Charges for Producers connected to Distribution Systems

eurelectric

Project report
November 2018

Eurelectric represents the interests of the electricity industry in Europe. Our work covers all major issues affecting our sector. Our members represent the electricity industry in over 30 European countries.

We cover the entire industry from electricity generation and markets to distribution networks and customer issues. We also have affiliates active on several other continents and business associates from a wide variety of sectors with a direct interest in the electricity industry.

We stand for

The vision of the European power sector is to enable and sustain:
- A vibrant competitive European economy, reliably powered by clean, carbon-neutral energy
- A smart, energy efficient and truly sustainable society for all citizens of Europe

We are committed to lead a cost-effective energy transition by:

investing in clean power generation and transition-enabling solutions, to reduce emissions and actively pursue efforts to become carbon-neutral well before mid-century, taking into account different starting points and commercial availability of key transition technologies;

transforming the energy system to make it more responsive, resilient and efficient. This includes increased use of renewable energy, digitalisation, demand side response and reinforcement of grids so they can function as platforms and enablers for customers, cities and communities;

accelerating the energy transition in other economic sectors by offering competitive electricity as a transformation tool for transport, heating and industry;

embedding sustainability in all parts of our value chain and take measures to support the transformation of existing assets towards a zero carbon society;

innovating to discover the cutting-edge business models and develop the breakthrough technologies that are indispensable to allow our industry to lead this transition.

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Summary of main findings and policy recommendations

1. Main outcomes of Eurelectric survey on charges for electricity producers applied in the EU distribution systems

A survey conducted by Eurelectric in 2017 showed the following characteristics of the distribution system charges across the EU and their effects on producers and different types of facilities. Secondly, on the basis of these findings, the authors of this report were able to derive policy recommendations which also confirm the previous findings and analyses by Eurelectric, see second part of this summary.

1.1. General findings

- In many countries, there are **increasing numbers of electricity producers** connected to the distribution system. These are renewable energy sources **(RES) and conventional producers** as well as **prosumers**, i.e. consumers who produce electricity primarily for their own needs and may feed part of this electricity to the network, either being remunerated for it, or not. At the same time, there are also **charging stations for electric vehicles (EVs)**, as well as **storage facilities**, connected to the distribution systems in some of the countries.

- With regards to the kinds of charges applied to the aforementioned producers connected to the distribution system, we identified the following categories: **connection charges, market related charges linked to network losses and ancillary services, other Distribution Use-of-System (other DUoS) charges[1], as well as taxes and levies, hereafter 'Distribution System Charges'**.

- There is a **variety of distribution system charging regimes applied** across the EU. In many cases these charges are not mirrored at the transmission level within a country. In a few cases, there are differences between regional distribution systems within the same country. More specifically, for producers participating in the market on competitive terms, there is a significant diversity of charging policies for both connection to and use of the distribution systems across the EU, as well as differences between charges at the TSO and DSO level. **This diversity stems from different local conditions at the distribution level in various Member States to ensure cost-reflectivity and give signals for an efficient distribution system use. However, our findings and country cases indicate that, in some countries, this diversity could hinder the level playing field for producers across different voltage levels and on the regional wholesale market.**

- As far as prosumers, EV charging stations and storage facilities are concerned, there is so far **no definite approach in terms of charging regimes** available for these producers or it is only in the making in a few countries.

1.2. Findings on market-related charges, other Distribution Use-of-System charges and taxes and levies applied to generators connected to the distribution system:

- There are vast differences regarding which and how different charges for generators are applied at the distribution level. The survey identified these **differences with regards to charges related to ancillary services and network losses, taxes and levies as well as other Distribution Use-of-System (DUoS) charges.**

- **There is no consistent approach for generators on ancillary services and charges related to network losses**, in particular if these generators are participating in the market on competitive terms. These types of charges do not appear to be consistently structured and seem to lack comparable cost estimation methodologies across the Member States, taking into account distribution systems' needs and a level playing field for producers.

- **Taxes and levies** are in some cases seemingly **used to transfer policy related cost elements to generators** which in turn could cause market distortions[2]. Overall, there is not a great level of transparency on who pays what on generator level with regards to such taxes and levies.

- In many countries, a **variety of other DUoS charges** are borne by producers in order to cover costs implicitly or explicitly caused by the generation unit, e.g. operation and maintenance costs, metering costs etc. but also in some countries not caused by generators – see also report and technical annex for further details.

1.3. Findings on connection charges for generators connected to the distribution system:

- **There are different connection charging schemes applied to producers connected to the distribution systems of Member States and they are either shallow, shallowish or deep[3]**. In contrast, connection charges at transmission level are usually shallow[4] across the EU.

[1] Equivalent to producer charge at the TSO-level according to Regulation 838/2010 , Part B point 2 (ACER: G-Charge)

[2] See also Eurelectric reports on Taxes and Levies on Electricity, 2014 and 'What really drives your bill up', 2014.

[3] As a definition, where shallow connection charges are applied, only costs for the physical connection of the generator to the nearest practical point of the existing network are borne by the generator whereas deep connection charges mean that generators also have to pay all necessary grid reinforcements beyond the connection point. Besides that there are hybrid connection charges which tend toward a shallow or deep regime and can be therefore called "shallowish".

[4] See also DG Ener, Study supporting the Impact Assessment on Transmission Tariffs and Congestion Income Policies, 2017

- The variety of applied connection charging regimes reflects different policy approaches to such charges, linked to historical pathways, grid topologies (meshed vs isolated) and overall grid robustness of the distribution system in question.
- Apart from deep connection charging regimes, there are no dedicated locational signals at distribution level, in contrast to a few cases where locational signals are applied in transmission grids across the EU[5].

1.4. Findings on charges to prosumers connected to the distribution system:

- In almost all Member States, there is now a rapidly increasing number of prosumers connected to the distribution system. We find different categories of prosumers, sometimes even in the same Member State: prosumers being paid for injecting excess electricity into the network, prosumers without reward (excess electricity is injected into the network free of charge) and, in some rare cases, prosumers who are not allowed to inject their electricity into the grid.

- At present, prosumers are treated mostly the same way as consumers, without any specific charging regime applied or having network charging rules applied in a provisional manner, with further dedicated legislation pending. Overall, there is no consistent approach on charging policies for prosumers visible across the EU Member States. Especially as regards prosumers who inject electricity into the grid and are remunerated for it, the survey finds that in some cases, they do not bear the same kind of charges as other producers.

- The amount of electricity absorbed from the grid is reduced when a customer becomes a prosumer. At the same time, in most European countries, grid tariffs for small and medium size customers are largely based on volumetric (kWh-based) charges. Consequently, in these countries, when a net metering tariffication policy is applied, prosumers contribute less to the costs of grid development and management and to covering already incurred infrastructure costs of the existing grid. However, the fixed network costs are not expected to fall with the increase in decentralised generation: the grid must still be designed to cover peak demand when there is no local production, in order to ensure the security of supply, take up all local electricity feed-in and also export excess production when there is low local demand.

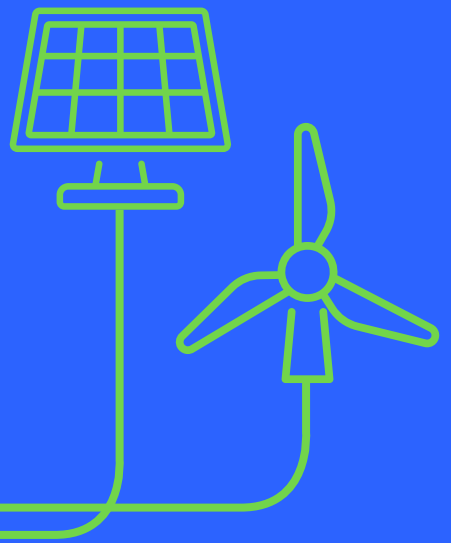
  This is most likely to happen if the regulatory framework is designed in a way to incentivise feed-in to the network rather than self-consumption at times where the grid is constrained. The gap in the recovery of network cost will have to be covered by collecting higher network tariffs from other customers, thereby leading to cross-subsidies[6].

1.5. Findings on charges to energy storage facilities connected to the distribution system:

- Where deployed, storage facilities at the distribution level, regardless of their rated power, are treated in the same way as consumers in the majority of cases (roughly half of the survey respondents have storage facilities connected at distribution level according to our survey), while in some cases they are also charged as a producer for the electricity they feed into the network. Overall, there is no EU-wide approach on storage charging policies established or visible so far.

[5] UK, Ireland, Sweden and Romania apply dedicated locational signals to generators connected to their transmission grids.

[6] See also Eurelectric position paper on 'Prosumers – an integral part of the power system and the market, 2015



Summary of main findings and policy recommendations

2. Policy recommendations:

The new design of the electricity market results in a gradually diffuse border between producers and consumers. Prosumers, storage facilities, local energy communities, are increasingly able to act both as a generator and a consumer, at different times. Additionally, they can offer a variety of products, such as flexibility for balancing and congestion management, as well as security of supply and services related to grid support. In this context, the policy recommendations hereunder can be safely assumed from the survey results and also confirm the previous findings and analyses by Eurelectric. However, one of the key take-aways of this report is also that further dedicated analyses are still needed regarding the charging regimes applied to those 'new' facilities described above, as the distribution use of system charges should consider their use of the system at their corresponding connection point.

- In view of the different conditions and features of distribution systems in various Member States, **defining and implementing distribution system charging regimes** for electricity producers **shall remain at the discretion of individual Member States**.

- **Despite the differences** of distribution system charging regimes for electricity producers across the EU, **some general principles can be identified** and should be taken into consideration to avoid unnecessary market distortions and **ensure a level playing field for generators**:

  - Distribution system charges for generators, if applied, shall be cost reflective and transparent on all voltage levels, meaning that the range of cost elements to be covered by the respective charging regime shall be clear for all generators, and shall give signals for an efficient system use.

  - If a Member State applies distribution system charges for electricity producers, such a Member State should ensure that its national charging regime does not contradict the proper and undistorted regional wholesale market functioning, particularly in view of these producers participating in the corresponding regional market with competitive terms (taking part in the bidding process, having exposure to price signals, etc).

  - As a general best practice, a transparent and inclusive dialogue between policy makers and the energy sector together with regulatory impact assessments should be the rule and should precede any decision on implementation of distribution system charges.

- Although taxation is with the jurisdiction of the Member States, **general principles of transparency and cost-reflectivity** as described above should also apply when it comes to the **taxes and levies borne by generators at distribution level**. As a principle, national policy makers should carefully consider taxes and levies unrelated to electricity production, if applied.

- The same is valid for **other DUoS charges**, in order for policy makers to provide further clarity and predictability for market participants across the EU. If other DUoS charges are applied they should be non-arbitrary and cost-reflective to guarantee the treatment of all producers on a level playing field and ensure an efficient system use. Neither of these two categories of charges should cover cost items not related to them.

- Evidently, an increasing number of electricity producers will be connected at the distribution level. **Connection charging regimes should therefore be adequately applied and reflect the grid reinforcements necessary** to connect any new production facilities, while taking into account the grid topology and robustness of the power system in question. In any case, whatever methodology or scheme is applied, it should be transparent to producers and cost-reflective in relation to why shallow, shallowish or deep connection charging regimes are incurred in the respective distribution system. Moreover, due to the more local nature of distribution grids, dedicated locational signals in addition to a deep connection charging regime, are typically not necessary at present.

- **Prosumers should contribute to the network cost recovery in a proportionate way**, to avoid other network users bearing a share of the prosumers' costs and ultimately to ensure a level playing field. In this context, national regulatory authorities **(NRAs) should acknowledge the risk and increasing reality of cross subsidisation of prosumers, as well as the potential for additional reinforcement costs, depending on how prosumers use the grid**. Net-metering schemes with volumetric tariffs should be avoided, in order to prevent cross-subsidisation and to avoid that a virtual storage capacity is available to prosumers free of charge[7]. In this regard more capacity-based network tariffs for all consumers are a means to safeguard that all consumers pay adequately for grid usage, without discrimination between them.

- Given that prosumers are also producers of electricity at distribution system level and in order to ensure a level-playing field with the other electricity producers, **prosumers should participate proportionately in covering the costs of the distribution systems attributable to generators, if any**; this is also applicable to all distribution system charges, including market-related charges[8].

[7] Also pointed out by CEER in their Clean Energy Package recommendations, see here: Renewable Self-Consumers and Energy Communities, CEER White Paper series, 2017

[8] Also pointed out by the Parliament and the Council in the review of the European Commission proposal on the Clean Energy Package, see Council General Approach on Market Design Regulation and Directive, and EP ITRE report, 2017-2018.

