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Smart Energy Europe

The smartEn Map

Network Tariffs and Taxes

2019

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About smartEn

smartEn is the European business association for digital and decentralised energy solutions. Our members include innovators in services and technology for energy and data management, finance and research. By taking an integrated perspective on the interaction of demand and supply, our mission is to promote system efficiency, encourage innovation and diversity, empower energy consumers and drive the decarbonisation of the energy sector.

For further information please visit **www.smarten.eu**

We also thank all smartEn Members for their invaluable contributions and feedback.

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Foreword

Foreword by the European Commission

Taxes and levies make up 40 % of average electricity costs. Network tariffs represent a significant share of total energy costs for households and, unless they benefit from derogations, industry. This immediately explains why tariffs, taxes and other levies are such an important element of the energy policy discussion. Tariff structures can provide incentives to invest into smart grids, use all available flexibility potentials, and steer system operators towards greater efficiency. Well-designed tariff structures and incentives will therefore be crucial to ensuring a successful and cost-efficient energy transition. In the Clean Energy for All Europeans package, I am happy that important new principles with importance for tariff setting have been agreed, in particular with regard to the use of flexibility instruments by system operators.

Nonetheless, taxes and tariffs are subject to very limited harmonization. Whereas common principles exist for network tariffs, notably on the transmission level, further steps towards harmonisation are often seen with great scepticism by Member States. The national frameworks on tariffs, taxes and levies are thus still very different, also as regards their impact on costs, as can be seen in the regular reports on energy prices and costs in Europe published by the European Commission.

While the network code gas tariffs provides for increased transparency and comparability in tariff setting, it is very far from achieving a common European tariff framework. For electricity, the new best practice report by ACER will provide a major opportunity to increase coherence and comparability of network tariffs, although the very short time available for preparing the first edition of course needs to be taken into account. While the report has no binding nature, it will be an important basis for analysing and improving tariff frameworks over the coming years.

Against this background, providing an overview over national taxes and tariff structures is of particular importance to all market participants, but also to policymakers looking to improve their national regulatory framework. I strongly welcome the publication of the smarten Map on network tariffs and taxes which will certainly provide an important contribution to this discussion.

Klaus-Dieter Borchardt
Deputy Director-General,
DG Energie, European Commission

Introduction

Christiane Mann
smartEn Chairman

Frauke Thies
smartEn Executive Director

Europe's clean energy transition largely depends on the uptake of innovative solutions and their optimal interaction in the energy system. This concerns renewable energy sources, but importantly also storage and demand-side flexibility, including from the integration of the heating and transport sectors.

Over the last years, we have witnessed significant progress not only in the development of the different technologies, but also in the opening of markets for these new solutions. The previous edition of The smartEn Map showed how the conditions for demand-side flexibility and decentralised resources are improving gradually. More broadly, the European Clean Energy Package, adopted earlier in 2019, targets a fair market access for all solutions.

However, the opening of markets will trigger an efficient and reliable clean energy supply for Europeans only, if prices adequately reflect the situation of the energy system. This is where the current edition of The smartEn Map ties in with its focus on network tariffs and taxes. While only one piece of the puzzle of price signals, these dues make up a very significant part of consumer's energy prices – often more than half of the total bill. Yet, the current tariff and tax design has been defined in a different reality of the energy system and has not been adapted to a world that needs flexibility and the engagement of decentralised energy users for the integration of variable energy resources. Current network tariffs often send mixed signals to market participants, not always reflecting the needs of today's energy system. Beyond this, taxes are typically rigid – blunting relevant price signals from the market or the network.

To shed light on the situation of network tariffs and taxes in European countries today, smartEn interviewed 17 Regulatory, 17 Transmission System Operators (TSOs), 25 Distribution System Operators (DSOs) and more than 20 business associations, suppliers, service providers and public institutions. Building on this valuable input and cooperation, The smartEn Map provides the summary of central factors enabling or discouraging the optimal use of decentralised energy resources and demand-side flexibility.

We hope to provide guidance to market-players and political decision-makers alike and inspire further discussions and relevant actions for the further improvement of price signals for the clean energy transition.

Mapping Network Tariffs and Taxes across Europe

After the successful first edition of our revamped *The smartEn Map* that covered the Electricity Balancing Markets across Europe to see how flexibility providers could ensure a stable and secure grid, the present publication takes a different turn to explore how much it actually costs for different technologies and market participants to use the grid.

The focus of this latest edition of *The smartEn Map* is on the **Network Tariffs and Taxes** of a select group of European countries. The objective of the report is twofold. First, to provide an overview of the different tariff and tax structures across Europe. Second, to illustrate what the ideal scenarios would be for an efficient and cost-reflective tariff design that encourages consumer's active interaction with the grid as well as the use of flexibility services.

smartEn acknowledges that there is no one specific tariff design that could satisfy all customers or achieve all objectives at the same time. After all, a specific tariff is designed in response to certain questions governments, regulators and network operators want to answer: *What is the priority and what principles should be followed? Is it fairness, cost-reflectiveness, cost-recovery or simplicity? What is our energy mix and how do we want to integrate distributed energy resources? What are the weak points in our grid that we need to address with this tariff design?* There is no easy answer to address all these questions. For the purpose of *The smartEn Map,* we focused our analysis on how to achieve a tariff design that is both cost-reflective and inclusive to new distributed energy resources and flexibility services, as we see these as a source to lower the overall grid costs and the total cost of electricity. Fairness is equally important, especially to keep vulnerable customers engaged. This dimension is partly addressed through the abovementioned lower prices from efficient system design. As required and politically desired, this should be complemented with targeted government programs that do not distort the tariff design.

Given the complexity of elements to address, we advise to consider the overall country comparison grading as a high-level overview only, while digging deeper into the chapters of this report to see how the tariff design of a specific country impacts customers and the services provided to the grid. It may well be that two similar tariff designs have a different impact in two different countries, given the specificities of their grid.

The selection of countries assessed in the report is based on the following criteria: We chose countries based on their overall weight and size in the European electricity network. We looked for unique traits that made a specific country stand out, for example, an innovative tariff design for electric vehicles or a healthy and varied choice for customers when choosing a supply contract. And finally, to be able to make a fair comparison between countries, we chose those where we could gather enough reliable data to be able to contrast differences based on official information sources.

For the countries selected, we were able to gather enough network tariff design traits to compare their differences for this report. Each chapter is categorised into four sections. The first begins by looking at the **infrastructure of a country.** Smart metering devices, which are the cornerstone for new and innovative tariff designs that serve the grid, are a key focus. Public smart charging and its role in integrating electric vehicles into the electricity network is also highlighted. In the next section, we explore the details of the **network tariffs,** both for households and SMEs - for the low to medium voltage grid at the distribution level - and then for industry, which is usually directly connected to the high voltage transmission grid. The composition of the **network tariffs** between the different terms (capacity, volumetric and fixed) is the main focus in this section. We monitored different tariff schemes for new technologies like storage and special programs for local energy communities. The third section covers **taxation** where we explain the various taxes and excises collected and analyse the weight and impact of taxes in the electricity bill. In the final section, we clarify **the contracts and pricing structures** available to customers to demonstrate the health and competitiveness of the market and to reveal the degree of transparency of the billing process.

