Energy communities to increase local system efficiency

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Introduction

The EU has been scaling up its climate and energy ambitions, and has now committed to reduce 55% of net GHG emissions by 2030. In order to achieve this target, massive investments in decentralized energy resources are required, such as solar, wind, storage, new loads such as electric vehicles or heat pumps, and all kinds of smart energy solutions that can allow these resources to use Europe's electricity infrastructure as efficiently as possible.

This is not only a financial challenge, but an organisational one. It requires the active participation of end-users and citizens. Energy communities can make an enormous contribution in this regard. As stated in the recent State of the Energy Union report[1], at least 2 million people in the EU are already involved with more than 7700 energy communities, and the engagement is on the rise. They have also contributed up to 7% of nationally installed capacities of renewables, estimated at 6.3 GW.

Before further diving into the potential of energy communities, we would like to clarify the term 'energy community' for the purposes of this report. 'Citizen energy community' (CEC) and 'renewable energy community' (REC) have been defined in respectively the Electricity Directive and the Renewable Energy Directive. CECs and RECs are legal entities based on open and voluntary participation and effectively controlled by their shareholders or members who are citizens, SMEs and/or local authorities and whose primary purpose is to provide environmental, economic or social community benefits for their members or the local area members. These two concepts have been set up to enable the participation of the civil society into the provision of energy services, where profit is not the main goal (e.g. cooperatives, associations, etc.).

Energy communities can engage in many different activities, many of which do not strictly require geographic proximity. However, in this paper we focus on those activities that do require geographic proximity, such as setting up collective self-consumption schemes, optimising the use of renewables and reducing grid congestion. In this way, we want to look at how energy communities can strengthen their business models, while also contributing to local system efficiency.

We also present how energy communities can benefit from new kinds of services. These services can be used both by energy communities that require geographic proximity, as well as 'communities' in a broader sense, such as virtual communities consisting of customers of the same aggregator or energy retailer, local peer-to-peer energy trading or local flexibility markets. The latter are usually not in themselves energy communities as defined in the EU framework, yet can provide valuable services, and enable energy communities to further develop their services and technological capabilities.

[1] State of the Energy Union 2021 – Contributing to the European Green Deal and the Union's recovery.

Improving the Business Models of Energy Communities

As stipulated in the introduction, this paper is taking a closer look at how some energy communities can strengthen their business models, while also contributing to local system efficiency. In this context, local system efficiency means optimizing the use of the existing grid, delaying and avoiding grid expansion, integrating more renewable energy, while electrifying transports and buildings. Depending on the national circumstances, this could require that communities, when located behind one feeder or substation, keep their collective peak consumption below the contracted amount. It could also be that the community sells their flexibility to local system operators in order to avoid grid expansion.

Savings through collective self-consumption

Self-consumption means consuming the electricity that you yourself produce. This can be measured both at an individual or community level. Each kWh of electricity that is self-consumed is electricity that does not need to be produced elsewhere and transported over the grid. Each kWh of electricity that is self-consumed does not need to be purchased from an energy retailer. Purchasing less electricity also means lower taxes and network charges (assuming that network charges are volumetric and not capacity-based). After an initial investment in the decentralized energy resource, such as rooftop PV, you do not need to pay for the self-consumed energy.

Collective self-consumption means widening the scope from an individual to a larger group of people. Households within an energy community may give the electricity to each other, or trade it, while paying reduced taxes and network charges and generally at more beneficial rates than those provided by the retailer and the grid. In France for example, consumers that participate in collective self-consumption receive a subsidy that covers at least the taxes and network charges. For more information on a collective self-consumption project, see for example the project by tiko and Engie in the Case Studies section.

Savings from transmission (TSO) network charges

If electricity that is produced locally is also consumed locally, this means that this electricity will not feed back into the TSO network, and will not take up any capacity in the high-voltage grid. In some countries, this can result in savings for energy communities. In France and other countries, communities that consume energy within the low-voltage network and do not feed back into the TSO network, do not need to pay TSO network charges.

Selling flexibility to avoid grid expansion

Investing in heavier cables will sometimes be necessary to accommodate the connection of new DERs and the uptake of EV and heat pumps to the low and medium voltage network. In some countries there may even be a need to increase electricity transport capacity to allow for further deployment of renewable based plants, like the case of the Netherlands[2].

However, network expansions takes longer to build and can be a costly, time-consuming and inconvenient solution for solving grid congestion. If communities' flexibility is harnessed by DSO's activation of flexibility markets, this could help avoid or delay grid expansion to some extent, especially if DSOs provide sufficient information to encourage additional local investment in flexible assets.

Creating community benefits

In addition to reduced cost and increased return on investing in renewable resources, there are many other energy community benefits. One such benefit lies in increased resilience of the local energy system, and improved response to adverse events. There is also a positive impact on economic social inclusion as reported by JRC[3] and demonstrated in multiple studies.[4] They also give ownership to citizens and voters, thus raising awareness and commitment.

[2] https://www.nu.nl/klimaat/6167439/nauwelijks-meer-ruimte-voor-zonneparken-op-bomvol-stroomnet.html
[3] JRC science for policy report: Energy communities: an overview of energy and social innovation, 2020.
[4] See for instance Modelling study to assess the potential benefits of trading in and between local energy communities in Germany, 2020.

