The changing regulatory landscape of household self-consumption

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THE CHANGING REGULATORY LANDSCAPE OF HOUSEHOLD SELF-CONSUMPTION

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EXECUTIVE SUMMARY

Self-consumption of solar energy will play an important role in achieving the European Union's net-zero target by involving consumers, increasing renewable deployment, providing additional sites for installations, mobilizing new financial resources, and encouraging consumers' participation in providing flexibility to the system. Its benefits have become even more pronounced in the context of the energy crisis, as self-consumption can make an important contribution to the EU's efforts to achieve energy independence.

Support schemes and compensation mechanisms to promote household self-consumption have been applied more widely in the EU since the 2010s, through direct and indirect support. In some countries, the falling technology costs of rooftop PV systems made it worth investing in solar PV systems, as self-produced and self-consumed electricity became competitive with the electricity purchased from the grid. This would mean that support mechanisms could gradually be phased out and small-scale RES-E could only be supported indirectly by creating a regulatory environment that encourages further development through market forces.

However, the increasing number of PV systems connected to the grid has posed significant challenges to the reliable operation of electricity systems in numerous regions, and prosumers in many countries (especially in those where formerly net metering was used) are required to contribute more towards grid costs. This, together with decreasing market prices in peak PV generation hours extends the payback period for investments in PV systems. Thus, purely market-based payment solutions may not yet provide favourable conditions for further deployment.

The compensation mechanisms applied to distributed generation by households have been modified in several EU countries in recent years, driven not only by the above-mentioned developments but also due to changes in EU regulation. The Electricity Directive[1] requires Member States (MS) to ensure that prosumers are subject to network charges that account separately for the electricity fed into and withdrawn from the grid, to make a fair contribution to the costs of the electricity system and to reduce the burden on consumers who do not operate PV systems. In practice, this means that net metering schemes, which in most cases have allowed part of the system costs to be offset together with the electricity fee during the netting period, had to be reviewed by the end of 2023 at the latest. At the same time, enabling frameworks for energy sharing and collective self-consumption have been put in place, facilitating higher self-consumption rates and shorter payback periods for prosumers.

The Renewable Energy Directive[2] stipulates that surplus electricity, which the prosumer cannot self-consume and is exported to the grid, shall be remunerated at rates that reflect the market price.

The main objective of this study is to investigate the following questions:

- What kind of metering and billing systems have countries that previously used net metering moved to?

[1] Article 15 of Directive (EU) 2019/944 on the common rules for the internal market for electricity, requiring that no new rights are granted from 31 December 2023 under schemes not accounting separately for the electricity injected into and withdrawn from the grid and ensuring that all consumers have their fair share of the overall cost of the electricity system.

[2] Article 21 of Directive € 2018/2001 renewables self-consumers are entitled to receive remuneration for the self-generated renewable electricity, that reflects the market value of that electricity.

- Do the compensation schemes meet the requirements of EU legislation?
- What can be learned from the experience of countries with other types of metering and billing arrangements in terms of
    - their ability to encourage deployment,
    - facilitating the adaptation of self-consumption to market conditions and grid flexibility?
- What recommendations can be made to regulators of the Energy Community Contracting Parties and other countries considering a review of their compensation mechanisms?

The study examines the self-consumption schemes of ten selected EU countries, five of which had (or still have) net metering systems (Denmark, Greece, the Netherlands, Hungary, Poland), one of which had net billing (Italy), three of which have separate metering and billing (Austria, Germany, and Portugal) and one of which has no formal compensation mechanism laid down in legislation (Slovakia).[3]

The case studies are largely based on interviews with experts from the countries analysed, which helped to understand the features of the building blocks of the compensation mechanisms in place, including[4]:

- The **metering and billing arrangements**, which define how electricity generated, consumed, and injected into the grid is measured and billed. The main forms of metering and billing arrangements are *net metering*, *net billing*, *buy all - sell all*, and *separate metering and billing* (described in Chapter 2).
- The **sell rate design**, which encompasses the price that prosumers receive for their excess electricity. It also includes the system charges, levies and taxes related to exporting electricity to the grid, which reduce the revenue that can be generated.
- The **retail price system** applicable to electricity consumed from the grid, consisting of the electricity fee, system tariffs, and other charges, levies and taxes associated with electricity consumption.
- And other **charges** that may be levied **on self-consumption**.

The features of analysed compensation mechanisms

Table 1 provides a summary of the key characteristics of the compensation mechanisms examined. It has to be noted that the table does not include the other charges, taxes and levies included in the retail component, due to their diversity across countries, but only indicates where one of them is applied differently or is levied on the amount fed into the grid or self-consumed.

[3] It is important to note that the old compensation schemes are still in place in most countries for a certain period of time for renewable systems installed before the old schemes were phased out.

[4] Based on Zinaman et al. (2017).

TABLE 1: OVERVIEW OF THE COMPENSATION MECHANISMS FOR HOUSEHOLD SELF-CONSUMPTION IN THE ANALYSED COUNTRIES

	Metering and billing arrangement	Sell rate	Retail rate (excl. taxes, levies and other charges)		Other
			Energy fee	System charges*	
AT	Separate metering and billing & buy all, sell all	Weighted average monthly market price with minimum and maximum limits or market premium (>10 kWp)	Fixed, variable, dynamic, depending on the supply contract	T-tariff: static D-tariff: static/ToU	
DK	Separate metering and billing	Market price (hourly) + charge for service to buyer, fee for metering /balancing to TSO, and injection charge to DSO	Fixed, variable, dynamic, depending on the supply contract	T-tariff: static D-tariff: static/ToU system balance tariff paid to TSO	Availability tariff levied on self-consumed electricity
DE	Separate metering and billing & buy all, sell all	FIT for 20 years	Fixed, variable, dynamic, depending on the supply contract	T-tariff and D-tariff: static, with large regional differences	
EL	Net metering (25 years) for some consumer categories, net billing to be introduced	No option for selling surplus after the 3-years crediting period expires.	Fixed, variable, dynamic, depending on the supply contract	Static/ToU at both transmission and distribution level	Public Service charge levied on self-consumption
HU	Separate metering and billing	Static, fixed	Static	T-tariff and D-tariff: static	
IT	Separate metering and billing	Dynamic: hourly zonal price with minimum	Fixed, variable, dynamic, depending on the supply contract, reduced VAT	T-tariff and D-tariff: static	VAT is lower on electricity consumed from the grid
NL	Net metering, without initially set eligibility period (planned to be phased out)	Non-regulated price set by the supplier, ~ 80% of electricity price	Mostly static but can also be variable or dynamic, depending on the supply contract	T-tariff: static D-tariff: static	Charge on net feed-in by some suppliers.
PL	Net billing	Monthly average price until 2024 July, then dynamic hourly market price, VAT levied also on credited amount	Static, variable, ToU, dynamic, depending on the supply contract	T-tariff: static D-tariff: static/ToU	
PT	Separate metering and billing, 15-minute net metering	Depends on contract with buyer (aggregator)	Static, variable, dynamic, ToU, depending on the supply contract, reduced VAT	Static/ToU at both transmission and distribution levels	VAT exemption on the sale of surplus electricity
SK	No specific scheme, market contracts	Depends on the supply contract, mostly virtual storage service. No compensation for surplus	Static	T-tariff: static D-tariff: static/ToU	

Note: T and D indicate whether the tariff applies to the use of transmission or distribution system.

In terms of **metering and billing arrangements**, separate metering and billing is the most common among the countries analysed. Net metering is still applied in the Netherlands, and in Greece for a limited number of prosumer types. In the latter country the former system has been phased out and the country is in the process of changing its system to net billing. Net billing is applied in Poland, while it will soon be phased out in Italy, which is moving to separate metering and billing. As mentioned above, Slovakia does not have a formal self-consumption scheme.

Some of the countries use a combination of schemes (Germany and Austria) or a hybrid scheme (15-minute net metering and buy all, sell all in Portugal), and some arrangements are also offered on the market (e.g. net metering/virtual storage in Slovakia and Portugal). In Austria and Germany, prosumers can choose a buy all, sell all or a separate metering and billing arrangement. In Germany, prosumers can combine both, in case they wish to self-consume part of the electricity they produce and be paid for what they can produce using the extra space available on their roofs.

As to the provision of Article 21 of the RED, that consumers should be able to sell their electricity at rates reflecting market prices, the picture is rather mixed.

There are three countries, where the **sell rate** is dynamic by regulation: Italy, Poland (from July 2024) and Denmark. It is possible to choose contracts with dynamic selling rates in Portugal, where prosumers are required to sell their electricity to aggregators in the market. Austria offers sell rates reflecting the weighted average market price of the previous month, or prosumers (with installations above 10 kW) can also apply for a market premium by participating in auctions. However, they can also enter into a contract with suppliers and agree on different terms for selling their surplus electricity. In Germany, prosumers are entitled to the feed-in tariff system, providing a fixed sell rate for 20 years, either under a separate metering and billing or a buy all, sell all arrangement, or both simultaneously.

In some of those countries, where the sell rate is linked to either the hourly or the annual market price, minimum selling price limits can be set to save prosumers from the risks of volatility and facing too long payback periods due to low prices. This is the case in Austria, Italy and is also contemplated in Poland. Due to the high market prices experienced in the last years, some countries have also applied upper limits (Germany and Austria).

In the countries studied, prosumers are subject to the same retail price system as non-PV consumers.

The only exceptions are Italy and Portugal, where a preferential VAT rate applies to prosumers on consumed electricity.

In most countries, static, flexible, time-of-use and dynamic price contracts are available to households. Although there are no legal restrictions on entering into a supply contract in the market, households in Slovakia and Hungary opt for the more advantageous regulated static prices available in their countries. With regard to system charges related to the consumption of electricity from the grid, time-of-use tariffs are used in all but four countries (Hungary, Italy, Germany and the Netherlands for households), mostly in the case of distribution tariffs, which provide an opportunity to encourage off-peak consumption.

The expectation that prosumers should contribute to the network costs is met in all the investigated countries, at least as far as charges for electricity purchased from the grid are concerned.

However, we have not assessed how these meet the requirement of being “fair” network costs.

It should be emphasised that the schemes in the Netherlands and Greece differ from the classical net metering schemes in that prosumers in both countries contribute to system costs in a similar way to other consumers. From this point of view, they comply with the regulatory requirements of the Electricity Market Directive.

On the other hand, Article 15(e) of the EMD states that the system charges to be paid by active consumers "shall separately account for electricity supplied to the system and electricity taken from the system". This would suggest that network operators charge for the use of the network in both directions. **Yet, it is not typical for prosumers to be charged for the amount they feed into the grid.** Looking at the countries analysed, only Danish prosumers have to pay a fee to the TSO for metering and balancing services and an injection fee to the DSO. They also have to pay a charge for the availability of grid electricity, which is based on the level of their own consumption.

Self-consumed electricity is rarely subject to any taxes or levies.

The countries that previously used net metering have chosen net billing and separate metering and billing in roughly equal proportions in our small sample of countries.

As can be seen from the above table, net metering is still in place in the Netherlands (scheduled to be phased out at the end of 2026) and in Greece for some consumer categories. Greece has already officially phased out net metering and will introduce net billing, but the rules for the new system were not fully in place at the time of writing.

Denmark has reformed its compensation mechanism earlier, moving first to hourly net metering and then to instantaneous netting within a separate metering and billing regime. Poland switched to a net billing system, with sell rates reflecting average monthly prices until mid-2024, after which the remuneration will be based on hourly market prices. Hungary has opted for a separate metering and billing arrangement. The fixed selling price in Hungary is set at the electricity fee available under the regulated universal service system, which is rather low, making it economically disadvantageous to feed in.

In the case of those moving to net billing, prosumers sell (will sell) their excess electricity to a central government agency (Poland and Greece), while in the countries switching to separate metering and billing, the approach is to contract with the supplier or another market player (Denmark, Hungary).

The experience of countries that have used other types of arrangements than net metering for a longer period suggests that additional support is still needed to maintain the dynamics of residential PV deployment in order to reach the ambitious RES-E targets.

As described above, despite falling technology costs, changes in the regulatory and technical environment of the electricity market have resulted in a longer payback period for investment in self-consumption systems. There are differences between countries in the way support is provided. In some countries, compensation mechanisms rely almost entirely on market prices, and additional support is mainly given in the form of investment grants, tax rebates, preferential loans, and other indirect policies and measures (e.g. Portugal, Italy).

In Germany, the provision of operational support and preferential loans is helping to increase capacity, but the long-standing FIT system has frozen a less flexible system in terms of adaptation to market conditions by prosumers. The situation is similar in Austria, where, despite a high penetration of smart meters, a fixed sales price is offered, although dynamic contracts are available on the market outside the support schemes. Slovakia, which has relied entirely on the market to compensate prosumers, has had a rather moderate take-up rate and investments are highly dependent on the investment subsidies available. Denmark also relies on the market, and does not provide additional subsidies, resulting in a stagnating prosumer sector.

The contribution of self-consumers to system flexibility varies across countries, depending on the type of sell rates, retail prices and the grid charges that apply to them.

Even in countries where the sales price is static, the retail price system or TOU grid tariffs can encourage prosumers to use their self-generated electricity during peak PV generation periods,

e.g. by using smart appliances, sharing their electricity if possible, or investing in storage. Demand response is less encouraged in Germany, Hungary, and the Netherlands, where both sales prices and grid tariffs are static for residential prosumers. Grants for investment in battery storage have been available in Hungary, for example, but this is probably not the most efficient way of supporting the flexibility and resilience of the electricity system.

Recommendations to the Contracting Parties of the Energy Community

The Energy Community Contracting Parties (including six countries of the Western Balkans, Georgia, Moldova, and Ukraine) are currently implementing the 2018 Clean Energy Package and REDII. The rules related to self-consumption, energy sharing, and energy communities are among the new provisions of the currently ongoing legislative changes. Most of the contracting parties have submitted their NECPs to the Energy Community Secretariat and it is expected that the plans will not only include policies and measures to support self-consumption, but also set national targets in this field. Most EnC contracting parties have transformed or plan to transform their net metering schemes into net billing schemes.

Although the Energy Community Secretariat has prepared its own Guidelines for the Integration of Renewables Self-Consumers (updated in 2020)[5] and published a similar guideline this year for renewable and citizen energy communities[6], based on the experiences of the analysed countries, we may still be able to make some useful recommendations for the design of their compensation schemes. The following findings and recommendations may also be useful for EU MS when further developing their schemes.

- **Simple, straightforward self-consumption schemes make it easier for households to participate in the energy transition.**

It is generally recommended that the compensation mechanism applied to households should be simple and straightforward. Net metering systems meet these requirements, but their phasing out has become necessary to allow prosumers to adapt to the price signals of the electricity systems and to pay for their use of the grid. From this perspective, it could be recommended that net billing is preferable to separate metering and billing, as it requires one contractual relationship, and prosumers receive only one bill including the net value of electricity exported to and imported from the grid.

On the other hand, in countries with more advanced retail markets, prosumers might value the possibility of being able to select among sell-rate market offers. Compensation schemes based on separate metering and billing might basically offer more flexibility to prosumers, as it is possible to choose among those market actors who offer a good price for the electricity fed into the grid, as well as a fair level of associated services, while they can also opt for having the same partner contracted as a supplier and a purchaser and arrange payments through a single billing procedure. In Portugal, for example, prosumers must sign a contract with aggregators who sell their electricity and provide balancing services, while most aggregators also act as suppliers in the market.

[5] Policy Guidelines on the Integration of Renewables Self-consumers, https://www.energy-community.org/dam/jcr:7e4760a1-3890-4a7a-a067-d9e16c80ddeb/PG_2020_03_RES.pdf accessed: 6/13/2024

[6] Policy Guidelines 01/2024-ECS of the Energy Community Secretariat on energy communities, https://www.energy-community.org/dam/jcr:70bed24f-42b1-41b4-920e-a451dd54f070/PG%200n%20energy%20communities_ECS_12032024.pdf, accessed: 6/13/2024

- **The payback of PV investments is to be ensured by accompanying subsidy programs.**

While net billing and separate metering and billing schemes have the advantage that they allow consumers to be more aware of market signals, they increase the payback periods of the investments substantially compared to the net metering arrangement. Thus, the new EU framework might not be able to provide the necessary incentives for households' PV deployment on its own, because it creates less favourable conditions. Our research suggests that in Member States, where residential PV capacities are constantly growing, governments provide additional support, such as investment grants, tax rebates, and low-interest loans.

However, subsidies made available infrequently, irregularly and in insufficient amounts are not able to promote the right level of investments (e.g. in case of Slovakia or Denmark). Thus, they should be provided regularly, in a predictable way, and it is advisable to allocate a dedicated proportion of funds to energy-poor households.

- **Smart meters are a precondition for the continuous deployment of self-consumption systems. Their cost to households should be socialized.**

Integrating the growing number of distributed generation systems in line with renewable energy targets is a challenge for grid operators, and the increasing rejection of connection requests is delaying further deployment. This reinforces the need to increase grid flexibility. The integration of more systems can also be facilitated by a higher level of self-consumption, which is also economically more advantageous for PV system owners. Smart meters provide real-time data on the amount of electricity being drawn from and fed into the grid, helping to optimise energy use patterns. In those countries, where smart meter penetration is high, it is usually the DSO who pays for the installation, and the costs are socialized for effective and rapid deployment. Prosumers are also required to change their meters and enjoy priority in most of the countries analysed. In some Member States, it is an option for electricity customers or prosumers entering the schemes earlier to replace their conventional meters on a voluntary basis if they contribute to the costs (e.g. in Hungary).

- **Differentiated prices and tariffs and well-functioning electricity markets are needed to enable prosumers to adapt to price signals**

In order to allow prosumers to benefit from more advanced metering and billing systems, it is necessary that the elements of the compensation scheme are designed to encourage demand-side adaptation. This requires either time-differentiated or dynamic selling/consumption prices or TOU network tariffs, as fixed tariffs do not encourage prosumers to adapt to market conditions, even if they are equipped with smart meters.

However, studies show that the simultaneous application of several time-differentiated price elements at the same time might result in a pricing structure possibly with conflicting signals that are difficult for the consumers to understand and adapt to. Therefore, it might be more effective to apply TOU or dynamic pricing to only one of the price elements, as in the case of Italy, for example, where the sell rate is dynamic (location and time-dependent) while the grid tariffs are static.[7] It is recommended that regulators determine which price elements should be prioritised in view of the locally emerging issues (network or market price).

[7] See for example Layer, Patrick and Feurer, Sven and Jochem, Patrick (2017): *Perceived price complexity of dynamic energy tariffs: An investigation of antecedents and consequences.* Energy policy, Vol. 106, pp. 244-254., https://doi.org/10.1016/j.enpol.2017.02.051 Joskow, P. L. (2012). "Creating a Smarter U.S. Electricity Grid." *Journal of Economic Perspectives*, 26(1), 29-48. *DOI: 10.1257/jep.26.1.2*

- **Sales price risks for household prosumers should be mitigated.**

Increasingly frequent low market prices during peak PV production periods may discourage investment by households when the rates received for the injected electricity reflect changes in market prices. Shielding prosumers from the risk of too low, or fluctuating market prices could be facilitated by encouraging suppliers/aggregators to provide market services of buying excess electricity and balancing. As they can invest in and operate virtual power plants and larger storage systems more efficiently than individual households, they can offer advantageous contracts with different pricing arrangements, tailored to the needs of individual customers. At the same time, it is important to designate a buyer/off-taker of last resort.

An alternative approach is to determine a guaranteed minimum sales price to reduce price risks for household prosumers. This approach has been implemented in Austria and Italy. However, in these countries the purchasing partners are central organisations.

- **TOU grid tariffs, preferential discrimination of prosumers or technical considerations can help mitigate grid connection issues.**

As grid congestion becomes increasingly prevalent at the DSO level, the problem of grid connection emerged in almost all of the analysed countries. Although, only in a few of the countries are connections delayed beyond the deadline set by legislation, there have been instances where the connection has been denied in specific locations. Time-of use grid tariffs can help to reduce grid capacity utilisation during peak hours and alleviate the issue of connections to a certain extent. Another potential solution is to take those households first in the queue which have storage systems or controllable appliances. In Germany, for example, grid tariffs are reduced if the owner of newly installed heat pumps, household batteries, and EV wall boxes (so-called "controllable consumption devices") can be dimmed in return for the decreased charges.

Another good example can be found in Greece, where prosumers and energy communities receive a dedicated share of new grid connection capacity in case of system upgrades.

- **New market models are beneficial for PV owners and help vulnerable customers**

With new emerging market models, PV-owners can sell their excess electricity also to other actors than electricity suppliers, and often receive a higher remuneration. By promoting new schemes and removing existing barriers to collective self-consumption, energy sharing or energy communities, governments can reduce the need for costly support schemes.

As also recommended by the Energy Community Secretariat[8] governments of the Contracting Parties could provide targeted additional funding to renewable energy communities and collectives to include energy-poor households in their communities/collectives. This can not only help the vulnerable households to be involved in RES-E investments and thus ease their cost burden, but they can also benefit from the shared management of the tasks related to building and operating PV systems and the associated administration, as opposed to installing systems on their own.

[8] POLICY GUIDELINES by the Energy Community Secretariat on the concepts of energy communities PG 01/2024 / 12 March 2024, https://www.energy-community.org/dam/jcr:70bed24f-42b1-41b4-920e-a451dd54f070/PG%20on%20energy%20communities_ECS_12032024.pdf, accessed: 6/13/2024

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LIST OF ABBREVIATIONS

CEC	Citizen Energy Community
CHP	Combined heat and power (production of both heat and electricity or power plant, using excess heat)
DG	Distributed generation
DSO	Distribution System Operator
EMD	Internal Electricity Market Directive, (EU) 2019/944
FIT	Feed-in tariff
LCOE	Levelized cost of electricity
NB	Net billing
NECP	National Energy and Climate Plan
NEM	Net energy metering
PPA	Power purchase agreement
PUN	National Single Price, the volume weighted average price of all price zones in Italy
PV	Photovoltaic
RED	Renewable Energy Directive, (EU) 2018/2001
RES-E	Electricity from renewable sources
ToU	Time-of-use (ToU tariffs change with different times of the day)
TSO	Transmission System Operator
VAT	Value added tax

INTRODUCTION

Self-consumption of solar energy will play an important role in achieving the European Union's net-zero target by involving consumers, increasing renewable deployment, providing additional sites for installations, mobilising new financial resources, and encouraging consumers' participation in providing flexibility to the system. Its benefits have become even more pronounced in the context of the energy crisis, as self-consumption can make an important contribution to the EU's efforts to achieve energy independence. The EU Solar Energy Strategy, as part of the REPowerEU Plan, aims to accelerate the deployment of solar energy and has proposed the EU Solar Rooftops Initiative, as one of its four flagship initiatives to promote the rapid and massive deployment of solar generation.[9]

Support schemes and compensation mechanisms to promote household self-consumption have been applied more widely in the EU since the 2010s, through direct and indirect support.

In many countries, the falling technology costs of rooftop PV systems made it worth to invest in solar PV systems, as self-produced and self-consumed electricity became competitive with the electricity purchased from the grid. This would mean that support mechanisms could be gradually phased out and small-scale RES-E could only be supported indirectly by creating a regulatory environment that encourages further development through market forces. However, the increasing number of PV systems connected to the grid has led to challenges to the reliable operation of the electricity system in many places. Connecting additional capacity requires grid upgrades or other solutions (demand-side management, storage, etc.) to improve grid resilience. The increased contribution to grid costs required from prosumers, as well as the price cannibalization caused by higher solar penetration, extend the payback period of investments in PV systems. As a result, purely market-based payment solutions may not yet provide favourable conditions for further deployment.

In Europe, there have been changes in the compensation mechanisms of several countries in recent years, driven by changes in EU regulation, that were required in light of the above-mentioned developments. The Electricity Directive[10] requires Member States (MS) to ensure that prosumers are subject to network charges that account separately for the electricity fed into and withdrawn from the grid, to make a fair contribution to the costs of the electricity system and to reduce the burden on consumers who do not operate PV systems. In practice, this means that net metering schemes, which in most cases have allowed part of the system costs to be offset together with the electricity fee during the netting period, had to be reviewed by the end of 2023 at the latest. The Renewable Energy Directive[11] stipulates that surplus electricity, which the prosumer cannot self-consume and is exported to the grid, shall be remunerated at rates that reflect the market price. Also, in the last years enabling frameworks for energy sharing and collective self-consumption have been put in place, facilitating higher self-consumption rates and shorter payback periods for prosumers.

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[9] Communication From the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Solar Energy Strategy, COM/2022/221 final

[10] Article 15 of Directive (EU) 2019/944 on the common rules for the internal market for electricity, requiring that no new rights are granted from 31 December 2023 under schemes not accounting separately for the electricity injected into and withdrawn from the grid and ensuring that all consumers have their fair share of the overall cost of the electricity system.

[11] Article 21 of Directive 2018/2001/EU requires that renewable self-consumers are entitled to receive remuneration for the self-generated renewable electricity that reflects its market value.

