PROSEU

Prosumers for the Energy Union: mainstreaming active participation of citizens in the energy transition

D3.2 Policy Brief: Strategies for Policy Coherence and Sustainability

Part 2: Sustainability guidance for prosumers and policymakers

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Summary of PROSEU

PROSEU aims to enable the mainstreaming of the renewable energy Prosumer phenomenon into the European Energy Union. Prosumers are active energy users who both consume and produce energy from renewable sources (RES). The growth of RES Prosumerism all over Europe challenges current energy market structures and institutions. PROSEU's research focuses on collectives of RES Prosumers and will investigate new business models, market regulations, infrastructural integration, technology scenarios and energy policies across Europe. The team will work together with RES Prosumer Initiatives (Living Labs), policymakers and other stakeholders from nine countries, following a quasi-experimental approach to learn how RES Prosumer communities, start-ups and businesses are dealing with their own challenges, and to determine what incentive structures will enable the mainstreaming of RES Prosumerism, while safeguarding citizen participation, inclusiveness and transparency. Moving beyond a case by case and fragmented body of research on RES Prosumers, PROSEU will build an integrated knowledge framework for a socio-political, socioeconomic, business and financial, technological, socio-technical and socio-cultural understanding of RES Prosumerism and coalesce in a comprehensive identification and assessment of incentive structures to enable the process of mainstreaming RES Prosumers in the context of the energy transition.

Summary of PROSEU's Objectives

Eight key objectives at the foundation of the project's vision and work plan:

- **Objective 1:** Document and analyse the current state of the art with respect to (150-200) RES Prosumer initiatives in Europe.
- **Objective 2:** Identify and analyse the regulatory frameworks and policy instruments relevant for RES Prosumer initiatives in nine participating Member States.
- **Objective 3:** Identify innovative financing schemes throughout the nine participating Member States and the barriers and opportunities for RES Prosumer business models.
- **Objective 4:** Develop scenarios for 2030 and 2050 based on in-depth analysis of technological solutions for RES Prosumers under different geographical, climatic and socio-political conditions.
- **Objective 5:** Discuss the research findings with 30 relevant stakeholders in a Participatory Integrated Assessment and produce a roadmap (until 2030 and 2050) for mainstreaming RE Prosumerism.
- **Objective 6:** Synthesise the lessons learned through experimentation and co-learning within and across Living Labs.
- **Objective 7:** Develop new methodological tools and draw lessons on how the PROSEU methodology, aimed at co-creation and learning, can itself serve as an experiment with institutional innovation.
- **Objective 8:** Create an RES Prosumer Community of Interest.

PROSEU Consortium Partners

Logo	Organisation	Type	Country
	FCIENCIAS.ID	Private non-profit association	Portugal
	UPORTO	University	Portugal
	ICLEI EURO	Small and medium-sized enterprise	Germany
	CLIENTEARTH	Non-governmental organisation	United Kingdom
	UNIVLEEDS	University	United Kingdom
	DRIFT	University	the Netherlands
	UNIZAG FSB	University	Croatia
	LEUPHANA	University	Germany
	ECO-UNION	Non-governmental organisation	Spain
	IÖW	Private non-profit limited company	Germany
	CE Delft	Small and medium-sized enterprise	the Netherlands

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Glossary

EE	Energy Efficiency
EU	European Union
kW	Kilowatt
MW	Megawatt
NECP	National Energy and Climate Plan
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Sources
RED II	Renewable Energy Directive (Recast) from 2018

Executive Summary

This document represents Part 2 of the Deliverable D3.2 *"Strategies for Policy Coherence and Sustainability"* and discusses sustainability related issues of prosumer projects. It contains a **Policy Brief** followed by a report which provides supporting background information.[1]

The overall objective of this policy brief and report on background information is to provide guidance in terms of how to make prosumer projects truly sustainable across all three sustainability dimensions, i.e. considering the environmental, social and economic perspectives. It does so by identifying and discussing the main sustainability issues facing prosumers within the three sustainability dimensions, and by providing concrete guidelines for a) prosumer initiatives (including both individual and collective prosumers) and b) policymakers.

Among the key recommendations are the promotion of grid-connected projects that can support the energy system, the maximisation of renewable capacity in the built environment, the importance of taking environmental impact assessments and material efficiency seriously, the promotion of inclusive business models that allow participation of all citizens, the prioritisation of local installers and contractors, and the contribution to maintain grid infrastructure.

Moreover, the report includes the high-level analysis of 16 sustainability criteria comparing the prosumer models of scale individual prosumers and collective prosumers vs. the non-prosumer models of Independent Power Producers (IPPs) and utilities.

[1] Part 2 of Deliverable 3.2 is about sustainability guidance for prosumers and policymakers. As the two aspects of task 3.2 which led to Deliverable 3.2 are quite different (policy coherence on the one side and sustainability issues on the other), it has been decided to submit two policy briefs, rather than one, each with a supporting background report.

Policy Brief

D3.2 Part 2: Strategies for Policy Coherence – Sustainability guidance for prosumers and policymakers

With the adoption of the new European Renewable Energy Directive in December 2018, it is now legally recognised that every citizen of the European Union has the right to produce, sell, store and self-consume renewable energy. While this is a major development to move towards the energy transition, prosumer energy projects may run the risk to deviate from a sustainable pathway unless certain precautions are taken. This would not only be disadvantageous from the sustainability point of view, but it would also undermine the credibility of prosumer projects.

This document aims to provide guidance in terms of **how to make prosumer projects truly sustainable across all three sustainability dimensions, i.e. considering the environmental, social and economic perspectives.** To that end, close to **40 recommendations** for prosumers (including both individual and collective initiatives) and policymakers have been developed, primarily based on desk research and project experience. These guidelines also provide answers to the most prominent concerns that are being raised against the phenomenon of prosumerism, such as the alleged lack of solidarity with other energy consumers or the potential revenue decrease for network operators and incumbents.

The **key sustainability guidelines** for prosumer projects are the following:

- **Promote only grid-connected projects that can support the energy system**: Only prosumers that stay connected to the grid (electricity or heating/cooling network) can support the energy system by providing electricity, heat storage or demand response services, thus enhancing their positive social impact and decarbonisation through sector coupling. Especially in cases where grid connections already exist, it would be counterproductive to disconnect from the main grid for (potentially minor) benefits of individuals or small communities. Prosumer models should thus keep, whenever possible their grid connection in order to increase the benefits for other energy customers by offering support services and surplus energy.[2] Policy makers, regulators and Distribution System Operators (DSOs) should, therefore, provide a **regulatory framework that makes prosumer grid-support attractive** by allowing simple technical access and fair remuneration for grid services and energy provided by prosumers. This also means that storage devices (batteries or hot water storage) should be installed and configured in such a way that they can provide grid services – which in turn requires that policymakers and regulators improve the regulatory frameworks for storage services and avoid unjustified charges or administrative burden.
- **Maximise renewable capacity in the built environment**: As buildings and other infrastructure are already existing, they should be used to the maximum extent possible for renewable energy generation in order to avoid the un-necessary sealing of soils or renewable energy (RES) deployment particularly in natural or protected areas. This means that the self-consumption ratio should not be the leading indicator for prosumers because it can lead roof owners to design their PV or other RES installations to be smaller than they otherwise could be. Roof owners, however,

[2] Exceptions are houses or villages in remote locations in the countryside or on islands.

will only invest in larger installations if they receive a fair remuneration for the energy fed into the grid or if it can be easily shared with others.

- **Take environmental impact assessments and material efficiency seriously**: Prosumer projects that are likely to have a significant effect on the environment—especially large projects and projects near or within natural sensitive areas—are required to undertake an Environmental Impact Assessment before the development phase (Directive 2014/52/EU). Furthermore, habitats should be respected, especially those with protected species, by, for instance, adopting appropriate mitigation protocols (e.g. switching-off turbines when birds approach). Smart planning of wind and solar parks can also reduce visual impacts, e.g. by grouping the farms according to clear patterns in order to achieve a harmonious integration into the landscape. Emphasis should also be put on using high-quality products with long durability that are easily repairable and which have spare parts that are easy to access and exchange. The EU and its members require end-of-life policies that make re-use and recycling legally binding through targeted regulatory frameworks.
- **Promote inclusive business models that allow participation of all citizens**: Prosumer business models should facilitate the participation of all citizens, including and especially those households that have neither the physical space nor the financial funds available to install or invest in renewables. This should be done to decrease their energy bills and make them actively part of the energy transition. Policymakers should make sure that energy-poor and marginalized households as well as tenants are thoroughly considered in prosumers policies and are given special financial and technical support.
- **Prioritise local installers and contractors**: Prosumer projects should aim to commission projects to local installers in order to create additional benefits for the local economy and to increase the public acceptance of the project. However, prosumer projects require professional project management, installation and execution skills, particularly in the case of large-scale plants akin to projects that are carried out by specialised utilities. Therefore, prosumer initiatives should conduct a rigorous selection process to determine the best technical and commercial offer. National and local governments can enhance the skills and expertise of suppliers and installers by supporting education and training activities. Furthermore, they can streamline administrative processes.
- **Contribute to maintain grid infrastructure**: Prosumers should pay a fair share of the grid infrastructure if they use it for back-up or for sharing energy. Since Distribution and Transmission System Operators have a natural monopoly in their respective networks, it must be ensured by the regulators that the services provided by these companies are excellent and that infrastructure costs are fully transparent. A functioning energy infrastructure is important for a modern society as even if certain prosumers may become completely self-sufficient with their homes, they also benefit from the energy infrastructure indirectly because other members of society need it. Policymakers may need to regularly assess the way grid operators run their businesses in order to ensure adequate investment in grid infrastructure and adequate cost and service levels. Grid operators should be enabled, and if necessary forced, to support prosumer projects. The financing of grid infrastructure may need to be adjusted to the new phenomenon of prosumers.

