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Smart Energy Europe

The smartEn Map

PROSUMERS

2020

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About smartEn

smartEn is the European business association integrating the consumer-driven solutions of the clean energy transition. We aim to create opportunities for every company, building and car to support an increasingly renewable energy system.

For further information please visit **www.smarten.eu**

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Disclaimer: Disclaimer: Please note that all historical figures provided in this report are valid at the time of publication (December 2020). When estimates are provided, they are based on a combination of different sources.

We also thank all smartEn Members for their invaluable contributions and feedback.

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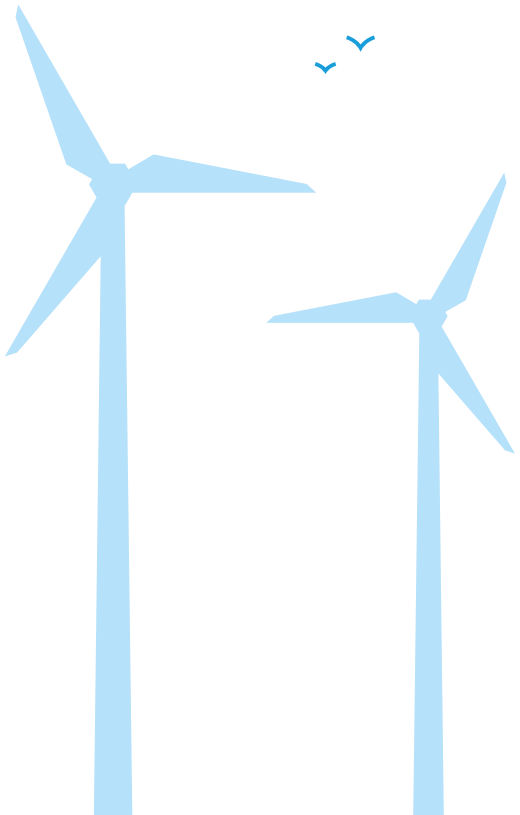


Foreword

It is my pleasure to write the foreword of this smartEn Map on Prosumers.

2020 has been an exceptional year in so many ways. It has also made significant waves in the energy sector, by now already gearing up for accelerated and fundamental change.

One such change is the role of consumers in the energy landscape. The Clean Energy Package aims, amongst many other objectives, to put the consumer more squarely in the *"driver's seat".* Consumers will be active participants in the energy market, i.e. not only consumers, but also 'prosumers', hence the subject of this year's smartEn Map.

Even though prosumers are not industry experts, they will need to make complex choices. Henceforth, new players will enter the market (e.g. aggregators) to help them make these choices. Growth in intermittent renewable generation means that flexible response will be an essential part of the market over the coming decade. The prosumer (and his/her aggregators) will thus increase in prominence.

Without careful policy-making, however, there is a risk that vulnerable, low-income households could be left behind as a 'prosumer divide' emerges between those that can manage and or afford novel dynamic solutions and those left reliant on the main grid, risking paying higher electricity costs. This should obviously be a key focus area for decision-makers.

ACER takes a keen interest in unlocking the flexibility potential of Europe's electricity markets, as I know the smartEn membership does as well. We aim for market rules to evolve to accommodate these changes, part of the backdrop to our recently issued **methodology to assess resource adequacy across the EU**. It is also the reason why our broader market monitoring efforts increasingly seek to demonstrate the role of as well as potential barriers to, *inter alia,* demand side flexibility.

In addition, **the 2019 Energy Retail and Consumer Protection volume of the ACER Market monitoring report** recognises the importance of the active energy consumer, relying on close-to-real-time information. Such information can lead to increased switching rates, driving increased competition between suppliers, and thus place downward pressure on the price that the energy consumer ultimately pays.

This downward pressure will be important as electricity consumption patterns change: the penetration of electric cars is proliferating, there is an increased focus on renewable heating and cooling, and so forth. This puts the focus squarely on prices as generation should rise to meet increased demand. According to ACER's Market monitoring report, however, electricity household prices are on the rise: Average household electricity prices increased in 2019 by 3.7% to 0.216 €/kWh in comparison to 2018. Average industrial consumers' electricity prices increased even more, by 7.8%.

This warrants a closer look at price dynamics and whether market frameworks remain fit-for-purpose, in addition of course to how network tariffs will further evolve.

Many focus areas up ahead, in other words!
I wish the reader happy onward reading.

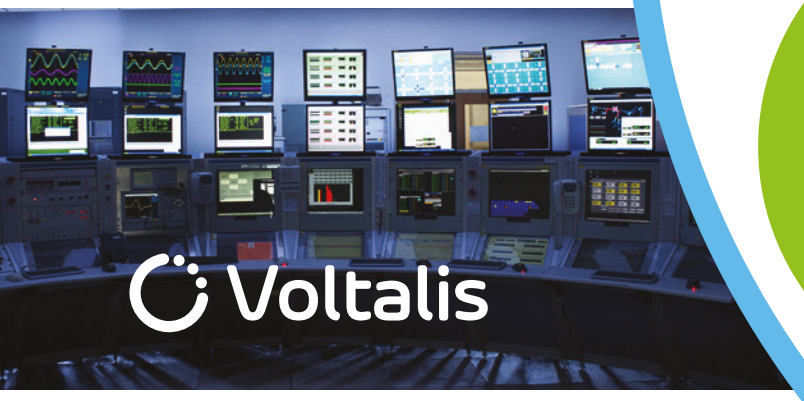
Christian Zinglersen

Director of the European Agency for the Cooperation of Energy Regulators (ACER)









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Introduction

With the advent of decentralised renewable energy generation, storage, demand-side flexibility technologies and increasing electrification, the European energy transition has enabled the rising role of prosumers across Europe. Prosumers, or active energy customers, include households living in single houses or multiple-family buildings, commercial areas or office buildings, large energy intensive industries and everything in between, such as energy communities. The common ground is the decision to activate or invest in their own energy resources, be it through installing their own renewable energy or storage assets or making use of their demand response potentials.

The motives for energy users to become prosumers can be various, as presented in smartEn's short study "Prosumers in the Lead". Factors such as energy independence, reliability of supplies, and the wish to play an active role in driving the clean energy transition are some of these. However, their way of engagement typically depends on the regulatory context and energy market design that defines what is legally and economically possible.

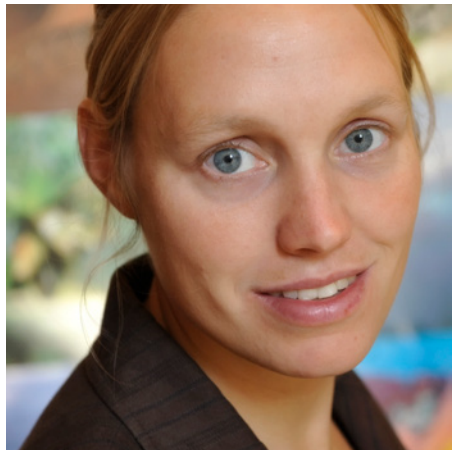
In a regulatory context defined by feed-in tariffs or net-metering for renewable energy generation, prosumers would typically invest in renewable energy assets and feed the power into the electricity system, without necessarily adjusting their own energy behaviour or interaction with their renewable energy source. In this situation, prosumers play an important role in the uptake of clean and decentralised energy technologies to drive the energy transition forward, while assuming that the management and balancing of the energy system is taken up by the energy market at large.

With advent of grid parity, i.e. the competitiveness of self-generation with the purchase of power from the network, decreasing direct support for renewable energy, and incentives for storage or self-consumption, the focus for prosumers shifts from feeding electricity into the network towards optimising the self-consumption of generated electricity. Beyond the investment in clean generation technologies, this stage of prosumerism drives the uptake of storage and demand-side flexibility solutions necessary for the energy transition. It can also result in reduced impacts on the energy system, specifically by reducing peak energy consumption or injection.

Finally, in a context where prosumers have the possibility to monetise their energy and flexibility resources by an active participation in the energy market, they are encouraged not only to invest in clean energy resources and optimise their use on-site, but also to activate these resources to the benefit of the energy system at large. As such, prosumers become essential drivers of an inclusive energy system that is ready to cope with growing shares of variable renewable energy resources in the most cost-effective manner.

The present smartEn Map sheds light on all the different dimensions of the regulatory conditions across European countries that determine the engagement options for prosumers. While every country has its own specificities, the report allows for an identification of barriers and good practice in the quest for a more efficient, cost-effective and clean energy system with energy users at its heart.

Andreas Flamm
smartEn Chairman



Frauke Thies
smartEn Executive Director

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Mapping prosumers across Europe

Our scope and purpose

Prosuming is not exactly a new thing, but the full extent to which prosumers can interact with the energy system is only beginning to emerge. In many countries, being a prosumer is a one-way relationship, where flexible generation is only used to support self-consumption, with very little to no interaction with the grid. In other countries, energy markets are opening their doors to prosumers, allowing flexible loads and generation through aggregation, to contribute to the resilience of the system. In this report, we focus on those prosumers that have assets or flexible loads "on-site". Overall, we have considered five different categories of prosumers, from households with generation all the way to industrial prosumers with on-site distributed energy resources (DERs) and flexible loads (see page 14 for a detailed account of the different models).

Prosumers can come in all shapes and sizes, and for the purpose of this report, we included types of prosumers that one might not think of as active customers in the first place. For example, a prosumer can be a home or a supermarket with rooftop solar photovoltaic (PV) and a battery, an office building with electric heating and an energy management system, or an energy-intensive industrial complex with interruptible loads. But it can also be a multi-family building or a commercial surface with rooftop solar PV installed, which feeds all its generation directly into the grid and that the dwellers of the building do not use. In this instance, those prosumers, even if they do not play an active role themselves, do have a financial incentive to rent out their rooftop to the energy company. We investigate what the financial drivers for these prosumers are, how they interact with the grid and what impact they could have on the energy system.

THE SMARTEN MAP PROSUMERS SEEKS TO ANSWER 3 QUESTIONS:

1. What are the different technologies available to prosumers in each country?
2. What are the financial drivers behind those technology choices and are they financially sustainable?
3. What roles do prosumers take on: are they passive players focused on self-consumption or are they actively providing their flexibility to the grid?

The ultimate objective of this edition of *The smartEn Map* is to provide a high-level summary of the conditions for prosumers across 16 European countries. We aim to shed light on the regulatory and economic conditions for prosumers and highlight those countries that are at the forefront of developing an integrated smart energy system. In doing so, we aim to encourage policy makers to set favourable framework conditions for prosumers to drive the energy transition and contribute to an efficient energy system for everyone.

The information and grading contained in this report is accurate at the date of publishing (December 2020). However, energy legislation is continuously changing. Hence the reader should understand this report as a snapshot in time, illustrating the path that brought us here, and the possibilities for the future. Finally, this report is not intended as a tool for companies to base their investment decisions on, but as reference material on which to start and support those decisions.

Our methodology and scoring system

Every year we review our methodology and approach to *The smartEn Map*. The topics we deal with vary significantly from year to year, and so do our sources and scoring system, to adapt to the specificities of each topic.

For *The smartEn Map* Prosumers 2020, we have interviewed more than 50 sources from across the industry and from a wide selection of countries. We approached National Regulators, Economic and Energy Ministries, TSOs, DSOs, Independent Aggregators, energy service and technology providers, automotive companies and other

associations. The countries published in this report are not the only countries analysed, but a selection was made to help us highlight the different and most interesting approaches that countries take and to highlight countries from all regions of Europe.

To accompany, verify and complete the primary research conducted through interviews, we complemented each chapter with thorough secondary research. The findings of this report were reviewed internally, with the smartEn membership, and externally with a wide range of actors to ensure the quality and accuracy of the outcomes.

Our research was also supported by another smartEn publication, *Smart Energy Prosumers 2020 (March 2020)*[1], which acts as a companion to this report, laying the theoretical groundwork on what the different prosumer models are, and their different financial and social motivations.

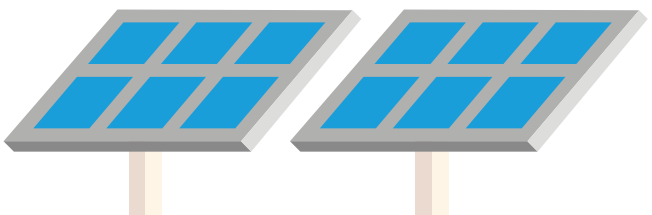
The scoring methodology in this report builds on the incentive structures and grid-interaction possibilities laid out in the previous publication. It was designed to give an overview and a basis for comparing otherwise differing markets. However, it is still difficult to compare countries, as each have their own idiosyncrasies and different energy mixes and consumer preferences. For this reason, the grade should not be taken as a final judgment of the country as it is accompanied by a text that describes its strengths and weaknesses.

The scoring in each category is based on an accruing point tally that is added up to determine the final score. The grading is performed on a high-level assessment based on the outcomes of our research. Not all categories are graded equally, since their importance varies on the overall goal of this smartEn Map. For example, a country with a high number of rooftop solar PV installations, but very little interaction of the customers with that technology and the grid can have a low grading. Some aspects have a heavier representation in the final score, as they are graded in different sections. For example, the use of implicit and explicit Demand Side Flexibility (DSF) is considered, both in the *Financial incentives* chapter and the *Roles of Prosumers in the System* chapter. The final objective is to highly score those countries where financial incentives provide prosumers the appropriate signals to play an active role and increase the overall efficiency of the energy system.

Our rankings

Our ranking is based on the three categories analysed in the report: Technology Deployment, Financial Incentives and the Role of Prosumers in the System. Alongside the aggregated grading of countries, it also allows the mapping of countries per category.

[1] https://smarten.eu/smart-energy-prosumers/



The smartEn Map scoring system

CATEGORY	DESCRIPTION	SCORING SYSTEM
Technology deployment	▪ Solar PV ▪ Stationary battery ▪ Heat pumps ▪ Water-heater ▪ Electric vehicles ▪ Smart charging ▪ Flexible loads	**0-4 based on asset-types used and their use as active technologies** **0 =** No technologies used as DER **1 =** Mostly solar PV low to medium penetration **2 =** Solar PV low to high penetration especially rooftop. And other technologies at low level **3 =** Solar PV medium to high. And/or growing presence of other technologies **4 =** Varied and widespread selection of technologies with high activity
Financial incentives	▪ Feed-in tariff or net-metering ▪ Direct payments or subsidies ▪ Tax exemptions ▪ Self-consumption ▪ Tariffs and taxes	**0-2 based on a high-level estimation of the leading financial incentives** **0 =** Not available **0.5 =** Available for legacy units or playing a very minor role **1 =** Available but limited in time and not primary financial incentive **2 =** Available and either unlimited or primary incentive
	▪ Monetisation of flexibility	**0-4 based on a high-level estimate of DSF monetisation and barriers** **0 =** No DSF monetised **1 =** Mostly basic implicit and interruptibility schemes **2 =** Explicit available but barriers exist **3 =** Explicit and implicit mostly without barriers **+1 =** Point if it is the main incentive
Roles for prosumers	▪ Self-consumption ▪ On-site optimisation	**Each category scores in the scale below** **0 =** Not applicable **1 =** Used but not main activity **-1 =** Main role for prosumers and if system interaction is disincentivised
	▪ Smart charging ▪ Vehicle to Grid (V2G)	**0 =** Non-existing **1 =** Available smart-charging but not widespread **2 =** Widespread availability of smart-charging and some V2G
	▪ Implicit use of flexibility	**0 =** Not used **1 =** Basic implicit day/night tariffs, very little use **2 =** Tariffs with dynamic components, medium usage **3 =** Varied dynamic tariff options and widespread adoption
	▪ Explicit use of flexibility	**0 =** Not used **1 =** Basic explicit use, with significant barriers. And/or interruptibility schemes **2 =** Explicit flexibility available but barriers exist **3 =** Explicit flexibility with small barriers, healthy market participation