The main objective of this study is to investigate the following questions:

- What kind of metering and billing systems have countries that previously used net metering moved to?
- Do the compensation schemes meet the requirements of EU legislation?
- What can be learned from the experience of countries with other types of metering and billing arrangements in terms of
    - their ability to encourage deployment,
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- What recommendations can be made to regulators of the Energy Community Contracting Parties and other countries considering a review of their compensation mechanisms?

The study examines the self-consumption schemes of ten selected EU countries, five of which had (or still have) net metering systems (Denmark, Greece, the Netherlands, Hungary, Poland), one of which had net billing (Italy), three of which have separate metering and billing (Austria, Germany, and Portugal) and one of which has no formal compensation mechanism laid down in legislation (Slovakia).[12]

The case studies are largely based on interviews with experts from the investigated countries. The compensation mechanisms are analysed from a regulatory perspective, focusing on the building blocks of these systems: the metering and billing arrangements, the sell rate design, the retail pricing system, and other charges that may be levied on self-consumption. The case studies also provide an overview of current deployment trends and provide an insight into the additional support instruments used in each country to encourage investment in investment in self-consumption systems.

The paper is structured as follows. The first chapter provides an overview of EU legislation related to household self-consumption and current trends in deployment. The second chapter describes the components of the compensation mechanisms: the metering and billing arrangements, the sell rates offered, and the retail rate design. The third chapter presents the country case studies, and a brief overview of recent regulatory developments related to self-consumption in the Energy Community Contracting Parties. The final chapter provides a summary and recommendations to the countries of the Energy Community.

[12] It is important to note that the old compensation schemes are still in place in most countries for a certain period of time for renewable systems installed before the old schemes were phased out.

1 TRENDS AND REGULATION IN THE EU

As the prices of solar PV systems have fallen and the demand for participation in the green transition has grown in recent years, it has become more common for households to generate part of their own electricity. Promoting the on-site consumption of self-produced renewable electricity has also long been on the agenda of the European Union.

1.1 Trends of deployment

While several renewable energy technologies can be used by households to generate their own electricity (e.g. wind generators, micro hydro), in practice, the vast majority of prosumers use solar PV panels. At the end of 2023, the cumulative installed residential rooftop solar PV capacity in the EU member states stood at 68.8 GW, according to SolarPower Europe[13]. At present, it is difficult to find a publicly available consistent time series on the capacity of household rooftop PV installations. The data available in the Eurostat database, disaggregated by size, are yet largely incomplete.

Historical data on the total installed capacity of renewable energy technologies are published by the IEA with a more aggregated division by market segments: distributed and utility-scale capacity.[14] The distributed generation category includes both the residential and the commercial and industrial capacity. As shown in Figure 1, both market segments followed a similar growth pattern in the period 2010-2023, but the distributed generation capacity was about twice as high as the utility-scale capacity. Please note that the figures up to 2022 have been taken from the IEA database, while the figure for 2023 has been estimated on the basis of SolarPower Europe data on newly installed capacities in that year.[15]

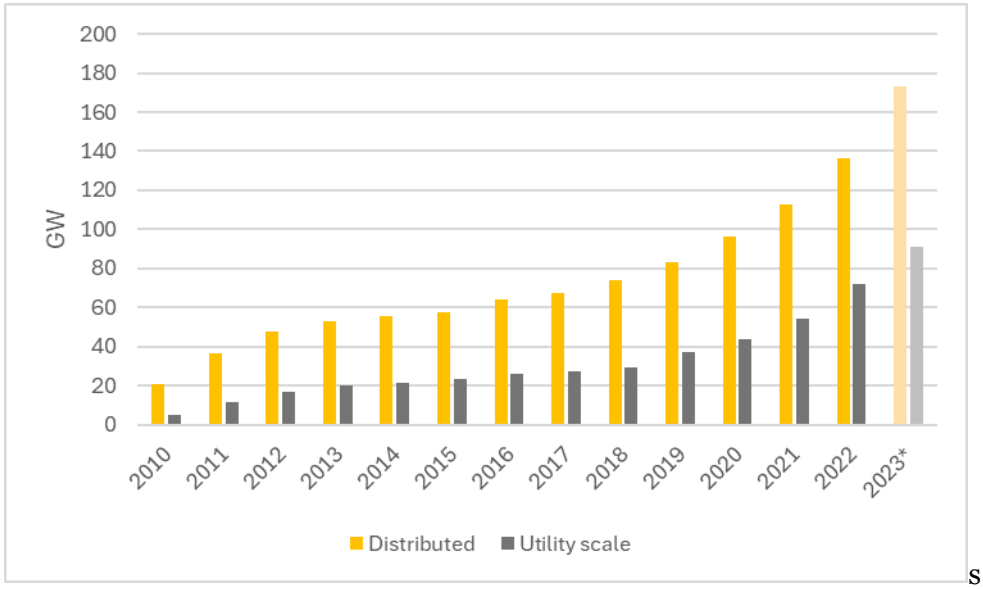
The dynamic growth of deployments in the early 2010s, driven by generous subsidies from Member States, slowed down from 2013 onwards, probably because some countries have reduced subsidies in some cases even retroactively (e.g. Greece, Czech Republic, Spain, etc.). Installations accelerated again from 2019, mainly due to the impact of falling technology costs and the approaching 2020 target date. In 2022, investments in self-consumption were mainly driven by supply uncertainties due to the Russian war on Ukraine and by higher prices caused by the resulting energy crisis. SolarPower Europe (2023) notes that the demand for rooftop PV systems decreased somewhat in the second half of 2023 with the fall in energy prices and national electricity price interventions, but the anticipated changes to the support schemes in countries with net metering schemes have reignited household interest in some countries, even leading to a surge in connection applications before the attractive support schemes expire.

[13] https://www.solarpowereurope.org/press-releases/eu-rooftop-solar-standard-alone-could-solar-power-56-million-homes, accessed: 24/05/2024. SolarPower Europe considers the category below 10 kW residential.

[14] IEA (2024), *Renewable Energy Progress Tracker*, IEA, Paris https://www.iea.org/data-and-statistics/data-tools/renewable-energy-progress-tracker, accessed: 24/06/2024

[15] SolarPower Europe (2023), EU Market Outlook for Solar Power, 2023-2027 https://www.solarpowereurope.org/insights/outlooks/eu-market-outlook-for-solar-power-2023-2027/detail, accessed: 24/05/2024

FIGURE 1: TOTAL INSTALLED PV CAPACITY IN THE EU, 2010 – 2023, BY MARKET SEGMENTS



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*Source of data: IEA (2024)[16] for years 2010-2022, *estimation based on SolarPower Europe[17] for 2023*

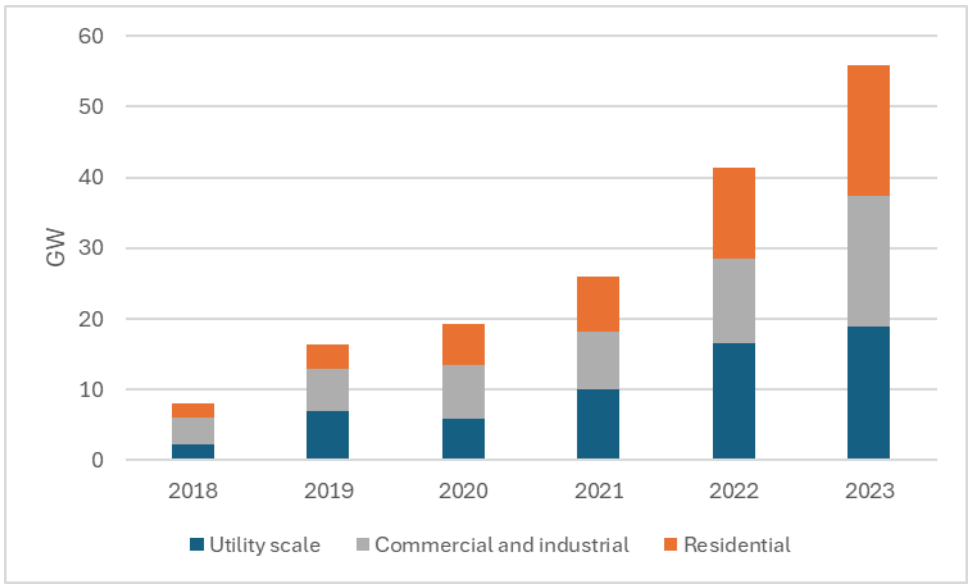
The trend shown above can also be observed in Figure 2, which displays the newly installed capacity by market segment in the EU, for the years 2018-2023. The figures were calculated on the basis of SolarPower Europe's data on total annual capacity additions and their shares by market segment, differentiating the distributed generation category into residential and commercial and industrial (C&I) installations. The amount of total capacity additions in 2023 was estimated by SolarPower Europe at 55.9 GW, of which about a third was in the residential segment.[18]

[16] IEA (2024), *Renewable Energy Progress Tracker*, IEA, Paris https://www.iea.org/data-and-statistics/data-tools/renewable-energy-progress-tracker, accessed: 24/06/2024

[17] SolarPower Europe (2023), EU Market Outlook for Solar Power, 2023-2027 https://www.solarpowereurope.org/insights/outlooks/eu-market-outlook-for-solar-power-2023-2027/detail, accessed: 24/05/2024

[18] Ibid.

FIGURE 2: NEWLY INSTALLED PV CAPACITY BY MARKET SEGMENTS IN THE EU, 2018 – 2023



Source of data: estimation, based on data from SolarPower Europe[19]

1.2 Policies and regulations related to self-consumption

In 2015, the Commission published a Communication on the regulation of self-consumption (EC, 2015), providing good examples of support scheme design for small-scale renewable generation. It recommended that Member States move their support mechanisms towards encouraging the highest possible level of self-consumption, which is more optimal for the grid. It also suggested the promotion of demand-side flexibility through price signals (e.g., through time-of-use tariffs or dynamic pricing), the use of smart meters, and allowing aggregators to help consumers participate in the wholesale market. It encouraged member states to review their policies on net metering and the grid tariffs applied, suggesting that all users of the electricity grid should contribute to the costs of the system, correctly reflecting their impact on the electricity network.

The Clean Energy for All (CEP) package[20], adopted by the EU in 2019 included important legislative measures in the renewable energy framework and the electricity market design with the aim of empowering consumers and increasing their self-consumption.

Internal Electricity Market Directive

Article 15 of the Internal Electricity Market Directive (EU) 2019/944 introduced the term of "active customers". Active customers (i.e. prosumers) generate, store, and consume electricity and can sell their surplus energy. The directive assures that "prosumers are subject to cost-reflective, transparent and non-discriminatory network charges that account separately for the electricity fed into the grid and the electricity consumed from the grid", thus prosumers

[19] SolarPower Europe, EU Market Outlook for Solar Power, annual publications of years 2019 to 2023, available at: https://www.solarpowereurope.org/insights/outlooks/, accessed: 24/05/2024

[20] https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en, accessed 13/05/2024

contribute to grid maintenance and development. The article also states that existing schemes that do not account separately for the electricity fed into the grid and the electricity consumed from the grid, shall not grant new rights under such schemes after 31 December 2023. This led to a move away from net metering schemes in several EU member states and in the contracting parties of the Energy Community.

Regulation on the internal market for electricity

Regulation (EU) 2019/943 on the internal market for electricity sets out several fundamental principles for well-functioning, integrated electricity markets. In Article 5 of the Regulation states that all market participants shall be responsible for the imbalances they cause in the system. However, it provides an exemption until 1 January 2026 for renewable energy installations with a capacity of less than 400 kW.

Renewable Energy Directive

Empowering consumers and introducing new models for self-consumption is a key part of the Renewable Energy Directive (EU) 2018/2001 (RED II) as well, which focuses on removing barriers and fostering a more supportive environment for prosumers to participate in the energy market. In Article 21, prosumers are called “renewables self-consumers”, and the Directive states that they are entitled to a remuneration for the self-generated renewable electricity that they feed into the grid, which reflects the market value of that electricity.

As a major development, RED III stipulates that the permit-granting procedure for the installation of solar energy equipment (and co-located energy storage) in artificial structures such as rooftops shall not exceed three months. For installations below 100 kW, including those by self-consumers and renewable energy communities, the process should take no more than one month. RED III also introduces 'administrative positive silence' for these smaller installations, where a lack of response from the authorities is deemed to be an approval. (Article 16d).

Energy Performance of Buildings Directive

New provisions on national renovation targets and the introduction of renovation passports, as well as the requirement for new buildings to be based entirely on renewable energy (zero emissions), will stimulate further investment in photovoltaics in the residential sector. The importance of solar energy is also underlined by the goal of making new buildings "solar-ready". SolarPower Europe estimates that the implementation of the Directive could increase the number of households equipped with PV systems by 56 million, creating an additional capacity of 150-200 GW in the EU over the period 2026-2030.[21]

Further strategies and initiatives

The **EU Solar Energy Strategy**[22] is part of the EU’s RepowerEU plan. One of its pillars, the **European Solar Rooftops Initiative,** aims to accelerate the installation of solar panels on buildings, help create a skilled workforce needed to produce, install and maintain solar panels, and support EU industry to expand the domestic production of photovoltaic panels.

A resilient, sustainable and competitive European solar value chain is also in the focus of the Net-Zero Industry Act, and the **European Solar Charter.** The latter was signed in April 2024 by the European Commission, Member States, and solar industry representatives, with the aim to strengthen the competitiveness of the EU photovoltaic sector.

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[21] https://www.solarpowereurope.org/press-releases/eu-rooftop-solar-standard-alone-could-solar-power-56-million-homes, accessed: 13/05/2024

[22] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A221%3AFIN&qid=1653034500503, accessed 13/05/2024.

Our analysis focused on how the self-consumption schemes of selected EU Member States and the Energy Community Contracting Parties meet the requirements of, in particular, Article 21 of the Renewable Energy Directive and Article 15 of the Electricity Market Directive.

2 BUILDING BLOCKS OF COMPENSATION SCHEMES FOR HOUSEHOLD SELF-CONSUMPTION

The main building blocks of self-consumption compensation schemes include (Zinaman, 2017):

- The **metering and billing arrangements**, which define how electricity generated, consumed, and injected into the grid is measured and billed.
- The **sell rate design**, encompassing the price that prosumers can receive for their excess electricity, as well as the fees and taxes related to the injection of electricity into the grid.
- The **retail price system** applicable to electricity consumed from the grid, consisting of the electricity fee, system tariffs, and other charges.
- **Charges** that may be levied **on self-consumption**.

These interrelated regulatory elements collectively influence the profitability of household-scale power plants and the behaviour and decisions of prosumers.

Other important elements of the schemes are

- the **system size cap**, which represents the maximum capacity up to which the renewable energy system owners can qualify for the compensation scheme,
- the **length of the eligibility period**, which determines how long the renewable energy system owner can participate in the compensation scheme, and
- the **netting frequency**, which is critical in net metering and net billing, specifying the time period during which the quantity or monetary value of excess generation can be credited to offset the quantity or value of electricity consumed from the grid.

Figure 3 summarizes the main components of compensation mechanisms and the different options available for their design.

FIGURE 3: ELEMENTS OF COMPENSATION MECHANISMS FOR DISTRIBUTED GENERATION

COMPENSATION MECHANISM	**Metering and billing arrangement**	Net metering
		Net billing
		Buy all, sell all
		Separate metering and billing
	Sell rate design	Price for injected electricity System charges related to injection Other (taxes, levies, etc.)
	Retail rate design	Electricity fee System charges Other (taxes, levies, etc.)
	Other	Levies on self-consumption

Based on Zinaman (2017)

2.1 Metering and billing arrangements

The metering and billing arrangements determine the frequency at which the amount of electricity fed into and withdrawn from the grid is measured (e.g., instantaneous, hourly, monthly, annually, etc.) and the basis on which crediting and billing is performed, i.e. whether it is based on the quantity of electricity (kWh) or its monetary value (e.g. EUR).

In the case of **net metering**, billing is based on the **net quantity** of electricity withdrawn from and injected into the grid during a given crediting cycle (e.g. annual, monthly). A longer crediting cycle can offer benefits to the renewable energy system owner; for example, annual netting allows excess generation in the summer to offset higher consumption from the grid in the winter when the number of sunny hours is much lower. In the case of positive net withdrawal, the consumption is subject to the standard retail tariff in most of the countries concerned, while excess electricity fed into the grid can be sold at a predetermined price to the party obliged to purchase the electricity (in most cases the consumer's electricity supplier). A major advantage of net metering is that it is simple and offers very favourable conditions for prosumers. It has been applied in many regions of the US, Canada, Australia, and many European countries, and has helped to stimulate investment in household-scale power plants. It is important to note that the billing cycle may differ from the crediting cycle (or credit reconciliation period). For example, in some cases the bills must be paid monthly, but excess generation can be carried forward to the next billing cycle and used against later consumption within a year.

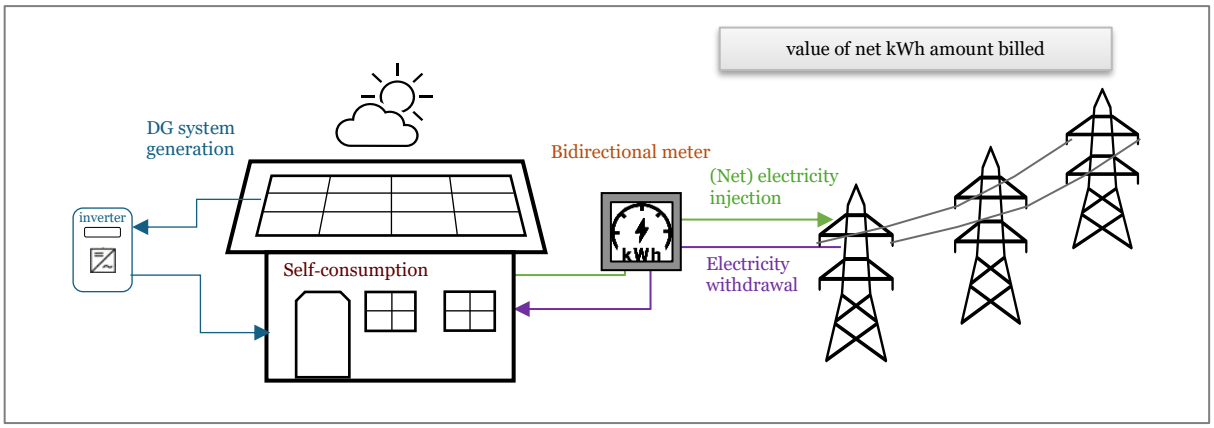
Under net metering, residential renewable installations are typically encouraged to be sized so that their production over the crediting cycle matches the household's annual demand for electricity. As a result, the amount of electricity drawn from the grid tends to be minimal.

As Figure 4 illustrates, net metering requires a bi-directional meter, as in most cases only the net consumption (the system owner’s consumption from the grid minus the electricity produced and fed in) is measured (alternatively, two unidirectional meters can also be used). As the payment obligation is based on this net amount, which may be zero or even a negative, PV system owners may pay only a small part of the system charges (usually the fixed grid costs) associated with their net consumption. Consequently, their contribution to the costs of maintaining and developing the electricity system is relatively small, even though they are constantly using it to take electricity from and feed it into the grid. In addition, the grid provides them with the service of daily and inter-seasonal storage.

On the other hand, as the installation rate of small-scale PV systems increases, the grid may need to be strengthened to accommodate new capacity. As penetration increases, ensuring stable voltage levels, power quality and security of supply becomes an increasing challenge. The grid costs of distribution system operators are recovered through system charges paid by electricity consumers. However, as more customers take advantage of net metering, fewer variable system charges can be collected, resulting in higher tariffs for electricity consumers who do not operate their PV systems.

In addition to unfair burden sharing, net metering does not reflect the current value of the electricity produced and consumed, and therefore does not encourage consumers to take electricity from the grid during periods of low demand (lower price) and increase their own consumption, or to feed electricity into the grid during periods of high demand (higher price). Thus, it does not encourage contribution to the optimal operation of the network, which would reduce development costs.

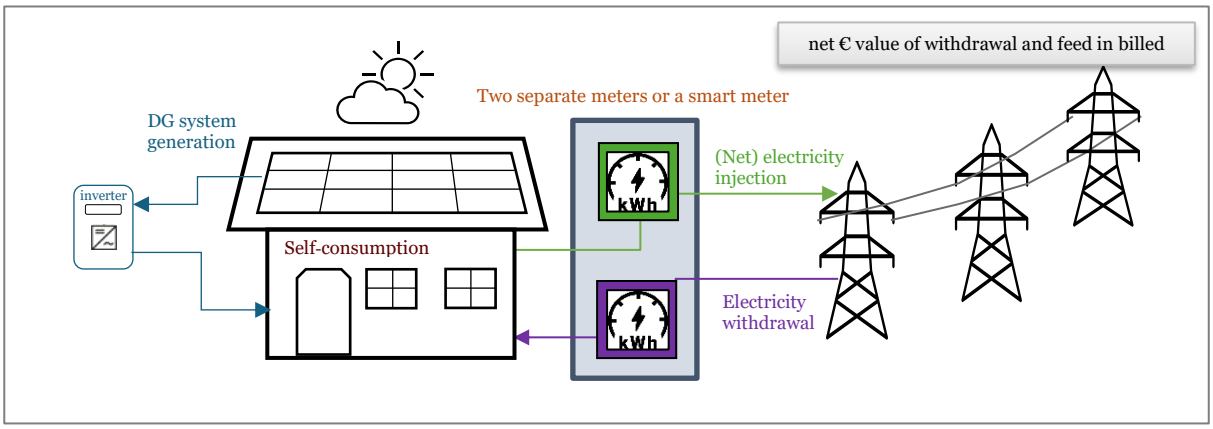
FIGURE 4: NET METERING



Net billing works in a similar way to net metering, with the crucial difference that instead of the net balance of the quantity of electricity (kWh), the net balance of the separately measured monetary values of consumption and injection is measured and billed. Electricity flows are measured at the moment of withdrawals from and injections into the grid, and the rate they are accounted for is based on a predetermined value assigned to them through the retail and sell-rate design. These values may vary with time, location, grid characteristics or market prices, in order to contribute to the smooth operation of the network. Quantities are therefore measured in real-time and billed/credited according to the actual value of the electricity, based on the electricity flows measured in both directions by two separate meters or one smart meter. (see Figure 5)

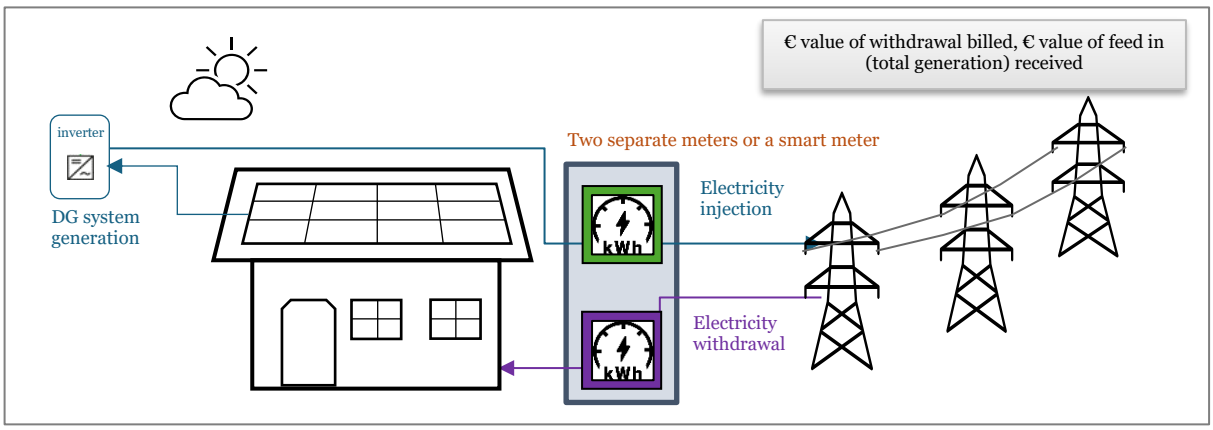
In addition to encouraging prosumers to adjust their consumption to the time periods with more favourable fees, the separate measurement of electricity flows in both directions allows appropriate distribution and transmission tariffs to be charged, thus ensuring a fair sharing of system costs. The applied electricity prices and system costs could value the withdrawn and injected energy in line with market and network conditions, thus increasing system flexibility and helping to avoid network congestion. This could reduce the relevant system costs and also facilitate the addition of new renewable capacity. The engagement of prosumers in demand response requires the use of advanced metering infrastructure that enables communication between consumers, retailers, and system operators, especially when dynamic tariffs are considered (Irena, 2019).