Table 1 provides an overview of the key guidelines directed to prosumer initiatives as well as to policymakers distinguished by the three sustainability dimension. More details can be found in the main report.

Table 1: Sustainability Guidelines for prosumer initiatives and policy makers

Issues	Guidelines for prosumer initiatives	Guidelines for policymakers
Ensuring social sustainability		
Solidarity with the other energy consumers	• Promote grid-connected projects to support the grid infrastructure and sector coupling • Advocate for sustainable and inclusive tariff structures	• Calculate the entire "value of solar" • Ensure that electricity costs and charges are transparently calculated and justified • Reform financing of the energy system to distribute costs fairly • Develop short and long term scenarios for prosumer uptake
Social Inclusiveness	• Promote inclusive business models that allow the participation of poorer households • Integrate Corporate Social Responsibility (CSR) criteria in procurement decisions • Aim for gender parity in initiative's management and membership	• Support business models inclusive of energy-poor and marginalized households • Incentivize RES/EE investments in poor households • Raise social awareness through targeted communication campaigns
Data security and privacy	• Reduce the amount of personal data collected • Implement data security and privacy schemes	• Provide clear data security and privacy regulations • Support data secure hardware and software
Ensuring environmental sustainability		
Material efficiency and reduction of environmental impacts	• Maximise renewable capacity in the built environment • Design RES installations to maximise energy output • Integrate environmental impact assessments for those projects that are likely to have a significant effect on the environment • Use only batteries or storage schemes that can provide energy system services	• Provide a framework to make prosumer grid-support attractive • Promote the use of existing public built spaces
Waste reduction, eco-design and recycling schemes	• Prioritise suppliers offering reuse, repair and recycling schemes • Plan reuse, recycling and decommissioning during the design and construction phase	• Implement eco-design and enforce obligatory collection, reuse and recycling schemes • Foster R&D in eco-design and circular economy
Ensuring economic sustainability		
Efficient use of economic resources	• Partner with professional suppliers and contractors • Prioritise local installers and contractors • Contribute to local taxes and levies	• Streamline processes for prosumer projects • Support on-line markets and solution platforms
Economic viability of the energy system	• Contribute to grid infrastructure costs • Provide grid services	• Regularly review grid operator services, costs and regulation • Refrain from subsidising utilities using non-renewable energy
Access to finance	• Prioritise low-risk projects with reasonable size • Professionalise project development and financing	• Provide stable economic schemes for prosumer projects • Educate, train and empower citizens and prosumers

Independent from the question on how to make prosumer projects more sustainable, the question may be asked if other, non-prosumer-based projects may be potentially more sustainable than prosumer projects with regards to certain aspects. To that end, the paper includes the high-level analysis of 16

sustainability criteria comparing the prosumer-based models of individual prosumers and collective prosumer project vs. the non-prosumer models of Independent Power Producers (IPPs) and utilities. The key findings are the following:

- The **social benefits of prosumers initiatives are clearly superior to non-prosumer projects**, i.e. regarding inclusiveness, citizen participation and involvement in the energy sector, solidarity with energy-poor households and other consumers, the fairness of redistribution of benefits and even gender aspects. This is mainly due to not-for-profit nature of prosumer projects and the social orientation of the cooperative governance model.
- In the **environmental dimension** individual and collective prosumers have advantages regarding overall energy savings and carbon emission reductions as well as biodiversity and ecosystem protection. For recycling and avoiding rebound effects, they are quite similar. IPP developers and utilities may be preferential when it comes to avoiding inefficient use of resources, as they may have a more mature and professional supply chain.
- In the **economic dimension**, the viability of business cases (without additional public support) and cost-efficiency tend to be higher for IPP and utility projects due to economies of scale. For local job and value creation and as well as avoided grid investments the individual prosumer model may be most advantageous. The impact on tax revenues (like local taxes, VAT on energy or VAT on equipment) depends on the circumstances and the scale of the projects.

Table 1 shows in which areas the different prosumer and non-prosumer models are advantageous.

Table 2: Mapping of prosumer vs. non-prosumer models against sustainability criteria

Criteria	Individual prosumer	Collective prosumers	Indep. Power Producers (IPP)	Utilities
Socio-economic/ social sustainability				
Social inclusiveness		x		
Citizen participation/in energy sector	x	x		
Solidarity (with other consumers)		x		
Fairness of redistribution of benefits		x		
Gender aspects		x		
Environmental sustainability				
Investments in low-carbon resources	x	x	x	(x)
Energy savings & GHG reductions		x	(x)	
Avoiding rebound effects	This issue needs to be investigated more deeply			
Efficient use of (raw) materials			x	x
Recycling schemes		x	x	x
Biodiversity and ecosystem protection	x			
Economic sustainability				
Viability of business cases			(x)	x
(Local) jobs and value creation		(x)		
Cost-efficiency and financial effectiveness			(x)	x
Avoided grid investments	x			
Impact on tax revenues		x	x	

It can be concluded that – if the guidelines described above are followed – overall prosumer projects will be largely sustainable in all three sustainability dimensions and potentially preferable to non-prosumer projects. Nevertheless, nothing prevents IPPs and utilities to adhere to these guidelines as well, which will enhance the sustainability of their projects, too.

In all, the prosumer model promotes a democratic, decentralised, renewable and sustainable energy system. The mainstreaming of prosumerism is therefore key for achieving the Sustainable Development Goals (SDG), especially SDG 7 on "ensuring access to affordable, reliable and modern energy for all" and SDG 13 on Climate Change. For this to happen, national policymakers should build on the new European legislation and implement stringent national regulatory frameworks that clearly incentivise individuals, communities, businesses, and public authorities in becoming prosumers, regardless of their economic capabilities, social position or administrative situation.

Background information report on

Sustainability guidance for prosumers and policymakers

1. Introduction

1.1 Objectives

With the adoption of the new Renewable Energy Directive in December 2018, it is now also legally acknowledged that every European citizen has the right to produce, sell, store and self-consume energy. It can be assumed that the prosumer energy model will become more widespread. While this is – from our point of view – a positive development, prosumer energy projects may run the risk (as with many other "trends") to deviate from a sustainable pathway unless certain precautions are taken. This would not only be disadvantageous from the sustainability point of view, but it would also undermine the credibility of prosumer projects.

This document aims to provide guidance in terms of how to make prosumer projects truly sustainable across all three sustainability dimensions, i.e. considering the environmental, social and economic perspectives. Especially when new prosumer business models are being designed, or any new technological innovations are being developed, this guidance may help to avoid getting trapped into seemingly good solutions for the short and medium term that in fact may have detrimental shortcomings in the long term.

While prosumerism has overall a positive connotation and is actively pursued by the European Union through its recently approved legislation, it is not without critique. Another objective, therefore, is to provide answers to the most prominent concerns that are being raised against the phenomenon of prosumerism. It does so by using the following approach:

- identifying and discussing the main sustainability issues facing prosumers within the three sustainability dimensions;
- providing concrete guidelines for a) prosumer initiatives (including both individual and collective prosumers) and b) policymakers.

If these guidelines are followed, it can be assumed that overall prosumer projects will be largely sustainable in all three sustainability dimensions and potentially preferable to non-prosumer projects.

It should be noted that, in general, **all renewable technologies can be deployed under a prosumer governance model**. However, given the high modularity and easy-to-install features of solar PV, this paper refers more often to examples of solar PV than to other technologies.

1.2 Vision of the energy future

There is growing scientific, societal and political consensus that EU energy systems need to be based on 100% renewable energy by 2050 at the latest (Deng, Cornelissen, Klaus, et al. 2011). This is necessary in order to be able to achieve a climate neutral Europe by 2050, to comply with the Paris Agreement and to keep global warming as close as possible to a 1.5 °C temperature increase. The latest IPCC report on the 1.5°C target has shown that the deployment of renewables needs to happen at an unprecedented speed within the next decade (IPCC, 2018).