Enabling services for energy communities

Across Europe, energy communities have already achieved significant progress in renewables investments and providing services to their members. Historically, the business models of these communities have been dependent on the feed-in-tariffs, which are in the process of phasing out in most EU member states. Below are some of the supporting services that could contribute to the further development and scaling up of energy communities in the post-subsidy stage.a

Financing services

ESCOs can facilitate direct financing of renewable assets acquired by members of the energy communities, or leverage financing from other sources. As explained in the Cleanwatts example in the Case Studies section, energy communities can start with a zero-capex model, based on 3rd party capital, sustained on the income generated by the energy generated and sold to the energy community at a significantly lower cost than buying it from the grid, and complemented by other value propositions delivered to the energy community members such as energy visualisation and efficiency. This model can start by financing the generating plants like Solar PV, to be installed on 'anchor' energy community members' roofs, with a clear and immediate benefit for the latter. Then the model can evolve to finance further assets like community batteries, and later prosumers with their own assets can be joined in as well.

Aggregation services

While enhancing local system efficiency, energy communities can simultaneously use their DERs and Demand Response to offer flexibility services to the overall energy system, for example by participating in DSO or TSO markets. This stacking of services can help improve the business model of the energy community, because flexibility is going to the stakeholder that values it the most. This can be done by the community themselves if they have the necessary expertise, or by partnering with a third-party commercial aggregator.

Facilitation/ consulting services

As illustrated in the case study by EPQ, companies outside of the energy community can provide valuable facilitation services in setting up the energy community. This could consist of analysing how and where to place energy resources in the most optimal way, assisting with legal and administrative processes, and identifying members that might be interested to join the energy community. Additionally, as shown in the case study by Spectral, partnering with companies can help communities connect with other players and help drive innovation for the entire neighbourhood.

Information and analysis services

There are many companies that provide platform services that could help energy communities visualize how electricity is being produced and consumed within the community, and some also show they could optimise the renewables mix at the household or community level, and how local trading would impact their economic and environmental objectives. This also opens up opportunities for community members to participate and feel more engaged. Such an interface could give community members insight into how their assets and those of the community energy assets are performing. For example, the platform could show a household that their solar panel has generated sufficient electricity to run their EV for a certain number of kilometres. For many prosumers, this type of information is essential for a more active participation in the energy transition. Some examples of such services include the Grid Singularity Exchange, which can also be used to deploy peer-to-peer trading in EU member states that allow it, such as Austria. Another example is that of the 'peer-to-beer' solar exchange by Powerledger. In this case, the participants can trade their solar energy for beers at their local brewery, and thus reaching people that might otherwise not be as engaged.

Concluding Recommendations

Below are a list of smartEn's recommendations that could improve the efficiency and effectiveness of energy communities.

Member States — Full implementation of the Clean Energy Package

The transposition of the EU Electricity Market Design and the Renewables Directive will allow citizens and local enterprises to help bring more renewable energy into the mix. Energy communities also need to be able to access all energy markets and participate in trading at all levels, which requires a more progressive implementation of energy community legislation by EU member states.

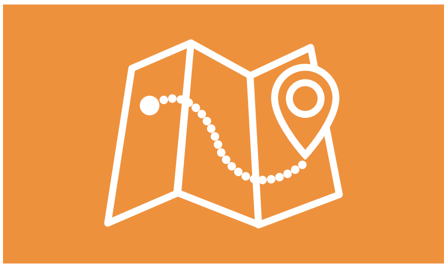
Commission — Shape guidelines to harmonise rules and regulations among EU member states

Harmonising rules and regulations on energy communities can reduce the burden of administration both for energy communities and their service providers.

Commission — DSO Transparency

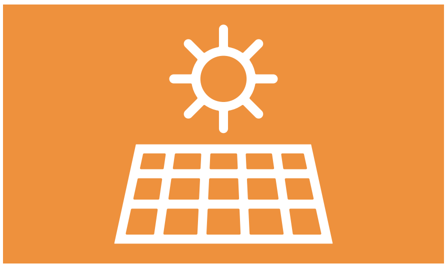
Transparency of the DSO on locational data of substations, as well as access to timely metering information would serve to better calculate the return of potential investment in flexible assets. This should be clarified under the Implementing Act on Data Access and Interoperability. In addition, information on the real-time greenhouse gas content and the share of renewable electricity will give energy communities better incentives to achieve their environmental objectives. This is also in the proposal for the revision of the Renewable Energy Directive and should be supported. In order to make sure this is done in an interoperable manner, it is necessary to ensure harmonised data sets and formats through a revision of the Transparency Regulation on data in electricity markets.[5]

[5] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:163:0001:0012:EN:PDF



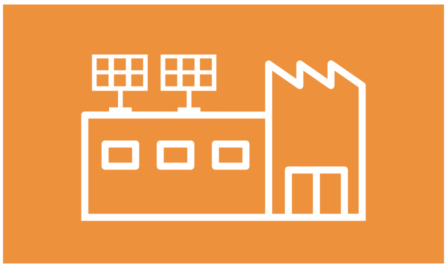
Member States — Remove arbitrary geographic limitations for collective self-consumption schemes

In some cases, Spain for example, there is a limitation of 500m. It may be difficult to create an energy community within this geographic scope that can have a positive impact on the local grid. Of course some limitations may be necessary, but this should be based on what makes sense in the context of the local grid, as opposed to an arbitrary limitation.