FIGURE 5: NET BILLING



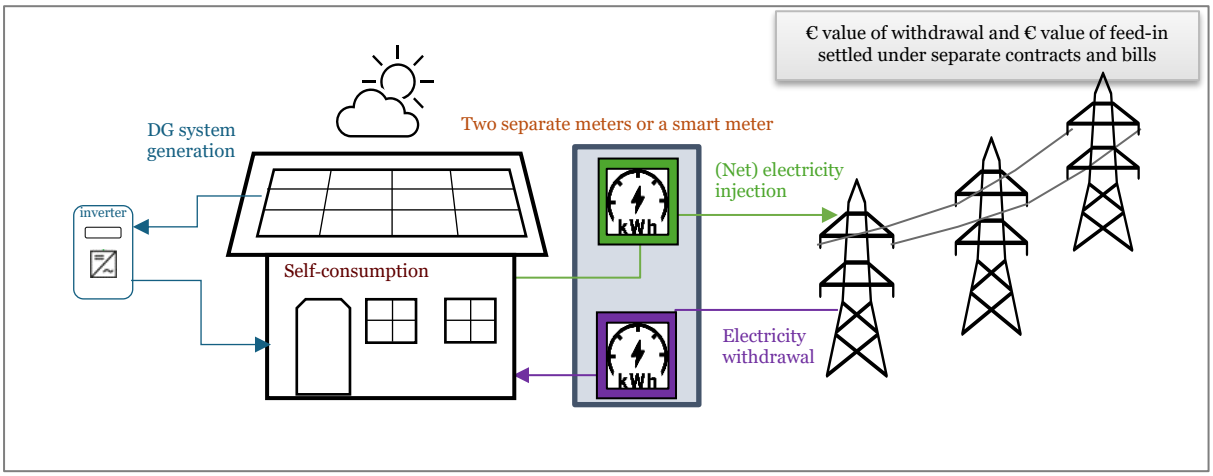
Under the **buy all, sell all** mechanism, there is no self-consumption. As Figure 6 shows, PV owners feed all the electricity they produce into the grid. The monetary value of the electricity consumed from and fed into the grid, which are measured separately (either by two separate meters or one smart meter), are reconciled through separate contractual relationships, so there is no netting, i.e. no credit for energy fed into the grid. This arrangement was commonly used in the early years of rooftop PV, when investment costs were high and self-consumption was not profitable. When the LCOE of residential PV reached and fell below the price of electricity consumed from the grid (grid parity), it was already worthwhile to consume the electricity locally, and governments also sought to encourage self-consumption to relieve the burden on distribution grids.

FIGURE 6: BUY ALL, SELL ALL



Under the "buy all, sell all" regimes, PV owners usually received a fixed feed-in tariff, paid by a different entity than their supplier. When self-consumption became a possibility, these systems sometimes retained the same contractual arrangements, meaning that the compensation for excess generation is provided by the same entity that previously paid the support. Therefore, although this system is similar to net billing in terms of electricity flows and payments, there is no netting of the values of electricity fed in and withdrawn on the same bill. To distinguish this option from net billing, we refer to this arrangement as **"separate metering and billing"** (shown in Figure 7). What distinguishes this option from net billing is that, whereas under the former, prosumers receive a single bill showing the net amount of the value of the electricity withdrawn and the value of electricity fed into the grid, in the latter case, two separate payments are made. Prosumers pay their suppliers for the electricity they take from the grid under a normal supply contract, while the electricity they feed in is paid for under a different contract.

FIGURE 7: SEPARATE METERING AND BILLING



2.2 Sell rate design

The sell rate design determines the level of compensation that prosumers receive for the excess electricity they feed into the grid.

As shown in Figure 8, the sell rate is made up of the price paid for the electricity fed into the grid, the system charges levied on the electricity fed into the grid (if any), and other taxes, levies and charges.

The price paid for the surplus electricity may be a predetermined fixed amount per kWh, or it may vary with time or location, monthly, daily, hourly, or other degree of granularity, depending on the specific contract. For example, a fixed payment per kWh (FIT) is provided over the support period in Germany. The price is linked to monthly wholesale market prices in Austria, and Portugal (in case of the buyer of last resort). Hourly market prices are paid in Poland and Denmark. Paying static time-of-use rates for the injected electricity is not common in Europe (they are used in Mexico and Australia), while location-dependent tariffs are offered in New York, USA (Irena, 2019). In many European Member States, it is set by regulation, at least for the case of the off-taker of last resort. The party, to which the prosumer sell their surplus electricity may vary across countries. It might be a state administrative body or a market player, which can be the same or different from the electricity supplier of the prosumer (the same in Austria, not necessarily the same in Portugal). Usually, it is possible in all countries to sell the surplus outside of the specific compensation mechanism, through the market, and in case a support system applies to self-consumers, they can sell their electricity through market contracts when the support period has expired. In case of market agreements, the price can be determined different ways, depending on the specific contract.

In most cases, regulators wish to encourage self-consumption to reduce the burden on the grid, particularly during peak hours. Since the electricity price includes, in addition to the electricity fee, system charges, taxes and other levies, while the injected electricity is usually remunerated at the market price/electricity fee (less some additional charges), the compensation that prosumers receive for the injected electricity is lower than the amount they can save by selling the unused electricity. Thus, the arrangement encourages self-consumption, as is the case in almost all the countries analysed.

It may also happen that the primary objective of the scheme is not to encourage self-consumption, but rather to encourage an increase in distributed generation capacity and to maximize the use of available rooftop space. In Germany, for example, there are two types of contracts available, offering different levels of FIT: one with self-consumption (under a separate metering and billing arrangement) and one without the possibility of self-consumption (under a buy all, sell all arrangement). PV owners can choose either or both contracts to make use of all the available space on their roofs.

The sell rate might also include fees related to the use of the electricity system. The so-called injection network charges can be capacity or power based, volumetric or lump sum, and change with time or location. As we have already presented, the EMD states that a contribution to the cost of the network should be paid separately for electricity fed into and withdrawn from the network. ACER (2023) also recommends that the tariffs of all network users should reflect the costs they impose on the network in order to ensure cost-reflectiveness and avoid market distortions. In spite of this, only one of the countries analysed levies a charge on the electricity that is fed into the grid (in Denmark, while in the Netherlands, service fees are charged on the injected net amount). This is not only the case in countries where no feed-in tariffs are levied on any of the producers, so that imposing them on prosumers would be discriminatory, but also in countries where such charges are levied on other producers. According to ACER (2023) the situation is the same in the other countries that are not covered by our analysis, with only

a few exceptions, e.g. in France, in the case of collective prosumers, or in Latvia, if the production capacity is higher than the self-consumption load (ACER, 2023, p. 38).

FIGURE 8.: SELL RATE DESIGN

Elements of sell rate	Types of sell rate elements
Price of injected electricity (+)	Fixed
	Time-of-use (ToU)/locational
	Linked to monthly market price
	Linked to hourly market price
System charges (-)	Capacity/Power-based (fixed, locational, ToU)
	Volumetric (fixed, locational, ToU)
	Lump-sum charge
Other (-)	Tax
	Charges
	Other

Based on Zinaman (2017), Eurelectric (2021) and ACER (2023)

As regards the other charges levied on the injected electricity, in case of net billing, VAT may be charged on electricity purchased from the grid even on the amount credited to the prosumer for excess electricity (e.g. in case of Poland).

2.3 Retail rate design

The two most important elements of retail prices are the electricity tariff and the system charges, which are complemented by other tariff elements, as illustrated in Figure 9.

FIGURE 9: RETAIL RATE DESIGN

Elements of retail rate	Types of retail rate elements
Energy fee	Fixed
	Variable
	Dynamic
System charges (related to transmission and distribution system)	Lump-sum charge
	Capacity/Power-based (fixed, locational, ToU)
	Volumetric (fixed, locational, ToU)
Other	Taxes, charges, levies

Based on Zinaman (2017), Eurelectric (2021) and ACER (2023)

Electricity tariffs can be fixed, variable or dynamic based on market prices, the introduction of the which being conditional on the availability of smart meters to facilitate reliable metering and information flows. Time-zone tariffs can be static or dynamic, the former being the more common. Dynamic residential tariffs, to which final customers should be entitled in case of

having smart meters, as required by the EMD[23], are based on hourly or shorter-time market prices.

As with retail prices, system charges can vary with time or by location, both in case of volumetric and capacity/power-based charges. Static time zone pricing is used in 21 EU countries, mainly on the distribution network. Locational pricing reflects the costs of congestion and, if properly designed, can help reduce network development costs (ACER, 2023).

The other taxes, charges and levies vary greatly across the EU countries but include VAT and energy tax in all cases (in Italy and Portugal a reduced rate), while prosumers might be exempted from paying some fees imposed on larger producers, such as the RES support surcharge. (For example, in Hungary, or since 2022 in Austria.)

In addition to the elements of retail rate, it is possible that fees are imposed on the self-consumed part of the electricity use. It is the case in Denmark for example.

[23] Directive (EU) 2019/944, Article 11.

3 COUNTRY CASE STUDIES

The following sections present the current role of self-consumption in selected EU member states, and the compensation mechanisms applied, based on the above shown structure. The old and new metering and billing schemes of the countries are listed in Table 2.

TABLE 2: PREVIOUS AND NEW METERING AND BILLING SCHEMES IN THE INVESTIGATED EU MEMBER STATES

Previous system	New system	Country
Net metering	Not yet in place	Netherlands, Greece
	Net billing	Poland
	Separate metering and billing	Hungary
Net billing	Separate metering and billing	Italy
Separate metering and billing	-	Austria, Portugal, Germany, Denmark
Other: no scheme	-	Slovakia

3.1 Austria

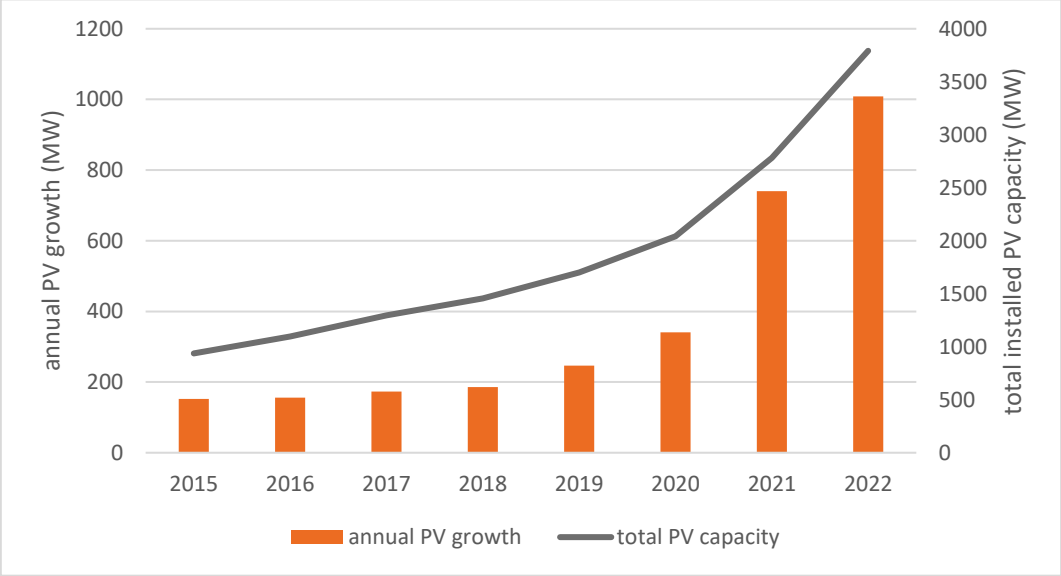
Austria already has a remarkably high share of renewables in its electricity mix and has set a target of 100% renewable electricity generation by 2030. It has also committed to becoming carbon neutral by 2040. To meet these targets, solar PV capacity will need to increase tenfold. At the end of 2022, the solar PV capacity stood at 3.8 GWp (see Figure 10). Decentralised PV installations (building applied and building integrated) make out the majority of the Austrian PV-capacity, with 83% (3.5 GW) in 2022, according to IEA. [24]

The role of self-consumption in energy policy

In Austria, households are encouraged to participate in renewable energy production through various schemes. The Renewable Energy Sources Act 2021 (EAG) has changed the support landscape for PV and energy storage by introducing a market premium system above 10 kWp. Premium support is granted via tendering (organised at least twice a year), for a period of 20 years. Unlike in most countries, households can also apply for the market premium scheme. Additionally, they can also engage in an investment support scheme, but the premium and investment support schemes cannot be combined, to avoid over-subsidisation. At the time of writing, Austria's draft updated NECP had not yet been published, and therefore no specific targets related to self-consumption could be found.

[24] National Survey Report of PV Power Installations in Austria https://iea-pvps.org/wp-content/uploads/2023/12/2023_12_14_NSR-2022_Austria.pdf. accessed 10/06/2024

FIGURE 10: INSTALLED PV CAPACITY IN AUSTRIA, 2015-2022



Source: Wien Energie[25]

Eligibility

Independently of the premium or the investment support scheme, households have the option to choose between exporting all the renewable energy produced to the grid (Volleinspeisung) or self-consuming part of it and selling the surplus (Überschusseinspeisung). In general, selling the surplus is more favourable.

The Austrian government's energy agency, OeMAG, is obliged to take over and remunerate the surplus electricity from renewable energy producers up to 500 kW. PV owners can also choose to sell the surplus electricity to market suppliers.

If the PV plant receives premium support, the financial settlement is done – including the monthly payment of the premium - by a subsidy settlement office (EAG-Förderabwicklungsstelle).

Households can apply for investment grants (fixed rates apply in the categories "A" - below 10 kW - and "B" - between 10-20 kW).

Metering and billing arrangements

Austria has a "separate metering and billing" scheme, where electricity consumed from and fed into the grid are metered and remunerated separately, with no netting.

There is a good roll-out of smart meters, with a target of 95% penetration by 2024. Customers do not have to pay for the installation of a new meter.

Sell rate design

Surplus electricity can be sold to OeMAG at a fixed "market price". This price was set on a quarterly basis until the end of 2023 (market price for Q4 2023: 12.464 cent/kWh), but the scheme was modified in 2024 to even better follow the evolution of market prices. Thus from 2024 onwards, OeMAG publishes a monthly market price based on the average volume-

[25] https://positionen.wienenergie.at/grafiken/installierte-pv-leistung-in-oesterreich/, accessed 21/04/2023

weighted hourly day-ahead electricity price. To reduce the risk of too volatile market prices, the OeMAG market price is subject to upper and lower limits (the upper limit (cap) is the still announced quarterly market price, the lower limit is 60% of the quarterly price).

The electricity supplier sends metering data to OeMAG, usually on an annual basis, but more and more customers are being directed into monthly settling. OeMAG sends the credit note with the amounts and prices for feed-in after receiving the data from the supplier. A monthly settling is possible if a smart meter is installed.

Eventually higher sell rates than the OeMAG price can be achieved by selling the surplus electricity to a supplier. However, in most cases an electricity supplier will only purchase the surplus if the PV owner also buys the electricity from them. (Prices currently range from around 4.50 to 18 cents/kWh[26]).

Household prosumers do not pay injection charges for the electricity they sell to the grid.

Retail price system applicable

Households can choose among several retail tariffs in Austria. Besides fixed-price and variable-price contracts, dynamic tariffs are also available, however, in the uncertain price environment of the energy crisis, the interest in dynamic and variable (flexible) tariffs decreased. Also, the cap on electricity prices (Strompreisdeckel) introduced in December 2022 (15 cent / kWh decrease in household prices for a yearly electricity consumption of up to 2900 kWh) does not incentivise the use of flexible and dynamic tariffs.

For consumed electricity transmission and distribution tariffs apply, which are energy and power based.

Other fees and charges on consumed electricity include the VAT and a fee paid to the local community (community levy - Gebrauchsabgabe). Since 2022 all households are exempt from the renewable energy and CHP surcharges. Also, the electricity duty (Elektrizitaetsabgabe) has been decreased by 90%. These cost brakes are expected to remain in place until the end of 2024.[27]

Other charges

There are no taxes or charges levied on the self-consumed electricity in Austria.

Policies and measures to support self-consumption

In addition to the schemes mentioned above, other investment support is available, e.g. from the Klima- und Energiefonds (Climate and Energy Fund) or provided at provincial or municipal level. In any case, however, the support schemes cannot be combined. The measure of zero VAT for PV systems up to 35 kWp and associated storage systems has been introduced as of January 2024. (This measure cannot be combined with an investment subsidy.)

Since 2017 “joint generation plants” (gemeinschaftliche Erzeugungsanlagen) can be established in Austria, in which residents of apartment buildings can generate their own solar power and consume it directly on site. The prerequisite is that the generation system and the consumption systems are connected to a common main line; the transmission of shared generation via the grid operator’s systems or the public grid is not permitted. These can be seen as the small forerunners of energy communities.

[26] https://www.tarife.at/energie/strom/ratgeber/photovoltaik-einspeistarife, accessed 09/04/2024
[27] https://infothek.bmk.gv.at/strompreisbremse-bis-ende-2024-verlaengert, accessed 09/04/2024

There are more than 1000 renewable energy communities operating in Austria. Participants must be located in the same network area, so they all have a grid access contract with the same grid operator. This has the advantage that a more favourable grid tariff is applied to energy purchases within the energy community due to the geographical proximity. As an additional financial incentive, no renewable energy surcharge has to be paid for the energy generated and consumed within the energy community.[28]

Genuine, private peer-to-peer trading is not yet possible until legislation is in place, but some suppliers such as eFriends, offer the possibility of sharing excess green electricity among their customers via an application.

Evaluation

In the Austrian scheme consumed and exported electricity are measured separately, which ensures that grid costs can also be accounted for in both directions. Yet, no network tariffs are set for the energy fed into the grid.

Although the selling price in Austria is static, the advanced roll-out of smart metering will enable flexible and dynamic retail tariffs, ensuring that households are aware of market signals. Energy communities also provide many opportunities for households to optimise their energy production and consumption. While Austria has a number of support schemes in place, there is a strong focus on the avoidance of over-subsidisation.

As far as the impact of rooftop PV on the local grid is concerned, in general there are no problems, but local constraints may arise.

3.2 Denmark

Danish self-consumption is dominated equally by small-scale (less than 1 MW) onshore wind, and solar PV[29]. However, onshore wind installations are generally large power plants, operated by energy communities and citizen initiatives, so it can be assumed that solar PV is the dominant technology for households.

By the end of 2023, Denmark had 3529 MW of installed solar PV capacity.[30]. According to the Energy Agency's statistics, 1.7 GW of this capacity is unsupported PV, 330 MW is self-consumption system under the current "separate metering and billing" scheme, while the rest has been installed under support schemes that have been phased out (tenders, old self-consumption scheme, etc.).

The role of self-consumption in energy policy

From 2010 to 2012, Denmark had a very generous annual net metering scheme for new installations, which accelerated the deployment of residential PV capacity. After the first scheme was phased out, a new scheme was introduced that was much less favourable to self-consumers. This scheme, which ran until 2017, applied hourly net metering to new

[28] Citizen energy communities (CECs) do not need to be geographically close to each other, members can be located in different grid areas, and electricity does not have to be generated exclusively from renewable energy sources. As a result, there are no reduced grid tariffs, and the renewable energy surcharge must be paid. There are around 150 CECs in operation in Austria.

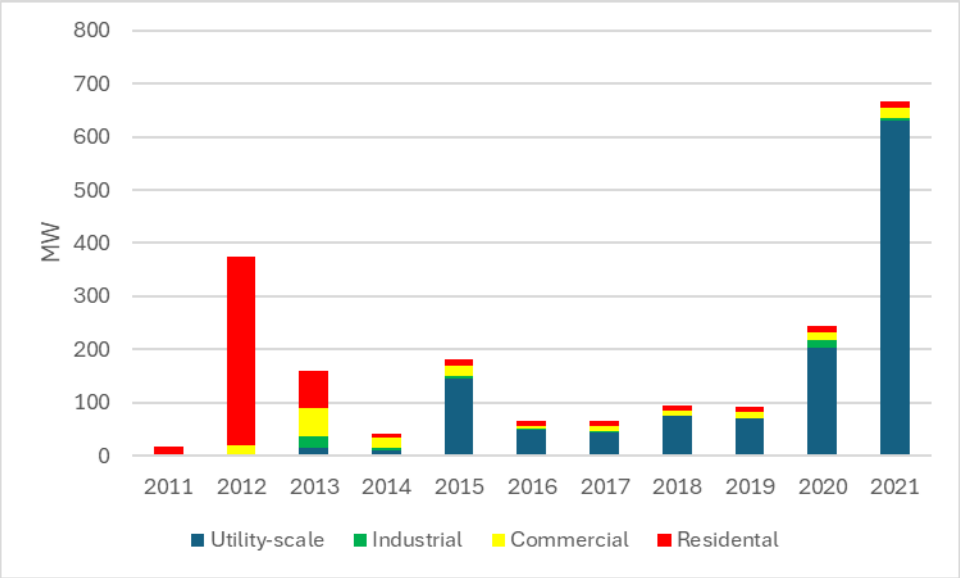
[29] Oslo Economics & Sweco (2019) :Distributed electricity production in the Nordics – A Report to the Nordic Council of Ministers, https://www.nordicenergy.org/wordpress/wp-content/uploads/2019/06/Distributed-energy-production-and-self-consumption-20190607-1.pdf, accessed: 06/05/2024

[30] Danish Energy Agency (2023): Solcelleudbygningen i Danmark pr. 4. kvartal 2023, https://ens.dk/sites/ens.dk/files/Sol/solcelleopgoerelse_4._kvartal_2023.pdf, accessed: 06/05/2024

installations.[31] Since 2017, new installations can only participate in the so-called "instantaneous netting" scheme, which is a real-time "separate metering and billing" scheme, with even less favourable conditions.

As a result, PV deployment in Denmark has been dominated by utility-scale projects since 2012, as shown in Figure 11:. At present, Denmark does not have an actual support scheme for residential PV, and capacity installations are mainly carried out through private PPA contracts.

FIGURE 11: PV DEPLOYMENT IN DENMARK BY MARKET SEGMENTS, 2011-2021



Source: PV-Magazine.com[32]

According to the Draft revised NECP of Denmark, the country is aiming for 11.7 GW of installed PV capacity by 2030, almost three times the current level[33]. The document clearly highlights that the target should be achieved along market incentives, i.e. without financial support, only non-financial measures would encourage PV deployment. The NECP does not include targets for self-consumption.

Eligibility

The instantaneous settlement is a general method for self-consumption in the country, not limited to households. There are some exemptions (such as a simplified installation process or streamlined entry to the settlement scheme) for household-sized installations with capacity of less than 6 kW.

[31] Webpage of Bodil Energy (2024) https://bodil.energy/solceller/regler-for-solceller/, accessed: 06/05/2024
[32] E.Bellini (2022) Unsubsidized utility scale solar changing shape of Danish PV market, Pv-magazine.com, https://www.pv-magazine.com/2022/03/02/unsubsidized-utility-scale-solar-changing-shape-of-danish-pv-market/, accessed: 06/05/2024
[33] Danish Ministry of Climate, Energy and Utilities (2023) Draft revised National Energy and Climate Plan (NECP), https://commission.europa.eu/document/download/31895e48-37c3-46fe-8a8f-8f61fbff6724_en?filename=EN_DENMARK%20DRAFT%20UPDATED%20NECP.pdf, accessed: 06/05/2024

Metering and billing arrangements

For new installations, Denmark operates a scheme, called "instantaneous settlement"[34]. The most important element of the settlement design is that when the self-consumer produces electricity it can only consume the electricity at the moment it is produced. Any surplus electricity that is exported to the grid is valued immediately. Each month, self-consumers receive the value of their aggregated sold energy from their supplier, who manages energy exports.

Consumers also receive monthly electricity bills based on the amount of electricity taken from the grid. The electricity supplier handling the exported energy, and the consumed energy may be a different entity. Charges related to consumption (network charges, taxes) are based on the amount withdrawn, so that the self-consumed part is exempt. However, Danish self-consumers must pay network costs and taxes after both the injected and consumed electricity.

The smart meter rollout in Denmark is 100% for household electricity consumers, which allows the operation of such a dynamic settlement scheme (ACER and CEER, 2023).

Sell rate design

The price received for the excess electricity is the spot market price in the relevant Danish price area (DK1 or DK2). The sell price is instantaneously calculated at the moment of production, every unit of energy which the household is not able to use, must be sold instantaneously at the price applicable at the moment of production. The billing period is monthly, so that each month the self-consumers receive financial compensation for their injected energy.

The sell rate may include additional surcharges as well, based on the agreement with the buyer/supplier, to cover the costs of providing the service. This may be either a variable surcharge (after each unit of energy sold the price is reduced) or a fixed charge (on a monthly basis) or both.

The following additional charges apply to the exported energy[35]:

- A balancing tariff for production: A tariff for the TSO to cover its cost related to balancing and system services.
- "Feed-in charge": Tariff for the TSO, for reading the metering point of the injected electricity
- Injection charge for the DSO (variable charge, introduced in 2023, (ACER, 2023))
- Income tax: If the annual value of electricity sold exceeds DKK 7000, income tax of 60% must be paid on the excess[36].

Retail price system applicable

In Denmark, the retail price system consists of several different elements, most of which are network charges. In the instantaneous measurement scheme, each billing element must be paid after the electricity taken from the grid, i.e. the total consumption minus the self-consumed energy. The electricity price is based on the agreement with the supplier. The price

[34] Webpage of NRGI (2024): REGLER FOR AFREGNING AF SOLCELLERS ELFORBRUG OG ELPRODUKTION https://nrgi.dk/privat/stroem/kundeservice/betaling/solceller-forbrug-og-produktion/, accessed: 06/05/2024

[35] Martín H, de la Hoz J, Aliana A, Coronas S, Matas J. Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark. *Energies*. 2021; 14(7):1990.https://www.mdpi.com/1996-1073/14/7/1990, accessed: 06/05/2024

[36] Webpage of Bodil Energy (2024), https://bodil.energy/solceller/regler-for-solceller/, accessed: 06/05/2024

usually reflects the hourly market price depending on the region (DK1 or DK2)[37] and may also include additional surcharges based on the agreement with the supplier. This can be either or both a variable surcharge or a fixed surcharge. Consumers pay their bills monthly.

