demonstrate – can leverage benefits for vulnerable citizens.

In this chapter, you will find more information on the production potential of solar energy, the solar ambitions of national and European politics, the energy savings and emission reductions triggered by solar energy, and potential benefits for vulnerable households.

Production potential of solar energy and policy ambitions

Solar energy has a huge production potential in all European Member States. The European Union wants to accelerate the use of this potential and is aiming for an annual production capacity of 30 GW by 2025. The current production capacity of solar panels in the EU is 4.5 GW per year (Source: PV Vlaanderen). In order to realize this, the EU Solar Strategy included in the 2022 REPowerEU package proposes that at least one renewable energy community is set up in every municipality with a population higher than 10,000 people by 2025.

In the National Energy and Climate Plans 2021-2030 you can find the ambition your country defined regarding the role of solar energy in the transition to a sustainable, reliable and affordable energy system. For example, in the Belgian National Energy and Climate Plan, a solar map was used to determine a potential of 57 GW with 'ideal' suitability class. The Spanish Integrated National Energy and Climate Plan 2021-2030 sets a target of around 39 GW installed

PV power, out of which self-consumption projects could represent between 9 and 14 GW, according to the national Self-consumption Roadmap. And the Czech Republic, in turn, plans to achieve a 22% share of renewable energy in gross final consumption by 2030 (CZ NECP 2020).

Sometimes, there might also be ambitions regarding solar power defined on regional or local levels. For example, in the Flemish Climate Strategy: Flanders aims to transform its energy system into a climate-neutral, sustainable, reliable and affordable energy system by 2050. In the long term, the share of fossil emissions in the electricity mix decreases systematically, to disappear completely by 2050. You might find more information on your region on the website of Regions4Development.

Energy savings: insulation and solar production

The electrification of the current energy system will cause a higher demand for electricity. Besides a maximum use of local and renewable energy sources such as solar energy, we also will have to focus on energy efficiency to meet the rising demand.

Regarding solar power, this means that, before PV panels are installed on a roof, the roof should be sufficiently insulated. For example, in Flanders, it is compulsory to provide a minimum amount of roof insulation before installing PV panels. In general, it is important to check how much roof insulation has already been installed and whether there are plans to renew the roof and insulation in the near future, i.e. within the first five years. Solar panels typically last at least 25 years. Producers of solar panels guarantee a panel yield of 80% after 25 years, so renovation and efficiency works should occur before the panels' installation.

The amount of solar energy that can be produced by an installation (that is, the amount of fossil fuel burning that is avoided) depends on the geographic location. For example, in Belgium, per kWp a solar panel produces an average of 900 kWh per year. In Czech Republic, the average is 1,000 kWh, and in Spain this can go up to 1,500 kWh per year. Software predicts yields in more detail, depending on the installed power, inverter power and orientation of the installation. If we calculate with the Belgium average, a PV installation will yield 22.500 kWh per installed kWp after 25 years of energy production.

Emission reduction

Calculating the CO_2 emission reduction from renewable energy generation by solar panels is a complex exercise and can be done in different ways. In order to be transparent in these kinds of calculations, it is important to be clear about the chosen calculation methodology.

The emission reduction can be determined relative to different parameters:

- The regional average CO_2 emission factor. For example, for Flanders this was 273g CO_2/kWh in 2020. This average varies annually based on the production mix.
- The CO_2 emission factor of a conventional combined cycle gas turbine (CCGT)1 powerplant. This CO_2 emission factor assumes that for a saving of 1 kWh electricity, 2 kWh less gas must be burned in a CCGT with an efficiency of 50%. This is a simplified, time-independent approach.
- The average CO_2 emission factor of conventional controllable thermal power plants:In Flanders, this is much higher than the CO_2 emission factor of a CCGT power plant, namely 661 g CO_2/kWh in 2020.

EXAMPLE OF ECOPOWER

Ecopower calculates CO_2 reduction by reducing the emissions of a CCGT power plant by the emissions of a solar panel plant. The emissions of a CCGT plant is 400 g/kWh.[2] The CO_2 emission factor of renewable energy sources is conventionally 0g CO_2/kWh. However, Ecopower takes into account the impact of materials and transport by calculating with a CO_2 emission factor of 45 g/kWh. That means that, for example, a solar panel installation providing 22,5 MWh of electricity in 25 years, reduces 8 tons of CO_2 emissions per kWp ((400 g/kWh - 45 g/kWh) x 22.5 MWh). A solar panel installation on a household is typically 4 kWp. On a large roof, installations of several MWp are possible.

[1] CCGT : combined cycle gas turbine. This powerplant is based on the combination of a gas turbine driving a generator and a steam turbine driving a generator with steam made of the heat of the hot exhaust gases of the gas turbine. Typical efficiency of CCGT plants is 50%, which means that 50% of the energetic value of the burned gas is turned into electricity. New designed CCGT plants go up to 60% efficiency due to innovation in gas turbine technology.

[2] For a long period, Ecopower followed 400g CO_2/kWh as emission factor of a CCGT to calculate the emission reduction realized by its renewable energy sources installations, as determined by the audit covenant committee. The Flemish Energy and Climate Agency (VEKA) indicates that the CCGT CO_2 emission factor is 381 gCO_2/kWh. However, for consistency reasons, we retain 400 g CO_2/kWh.

Other potential direct and indirect benefits for vulnerable households

By co-investing in cooperative solar panels, citizens who do not have a suitable roof for solar panels or do not have the budget needed to install PV panels themselves, can still become part of the energy transition. Joining a renewable energy cooperative means taking control of the energy supply in a sustainable manner through direct participation. Members control the cooperative democratically, receive a dividend of up to 6% in the yield of the installations if there is a profit, and in many cases, can also buy energy generated by the installations at cost price. Co-ownership of all the cooperative's renewable energy installations reduces risks. Administratively, everything is taken care of through the cooperative. Citizens can be part of an energy community and help create as much renewable energy as possible without setting up a new legal entity.

2.2

Technical aspects

Of course, desides the economic aspects of a PV installation, you also have to look into the technical side. In this chapter you can learn more about the necessary steps towards solar installations. For a step-by-step approach to the screening of a building, have a look at chapter 2.5.

Screening of rooftops

To do an initial screening of whether a roof is suitable for solar panels, online solar maps can be used if made available by the government. Also (online) aerial photos are useful to get an initial indication of whether there are a lot of shadows on the roof and, therefore the roof is favorable for solar panels or not. However, remember that these photos are often not recent. A visit to the building, including entering the roof, is always recommended.

During a screening, the following issues are considered:

- Dimensions of the roof. They help you calculate how many solar panels fit on the roof, taking into account the type of support structure, spacing between rows on flat roofs, minimum distance from the eaves and any obstacles on the roof that cause shade (you will read more about this in the next sub-chapter).
- Condition of the roof covering.
- Areas where other buildings, trees, etc. may cause shade
- An initial assessment of the roof's structure in terms of stability. This is often not visible, but try to gather as much information as possible from the owner.
- The presence of insulation. This, too, is often not visible and should be asked to the owner.

- The power rating of the connection. You can usually find this on the electrical diagram of the general low-voltage board or at the circuit breakers. The inverter power (in KVA) should not exceed the current connection power of the grid connection. If it does, consideration can be given to adding weight to the connection, which involves a fairly large cost. Often, the inverter power is then rather limited.
- Check whether you are dealing with a low-voltage or high-voltage connection. Is there a high-voltage cabin present?
- Where the main meter is located. Note the type of meter or take a picture.

EXAMPLE FROM FLANDERS: solar map of the Flemish government

In Flanders, you can do an initial check via the Flemish government's solar map. On this site you can find estimates of the expected return, purchase price, payback time, average savings on energy bills, etc. The numbers only give an indication. Each project must first be studied thoroughly because several factors determine how many solar panels are possible: stability, orientation and size of the roof, whether there is shade, how much electricity is consumed and at which times.

Estimate the potential of solar panels on a rooftop

To know how many PV panels can be installed on a rooftop, you can use two methods.

The first is to measure the roof based on online aerial photos. You need to know the dimensions of the solar panels you wish to install. A frequently used solar panel size is currently 1.76m x 1.13m (420 Wp), for example, but there are of course many other possibilities, and this is also evolving rapidly. On a flat roof, the spacing between rows is usually between 0.5 and 0.7m. It is also important to maintain enough distance from the roof edge; the higher the building, the greater the distance from the roof edge should be. A rule of thumb that you can use is 1 meter for one building storey, 1,5m for 2 building storeys and 2m for 3 building storeys.

The second method is to use online tools to design a solar panel system. There are free tools, like Sunny Design, and there are tools you have to pay for, like Solar Monkey. With these tools you can easily design a rooftop system without measuring and calculating. They use aerial photos, and if you choose a brand and type of solar panel, the dimensions of the panel is known by the system so you do not have to worry about dimensions. With these tools, you can also easily calculate the expected energy yield of the solar system.

You can also already determine the orientation of the solar panels. Sometimes the orientation is evidently fixed due to the shape of the roof. South-facing provides a greater yield, but for large flat roofs, an east-west structure is often opted for. For the latter, the yield per kWp is slightly lower, but the difference with south-facing installations is limited. The advantage of using 'east-west' structures is that you can provide more power (kWp) per square meter, and slightly less ballast also needs to be provided.

Figure 1 - Solar panels in an east-west configuration

Figure 2 - Solar panels in a south-facing configuration

Determining the power of the inverters

Once the desired capacity of solar panels in kWp is known, you can also determine the capacity of the inverter(s).

Most inverters can be over-dimensioned. This means that you can connect a higher capacity of solar panels (in kWp) to the inverter than the capacity in kVA of the inverter. Consult the technical sheet of the inverter for this or contact the manufacturer. Solar panel installers are also well aware of the possibilities. A ratio of 125% is always possible, i.e. 125 kWp connected to an inverter of 100 kVA. Today, more kWp is often provided per kVA.

The disadvantage of over-dimensioning your inverter is that at peak times in the sunny months, you will see a capping of production, resulting in a loss of production. Since there will often be surplus electricity production at those peak times, this is not necessarily a negative thing. In southern countries with more sun throughout the year, it will probably make more sense to keep a higher inverter power, as the loss will be higher there.

Orientation also plays a role in inverter sizing. By orienting solar panels to the east or west, you can provide more kWp per kVA of inverter power since the yield they generate is lower. So the yield of the PV installation will be slightly lower but, especially with a low inclination (10 to 13°) of the modules, the difference with a south-facing PV installation is limited. A good rule of thumb is not to oversize by more than 150% for east-west oriented solar panels, e.g. maximum 75 kWp on 50 kVA inverter power.

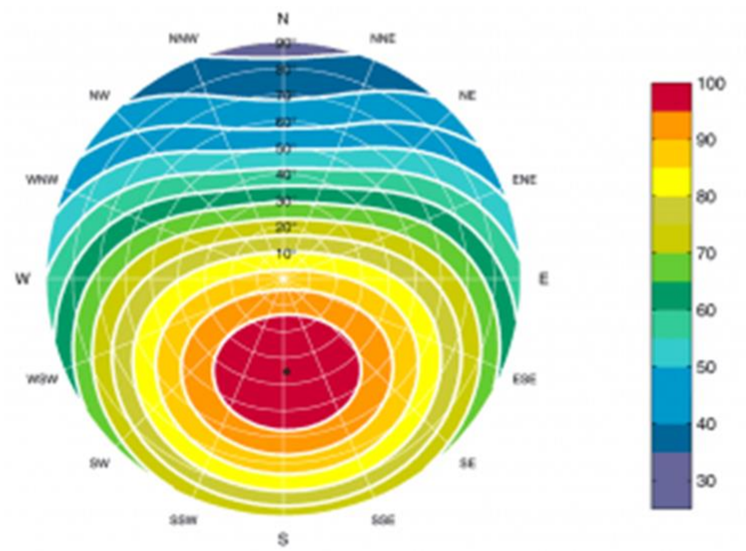


Figure 3 - The irradiation factor indicates how much direct sunlight reaches the panels on the roof

In some countries, you should bear in mind that from a certain inverter power the grid operator imposes the installation of a grid protection system. In Belgium, for example, it is requested for more than 30 kVA, and the cost of a grid protection system is between 6,000 and 10,000 euros.

Construction of the PV installation - points of attention

For the construction of a photovoltaic installation, you need to hire an installer. Here are a few points to watch out for;

- Draw up specifications describing the technical conditions, but also include requirements regarding the contractor's insurance. Attach these specifications to the agreement you make with the installer.
- Prior to the photovoltaic installation, in most cases you should request a grid study from the grid operator. This study will check whether and under what conditions the PV installation can be connected to the electricity grid.

- During and after the installation work, it is important to **ensure that it is done according to the rules and the specifications**. A correct installation is important and reduces the likelihood of any problems during operation. It is important to note that a positive electrical inspection does not guarantee everything has been done correctly according to the specifications.
- **Ensure that the PV installation does not damage the roof**, for example, by covering cables in covered cable ducts.
- It is also important to set up a **system to monitor the PV installation**. For this, separate hardware, such as data loggers and 4G routers might need to be provided. A simple choice is to use the inverter manufacturer's monitoring software. In this case, connecting the inverters to the internet is sufficient. It is advisable to decide on a strategy in advance on how you will go about this. Also discuss this with the installer beforehand.

2.3

Economic aspects

Several aspects play a role in financing a solar installation. In this chapter, you will read more about the most important ones:

- Investment costs, i.e. all costs related to the purchase of the installations;
- Operating and maintenance costs once the PV panels are installed;
- Which financial revenues you can expect:
    - From direct consumption
    - From injection into the grid
    - From subsidies
- How the profitability of the project can be calculated
- The impact of the profitability study on the dimensioning of the PV plant

Interested in reading more on financing of cooperative solar projects? The following resources might be useful:

- SCCALE financing guide for energy communities
- Energy Community Platform: online one-stop shop with tools relevant to energy communities, like examples of solar maps, rentability calculation tools, etc.
- Energy Cities Espresso training on community energy, including a module on financing basis

Investment costs

Investment costs can vary greatly between projects, which makes it difficult to provide general information.

What kind of costs are we talking about when speaking of investment costs? Below, you can find the main costs associated with the realization of a PV project, realized and financed by an energy community.

- Materials: solar panels, inverters, cabling, support structure
- Installation costs (installer)
- Costs for the grid operator (grid study, meter replacement,...)
- Costs for a stability study
- Costs for electrical inspections
- Costs for monitoring: data loggers, production meters and possibly internet (via 4G)

Nevertheless, there are some rules of thumb that apply in most situations.

The bigger the installation, the cheaper the relative cost price. In general, it can be said that the cost price (euro/kWp) of a PV installation decreases when the installed capacity of the PV installation increases.

Costs depend on the type of roof and its covering. Flat roofs with classic roofing or pitched roofs with tiles are the cheapest. Solar panels on slate roofs are very expensive.

The less inverters, the cheaper. The number of inverters or inverter power also plays a major role in the investment cost. You can reduce costs by limiting the number of inverters. Several low-power inverters are more expensive than one high-power inverter.

The bigger the installation company, the cheaper (but less support for the local economy). There are also big differences between installers. Smaller, local installers will often charge a higher price than larger installers. Yet many energy communities prefer to work with local installers to support the local economy. This trade-off can be made on a project-by-project basis.

PV on roofs and on land is cheaper than on water surfaces. Besides classic PV installations on roofs, more and more PV installations are envisaged on land and car parks (solar carports). Floating PV on large water surfaces is also on the rise. The investment cost of PV on land and PV on roofs is comparable, with large installations always being cheaper than small ones due to economies of scale. Solar carports and floating PV are significantly more expensive than solar panels on roofs: you have to calculate twice the price of a roof top installation or more. These types of projects certainly require a sufficiently large scale to somewhat reduce the cost. In addition, subsidies are usually needed to make these projects profitable (see later on in this chapter).

In addition to these investment costs, there are also **potential costs that are not directly linked to the PV installation itself**. Sometimes all of these often rather small costs add up to a considerable amount and might impact the overall assessment, especially of smaller projects.

- Personnel costs for the development of the project by the energy community, follow-up of the works, and related administration
- Notary fees if a right of superficies is concluded, linked to which a surveying plan must be made by a surveyor, which entails an additional cost.
- Personnel costs for preliminary surveys of the roofs (internal personnel costs or external costs)
- Costs for developing and implementing a communication campaign (personnel costs, printing, rental of a location for an information event, etc.)
- Cost of extending the electrical connection of the building. These costs can be quite high, and in many cases it is opted not to increase the electrical connection but to limit the power of the PV installation (inverters)

Operating costs

Once the investment costs are made and the PV plant has been installed, you have to foresee a certain budget for the follow-up of the plant's operation:

- Personnel costs for monitoring and managing the PV plant.
- Costs for a brand-independent monitoring portal (subscription). This is recommended for energy communities with multiple PV plants with inverters of different brands. Energy communities with a limited number of PV installations in their portfolio can use the inverter manufacturer's free portal for this purpose.
- Staff costs for preparing invoices for the sale of electricity generated by the PV plant
- Costs for reparations and replacements of defective parts. This includes the cost of materials, installation costs and personnel costs for following up on these reparations.
- Insurance costs for the PV plant.

Financial return/revenue

Ideally, a PV plant will provide the energy community with a certain financial revenue that can serve to pay back the investment costs, finance new projects, or cover other costs related to the activities of the energy community. There are several ways that PV plants can generate revenues:

- The electricity is consumed directly in the building (self-consumption), generating an advantage on the owner's electricity bill.
- The electricity generated by the plant is sold directly to the user, typically at a fixed price, which may or may not be indexed annually.
- The electricity generated by the plant is injected into the grid and sold to an electricity supplier.
- Any revenue from subsidies.