With these four topics, we aim to offer a high-level and sound understanding of the network tariffs and taxes applied in practice across Europe. This report does not comment on what is the best possible network tariff design theory, which would be subject of a more academic debate. Instead, through the synopsis we provide, we strive to facilitate an understanding of the effects of current practices and how network tariffs and taxation could be improved.

What are the different network tariff components?

Network tariffs are the way for DSOs and TSOs to recuperate costs that come from operating their network. Depending on their goals and principles followed (cost-reflectiveness, fairness, etc.) one or the other tariff structure will be more effective. In most cases a combination of them are used.

Volumetric	A tariff expressed in €/kWh, it varies depending on the electricity consumed by the customer. This type of tariff is deemed fairer in principle, because people consuming more, pay more.
Capacity	A tariff expressed in kW, customers pay depending on their peak demand. This peak demand can be measured based on different timeframes, for example the maximum consumption over one hour or fifteen minutes. This type of tariff is considered more cost-reflective, if based on measurements of the capacity used, because the main driver for network costs is the maximum hosting capacity of the electricity lines.
Fixed	A set amount that doesn't vary with consumption. The fixed component is generally used to recover sunk costs. A high fixed component could have a negative effect on redistribution, since it shifts network costs created customers with high consumption patterns to those with lower consumption.
Connection charges	Usually a one-time payment at the moment of connecting the customer to the network. Connection charges can be either super shallow, shallow or deep.
Super shallow connection charges	Usually a one-time payment at the moment of connecting the customer to the network. Connection charges can be either super shallow, shallow or deep.
Shallow connection charges	Administrative costs and local connection costs, the cable between the feeder and the connection point.
Deep connection charges	Same as shallow connection charges plus costs incurred to reinforce the grid if needed.

General Overview

The smartEn Map – Network Tariffs and Taxes reflects a heterogeneous field across Europe. Network tariff design can vary from country to country significantly, adapting to the needs of the grid but also to historic aspects of their electricity market.

The research shows, that network tariff and tax design is one of the main barriers limiting the use of flexibility services, severely limiting business cases and hampering their development. Added to that, changes in tariff design tend to be slow and linked to 3-5 year long regulatory periods. Their impact on the electricity bill depends on many factors not necessarily related to the actual tariff design. That being said, some countries have been making efforts and changes in the last years or are considering them at present day. Most of these changes have the common goal of striving towards a more balanced, while still cost-reflective, tariff design, one that accommodates and answers all the questions the inclusion of new variable energy resources raise. These changes are driven by the need to better understand the grid and its intricacies as well as with a growing interest from customers to take energy consumption matters into their own hands and play an active role in the system.

All sections in this report are equally relevant. But given the important signals network tariffs and taxes provide to customers we decided to weigh these two categories slightly more than Infrastructure and Contracts & Pricing. This way we avoided to overrepresent countries that have advanced their smart meter roll-outs without the necessary tariff reforms, or countries with low energy prices for other reasons than the tariff or tax design. As we state in the following chapters, there is no one single tariff design that achieves all possible goals at the same time, but a balanced combination of volumetric and capacity tariffs can at least provide an approximation to the goals deemed most important by the regulator, system operator or government, while minimising negative side-effects of a one-sided tariff design.

Overall, it is noteworthy that no country achieves the best possible grade and distortive effects can be still found across Europe, discouraging innovative flexibility solutions. Nevertheless, several countries exhibit a fairly well-rounded situation. In general, we see a relatively good balance in Nordic countries like Finland, Sweden, Norway and Estonia, but also in Great Britain and Slovenia. These countries show similar traits: their smart meter roll-outs are at an advanced state, diverse contract types are offered to reflect different customers' needs and valuing their flexibility, and a network tariff design that includes different components to reach a balance between cost-reflectiveness and fairness. Finally, these best performers show an interest by the regulators to encourage the use of new and innovative technologies and solutions. In some cases, they also have special tariff regimes, for example to take advantage of the capabilities of electric vehicles. The next step will be to extend these tariff designs to storage assets and other Distributed Energy Resources (DER), fully harnessing the flexibility they can provide, and providing a cost-reflective and fair network tariff, a network tariffs design that includes different components to reach a balance between cost-reflectiveness and fairness.

Lower scores do not mean that a country is performing badly on all aspects. Some countries like Spain, have laid the groundwork for a transition into a smarter tariff design and others are in the process of reassessing their current tariff design. But the main outstanding issue across Europe is the weight taxes take on the electricity bill, which can distort other price signals that are sent by the tariff design, or by explicit and implicit Demand Response (DR). While we are not questioning the need for taxes that support environmental and social programs, alternatives need to be presented so that price signals remain effective, while still reaching the collection targets. The challenge becomes evident in the evolution of electricity prices, where wholesale prices have been going down in the past years while the final retail prices have remained stable, or even increased in countries like Germany, Belgium, Denmark or Spain, due to growing taxes, both in relative and absolute terms.

While the current picture is far from optimal, the input and cooperation we experienced for the present report give us reason to be optimistic for the future evolution of network tariff and tax design. Regulators and system operators are showing genuine interest in adapting the tariff design to the new landscape that the energy transition is bringing to the European electricity networks. Consumer awareness and demand for new technologies will further drive this change, and we hope that in upcoming editions of this smartEn Map we can show a favourable change.