The following additional charges apply to the electricity consumed from the grid:

- DSO tariff, to cover the costs of operation for the DSO (energy based and lump-sum)
- TSO grid tariff, to cover the operation and the maintenance of the transmission system
- TSO system tariff, to be paid to the TSO for the provision of secure and high-quality service
- Balance tariff for consumption, paid to the TSO to cover its costs related to balancing and system services
- Electricity tax, to be paid to the Danish Treasure (different reductions and exemptions are available for different consumer groups)
- VAT (25%).

Distribution tariffs can be ToU in Denmark, but the use of such tariffs is not mandatory. Depending on the actual load, there are peak and off-peak periods with different tariffs. The system does not include any other type of time-based differentiation. The Danish regulator is considering the possibility of introducing a ToU tariff option also for TSO tariffs (ACER 2023).

Due to the multiple tariff elements and high taxes, the final electricity price for household consumers is by far the highest in Europe. According to the ACER retail market monitoring report (ACER and CEER, 2023), in 2022 the average final electricity bill was 52.2 cents/kWh, which is more than 10 cents/kWh higher than the second largest value of Belgium. About 50% of the electricity bill is related to direct energy cost, which can be considered a low share compared to other countries.

Other charges

In Denmark, a tariff is levied on the self-consumed energy of prosumers. The “availability tariff” is paid in proportion to the self-consumed energy for the availability of the grid.

Policies and measures to support self-consumption

As Denmark, in general, does not provide financial incentives for mature RES technologies, such as PV, there are few additional measures to be identified. The country allows collective self-consumption for both households and energy communities. In the case of collective self-consumption all consumers and producers have to be connected to a private grid with a common meter.[38]

Evaluation

The Danish government does not intend to subsidise the deployment of solar PV in the country. Although self-consumption may still be worthwhile, as it can save a very high retail price, the transition to the instantaneous settlement of production and consumption has discouraged

[37] Martín H, de la Hoz J, Aliana A, Coronas S, Matas J. Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark. *Energies*. 2021; 14(7):1990.https://www.mdpi.com/1996-1073/14/7/1990, accessed: 06/05/2024

[38]Dorian Frieden, Andreas Tuerk, Josh Roberts, Stanislas d'Herbemont, Andrej Gubina (2019): Collective self-consumption and energy communities - Overview of emerging regulatory approaches in Europe https://www.rescoop.eu/uploads/rescoop/downloads/COMPILE_Collective_self-consumption_EU.pdf, accessed: 06/05/2024

consumers from installing solar PV as they can only use their self-produced energy at the moment of production. In addition, various fees and taxes are levied on the electricity fed into the grid, and a grid fee is paid even after the self-consumed electricity. Producers receive less for the energy they produce than the wholesale market price (due to tariffs and fees), while they pay 2-3 times more to buy the electricity, so the compensation scheme strongly encourages self-consumption.

In terms of the dynamics of new installations, when the very generous net metering scheme expired in 2012, the use of PV for individual self-consumption in the country fell dramatically. From 2014 onwards, most of the newly installed electricity capacity was utility-scale, with a smaller contribution from commercial and residential self-consumption systems.

There is no indication whether the situation will change drastically in the future, as the Danish NECP does not include any plans or targets for self-consumption in the medium and long term.

3.3 Germany

Germany has long been a forerunner in renewable energy production. In 2022, the German PV capacity accounted for 82.2 GWp, in 2023 the newly installed capacity in Germany was 14.9 GWp. Systems below 10 kW_p, which are often purchased by households, account for approx. 15 percent of the total installed capacity, according to Fraunhofer ISE.[39] Unfortunately, it is difficult to find publicly available statistics on the development of total installed PV capacity by system size or market segment.

The latest version of the German renewable energy act (EEG 2023) aims to further accelerate renewable electricity production, with a targeted increase in solar PV capacity of 9 GW in 2023, 13 GW in 2024 and a further 22 GW per year as of 2026. Half of the new solar energy installations are to be placed on rooftops.

The role of self-consumption in energy policy

Self-consumption of self-generated renewable electricity became possible in Germany in 2006. The main motivation for self-consuming solar energy is to avoid the high prices of grid electricity. Currently, solar PV owners can choose between a self-consumption scheme, where a feed-in tariff (FiT) applies to the excess solar electricity (Eigenversorgung), or a scheme with a full export of all generated solar energy (Volleinspeisung) for a higher FiT. With the aim to maximise the solar energy production, the German government raised the feed-in tariffs for solar energy export in January 2023, but feed-in tariffs decreased again in 2024 in line with falling technology costs.

Eligibility

Renewable electricity producers are entitled to feed-in tariffs in Germany. Feed-in tariffs decrease with increasing capacity, and household solar PV installations up to 10 kW (Kleinanlagen) receive the highest remuneration. Feed-in tariffs are paid for 20 years and remain constant over the years. From 2024, feed-in tariffs for new installations are updated biannually.

[39] Recent Facts about Photovoltaics in Germany https://www.ise.fraunhofer.de/content/dam/ise/en/documents/publications/studies/recent-facts-about-photovoltaics-in-germany.pdf, accessed 10/06/2024

Metering and billing arrangements

The FiT scheme can be described as a "separate metering and billing"scheme, where the electricity taken from the grid and fed into the grid is accounted for separately. The grid operator to which the system is connected also pays the remuneration, i.e. prosumers have no right to select the buyer of their electricity.

Below 100 kW capacity, remuneration of the surplus is based on the standard load profile (Standardlastprofil), so that each PV owner receives a bill for the whole year up to 31 December. On the basis of this annual bill, the PV owner receives the remuneration in 11 monthly installments during the following year.

The PV owner receives a separate bill for its electricity consumption from its electricity provider, which can be the base supplier (Grundversorger), or a market participant chosen depending on the location, the type of tariff, or the electricity mix (e.g. green electricity).

Germany has a low share of smart meters installed. It was not until 2023 that the government passed legislation to achieve a 20% roll-out by the end of 2025. From 2025 all consumers will have the right to request a smart meter, the cost of which will be capped at EUR 20.[40]

Sell rate design

In the German FiT-scheme, the PV owner can choose between a self-consumption model or a buy all, sell all model. In both cases, the sales price is constant over 20 years. This means that sell rate is independent of the electricity market characteristics and trends and pursue the aim to maximise renewable electricity production.

TABLE 3: FEED-IN TARIFFS FOR NEW INSTALLATIONS IN THE FIRST HALF OF 2024 IN GERMANY

Installed capacity	Self-consumption	No self-consumption (total export)
up to 10 kWp	8,11 Cent/kWh	12,87 Cent/kWh
15 kWp	7,75 Cent/kWh	12,17 Cent/kWh
20 kWp	7,57 Cent/kWh	11,83 Cent/kWh
30 kWp	7,39 Cent/kWh	11,48 Cent/kWh

Source: Finanztip.de

The selling price is the feed-in tariff, which is defined in the Renewable Energy Act (EEG) and varies according to the size of the installation and the model chosen (see Table 3) To receive FiT support, installations need to be registered at the regulator (Bundesnetzagentur).

After the 20-year support period, excess renewable electricity can be sold to the DSO, which pays a solar market price (Marktwert Solar – the average market price of sold solar electricity of the previous year) minus marketing costs. In 2024, these market revenues for surplus electricity are capped at a maximum of 10 cents/kWh.[41]

[40] https://www.smart-energy.com/industry-sectors/smart-meters/germany-mandates-smart-metering-from-2025/ accessed: 12/04/2024

[41] Source: https://www.finanztip.de/photovoltaik/einspeiseverguetung/ accessed: 12/04/2024

Recent changes to tax rules mean that from 2022, no personal income tax is payable in relation to PV solar systems under 30 kWp.

No injection charge applies to prosumers.

Retail price system applicable

All household customers in Germany are entitled to a designated electricity (and gas) supply (Grudversorgung). The designated supplier is the energy supply company that supplies electricity to most household customers in the respective local grid area at general prices and conditions.

Currently, only about 100,000 consumers have variable retail tariffs. However, as the installation of smart meters is accelerated, consumers with smart meters will have the possibility to access variable and dynamic electricity price rates. From 2025, all electricity suppliers will have to offer variable and dynamic tariffs to their customers.

Two measures taken by the German government as part of its budget consolidation led to an increase in electricity prices at the beginning of 2024. First, the 40 ct/kWh cap on household electricity prices was lifted in 2023. Second, grid fees increased as previously planned government subsidies totalling 5.5 billion euros were removed.

Grid charges for withdrawal are energy-based and power-based and need to be paid for transmission and distribution costs. (ACER 2023)

Other charges

There are no taxes or charges levied on the self-consumed electricity in Germany.

Policies and measures to support self-consumption

Grid tariffs in Germany vary widely according to geographic location. The issue, which has been exacerbated by the significantly higher increases in grid fees in rural areas, has sparked a debate about fairness in recent years. The Federal Network Agency intends to determine the cost burden on individual grid operators resulting from the expansion of renewable electricity plants and then (re)distribute it across Germany[42]. Also, according to the "Solar Package 1", the government should initiate the process to standardise the Technical Connection Conditions (TAB) nationwide. At present, grid connection conditions vary from one grid operator to another.

With the increasing number of air conditioners, heat pumps, household batteries and EV wall chargers, the integration of these devices into local grids is a key issue for the German government. To stabilise the electricity grid and avoid overloading, Article 14 of the EnWG (Energiewirtschaftsgesetz) stipulates that the Federal Network Agency may set regulations to enable the grid-oriented control of "controllable consumption devices" in return for a reduction in grid fees. The implementation of Art 14 EnWG will take place in the course of 2024.

According to the new regulation, load reduction of controllable consumer devices (above 4.2 kw) will be mandatory for installations after 1 January 2024. In return, not only will grid fees be reduced, but the grid operator will no longer be able to delay or refuse the connection and use of controllable appliances on the grounds of grid overload. In principle, the grid fee reduction is granted as a lump sum, independent of the level of consumption. The amount

[42] https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Aktuelles_enwg/VerteilungNetzkosten/eckpunktepapier_verteilungnetzkosten.pdf?__blob=publicationFile&v=5 Accessed: 12/04/2024

varies between €110 and €190 gross per year, depending on the grid fee charged by the local grid operator. For appliances with a separate meter, consumption-dependent reduction is also possible and must be requested by the consumer from the relevant energy supplier. Dimming is only possible up to a minimum capacity of 4.2 kW. [43]

A new addition to the "Solar Package 1" is the rules on the supply of electricity to communal buildings. In future, tenants' electricity will also to be subsidised if the photovoltaic systems for supplying tenants in apartment buildings are installed on outbuildings (e.g. commercial buildings or garages). Shared building supply is intended to be a first step towards energy sharing, but the process of full implementation has not yet been completed in this case.

Simplifications for the so-called "photovoltaic balcony systems" are an important part of "Solar Package 1". Among other things, this will reduce bureaucracy in the registration procedure. In future, simplified registration with the Federal Network Agency will suffice, and the grid operator will no longer need to be informed about the installation of a plug-in solar device.

In addition to the feed-in-tariff, a subsidised loan from the Deutsche Kreditbank für Wiederaufbau (KfW) is available to finance solar installations. Some federal states and municipalities also offer investment grants. These subsidies can be combined.

Since 1 January 2023, the purchase and installation of a PV system (up to 30 kW, or 15 kW per apartment in multi-apartment buildings) and associated electricity storage systems has been exempted from VAT.

Evaluation

In the German system, there are many opportunities for citizens to green their energy use. The government is constantly trying to promote solar investment and simplify administrative procedures. While maximising solar installations is a top priority, the compensation mechanism used is less flexible. Feed-in tariffs are fixed for 20 years, and do not take into account short-term market prices, while the roll-out of smart meters and the uptake of dynamic tariffs have also been slow. These limit the motivation for prosumers to adjust their consumption.

3.4 Greece

The role of self-consumption in energy policy

Grid-connected PV systems have been supported in Greece since 2007, but self-consumption was not yet possible at that time. Total PV deployment surged until 2013, when the renewable target set for 2020 was reached due to an overly generous FIT provided to investors. The resulting increase of the support budget amidst the Greek financial crisis prompted retroactive regulatory changes to the support system that have stalled investments.[44] At the same time, the restrictive measures taken as part of the economic adjustment program in response to the Greek financial crisis have increased inequality and poverty among the population.[45] When the

[43] https://www.enbw.com/service/faq/steuerbare-verbrauchsanlagen. accessed: 12/04/2024

[44] Nikas et.al (2020) Barriers to and consequences of a solar-based energy transition in Greece, Environmental Innovation and Societal Transitions, Vol. 35, 2020, Pages 383-399, https://doi.org/10.1016/j.eist.2018.12.004.

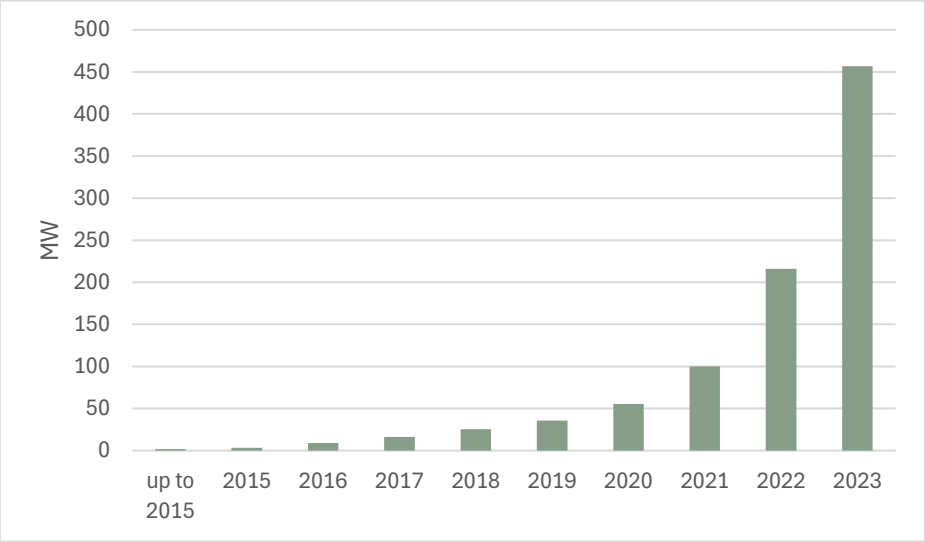
[45] Kaplanoglou, and Rapanos (2018) Evolutions in consumption inequality and poverty in Greece: the impact of the crisis and austerity policies, Rev. Income Wealth, 64 (1) (2018), pp. 105-126, DOI: 10.1111/roiw.12287

regulatory framework for self-consumption and net metering was introduced into legislation[46] and launched in 2015, it was seen not only as a means of empowering consumers, but also as a measure to help combat energy poverty. In 2016, virtual net metering was also made available.[47]

Self-consumption contributes to increasing energy independence and to achieving the country's ambitious renewable energy targets. Greece's renewable energy target for 2030, as set out in the draft of its revised National Energy and Climate Plan (NECP), is 44%, with an 80% share of renewable electricity (RES-E). This is expected to increase to almost 95% by 2035. The provisional target for solar capacity is 13.4 GW.[48]

As shown in Figure 12, self-consumption PV capacity has been growing dynamically since 2016, reaching 457 MW by the end of 2023, accounting for 6.4 % of the total PV capacity of around 7088 MW.[49]

FIGURE 11: INSTALLED CAPACITY OF SELF-CONSUMPTION PV SYSTEMS IN GREECE



Source of data: HELAPCO, 2024[50]

[46] Established by Law 4203/2013.Source: Tselepis, S., THE PV MARKET DEVELOPMENTS IN GREECE, NET METERING STUDY CASES, CRES, Center for Renewable Energy Sources and Saving, http://www.cres.gr/kape/publications/photovol/new/S%20%20Tselepis%20%20The%20PV%20Market%20Developments%20in%20Greece%20%20Net metering%20Study%20Cases%2031st%20EUPVSEC%202015%20Hamburg%20%207DV.4.26.pdf, accessed: 2/04/2024

[47] By amending Low No. 3428/2006. Source: RES-Legal, 2019, http://www.res-legal.eu/search-by-country/greece/single/s/res-e/t/promotion/aid/net metering-law-no34682006-amended-by-law-no42032013/lastp/139/, accessed: 2/04/2024

[48] Draft Updated NECP of Greece, 2021-2030, November 2023, https://commission.europa.eu/publications/greece-draft-updated-necp-2021-2030_en, page 7, accessed: 20/05/2024

[49] https://helapco.gr/xoorigle/2024/02/pv-stats_greece_2023_eng.pdf, accessed: 16/05/2024

[50] https://helapco.gr/xoorigle/2024/02/pv-stats_greece_2023_eng.pdf, accessed: 16/05/2024

The current framework

The possibility to participate in the net metering program was closed in May 2024 for new installations (with some exemptions[51]), based on Law 5106/2024.[52] A net billing system is to replace net metering, but the secondary legislation with the implementing rules has not yet been adopted. Therefore, the exact details are not yet known. Stakeholders are concerned that this could lead to a temporary halt in the further expansion of self-consumption.[53]

Eligibility

Initially, net metering was available for installations up to 20 kW or up to 50% of the contracted capacity in the case of entities with higher electricity demand (100% in the case of public organizations, such as schools, hospitals, etc.), until the total PV capacity remained below 500 kW. The rules were different for islands not connected to the mainland electricity grid. In 2021, the 500 kW limit was extended to 3 MW for those consumers connected to the mainland grid. However, in 2023, as part of the transition to the new system and reportedly due to grid constraints, the size of eligible installations was reduced to 10 kW for households and 100 kW for commercial and public organizations.[54]

The duration of the net metering contracts signed with the suppliers of household consumers was 25 years. Virtual net metering could also be used by prosumers, with the same contract duration, available to legal entities with activities in the public interest, farmers, and energy communities with natural persons as members.

In case of the upcoming net billing system, no size limit exists for entities wishing to self-consume their own generation. Virtual net billing will be available for businesses as well, as opposed to net metering, either as a single company or through an energy community.[55]

Metering and billing arrangements

The DSO in Greece (HEDNO) is recently changing its practice of reading electricity meters every 4 month to monthly readings. Prosumers under the net metering scheme pay for the net electricity consumed if they buy more electricity from the grid than they feed into it. Otherwise, if they have a net surplus, kWh credits are granted, which can be carried over to the next billing cycles within a 3-year period. At the end of the 3-year credit reconciliation period, the positive net amount is lost, encouraging prosumers to install PV systems of a size adapted to their annual needs.

The net metering system enables to save on the electricity fee, but prosumers have to pay the grid costs and taxes on all the electricity they draw from the grid, without considering the

[51] Exemptions are farmers with installations up to 30 kW, general government bodies and installations built to meet the demand of energy poor households. Source: https://deddie.gr/en/themata-stathmon-ape-sithia/fv-apo-autoparagwgous-me-energeiako-sumpsifismo-heikonikoenergeiako-sym/anakoinoseis-net metering/anakoinosi-efarmogi-tou-nomou-5106-2024/, accessed: 29/05/2024

[52] https://deddie.gr/el/themata-stathmon-ape-sithia/fv-apo-autoparagwgous-me-energeiako-sumpsifismo-heikonikoenergeiako-sym/anakoinoseis-net metering/anakoinosi-efarmogi-tou-nomou-5106-2024/, accessed: 29/05/2024

[53] https://energypress.gr/news/sef-ti-epitassei-i-koinotiki-kai-ethniki-nomothesia-gia-tin-aytokatanalosi-energeias, accessed: 29/05/2024

[54] https://balkangreenenergynews.com/greece-slashes-allowed-capacity-for-prosumers-tightens-rules-for-energy-communities/, accessed: 20/05/2024

[55] https://helapco.gr/xoorigle/2023/11/HELAPCO_Self_Consumption.pdf, accessed: 20/05/2024

excess electricity they feed in.[56] Therefore, all customers pay their fair share of the system costs, which is a particular advantage of the Greek net metering system.

The detailed rules of the new net billing scheme are not yet fully published.

Sell rate design

As previously written, under the net metering system, it is not possible to sell the surplus at the end of the 3-year reconciliation period, so the remaining credits are lost. The virtual account is held by the supplier of the prosumers. In the case of a change of supplier, the contract with the old supplier is terminated and a new contract is concluded with the new supplier for the remaining years of the 25-year period.

With the introduction of net billing, there will be a real-time clearance of electricity drawn from and fed into the grid. No final decision has yet been taken on the selling price of excess electricity. According to news reports, the Ministry of Environment and Energy is considering a fixed sales price for smaller PV systems, which would be lower than the electricity tariff paid for electricity drawn from the grid. The aim is to encourage immediate consumption of the electricity generated while also ensuring a relatively reasonable payback period.[57] Prosumers will have a contract with DAPEEP, the renewable energy market operator, which will pay for the electricity. Prosumers are expected to receive a single bill that includes the amounts sold to and consumed from the electricity grid.

No network fees are applied in case of electricity injection at the moment.

Retail price system

The Greek retail price is made up of the electricity fee, the electricity system charges, and other taxes and levies. Depending on the supply contract, the electricity fee can be fixed, variable (i.e. changing with the monthly prices), or dynamic (changing during the day)[58]. System charges include the fixed and variable transmission and distribution tariffs. Other charges and levies include the Special Levy on Pollutant Emissions, the Public Service Obligation fee (see the next subsection), the Special Consumption Tax (which is also subject to VAT), the "Special 5% Duty" to cover fees for customs operations, the State fee in favour of the Hellenic Broadcasting Corporation, as well as other, third-party fees, including local taxes. All tariff elements are levied on the amount of electricity consumed from the grid. However, the Public Service Obligation is levied on the total consumption, which means that the amount of self-consumed electricity is also subject to payment.[59]

Other charges

The above-mentioned Public Service Obligation fee is not specifically levied on self-consumption, but its basis is considered relevant to all electricity consumed. Its main objective is to provide funds to compensate for the difference in the electricity prices for customers in the mainland and the customers in the non-interconnected islands, as the electricity supplied in those islands is generated at higher costs. The fee also provides funds to cover the special tariffs for large families and vulnerable consumers, and the so-called "solidarity service rates"

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[56] https://www.energy-community.org/dam/jcr:5ee4d036-ac87-47b5-991f-28989dfdea2e/REWS_HEDNO_112018.pdf, accessed: 20/05/2024

[57] https://energypress.gr/index.php/news/ypoyrgiki-gia-net billing-ta-dyo-kleidia-gia-tin-elkystikotita-toy-neoy-monteloy-enishysi-stin, accessed: 04/06/2024

[58] https://tsf-plus.gr/electricity-bills-new-tariffs-from-january-2024/, accessed: 8/04/2024

[59] https://www.irena.org/-/media/Files/IRENA/Agency/Presentations/Socioeconomic-impact/2018/Nov/SEE-workshop-Session-VI_HEDNO_NET METERING-IN-GREECE, accessed: 8/04/2024,

for legal entities of a welfare nature, such as church–charity foundations, non-profit entities providing social care services, etc.[60]

Policies and measures to support self-consumption

Greece is offering investment grants and tax incentives to encourage PV deployment. For example, an EUR 238 million subsidy program for rooftop PV with batteries was launched this year, providing grants to households and farmers, to cover 40-75% of investment costs. Part of the subsidy budget is earmarked for vulnerable households, while a 10% bonus is given to people with disabilities and families with at least three children.[61] A tax incentive amounting to 40% of the total cost is also available for improving the energy efficiency of existing buildings, including the installation of renewable energy systems.[62]

Greece has created the necessary legal framework to enable the establishment of energy communities and collective energy self-consumption. As a large proportion (60%) of households live in apartment blocks, the Greek NECP emphasises the need for targeted incentives to promote collective renewable self-consumption.[63]

Because the lack of grid connection capacity is a major obstacle for new installations, a special rule is applied for the provision of capacity to self-consumption units. In case the capacity of a grid substation is increased due to network development, 10 MW of the new available connection capacity per substation will be made available to household installations (up to 10.8 kW capacity), energy communities, farmers and small and medium-sized enterprises.[64] Peer-to-peer trading or selling electricity through aggregators from household systems has not yet been relevant so far, given that no trading of excess electricity is possible under the net metering system. No clear rules are in place yet related to this for the new net billing scheme.

Evaluation

Although the previous net metering system met the requirement to make consumers contribute to the costs of the electricity system, it did not allow for the sale of surplus electricity. Nevertheless, it offered investors favourable payback conditions with an unusually long netting period of 3 years. However, the transition from net metering to net billing is not going smoothly. While the previous system was terminated, contracts under the new system are not yet available due to the lack of secondary legislation. This has led to a final rush of applications before the old system was suspended, while some experts fear that the market may freeze due to the delay in the implementing ministerial decision.