- **Further analysis is needed on overall charging regimes that include prosumers**: how they should be designed to be ultimately proportional, cost-reflective and ensure an efficient distribution system use, compared to other electricity producers, and how they should be revised on a regular basis in view of the increasing number of these new producers' types.
- Policy makers and, accordingly, DSOs should scrutinise any existing cases of **specific charges for storage facilities connected at distribution level, currently mostly batteries and pumped hydro**. Generally, further analysis on charging policies for storage facilities is needed in light of the likely increase of these facilities at DSO level, especially when these facilities offer flexibility services to the distribution system.

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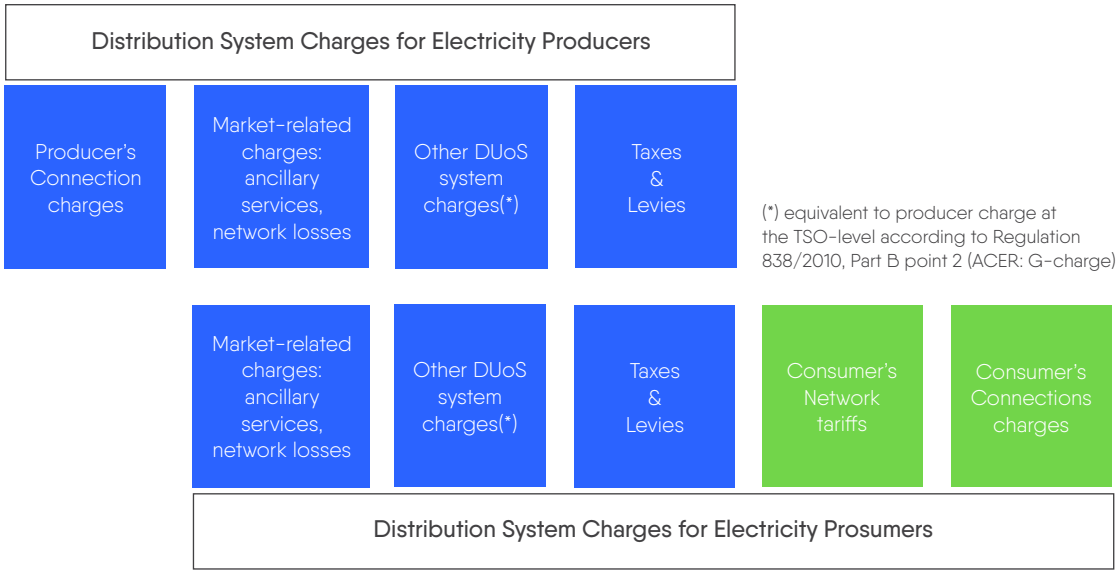
Introduction

As a definition and also most commonly used, at distribution level charges for producers include, if applied, besides connection charges also charges on ancillary services, network losses, taxes & levies **and other Distribution Use-of-System (other DUoS) Charges.**

Graph 1: Overview of distribution system charges



These other DUoS charges are calculated in EUR/kWh or EUR/kW or other means such as lump sum charges. Usually, they can cover Operations & Maintenance (O&M), administrative or other related costs induced by generators. **At the TSO level**, these other use-of-system charges are commonly referred to as 'G-charges' and are regulated at the EU level in the so-called ITC Regulation[9]. They are capped accordingly at 0.5 €/MWh (continental Europe), 1.2 €/MWh (Scandinavia), 2 €/MWh (Romania) and 2.5 €/MWh (UK & Ireland). Pursuant to this Regulation, ACER monitors these 'G-charges' across the EU and reflects their findings in a public opinion with the objective to regularly assess the appropriateness of these charges with regards to their impact on the Internal Energy Market.

At the DSO level, the situation is different. Charging regimes at this level are at the Member States discretion only and often go beyond the narrower definition in comparison to the TSO level. In addition, there is so far no comprehensive reference study or overview available at the EU level that looks into this topic at the distribution level in a comparative way. The lack of information is surprising given the increasing amount of electricity generators connecting at the DSO level as well as new types of grid users, such as prosumers, electric vehicles and increasingly also storage facilities.

Given the **increasing participation of renewable energy sources (RES) in the market, mainly at the DSO level**, as well as the **promotion of more active customers, local energy communities, electric vehicles (EV) and storage facilities**, the active management of distribution systems, as well as related power market operations, become evidently more complex, potentially leading to increased costs, which need to be carefully examined. Taking into account that there is a variety of distribution network charging policies applied across the Member States, there is an obvious need to further analyse these policies and their effectiveness towards the objectives of cost recovery, income predictability, fair cost allocation and the efficient use of the system. Therefore, besides filling an apparent information gap, a pan-European inventory and analysis of such charges at the distribution level, including connection charges, becomes a necessity.

With regard to **prosumers** in particular, i.e. consumers who produce electricity primarily for their own needs and may feed part of this electricity to the network, either being remunerated for it, or not, there is another knowledge gap related to the kind of charges applied to them and whether a different charging policy is needed, to reflect the costs they imply for the network and related market operations more accurately, whenever they participate in it.

As Eurelectric has been advocating for more capacity/power demand (kW)-based tariffs applied to the load of distribution networks[10], it would be beneficial to investigate if any such tariff structures can be applied to prosumers, in order to ensure better cost recovery and eliminate potential cross-

[9] See also Commission Regulation No 838/2010, Part B point 2

[10] See also Eurelectric position paper on 'Network tariffs', 2016

subsidies. In view of this, it is important to establish a very first reference point and overview at the EU level looking into this topic in a comparative way. As Eurelectric has been advocating for more capacity/power demand (kW)-based tariffs applied to the load of distribution networks , it would be beneficial to investigate if any such tariff structures can be applied to prosumers, in order to ensure better cost recovery and eliminate potential cross-subsidies. In view of this, it is important to establish a very first reference point and overview at the EU level looking into this topic in a comparative way.

Based on the data collected from our membership via a dedicated survey and questionnaire, the project group worked by **listing and analysing the different categories of distribution system charges** for electricity producers including prosumers currently in place across Europe, as well as their structure, level and relation of these charges to the respective DSOs' cost structures. Based on these fact findings, the group was able to outline first policy recommendations relevant across the entire Eurelectric value chain on charging regimes at the DSO level, in view of their potential impact on cost recovery, fair cost allocation and efficient use of the system.

In addition to information gathering this project report and annex with the survey related evidence summarised country by country expediently and examined the effects of distribution system charges on both the electricity producers' and system operators business cases. Specific country-cases are also included to highlight the particular conditions that apply in various Member States. Lastly, the report identified where further follow-up analysis might be required.

Contributors to this report and what level of kV lines are operated by the DSO of each country

Austria

Netz Burgenland & Energienetze Steiermark GmbH (DSOs)

Distribution level represented: **< 110 kV**

Germany

German Association of Energy and Water Industries – BDEW

Distribution level represented: **< 220 kV**

Switzerland

Swiss Electricity Industry Association

Distribution level represented: **< 220 kV**

Spain

UNESA

Distribution level represented:
< 220 kV on mainland and
< 66 kV on islands

Denmark

Danish Energy

Distribution level represented: **< 60 kV**

Finland

Finnish Energy & Elenia (DSO)

Distribution level represented:
Mainly **0.4** & **20 kV**
in some cases up to **30** & **45 kV**

Italy

Elettricità Futura

Distribution level represented: **1** - **30 kV**

Norway

Energi Norge

Distribution level represented: **< 66 kV**

Poland

PKEE

Distribution level represented:
0.4 – 110 kV

France

EDF

Distribution level represented: **< 20kV**

Latvia

AS Latvenergo (generator) & AS Sadales tikls (DSO)

Distribution level represented: **< 20kV**

Slovakia

Slovenské elektrárne (generator) & Východoslovenská distribučná (DSO)

Distribution level represented:
0.4, 11, 22, 35 & **110 kV**

Hungary

Hungarian Electricity (generator), ELMÜ (DSO) & E.ON (representing 3 different DSOs)

Distribution level represented:
0.4, 6, 10, 20, 35 & **120 kV**

Bulgaria

CEZ Distribution Bulgaria (DSO)

Distribution level represented:
0.4, 6, 10, 20, 35 & **110 kV**

Czech Republic

PREdistribuce (DSO)

Distribution level represented:
6, 22, 35 & **110 kV**

Estonia

Elektrilevi OÜ (DSO)

Distribution level represented:
0.4, 6, 10, 20, 35 & **110 kV**

Greece

HEDNO (DSO)

Distribution level represented:
0.4, 20 & **66 kV**
(the latter only in Attika region)

Luxembourg

Creos (DSO)

Distribution level represented:
0.4, 5, 20 & **65 kV**

Netherlands

Enexis (DSO)

Distribution level represented: **< 150 kV**

Portugal

EDP Distribuição (DSO)

Distribution level represented:
10, 15, 30 & **60 kV**

Sweden

Vattenfall Eldistribution & Ellevio (DSOs)

Distribution level represented: **< 130 kV**

Ireland

ESB Networks (DSO)

Distribution level represented:
10, 20, 38 and partly **110 kV**
in greater Dublin area

1. Charges for conventional & RES electricity producers connected at distribution level

In general, all charges applied to generators shall be based on two principles – cost reflectivity or cost recovery, while all charging regimes shall be predictable and transparent to maintain stable business conditions for the generators participating in the market on competitive terms, as well as to ensure the proportionate cost allocation for system utilisation.

Based on the survey results, **4 different groups of distribution system charges applied to electricity generators** in European countries have been identified:

- **Ancillary service charges** based on power (kW), energy (kWh) or other principles;
- **Network losses charges**
- **Taxes, fees and levies related to energy**
- **Other Distribution Use-Of-System (DUoS) charges**

Out of 22 countries participating in the survey, **17 stated that there are distribution system charges applied to producers**. Only Germany, the Czech Republic, Latvia, Poland and Italy do not apply any distribution system charges to electricity generators for the time being.
When looking at the variety of charges and fees in place, the following can be differentiated:

- **Ancillary service charges** – ancillary services are used to refer to a variety of operations beyond generation, transmission and distribution that are required to maintain network stability and security of supply. These services generally cover frequency control, spinning reserves and operating reserves. Based on the results of the survey, we see different approaches towards charges for ancillary services among European countries. In Austria, Hungary, Norway and Spain the charge is based on €/kWh and the nominal value is set by a national price cap (e.g. in Norway 0,50 €/MWh) or by the system operators reflecting costs for specific transmission services (e.g. in Hungary or Spain for balancing and tertiary control or in Austria for primary control). There are also countries that base the ancillary service charging on kW (e.g. in Estonia, the fee is charged monthly and reflects frequency control, spinning reserves and operating reserves costs).

Seven countries apply **ancillary service charges** based on power (kW), energy (kWh) or other principles.

- **Network losses charges** – the costs of losses for both distribution and transmission level are usually covered by system charges to all generators. The network losses charge is based on the marginal losses created by the new generating source connected to the network. Generators are in principle motivated to reduce losses in the system to which they are connected, thus often resulting in a negative network losses charge (meaning producers are being compensated for reducing the marginal costs of losses). On the other hand, in case producers create additional system losses, they are penalised by higher network losses charges. The compensation or penalty is calculated individually for each network node or connection point and considers the technical impact of the generator on overall losses performance. This principle is applied in Ireland, Norway and Sweden.

  Six countries apply **network losses charges** (distribution and/or transmission), all based on € per kWh.

- **Taxes, fees and levies related to energy** – there is a variety of taxes and levies in place in the European energy system. Some countries (e.g. France or Hungary) put VAT or other tax measures based on generated electricity (kWh). Other countries apply special taxes for certain types of generating technology (e.g. Switzerland's "water tax") based on reserved capacity (kW). Ireland and Spain apply both principles. In Spain, generators are charged an tax of 7% on the value of the energy generated which is paid directly by generators to the public bodies independently of voltage level and comprises the nuclear tax on the production of radioactive waste resulting from the electricity generation, tax on the storage of radioactive waste, hydroelectric levy for the use of surface and underground water to produce electric energy, taxes on hydrocarbon fuels etc. They also have to pay the market operator and system operator fees applied to available capacity. Ireland applies a 13.5% VAT on DUoS charges and a special Public Service Obligation levy, a policy set by the government and the regulator to collect certain amounts from all users of the system to primarily support renewable generation. Several other countries apply different taxes and charges to contribute to system security (e.g. in Bulgaria, a 5% tax on monthly revenues from the electricity sold) or to "socialise" system revenues (e.g. in Greece, a special levy of 1% of the producer´s income is applied to renewable generation from wind, water and biomass and subsequently returned to local consumers).

  Seven countries also apply different kinds of **taxes, fees and levies related to energy** (VAT, System operation fees, etc).

