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Regulatory challenges and opportunities for collective renewable energy prosumers in the EU

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ABSTRACT

The transition to a low-carbon future based on renewable energy sources is leading to a new role for citizens, from passive energy consumers to active energy citizens - the so-called renewable energy (RE) prosumers. Recent EU energy policy seeks to mainstream RE prosumers in each Member State. This study carries out a cross-country comparison between the regulatory frameworks of nine countries and regions - Belgium (Flanders region only), Croatia, France, Germany, Italy, Portugal, Spain, Netherlands and the United Kingdom - to reveal the main challenges and opportunities that these have posed to collective RE prosumers (i.e. renewable energy communities, citizen energy communities and jointly-acting renewable self-consumers). Four countries have had more favourable frameworks for collective prosumers: France, Germany, Netherlands and United Kingdom. The results indicate that the current legal framework at the EU level represents a clear opportunity for collective prosumers. Spain and Portugal have both already shifted from a restrictive regulation to implementing in 2019 a legal framework for collectives. The study provides a starting point to distil policy implications for improving legal frameworks relevant for collective RES prosumers across Europe.

1. Introduction

Today's transformation of energy systems requires the phase-out of predominant energy sources (i.e. fossil fuels), ensuring a low-carbon future based on clean and safe energy for all (Sovacool, 2016). Some transition scenarios carry the additional prospect of a transition from centralized towards decentralized energy systems, posing socio-political and economic challenges, as well as technological (Burke and Stephens, 2018).

The transition to a renewable energy (RE) model may also mean new roles and opportunities for citizens (Hisschemöller and Sioziou, 2013), acting as energy producers and consumers (Kalkbrenner and Roosen, 2016), or prosumers (Butenko, 2016). RE prosumers may be active energy citizens, willing to participate in energy markets (Kalkbrenner and Roosen, 2016) who, if acting together in collectives (i.e. companies, municipalities, condominiums, energy communities, etc.), can develop diverse decision-making and organisational forms (Ruotsalainen et al., 2017; Gui and MacGill, 2018). This paper focusses on such collective forms of energy production, self-consumption and active energy citizenship, referred here as collective prosumers.

Literature on collective prosumerism (Bauwens and Devine-Wright, 2018; Capellán-Pérez et al., 2018), has focussed on concepts such as "community energy" (i.e. community-based initiatives involving RE) (Walker and Devine-Wright, 2008; Brummer, 2018), "community solar" (solar installations co-owned by a local community) (Hoffman and High-Pippert, 2015); and "clean energy communities" (a wider concept that includes a typology of these communities – i.e. "virtual power plants; peer-to-peer trading, microgrids and community-scale energy projects") (Gui and MacGill, 2018). The variety of concepts is likely to increase, as different business models, governance arrangements and technology solutions are adopted by prosumers.

Some forms of collective prosumers are not confined to a specific location (Capellán-Pérez et al., 2018). For instance, a virtual prosumer project can be established when the consumption and production of a group of households "can be aggregated to form a flexibility capacity equivalent to that of a power plant" (Koirala et al., 2016, p. 727). Legal

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mechanisms, such as Green Certificates (Verhaegen et al., 2009), Guarantees of Origin (Ragwitz et al., 2009) and the role of aggregators (a market participant that combines multiple customer loads or generated electricity for sale, purchase or auction) (Herbes et al., 2017; Brown et al., 2019) may provide opportunities for virtual projects.

Some collective prosumers are clearly place-based, such as renewable energy communities, and prosumers located in the same multi-apartment building. New business models that pool self-consumption in specific communities are also emerging (Brummer, 2018; Dóci et al., 2015; Brown et al., 2019). Some fear the expansion of prosumer business models creates so-called 'death spiral' for utility companies (Kantamneni et al., 2016), wherein cycles of rising electricity prices, as an increasing number of consumers become prosumers, lead to a continuous loss of utility revenues (Laws et al., 2017). How these outcomes manifest is a function of each national energy market and the various grid policies targeting prosumers (Castaneda et al., 2017; Laws et al., 2017).

At the country level, regulatory frameworks aim to regulate the relationship between RE prosumers and the energy grid (IEA-RETD et al., 2016; Parag and Sovacool, 2016). Regulations play a structural role in the energy transition and can be highly complex, given the growing variety of schemes, business models, typologies of prosumers and grid-related issues (Heffron and Talus, 2016; Lampropoulos et al., 2010). While previous literature focused on the specific legal aspects of self-consumption, mainly on PV individual prosumers (European Environment Agency, 2013) and energy markets (Butenko, 2016), there is still a lack of major studies focusing on regulatory frameworks for collective RE prosumers. A recent report from the Council of European Energy Regulators (CEER, 2019) provides a synthesis of European regulatory aspects for collective prosumers. Nevertheless, a cross-country comparison of how EU Member States regulate collective RE prosumers is still missing, and such comparison is the aim of this paper.

The research leading to this article has been conducted within the European project PROSEU, which aims to understand the key incentive structures for the mainstreaming of RE prosumerism in the context of the energy transition.

Following recent European legislation, this study draws on three concepts for collective RE prosumers, namely: Renewable Energy Communities, Jointly Acting Renewable Self-consumers and Citizen Energy Communities (further explained in section 2). These types of prosumers may require a specific legal framework to support schemes such as the possibility of selling surplus energy directly to another consumer (e.g. peer-to-peer schemes), or the possibility of having more than one household meter connected to one installation.

Given the recast of European Union (EU) Directives, under the Clean Energy Package, Member States will soon need to ensure legal frameworks for prosumers exist in home market regulation. Thus, the driving research question of this article is to understand what the key regulatory challenges and opportunities for the emergence and development of collective RE prosumers have been. The question is addressed by establishing a baseline knowledge on the current legal frameworks of representative Member States. This provides a starting point to distil policy implications for introducing and/or improving legal frameworks relevant for collective RE prosumers across EU Member States.

We proceed as follows: Section 2 provides an overview of the definitions for collective prosumers in the Clean Energy Package. Section 3 explains the methods used to analyse regulatory frameworks across 9 European countries. Section 4 presents the results, which are discussed in section 5, with a focus on the key challenges and opportunities for collective prosumers. Finally, section 6 highlights the policy implications of this study and points to further avenues of research.

2. European legal concepts for collective renewable energy prosumers

Recent EU regulations provided different legal definitions of collective RE prosumers. In November 2016, the EU Clean Energy Package was proposed, comprising of a series of policy documents and legislative proposals that included provisions on prosumers. The most relevant legislative proposals for this study are the recast of the Renewable Energy Directive (Directive (EU) 2018/2001) or RED II, and the recast of the Electricity Directive (Directive (EU) 2019/944), or ED.

The RED II defines 'Renewable Energy Communities' (RECs) (Art.2.16) as legal entities which are optional, member-controlled organisations proximate to RE projects they own or operate. RECs must also be natural persons, SME's or municipalities i.e. non corporate actors, and whose primary purpose are social, economic, or environmental outcomes beyond financial profit.