Revenue from the sale of directly consumed electricity.

The unit price for selling electricity is a parameter that energy communities are generally free to determine. Thus, to improve the profitability of a project, you can easily increase the price.

However, it is important that a project also provides a financial benefit to the building owner, who is usually also the buyer of the generated electricity. This means that the price buyers pay for the electricity they take from the PV installation will usually have to be lower than the price that they pay for the electricity taken from the grid.

Thus, a win-win must be created for all actors involved. If the price is too high, the customer will not be convinced to take up the energy community’s offer. Everything comes down to working out a proposal that is beneficial to all parties.

EXAMPLE OF A SPANISH ENERGY COMMUNITY: CEL CASTELLAR-L'Oliveral

In the first energy community in the city of Valencia, the CEL Castellar-L'Oliveral, the produced energy is distributed among the community members according to an "energy shares agreement" signed by all members. In this case, shares are proportional to the investment of each member. For example, a 600 euro investment gives the right to obtain the energy produced by 0,50 kWp, i.e. a 1,052% share of the installation. This share should lead, on average, to around 130-140 euro annual savings (real data obtained from first energy bills seems to validate these calculations). Calculations were made based on the legal mechanism for collective self-consumption and setting some parameters such as market electricity price, produced energy, etc. Assumptions were made in a conservative way to avoid false expectations.

Shares were allocated according to the actual needs of every member, performing an individual assessment for every case. A personalized report was provided by the municipality, offering indications on multiple investment choices with its related, estimated energy and economic indicators. Members were encouraged to choose the option with the highest direct self-consumption estimation, chasing values above 90%.

For performing these estimations, the municipality had no real profiles (load curves) so they considered different scenarios in a summary table, a combination of different cases crossing total consumption (yearly value) and consumption trends (low, medium or high consumption during the day, on sunny hours). This helped to have a first understanding of what the ideal participation would be for each case from an energy-efficient and economic point of view (maximize direct self-consumption, minimize payback period). The personalized reports contained indications and advice for members, encouraging them to try to change their consumption trends and move some consumption to those hours when the solar production is higher.

Direct consumption versus injection

Of all the electricity generated by a PV system, some will be consumed directly in the building and some will be injected into the grid.

The electricity **consumed directly** can be sold at a fixed price, which may or may not be indexed annually. On the electricity taken directly, the customer pays no grid costs and contributions or taxes. However, for electricity taken from the grid, these grid costs and contributions or fees must be paid. This, of course, is the advantage of buying electricity directly from solar panels.

The electricity that is not consumed directly and thus injected into the grid can be sold. For this, an agreement is made with an electricity supplier. The latter will pay a price for this electricity that is usually linked to market prices for electricity. The value of the injected electricity is lower, because taxes and grid costs will have to be paid on it after further sale by the supplier. The income from selling this electricity is, therefore, generally lower than that from direct consumption. Also, the revenues to be expected by injection are difficult to predict in the longer term, knowing that the duration of a PV project is often 20 years. Only when market prices are high, as was the case for most months of the year 2022, can revenues from injection sales be relatively high. But when market prices fall back, the price a supplier is willing to pay for the injected power will also decrease. This is why it is important to exercise caution when calculating your injection revenues.

With the above information in mind, it is obviously important to estimate direct consumption as best as possible when investigating the financial feasibility of a project. By comparing the quarterly consumption profile of a certain building in the past with the expected production profile of the solar panels on a quarterly basis, future direct consumption can be estimated relatively well. The prerequisite for this is the availability of a quarter-hourly consumption profile. The availability of such a profile varies by region or often even by type of customer. A digital meter is required in any case.

EXAMPLE FROM SPAIN: individual and collective self-consumption installations

In Spain, you do not need to pay taxes or additional costs for self-consumption installations (both individual and collective ones), even if the energy is injected into the grid. It works basically as a virtual self-consumption, as long as you comply with the requirements for self-consumption installations (mainly proximity). The energy received through self-consumption is tax-free and automatically reflected on the bill as "avoided consumption" plus a compensation for the surplus energy.

Subsidies

Subsidies such as feed-in tariffs for energy communities (kWh-based) or grants for PV plants on buildings (kWp-based) are being phased out in many regions. However, many projects are also profitable without subsidies. For more complex projects with a higher investment cost, such as for example solar carports and floating PV, subsidies are usually necessary.

EXAMPLES FROM POWER UP PILOT COUNTRIES

In Spain, there are national and regional grants specifically targeting energy communities but also for self-consumption projects in general. They are available normally during specific periods, year by year, through open calls and competitive tendering. There are also local and regional tax incentives for PV installation.

In Czech Republic, investment support for PV installation ranges from 30%-50% of the final price, depending on the type of funding programme and the building type.[3]

Assessment of profitability

Assessing whether a project is profitable for an energy community depends on all of the above factors, and of course on the return the energy community expects on its investment. For many energy communities, the expected rate of return (IRR) is 5% to 6%. However, this can vary from project to project.

Dimensioning a PV installation

Because of the uncertainty about the value of electricity injected into the grid, it is important to take direct consumption into account when dimensioning a PV plant. The more direct consumption there is in the building or on the site, the more certainty about revenue.

For example, most energy communities in Flanders aim for a minimum direct consumption of 50%. This also means that the available roof area is not always fully utilized. This is obviously

[3] New Green Savings (Nová zelená úsporám): https://novazelenausporam.cz/bytove-domy/
Modernisation Fund (Modernizační fond): https://www.sfzp.cz/dotace-a-pujcky/modernizacni-fond/vyzvy/

also a trade-off between the financial aspect and the target of providing as much renewable energy as possible.

That 50% direct consumption is not a general rule because every project is different. Sometimes it may also be that the prospective customers, for example government agencies, want to provide as much renewable energy as possible, and are willing to pay a slightly higher price for the directly consumed electricity. The fact that the customer will pay a fixed price for the electricity purchased for a long period and that it is renewable energy, may also be a sufficient motivation for a customer to accept an offer.

EXAMPLE FROM CZECH REPUBLIC

The Czech Energy Regulatory Office put together a list of 7 things that are definitely not worth underestimating when setting up a PV plant in an apartment building.

Network Connection: Check with the local distributor to ensure the distribution network can handle the power plant installation in a residential building, as it requires a non-zero reserved capacity and verification of feasibility before proceeding.

Inverter Settings: Proper inverter configuration is crucial to avoid issues such as exceeding reserved power capacity, penalties, grid charging of energy storage, and non-compliant electricity flow.

Reserved Power Capacity: Requesting an incorrect value and subsequently contracting it can lead to penalties from the distributor for exceeding the reserved capacity.

Technical Readiness: Issues, such as unprepared distribution panels or missing components like switches or relays, can cause delays in connection requests at consumer premises.

Neighbours Readiness: In a collective project for a power plant in a residential building, effective communication among residents is key. Discuss and agree on aspects like financing, individual contributions, and electricity allocation.

Connection Request: When submitting a connection request, ensure accurate and complete documentation to the distributor, including technical parameters and required attachments, to avoid errors or omissions.

Grid Feed-in: Consider the potential impact on project profitability as electricity traders may show limited interest or offer low prices for excess electricity, prolonging the payback period of the power plant installation.

2.4

Legal aspects

Besides technical and economic elements, also the legal sides of solar installation deserves your attention: who owns the roof and/or the solar panels and how do you minimize the risks related to the rooftop, the installation itself or changing circumstances? In this report, we only cover the general installation-related legal aspects that are applicable everywhere. However, you should check if there are any specific local or national regulations applicable to the collective production of solar energy.

Ownership

If an energy community invests in a third-party rooftop PV installation, the energy community retains ownership of the PV installation for the duration of the project (typically 20 years). It is important that this is well described in an agreement. In Belgium for example, a right of superficies, concession or rental agreement is usually concluded between the energy community and the owner of the building.

An agreement containing good arrangements is very important and to the benefit of all parties involved. This avoids any discussions in the future. For drafting (model) agreements, working with a legal advisor is an absolute must for the energy community. There are different types of agreements.

- A right of superficies agreement offers the most legal certainty because it is executed by a notary. The procedure is similar to selling a house or land. This procedure has a certain cost; you should count around several thousand euros.
- A concession can only be granted by a government.
- In a lease or rental agreement, an energy community rents the roof of a building for a certain period of time.

The concession agreement and the rental agreement are not notarized and are therefore a cheaper option.

Risk management

Some things should be described in the agreement to mitigate the risks for the energy community that has invested in the PV installation.

- Who bears the costs in the event of any roof repair that might require the temporary removal of the PV plant. Not only the removal and reinstallation have a cost, but missing some production in the meantime also causes a loss. Both costs should best be carried by the owner of the rooftop. If this is not the case, the potential loss should be taken into account in the business model.
- Insurance against fire and storm damage. Clear agreements are important to avoid discussions between insurance companies. For example, in case of a claim under fire insurance, it can be stipulated that each party's insurance will cover its own damages, regardless of the cause of the fire.
- Other specific situations, such as the sale of the building on which the solar panels are located, should be addressed clearly in the agreement. What happens to the PV installation in such a case? Preferably, the new owner takes over the agreement with the old owner. If that is not possible, the PV installation is sold to the owner of the building, who can then sell it with the rest of the building. There are, of course, several other possibilities, but it is important that this is addressed. It must be ruled out that the energy community suddenly no longer has a buyer for the power generated by the PV plant, and no solution or compensation is provided for this.

2.5

Step-by-step approach for building screening for solar production

The step-by-step approach is based on the Ecopower information file on solar panels (cfr. text box) and the approach for building screenings used at Ecopower in Belgium. This approach is a snapshot of their practice in 2023 and may evolve over time. Please be aware that in your country or specific context, other or different steps might be needed to proceed with a solar project.

EXAMPLE FROM FLANDERS: Ecopower information file on solar panels More and more people are investing in solar energy in Flanders. Ecopower developed an information file on solar panels to give guidance to those wishing to invest in solar panels. The up-to-date information (in Dutch) can be found via this link. Both information on how to recognise a suitable roof, how to find a reliable installer, which premiums are available and more can be found there.

Step 1: first check of the possibilities of the building

To start with, copy an **aerial photo of the site** (google maps) into a word document so you can put arrows at the rooftop and take notes in this document.

Then, **gather the first information on the building**, best by phone or in an in-person meeting with the owner. Questions to cover in this phase:
Is the building used by the owner itself? If not, who is the building owner? Involve them as soon as possible.

- Which roofs would qualify according to the owner, taking into account future plans such as renovations, for example.

- Are the roofs well oriented and is there much shade, for example, from trees or neighbouring buildings? This can usually be determined on the aerial photo.
- What is the type of roofing?
    - Pans: here, the condition matters more, regardless of the age. Usually, there is no problem.
    - Slates: more expensive to install a PV installation on, more difficult to waterproof finish properly. Better avoid these kinds of roofs unless there is no other option.
- What is the age of roofing? A roofing younger than 15 years is probably suitable.
- What is the annual consumption of the building or the site? Only take into account the meter(s) used for billing.
    - It is common that you do not receive an immediate answer to this question. You can ask for a recent billing invoice to get the needed information.
    - The minimum consumption needed to make a project profitable depends on the context and the goals of the project.

Step 2: First analysis of possibilities

Based on the information gathered in Step 1, answer the following questions:

- Is there a sufficient suitable roof area? You might want to calculate a minimum of 15 kWp solar panels (+/- 230 m² flat roof) for a small consumer.
- Is the consumption sufficient? See above, this depends on your context and goals. For Ecopower for example, the consumption should be higher than 20.000 kWh/year.
- What is the unit price from the invoice? To calculate this, you divide the total amount in Euro (excluding VAT) by the consumption in kWh during the billing period.

If this analysis does not reveal barriers to the project, you can proceed to step 3.

Step 3: Request additional data

As this is the data you want to build your model on, it is best to request additional data by e-mail or by phone with a confirmation via email. Questions to cover in this phase:

- If an AMR meter is present: what is the quarterly consumption
- Have a proxy signed by the owner or the user
- Do they have their own high-voltage cabin?

- Information regarding the stability of the roof:
    - What is the roof structure (concrete, wooden beams, etc.)?
    - Have any stability studies already been carried out in the past?

With this information, a first feasibility screening can be carried out. If this is positive, a site visit can be scheduled.

Step 4: Site visit

Use the site visit to discuss and assess the following points:

- Explain the screening results to the owner and provide information on the further steps
- Enquire about the decision-making process within the owner's organization
- Visit the rooftop: what is the condition, are there any new shadow elements, what are the visible roof structures. Don't forget to take pictures of the roof.
- View the main electricity board and meter(s)
- Search for possible location of inverters

Step 5: Prepare and submit a quote

The energy community prepares a quotation based on the results of the screening.

Step 6 (optional): Working with a solar panel installer

If your energy community does not install the solar panels itself, you have to engage an installer. To find a good installer, you should

- ask for several reference projects.
- check how long the installer is active.
- screen the installer's financial situation.
- check if the installer has the right skills.

EXAMPLE FROM BELGIUM: Ways to check the quality of an installer

In Belgium, checking whether a contractor has debts can be done via www.checkinhoudingsplicht.be, a site of the National Social Security Office and the FPS Finances, two government institutions in Belgium. Verifying whether the right skills are present can be done at the Crossroads Bank for Enterprises. Installers of renewable energy can also get a specific certificate, the RESCert certificates of competence. However, this certificate is not applied for by all installers as there is an administration attached to it.

03

General guidelines on developing a wind plant

In this chapter, we focus on the role of wind energy in the transition to renewable energy and shed light on the technical, economic, and legal aspects of wind energy. As in the POWER UP project, only one of the five pilots (Belgium) is based on wind as a source, this chapter focuses more specifically on the Flemish context.

3.1

The role of wind energy in the renewable energy transition

Production potential of wind energy and policy ambitions

Wind now meets 15% of Europe's electricity demand on average, and much more in many countries (e.g. Denmark 44%; Ireland 31%; Portugal 26%; Spain 24%; Germany 23%). The International Energy Agency (IEA) expects wind to be the number 1 of power in Europe by 2027. The EU Commission sees wind being half of Europe's electricity by 2050, with wind energy capacity rising from 190 GW today to up to 1,300 GW. That entails a 25x increase in offshore wind in the EU. But most of the GW capacity increase will come from onshore wind.

Europe needs to accelerate the build-out of wind energy to deliver on the REPowerEU ambitions. The EU is set to build 18 GW of new capacity per year between 2022 and 2026. But it needs 39 GW a year to meet the objectives set out in REPowerEU. The energy transition also requires doubling annual investments in electricity grids by 2025.

The further expansion of wind energy will be driven by new wind farms on new sites. But it also requires significant investment in the repowering and lifetime extension of existing wind farms. Nearly half of Europe's existing wind farms will reach the end of their normal lifespan by 2030.

The expansion of wind requires progress on electrification, a competitive supply chain, supportive policies, notably on planning and permitting and finally, energy markets and grids adapted to this evolution. If all these requirements are developed, the potential for wind energy, both onshore and offshore, is very large (source: Wind Europe).

A 2019 joint study by the universities of Sussex in Britain and Aarhus in Denmark, mapped all suitable sites for wind energy in Europe. If all additional capacity were utilised, there is a potential of 52.5 terawatts of wind power. Of Europe's land area, 46 % is suitable for placing wind turbines on it. If wind turbines were installed in all suitable locations on the continent, this would even enable Europe to supply the whole world with renewable energy by 2050.

Just like for solar energy (cfr. chapter 2.1), ambitions for wind energy are also set out at a national and sometimes even regional level. You find your National Energy and Climate Plan on the website of the European Commission.

For example, for Belgium, the potential growth for onshore wind projects by 2030 has been estimated at 100 MW per year, towards a total installed capacity of 2.5GW by 2030. (Source: National Belgium Energy and Climate Plan)

In the Flemish Climate Strategy, Flanders aims to transform its energy system into a climate-neutral, sustainable, reliable and affordable energy system by 2050. In the long term, the share of fossil emissions in the electricity mix decreases systematically, to disappear completely by 2050. The focus is on energy efficiency on the one hand, but with the electrification of the system on the other, a higher demand for electricity is expected, which will have to be met sustainably by maximum use of local and renewable energy sources such as wind energy, solar energy, climate-neutral fuels, etc.
(Source: Flemish climate strategy 2050).

We expect that the electrification of households will reduce the primary energy demand by 70% but will triple the need for green electricity. In Flanders, the average household consumes around 35.000 kWh primary energy of which 10% for electricity, 30% on mobility and 60% on heat. A transition into electric vehicles and heat pumps is three times more efficient and will bring the total primary energy need of a household to 14.000 kWh per year.

In Belgium, solar and wind production are very complementary. During the summer period we have sunlight more than twelve hours a day but less wind; during the winter period we have a lot of wind to compensate for the darker period.

Looking at the European onshore wind atlas (EWEA) Flanders is the second-best region to operate onshore wind turbines. In 2022 there were 640 onshore wind turbines in operation in Flanders. Nevertheless, only 3% are cooperative wind turbines producing citizen energy.

Energy savings

The annual production of green electricity can be determined depending on the type of wind turbine. A large onshore wind turbine produces an average of 6 to 9 GWh/year in Flanders depending on the location; for example, coastal areas are windier than inland areas.