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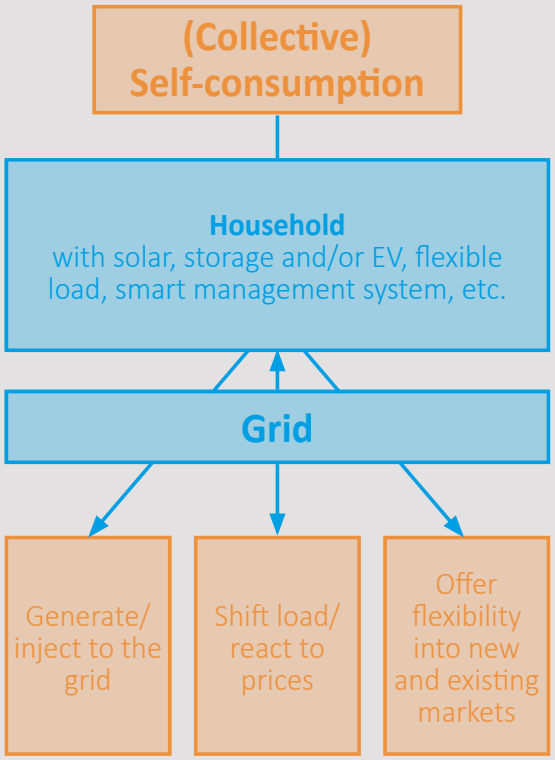
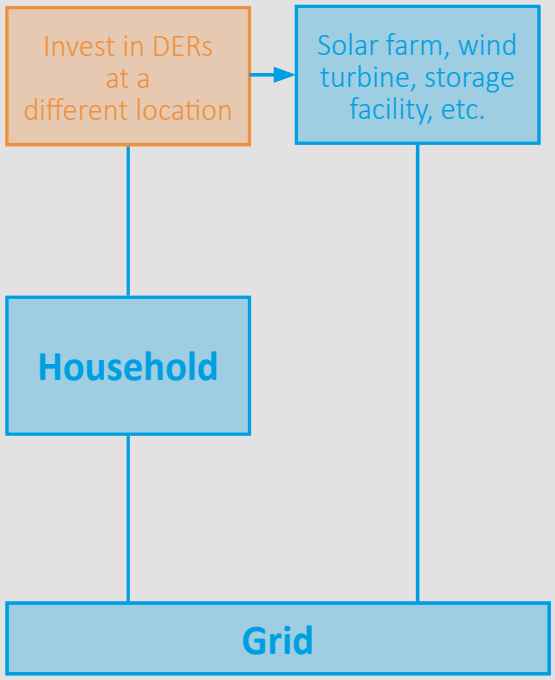
Prosumers models

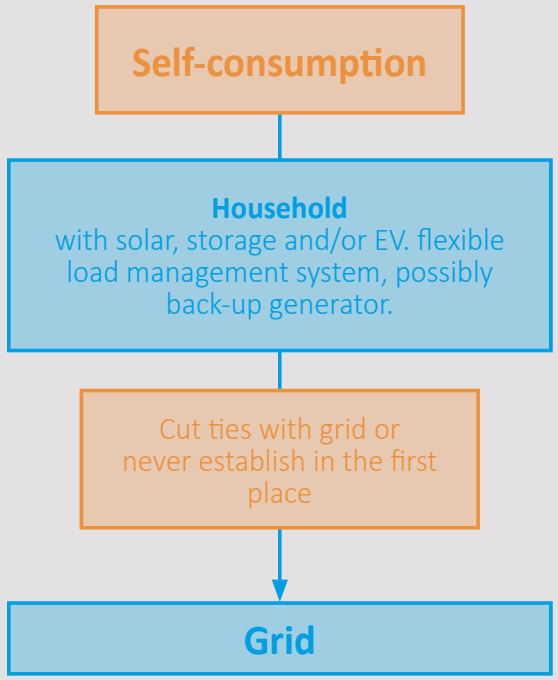
Grid-connected households with onsite PV, storage and/or flexible load

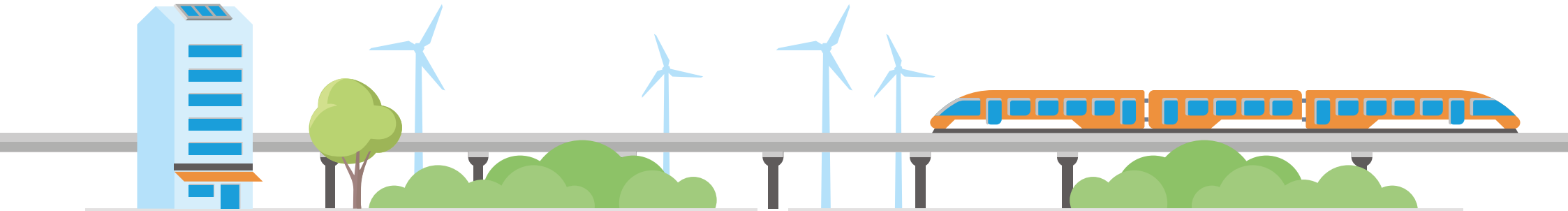


Grid-connected households with offsite DERs

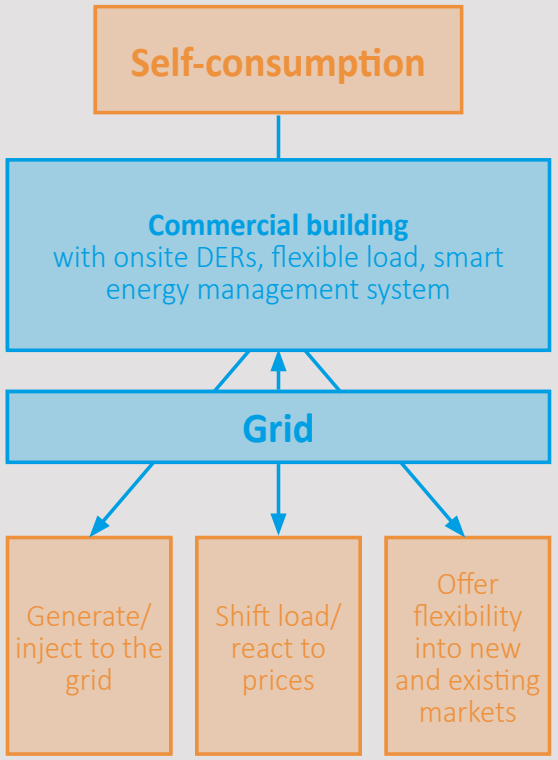


Off-grid households

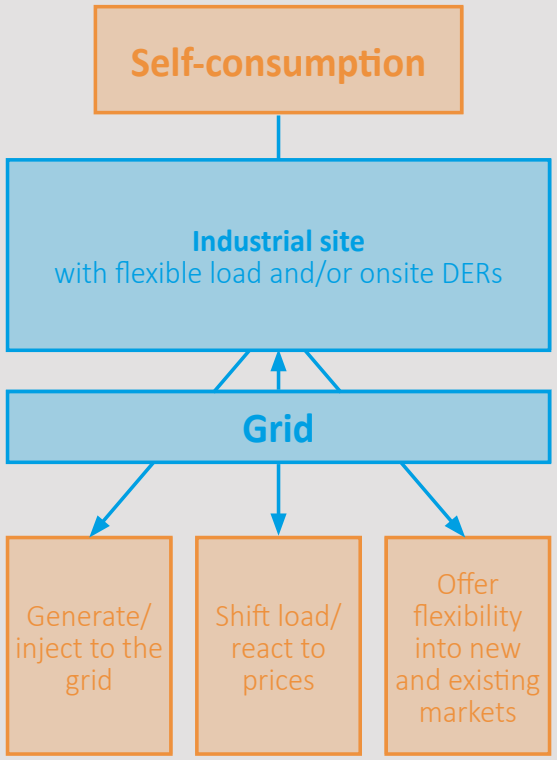




Commercial building



Industrial site



Overview

The number of prosumers in Europe has grown significantly in past years, in many cases inadvertently, led by policy-driven incentives. Many countries have adopted smart-metering devices, and customers are being offered dynamic price contracts by their suppliers without having to raise a finger. More recently, direct subsidies for electric vehicle (EV) purchasing have made them a consideration in every car-buyer's research.

Unsurprisingly, the most common technology in Europe for prosumers is rooftop solar PV, mainly due to the strong push on an EU-wide and national level to reach decarbonisation targets. This strategy crystalised in the form of aggressive subsidies (feed-in tariffs or net-metering schemes), as well as direct payments and tax exemptions. **Countries included in this report, that are leading in rooftop solar PV capacity include Germany, Italy, The Netherlands and France, and most of them point towards significant growth in the coming years, even as feed-in tariffs and net-metering schemes are rolled back.**

The main incentive to actively become a prosumer surfaced by this report is, and probably will continue to be, a financial motivation. In most countries, prosumers want to reduce their electricity expenses, pay a stable amount each period, and, mostly for industrial customers, guarantee the security of supply at a stable price. Prosumers in Denmark and Germany for example, even without feed-in tariffs, are still motivated to adopt generation technologies to avoid paying high electricity prices, and to avoid taxes and tariffs.

The countries that stand out for prosumer development show a mix of incentives: governmental support mechanisms, decreasing costs of adopting technologies, electricity prices and taxes and tariff structures that encourage self-consumption and the possibility to monetise flexibility directly with the supplier or with independent third parties. Flexibility is where many European countries still lag. Monetisation of flexibility encounters severe barriers that limit the business opportunities and offerings for prosumers. This is slowly changing with the adoption of the Clean Energy Package which ensures that Demand Side Flexibility (DSF) is used by system operators. One such country would be Finland. Adoption of prosumer technologies is growing significantly. This is guided by a governmental push to electrify their economy, but without resorting to distorting feed-in tariffs to push generation, but by establishing a framework that allows prosumers to be resilient, optimising their consumption and granting flexibility access to different markets. Other countries that stand out in the overall ranking do so very much influenced by their developed distributed energy resources stock and governmental financial incentives created to grow this technology stock. While in some countries, like for example in France, Germany or Denmark, it might be financially sound to become a prosumer, their interaction with the grid is mostly passive, especially in the residential and commercial segments, limiting those prosumers' flexibility allowing it to do little for the overall system efficiency. If this is to change, and if electrification is to expand to different sectors in a financially stable way, governments need to unlock the various revenue streams available to prosumers through their flexibility, by lifting regulatory and technical barriers still existing in legislation.

Overview

PROSUMERS 2020

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Technology deployment

Technology deployment, both in volume and in variety, is an indication of the interest and viability for consumers to become prosumers. **Common technologies used by prosumers include solar PV, batteries, electric heating and water heaters, and other flexible load technologies (especially for industrial customers).** With the growth of electric vehicle adoption, we also see a slow but steady increase in the number of smart chargers. For the purposes of this report, we have only considered technologies that are placed on the premises of the prosumer. We've excluded public charging stations, other sources of renewable energy, and other prosumer pathways such as renewable power purchase agreements (PPAs), guarantees of origin (GOs), or energy communities. We will address these topics in an upcoming report.

The most prevalent technology for prosumers is solar PV. It is used across all segments, from households to industrial sites, and its success is rooted in the maturity of the technology paired with years of governmental support mechanisms. Recently, the installation of solar PV paired with batteries has also started to grow, thanks to the rapid reduction in cost. Countries like Germany stand out on this regard with almost 700 MW of batteries deployed to complement solar PV installations. The advent of electric mobility has also brought electric vehicle batteries as a resource to the grid, although usually only used as a support for the home (if renewable energy is available). This is because smart-charging is still in a very early stage of deployment, and predominantly available to fleets of cars or in commercial areas with several charging spots.
Another technology widely adopted in most countries are smart-metering devices. They have proven to be the most basic tool for prosumers to benefit from their flexibility, unlocking the possibility for dynamic price contracts and special tariffs for EV charging. Spain, Italy, the Netherlands and all the Nordic countries have close to, or fully 100%, penetration, and in some countries the deployment of second-generation smart meters has already started.

There is a clear correlation between the technologies deployed and the availability of governmental incentive mechanisms. Market incentives are enough for customers to adopt a new technology or make the change to an electric alternative (e.g. gas to electric heating) in very few countries. Denmark stands out in this regard, where adoption of renewable energy for self-consumption is still growing, even without support mechanisms, thanks to high electricity prices and heavy taxation and tariffs. A different example is Great Britain, where the use of flexible loads is extended thanks to a variety of markets procuring flexibility and competitive products, rather than support mechanisms.

As a final observation, we have seen that direct subsidies and governmental programmes like feed-in tariffs are very effective in kickstarting the deployment of new technologies and services, but for continuous growth and activity, unhindered access to flexibility markets is indispensable.

TECHNOLOGY DEPLOYMENT

- Breadth of technologies used: solar PV, storage, electric vehicles, smart-charging, heat pumps, water boilers, flexible loads.
- Absolute numbers in capacity or units of deployed assets

Technology deployment

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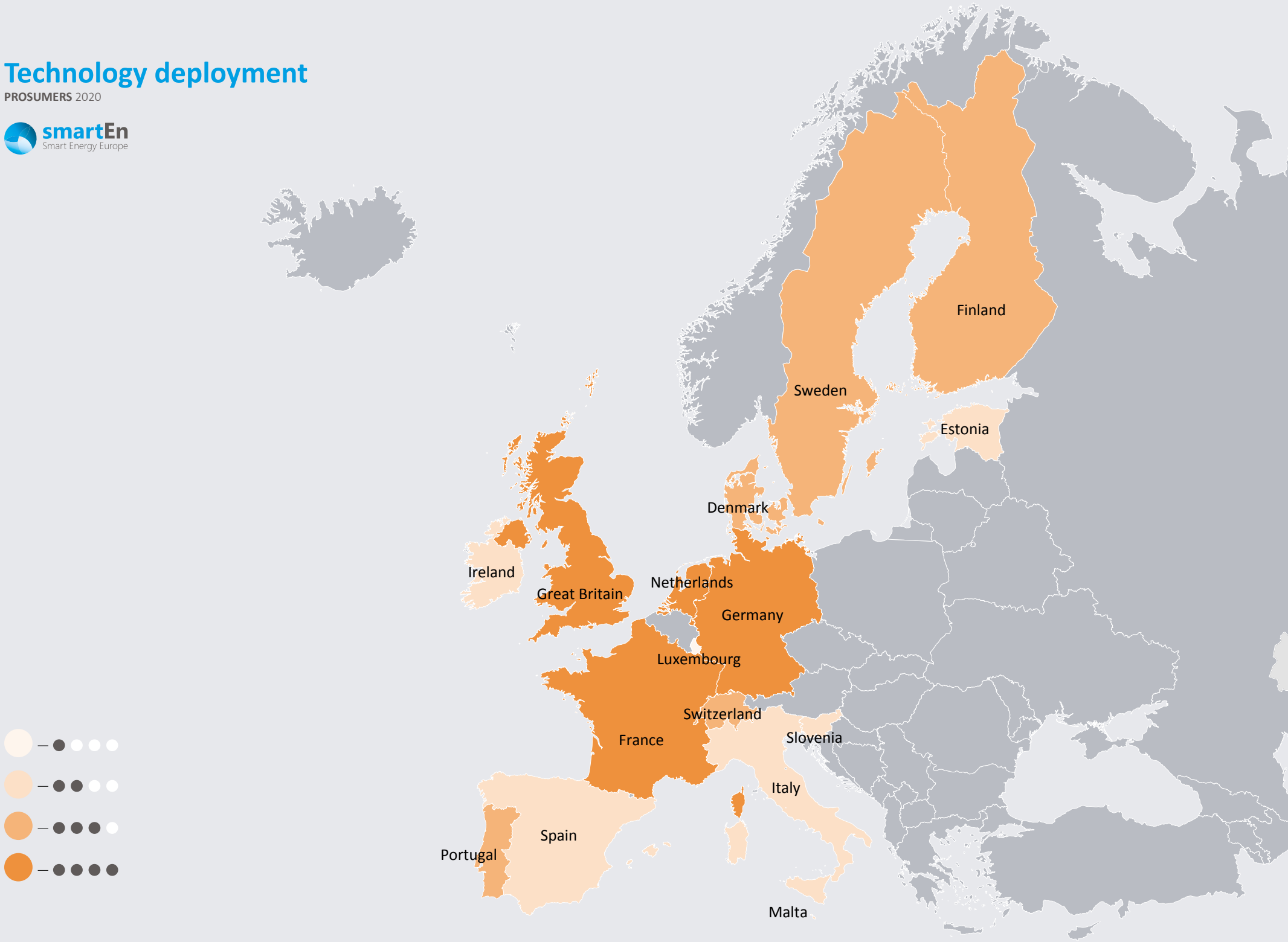

Financial incentives

Even though social incentives (such as the willingness to participate in the green transition, be part of a community, or drive brand visibility) are important for prosumers of all types, ultimately most decisions are still taken based on financial viability. Financial incentives can be grouped into three main categories:

1 **Self-consumption or on-site optimisation.** This is a driving incentive for countries with high electricity prices and/or where network tariffs and taxes take a high proportion of the final energy bill. This includes time-of-use optimisation and the avoidance of periods of high tariffs and reducing peaks.

