EUROPEAN POLICY ADVISORY PAPER

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Introduction

The European Policy Advisory Paper addresses decision-makers and the wider stakeholder energy and climate action community at EU and national level, delivering policy recommendations on how to make more Europeans become PV Prosumers, and finding solutions that effectively remove barriers and allow the integration of higher shares of renewable into the electricity networks.

The current policy context, in particular the recently proposed Green Deal as well as the National Energy and Climate Plans are meant to increase Europe's efforts in deploying more renewable energy technologies, and make PV prosumers benefitting from generating, storing and consuming their own electricity – and selling any surplus for market value. Therefore, the European advisory paper includes an overview of the current state of play in solar energy, outlining the solid growth rate in PV prosumption, but also the significant potential yet to be exploited.

In order to make recent regulatory changes accessible to a broader audience, the Advisory Paper further sums up the EU's new set of rules on individual and shared (or collective) self-consumption, as well as the new DSO framework targeting to accommodate higher shares of renewables, including increasing numbers of PV prosumers – most of which are connected at distribution level. This requires network operators apply innovative solutions in order to maintain Europe's high standards in security of electricity supply – and make the energy systems fit for a decarbonised, decentralised and digital future.

Part I - Recommendations for improving the EU Framework and the Removal of Barriers

To seriously acknowledge our planet's climate emergency, decision-makers in the EU's capitals and Brussels need to take consequent action to decarbonise further and faster[1]. This includes removing the

[1] "Decarbonise NOW!" - PVP4Grid statement to drastically reconsider the EU and its Member States' policy priorities, and commit to sustainable development and more ambitious energy and climate targets

barriers[2] that were identified in the 12 target countries[3] covered in the three H2020 projects PVP4Grid, EU Heroes and iDistributedPV - and that prevent Europeans from becoming PV prosumers. Everybody should get access and be encouraged to use the sun to make their own electricity, whether that is in urban or rural areas, in single or multi-apartment houses, as landlords or tenants, for residential or industrial purpose. In parallel, we need to incentivise smart and decentralised infrastructure development that can connect and integrate higher shares of renewables and get our energy (distribution) systems fit for the future.

To limit global warming, PV prosumers cannot be dealing with lengthy administration procedures, be left without proper information and financial incentives, or prevented from getting easily connected to the grid, or else having countries not establish nor maintain reliable framework conditions. Where not done so yet, national governments and regulators will need to establish regulation that supports self-consumers, and provides the right incentives for making the energy networks accommodate much more renewables in the 2030 and 2050 time horizon. In the meanwhile, Member States should be closely monitored to consequently transpose the "Clean Energy Package" into national legislation, while the EU's institutions need to step up the pace and make the "Green Deal" go beyond existing EU targets and rules, to get PVs on every available roof space and have many more citizens taking part in the transition.

Based on the PVP4Grid project and the implementation of its deliverables[4], four clusters with recommendations have been identified: 1) to policy makers at EU level involved in developing the upcoming policy initiatives under the Green Deal and in assessing the National Energy and Climate Plans; 2) to policy-makers from the Member States involved in the transposition of the Clean Energy Package and the wider national decarbonisation strategy; 3) to decision-makers at both national and EU as for improving regulation network access and connection of new PV systems; 4) to decision-makers at both national and EU as for the further development of smart and decarbonised energy infrastructure.

1) To policy-makers from the EU institutions, we propose the following recommendations:

- The EU should keep sending clear signals - as done by proposing the European Green - to national governments that future policy will be designed to facilitate a flexible, zero carbon energy future.

[2] Please see a summary of the „Key Barriers identified by the EU Projects PVP4Grid, EU Heroes & iDistributedPV", presentation used at European Policy Workshop "PV prosumers on the rise – how Europe can empower more people to produce, consume & sell their own electricity", 21 November, organised within the PVP4Grid project.
[3] Please see below Annex I for the list of barriers identified in the 12 target countries (Austria, Belgium, France, Germany, Greece, Italy, Lithuania The Netherlands, Poland, Portugal, Spain and the UK)
[4] https://www.pvp4grid.eu/guidelines-policy-papers/

Decision-makers in capitals across Europe need a clear mandate to treat carbon emissions reduction as an absolute priority, next to security of supply and energy customer protection. Wherever feasible, the criterion of sustainability should even be prioritised above the two latter.

- The EU needs to maintain its commitment to "Net Zero 2050" and take on the leading role for making Europe become the first climate neutral continent – which can only succeed if clear goals, limits and criteria are set at EU level and Member State level. Therefore, we support plans to revise all relevant energy and climate legislative measures to reflect significantly higher climate ambition, including the Energy Efficiency and Renewable Energy Directives.
- Renewables represent the only viable and economic option to provide sustainable and secure energy for EU citizens – which is why we propose to increase the EU's renewable energy target from the current – and insufficient – 32% to at least 40–45% by 2030, and up to 100% by 2050 at the latest. For instance, in the context of exploiting the still widely untapped potential of solar energy, "re-opening" the Renewables Energy Directive should lead to improve the current EU framework and push Member States to further remove barriers that continue persisting and prevent Europeans from engaging as PV self-consumers.
- When defining concrete strategies under the Green Deal, we encourage EU policy makers to use the momentum of customer engagement and recognise and inform about the great value that goes beyond monetary terms, such as social, environmental and climate awareness related benefits.
- We support the EU's imitative to engage with Member States in a 'renovation wave' of public and private buildings and to rigorously enforce the legislation related to the energy performance of buildings. Renovation standards and the energy performance should incentivise and support the installation of solar panels where adequate.
- For the building sector, additional measures should be assessed, such as obligations to equip new buildings with solar panels and regulation for constructing buildings so that rooftops are compatible and energy profitable with solar panels (avoidance of shade etc.); also, targets should be considered for covering sealed areas with solar panels, such as parking and industrial facilities.
- The European Commission should closely monitor and enforce within the full extent of its competence the transposition of the Electricity Market Directive and the Renewables Energy Directive, and in particular the provisions related to active consumers[5] and renewable self-consumers[6].