For each project, it is necessary to take into account the shutdowns or reduced production phases required for noise, cast shadow, birds and bats. The available wind supply will also strongly influence the electricity production of a wind turbine.
The Global Wind Atlas gives a picture of the average amount of wind by altitude and region. An onshore wind turbine is designed for a lifespan of 20 years, in some cases life extension is possible. If we calculate with the average, a large wind turbine provides 120 GWh (inland area) up to 180 GWh (costal area) of electricity production in 20 years. Depending on the weather, the yearly production of an onshore wind turbine can change more than 15% between a windy year and a silent year.

Small domestic wind turbines attract a lot of interest lately. However, different studies show that small wind turbines are rarely profitable. The cost is higher, and the production is much lower because of the low wind profile under 30 meters height (obstruction from landscape, trees, buildings). Since the yield is quadratic with the rotor diameter and proportional to the third power of the wind speed, small domestic wind turbines only make sense in coastal areas, such as in the flat area of Flanders with a distance to the sea of less than 30 km. Therefore, the government does not support small domestic wind turbines with subsidies in Flanders. It is better to invest in bigger wind turbines with a higher efficiency, both energetical and economical.[4]

[4] Source: https://www.ugent.be/power-link/en/projects/windkracht13/windkracht13

Emission reduction

As stated already in the chapter on solar power, calculating the CO_2 emission reduction from renewable energy generation is a complex exercise and can be done in different ways. Please consult chapter 2.1, for an overview of the different ways to calculate emission reductions, as they apply for renewables in general.

EXAMPLE OF ECOPOWER
Ecopower calculates CO_2 reduction by comparing the emissions of a CCGT power plant by the emissions of a wind turbine. The emissions of a CCGT plant is 400 g/kWh. The CO_2 emission factor of renewable energy sources is conventionally 0g CO2/kWh. However, Ecopower takes into account the impact of materials and transport by calculating with a CO_2 emission factor of 11g/kWh for wind projects. That means that, for example, an onshore wind turbine producing 180 GWh of electricity in 20 years, reduces 70.000 tons of CO_2 emissions during its whole lifespan, or 3.500 tons annually.

Other potential direct or indirect benefits for vulnerable households

In contrast to solar power, the Belgian support mechanism allows that all the wind injection can be shared among the members of the energy community. That makes it more interesting than solar power, where self-consumption is the driver of the support mechanism and business model which limits the full use of existing roof space.

The benefits of the wind turbine can be shared directly with the members in the form of electricity at cost price which creates an advantage on the electricity bill of the individual member. In this ‘supply model’ the added value is distributed to the members according to the transactions they make. This includes a solidarity mechanism: 70% of the members have only one share but can still use their entire annual consumption thanks to 30% of the members that have more shares than necessary for their annual consumption. This is the model that Ecopower uses.

An energy community can also choose to sell the energy production to the grid (wholesale market) and share the monetary benefits with its members, for example, in the form of a dividend. In this 'investor model,' the added value is distributed to the members proportionally to the amount of their investment.

EXAMPLE OF ECOPOWER

Participating in a cooperative wind turbine has several benefits for citizens. Joining a renewable energy cooperative means taking control of your energy supply in a sustainable manner through direct participation. Energy supply at cost is a service to the members. Members have a double relationship with their cooperative: they are owners of the company, including installations and production (as shareholders), and they use the energy they produce at home (as consumers).

Ecopower has 65.000 members: 70% of them only have 1 share of 250 euro, and 80% use the energy at home. So, members don't join the cooperative to invest and get rich through the dividend, but to have access to locally produced sustainable energy at a fair price. The average financial benefit of a member, i.e. a reduction on their energy bill, is a multiple of the financial benefit or dividend as a shareholder.

Ecopower produces enough electricity annually to supply its members. The solidarity mechanism inside the cooperative makes it possible that people who can only afford one share (70%) still can use all the electricity they need at home. It is the 30% members with more shares (maximum 20 cooperative shares per person) than necessary to cover their own consumption who make this possible. Ecopower is sharing its supplier license with more than 10 other citizen energy cooperatives in Flanders.

Informing and educating members on renewable energy, energy reduction and cooperative entrepreneurship, activates them to reduce their consumption by using efficient technology and adapted behavior. The less energy we need, the more members can use the produced energy from the collective installations. An average member uses around 1.800 kWh/year electricity, for an average Flemish household that is 3.500 kWh/year. Becoming a member of an energy community stimulates to take part in a just energy transition.

A Renewable Energy Source cooperative (REScoop) always works in the interest of its members and the public good. For example, in relation to the environmental impact of wind turbines, maximum consideration is always given to the neighbourhood. REScoops meet both European definitions of energy communities.

3.2

Technical aspects

In this report, we explain the approach for screening wind projects used at Ecopower. This approach is a snapshot of their practice in 2023 and may evolve over time.

Screening for a wind turbine site

In Flanders, suitable sites for wind turbines are scarce. After all, wind turbines cannot be built everywhere. A suitable location for a wind project is determined very meticulously and requires a lot of study.

Firstly, we look for connections with existing linear elements that already define the landscape. Think of motorways, canals, a high-voltage line or an industrial area. We also 'cluster', so that several wind turbines are located together. We also consider where the strict Flemish standards for noise, nature, landscape, etc. are feasible (cfr. 3.2). Furthermore, wind developers have to take into account practical constraints due to aviation or telecommunications.

After all these restrictions, we focus on the zones where wind turbines can be built and look at how we can generate as much green electricity as possible with the least possible impact on the environment. To do this, at Ecopower we use the WindPro programme to determine the impact of noise and cast shadow and calculate the expected yield of the project. If these results are also positive, we consider the potential site determined.

Once the contracts with the owners of the site are signed, further study work can be carried out. This involves drawing up a location memorandum with or without an Environmental Impact Report.

Wind turbines are efficient machines, almost 50% of the available wind energy is converted into electricity. Only when the generator is running at full load at higher wind speeds, wind is let through by turning the blades slightly out of the wind. This results in a high capacity factor of approximately 2500 full load hours a year for a wind turbine on a good location. So, a wind turbine of three MW will produce around 7.5 GWh a year. The graph below shows the annual average wind speed in Flanders.

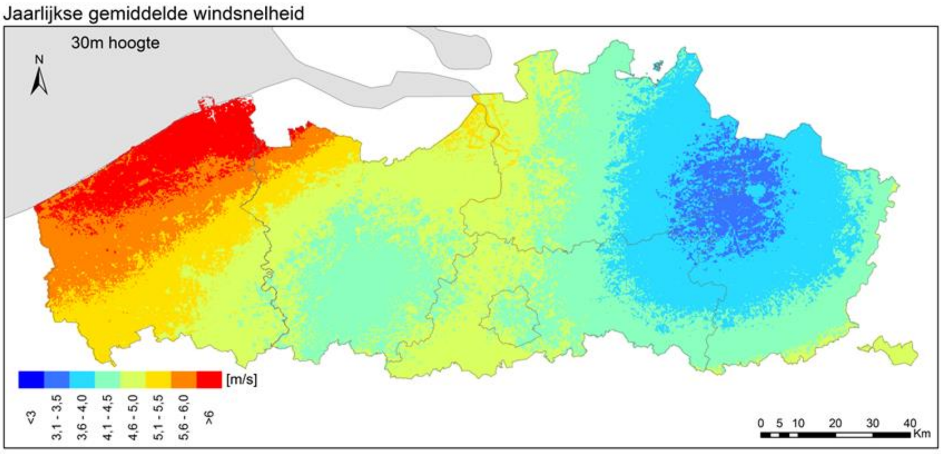


Figure 4 - Annual average wind speed in Flanders

Construction of the wind turbine

Construction of the wind turbine starts with the preparation of the site and the construction of the roads and other civil works to make the site accessible to heavy traffic and heavy parts.

During the construction of the foundations, the electrical connection to the grid must be installed.

Once the foundation is hardened, the wind turbine parts come on-site and installation can begin. Depending on weather conditions the tower-Hub-blades combination can be realized in 1 week. We like building wind turbines in windy locations, but we need windless periods to install them.

Then follow the internal assembly and connection, final inspection and try-out period.

Once the installation has proven to be fully operational without major issues, there is an official take over and the wind turbine enters operation.

Dismantling a wind turbine at the end of its lifespan

Basically, wind turbines have a lifespan of 20 years. Environmental permits used to correspond with this period. Some wind turbines may be replaced earlier by larger installations, others - like the first Ecopower wind turbine in Eeklo - get a permit extension and can run for a few more years as long as they are technically flawless and meet the operating conditions.

Sometimes wind turbines are dismantled in one place to be rebuilt in another, giving them a second life. The types of wind turbines on the market today cannot be compared to those of 20 years ago. Wind turbines have become quieter and can generate more energy at the same time. Sometimes it is smart to replace an older, less quiet wind turbine with a more modern one at a location closer to residential areas. The older turbine can then still serve perfectly in a more remote location or abroad.

If the wind turbine is not used again in another project after its lifetime in one project, it is dismantled. The parts are reused for new turbines or recycled. Modern wind turbines can be well recycled and therefore generate hardly any waste. The mast consists of steel or concrete, as does the foundation. The generator consists of copper and steel, the cables are copper or aluminum. Only the rotor blades, which are usually made of fiberglass and synthetic resin (light and strong), are more difficult to recycle. However, they can often still serve for lower-grade applications such as traffic poles. Of course, innovation is not standing still in the field of materials either, and much progress is being made in terms of recycling and circular economy.

3.3

Economic aspects

As regards investing in onshore wind projects, several aspects play a role from a project development and exploitation point of view. In this chapter, you will read more about the structure of the costs and benefits for an onshore wind project.

The cost of a wind project falls into two major categories: upfront investment costs and ongoing operating costs. The structure of the costs for an onshore wind project can be subdivided into development costs, investment costs, operational costs, project dismantling costs (decommissioning) and financing costs (financing).

However, we start this chapter with two aspects that strongly influence the costs and benefits of a wind project: location and wind supply.

Importance of location and wind supply

The consultancy Ecofys was asked by the Dutch Wind Energy Association (NWEA) to calculate the levelized cost of energy (LCOE) of electricity generated with onshore wind for a number of standard situations in terms of location and wind supply. The general results of this study still give a good insight into the cost and profit structure of an onshore wind project in The Netherlands. The mutual relations between the numbers are important; the specific amounts of costs and profits are indicative because they date from before the recent energy crisis.

The Ecofys study compares a wind project based on a 3.6 MW wind turbine (with HUB height and rotor diameter more than 115 meters) in 4 different regions of the Netherlands (Regio 1-2-3-4), Each region has its own wind supply (high – mid – low wind) and environmental profile. The results show a clear relationship between the location and wind supply on the one hand

and the LCOE (Euros/MWh) on the other hand, which shows differences of up to 30% depending on the location.

In the graph below you can see that the CAPEX (upfront investment cost) is dominant in all cases – about two third of the LCOE (leverized cost of energy Euros/MWh).

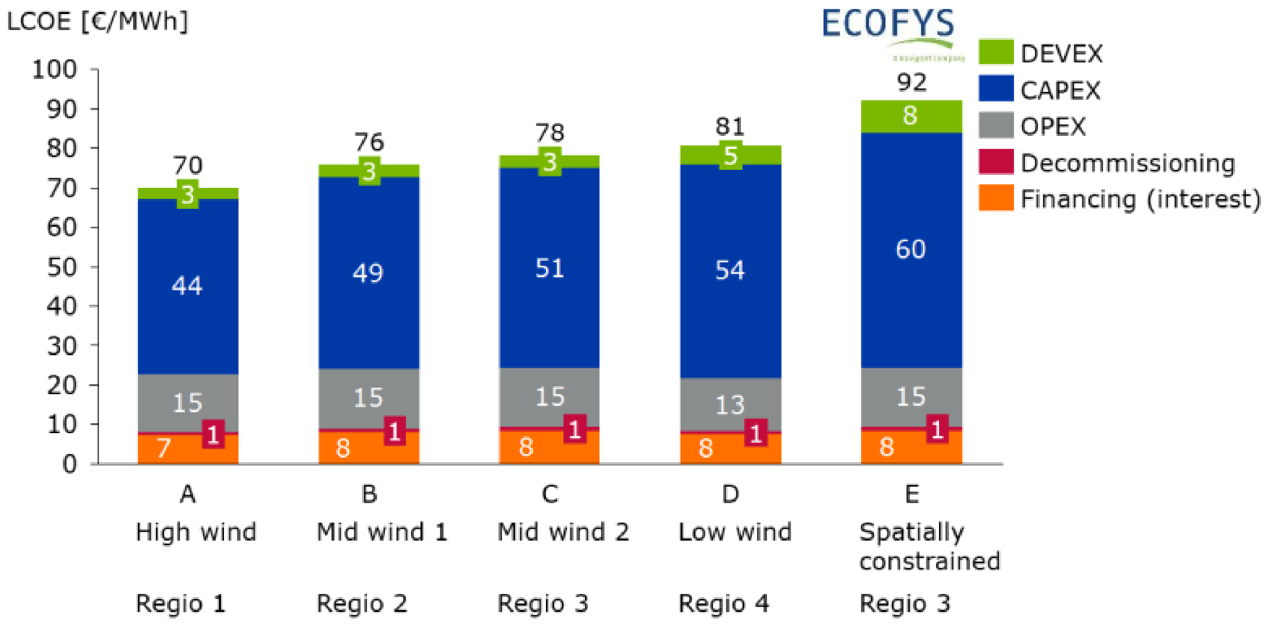
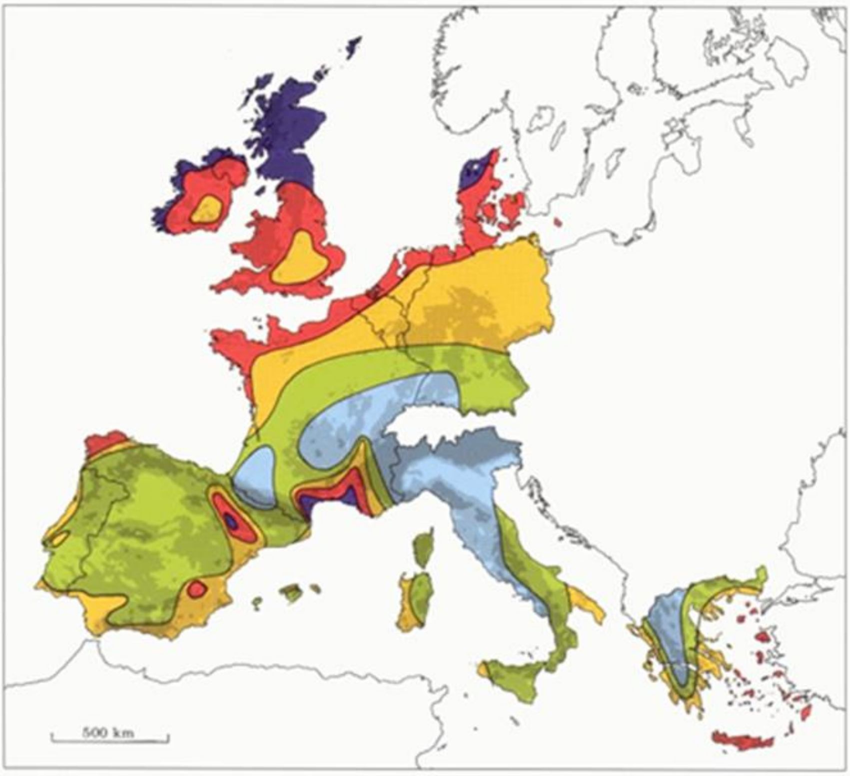


Figure 5 - Annual average wind speed in Flanders

The "European onshore wind atlas" with average wind resources gives a picture on the average amount of wind by altitude and location in Europe. The darker the color, the greater the wind supply. (source EWEA https://www.wind-energy-the-facts.org/wind-atlases-7.html).



Wind resources[1] at 50 metres above ground level for five different topographic conditions										
	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

Figure 6 - Annual average wind speed in Flanders

Development costs:

These are costs that arise during the development of the project. This includes, for example, costs of the project team, the Environmental Impact Assessment, impact studies on sound, cast shadow and risks, the wind resource assessment and legal costs.

The development includes all preparation costs for the environmental and building permit application. In Flanders an application file must consist of a localization note according to the guidelines described by the government. It contains a justification and substantiation of the various consideration elements and possible impact of the wind project on the environment and neighbourhood. This note also has to take into account the recent amendments to the spatial planning decree and the regulations in the field of noise and cast shadow (VLAREM).