According to the RED II, Art. 22.1, RECs are entitled to self-arrange sharing of renewable energy within the community and to access all suitable energy markets directly or through aggregation in a non-discriminatory manner. RECs are place-based, limited to renewable energy technologies and may be active in all energy sectors (CEER, 2019). Participation in a REC should be accessible also to low-income and vulnerable households (Art. 22.4(f)). Yet, despite its call for inclusiveness, the RED II does not provide explicit guidelines and measures to ensure that RECs are accessible to low-income households.

The RED II also defines 'Jointly Acting Renewable Self-consumers' as a "group of at least two jointly acting renewables self-consumers in accordance with point (14) who are located in the same building or multi-apartment block" (Art. 2.15). This concept describes a form of collective self-consumption, possible only to households who share a specific geographic location (CEER, 2019).

Thus, these two definitions pose some shortcomings when it comes to ensuring inclusiveness.

Additionally, the ED presents the definition of 'Citizen Energy Community' (CEC) (ED, Art. 2.11), which is similar to that of a Renewable Energy Community, but CECs also may engage in operating grid infrastructure, aggregation, storage, energy efficiency services or 'other' energy services.

CECs differ from RECs because activities are restricted to the electricity sector. Also, the ED does not specify that the activities of CECs cannot constitute a primary commercial or professional activity and there is no geographic limitation, so this type of community can be a virtual network, as is often the case with renewable energy cooperatives (Wierling et al., 2018). CEC's provide a potentially more inclusive model than RECs, since participation is not restricted to a specific location.

These concepts establish for the first time a shared understanding (among EU Member States) of what collective RE prosumers are, however, they may not always translate into inclusive frameworks which effectively result in affordable and clean energy for all. Additionally, the transposition of these Directives, which offer one-size fits all definitions of collective prosumers, may pose specific problems at the national level, as newly adopted legal frameworks may increase the complexity of navigating through the diversity of collective prosumers that already exists. How these legal provisions may integrate with existing Member States energy markets is the focus of the remainder of this paper.

3. Materials and methods

The article develops a comparative assessment of the legal frameworks of nine Member States with different trajectories for decentralized RE production: Belgium/Flanders region, Croatia, France, Germany, Italy, Portugal, Spain, Netherlands and the United Kingdom.

Considering that cooperatives are the most common legal form used by collective prosumer initiatives (Horstink et al., 2019), the number of energy cooperatives provided an indicator for selecting these countries, based on the market integration of collective RE prosumers. Germany, the Netherlands and the United Kingdom have witnessed over the past decade a significant market integration of prosumers (Hendricks and Mesquita, 2019). A directory of UK cooperatives (UK Coop, 2019) shows 248 results for energy cooperatives. In Germany, there were 791 active

energy cooperatives in 2018 (Wierling et al., 2018). In the Netherlands, the Hier opgewekt (2019) platform showed 484 energy cooperatives in 2018. The diffusion of decentralized energy is also significant in Belgium, France, Spain and Italy, although not as much as in the previous four countries. REScoop.eu's (a network of cooperatives in Europe) map on energy communities (REScoop.eu; 2019) shows 31 members from Belgium, 156 from France, 21 from Spain and 44 in Italy.

Lastly, Croatia and Portugal have more recently started to pick up pace in decentralized RE production. In these countries, renewables have been mainly in the hands of large utility companies, and small-scale projects are exceptions. For both countries, the RESCOOP map shows only one energy cooperative.

Data collection methods included the application of a semi-structured questionnaire and documentary and literature review. The questionnaire aimed to help collect information on the national legal frameworks that regulate collective self-consumption. Questionnaires were completed by a total of eighteen policy experts, selected based on their expertise with renewable energy policy and self-consumption laws in each country. The respondents (whose identity is kept anonymous) included: one lawyer per country, three representatives of NGOs and six energy policy researchers. On average there were two responses per country, although in Germany, three people responded, and in Croatia only one expert lawyer was consulted. The questionnaire was applied from July 2018 to May 2019. Some responded in writing (sending their replies via email) others orally (via teleconference calls).

The results of the questionnaire were complemented and validated for fact-checking and consistency through the review of the most relevant national legal documents (selected based on the indications of the experts interviewed), listed in Table 1. The time scope of the legal documents analysed goes as far as 1989 (i.e. the UK Electricity Act) and ends in laws published by October 2019 (i.e. Portuguese DL162/2019).

4. Results: national regulatory frameworks for collective prosumers

In what follows, the results of the analysis of the regulatory frameworks in nine countries are presented, including quotes from the interviews. All references of legal documents included in this section are listed in Table 1. Additionally, Table 2 summarizes the types of collective RE prosumers that are legally possible in each country (i.e. renewable energy communities, jointly acting renewable self-consumers and citizen energy communities), and the existent remuneration schemes for surplus energy (until 2019).

4.1. Belgium/flanders

Belgium is composed of three regions, and energy is regulated at the federal and regional level. The main federal law for self-consumption is the law of April 1999 (Organisation of the Electricity Market). In this study, the focus is on the Flanders region.

There is no clear definition of a renewable self-consumer in Flemish legislation, yet according to one of the experts interviewed:

> "In spite of the lack of a proper definition, self-consumption has been regulated for a long-time in Flanders, e.g. sugar industry has been considered for years a self-consumer. And households that have PV panels on their roof are now called prosumers by the grid operator and the regulator." (July 2018, interview excerpt)

Self-consumers can participate in energy markets, directly or through aggregators. In all regions of Belgium it is possible to receive compensation for the surplus of self-generated electricity (with a reduction in the electricity bill, as the electricity meter counts back when energy is injected in the grid), through a net-metering scheme applicable to installed capacities equal or lower than 10 kW (Art. V.2.4.2 Technical Regulation, 2015).

Table 1
Legal references consulted and reviewed for the analysis of regulatory frameworks relevant for collective RE prosumers in the EU and in nine EU countries.