[5] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 15

[6] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) Article 21

- The European Commission should thoroughly assess the ambition of the National Energy and Climate Plans (NECPs), and demand additional measures if the level of ambition is not sufficient. As for PV Prosumption, the European Commission should make sure the NECPs address the untapped potential and its contribution for achieving national climate and energy targets.

2) To policy-makers from the Member States involved in the transposition of the Clean Energy Package and the wider national decarbonisation strategy, we propose the following recommendations:

- Member States need to ensure the best possible transposition of the new EU rules regarding active consumers and renewable self-consumers, in particular Article 15 from the Electricity Directive and Article 21 the Renewables Energy Directive, and develop supporting legal and institutional frameworks that: 1) recognise and support a range of organisational forms of PV prosumers; 2) develop long-term and consistent approaches to provide financial support; 3) simplify the administrative procedures and reduce the number of bodies that are involved in the process (and establish one-stop-shops instead).
- National policy makers should design legal frameworks that enable selling excess electricity without supplier licence or registration or being obliged to pay any sort of charges (levies, fees, taxes) on the electricity sold.
- Legal frameworks should allow virtual - and collective - self-consumption with virtual metering points and not limit the installed capacity nor the geographical distance.
- Multi-apartment buildings should be enabled to install solar panels on their roofs for shared self-consumption when a majority of the households/consumers agree, without having to reach consensus among all parties involved[7]. Of course those deciding not to join the shared self-consumption should keep their consumer rights and protection, such as free supplier choice, etc.
- For consumers that are sharing energy with other active consumers or renewable self-consumers, the same rights and protection as for any other (passive) consumers should apply, in terms of supplier switching, billing, termination fees, access to alternative dispute resolution mechanisms and measures for vulnerable customers.

[7] Best Practice Portugal: PV installation for shared consumption on a common part of a building is preceded by authorization by the respective assembly of joint owners, decided by a simple majority (50+1%)

3) For improving regulation around network access and connection of new PV systems, we propose the following recommendations:

- We encourage to strengthen the cooperation among policy-makers, regulatory authorities, network operators and relevant stakeholders such as consumer organisations to ensure fair, open, and transparent access for PV prosumers to the electricity network infrastructure.
- The regulation around network connection of new PV systems is often driven by concerns related to network operation and security, and the affordability for customers. Given the urgency of decarbonisation, sustainability should be recognised as an equal priority – at least.
- European and national regulation for network access and connection, as even within Member States needs to further streamlined, as such regulation differs even among regions within countries – which can be detrimental to planning security and investments. Costs for new connections to the system should be transparent and easily accessible.
- To simplify procedures for network access and connection, direct and efficient communication among customers and the DSOs should be enabled, so customers (incl. prosumers or those interested in installing solar panels) can access appropriate and comprehensive technical information on grid related issues.

4) For the further development of smart and decarbonised energy infrastructure, we propose the following recommendations:

- The development of decentralised, smart and flexible electricity networks requires forward-thinking regulation that recognises the changing nature of our energy infrastructure needs, including a coordinated approach when designing regulation for prosumption and networks that can foster increased and fast-growing PV penetration.
- National regulators (or the competent authority) should transpose the EU's new regulatory framework for DSOs to become "neutral market facilitators" - and assess how and to what extent DSOs are able to become veritable "system operators" – and take over more functions related to active system management, data management and market platforms. This would contribute to make distribution systems future-proof that can connect and integrate the much higher shares we will need for effective decarbonisation.

- The further development of smart and decarbonised energy infrastructure is likely to require, depending on the country specific context, conventional network reinforcement as well as the deployment of smart grids, in combination with the procurement of flexibility options.
- The collection and management of data by DSOs needs to be standardized as this will be crucial in providing value added services to consumers (and prosumers), as well as for enabling successful network operation and management. The communication infrastructure needs to facilitate the complex interactions between DSOs and PV prosumers.

Part II - Policy Context at EU and Member State Level

• The "Green Deal" and its upcoming EU policy initiatives

On condition that the planet's climate emergency is seriously acknowledged, the European Commission's new European Green Deal offers a tremendous opportunity to apply further, and more serious commitment to make Europe become the first climate neutral continent by 2050. This new set of policy initiatives acts as a roadmap towards the supply of clean, affordable and secure energy to all Europeans through the use of clean technologies and green financing – and could increase the EU's 2030 energy and climate targets: the current and binding EU 32%[8] of renewables in the energy mix, the 40% GHG reduction in emissions, and the 32,5% for the increase of energy efficiency.