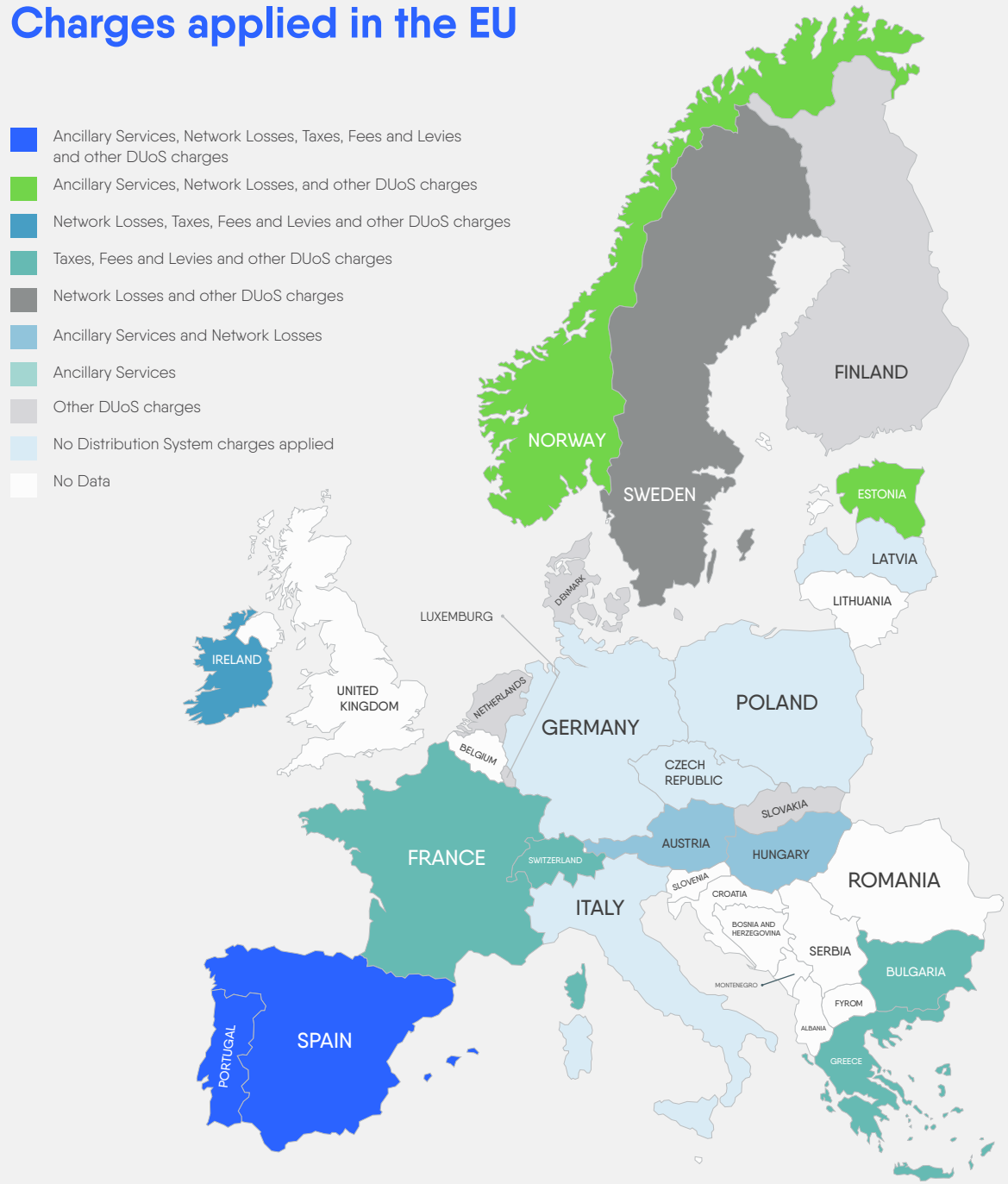
- **Other Distribution Use-Of-System Charges** – by definition, other DUoS charges cover part of the generation charges that exclude connection costs, ancillary services charges, network losses charges, and taxes, fees and levies related to energy. The survey results showed that these other DUoS charges are the most common means of charging generators across the EU Member States. However, each of the countries for which input was received follow their own approach in relation to these DUoS charging regimes. There are countries which apply charges based on kWh of generated electricity (e.g. in Bulgaria – DSOs are collecting tariffs from wind and photovoltaic power plants not only for distribution system access but also for access to the transmission grid; or in Norway – where the charges are based on the 10 years average production profile). Until a new charging policy is in place, Spain is currently charging a transitory energy charge on the DSO level.
  Several other countries based other DUoS charges on power and capacity used (kW). We can find this kind of charging regime in Estonia, Luxemburg, Slovakia and Sweden, where generators pay a tariff for the installed or maximum reserved capacity. The difference is in the ratio of tariff paid by producers compared to consumers for the same capacity. According to the survey results, the same principle is applied in Estonia to both producers and consumers. In contrast, producers in Slovakia pay for 30% of the maximum reserved or installed capacity of the generating unit. Many other countries introduced various types of other DUoS charges aiming at covering costs of metering (e.g. France and Switzerland) or operation and maintenance costs (e.g. Greece, Ireland and the

Netherlands). We can also follow examples of the countries, where producers pay a flat fee depending on connection capacity (e.g. Luxemburg).

Other DUoS charges are applied in 13 European countries with the following peculiarities:

- Four countries base the charges on energy or production profile (kWh), three countries base the calculation on power component or reserved/installed capacity (kW);
- Seven countries identified other principles for calculating other DUoS charges: fixed monthly/annual price or one-time payment for metering or connection;
- In seven countries the other DUoS charges are based on a connection or access contract to the network, in four countries on metered generation (kWh) and five countries identified other elements (legal obligations, kW etc);
- Other DUoS charges vary according to location (in three countries) as well as different voltage level (in four countries),
- Three countries stated that the reason for introduction of the other DUoS charges was to cover a certain share of total DSOs costs, in six countries the reason was to cover costs implicitly or explicitly caused by the generation unit (operation and maintenance costs, depreciation, customer service etc.);
- Five countries stated that other DUoS charges have neutral effect on the business operation of the producers, only two countries stated its rather negative;
- Five countries stated that the same tariff scheme of the distribution system charges are applied both to producers and consumers, whether in the form of the same structure or the same price level;
- So far there are no signs of any ongoing alignment between different countries concerning other DUoS, only in two countries the tariff is aligned regardless of voltage levels between the TSO and DSO level.

Categories of Distribution System Charges applied in the EU



1.1 Other DUoS charges and implications in the EU Member States

The survey shows there are various reasons and methodologies for introduction of other DUoS charges. Most of the countries where this type of charges is applied based their application on:

- **Connection contract** (e.g. in Estonia, Luxemburg, France, Sweden and Switzerland producers are charged a monthly or annual flat fee defined in the contract, while in Ireland the connection contract defines generators' O&M costs charged for the connection equipment, and in Greece the charge reflects the actual costs of work involved)

OR

- **Access contract** (e.g. in Slovakia the charge is based on an access contract and calculated for installed or maximum reserves capacity)

Only a few countries use **metered generation** of electricity for the calculation of the charges (e.g. Bulgaria, Norway and Spain).

Geographic location and voltage level of connection also have an impact on the charging of generators. These signals are mostly present in case of Slovakia, where there are three regional DSOs, each having a different tariff for the reserved capacity regulated by the national authority (due to the grid topology, available capacity etc). Despite the calculation mechanism being the same, the final absolute value of the charge differs in each region. A similar approach is defined for different voltage levels. The lower the voltage level, the higher the absolute value of the charge, however, the absolute value largely depends on the actual usage of the reserved/installed capacity on each voltage level as well. Other DUoS charging schemes applied in Estonia and Sweden also take locational and voltage level signals into consideration.

In principle, a variety of other DUoS charges were applied to cover costs related to generating units. These costs borne by the producers should be forward looking and predictable. The survey results show a variety of reasons why the charges were introduced and what kind of costs they shall cover::

- **To cover a certain share of total DSO's costs** (e.g. Estonia and Slovakia, however, not defined what share of the total costs is covered)
- **To cover costs implicitly or explicitly caused by the generation unit** – most of the countries argue that they apply other DUoS charges for covering costs directly caused by the generating unit to the system operator. However, there is no clear guidance and unified approach on the scope of these costs:
  - **operation and maintenance costs** – costs related to equipment or work utilised for connecting the generating unit and maintaining the necessary network assets (applied in Greece, Ireland, and Sweden)
  - **depreciation of network Assets/CAPEX/return on network's assets** (e.g. in Ireland covered within the annual O&M charge, also in Sweden)
  - **customer service** – refers to invoicing costs or costs for general connection services (e.g. in France, Ireland, and Sweden)
  - **other** – refers to costs for metering or costs for managing related services (seen in case of France, Luxemburg and Switzerland)
- **Other reasons** - e.g. to decrease the final electricity price for consumers (Slovakia) or to cover certain policy costs like RES support (Spain)

The most important point in the discussion about other DUoS charges is the implication for producers and the impact of these charges on their business operations. In general, the other DUoS charges influence generators' decisions in the following four areas:

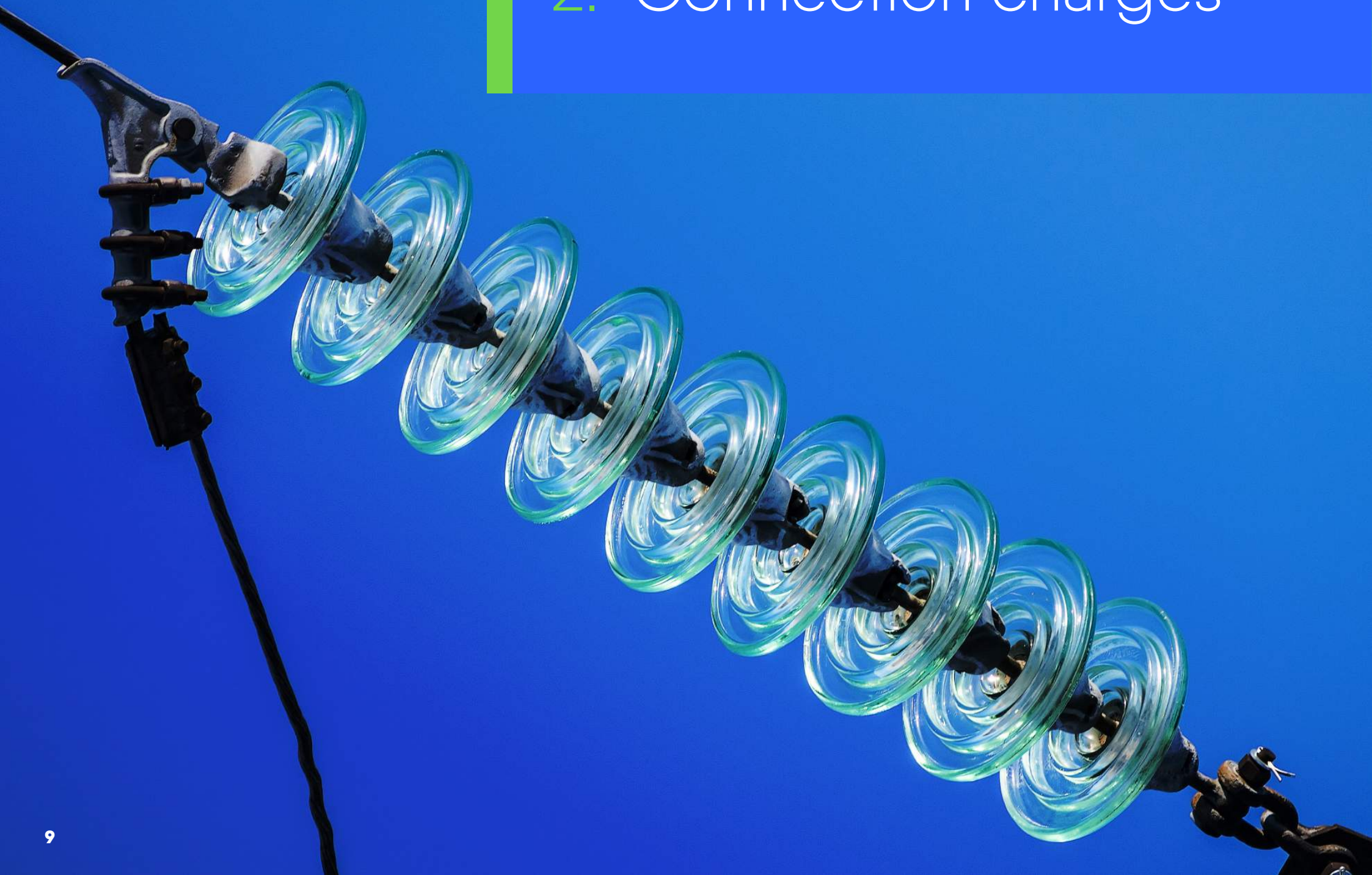
- **Electricity dispatch decisions** – most countries stated the impact is neutral (France, Greece, Ireland, Norway and Spain). However, Spain responded that the global impact of other DUoS charges and taxes may be negative. Despite feed-in premiums, the other DUoS charges and taxes and their absolute value together with different TSO and DSO methodology can result in dispatch distortions. Current charging regime do not incentivise producer´s contribution in peak hours as they have the same value independently of grid restrictions. This applies partially to Slovakia as well. Furthermore, Slovakia and Spain responded that other DUoS charges can influence the bidding behaviour and market position of generators operating in interconnected markets on competitive terms.
- **Investment decisions** – other DUoS charges as well as other charges, taxes and levies are usually considered in any future investment decisions as they are supposed to present a predictable part of the costs for the generators. The impact is seen negatively mainly in Luxemburg, Slovakia (for sources connected to DSO level acting in the wholesale market on competitive terms) and Spain (e.g. in case of national RES auctions) or.
- **Decision to connect to the network** – most countries do not see any negative impact of other DUoS charges on the decision to connect to the system (France, Greece, Ireland and Norway).
- **Decommissioning** - there are a few cases where the high charges were one of the incentives leading to decommissioning of back-up generators (e.g. in Spain) or disconnection from the DSO network (e.g. thermal and CCGT power plant in Slovakia).