Italy	DL 79/99. Decreto Legislativo 16 marzo 1999, n. 79. Attuazione della direttiva 96/92/CE recante norme comuni per il mercato interno dell'energia elettrica, „Decreto Bersani"– **Decree for the Regulation of the Electricity Market.** DL 387/03. Decreto Legislativo 29 dicembre 2003, n. 387. Attuazione della direttiva 2001/77/CE relativa alla promozione dell'energia elettrica prodotta da fonti energetiche rinnovabili nel mercato interno dell'elettricità – **Decree for the Promotion of Renewable Energy.** DL 239/04. Legge 23 agosto 2004, n. 239. Riordino del settore energetico, nonchè delega al Governo per il riassetto delle disposizioni vigenti in materia di energia - **Act on the Reorganisation of the Energy Sector.** AEEG 34/05. Delibera n. 34/2005. Modalità e condizioni economiche per il ritiro dell'energia elettrica – **Conditions on Electricity Supply to the Grid.** AEEG 280/07. Delibera n. 280/2007. Modalità e condizioni tecnico-economiche per il ritiro dell'energia elettrica – **Conditions on Electricity Imports to the Grid.** DM 18/12/08. Decreto 18 dicembre 2008. Incentivazione della produzione di energia elettrica da fonti rinnovabili. "Decreto Rinnovabili"– **Decree on Renewable Energy**. ARG/elt 99/08. Deliberazione 23 luglio 2008 - ARG/elt 99/08. Testo integrato delle condizioni tecniche ed economiche per la connessione alle reti elettriche – **Resolution on the Terms and Conditions for Access to the Grid**. L 99/09. Legge 23 luglio 2009, n. 99. Disposizioni per lo sviluppo e l'internazionalizzazione delle imprese, nonché in materia di energia – **Act on the Development of the Business and Energy Sectors.** ARG/elt 199/11. Delibera n. 199/2011. Testo integrato delle disposizioni dell'Autorità per l'energia elettrica e il gas per l'erogazione dei servizi di trasmissione, distribuzione e misura dell'energia elettrica per il periodo di regolazione 2012-2015 e disposizioni in materia di condizioni economiche per l'erogazione del servizio di connessione – **Resolution on the Transmission and Distribution of Electricity.** 570/2012/R/efr. Deliberazione 570 2012. Testo integrato delle modalità e delle condizioni tecnico-economiche per lo scambio sul posto. "TISP" – **Conditions for Net Metering.** Energy Authority Resolution 165/2013/R/eel.
Portugal	DL 225/2007. Decreto-Lei 225/2007 de 31 de Mai – **sets measures related with renewable energies as provided in the National Energy Strategy**. Ordinance DGEG of 26 December 2013. Despacho DGEG de 26 de Dezembro de 2013 – **sets the annual reduction rate and the electricity tariff applicable to microproduction units in 2014**. Ordinance DGEG of 26 December 2013. Despacho DGEG de 26 de Dezembro de 2013 – **sets the annual reduction rate and the electricity tariff applicable to miniproduction units in 2014.** Ordinance 286/2011, Portaria n.° 286/2011 de 31 de Outubro – **sets the coefficient Z for the calculation of the FiT for wind offshore projects.** DL 153/2014. Decreto-Lei 153/2014 de 20 de Outubro - Decree-Law No. 153/2014 of 20 October 2014 - **Self-consumption law.** Portaria 14/2015. Ordinance n. ° 14/2015 de 23 de Janeiro – **sets the legal regime applicable to small production (UPP) and self-consumption (UPAC) units**.). Portaria 15/2015. Ordinance n. ° 15/2015 de 23 de Janeiro – **sets the reference tariff for small production (UPP) and self-consumption (UPAC) units, foreseen in DL 153/2014.** DL 162/2019, 25 de outubro 2019. Decreto-Lei do autoconsumo coletivo e comunidades de energia aprovado em Conselho de Ministros – Decree-law on collective self-consumption and renewable energy communities.
Spain	RD 1955/2000. Real Decreto 1955/2000, de 1 de diciembre, por el que se regulan las actividades de transporte, distribución, comercialización, suministro y procedimientos de autorización de instalaciones de energía eléctrica – **Royal Decree on the Distribution and Transmission of Electricity**. RD 2017/1997. Real Decreto 2017/1997, de 26 de diciembre, por el que se organiza y regula el procedimiento de liquidación de los costes de transporte, distribución y comercialización a tarifa, de los costes permanentes del sistema y de los costes de diversificación y seguridad de abastecimiento - Royal Decree **Organising and**

(*continued on next page*)

Table 1 (*continued*)

	Regulating the Procedures for the Liquidation of Costs related to Transport, Distribution and Commercialisation, of Permanent System Costs, and of Costs related to Diversification and Security of Supply. RDL 6/2009. Real Decreto-ley 6/2009, de 30 de abril, por el que se adoptan determinadas medidas en el sector energético y se aprueba el bono social - **Royal legislative decree 6/2009 of 30 April 2009, approving specific measures in the energy sector and the social bonus.** Ley 24/2013. Ley del Sector Eléctrico – **Law on the Electricity Sector.** RDL 2/2013. Real Decreto-ley 2/2013, de 1 de febrero, de medidas urgentes en el sistema eléctrico y en el sector financiero. - **Royal decree-law for urgent measures in the electric system and in the financial sector.** RDL 9/2013. Real Decreto-ley 9/2013, de 12 de julio, por el que se adoptan medidas urgentes para garantizar la estabilidad financiera del sistema eléctrico. - **Royal Decree-law, adopting urgent measures to ensure the financial stability of the electricity system**. RD 413/2014. Real Decreto 413/2014, de 6 de junio, por el que se regula la actividad de producción de energía eléctrica a partir de fuentes de energía renovables, cogeneración y residuos. - **Royal Decree, regulating the activity of electricity production from renewable energy, CHP and waste**. RD 900/2015. Real Decreto 900/2015, de 9 de octubre, por el que se regulan las condiciones administrativas, técnicas y económicas de las modalidades de suministro de energía eléctrica con autoconsumo y de producción con autoconsumo. - **Royal Decree regulating the administrative, technical and economic conditions for the supply and production of electricity under self-consumption**. Ley 27/1999, de 16 de julio de Cooperativas, State Gazette BOE-A-1999-15681 **Law on cooperatives.** RD 15/2018. Real Decreto-ley 15/2018, de 5 de octubre, de medidas urgentes para la transición energética y la protección de los consumidores. **Royal Decree-Law with urgent measures for the energy transition and the protection of consumers**. RD 244/2019. Real Decreto 244/2019, de 5 de abril, por el que se regulan las condiciones administrativas, técnicas y económicas del autoconsumo de energía eléctrica. Ministerio para la trnaisición ecológica**. Royal Decree regulates the technical conditions of electric self-consumption.**
Netherlands	Wet belastingen op milieugrondslag. 1995 - **Act on the Environmental Protection Tax** (last amended 2018). Elektriciteitswet 1998 – **Electricity Act general law on electricity (last amended on 2018).** Wet IB 2001. Wet van 11 mei 2000 tot vaststelling van de Wet inkomstenbelasting 2001 – **Income Tax Act.** WBM 1995. Wet Belastingen op Milieugrondslag – **Act on the Environmental Protection Tax**, last amended on 16-09-2018. GGOEHE 2015. Regeling garanties van oorsprong voor duurzame elektriciteit – **Regulation on Guarantees of Origin for Renewable Electricity**, last amended on 2018. SDE. 2012 Besluit stimulering duurzame energieproductie – **Renewable Energy Production Incentive Scheme.** RAC 2018. Regeling aanwijzing categorieën duurzame energieproductie 2014 – **Regulation designating sustainable energy production categories.**
United Kingdom	EA 1989. **The Electricity Act** 1989, c.29. EnA 2008. **The Energy Act** 2008, c. 32, sections 41.43, legal basis to set up a feed-in-tarrif for small scale renewables electricity generation. ROO 2009. **The Renewables Obligation**, Order 2009, No. 785. FTO 2010. **The Feed-in Tariffs Specified Maximum Capacity and Functions** Order 2010, No.678. FTO 2012. **The Feed-in Tariffs**, Order 2012, No. 2782. EnA 2013. **The Energy Act** 2013, c. 32 EMR General Regulations 2014. **The Electricity Market Reform** (General) Regulations 2014, No. 2013. FTO 2015. **The Feed-in Tariffs (Amendment)** No. 3 Order 2015. EnA 2016. **The Energy Act** 2016, c 20. CfD Definition of Eligible Generator Regulations 2014. The Contracts for Difference (**Definition of Eligible Generator**) Regulations 2014, No. 2010. ROO 2015. **The Renewables Obligation**, Order 2015, No. 1947). FTO 2018. **The Feed-In Tariffs** (Closure, etc.) Order 2018.