This means that both large and small scale renewable energy projects need to be developed in parallel in order to able to reach these ambitious climate goals. For small scale projects, it is essential that they can benefit from low-cost, easily accessible renewable energy (e.g. through PV or solar thermal panel installations and renewable heating systems) in any suitable location. While for small scale installations the prosumer model will most likely prevail, for large scale projects it will have to be assessed in more detail to determine if the underlying business model shall be prosumer or non-prosumer based.

1.3 Sustainability pillars – key questions for prosumers

The main sustainability issues that have been brought forward with regards to prosumers are included below. They are sorted according to the sustainability pillars.

- **Ensuring social sustainability:**
  - Solidarity with the other energy consumers: How to ensure that prosumers not only focus on their own benefits but are also considerate of the needs of other consumers and of societal benefits as a whole?
  - Social Inclusiveness: How to ensure (ideally) that anybody can become a prosumer, without economic or cultural limitations?
  - Data security: How to ensure that prosumers do not lose their privacy and that they can maintain control over their personal data?
- **Ensuring environmental sustainability:**
  - Material efficiency and reducing environmental impacts: What needs to be done to ensure that prosumer installations work efficiently and use as few materials as possible?
  - Waste reduction and recycling schemes: Any product has an effect on the environment – how is it possible to ensure that the entire life-cycle of prosumer plants is truly sustainable?
- **Ensuring economic sustainability:**
  - Economic resources: How to make best use of limited economic resources and how to ensure project viability?
  - Economic viability of the energy system: Prosumers take market share from incumbent players in the energy market – is their demise unavoidable ("utility death spiral") or are certain utility functions needed?
  - Access to finance: How do we ensure that prosumer projects can be supported by traditional financial mechanisms (loans, grants) along with new emerging and collaborative schemes?

At the end (section 5) a high-level comparison between prosumer vs. non-prosumer business models is carried out for a number of sustainability criteria. This analysis aims to identify the strengths and weaknesses of prosumer models.

This paper does not intend to provide detailed solutions for all sustainability-related or technical issues that can arise from prosumerism. In most cases, technical solutions are possible, and it therefore becomes rather a matter of balancing costs and benefits. Therefore, this document focuses more on the strategic aspects to be considered when introducing prosumerism on a large scale.

Table 3 provides an overview of the key guidelines which are described in detail in the following sections, separated between the ones for prosumer initiatives and the ones for policy makers.

Table 3: Overview of Sustainability Guidelines for prosumer initiatives and policy makers

Issues	Guidelines for prosumer initiatives	Guidelines for policymakers
Ensuring social sustainability		
Solidarity with the other energy consumers	• Promote grid-connected projects to support the grid infrastructure and sector coupling • Advocate for sustainable and inclusive tariff structures	• Calculate the entire "value of solar" • Ensure that electricity costs and charges are transparently calculated and justified • Reform financing of the energy system to distribute costs fairly • Develop short and long term scenarios for prosumer uptake
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Waste reduction, eco-design and recycling schemes	• Prioritise suppliers offering reuse, repair and recycling schemes • Plan reuse, recycling and decommissioning during the design and construction phase	• Implement eco-design and enforce obligatory collection, reuse and recycling schemes • Foster R&D in eco-design and circular economy
Ensuring economic sustainability		
Efficient use of economic resources	• Partner with professional suppliers and contractors • Prioritise local installers and contractors • Contribute to local taxes and levies	• Streamline processes for prosumer projects • Support on-line markets and solution platforms

Issues	Guidelines for prosumer initiatives	Guidelines for policymakers
Economic viability of the energy system	• Contribute to grid infrastructure costs • Provide grid services	• Regularly review grid operator services, costs and regulation • Refrain from subsidising utilities using non-renewable energy
Access to finance	• Prioritise low-risk projects with reasonable size • Professionalise project development and financing	• Provide stable economic schemes for prosumer projects • Educate, train and empower citizens and prosumers

2. Ensuring social sustainability

2.1 Solidarity with the other energy consumers

2.1.1 Description of the issue

A common argument against prosumerism is that if certain people set up their own energy generating installations, they not only reduce their energy consumption from the grid, but they also decrease the share that they pay in energy system fees and charges, thus increasing the burden on non-prosuming consumers. This argument has led to prosumers being accused of lacking solidarity, putting the financing of the electricity infrastructure at risk, and circumventing taxes (such as VAT or excise tax) and renewable energy levies.

This problem is more pronounced in countries where fees and charges are primarily linked to energy consumed, i.e. where only very low or no fixed capacity charges apply like in Germany. Therefore, for every kWh less that is consumed, money is then "missing" to recover system costs or to contribute to other charges like electricity taxes or levies.

However, **self-consumption is not any different than applying energy efficiency measures or saving energy *in terms of energy not bought from the grid*** which means that in both cases the amount of kilowatt hours which need to be delivered to the customer through the grid are reduced.[3] This means that the effect on kWh-based revenues of suppliers, grid operators and tax authorities remains the same. While no one would denounce energy savers for not consuming enough energy, prosumers face this allegation in many countries.

Prosumer installations *are* different to energy efficiency measures when it comes to the *injection of surplus energy*. In that case technical measures need to be applied to e.g. control ramp rates and ensure system stability; some of these mitigation measures are already paid by the prosumers because they are integrated in the inverters or through the use of batteries, others need to be taken up by the network operators. But as stated in the vision above and further explained below, renewable surplus energy from prosumers is crucial to achieve the climate targets.

Another claim states that if prosumers have used incentives to finance and/or run their installations (even though they may be affluent because they own houses with rooftops and may have enough funds available to pay for an RES installation), it would be unfair towards the tax and rate payers from whose money the incentives stem from.

However, this claim disregards the reason why **incentives** are actually required, namely that they **are meant to be a necessary instrument to reach a level playing field with incumbent (fossil or nuclear) technologies**, and to introduce a new, sustainable technology into the market. Despite this, it is true that during certain periods in certain countries incentive systems have not been adequate in the sense that they have led to quite favourable return rates (e.g. in Spain and Germany in the early 2010s). These periods, however, were usually limited because newly introduced legislation terminated these

[3] Potential technical effects of prosumer installations like steep ramp rates for grid-injected surplus energy are not related to the amount of kWh self-consumed or saved.

developments quite quickly, frequently in such an abrupt manner that the measures led to a stalling of installation numbers in almost all European countries. The European PV sector still has not fully recovered from these drastic policy adjustments.

While the instantaneous self-consumption of energy, which is self-produced in the immediate proximity, is comparable to applying energy saving measures (which should be allowed at any time and independently from the grid status), the situation is different in the case of **net metering** where consumers can subtract excess energy from their energy bills. In jurisdictions that allow net metering to not be limited in time or with long balancing time periods (e.g. energy produced can offset own consumption after a year or more) it is obvious that the grid is used for storage; therefore a certain contribution can be expected as long as the business case for the prosumer is not jeopardised.

2.1.2 Guidelines for prosumer initiatives

Promote staying grid-connected to support the grid infrastructure: Only prosumers that stay connected to the grid can also potentially support the energy system by providing electricity, storage or demand response services. Currently, not all of these services can be easily offered because technological and regulatory barriers still exist (for instance, feeding electricity in at the right moments, storing electricity when it is most beneficial at times with high RES supply, or operating virtual power plants). However, in the future, this situation is likely to change so that prosumers can do more than just reduce their energy bills.

Grid defection by individual homes, neighbourhoods or small municipalities would mean that these entities become completely autonomous. They would not need the grid anymore at the expense of installing batteries – which also need to be larger than if they had just stayed connected (which entails potentially environmental questions, see below) because they need to cover longer periods of time. Especially in cases where grid connections already exist, it would be counterproductive to disconnect from the grid for the purpose of (potentially minor) individual or – in the case of community projects – collective economic benefits. Prosumer business models should thus keep their grid connection and try to also increase the benefits for other energy customers by offering support services and surplus energy. However, this flexibility will lead also to an increased complexity of the system, requiring higher sophistication for its management. As stated by Brown et al. (2019), this means that the prevalent narrative of prosumers, which promotes autonomy and independency, may be countered through the necessity to become more interconnected. Nevertheless, having the possibility to self-consume and produce does offer additional choices for prosumers.

Exceptions are houses or villages in remote locations in the countryside or on islands. In these cases, it may make sense to not connect to or even disconnect from the main grid if the maintenance costs of a power connection are costlier for the residents, the utility and for society. Still, if there are several buildings, they are probably better connected among each other to increase resilience.

Advocate for sustainable and inclusive tariff structures: Prosumers act within the frameworks that they are given, and policy makers and regulators need to make the right calls. It is not the task of prosumer initiatives to establish the financial viability of the entire energy system. Nevertheless, with the increasing relevance of prosumers, their responsibility as actors in the energy markets also increases.