2 **Governmental programmes.** These can come in the form of direct subsidies, tax exemptions or feed-in tariffs, net-metering or net-billing. They are usually temporary and are an effective way to kickstart the adoption of flexible technologies by active customers.

3 **DSF monetisation.** Prosumers can usually monetise their flexibility in implicit and explicit ways. Implicit flexibility is available in countries with a high penetration of smart-meter devices and dynamic price contracts. Explicit flexibility is primarily available in countries with aggregator activity and where flexibility can be sold into the different electricity markets.

Most prosumers in the EU that adopted generation technologies in the past can still participate to feed-in tariffs or even net-metering in some countries. However, these programmes are being phased out as the price of electricity from renewable energy becomes more competitive.

Net-metering is also being phased out, because of the contradictory signals it provides to the grid. While this type of programme is very beneficial to users, interaction with the grid is minimized. So far, this scheme is only available in The Netherlands, Slovenia and Great Britain, and some have plans to terminate it. A different mechanism is net-billing, used for example in Italy. This system allows prosumers to adapt their consumption and injection patterns more efficiently, basing their decisions on signals received from the grid, as the prices used in net-billing for injection and consumption are different.

The main financial incentive remains self-consumption, due to the limited access to markets and monetisation possibilities for flexibility services. Households and commercial areas are most interested in lowering their overall offtake from the grid, while industrial customers strive for stable energy prices, resilience and time of use and price arbitrage optimisation.

Countries where financial incentives are available, such as Great Britain and France, have created a blooming prosumer community, thanks to the possibility for monetisation of flexibility. Germany and Denmark have also seen prosumer growth, driven by high electricity prices and a large share of tariffs and taxes in the electricity bill. It is noteworthy that these financial incentives, while they are beneficial for the prosumer and for the adoption of different technologies, might not be facilitating overall system efficiency.

FINANCIAL INCENTIVES

- Governmental support schemes available:
  - Feed-in tariff, net-metering and net-billing
  - Direct payments or subsidies
  - Tax exemptions
- Final energy prices for consumers
- Tariffs and taxes
- Monetisation of flexibility: Implicit DSF, Explicit DSF (ancillary services, wholesale markets, interruptibility schemes, DSO markets, capacity mechanisms)

In this report, all financial incentives increase the grade of the country, but not all bear the same weight. For example, while direct subsidies are interesting to kickstart the adoption of certain technology (e.g. a subsidy on the purchase of an EV), they do not ensure that prosumers will remain active. For this reason, governmental support schemes that happen on a regular basis, or facilitate generation and injection, or high electricity prices that incentivise on-site optimisation and self-consumption, provide a higher grade in this section than single payment subsidies.

Financial incentives

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Roles for prosumers

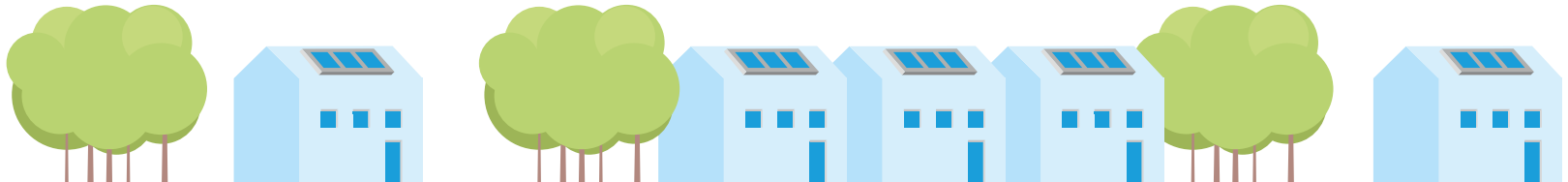
Prosumers perspective

The role that prosumers decide to play is tightly linked to the financial incentives available to them, as described in the previous chapter. **In most countries, the main activity for prosumers is self-consumption, and on-site optimisation through generation or energy management systems.** The second main activity is the implicit use of prosumer flexibility, thanks to the ease of use directly offered by their suppliers through dynamic pricing contracts. **Explicit use of flexibility is still very limited in most countries, primarily due to market design legislation that does not encourage it and maintains market and technical barriers.** For example, the lack of a regulatory framework for aggregators, or more specific technical barriers like high minimum bid sizes that make it difficult for third parties to pool enough capacity to participate. Another barrier is the lack of interest from prosumers because of the financial incentives linked to the offers.

The adoption of EVs is still mostly unrelated to any possible interaction with the grid and is more dependent on social and financial incentives. Users may want to play a role in decarbonisation, or there may be aspirational or lifestyle motivations behind an EV purchase. Use of EVs is mostly passive, with very little access to smart-charging and, only in very limited (usually pilot) projects, access to V2G, like in Denmark.

A large proportion of prosumers in the EU, especially households, are motivated by more than financial factors. Participating in the green energy transition, increasing their own autonomy or security of supply, and better controlling their energy consumption are among the most important drivers. For the needs of prosumers and the grid to come together we will need a system (including simpler access to markets) that values their flexibility appropriately and allows them to benefit from a revenue stream that goes beyond the initial direct subsidies received with the first purchase.

This category is where the shortcomings of integrating DSF become more apparent. In most cases, while prosumers can benefit from self-consumption, their interaction with the energy system is very limited. The countries with the highest activity of prosumers in terms of volume and participants are France, Germany and Great Britain. However only in Great Britain and Finland is the activity of prosumers really benefitting overall system efficiency. Other countries that do stand out for the possibility of prosumers, where they can combine their maximization of benefits with an increase of system efficiency with their activity, include Finland, Great Britain and The Netherlands (in particular if net-metering is excluded).



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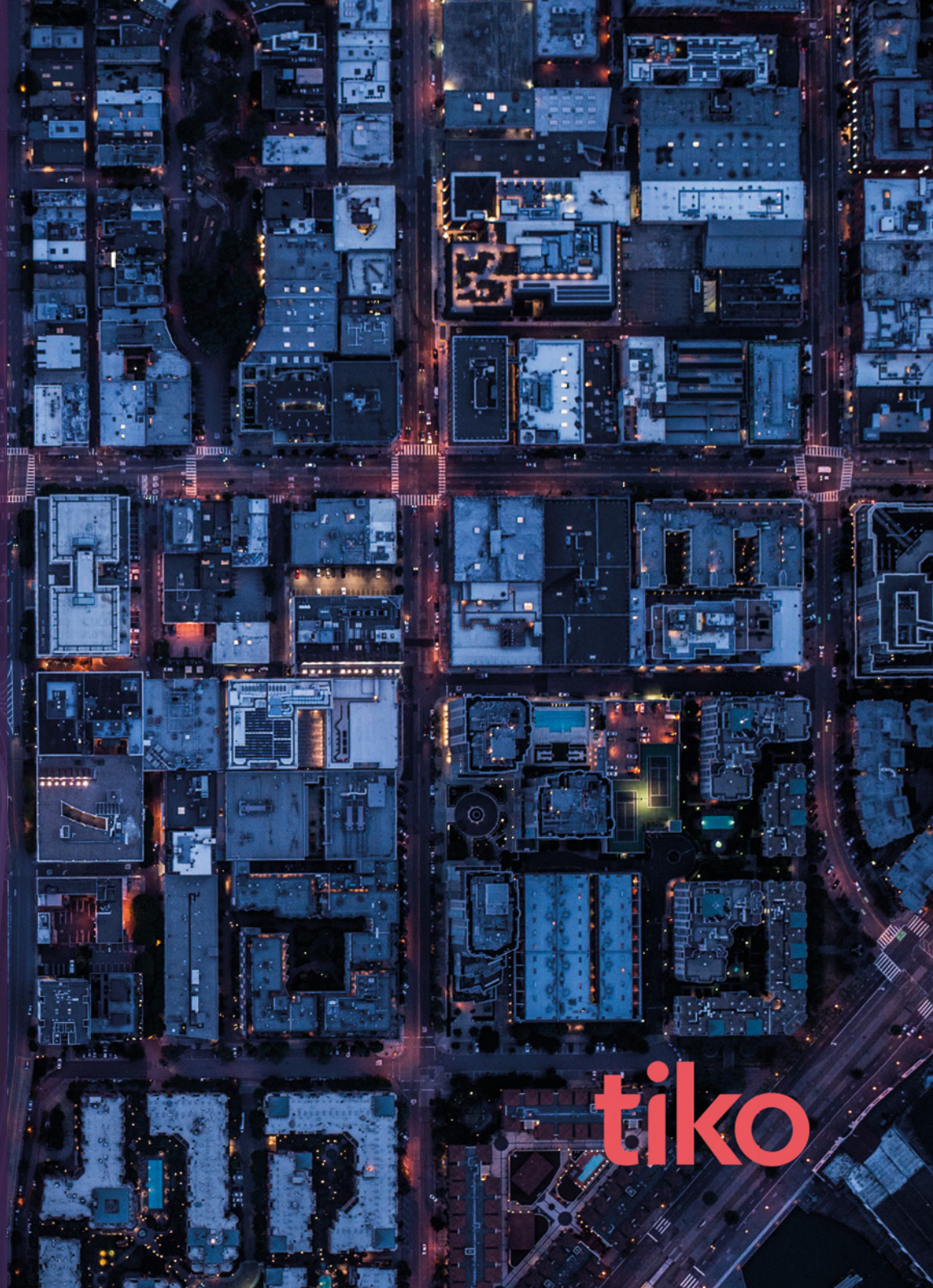


System integration perspective

The incentives prosumers receive for their activity are not always aligned with the needs of the grid, or put otherwise, the grid cannot always take advantage of the flexibility that prosumers can provide and, in some cases, receives contradictory signals. This is particularly the case with net-metering schemes. However, these are being phased out in many countries, The Netherlands, Slovenia and Great Britain (through the SEG) will still offer it for the next 10-12 years at least. Explicit use of flexibility is available across many of the countries studied, but in most cases, is only accessible to large industrial consumers. In most countries, participation from smaller loads is still very limited, primarily due to regulatory limitations and the lack of local flexibility markets where these could play a more significant role.

The largest use of explicit flexibility, in terms of volume and market participants, can be found in Great Britain, France, Germany and Finland. Implicit flexibility is also widely available; however, in most countries, it comes in the form of very limited dynamic pricing contracts that have only two or three different periods, and in very rare cases like in Finland hourly pricing, or even 15-minute pricing in The Netherlands.

Implicit flexibility is more readily available for households than explicit flexibility but is limited due to the lack of dynamic network tariff and tax design that provide effective price signals. Some countries like Denmark are currently discussing a move away from this model and introducing tariffs that remain cost-reflective but provide prosumers the possibility to react to prices. But so far, the process is slow and adoption of these kind of tariffs almost non-existent or only with big caveats.

In most countries, the integration of decentralised energy resources is very advanced, but not the flexible use of them. Injection is done mostly without considering the situation of the grid, encouraged by predefined feed-in tariffs, and the lack of the appropriate signals to users and service providers, forcing many assets to continue playing a passive role in the energy system.

This need to better integrate and take advantage of the available flexibility is reflected by the overall low scores in this section.

ROLES FOR PROSUMERS

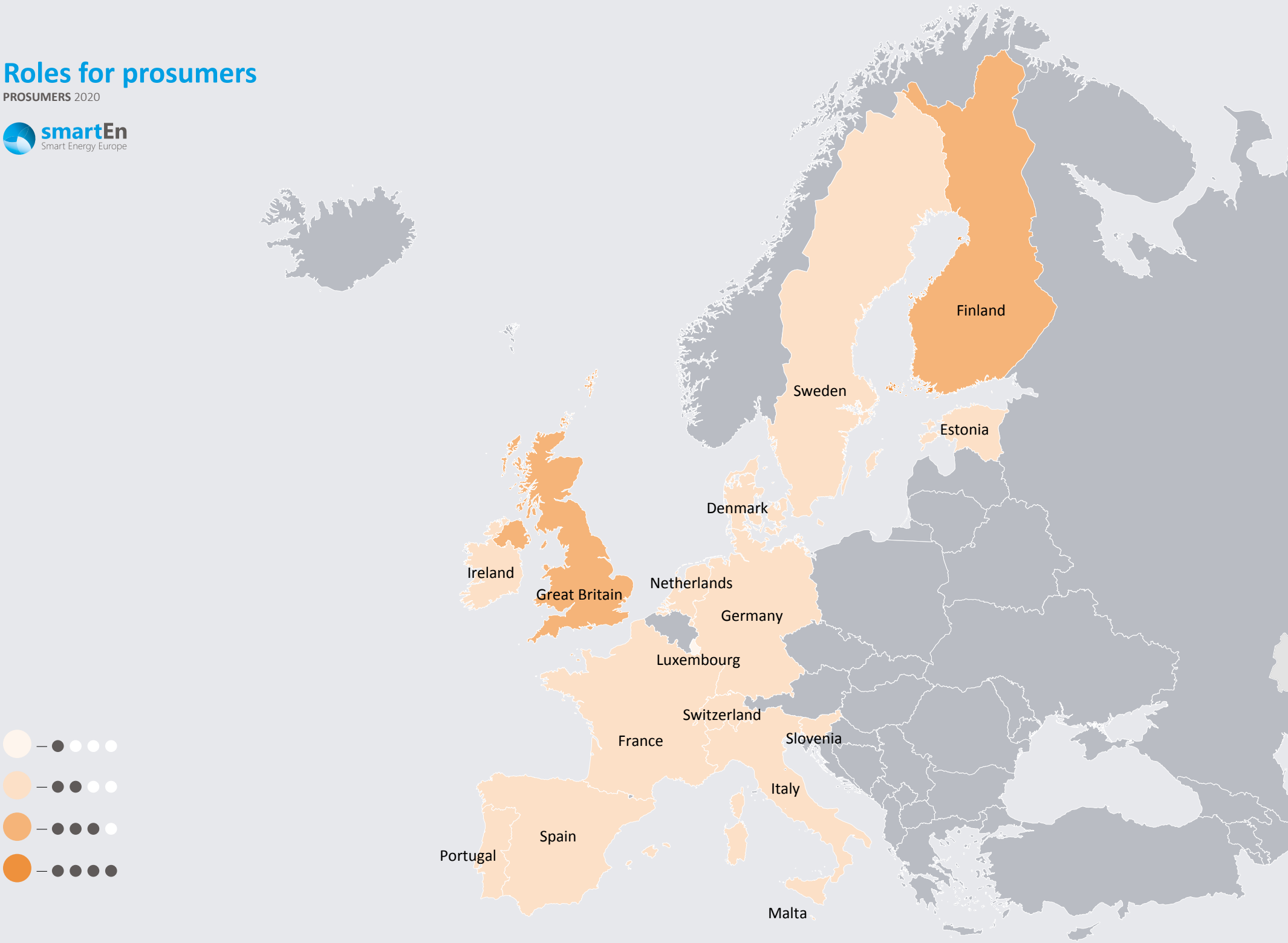
In this section we value two things: **the main activities of prosumers,** and **whether they interact with the system in a way that increases its overall efficiency.**

In this category, the final score for a country is the result of the accumulation of options. For example, a country where prosumers mostly act passively, or self-consume, will have a lower grade, and no more than a two out of four points. Countries where prosumers interact positively with the grid, providing their flexibility to offer system services, for example, will have higher scores. This is because where the latter is possible, the former is always a possibility. Prosumers can choose to only self-consume, or only dedicate themselves to optimise their own processes. However, the opposite is not true: where self-consumption is possible, grid interaction may not be.

Roles for prosumers

PROSUMERS 2020

smartEn
Smart Energy Europe



DENMARK

Denmark is a very interesting case for prosumers. In the past few years, most governmental financial support for renewables has been removed, but prosumers are still adopting renewables due to high Danish electricity prices. The outstanding challenge for Denmark is now to provide the right market incentives for prosumers to interact with the grid. Explicit use of prosumers' flexibility is still quite restricted, mostly limited to the industry, and while the implicit use of flexibility is possible and quite extensive, benefits are not significant enough. One hurdle Denmark must overcome is the reformation of its tariff and tax structure, making sure that the right price signals reach prosumers.