On the other hand, other DUoS charges might incentivise prosumers to increase their self-consumption (e.g. with devices to prevent energy injection into grid used in France) and thus reduce costs for reserved network capacity or payments for metering and other services. Other DUoS charges might give **efficient signals** for the use of the system or connection/location of the generating unit, however, this is reflected only in few countries (e.g. Norway and Estonia).

Overview on other Distribution Use of System charges (oDUoS) and what cost elements they cover

- No other oDUoS charges applied
- General share of DSO costs and also other cost elements
- Costs caused by generation unit: Operation & Maintenance costs
- Costs caused by generation unit: Operation & Maintenance, Depreciation/CAPEX, Customer Service costs and also other cost elements
- Costs caused by generation unit: Operation & Maintenance, Depreciation/CAPEX and Customer Service costs
- Costs caused by generation unit: Operation & Maintenance, Customer Service and also other cost elements
- Costs caused by generation unit: Customer Service and also other cost elements
- Costs caused by generation unit: Customer Service costs
- Other/no classifiable cost reference with regards to other DUoS charges
- No Data

2. Connection charges



This part of the survey focused on the different connection cost regimes for generators and prosumers, their effect on the business operation and legal provisions in the different countries on access contracts and grid in-feed.

Connection charging regimes differ in their methodologies of dividing the costs between the generator and the DSO for connecting the asset to the grid, as well as extending and reinforcing the grid. Where shallow connection charges are applied, only costs for the physical connection of the generator to the nearest practical point of the existing network are borne by the generator whereas deep connection charges mean that generators also have to pay all necessary grid reinforcements beyond the connection point. Besides such a clear-cut categorisation, there are hybrid connection charges that have a tendency towards a shallow or deep regime and are therefore either called "shallowish" or "deepish". Their cost sharing principle is mostly based on theoretical allocations, such as a capacity share, and shall reflect the proportional use of new grid assets.

The survey results show that a clear deep or shallow connection cost regime is applied in 14 out of 22 countries having responded to the survey. Eight countries apply a shallow[11], six a deep connection charging regime. A shallowish or deepish connection charging regime is applied in three countries. Four countries indicated that the type of connection regime depends on the type (RES, CHP, prosumers or conventional generators) or rated capacity of the generator. One country also indicated that, by law, negotiations between generator and DSO are planned, however, not put in place yet.

Most of the connection charges show a correlation with the distance of the generator to the grid's connection point. This correlation is either implicitly reflected in investment costs, where also other parameters such as voltage level and capacity are taken into account, or explicitly mentioned as a parameter in a specific connection cost formula. Where such a formula is applied, in some countries there are standard costs for distances or capacities within a certain threshold and variable costs beyond that.

The survey also clearly shows that connection charges do not have any effect on the daily business operation of the generators since they are applied on one occasion when the generator gets connected to the grid. Therefore, these costs are reflected in the initial investment but not in the dispatch decision. As connection charges largely differ due to the regime or distance to the grid connection point, their impact on the investment decision can therefore also vary from negligible to significant.

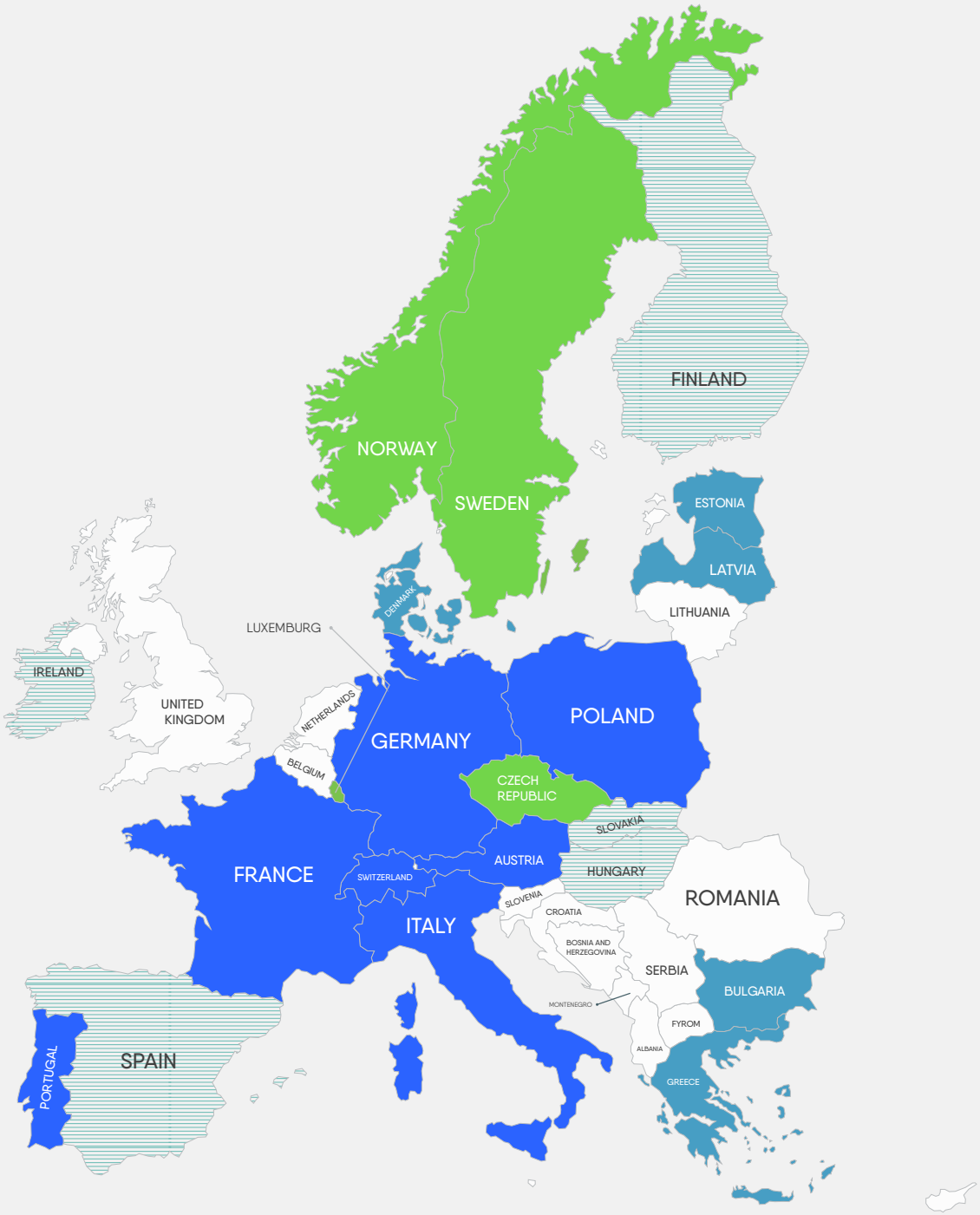
In the vast majority of the countries generators have a legal obligation to sign an access contract with the DSO. Where this is not the case, generators have the right to claim an access contract but must at least respect the DSO's technical terms and conditions. Exceptions are made for total self-consumption (island solution) and in some cases for household prosumers whose electricity providers have already signed such contracts. In one case, the access contract is signed between the generator and the TSO although the asset is located in the distribution grid. Furthermore, in all cases generators have the right to get access to the grid.

In general, all countries state that there is no legal obligation for generators to have a physical infeed to the grid. However, it is mentioned that for certain generators with specific incentive schemes such as RES, an injection is the only way to receive the incentive and therefore a direct access to the grid is necessary. In one case, generators have to make offers to the energy market and RES have to demonstrate a certain minimum production to receive the feed-in premium. Nonetheless, generators can choose to feed-in energy or use it for self-consumption.

[11] Discounts of the shallow connection charges may apply for certain types of producers.

Connection charges for generators at distribution level

- Shallow: Producer pays only for the cost of equipment needed to make the physical connection to the grid. Costs of grid reinforcements are borne by the DSO
- Shallowish: Producer pays for the physical connection to the grid, plus a proportion of any upstream grid reinforcement costs based on its proportional estimated use of new grid assets
- Deep: Producer pays for the physical connection to the grid, plus a proportion of any upstream grid reinforcement costs based on its proportional estimated use of new grid assets
- Other/Connection charging regimes varied according to producer types or other parameters
- No Data



Connection charges for generators at transmission level

- Shallow
- Shallowish
- Deep
- No info/not assessed
- No Data

3. Charges related to prosumers

3.1 General characteristics of prosumers in the EU

Prosumers are already a reality in the European market, with an increasing number connected to distribution networks. In almost all Member States, national regulation contemplates prosumers explicitly, albeit heterogeneously, in terms of charging regimes.

In just a few countries, prosumers have not been incorporated into their regulations at all (i.e. Bulgaria, where they are treated as generators for their generated energy) or defined (i.e. Slovakia). In other countries there is no specific charging regime for prosumers (i.e. Estonia) or it is currently in the making (i.e. France).

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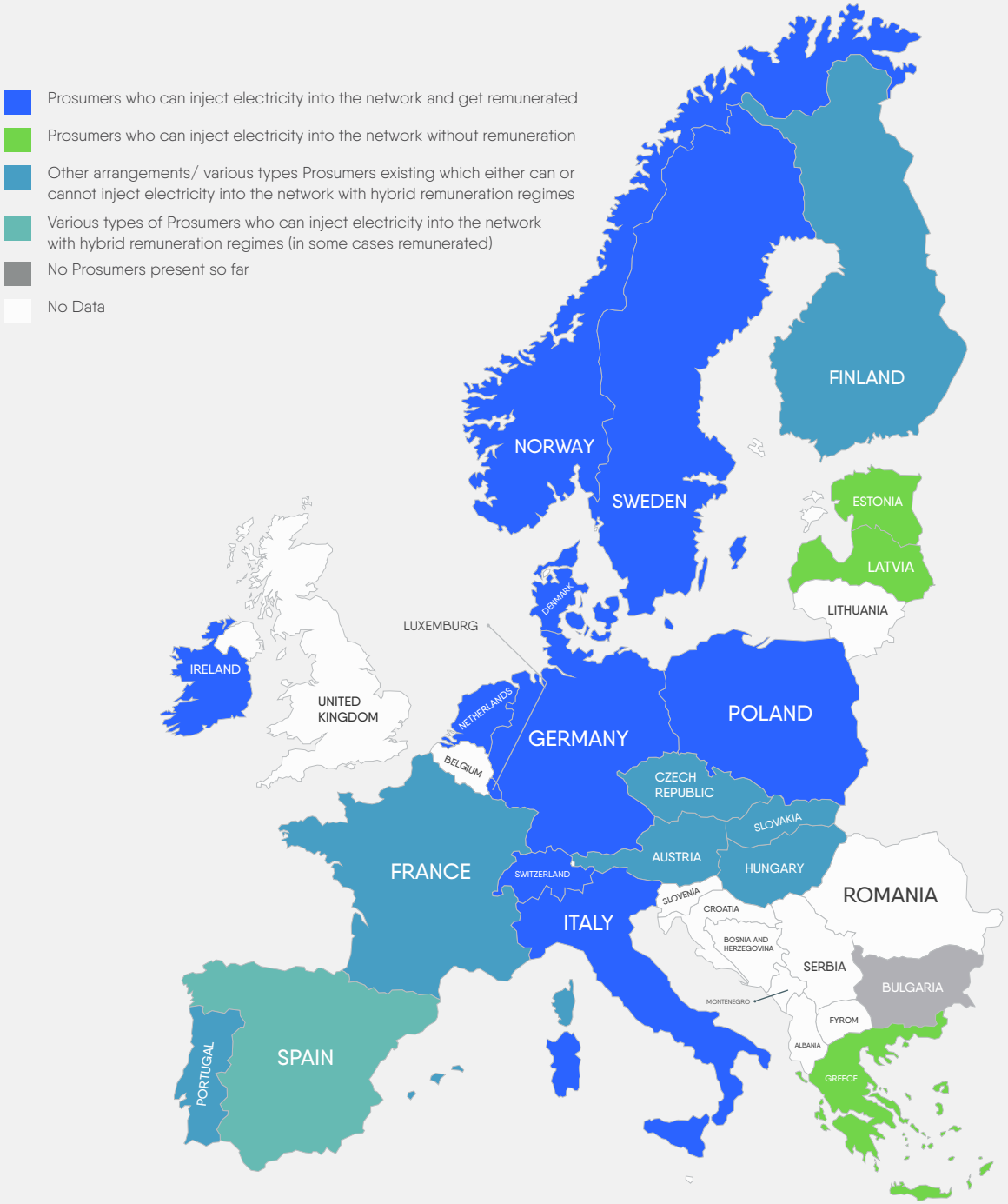
We can find different categories of prosumers: prosumers paid for injecting excess electricity into the network, prosumers without reward (the excess electricity is injected into the network for free) and, in some rare cases, prosumers who are not allowed to inject their electricity into the grid. The most common type of prosumers is the one injecting the electricity and paid for it – applies to the majority of the EU countries (18 countries out of the 22 surveyed). In addition, in almost half of them (nine countries) different categories coexist within the same Member State.