Member States — Remove arbitrary local plants limitations

In some countries, there is a limitation of the generation that can exist within the energy community (for example, in Spain it is 100kW), which can limit the reach of the energy communities and its access by citizens willing to reduce their bills through consumption of cheaper locally produced renewable energy. Further, wider energy communities that can combine diversity of loads will be able to better collectively self-consume the energy generated by the energy community assets.



Member States — Encourage SMEs and C&I involvement for better balancing

Commercial and industrial sites often have different load profiles from households. By encouraging C&I sites, as well as SMEs to participate in or contribute to energy communities, they could help balance out load profiles, and further encourage energy to be consumed close to where it is produced.

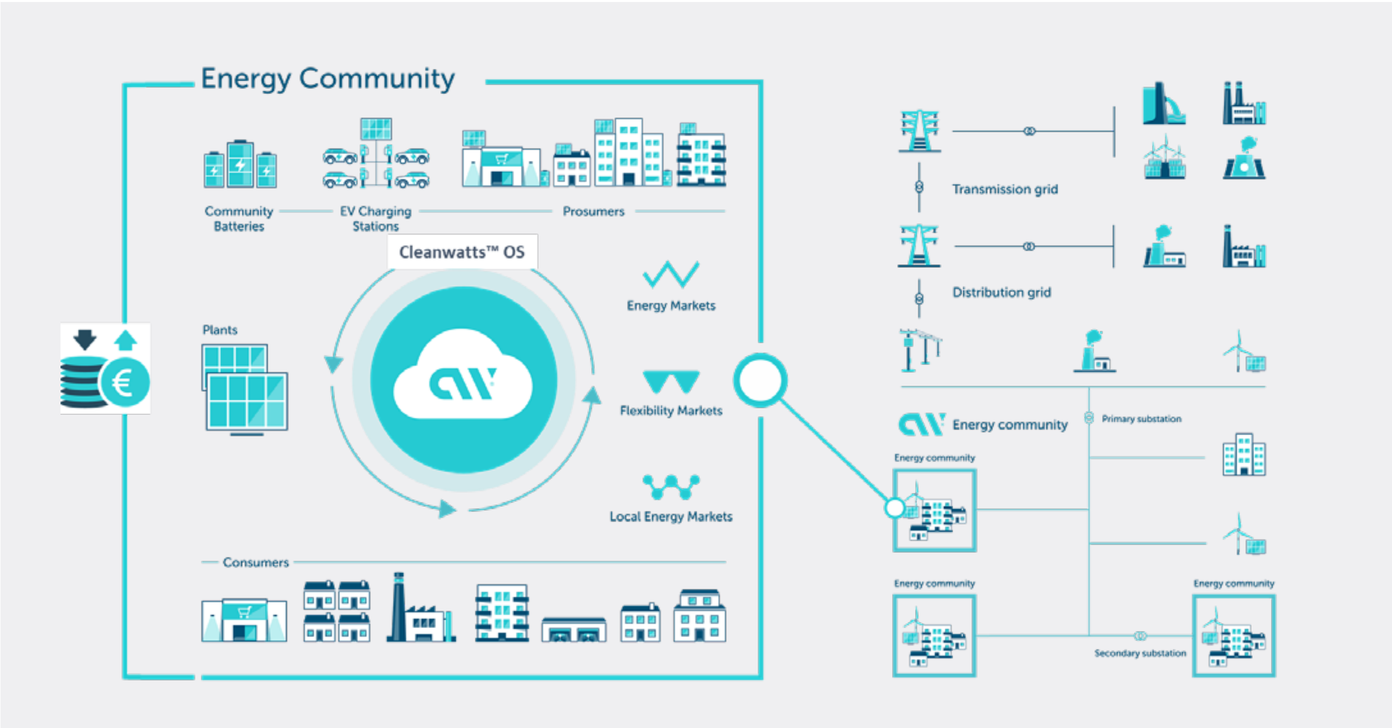
Member States — Revise national network tariffs

Amend network tariffs so that energy communities can pay for the grid infrastructure they effectively use to transport electricity from the local plants to local consumption sites within the community, as was recently done by Austria.[6] At the same time, any changes in network-tariffs should be cost-reflective, and not leading to cross-subsidies.

[6] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20010107&ShowPrintPreview=True

Case Studies of Energy Community Business Services

Cleanwatts: services to set up Renewable Energy Communities in Portugal



As soon as Portugal set the necessary framework for Renewable Energy Communities (RECs), Cleanwatts started leading this development by engaging multiple actors as ‘anchor’ clients. Generally, these are organizations that have available rooftop or land to develop Solar PV generation, such as companies, industry, business parks and municipalities.

Cleanwatts expects to create around 20 new RECs per month during 2022 in Portugal and until January 2022 has already contracted 34 RECs, with a total generation of approximately 5.8MWp, and 276 members. Some of these RECs are being created under the “100 Villages” program which aims to help tackle energy poverty in rural villages across Portugal.