Technology deployment

Denmark is currently in a transition phase, between the early days when renewable technologies were incentivised with profitable governmental support mechanisms towards a new model where they are becoming another regular player in the energy system. This has had an impact on the growth of prosumers in the past years. But this dynamic seems to be coming to an end, with steady growth again due to high electricity prices. Indeed, without support mechanisms, Danish energy prices are driving the growth of solar PV and battery installations. Rooftop solar, for residential buildings and single-family homes, as well as commercial areas and farms, saw slow but steady growth in the past few years, with 18 MW of installations in 2019. In 2020, significant growth is expected with 52 MW of rooftop installation projected.

The country's ambitious target of doubling PV generation by 2026 has so far focused on utility-scale installations. Adoption of EVs is also growing at a fast pace, with a 330% increase of EV adoption in 2019 over 2018. However, the total stock of EVs is still reduced, at 15 507 vehicles as of 1st January 2020, amounting to only 0,56% of the total passenger vehicle stock.

Financial Incentives

The main financial incentive for prosumers in Denmark is reducing their energy bill, and with the highest electricity prices in the EU, many consumers have more incentive to install their own generation, even without any support mechanisms. The highly beneficial annual net-metering programme stopped taking new applications in 2012 and was substituted by an hourly net metering programme that closed in 2017 (both programmes remain active until 2032).

In the annual net-metering programme, users only pay tariffs and taxes for net consumption. The hourly net metering programme was available for all solar PV units with a capacity of 6 kW or less. These prosumers were only taxed for the net consumption within each given hour. New solar PV installations since 2017 must adhere to instant settlement, making only the energy directly consumed

free from taxation. The difference in programmes is significant, since Danish customers pay the highest level of energy taxes and charges in the EU (up to 66% for residential customers). As a result, the main driver for self-consumption is avoiding these taxes.

A feed-in premium exists for different renewable technologies, but is closed to new entrants. The premium is paid on top of the market price upon injection onto the grid. The premium is reduced every year and is only valid for 10 years after the grid connection is established. In 2019, for installations up to 6 kW, the maximum subsidy paid was 0,46 DKK/kWh (approx. 0,06 €/kWh).

For other technologies, direct subsidies are available for a short period of time. EVs are exempt from paying registration fees, and users swapping from oil or gas heating to an electric heat pump can apply for a minor direct subsidy and a reduced electricity tax. EV owners have access to different offers from service providers, linked to smart-charging and Vehicle to Grid (V2G) capabilities, that provide a fixed reduced price for electricity, among other services.

Dynamic electricity pricing is prevalent in Denmark, as are time-of-use tariffs, both facilitated thanks to an extensive network of smart metering devices. These contracts link retail prices to the wholesale electricity market.

Another minor source of income for small and medium prosumers comes from selling their flexibility to the market through aggregators. But this is only possible through pilot projects currently operating in Denmark. Large prosumers have more possibilities to market their flexibility to balancing markets, also through aggregators. Industrial customers also have access to interruptibility schemes, that reduce their tariffs and connection fees, on top of a capacity payment.

Role of prosumers in the system

The main role for prosumers in Denmark is self-consumption and on-site optimisation, with the minor participation, of mostly industrial customers, in the ancillary markets. The main reason for this is a combination of high electricity prices and a high rate of static taxation, up to 66% of the electricity bill, which incentivise self-consumption. In addition, the lack of feed-in tariffs and the requirement to find a commercial party that will take your generation, reduces the incentives for injection.

Explicit use of flexibility is limited due to several barriers for independent aggregation and the high level of rigid taxes that do not accurately reflect the needs of the grid. Prosumers are mostly limited to work with their supplier, as independent service providers must be registered themselves as suppliers and a Balance Responsible Party (BRP). This significantly reduces the available offers, and most of the ancillary services continue to be provided by retailers.

EV owners, however, have more possibilities than in most EU countries to take advantage of the flexibility their vehicles provide. A handful of companies[2] offer a wide range of services, from fixed or reduced energy prices for charging and tariff avoidance to a state of charge guarantee. In exchange, these companies use connected vehicles, pooling them with other resources as a source to provide ancillary services, as in the electricity balancing markets.

The implicit use of flexibility is much more available and slowly growing. Most customers now have different dynamic price contracts available to them, and many distribution grid companies have implemented time-of-use tariffs. This is all possible thanks to an advanced penetration of smart metering equipment. Adoption is still low, however, with around 10% of Danish consumers using a dynamic price, mainly due to the low impact of the energy component in the final electricity bill.

Generators are heavily incentivised to consume their generation, especially since the feed-in premium was closed to new prosumers in 2016. But contrary to other countries, self-consumption in Denmark is a very viable activity, not because the lack of alternatives, but because it makes financial sense due to the high electricity prices. Injection is permitted, and off-take is guaranteed, but the prosumer must either pay for the off-take or find a commercial party willing to buy their electricity.

[2] E.g. Nuvve, CELVER, E.On, True Energy

ESTONIA

Estonian prosumers are focused on two main axes. The first is production of renewable energies, particularly rooftop solar PV, together with a feed-in premium. The second is on-site optimisation and self-consumption. In both options, prosumers are supported by governmental subsidies and incentives that make it financially viable to invest in different technologies. But even for those consumers that do not want to install their own generation, options like dynamic price contracts exist to allow them to play an active role in the energy system. However, remuneration for explicit use of flexibility is quite low, making it a niche use, where only some industrial customers participate.

Technology deployment

The primary technologies used by prosumers in Estonia are solar PV and EVs, and both have seen significant growth in past years, fuelled by attractive governmental support mechanisms. Since 2018, the country has grown its solar rooftop PV market significantly, starting from 17 MW rooftop and small installation capacity, to the current 181 MW. This growth has been a direct result of new governmental support mechanisms, like feed-in tariff and feed-in premium, but also thanks to p2p RES trading business models. Additionally, a new 2020 regulation on energy efficiency in buildings which mandates the installation of rooftop solar in new and renovated buildings could have a significant impact, with estimations from the Estonian Solar PV Association reaching 50 MW installed annually. EV ownership is growing slowly, by only 5% in past years, especially considering that Estonia has one of the best public charging networks in the EU, achieved through a governmental roll-out that ensured charging stations are within 60 km of one another across the country.

Financial Incentives

Estonia has driven up the number of prosumers through significant direct subsidies and support mechanisms for solar PV, EVs and charging stations. The main incentive to install rooftop solar PV comes from the Renewable Energy Support mechanism, a feed-in premium that, for the first twelve years of generation, pays out 0,0537 €/kWh on top of the wholesale price. This tariff is valid for installations of up to 50 kW capacity.

New business models are being implemented, with an advanced direct line mechanism, where a prosumer with renewable generation can sell directly to neighbours that have a direct connection to the prosumer. This programme was previously limited to neighbouring plots and has now been extended to a broader distance with a direct connection. This business model is especially interesting for commercial areas, and business parks with several customers, where prosumers can sell their generation directly, without having to go through the distribution network, avoiding associated costs.

EVs purchased in 2020 have a direct subsidy discount offered by the government of 5 000 €. This programme financed the purchase of 232 EVs in 2019, mainly for car fleet companies. The programme has a budget of 1.2 million EUR for 2020, expecting to finance the purchase of around 200 more EVs. The programme is fully financed by the sales of EU ETS (EU Emissions Trading System), but is relatively small compared to the sale of traditional vehicles, amounting to less than 1%.

Role of prosumers in the system

Prosumers in Estonia are not limited by the ownership of technologies like solar PV and EVs, with a wide range of possibilities to play an active role in the energy system. All customer segments can opt for a dynamic price contract due to one of the most developed smart metering infrastructures in the EU. About 36% of all electricity consumption is through such contracts, amounting to 39% of all customers. The main driver for prosumers is the financial incentive from reducing their energy consumption, even though Estonia already has a very low electricity price (on average, 125 €/MWh for residential customers and 75 €/MWh for industrial customers).

Estonian generators have the option to provide their electricity through a direct line to other consumers in their area. This is being developed into power purchase agreements (PPAs) in commercial areas and business parks and is being expanded to nearby neighbourhoods.

The Estonian market is currently undergoing a regulatory reform process to fall in line with the new European Electricity Market Directive. This includes the adoption of an aggregator framework that allows the country to access all markets, from day-ahead and intraday to balancing markets. So far, independent aggregators only have access to the tertiary reserve in the balancing markets (the manual Frequency Restoration Reserve, mFRR), to which industrial customers participate most.

Several issues are keeping the participation of DSF low compared to its potential. On the one hand, the market settlement model provides reduced incentives to DSF, making the business case to offer these services very limited. On the other hand, although aggregators do not need any agreement with the supplier, they must pay a compensation through the consumer.

Markets at a local level (DSOs) are currently non-existent, but the Estonian TSO and DSO, and the Latvian TSO, are developing a regional flexibility platform that will allow DSF to participate into different markets.

Finally, especially for industrial customers in Estonia, given the limited possibilities (mainly low prices) in the current electricity markets, the main use of their flexibility and their onsite generation is self-consumption and on-site optimization.

FINLAND

Finland is an excellent example of how prosumers can take a central role in an increasingly electrified society, even without the need for governmental subsidies. Electrification of heating has brought a great amount of available flexibility to the grid, which numerous actors are exploiting by using it in the electricity markets. This has provided additional revenue streams for prosumers, decreasing the cost of the new investment. This is only possible thanks to a market design of low technical barriers that facilitates the participation of all kinds of resources, both generation and demand. Even consumers without generation or significant flexible loads can benefit from widely available, dynamic tariffs. Finland is one of the EU countries where the incentives for prosumers are integrated in the interests of the grid, creating a perfect landscape for the future growth of prosumers and flexibility.

Technology deployment

Electrification in Finland is growing significantly, incentivised through a governmental push to reach the country's climate targets, and with it, many customers are taking the leap to becoming prosumers. Given the climate, and dispersed population in rural areas, reliability is a significant concern for Finnish consumers. Electric heating is used extensively in the region by many different technologies like heat pumps, water heaters and other space heating devices, and saunas, which together consumed 3TWh in 2018. The significant amount of electric heating also provides a great flexibility stock to the grid.

Renewable generation is also growing in the Finnish residential and commercial sectors. This is characteristic of Nordic countries, where utility-scale installations are practically non-existent. In 2019, almost 80 MW of rooftop solar PV were installed in the country, with more than 90% of it in households and commercial areas. This rate of installation is expected to grow in 2020 and onwards. Battery storage adoption is growing together with solar PV, mainly due to the limited hours of sun during a significant part of the year.

EVs have also seen a significant uptake in Finland in the past two years, incentivised through tax breaks and subsidies. However, the number of EVs circulating is still smaller than Finland's Nordic neighbours. While EVs circulating in Finland grew by 93% in 2019, the absolute number is still modest, with almost 5 000 EVs. The current target expects 225 000 EVs circulating in Finland by 2025. Finland also has one of the largest penetrations of smart meters in the EU, with hourly and 15-minute measurement available, resulting in a varied offer on electricity contracts.

Financial Incentives

The main financial incentives for Finnish prosumers come from on-site optimisation and by reducing their energy bill and avoiding tariffs and taxes, with few direct subsidies offered by the government. A feed-in tariff for renewable energy exists in Finland, but solar PV production is not included in

it, making the primary incentive tariff and tax avoidance. Prices of electricity in Finland are around the EU average, and the percentage of taxes and tariffs in the energy bill are in the lower end of the spectrum (around 60%). The percentages are even lower for industrial customers. Generators that inject their excess production to the grid need to have a contract with a supplier, which will pay for the injected electricity at market prices. Small scale generators, under 100 kVA, are exempted from electricity taxation.

One of the most important financial incentives for Finnish prosumers are dynamic price contracts, which are commonly extended, with a growing number of customers using hourly pricing. This is possible due to the high penetration of smart metering devices and even more relevant now with the growth of electrification in heating and mobility.

Also important is the monetisation through explicit flexibility, marketed in particular to a wide variety of ancillary services markets where all kinds of flexible technologies are able to participate to through an aggregator.

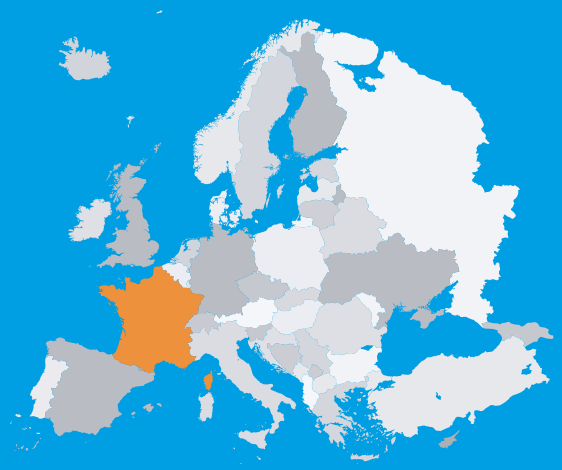
Direct subsidies are rare in Finland and usually last for only a few years at a time. Residential buildings receive a subsidy directed at energy efficiency measures. This subsidy is one of the incentives for the electric heating transition and is valid from 2020 to 2022. Consumers that make the jump to EVs, receive, until 2021, a direct subsidy in the form of 2 000 € and a reduction in the purchase tax of 75%.

Role of prosumers in the system

Prosumers in Finland can play many different roles, facilitated by markets open to flexibility services, the implicit use of flexibility and the incentives for self-consumption. As stated in the previous chapter, prosumers with generation mostly dedicate it to self-consumption to reduce their energy bills. There are no specific limitations to injection to the grid, but prosumers are responsible for their balance, so they need to find a supplier that will take their excess production. But this is generally easy, as most suppliers have contracts for generators, where the injections are paid at market price.

Both explicit and implicit use of flexibility is readily available in Finland. Implicit DSF is widely used since metering infrastructure is very developed in the country.

All suppliers offer dynamic pricing contracts, and 11% of customers have contracts with an hourly granularity and prices linked to the day-ahead market. Explicit use of DSF, although also available, is less extended than implicit DSF. Technical requirements for most products are designed in a way that the demand side can participate without significant barriers. Around 20 aggregators, both independent and suppliers, are active in Finland, and they bring together both generation and flexible loads where clients receive a payment in exchange for the flexibility or generation provided.



FRANCE

France shows a high penetration of different prosumer technologies and possibilities. However, their actual interaction with the grid is still limited. Barriers to monetise flexibility limit market participation, even though France has one of the most technology-neutral frameworks, which should, theoretically, encourage the participation of demand side flexibility. In practice, prosumers are mostly focused on injecting their generation to the grid, on site optimisation, self-consumption, and in some cases — such as energy-intensive industries — providing their flexible loads to support the grid. The adoption of technologies in France has been encouraged through numerous governmental support mechanisms which reduce the price of the asset or makes their adoption sustainable. However, France needs to provide more incentives for prosumers to make their flexibility available to the grid and remove the regulations limiting innovative services like V2G.

Technology deployment

French consumers can choose from a wide range of technologies, with renewable generation playing an important role as well as also household technologies like electric water boilers or EVs. Industrial customers are also participating through flexible loads and generation. Renewable energy, and in particular solar PV, have grown thanks to a feed-in tariff. By the end of 2019, 5.5GW of rooftop solar PV were installed in France, with more than 50% on commercial surfaces and 1.6GW on households. This puts France in third position of small solar PV installations across the EU, behind Germany and Italy. Whilst not typically considered a prosumer technology, electric water heaters (most of which can receive signals from the grid) and a special tariff for water heating have been widely adopted by French customers. In addition to using renewable energy, industrial customers provide their flexible loads to the system. While no exact participant number is available, around 500-700 MW of flexible loads are procured for ancillary services yearly, and 730 MW of demand response is available in a specific product called *Appel d'Offres Effacement* (AOE). The new conditions for the 2021 were published recently, with 1.5 GW of capacity awarded. This increase is linked to a change in the tendering procedure, an increased price cap, and removal of some barriers, but it still has to be approved by the European Commission in the context of State Aid.

Finally, EVs and smart charging are growing significantly in France, facilitated by a generous direct subsidy that has been renewed in 2020, along with tax exemptions for both technologies. France is currently the second largest EV market in the EU, growing from a 2,5% market share in 2019 to a 9% in June 2020. In June 2020 alone, around 14 000 EVs were sold in France.