Therefore, prosumer advocates need to take up this new role, be aware of and get prepared for the discussion about tariff structures, and develop solutions in the best interest for society. They should be particularly aware of the need to contribute to actions against energy poverty, as this is more likely to affect consumers that lack the financial, cultural and technical capability to engage in prosumerism. Prosumers should also develop business models so that they are robust enough to deal with regulatory changes of the tariff structure. For instance, if the variable parts of the retail tariffs are lowered and fixed parts are increased, the savings per kWh become reduced, which in turn may mean a decreased viability of prosumer projects. This would go in the direction of a flat rate for energy, which might lead to an increase of energy consumption in general. It is therefore important to find the right balance of fixed and variable tariffs.

2.1.3 Guidelines for policy makers

Calculate the entire "value of solar": Policy makers should commission studies that calculate the socio-economic benefits and costs of prosumer projects at a country-level or for the EU in general. This approach called "value of solar" has been applied in various states in the USA (Solar United Neighbours). A recent study was carried out for Spain that took into consideration typical cost/benefit categories such as avoided upgrades for transmission and distribution infrastructure, avoided fuel costs, environmental benefits, social benefits, etc. (van der Vlies, van Breevort & Winkel, 2018). This kind of study helps to inform the debate on fair tariffs and the financing of the energy system. The specific benefits of prosumer projects should be at the core of such studies (which may also consider other prosumer technologies aside from solar PV into account).

Ensure that electricity costs and charges are transparently calculated and justified: Confidence in the justification of electricity costs, fees and charges is important to avoid prosumers from losing interest in supporting the energy system. This means that network operators and energy generators must only be allowed to charge costs that do not provide disproportionate profits. For instance, system operators in countries like Spain have almost a risk-free business model as they enjoy a monopoly market situation where – unlike in jurisdictions where concessions are awarded – they own the electricity grid (Capellán-Pérez, Campos-Celador, Terés-Zubiaga J, 2018). This impacts the level of service they provide, resulting in poor customer service, long lead times, and high costs for consumers. Moreover, the recent EU legislation requires that "renewables self-consumers should not face discriminatory or disproportionate burdens or costs and should not be subject to unjustified charges" (EC RESD II, 2018).

Reform financing of the energy system to distribute costs fairly: With the development of prosumerism, the financing of the energy system may have to be revised in order to be socially and economically sustainable. Grid and other infrastructure costs could be recovered through new or different fees, charges and tax schemes. These could target all beneficiaries of the power system, including the industrial sector where many energy-intensive industries receive tax exemptions to keep them competitive. This leads to a distortion of the fair distribution of energy systems costs. In some countries, like Germany, this practice puts an additional burden on private customers.

It may therefore be investigated to – at least partially – finance the energy infrastructure through taxes as it is done for other infrastructure like roads. This could ensure that poorer households pay less than affluent ones do, as they would contribute in accordance to their financial possibilities and not just according to their energy consumption. The pros and cons need to be carefully balanced though. Taxes,

which are subject to annual budget negotiations within the government, can lead to strong and unpredictable fluctuations in available funding (as has been shown in the USA with its tax-based RES support systems). Another way to support poor households could be to offer subsidized contracts where (fixed) charges are reduced. The financing of these support mechanisms may then come from tax-money (similarly, the support for energy-intensive industry may not be financed through energy rate payers).

Develop short and long-term scenarios for prosumer uptake: Prosumer uptake needs to be correctly planned in order to avoid potential market distortions and social externalities. It should be supported by sound policies and the energy market should be adjusted accordingly. The EU Governance Regulation demands that Member States set targets for the share of prosumer projects in their National Energy and Climate Plans (NECPs), therefore appropriate Key Performance Indicators will need to be developed as well [this will be treated in Task 3.3]. Also, the Long Term Strategies (LTS) should clearly propose targets and measures for prosumer uptake.

2.2 Social Inclusiveness

2.2.1 Description of the issue

Currently, not everybody may be able to become a prosumer. For instance, barriers may include a lack of financial resources, unawareness, or a lack of opportunity (e.g. they do not own a roof and no local prosumer initiative or support is available). Critics claim that prosumerism is only possible for the well-educated and affluent home owners. But ideally, the goal should be that all European citizens have the opportunity to become prosumers in one way or another by overcoming financial, social or any other technical or non-technical barriers. In general, households that may be considered energy poor or marginalised may not be interested or may not have the means to invest in their own prosumer equipment or to participate in joint prosumer initiatives.

Social inclusiveness can also be an issue in the project implementation phase. This is as companies (suppliers, developers, and installers) may get selected based on purely profit-driven criteria without their being given sufficient importance to societal benefits. Products and services in the RES value chain can have negative social externalities (like low salaries or poor working conditions) which may offset environmental benefits. Therefore, the uptake of prosumerism is also relevant to all traditionally marginalized groups such as women, youth and minorities.

2.2.2 Guidelines for prosumer initiatives

Promote inclusive business models that allow participation of poorer households: Poor households that have neither the physical space nor the financial funds available to invest in renewables should be enabled so that they too can participate in prosumer projects. This should be done in order to decrease their energy bills and make them actively part of the energy transition. These households could be supported by setting up special schemes that allow them to benefit from shared roof-top systems or from power plants that are installed on public facilities and whose energy is then distributed to households via virtual power sharing (Greenpeace Greece & RESScoop.eu, 2018). This model has been promoted in Greece and is currently being discussed in Spain (Pizzinato, 2018). Prosumer communities can pro-actively initiate and propose such schemes to local and national policy makers.

Integrate Corporate Social Responsibility (CSR) criteria in procurement decisions: Prosumer initiatives may check if contracting parties such as engineering firms, material suppliers or installers pay special attention to non-economic benefits, such as employing marginalised people (e.g. disabled persons), providing eco-certified products and running low-carbon operations (e.g. by using electric vehicles in their fleets). However, especially for small companies, this may not be easy to do as they may struggle to keep their businesses going. Therefore, this may be rather a requirement for large scale projects that are carried out with larger companies.

Aim for gender parity in initiative's management and membership: Actively addressing women to become members of a prosumer initiative will ensure that initiatives have a broad, solid foundation within society. Campaigns may focus on women, either directly or indirectly, through images, wording, content focus, etc. The Board, secretariat and staff of these initiatives should be aiming for gender parity, something which can be achieved through targeted hiring policies. Apart from women, prosumer initiatives should also try to include other traditionally marginalized populations such as youth, minorities, rural populations, etc.

2.2.3 Guidelines for policy makers

Support business models inclusive of energy-poor and marginalized households: Policymakers should make sure that energy-poor and marginalized households are thoroughly considered in prosumers policies and are given a special financial and technical support. The Greek model mentioned above shows that public financial support is needed, in addition to shared access to public roof space. Local governments can also play a role in facilitating neighbourhood wide community-based approaches to prosumerism. In the Netherlands, measures for renewable, low temperature (hybrid) solutions are developed with community-based cooperatives to get neighbourhoods out of gas.

Incentivize investments in Renewable Energy and Energy Efficiency: Public investments should support energy efficiency and related rehabilitation of energy-poor households through special support schemes or favourable financing schemes. This can then be combined with renewable like e.g. in Flanders where in order to get incentives, a certain level of energy savings must be reached which may only be possible with additional RESS measures. These could target RES installations for households that are below a certain income threshold or those that are part of marginalized populations (e.g. rural areas, minorities, etc.).

Raise social awareness through targeted communication campaigns: Capacity building measures on how to save energy or make use of renewables are another important tool to help energy-poor or marginalized households. For instance, the municipality of Barcelona has established several offices across the city that provide information and guidance to citizens to reduce energy their consumption and energy bills (Ajuntament de Barcelona, n.d.). They also offer in-situ energy audits. The establishment of local energy agencies is another option which can offer this kind of service to citizens.

2.3 Data security and privacy

2.3.1 Description of the issue

In order to reap the full potential of prosumerism, a large amount of data will need to be shared with various organisations like grid operators, retailers, aggregators, virtual power plant operators, neighbours, etc. This poses a considerable challenge in terms of privacy because detailed profiles of customers can be made out based on their consumption patterns, their use of specific appliances and the times at which they are present at home (European Smart Grids Task Force, 2016). If this data gets into the hands of unauthorized people who are driven by unethical business-driven goals or that have bad intentions, prosumers risk that their data will be used for illegal, criminal or otherwise non-intended purposes.

For instance, data could be sold to companies for non-solicited advertisements, or burglars would know when people are not at home. Moreover, prosumers may become potential entry points via their internet-connected smart meters or PV inverters for hackers who want to crack into the energy system and grid infrastructure. This is as prosumers are more vulnerable than professional energy companies who are more likely to be better equipped with firewall and authorization systems. This could potentially put in danger the security and integrity of the whole electrical infrastructure, and by extension cause substantial economic, social and political damages to an entire region, country or even Europe. On the other hand, a distributed energy system with many local energy grids that can work potentially independently (even though interconnected) may also be more difficult to take over in their entirety compared to a few central power plants which, if successfully hacked, could affect even more people (Memoori, 2018). In the case of nuclear power plants this could be potentially disastrous. Still, digitisation of the energy system, more players like prosumers and increasing complexity will create new security threats that need to be mitigated.