The availability of grid connection capacity is a major problem and grid congestion is becoming more frequent. Self-consumers cannot fully utilize the peak capacity of their plants to avoid congestion at peak production times. Occasional curtailments also occur. The allocation of capacity improvements to self-consumers helps to implement the subsidy programs, allowing the connection of new systems, and investment subsidies are offered for the installation of co-located batteries to alleviate grid congestion problems.

However, as the implementation rules related to the new, net billing system have not yet been published, it is not yet known at what price PV owners will be able to sell their excess electricity.

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[60] https://heron.gr/en/breakdown-of-electricity-bill/, accessed: 8/04/2024

[61] https://balkangreenenergynews.com/greece-launches-subsidy-program-for-rooftop-pv-with-batteries/, accessed: 31/05/2024

[62] https://clean-energy-islands.ec.europa.eu/countries/greece/legal/energy-efficiency-policies-ee/energy-efficiency-measure-tax-rebate-energy, accessed: 2024/06/04

[63] Draft revised NECP of Greece, October, 2023, p. 195, 83ffdc95-2d22-4c67-8d4c-a3e59f752921_en (europa.eu), accessed: 04/06/2024

[64] IBID, p. 190

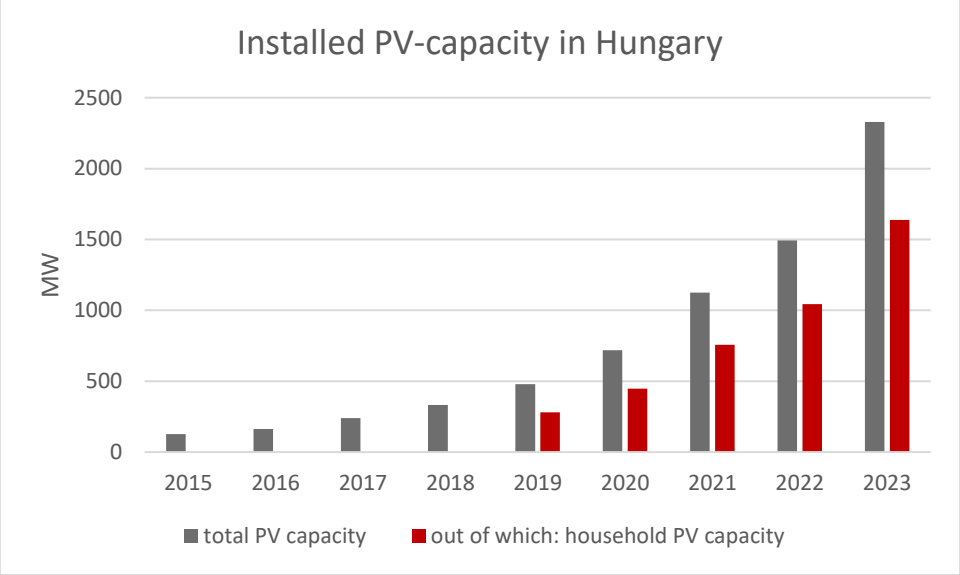
Although the Ministry's plan to set a fixed selling price can help prosumers to predict the expected benefits of their investments, it does not encourage demand-side adjustments to avoid grid congestion, nor does it facilitate the adequate use of batteries.

Nevertheless, the virtual net billing offered by the new scheme will help to achieve a higher level of self-consumption.

3.5 Hungary

In Hungary, decentralised electricity generation, the so-called household-sized generation (HMKE), has grown rapidly in recent years. The main technology installed is solar PV, which now provides 99% of the capacity of household-sized generation. There has been a significant change in the self-consumption scheme as of January 2024, and a slowdown in new investments is expected in the coming years.

FIGURE 12: DISTRIBUTED SOLAR PV CAPACITY IN HUNGARY, 2015 – 2023



Source of data: MEKH[65]

The role of self-consumption in energy policy

Over the past few years, residential solar PV installations in Hungary have exceeded all expectations. The government's previous target of having at least 200,000 households with an average of 4 kW of rooftop solar by 2030 has already been surpassed. In December 2023 the solar PV capacity below 50 kW reached 2,3 GW. 70% of this capacity (1.6 GW) was installed by households.[66] The main driver of residential solar PV investments was the net metering scheme, which allowed a yearly netting of electricity volumes fed into and withdrawn from the grid.

[65] Source: https://mekh.hu/nem-engedelykoteles-kiseromuvek-es-haztartasi-meretu-kiseromuvek-adatai , accessed 29/05/2024

[66] Ibid.

Hungary's Draft Updated National Energy and Climate Plan[67] states that the electricity grid needs to be prepared for the increased decentralized generation, and that "the new priority target group for the deployment of renewable capacities with installed capacity below 50 kW is enterprises". This shows that the government sees grid investments as the main tool to cope with increased distributed generation and neglects the potential in encouraging the self-consumption of produced solar power adapting to market prices through demand-side measures by households.

Also, the newly imposed separate metering and billing scheme called "gross metering" (bruttó elszámolás), which follows the previous net metering scheme lacks elements that would encourage demand side response.

Eligibility

Household sized power generation (in Hungarian "háztartási méretű kiserőmű – HMKE) is limited to 50 kVA. There is no constraint on the energy source, but in practice 99% of volume and capacity is made of solar PV.

Metering and billing arrangements

From 8 September 2023, new HMKE installations are no longer eligible for net metering but are subject to separate metering and billing ("bruttó elszámolás"). Electricity exported to the grid and electricity withdrawn from the grid are measured separately. Existing HMKE installations must switch to the new separate metering and billing scheme after 10 years of net metering.

Excess electricity exported to the grid is taken over by MVM Next Zrt., the sole universal service provider of electricity to households. According to the legislation, households will also be able to sign a contract with any electricity supplier, but so far there are no offers from trading companies to households to buy their excess solar energy.

Sell rate design

According to the legislation, the selling price for exported electricity is linked to the energy component of the regulated household retail price[68], which, in 2024, amounts to around 5 HUF/kWh (approximately 1.3 EURcent/kWh)[69]. For non-household prosumers the sell rate is even lower, only 1 HUF/ kWh (approx. 0.3 EURcent/ kWh). These rates are the result of the government policy of maintaining the utility costs at a low rate within the universal service, through imposing strict price controls on suppliers, which led to distorted end user prices and cross subsidisation (see also the next subsection).

Currently, no grid fees apply to electricity exported to the grid.

Retail price system applicable

Household electricity prices have been regulated by the government since 2013. In August 2022 the scheme was changed and regulated energy prices only apply to electricity consumption up to the national average (up to 210/kWh monthly consumption). Above the average consumption, the price is double of the regulated price.

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[67] https://commission.europa.eu/publications/hungary-draft-updated-necp-2021-2030_en , accessed 28.05.2024.

[68] See Annex 2 to 4/2011. (I. 31.) NFM decree

[69] Non-household generators receive even less remuneration for exporting excess solar electricity: 1 HUF / kWh.

Within the universal service, households can choose between different tariffs. The standard A1 tariff consists of a fixed energy fee and other price elements (network charges, taxes). The A2 tariff has two time zones: the peak period between 7:00 and 23:00 on weekdays, and the reduced off-peak period between 23:00 and 7:00 on weekdays and weekends. The B tariff can only be used to operate appliances with a controlled connection point, i.e. measured by a separate meter and permanently connected to the grid. It is recommended for the operation of heat storage appliances such as boilers. Electricity is available for only 8 hours a day, mainly during off-peak hours, controlled by the DSO.

Due to the low, regulated price level, there is no incentive for households to leave the universal service. As a result, there is also a lack of demand for retail services outside the universal service, which means that market players do not offer supply contracts to households.

Transmission and distribution grid fees apply to the electricity taken from the grid. In case of households, the distribution grid tariff consists of a fixed (lump-sum) and a variable (energy-based) charge, and in case of the transmission fee only an energy-based charge.[70]

For the electricity withdrawn from the grid, 27 % VAT applies. An income tax related to surplus electricity needs to be paid if the income or revenue exceeds the threshold set by the tax law.

Other charges

No charges or taxes are levied on the self-consumed electricity in Hungary.

Policies and measures to support self-consumption

At the beginning of 2024, the Hungarian government launched a HUF 75 billion (EUR 199 million) support scheme („Solar Energy Plus Programme") to provide non-refundable financial support to households for the installation of solar panels and energy storage systems. Eligible technologies are new installations of solar PV with an inverter of 4-5 kW and a battery storage capacity of 7.5-10 kWh. Applications can be submitted until the available budget is exhausted.

The H-tariff (*H* stands for heat pumps) is also an electricity tariff available to households. It was created to provide a preferential tariff for heat pumps and heating systems using renewable energy sources such as solar energy. This special tariff was established by decree in 2010 and has since been available as part of the universal electricity service. Its main feature is that it is not available all year round: the preferential rate is only available from 15 October to 15 April, so it is not available for cooling in summer. In addition, the combination of solar PV and heat pumps requires the operation of two separate meters with two different tariff systems, as the PV systems can only be operated at the A1 tariff.

The Electricity Act has transposed the provisions on energy communities. The energy regulator (MEKH) lists four energy communities in its registry.[71] However, detailed regulations are still lacking, which is delaying the operational start of these energy communities in Hungary. No rules have yet been developed on how residents of multi-apartment buildings can share the electricity from PV systems installed on the roof of the building. Solar panels on the balcony are also not allowed.

[70] A capacity-based distribution fee (elosztói teljesítménydíj) has been imposed into legislation, but it has been kept at zero HUF/kW/year for consumers with load profile tariffs (currently all households under universal service). Consumers with metered consumption pay a capacity-based fee of around 40 EUR/kW/year. Source: Annex B to MEKH decision H5847/2023.

[71] Source: https://mekh.hu/villamosenergia-ipari-engedelyesek-listaja, accessed: 29/05/2024

Evaluation

The change from the *net metering* scheme to the *separate metering and billing* scheme allows for a fairer distribution of grid costs among electricity consumers. However, from the point of view of PV owners, their revenue streams will change not only with the amount of grid fees to be paid, but also with the instant valuation of injected electricity. The export fee of 1.3 EUR cents/kWh is very low even at the Hungarian price levels, and there are currently no offers from market participants to buy their excess electricity. Retail tariffs in the universal service provide little motivation to adjust consumption to market signals.

Due to regulatory burdens, energy communities and other energy-sharing business models are not yet operational, while they could serve as an alternative to selling the surplus to the buyer MVM Next.

Investment incentive programs are irregularly available and are often paid out slowly.

3.6 Italy

While Italy has easily achieved its 2020 renewable energy target, the 2030 targets - particularly the updated ones resulting from the European Union's (EU) Fit for 55 (FF55) package - are much more ambitious. Even though capacity additions have increased recently due to changes in the regulatory framework, Italy is far from installing 4 GW of new renewable capacity per year needed to meet the 2030 targets. In 2022, 1.6 GW of new PV capacity and 0.5 GW of new wind capacity were installed in Italy.[72]

The role of self-consumption in energy policy

Italian self-consumption is dominated by PV, but some other technologies can also be observed. According to the statistics of the Italian Government Agency for Sustainable Energy, Gestore Servizi Energetici (GSE), in 2017, 75% of the self-consumed energy (not only in households) comes from solar PV, complemented by 16% from bioenergy and 10% from hydropower[73]. It can be assumed that the share of solar energy is even higher if only the residential sector is considered.

The evolution of PV capacity in Italy are summarised in Figure 13.

The growth is driven by several channels, namely new capacity under self-consumption schemes, new capacity from renewable tenders and private PPAs. Italy's PV-based electricity production accounted for 14% of the country's electricity mix in 2023[74]. In 2023 out of 30.3 GW total installed PV capacity a little more than 7 GW accounted for household size installations.

The government has very ambitious targets for solar PV, as according to Italy's draft updated NECP, the plan is to increase the total PV capacity to 80 GW by 2030, more than three times the current level[75]. The strategic document highlights that self-consumption will be an important element of future PV deployment, but not in its present form. Current incentives

[72] Source: https://www.iea.org/reports/italy-2023, accessed 28/06/2024

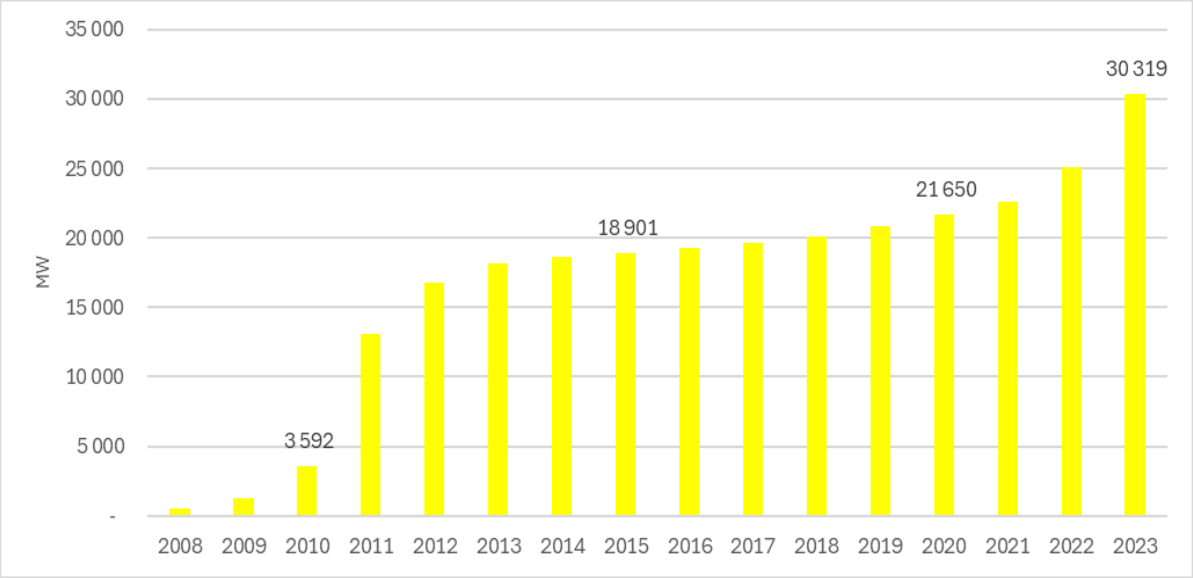
[73] F. Ceccaroni (2019): Self-consumption schemes in Italy, GSE presentation, https://www.energy-community.org/dam/jcr:84196734-6a9d-4102-af64-1f5d06810370/RESWS_GSE_112019.pdf, accessed: 08/05/2024

[74] https://www.terna.it/en/media/press-releases/detail/electricity-consumption-2023, accessed 28/06/2024

[75] Ministry of the Environment and Security (2023): Draft revised National Plan for Integrated Energy and Climate (NECP), https://commission.europa.eu/document/download/75b8162c-3d62-4627-8706-c62997b324da_en?filename=ITALY%20-%20DRAFT%20UPDATED%20NECP%202021%202030%20%281%29.pdf, accessed: 08/05/2024

allowing the use of the network as a storage will be phased out, but new measures will be introduced to encourage virtual and collective self-consumption.

FIGURE 13: PV CAPACITY INSTALLATIONS IN ITALY, 2010-2023



Source: Webpage of GSE[76]

Italy currently operates two parallel compensation schemes for individual self-consumption, which are mutually exclusive. The first is the "Scambio sul Posto" which is a net billing scheme that started in 2012 but is scheduled to be phased out at the end of 2024. The second one is the "Ritiro Dedicato", which is basically a one-sided sliding feed-in premium support introduced in 2008.

Eligibility

The eligibility criteria are different for the two self-consumption schemes. In the "Scambio sul Posto" any renewable or partially renewable (hybrid) system can participate, provided that the share of non-renewable energy production is less than 5%, and that the total installed capacity does not exceed 500 kW[77]. For CHP plants, the maximum allowed capacity is 200 kW[78].

The "Ritiro Dedicato" is open to any renewable power plant using the following technologies: wind, solar, geothermal, wave, tidal, and hydro, as long as its installed capacity is less than 1 MW, and it does not benefit from any additional support for renewable energy. It is also possible to participate in the scheme if the power plant receives additional support, if the plant is a solar PV installation up to 100 kW or a hydroelectric plant up to 500 kW. In any case, it is not possible to participate in the "Scambio sul Pusto" and "Ritiro Dedicato" schemes in parallel. The main difference between the two compensation schemes is that the Scambio sul Pusto is a dedicated scheme for self-consumption, while Ritiro Dedicato is open to any production plant that meets its requirements, and therefore has a broader focus than self-consumption.

[76] Webpage of GSE: Statistics (gse.it), accessed: 08/05/2024
[77] If the power plant entered into operation after 2014, in case of power plants with a commission date between 2008-2014 the capacity limit 200 kW, and before 2008 it is 20 kW.
[78] Webpage of GSE (2024), https://www.gse.it/servizi-per-te/fotovoltaico/scambio-sul-posto/chi-pu%C3%B2-accedere, accessed: 08/05/2024

According to the statistics of ARERA (Italian regulator)[79], in 2022 the total capacity of the Ritiro Dedicato was around 8.8 GW, the majority of which was solar PV. The total energy injected into the grid was 8.2 TWh, of which about 6 TWh was solar. The exact share of residential installations is not known. In Scambio, the total participating capacity was 7.8 GW, almost exclusively solar, with 2.9 TWh of energy exchanged. Contracts for both the Ritiro Dedicato and Scambio Sul Pusto systems are always for one year, but they can be renewed indefinitely[80].

Metering and billing arrangements

In Ritiro Dedicato, consumers actually sell their electricity; in Scambio the value of the energy sold and purchased is netted, and consumers receive ex-post compensation based on their use of the grid as virtual storage.

Scambio sul pusto is a net billing scheme, where prosumers normally pay for the electricity they consume from the grid in their monthly bills but receive a compensation every six months that reflects the monetary credit they receive for the excess electricity they feed into the grid during the semi-annual period. This means that there is effectively a half year netting period. However, in case the electricity feed in is higher than the electricity taken from the grid, the countervalue of the surplus can be settled at the end of the year[81] (see the next subchapter).

The scheme is not in line with the EU legislation, as associated network costs are also netted. Therefore, it will be phased out at the end of 2024.

Ritiro Dedicato is not a dedicated self-consumption scheme. Electricity injection and consumption are handled separately within the scheme, i.e. it is a separate metering and billing system. The system provides a guaranteed minimum price for the first 1.5 GWh of electricity injected into the grid (2 GWh in the case of biomass) on an annual basis[82]. GSE makes monthly payments for the electricity sold, which are settled at this guaranteed minimum price. It is also possible to access the scheme in a simplified manner, when the payments are made by the network operator[83]. At the end of the year, additional compensation is paid for each hour of the year in which the hourly zonal price was higher than the guaranteed minimum price (and the 1.5 GWh is not exceeded).

In the Ritiro Dedicato system, electricity consumption is billed in the same way as for non-self-consumer Italian households, except for the instantaneously self-consumed energy. The smart-meter rollout in Italy is 97.5% (ACER and CEER, 2023) for household electricity consumers, which allows for the operation of such dynamic settlement schemes.

Sell rate design

Under the Scambio sul Pusto scheme, there is no actual selling of electricity in the traditional sense, instead, the prosumers receive a compensation payment from GSE, based on the relative magnitude of the exported and withdrawn energy.

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[79] ARERA (2023): Stato di utilizzo e di integrazione degli impianti di produzione alimentati dalle fonti rinnovabili e di generazione distribuita https://www.arera.it/fileadmin/allegati/docs/23/335-23.pdf, accessed: 08/05/2024

[80] Webpage of Sorgenia (2024), https://www.sorgenia.it/guida-energia/ritiro-dedicato, accessed: 08/05/2024

[81] M. Tricarico (2024): Scambio sul posto: cos'è, come funziona e calcolo, switcho.it, https://www.switcho.it/blog/luce-gas/scambio-sul-posto/, accessed: 08/05/2024

[82] ARERA (2023): Stato di utilizzo e di integrazione degli impianti di produzione alimentati dalle fonti rinnovabili e di generazione distribuita, https://www.arera.it/fileadmin/allegati/docs/23/335-23.pdf, accessed: 08/05/2024

[83] Webpage of Sorgenia (2024), https://www.sorgenia.it/guida-energia/ritiro-dedicato, accessed: 08/05/2024

The compensation is paid on a semi-annual basis and is calculated according to the following formula.

$$C = min(\sum_t PUN_t * qw_t\,;\ \sum_t PZ_t * qi_t) + EF * \min\,(\sum_t qw_t\,;\ \sum_t qi_t)$$

where C represents the total compensation received, PUN_t is the volume weighted average price of all price zones in Italy (also called National Single Price)[84] in the respective hour, qw_t is the withdrawn energy in the respective hour, PZ_t is the hourly zonal electricity exchange price, and qi_t is the amount of injected energy in the given hour. EF is a fixed exchange fee (grid charge) depending on the type of the network, aggregating all fees and tariffs, while t stands for the respective hours[85].

This means that the compensation is equal to the monetised value of the energy withdrawn from the grid or injected (whichever is lower), plus the energy exchanged (minimum of the energy withdrawn or injected), multiplied by the flat rate representing the associated network costs and fees. Thus, through the compensation, the prosumers of Scambio sul Pusto can use the grid as a virtual storage during the netting period, as the associated costs of using the grid are reimbursed.

Actual selling of the electricity only occurs if the value of the energy injected is greater than the value of the electricity consumed from the grid during the year. In this case, the difference in value is paid back to the prosumer at the end of the year, but it is also possible to use the access revenue as a credit to reduce the next year's consumption value. The compensation mechanism is fully managed by GSE in Italy.

Under the "Ritiro Dedicato" scheme, the guaranteed minimum price is set by the GSE for each year. In 2024, the guaranteed minimum price for photovoltaic power plants was 46.6 EUR/MWh.[86] Power plants that produce throughout the year receive the guaranteed minimum price for each unit of energy fed in (up to 1.5 GWh, and then the zonal exchange price). The billing period is monthly. At the end of the year however a compensation is paid, for all the hours during which the market price (zonal hourly electricity exchange price) was higher than the minimum price. The compensation is the difference between the actual market price and the minimum price multiplied by the injected quantity and aggregated over the year. Thus, in practice, power plants receive the market price, unless it is lower than the guaranteed minimum price, up to 1.5 GWh.

No system charge is levied on the electricity injected (ACER, 2023).

Retail price system

Italy operates three separate retail markets, a free market and two regulated markets: one for all types of customers (Maggior Tutela), which will be closed in mid-2024, and one for vulnerable customers. In 2021, almost 60% of household customers were in the free market[87], which share will probably increase with the phasing out of the Maggior Tutela in 2024. Self-consumers can choose any of the retail markets.

[84] Volume weighted average zonal price, also called Single National price.
[85] M. Tricarico (2024): Scambio sul posto: cos'è, come funziona e calcolo, switcho.it, https://www.switcho.it/blog/luce-gas/scambio-sul-posto/https://www.switcho.it/blog/luce-gas/scambio-sul-posto/, accessed: 08/05/2024
[86] For other technologies the guaranteed minimum price differs.
[87] IEA (2023): Italy 2023 – Energy Policy Review, https://iea.blob.core.windows.net/assets/71b328b3-3e5b-4c04-8a22-3ead575b3a9a/Italy_2023_EnergyPolicyReview.pdf, accessed: 08/05/2024

In the free market, the electricity consumed is valued on the basis of the agreement with the supplier. For regulated consumers, it is indexed to the PUN value. The PUN price, known as the National Single Price, is the volume-weighted average price of all price zones in Italy[88]. In addition to the market price element, the retail price also includes a fee paid for the services of the retailer. In both systems, prosumers are billed for the consumption excluding their instantaneous self-consumption, although in Scambio, the credit received for feed in reduces the final bill, as shown in the previous sub-section.

The retail rate includes other charges and taxes as well, which are partially or fully compensated in case of the Scambio Sul Pusto, but must be paid under the other scheme.

The main charges that consumers have to pay are the energy and power-based transmission system charges, and the power-based and fixed distribution system charges, all of which are static fees (ACER, 2023), the excise tax, renewable energy levy, and a reduced VAT of 10% for self-consumers (normally 22%)[89].

In Italy the final electricity price can be considered relatively high, according to Eurostat data, it was for 35.7 cent/kWh in 2023 for the largest household consumer category, which was the 5th largest value in Europe[90]. Around 66% of the total price is the energy fee, which is higher than the European average.

Other charges

There are no taxes or charges levied on the self-consumed electricity in Italy.

Policies and measures to support self-consumption

Tax incentives are one of the main policy instruments to promote PV installations in Italy. The most widespread is the so-called "Superbonus" scheme. This is a special tax scheme that was introduced in July 2020. It is a 110% tax refund for works to improve the energy efficiency of homes, including the installation of solar panels and charging points for electric vehicles[91]. Electricity producers benefiting from the Suberbonus tax credit are obliged to participate in the Ritiro Dedicato system for at least 5 years. The scheme was originally planned to run until July 2022, but it was extended under the same conditions until the end of 2023 and further extended until 2024 for those projects already started[92]. It is important to note that the “Superbonus“scheme is not compatible with the Scambio sul Pusto settlement system.