Financial Incentives

French prosumers have a wide range of governmental support mechanisms that either subsidise the adoption of flexible technologies or allow for a direct monetisation of their assets. All prosumer types, from the residential customer to the large energy consumer, have access to different feed-in tariffs, direct

subsidies for certain technologies. Many technologies can also access different electricity markets through aggregators to explicitly market their flexibility. Perhaps the most important feed-in tariff for prosumers is the *Tariff d'Achat,* particularly affecting solar PV, especially for installations below 300 kW capacity (which was raised at the beginning of 2020 from 100 kW). The tariff has been steadily declining in the past decade to the current price of 0,158 €/kWh, which is still a very attractive price, given that the purchase price over the same period was only 0,06 €/kWh. The current increase in capacity allowed for this simplified feed-in tariff, which does not require a tendering process, to be implemented to facilitate prosumers to adopt solar PV.

The main financial incentives for French EVs and charging stations come from the direct subsidies (*Bonus-Malus Ecologique* and the *Prime à la conversion*) that make them competitive with internal combustion vehicles (ICVs). So far, smart charging is still reduced and there are few offerings from charging providers. EVs and plug-in hybrids receive a direct grant of up to 7 000 €, with some local subsidies complementing this amount with up to 5 000 €. EVs are exempt of registration taxes in most of France (except in Bretagne and Centre-Val de Loire where the exemption is 50%). Chargers and smart chargers receive a 300 € direct subsidy for private charging stations in households, and companies receive up to 50% of the purchase and installation costs of charging stations. The installation of charging stations is further incentivised, with all EV drivers able to request the installation of a public charging station within 500 meters of their residence or workplace.

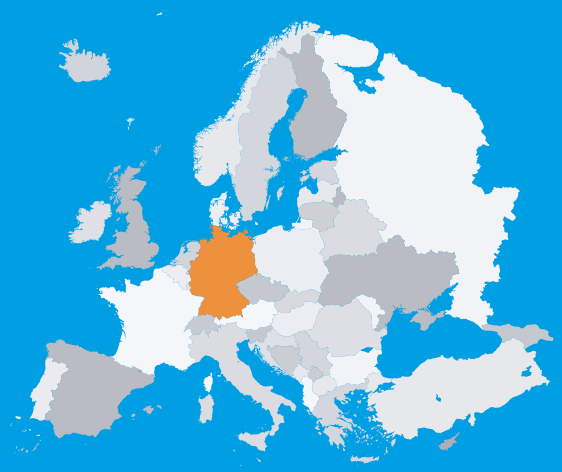
Role of prosumers in the system

French prosumers can play different roles in the system. However, most of their activity is centered on self-consumption and injection of generation. Even with access to electricity markets to monetise flexibility, the participation is limited due to costly barriers for flexibility. The explicit use of flexibility is available through independent aggregators to industrial customers, but also to the tertiary sector and residential prosumers. Around 2 GW of flexibility is currently certified on the French capacity market, but only around 49 GWh were delivered in 2019. The reasons are regulatory barriers and burdens that are still limiting the active participation of these sources due to a lack of a sustainable business case. In 2021, a fully market-based approach will be adopted to remove some barriers, like the current limitation for DSR to participate through a secondary market in certain balancing products (aFRR). Other participation limits include the inability to bid the same load into different balancing services or wholesale market and the pooling of demand and generation to bid into most markets (except Frequency Containment Reserve). The new conditions for the 2021 AOE have increased the capacity of DR tendered, which will certainly increase prosumer participation, even if those changes might be temporary and not extended after 2021.

Industrial customers can also participate in an interruptibility scheme offered by the French TSO, RTE. The programme is based on a series of tenders that contract 1.3 GW of capacity on a yearly basis, with an estimated global cost of 100 M€.

Implicit use of flexibility through, for example, dynamic pricing contracts, is not prevalent in France, even though the option exists. A demand response tariff was introduced in the 1990s through the Tempo signal, managed by RTE. This signal provides information to suppliers on congestion, allowing them to provide contracts with demand response clauses. However, the uptake has been limited, and in 2018, only 700 MW were made available based on these tariff-based mechanisms.

Most prosumers also benefit from a reduction in the cost of the electricity they pay for, both if they are self-consuming or if they participate in the market through an aggregator. In addition, it is common for aggregators in France to offer energy management systems which focus on on-site optimisation.



GERMANY

Germany boasts some of the most diverse technologies and deployments across the EU. Numerous households and businesses have invested in their own renewable energy and flexibility solutions, supported by numerous subsidies and support mechanisms designed to reduce costs or increase efficiency. However, the use of these technologies is typically confined to the prosumer's premises. Regulatory and technical barriers limit the participation of aggregation, reducing the range of possible options for prosumers. For residential prosumers, interactions with the grid are limited, usually not going beyond the injection of non-consumed energy. Industrial and commercial prosumers have a wider range of opportunities through interruptibility schemes and interactions with the electricity markets.

Technology deployment

Germany is at the forefront of solar PV rooftop installations in the EU with almost 3GW capacity available spread out between households, commercial areas and industrial sites. These make up to 66.5% of the total solar PV capacity installed in Germany (units under 500 kW). The wide use of residential solar also explains the growing adoption of battery storage, with more than 206 000 residential batteries installed by the end of 2019. Other technologies generally used by prosumers, but to a lesser extent, are EVs and smart charging stations. Night storage units, an older technology used across Germany, also provide flexibility.

The adoption of EVs in Germany grew significantly in 2019, fuelled by a 50% increase in subsidies from 2020-2025. However, no nationwide standard for charging stations exists, but a target number for installations is currently being discussed. Separate meters are installed for EVs and the charging stations can connect to a smart meter.

Financial Incentives

A wide range of financial incentives has resulted in Germany being at the forefront of the adoption of different technologies in the EU. One key driver is a feed-in-tariff that exponentially increased the installation of renewable energy. Prosumers are also supported through direct subsidies and avoided taxes. These programmes continue to provide investment certainty to the consumer in the medium-term, as most of them are valid for installations until 2030, with some having a specific, dedicated budget. Solar PV generators in all segments receive a feed-in tariff which has been consistently reduced in recent years with the growing number of systems installed. The amounts of the FIT range from 0.1008 €/kWh for up to 10kW installations, to 0.0695 €/kWh for installations up to 750 kW. The feed-in tariff is also applied to both on and off-shore wind, biomass, geothermal and other renewable energy sources.

Direct support mechanisms have played a significant role in making Germany

the EU country with the highest growth in EV sales in 2020. EVs and battery storage can benefit from significant direct investment subsidies[3] that were increased in February 2020. Charging stations are also eligible for several direct investment subsidies[4]. In addition, a line of low interest rate financing is available for customers purchasing solar PV systems and battery storage.

Avoided taxes are also a significant German financial incentive for EVs, with the exemption of several vehicle-related taxes[5]. In addition, energy taxes for electricity used for charging at the employer's site is avoided (valid until December 2030). Additionally, German delivery vehicles are subject to a special depreciation regime, encouraging companies to turn to EVs for their vehicle fleets (valid until the 31st of December 2020).

Lastly, there is a financial benefit when not using the DSO-grid, avoiding high network fees, especially for residential customers. This has been another instrumental aspect in the growth of combined solar PV and battery storage systems.

Role of prosumers in the system

In contrast to the wide penetration of distributed assets, the contribution of flexibility to balance the German energy market and the transmission and distribution networks is significantly limited due to regulatory barriers and the political reluctance towards DSO flexibility markets. The best use of distributed flexibility for prosumers across all segments is on-site optimization, avoiding high electricity prices and network tariffs. Grid injection supported by a feed-in tariff mechanism is also one of the main activities for prosumers. Commercial and industrial customers also take advantage of their flexibility through energy management and on-site optimisation services offered by aggregators.

Prosumers can inject their generation into the grid, but only if they subscribe to the feed-in tariff. This is particularly problematic for older installations that will not receive a subsidy after 2020 and will have to find a solution for their unused generation. To help support the grid and other renewables programmes, self-consumption is subject to taxes and levies with a reduced rate. The prices consumers receive for their energy is usually fixed and subject to the Renewable Energy Levy EEG (see Financial Incentives section). Payment received more often includes a management fee to encourage direct marketing.

Prosumers of all types can, in theory, participate in the energy market, providing their flexibility through their energy supplier or an aggregator. However, a dynamic service offering is hampered by significant hurdles, as the participation of independent aggregators to the electricity markets is only allowed through a supplier. Explicit use of flexibility is — so far — only available at transmission level and used mostly by commercial and industrial segments. Households have no access to explicit demand response, and implicit demand response is only available from some suppliers. Demand for these services is very low from customers, due to the installation costs for smart meters and the lack of rewarding offers.

Pooling of generation and loads, and stacking of services, is allowed, which facilitates the activity of aggregators. This includes pooling of EVs, but margins are small, currently limiting business interest in that service. The main markets with aggregator activity are balancing, day-ahead and intraday markets, where volumes traded, and margins, are reduced.

Industrial customers can also participate in interruptibility schemes, for up to 1 500 MW with a price cap of 500 €/MW capacity price and 400 €/MWh energy price when called upon. This programme ends in July 2022.

Some rudimentary grid-use flexibility programmes exist. For small customers connected to the low voltage grid, DSOs can temporarily interrupt the consumption of certain devices (typically storage heaters), in return for a lower distribution network tariff (§ 14a EnWG). Large consumers connected to the medium and high voltage grid can benefit from avoiding the "Hochlastzeitfenster", a timeframe set by the DSO in which consumption is the highest. Customers whose maximum load lies outside these time frames benefit from a network tariff reduction.

[3] "Umweltbonus" and "Förderrichtlinie Elektromobilität" valid until the 31st of December 202
[4] "Förderrichtlinie Elektromobilität" and "Förderrichtlinie Ladeinfrastruktur" valid until the 31st of December 2020
[5] "Kraftfahrzeugsteuerbefreiung" until the 31st of December 2020, "Dienstwagenbesteuerung" until the 31st of December 2030

GREAT BRITAIN

Great Britain offers prosumers some of the widest possibilities in Europe, through financial incentives such as the Smart Export Guarantee (SEG), a sort of market-based mechanism that replaced the feed-in tariff, or direct subsidies, but also by allowing prosumers to make the best use of their assets, providing their flexibility to the energy system. In this way, Great Britain could be one of the first countries where governmental support mechanisms stop being the main financial incentive to adopt certain technologies, and could even see the future the reduction of these, given that prosumers have enough options to market their flexibility. Further improvement could be geared towards inclusion of demand response in more streamlined electricity market products. As is the case in most of Europe, Britain also needs to take a step towards the adoption of V2G and smart charging, where some innovative projects are already being tested.

Technology deployment

British prosumers have one of the largest selections of prosumer technologies in Europe, both in variety and capacity. On the residential and commercial level, solar PV and flexible heating are the main technologies adopted. By May 2020, more than 1 million British households, commercial areas, farms, and small companies had solar panels installed (up to 50 kW in capacity). 943 000 of these are small residential prosumers with rooftop solar PV. The total capacity of rooftop solar PV installed by May 2020 amounts to 3.7GW, which makes Great Britain the European country with the largest capacity of rooftop solar by a significant margin.

Another key technology deployed in Great Britain are heat pumps, which have seen rapid growth, with installations of circa 30 000 units to date. Residential and small-scale batteries have seen slow growth so far, with around 3 000 units being installed by 2020. This number is likely to increase soon, due to the decrease in battery price, and pushed by support mechanisms like the SEG or direct subsidies.

British industrial consumers have access to onsite resources like small and medium wind turbines and interruptible loads.

EVs have also seen significant adoption. 4,7% of cars sold are electric, with year-over-year growth in sales of 262% between 2019 and 2020. A government discount has also facilitated a corresponding growth in home-charger installations.

Financial Incentives

The development of flexible and decentralised technologies in Great Britain has been encouraged through a variety of governmental support mechanisms and through the possibility to provide remunerated services to the electricity market, making costly investments much more interesting for a variety of prosumers. Probably the most significant of these support mechanisms was the feed-in tariff that propelled the installation of renewable energy through March 2019. This mechanism has been replaced by the SEG which differs from the traditional concept of a feed-in tariff, in that the generator receives a payment by the utilities

rather than the government, at a price set by the utility that can vary between them. This is applied only to the energy exported and not to total generation. The prices of the export tariffs set by different suppliers range from the 4.0p/kWh from *Scottish Power* and *Ovo Energy* to the 5.6p/kWh of *Social Energy.* As a side benefit, this new programme applies equally to the electricity injected into the grids by battery storage, and eventually, EV batteries. While net-metering was not commonly used in Great Britain until now, the introduction of the new SEG tariff will likely increase its use.

Flexible electrical heating is also supported through the Renewable Heat Incentive a governmental subsidy paid for the generation of renewable heat from biomass, solar thermal or heat pumps, which was recently extended to March 2022. This is the main financial incentive for the installation of flexible heating.

The primary financial incentives for other technologies, together with the SEG, are wholesale and network charge avoidance and onsite optimisation. In addition, a smaller financial incentive can be activated through independent aggregators, selling the flexibility both to local and transmission level markets.

Role of prosumers in the system

British prosumers have a wide range of options to make the best use of their flexibility, in ways that not only rewards them for adopting new decentralised technologies for their own benefit, but also interacting with the energy system, increasing its overall efficiency. The main motivation is still to reduce the payment of electricity through self-consumption, which remains un-taxed, and to reduce overall consumption through on-site optimisation. The remaining generation can easily be fed back to the grid thanks to the new Smart Export Guarantee programme. Prices are market-based and set by the suppliers, leaving room for prosumers to choose the option that serves them best.

In addition, prosumers can participate in the electricity markets through a wide range of aggregators that offer their services in Great Britain. The most common offers are a smart use of the prosumer's assets by the aggregator, in exchange for a monthly payment to the prosumer. Services provided by aggregators include on-site optimisation, energy management, and other services, such as a guaranteed user-defined state of charge for EVs. Aggregators use the flexibility to bid into a wide range of markets and products, from day-ahead to balancing markets on the TSO level. Wholesale markets are not yet accessible to independent aggregators. A code change proposal to allow this (P145) has just started its assessment process, with implementation targeted for 2022. Local flexibility markets are organised by independent parties such as Piclo Flex, which provide a platform to provide system services to the DSO.

Prosumers of all types can make use of their implicit flexibility, although the options are more reduced in this case. For residential customers, there are currently four dynamic contracts that offer time differentiated-based pricing, which is low compared to other EU countries that also offer time-of-use tariffs. Only one of these tariffs, Octopus Agile, provides negative pricing using half hourly time intervals. The other three time-of-use tariffs are static, using different time frames with differing pricing structures throughout the day. Some innovative adaptations of time-of-use tariffs have also appeared recently; for example, a tariff offered by Kaluza, based on distribution price signals, geared towards the optimisation of EV charging, avoiding times of congestion at the local distribution grid.

IRELAND

Irish customers that desire to play an active role in the energy system can benefit from a wide range of financial incentives in the form of governmental subsidies, a beneficial feed-in tariff and participation in the energy markets. This, coupled with changes in legislation, have facilitated the adoption of different renewable technologies across the country. So far, the possibilities offered to commercial and industrial prosumers are broader than for domestic users, who are limited to on-site optimisation, with energy expense reduction from the feed-in tariff their main driver for generation adoption. However, upcoming changes in legislation portend domestic prosumers playing a larger role, joining industrial and commercial prosumers in providing their flexibility to the grid.

Technology deployment

Ireland has seen significant changes in regulation in the past two years, facilitating the expansion of small-scale adoption of decentralised technologies. The main technologies being adopted are solar (both photovoltaic and thermal), wind, and EVs. Battery storage is still at an early stage, but a new governmental support mechanism has kickstarted its adoption in residential and small commercial areas when installed with solar PV.

Ireland is the second-ranked EU country in wind energy production, and this extends to prosumers in the industrial segment and large commercial parks, especially through self-generation or PPAs.

A very rudimentary smart charging, that allows the operator to throttle or stop charging, is generally available in many locations, but so far, no V1G or V2G capabilities exist. New construction and renovation of buildings are mandated to include charging stations, but there are no requirements for them to be smart. No incentives currently exist to install charging stations, and no detailed roll-out is planned, as the largest network of charging stations is state-run by the utility ESB.

Financial Incentives

Irish prosumers can benefit from a large range of government benefits and grants, as well as tax reductions and the introduction of a new feed-in tariff, as the main incentives to take an active role in their energy consumption and generation. The main support mechanism for generators in the commercial and industrial segment is the Renewable Energy Feed-in Tariff (REFIT). This programme accepted applicants until 2020, and will be replaced by a new scheme, the auction-based Renewable Electricity Support Scheme (RESS) from 2021 onwards. Until 2020, prosumers that were part of the REFIT received a fixed amount for the electricity injected for the next 15 years. REFIT was rolled out in three stages, but none included solar PV. The most relevant technologies included in REFIT for prosumers are wind and biomass, which receive from

72.81 €/MWh to 100.72 €/MWh depending on the size and specific technology used. These tariffs are higher than the average price of electricity in Ireland.