However, in order to sell electricity to the grid, the self-consumer must have a meter that gives a distribution system operator (DSO) or a supplier precise data on self-production and consumption (quarterly meter, taking measures every 15 min) and the amount injected in the grid. According to one interviewee, such meters are normally not installed by individual consumers.

Flanders introduced a prosumer grid tariff (Technical Regulation, 2015) reducing benefits for prosumers (who must pay, depending on the installed capacity, a prosumer tariff between 80 and 113Euros per kW as a fee for the use of the grid). This tariff can be avoided by switching to a self-consumption scheme (with an installed capacity that matches as much as possible local consumption, resulting in minimum surplus energy), in which case the prosumer will not be eligible for net-metering.

There are no special rules for communities on generation, consumption, storage and selling of RE. Different consumers cannot operate a private grid and balance production and demand on a common level, since every household is required to choose an energy supplier in the market. It is forbidden to exchange surplus electricity directly between neighbours, RECs would therefore be restricted to business models that do not include these activities. However, neighbouring industrial consumers can exchange energy by installing a private grid. If it becomes necessary to reinforce or upgrade the grid, the investor may be obliged to provide necessary funds for it (Art.V.2.4.2 Technical Regulation, 2015).

CECs are possible due to the 'Green Certificates' policy, which implies that an energy producer (who could be also self-consuming the generated power) will be able to prove that a certain quota of the electricity supplied was generated through renewables. Green Certificates have been existing in the three Belgium regions, with minor differences, since 2002 (Art. 7.3, Royal Decree of 16 July 2002 states that the Federal Authority for the Regulation of Electricity and Gas issues one certificate per MWh of green electricity):

> "These certificates are used in Belgium as a support mechanism for producers, which guarantees certain revenue (for big solar self-consumers it may generate maximum of 5% benefit, for big wind self-consumers it may generate maximum of 8% profit). Green certificates are given to producers to support their investment. Currently, there are no more green certificates for small self-consumers investing in solar panels on their roof (less than 10 kW)." (July 2018, interview excerpt)

Belgium currently hosts several active energy cooperatives which can be considered CECs, such as Eco-Power, with around 48.000 members (REScoop.eu, 2019).

4.2. Croatia

In Croatia, the 2015 Law on Renewable Energy Sources and High Efficiency Cogeneration (or Renewable Energy Act) is the most important legal reference and defines prosumers as households or entrepreneurs who are end buyers of electricity whose installation is connected to a production facility (Art. 44). This law offers opportunities for some types of collectives (mainly in the industry sector).

Access to the grid depends on the type and/or size of the production facility. Private and legal persons whose production facility's installed capacity does not exceed 1 MW, or who produce electricity exclusively for their own consumption, are not obliged to obtain a respective energy license.

Individual prosumers can sell their surplus energy to energy suppliers, but not to other consumers:

> "The Renewable Energy Act explicitly regulates the sale of surplus of self-generated energy. It sets out conditions which collective prosumers must fulfil in order to be able to obtain remuneration for the sale of surplus electricity. These are: (i) obtaining the status of the eligible electricity producer, (ii) acquiring a right of permanent

Table 2
Legal Frameworks and viability to set up RECs, Jointly Acting Renewable Self-consumers and CECs across nine European countries; and remuneration schemes for surplus energy (until October 2019).

Country	Legal definitions and feasibility for Renewable Energy Community (REC)	Legal frameworks and feasibility for Jointly acting renewable self-consumers	Legal frameworks and feasibility for Citizen Energy Community (CEC)	Existent Remuneration scheme for surplus energy generated by prosumers
Belgium/ Flanders	No legal definition exists.	No, tenants are not able to sell surplus energy between them. No specific legal framework exists.	Yes, through the Green Certificates Policy, and in the form of energy cooperatives. No specific legal framework exists.	Net-metering
Croatia	No legal definition exists.	No, tenants are not able to sell surplus energy between them. No specific legal framework exists.	Yes, in the form of energy cooperatives. No specific legal framework exists.	Feed-in-tariff Premium tariff
France	No legal definition exists, but there is a legal definition for collective self-consumption operation (CSO)	Yes, tenants can sell surplus energy between them, using the CSO legal framework	Yes, as an energy cooperative. No specific legal framework exists.	Feed-in-Tariff Premium tariff Tax reduction (reduced VAT rate)
Germany	Yes, legal definition of "Citizen Community" defines communities with characteristics like RECs	Yes, there is a legal framework - Tenant supply act.	Yes, legal definition of "Citizen Community" allows communities with characteristics like CECs.	Feed-in-Tariff Tenant electricity surcharge
Italy	No legal definition exists.	No, tenants are not able to sell surplus energy between them. No specific legal framework exists.	Yes, in the form of energy cooperatives. No specific legal framework exists.	Net-metering Premium tariff Tax reduction (e.g. real-state tax)
Netherlands	Yes, under the postal-code-area regulation, people living in proximity could form a REC	Yes, under the postal-code-area regulation	Yes, as an energy cooperative. No specific legal framework exists.	Net-metering Premium tariff Tax exemption (exemption of the Act on the Environmental Protection Tax)
Portugal	Yes, but not possible until October 2019. New decree-law includes the REC definition (as it appears in RED II)	Yes, but not possible until October 2019. New decree-law includes a definition of collective self-consumption	Yes, as an energy cooperative. No specific legal framework exists.	Self-consumption regime with renumeration for surplus energy at 90% of market price.
Spain	Yes, but not possible until April 2019. New Royal Decree for collective self-consumption offers a legal framework suitable to RECs	Yes, but not possible until April 2019. New Royal Decree for collective self-consumption law defines "neighbour communities"	Yes, as an energy cooperative. No specific legal framework exists.	No mechanism for renumeration of surplus energy Savings in energy bill
United Kingdom	Yes, there are no legal barriers to set up RECs, although no specific legal framework exists	Yes, there are no legal barriers, although no specific legal framework exists	Yes, as an energy cooperative. No specific legal framework exists.	None

connection to the grid, (iii) total connection capacity not exceeding 500 kW, (iv) outward connection capacity not exceeding the inward connection capacity, (v) a prosumer can only use one metering point for injecting and receiving electricity from the grid and (vi) keeping data of electricity produced and delivered. The law sets a formula and additional rules for calculating the minimum remuneration the supplier is obliged to pay to a prosumer for the surplus of electricity. However, the parties are free to agree on a higher remuneration than the minimum set by law." (February 2019, interview excerpt)

In the case of jointly acting self-consumers, each apartment must be connected directly to the public grid via its own metering point, and tenants are not able to sell surplus energy between them. It is not possible for households in a multi-apartment building to exchange locally self-produced energy (Law on the Regulations for Energy Activities, Art. 26). RECs would be restricted to a set of business models as in the case of Belgium.