There is another tax relief called the renovation bonus, which is a 50% reduction in income tax associated with the purchase of a PV system[93]. In addition, Italy has investment grants specifically for agricultural PV and low-income households[94].

The European Commission approved the Italian State Aid scheme for collective self-consumption and energy communities in early 2024. The scheme consists of two elements

[88] https://www.enel.it/en/supporto/faq/cos-e-il-pun, accessed: 08/05/2024
[89] ENEL, https://www.enel.it/en/supporto/faq/come-leggere-bolletta-luce, accessed: 08/05/2024
[90] Average annual value for the consumption category of 2 500 kWh to 4 999 kWh - band DC. Source: EUROSTAT, Table of Electricity prices components for household consumers - annual data [nrg_pc_204_c__custom_11206051], accessed: 08/05/2024
[91] European Commission (2024), https://clean-energy-islands.ec.europa.eu/countries/italy/legal/energy-efficiency-policies-ee/tax-regulation-mechanism-superbonus-110, accessed: 08/05/2024
[92] A. Avante & A. Armellini (2023): Italy to partially extend costly 'superbonus' tax credits, reuters.com, https://www.reuters.com/world/europe/italy-partially-extend-costly-superbonus-tax-credits-2023-12-28/, Accessed: 08/05/2024
[93] Biotech Energia, https://www.biotechenergia.it/en/bonus-fotovoltaico-2023/, accessed: 08/05/2024
[94] CAN (2024): Italy’s Solar Rooftop Country Profile, updated, https://caneurope.org/content/uploads/2024/04/Italy-Residental-Rooftop-Solar-Country-Profile.pdf, accessed: 08/05/2024

applicable to energy projects with a maximum total capacity of 1 MW, where a premium tariff of 100 EUR/MWh is paid over 20 years, and an investment grant is also provided, which can cover 40% of the total cost[95].

Evaluation

Italy introduced a net billing, and a buy all, sell all type of settlement scheme relatively early compared to other European countries. As a result, the pace of deployment of new installations was less stimulated by the compensation mechanism itself, so that additional incentives were needed for greater deployment. Many additional incentives have been introduced in the country to support self-consumption by households, the most important of which is probably the "superbonus" introduced in 2020, which provided a very generous tax refund for households installing new PV for self-consumption.

Italy operates two parallel compensation schemes. The first is a net billing system called Scambio sul Pusto, which will be phased out at the end of 2024 because it is incompatible with EU legislation by including electricity system charges in netting. Although net billing systems could be redesigned to exclude the grid tariffs from netting, Italy opted for a separate metering and billing scheme as an alternative. This scheme, called Ritiro Dedicato, allows only instantaneous self-consumption, and prosumers also contribute to the electricity system charges. The price received for the injected electricity can be considered dynamic, linked to the zonal hourly market price, which together with the use of smart meters can encourage demand response, i.e. increasing self-consumption/decreasing feed-in during the peak PV production hours.

Increasing the self-consumption rate can be achieved by investing in household storage systems, which gained momentum with the superbonus tax relief and the high electricity prices during the energy crises, although penetration is not yet very high. Another option is the sharing of the electricity produced through collective self-consumption and energy communities, which has recently been the focus of Italian renewable energy support policy. Several parallel schemes exist in the country and a very generous support scheme has been approved by the European Commission in early 2024. Currently, the installed production capacity associated with collective self-consumption is not yet high, so it remains to be seen whether the current incentives will be sufficient to facilitate spectacular growth in this sector.

3.7 Netherlands

The role of self-consumption in energy policy

The Netherlands has a very generous net metering scheme in place, which is designed to incentivise new installations by guaranteeing that the investment will pay for itself within 7 years. The scheme has boosted the development of small-scale PV installations, as shown in Figure 15. The installed capacity of residential PV systems has grown from 0.4 GW to over 10 GW in the last decade, accounting for 42% of the total installed capacity of 23.9 GW at the end of 2023[96].

Withdrawal of the scheme has been on the agenda of policy makers in recent years due to its high cost. The latest plan was to phase out the scheme gradually between 2025 and 2030 and

[95] European Commission, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5787, accessed: 08/05/2024

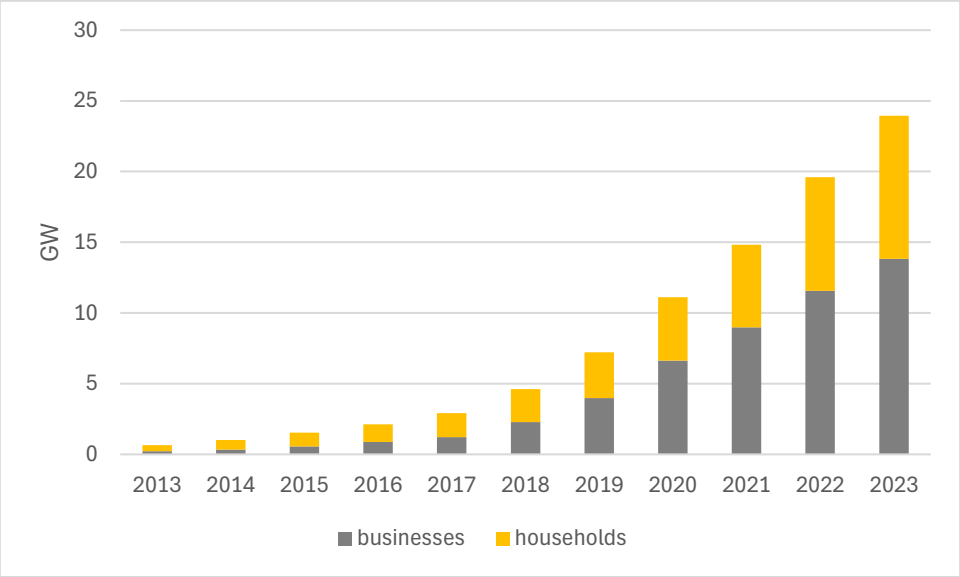
[96] CBS (Statistics Netherlands), https://www.cbs.nl/en-gb/news/2024/25/power-from-solar-panels-increased-slightly-in-2023, accessed: 29/06/2024

close it from 2031. However, the new government coalition announced in May 2024 that it will abolish the net metering system for all prosumers in one go from 1 January 2027.[97]

Suppliers have already started to phase in so-called "feed-in charges" in recent years, which prosumers have to pay when a net surplus is fed into the grid, in order to cover the costs of their associated services.[98]

The current system is designed to prioritise the use of already developed areas and surfaces for renewable energy production, before new undeveloped areas are included. The Netherlands is one of the leading countries in Europe (highest per capita solar capacity on the continent) with its dynamic capacity expansion over the last decade, which is expected to slow down soon as the grid's absorption capacity reaches its limits. Based on the analysis[99] of the revised NECPs, the Netherlands, unlike other countries, has not increased its ambitions to install new solar power plants compared to the 2019 version.

FIGURE 15: TOTAL INSTALLED SOLAR PV CAPACITY IN THE NETHERLANDS BY MARKET SEGMENT, 2013-2023



Source: CBS, 2024[100]

Eligibility

The set of eligible actors is defined by the limit on the installed capacity of the connection, which limit is 3x80 A. Households in the Netherlands have either a 3x15 A or 3x25 A connection, so they are all eligible. This limit has an impact on the companies that want to participate in the scheme.

[97] https://www.pv-magazine.com/2024/05/16/netherlands-to-phase-out-net-metering-scheme-in-2027/, accessed: 29/06/2024

[98] Sources: https://www.pv-magazine.com/2024/05/10/netherlands-approves-grid-fees-for-rooftop-pv-system-owners/ and https://www.keuze.nl/energie/terugleverkosten, accessed: 29/06/2024

[99] EMBER_ A power sector analysis of draft NECPs (2023) https://ember-climate.org/app/uploads/2023/11/NECP-analysis-for-EU-COM.pdf , accessed: 18/04/2024

[100] CBS (Statistics Netherlands), https://www.cbs.nl/en-gb/news/2024/25/power-from-solar-panels-increased-slightly-in-2023, accessed: 29/06/2024

Even though the stated aim of the scheme is to guarantee the payback of the investment in 7 years, eligibility does not end at the end of the 7th year. There is no general time limit on the support period of the installations, but with the abolition of the scheme constantly on the political agenda, there has been uncertainty recently.

Metering and billing arrangements

In most cases, annual netting is used, but there is also the possibility to use alternative time frames, such as half-yearly netting or monthly netting. Another, less common alternative is to use dynamic contracts with hourly or quarterly netting.

Billing is monthly and consumers typically pay an average flat-rate bill, and at the end of the year volumes and payments are netted over the year. Surpluses cannot be carried over to the next annual netting period.

As explained in the section on the retail price system below, the grid tariffs paid by households do not vary with the amount of electricity consumed, so they cannot be avoided by netting. Prosumers can only save the cost of the electricity supplied, the energy tax, and the VAT on the amount taken from the grid to the extent that it is offset against the amount fed in.

Sell rate design

Netting takes place through the contractual relationship between self-consumers and their electricity suppliers, who therefore take and pay for the surplus electricity. At the end of the netting cycle, prosumers with a surplus receive the price set by their supplier (non-regulated), which is around 80% of the market price and free of all taxes and levies.

As mentioned above, some suppliers charge prosumers for feeding their net surplus back into the grid. Depending on the supplier, the charge may be fixed or variable based on the amount of kWh fed in.[101]

Retail price system

Until the energy crisis, annual fixed energy prices were the most popular (annual or even three-year fixed prices); since then, shorter-term, more dynamic price structures have appeared to reduce the risk of price changes on the supplier side. As prices have returned to pre-crisis levels, the reintroduction of annual contracts is being encouraged. If a consumer wants to get out of the contract before it expires, they are subject to fines, which reduces the risk for suppliers.

Household retail rates consist of the following elements:[102]:

- Supply cost: The price of electricity supplied, called “delivery rate” consists of a *fixed* and a *variable* part. The fixed part covers the costs of the supply service (also called standing charge), while the variable part is the price per kWh set by the supplier. Consumers can have a single meter, a double meter or a smart meter. With a double or smart meter, a TOU rate is available, i.e. different prices are paid during the peak and

[101] https://www.keuze.nl/energie/terugleverkosten, accessed: 15/05/14

[102] Sources: CBS Statistics Netherlands (2023): Average energy prices for consumers, 2018 - 2023 https://www.cbs.nl/en-gb/figures/detail/84672ENG#TransportRate_6, https://www.consumentenbond.nl/energie-vergelijken/energierekening, https://www.overstappen.nl/energie/energierekening, accessed: 14/04/2024

off-peak hours (normal/low rate).[103] More and more suppliers are offering dynamic rates (hourly prices), which can be selected when a smart meter is installed.

- Network tariffs: In the Netherlands, grid tariffs do not depend on the amount of electricity used. They consist of a periodic connection charge, a capacity charge and a metering charge. They are paid in the bill to the supplier, who passes on the payments to the DSO, who passes on part of it to the TSO.
- Taxes: These include the energy tax, which is levied per kWh consumed. The energy tax is reduced up to a certain amount (considered as basic needs) in the form of a tax credit. In addition, the former renewable energy surcharge (ODE) has been incorporated into the energy tax. The VAT on electricity consumption is 21%.

Other charges

There are no taxes or surcharges to be paid on the self-consumed electricity.

Policies and measures to support self-consumption

In addition to the generous net metering scheme, the installation of residential-scale renewable energy systems is supported by preferential loans, and there is no VAT on solar panels.

There are also incentives at the collective level. The SCE scheme (Subsidy scheme for Cooperative Energy Generation) is available to energy cooperatives and homeowners' associations that want to produce renewable energy from solar (PV), wind or hydro power[104].

Evaluation

The net metering scheme in the Netherlands generously supports household-sized prosumers, resulting in a substantial number of small-scale PV installations and significant costs for the government. This measure was introduced without a specified end date for the scheme or the duration of support for installations. The scheme provides credits for injected electricity on a kWh basis; therefore, it does not encourage consumers to use the energy they produce immediately.

However, the scheme meets the requirements of EU regulation in terms of a fair contribution to system costs, as these do not vary with consumption, and are therefore not included in netting.

Grid connection for households is not delayed currently but grid congestion is becoming an increasing problem, and it is expected that higher levels of electrification can cause more difficulties. For example, if electric cars and heat pumps are operated in a household and the timing of their energy use does not coincide with the peak production of PV panels, the grid can become congested at different time periods.

The latest status of the net metering scheme is determined by the new government's coalition agreement, which decided to phase out the scheme earlier than expected, for all PV owners. However, this affects self-consumers in different ways, negatively affecting the payback period for prosumers who have recently installed their PV systems, and also discouraging new investment in the residential sector.

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[103] Aansluiting regelen (2022) https://www.aansluitingregelen.nl/wl/corporate-housing-solutions-en1117/meer-informatie.php?pakket=stroom-gas_1&U= accessed: 20/04/2024

[104] Business.gov.nl : Subsidy scheme for Cooperative Energy Generation (SCE) https://business.gov.nl/subsidy/subsidy-scheme-generating-cooperative-energy/ accessed: 20/04/2024

3.8 Poland

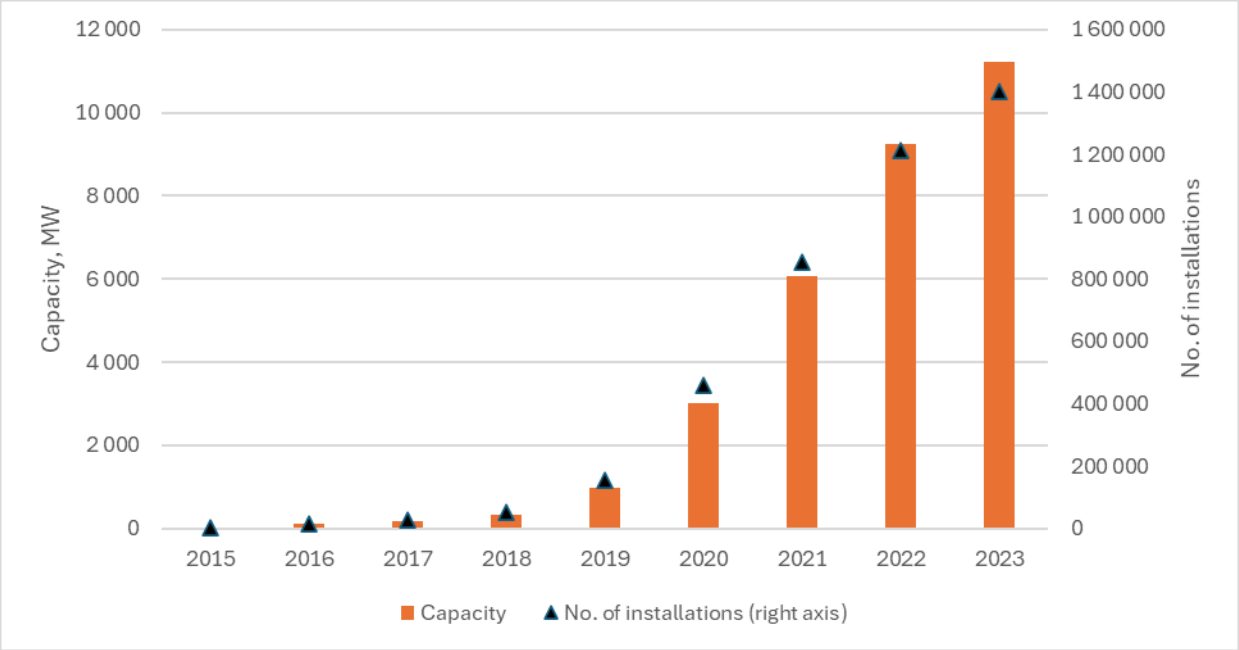
The role of self-consumption in energy policy

The goal of the Polish government by involving citizens in energy production, is to make them contribute to reaching the net-zero target of the country and increase energy security.[105] The revised NECP draft of Poland sets an overall renewable energy target of 29.3% for 2030, and 50.1% renewable electricity (RES-E) share. It estimates that the number of prosumers might increase to 2 million by 2030.

As can be seen on Figure 16, the number and capacity of self-consumer micro installations have started to increase dynamically in 2019, and reached 11.2 GW at the end of 2023, increasing to 11.3 GW in February, 2024 operated by over 1.42 million prosumers.[106] The capacity made up about 66% of the total installed PV capacity in the country (17,057MW) at the end of 2023.

A net metering system was used formerly to support self-consumption which was replaced by a net billing system in April 2022.

FIGURE 16: CAPACITY AND NUMBER OF SELF-CONSUMER MICRO-INSTALLATIONS (UP TO 50 KW) IN POLAND, END OF YEAR, 2015 - 2023



Source of data: PTPiREE based on ARE Monthly Bulletins [107]

[105] Ministry of Climate and Environment: Net billing – system rozliczeń w praktyce, https://www.gov.pl/web/klimat/nowy-system-rozliczania-tzw-net billing, accessed: 22/03/2024

[106] PTPiREE, Mikroinstalacje w Polsce, http://www.ptpiree.pl/energetyka-w-polsce/energetyka-w-liczbach/mikroinstalacje-w-polsce, accessed: 20/03/2024

[107] https://www.are.waw.pl/badania-statystyczne/wynikowe-informacje-statystyczne/publikacje-miesieczne, accessed: 02/04/2024

Eligibility

In Poland, consumers, who produce renewable electricity from micro-installations up to 50 kW capacity for self-consumption can become prosumers. These can include households and enterprises in case the goal of generation is not to pursue an economic activity. Eligible consumers can benefit from the scheme for 15 years.

Metering and billing arrangements

The metering and billing arrangement in Poland transformed into a net billing system from net metering in place previously. Before that no special scheme was in place, producing energy from a household-sized PV system was possible with an operation permission, similarly to any other electricity plant, selling the electricity at market prices. Self-consumption was also possible, as the plant was located behind the meter.

Virtual net metering will be possible from next year as regulated by the Renewable Energy Law.[108]

Household-consumers have smart meters, the penetration of which is gradually increasing to meet the rate of 80% by 2028.[109] In case of a newly installed PV system, the household has to replace the electricity meter. The metering interval is one hour. The billing cycle can be monthly, half a year, or quarter of a year.

The netting period of the net billing system is one hour. For the hours in which exported electricity is higher in a month, the average monthly market value of electricity (value of exported electricity) is placed into a special virtual account with the electricity provider. This money is used to pay for the bills.

From next year the value of the hourly electricity fed into the grid is going to be accounted for using the hourly market value. It is possible to transfer a positive monthly amount to the next month up to a year. At the end of the year, only 20% of the accumulated money can be paid out to the prosumer, the rest is deleted in order to encourage self-consumption.

Sell rate design

Surplus rate is static for injecting into the grid until 30th of June 2024, based on the average monthly market price. From 1 July 2024, the value of injected electricity will be the hourly day-ahead market price. No grid tariff has to be paid for the amount fed into the grid.

As regards taxes in relation to surplus energy injected, no system fee or additional charges are levied on the amount fed in. However, there is a burden of paying VAT when buying electricity from the grid, even when using the credited energy value stored on the virtual account of prosumers. Income tax must be paid if the revenue from energy sales at the end of the reconciliation period (one year) is high, however, because only up to 20% of saved surplus can be paid out, it is quite rare.

The exported electricity is taken and paid for by the supplier of the prosumer.

[108] URE, https://www.ure.gov.pl/en/communication/news/358,The-long-awaited-amendment-to-the-Energy-Law-comes-into-force-today-What-are-the.html, accessed: 02/04/2024

[109] IEA, Energy Law Amendment in Poland, https://www.iea.org/policies/12773-energy-law-amendment, accessed: 2024/04/22

Retail price system

The electricity fee to be paid for electricity drawn from the grid can be static, time-of-use or dynamic, depending on the specific contract consumers have with their suppliers. Suppliers may also charge a fixed monthly fee to cover the cost of their services.

The network tariff has a fixed and a variable component. Other charges include a subscription fee, which has to be paid for reading the meter, and depends on the frequency of readings. A transition fee is charged to collect funds for power plants closed earlier than planned, which is a fixed monthly fee. The quality fee is related to the costs of maintaining the quality of electricity supply in the country, while the capacity fee aims to compensate generators for maintaining energy security (its value depends on the annual electricity consumption). The RES and Cogeneration charges cover the costs of supporting to these types of installations.[110] The renewable contribution largely depends on the actual electricity market price.

Electricity consumption is subject to 23% VAT.

Other charges

There are no taxes or surcharges to be paid on the self-consumed electricity.

Policies and measures to support self-consumption

Poland offers grants supporting investments in the installation of PV micro-installations and energy storage facilities. One of these is the "My Electricity" program, the 6th phase of which will be announced in 2024. It might reimburse up to 50% of the investment costs of PV systems, storage, heat storage, heat pumps and energy management systems.[111] In the last phase of the programme, the subsidy amounted to up to 50% of eligible costs and PLN 6000-7000 (EUR 1390-1620) could be acquired. Another financial instrument, the Clean Air Priority Programme provides funding for the comprehensive energy renovation of buildings and replacement of outdated heating systems, also including the installation of solar panels.[112]

New business models of shared self-consumption are made available by the changes in regulation. Virtual net metering will also be allowed from next year. Although peer-to-peer trading is possible, it does not yet work in practice.

Evaluation

One of the bottlenecks to development is the lack of connection capacity, and the problems of solving grid congestion and flexibility issues. The new scheme aims at alleviating the problems by changing the sell rate from monthly average to hourly market value. This will create an incentive for PV system owners to adjust their consumption to market prices, thus inducing a certain degree of demand response. On the other hand, PV owners might consider the uncertain market prices to be of high risk, as the value of their exported electricity might be low in the sunny hours, while household storage systems are still expensive. The investment support schemes might contribute to installing some storage systems in the households helping to optimize injections to the grid, but the support is not available for everyone and is not continuously available.

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[110] https://enerad.pl/wiedza/rachunek-za-prad/, accessed: 2024/04/18

[111] Gazeta Prawna , 27 February 2024, "My Electricity 6.0" in 2024, https://serwisy.gazetaprawna.pl/energetyka/artykuly/9442718,moj-prad-60-w-2024-pierwsze-informacje-o-zasadach-nowego-programu.html, accessed: 2024/04/22

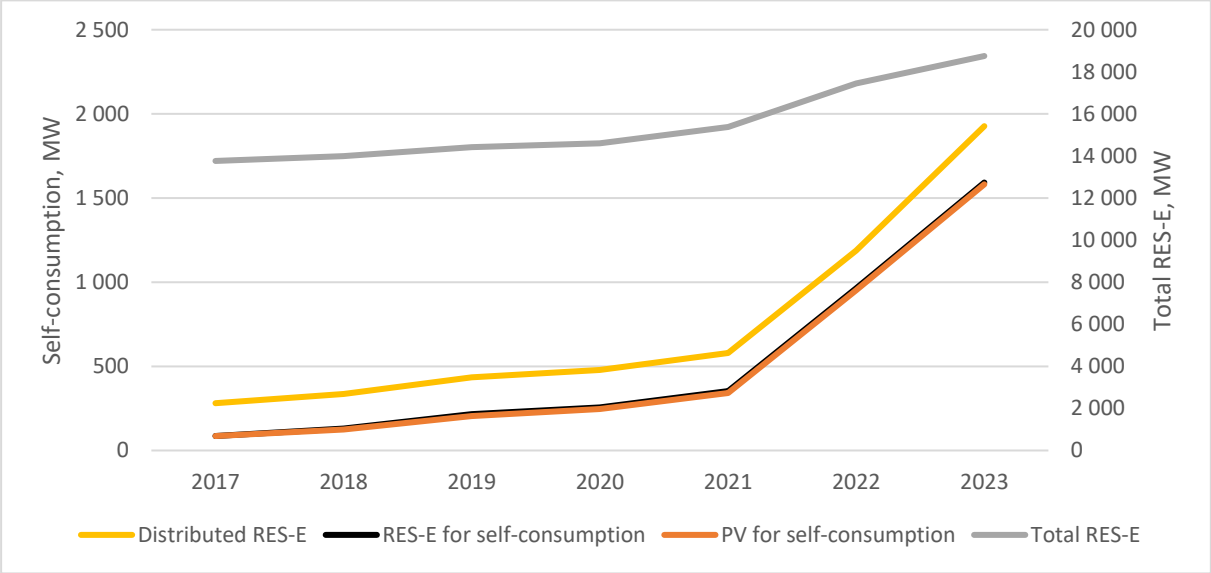
[112] EC, https://commission.europa.eu/projects/update-clean-air-priority-programme_en, accessed: 2024/04/22

3.9 Portugal

Portugal sets an ambitious, 49% RES goal until 2030 in its draft updatedNECP, within which the share of renewable electricity would be 85% (90% with renewable hydrogen consumption).[113]

The capacity of self-consumption production units, the majority of which is solar PV installation, increased from 86 MW in 2017 to 1592 MW in 2023, with solar capacities accounting for 1581 MW. This figure contains household units and the self-consumption units of companies and other entities. The deployment accelerated from 2021, due to decreasing installation costs and the increasing market prices together with some advantages provided by the government. The share of self-consumption capacity within the total renewable capacity was 9% at the end of 2023, while the share of units for self-consumption represented 82% of the distributed generation capacity in the country.[114]

FIGURE 14: EVOLUTION OF RES-E CAPACITY IN PORTUGAL: TOTAL, DISTRIBUTED, SELF-CONSUMPTION UNITS, AND SELF-CONSUMPTION PV, 2017-2023



Source: DGEG[115]

[113] Draft National Energy and Climate Plan 2030 of Portugal, June 2023, (Draft NECP, 2023) page 37. https://commission.europa.eu/publications/portugal-draft-updated-necp-2021-2030_en, accessed: 2024/04/11

[114] DGEG – Direção Geral de Energia e Geologia, Estatísticas rápidas das renováveis, https://www.dgeg.gov.pt/media/mdmivv3u/dgeg-arr-2024-02.pdf, accessed: 2024/04/18

[115] Ibid.