In countries with only one type of prosumer, it is usually the type of prosumers exporting to the network and being paid for it, except in Greece and Latvia, where only prosumers who export electricity back to the grid without being paid for it can be found.

There is a variety of different distribution system charging regimes applied to prosumers connected to distribution networks in the EU, although in most countries prosumers have the same contribution scheme for connection costs, compared to customers.

Prosumers – General overview



3.2 Network tariffs paid by prosumers as consumers

The variable component of network tariffs applying to prosumers as consumers have special relevance in many countries, although there is no clear trend, and consequently there is a high heterogeneity in the recovery of costs by the DSOs in the EU.

In countries where there are both types of prosumers injecting into the grid (i.e. paid and not paid), the same network tariffs charging structure as for consumers applies, regardless of whether the excess energy is remunerated or not.

In particular, the survey results show that there is no concrete rule as to whether network tariffs are mostly based on volumetric (kWh-based) charges, or mostly based on fixed & capacity-based charges - charging policies in these countries are almost evenly split between these two cases. Moreover, there are no significant differences in the treatment of household versus SMEs and prosumers, with the exception of Portugal.

More specifically, as far as household prosumers are concerned, in Denmark only volumetric charges are reported, while in Italy and the Netherlands, only fixed charges are observed.

On the other hand, the countries with the greater percentage of fixed and capacity components are Italy, the Netherlands, Spain and Sweden.

The results, therefore, show that there are many European countries, where grid tariffs for small and medium-sized customers are still largely based on volumetric (kWh-based) charges. When a customer becomes a prosumer, the net amount of electricity distributed through the grid is reduced. Consequently, in these countries prosumers contribute less to the costs of grid development and management. However, the fixed network costs are unlikely to fall with the increase in decentralised generation. Network costs can even rise if extended network connection and network reinforcement are needed. The gap in the recovery of fixed network costs will have to be covered by collecting higher network tariffs from the other customers leading to cross-subsidies. However, the regulatory framework should ensure an efficient and fair allocation of costs and benefits. Therefore, an evolution towards more capacity-based network tariffs would help ensure that customers pay for the grid they use[12] and towards a structure of network tariffs ensuring that adequate price signals are put in place to incentivise efficient grid use, as for instance through Time-of-Use network tariffs[13].

3.3 Distribution system charges paid by prosumers as producers of electricity

There is a great heterogeneity in the nature of costs charged to the prosumers connected to the distribution networks, apart from the network charges they pay as consumers. The main types of such charges are market-related charges, i.e. for ancillary services and network losses, taxes, fees and levies, standing charges as well as other charges. More specifically, with regard to prosumers who are paid for the electricity they inject into the grid, out of 18 countries who reported:

- Eight countries apply ancillary services charges
- Seven apply network losses charges
- Eight apply taxes, fees and levies
- Six apply standing charges
- Nine apply other charges

More importantly, the survey results show that, in many countries, prosumers, who inject electricity to the grid and are paid for it, do not bear the same kinds of charges as other conventional/RES producers connected to distribution network. This refers to both market-related charges for ancillary services and network losses, and to taxes, fees and levies, and other charges:

- Eight countries have a different treatment towards ancillary services
- Five countries have a different treatment regarding network losses
- Six countries have a different treatment towards taxes, fees and levies
- Six countries have a different treatment of other charges

3.4 Further analysis of "other charges"

There are different approaches in terms of billing parameters regarding the "other charges" applied to prosumers: in some countries, these charges are based on either an energy-based charge, or a capacity-based charge. However, there are also four countries applying both.

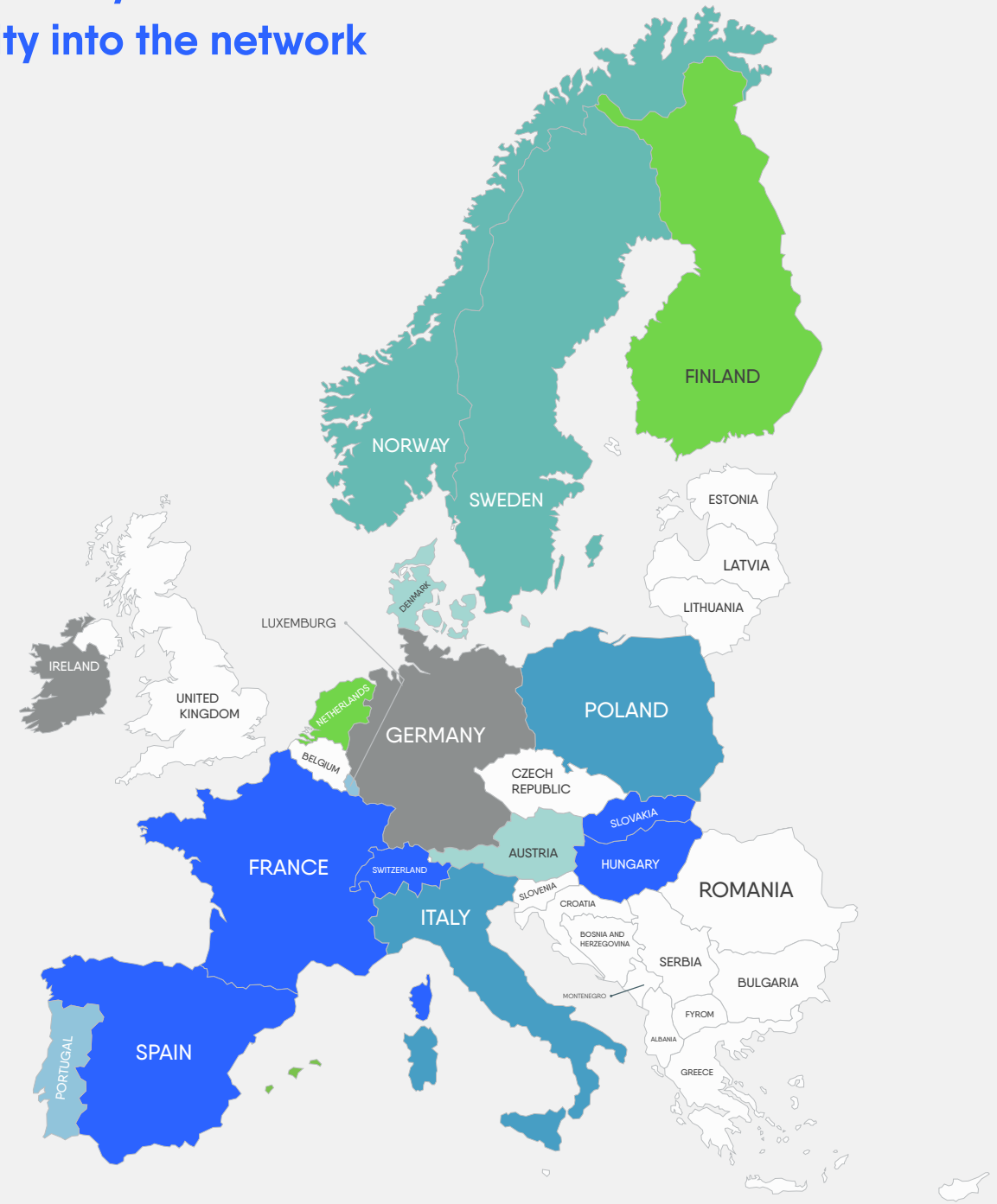
Where a variable "other charges" component is applied, in most countries it is based on the energy absorbed from the network. In the case of Greece, it is based on the total consumers' consumption (energy absorbed + produced - injected), in Italy and Spain it is based on the net-metered energy (energy absorbed -energy injected), while in Luxemburg it is based on the energy generated and consumed (synchronised) in prosumer facilities.

The fixed and capacity components of "other charges" show different approaches towards the capacity considered as a basis for the charges (maximum contracted capacity or additional capacity). Also, in some cases, there is a combination of fixed and capacity terms.
The "access payment into the electricity grid for electricity generators" (G-charge) was introduced by the Slovak energy regulator in July 2013. Other DUoS payments have been put in place as of 1 January 2014.

[12] "Prosumers – an integral part of the power system and the market", a Eurelectric paper, 2015
[13] "Network Tariffs", a Eurelectric position paper, 2016

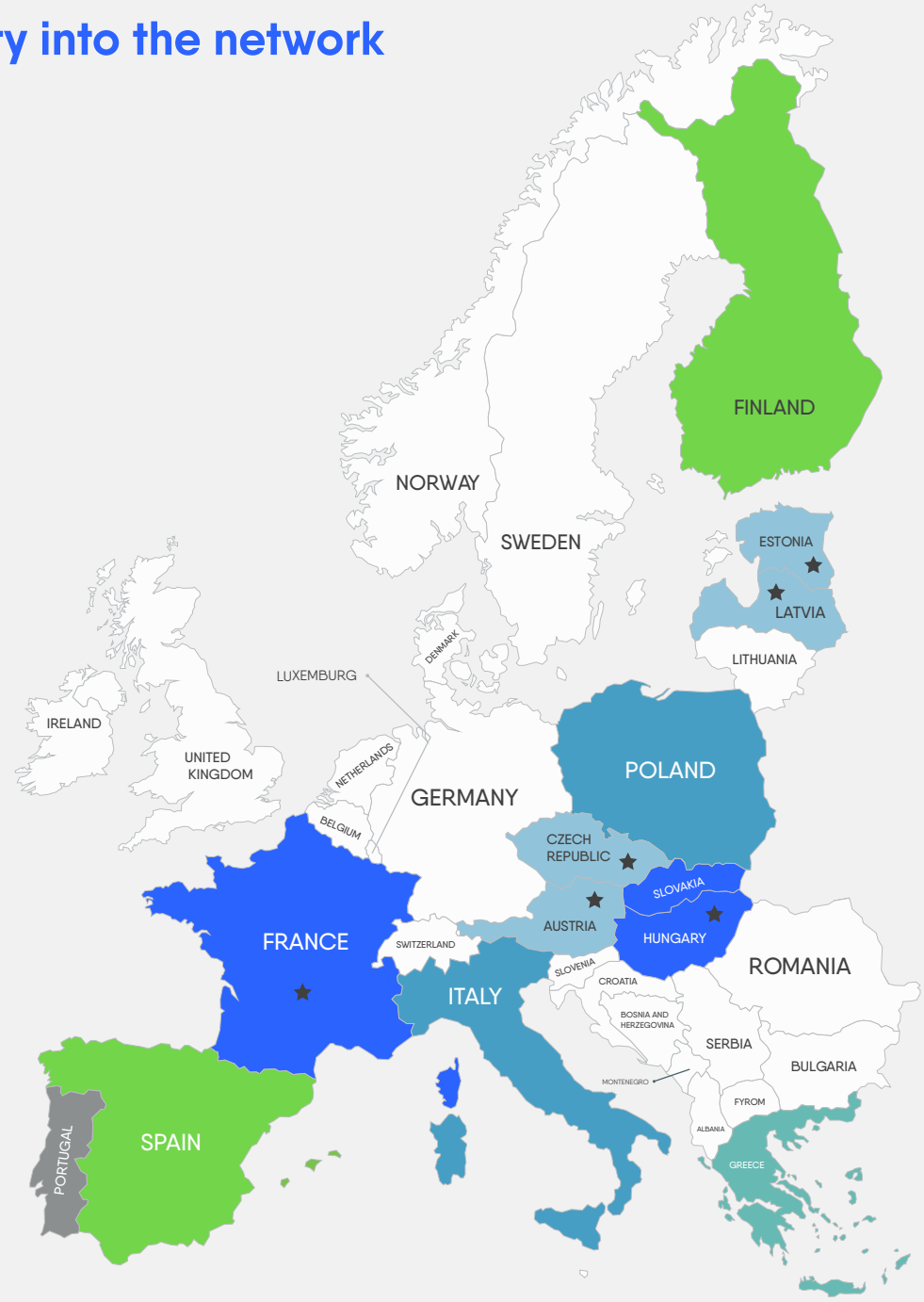
Prosumers' charges and what cost elements they cover – The case of Prosumers who inject electricity into the network and get remunerated