Study costs are an important part. In Flanders, for example, the following studies are required to prepare an application file for an environmental and building permit. Most studies must be carried out by an accredited expert or study bureau:

- safety study
- sound and shadow study (impact of sound and shadow)
- background noise measurements
- nature study
- bird censuses
- bat counts
- archaeological study
- radar study (aviation and meteorologic)
- Telecom/radiation link study
- coordinated aeronautical advice
- drainage note (groundwater impact)
- landscape study
- visualizations of the project (visual impact on the landscape)

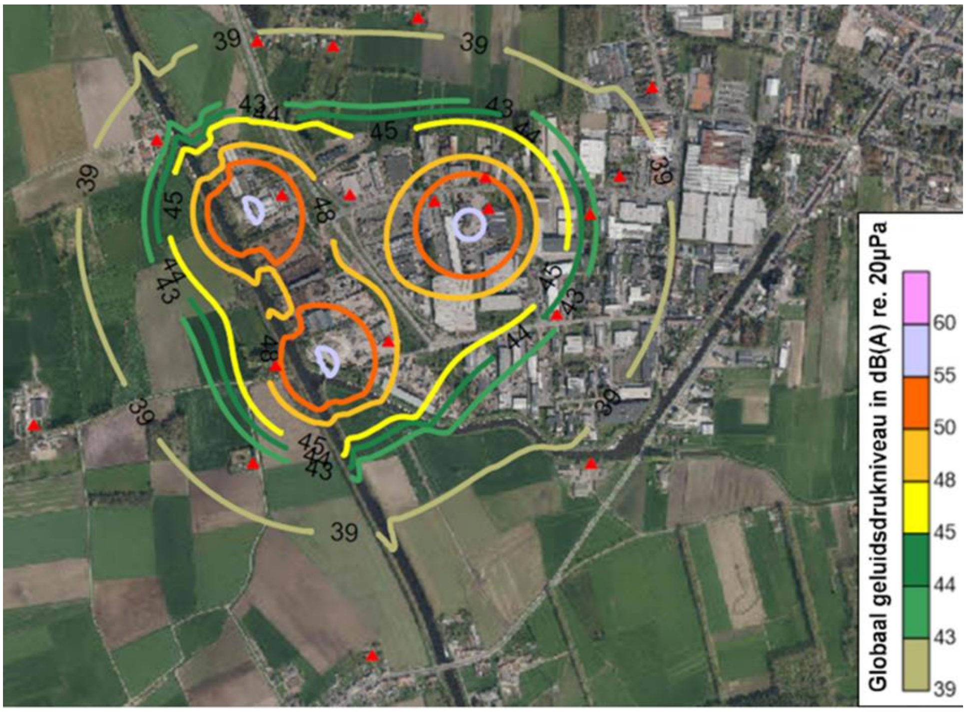


Figure 7 - Example of a sound impact map

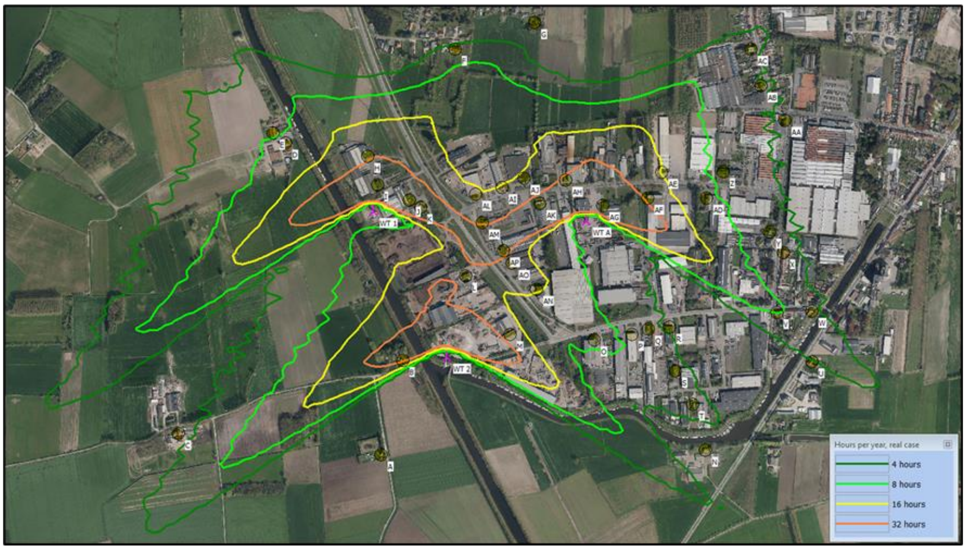


Figure 8 - Example of a shadow impact map

There are also costs for preparing all kinds of plans, an exploratory network study, the ground surveys, and also staff costs for following up on the project.

Investment costs

This includes investments for the purchase and construction of wind turbines, electrical infrastructure, foundations, roads and other civil works. But also, costs to finance the project, such as interests, have to be integrated into this calculation.

To give an indication: in 2022, the investment cost of an onshore wind turbine of 3 MW with a tower and rotor diameter of both more than 100m has been approximately 4 to 5 million euros. This includes the cost of:

- the wind turbine itself,
- the foundations,
- the electrical connection to the grid,
- the civil works to make the site accessible during and after construction
- the development and preparation costs to receive an environmental and building permit

However, the investment cost is highly dependent on the project and its specific circumstances, which create the boundaries to choose the best performing machine for the location taking distances to buildings and nature, sound- and shadow-effects into account.

In the design and tender phase, investment costs are provided for soil investigation, impact study on drainage, probing, foundation design and follow-up during construction, detailed network study, etc.

Finally, there are also investment costs for the construction of the wind turbine itself and the construction of the site, as well as legal and financial costs.

Operating costs:

These comprises all costs that occur during the operational phase of the wind farm. This includes maintenance and operation costs, repair costs, land costs and insurance fees.

An indication for a wind turbine on land is approximately 100.000 euros per year. However, the maintenance and operation cost depends on the yearly production volume and on the service contract. More wind means more wear and tear and more maintenance and repair. It also includes the yearly fees for the right of superficies to use the land where the wind turbine is placed (foundation, rotor overlay, grid connection) and an insurance fee.

Project dismantling costs: Decommissioning

These costs include all costs that occur when the wind turbine has reached the end of its lifespan and has to be dismantled. That means that these costs occur only at the end of the lifecycle of the project. They include removing and disposing of the wind turbine, foundations and the electrical infrastructure.

Ecopower takes a provision of 100,000 euros for the demolition of the wind turbine and restoration of the site to its original condition.

Revenues

The income of a wind farm consists of the sale of the electricity produced and the green energy certificates (support mechanisms or subsidies to make up the difference with fossil installations by stimulating clean sources).

The electricity produced can be sold to the wholesale market at fluctuating market prices or for a long period at a fixed price using PPA 's (power purchase agreements). Before 2021 the wholesale market prices in Europe were rather low and stable for more than 10 years. Since the energy crisis, the price has become high and volatile. The graph below shows the evolution of the electricity prices over the last 10 years in Belgium and its neighbouring countries the Netherlands, France and Germany, due to the international GRID-connections, they closely follow each other (source: CREG).

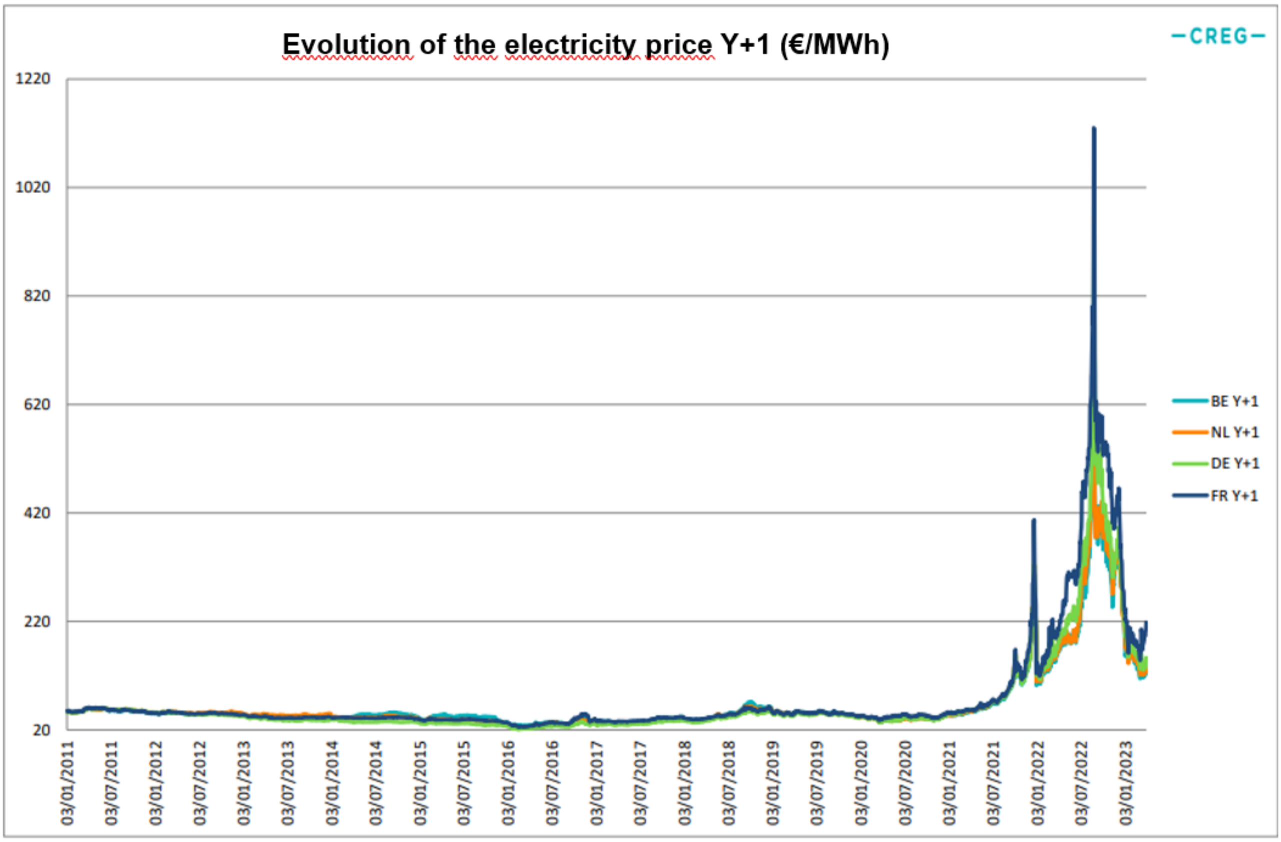


Figure 9 - Example of a shadow impact map

Return on investment (financial)

The standard assessment of profitability depends on the local wind supply (location), dimensions of the wind turbine (technology), energy prices on the wholesale market, and support mechanisms (energy market).

In Flanders, the support for constructing and operating an onshore wind park (green power certificates) is calculated periodically by the government with the "unprofitable top model". That ensures investors a return of investment (ROI) of 5%. When the market prices go up, the subsidies (green power certificates) go down and vice-versa.

Return on investment (economic)

The assessment of the cooperative profitability is different as a cooperative wind park is not business as usual. Members have a double relationship with their cooperative: they are owners of their company including installations and production (as shareholders) and they use the produced energy at home (as consumers). So they create added value on both sides: they receive a dividend as shareholders (financial return) and an energy bill at a fair price (economical return). Energy supply at cost price is a service to the members.

The average economic benefit of a member (energy bill) is a multiple of the financial benefit as a shareholder (dividend). In the graph below you see the average added value for an Ecopower member over the last 10 years: blue is dividend, red is benefit on the energy bill. It is clear that, in a citizen cooperative, the economic added value is a multiple of the financial added value, which is logical because it is the goal of the cooperative.

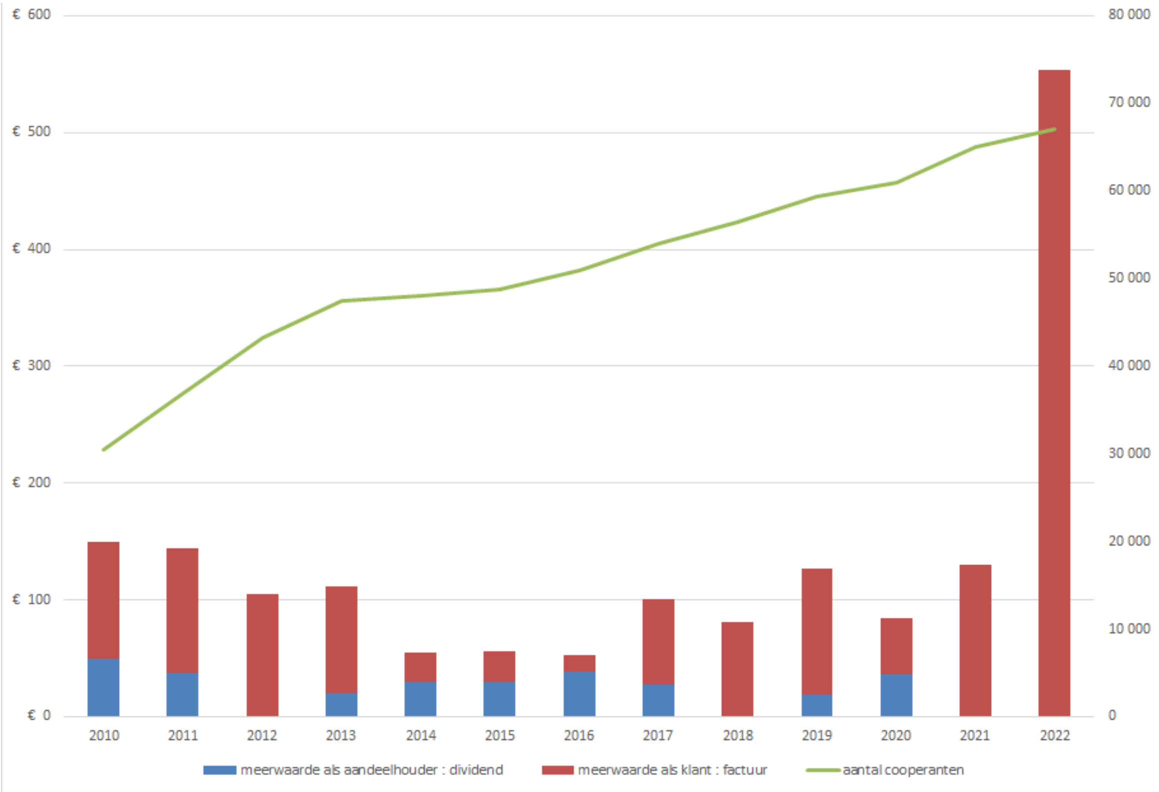


Figure 10 - Average added value per member.
Blue: dividend. Red: benefit on the energy bill. Green: number of members.
(Source : https://www.rescoopv.be/sites/default/files/rapport-pv-102022.pdf)

3.4

Legal aspects

Large wind turbines cannot be placed everywhere. In Flanders for example, every environmental permit application is assessed in terms of both planning and environmental standards; you can read more on the impact assessment on noise, shadow and nature below. The VLAREM (Flemish regulation on environmental permits) contains the general provisions that must be met in the environmental field. In addition, it is essential to create support for wind projects. There are a lot of misconceptions about wind energy.

EXAMPLE FROM ECOPOWER

To guide people to the right information, Ecopower created an information file on wind energy (in Dutch). Both general information and information about noise impact, environment and nature can be found there. It also explains why investing in wind energy remains important and why it is not possible to develop only alternative renewable energy production.

Noise

Wind turbines cause noise when they rotate. The noise comes from the generator in the nacelle and from the rotation of the blades. If there is little wind, they will hardly make any noise; if there is a lot of wind, the ambient noise from trees and bushes often drowns out the wind turbine. In between, the wind turbine is best heard.

Sound is expressed in decibels or dB(A). Noise in a daily working environment is about 50 to 60 dB(A). When the noise level drops below 35 dB(A), the environment is very quiet. In quiet areas, the loudest sounds fluctuate between 35 and 40 dB(A).

Every wind project must comply with environmental legislation. In Flanders, this legislation includes guideline values for wind turbine noise that apply in the vicinity of buildings (outdoors).

Buildings in residential areas are better protected by the regulations than buildings in areas other than residential.

In the permit application, noise studies show whether the wind turbines can meet noise standards when running at full power, i.e. at wind speeds above 8 m/s. The license application is always done with worst-case calculations, where the wind comes from all directions - which, of course, cannot happen in practice - and for the combined noise of all wind turbines in the project.

Modern wind turbines can be regulated so that they never exceed noise standards. At night, for example, a wind turbine will often not run at full power but in a slightly reduced state, limiting the rotation speed and power somewhat and reducing the noise.

Shadow casting

Cast shadow is the flicker of light created when the blades move in front of the sun. Having this kind of flickering light in a home or office is not pleasant, which is why there are strict standards and very targeted solutions.

Just as for noise, there might be legislation for cast shadow that falls inside indoor spaces in your country. For example, in Flanders, we have the following regimentations on cast shadow:

- The cast shadow on a dwelling must not exceed 8 hours a year and must never be more than 30 minutes a day;
- For offices, the maximum is 30 hours per year, again never longer than 30 minutes per day.
- If the daily or yearly limit is reached, a wind turbine is automatically shut down, thanks to the use of cast shadow sensors and specific counting programming for each individual dwelling.
- The operator must keep a cast shadow calendar for each 'cast shadow sensitive dwelling' in a logbook that can always be checked by the environmental inspector.
- Even if there are several wind turbines near a building, the limit of a maximum of 8 hours per year and 30 minutes per day applies to all turbines together.

Nature

When looking for a suitable site for a wind turbine, the natural environment is always taken into account. The permitting process carefully examines the possible impact on nature and develops measures where necessary or possible.

In Flanders, for example, a permit process always includes an environmental study. This contains a full description of the impact of the wind turbine on protected areas, woodland and valuable nature, bats and birds. In some valuable natural areas, wind energy is excluded.

Sometimes, a wind turbine is located in a wooded area. This also has advantages because there are often fewer people living nearby. The permanent deforestation required at the site of the wind turbine is limited and is compensated elsewhere. Often, there is also temporary deforestation to provide an access road or a crane site for the construction of the turbine. In Flanders, this forest must be replanted once construction is completed.