The new programme, RESS, launched in August 2020, with its first auction, which provides participants with support until 2037. RESS also includes solar PV, but the minimum size is 1 MW, essentially excluding roof-top PV from the mechanism. However, the RESS scheme facilitates the participation of communities, including small businesses, schools, farms, and other prosumers that by themselves would not be able to reach the threshold, to bid into the auction as a single community. Additionally, all bids into the RESS scheme must contribute to a community benefit fund to foster local renewable energy projects of smaller scale that could not join the auctions.

For certain prosumers — especially households and small businesses — the SEAI provides a direct investment subsidy of 3 000 € for the installation of solar PV (up to 2 kW for solar PV and 4 kW if installed together with battery storage), EVs and home charging stations and solar thermal. Private EVs receive a grant that ranges from 2 000 € to 5 000 €; for commercial vehicles the limit is 3 800 €. In addition, EVs are exempt from paying certain taxes related to carbon dioxide (CO_2) emissions and from the Vehicle Registration Tax until the end of 2021. Private charging stations receive a grant of 600 €; public charging points are also supported with 75% of the capital costs up to 5 000 €. Several other grants are applied to energy efficiency measures such as the installation of heat pumps and solar water heating.

In addition to these grants, prosumers in certain segments (particularly farms, commercial areas and companies) that invest in energy saving technologies can adhere to the Accelerated Capital Allowance (ACA), a tax regime that allows them to deduct the cost of the equipment from their profits in the year of purchase. On average, the reduction in tax paid amounts to 12.5% of the value of the capital expenditure. This special depreciation programme affects different technologies included in the Triple E register by SEAI for energy efficient products, including, among others, wind turbines and solar PV.

In addition to these advantages, industrial customers can also be a part of an interruptibility scheme called STAR (Short Term Activation Response) that provides services to the TSO Eirgrid, and which pays on activation, based on the committed energy.

Role of prosumers in the system

Roles for prosumers in Ireland are significantly different between households and commercial and industrial prosumers. In households, the main use of flexibility is reduction of the energy bill and on-site optimisation, while commercial and industrial consumers can also join demand response programmes and interruptibility schemes, combining them with the feed-in tariff and on-site optimisation.

Household prosumers can optimise their consumption using different technologies, but with a limited interaction with the energy system. So far, the options for implicit DSF are also limited, with only day/night tariffs being offered to households. This will change with the adoption of the National Smart Metering Programme in January 2021. Under this programme, suppliers will be required to offer a dynamic tariff to customers. Different options will be available, with a standard day/night/peak-time tariff.

Self-generating small consumers can decide to feed into the grid, after notifying the DSO, but will not receive any payment for the injected energy. This will change with the rollout of the National Smart Metering Programme, which will include the possibility to measure energy exports. A framework for a compensation of the injected energy is currently being discussed. With the new RESS scheme, citizens and communities that want to become prosumers will have preferential access to investments in renewable energy projects in their area, and procure directly from those sources, using their flexibility as they see fit.

The use of explicit DSF is not yet extended for households, but commercial and industrial units can participate in the markets through demand side units (DSU). These units can participate to TSO markets like balancing, capacity, system services and day ahead markets, through demand adjustment. Different assets can be aggregated into one single DSU that bids into the market as one. The main rewards are capacity payments and energy payments based on activation. As mentioned above, industrial customers can also participate in an interruptibility scheme.

The Irish regulator published a roadmap[6] in March 2020 to implement the aggregator figure in the context of the EU Electricity directive, as well as defining the roles of prosumers, and facilitating their activity through explicit use of their flexibility.

[6] https://www.cru.ie/wp-content/uploads/2020/03/CRU20043-Roadmap-for-the-Clean-Energy-Packages-Electricity-and-Renewables-Directives.pdf

ITALY

Italy shows significant development of different technologies for prosumers and the integration of their flexibility into the system. To date, the incentives for becoming a prosumer are still reliant on different governmental schemes, like feed-in tariffs and premiums. The existing flexibility programmes, which could be a good opportunity for prosumers, are not yet profitable enough to make a business case, due to market access barriers. In the meantime, the regulator continues to adapt technical conditions for participation of flexibility into different electricity markets, especially ancillary services. If this continues, Italy could become one of the most interesting countries for prosumers.

Technology deployment

Thanks to its weather conditions and generous support mechanisms, Italy's most adopted prosumer technology, across consumer segment, is solar PV. The statistics indicate that around 89% of all installed solar PV were installations below 1 MW. From those, around 56% are residential and commercial rooftop installations. The second most prevalent technology is high efficiency combined heat and power (CHP), for residential customers and commercial areas. Battery storage has started to see steady growth, coupled with solar PV systems. Around 5 000 batteries are currently installed in homes and small-to-medium enterprises. EVs have also shown recent growth, amounting to 2% of all vehicle sales in January 2020. This growth is encouraged by subsidies, but is, at the same time, held back by low development of charging stations, with only 9 000 installed across Italy, of which approximately 7 000 are private.

Financial Incentives

All the above-mentioned technologies receive governmental support through feed-in tariffs, direct subsidies and tax exemptions, making these the most important financial incentives for their adoption. For renewable energy systems, several types of support mechanisms exist, depending on the technology, size and use of the installation. The most significant are feed-in tariffs and premiums from grid injection and self-consumption and the net-metering scheme *Scambio sul Posto.* These programmes are the main financial incentives that facilitate the current growth of renewables in Italy.

Probably the most relevant support scheme for small and medium prosumers, is the *Scambio sul Posto.* Both renewable energy generators under 500 kW capacity, and high efficiency CHP plants under 200 kW capacity, can apply to a net-billing programme called *Scambio sul Posto*[7]. It remunerates the difference between injected and withdrawn energy at a value based on the zonal price of the hourly wholesale market. In this programme, prosumers also receive

[7] https://www.gse.it/servizi-per-te/fotovoltaico/scambio-sul-posto

financial compensation for the double imposition of the volumetric term of the network tariff, in c/kWh. This net-metering programme is very commonly used by prosumers in the range of 3 kW to 20 kW generation and can be combined with other tax deductions (but not with the *Ritiro Dedicato programme*).

A feed-in tariff for solar PV, *Tariffa Onnicomprensiva*, was adopted in July 2019 for installations with a capacity below 250 kW. Installations with a capacity below 100 kW receive an additional premium for self-consumed energy if that energy is more than 40% of annual production. This premium incentivises users to adopt renewables, whether they inject into the grid or use it for self-consumption. For solar PV installations smaller than 250 kW, the cap is 105 €/MWh (20-100 kW) and 90 €/MWh (100 kW- 250 kW), with additional premiums of 10 €/MWh on the share of energy self-consumed, and 12 €/MWh on the energy produced for rooftop facilities that include the removal and substitution of asbestos.

The second incentive for PV owners is tax exemption on the personal income tax (IRPEF) for installations of solar PV and storage and for households and building refurbishment that include these technologies. Adopters benefit from a 50% deduction of the investment costs, up to a maximum of 96 000 €. Until the end of 2021, this incentive has been increased to a 110% tax deduction of the total investment cost for buildings with major refurbishment needs, thanks to the *Decreto Rilancio* adopted in May 2020 in the context of the public health crisis brought on by COVID-19.

For non-solar PV generators, a feed-in tariff called *Tariffa Omnicomprensiva* exists for assets between 1 kW and 1 MW capacity (though wind power is limited to 200 kW). This tariff accepts no new entrants, but lasts for 15 years. It is incompatible with the *Ritiro Dedicato* and the *Scambio sul Posto* programmes and pays between 0.18 €/kWh and 0.3 €/kWh depending on technology.

Vehicle buyers receive an "eco bonus" incentive when scrapping their old vehicle. The bonus amounts to 6 000 € for the purchase of EVs and vehicles with CO2 emissions up to 20 g/km. If no old vehicle is turned in, the direct subsidy is reduced to 4 000€. Both amounts are limited to purchase of a vehicle under 50 000 € without tax. A second EV incentive is tax relief, where EVs do not pay for road tax for the first five years of ownership alongside free parking in numerous city centres.

CHP users receive white certificates that are applied to primary energy savings compared to reference solutions. This programme is valid for 10 years after start of operation, or 15 if CHP is combined with district heating.

Prosumers have limited ability to monetise their flexibility explicitly. The Virtually Aggregated Mixed Units (UVAM) pilot project allows generation and demand to provide balancing services; however, the price margins are still low. An interruptibility programme is available for industrial customers. This programme procured 3.9GW of maximum interruptible capacity between 2018 and 2020. The auction price is defined by a descending clock auction, starting from a reference price of 105 000 €/MW/yr. A similar pilot project is being introduced at the end of 2020 targeting in particular battery storage and EVs. For the instantaneous interruptibility service and 60 000 €/MW/yr. for the emergency interruptibility service in mainland Italy. For the resources in the islands of Sicily and Sardinia, the price is increased 20%.

Role of prosumers in the system

Prosumers in Italy can use their flexibility in different ways, but the choices available are dependent on the size of the prosumer. Even then, the financial incentives from the explicit use of their assets, together with a limited number of accessible products, are insufficient for the market to develop. This is especially true for small prosumers, while the generation loads, and demand of industrial prosumers facilitates participation. For this reason, the focus of prosumers at all levels is reduced cost of their energy consumption and, for industrial customers, on-site optimisation. Self-consumption is further encouraged by the premium pricing described above and the avoidance of network tariffs. Energy in storage facilities still must pay charges, but the removal of this condition is currently being discussed.

Households and small and medium businesses can opt for dynamic price contracts with hourly pricing if a smart meter is present. To date, the roll-out of smart meters that include hourly measurements is ongoing but has seen severe delays due to COVID-19 public health crisis in 2020. For this reason, the users. As a result, adoption of these dynamic tariffs is quite low, as hourly measurement was only compulsory for customers above 55 kW. To date, 14% of residential

customers and 40% of non-residential customers are using these dynamic tariffs.

Large Italian prosumers, like industry or commercial parks, can participate to the energy markets through independent aggregators. The aggregator framework is undergoing a renovation to include the new provisions from the Electricity Market Directive. The markets currently available are a capacity market, an interruptible loads programme and the UVAM project. Prosumers must choose one and cannot participate to different markets with the same load.

The UVAM project — probably the most interesting programme for demand response — currently allows for a minimum bid size of 1 MW, which can be achieved by aggregating different units. (There is an ongoing discussion of reducing this minimum bid size to 0.2 MW in 2020). Both stationary battery storage and EVs can participate to this programme. A framework for V2G is also being designed to deploy once the minimum bid size is set to 0.2 MW. A recent decision by the Italian regulator, ARERA (Del. 153-20 (5/5/2020)), introduced the possibility for small prosumers to take part in the UVAM flexibility programme, if they had less than 55 kW generation without hourly metering.

Industrial customers can also participate in interruptibility schemes, as seen in the previous chapter, which are generally more profitable than the flexibility programme. The current regulation will expire in 2020, but an extension is foreseen for three years.

LUXEMBOURG

Prosumer activity in Luxembourg is very limited. Low energy prices reduce the incentives for self-consumption, and the lack of opportunities to use flexibility, explicitly or implicitly, limit the interaction with the grid. However, beneficial feed-in tariffs for solar PV, and EV incentives, are facilitating the growth of those technologies, paving the way for more prosumers in the future.

Technology deployment

Technology used by prosumers in Luxembourg is almost exclusively solar PV. In total, around 160 MW of solar PV is installed in Luxembourg, with the largest part being rooftop installations. Almost all of this generation is connected in full injection mode, with very little self-consumption, thanks to the beneficial support mechanisms and remuneration schemes, and to the overall low energy prices. Stationary battery storage adoption is also limited, thanks to a lack of incentives and until recently, the high price of the technology. EVs are still a niche technology, with only 0.65% of registered passenger vehicles being electric. This will change as the result of a recent policy push by the government which includes new subsidies to purchase an EV and further roll-out of charging stations.

Financial Incentives

The financial incentives to become an active consumer are reduced to governmental support mechanisms and direct subsidies, with no real incentive from the private sector to encourage self-consumption. Solar PV can benefit from a feed-in tariff for installations under 500 kW, with the caveat that support for installations between 200 kW and 500 kW is only open for cooperatives or energy communities. The feed-in tariff varies from 0.16 €/kWh for installations up to 10kW to 0.12 €/kWh for installations of 500 kW. In 2020, the prices per kWh for residential and small consumers, depending on supplier, vary between 0.146 €/kWh and 0.174 €/kWh. For small consumers with a consumption below 20 MWh, the average price of electricity in the second half of 2019 was 0.163 €/kWh. With energy prices close to or below the remuneration of the feed-in tariff, prosumers are incentivised to inject all their generation.

EVs receive a direct subsidy of 8 000 €, raised from a previous 5 000 € through a COVID-19 recovery package. Leased EVs also have an advantageous tax deduction.

No other incentives exist today, for storage or charging stations, although the government is currently studying the possibility of new subsidy schemes.

Role of prosumers in the system

The role of prosumers in Luxembourg is reduced to grid injection of their generation, onsite optimisation, and energy management, with few incentives for self-consumption or energy market participation due to low energy prices. The main action, due to the feed-in tariff described above, is direct injection to the grid. Explicit or implicit use of flexibility does not currently exist in Luxembourg. Even though the concept of aggregator is recognised in the legal framework, no aggregator is currently active in the country. Since June 2020, customers can access the aFRR product in the German balancing market, but the access to national balancing markets in Luxembourg is not yet possible. As well, no dynamic tariffs are offered by energy suppliers. Self-consumption is taxed, with 0.01 €/kWh (the removal of this tax is currently in the last stages of parliamentary procedure).

MALTA

Malta is unique, given that it is a small island state that is heavily dependent on energy imports. For that reason, the government has incentivised the use of decentralised renewable energy, particularly solar PV. Through an advantageous feed-in tariff, and direct subsidies and tax cuts for those that install rooftop solar PV, the government aims to guarantee security of supply while leveraging the high irradiation of the island. However, self-consumption or grid injections are the extent of prosumer actions in Malta. The lack of an organized market, or use of flexibility from the system operator, means that no independent market actors are incentivised to offer onsite optimisation services to tap into the flexibility resources of prosumers.

Technology deployment

The most prevalent decentralised technology used in Malta is solar PV. This has facilitated electrification of rural areas and is supported by a 20-year feed-in tariff. The adoption of battery storage is also growing, but is still mainly used in large-scale plants. There is a current governmental scheme to provide incentives to install smart-charging stations for homes, and commercial areas, like supermarkets.

Financial Incentives

The main financial incentives for Maltese prosumers come from the feed-in tariff and tax exemptions linked to the use of renewable resources. The feed-in tariff awards solar PV generators with capacities from 1 kW to 400 kW a fixed payment. However, the amount that can be injected into the grid under the feed-in tariff is limited to an annual maximum threshold equivalent to the kW of the installation multiplied by 1 600, and not exceeding 4 800 kWh/annum for households and 160 000 kWh for commercial areas and larger generators. Any energy exported above that limit is paid out based on the marginal price of electricity, which is a fixed amount set on a yearly basis. The feed-in tariff is awarded for a limited period of 20 years, and the amounts paid out depend on the capacity and how much is exported, based on the above calculation to establish the limits. The feed-in tariff paid out to households is in the range of 0.105 €/kWh to 0.28 €/kWh. On average, households pay around 0.13 €/kWh for their energy consumption. For other generators, the range is between 0.14 €/kWh and 0.2 €/kWh. On average, the price paid is between 10.15 c/kWh and 0.25 €/kWh.

An additional incentive for household and small business installations comes in the form of a grant provided by the government and administered by the Regulator for Energy and Water Services (REWS), consisting of 50% of the purchasing costs up to a limit of 3 000 €. This programme comes together with a 20-year feed-in tariff that pays 0.105 €/kWh.

Role of prosumers in the system

Given the financial drivers, prosumers in Malta have two clear options to take advantage of their assets. The choice is between injection into the grid based on the feed-in tariff and self-consumption of the generated electricity. There is only one DSO in Malta, Enemalta, which also acts as the sole supplier.