- Network Losses, Ancillary Services, Taxes, Fees and Levies and other charges
- Network Losses, Ancillary Services and other charges
- Ancillary Services, Taxes, Fees and Levies and other charges
- Network Losses
- Taxes, Fees and Levies
- Other charges
- No prosumer-specific distribution system charges
- Not applicable or no data



Prosumers' charges and what cost elements they cover II – The case of Prosumers who inject electricity into the network with no remuneration

- Network Losses, Ancillary Services, Taxes, Fees and Levies and other charges
- Network Losses, Ancillary Services and other charges
- Ancillary Services, Taxes, Fees and Levies and other charges
- Taxes, Fees and Levies and other charges
- Other charges applicable
- No prosumer-specific distribution system charges
- Not applicable or no data
- ★ Same charging regime applicable in case of Prosumers with blocked exportation capability

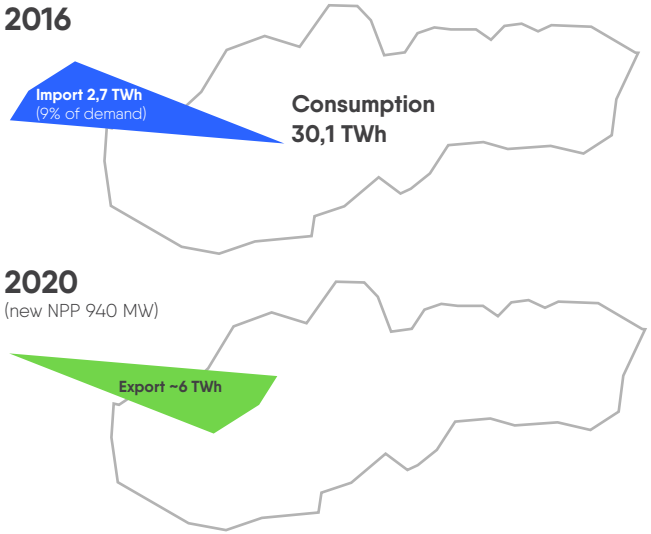


4. Case Studies

4.1 SLOVAKIA: OTHER DUOS CHARGES IMPLEMENTATION AND IMPLICATIONS FOR THE SLOVAK ELECTRICITY MARKET

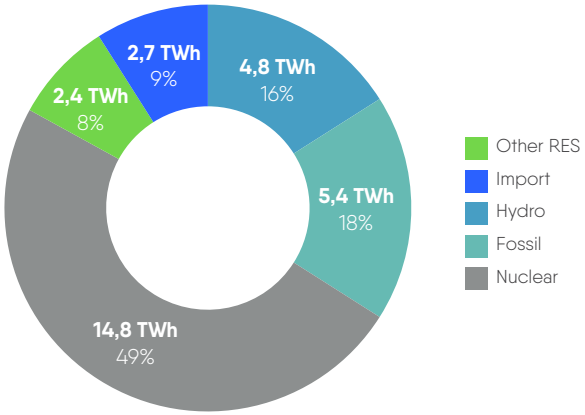
4.1.1 Fundaments of the Slovak electricity market

Electricity Demand in Slovakia



- Slovakia **has slight import orientation** to cover the difference between production and consumption. Situation will change after commissioning of new nuclear power plant. Mochovce 3&4, when approx. 6 TWh of electricity shall be exported.
- Good interconnections with neighboring countries
- Total installed capacity **7 900MW**

Slovak Production Mix 2016



- **More than half of the electricity generated in Slovakia comes from nuclear**, followed by the thermal and hydro power plants
- Over 70% of Slovak production is **carbon free**
- Major market player (Slovenske elektrane) with installed capacity of 4176 MW and 73% share of overall product

4.1.2 Implementation of other DUoS charging regimes in Slovakia

- All electricity generators connected to TSO network pay to the TSO charges for the access calculated based on reserved capacity, special coefficient and the value of the tariff for reserved capacity. The payment calculation is set with the limit not exceeding 0,5 €/MWh on average.
- All electricity generators connected to the DSO network are charged by the relevant DSO for the access to the distribution system in the amount of 30% of the maximum reserved capacity or installed capacity multiplied by the tariff for 12 months reserved capacity. The payment converted into EUR for generated volume of electricity varies according to each regional DSO and voltage level in the range of ~1-32 €/MWh.

All generators qualifying as prosumers pay only one fee for capacity – either the other DUoS charge or tariff for electricity offtake, depending whichever is higher.

The reserved capacity for generating units at each voltage level is based on technical and commercial conditions of the TSO or DSO agreed in the connection contract or on the installed capacity of the generating unit. Other DUoS charges are applicable to all existing as well as new/planned generation sources. Exceptions from other DUoS charges are applied only to generation units providing exclusively ancillary services, suppling regulation electricity and to small hydropower plants with up to 5 MW of installed capacity.

The main reason for introducing the access payment to the network was to proportionally allocate costs related to unlimited and non-discriminatory operation of the network for all its users.

4.1.3 Impact on Slovakia's electricity market

a) Economic Impact

The introduction of other DUoS charges has created unexpected costs for existing generating units and affected business operations and planning of the generators. Total impact on Slovak generators is estimated at the level of ~50-60 mln. €/year. The value of other DUoS charges differs between level of connection and generating technology. The lowest level of such other DUoS charges is calculated for nuclear and thermal (coal) power plants connected to the TSO with 0,40 €/MWh and 1,5 €/MWh respectively. On the DSO level, the other DUoS charges depend very much on the time of use of the power generators capacity for commercial production. For CCGT and Thermal (coal) it ranges between 1,5-6 €/MWh. In case of hydropower plants (HPPs), other DUoS charges might reach up to 32 €/MWh[14], while used for commercial generation only, or even up to 80 €/MWh[15], while used primary for the provision of system services for TSO, but also with spare capacity for commercial generation. For other "best in class" producers connected to one of Slovak regional DSOs, the values range as follows:

[14] This is the case of HPPs located in the so called "Vah river cascade" comprising of 18 HPPs with total installed capacity of 685 MW, which were designed and are being operated as one hydrologically interconnected production unit. Based on their technical parameters and limitation, the operation regime of these HPPs is subject to overall optimisation strategy considering seasonal hydrological situation. The high charges need to be seen from the perspective of total volume of electricity produced vs. reserved or installed capacity.

[15] The majority of capacity and time of use (90%) of the power plant is dedicated to its primary designation – provision of system services for the TSO. Only the remaining capacity/time (<10%) is used for commercial generation, where other DUoS charges are applied, but the value is calculated for 100% capacity anyway.

Type of technology	Voltage level	Utilization of max. installed capacity (h)	G-charge €/MWh
Biomass	HV	4 125	6,8*
	MV	8 399	8,4*
Biogas	MV	8 066	8,7*
Municipal waste	MV	3 000	23,5**
Solar	MV	1 566	45,0***
Hydro (>5MW)	MV	881	80,02
CHP (Natural gas)	HV	5 744	4,9*
	MV	6 176	11,4*

Note: Prosumers on low voltage level pay for the off-take capacity, which is higher or equal to supply capacity into the network, thus, they are not affected by other DUoS charges at all.

* Producers do not act on the market on competitive terms as they have priority access to the network. The impact of other DUoS charges is on Return on Investment (ROI) only

** Producer who generates electricity as a secondary business and has apriority off-take as part of subsidy scheme

*** Relates mainly to large PV installations on agriculture land distant from major consumption areas.

The introduction of other DUoS charges also led to a decrease in final consumer electricity prices as a result of network costs allocation to network users. The network component of electricity price for medium size household consumers decreased by 12,9 % and for medium size industry by 11,5 % in the first year. The final electricity prices continued to decrease from 2014 to 2016, driven mostly by commodity price development on the market.The introduction of other DUoS charges also led to a decrease in final consumer electricity prices as a result of network costs allocation to network users. The network component of electricity price for medium size household consumers decreased by 12,9 % and for medium size industry by 11,5 % in the first year. The final electricity prices continued to decrease from 2014 to 2016, driven mostly by commodity price development on the market.

b) Business operations and investments

In general, other DUoS charges are affecting electricity dispatch decision of the generators, level of offered prices, investment planning and the decision to connect/ disconnect to the network. High levels of other DUoS charges applied at DSO level negatively affect decisions about potential investments in new generating capacity. Since 2014, several larger projects at DSO level were mothballed – CCGT PPC Bratislava 220 MW with other DUoS charges level of 1,5-2,1 €/MWh or thermal (coal) power plant Vojany 220 MW with other DUoS charges level of 6,1 €/MWh. However, we need to differentiate between generators participating in market on competitive terms and subsidised generators, who are subject to a preferential access to the network and have a guarantee of the electricity being sold at a regulated price. Other DUoS charges impact only the ROI expectations of these generators (e.g. ROI of subsidised generators connected to the one of the regional DSO mentioned above is six years on average, while subsidised prices are fixed for 15 years).

c) Trading on wholesale market

The introduction of other DUoS charges created an additional burden for generators in Slovakia participating in the market on competitive terms compared to their competitors. As other DUoS charges are paid in advance for every MW of reserved or installed capacity, they represent a cost for the generator, which is translated into unit cost and

thus influences their market offer. As generators in Slovakia are active on a regional wholesale electricity market with ongoing market integration, any additional charges or taxes can disqualify certain production capacity from wholesale market trading. This can be supported by the fact that the cross-border price range within the region decreased from 9,10 €/MWh in 2014 to 3,90 €/MWh in 2016 (comparing most expensive to least expensive baseload price in 2014–2016). However, the position of Slovak generators depends not only on the other DUoS charges, but also on their substitutability on the regional market by foreign producers and available cross-border capacity.

4.1.4 Lessons learned

From Slovakia's perspective, the most important lessons learned about the implementation of other DUoS charges are:

- **Open and detailed public discussion** with all interested stakeholders **and regulatory impact assessments** from national policymakers shall be carried out and precede any decision about the implementation of other DUoS charges;
- **In case of Slovakia, a harmonised methodology for TSO and DSO UoS charges** (e.g. price caps on all voltage levels) **would make the system more balanced and predictable**. While a price cap on other DUoS charges per MW can act as a natural selector for different types of generating technologies (efficiency of the technology or utilisation of the power plant determines MWh costs), a price cap for other DUoS charges per MWh creates equal competitive terms;
- Other DUoS charges **shall be cost reflective for all voltage levels**. An exact explanation for the scope of TSO and DSO costs to be covered by the other DUoS charges shall be clear to all network users;
- **National generators should not face additional costs** from other DUoS charges application compared to foreign competitors, which cannot be automatically reflected in the wholesale price as they are all active on the same regional wholesale electricity market;
- It is necessary to **integrate all subsidised generators into the competitive market**. To this end, only tariffs and subsidies that do not distort market prices and hinder competition, should be applied.

4.2 SWEDEN: DISTRIBUTION SYSTEM CHARGES IMPLEMENTATION

The Swedish power system is characterised by long distances between production and consumption. While a lot of hydropower production (43% of Sweden's total production relies on hydropower) is from the more northern regions, the consumption is concentrated in the southern parts. This results in a transmission network primarily constructed to handle production capacity in the northern regions. The capacity required in the grid in these regions with a lot of production are larger than the consumption and the cost is therefore allocated to both producers and consumers. In these areas there is a charge to feed in electricity into the grid.

The further the electricity is transmitted for consumption, the smaller share of the grid is allocated for production and when the capacity required for production is less than the capacity for consumption, the consumers bear the full cost of that grid. The aim is to ensure adequate cost allocation between producers and consumers. If production is located close to consumption, the cost to inject into the grid is low and can also be turned into a revenue.