It is possible for a community to manage a closed distribution system (Electricity Market Act, Art. 37). This is defined as a system which distributes electricity within a geographically closed industrial and/or commercial location. Therefore, this option only applies to industrial and commercial prosumers.

CECs are possible, through the legal form of cooperative. Co-operatives are not bound by specific proximity and are entitled to obtain an energy license since they are considered legal persons. Energy co-operatives may participate in energy markets, if they obtain a relevant license.

The Croatian "system of guarantees of origin" (GO) could be an incentive for RE prosumers.

"One GO corresponds to the sale of 1 MWh of electricity from RE delivered to the grid. Nevertheless, 1 MWh is a quite high threshold for small scale producers, and in practice means that the GO system mainly applies to aggregators. The Croatian Fund for Environmental Protection and Energy Efficiency also supports RE through various tenders, including those specifically intended for family houses." (February 2019, interview excerpt)

4.3. France

Regulations on self-consumption were integrated in the French Energy Code in 2015 and 2016. The most important legal provisions are the 2015–992 Energy Transition Law and the 2016-1019 Self-Consumption Ordinance that regulates individual and collective self-consumption. Producers and consumers of electricity must have an equal and non-discriminatory access to the grid, which is controlled by the Energy Regulatory Commission.

The Energy Code defines an 'individual self-consumption operation' and a 'collective self-consumption operation'(CSO) (Art. 315), stating that self-consumption is collective when electricity is provided between one or more producers, and one or more final consumers who are tied (among themselves) within a legal structure of a legal person, located in proximity, and whose extraction and injection points are situated after the same low-to-medium voltage transformer station.

CSOs can generate and sell their RE. Depending on the size of the project, they may benefit (or not) from certain support schemes:

"It is possible for CSOs to participate in energy markets, except if they benefit from the feed-in tariff (FIT). When benefiting from fixed FIT, a CSO would not be active on the market; the company buying

their energy would be responsible and taking care of all market-related activities." (November 2018 interview excerpt)

Small installations of up to 3 kW can choose to 'donate' to the grid. All CSOs can benefit from an investment premium and a FIT for projects under 36 kW, also from tenders for bigger projects (above 100 kW) and some grid tariffs and tax exemptions. According to one interviewee (November 2018), the payment for the surplus energy of a CSO is done based on the contract that binds the members of the community.

CSOs are exempted from energy suppliers' responsibilities, they:

"could decide to register as an energy supplier. Yet, they would be subject to strict and demanding requirements, such as balancing responsibility, as well as technical and financial capacity." (November 2018 interview excerpt)

There is no legal definition for RECs, but these may adopt the legal form of a CSO. Residents of multi-apartment buildings or condominiums can equally adopt this legal form and sell surplus energy to each other, thus becoming jointly acting self-consumers. Although a CEC would not use the legal form of CSO, it could be a cooperative.

CSOs still face a few difficulties related to the grid. Specific grid tariffs are fixed by the National Regulatory Authority on a request by the Parliament, which are sometimes more expensive than the normal grid tariffs, according to the expert interviewed (November 2018).

4.4. Germany

The main legislation relevant for prosumers is the Renewable Energy Sources Act 2017 (EEG). The EEG defines self-supply and includes a definition of energy community, literally translated as 'Citizen Community' (EEG, section 3 no. 15).

The grid operator must favour energy from renewables. All types of self-consumers can participate in the energy market directly and through aggregators:

"Energy communities usually participate via "aggregators" and/or service companies/suppliers that sell the electricity directly under their name or as white label product under the name of the energy community. Regulations applicable to energy communities are the same as for other energy suppliers (in practice they must reach a certain scale to make the business profitable)." (January 2019 interview excerpt)

To participate directly it is necessary to be registered as an energy supplier and obtain a supplier permit, which according to one interviewee comes with high regulatory burdens and may be cost-prohibitive.

Different types of compensation can be allocated to an installation: the market premium; FIT (range from 10.28 cents (<100 kWp), to 11.83 cents (<10 kWp) per kWh.); tenant electricity supplement or other direct selling (EEG, 2017). Remuneration for surplus energy is dependent on the size of RE power plants (e.g. installed capacity above 750 kW must participate in a public tender).

It is possible to share electricity in the same multi-apartment building or neighbourhood due to the Tenant Supply Act (EEG, 2017), or *Mieterstrom*, which is a system of collective self-consumption in the same multi-apartment building. Under this scheme, the building owner, who must become a licensed supplier, may produce electricity from solar panels on the roof and sell it to its tenants. For surplus electricity fed into the grid, tenants receive the same feed-in tariff remuneration. For their self-consumed energy, they receive an additional 'tenant-electricity surcharge' (EEG 2017, Sections 19(3) and 21(3)). In return, they are obliged to pay 40% of the EEG-apportionments intended for traditional electricity consumers (EEG 2017, Section 61b (1)).

There is a specific legal definition of energy community - i.e. 'Bürgerenergie' (EEG, section 3 no. 15) - financial participation via equity in a RE installation -, which is not equivalent to any of the EU definitions for energy communities. 'Bürgerenergie' refers to a "Citizen Community", consisting of at least 10 natural persons, in which at least 51% of voting rights are held by natural persons from the district in which e.g. a wind farm is installed, and in which no member holds more than 10% of the voting rights. Since there are no specific spatial limits, and the definition can be applicable to any type of energy installation (not just using RE sources), although the EEG specially mentions wind onshore. Thus, communities can have the characteristics of both the REC and the CEC concepts.

There are some incentives for RECs. They may participate in wind tenders, and the project size is defined by a maximum of six wind turbines with maximum 18 MW. Local authorities have the right to invest in the project (up to 10%). Until the beginning of 2018, RECs were able to participate in the process of tendering before all others (i.e. without permits under the Federal Immission Control Act, last amended May 2000). Several Federal States have support schemes for these communities.

Relative to other countries, Germany seems to have a stronger regulatory framework for collective prosumers, but not all changes have been financially beneficial:

"The numerous changes in the EEG 2017 law make it a very complex law, which results in a complex legislative structure and often leads to extra unforeseen costs for prosumers." (January 2019 interview excerpt)

4.5. Italy

Despite the absence of specific laws for self-consumption, Italian law provides a definition of "self-producer" which allows the self-generation and self-consumption of renewable energy. The Energy Authority Resolution (n. 578/2013/R/EEL.), regulates also independent local grids, as some regions in Italy have their own historical cooperatives who own the local grid.