The business model in Portugal works as follows:

- Cleanwatts engages the potential ‘anchor’ clients.

- Cleanwatts builds a zero-capex business model for customers (delivered by 3rd party capital working together with Cleanwatts) that can satisfy the ‘anchor’ client self-consumption and provide excess generation to be shared in an energy community; in accordance with Portuguese regulations, Cleanwatts also manages the REC on behalf of the REC legal body.

- Upon signing a contract with the anchor client Cleanwatts:

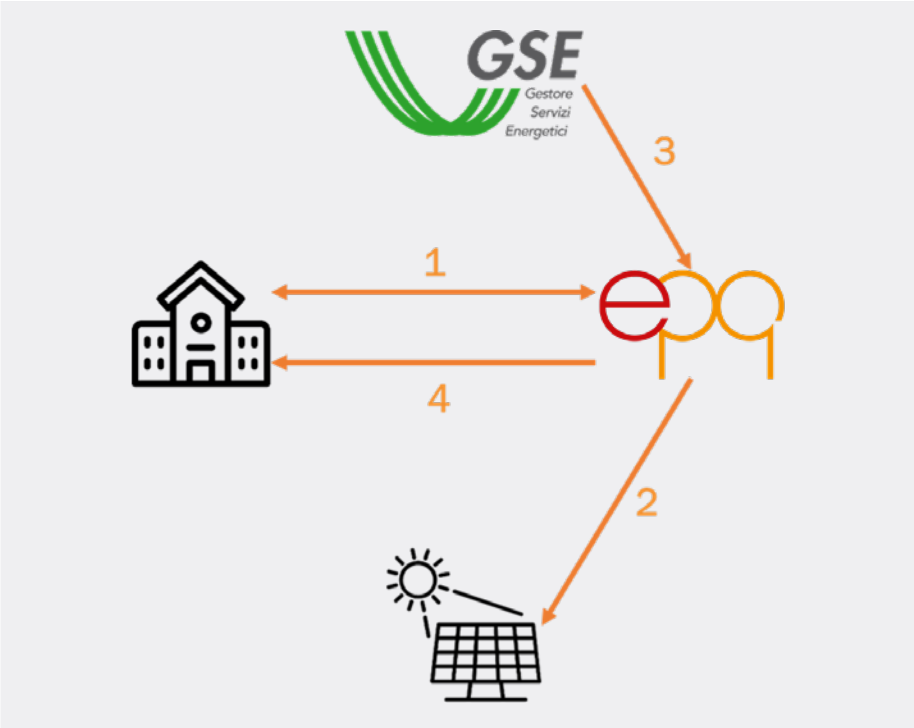
  - Engages Energy Performance Contracts and oversees the installation of generation assets.
  - Engages and contracts members for the REC .
  - Submits REC documentation for approval by the energy directorate.
  - Deploys its modular and fully integrated Operating System (OS) to manage energy flows and transactions within the REC, as well as member level engagement for efficiency, optimization and gamification.
  - Interacts with the DSO to manage energy allocation coefficients for REC members.
  - Bills and credits all transactions within the REC.

- Cleanwatts also:

  - Liaises and reports back to the financier in respect of the ongoing profitability of the financed assets.
  - Reports back to the energy directorate on a yearly basis.

Some of these RECs are expected to evolve into "actively managed" RECs, meaning there will either be community owned assets (e.g. batteries) or prosumer owned energy assets (e.g. batteries, heat pumps, etc…) so that collective self-consumption can be further improved and aggregation of smalls scale REC flexibility for TSOs and DSOs can be then further explored.

EPQ: from creation to management of a Renewable Energy Community in North-East Italy



Together with EPQ, an Italian energy services company, the Municipality of a small town in North-East Italy is exploring the possibility of establishing a Renewable Energy Community (REC). They have identified two rooftops of public schools where PV panels could be installed. Although it was challenging to reach out to so many different types of parties, they managed to get shop owners, a private clinic, a kindergarten and a few condominiums on board.

EPQ has supported this entire process, including the identification of the parties that could potentially be aggregated, the analysis of the relative electric consumptions and the optimization of the PV power to be installed in order to maximize the energetic and economic benefits for the configuration.

While performing these analytical and explorative activities, EPQ also dealt many of the legal and administrative obligations of the project, such as identifying the most suitable legal status for the REC and ensuring compliance with the Public Administration. For example, obtaining the concessions required to install the PV plant on a publicly owned building entails a specific and slow bureaucratic process.

In the approach defined by EPQ, the following flow and actions are contemplated in order to give insight into the different actors involved, the following scheme sums up all the economic and administrative flows and actions between stakeholders:

- EPQ signs a contract with the Municipality in which it commits to supporting the identification of the Members of the REC and other entities involved, preparing the necessary administrative paperwork required, identifying the best legal status for the REC and the sizing of the PV plants (according to the underlying consumptions). EPQ will have a mandate as the Representative of the REC, managing all activities and economic flows, including collection of the incentives in favour of the REC.