General Overview

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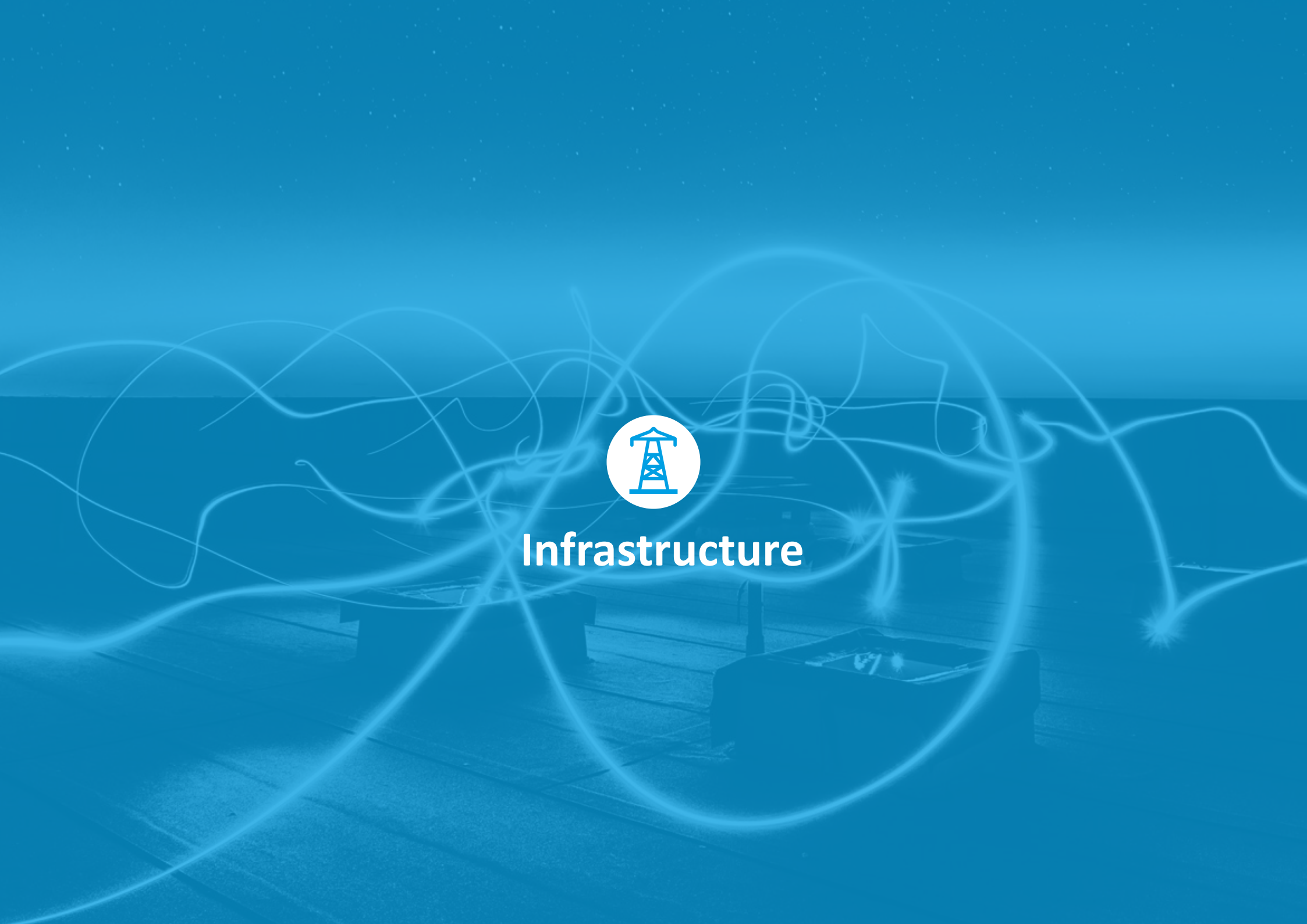
Infrastructure

Smart meters and smart-charging[1] stations for electric vehicles (EVs) have become central components of today's power networks, enabling both consumer choices and system optimisation for the energy transition.

While electricity lines and feeders remain the backbone of the grid infrastructure, the appearance of new technologies and services for the efficient interaction with the electricity network add a new dimension on infrastructure development. In particular, smart meters and smart-charging[1] stations for electric vehicles (EVs) have become central components of today's power networks, enabling both consumer choices and system optimisation for the energy transition. The EU aims to achieve 80% smart meter deployment by 2020. This target is conditional on a positive cost-benefit analysis of their instalment in each member state. The reality, however, is that smart meter roll-outs have been very uneven across the EU. Only 37% of customers have smart meters installed as of today, and in some countries, like Germany and Portugal, there are no specific plans for national roll-outs. Front runners in the roll-out race are Spain, Italy, Estonia, Finland, Sweden and Norway, having reached (very nearly) 100% coverage of smart meters. Other countries like Denmark have already passed the 80% mark with a plan for further roll-outs until 2020. The existence of hardware is not the only important aspect, and its success depends on its functionalities and how it is used. For example, even though a country like Spain has 100% coverage using smart meters, it mostly lacks commercial offers (like dynamic pricing contracts) to take advantage of the meters. In some cases, the hardware is not fully compliant with the EU requirements and will require updating in the years to come. The average cost across the EU to install a smart meter is between 200€ and 250€. In most of the countries assessed, the DSO pays the cost upfront, which is then included in the DSO part of the tariff.

Public infrastructure for smart charging of EVs is still quite underdeveloped across the EU. Some countries like Denmark and Estonia offer smart charging services with 80-100% coverage, the rest being regular charging stations. It is crucial that charging infrastructure be further developed to allow electric vehicles to offer the wide range of services they are capable of providing. This will properly integrate them into the power system and transform electric vehicles into a resource, rather than a burden for the grid.

Without smart meters and smart-charging stations, the tools available for an efficient and effective system management are limited. For example, the availability of a cost-reflective and dynamic network tariff design, but also more explicit market participation by decentralised users, often depend on the existence of such meters. Finally, an extended network of smart-metering devices will also help provide an updated and close to real time vision on the system needs and congestion risks.

1 "Smart-charging" is the active charging of an electric vehicle, taking into account the needs of both the grid and the customer, depending on the current status of power generation and system load.

No smart meters installed.
No public smart charging stations available.

Smart meter roll-out planned but not implemented yet or under 10% penetration.
No public smart charging stations available.

Smart meter roll-out ongoing and between 11% and 40% penetration.
No public smart charging stations available.

Smart meter roll-out ongoing and between 40% and 70% penetration.
Reduced public smart charging pressence.

Smart meter roll-out ongoing and between 70% and 90% penetration.
Active roll-out ongoing for smart-charging stations.

90%-100% Smart meter coverage.
Smart-charging stations readily available across the country.