There are no restrictions on the size of RE systems installed for self-generation and no limits on the amount of electricity that can be fed into the grid (Resolution on the Terms and Conditions for Access to the Grid, 2008). There is also an obligation imposed on the system operator to buy electricity from RE producers, and it is possible for (individual) self-consumers to sell electricity to the grid (Art. 3.3 DL 79/99).

There are support schemes for RE electricity, such as a favourable VAT regime (10% instead of 20%), real estate tax deductions, possibility to sell RE electricity on a guaranteed minimum price ("ritiro dedicato"), and net-metering ("scambio sul posto"). The two last schemes cannot be combined (prosumers must opt for one). Ritiro Dedicato refers to a simplified purchase and resale arrangement, where energy producers may opt to receive a guaranteed minimum price or a market price (Art.15.4, Annex A, Conditions on Electricity Imports to the Grid, AEEG 280/07). "Scambio Sul Posto" is based on an agreement between a producer and an electricity system operator, under which generated electricity is sold to the grid, instead of being sold through a bilateral contract or directly on the market (applicable to plants with capacity equal or lower than 500 kW) (Resolution 570/2012).

"Through the net-metering mechanism electricity fed into the grid is remunerated through an "energy quota" that is based on electricity market prices and a "service quota" that depends on the cost of grid services (transport, distribution, metering and other extra charges)." (January 2019 interview excerpt)

It is also possible for prosumers to participate directly in energy markets:

"However, the requirements for accessing electricity markets are very complicated (e.g. requesting special bank guarantees), which, in practice, makes it difficult for small players to participate." (January 2019 interview excerpt)

As in the case of Belgium and Croatia, each prosumer must have its own single meter - it is not possible to sell the energy produced by a household to another. Therefore, RECs are limited to activities which do not include these, and collective self-consumption is not possible. CECs are possible, using the legal form of a cooperative, association or limited company.

However, there are two specific forms of collective RE prosumers (Energy Authority Resolution 578/2013/R/eel): a) a special regime for historical energy cooperatives, whose legal framework was created in the 1960s. Some communities co-managed local plants (mainly, hydro plants) and developed a local grid, with a point of connection to the national grid; and b) a 'Utility Efficient System' (Sistema Efficiente di Utenza). It allows using electricity produced locally in a nearby building and applies to installed capacities of up to 20 MW, who can consume their produced electricity or sell such electricity to a unique local consumer. This type of installation could be used by large commercial or industrial consumers.

Recently, there have been frequent changes in regulations which create more complexity and uncertainty for future prosumers. Accordingly:

> "Ongoing political discussions consider the possibility of allowing one installation to have multiple meters associated to it, which would allow the setup of a REC." (January 2019 interview excerpt)

4.6. Netherlands

The main law relevant for prosumers is the Electricity Act 1998 (last amendment in 2018). Although this law does not provide a specific definition of self-consumer or of collective RE prosumers, some provisions offer incentives for prosumers, and different forms of self-consumption are possible. In particular, the postal-code-area regulation (*Postcoderoosregeling*, Act on the Environmental Protection Tax, Art. 64 (1) and Art. 50 (4), (5), 2018) is applicable to collective prosumers engaged in local RE production who want to supply their own members.

Prosumers can only participate in retail electricity markets if they have the status of a supplier:

> "To be considered as a supplier it is necessary to fulfil certain requirements and comply with complicated technical rules, which make the process difficult, as they are set for traditional supply companies." (November 2018 interview excerpt)

The rules are different depending on the size of the connection (and not on whether it is an individual or collective prosumer). According to the experts interviewed, in most cases, communities work with energy suppliers 'specialised' in collectives (either via net metering or commercial contracts).

Self-generated energy injected into the grid is always remunerated on a yearly basis. A net metering system is available for prosumers whose maximum self-consumed energy is 10.000 kWh/year (prosumers must have a bi-directional meter) (Art, 95 and Art 31, Electricity Act, 2018). During the year, a prosumer produces energy and injects the surplus into the grid. At the end of the year, this prosumer receives money for the quantity provided to the grid (calculated as energy produced minus energy consumed):

> "For the total surplus of electricity introduced into the grid, the self-consumer receives a remuneration, based on a fixed price for the electricity. This price is lower when compared to the retail market price for electricity." (November 2018 interview excerpt)

Energy cooperatives and other communities are entitled to exchanging electricity among themselves and run a REC. Yet, the members will need to share the same postal code, due to the 'collective net metering' law. RECs and jointly acting renewables self-consumers can produce locally their own energy and benefit from tax advantages that come with this system (Art. 48 and 50, Act on the Environmental Protection Tax, 2018).

CECs are possible, and there are several energy cooperatives in the Netherlands that maybe considered a CEC. These communities also benefit from Netherlands' Guarantees of Origin Market (Regulation on Guarantees of Origin, 2018).

4.7. Portugal

Before 2014, RE self-consumption was not regulated in Portugal. The 2014 decree-law (DL 153/2014) introduced the definition of 'Small Production Units for Self-consumption' (in Portuguese referred to as UPACs), which were limited to individual or collective persons, with each production unit being associated only to one single meter, thus rendering impossible any form of collective RE prosumer initiative.

As a response to the RED II, a new DL was issued on the 25th of October 2019 (DL 162/2019). The new regime allows direct exchange between two or more prosumers and sets the ground for the development of micro-grids and various collective self-consumption business models (including peer-to-peer schemes).

DL 162/2019 also simplifies administrative procedures. Before, for an installed capacity between 200 and 1500 Watts, no permit was required. The producer merely communicated that the UPAC existed to the National Directorate for Energy and Geology, or DGEG. If the installed capacity was higher than 1500 Watts, the producer would need to attain a license (the cost varied according to the installed capacity). Under the new DL, the communication requirement is extended to 30 kW, and only installations bigger than 100 kW will need approval from the grid operator (which may be a lengthy administrative process).

Under the previous DL 153/2014 regime, self-consumers could inject their surplus energy into the grid and receive a payment:

> "In 2017, electricity prices assumed values between 0.044 and 0.075 €/kWh. Considering that the yearly mean value was 0.052 €/kWh and using this value as an example one obtains a surplus energy remuneration of 0.047 €/kWh. So, the installed capacity of these systems should be dimensioned to match the consumption needs." (November 2018 interview excerpt)

DL 162/2019 states that collective self-consumption and RECs should receive a renumeration for surplus energy supplied to the grid that reflects the market value of that electricity and which can be commercialised by an independent aggregator or utility company.

For the first time, there is a legal framework for jointly acting self-consumers and RECs, which is a copy of the RED II definition. There are no set spatial limits for the proximity between prosumers (i.e. in km), although DL 162/2019 states (as in the RED II) that members of the community should be located within proximity of the RE installation.

DL 162/2019 also states the DGEG must produce an assessment report of the development of RECs one year after the legislation comes into force, and subsequently a new report every 2 years. DGEG's assessments should be integrated and, if necessary, lead to new legal amendments in order to promote RECs and ensure that they are accessible to all consumers, including lower income families.