Contracts with landowners

Once all requirements above are met, and there is real potential at the specific site, contracts are concluded with all landowners. Different types of agreements have to be made:

- For the location of the turbine itself: a right of superficies.
- For the provision of over-turn: a right of over-turn
- For the groundworks for the cable: a right of passage.

04

Valencia pilot: technical, economic and legal development

The Valencia pilot consists of two models.

The first one implies the creation of an **energy community** that invests in a PV system on a public roof and shares the production by collective self-consumption. While households profit from self-consumption from the PV plant (according to their investment), selected households can benefit from this scheme by a limited amount of free shares dedicated to vulnerable households (according to public partner investment). The existing energy community Castellar-L-Oliveral, which has been realized outside the POWER UP project, serves as a reference for this model. As the figures of the Castellar community are expected to be very similar to the future POWER UP pilot energy community, they are being used as a reference in this report.

The second model is called the **fee model**. It implies the installation of PV systems on public land by an investment of and in the hands of the municipality, with citizens being granted temporary access to a share of the production via an energy-sharing agreement by paying a fee. Selected vulnerable households could benefit from this scheme by being granted access to the energy-sharing agreement without having to pay that fee.

4.1

Technical aspects

Screening of rooftops

The building used in the existing CEL Castellar-L'Oliveral case, which serves as a reference to the future POWER UP pilot, was selected because of the location, the ownership and the orientation. The roof was in perfect condition (already insulated) when the project started. Just as in the Castellar example, for the POWER UP pilot energy community, each building should be assessed individually, but roofs are generally in good condition.

For the fee model model, the roofs that will be used are located in cemeteries. This choice was a political choice: it is the same councillor who is responsible for energy transition and for cemeteries, making the process easy to start. Some civil works will still be needed to prepare the rooftops. Those are included in the context of the PV project.

Production potential of the installations

Expert companies have analyzed the production potential using specific simulation tools (PVSyst). For the exemplary Castellar project, according to the execution project description from the installing company, the installation has a potential of 71,55 MWh/year. The potential for the POWER UP energy community is hard to estimate as available surface and installed power will vary across projects. However, what can be said with certainty at this stage is that PV installations will not exceed 100 kWp, as this is the current limit for having a simplified compensation (on bills) for surplus energy, which is the most convenient for consumers and also administratively for energy communities. For the fee model, according to the preliminary project design, the production potential for the 5 cemeteries together is 3.838,53 MWh/year.

Connection of the installation to the meter

Just as in the Castellar-case, the PV installation of the future POWER UP energy community will be connected to the generation meter. For the fee model, there will be a generation meter for each installation.

Practical installation of the plant

Good experiences have been made in the Castellar example by working with an expert company contracted directly by the energy community for the installation of the PV plant. In the case of Castellar, a local cooperative was contracted. The fee model installations will be performed by a company selected through a public procurement process.

Potential emission reductions of the installation

According to the execution project description from the installing company, the Castellar-installation will account for an emission reduction of 11,8 tn CO_2/year, which is a good indication for the emission reduction potential of the future Power Up energy community pilot. For the 5 cemeteries of Réquiem in Power, according to preliminary project design, this will be 1.019,35 tn CO_2/year.[5]

[5] Numbers based on calculation of the City of Valencia. When using the formula of the Power Up project, the result is even higher. The formula is: Average yearly energy production in your location (kWh/kWp/y) * nominal power (kWp) * average CO2 content (gCO2e/kWh) / 1.000.000 = CO2 emission avoided/y. For Valencia this is: 1.700 kWh/kWp/y * 2897,85 kWp * 304 gCO2e/kWh / 1.000.000 = 1.497,7 t CO2e/y for both models together.

4.2

Economic aspects

Investment costs of the installation

In order to illustrate the expected costs for the future POWER UP energy community pilot, it is useful to look into the investment costs of the Castellar case, as it is expected to be very similar to the future pilot. The Castellar energy community worked with a turnkey contract for the installation of the collective self-consumption PV system with a simplified compensation for surplus energy (47,8 kWp) of 55.913,12 euro, which has been paid by the energy community itself. The low-voltage electric line extension and civil works were around 5.800,00 euros, paid by the local DSO as a contribution to support the project. Electric works and the legalization of a new grid connection point (an extraordinary, non-expected cost related to the singularity of the connection point – "Emergency Supply Point") was 7.632,50 euros and has been paid by VCE. Finally, the insurance for the installation for CEL Castellar-L'Oliveral is 262 euros per year.

For the fee model, all investment costs will be paid by the municipality. For the project preparation (pre-design, simulations, technical specifications, etc.), around 45.000,00 euros is required. For the construction works of 5 different PV plants in the cemeteries of the city, baseline cost data has been obtained from public procurement (could be significantly lower depending on received offers). The amounts for the different localities are:

- Grau (62,79 kWp): 94.645,43 euro (59.532,00 Euros)
- Benimamet (111,37 kWp): 195.653,13 euro (118.701,00 Euros)
- Campanar (161,25 kWp): 373.235,68 euro (257.987,73 Euros)
- Cabanyal (617,91 kWp): 894.578,37 euro (725.532,23 Euros)
- General (1896,73 kWp): 2.509.863,23 euro (2.115.498,89 Euros)

There are no rent costs as it concerns a municipal space and the PV plant will be constructed and operated by the municipality itself.

Operating / maintenance costs of the installation

For the future energy community pilot, it is realistic to expect a similar approach as for the Castellar example. Here, the turnkey contract for the installation contemplates a warranty of 3 years, and 10 years for the PV panels. It has been decided (for now) not to hire an operation and maintenance service. The secretary of the renewable energy community supervises the generation readings directly through the PV inverter App and also helps members with all administrative procedures with energy suppliers. As for maintenance, they take care of cleaning the PV panels and will ask for some technical help to revise the technical components periodically (in principle, once a year).

For the fee model, the operating and maintenance costs of the installation are still to be defined; probably, a new contract should be procured by the municipality.

How will the installation be financed?

For CEL Castellar-L'Oliveral, the cost of the PV installation was financed by the members of the community with their own funds. There was an up-front investment by every neighbour to participate in the community, making bank transfers to the bank account of the association "CEL Castellar-L'Oliveral" when signing the participation contract. These investments have been made very rapidly (the needed amount was gathered in 2-3 weeks) and allowed the association to contract the installation company and move forward with the project.

Afterwards, the association received a subsidy from the regional government through IVACE, targeted to pioneer energy communities, accounting for 43% of the installation costs, i.e. 24.042,64 euro. The association gathered its members to decide how to use this amount. The members decided to keep the money for the next installations for legal reasons; they asked for expert advisory on legal and administration issues for associations and concluded that, as association, they cannot distribute the grant (earnings) among members as it would be similar to a "dividend". This is a consequence of how the investment contributions by each member were considered. For next installations, they will try to label it as a "lend" to the association, so the energy community can return part of it to the members once the potential subsidy is received. Regarding electric and civil works, costs were covered by own funds from VCE and the local DSO.

New energy communities in the city will need to define their financing plan, either imitating the Castellar example or looking for other financing solutions (bank loans, crowdlending, etc.). Subsidies are available for renewable self-consumption projects from the regional government, as well as other calls addressing specifically energy community projects at the national and regional levels.

The fee model is being financed directly with municipal funds. No possible subsidies have been identified by now.

Potential energy savings of the installation

New energy communities should intend to optimize the distribution of shares, trying to maximize direct self-consumption of energy, following the example of Castellar (see text box section 2.3). This is the most efficient use of energy, also economically. In general, with regards to the estimation of savings, collective self-consumption schemes follow the same mechanism regardless of the overall model and governance behind the project. Savings and costs related to a fixed share of installed PV power will not vary too much over projects.

For the fee model, once the model is ready to be implemented, different shares (0,50-1,00 kWp, or even bigger shares for SMEs) will be offered, depending on the actual needs of interested citizens. Both energy communities and the fee model look for a maximization of direct self-consumption.

Direct benefits for vulnerable households

In the Castellar case, Valencia's first experience with the energy community model, vulnerable households were approached after the project had already been defined and executed. VCE shares have been distributed among vulnerable households around Castellar. At that time, there was a physical limitation to share energy in collective self-consumption projects of 500m from the PV installation. With that limitation, VCE sent this spatial criteria to Social Services of the Municipality so they could cross that information with their database of households asking for aid on energy bills. Six families were identified and contacted by the social worker of the Energy Office, to offer them taking part in the collective self-consumption, that way having some renewable energy for free to alleviate their situations. All six families showed interest in participating but half of them couldn't join for different reasons: issues with the entitlement of energy bills, bad relationship with the landlord, mistreatment from ex-husband who still owns the apartment etc.

For next energy communities, if the model to be implemented allows to have vulnerable households as shareholders (full members), they will be engaged from the start having the same baseline information as any other potential member. If not possible, vulnerable households will participate in a similar way as the CEL Castellar example, as beneficiaries of renewable energy with no cost and with social services (or another entity with appropriate competences) acting as intermediary.

Other potential indirect benefits for the households in the energy community model include community building, empowerment, ownership (for the energy community cases) and advancing energy literacy.

4.3

Legal aspects

Ownership

For CEL Castellar-L'Oliveral, the ownership of the rooftop and the installation has been split: while the rooftop is owned by the municipality, which gave it to VCE based on an agreement with the association for the use of the roof, the installation itself is owned by the energy community. For the next energy communities, the split ownership might be organized by procurement rather than by a specific agreement.

For the fee model, both the roofs and the installations are owned by the municipality.

Other relevant local/regional/national legislation

The Royal Decree 244/2019 and later amendments govern the administrative, technical and economic self-sufficiency of electrical energy and carries out the regulatory development of different aspects related with collective and self-consumption. While this decree is applicable to the Valencia pilot, at the moment of writing it only contains definitions, as the transposition from EU Directives on Energy Communities is still not complete.

05

Rožnov pilot: technical, economic and legal development

The Rožnov pilot project consists of two integral components. Firstly, it aims to assess the feasibility of establishing a comprehensive One-Stop-Shop (OSS) dedicated to promoting energy sufficiency and sustainable homes, and secondly installing the city's first PV installation on an apartment building owned by the city, in order to self-consume the electricity produced and sell the surplus to the grid.

One-Stop-Shop

The Rožnov local authority established the One-Stop-Shop in Autumn 2022 with the goal to provide advice to citizens on various energy-related matters, including energy savings, energy sources, energy billing, and subsidy opportunities.

The OSS team consists of two local authority staff members, an Energy Manager and a Clean Air Manager - the ability to leverage the existing staff capacities of the municipality is a notable advantage of the One-Stop-Shop as it enables efficient utilization of resources to deliver effective services to the community. Additionally, the Power U project has extended valuable support to the establishment and ongoing activities of the One-Stop-Shop, further enhancing its capabilities.

Although the OSS currently holds an informal status without official recognition, it actively engages in consultations with the public. Consultations can be conducted through various channels, including in-person appointments, email correspondence, or over the phone. On average, the One-Stop-Shop handles approximately 50 to 100 consultations per month, ensuring personalised assistance to meet the diverse needs of the public. In addition, OSS staff had organised comprehensive information campaigns. These campaigns use platforms such as the city's official website, as well as local magazines. Additionally, the office creates and distributes informative brochures, leaflets, and other materials. These resources cover a range of topics, including opportunities for subsidies, and offer practical tips for energy savings in areas such as heating, hot water usage, and efficient appliance usage.

The City Management considers the initial phase of the One-Stop-Shop (OSS) operation to be a success and intends to preserve the existing service format without the need to establish a new separate entity. However, there are plans to expand the expertise of the OSS and broaden the range of services it offers in the future. The OSS-option is on-hold politically by the time of writing, and does not involve technical development or investment.

PV installation on a municipal apartment building

The second part of the pilot project in Rožnov is the installation of the city's first PV system on an apartment building owned by the city. The objectives of this installation are to enable self-consumption of the generated electricity and to sell any surplus energy back to the grid.

This chapter primarily focuses on the technical, economic, and legal aspects solely related to the PV installation component of the project. Due to political circumstances at the time of writing, the OSS option is temporarily on hold, and thus does not involve any concurrent technical developments or investments.

5.1

Technical aspects

Screening of rooftop

A new roof is already planned for the apartment building, and in June 2023, a structural assessment was completed after an in-person inspection of the rooftop. The assessment concluded that the existing roof structure is capable of withstanding the increased load from the installation of PV panels, demonstrating its sufficiency. The decision regarding roof insulation is expected to be made in autumn 2023.

Production potential of the installation

The expected production of the PV installation is 39,1 MWh according to the calculations in an energy assessment that has been carried out.

Practical installation of the plant

For the installation of the PV panels, a public tender will be organized by the City in 2024.

Potential emission reductions of the installation

The expected emission reduction of the PV installation is 39,1 MWh (Power Output) x 0,39 t CO_2 (CO_2 emission factor of electricity production in Czech Republic, as per year 2021), i.e. 15,2 t CO_2 per year. This has been calculated as part of the energy assessment.

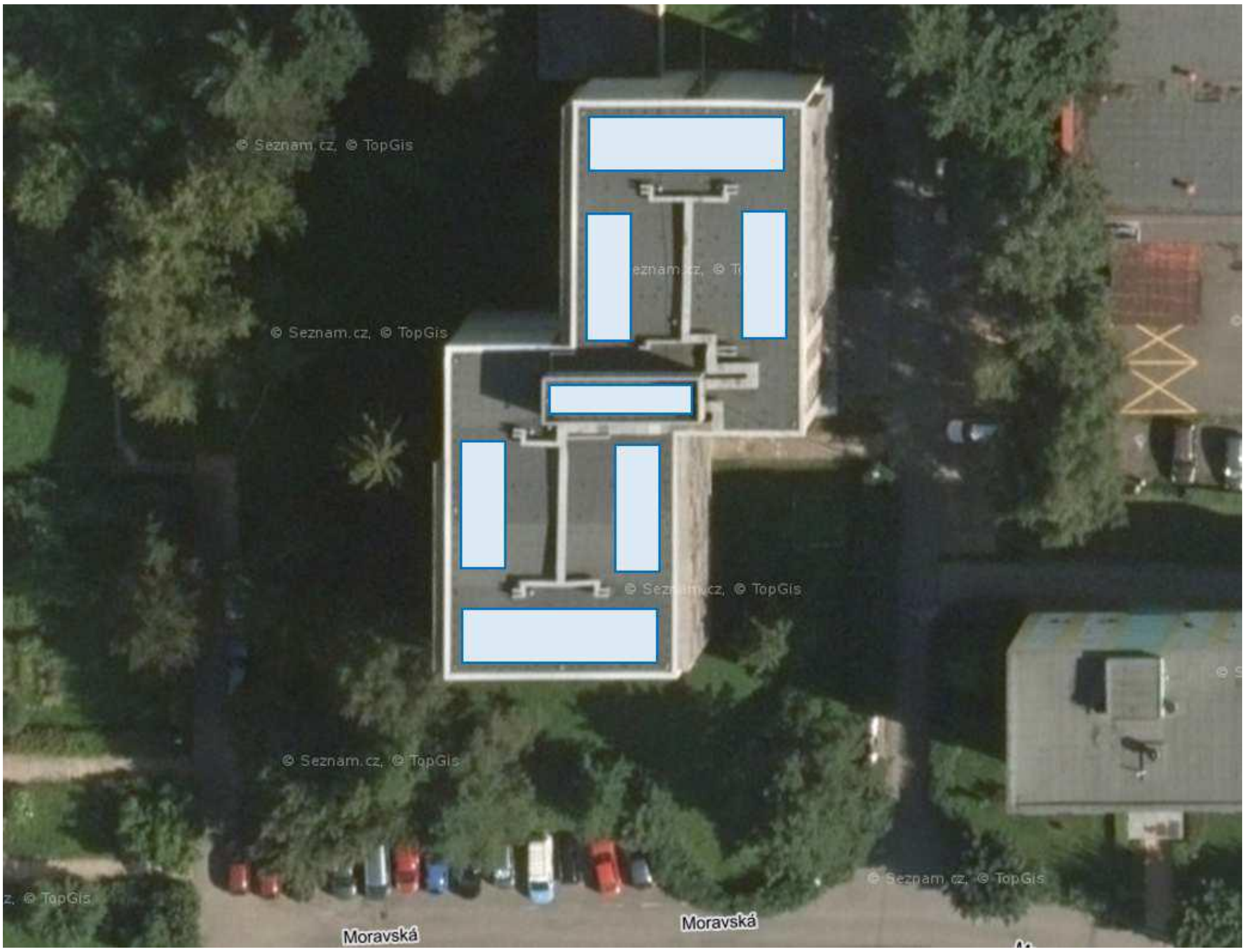


Figure 11 - PV panels placement possibilities, using www.mapy.cz. Source: Energy assessment report.

5.2

Economic aspects

Investment costs of the installation

The total preliminary investment for the 39.1 kWp PV installation, including battery storage but without subsidy, is 1 732 629 CZK, excluding VAT. An extra cost is the licence needed for PV production.

Operating / maintenance costs of the installation

The types of costs included here are the monitoring of PV production, regular revision of the PV installation, and maintenance costs. These costs will reach about 5 000 CZK annually (equivalent to 200 Euro). Other costs have to be considered after 1 January 2024 when the new legislation regarding energy communities comes into force. All of these costs will be covered by the owner of the installation, the City of Rožnov.

How will the installation be financed?

There will be three sources for the financing of the installation: in the first phase the city invests from its own budget, and uses subsidies to cover part of the investment. Currently, the subsidy accounts to 40-50% of the total investment. Some additional income can be expected from selling the electricity to the grid once the installation is in operation.