Infrastructure

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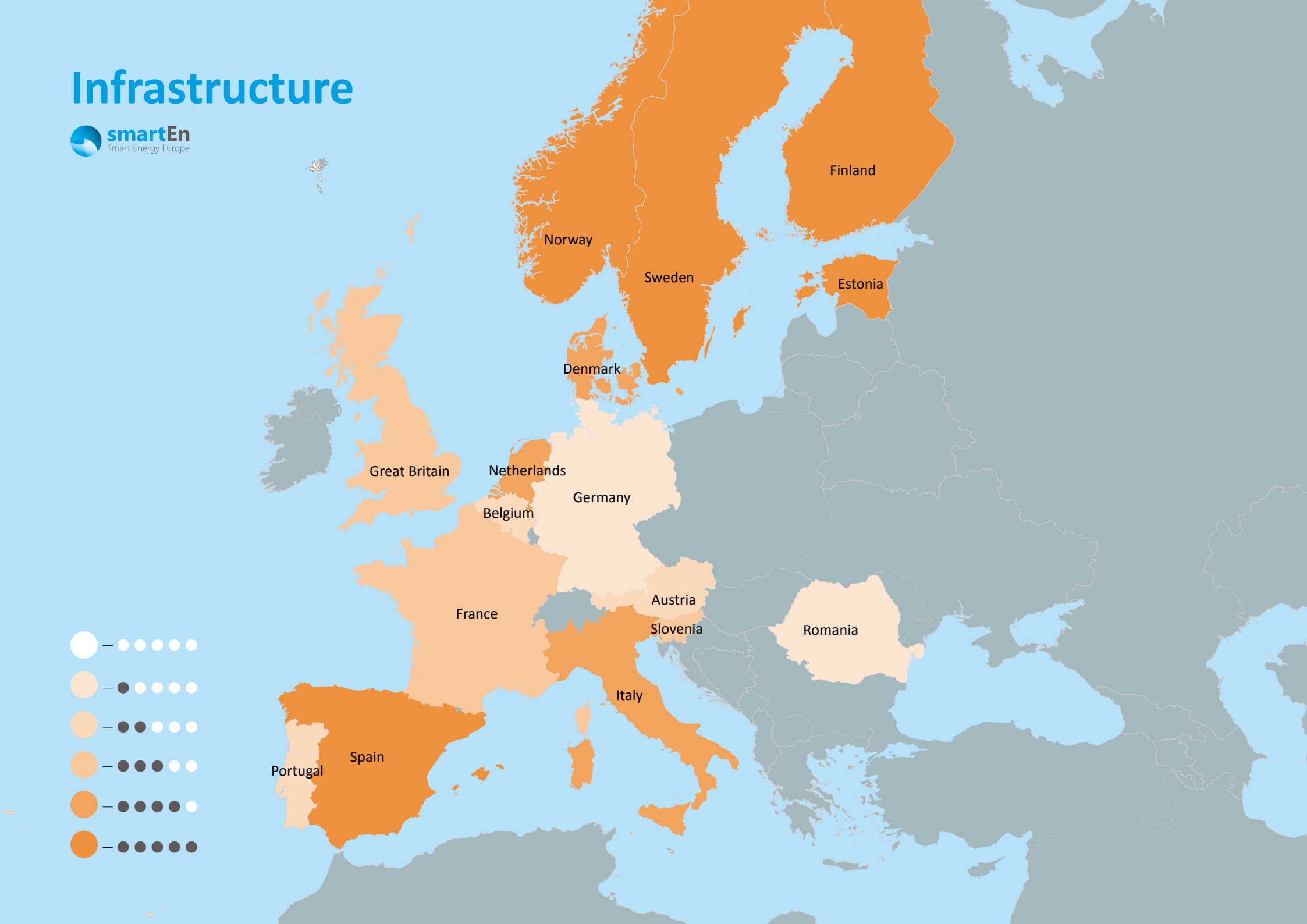

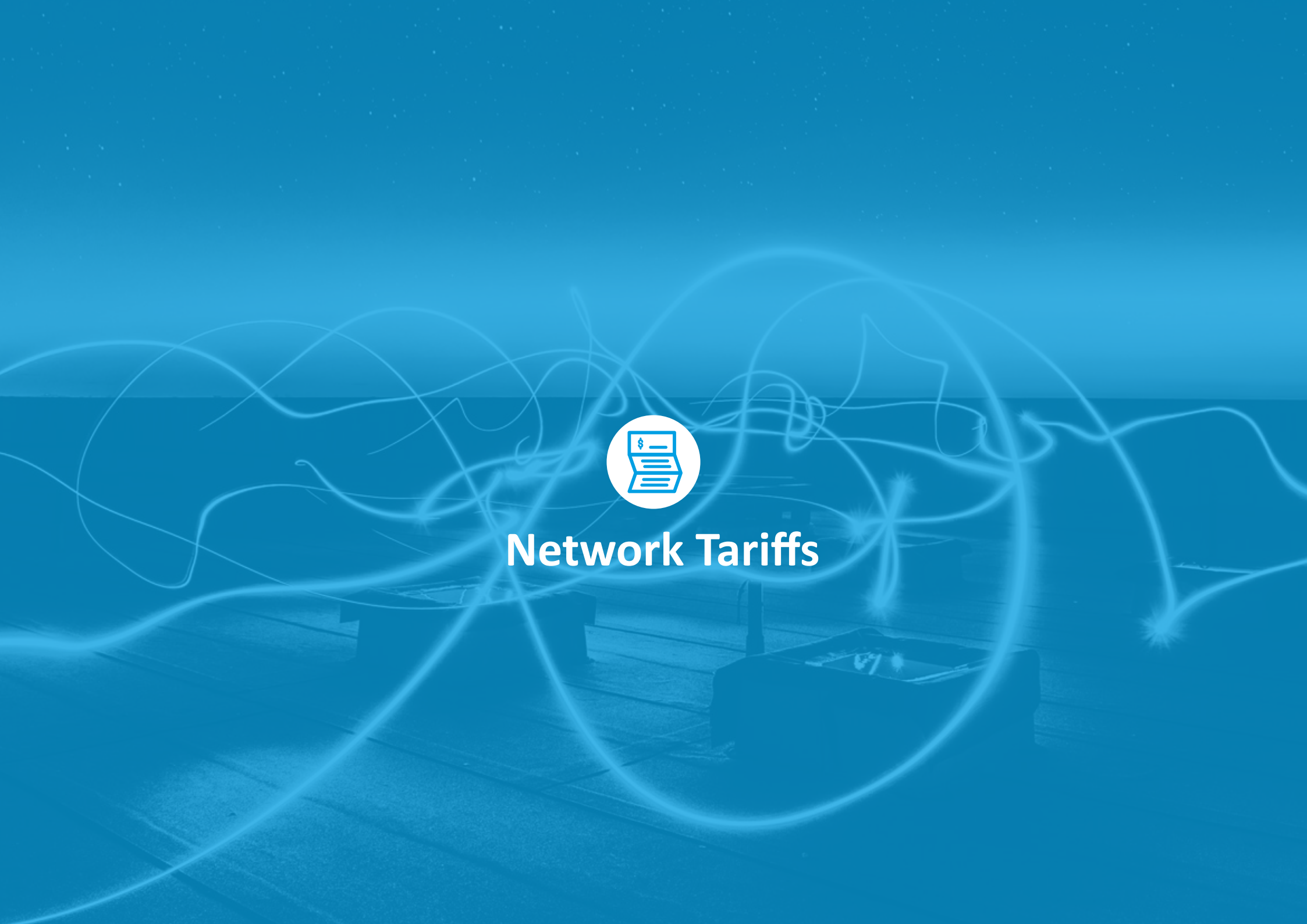

Network Tariffs

> Network tariffs for EU consumers average 27% of the electricity bill, and the largest part is dedicated to distribution network tariffs. Taking such an important role in the total cost for electricity users, the nature of the tariff design can facilitate the use of new technologies and services or create barriers for them.