There are no legal provisions for CECs. However, DL 162/2019 offers equally a legal basis for aggregators and the use of Guarantees of Origin (producers and energy suppliers may use this mechanism), allowing the setting up of new business models and new networks and social innovations that may further develop CECs in Portugal.

4.8. Spain

Under the RD 900/2015, a tax was applied to any RE electricity generated and self-consumed. Legal procedures for prosumers were complicated and could mean high fines for non-compliance. The

legislations issued in 2018 (Royal Decree-Law (RD-L 15/2018)) and 2019 (RD244/2019) eliminated the so-called 'solar tax' and provided a legal provision for collective forms of self-consumption:

> "The RD 244/2019 decree provides new incentives for Spanish prosumers by establishing compensation mechanisms and simplifying administrative procedures. The modifications affect the definition of self-consumption (to include collective self-consumption) and reduce the forms of self-consumption to two (self-consumption with or without surplus); simplify the registration of the installations and eliminate the need to get access and connexion permits for some production installations (without surplus)." (April 2019, interview expert)

There are different legal standards for self-consumers, according to the installed capacity. Installations between 15 and 100 kW will need to process a connection point with a distribution company, and installations higher than 100 kW are not considered prosumers. Permitting varies also between small installations of up to 15 kW (no permit required, the procedure is simplified); between 15 and 100 kW it will be necessary to process a point of connection to the energy grid.

Before this legislation came into force, surplus energy was not remunerated for small installations. Only installations above 100 kW duly registered as production installations could effectively sell their surplus energy. Excess energy injected into the grid was remunerated at market price in real time, at an hourly basis. Installations equal or below 100 kW would not receive remuneration for excess electricity. Under the RD 244/2019, installations up to 15 kW should consume as much as possible the energy produced; while installations from 15 to 100 kW receive a compensation in the form of savings to their electricity bill. In the case of collectives, the new DL specifies that compensation for surplus energy includes a distribution of the savings among neighbours.

Although RECs are not specifically mentioned, technical and economic aspects relevant for collective prosumers are regulated under RD 244/2019. Jointly acting self-consumers are considered "neighbour communities" formed by those within one apartment block. According to this law, the self-consumer must be at a maximum distance of 500 m from the installation. The limitations of 100 kW (installed capacity) and of 500 m for collective self-consumption are not derived from the RED II and may provide a barrier to some types of RECs.

Concerning CEC, these are possible to set up, as virtual networks of RE producers. Som Energia, for instance, is a large energy cooperative in Spain, who aside from owning its own plants for collective self-production, integrates local working groups, creating a national decentralized network throughout Spain, which is a good example of this type of community.

The new legislations were set up by a new Minister for the Ecological Transition, with goals for reducing carbon emissions until 2030, and encourage a much wider adoption of RE for collective prosumers (Instituto para la Diversificación y Ahorro de la Energía (IDAE), 2019).

4.9. United Kingdom

UK laws are applicable across the country, but they are interpreted differently in Northern Ireland which has its own regulator and electricity market. Therefore, this analysis does not cover Northern Ireland. Laws are interpreted by OFGEM for Great Britain (England, Wales and Scotland), and out case research occurred in England.

The legislation relevant for prosumers is the Electricity Act of 1989. Despite the absence of specific legislation for self-consumption, UK law includes important provisions that have incentivised individual and collective self-consumption over the past decades; namely the FIT regulations (Feed-in Tariffs Order, 2012; No. 2782).

Over the past decades, laws and policy documents have promoted and supported collective forms of self-consumption, including the introduction of FIT for small-scale RE production. The FIT scheme was consistently reduced over the past years until it ended March of 2019. It applied to any generation under 5 MW and provided a subsidy for each kWh generated.

> "This means a loss of subsidies for prosumers. Nevertheless, the cost of equipment and technologies has also decreased since the FIT was first set up." (April 2019 interview excerpt)

To participate in energy markets, prosumers need to participate in the national BETTA (British Electricity Trading and Transmission Arrangement) market, which requires significant overheads, often too large for community and small commercial schemes. Alternatively, they could sell their output via a 'third party' which is a BETTA participant. Aggregators can participate in the wholesale market if they are registered suppliers for the sites they are aggregating.

Self-consumers and RECs can be considered small suppliers. According to British FIT regulations (Feed-in Tariffs Order, 2012; No. 2782), persons (other than licensed suppliers) who only supply electricity which they generate themselves are not allowed to supply more electrical power than 5 MWh, of which no more than 2.5 MW is supplied to domestic consumers. In this case, prosumer communities can trade their surplus energy. Nevertheless, in order to connect RE generators to the power grid, communities must comply with distribution grid codes and with technical specifications to prevent damage to the network.

There are no barriers for RECs and jointly acting self-consumers, although these are not legally defined. Individuals living in the same multi-apartment building or neighbourhood can establish and run a separate energy community, and no specific spatial limits are set.

After the FIT ended "some energy stakeholders fear that self-consumers will not be able to profit from their surplus self-generated energy" (May 2019, interview excerpt). However, ending the FIT removes the obligation on suppliers to buy the energy that prosumers produce at a fixed price:

"While this may lead to aggregator tariffs to emerge (which buy up the excess prosumer energy and trade it in the market), it also might be a boost to P2P models to sell excess energy. Britain had in place the renewable portfolio standard scheme, under which energy utilities must either generate a fixed quota of their electricity from renewables or pay a compensation. Despite the lack of direct subsidies or support for RECs, this scheme could be an indirect incentive for energy communities." (May 2019 interview excerpt).

The Grid Code (technical code for connection and development of the National Electricity Transmission System) and the Balancing and the Settlement Code are undergoing modifications. The changes may open the door to virtual energy communities as a form of CEC and provide direct access to the wholesale market for self-consumers, expanding the potential for prosumers to secure revenues from a diversifying flexibility market. Equally, the balancing market is opening for independent aggregators which creates an opportunity for groups of prosumers to pool and benefit from controllable load (Bray and Woodman, 2019).

5. Discussion: challenges and opportunities

Until now, the main regulatory challenges for collective prosumers have included not being able to legally set up a renewable energy community (REC); lack of incentives to set up jointly acting renewable self-consumer projects and, in some cases, the reduction or removal of existent incentives, such as FITs.

Four countries have had more favourable frameworks for collective RE prosumers: France, Germany, the Netherlands and United Kingdom. Belgium, Croatia and Italy still do not allow collective self-consumption schemes. Spain and Portugal shifted from a restrictive regulation to implementing in 2019 new legal frameworks for collectives. These changes appear to largely derive from the push provided by new European legislation. In addition, problems such as energy poverty, energy security and climate change seem to be promoting new self-consumption

policies (CEER, 2019).