- EPQ is the ESCo Company (i.e. investment in the PV plant, installation and maintenance, management of the REC, distribution of the economic value among the different actors). Formally the REC is set up.

- The GSE (the public-owned company which is responsible for the delivery of the incentives) calculates and delivers the incentives to EPQ on a monthly basis.

- EPQ withholds a share of the incentives to repay the investment, channelling the remaining share towards the REC.

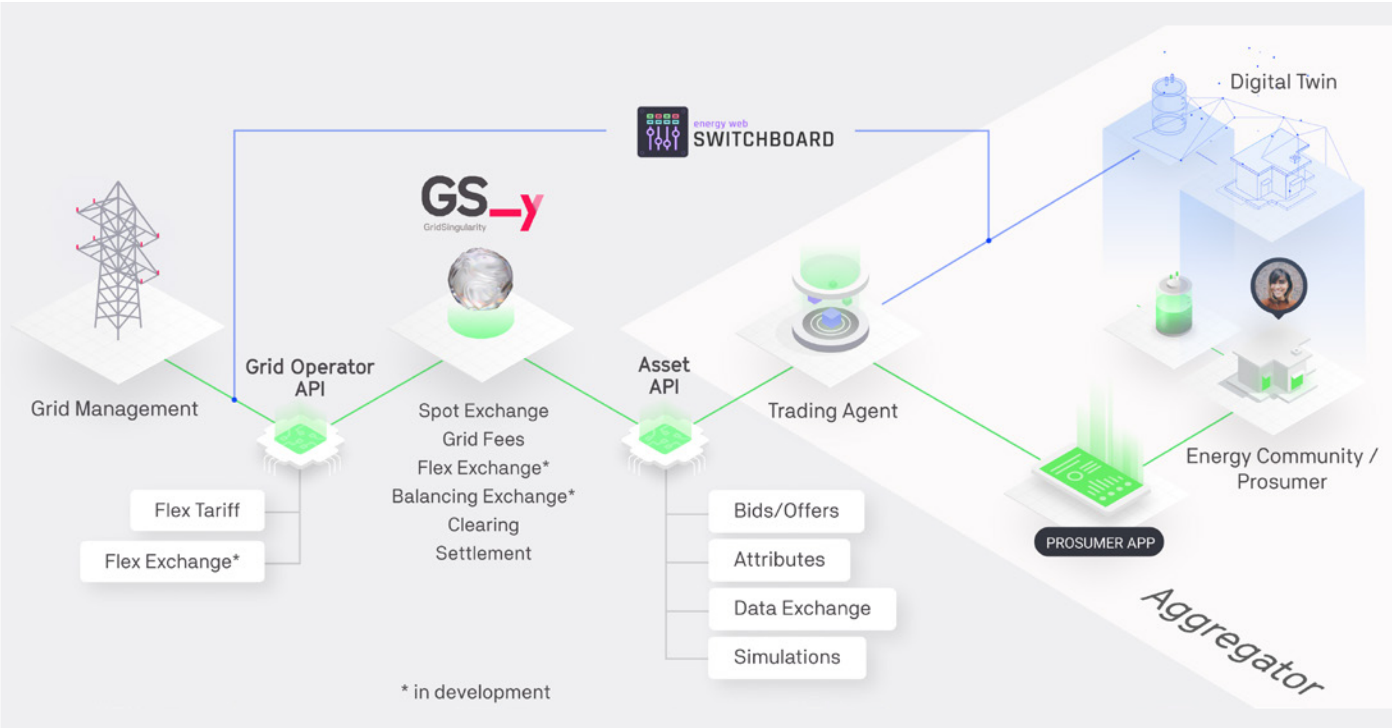
Project details:

- The power to be installed will be 76 kWp, with an expected production of over 90 MWh per year.

- The underlying aggregated consumptions are over 1.000 MWh per year, leading to an optimal ratio of self-consumption of the PV-produced energy of 100%. On the other hand, in the first stage the production only covers as little as 9% of the REC total consumptions. The magnitude of the aggregated consumptions would ideally require to identify other areas where to install new PV power, in order to boost the quota of the consumptions covered by the PV-produced energy (this value could grow up to 30/40%).

- According to business plan the project generates an economic return of approximately 18.800 €/year, of which approximately 75% payed to EPQ (covering investment + OPEX) and 25% payed to the REC. The REC stakeholders are considering setting up a fund for energy poverty (i.e. providing financial aid for paying electricity bills of households in need of assistance) and promoting additional services (ex. free EV charging stations) within the community.