Potential energy savings of the installation

According to the energy assessment report, 30-40% of the electricity produced by the installation will be used in the apartment building itself. This will lead to operational costs savings of 200 000 CZK per annum for the whole building.

Benefits for vulnerable households

This plan is still in the process of being developed with a more detailed design. The leader of the pilot project envisions multiple ways in which vulnerable households can benefit from the installation of photovoltaic (PV) systems. Firstly, the city will experience reduced operational costs for the building since the electricity generated on the roof will be utilized in the common areas, such as lighting and elevators. Secondly, taking advantage of Czech legislation that allows electricity sharing in apartment buildings (refer to the chapter on Legal aspects), households will have the opportunity to self-consume the electricity produced within the building, resulting in cost savings on their individual electricity bills.

5.3

Legal aspects

Ownership

The City of Rožnov is both the owner of the roof and the owner of the PV installation.

Risk management

This is done internally by the city.

Other relevant local/regional/national legislation

Electricity Sharing in Apartment Buildings

A new decree from the Energy Regulatory Authority, in effect since 1 January 2023, allows electricity sharing in all apartments that express interest, without the need to pool consumption points. This change will replace the costly installation of Type B net metering, which would have been installed at the distribution system operator's expense. The responsibility for calculations, data collection and processing, including provision to customers, now lies with the DSO. Residents will be able to distribute the electricity generated according to a pre-agreed allocation key. If the power plant does not supply enough energy, the dwellings will still be connected to the public distribution system and buy electricity from their supplier.

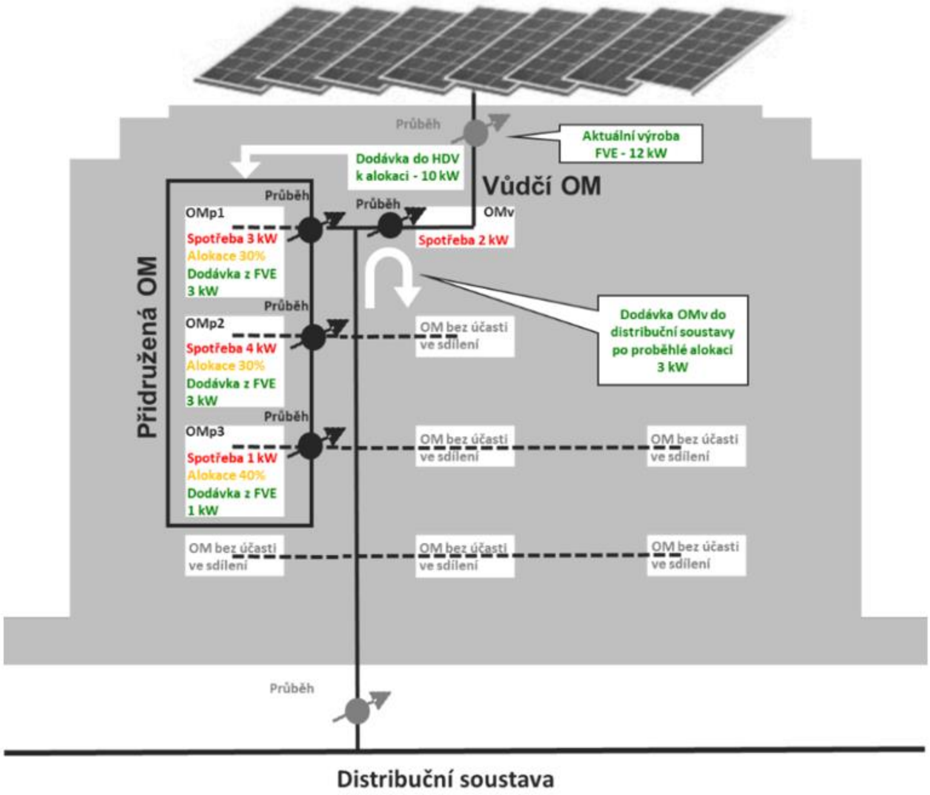


Figure 12 - Visualisation of electricity sharing in an apartment building, Source: EG.D

LEX OZE I

On January 24, 2023, an amendment to the Czech Energy and Building Act, known as LEX OZE I, came into force, aiming to significantly facilitate the development of community energy for municipalities. The Law 19/2023 Collection amends Act No. 458/2000 Coll. on conditions for conducting business and performing state administration in the energy sectors and amending certain other laws (the Energy Act), as subsequently amended, and other related laws.
The law contains two important elements concerning local governments.

1. <u>Licences and building permits</u>

The amendment allows for easier implementation of renewable energy sources: for an installed capacity below 50 kW, there is no longer a requirement to apply for a licence from the Czech Energy Regulatory Authority for electricity production. This step is complemented by a change in the building law, stating that for small sources up to 50 kW, there is no need for territorial consent, building permits, or notification to the building authority.

2. Public interest

The amendment newly defines electricity production from renewable energy sources or low-carbon electricity production with a total installed electrical capacity of 1 MW or more as structures of public interest. This means that, in the case of their installation, an approved change in the territorial plan is not necessary. This regulation will be followed by a second amendment to the Czech Energy Act, called LEX OZE II, which will ensure the sharing of electricity within energy communities. It is currently in the commenting phase, and after addressing the comments, it should be submitted to the Parliament. It is anticipated it will come into force in 2024.

06

Eeklo pilot: technical, economic and legal development

The Eeklo pilot consists of a cooperative wind turbine financed and owned by the members of citizen energy cooperatives Ecopower and Volterra (respectively 74% and 25%), and the city of Eeklo (1%). The city of Eeklo will use its part in the wind turbine to pre-finance social shares of Ecopower for vulnerable inhabitants who, this way, will be able to become not only a member of Ecopower but also a client of its cooperative supplier activities and consume the green energy at cost price at home. This chapter focuses on the technical, economic and legal aspects of the cooperative wind turbine, which is central to this scheme, the 'Huysmanhoeve' wind turbine. You can also read more about this wind turbine on the Ecopower website.

6.1

Technical aspects

Production potential of the installation

The installed wind turbine is a Senvion MM100 with a nominal power of 2.0 MW, a rotor diameter of 100 meters and HUB height of 100 meters. The average wind speed in the area is 6.1 m/s, which gives a capacity factor of about 2500 full load hours. The yearly production is approximately 5.000.000 kWh, all of which is injected into the grid. The installation is connected to the distribution grid at 36 kV.

Practical installation of the plant

The construction of the Huysmanhoeve wind turbine started with the preparation of the site and the construction of the roads and other civil works to make the site accessible to heavy traffic and heavy parts. This part of the work has been done by local suppliers. During the construction of the foundations by a specialized company, the electrical connection to the grid has been installed in association with the DSO. Finally, the wind turbine has been installed and maintained by Senvion, one of the international wind turbine suppliers.
In the following tables you can find the technical data of the installed wind turbine (Senvion MM100).

Design Data	
Nominal power (kW)	2,000
Cut-in wind speed (m/s)	3.0
Cut-out wind speed (m/s)	22.0
Nominal wind speed (m/s)	11.0
Operating temperature range (°C)	-20 to +35
optional (°C)	up to +40

Certification			
Hub height (m)	Wind class	DIBt wind zone	Transformer
74.5–76.5	Up to IEC S (based on IIB)	–	ITS/ETS
78.0–80.0	Up to IEC S (based on IIB)	WZ 3, GK I	ITS/ETS
98.0–100.0	Up to IEC S (based on IIB)	WZ 3, GK I	ITS/ETS

Rotor	
Diameter (m)	100.0
Rotor area (m²)	7,854
Power control	Electrical pitch system

Rotor Blade	
Length (m)	48.9
Type	GRP

Electrical System	
Nominal Frequency (Hz)	50/60
Converter type	Frequency converter
Generator	Double-fed induction generator
Generator protection class	IP 54

Sound Power Level	
Max. sound power level (dB (A))	103.8
Sound management	various

Power Curve

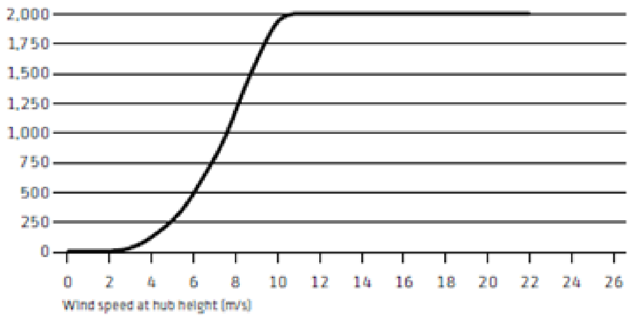


Figure 13 - Technical data of the Senvion MM100 wind turbine

Potential emission reductions of the installation

A yearly local production of 5.000.000 kWh of wind energy represents a yearly reduction of approximately 1.945 tons of CO2, or 39.000 tons of CO2 emissions, during the whole lifespan of the wind turbine (20 years). Ecopower calculates CO2 reduction by comparing the emissions of a CCGT (combined cycle gas turbine) power plant with the emissions of a wind turbine. The emissions of a CCGT power plant are 400 g/kWh. The impact of materials, transport and construction of a wind turbine is 11 g/kWh.

6.2

Economic aspects

Investment costs of the installation

The development cost of the project (DEVEX) is 150.000 Euro, the investment cost (CAPEX) is 3.125.000 Euro. The wind turbine was built and put into operation in 2021. The city of Eeklo had the right to participate directly at up to 25% into the cooperative wind park. In December 2022, the city decided to participate with 25.000 Euros to be able to create 100 social shares.

Operating / maintenance costs of the installation

The operating cost (OPEX) is approximately 100.000 euro per year. Costs and revenues are divided proportionally among the participating parties. The annually recurring costs that are indexed comprise the following elements:

- Rent location: 32.000 Euros
- Environmental fund: 6.000 Euros
- Insurance installations: 1.500 Euros
- Maintenance cost: 45.000 Euros
- Periodic legal inspections 2.000 Euros
- Wind turbine consumption: 3.000 EurosOperating cost: 10.000 Euros

How will the installation be financed?

As this is a cooperative wind park, the installations are financed with equity from the participating parties: 74% by citizen energy cooperative Ecopower cv, 25% by citizen energy cooperative Volterra cvso, 1% by the city of Eeklo. This cooperative project is open to 100% citizen participation and already fully funded. During the construction phase, a bridging loan

was used to pay the manufacturers' invoices. This approach makes it possible to involve as many people as possible in the project. 70% of the members only have 1 share of 250 Euro. That means that approximately 3.000 members participate in the cooperative wind turbine. Working with as little debt as possible makes the citizen cooperatives very stable financially and ensures that the added value remains entirely within the cooperative.
As regards subsidies, this cooperative wind project uses the same support mechanism (green energy certificates) as commercial wind projects. The value of the certificates depends on the evolution of the electricity price on the wholesale market.

The production is not sold to the market. As a citizen energy cooperative with a supply license Ecopower provides electricity supply as a service to the members (collective energy sharing). This results in a fair price that reflects the cost of production and is among the cheapest on the market. For the cooperative members the economic added value (energy bill) is a multiple of the financial added value (dividend).

Potential energy savings of the installation

The wind turbine produces yearly approximately 5.000.000 kWh, enough for about 2000 cooperative households. A typical wind profile produces more energy in winter than in summer. As a cooperative supplier, production and consumption is balanced for the portfolio of the cooperative installations and the cooperative consumers so that green electricity is always supplied.

Other potential direct/indirect benefits for the households

Through collective energy sharing, people participating in the project will benefit from fair energy prices that reduce their energy bill compared to the commercial market and especially to the regulated standard prices for people dropped by commercial suppliers. This benefit on their energy bill will enable vulnerable households to pay off their energy debts more quickly.

Besides direct financial benefits, households also profit from other aspects of being a member of a citizen energy cooperative. Firstly, the ownership of installations and production that comes with the cooperative membership, guarantees participation and long-term stability for the members of the cooperative. Secondly, by participating in a citizen energy cooperative, vulnerable households become members of an energy community that focuses on sustainable energy production and energy-saving measures. This approach makes renewable energy sources accessible to vulnerable households, it works inclusively so that everyone is involved in the local energy transition. There is no difference between ordinary and vulnerable households regarding their membership in the cooperative, except for the aspect of pre-financing of the cooperative share by the city of Eeklo. The co-creation approach with vulnerable households is led by the city of Eeklo social department, supported by Ecopower cv.

6.3

Legal aspects

Ownership

The wind turbine is built on public land owned by the social department of the city of Eeklo. The cooperative wind park is owned by the members of citizen energy cooperative Ecopower cv (74%), by the members of citizen energy cooperative Volterra cvso (25%), and by the city of Eeklo (1%). This means that the installation and the production are in the hands of the people.

To organize this, two contracts have been made: one contract with the landowner to be allowed to use the land for 20 years to build and operate a wind plant, in exchange for a yearly building and operating fee. And another contract on the cooperation between the participating parties which describes who takes responsibility for what and how the costs and benefits are divided according to the degree of participation. Ecopower takes care of the exploitation of the wind park.

Risk management

Risks are mitigated in different ways in the different stages of the project. To start with, in the development phase, by choosing a good location for the wind project that is permissible under government regulations, with low impact for sound and shadow, with respect for the environmental and social circumstances. The building and environmental permit are on the name of Ecopower, which shares the project with partners Volterra and the city of Eeklo. Secondly, during the phase of the business plan compilation, by choosing the best technology suitable for the site, with positive profit and loss calculations in different scenarios and different wind supply conditions. Finally, during the operation and Maintenance phase, by developing and sticking to a strict maintenance plan with warranty conditions for availability, insurance against loss of production and damage to third parties.

Other relevant local, regional or national legislation

The federal government is responsible at national level for the offshore wind, nuclear energy and high-voltage grid in Belgium. The regional governments are responsible for onshore renewable energy and energy conservation on their territory: Flanders, Wallonia, Brussels capital region. Regionally the following regulations apply in Flanders: the circular on wind energy spatial planning, the Vlarem environmental regulations and the support model for wind energy of the province of East Flanders.[6]

Locally, Eeklo was the first city in Belgium to create a local wind plan that determined where and how wind energy was to be harvested in the territory, back in 1999. Their starting point was that the wind belongs to everyone, a common good that should be accessible to everyone. Eeklo defined wind energy as a regional product and invited developers to harvest the local wind together with the local community. A local support model for wind energy with citizen participation was approved in a municipal council decision.

[6] [1] Read more on the support model on https://www.rescoopv.be/sites/default/files/PRB_OOST-VLAANDEREN__20130424%20draagvlakmodel_windenergiemet.pdf and on https://www.rescoopv.be/sites/default/files/PRB_OVL_268895_Provincieraadsbesluit_14oktober2020.pdf

07

Campania area pilot: technical, economic and legal development

The Campania Area/UCSA pilot consists of two models: one focusing on social housing buildings, one focusing on school buildings and other public areas.

As concerns the first one, solar panels will be installed on 6 social housing buildings in the municipalities of San Giuseppe Vesuviano and Palma Campania, with about 200 households in total. Additionally, the pilot partners investigate the possibility of sharing the energy surplus from existing public PV systems to support households in energy poverty situations engaged in energy communities.

Regarding the second one, the Municipality of Palma Campania is also studying the possibility of installing new systems in two schools ("Vincenzo Russo" - 59 kWp and "Antonio de Curtis" - 100kWp) and in a public area confiscated from the mafia on the A30 (609 kWp), all in Palma Campania. The energy surplus produced would be designated to be shared by the energy community, thereby supporting families in energy poverty situations.

Both models were presented and deepened in public events during 5 co-creation meetings held throughout October and November 2023 with vulnerable households, citizens, civil servants and political representatives from the municipalities involved.

7.1

Technical aspects

Screening of rooftops

During a first meeting with the representative of U.C.S.A. it was possible to identify 2 public buildings (schools) for the preliminary feasibility studies:

N	Municipality	SITE NAME	ADDRESS	BUILDING TYPE	Picture
1	Municipality of Palma Campania	Istituto Comprensivo Statale 2° "Vincenzo Russo"	Via Marcello (coordinate 40.86113 14.54981)	School	
2	Municipality of Palma Campania	Scuola Secondaria de 1º Grado "Antonio de Curtis"	Via Municipio, 65 (coordinate 40.87028 14.55640)	School	

Figure 14 - Specifications of the two public buildings identified for the preliminary feasibility studies

N	MUNICIPALITY	SITE NAME	ADDRESS	BUILDING TYPE	PICTURE
1	Palma Campania (NA)	A30 Caserta - Salerno	A30 Caserta - Salerno (Coordinate 40.84849 14.542273)	Public Land	

Figure 15 - Specifications of the public land area identified for the preliminary feasibility studies

In successive meetings with the UCSA representatives, areas of interest and priority social housing buildings were identified for carrying out the preliminary studies and engagement activities. The 6 buildings are located in the municipalities of Palma Campania and San Giuseppe Vesuviano (3 in each) and together, they count around 200 resident families.