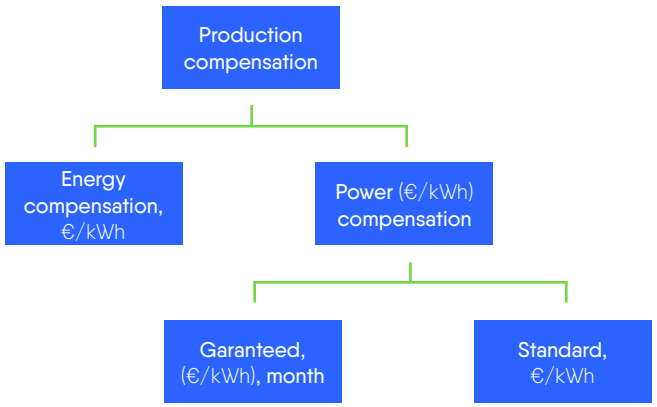
Graph 2: Distances in Sweden compared to the continental European grid

The long distance from the northern part of Sweden to reach the consumers in the southern part of Sweden can be seen on the above maps. It can also be compared with the distance between the northern coast of Germany and the Mediterranean while there is an obvious difference in population density and number of consumers for the same distance. Therefore, in some parts of Europe it is appropriate to inject free of charge from a cost allocation perspective, whereas in other parts of Europe it is relevant to impose a charge for production. The important conclusion is that every stakeholder should pay for their share of the capacity in the grid.

4.2.1 Production tariffs at local grid level 0,4-24kV

If production capacity is larger than consumption capacity there is usually a production tariff. All production is measured hourly and so is consumption. Producers shall have both a production tariff and a consumption tariff. The consumption tariff should be a power demand tariff. The price of the feed-in tariff is based on the price for the power demand consumption tariff on the same voltage level. The exception is made for the production of up to 1500 KW that is only charged a fixed fee covering administrative costs and a cost for eventual consumption. The energy is sold to the market at competitive prices.

4.2.2 Production compensation



Production compensation is designed to reflect the cost reduction the producers generate with their production at the actual voltage level they operate. The compensation consists of two parts - energy and power compensation.

I. **Energy compensation** is the compensation for reduced grid losses. Both reduction on required energy from overlaying grid and on grid losses on the actual voltage level
II. **Power compensation** is the compensation for reduced power subscription to overlaying grid that a producer generates, this can be calculated either based on:

Guaranteed power: the actual power the producer can guarantee with control over their production, not applicable to solar or wind sources since they cannot guarantee production.

Standard power compensation: calculated based on energy/month. This is applicable to solar and wind production as they generally reduce subscription to overlaying grid to some extent. This compensation is lower than the guaranteed compensation.

4.2.3 Customised distribution charges for regional networks (RN - 30-130kV)

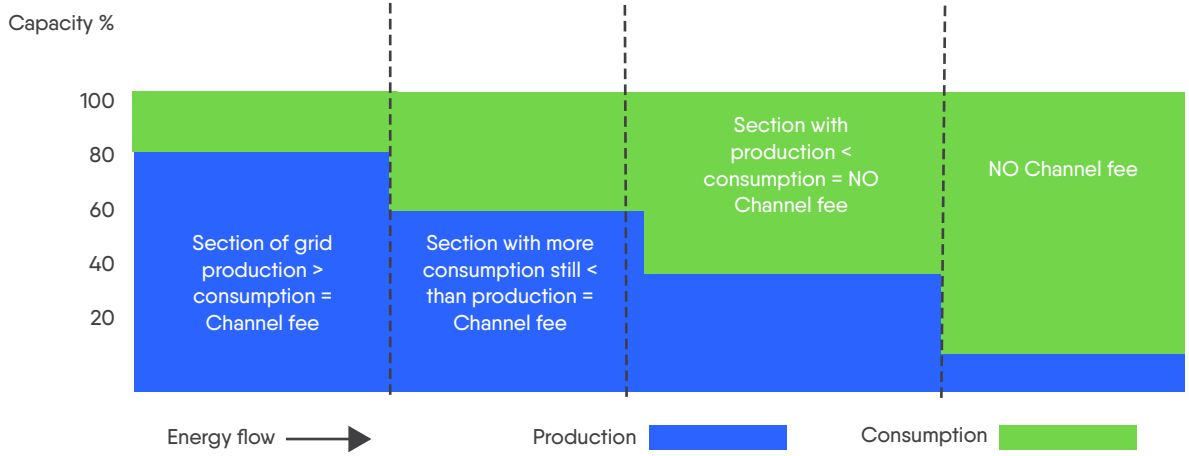
Customised and consequently individual distribution charges for regional networks for each producer can be established in Sweden through a so-called "channel tariff".

"Channel tariff" represents the cost for the share (the channel) of the grid that the producer uses. The relevant 'channel' is defined as the sections on the grid on the same or higher voltage level dominated by production (production exceeding consumption). The channel exists until the maximum consumption exceeds the maximum production and the production fee per section is the share of a feed-in in each section.

The channel is calculated by extremes both with maximum production and maximum consumption in every segment of the grid. This way parts of the production grid and parts of the consumption grid can be distinguished. Furthermore, it is possible to determine which share of a channel is attributed to one producer.

The reasoning behind this model is to reflect costs induced by each player in a neutral way.

Graph 3: Channel tariff as a cost reflective way to treat production and consumption



Fairness is one of the cornerstones in regulation, which combined with adequate cost allocations can be seen as a straightforward approach to treat consumers, prosumers and producers in a fair and neutral way. Thus, the system operator can handle changes in capacity requirements from either consumers or producers in a fair and cost reflective way. As mentioned above, Sweden is an elongated state and the remuneration based on kWh can vary depending on the cost to inject electricity to a revenue and whether the grid is mainly a production or a consumption grid.

4.2.4 Charging regimes for prosumers in Sweden

The following charging regime applies for micro production and prosumers in Sweden, namely for customers that:
The following charging regime applies for micro production and prosumers in Sweden, namely for customers that:
produce less than they consumes that:

I. produce less than they consume
II. have a main consumption tariff

Neither production tariff nor monthly fee are imposed and a new meter is installed free of charge. Capacity and energy are charged through the consumption tariff that is the main tariff. However, the compensation to producer is based on the reduction in grid losses, on the actual voltage level and the reduced need from the grid.

Neither production tariff nor monthly fee are imposed and a new meter is installed free of charge. Capacity and energy are charged through the consumption tariff that is the main tariff. However, the compensation to producer is based on the reduction in grid losses, on the actual voltage level and the reduced need from the grid.

4.2.4 Lessons learned

Discretion at the Member States level versus added value of a harmonised approach

EU harmonisation attempts could be a challenge since it might be hard to reflect the vast varieties in national conditions in demography, regulation, geography, etc. We suggest that general guidelines are rather under the jurisdiction of the national regulators to regulate other DUoS charging regimes in a cost reflective way allowing for a national discretion to consider other DUoS charging regimes in line with each country's regulation and local challenges. The cost of capacity is also recommended to be handled in a cost neutral way with a fair cost recovery. If part of the total capacity is required to handle production, the producers should pay for their share and the other way around with consumption.

Avoiding fixed levels

Sweden has a stipulated fixed production limit of 1500kW where different charges are applied above or below this fixed limit. Since there is no big difference between 1400kW and 1600kW, this has led to some producers "restricting" their production capacity to fall below this 1500kW limit and hence the production system is sub optimised.

4.3 SPAIN: DISTRIBUTION SYSTEM CHARGES IMPLEMENTATION

In Spain, there are two main distribution system charging schemes for producers connected to distribution networks depending on whether they are producers or prosumers.

4.3.1 Charges applying to conventional and RES producers

Since 2011, a regulated other DUoS charge (G-charge)[16] applies to energy injected into the grid by producers connected to both transmission and distribution networks. The charge is collected by transmission and distribution companies and is delivered to the national regulated income and costs clearing system.
The price, which is approved in the context of measures implementation to solve the tariff deficit issue, is set at the upper limit of the annual average transmission charges for Spain[17] (0.5€/MWh) until a methodology is developed. The price does not vary according to the voltage level or location, but a correction factor applies to pumping hydro in order to consider both produced and consumed electricity[18].

4.3.2 Charges applying to prosumers

Current legislation related to prosumers supply[19] was introduced in 2015 with the objective that self-consumption contributes to the financing of all system costs and services in the same amount as the rest of the consumers. It provides three different kind of charges:

[16] Royal Decree 1544/2011, of 31 October, establishing the transport and distribution network access tariffs to be paid by electricity producers
[17] Part B of the Annex to Regulation (EU) No 838/2010
[18] Correction factor for pumping hydro: (Energy produced + Energy consumed *(1-0.7))
[19] Royal Decree 900/2015 adopted on 9th of October 2015 regulates administrative, technical and economic modalities for electricity supply and generation with self-consumption.

- **Network tariffs** applied at grid connection point.
- **Other regulated costs** (capacity payments, renewable promotion, non-mainland compensation, deficit annuities, etc.) applied at consumption point (including self-consumption).
- **Other services** (back-up and ancillary services) applied to self-consumption.

However, as the cost allocation methodology for the other regulated costs and other services have not been developed yet, the following transitory scheme applies:

- **Access tariff** financing network and other regulated costs at the grid connection point:
  (i) Energy term (€/kWh) applied to the hourly net demand (energy absorbed minus energy injected)
  (ii) Capacity term (€/kW) applied to the contracted capacity
- **Additional charges:**
  (iii) Capacity term (€/kW) applied to the additional capacity of manageable generation. Otherwise, there is no fixed charge.
  (iv) Energy term (€/kWh) applied to the hourly self-consumption.

Additionally, small prosumers (contracted capacity ≤ 10kW), some non-mainland prosumers and CHP (up to 31.12.2019) are exempted from paying any additional charges.

Table 2: Transitory charges for consumers with self-consumption.

	Access tariff		Additional charges associated to system costs	
	(i) Capacity term (€/kW)	(ii) Variable term (€/kWh)	(iii) Capacity term (€/kW)	(iv) Variable term (€/kWh)
Contracted capacity at grid connection point	X			
Hourly net-metered energy at grid connection point		X		
Self-consumption				X
Capacity for system charges			X	

In addition, prosumers who export electricity back to the grid and are paid for it[20] pay the other DUoS charges, taxes, fees and levies as those applied to conventional generators for the energy injected to the grid.

[20] Producers injecting their production via consumers' internal grid.

4.3.3 Need of a global scope related to prosumers' charges in Spain

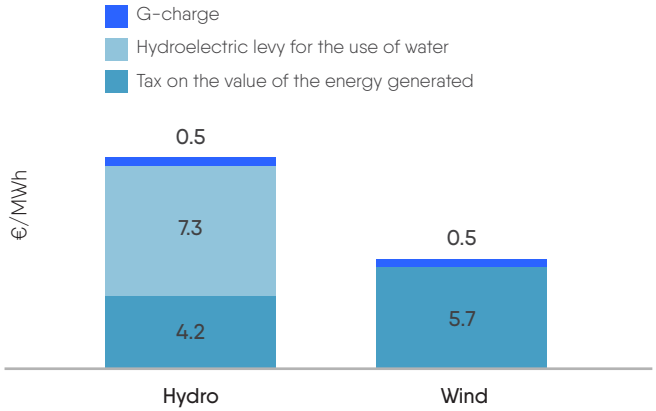
G-charges/other DUoS charges in Spain are just a part of a wide array of charges applying to producers, which finance network, system costs and public policies. The following table summarises the different charges related to energy for conventional & RES producers, as well as prosumers:
As other DUoS charges constitute only a part of the overall

Table 3: Charges related to energy for conventional/RES producers and prosumers in Spain

Charge	Producers (conventional & RES)	Prosumers
Ancillary services	Charges through the energy market.	Charges through the energy market at grid connection. Ancillary services of self-consumption financed by transitory additional charge.
Network losses	T&D losses related to supply through the energy market.	
Taxes, fees and levies related to energy	Taxes related to energy sustainability : Tax on the value of the energy generated (7%), hydroelectric levy for water use, nuclear tax on radioactive waste production, tax on storage of radioactive waste, and increase of tax rates on hydrocarbon fuels (green cent) and introduction of new taxes. Market and System Operator fees. Other regional and local energy taxes (wind, pollutants, emissions, etc.).	Policy costs of self-consumption financed by transitory additional charge. Prosumers who export electricity to the grid and are paid for it pay the same taxes, fees and levies as applied to conventional producers for the energy injected to the grid.
OTHER distribution use-of-system charges	Network cost financed by G-charge/ other DUoS charges applying to energy injected to the grid.	Network cost financed by G-charge (other DUoS/ other charge) applied to the energy injected to the grid only for prosumers who export electricity back to the grid and are paid for it.
	Network cost financed by access tariff (L-charge) applying to the energy demanded from the grid	
Connection costs	Deep connection costs apply to producers and prosumers, although shallow connection costs could also apply to small producers/prosumers.	

charges, their price signal is added to the rest of charges. Thus, a global scope considering the joint impact of all charges is needed in order to ensure efficient behaviour of all grid users and to avoid market distortion.