Higher and enforceable targets would send strong commitment signals, as well as investment incentives, to both the European industry and its citizens. In this respect, the Commission is set to start reviewing the – just recently adopted - Renewable Energy Directive (RED II) and Energy Efficiency Directive within the first half of 2021. Providing milestones and trajectories for the EU and for the Member States are required for the faster uptake of renewables and energy efficiency – which will need to be triggered within the first half of the 2020 decade, given the time lag between policy decisions and associated emission reductions. (For instance, and in the context of exploiting the still widely untapped potential of PV prosumption, "re-opening" RED II could lead to improve the current EU framework and push Member States to further remove barriers that continue persisting and prevent Europeans from engaging as PV self-consumers).
Among the initiatives, which will assist in the decarbonisation of Europe's economies, the Commission recently proposed the "Climate Law" legislation, enshrining for the first time climate neutrality (by 2050)

[8] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

into law – which could in return set the level for the above mentioned climate and energy targets, at least for the 2030 timeframe. According to the proposal's greater idea, all EU policies shall contribute to achieving climate neutrality, and all sectors of the economy play their part.
Further policy and legal measures to deliver on the increased climate ambitions include the Strategy for Smart Sector Integration (coupling electricity, transport, heating and gas), the Strategy for Sustainable and Smart Mobility (first and foremost to support the electrification of transport), the review of Emissions Trading System Directive and the Energy Taxation Directive, as well as a Renewed Sustainable Finance Strategy (to redirect private capital flows into green investments) and the Just Transition Mechanism (to provide funding to the regions and sectors most likely to be affected by the transition).

- ## The National Energy and Climate Plans: Renewables and PV Prosumers

The national target-setting and progress depends on the historic energy-mix and country specific RES potential. Now, under the Clean Energy Package's Governance Regulation[9], EU Member States are required to develop 10-year National Energy and Climate Plans (NECPs), outlining how they will reach the targets, taking the countries' starting points and overall potential for renewables into account. Most Member States submitted their final plans for 2021-2030 to the European Commission by the end of 2019 – which will now be assessed until mid-**2020**, before the Commission will inform if the targets outlined in the NECPs are sufficient and if its recommendations haven been taken into account. According to the latest progress report[10], the renewable energy shares reflect the large diversity among the Member States in respect to energy mix and renewable energy generation potential, ranging from a 45-55% target for 2030 in the NECPs submitted by a number of countries (such as Denmark, Finland, Portugal or Sweden), to 15 to 25% by others (Belgium, Hungary or Poland).

Within the H2020 project Proseu, preliminary checks on the provisions on self-consumption in the draft NECPs of nine Member States (BE, DE, ES, FR, HR, IT, NL, PT, UK) have been carried out. The main findings are that only France and Spain put a reasonable emphasis on the importance of self-consumption as mandated by the Clean Energy Package. Germany and Italy show a medium level of efforts while the NECPs of the remaining five countries contain only weak or no provisions on prosumers. Most countries don't define neither targets nor measures in this respect.

[9] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action
[10] European Commission Communication (2019) 285. United in delivering the Energy Union and Climate Action - Setting the foundations for a successful clean energy transition

In conclusion, the level of ambition and policy support for renewables as such, including individual and collective self-consumption, which is demonstrated by the European Commission's Green Deal initiative, does not reflect at national level. In parallel, much will depend on the level of ambition and consequence of how Member States will proceed and transpose the recently adopted Clean Energy Package into their national legislation – of which the effects on the regulatory environments for PV prosumption are yet to be seen in most countries across Europe.

Part III - Europe's Solar Energy and its PV Prosumers

• Solar Energy and its Contribution to decarbonizing the EU

In the EU, the energy sector including transport, industry and heating is responsible for close to 80% of total GHG emissions, of which fossil fuels combustion still represent 75%[11]. In parallel, the current 20% share of electricity in the total energy consumption is expected to increase to at least 30% by 2030, mainly due to phasing out fossil fuels and the further electrification of the transport and heating sectors. According to recent figures published by the International Renewables Energy Agency (IRENA), renewables must grow 4 times faster until 2030[12], if we want to get on the pathway to climate safety and meet the Paris agreement of limiting global warming to 1,5° degrees in the 2050 time horizon.

In this context, exploiting the untapped potential that solar energy is offering plays a key role. Although 2019 was one of the best years ever for solar energy in the European Union, still less than 10% of Europe's available roof space is currently equipped with solar panels, with a total installed capacity of around 80 GW. However, **the potential to put solar PV on rooftops of existing buildings in the EU is huge, estimated to be about 680 TWh, corresponding to 25% of current electricity consumption – which in return would reduce GHG emissions by 7 million tons less CO2 each year[13]**, having a positive impact on the energy sector's 80% GHG emissions share mentioned above – in particular, when using solar electricity for decarbonizing the heating and transport sectors.
In 2019, the European Union installed 16.7 GW – a 104% increase over the 8.2 GW added the year before. In general, growing policy and public support for solar across the EU resulted in a total of 131.9 GW by the

[11] European Commission (2019). In-depth in support of the European Commission Communication (2018)773 "A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy"
[12] International Renewables Energy Agency (2020). 10 Years: Progress to Action
[13] Solar Power Europe (2019): EU Market Outlook for Solar Power / 2019-2023.

end of 2019, a 14% increase over the 115.2 GW installed by the end of 2018. After demand for solar PV in general more than doubled in 2019, a further 26% growth - or a total of 21,9 GW - are foreseen to be installed in course of 2021, which would come close to the EU's all-time high for solar installations in one year, hitting 22.2 GW in 2011[14].