2.3.2 Guidelines for prosumer initiatives

Reduce the amount of personal data collected: Any actor or service provider in the energy system should try to avoid collecting too much personal data from prosumers. The data that is used should also be encrypted and processed in an anonymised way whenever possible. Strong precautionary measures should be taken to avoid unauthorized access to this data. The users should also be fully aware of the kind of data shared and its planned use, in compliance with the EU directive on Data Protection. The possibility to potentially opting-out of certain data collection measures should be given.

Implement data security and privacy schemes: Prosumers and prosumer initiatives need to take the threat of cyber-crime seriously and they need to get informed about the ways in which they can protect themselves. This may be costly and complex but it can prevent harm and potential indemnification claims that may be made at a later stage. Use of open security software that is developed and improved by the prosumer community itself might help to reduce the risks.

2.3.3 Guidelines for policy makers

Provide clear data security and privacy regulations: Policy makers need to ensure that regulations are keeping up with technological developments so that prosumers (and consumers) are well protected

against mis-use of data. At the same time, regulations need to be sufficiently flexible to allow innovative business models to be developed. Guidance should be given to SMEs and prosumer initiatives on how to deal with data security and privacy.

Support data secure hardware and software: The development of secure hardware like inverters, encryption methods (such as block-chain) and safe energy-related applications could be supported through targeted incentives. Standardised and certified hardware and software could then be made available to prosumer initiatives so that they can avoid investing their own time in solving data security issues.

Support resilient energy networks in islanding mode: Future electricity networks should be enhanced in a way that certain parts they can potentially disconnect from the main grid and go into islanding mode. Usually this is being avoided because the sudden loss of load can destabilise the entire grid. Innovative technical solutions are needed to allow islanding which can be beneficial in case of hacker attacks that aim to produce wide-spread black-outs, or extreme weather events. Policy makers can incentivise prosumer projects with back-up power possibilities which develop technical solutions that can be applied at a larger scale for increased overall resilience of the energy system.

3. Ensuring environmental sustainability

3.1 Material efficiency and reducing environmental impacts

3.1.1 Description of the issue

Energy producing equipment has – as any other equipment or goods – during its production process as well as during operation or use an impact on the environment. For renewable energy equipment to be environmentally sustainable, highest standards should be applied so that impacts on flora, fauna and climate are minimised and other aspects (like visual impacts) are thoroughly considered.

It is often argued that e.g. **installing PV panels in Northern Europe is less efficient compared to installing them in Southern Europe,** or that large, centralised systems are more efficient than small-scale, distributed systems, not only in terms of costs per kW installed but also in terms of energy output per material input, i.e. material efficiency. There is no doubt that it is important to aim for a high material efficiency and to consider the entire life cycle of RES equipment.

However, **efficiency is not the only criterion** that informs investment decisions. An energy system that is powered by renewable energy requires distributed generation by a variety of different technologies to appropriately balance the variable supply. Moreover, citizens do have the right to produce electricity through their own installations if they want to do so (see section on social sustainability).

Apart from that, the claim to use material as efficiently as possible is actually true for all goods that are used or consumed. For instance, apartments that are only occupied during the holiday season, drilling machines that are seldom used, or cars that are parked most of the time – many things that people own are not used in an efficient way. In that sense, renewable energy generating equipment has the two advantages: i) it can not only recover but by far exceed the energy input required for its fabrication; ii) it can be shared more easily as there is already a means available to easily share the "service" that such

equipment provides: the electricity grids. For other services, it can be more complicated to use sharing platforms and to make the best use of the equipment. Sharing renewable heat is also possible through district heating networks but these are not as widely available as it would be desirable.

Another point to be mentioned in that context is the concept of **sufficiency**, i.e. the modest but adequate scale of living where everyone's needs are met (ECEEE, Darby & Fawcett, 2018). Prosumers may be tempted to buy more energy-consuming equipment than other consumers because they might say "I use my own renewable energy". But this would firstly consider the environmental impact which every product has, and secondly it would not help to contribute meeting other people's energy needs. Therefore, also prosumers should try to abstain from "purely luxurious" investments or purchases.

3.1.2 Guidelines for prosumer initiatives

Maximise renewable capacity in the built environment: As available buildings and other infrastructure are already existing, they should be used to the maximum extent possible for renewable energy generation in order to avoid the un-necessary sealing of soils or RES deployment in natural or protected areas (free land should be better assigned to become habitats preserved for flora and fauna given that there already exists great pressure on natural areas). Moreover, if roof-tops or other suitable locations remain "under-used", it may not be possible to ramp up RES generation sufficiently fast enough to mitigate climate change. Therefore, the capacity of any solar (or other renewable) energy installation in the built environment should ideally be maximised to make the most use of the entire (suitable) space at a given location. This means that the self-consumption ratio should not be the leading indicator for prosumers because it can lead roof owners to design their PV plants to be smaller than they otherwise could be.[4] Roof owners, however, will only invest in larger installations if they receive a fair remuneration for the energy fed into the grid or if they can easily share excess generation (see also section 4 on economic sustainability). Currently many governments rather tend to promote self-consumption schemes that try not to produce excess energy. This restrictive policy should be abolished.

Design RES installations to maximise energy output: Related to the previous point is the goal to produce as much renewable energy as possible from any installation.[5] Technically the maximisation of capacity (kW) and energy (kWh) can be conflicting goals (a 10 kW installation on the same roof may produce less kWh per year than a 9 kW installation depending on orientation, shading, etc.). Leading principle should be the way on how to reach a 100% renewable energy system as fast as possible, prioritising the use of the most suitable locations. The proper design, choice of equipment, and, in case of solar panels, orientation is key. In certain cases, east-west orientation may be beneficial to smoothen the midday-peak. Nevertheless, most sites (especially roof-top sites) will have some disadvantage at one point in time during the day, so an optimisation calculation will be required.

Take environmental impact assessments seriously: Prosumer projects that are likely to have a significant effect on the environment—especially large projects and projects near or within natural

[4] See also https://www.pv-magazine.de/2018/04/30/quaschning-stoppt-den-photovoltaik-eigenverbrauch-und-macht-die-daecher-voll/ (in German only).

[5] Technically the maximisation of capacity (kW) and energy (kWh) can be conflicting goals (a 10 kW installation on the same roof may produce less kWhs per year than a 9 kW installation depending on orientation, shading, etc.). Leading principle should be the way on how to reach a 100% renewable energy system as fast as possible.

sensitive areas—are required to undertake an Environmental Impact Assessment before the development phase (Directive 2014/52/EU). Even, in cases where an Environmental Impact Assessment is not legally required, they should still be conducted (maybe in a leaner fashion) where potential environmental effects can occur and should be avoided. Furthermore, habitats of especially protected species should be respected and appropriate mitigation efforts taken (e.g. by switching turbines off when birds approach). A smart planning of wind and solar parks can also reduce visual impacts, e.g. by grouping the farms according to clear patterns in order to achieve a harmonious integration into the landscape.

Use only batteries that can support the grid: The use of batteries in individual homes can improve the viability of a renewable energy installation and can provide a higher degree of self-sufficiency and independence for the prosumer. However, as discussed above regarding the grid connection, it is important that the batteries can potentially be used to provide grid services. Nowadays, not all systems may be equipped accordingly but where such solutions already exist, they should be applied (Solarwatt, n.d.; New Energy Update, 2016). This will help to make use of the batteries at a broader scale, allowing them to be combined with a range of different generation technologies in virtual power plants, to support demand response, or to supply power in emergency situations.

3.1.3 Guidelines for policy makers

Provide a framework to make prosumer grid-support attractive: For prosumers, the provision of grid support for the equipment they have installed should be facilitated. Policy makers, regulators and DSOs should therefore provide a regulatory framework that allows simple technical access and a fair remuneration for grid services provided by prosumers.

Promote the use of existing public built spaces: Firstly, policy makers should support the installation of RES in available public spaces with the best potential for energy production, so that many citizens can benefit from them. Collective prosumers initiatives who present the most sustainable proposals (in all three dimensions, i.e. environmental, economic and social) should be awarded the projects.

Support eco-certified equipment, green products and low-carbon services: To reduce environmental impacts public authorities should support the use of eco-certified equipment from ideally locally suppliers, green products and low-carbon services through e.g. awareness raising campaigns or tax incentives. On-line platforms and market fairs showcasing clean solutions could help educate and influence consumers and prosumers. Public procurement should lead by example.

3.2 Waste reduction and recycling schemes

3.2.1 Description of the issue

Any manufactured product has an environmental impact. This is especially true for electronic equipment, from the extraction of raw materials, over its own use, and up to the end of its lifetime. Batteries, PV panels and other related RES equipment contain rare or partially hazardous materials and substances. The amount of decommissioned PV panels is projected to grow to over 60 million tons in 2050, even though the large majority consist of non-hazardous materials (glass, aluminium polymers) (Weckend, Wade, Heath, 2016). It is also anticipated that at its current rate of development the renewable energy

industry could be about to face shortages in the supply of rare metals that are required for PV panels and electric batteries (van Exter et al., 2018). Without proper reduction, reuse and recycling schemes in place, the resulting amount of waste would not only become a serious environmental problem but it also could potentially affect the availability and costs of raw materials for new equipment.