Grid Singularity Exchange: enabling local energy markets



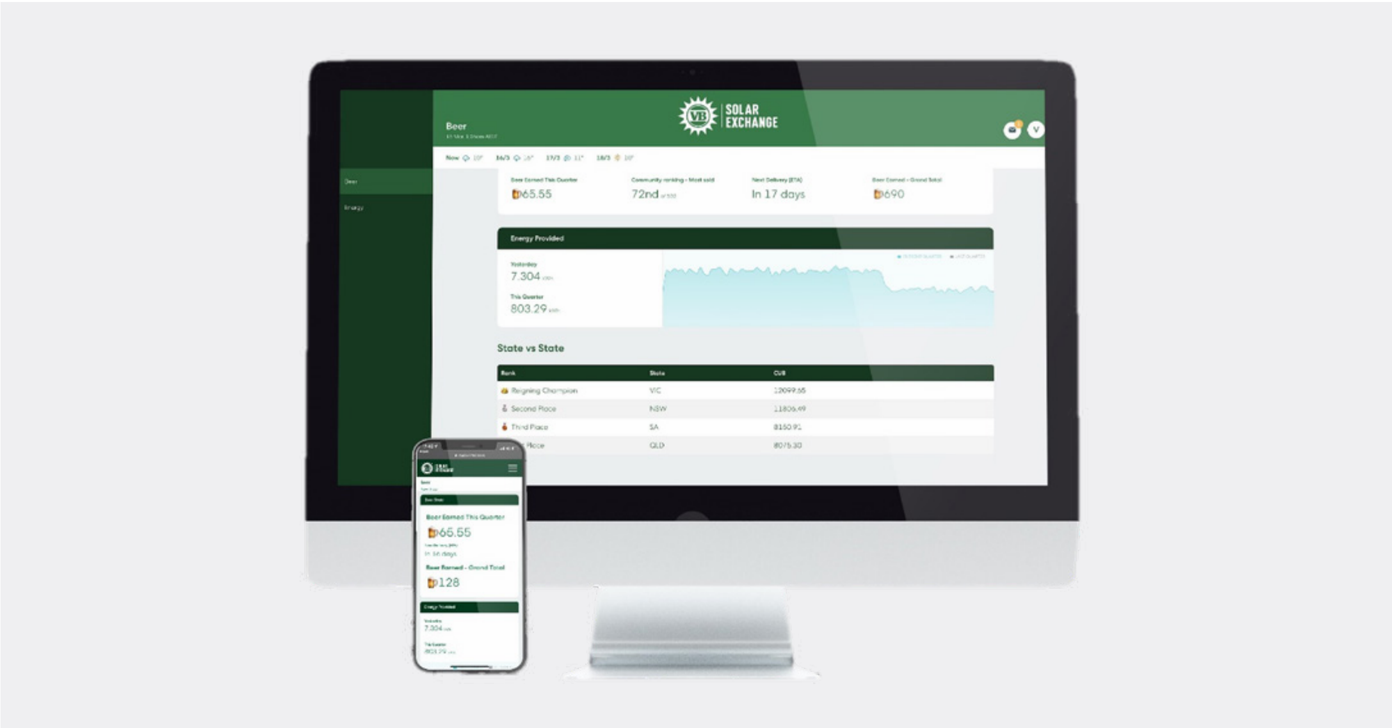
Grid Singularity Exchange enables prosumers and consumers organized in energy communities to simulate and implement peer-to-peer and community energy trading through the creation of active local energy markets (LEMs). Importantly, the open source and modular platform optimises the use of local resources and enables individuals with equitable access to energy trading, at par with large energy suppliers.

Grid Singularity facilitates an individual or energy asset centred, bottom-up, hierarchical market design by connecting aggregators and grid operators, through an application interface (Asset API and Grid Operator API, respectively). More specifically, aggregators connect distributed energy assets of a community (including households, businesses and other energy users), while grid operators account for grid costs and access local flexibility for advanced grid management. Connected energy assets are digitally represented by trading agents pursuing trading strategies based on user preferences, such as consuming only renewable energy or trading with a preferred partner, achieving diverse degrees of freedom. Assets are typically grouped inside homes based on the owner and trade in a community market. Multiple communities can be connected inside higher markets depending on the geographical reach of the peer-to-peer system and voltage architecture of the grid.

When the Grid Singularity Exchange is deployed as a distributed local energy exchange, the traditional role of the grid operator, which manages the connection to the power grid, and the utility, as a provider of energy, would still continue to be required to integrate the local energy market with the wider grid network. This ensures the reliability of supply in case of a deficit within a community but also export possibilities in case of a surplus. The primary difference is that a utility would no longer be the only market actor with which a household exchanges energy, but one of multiple.

The first step towards deploying a local energy market is to configure and optimise its structure using Grid Singularity's free, web-based simulation (user interface). The user can build a "digital twin" representation of physical energy systems and energy markets (using template or real-world data) and run simulations in order to assess the financial and social benefits of local trading and the impact of different actions or assets in the system. The Grid Singularity wiki provides a detailed guide for prosumers and energy communities to set up a simulation, as well as additional guidelines for aggregators and grid operators.

Powerledger and Carlton & United Breweries: Solar Exchange

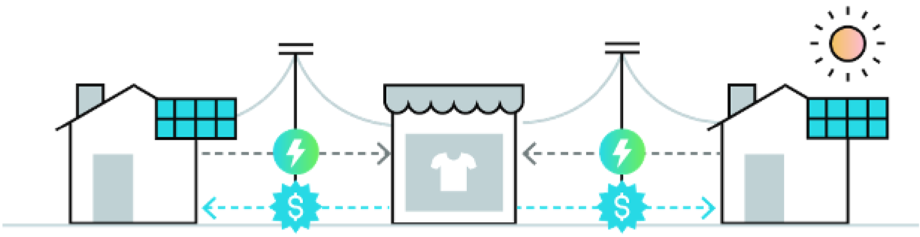


The “VB Solar Exchange” is a Powerledger Project in partnership with Carlton & United Breweries (CUB) and Diamond Energy. It is a world-first “peer-to-beer” solar exchange that enables customers to trade excess solar power for VB beer.