Nevertheless, developments - and the installed PV capacities - differ significantly across EU Member States, with Germany having installed 49.9 GW, followed by Italy reaching 20.5 GW. From the other countries covered within the PVP4Grid project, Spain and France have around 10 GW, followed by the Netherlands with 6.7 GW and Belgium with 4.7 GW – while the Austria and Portugal stand at 1-2 GW.

Europe's solar market is split among the following segments: utility-scale, commercial, residential and industrial. By the end of 2018, utility-scale together with the commercial accounted for 64% of EU's cumulative PV system capacity, while 19% was installed on residential rooftops and 17% in the industrial segment[15]. The further evolution of the segments will depend upon the regulatory and policy frameworks at European and national level. While regular tenders and compelling conditions allow for an increase of utility-scale power plants and large rooftop systems in most countries, distributed rooftop solar PV in particular needs regulatory environments that enable self-consumption.

- **Potential for renewable energy generation and PV self-consumption**

Nevertheless, the positive prospects also extend to the residential segment, with an estimated 83% of the EU's households (= 187 Mio in numbers) in 2050 playing an active role and produce renewable electricity, adapt electricity demand to renewable energy production or store energy at times of oversupply. Half of the EU households, around 113 million, may generate renewable energy by 2050, with 60 million having solar PV on their roof and another 64 million participating in renewable energy production through collective schemes, generating together close to 600 TWh of electricity from the sun[16].

As for the 2030 time window, the European Commission analysed – ahead of proposing in November 2016 the legislative files of the Clean Energy Package (including the recast Renewable Energy Directive) - in its impact assessments the potential of self-consumption, forecasting the effect of empowering consumers with PV panels, as well as the share of self-consumed electricity, while identifying various legal and regulatory requirements, barriers and social effects. The estimated PV rooftop generation in 2030 was

[14] Solar Power Europe (2019): EU Market Outlook for Solar Power / 2019-2023.
[15] Solar Power Europe (2019): EU Market Outlook for Solar Power / 2019-2023.
[16] CE Delft (2016). The potential of energy citizens in the European Union

calculated in four scenarios and ranges from around 120 TWh in the reference scenario to approximately 145 TWh in a scenario with 27% RES share at EU level. This result includes an increase of rooftop solar PV deployment by up to 50%, compared to 2020. Furthermore, the more ambitious 27% scenario states that 20% more rooftop solar PV deployment compared to the reference case would be required. The increase of self-consumed electricity is up to 200% (without battery deployment), compared to 2020. Additional battery deployment could almost double self-consumption rates. Nevertheless, the total share of self-consumption of the final residential electricity consumption remains limited in all scenario options for 2030, and varies from around 5% (without battery) up to 10% (with battery). The total electricity production from PV (including the self-consumed amounts) in the residential sector is about 15% of the total electricity demand.

Based on these assessments, the Clean Energy Package acknowledged and addressed the potential for renewable energy generation and PV self-consumption, by establishing frameworks (see Part III, p. X16) meant to make citizens engage as prosumers, individually and collectively. In this context, such engagement encompasses investing in renewable energy, most obviously solar panels, and then consume, store or sell the energy they produce, and benefit from functioning and organized electricity markets.

In parallel, also decision-makers at Member States level are establishing new national frameworks and/or introducing significant changes to existing regulation, as part of their respective decarbonisation and renewables strategy (incl. the National Energy and Climate Plans (NECPs)), and in the process of transposing the Clean Energy Package into national legislation. For instance, in the EU's four biggest solar PV markets - Spain, Germany, Netherlands and France – recent regulatory modifications were designed to increase the number of PV self-consumers: in Spain, where new regulation plus an electricity tariff sends appropriate economic signals, expected to trigger the installation of 300 MW to 400 MW of PV self-consumption per year: in Germany, where the Mieterstrommodel (on-site community solar) enables collective self-consumption of solar PV installations on apartment buildings[17]. In France, where an open feed in tariff (FIT) for rooftop installation below 100 kW, both for injection and self-consumption, brings around 250 MW of new capacities every year. In the Netherlands, where the residential solar market is driven by net-metering, without any limitation or charge for net-delivery, resulting in the residential market reaching a share of nearly 40% (0.8 to 1 GW) in 2018.

[17] 6.8 MW were installed in 2018 & 10.6 MW in the first ten months of 2019, leaving room for improvement, as the annual cap is set at 500 MW cap

Part IV - Consumer Empowerment and its Key Role for building the EU Energy Union

The recently adopted Clean Energy Package aims to further develop one of the EU's major long-term policy initiatives: the EU Energy Union. Its major objectives include, among others, to place renewable energy and energy efficiency into the centre of a new internal energy market and put citizens at the core of the Energy Union[18]. The EU's new frameworks shall enable citizens to actively participate on a level playing field across the market and to benefit from Europe's energy transition and aims at empowering and protecting consumers through better information on energy consumption and costs, and helps issuing a tighter safety net to addresses energy poverty and vulnerable consumers. In addition, energy labels and eco-design measures are directed to increase cost savings and energy-efficient behaviour. Even more prominently, consumers are given more choices in their homes, making it easier to play a more active role and engage as self-consumers – or *"prosumers"* - individually or collectively.