Network tariffs are one of the central factors influencing the customers' interaction with the electricity grid. This is especially true for active customers and prosumers. The new challenges that the energy transition poses for the electricity network, and specifically the integration of decentralised energy resources, require a transparent and inclusive tariff design that brings visibility on the system needs and reflects its costs. This tariff design should be linked with the physical condition of the grid at any point in time. This will create an opportunity for customers to valorise their flexibility and reduce their network tariffs

Network tariffs for EU consumers average 27%[2] of the electricity bill, and the largest part is dedicated to distribution network tariffs. Taking such an important role in the total cost for electricity users, the nature of the tariff design can facilitate the use of new technologies and services or create barriers for them. In general, there is not a single perfect network tariff design that is both transparent and addresses all concerns for consumers and network needs. There will always be trade-offs between cost-reflectiveness, cost-recovery and fairness. Depending on the system needs, a combination of capacity, volumetric and fixed tariffs – possibly including a dynamic dimension -- appears as the least distortive approach of recovering the systems costs, while allowing customers to optimize their consumption and properly valorise their flexibility. This is especially true when combined with an explicit procurement of network services.

The current predominating tariff design in the EU relies heavily on the volumetric term, which is often deemed more fair for consumers with a lower total energy use. Only a few countries like Norway, the Netherlands, or to a lesser degree, Spain, Portugal, Sweden and Italy have a more mixed approach between the volumetric terms, and the capacity and fixed costs.

All the countries analysed also apply connection charges, with a significant difference being whether they have either shallow or deep connection charges. Essentially, deep connection charges, charge the customer with the extra reinforcement costs originating from their connection and thus provide a clear signal in congested areas. Shallow connection charges exclude locational network signals by covering only the connection of assets, while reinforcement costs are shared among networks users. Most countries use either one of the two approaches, while a few, like France or Finland, make distinctions between grid users, and only apply deep charges to industrial customers.

A great challenge across Europe is a lack of preparation of network tariffs for new technologies like batteries, EVs, distributed generation and behind-the-meter generation. Due to the particularities of the technologies and the services they provide to keep the grid stable and secure, an appropriate tariff design is required that facilitates their smart interaction with the grid. In that regard, Denmark is one of the countries moving forward with a reform of the tariff structure that will incentivise the smart use of electric vehicles and vehicle-to-grid services. Estonia is already offering a tariff suited to the smart charging of EVs. To avoid more investment in grid infrastructure, other countries still need to move forward by providing a framework without the double imposition of charges to technologies that are providing services to the grid.

So far, sandboxes and special tariffs for local communities are quite rare. Where they exist, they usually appear in the form of tariffs for local communities in the same building with one connection point, such as common in Austria.

Given the variety of factors to be considered, the grading of countries cannot be fully comparable. However, in general, countries that performed well are those that used network tariffs as an efficient and transparent tool to reflect grid costs only, while taking into consideration the different needs of consumers and the different opportunities technologies can provide.

2 *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2016,* ACER, October 2017

●○○○○	Purely volumetric tariffs. No capacity or fixed terms. Presence of several detrimental aspects: Net-metering, G-charges for DERs, non-grid related costs in tariff. No incentivising tariff structures for DERs, sandboxes or Energy Communities. No tariffs valorising flexibility.
●○○○○	Mostly volumetric tariffs. Some capacity or fixed terms. Presence of some detrimental aspects: Net-metering, G-charges for DERs, non-grid related costs in tariff. Mostly no incentivising tariff structures for DERs, sandboxes or Energy Communities. No tariffs valorising flexibility.
●●○○○	Volumetric tariffs heavy tariff with capacity or fixed terms. Presence of some detrimental aspects: Net-metering, G-charges for DERs, non-grid related costs in tariff. Mostly no incentivising tariff structures for DERs, sandboxes or Energy Communities No tariffs valorising flexibility.
●●●○○	Mixed tariff design with mainly volumetric term with some capacity or fixed terms. Presence of few detrimental aspects: Net-metering, G-charges for DERs, non-grid related costs in tariff. Some incentivising tariff structures for DERs, sandboxes or Energy Communities. Different tariffs valorising flexibility appearing.
●●●●○	Mixed tariff design, capacity fixed and volumetric terms. Almost no detrimental aspects: Net-metering, G-charges for DERs, non-grid related costs in tariff. Wide use of incentivising tariff structures for DERs, sandboxes or Energy Communities. Some tariffs valorising flexibility.
●●●●●	Mixed tariffs, heavy on capacity and fixed term. No detrimental aspects: Net-metering, G-charges for DERs, non-grid related costs in tariff. Extended use of incentivising tariff structures for DERs, sandboxes or Energy Communities. Tariffs valorising flexibility easily available.

Network Tariffs

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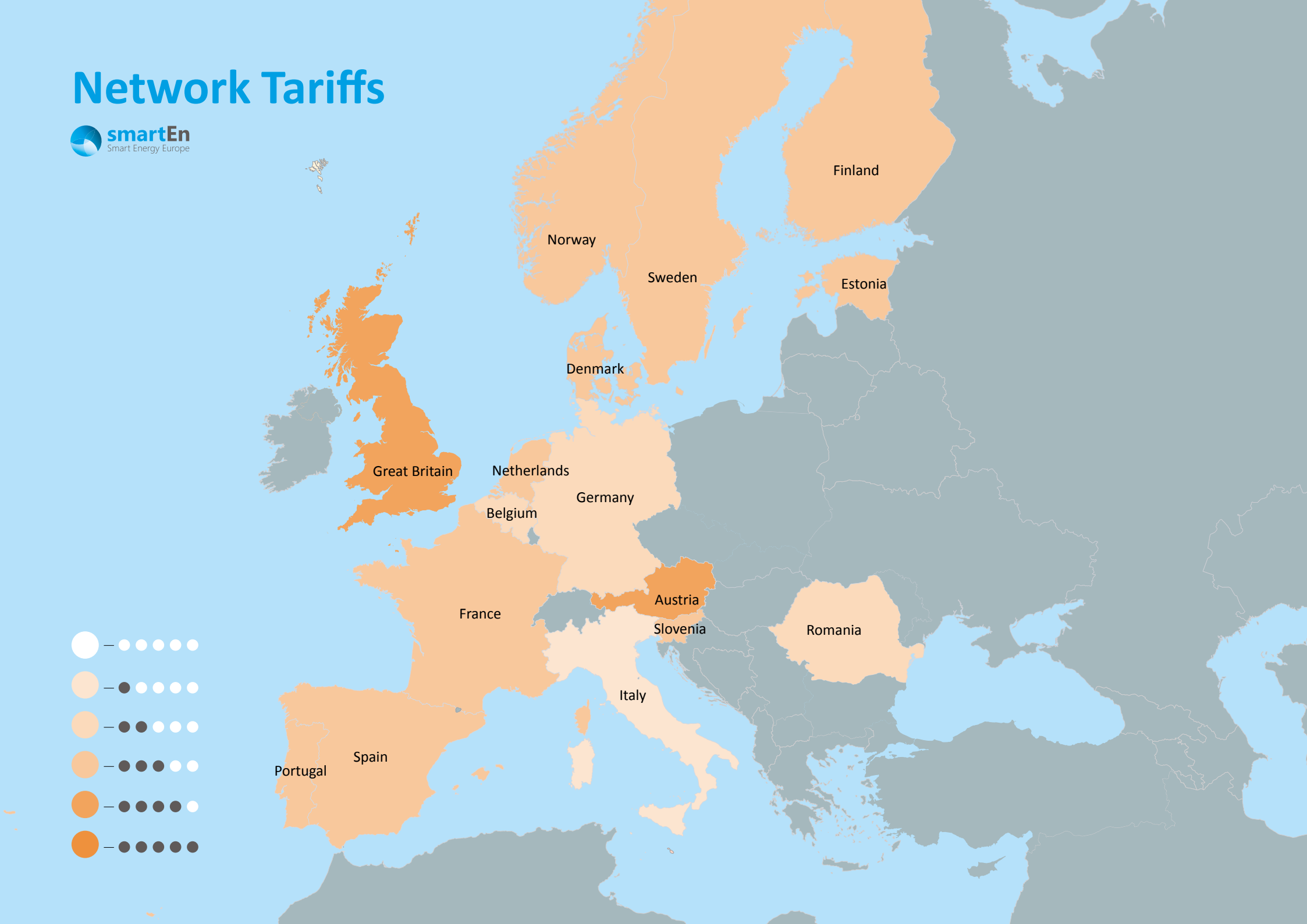