Graph 4: Average other DUoS charges for wind and hydro power production in Spain in 2017



For instance, according to the Spanish NRA taxes estimation[21], other DUoS charges (G-charges) paid in 2017 by hydro and wind producers for their energy injected to the grid were much lower than the corresponding G-taxes related to energy sustainability.

[21] Report on the proposed Order establishing the electric access tariffs for 2018 (CNMC).

4.3.4 Lessons learnt from the Spanish G-charges/ Other DUoS charges case

Other DUoS charges and taxes related to supporting energy sustainability in Spain were introduced in a tariff deficit context. In addition, the later introduction of the additional charges applied to electricity supply and generation with self-consumption was not well received and widely opposed.
The expected development of the methodology for the other regulated costs would be an optimal occasion to analyse G-charges/other DUoS charges in a global scope considering some of the lessons learnt:

- Other DUoS charges should not include policy support costs, levies and taxes.
- As other DUoS charges are only a part of the overall charges, a global analysis considering all charges is needed to ensure efficient behaviour as grid users and avoid market distortion.
  Producers and prosumers who export electricity to the grid and are paid for it ultimately contribute to the financing of the distribution use-of-system costs from network charge applied to both energy/capacity demanded from the grid and energy injected into the grid.

4.4 PORTUGAL: DISTRIBUTION SYSTEM CHARGES IMPLEMENTATION

The Portuguese power system is characterised by a high penetration of renewable energy sources (RES), mainly hydropower - 35% of the installed capacity - and wind - with a 24% share - but also 2% of solar which is expected to grow significantly in the short term. The load is also secured by two coal power plants and three combined cycle facilities.
The total installed capacity is about 19GW, of which nearly 19% (4,5GW) is connected to the national distribution grid, at 15kV/30kV (MV – medium voltage) or 60kV (HV – high voltage) voltage levels, and concentrated in the northern part of the country, as is most of the installed hydropower capacity although in this case connected to the transmission grid. The conventional power plants (coal and combined cycle) are located in the proximity of the main consumption areas.
Most of the RES capacity, other than hydro, is imposed a feed-in-tariff and is not directly included in the MIBEL (Iberian Energy Market), where most of the wholesale energy trade in Iberia occurs and where energy prices are set.

The national transmission grid transports energy at voltages between 150kV and 400kV (VHV – very high voltage) and its operation is granted by government for a 40-year period. Energy is delivered by the transmission grid to the national distribution grid and then distributed at 60kV HV and a 15kV or 30kV MV. The HV\MV distribution grid operation is also government granted but, in this case, for 35 years. Low voltage (LV) distribution operates at 400V\230V and the activity is granted by municipalities for a 20-year period.

Grid access tariffs are defined by the National Regulatory Authority (NRA) on an annual basis and include: (i) transmission tariff; (ii) HV, MV and LV distribution tariffs; (iii) global use of system tariff.
A significant part of the grid access tariffs revenue is used to recover general economic interest costs (CIEG), which include RES incentives, NRA and other administrative costs, sharing of the insular electric systems extra cost, municipal concession rents, amongst others. The remaining revenue assures the retribution to transmission and distribution operators.

Grid access tariffs are paid exclusively by consumers. The only exception is the transmission G-charge implemented in Portugal in 2012, following the decision of the Spanish government of introducing a similar charge in 2011. The main objective of introducing this tariff in Portugal was the maintenance of the wholesale market level playing field.

Other DUoS charges were never applied in Portugal, since the generally accepted idea is that these could create market imbalance. This would, even if indirectly, be reflected in the final energy price and will consequently be passed on the final energy consumer. However, producers connected to the distribution grid also pay the previously mentioned transmission G-charge. This revenue recovery system is in place, with minor changes, since 1999 and has proved to suit the country's particularity.

As for the distribution grid, and specifically the producer connection charges in use, these include the connection costs and grid reinforcement costs. Connection costs comprise all the costs associated with the construction of the connecting infrastructure including all the corresponding administrative costs. Grid reinforcement needs are paid by producers based on an average charge (proportional to the connection capacity - euro per kVA) established by NRA and intended to internalise the impact of the new facility on the system. The aggregation of connection costs and grid reinforcement costs results in a connection charge that may be considered deep. There are, however, no locational signals comprised in the connection charges, since the country's size and the distances between production and consumption facilities do not justify the added complexity of introducing such signals. Furthermore, the robustness of

the national transmission and distribution grids prevents any bottlenecks and ensures the adequate levels of service. With regard to energy production for self-consumption due to the expected steep growth rate in the number of prosumers, the Portuguese government decided to introduce in 201, a new charge designed specifically to recover a part of the general economic interest costs (CIEG), in an attempt to mitigate the expected decrease in the collected revenue that would occur with high penetration of prosumers. This charge is currently 0% of the CIEG and, according to the weight of prosumers installed capacity vs. total installed capacity, it is expected to go up to 50%. The expected revenue decrease is a reflection of the mismatch between the cost structure (mainly fixed) compared to the revenue structure ensured by the tariff (mainly variable), as the tariff design scheme, for domestic energy users, is strongly based on energy consumption as opposed to contracted power (variable vs. fixed terms).

Although this new tariff can solve the problem of recovering a part of general economic interest costs, it will not address the issue of recovering the revenues of the system for transmission and distribution system operators that will arise with a high penetration of self-consumption facilities. If no other changes to the tariff scheme are implemented, this revenue gap would, be transferred to customers that could not themselves benefit from self-consumption.

Other than building a specific tariff scheme for prosumers, strengthening the impact of contracted power on tariff design or implementing a well-designed and mandatory access time of use (ToU) tariff could help tackling the challenges imposed on the system by a high number of prosumers. On the other hand, this could promote the alignment of real grid costs with the price paid by consumers, bearing in mind that grid costs are intimately related to consumption in peak hours which, in Portugal, differ from solar production peak hours.

Electric mobility, and its eventual impact on grid operations, is another subject that concerns the Portuguese electric system stakeholders. On the one hand, the development of electric mobility carries numerous benefits for society, the electric system and addressing the commitments of decarbonisation via electrification, on the other it represents a challenge to the distribution grid. With increasing numbers of electric vehicles (EV) on the road, the electric energy consumption will grow, creating an opportunity for producers and retailers. For grid operators, DSOs above all, managing this increased and more complex energy flows will require in future the recognition of allowed revenues recovery schemes that should address this re-designed role for DSOs.

How many vehicles, how they will be charged (fast or slow) and at what time the users will charge their batteries will be the main issues to address when assessing the impact of electric mobility for grid operations. Although several studies on these matters were published, none of them points to a probable answer to country specific cases.
In Portugal, one of the first countries in Europe to deploy a nationwide, integrated EV charging infrastructure, this topic is being discussed since 2009, the year that marked the deployment of the national electric mobility program, with no definitive conclusions. If the numbers of EVs and their average energy consumption can be estimated with a satisfactory degree of precision, the location, type and charging mode that users will preferably use are still not well understood.

On the other hand, the Portuguese electric mobility model needed a specific electric mobility access tariff to be implemented. This fact led the NRA to introduce such a specific tariff in 2016. The new tariff is a ToU energy-based tariff, with distinction by voltage level and time period (2 or 3 time periods).

4.5 NORWAY: DISTRIBUTION SYSTEM CHARGES IMPLEMENTATION

Connection Charges for Producers

In Norway, DSOs can raise fees for connection charges, under the principle that comparable customers are treated equally.

It is difficult to distinguish connection charges in the meshed network which is the transmission grid as well as the regional grid (all networks from 22 kV and above).

Regarding prosumers, the DSO can raise connection charges.

From 2019 both the DSO and TSO is obliged to raise connection charges in the meshed network. The DSO (and TSO, if a producer is connected to the transmission grid) shall receive connection charges, also in the meshed network (the connection charge is 50 % of the cost in the meshed grid). If the producers' capacity is less than 1 MW they shall not pay connection charges in the meshed network.

If a producer is connected to the distribution grid, the producer might pay both for investment in the distribution grid and in the transmission grid.

Other DUoS charges

Power producers shall pay a flat fee of 1,3 øre/kWh both at distribution and transmission level. The basis for calculations is the average production during the past ten years. Prosumers under 100 kW delivered into the network are exempted from the tariff.

Market releated charges: Losses

Marginal losses charges shall reflect marginal losses in the respective grid node (Marginal loss in % multiplied with the power price).

The next tables present the current and the new rules from 2019 concerning charges for producers in distibution networks.

Table 4: Current rules

	Power producers	Prosumers
Connection charge	DSO can raise connection charges, though comparable customers have to be treated equally. If connection charges are not applied, the DSO shall charge a network tariff equivalent to the costs of the grid components that are production specific within certain limits. However, it is difficult to distinguish connection charges in the meshed network.	DSO can raise connection charges.
Tariffs	Power producers shall pay a flat fee of 1,3 øre/kWh. The basis for calculations is the average production during the past ten years. Power producers with less than 1 MW in installed capacity are treated differently: the actual production is used as a basis for calculation.	Prosumers under 100 kW delivered into the network are exempted from the tariff.
Marginal loss charges	Marginal loss rates shall reflect marginal losses in the respective grid node.	

Table 5: New rules

	Power producers	Prosumers
Connection charge	DSO and TSO (if a producer is connected to the transmission grid) shall receive connection charges, also in the meshed grid (50 % of the cost in the meshed grid). If the producers' capacity is less than 1 MW they shall not pay connection charges in the meshed grid.	DSO shall receive connection charges (in practice, it will seldom apply), but not in the meshed network if the capacity is below 1 MW.
Tariffs	Power producers shall pay a flat fee of 1,3 øre/kWh, regardless of the size and where they are connected.	Prosumers under 100 kW delivered into the network are exempted from the tariff.
Marginal loss charges	For producers with installed capacity over 1 MW, the marginal loss rate shall reflect the marginal losses and be node specific. The rate shall, as a minimum, be differentiated for each week and between days and night/weekend. For producers with installed capacity under 1 MW, the marginal loss rate shall reflect marginal losses at the local and regional level.	The marginal loss rate shall reflect marginal losses at the local and regional level.

5. Outlook and further potential work streams

This study covered a wide range of charges borne by producers at distribution level, besides other DUoS charges these also included connection charges and charges specifically applicable to prosumers. The initial aim was also to cover EV charging stations as well as storage facilities, however, the survey results mostly revealed that so far there is no definite approach in terms of charging regimes visible for these facilities or it is only in the making in a few countries. Overall, the received input was too little to derive any meaningful conclusions or policy recommendations just yet.Where deployed, storage facilities at distribution level, regardless of their rated power, are treated the same way as consumers in the majority of cases. According to our survey, roughly half of the survey respondents have storage facilities connected at distribution level, while in some cases they are also charged as a producer for the electricity they feed into the network. Overall, there is no EU-wide approach on storage charging policies established or visible so far.

Consequently, we can safely recommend further analyses on charging policies for storage facilities in view of the likely increase of these at DSO level, especially with such facilities being able to offer flexibility services to the distribution system[22]. Policymakers and, accordingly, DSOs should therefore scrutinise any existing cases of specific charges for storage facilities connected at distribution level, at present mostly batteries and pumped hydropower.

E-mobility and its impact on grid operations is another subject of major concern that has not yielded the required input as there is seemingly too little information available at present with dedicated charging regimes only in the making or simply not existing in many cases.
It is undisputed that the development of electric mobility carries numerous benefits for society and it is an indispensable means for decarbonisation efforts in general. On the other hand the rapid growth of EVs will pose a challenge to distribution grids which is at present mostly unaccounted for. It is certain that, with increasing numbers of EVs power consumption will grow which in turn will create various opportunities for producers, retailers and other service providers. To grid operators, DSO's above all, managing these increased and more complex energy flows require recognition in future revenue and cost recovery schemes that should take into account this development.

Questions such as the roll-out rates, charging technologies (fast or slow) and core charging timings will be the main issues to address when assessing in detail the impact of e-mobility in grid operation. Although several studies tackling these subjects were published already, we still can state a knowledge gap, not least with regards to more granular country specific scenarios including

the EVs' average energy consumption, location, EV types and charging modes that users will preferably use and lastly, adequate charging regimes tailored for EVs.

6. Annex – Detailed country results

Detailed country results can be found on the Eurelectric member net.

[22] See also Flexibility in the Energy Transition – A toolbox for Electricity DSOs, joint report by Eurelectric, EDSO, Geode and CEDEC, 2018.

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