The role of self-consumption in energy policy

One of the Portugal's main objectives with promoting self-consumption units is to contribute to the country's high RES-E target. The draft updated NECP sets a specific target of 5.5 GW of decentralized solar capacity to be reached by 2030.[116]

Self-consumption has been possible in Portugal since 2015, before which micro (up to 150 kW) and mini (up to 250 kW) installations could only produce electricity to inject into the grid.[117] At present, Decree-Law 15/2022 sets the rules for self-consumption units (UPAC), promoting individual and collective self-consumption as well as renewable energy communities, which are entitled to produce, self-consume, share, store and sell energy.[118]

The current framework

Portugal has a separate metering and billing system, in which prosumers have two contractual relationships, one with their supplier, from which they buy the electricity consumed from the grid, and one with an aggregator, to which they can sell their surplus electricity. In case the self-consumer agrees with an aggregator and sells the electricity on the market, then they agree on the price. In this way, both the retail price and the selling price are formed in the market.

Those prosumers who, for whatever reason, are temporarily without a contractual partner can sell their electricity to the aggregator of last resort for a certain period of time. In this case, the selling price is set by regulation, its value is linked to the monthly market price. Between 2015 and 2019, surplus energy could be sold to the last resort supplier at 90% of the average monthly market price. This discount was abolished, but a fee must be paid for the services of the aggregator.

The self-consumption framework established in late 2014 was changed in 2019 to comply with the EU regulation. The major changes were the abolishment of the previous system, which provided a market-indexed fixed price for the sale of excess electricity, and the introduction of 15-minute metering and netting for self-consumers. It also defined cost-reflective network tariffs, which means that grid users are only charged for the use of those electricity grid segments that they actually use.

The regulatory framework adopted in 2020 already took into account the provisions of the EMD, however, there were changes in 2021 and, more recently, in 2023 (due to changes in the legal framework in 2022). Some of the most important aspects that have been developed were the rules for collective self-consumption, the metering responsibilities – including for generation and storage facilities – and the definition of the conditions for the aggregator of last resort to purchase the excess electricity when needed.

Under the new framework, virtual self-consumption is allowed by using the public grid. In this case, local grid tariffs apply. In the case of collective self-consumption within a building, no grid tariffs have to be paid as only the private internal grid is involved in the transfer of electricity. The DSO makes the calculation for the deduction of generation from metered consumption.

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[116] Draft National Energy and Climate Plan 2030 of Portugal, June 2023, (Draft NECP, 2023) page 43, https://commission.europa.eu/publications/portugal-draft-updated-necp-2021-2030_en, accessed: 2024/04/11

[117] Decree-Law 153/2014, https://www.dgeg.gov.pt/media/mdmivv3u/dgeg-arr-2024-02.pdf, accessed: 2024/04/18

[118] Draft National Energy and Climate Plan 2030 of Portugal, June 2023, (Draft NECP, 2023) page 8, https://commission.europa.eu/publications/portugal-draft-updated-necp-2021-2030_en, accessed: 2024/04/11

Eligibility

As regards the eligibility to participate in the system, there is no size limit for the self-consumption scheme in Portugal, and producers can participate in the scheme without any time limit. As a general rule, self-consumption units have to be the size of capacity adequate for the energy needs of the consumer, corresponding to peak hour consumption.

Metering and billing arrangements

The current compensation mechanism can be seen as a separate metering and billing scheme, but the electricity exported to and imported from the grid is netted every 15 minutes, so net metering is incorporated into the system for this short time period. Currently, more than 85% of consumers have smart meters, the roll-out of which will be completed in 2024. It is mandatory for self-consumers to install a smart meter, which will be provided by the DSO when they register for self-consumption.

The billing cycle is monthly. There is no netting of the imported and exported electricity beyond the 15-minute periods. In the case of consumers with a 3-phase grid connection, netting is done for the 3 phases aggregated. In Portugal, the legal framework does not limit the possibility of providing virtual storage or net metering through a private contract, so market players can offer this possibility. However, network tariffs cannot be subject to net metering or net billing beyond the 15-minute interval. By default, it is not possible to transfer positive values between netting periods.

The compensation system ensures that the income that can be received for feeding electricity into the grid is much lower than the amount that can be saved by using the energy from the RES-E system, thus encouraging self-consumption.

Sell rate design

The electricity that is not consumed can be sold to an aggregator under special contracts at a negotiated price, so there is no specific regulated selling price. This party may or may not be the consumer's supplier. The default situation is the establishment of bilateral contracts with aggregators under market conditions. If these conditions are not available (no market offers or if the contracted aggregator goes out of business), the aggregator of last resort may conclude a contract according to the existing rules for a period of up to four months.

Regarding the selling price, the conditions are to be agreed between the aggregator and the prosumer. The price can be of different types, such as fixed, variable, TOU or other, depending on the contracts offered in the market. In the case of turning to aggregator of last resort, the price is the average of the hourly prices of the daily Iberian market, adjusted to the generation profile of each producer, net of a certain fee for representation and services.

As retailers can also be aggregators, almost all are registered as both supplier and aggregator. However, prosumers do not necessarily contract with the same partner for both activities. Last year there were not enough offers on the market to buy the electricity produced, and the selling prices were considered low in lack of interest and competition for the excess electricity injected. In addition, online comparison tools similar to those used to compare retail offers are not yet available. As a result, there is currently insufficient information for end-users to compare the purchase offers of potential partners to whom they can sell the electricity they export to the grid. On the other hand, many suppliers are also in the business of selling and installing PV systems for self-consumption, under special financing structures, similar to an ESCO contract.

In addition to the selling price of the electricity, there are fees to pay for the services of the aggregator.

No grid tariff is paid for the amount injected into the grid. Installations of less than 1 MW are exempted from paying the 23% VAT on their surplus electricity, which is an incentive provided

to increase the deployment of self-consumption (not applicable in case of companies). [119] Income tax must be paid, as with other income, and self-consumers must declare earnings to the tax authorities [120].

Retail price system

For households, the retail price is mainly static, but in the low-voltage grid about 10% of contracts have ToU tariffs, which are mostly for 2 periods. As the roll-out of smart meters is not yet complete, only estimates can be used for TOU consumption. Retail tariff offers on the market include: (1) static without ToU, (2) static with ToU (usually 2 periods, rarely 3 periods), (3) indexed with or without ToU, i.e. the price level is adjusted on a monthly basis to the average price level on the wholesale market, (4) dynamic price contracts with hourly indexation to the wholesale market (starting to be offered). Most offers are static on the market and indexed price contracts have been relatively popular in the last period.

It is also to be expected that dynamic price contracts will appear on the market soon, as the large suppliers will have to have at least one offer with rates that follow the hourly market prices.

Grid tariffs are static with or without ToU. For households up to 20.7 kVA, the ToU signal is optional (with 2 or 3 time periods). The fixed component depends on the connection capacity. Network tariffs are uniform throughout the country. The NRA sets network access tariffs which, in addition to the grid tariffs for the use of the network, also cover energy policy costs to be allocated to all network users, including the support for renewables. They are not run through the same budget but are allocated through this access tariff. Their value varies from high to even negative values. However, self-consumption and energy sharing are exempt from those costs, as they are not allocated to renewable production.

With regard to the taxes associated with the purchase of electricity, VAT is differentiated according to the level of electricity consumption, and can be 23%, 13% and 6%, depending on the amount used. There is also a special consumption tax (euros/kWh) and the so-called public broadcasting contribution, which all electricity consumers have to pay.

In the case of collective self-consumption, where the shared energy only travels through the internal grid of a building, no system charges are applied to the amount of electricity used. If the shared energy has to use the grid beyond the internal grid, network tariffs are applied based on the voltage levels involved in transmitting the energy from generation to consumption (e.g. if both are on the LV grid, only the LV distribution tariff applies; if generation is in MV and consumption in LV, the sum of the MV and LV distribution tariffs applies).Therefore, if the self-consumption does not use the higher voltage levels of the public grid (e.g. transmission), it is exempted from the respective grid tariffs for the use of the system. There are two conditions for this partial exemption: (1) the installations/facilities must be in reasonable proximity (2) if inverse power flows become dominant, the partial exemption will be reduced by the regulator.

Other charges

No charge has to be paid on self-consumed electricity.

[119] Decree-Law no. 85/2022, of 21 of December

[120] In 2023 the selling of self-consumption surplus from generation units up to 1 MW did no pay taxes below 1 000 € (not applicable to enterprises), established in the yearly state budget law.

Policies and measures to support self-consumption

In Portugal, public subsidies are occasionally available to support the installation of renewable generation units through some funds. As part of the Recovery and Resilience Plan (RRP), the Ministry of the Environment and Climate Action created the Environmental Fund, which includes support for those wishing to install solar panels on their homes. Under the Buildings + programme, an investment grant of up to 85% of the purchase of solar panels and for PV+ batteries were available in 2023 up to a certain amount. Support is also available to help finance new Renewable Energy Communities and Collective Self-Consumption units.

In addition to these, the Portuguese government also provides tax incentives. Households that produce renewable energy from solar panels with a maximum capacity of 1MW, and whose income from the sale of surplus energy does not exceed €1,000, are entitled to an exemption from the income tax. In addition, the value added tax applicable to the installation of solar panels has been reduced from 23% to 6% (in some regions even lower).[121]

There are no restrictions on the use of solar panels on balconies.

As mentioned above, collective self-consumption, aggregators, energy communities can be established and operate in the country. Energy communities are separate legal entities, which can generate, consume and share energy under certain rules. There are also citizen energy communities founded by citizens.

Evaluation

Regarding the challenges related to the compensation mechanism of distributed generation systems in Portugal, no major problems can be identified, the legal and regulatory framework is working well. As in other countries, there may be problems with connection to the grid, although this is mainly the case for larger systems. Up to 30 kW there are rules to protect prosumers, e.g. if the capacity of the system is up to 50% of the contracted capacity, the DSO has to accept the request for connection to the grid in a simplified procedure. However, above this size, there may be restrictions on connection with the desired capacity. In this case, either a new connection point has to be found, or it is possible to ask for grid reinforcement, to which the system owner has to contribute financially.

Although there is no size limit for the scheme, there is a threshold for the purposes of licensing. Under 30 kW, a simple notification to the Directorate General of Energy and Geology is required, stating how much capacity the consumer wishes to install, and some specific conditions must be met. There is no registration fee for this size category. Network restrictions may occur but are not yet common. In the case of collective self-consumption, there are some licensing issues to be resolved, but the regulation is gradually improving.

The legal framework requiring prosumers to sell their surplus by joining an aggregator is intended to make it easier to sell electricity on the market, especially for smaller individual consumers. However, the expected lower electricity prices in the future could be a barrier to investment.

In addition to simplified rules, a good practice in Portugal is that the regulatory process is based on continuous communication with prosumers. For example, several workshops were organised in 2020 and 2021 to find out what rules related to collective self-consumption prosumers would prefer. With regard to the sharing of electricity between households, they wanted to be given the freedom to define their own rules.

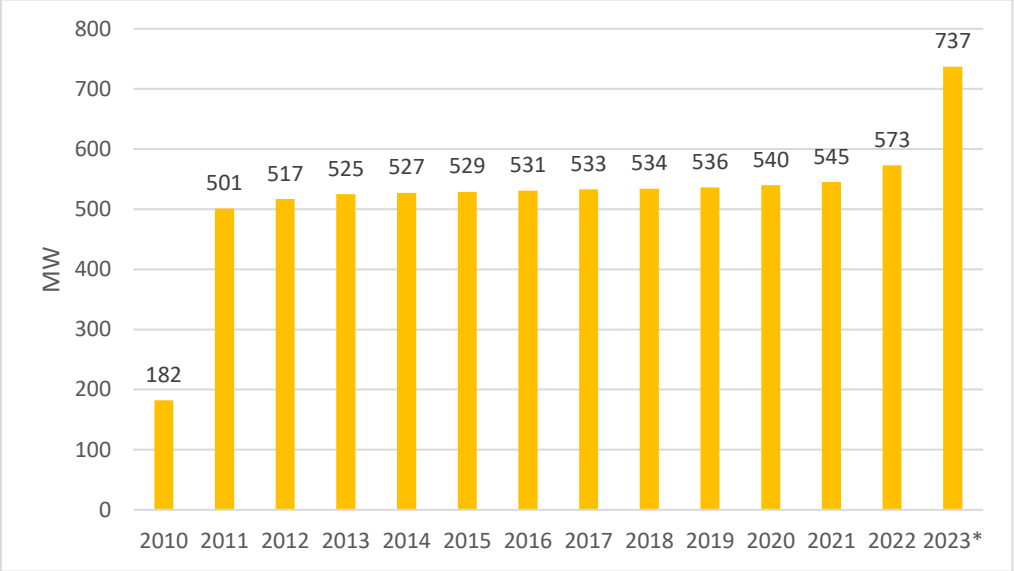
[121] https://selectra.pt/energia/info/paineis-solares, accessed: 05/05/2024

Sharing is managed by the DSO, which allocates the costs according to these rules, whether it is proportional sharing with a fixed sharing ratio, or based on hierarchical or dynamic sharing. In case of hierarchical sharing, the electricity is allocated first to the households at the top of the hierarchy and then to the other consumers, and finally it is fed into to the grid. In case of the dynamic allocation, sharing depends on who is operating appliances at the time of production. If one person is at home and the other is not, the first person should be able to use all the electricity. When the other consumers come home, they also receive part of the electricity produced.

3.10 Slovakia

The level of PV capacity installations in Slovakia is moderate (see Figure 18). A moratorium on connecting installations above 10 kW was imposed for eight years, which kept total PV capacity at 500-550 MW in the 2010s. The slight capacity growth in this decade was the result of new small-scale installations. The relatively higher growth rate of the last two years was mainly due to the introduction of subsidies for prosumers at both the small residential ("small source") and small commercial ("local source") level. The utility-scale segment in Slovakia is still lagging behind and faces one of the highest grid connection costs in Europe. [122]

FIGURE 15: INSTALLED SOLAR PV CAPACITY IN SLOVAKIA, 2010 - 2023



Source: SAPI (data from December 2023)* [123] [124]

[122] PV Magazine (2024): Slovakia's solar additions hit 220 MW in 2023 https://www.pv-magazine.com/2024/01/04/slovakias-solar-additions-hit-220-mw-in-2023/ accessed: 20/04/2024

[123] Slovak Association of Photovoltaic Industry and RES (SAPI) (2023): Slovak Renewable Electricity Market Report 2022 https://www.sapi.sk/files/246_slovak-renewable-electricity-market-report-2022-finalpdf.pdf accessed: 15/04/2024.

[124] PV Magazine (2024): Slovakia's solar additions hit 220 MW in 2023 https://www.pv-magazine.com/2024/01/04/slovakias-solar-additions-hit-220-mw-in-2023/ accessed: 15/04/2024

The role of self-consumption in energy policy

Small-scale PV and prosumers are the main basis of solar expansion in the country, but this expansion is driven more by small-scale commercial PV than by households. Small businesses are supported by investment and operational benefits, while household prosumers can only receive investment support. Metering and billing arrangements are not defined by a comprehensive legal framework in the country, and the conditions for metering and billing of purchased and sold electricity are determined by individual contracts.

Prosumers enter into a contract in the market with a supplier who acts as their retailer and also takes the exported electricity. These contracts also specify who will be responsible for any deviations from the typical production profile.

This market-based system has not been transformed into a more regulated framework during the implementation of the Clean Energy Package, because it has been found to be working well and is preferred by prosumers (both small and local) due to its simplicity and lack of administrative requirements for participants.

Slovakia set a target of 29.5 % RES-E for 2030 according to its updated draft NECP[125]. The NECP recognises the importance of promoting the self-consumption of renewable energy, but no specific measures have been identified or defined in the document. The estimated trajectory for solar PV is 1,000 MW in 2025 and 1,400 MW in 2030, which is relatively easy to achieve from the current level.

Eligibility

A household sized prosumer is called a 'small source', and this definition applies up to a capacity of 10.8 kW. Being a "small source" prosumer has some advantages, e.g. easier grid connection approval. There is also a targeted investment subsidy for this category ("Green Household"), but in terms of being a renewable electricity prosumer, there is no specific scheme to incentivise or influence the behaviour of these actors in a centrally controlled way.

More attention is paid to the role of the larger self-consumer category, the so-called "local source", with a slightly more regulated framework compared to the case of households (until 2022, the size limit of this category was 500kW, but it has been abolished).

Metering and billing arrangements

Metering is generally done on an hourly basis, but with smart meters it is done on a 15-minute basis. If a household installs a PV system, the DSO is obliged to replace the old meter with a smart meter free of charge. The metering unit is the same for electricity fed into and withdrawn from the grid.

The billing cycle is specified in the individual contracts and is usually one month, but billing by calendar year is also possible. In the case of using a virtual battery service, which is offered by suppliers in the market, the billing cycle is usually one month, and it is possible to transfer kWh credits between billing periods up to one year. Only the energy component is taken into account when netting the surplus produced against the quantities consumed, and system charges are excluded.

[125] European Commission: Slovakia – Draft Updtaed NECP 2021-2030 https://commission.europa.eu/publications/slovakia-draft-updated-necp-2021-2030_en accessed: 20/04/2024

Sell rate design

Residential self-consumers mostly sign contracts for a virtual battery service, which works similarly to a net metering, but as it is not defined in any regulatory document, its application can vary from contract to contract. For example, ZSE, one of the largest gas and electricity suppliers in Slovakia, has been offering this service since 2019, charging a service fee per month (currently EUR 3/month). The net surplus is compensated at the electricity price. ZSE designed its service to be profitable if a prosumer "stores" approximately 500 kWh electricity per year. The billing cycle is exactly the same as for regular electricity consumption. [126,127]

Another way of selling surplus electricity is to share it with another consumer who has the same electricity supplier, regardless of their geographical location in the country.

Retail price system

The final household electricity price has several components aside from the energy price, which is mostly single or double tariff, but dynamic contracts are also offered in the market.[128] Supply and distribution charges both have a small fix and a variable part. The value of these charges mostly depends on which tariff category the user belongs to among the eight different category labels Slovakian DSOs can apply (D1-D8). The value of National Nuclear Fund charge[129] and VAT is defined by laws, while further charges (e.g. system operation charge) are determined by the Energy Regulator. [130]

The latest report of the Slovakian Energy Regulator (URSO) presents the distribution of these charges (without VAT and Nuclear Fund charge), according to which, in 2022 the price of commodity accounted for about 47% of the average electricity price, and the fixed supply fee to cover the costs of supply and profit was 5.7%, while system charges, including system services and profits, system operation and grid losses at both the transmission and distribution level made up the rest (47.3%).[131]

Other charges

There are no taxes or surcharges to be paid on the self-consumed electricity.

Policies and measures to support self-consumption

The main subsidy programme supporting new RES installations at the household level is the so-called "Green Household" scheme, which had several phases and provided mostly continuous support for small investments since 2015. Previous phases of the programme supported 60,000 installations and were mainly financed by EU funds and national sources. So far, EUR 124.5 million has been spent on the programmes and the total supported capacity exceeded 460 MW. The current phase started in 2023 and provides 156.1 million EUR to support solar

[126] PV Magazine (2019): Slovakian utility ZSE launches virtual battery for residential PV https://www.pv-magazine.com/2019/02/12/slovakian-utility-zse-launches-virtual-battery-for-residential-pv/ accessed: 20/04/2024

[127] ZSE: A virtual battery for your home (2024) https://www.zse.sk/produkty/virtualna-bateria/virtualna-bateria-pre-vas-domov accessed: 20/04/2024

[128] See for example: https://www.vse.sk/produkty-a-sluzby/elektrina/dynamicka-tarifa, accessed: 20/04/2024

[129] As a result of the energy crisis payments into the National Nuclear Fund were suspended in 2021. https://world-nuclear.org/information-library/country-profiles/countries-o-s/slovakia accessed: 01/06/2024

[130] Janicek F – Ponican J. Sadlon M. (2021) Impact of the fixed and variable component of electricity price on the economic viability of a small-scale photovoltaic power plant, Journal of Electrical Engineering http://iris.elf.stuba.sk/JEEEC/data/pdf/2_121-10.pdf accessed: 01/06/2024

[131] URSO (2023) Annual report 2022 https://www.urso.gov.sk/data/att/7dc/2683.305ded.pdf accessed: 01/06/2024

water heaters, heat pumps, biomass installations and solar thermal collectors of the size of houses/families or apartment buildings in addition to PV, with a cap of 10 kW.[132,133]

No preferential loans or tax reduction are provided by the state. Some financial institutions offer green loans, but they are commercial products.

Peer-to-peer trading is not possible, the supplier is the intermediary in all cases. Energy communities are still in the early stages, as primary legislation is still in its infancy and there are currently no incentives to join an energy community.

Evaluation

Slovakia is in a rather unique situation, as it has not established a legal framework for how electricity consumed from and injected to the grid by self-consumers should be accounted for but has left it to market players to decide on the terms of metering and billing in the form of individual contracts. The contractual system between prosumers and suppliers is well perceived, and considered simple and user-friendly by users, but has not been able to contribute to a significant increase in solar capacity.

In most parts of Slovakia, grid connection is not a problem for households, so it is not yet a major bottleneck for the expansion of rooftop PV. So far, there are only a few hundred MW of small-scale PV in the country, so there are no major grid bottlenecks. However, difficulties might arise at a technical level, as some of the PV panels installed so far are single-phase systems, which have a negative impact on the grid compared to three-phase systems due to the asymmetric feed-in to the grid. At the local level, the DSO can decide if the grid cannot integrate more PV and refuse the connection.

The Slovak example provides an interesting case study of the feasibility of self-consumption systems operating purely on market principles. At present, the system is in its early stages of deployment, with negligible issues relating to the network, and thus low associated costs of virtual storage. The future will show whether, with higher PV penetration rates, this approach can evolve into a system that provides adequate compensation for self-consumers, facilitates further deployment and supports seamless grid integration of small-scale distributed generation.

[132] PV Magazine (2023): Slovakia offers $156.1 million for 2023 residential PV, heat pump rebates https://www.pv-magazine.com/2023/07/13/slovakia-offers-156-1-million-for-2023-residential-pv-heat-pump-rebates/ accessed: 22/04/2024

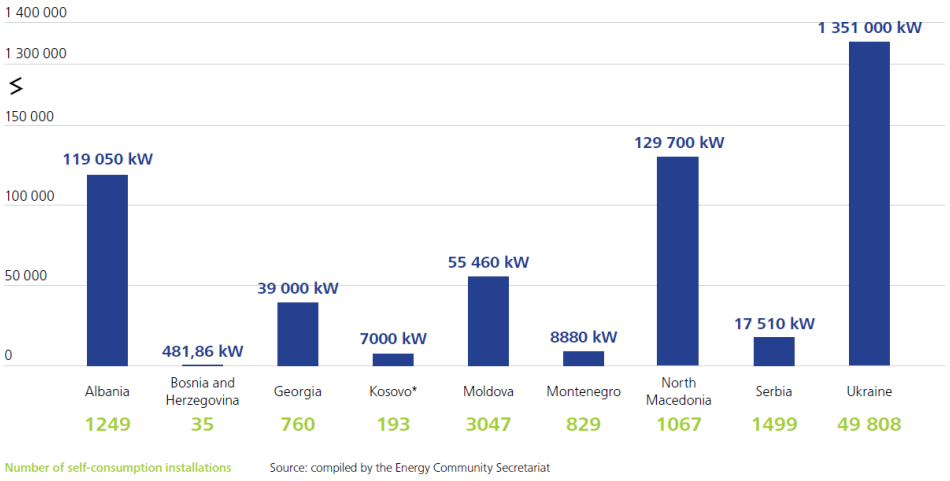
[133] Zelená dománostiam https://zelenadomacnostiam.sk/ accessed: 21/04/2024.

4 EVOLUTION OF SELF-CONSUMPTION REGULATION IN THE ENERGY COMMUNITY COUNTRIES

Energy Community Contracting parties (including six Western Balkan countries, Georgia, Moldova and Ukraine) are currently implementing the Clean Energy Package and RED II of 2018. The deadline of implementation expired at the end of 2022 (most of delays are related to the transposition of the sustainability criteria), and the implementation of the amendments of the directive (RED III) is not expected within a year. The role of self-consumption and energy communities is among the new provisions of the currently ongoing legislative changes. Most of the contracting parties submitted their draft NECPs to the Energy Community Secretariat and it is expected that the plans contain not only policies and measures to support self-consumption, but also to provide national targets in this field. [134]

The Secretariat prepared their own guidelines on the Integration of Renewables Self-Consumers (updated in 2020) focusing on policy frameworks to be included in NECPs, the adequate definition of procedures, terms and conditions, technical requirements, rules for participation in the electricity market, suggestions for remuneration schemes, principles for developing network tariffs and options regarding the application of charges, taxes and levies. A similar guideline was also published this year for renewable and citizen energy communities.