- **The EU's new rules on individual and collective self-consumption[19]**

Although self-consumption is not a new concept, and individual self-consumers are relatively widespread across Europe, the EU obliges its Member States to adopt enabling legislative frameworks in this respect – and demonstrates its vision that consumers shall participate in energy markets as equals among all market players. By introducing new provisions and its corresponding definitions, the EU for the first time formally recognised self-consumers, as "renewable self-consumers" and "active customers"[20], entitled to generate, store and consume electricity from *renewable* sources, but also to carry out activities beyond the self-consumption, such as the participation in flexibility or energy efficiency schemes. Hence electricity, produced either individually or collectively, can be fed into the grids and in return make self-consumers receive remuneration that reflects market value. Nevertheless, this is not supposed to represent one's primary commercial or professional activity. For electricity behind the meter no fees or charges can be imposed, although exemptions are foreseen for installation larger than 30 kW, as well as for electricity that benefits from support schemes, or if there's system risks resulting from increasing amounts of the electricity

[18] https://ec.europa.eu/energy/topics/energy-strategy/energy-union_en
[19] For detailed information on the EU's new regulation, please consult Deliverable 3.1. of the H2020 project PROSEU: "Assessment of existing EU-wide and Member State-specific regulatory and policy frameworks of RES Prosumers"
[20] For detailed provisions and definitions on "renewable self-consumers" and "active consumers" – please see CEER Report "Regulatory Aspects of Self-Consumption and Energy Communities", pages 10 to 12

fed into the grid (from 2026 onwards, in case 8% of a country's total capacity are exceeded)[21]. Such active participation in energy markets is further enhanced by facilitating power-purchase agreements, peer-to-peer trading and demand response schemes.

Furthermore, the Clean Energy Package marks the first time that *collective* self-consumption is formally being recognised in EU legislation, while it already has been regulated in certain national legal frameworks – such as in France and Austria. In the Electricity Market Directive, the concept of active customers includes groups of jointly acting customers, whereas the Renewable Energy Directive defines jointly acting renewable self-consumers[22] in a separate definition5. This definition is restricted to groups of renewable self-consumers who are located in the same building or multi-apartment block and does not explicitly allow Member States to extend the geographic scope.

The new provisions aim at tackling barriers related to over-burdensome bureaucracy by preventing consumers from being subject to disproportionate technical and administrative requirements and procedures. For instance, self-consumers owning energy storage facilities have the right to a grid connection within reasonable time and are not subject to any double charges, including network charges, for stored electricity remaining within their premises or when providing flexibility services to system operators[23].

Part V - Integrating Renewables into Electricity Distribution Networks

As such, distribution system operators (DSOs) are in charge of operating, maintaining and developing the distribution network to ensure that electricity is delivered to - and nowadays increasingly among - end-users. In total, there are around 2,400 DSOs in Europe, out of which 90% are serving less than 100,000 customers each. On the other hand, the larger DSOs (10%, approx. 240 DSOs) cover more than 70% of the European population. Nevertheless, the EU countries display a great variety in how electricity

[21] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) Article 21
[22] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) Article 2 (15)
[23] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 2 (11)

distribution is organised and governed, varying from a single DSO to hundreds of DSO operating in one country, and from state to entirely private ownership.

The increasing decentralisation of Europe's energy system has a major impact on how to operate electricity networks in an affordable, sustainable and secure way. Large shares of renewable energy sources (above 90%), including the electricity produced by self-consumers, are connected at medium and low voltage level and integrated by DSOs into the networks. Bidirectional and less predictable energy flows from increasing renewables generation paired with more active customers require innovative network planning and operation, next to the investment needs stemming from both the conventional network reinforcement (and replacement of assets reaching the end of their lifetime), as well as from the implementation of flexibility options and digital solutions. Additional tasks assigned to DSOs include serving the infrastructure needs of e-mobility and integrating the sectors of electricity, gas, transport and heating.

- **The new EU DSO framework to enhance smart, flexible and digitalised electricity distribution networks**

Therefore, the EU has assigned new roles and responsibilities to DSOs who in their function as regulated monopolistic entities (there is no parallel electricity grids, for good reasons) shall become "neutral market facilitators" and will need to carry out more active system management, but without interfering in existing and functioning markets. While not explicitly referring to active customers and renewable self-consumers, this is reflected in the new EU regulatory framework for DSOs and designed to incentivise the further development of smart, flexible and digitalised networks - a prerequisite also for connecting and integrating self-consumption. This entails, in particular for variable electricity, the use of flexibility[24] for shifting loads and matching generation and demand (electricity networks must be in balance at all times), access to storage facilities[25], rules for congestion management[26] (in times with lots of sun or wind), data exchange and management models[27], the further roll-out of smart meter[28] and a better cooperation between

[24] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 32
[25] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 36
[26] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 31
[27] [27] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 23, 24
[28] [28] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 19, 20

Transmission System Operators (TSOs, operating high voltage and long distance networks) and DSOs[29], as well as the interaction with market parties.