Taxes

On average, 13% of the EU electricity bill corresponds to charges destined to said support mechanisms. While these support instruments are politically desired, the approach of including them in the form of rigid taxes or levies in in the electricity bill hampers the pricing effects of both market signals and an efficient tariff design.

Taxes and levies make up for a significant part of the final price consumers pay for electricity, reaching an average 40% across the EU. Due to their high weight in the final bill and based on the fact that these price components are typically defined in a rigid manner that does not reflect the costs associated with the provision and transmission of energy, they have a severe blunting effect on price signals to network users. While a more dynamic approach to taxation, linking the dues to the price variability of electricity, the network usage, and even the source of electricity, could be possible in theory, but is currently not implemented in practice. Rather, best performing countries in this category limit their taxes and excises strictly to energy terms.

It is quite common across Europe to include secondary taxes for public services or environmental reasons in the electricity bill. Most countries finance part of their support schemes for renewable energy, high-efficiency Combined Heat and Power (CHP) or other decarbonisation efforts through levies collected through the electricity bill. On average, 13% of the EU electricity bill corresponds to charges destined to said support mechanisms. While these support instruments are politically desired, the approach of including them in the form of rigid taxes or levies in in the electricity bill hampers the pricing effects of both market signals and an efficient tariff design. Numerous studies show that a high share of taxes has a strong negative impact specifically on cost-reflectiveness and fairness.

In addition to these levies, most countries apply the general VAT to the energy consumed, with only some countries, especially The Netherlands and the Great Britain, applying a reduced VAT for electricity. Denmark has introduced an innovative tax regime to encourage the electrification of the heating sector by applying a very favourable tax rate for electricity used for heating above a certain consumption threshold. At the same time, however, Denmark and Germany are the countries that extract the largest part of the household consumer electricity bill through taxes, the extreme case being in Denmark with nearly 70% of the bill corresponding to taxes.

As with network tariffs, the taxation of industrial customers is, in general, lower than for households across Europe, in an effort to keep the industry competitive. Nordic countries like Norway and Finland stand out in this regard, offering the lowest taxes on industrial consumption. Whereas industrial consumers pay the highest taxes in Germany, with more than 50% of the bill consisting of taxes, Denmark's industrial customers pay less than 25% taxes in the bill in for their energy.

●○○○○	70% or above the bill corresponding to rigid taxes and charges. Numerous non-energy related taxes included in the bill.
●●○○○	69%-41% of the bill corresponding to rigid taxes and charges. Numerous non-energy related taxes included in the bill.
●●●○○	40%-31% of the bill corresponding to rigid taxes and charges. Some non-energy related taxes included.
●●●●○	30%-21% of the bill corresponding to rigid taxes and charges. Some non-energy related taxes included.
●●●●●	20% or less of the bill corresponding to rigid taxes and charges. Some non-energy related taxes included.
●●●●●	20% or less of the bill corresponding to rigid taxes and charges. No other taxes other than energy and VAT.

Taxes

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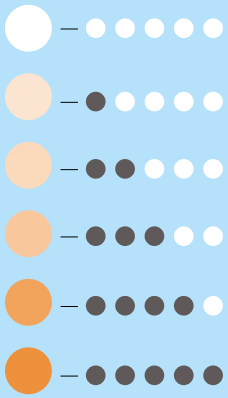

Contracts and Pricing

Ideally, customers should have the possibility to opt for a contract that corresponds to their consumption patterns, preferences and technical capabilities.

Ideally, customers should have the possibility to opt for a contract that corresponds to their consumption patterns, preferences and technical capabilities. The smart meter infrastructure available in a given country largely dictates the contracts available to customers. It is therefore no surprise that countries that performed well in terms of smart metering infrastructure, usually do so also in this section. In general, these countries tend to have a broader range of contract options, including dynamic pricing contracts. However, this is not always the case since they depend on the suppliers.

For example, although Spain has reached 100% smart meter coverage, it does not take full advantage of them. The offer is limited to one regulated dynamic tariff that suppliers avoid publicising in favour of their more profitable static offers.
The widest range of contract offers is available in The Netherlands, Estonia and Finland, with consumer acceptance of dynamic pricing contracts growing in parallel with the smart meter roll-out.

On the other hand, models in which decentralised energy users and producers explicitly valorise their flexibility in the market or towards transmission or distribution system operators, often operate on the basis of dedicated measuring devices specifically installed. They have thus far circumvented the challenge of insufficient smart metering infrastructure.

Electricity prices, both wholesale and final, have been slightly decreasing as a whole in the EU over the past years. This is largely due to the inclusion of renewable energy sources in the electricity mix that has pushed down the energy price component, but also due to higher grid efficiency brought on by new technologies and demand-side flexibility. Nevertheless, the growing overall weight of taxes and levies has largely kept the price levels stable or led to a slight reduction only. The highest electricity prices can still be observed in Germany, with over 300 €/MWh for households and 75% of the bill being taxes and tariffs. This spread is similar in many of the observed countries, with the taxes and tariffs taking up the majority of the final bill - between half and three-quarters of the price - paid by the customer. Due to the abovementioned schemes and to encourage a competitive European industry, Industrial customers pay fewer tariffs and taxes.