No markets for flexibility currently exist in Malta, and there are no aggregators active in the country. This may change with the adoption of the new Electricity Market Directive. The DSO already foresees the use of demand side response, but the lack of an organised electricity market structure in Malta makes a viable business case for aggregators challenging.

There is also no use case for implicit flexibility, with no time-of-use tariffs or signals provided by the supplier. However, the introduction of a special night tariff for EV charging is currently being studied.

THE NETHERLANDS

The Netherlands has one of the largest adoptions per capita of solar PV, electric vehicles, and charging infrastructure. System operators have implemented pioneering platforms like the GOPACS platform and are testing new possibilities that their large EV fleet provides as a source for flexibility. The government has for several years now implemented an aggressive support strategy for the adoption of green and flexible technologies. However, the end result is still many prosumers benefitting from it mostly as "passive" participants trying to benefit from cost reduction brought by the support mechanisms available. Once these support mechanisms are phased out (mostly in 2024), new forms of revenue streams and options will be necessary for this growth not to stagnate. Starting with a full opening of the electricity markets to flexibility services and to independent aggregators that can provide services both to the grid and prosumers.

Technology deployment

The Netherlands has experienced a significant surge of DERs in the past years, driven especially by financial advantages offered by the government. This is particularly the case for solar PV, and more recently, for electric vehicles and smart charging stations. The Netherlands has the fourth highest rooftop solar PV capacity in the EU, with 5.3 GW installed capacity as of December 2019. This capacity is centred mostly on households, which amount to almost 3 GW of the total rooftop capacity installed, with the rest being equally divided between commercial and industrial prosumers.

Electric vehicles have also grown significantly in the past years, with an EV fleet of almost a 100 thousand vehicles in 2020, which amounts to around 2% of all the vehicles in the Netherlands. Charging station installations have increased accordingly, being the Netherlands the world leader in installations.

Households in addition have the option to install electric heat pumps, which have smart capabilities and could provide flexibility. As of 2019, 412 000 such heat pumps were installed in the Netherlands.

Financial Incentives

The adoption of DERs by Dutch prosumers has been led by governmental support schemes like net metering, tax exemptions and direct subsidies, which have acted as their main driver. So far other options for monetisation of flexibility are reserved for large commercial or industrial customers. A very successful net metering scheme for solar PV is the main reason behind the exponential growth of rooftop PV installations, in particular in households. However, with the already significant expansion of solar PV and the reduction in costs of installation over the past years, this net-metering scheme will start a phase out in 2023 until being completely terminated in 2031. Under the current net-metering scheme, generators that inject more than they take off the grid, receive a feed-in tariff equal to the price they pay for their delivery contract. This amounts to between 0.07 €/kWh and 0.10 €/kW. In the future, once the net-

metering scheme is phased out, injection remuneration will be based on market-prices.

Electric vehicles have also seen their numbers grow thanks to a governmental effort in reducing their price through support mechanisms, both for the vehicle and for the required charging stations. EVs are currently exempt from paying various taxes and charges. Until 2024 EVs are exempt from the purchase tax (BPM, *Belasting van personenauto's en motorrijwielen*). In 2025 buyers will pay 360 € per vehicle, amount that will increase gradually every year. EVs are also exempt from the motor vehicle tax (MRB) until 2024, in 2025 they will be charged 25% of the BPM and after that the full amount. These tax exemptions come together with numerous municipal programmes that include free public charging, subsidies for companies to install charging stations on their premises and additional direct subsidies for individual owners. The latest direct subsidy implemented nationwide, is a 4 000 € direct payment for the purchase of an EV. All these incentives have made the ownership of an EV cost equal to that of an internal combustion vehicle, or even cheaper.

Other than subsidies and tax exemptions, the revenue streams for prosumers in the Netherlands are quite limited. For small prosumers, monetisation of their flexible loads is almost nonexistent, except for some pilot projects. Dynamic price contracts exist, but are not very extended and the dynamic component is only linked to the energy price, as network tariffs are fixed.

Role of prosumers in the system

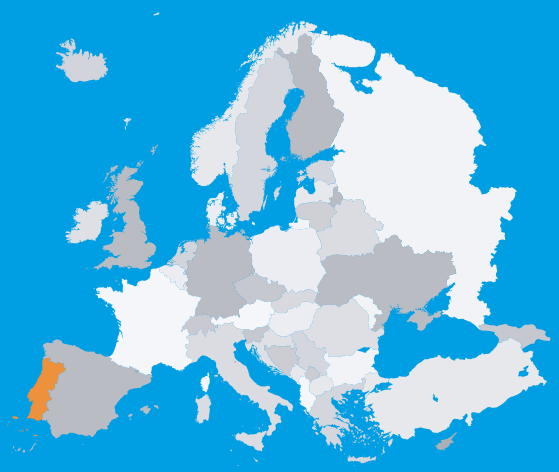
Possibilities for prosumers in The Netherlands are highly dependent on the type and size of the prosumer, but overall, the main activity is self-consumption and on-site optimisation driven mostly by the support mechanisms, and by a legislation that limits aggregator participation.

Households and small commercial prosumers with generation are mostly self-consuming or otherwise optimising their energy use. This is driven by the lack of possibilities to monetise flexibility directly with aggregators or the suppliers, but also driven significantly by the support schemes available. So much so, that the current net-metering scheme and the feed-in tarifff have directly influenced the size of the solar PV installations, to a point that prosumers install capacity just below their usual consumption, because injection prices are not beneficial enough.

Larger, mostly industrial prosumers, have more options, and can provide their flexibility to the grid bidding into different markets. But activity is severely limited due to regulatory barriers for independent aggregators, which as of 2020 have not been fully recognised in legislation and don't have the possibility to access customers directly. Aggregation is only possible when linked with a supplier, or the aggregator as a service provider model (rather than trading electricity). Both approaches limit the possibilities to market explicit DSF. This is expected to change with the implementation of the Electricity Market Directive.

An innovative cooperation platform between the TSO and DSOS, called GOPACS is currently being tested. This platform allows for local congestion management using excess or demand from other areas. While this platform is not a market in itself, it functions with the existing markets, and allows a new outlet for the monetisation of flexibility, in particular for large loads.

The Netherlands has one of the densest charging station networks in the world, most of them have smart charging capabilities. Some operators and service providers are already offering options for various degrees of smart charging. Vehicle to grid (V2G) is being tested and implemented by operators. However, services for car owners are still based on mostly reduced prices and other supply services, like a state of charge guarantee, rather than as a way of monetizing their flexible load.



PORTUGAL

Prosumers playing an active role in Portugal has seen ups and downs in the past decade. While the previous feed-in tariff is not applicable for units connected since 2012, other recently adopted programmes are encouraging and preparing the landscape for prosumers to take charge from 2021 onwards. Until then, the largest prosumer incentive is the avoidance of tariffs and other charges. Some technologies are made competitive with direct subsidies, and a country-wide push to adopt electric heating and cooling favors the adoption of flexible technologies. One primary barrier is that there is no explicit participation of flexibility in the energy markets. Upcoming changes in legislation, and the adoption of the EU Electricity Directive, will most likely bring new prosumer opportunities soon.

Technology deployment

Portuguese prosumers have increasingly easy access to a variety of renewable technologies, mainly solar PV and wind, but also smart technologies like heat pumps, which, in past years, have taken a central role in the development of national energy and efficiency plans, and, to a smaller extent, EVs. A renewed effort by the government at the end of 2019[8] has facilitated the adoption of renewable energy and storage for small and medium consumers. Portugal has around 30 000 self-consumption and self-generation facilities across all different customer segments. The most prevalent technology is solar PV, although still under 700 MW cumulative capacity, 205 MW of that corresponding to installations above 30 kW.

The Portuguese government has ambitious plans to reach their 2030 National Energy and Climate Plan (NECP) goals. Administrative barriers have been simplified to support different generation technologies, now allowing the aggregation of different generation units, both for energy communities, which were not envisioned by the previous legislation, and individual customers. Additionally, new regulation to facilitate the installation of battery storage has been adopted alongside new energy poverty and renovation measures to incentivise the installation of heat pumps.

EVs are still a niche technology; only 0.3% of the country's fleet is fully electric. But growth is apparent: 6% of new car sales in 2020 were EVs, up from 3.3% in 2019. Charging station development is mostly passive with no official plan for smart-charging or V2G. However, pilot projects are already using both technologies. Governmental estimations are that by 2030, 2% of the flexible capacity will correspond to V2G.

Financial Incentives

The main prosumer financial incentives are avoided taxes, charges, and

[7] https://dre.pt/pesquisa/-/search/125692189/details/maximized

other fiscal advantages, as explicit remuneration of flexibility is limited and implicit flexibility available only for large consumers. Governmental support mechanisms like feed-in tariffs exist for most renewable technologies. However, small installations of solar PV only receive a feed-in tariff if they were installed before 2012. In 2019, the government introduced a new regulation to facilitate self-consumption for individuals and energy communities. Any non-consumed energy fed into the grid is sold under market conditions.

There is a series of direct subsidies and fiscal exemptions in Portugal to drive the adoption of certain technologies. Since 2019, self-consuming prosumers with self-consumption are exempt from paying charges related to energy and economic policies (CIEG). This includes charges in third-party access tariffs for self-consumed energy that uses the public grid, such as an energy community. The State Budget Law of 2020 foresees the creation of environmental deductions for renewable self-consumption production unit acquisitions as well as heat pumps with class "A" or higher energy efficiency. This is applied both for individuals and companies.

EVs also benefit from direct subsidies and tax-exemptions. An initial direct payment of 3 000 € for individuals and 2 000 € for companies is foreseen.

Role of prosumers in the system

Prosumers in Portugal primarily use their assets for self-consumption and onsite optimisation to avoid the payment of taxes and electricity prices. Interaction with the grid is limited, and mostly used by larger prosumers. Explicit use of flexibility is very limited due to regulatory barriers. Only one aggregator, acting as a Balancing Services Provider (BSP) and only as a pilot project, is currently offering aggregated demand services to the ancillary services markets (regulation reserve market). The only other active aggregators are mediating between renewable energy system generators and the day-ahead and intraday markets, acting as Balance Responsible Parties (BRP). However, the national energy regulator is currently adopting the EU Electricity Directive which will allow prosumers to participate in different markets and be remunerated for it. This provision is already included in the new self-consumption regulation.

As an alternative, large industrial consumers, connected to the medium to high voltage grid, can participate in an interruptibility scheme if they provide at least 4 MW capacity. Remuneration in this case is both for service and for utilisation. The formula is indexed to the fixed operation costs of a combined cycle gas turbine (CCGT) and depends on the ratio of peak/off-peak consumption of the provider. Remuneration based on activation is indexed to the average of day-ahead prices in the period of utilisation.

The implicit use of flexibility is possible, although most users are in the segment of large consumers (>41.4 kVA). Dynamic tariffs for those consumers are indexed to spot market prices. Households and medium-sized consumers have two possible offers, which adapt their prices on a monthly basis depending on the spot market. Households have no real dynamic pricing contracts because quarter-hour consumption measurement is not yet possible. Both industrial and household consumers can access static time-of-use network tariffs, with three different price blocks during the day for residential customers and four blocks for industrial customers.

Generators are encouraged to self-consume their production, especially those that cannot participate in the feed-in tariff. Surplus can be injected to the grid, trading it in the market, through bilateral contracts, or through their supplier or a market-facilitator (which is a role that aggregators are adopting, known as "last-resort aggregators"). If they decide not to act through a market agent, generators under1 MW have a possibility of guaranteed off-take through these last-resort aggregators.

SLOVENIA

Slovenia shows significant promise for prosumers, but future developments will dictate whether prosumers can be independent or will continue to depend on governmental incentives. Today, significant support mechanisms from the government guarantee the viability of installing different technologies, especially solar PV, but also EVs, smart charging and even innovative and unique V2G stations. However, the explicit use of flexibility and the revenue streams coupled with it are only available to large industrial customers, and even then, with significant limitations. This will most likely change as improvements are made by the national regulator and government, bringing their legislation up to the standards of the new Electricity Market Design (EMD) Regulation and Directive.

Technology deployment

The star technology for Slovenian prosumers is solar PV, which has shown significant growth in the past two years, driven mostly by prosumers taking advantage of government incentives and a reduction in administrative barriers. Other technologies that are slowly growing are EVs, and with them, smart charging stations. But solar PV remains the leader, with a 2019 increase of installations by 233% over 2018; Slovenians installed 2 496 solar PV systems amounting to 32.2 MW. Most of these installations are from systems below 11 kW capacity.

EVs adoption has also increased, growing from 0.21% of the total vehicle fleet in 2015 to almost 1% in 2019. While this growth appears modest, it is close to the EU average of 1.75%. Public charging stations have also seen recent growth, thanks to a government plan for creating green corridors. This expansion has included several V2G projects, such as X-FLEX[9] and INCIT-EV[10], and more smart charging stations.

Financial Incentives

The growth of prosumers in Slovenia is a direct result of renewed effort from the government, providing a feed-in tariff, net-metering and direct subsidies to consumers willing to install technologies to help Slovenia reach its renewables targets. The main financial incentive offered to solar PV installations is a feed-in tariff, applicable to all prosumers with an installed capacity up to 100 MW. The tariff is based on a tender for large installations. Every project accepted into the tender receives a different price, which can vary significantly. For solar PV, prices range between 65 €/MWh and 85 €/MWh. In general, the feed-in tariff covers the difference between the cost of production of the electricity and the annual reference price of electricity, set by the Slovenian Energy Agency.

A different incentive comes in the shape of net-metering, which is calculated on a

[9] http://xflexproject.eu/
[10] https://www.incit-ev.eu/

yearly basis. This scheme provides an incentive to those prosumers unable to join the feed-in tariff. So far, no phase-out is planned for this programme, but it will be aligned with the provisions of the new EMD, which prohibits schemes with net flows. Some of these programmes are mutually exclusive. Even if the feed-in tariff for renewable energy is valid for 15 years, prosumers cannot apply for net-metering once it runs out.

Finally, there are direct investment subsidies for numerous technologies provided by the Ministry of Infrastructure[11] or through the Slovenian Environmental Public Fund, known as Eco Fund[12]. These provide support to solar PV, EVs, and smart charging stations, both public and private, and cover energy efficiency measures. The support provided by the Eco Fund in the form of direct subsidies and favorable loans is significant, amounting on average to 30% of the total investment cost.

The financial incentives for industrial prosumers move beyond support mechanisms, as they play an active role in the energy system, selling their flexibility through aggregators, mostly to the balancing markets. However, these incentives are still reduced, due to significant market barriers that limit their participation (see below).

Role of prosumers in the system

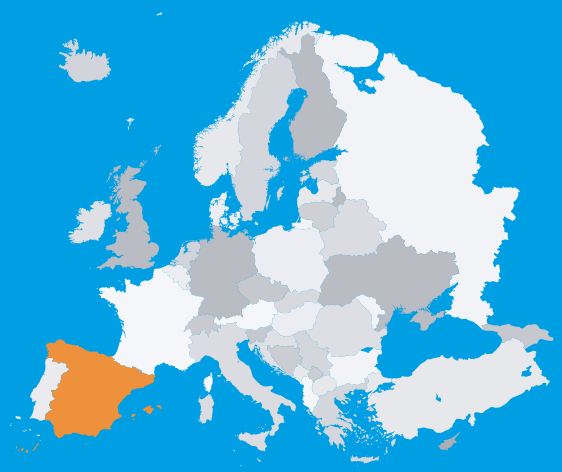
The roles of prosumers in Slovenia can be reduced for small prosumers and expanded for industrial consumers with larger loads. While households must content themselves with self-consumption, larger commercial areas and industrial prosumers have, in addition to self-consumption and on-site optimisation, the possibility to sell their flexibility to the electricity markets. Households' main activity is self-consumption and avoiding the payment of network tariffs and taxes. Optimisation of the households' consumption is limited to a very basic time-of-use tariff (peak/off-peak differentiation), which about 70% of Slovenian households use and is applied to the tariff and the energy component. Implicit use of flexibility is being tested in several pilot projects through an incentive scheme offered by the national regulator to employ a dynamic network tariff - critical peak pricing (CPP) for the distribution network tariff[13]. Additionally, suppliers involved in these pilot projects can also provide their own incentives for customers. Energy that is not consumed is injected into the grid, at retail price, with the option to receive the premium described above or by participating in the net-metering scheme.