The Project is open to any commercial or residential customer of Diamond Energy, that has rooftop solar and a smart meter installed. CUB buys excess solar from participants, which they use to produce beer sustainably, paying participants with VB beer instead of cash in exchange for their energy. This way, CUB procures low-cost green energy, as they only pay for the beer production costs, and the participants receive a value for their excess energy which is double the usual feed-in tariff.

Powerledger’s xGrid platform tracks the kilowatt-hours and provides the accounting summary for when beer is due for delivery. Every $30 of solar credit traded with VB equates to one case of beer containing 24 x 375ml bottles. For the average Australian household earning $90 per quarter for excess solar, it will equate to three cases of beer for the same amount of energy, which retails at $165.

The xGrid platform allows prosumers to have real-time visibility over energy consumption and sources, including financial settlement. Transactions are viewable on the blockchain (with a front-end user interface provided to prosumers). Electricity credits are automatically converted to fiat currency and prosumers can be rewarded with any goods or services of greater value. The user interface can be tailored and include usage data and the rewards accrued. The platform is flexible and modular, with various models of energy allocation to and from distributed energy resources.



Peer-to-peer and solar swap projects can allow for dynamic price discovery, taking into account both the buyer and seller's preferred pricing, and near real-time supply and demand, matching energy generation and consumption locally on a per-interval basis, down to 5-minute intervals. With a configurable trading logic based on the desired market type, users can prioritize their preferred types of energy, allowing consumers and businesses to take a more proactive approach in achieving net zero.

Distribution and transmission utilities can also benefit from these projects: dynamic pricing for renewable energy throughout the day encourages load shifting to deal with demand and consumption peaks. Over the longer-term, load shifting improves grid resiliency and defers the need for grid upgrades.

This partnership between Powerledger and CUB highlights the opportunities when blockchain enabled technology is integrated into the energy market. The use of blockchain allows retailers and prosumers to benefit from fast and secure settlement, with all transactions stored and easily retrieved – improving energy transparency, while unlocking new revenue streams. In turn, investment in distributed energy resources is encouraged, getting closer to achieving carbon-free energy targets.

Figure 1: model of peer-to-peer solar swap between prosumers and a retailer.

Spectral: a smart energy showcase for creating Energy Positive Districts

Over the last couple of years, the innovation company Spectral has been working with energy communities and project developers to realise smart microgrids in the Buiksloterham neighborhood in Amsterdam north. Within the ATELIER project, these smart microgrids will be integrated into an overarching, district-level smart-grid in order to increase the benefits to the communities, better balance the local energy supply and demand, and integrate even more renewables.

The communities and smart microgrids participating in this demonstration are very diverse in nature. They include new-build area developments (consisting of residential apartment buildings, a large hotel, offices, restaurants, and commercial spaces), the floating neighborhood Schoonschip, circular innovation hub De Ceuvel (including offices and a café), and energy cooperative PEK Ecostroom (which shares ownership of a large solar plant in the area). These five sites will be connected via Spectral's smart-grid platform, along with rooftop solar PV systems in the area, and a floating wastewater resource recovery station developed by Amsterdam's water utility, Waternet. All together, these innovation plots will form a 'Positive Energy District' (PED).

The technologies included in this Positive Energy District are also very diverse. It will integrate electrical and thermal energy networks, including more than 1 MWp of solar plants, smart heat pumps, (underground) heat storage, smart electric vehicle charging hubs, and both (30+) decentralized home batteries, as well as a (>1MWh) centralized community battery system.

All of these different energy assets will work together in order to create as much value for the Positive Energy District as possible. Through Spectral's Local Energy Market platform, local citizens and businesses in the Buiksloterham community will be able to exchange renewable energy, and generate additional revenues using their flexible energy devices, such as heat pumps and batteries, to provide smart energy services to grid operators and energy companies. In this way, the Local Energy Market not only enables additional revenue streams for participants but also ensures that the (local) energy network is kept in balance, allowing for higher penetration of renewable energy sources.