○○○○○	Prices not reflective of energy cost. Energy price component less than 20%. No dynamic pricing contracts available. Opaque contracts with no clear separation of costs. No possibility of unbundled contracts (network and supply).
●○○○○	Prices not reflective of energy cost. Energy price component between 20% and 30%. No dynamic pricing available. Freedom of choice between contracts. Opaque contracts. No possibility of unbundled contracts (network and supply).
●●○○○	Prices indicative of energy cost. Energy price component between 30% and 40%. Some dynamic pricing available. Freedom of choice between contracts. Contracts clearly detailed. No possibility of unbundled contracts (network and supply).
●●●○○	Prices indicative of energy cost. Energy price component between 30% and 40%. Dynamic pricing available. Freedom of choice between contracts. Contracts clearly detailed. No possibility of unbundled contracts (network and supply).
●●●●○	Prices reflective of energy cost. Energy price component between 40%-50% Various contracts available. Dynamic pricing contracts. Unbundled contracts are possible. Complete and clear information available in bill.
●●●●●	Prices reflective of energy costs. Energy price component 50% or more. Various contracts available. Dynamic pricing contracts Unbundled contracts are possible. Complete and clear information available in bill.

Contracts and Pricing

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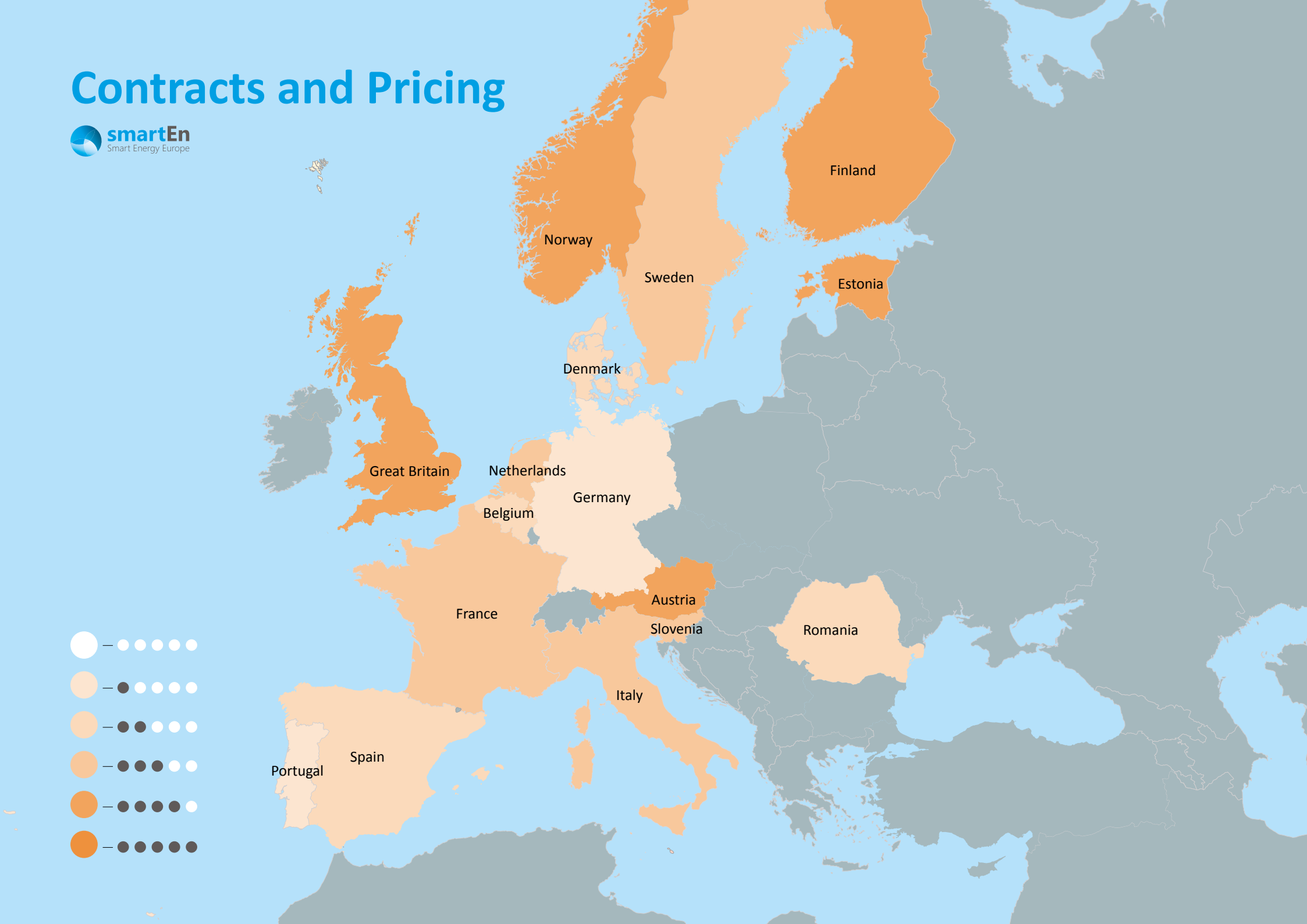

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AUSTRIA

Austria's highlight lies within the design of its network tariffs. A balanced approach, with a mix of volumetric, capacity and fixed terms, allows for a tariff design that could be easily adapted to consider the needs of the network. In addition, a profound granularity in the network's levels, with up to 7 different grid voltage levels, allows for a more tailored approach to the needs of each customer group. Still, a very reduced smart charging infrastructure will pose a challenge in the coming years, since the original installation targets are likely not to be met by the end of 2020. The Austrian regulator is currently undergoing a reform of the tariff structure, and the question remains on how far that reform will go, without the appropriate smart-meter infrastructure to go with it.

Infrastructure

The plan to reach 2.2 million smart meters by the end of 2019 is unlikely to be reached, and this estimate was recently adjusted downward. Currently out of the 6 million existing electricity metering points, roughly 1 million are smart meters, which constitutes a 17% penetration rate. Based on *Intelligente Messgeräte-Einführungsverordnung (Smart-Meter Introduction Ordinance),* Austrian DSOs are working out a roll-out plan for smart meters. Each DSO follows a different schedule and smart meter penetration varies significantly between DSOs. Smart meters that are already installed or planned, are prepared for dynamic pricing. However, customer adoption of dynamic pricing contracts will depend on further advancing the DSO roll-out and supplier offerings. All smart meters can deliver 15-minute measurements, although the standard measurement is daily (with a change to 15-minute measurement upon request and customer agreement). At the end of 2017, 7.6% of smart meters were configured to perform 15-minute measurements.