N	SITE NAME	MUNICIPALITY	ADDRESS	BUILDING TYPE	PICTURE
1	Immobile 1.1	Palma Campania (NA)	Viale Giacomo D'antonio 41	Social housing	
2	Immobile 2.1	Palma Campania (NA)	Viale Alcide De Gasperi 28	Social housing	
3	Immobile 3.1	Palma Campania (NA)	Viale Alcide De Gasperi 73	Social housing	
4	Immobile 1.2	San Giuseppe Vesuviano (NA)	Via Padre Gino Ceschelli, 43	Social housing	
5	Immobile 2.2	San Giuseppe Vesuviano (NA)	Traversa Milano, 2	Social housing	
6	Immobile 3.2	San Giuseppe Vesuviano (NA)	Traversa Ceschielli SNC	Social housing	

Figure 16 - Specifications of 6 identified social housing buildings

The figure below shows the conventional areas for the development of CERs identified by E-Distribuzione (Italian DSO). These areas are identified pursuant to art. 10 of the Integrated Text on Widespread Self-consumption (TIAD) by the Italian Regulatory Authority for Energy, Networks and the Environment (ARERA) and identify the perimeter of action of the primary substations in which the energy produced by the generation system can be shared with the members of the energy community with the attribution of an economic incentive.

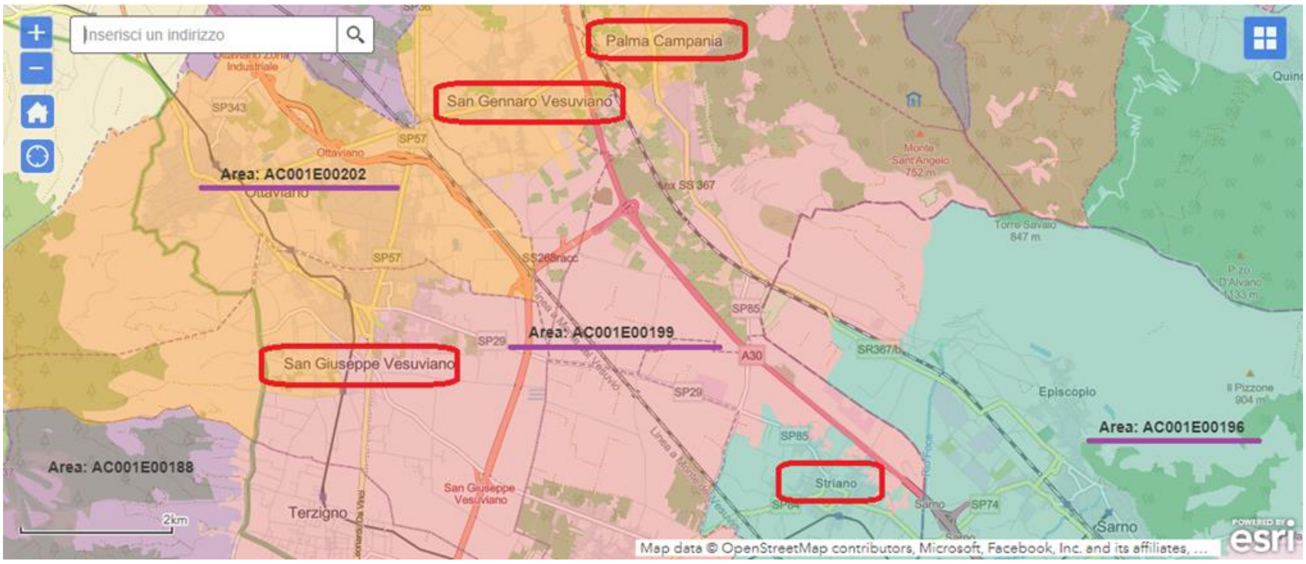


Figure 17 - Map of conventional areas in the UCSA/Campania region

As can be seen from the figure above, the UCSA/Campania area refers to three different conventional areas, therefore, the energy should be shared by the generation system and members inside the same conventional area to which it belongs.

It is important to point out that 3 of the 4 municipalities that make up UCSA have their territories wholly or partially included in the Area AC001E00202, the reason why this area was adopted as a priority for the take-off.

Production potential of the plant

Regarding the selected buildings, the photovoltaic potential was calculated using coefficients (kWp/m2) based on the direct experience of AESS, discretizing between the different types of rooftops or surface present in the group of sites considered, therefore not using a single standard value, to better adhere to the real context.

Considering the maximum power that can be installed in each of the buildings, if the entire useful area of the roof is allocated to the photovoltaic system, a total installed power of 1,100 kWp could be reached.

After estimating the photovoltaic power potential for each selected building, using an internal AESS tool, the energy that could be produced, that directly self-consumed on site, and that can be made available to members of the renewable energy community was calculated.

The self-consumption rate was based on the direct experience of AESS in similar buildings (schools and social housing buildings) since electricity bills were not provided for this first analysis. This allowed us to estimate the self-consumed renewable electricity compared to the portion made available to the REC according to the Art. 31, paragraph 1 of Legislative Decree 199/2021.

The power of the "Antonio de Curtis" school PV system has been limited to 100 kWp to make it possible to proceed with a low-voltage connection.

For the second and third public meetings, some analysis was deepened through the application of dedicated software (SolarEdge) for the selected sites.

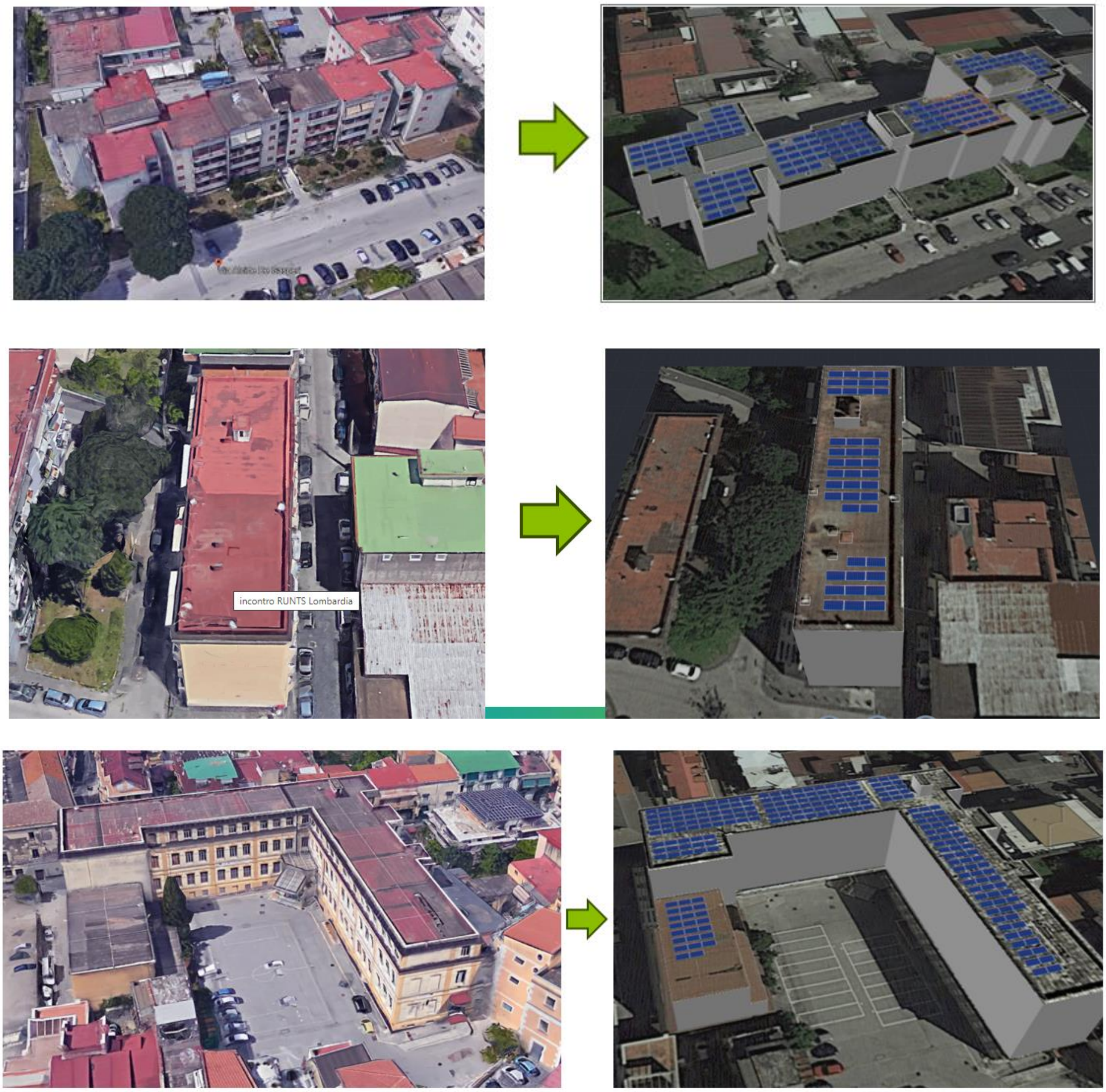


Figure 18 - Installable power per site

In the next phase, the analysis will be carried out with the real consumption for each site, with details of monthly consumption and divided into bands F1, F2 and F3, which can be easily found on the electricity bill, for a more accurate simulation.

Using the models developed by AESS, the estimated consumptions were subsequently divided on an hourly basis and compared with a standard profile of energy production from PV systems. In this way, it was possible to obtain a percentage of self-consumption of electricity as close as possible to a real context;

The preliminary analysis has allowed us to estimate that the total number of families that can be involved in the REC initiative, inside the area AC001E00202, is about 400 and inside the area AC001E00199, is about 600.

Potential energy savings of the installation

According to the AESS simulation, the total power of 1,100.64 kWp would make it possible to produce 1,586,700 kWh/year. From the estimated consumption, it appears that 106,160 kWh/year could be self-consumed directly, therefore configuring energy savings, with a consequent direct benefit in the bills of 23,355.29 (applicable only to the user direct connected to the PV system), while the remaining amount of 1,480,540 kWh/year can be made available for the members of the REC. In this configuration, assuming a 70% of energy will be shared among the members, it would be possible to involve about 592 families in energy poverty, by providing an annual contribution ranging from 157 Euros to 43 Euros for each family engaged.

It is important to highlight that such values were calculated with preliminary or estimated data. Moreover, Italy the incentive that will be ttributed to shared energy among community members has still not been quantified. Therefore, such values may suffer major variations in future simulations.

Potential emission reductions of the installation

Regarding the GHG emissions avoided, they were calculated based on the expected annual renewable energy production with reference to the Italian grid emission coefficient, which is 0.000295 tonCO2/kWh. Thus, the expected CO_2 emissions avoided are 468,00 tons/year.

Practical installation of the plant

The feasibility studies carried out so far show that the roofs of the 6 social buildings have less impact on direct consumption (since they should be connected to the condominium) and, therefore, have a longer payback time in relation to the other photovoltaic systems studied in the Campania/UCSA area, being, therefore, classified with lower priority (see more details in 7.2 Economic aspects below).

Given that the social buildings in Palma Campania still have roofs that are public property, the possibility of insulating them will be evaluated in a second phase, during the 2024 meetings focusing on energy efficiency measures.

In the activation phase, some photovoltaic systems in the municipalities of San Giuseppe, San Gennaro and Palma Campania will be used since they are not yet connected to the electricity grid due to technical and administrative problems. Therefore, such systems may be considered eligible for energy sharing and receiving REC incentives. The preliminary data collected showed 14 PV systems in these conditions, for a total of 252,5 kWp in the municipalities of San Giuseppe Vesuviano (4 PV systems for a total of 42 kWp), San Gennaro Vesuviano (5 PV systems for a total of 150 kWp) and Palma Campania (4 PV systems for a total of 60,5 kWp).

After the activation of the REC, the systems to be installed first by the REC will probably be those at the "Antonio de Curtis" school (99,82 kWp) or on the public land confiscated from the mafia on the A30 (609 kWp), both in Palma Campania.

For now, no in-depth studies are foreseen for the social buildings selected in the SGV. This is dueto three reasons: 1) the the lack of participants from the respective buildings in recent meetings held, 2) the fact that the roof is private, and also 3) because these buildings are the least convenient from an economic and energy point of view (possibility of direct self-consumption or having surpluses to share).

7.2

Economic aspects

Investment costs of the installation

The investments for the systems with a total power of 1,100.64 kWp stand at 1,844,500.00 Euros, including the cost of the systems (supply and installation), technical costs (15%), safety charges (10%), VAT on installations (10%) and VAT on technical expenses (22%). For the specific cost of the photovoltaic panels, values in line with market prices were considered, taking in consideration the size of the different PV systems.

ID	Comune	Edificio	Potenza Installabile Impianto FV	FPO Fotovoltaico	Totale Lavori e Forniture	Oneri per la sicurezza	Totale Lavori, Forniture e OOS	IVA su Lavori, Forniture e OOS	Spese Tecniche	IVA su Spese Tecniche	Totale Quadro Economico arrotondato	Tempo di ritorno semplice	Tempo di ritorno semplice con CER
			kWp	€	€	€	€	€	€	€	€	anni	anni
1	Palma Campania (NA)	Condominio 1.1 - Viale Giacomo D'antonio 41	57,96	78.246 €	78.246 €	7.825 €	**86.071 €**	8.607 €	12.911 €	2.840 €	**110.500 €**	14	7
2	Palma Campania (NA)	Condominio 2.1 - Viale Alcide De Gasperi 28	70,84	95.634 €	95.634 €	9.563 €	**105.197 €**	10.520 €	15.780 €	3.472 €	**135.000 €**	14	7
3	Palma Campania (NA)	Condominio 3.1 - Viale Alcide De Gasperi 73	71,76	96.876 €	96.876 €	9.688 €	**106.564 €**	10.656 €	15.985 €	3.517 €	**136.800 €**	14	7
4	San Giuseppe Vesuviano (NA)	Condominio 1.2 - Via Padre Gino Ceschelli, 43	19,78	38.571 €	38.571 €	3.857 €	**42.428 €**	4.243 €	6.364 €	1.400 €	**54.500 €**	18	9
5	San Giuseppe Vesuviano (NA)	Condominio 2.2 - Traversa Milano, 2	19,78	38.571 €	38.571 €	3.857 €	**42.428 €**	4.243 €	6.364 €	1.400 €	**54.500 €**	20	10
6	San Giuseppe Vesuviano (NA)	Condominio 3.2 - Traversa Ceschielli SNC	19,78	38.571 €	38.571 €	3.857 €	**42.428 €**	4.243 €	6.364 €	1.400 €	**54.500 €**	20	10
7	Comune di Palma Campania	Istituto Comprensivo Statale 2° "Vincenzo Russo"	58,88	79.488 €	79.488 €	7.949 €	**87.437 €**	8.744 €	13.116 €	2.885 €	**112.200 €**	11	7
8	Comune di Palma Campania	Scuola Secondaria de 1° Grado "Antonio de Curtis"	99,82	134.757 €	134.757 €	13.476 €	**148.233 €**	14.823 €	22.235 €	4.892 €	**190.200 €**	10	6
9	Comune di Palma Campania	Terreno A30 Caserta - Salerno	609,04	700.396 €	700.396 €	70.040 €	**770.436 €**	77.044 €	115.565 €	25.424 €	**988.500 €**	12	6
10	Palma Campania	Casa Comunale Via Municipio	25,00	- €	- €	- €	**- €**	- €	1.000 €	220 €	**1.300 €**	1	1
11	Palma Campania	Centro Polifunzionale O' Giò Via Ugo Di Fazio	6,00	- €	- €	- €	**- €**	- €	1.000 €	220 €	**1.300 €**	1	1
12	Comune San Giuseppe Vesuviano	Scuola Rossilli Via Ceci	15,00	- €	- €	- €	**- €**	- €	1.000 €	220 €	**1.300 €**	1	1
13	Comune San Giuseppe Vesuviano	Scuola Ammendola Via Marciotti	10,00	- €	- €	- €	**- €**	- €	1.000 €	220 €	**1.300 €**	1	1
14	Comune San Giuseppe Vesuviano	Scuola Ceschelli Via Ciferi	12,00	- €	- €	- €	**- €**	- €	1.000 €	220 €	**1.300 €**	1	1
15	Comune San Giuseppe Vesuviano	Scuola Elementare Nappi Via Nappi	5,00	- €	- €	- €	**- €**	- €	1.000 €	220 €	**1.300 €**	1	1
			1100,64	**1.301.110,00 €**	**1.301.110,00 €**	**130.111,00 €**	**1.431.221,00 €**	**143.122,10 €**	**220.683,15 €**	**48.550,29 €**	**1.844.500,00 €**	**0**	**0**

Figure 19 - Installable power per site

It is important to point out that, at this stage, all roofs were considered suitable for installing the PV systems, since no technical visits were made to the sites to verify the structure.

Operating / maintenance costs of the installation

The operating and maintenance cost are calculated based on the CAPEX of each of the systems, being equivalent to 1.5% of the total cost. The management costs of the legal entity of the REC would depend on the adopted typology and the number of members. All those costs are taken into consideration in the economic feasibility studies, in a way that such values are subtracted from the revenues derived from the incentives regarding the shared energy and from the payments regarding the energy injected into the grid before the distribution among their members.

How will the installation be financed?

Two different models of an energy community will be tested in the UCSA area.
The first model aims to install the generation systems directly on the social housing building's rooftops.

The project, through AESS, will provide tailored feasibility studies and support to the identification and contracting of an Energy Service Company – ESCo, which can finance and install the PV system. The ESCo, therefore, would install the system directly and recover the initial investment and the maintenance costs through the retention of 100% of the value obtained with the injection of energy surplus into the grid (RID) and part of the benefits (between 30% - 70%) resulting from the sharing of energy between the members of the REC. The percentages and values should be defined on a case-by-case basis, considering the availability of initial resources from the founding members and also the national and regional dedicated financing lines and incentives that should be made available after the definition of the Italian normative framework on RECs.