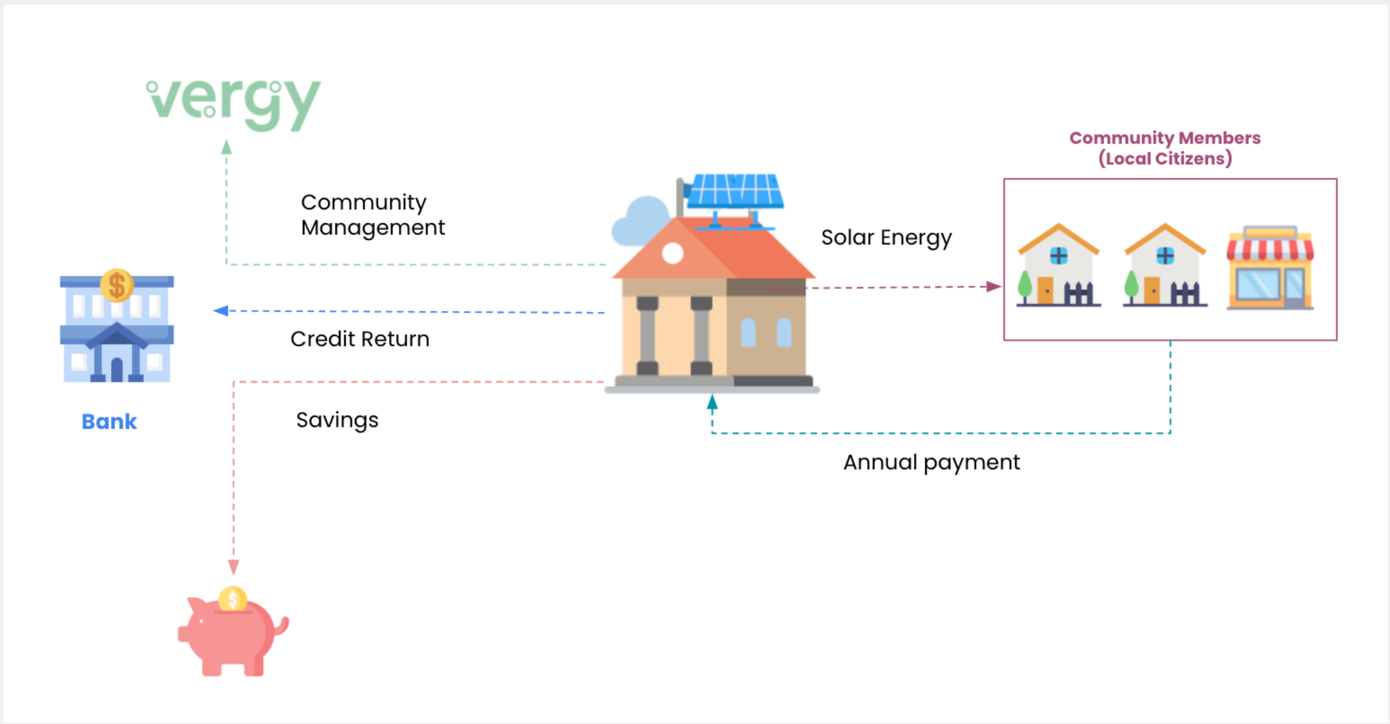
tiko & ENGIE: the first Collective Self-Consumption project in France

ENGIE together with the town hall of Ile d'Yeu, launched the first collective self-consumption project of France called Harmon'Yeu.

As part of this project, 23 households share the electricity produced by solar panels installed in 5 of them. The houses were also equipped with a gateway and smart meter from tiko Energy, which permits ENGIE to manage the assets to optimize the match of production and consumption, while at the same time providing the customer with an app to visualize their energy activity. Also, one battery and some heat pumps were installed, to store part of the energy produced and not immediately consumed.

This configuration allowed the participants to consume 96% of the electricity produced during the first three months of the project, meeting 28% of the needs of the households involved.

Vergy – simplifying participation in Renewable Energy Communities in Spain



The municipality of Fornes, a small town located in Granada, Spain, is one of the first in a list of 17 energy communities Vergy has been working on in 2021. This Energy Community has been designed with a clear goal: simplify the participation process so that citizens can easily get easily involved and see the value it provides.

The way it will work is:

- The City Hall will be responsible for the whole solar infrastructure investment. They will also provide the public space in which solar panels will be installed.

- Part of the solar energy will be consumed by the city hall and its public buildings. The other part will be offered to the citizens in "energy packages" (0.5KW, 1KW, 2KW...)

- Citizens who get access to these "energy packages" will pay in return an annual fee that will always be lower than the annual saving provided by the solar energy

- The City Hall will use that money to:

  - Paying back the potential bank credit requested
  - Pay Vergy for the community management (maintenance, community support, etc.)

- Fill a “community piggy bank” that will be used to improve the energy community (i.e.: adding more solar panels) or promoting social activities in the municipality. The decision will be made by the community members.

Through this model, citizens will have explicit benefits (savings, clean energy, comfort) but, at the same time, they will be contributing to develop the municipality in other ways.

This model is conceived as a way of helping people to understand the value of sharing energy and making decisions together. Later on, the goal is to move to other models such as private associations or cooperatives in which citizens will be able to get involved taking actions such as investing or providing roofs.

Vergy’s goal has been to work closely with the City Hall to:

- Understand the value of an Energy Community for the council.
- Validate the citizens’ interest in a project like this.
- Energy community technical design. From roof evaluation to energy distribution among members.
- Give support on legal and administrative issues.

Their vision is to become the “Energy Community facilitator”, not only helping in the day-to-day of the community, but also putting in place technologies and solutions that will enable a better energy optimization for the community (Community Virtual Power Plants, Flexibility, Aggregation, etc.).

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smartEn is the European business association for digital and decentralised energy solutions. Our members include innovators in services and technology for energy and data management, finance, and research. By taking an integrated perspective on the interaction of demand and supply, our mission is to promote system efficiency, encourage innovation and diversity, empower energy consumers, and drive the decarbonisation of the energy sector.

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