More legal clarifications are expected to be defined in the new Network Codes – which are legally binding European Commission implementing regulations to govern all cross-border electricity market transactions and system operations. The new Network Codes[30] as agreed in the recast Electricity Regulation (one of the Clean Energy Package's 8 legal files) – such as on demand response, including aggregation and energy storage – will be drafted within the next years and are likely to further develop also the framework for active customers and renewable self-consumers. In this context, the new EU DSO entity[31] will, from 2021 onwards, be assigned at institutional level with specific tasks and cooperate with Transmission System Operators (TSOs) on network operation and development.

- **Sustainability vs affordability: allocating system costs among active and passive consumers**

Integrating renewables into the electricity networks, and in particular at distribution level, creates specific challenges from a macro-economic perspective. The overall system costs need to be allocated among all network users while striking a balance for pursuing the two overarching – and potentially conflicting - principles of sustainability and affordability. Sustainable, because incentivising active customers and renewable self-consumers (as well as consumer engagement in other forms, such as citizens' and renewable energy communities) increases the RES share in the EU's energy mix and contributes to achieving the EU's decarbonisation targets. And affordable, because most of Europe's network costs are socialised among all system users and paid in form of network tariffs to ensure the network operators' revenue stream. When now an increasing number of consumers gain a higher energy autonomy and in consequence contribute less to the network and the overall system costs - while in most cases remaining connected to the distribution networks for times without sun or wind - the "passive" consumers or those without means or access to renewable self-consumption will need to afford a higher share of the system cost and might face increasing energy bills (at the same time, a higher share of self-consumed electricity

[29] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 53
[30] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 55
[31] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 49, 50, 51

can also reduce the constrains of the overall grid and thereby reduce costs for grid development and curtailment). The new EU rules acknowledge and address the need to outbalance this conflict of interests:

- Network charges need to be cost-reflective[32] and contribute to the overall cost sharing of the system, and account separately for electricity consumed from the grid and electricity fed into the grid, phasing out net metering schemes beyond 2023, to make sure that self-consumers pay the full cost of service to use the grid and do not shift their share of the costs onto customers without renewable self-consumption.
- Setting principles for network charges and tariffs[33] - such as for connecting consumers to the networks – which shall encourage consumers to become self-consumers. Also, distribution tariffs may be differentiated, based on the system users' consumption or generation profiles.
- Active customers are financially responsible for the imbalances they cause in the electricity system[34] but can delegate their balancing responsibility to market actors offering such services (so-called “aggregators”). Regarding demand response, consumers have to pay a compensation to other market participants or their balancing responsible party that are directly affected by their demand response activity.

Many of the new provisions in this respect are kept at rather general level, as the cost allocation and financing of accessing and using energy networks differ to large extent across the EU.

- **PV Prosumers and Distribution Systems: Challenges and Solutions**

According to a recent survey among EU DSOs[35], less than a third (28%) of the DSOs currently handles with prosumers[36] but rather that prosumers are treated as normal connection points. The study however states that the prosumers are considered to become more important actors in the future, and are currently addressed in pilot projects. The reasons why the prosumers are not currently managed by the DSOs varies

[32] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 16 (1)
[33] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 16(2), 16(7)
[34] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market in electricity (recast) Article 16(2)
[35] The survey covered 190 DSOs that have to comply with the unbundling requirements set out in the EU Electricity Directive (i.e. the DSOs serving more than 100,000 customers, also referred to in the report as "larger DSO"). 79 out of the 190 larger DSOs responded to the survey.
[36] Prettico, G., Flammini, M. G., Andreadou, N., Vitiello, S., Fulli, G., and Masera, M. (2019) Distribution System Operators Observatory – Overview of the electricity distribution system in Europe. EUR 29615 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-79-98738-0, doi:10.2760/104777, JRC113926

depending on the country-specific context. Some DSOs mentioned that by now there just wasn't any need, others claim that although they manage distributed generators larger than 100 kW, these are not used for ancillary services. Still others informed not to handle prosumers because of the current regulatory framework not allowing them to do so, or that the regulatory framework is still under definition regarding the management of prosumers and active customers.

Within the PVP4Grid project, the 8 national consortium partners have analysed[37], among others, the impact increasing PV prosumers have on the distribution networks. In current stages, connecting and integrating PVs – at least at household level, including shared self-consumption - have not put any major constraints and congestions on the low and medium voltage grids. Even in areas where more than 30% of households are prosumers, conventional grid reinforcement has by now rarely been necessary, with the exemption of some rural areas. From the perspective of DSOs, increasing PV prosumption is considered as one among a number of elements that will impact the design and operation of the networks, alongside e-mobility and its charging infrastructure, electric heat pumps or storage facilities.

Yet, looking ahead into an advanced decarbonised and decentralised energy future might change that: For reaching their renewable targets by 2030 and then 2050, many countries will need to accelerate the process of deploying further renewable generation, including getting more PVs on people's rooftops. Addressing this challenge will entail reinforcing and replacing existing electricity grid components (many of which have come to the end of their lifetime) - and at the same time make use of innovative technologies for the networks to accommodate significant sources of flexibility[38], such as demand side management and aggregation, storage, as well as generation / load adjustment or combined heat and power systems. In other terms, networks need to become "smart", by installing new intelligent control, automation and adjustable network topology equipment, such as Active Network Management solutions, better monitoring equipment, such as smart meters and intelligent sensors, and new business models, such as flexibility markets.