3.2.2 Guidelines for prosumer initiatives

Prioritize suppliers offering reuse, repair and recycling schemes: At this stage, there are probably only a few suppliers of PV equipment, batteries and other RES technologies that have processes in place to take back equipment at the end of the life-time. Usually, they would leave recycling to specialized companies. Second-Life batteries or equipment, e.g. from EVs, can represent ecological (and economic) advantages over new, specific batteries produced for home applications (Schaufenster Elektromobilität, 2016).

Plan reuse, recycling and decommissioning during design and construction phase: Prosumer initiatives that engage project developers should put emphasis on an engineering design for installations which allows the easy decommissioning of the plant and the potential renaturation of the site. For instance, new solar fields hardly use concrete anymore for foundations which allows for the recuperation of the land. The use of eco-designed equipment which can be easily repaired or replaced will also reduce its environmental impact. The Waste Framework Directive (WFD) (Directive 2008/98/EC) and the Waste electrical and electronic equipment (WEEE) Directive (Directive 2012/19/EU) which are both part of the Circular Economy Package, require recovery/recycling rates of 75%/85% of PV modules in a way that does not harm the environment. While large electric utilities are used to complying with these EU regulations, small-prosumer initiatives should offer special attention in complying with the different EU waste and recycling policies.

3.2.3 Guidelines for policy makers

Implement eco-design and enforce obligatory collection, reuse and recycling schemes: In order to motivate product designers to take the end of the product life into account, end-of-life policies are required that make re-use and recycling legally binding through targeted regulatory frameworks.[6] Emphasis should be put on using high quality products with long durability that are easily repairable and which have spare parts that are easy to access and exchange.

The EU has pioneered PV electronic waste (e-waste) regulations, which cover PV-specific collection, recovery and recycling targets through the EU Waste Electrical and Electronic Equipment (WEEE) Directive (European Commission, 2019a), which is a legislative pillar of the 2015 Circular Economy Package. The Circular Economy package aims at increasing the lifetime of products through greater re-use and recycling. Producers of PV equipment are required to finance the collection and recycling of PV panels at the end of their lifetime. The EU Battery Directive is, in general, taking a similar approach but is not strict enough when it comes to allowing disposal in landfills (European Commission, 2019b).

[6] In fact, this goes beyond products for energy use and should become common practice for any kind of product.

The necessary recycling infrastructure needs to be set up so that: waste from RES technologies can be recycled without having to be shipped long distances, and pollution and leakage to foreign countries with less strict regulation can be avoided.

Foster R&D in eco-design and circular economy: The efforts to provide solutions for a circular economy in the field of renewable energy also need to be ramped up in terms of R&D. Innovative recycling processes should be defined together with the industry and green firms and processes should be supported (SEAI, n.d.).[7] These efforts will also create additional support amongst citizens for renewable technologies and contribute to a green economy.

4. Ensuring economic sustainability

Prosumer models need to ensure economic sustainability in two dimensions:

- at macro-economic level where society as a whole should benefit from prosumers projects;
- at micro-economic level where an individual project needs to be economically viable and where prosumer investors can expect a reasonable return at an acceptable risk.

This section will address both dimensions, depending on the issue focusing either on one or both of the levels. In general terms, the macro-economic dimension requires more attention than the micro-economic one because an individual project may be harmful to society and the environment over the long-term despite its short-term economic viability. Nevertheless, if individual projects cannot secure long-term economic viability, they will not be initiated and thus they won't be able to create their potential benefits.

4.1 Efficient use of economic resources

4.1.1 Description of the issue

Economic resources are usually limited[8] and should thus be allocated to maximize societal benefits. It is being argued that instead of investing in small-scale systems, it would be more beneficial to put most available funding into large scale systems that provide more kilowatt hours per Euro invested. (Small) roof-top installations can be potentially less efficient (with regards to material input and manpower), and are more expensive per kW installed (due to lower economies of scale). Additional incentives or subsidies may therefore be needed to make such installations competitive and attractive. Hence, small-scale prosumer installations may make less economic sense than large-scale installations in resource-rich areas (similar to the efficiency discussion in the previous section).

[7] See the following examples, USA: https://www.seia.org/initiatives/pv-recycling; EU: https://www.pv-magazine.com/2018/08/23/eu-funds-pilot-plant-for-pv-module-recycling/; https://www.reuters.com/article/us-solar-recycling/europes-first-solar-panel-recycling-plant-opens-in-france-idUSKBN1JL28Z ; http://www.pvcycle.org/organisation/about/

[8] We will not further analyse the unequal distribution of wealth and economic resources on a global scale in this paper.

However, this kind of argument often does not sufficiently consider the other sustainability criteria and socio-economic benefits of small-scale installations such as the creation of local jobs, behavioural changes resulting in more efficient energy use, avoided land use, avoided transmission costs, speed of deployment and local ownership (Farrell, 2016). With RES equipment costs coming down in general and generation costs competing against retail prices, the issue of needing incentives is becoming less relevant as the economic business case is improving for small installations.

Another issue could be that in cases where prosumer initiatives do invest in large-scale projects, these may not be as professionally managed as the ones developed by large utilities or specialised project development firms. This may lead to a less efficient use of financial resources, i.e. members of the prosumer initiative may get less value for their investments than they could potentially get when investing in RES utility projects. But this would again mainly look at one criterion and disregard other sustainability criteria.

4.1.2 Guidelines for prosumer initiatives

Partner with professional suppliers and contractors: Prosumer projects require professional project management, installation and execution skills, particularly in the case of large-scale plants akin to projects that are carried out by specialized utilities. Therefore, prosumer initiatives should conduct a rigorous selection process to determine the best technical and commercial offer. Not all the criteria that need to be met are of financial nature, i.e. not only the price should make the difference but also other added value benefits like the employment of local installers and O&M staff or the provision of additional community services. Also, for small-scale prosumer projects, it is important to be able to choose between several providers to maintain a level of fair competition and decrease costs.

Prioritise local installers and contractors: Prosumer projects should aim to have projects commissioned by local installers in order to create additional benefits for the local community. This may not be possible in all cases as local experience or expertise may be missing, or certain local companies may not be able to offer the expected services at competitive prices. Small, local companies may sometimes simply be more expensive. However, the potentially higher prices can be seen as a contribution to the local economy and to increase the public acceptance of the project. If operations and maintenance is conducted by service providers close by, less transport is needed and communication might be easier. Hence, the pros and cons of local sourcing need to be carefully assessed for each project.

Contribute to local taxes and levies: Depending on the country, investors may or may not have to pay local taxes and levies, as often these are paid in the jurisdiction of their company headquarters. Where possible, prosumers should pay taxes to the municipality of where the plants are based so that all community members can indirectly benefit from the installations even if they may not be participating financially.

4.1.3 Guidelines for policy makers

Streamline processes for prosumer projects: Especially for smaller installations, the administrative procedures should be simplified in a way that allows prosumers to carry out their projects as efficiently as possible. Potential prosumers will refrain from carrying out projects if there are many administrative

hurdles, even if the business case as such is beneficial. This means that there should be: a single or clear entry point for administrative procedures (one-stop-shop); no fiscal burden for small-scale prosumer applications, i.e. no treatment as "producer" for plants below a certain threshold (e.g. 100 or 500 kW); an adequate fiscal regime for small-medium sized installations; and clear responsibilities of installers and distribution companies including monitoring of lead times.

Support on-line markets and solution platforms: Comparing prices and products among various installers or project developers helps customers to select the best offer. While governments don't have to develop these portals by themselves, they could financially support those that deliver high-quality information and objective results. In particular, they can do this through the expertise of national associations of consumers and/or partnerships with business associations. Several platforms are already facilitating such information for other markets (car industry, electronic appliances, etc.) and could be used as a model.

4.2 Economic viability of the energy system

4.2.1 Description of the issue

Utilities, i.e. companies that earn their revenues from generating and selling power, and/or through the transport and/or distribution of electricity, see their business model as being in jeopardy if prosumers become more wide-spread. Power generating utilities fear that they will lose market share and will face decreasing revenues. Utilities active as Transmission System Operators (TSOs) or Distribution System Operators (DSOs) are concerned that self-consumption will lead to less power demand through the grid infrastructure and therefore – depending on how the financing scheme is set up – reduced possibilities for them to earn back investments into the grids. If these companies then increase their prices, even more customers would turn into prosumers, thus exacerbating the trend of decreasing TSO/DSO revenues, leading to an effect which is called **the "utility death spiral".**

When utilities run into financial problems, jobs may get lost and uncertainties get introduced into the energy system – developments which go against the social and economic sustainability goals. However, the macro-scale needs to be looked at in order to be able to gauge the overall value that utilities bring to society. With regards to system operating utilities, a well-maintained grid infrastructure is important for all actors, including for prosumers, therefore it cannot be in the interest of prosumers that system operators have financial issues which can lead to a lack of investment in these critical infrastructures.