FIGURE 19. INSTALLED CAPACITY OF SELF-CONSUMERS (KW)



Source: Energy Community Secretariat[135]

Figure 1919 presents self-consumer installed capacity data from Q1 2023. Collection of more up-to-date data is currently being collected, and it is already known that some countries doubled or even tripled the number/capacity of self-consumption compared to the figure.

[134] Based on panel discussion comments and presentation of Naida Taso (Energy Community Secretariat): Challenges of self-consumption in Energy Community at REKK's online workshop: The changing regulatory landscape of household self-consumption, 10 of May 2024.

[135] Energy Community Secretariat (2023): CBAM-Readiness tracker https://www.energy-community.org/dam/jcr:d6e80d5e-9290-4e8b-ac7e-5170ec59808a/EnC%20Tracker%2006_2023_final.pdf accessed: 15/05/2024

Serbia is leading the rate of expansion, and Bosnia and Herzegovina also significantly increased the installed capacity.

Contracting parties apply different capacity limits for renewable self-consumption, which define who can participate in the applied remuneration schemes. A few countries differentiate households and legal entities, but most of them define one capacity limit. The differences between the limits are quite significant, especially for legal entities, where there can be a tenfold difference.

FIGURE 16. INSTALLATION CAPACITY LIMIT (KW)*

	Households	Legal entities
Albania	500 kW	
Bosnia and Herzegovina	10,8 kW	50 kW
Georgia	500 kW	
Kosovo*	100 kW	
Moldova	200 kW	
Montenegro	no limit	
North Macedonia	6 kW	40 kW
Serbia	10,8 kW	150 kW
Ukraine	50 kW	

Source: Energy Community Secretariat[136] **Kosovo defined upper limit as the consumer's contracted connection capacity*

EnC contracting parties follow quite similar patterns as EU member countries, their current status of self-consumption related schemes and regulatory changes are the following:

- Albania: from 1st of January 2024 the country switched to net billing
- BiH: net metering is applied for households under 10.8 kW, net billing up to 50kW
- Georgia: currently net metering is applied but they are finalizing the implementation of RED II and are expected to switch to net billing soon
- Kosovo and Moldova: both implemented new renewable energy laws introducing net billing
- Montenegro: still have net metering but they are also in final stages to implement new legislation
- North Macedonia applies a net billing scheme
- Serbia: net metering is in place for households under 10.8 kW, net billing up to 150kW
- Ukraine: a new law was adopted in June 2023 to introduce net billing, in parallel administratively set feed-in-tariffs are still kept for consumers who were already in the scheme until 2029.

EnC countries are facing slightly different challenges than most of the EU member states. Firstly, the generally lower energy prices make investments more difficult to pay back leading to a conclusion that investment grant support would be necessary to further boost deployment. Also, the proportion of the energy-poor population is particularly high in the EnC, as there are

[136] Ibid.

Contracting Parties, where it reaches 30% of the population. Awareness raising campaigns would be helpful to shift focus from the cheapness of energy to questions of sustainability and energy independence. Serbia is a good example in this area, with an online tool that helps calculate an individual's solar potential based on their energy bills and certain characteristics of their residential buildings. The tool also provides all the necessary information on potential financing products offered by banks.

The EnC Secretariat examined the main challenges of reaching higher volumes of self-consumer capacities in the member states and offered suggestions on how to manage these issues. Firstly, for potential network constraints, their recommendation is to identify areas which can absorb more self-consumer capacities and make this information public. The idea of virtual net billing, which is already used in a few countries, can also be helpful. In this case production and consumption occurring at different locations but at the same distribution network can also relieve some load on the network. Another recommendation for DSOs is to consider and adapt their development plans to the high number of new connection permits, and to keep strict timelines for the installation of new connections by giving the right to connect further applicants if those who already got permission cannot meet the deadlines. The last network related recommendation is to encourage governments to conduct in-depth analysis of electricity consumption patterns of standalone houses and multi-store buildings, just like the analysis of electricity generation of PV systems. These assessments can be the basis of further development plans.

As regards transitioning from net metering to more market-oriented metering and billing arrangements, Contracting Parties are recommended to apply real-time prices for the electricity fed into the grid, to encourage prosumers to adjust their consumption and production to market signals. Self-consumer network tariffs should also be designed in a way that ensures cost recovery and reflects the value of grid usage regardless of which scheme is applied.

Balancing responsibility should also be introduced in a way that is not too complex and burdensome for small actors. Contracting Parties are also advised to to implement a regulatory framework for energy storage (in line with the Renewable Energy Directive which is not yet fully implemented) to enable the installation of storage systems.

5 SUMMARY OF THE COUNTRY ANALYSES

The compensation schemes applied to household self-consumption in the ten analysed EU countries can be classified into one or two of the four basic categories in terms of the metering and billing arrangements, although some of them combine the features of multiple mechanisms. They also differ in the design of the sell rate, i.e. the price prosumers receive and the associated costs they have to pay for their surplus electricity sold to the grid, and in the structure and design of the retail price system, which is relevant to what prosumers pay for the electricity they buy from the grid. Table 4 summarizes the main features of the reviewed compensation mechanisms. Please note that the table does not include the other taxes and levies included in the retail rate component, due to their diversity across the countries, but only indicates when one of them is applied not only to the amount consumed from the grid, but also to the amount fed into the grid or self-consumed.

TABLE 4: OVERVIEW OF THE COMPENSATION MECHANISMS IN THE ANALYSED COUNTRIES

	Metering and billing arrangement	Sell rate	Retail rate (excl. taxes, levies and other charges)		Other
			Energy fee	System charges*	
AT	Separate metering and billing & buy all, sell all	Weighted average monthly market price with minimum and maximum limits or market premium (>10 kWp)	Fixed, variable, dynamic, depending on the supply contract	T-tariff: static D-tariff: static/ToU	
DK	Separate metering and billing	Market price (hourly) + charge for service to buyer, fee for metering /balancing to TSO, and injection charge to DSO	Fixed, variable, dynamic, depending on the supply contract	T-tariff: static D-tariff: static/ToU system balance tariff paid to TSO	Availability tariff levied on self-consumed electricity
DE	Separate metering and billing & buy all, sell all	FIT for 20 years	Fixed, variable, dynamic, depending on the supply contract	T-tariff and D-tariff: static, with large regional differences	
EL	Net metering (25 years) for some consumer categories, net billing to be introduced	No option for selling surplus after the 3-years crediting period expires.	Fixed, variable, dynamic, depending on the supply contract	Static/ToU at both transmission and distribution level	Public Service charge levied on self-consumption
HU	Separate metering and billing	Static, fixed	Static	T-tariff and D-tariff: static	
IT	Separate metering and billing	Dynamic: hourly zonal price with minimum	Fixed, variable, dynamic, depending on the supply contract, reduced VAT	T-tariff and D-tariff: static	VAT is lower on electricity consumed from the grid
NL	Net metering, without initially set eligibility period (planned to be phased out)	Non-regulated price set by the supplier, ~ 80% of electricity price	Mostly static but can also be variable or dynamic, depending on the supply contract	T-tariff: static D-tariff: static	Charge on net feed-in by some suppliers.

PL	Net billing	Monthly average price until 2024 July, then dynamic hourly market price, VAT levied also on credited amount	Static, variable, ToU, dynamic, depending on the supply contract	T-tariff: static D-tariff: static/ToU	
PT	Separate metering and billing, 15-minute net metering	Depends on contract with buyer (aggregator)	Static, variable, dynamic, ToU, depending on the supply contract, reduced VAT	Static/ToU at both transmission and distribution levels	VAT exemption on the sale of surplus electricity
SK	No specific scheme, market contracts	Depends on the supply contract, mostly virtual storage service. No compensation for surplus	Static	T-tariff: static D-tariff: static/ToU	

Note: T and D indicate whether the tariff applies to the use of transmission and distribution system.

Austria and Germany operate two different **metering and billing arrangements**, including "separate metering and billing" and "buy all, sell all" mechanisms, Greece would continue to offer the net metering option for certain types of consumers alongside the net billing system to be introduced, and in Portugal, there is effectively a 15-minute net metering due to the 15-minute measurement applied. In those countries, in which the metering and billing arrangement is separate metering and billing, but contractual relationships are based on market agreements, suppliers might decide to account for the net value of injected and withdrawn electricity on a single bill instead of two separate bills (e.g. as planned in Hungary). This makes the system similar to net billing. Other options are also possible depending on the various purchasing and retail options available in the market. In Slovakia, where the regulation does not provide for the establishment of any formal metering and billing scheme, suppliers are ready to offer the service of virtual electricity storage, resembling the net metering arrangement, although without including the system tariffs in the netting.

Net metering is still applied in two of the investigated countries. Greece is in the process of finalizing secondary legislation after phasing out net metering (with some exceptions, such as farmers and vulnerable consumers). The scheme in the Netherlands did not set a specific eligibility period for net metering, however, the gradual phase out and the revision of the self-consumption scheme is in plan. It has to be emphasized, that these two cases are different from the classic net metering schemes, as prosumers have been contributing to system costs in both jurisdictions.

As regards the **sell rate design**, we can state that the main objective of the compensation schemes is to encourage self-consumption. Nevertheless, in some of the countries (e.g. in Austria and Germany) there are schemes available which encourage the injection of generated electricity into the grid, to make use of as much surface area for PV installations as possible, helping to reach national renewable ambitions. In Germany, it is possible that one prosumer enters two different types of compensation schemes.

As to the provision in EU regulation that consumers should be able to sell their electricity at rates reflecting market prices, the picture is rather mixed. There are three countries, where the sell rate shall be dynamic by regulation (Italy, Poland and Denmark), while in Portugal, where prosumers enter into a contractual relationship with an aggregator, the sell rate can be agreed upon in the market, allowing prosumers to choose contracts with the preferred type of sell rates (in case adequately diverse offers are available in the market). The situation will be similar in Hungary, where, at the moment, the sell rate equals the very low, administratively set electricity fee that applies within the universal service system. Although still under elaboration, the regulation will make it possible for prosumers to have private contracts with suppliers for both purchasing and selling electricity at various rates, depending on the available offers. Austria offers sell rates reflecting the weighted average market price of the previous year, or

prosumers can apply for a market premium by participating in auctions. However, they can also enter into a contract with suppliers and agree on different terms for selling their surplus electricity.

Regarding the net metering systems, in the Netherlands it is possible to sell the net surplus at the end of the crediting cycle (usually one year), it is not possible in Greece when the 3-year credit reconciliation period ends. This arrangement has been phased out for most of the users, and the rules of the new net billing system are under elaboration. However, in Slovakia, where there is no formal self-consumption scheme available, and the compensation is arranged through private contracts on the market offering virtual storage, it is not common to pay for the surplus electricity by the suppliers. In Germany, prosumers choose the FIT system, providing fixed sell rate for 20 years, either under the separate metering and billing or the buy all, sell all arrangements, or both simultaneously, as they provide safe returns on investments. When the support period ends, prosumers can sell their surplus to the DSO, and receive a rate equal to the average market price of the previous year less the costs of service.

In some of those countries, where the sell rate is linked to either the hourly or the annual market price, minimum selling price limits can be set to save prosumers from the risks of volatility and facing too long payback periods. This is the case in Austria, Italy and is also contemplated in Poland. Due to the high market prices experienced in the last years, some countries have also applied upper limits (Germany and Austria).

Electricity flows in both directions (injections to and withdrawals from the grid) are metered separately in all the countries investigated, either with two separate meters or with a smart meter. Actually, smart meters are required to be installed along with new solar PV installations in all analysed countries to allow measuring instantaneous electricity flows. Although this would enable utilizing demand response to help system flexibility, only three countries encourage feed in in high electricity periods with dynamic sell rates (Denmark, Italy and Poland).

Prosumers are subject to the same **retail price system** as consumers without a PV system. Static, flexible, ToU and dynamic price contracts are available for households in several but not all countries in the retail market. Although there are no legal restrictions to enter into a supply contract in the market, households in Slovakia and Hungary opt for the regulated static prices available in their countries. As regards system charges, time-of-use tariffs are used in all but three countries (Hungary, Italy and Germany), mostly applied in case of distribution tariffs, providing opportunity to encourage electricity withdrawals in off-peak time periods.

The expectation that prosumers should contribute to the network costs is met everywhere, at least as far as charges for electricity purchased from the grid are concerned (however we did not evaluate how these meet the requirement of being “fair” network costs). The EU legislation (Article 15 (e) of EMD) stipulates that the system charges that active consumers would have to pay shall “account separately for the electricity fed into the grid and the electricity consumed from the grid”. This would suggest that network operators charge for network use in both directions. Yet, it is not typical that the amount fed into the grid by prosumers would be subject to grid charges. Looking at the countries analysed, only Danish prosumers are subject to a fee for metering and balancing services to the TSO, and an injection charge to be paid to the DSO. They also have to pay a fee for the availability of grid electricity, levied on the amount of self-consumption.

Self-consumed electricity is rarely subject to any taxes or levies. Prosumers have to pay a tariff for the option to draw electricity from the grid when they use their self-produced electricity. In Greece, self-consumption is not exempt from the payment of the Public Service Obligation charge, collected to contribute to the electricity costs of consumers in the non-connected islands and vulnerable consumers, among others.

The countries that previously used net metering have chosen net billing and separate metering and billing in roughly equal proportions in our small sample of countries.

As can be seen from the above table, net metering is still in place in the Netherlands (scheduled to be phased out at the end of 2026) and in Greece for some consumer categories. Greece has already officially phased out net metering and will introduce net billing, but the rules for the new system were not fully in place at the time of writing.

Denmark has reformed its compensation mechanism earlier, moving first to hourly net metering and then to instantaneous netting within a separate metering and billing regime. Poland switched to a net billing system, with sell rates reflecting average monthly prices until mid-2024, after which the remuneration will be based on hourly market prices. Hungary has opted for a separate metering and billing arrangement. The fixed selling price in Hungary is set at the electricity fee available under the regulated universal service system, which is rather low, making it economically disadvantageous to feed in.

In the case of those moving to net billing, prosumers sell (will sell) their excess electricity to a central government agency (Poland and Greece), while in the countries switching to separate metering and billing, the approach is to contract with the supplier or another market player (Denmark, Hungary).

The experience of countries that have used other types of arrangements than net metering for a longer period suggests that **additional support is still needed to maintain the dynamics of residential PV deployment** in order to reach the ambitious RES-E targets.

As described above, despite falling technology costs, changes in the regulatory and technical environment of the electricity market have resulted in a longer payback period for investment in self-consumption systems. There are differences between countries in the way support is provided. In some countries, compensation mechanisms rely almost entirely on market prices, and additional support is mainly given in the form of investment grants, tax rebates, preferential loans, and other indirect policies and measures (e.g. Portugal, Italy).

In Germany, the provision of operational support and preferential loans is helping to increase capacity, but the long-standing FIT system has frozen a less flexible system in terms of adaptation to market conditions by prosumers. The situation is similar in Austria, where, despite a high penetration of smart meters, a fixed sales price is offered, although dynamic contracts are available on the market outside the support schemes. Slovakia, which has relied entirely on the market to compensate prosumers, has had a rather moderate take-up rate and investments are highly dependent on the investment subsidies available. Denmark also relies on the market, and does not provide additional subsidies, resulting in a stagnating prosumer sector.

The contribution of self-consumers to system flexibility varies across countries, depending on the type of sell rates, retail prices and the grid charges that apply to them.

Even in countries where the sales price is static, the retail price system or TOU grid tariffs can encourage prosumers to use their self-generated electricity during peak PV generation periods, e.g. by using smart appliances, sharing their electricity if possible, or investing in storage. Demand response is less encouraged in Germany, Hungary, and the Netherlands, where both sales prices and grid tariffs are static for residential prosumers. Grants for investment in battery storage have been available in Hungary, for example, but this is probably not the most efficient way of supporting the flexibility and resilience of the electricity system.

Scarce grid connection capacity and grid congestion is a problem in almost all countries, but in most of them the DSOs are required to implement connection in a specific time period. Still it might happen that the connection is refused and delayed for longer time periods, because strengthening of the grid takes time. Nevertheless, all countries were making efforts to ease administration for new investments in the size categories for residential prosumers, as requested by the RED.

Legislation related collective self-consumption and energy communities are in place in many of the countries, and there are good examples of their operation, especially in the Netherlands, Germany, Greece, Portugal, and Italy. Virtual self-consumption is made possible mainly for

prosumers sharing electricity production and consumption. Investment subsidies (grants, tax rebates) are available in all the countries analysed to alleviate the burden of high initial investment costs, although these subsidies are usually not available on a permanent basis. PV plus storage investments are also encouraged in many countries to decrease grid congestion and facilitate grid connections as well as grid flexibility, although experts' opinions differ on whether supporting individual storage systems is the most efficient way of promoting renewable integration.

6 CONCLUSIONS AND RECOMMENDATIONS

The Energy Community Contracting Parties (including six countries of the Western Balkans, Georgia, Moldova, and Ukraine) are currently implementing the 2018 Clean Energy Package and REDII. The rules related to self-consumption, energy sharing, and energy communities are among the new provisions of the currently ongoing legislative changes. Most of the contracting parties have submitted their NECPs to the Energy Community Secretariat and it is expected that the plans will not only include policies and measures to support self-consumption, but also set national targets in this field. Most EnC contracting parties have transformed or plan to transform their net metering schemes into net billing schemes.

Although the Energy Community Secretariat has prepared its own Guidelines for the Integration of Renewables Self-Consumers (updated in 2020)[137] and published a similar guideline this year for renewable and citizen energy communities[138], based on the experiences of the analysed countries, we may still be able to make some useful recommendations for the design of their compensation schemes. The following findings and recommendations may also be useful for EU MS when further developing their schemes.

- **Simple, straightforward self-consumption schemes make it easier for households to participate in the energy transition.**

It is generally recommended that the compensation mechanism applied to households should be simple and straightforward. Net metering systems meet these requirements, but their phasing out has become necessary to allow prosumers to adapt to the price signals of the electricity systems and to pay for their use of the grid. From this perspective, it could be recommended that net billing is preferable to separate metering and billing, as it requires one contractual relationship, and prosumers receive only one bill including the net value of electricity exported to and imported from the grid.

On the other hand, in countries with more advanced retail markets, prosumers might value the possibility of being able to select among sell-rate market offers. Compensation schemes based on separate metering and billing might basically offer more flexibility to prosumers, as it is possible to choose among those market actors who offer a good price for the electricity fed into the grid, as well as a fair level of associated services, while they can also opt for having the same partner contracted as a supplier and a purchaser and arrange payments through a single billing procedure. In Portugal, for example, prosumers must sign a contract with aggregators who sell their electricity and provide balancing services, while most aggregators also act as suppliers in the market.

- **The payback of PV investments is to be ensured by accompanying subsidy programs.**

While net billing and separate metering and billing schemes have the advantage that they allow consumers to be more aware of market signals, they increase the payback periods of the investments substantially compared to the net metering arrangement. Thus, the new EU framework might not be able to provide the necessary incentives for households' PV deployment on its own, because it creates less favourable conditions. Our research suggests

[137] Policy Guidelines on the Integration of Renewables Self-consumers, https://www.energy-community.org/dam/jcr:7e4760a1-3890-4a7a-a067-d9e16c80ddeb/PG_2020_03_RES.pdf accessed: 6/13/2024

[138] Policy Guidelines 01/2024-ECS of the Energy Community Secretariat on energy communities, https://www.energy-community.org/dam/jcr:70bed24f-42b1-41b4-920e-a451dd54f070/PG%20on%20energy%20communities_ECS_12032024.pdf, accessed: 6/13/2024

that in Member States, where residential PV capacities are constantly growing, governments provide additional support, such as investment grants, tax rebates, and low-interest loans.

However, subsidies made available infrequently, irregularly and in insufficient amounts are not able to promote the right level of investments (e.g. in case of Slovakia or Denmark). Thus, they should be provided regularly, in a predictable way, and it is advisable to allocate a dedicated proportion of funds to energy-poor households.

- **Smart meters are a precondition for the continuous deployment of self-consumption systems. Their cost to households should be socialized.**

Integrating the growing number of distributed generation systems in line with renewable energy targets is a challenge for grid operators, and the increasing rejection of connection requests is delaying further deployment. This reinforces the need to increase grid flexibility. The integration of more systems can also be facilitated by a higher level of self-consumption, which is also economically more advantageous for PV system owners. Smart meters provide real-time data on the amount of electricity being drawn from and fed into the grid, helping to optimise energy use patterns. In those countries, where smart meter penetration is high, it is usually the DSO who pays for the installation, and the costs are socialized for effective and rapid deployment. Prosumers are also required to change their meters and enjoy priority in most of the countries analysed. In some Member States, it is an option for electricity customers or prosumers entering the schemes earlier to replace their conventional meters on a voluntary basis if they contribute to the costs (e.g. in Hungary).

- **Differentiated prices and tariffs and well-functioning electricity markets are needed to enable prosumers to adapt to price signals**

In order to allow prosumers to benefit from more advanced metering and billing systems, it is necessary that the elements of the compensation scheme are designed to encourage demand-side adaptation. This requires either time-differentiated or dynamic selling/consumption prices or TOU network tariffs, as fixed tariffs do not encourage prosumers to adapt to market conditions, even if they are equipped with smart meters.

However, studies show that the simultaneous application of several time-differentiated price elements at the same time might result in a pricing structure possibly with conflicting signals that are difficult for the consumers to understand and adapt to. Therefore, it might be more effective to apply TOU or dynamic pricing to only one of the price elements, as in the case of Italy, for example, where the sell rate is dynamic (location and time-dependent) while the grid tariffs are static.[139] It is recommended that regulators determine which price elements should be prioritised in view of the locally emerging issues (network or market price).

- **Sales price risks for household prosumers should be mitigated.**

Increasingly frequent low market prices during peak PV production periods may discourage investment by households when the rates received for the injected electricity reflect changes in market prices. Shielding prosumers from the risk of too low, or fluctuating market prices could be facilitated by encouraging suppliers/aggregators to provide market services of buying excess electricity and balancing. As they can invest in and operate virtual power plants and larger storage systems more efficiently than individual households, they can offer advantageous

[139] See for example Layer, Patrick and Feurer, Sven and Jochem, Patrick (2017): *Perceived price complexity of dynamic energy tariffs: An investigation of antecedents and consequences.* Energy policy, Vol. 106, pp. 244-254., https://doi.org/10.1016/j.enpol.2017.02.051 Joskow, P. L. (2012). "Creating a Smarter U.S. Electricity Grid." *Journal of Economic Perspectives*, 26(1), 29-48. *DOI: 10.1257/jep.26.1.2*

contracts with different pricing arrangements, tailored to the needs of individual customers. At the same time, it is important to designate a buyer/off-taker of last resort.

An alternative approach is to determine a guaranteed minimum sales price to reduce price risks for household prosumers. This approach has been implemented in Austria and Italy. However, in these countries the purchasing partners are central organisations.

- **TOU grid tariffs, preferential discrimination of prosumers or technical considerations can help mitigate grid connection issues.**

As grid congestion becomes increasingly prevalent at the DSO level, the problem of grid connection emerged in almost all of the analysed countries. Although, only in a few of the countries are connections delayed beyond the deadline set by legislation, there have been instances where the connection has been denied in specific locations. Time-of use grid tariffs can help to reduce grid capacity utilisation during peak hours and alleviate the issue of connections to a certain extent. Another potential solution is to take those households first in the queue which have storage systems or controllable appliances. In Germany, for example, grid tariffs are reduced if the owner of newly installed heat pumps, household batteries, and EV wall boxes (so-called "controllable consumption devices") can be dimmed in return for the decreased charges.

Another good example can be found in Greece, where prosumers and energy communities receive a dedicated share of new grid connection capacity in case of system upgrades.

- **New market models are beneficial for PV owners and help vulnerable customers**

With new emerging market models, PV-owners can sell their excess electricity also to other actors than electricity suppliers, and often receive a higher remuneration. By promoting new schemes and removing existing barriers to collective self-consumption, energy sharing or energy communities, governments can reduce the need for costly support schemes.

As also recommended by the Energy Community Secretariat[140] governments of the Contracting Parties could provide targeted additional funding to renewable energy communities and collectives to include energy-poor households in their communities/collectives. This can not only help the vulnerable households to be involved in RES-E investments and thus ease their cost burden, but they can also benefit from the shared management of the tasks related to building and operating PV systems and the associated administration, as opposed to installing systems on their own.

[140] POLICY GUIDELINES by the Energy Community Secretariat on the concepts of energy communities PG 01/2024 / 12 March 2024, https://www.energy-community.org/dam/jcr:70bed24f-42b1-41b4-920e-a451dd54f070/PG%20on%20energy%20communities_ECS_12032024.pdf, accessed: 6/13/2024

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