Various countries have gone through subsequent reviews and updates of existing laws. This indicates that RE prosumerism is a complex issue for regulators, requiring an ongoing assessment of social, economic, technological and environmental considerations (Akerboom and Scholten, 2014; Heffron and Talus, 2016). These regulatory updates are likely to cause a sense of instability in prosumers which could reduce future investments (Bolton and Foxon, 2015; Karneyeva and Wüstenhagen, 2017).

The absence of legal provisions is more striking in the case of RECs and CECs. Belgium, Croatia and Italy have legal options for collective self-consumption, which are only specific to commercial or industrial prosumers. Also, collective self-consumption laws tend to have a one-size fits all approach and set spatial limits and/or restrictions on installed capacity that can inhibit the innovation potential of RECs. Local energy needs and energy sources (dependent on geographic conditions, climatic features, and/or socioeconomic factors) may pose additional challenges or opportunities. Moreover, permitting processes need to be simplified, considering financial and social issues that are specific to the communities involved (Capellán-Pérez et al., 2018; Kounelis et al., 2017; Yang et al., 2016).

Key opportunities identified include improved competitiveness of business models. Virtual net metering, which is legally possible in Germany and the UK, can potentially open a range of opportunities for collectives. As Burke and Stephens (2017) explain "virtual net metering broadens the sharing of benefits from renewable energy projects by allowing those lacking access to a suitable generating site to participate in sharing the output from a single facility" (p. 39). Schemes such as FITs are pointed out as an opportunity for self-consumption, yet require "appropriate and transparent pricing schemes" (Burke and Stephens, 2017). As an alternative, recent regulations tend to encourage the dimensioning of RE systems according to individual consumption levels. The self-consumption regime would work well if prosumers could be allowed to exchange their surplus energy with others, through peer-to-peer mechanisms making use of bilateral contracts (Sousa et al., 2018). The ability to set up these agreements is a crucial incentive for the growth of collectives, since this provides an effective solution to the problem of storage (still technologically limited and expensive). It may also avoid grid deflection, working against a 'death spiral' effect (Laws et al., 2017), in case utilities recognize the potential for developing services for RE prosumers. Additionally, the imposition of grid tariffs specific to prosumers (who only use the local low-voltage grid), as is the case of Belgium/Flanders and France, reflects a policy concern with distributing grid costs as the number of prosumers increases.

Nevertheless, despite the various legal 'blanc spots' across EU countries, local communities and municipalities continue to build their own collective RE prosumer models (Kalkbrenner and Roosen, 2016; Brown et al., 2019). Across Europe, groups of citizens are developing new modes of governance, business models and alternative financial mechanisms to enable the production and self-consumption of renewables, even when legal frameworks pose barriers (e.g. Somenergia cooperative in Spain, Eco-power in Belgium, and Coopernico cooperative in Portugal).

This points to a crucial quality indicator for regulatory frameworks: flexibility. FITs are normally presented as an important incentive, and the tendency to reduce these tariffs as a disincentive (Nolden, 2013; Newbery, 2016). Nevertheless, when regulatory frameworks are flexible enough to allow for different solutions to emerge from the bottom (e.g. aggregators, virtual power plants, peer-to-peer schemes), such as the UK and the Dutch cases, communities are finding creative ways of taking advantage of untapped opportunities (Brown et al., 2019). Conversely, regulatory frameworks can be inflexible and locked into a set of schemes that do not provide local communities with enough manoeuvring space to create new solutions, as was the case of Portugal, before the 2019 Decree-Law (DL162/2019).

6. Conclusion and policy implications

Collective RE prosumers should benefit from a regulatory structure that boosts their innovation potential, but equally ensures they have enough legal support to operate in the extant energy market.

The EU Clean Energy Package is leading to legislative changes across Member States, yet some features of the EU provisions are open to interpretation, and the transposition to national laws may vary. Therefore, the following recommendations can be distilled:

Collective self-consumption laws are not enough to provide a robust legal framework for RECs. Given the complexity of needs (e.g. demand-side management schemes, organisational structures), challenges (e.g. costs of equipment, as well as batteries and grid charges) and opportunities (e.g. new business models involving aggregators and third parties), RECs require a specific legal framework.

Given the innovation potential of RECs and the new business and financial models which are likely to emerge, new laws should account for innovation and experimentation, integrating provisions for a periodic evaluation and monitoring of RECs, to ensure future improvements of the legislation.

Given the costs, as well as organisational and knowledge needs required for groups of citizens to set up a local project, it is important to prevent the exclusion of more vulnerable communities and lower income families. Citizen Energy Communities (CEC) may involve a wide range of citizens in the energy transition that are not able to participate in place-based communities. Yet, legal frameworks seem to ignore this type of collective. Self-consumption laws should include provisions that directly address CECs.

Countries need to set clear and ambitious targets for decentralized RE production until 2030 and 2050 (in line with European Energy Union policies). Once legal barriers are overcome, financial, technological and organisational barriers need to be addressed, through policies that help communities develop new business models, as well as affordable and accessible demand-side management schemes.

The EU should assist Member States in the transposition of the directives, by creating a European prosumer platform, enabling new communities of practice and encouraging knowledge sharing and dialogue among RECs, CECs and national legislative bodies.

By establishing a baseline knowledge of the current legal frameworks for nine representative Members States, this study offered a starting point to evaluate the effectiveness of new EU legislation in promoting the mainstreaming of prosumers in the context of the energy transition. Further research should evaluate how European legal concepts for collective RE prosumers are being transposed to the Member States' national laws, if possible across all EU Member States, in order to critically assess the effectiveness of the new legislative proposals in enabling and encouraging an active role for citizens and communities in the energy transition and in preventing (or not) the increase of inequalities and energy poverty. Furthermore, attention should be paid to how countries across the world are responding to the regulatory challenges of collective RE prosumerism, in comparison with the European experience.

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7. Credit author statement

The authors have contributed in the following aspects:

Inês Campos has led the conceptualization (formulation of research goals and aims), and methodology, and has implemented the

investigation (data collection and data analysis), as well as validation of results and formal analysis. She has been responsible for the original draft, as well as for editing the subsequent revisions of the manuscript (after receiving feedback from reviewers). She has also been responsible for the preparation and presentation of the published work. She has been responsible for project administration and the acquisition of the financial support for the project leading to this publication.

Guilherme Luz has been involved in the conceptualization, methodology and investigation (data collection and analysis), as well as preparation and presentation of the published work, and has reviewed the different versions of the manuscript leading up to the final draft.

Esther González Marín has been involved in methodology and investigation (data collection), as well as validation of results and formal analysis. She has equally contributed to writing sections of the original draft and has critically reviewed the different versions of the paper leading up to the final draft.

Swantje Gährs has been involved in the conceptualization, methodology and investigation (data collection) and has critically reviewed the different versions of the paper leading up to the final draft.

Stephen Hall has been involved in the conceptualization, methodology and investigation (data collection), as well as validation of results, and has critically reviewed the different versions of the paper leading up to the final draft.

Lars Holstenkamp has been involved in the conceptualization, methodology and investigation (data collection) as well as validation of results and has critically reviewed the different versions of the paper leading up to the final draft.

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