Debates on this matter among decision-makers and stakeholder differ across the EU – whereas conventional network reinforcement, which usually is cost-intensive and impact the end-customers' energy

[37] https://www.pvp4grid.eu/guidelines-policy-papers/

[38] GEODE Fact Sheet on Flexibility (2020) Definition: *"Flexibility is the modification of generation injection and/or consumption patterns, on an individual or aggregated level, often in reaction to an external signal, in order to provide a service within the energy system or maintain stable grid operation. The parameters used to characterise flexibility can include: the amount of power modulation, generation forecasts, the duration, the rate of change, the response time and the location."*

bills, is considered indispensable in some countries, implementing smart tools for managing networks in combination with the procurement of flexibility options are said to be sufficient in others. As such, regulators and the energy industry are assessing how and to what extent DSOs are able to become veritable “system operators” – and take over functions assigned to Transmission System Operators, such as active system management, data management and market platforms.

In this context of the evolving role and responsibilities assigned to DSOs, also the need for reviewing network tariff structures (and which costs to be included into the DOSs’ revenue streams) is since a number of years being discussed at European[39] and national level: on the one hand, tariff structures should contribute to future developments in networks, incentivising DSOs to integrate smart technologies (instead of alongside conventional and costly network reinforcement), and on the other hand provides customers with incentives to optimise their consumption and production while contributing to the efficiency of the whole energy system. Possible options are more capacity based grid tariffs (for reducing peal loads), combined with the more conventional energy based supply pricing, dynamic or time-of-use tariffs.

Further solutions are available by taking holistic to energy – and integrate the electricity, gas, mobility and heating sectors into “one” system (sector integration). For instance, excess renewable electricity can be transformed via Power-to-Gas into hydrogen and stored and transported via the existing gas infrastructure, and used in the heating and transport sector. As of today, such technologies have not reached market maturity and would need support schemes.

[39] European Commission (2015) Study on tariff design for distribution systems

ANNEX 1

List of Barriers from the 12 Target Countries covered within the 3 H2020 Projects "PVP4Grid", "iDsitributedPV", "EU Heroes" (as of November 2019)

Barriers	Austria	Belgium	France	Germany	Italy
Financial	Inefficient ex-ante competition/reward procedure of financial PV support	Flandern: Prosumer is obliged to pay tariffs to DSO for the use of the grid under the net-metering scheme. Installing a smart meter exempts from such tariffs, but also excludes prosumers from net metering. The prosumer tariff will most likely be implemented as well in Wallonia from the January 2020.	Unpredictability of future revenues, in particular for an industrial site over 10-12 years investment periods	Only installations smaller than 10 kWp AND <10 MWh are exempted of the EEG-levy. Bigger installations need to pay 40% of the EEG-levy)	Remuneration of the excess electricity fed into the grid (usually between 6 and 10 c€) is likely to be cancelled. Thus, to be economically viable, self-consumption should be encouraged by increasing the tax reduction, e.g. to 65%
Technical / Grid related Barriers	Heterogeneous grid access policies Heterogeneous grid planning approaches and grid (interface) protection standards No support from grid operators for "virtual metering points"		Unpredictable and volatile grid connection costs, in particular for low capacity installations. DSO does not provide estimation of connection cost, nor does it guarantee beforehand a	Complex technical requirements for self-consumers to measure and prove the simultaneity for each 15 min interval, requiring appropriate meters, evaluation and reporting methods, mainly	Installation of the 2nd generation of smart meters is still in progress, so far only 40% has been replaced.

	Bigger PV plants can be split into multiple smaller units with sizes marginal below the different thresholds to get the highest benefits in terms of financial support. BUT: each one then has its own grid connection point Missing obligation of DSOs for accounting/billing in reasonable time		maximum cost limit DSO makes the first free feasibility study while the following ones must be paid for. This complicates the connection of small installations	for industrial and commercial sector	
Regulatory	Not possible to extend existing PV plants if under an ÖMAG (Austrian support scheme) subsidy contract	For selling excess electricity, self-consuming industrial installations need to find energy purchasing parties themselves		Free-of-charge self-consumption requires the plant operator and electricity consumer to be identic. Or else, the transfer of electricity is considered as the supply of a third party – and subject to full EEG levy Limited capacity for shared PV: Mieterstromgesetz only for PV with less than 100 kW No self-consumption of electricity allowed that is participating in a tender (PV systems above 750 kWp have to win a tender!)	Lack of regulatory framework allowing collective use of self-consumption, neither in the residential sector nor for commercial or industrial application (substantial barrier) Current “net metering” scheme for PV under 20kw does not justify investment in load management and storage.