By contrast, the utilities that are active in power generation are subject to competition and they would not deserve special protection. This is even more relevant as many large-scale utilities around the world still maintain fossil fuel and nuclear-powered power plants both of which need to be pushed out of the market for reasons of climate and environmental protection. This means that prosumer initiatives should contribute to a functioning grid – where possible by providing also system balancing services – but they do not need to help maintaining the businesses of power generation utilities. A reduction of consumed energy cannot be regarded as negative but rather as positive at the macro-economic scale (and especially in view of the environmental sustainability goals). The issue of reduced revenue also occurs for energy efficiency and savings measures – which are also claimed by utilities to be a major problem even if the reduced energy demand by customers is a direct consequence of utilities charging higher prices (Creamer, 2018).

In that context, it is also claimed that utilities and tax payers must bear the additional costs to stabilize the grid. These concerns seem to be rather exaggerated though, at least for small- scale PV systems (Muaafa et al., 2017) and in the urban context. Notwithstanding, the energy transition does require additional investments but this is the price that societies have to pay to achieve sustainable energy systems and is per se not an issue of prosumerism.

4.2.2 Guidelines for prosumer initiatives

Contribute to grid infrastructure costs: As already discussed above (see social responsibility), prosumers should pay a fair share of the grid infrastructure. In certain areas, it can become problematic for the stable operation of the electricity grid if too many prosumer projects get connected to the same distribution line (i.e. the same feeder cable). The feeders may become overloaded and the electricity supply interrupted. The infrastructure costs should be transparent (see guidelines for policy makers below) and it must be ensured that the services provided by TSOs and DSOs are excellent despite the monopolistic set-up that exists. Unfortunately, in many countries grid operators are often not supportive of prosumer projects as they tend to take a conservative stance when it comes to introducing changes to their operations (which can indeed affect system security if not well planned). A functioning energy infrastructure is important for a modern society as even if certain prosumers may become completely self-sufficient with their homes, they also benefit from the energy infrastructure indirectly because other members of society need it.

Provide grid services: Prosumer projects can also provide additional grid services that maintain the stability and improve the quality of the energy system. This would not help power generating utilities as this would tap into another one of their businesses, but it can help to defer or avoid investment in grids under certain circumstances, thus avoiding additional costs for system operators and rate payers. The necessary technical standards can and should be made mandatory for any project. For instance, solar PV inverters must be capable of reducing their output during over frequency situations or to turn themselves off smoothly in order to avoid sudden changes, thus securing grid stability (Delta Energy Systems, 2012). Similarly, wind turbines must have a so-called ride-through capability which avoids sudden disconnection in case of power outages of conventional generators, avoiding wide-spread black-outs (Hu et al., 2017).

4.2.3 Guidelines for policy makers

Regularly review grid operator services and regulation: As discussed above, policy makers may need to regularly assess the way grid operators run their businesses in order to ensure adequate investment in grid infrastructure and adequate cost and service levels. Grid operators should be enabled, and if necessary forced, to support prosumer projects. The financing of grid infrastructure may need to be adjusted to the new phenomenon of prosumers. Sanctions must be in place in cases where system operators do not meet defined quality and performance standards. For distribution grids in Germany concessions are given for a maximum of 20 years which allows a certain competition when they are tendered, while e.g. in Spain distribution grids are in the hands of private companies, making sanctions more difficult as the distribution companies do not run the risk to lose their business (unless they would be expropriated).

Refrain from subsidising utilities using fossil or nuclear energy: Large power generating utilities continue to enjoy subsidies, leading to market distortions and an unlevelled playing field for prosumers. A recent analysis shows that capacity mechanisms alone amount to some €58bn in Europe for mainly fossil fuel-powered capacity (Greenpeace EU, 2018). Instead of trying to maintain the business models of the incumbents, policy makers should focus their support on renewable solutions. In addition, (former) employees of these utilities that need to find new jobs (e.g. in the renewable sector) should be supported. Due to the distributed model of prosumer projects, local jobs can potentially be created more easily.

4.3 Access to finance

4.3.1 Description of the issue

Prosumers and prosumer initiatives may not be able to raise sufficient funding for their projects. To build wind or solar parks, for example, several millions of Euros are needed. Banks may be hesitant to provide financing if there are no stable support schemes in place, or if they doubt that the project will be managed professionally. Prosumer initiatives may have less experience with project development and financing than large utilities or professional project developers do. This means that third party financing may be costlier, i.e. finance institutes may ask for higher interest rates from prosumer initiatives than from utilities.

Raising equity through many participants is also more complex and time-consuming than having access to a large investment budget. Crowdfunding may be a relatively new way of collecting large amounts of money in a fairly efficient way. The advantage of prosumer projects is that usually, the return rate expected by the investors is lower than for utility-financed projects (IEA-RESTD (2016).

4.3.2 Guidelines for prosumer initiatives

Prioritize low-risk projects with reasonable size: Prosumer initiatives should avoid developing projects that are either too large (several dozen MW) or that are too complex and risky to be managed by a group of people that are not necessarily energy professionals. Instead, it may be more adequate to run a number of smaller projects where the risks are smaller so that a potential issue with an individual project does not lead to a financial collapse of the entire initiative.

Professionalize project development and financing: The team that develops the project and organizes the financing should consist of experienced and knowledgeable professionals that can ensure that the projects are executed according to state-of-the-art standards. Even though prosumer initiatives often want to achieve more than just financial returns (e.g. by providing social benefits for the local community or fighting against climate change), they should be sure that they really are capable of managing projects that are financed with the personal savings of their members to not potentially put at risk their economic sustainability.

4.3.3 Guidelines for policy makers

Provide stable economic schemes for prosumer projects: Governments can help prosumer projects by providing a stable framework that allows renewable energy projects and prosumer projects to

generate a predictable revenue stream. This can be done through Feed-in-Tariffs or PPAs (combined with tenders), potentially combined with other schemes like tax exemptions or direct investment support (grants or low-interest loans).

Educate, train and empower citizens and prosumers: Policymakers, authorities and regulators should ensure that potential or existing prosumers have enough of an understanding about the risks and opportunities of such projects. In particular, they could be trained and guided to design, launch and manage economically and technically viable RES installations on their premises. These new skills should be part of the curriculum of formal and informal educational schemes.

5. Comparison of prosumer vs. non-prosumer projects

5.1 Introduction

Independent from the question on how to make prosumer projects more sustainable, the question may be asked how prosumer projects compare to non-prosumer projects, i.e. if maybe other type of models may be potentially more sustainable with regards to certain aspects than prosumer projects. To this end, the following section explores the differences between prosumer and non-prosumer renewable energy projects along a number of the sustainability-related criteria that have been discussed above.

The following definitions are being used:

- **Prosumer projects:**
  - **Small scale individual prosumer:** Projects that are owned by individuals who contract engineering firms or installers. Usually roof-top PV installation between a few kW to a maximum of some 100 kW. For the larger roof-tops of small and medium-sized enterprises these could also fall under the IPP developer model.
  - **Collective prosumers:** These can be large roof-top or ground-based PV projects but may also include other technologies like wind parks, biomass or hydro. Collectives may have their own engineering and project development capability but would usually buy these services from specialised firms.
- **Non-prosumer projects:**
  - **Independent Power Producer (IPP) developers**: The project developer business model consists of typically smaller sized organisations. They often sell projects to IPPs prior to entering into construction and are (in comparison to the utility model) limited by their financial capabilities.
  - **Utilities:** They typically have been active in large scale power generation (mainly fossil or nuclear based but in recent years also renewable), distribution and transmission. They mainly use balance sheet financing which allows them – due to their size – to carry out and operate large projects with potentially higher risks. Utilities are clearly profit-driven and thus adopt higher risk approaches, with more contracts and more aggressive scheduling.

For each of the criteria, a short assessment is given and the business model which is most advantageous is marked **(X)** and highlighted in green.

5.2 Findings of the comparison

The analysis of 16 sustainability criteria chosen in the table below shows that in most cases, the collective prosumer model is more sustainable than non-prosumer projects.

This is the case for all criteria within **social dimension**, i.e. Inclusiveness, citizen participation/involvement in energy sector, solidarity (with energy-poor households, other consumers), fairness of redistribution of benefits and gender aspects.

In the **environmental dimension** individual and collective prosumers have advantages regarding investments in low-carbon energy resources, overall energy savings and carbon emission reductions as well as biodiversity and ecosystem protection. For recycling and avoiding rebound effects a clear winner is difficult to name. IPP and utility projects may be preferential when it comes to avoiding inefficient use of raw materials.