In the second case, the initiative would start from public systems installed in public buildings that share the surplus of energy generated with members of the energy community in situations of energy poverty. In this case the PV systems will be financed directly by the UCSA's Municipalities through their own resources or national and regional dedicated financing lines that should be made available after the definition of the Italian normative framework on RECs.

These two models were presented and deepened in the public events during the five co-creation meetings held throughout October and November 2023 with the vulnerable households, citizens, civil servants and political representatives from the municipalities involved, in order to take in account the specific opportunities and barriers of the UCSA/Campania area.

Other potential direct/indirect benefits for the households

This aspect should be better defined in 2024 after the definition of the Italian REC incentive scheme. Nevertheless, at this moment it would be possible to infer that in the first case, the vulnerable households can benefit from the installation of PV systems: they will benefit from lower operational costs of the condominium since the electricity generated on the rooftop will be utilized in the common areas such as lighting, pumps, and elevators. The revenues that remain after the payment of the investment and maintenance made by the ESCo could be used to activate common services in the benefit of the local community.

In the second case, the energy will be used directly by the public building, reducing the Municipality energy bill and the surplus produced will be shared among the REC members. If all PV systems were installed, and considering that 70% of the energy made available is shared, it would be possible to involve about 592 families, by providing an annual contribution ranging from 157 Euros to 43 Euros for each family engaged.

7.3

Legal aspects

Ownership

The PV systems installed in the public buildings (schools) or areas will be owned by the respective Municipality.

Regarding the PV systems installed in the social housing buildings, the system should be owned by the condominium or directly by the REC. This aspect should be defined case-by-case in 2024, after holding the series of public meetings foreseen and in view of the national and regional incentives that should be made available after the definition of the Italian normative framework on RECs.

Risk management

This section describes the main risks, uncertainties or difficulties related to the implementation of the Pilot in the UCSA/Campania area in the first part of 2024 and the measures/strategy that will be implemented for addressing them.

a) Normative : as will be detailed in the item below, the legal framework of reference for energy communities in Italy is not yet complete, as there is a lack of a normative decree that should be issued by the Italian Ministry of Environment and Energy Security - MASE, which will lead to the updating of the technical rules of the National Energy Services Manager - GSE. This fact creates great legal uncertainty and prevents the implementation of concrete measures, since the ECs are not yet fully operational in the country. It is expected that this situation will be solved by the end of this year with the publication of the norms at National level.

b) Citizen Engagement : the participation in the 5 meetings held during the second part of 2023 was lower than expected given the broad communication campaign carried out. Participation and interest of families in situations of energy poverty remained below expectations. Also, we noted the absence of families residing in buildings selected by the municipalities of Palma Campania and San Giuseppe Vesuviano to the feasibility studies within the project. The meeting and the campaigns in 2024 will be more targeted and some of the meetings will be held near the selected areas instead of in the municipalities headquarters.

c) Administrative: The creation of the legal entity that will manage the energy community was discussed in 3 of the 5 co-design meetings held in 2023. Some decisions were taken after the meetings, such as the joint deliberation of the mayors of the 4 municipalities that are members of UCSA, in order to promote the creation of the CER in the form of a legal association. However, the lack of a complete picture in the national legal framework still generates uncertainty, esp. when it comes to incentives and tax repercussions. It is expected that most of the issues will be clarified soon, in a cascade of the various bodies of the Italian government, such as the National Tax Agency, after the publication of the MASE decree and the technical operating rules by the GSE. The issue of permitting also awaits a legal definition with the issue of suitable areas, which could particularly impact the viability of the photovoltaic system on public land in the A30 area.

d) Financial: The uncertainty regarding the value of the incentives that will be allocated to energy shared internally by the members of the REC and the high initial costs for installing new systems and taking off the initiative (creation of the legal entity) are considerable risks, especially when it comes to actions that involve economically vulnerable householders. In this aspect, the support of UCSA's municipalities, especially in the initial phase, should be decisive.

Other relevant local, regional or national legislation

In March 2020 through Law n. 8/2020, Italy started to put in place an experimentation phase regarding REC. However, it was limited to new and small systems (up to 200 kWp, built up after March 2020) and with very limited electric perimeter: the same low voltage feeder.
In December 2021, the national law for the transposition of the REDII was enacted by the legislative decree n. 199/2021. The REC definition touches upon the open and voluntary

membership and effective control, the different activities that they can undertake.The law, though, states that ECs can take any legal form, as long as it is clearly stated that the main aim of the community is to bring environmental, social and economic benefits at the local community where they operate, as financial profits cannot be the main aim of the EC.

Interestingly, REC provisions explicitly promote inclusiveness by mentioning the need to ensure participation is open to low-income or vulnerable households. The RECs definition refers to most of the criteria contained in the RED II definition, including autonomy and effective control, which were not touched upon in previous legislation.

The new legislation increased the previous cap on capacity, which now cannot exceed 1 MW for each REC's plant. Also, the geographical proximity has been changed with the new legislation and has been defined as consumption points connected under the same medium voltage station (primary feeder) to share energy within incentives (a premium tariff) and the same market zone to share energy without incentives.

Nevertheless, both National Decrees require action by the Italian's regulatory bodies, such as ARERA, MASE and GSE, to be fully operative. Regarding the REDII, the normative of ARERA (Integrated text on shared self-consumption for buildings, condominiums and energy communities) was published on December 2022 and, in the same month, the MASE decree was put under public consultation, the latter should be published in the definitive version by the second half of 2023.

Thus, Italy does not have yet a complete legal framework regarding RECs, reason why the provisions enacted for the experimentation phase are still being applied in a provisory way, even if they include several limits to RECs.

It is important to highlight that by the end of 2022 the pathway towards the full adoption of the RED-II has been traced even if not all the technical aspects have been cleared in a definitive way. The evolution of this process should lead to the creation of a real energy market also for the energy communities, allowing the different stakeholder, as groups of citizens, to identify commercial proposals that fit with their context, capabilities and opportunities.

However, until now, in Italy, the energy market renovation, pushed by the CEP, has been proceeding very slowly. In addition, the complementary parts, as the economic analysis and funding, are still not aware of the opportunities and are completely unable to provide services and proposals to the RECs.

The definition of the technical and economic rules for the RECs in the next months shall cancel the doubts and uncertainties by allowing the energy market to evolve on the basis of European directives.

The table below summarizes the main differences between the current phase and the definite one, that will be in place with the release of the MASE decree.

	Law 08/2020	Law Decree 199/2021
Maximum installed capacity of the generation systems	<200 kW	<1 MW
Perimeter of the energy community	Medium / low cabin	Primary cabin
Allowed generation systems	Systems installed after March 2020	Systems installed after December 16, 2021 + 30% of energy from existing generation plants
Members Admitted	Citizens, SMEs, local authorities	Citizens, SMEs, third sector entities, local authorities

Table 1 - Main differences between current and definite juridical framework

According to the latest data available, at the end of 2022, in Italy, 46 configurations of Collective Self-Consumption (CSC) and 21 REC were active, corresponding to a total of 1,4 MW photovoltaic power. The majority of the configurations (75%) are up to 20 kW. In total, 501 users are connected to these configurations, and almost 70% are included in CSC schemes (GSE, 2023).

08

Heerlen pilot: technical, economic and legal development

By December 2023, it was not yet clear if the POWER UP pilot in Heerlen will materialize due to several juridical and business model-related challenges. This chapter summarizes the plans regarding the pilot as known during the writing of this report.

Vrieheide is a residential neighbourhood in Heerlen with 128 blocks of six homes each. These houses often belong to homeowners and are in poor condition, with a low insulation degree and, as a consequence, high energy bills. The owners have no financial reserves and, therefore, in part, face energy poverty. This is where the pilot comes in. As a test-case, one of the blocks of six homes will be completely renovated. Each house will receive energy renovation and get 14 solar panels on the roof. It is the aim that, after the positive test-case, by 2030 64 blocks will receive the same solution, scaling up the test case.

Next to the goals related to combating energy poverty, Heerlen and the Parkstad Limburg region want to be energy neutral by 2040. They want to do this by equipping all available roofs with solar panels. There is no room for solar on (agricultural) land in Heerlen. In time, they also want to place windmills in Heerlen South which could be connected to the Power Up solar pilot by working with the same energy cooperative.

Figure 20 - A part of Vrieheide: blocks of 6 homes with flat roofs

8.1

Technical aspects

Screening of rooftops

The overall condition of the houses in the selected neighbourhood is bad. This is why the POWER UP pilot is linked to another project, which calls for an energetic renovation, including renovation and insulation of the flat roof. The selection criteria were based on the roofs that will be already renovated, so they can receive PV installations.

Production potential of the plant

The solar panels that will be used in the Vrieheide pilot will be of modern quality and the highest efficiency. These will each have a peak capacity of 400 Wp. The flat roof can accommodate up to max. 14 solar panels. This means that each house will generate 14*400 Wp = 5600 Wp (or 5.040 kWh per year). This means that after the renovation of all 128 blocks in Vrieheide there is a generation capacity of 3.870.720 kWh per year.

Potential energy savings of the installation

Direct own consumption per home is estimated at 30% of the generated electricity. This corresponds to 907.2 kWh. The financial benefit is estimated at 360 euros a year.

A typical solar profile produces more energy in summer than in winter. By working with a cooperative supplier of renewable energy, production and consumption are balanced over the portfolio of the cooperative installations and the cooperative consumers so that green electricity is always supplied.

Potential emission reductions of the installation

A yearly local production of 5.040 kWh solar energy each house represents a yearly reduction of approximately 1.814,4 kg of CO2, or 45.360 kg of CO2 emissions during the whole lifespan of the solar panels (25 years). The impact of materials, transport and construction of the solar is 200 kg CO2/y calculated. Netto reduction CO2 during lifetime is 40.360 kg.

That means linear calculated after the renovation of ALL blocks a CO2 reduction of 30.996.480 kg CO2 (=30.996 ton).

Figure 21 - Map of Vrieheide solar potential. In green: the properties on which solar panels have already been installed. In purple: properties with potential for solar panels as part of the pilot. The circled location is where the pilot will run.

Practical installation of the plant

At this stage of the project, it is too early to give details on the installation of the plant.

8.2

Economic aspects

There are currently two potential business models being investigated. By the time of writing, the decision on one of the two models has not yet been taken. This is why, in this section, we include information on both models, as costs will differ.

Investment costs of the installation

Current prices in the sector were used in setting up the budget (prices of September 2023). Per house, 8,960 Euros are spent on 14 panels and installation costs. Purchase of solar panels is exempt from VAT. The roof renovation is calculated at 15,000 Euros exc VAT per house. To renovate the roof, 50% of the cost can be paid from the grant "Housing Fund" (Volkshuisvestingfonds). Per dwelling, the cost is 16.460 Euros (8.960 Euros + 7.500 Euros). For a block of 6 houses, the total investment is 98,760 Euros.

A linear translation of the investments over all 128 blocks (= 768 homes) shows a total amount of 12,642,000 Euros.

Operating / maintenance costs of the installation

The exploitation costs for the two potential models differ.

In the first model, 6 individual connections to the PV installation are installed by a cooperative. In this model, the exploitation per household per year is 1,435 Euros (= 8,610 Euros per block).

In the second model, there is one collective connection to the installation. Annual operating costs in this model are estimated at 7,720 Euros. No fee for roof use is charged to the owners.

How will the installation be financed?

The renovation of the roof is subsidized for 50% of the costs in the context of the Vrieheide project (e.g. from Housing Fund and ISDE). The financing of the solar panels in the context of the POWER UP project is not yet clear.

In the first model, homeowners basically pay their own share. After subsidies are deducted, homeowners themselves have to contribute with 16.460 Euros (= 18.150 Euros incl VAT). Owners can release this money from the excess value of their homes. So a new mortgage, which may be cheaper than their old one because of low interest rates. When this is not interesting or not enough funding, owners can borrow from the Heat Transition Fund with a 0% interest rate. There is also an option for this target group to borrow money from the municipality. With the municipal sustainability scheme (or GVR), the cost is spread over 15 years and is collected through municipal taxes. The Heat Transition Fund and Municipal Sustainability Scheme have no credit registration, which makes borrowing easier for this target group. By entering the project, the homeowners instruct the energy cooperative to arrange the installation and the cooperative is paid directly from the loan.

In the second model, to partially cover the costs, it is assumed that the cooperative may also use the existing funds, such as the Public Housing Fund (Volkshuisvestingsfonds). The difference remaining after deducting subsidies will have to be paid by the cooperative. It remains to be worked out what form of financing the energy cooperative will follow:

- The energy cooperative borrows the money from a commercial bank. Banks are reluctant to finance this type of investment because there is a risk of non-payment and uncertainty about the business case because of the balancing scheme. As a result, the interest rate will be high.
- The energy cooperative borrows the money from the municipality. The possibility exists for municipalities to borrow money at low-interest rates. However, the municipality also

runs a risk of non-payment if large amounts of solar panels and money are involved. However, the municipality could decide to take that risk.

- The energy cooperative raises money by issuing shares. These shares provide membership and thus access to the cooperative tariff and possibly additional saving services offered by the cooperative. The shares (crowdfunding) offer the buyers a dividend and eventually, they can ask for their initial investment back. The advantage of this is that there is no loan for the households, but a fee for the use of the energy, i.e. the cost of electricity. However, there is also a risk of non-payment in this.

Other potential direct/indirect benefits for the households

Through collective energy sharing, people participating in the project will benefit from fair energy prices that reduce their energy bill compared to the commercial market.

In addition to the direct financial benefits, households benefit from other aspects of membership of a community energy co-operative. First, the ownership of equipment and production that comes with cooperative membership ensures long-term participation and stability for cooperative members. Second, by joining a community energy co-operative, vulnerable households become members of an energy community focused on renewable energy production and energy conservation. This approach makes renewable energy accessible to vulnerable households and works in an inclusive way, involving everyone in the local energy transition.

The business case does not include the benefit of the roof renovation. Insulating the roof will save on gas consumption. It is estimated that this is about 200-300 m3 of gas per year. With current gas prices, this provides an annual financial benefit of approximately 300 Euros – 350 Euros.

In Heerlen, actions are also underway to reduce energy consumption, even if they are not related to POWER UP project. Old refrigerators, washing machines and possibly dryers can be exchanged for more modern and energy-efficient versions. Old light bulbs can be exchanged for more sustainable LED bulbs.

People can also get an E-card worth 250 Euros to take simple energy-saving measures themselves. They can be advised by an energy coach who will visit them at home.

8.3

Legal aspects

Ownership

This point still has to be clarified further. The co-creation process with the homeowners and the conversation with partners such as the cooperative and the social housing company still have to be started. These discussions will allow to clarify who wants and will receive ownership of the solar panels after 15 years (first model). The preferred model would be for the ownership to remain with the cooperative, relieving the homeowners from extra costs such as the maintenance of the roof and solar panels.

Risk management

Risks exist in the different phases of the project. With active risk management, these are mitigated in various ways. As the model is not mature, risk are still unclear. One, for example, is fear of failure in the development phase, as indicated by the energy cooperative, related to the risk of non-payment by the participants. A solution to this risk could be for the municipality to provide a guarantee for this group (estimated rate of non-payment 1.5%).

Other relevant local, regional or national legislation

The 1998 Electricity Act defines responsibilities at high, medium and low voltage levels. The authority "Consumer and Market" monitors the compliance with the law and regulations by the various authorities and market parties.

The regional authorities are responsible for renewable energy on land and for energy savings on their territory. This is laid down in the Regional Energy Strategy to which all municipalities in South Limburg have committed themselves. The following regulations apply to the realization of the solar panels: Building Decree 2012 and BBL 2023, Environmental Act (from 1 January 2024), Regional environmental ordinance, Welstand.

09

Conclusions

This report aimed at providing basic information on the technical, economical and legal aspects of renewable energy installations, focusing on solar power installations (chapter 2) and wind power installations (chapter 3) as most common technologies.

Chapters 4 until 8 provided a state of the art of the technical advancement, the financing and legal considerations in the context of the Power Up pilot projects. As the projects are very diverse, comparison makes limited sense. However, to give an overview, you can find the key figures of the five pilot projects in the table below. The data is provided by the pilot leaders based on technical assessment of the renewable energy plant or information provided by the installer, and represents the potential currently assessed in each pilot.

	Valencia[7]	Roznov	Eeklo[8]	UCSA	Heerlen[9]
Energy source	Solar	Solar	Wind	Solar	Solar
Nominal power of RES production (kWp)	2.850,05 k	39,13	2.000.000	438	33,6
Expected yearly production potential (kWh)	3.838.530	39.130	5.000.000	525.600	30.240
Potential yearly emission reduction (t eq CO_2)	1.019,35	15,2	1.945	155,05	10,886
Investment cost	4.112.975,84 Euros [10]	1.732.629 CZK, excluding VAT (aprox. 71.958 Euros)	3.275.000 Euros	752.400 Euros	53.760 Euros [11]

Table 2 - Key figures of RES production installations of Power Up projects

[7] Total of the 5 fee model sites

[8] For the Eeklo pilot, no KPI's have been set regarding the technical side of the project as the Huysmanhoeve wind turbine had already been constructed when the Power Up project started. However, to give you an idea of the technical details, we decided to include the data in this table.

[9] Data added for the test case of one block of six homes in Vrieheide

[10] Including project preparation costs. Investment costs could be significantly lower depending on received offers.

[11] Costs of 14*6 solar panels on one block of six homes

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