Complexity / Administrative	Monetary benefit from implementing shared PV self-consumption models does currently not justify the effort and the cost, due to a too complex organizational framework of a shared-use PV unit resulting from legislation Sub-optimal usage of available space (rooftop, facade) of already sealed surface		Residential PV self-consumption installations: main barrier is obtaining administrative authorizations	Challenges for real estate owners since subsidiaries are needed for avoiding to pay taxes on profits Increasing complexity of the German Energy Law Operators of PV systems recognised by the EEG are obliged to register their PV system	

Barriers	The Netherlands	Portugal	Spain	The UK	Poland
Financial Barrier	Feed-in subsidy will replace the net-metering in the future - which may discourage new investments. Still, a 7-year economic payback time is guaranteed Energy tax on produced energy is a barrier to collective self-consumption	Certain costs not yet clearly defined in the old legislation - certain costs related to the process were invoiced to some clients, mainly related to the inspection of the connection to the grid. Neither the decree of law mentions this fee, nor is it part of the procedure	Although decreasing, pay-back periods can be considered still slightly long, i.e. 10 years for residential sector, 7 or 5 for industrial or commercial Regional difference in providing incentives: tax deductions could be more beneficial to enhance	Lack of incentives. Feed in Tariff phased out before subsidy-free PV is viable in most applications High degree of uncertainty on income streams and what regulation will apply Subsidy-free PV prosumer models at larger scale with	Complex agreement for the purchase of electricity and its distribution is obligatory, if end-user uses net-metering No incentives /dedicated support schemes for PV energy communities

		published. The new Legislation however mentions clearly the fees that have to be paid.	prosumption than subsidies - which certain regional governments choose to apply instead of using result-oriented taxation regimes.	simple, low-cost installations Innovative products and services - not yet available/affordable Electricity traded over the existing public network must pay “use of system charges”, significantly decreasing the cost advantage for on-site use	
Technical / Grid related Barriers		Major connection issues to be clarified, as well as grid protection rules in the old legislation: specifications concerning the connection to the grid have never been published. New legislation is expected to provide clarity, entering into force on the 1st January 2020, with supporting technical rules to be published until the end of 2019.	The communication protocols which regulate the communication between DSOs, suppliers and autonomous governments are still missing and should be issued soon, leading to some DSOs hindering the development of self-consumption. Yet, after the publication of these communication protocols, the DSOs will have one month to update their internal procedures.	Smart meters not suited for all prosumer applications	Obligation to have 3-phase inverter in case of installed nominal PV capacity exceeding 3,68 kW_p Electricity quality issues especially in areas of high concentration of 1st generation PVs

			Lack of accessibility to consumption and generation data limiting the potential for collective self-consumption Lack of mechanisms of support to reduce storage system costs		
Regulatory	Collective self-consumption: real estate owners must own part of the full PV installation – while the excess energy produced by the PV unit cannot be consumed by other owners.	Lack of regulatory framework for collective self-consumption– BUT: new law has already been approved and will enter into force on 1 January 2020	Limiting the distance between production facilities and associated consumption points to a maximum of 500 meters Need to develop the collective self-consumption procedures (for the static as for the dynamic collective self-consumption)	Most prosumer models are currently required to partner with a licensed supplier – in which a very limited number of suppliers are interested Supplier switching at 28 days' notice, creating significant additional risk, particularly for any model with a limited pool of customers (such as single building or single site shared consumption)	No collective self-consumption in Poland Volatility of legal regulations Lack of precise legal regulations enabling efficient the installation of photovoltaic systems "Incomplete net-metering" – PV with capacity up to 50 kW allowed to exchange the surplus of energy produced under favourable conditions for gaps in energy

					production, BUT: not 1 to 1 No enabling framework for energy communities
Complexity / Administrative		Delay in approving PV individual self-consumption projects, due to severe lack of manpower in the competent authorities	With a new law introduced in 2019, administrative procedures have improved, but barriers regarding the complexity of administrative procedures persist at local level, where in some cases authorities may hinder the development of self-consumption installations		Excessive length of proceedings regarding issue of licenses for electricity generation

Barriers	Greece	Lithuania
Financial Barrier	Lack of financial incentives and proper advertisement from the government to promote new PV installations Under Net-Metering scheme, the excess energy injected into the grid can be compensated with energy consumed later on However, for this part of produced energy, only the competitive charges are subject to the net-metering scheme. Under Virtual Net-Metering, only the competitive charges are avoided for the total amount of the produced energy. The rest charges (such as transmission and distribution grid charges, social services fees, CO2 emissions fees) applied throughout the total amount of the produced energy.	Support schemes for prosumers but only for individual households and only up to 10 kW Despite all support mechanisms (323 Euro fixed support for 1kW installed, easy connection etc.) PV remains too expensive. The real payback time is still too long and dependent on technological parameters could be more than 10 years.

Technical / Grid related Barriers	Extensive penetration of PVs can jeopardize the scheduled operation of thermal and hydro generators as well as the exchanges through the interconnections. Hence, large secondary reserves are necessary in order to prevent a generalized system collapse as well as to cope with voltage, frequency and power flow stabilization schemes. Therefore future PV investments (without energy storage systems) are very likely to be subject to curtailment operation	Contacting network operators or building inspection operators can be difficult
Regulatory	Delays on the implementation of new laws. For example, the law about virtual net-metering was in force two years before first applications were accepted (March 2019) Lack of benefits of PV by society. More positive experience (decrease bills for electricity, PV plant as positive investment case, real decrease in CO2 emission etc.) is needed for the technology to become more attractive.	Legal and administration environment for renewables installation is rather friendly in Lithuania BUT: No legislation for shared consumption at building level Unclear rules and procedures for energy communities, although under development
Complexity / Administrative		