In the **economic dimension** the viability of business cases (without additional – public - support) and cost-efficiency tends to be higher for utility projects due to economies of scale. For (local) job and value creation and avoided grid investments the individual prosumer model may be most advantageous. The impact on tax revenues (like local taxes, VAT on energy or VAT on equipment) depend on the circumstances and the scale of the projects.

Table 4: Mapping of prosumer vs. pon-prosumer business against sustainability criteria

Criteria	Individual prosumer	Collective prosumers	IPP developer	Utility
Socio-economic/social sustainability				
Inclusiveness		x		
Citizen participation/in energy sector	x	x		
Solidarity (with other consumers)		x		
Fairness of redistribution of benefits		x		
Gender aspects		x		
Environmental sustainability				
Investments in low-carbon resources	x	x	x	
Energy savings & GHG reductions		x		
Avoiding rebound effects	This issue needs to be investigated more deeply			
Efficient use of raw materials			x	x
Recycling		x	x	x
Biodiversity and ecosystem protection	x			
Economic sustainability				
Viability of business cases				x
(Local) job and value creation	x			
Cost-efficiency				x
Avoided grid investments	x			
Impact on tax revenues		x	x	

Overall it can be stated that prosumer projects should be the preferred option of private or public investors that focus in on long-term sustainability and societal benefits.

5.1 Comparison across sustainability criteria

Table 5: Comparison of sustainability criteria across different business models

Criteria	Small scale individual prosumer	Collective prosumers	IPP developer	Utility
Socio-economic/social sustainability				
Inclusiveness	In principle any citizen has the right to become a prosumer. But any individual prosumer needs to have at least some access to a renewable source, for instance in case of solar energy some unshaded space like a roof (or part of a roof) or balcony. Certain individuals like farmers may be able to harness wind energy, biogas or hydro power. In addition, an individual prosumer needs certain private funds or access to finance (related to liability/wealth) as well as basic awareness/interest (linked with educational/cultural background).	Vulnerable groups or minorities can become prosumers through shared and/or dedicated projects or initiatives. In addition, energy cooperative usually apply the 1 member = 1 vote principle, independently of the amount of capital invested / shares participation. **X**	Usually no special focus on inclusiveness beyond normal practices and legal aspects. May include this under CSR.	Citizens could buy a share of a (public) utility but would remain marginal shareholders as they would not have executive power which depends on shares owned. Inclusiveness may be part of CSR policy on a voluntary basis.
Citizen participation/involvement in energy sector	Direct involvement of citizens is the core of this business model **X**	Direct and/or indirect involvement of citizens is the core of the business model **X**	Citizen involvement not guaranteed but possible.	Citizen involvement not guaranteed but possible, even though not likely unless legislation demands it (in participatory processes)
Solidarity (with energy-poor households, other consumers)	In general, small-scale prosumerism is an individual approach but it helps society in the sense that the 100% RES goal is reached quicker. The rooftop is made available for society's benefit in a sense.	Can create business models where energy-poor households benefit or get support from the collective. **X**	If there is no self-consumption planned in the projects, solidarity is usually not mentioned as an issue.	Projects are usually considered pure generation projects, therefore no impact on the energy system's cost structure nor re-distribution is under debate. Main issue is seen if levies to finance RES incentives (like FiT) lead to increased electricity costs.
Fairness of redistribution of benefits	Benefits are not redistributed, as all the benefits go to the prosumer.	Benefits are shared among the members of the collective. **X**	Benefits go to the project developer and the IPP	Benefits go to shareholders

Criteria	Small scale individual prosumer	Collective prosumers	IPP developer	Utility
Gender aspects	Typically gender doesn't play a role, anybody could become a prosumer.	Could / should be part of the statutes that balanced gender participation is intended (e.g. through special workshops for women). **X**	Typically, not in focus.	Larger companies may have more possibilities to apply gender balancing policies than small companies.
Environmental sustainability				
Investments in low-carbon energy resources	RES prosumers by definition invest in low carbon energy resources. **X**	RES prosumers by definition invest in low carbon energy resources. As they have more reach, they may impact more than individual projects **X**	If the focus is clearly on renewables, no difference to prosumer models. **X**	Utilities may still have gas or coal in their portfolio. Large-scale, centralized projects fit naturally better into their business model, therefore they tend to keep on investing in fossil fuels or maintaining that business.
Overall energy savings and carbon emission reductions	Prosumers have a higher energy awareness and thus tend to save energy. In addition, losses in the energy systems are avoided (direct consumption on site).	Research shows that prosumers become more energy aware and reduce their energy consumption (see RESScoop presentation in Barcelona 2017). RESScoops also don't really try to sell more energy to their clients but rather try to rather increase their client base. **X**	No positive impact on energy savings.	Energy saving services may be offered to clients but in general utilities tend to try sell more kWh.
Avoiding rebound effects [Note that this issue would need to be investigated more deeply, a clear winner is difficult to name]	Rebound effects can happen if a prosumer has a large installation and puts more appliances than "needed" because "energy is so cheap". On the other hand it may also be the case that the self-produced electricity or heat is considered to be more precious. IÖW has started a project on that in Germany.	Rebound effects potentially possible if prosumers think that they can consume more because "the energy is green anyways". Within a community people may not want to use more energy than their peers due to "peer pressure" (which means though that they have to know the energy consumption of the others).	No effect: People will not use energy that is produced by an IPP developer differently.	No effect: People will not use energy that is produced by a utility differently.

Criteria	Small scale individual prosumer	Collective prosumers	IPP developer	Utility
Avoiding inefficient use of raw materials (e.g. for batteries in cases where they can be avoided).	Small installations may not always be put in the ideal locations, so output per kW installed can be comparatively lower than for larger installations. The individual use of batteries increases the self-consumption ratio but also the need for raw materials. If the batteries are connected to a Virtual Power Plant the positive effects for the energy system may be higher though. However, this requires a good business case but a good business case is not necessarily connected to an efficient use. Staying in the battery example: In Germany, the best business case is self-consumption or balancing energy, but the most efficient use would be combining several use cases for the battery. But because of the regulatory framework there is no business case for that.	Projects probably use good locations but as the financial return is not highest priority, they may not be as ideal as the ones executed from project developers (e.g. a certain community wants a wind project in the municipality, even if wind resources may be moderate).	Larger projects tend to use less material per kWh produced. Locations are chosen with good resources (e.g. no shading). Batteries would only be included if there is a strong business case, therefore inefficient use of raw materials is not likely. **X**	Same as for project developer model: Inefficient use of raw materials not so likely. **X**
Recycling	Maybe people give panels to collection points but recycling is hard to control.	Proper recycling of plants can be ensured through contracts. Collectives may be more aware of this issue but they may also not have the experience on how to organize it, or the scale may not be high enough. **X**	Proper recycling of plants can be ensured through contracts. **X**	Proper recycling of plants can be ensured through contracts. **X**
Biodiversity and ecosystem protection	No direct negative effects as systems are small, and in case of PV likely on existing roof-tops. **X**	Collectives may put special emphasis on biodiversity protection for their larger projects.	Projects will be developed within the legislative and regulatory framework.	Projects will be developed within the legislative and regulatory framework.

Criteria	Small scale individual prosumer	Collective prosumers	IPP developer	Utility
Economic sustainability				
Viability of business cases (without additional – public - support)	Depends highly on individual RES resources and support schemes.	May depend on support schemes, even though certain purchasing power is there due to (moderate) economies of scale compared to individual prosumers.	They can use purchasing power to achieve low LCOEs and be competitive.	Usually large-scale projects have very low prices due to economies of scale and they can therefore compete with low market prices, making this business model potentially work potentially without additional support. **X**
(Local) job and value creation	Individuals probably tend to use local installers. **X**	They use local installers if projects are not too big. For larger ones, national or regional installers may be used.	Same as for prosumer collectives but potentially less focus on local value-creation.	Framed contracts with national or regional installers are likely. No special interest in local installers.
Cost-efficiency	Individuals may not always have the means to find the best price offers in the vicinity. Small scale projects have higher prices per kW installed.	Prosumer collectives can run cost-effective projects but the level of professionalism may be lower.	Cost efficiency is quite high to secure margins for projects.	Utilities tend to work very cost efficiently due to economies of scale. **X**
Avoided grid investments	Especially in cities prosumer projects can lead to avoided or deferred grid investments as self-consumption can lead to decreased loads. (In general, grid investment is only necessary in rural areas. In cities, the load is usually high enough, that a lot of RES can be installed before it has an impact on the grid.) **X**	Even larger projects are usually set up close enough to the demand so that additional grid investments are minimised	Large-scale projects can be set up remote from demand centres. Transportation grid investments may be needed.	Same as for IPP developers.
Impact on tax revenues	Self-consumption reduces tax revenues (energy and VAT on energy), but individual projects can increase VAT income.	If self-consumption is part of the business model, tax revenues (energy and VAT on energy), will decrease. Tax income through projects may be higher, especially at the local level. **X**	No impact on tax revenue unless including self-consumption projects. **X**	Large (international) companies and projects tend to shift, avoid and reduce taxes.

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