Industrial customers and larger commercial areas also have the possibility to access additional revenues when selling their flexibility to the grid through an aggregator, mainly to the electricity balancing markets (aFRR and mFRR). However, this is still quite limited for a variety of reasons, in particular, regulatory barriers. The figure of the independent aggregator is not fully developed and only recognized on a limited basis in the regulation as BSPs. Technical requirements like high minimum bid sizes and reduced DSF activation in the balancing markets limit the possibilities for prosumers that want to monetise their flexibility. This situation may change as Borzen, the Slovenian regulator, adapts the new EMD.

[11] https://www.gov.si/zbirke/javne-objave/javni-razpis-za-sofinanciranje-nakupa-in-postavitve-naprav-za-proizvodnjo-elektricne-energije-z-izrabo-soncne-energije-za-obdobje-2019-2022/

[12] https://www.ekosklad.si/prebivalstvo

[13] Based on Article 135 of the Legal act on the methodology for determining the regulatory framework and network charges for electricity operators http://www.pisrs.si/Pis.web/pregledPredpisa?id=AKT_1050



SPAIN

Spanish prosumers have played a minor role in the energy system in the past, but the removal of the so-called “sun tax” legislation makes self-consumption more profitable. However, changes to legislation still are required, and full adoption of the Electricity Market Design (EMD) will allow the demand side to participate in the markets, unlocking new revenue streams for all prosumers. Besides self-consumption, Spanish prosumers only use their flexibility to improve their on-site energy management. Some subsidy schemes, especially for renewables and EVs, provide incentives for adoption of these technologies; however, the revenue streams after purchase are limited and reduced to avoiding network tariffs and taxes.

Technology deployment

Due to legislative restrictions, adoption of technology by prosumers in Spain has been slow, especially rooftop solar PV. With the lifting of the “sun tax”, solar PV has seen significant growth, with 551 MW of rooftop installation, 121 MW on households and the rest in commercial and industrial sites. Other technologies like EVs and smart charging have also seen major growth, reaching a stock of 54 000 EVs on Spanish roads by the end of 2019, amounting to around 2% of the vehicle fleet. While these numbers may seem modest, in 2015, Spain had circa 7 000 EVs. This growth is encouraged by a public subsidy scheme that was renewed in 2020 (MOVES 2019 and 2020). Its renewal is on an annual basis, which could mean a slower deployment of EVs if the programme is terminated, making it difficult to project future growth. Other technologies, like heating, are rarely electric (about 7% is electric heating), and even though there is significant stock of electric cooling in Spain, it has usually no capabilities to react to signals from the grid.

Financial Incentives

The main financial incentive for Spanish prosumers is reduction of electricity expense, especially given high taxes and tariffs. In addition, they are supported by interesting subsidy schemes and fiscal advantages, some of them unique compared to other EU countries. Solar PV adopters connected to the grid can benefit of a self-consumption scheme that allows for injection into the grid to be remunerated. Injected electricity is sold in the day ahead market at spot price, unless the generator has a specific agreement with their retailer. Individual and collective renewable energy plants with a capacity less than 100 kW can also access a net billing mechanism with their retailer.

Households also receive a reduction of the municipal housing tax for the five years after the installation and can also opt for a direct subsidy plan with a limited cap that is renovated every year. These savings in municipal taxes amount to around 400 to 500 € yearly for households and small and medium prosumers. EVs and smart charging stations can opt for direct subsidies through the newly renovated

MOVES II plan (June 2020), applicable to all types of EVs, including buses and lorries. The help amounts to 5 500 € – 6 000 € for EVs and up to 15 000 for heavy duty vehicles. Smart charging stations are supported with remuneration of 30% of the installation cost.

Implicit and explicit use of flexibility provide very little financial incentives in Spain so far. This might change soon, with the opening of the markets to aggregator participation and with the introduction of a new tariff design (see below).

Role of prosumers in the system

The role of prosumers in Spain was limited until 2018, when the "sun tax" was lifted. While this legislation has been removed, others still limit the participation of demand side in the markets, reducing the possibilities for prosumers to take advantage of their assets. As it is, prosumers in all segments in Spain are mainly focused on self-consumption and energy management. To date, prosumers have had no access to explicit use of their flexibility, but this is about to change. Since June 2020, the independent aggregator has been recognised in new regulation following the implementation of the EMD. As of October 2020, prosumers will be able to provide balancing services to the electricity market through aggregation offered by suppliers, which will bring an additional source of revenue. In mid-2021 this will also be possible via independent aggregators. However, the technical conditions yet unclear and might continue to be restrictive, as it will not be possible to aggregate generation loads and stacking of services will not be possible.

Implicit use of flexibility is also available through a supplier, although in a rudimentary way. A regulated tariff called PVPC offers dynamic pricing for users with contracted capacity below 10 kW. This tariff is calculated based on hourly pricing on the day-ahead market, and the dynamic tariff is only applied to the energy component. However, it is expected that by 2021 all network tariffs and levies will be time-dependent. The new proposed network tariff, that will be approved in March 2021, will have three differentiated periods for the energy component and two periods for the capacity component of the tariff. This might provide further incentives for the use of implicit flexibility and load shifting.

Finally, energy intensive industry customers can apply to an interruptibility scheme that in the first half of 2020 procured 740 MW with an average price of 8 764 €/MW/year. However, this scheme may be phased out soon, as there are current negotiations underway for a new royal decree on energy-intensive customers. So far, it has not been renovated for the second half of 2020 as was originally planned.

SWEDEN

Sweden's prosumers are mainly focused on generation for self-consumption through solar PV and flexible loads like heat pumps. Investment in solar PV has been driven by a government subsidy that has gradually reached more and more consumers. Use of these technologies is limited to the premises where they are installed. The main driver for prosumers continues to be reducing electricity bills and avoiding network tariffs, while interaction with the grid comes mostly from smart heat pumps. This is something that could change in 2020, with the introduction of a new aggregator framework that will allow prosumers to make an explicit use of their flexibility sources.

Technology deployment

Prosumers in Sweden are mostly active through two technologies, solar PV and a large stock of flexible heat pumps. Solar PV saw a surge in 2019, installing 287 MW, most of them under 20 kW of capacity. While batteries have so far played a small role, they are expected to increase in 2020 with the new governmental incentive scheme approved in November 2019[14]. So far only 700 storage units have already been supported by the energy agency, with 700 more to come. 60% of Swedish households also have heat pumps installed. EV deployment is growing slowly and only 20% of EVs sold are fully electric, non-hybrid models. EVs in Sweden are used as a mode of transport, and to contribute to decarbonisation, encouraged by the new governmental subsidies. No V2G services yet exist and smart charging is very limited, with public and private charging stations inflexible in their ability to react to price signals.

Financial Incentives

The different subsidy mechanisms in Sweden remain the main driver for becoming a prosumer, even with a recent drop in technology prices. The significant growth in solar PV installations, and the new boost to battery and EV adoptions, are directly linked to an increase in the direct subsidies offered by the Swedish government. Residential customers benefit from a government subsidy of 60% of the cost for the installation of home batteries. Similar mechanisms exist for solar PV, with a subsidy programme that has seen a constant increase in past years, leaving a total budget to support residential and commercial solar PV adoption of 112 million €. Charging stations for all customer types have seen renewed support since 2019, with a new mechanism that subsidizes up to 50% of the infrastructure costs for both public and private charging stations (*Klimatklivet*). Since Sweden's network tariffs and taxes and overall energy prices are reasonable, the primary incentive for the adoption of

[14] DON'T INCLUDE IN FINAL REPORT:
https://energystorageforum.com/blog/sweden-give-60-subsidy-residential-energy-storage-batteries

new technologies by consumers is dictated by subsidies. No revenue streams are yet available to prosumers through explicit sale of their flexibility, with no activity from aggregators in Sweden.

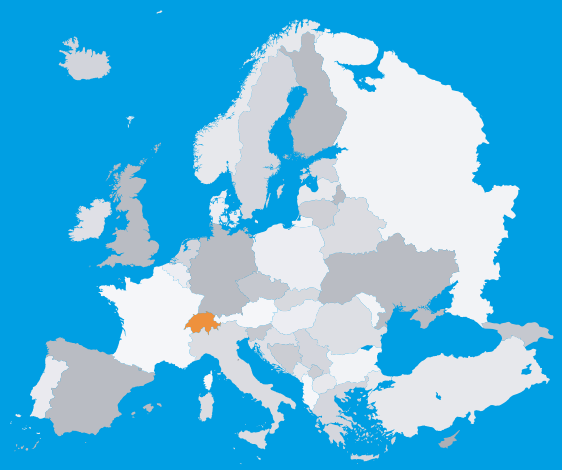
Role of prosumers in the system

Marketing of flexibility in Sweden is limited at the present time and the use of flexibility is reduced to on-site optimisation and avoidance of electricity prices. Customers have the choice for dynamic contracts with hourly pricing, but interest has been low. Explicit use of DSF is not available, and no aggregators are active in Sweden. This limits the possibilities for monetisation of prosumer flexibility. However, Ei, the Swedish regulator, is currently developing a framework to introduce aggregators, following the adoption of the Electricity Market Design regulation. In addition, industrial consumers do not have the option of participating to interruptibility schemes. For these reasons, the main driver for prosumers in all segments is to avoid peak electricity prices.

For households and small businesses, 75% of network tariffs in Sweden are a fixed component dependent on the size of the connection, which disincentivises most small to medium prosumers to use their flexibility to avoid network tariffs. Industrial consumers mostly use their flexibility for on-site optimisation, avoiding peak prices in electricity and the payment of a network tariff dependent on a capacity term calculated based on measurement of consumption during peak periods.

All prosumers with on-site generation can inject electricity in the grid and be rewarded for it. As of 2019, 17 700 households and commercial areas had solar PV installed and were selling their generation, amounting to 0,38% of Swedish consumers feeding into the grid. Prices for injected electricity depend on individual contracts with the DSO, and they are variable, depending on the market price of injection. No feed-in tariff has been implemented in Sweden. For this reason, prosumers are incentivized to consume their own generation if possible, and only inject the remaining electricity to the grid. Industrial consumers can profit from injection to the grid depending on the time of day, given that electricity prices for this segment are significantly lower compared to other markets.

Finally, prosumers with solar PV generation can opt into the Norwegian-Swedish solar certificate scheme. But the programme is little used; only 24% of the solar energy produced in Sweden received this certificate in 2019. For most consumers, the measuring device is installed at the grid connection point, measuring only the injected electricity and not the self-consumed. Installation of an additional meter is costly, and the overall administrative complexity of joining the certificate programme deters participation.



SWITZERLAND

Prosumers in Switzerland have, in theory, a variety of options to make use of their production and flexibility. In practice, however, the main use is self-consumption and limited participation in ancillary services by large industrial consumers. Adoption of some technologies — mostly solar PV and batteries — is incentivized by federal and cantonal governments through financing schemes and fiscal deductions. After that, the main use of these technologies is self-consumption with a limited interaction with the grid. The new "*Zusammenschluss zum Eigenverbrauch*" (ZEV) allows multi-family dwellings to produce and consume renewable electricity as a single unit. Switzerland must yet complete the ownership unbundling of the electricity market. This would allow households and small consuming entities to easily switch supplier, allowing a wider range of customer types to interact with the grid, offering their flexibility both implicitly and explicitly.

Technology deployment

Prosumers in Switzerland have at their disposal a wide range of technologies, both to be used as a source of flexibility that can be monetized or as a means of optimizing energy consumption. However, their actual use is limited due to regulatory, economic and market-access barriers. The main technology used is solar PV, driven by a subsidy plan. Rooftop and small to medium capacity installations have grown by 120 MW in 2019 reaching a total 2.5 GW capacity, and it is expected to continue growing in the coming years. Prosumers have also begun to install small-scale batteries to complement their solar energy production. One in every ten solar PV installations includes a battery.

Some households can access flexible water heaters and heat pumps; however, these options are offered by only one energy service company in Switzerland, as technical and regulatory barriers make the business case marginal. Smart charging is slowly opening its way in Switzerland, but the penetration of EVs is still low, at 0.6% of the passenger car fleet in 2019. Switzerland plans to have a 20% share of passenger car EVs by 2035 and 41% by 2050, and light-duty vehicle adoption of 15% (2035) and 29% (2050) respectively. The possibility to monetise DSF in the electricity markets has also prompted prosumers to install Home Energy Management Systems (HEMS) to sell their flexibility. This service is primarily offered by suppliers and by only one independent aggregator in Switzerland.

Financial Incentives

The main financial incentives for prosumers are the reduction of the electricity bill together with governmental support mechanisms. Small solar PV receives a direct investment subsidy that covers up to 30% of the capital expenditure of the installation, and fiscal deductions are available for those installing renewable systems that are variable, depending on the canton. The investment subsidy is set to expire in 2030 but will likely be prolonged to 2035. No feed-in tariff exists for new solar PV, but the local DSO (or supplier, as there is limited unbundling of the sector in Switzerland) has the obligation to buy the electricity fed into the

grid by prosumers. The price paid for this electricity must be at least equal the cost of the electricity generation or acquisition of the DSO/supplier that they sell to their customers.

In general, prosumers prefer to self-consume or store the electricity rather than sell it to the grid, because the prices paid are below the retail prices. In 2020 the *Rückliefertarif*, a sort-of feed-in tariff, paid between 0.02 €/kWh and 0.13 €/kWh, while the retail prices typically vary between 0.18 €/kWh and 0.25 €/kWh for households and 0.10 €/kWh to 0.16 €/kWh for industrial customers. Other renewable energy sources have the option of a regular feed-in premium, as does older solar PV. However, this programme will be phased out for solar PV in 2023.

Prosumers could, for an additional financial incentive sell their flexibility to the electricity balancing markets. However, due to technical restrictions, this service is offered by only one aggregator in Switzerland, with limited use. Residential consumers living in an apartment building can now join the ZEV, which connects them through a single point to the grid and allows them to manage either off-take or injection from that single point. This enables renters and owners to benefit from solar PV and reduce their energy consumption.

Role of prosumers in the system

The main driver for prosumers in Switzerland is on-site optimisation and self-consumption to reduce their electricity bill, avoid payment of taxes and tariffs, and to take advantage of fiscal deductions for renewable energy generators. Even though prosumers theoretically have access to sell their flexibility to the ancillary and day-ahead markets, only one aggregator is active in the field, and ancillary services are mostly provided by large energy consumers, like waste incineration plants, which are supported by additional generation. The aggregator, while allowed to operate, is still not clearly defined in Swiss legislation, which limits the development of the explicit use of DSF. Households that join an aggregator to provide their flexibility usually do not receive additional payments but do benefit from home energy management systems and more efficient consumption patterns and energy monitoring.

Implicit use of flexibility is available but rudimentary, especially for households and small and medium enterprises. DSOs offer their customers basic day/night tariffs that provide an incentive, especially for electric boilers that are connected to an old ripple control system. This same system is used for flexible heat pumps, which are interrupted daily between noon and 13:00 hours. The lack of dynamic tariffs also limits the possibilities for prosumers to adapt their consumption patterns. Only a few utilities offer tariffs with a dynamic energy component, limited to some parts of the service provided.

Generators are encouraged to self-consume the energy produced, given the lack of a feed-in tariff, and the overall low prices paid by the DSOs for the energy injected.

List of Acronyms

ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserve
BRP	Balance Responsible Party
BSP	Balance Service Provider
CHP	Combined Heat and Power
DER	Distributed Energy Resource
DR	Demand Response
DSO	Distribution System Operator
DSF	Demand Side Flexibility
DSR	Demand-Side Resources
EC	European Commission
ENTSO-E	European Network of Transmission System Operators for Electricity
EV	Electric Vehicle
FiT	Feed-in tariff
FRR	Frequency Restoration Reserve
GW	Gigawatt
GWh	Gigawatt hour
ICV	Internal Combustion Vehicle
mFRR	Manual Frequency Restoration Reserve
MW	Megawatt
MWh	Megawatt hour
NRA	National Regulatory Authority
PVPC	Precio Voluntario al Pequeño Consumidor (Spanish regulated tariff)
RES	Renewable Energy Sources
SME	Small and Medium Enterprise
ToU	Time of Use
TSO	Transmission System Operator
TW	Terawatt
TWh	Terawatt hour
V1G	Smart charging, ability to dynamically modify the charge rate of an EV
V2G	Vehicle to Grid, bidirectional energy flow between EV and charging station
V	Volt
UVAM	Virtually Aggregated Mixed Units (Italian ancillary services product)
IRPEF	Italian Personal Income Tax

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