A specific metering charge is included in the network tariff, with various ceilings depending on the metering performed and the network level of each end-user. This charge covers installation, operation, calibration, and data collection.[3]

The Cost-Benefit Analysis (CBA) performed for the smart meter roll-out in Austria does not take into account benefits provided to the grid, – such as congestion and network costs - but assesses final customers, network operators, suppliers, the market model as well as macroeconomic implications.

While there are no statistics on smart-charging infrastructure for electric vehicles penetration in Austria, the public charging infrastructure available must have a smart meter with 15-minute measurements.

3 For a detailed account of the different metering tariffs, please refer to Section 10 of the Austrian Electricity System Charges Ordinance https://www.e-control.at/documents/1785851/1811597/SNE-V_2018+_2017-11-29+final_en.pdf/de2d5753-781a-f4ef-c019-0453ffdcda4e?t=1517571562512

Network Tariffs

General Aspects

Austria stands out thanks to its highly granular transmission and distribution network, with up to seven different voltage grid levels, and certain tariff designs encouraging technologies providing balancing services.

Network Tariffs for system utilisation vary significantly between DSOs or grid areas and are payable by the withdrawing party.

Austria is divided into 14 grid areas for electricity defined as “parts of the network for the use of which the same system charges apply”. Seven different tariff levels exist, depending on the voltage level with the highest level 1 comprising 380/220 kV and the lowest 230/400 V. The different tariff levels are tacked onto each other, from the highest to the lowest network level used.

Grid users (including power park modules) that are exclusively generating with units of a capacity over 5 MW behind a single connection point must pay for system losses and system services, based on the cost of the FRR capacity costs. All grid users, including generating units, pay the systems admissions charge, metering charge, and the supplementary service charges. Also, the network operator defines the economically and technically relevant grid connection point. Direct connection costs to this point are covered by the generator.

There are specific tariffs in place to encourage the use of Balance Service Provider (BSP) units providing negative reserves, for example, pumped-storage facilities, to supply balancing services and avoid high connection fees at critical moments.

Pumped storage power plants (PSP) have a special tariff for withdrawing from the grid. They also pay the standard G-Charges for system losses and system services but also pay a special PSP-tariff for pumping according to Section 8 of

the Electricity System Charges Ordinance. The volumetric tariff (kWh) is the same as the volumetric tariff on grid level 1, the energy power tariff (kW) is fixed at 1€/kW.

The Austrian regulator, E-Control, is currently developing a redesign of the network tariff structure in order to address the challenges seen by an increase in decentralised energy resources and to address issues of fair and efficient cost allocation. Details on the network remodelling can be consulted in E-Control's position paper "Tarife 2.0".[4]

Households and SMEs

Tariffs show a mixed structure, with volumetric (kWh), energy power (kW) and fixed components. For the network charges, the energy term amounts to around 34% and the volumetric term to around 66% for customers with a metered load. Customers with an unmetered load pay a yearly fixed charge of 30 € and a variable volumetric term. For a customer with an annual consumption of 3 500 kWh, the fixed charge makes up around 15%, while the variable part amounts to 85%.

The system provision charge for grid-level 7, which corresponds to below 1 kV, varies between 166.74 €/kW and 293.63 €/kW.

The capacity term is defined by a contracted capacity of 4 kW, which is the standard connection in Austria. For customers without peak load metering this capacity is often measured with the annual consumption. Here the threshold varies from DSO to DSO (e.g. for the Viennese DSO, customers below 15 000 kWh per year are in the category of a contracted capacity of 4kW). For the volumetric term, accounting of energy withdrawn is performed separately from energy injected. It can vary in each area between summer and winter and during the daytime (high tariff and low tariff). For energy used for balancing purposes (FRR) a specific tariff is applied. The fixed term amounts to 30 € for all customers on network level 7 without peak load metering.

Industry

For the industrial sector, and depending on the grid area, capacity- and volumetric-related tariffs can vary. The system provision charge for grid-level 5, which corresponds to a voltage level between 1kV and 36 kV, varies between 61.16 €/kW and 136.86 €/kW. For grid level 3, which corresponds to up to 220 kV voltage level, the charges vary between 10.29 €/kW and 29 €/kW. All system admission charges depend on the actual expenditures of the network operator.

Tariffs show a mixed structure, with volumetric (kWh) and energy power (kW). For industrial customers, the lower the connection level, the more weight the capacity term takes in the overall network tariff, giving more importance to the peak consumption. At network level 5 (20 kV), the capacity term amounts to around 39% and the volumetric term to 61%. At network level 3 (100 kV), the capacity term amounts to around 65% and the volumetric term to 35%.

The connection charges to the transmission network for generators are shallow, only covering costs directly linked to connecting a generation plant to a system for the first time or altering a connection to account for a system user's increased connection capacity. For withdrawing parties the connection tariffs are deep covering both the direct costs for the connection as well as a one-off payment reflective of capacity, called the system provision charge, which covers the past and future system development measures necessary to enable such connections. These connection charges are applied to all connections for grid levels 1 to 7. For grid-level 1 the connection tariff amounts to 8.70 €/kW and for grid-level 2, 9.80 €/kW. There is no fixed definition on the capacity term since it depends on the size of the connection. The contracted demand is expressed in kW. Net-metering is not applied on the volumetric term, but, for the system utilisation charge at network levels 3 and below, separate accounting with the same day and season variability as for households and SMEs applies.

Differences between TSO and DSO tariffs

DSO and TSO tariffs are in general aggregated by the supplier, but an option exists to receive separate bills. In any case, both the transmission and distribution tariffs are clearly stated in case they are presented in the same bill. If connected at transmission level, customers always receive a separate bill with the TSO tariffs. The cascading principle is used in Austria, so a proportion of TSO costs is passed down in the DSO tariff. No non-grid related costs are included in the network tariffs (no costs for green certificates for example).

4 https://www.e-control.at/marktteilnehmer/strom/netzentgelte/tarife-2-0

Taxes

The weight of taxes and levies in Austria have a blunting effect on price signals. All taxes and excises together amount to approximately 42% of the electricity bill for the average household consumer. The percentage for industrial consumers is slightly lower with 25% of the bill corresponding to taxes.

Taxes collected include a tax on electricity, fees for combined heat and power, two environmental charges (the renewables contribution and the flat-rate renewable charge per metering point, for which vulnerable customers are exempt) and community levies for the use of public land. The renewables contribution amounts to about 14% of the average household electricity bill. The energy tax amounts to 1.5 cent/kWh. A 20% VAT is added to each price component. Finally, some communities collect additional levies for electricity grids.

Taxation does not take into account any special regimes for grid-connected generators and does not have any asset specific rules, for example, no exemption for energy losses for storage assets.

Contracts and pricing

Austria is characterised by a good combination of varied contract possibilities with a competitive electricity price. The average household pays around 175 €/MWh while the average industrial consumer pays 82 €/MWh. Network tariffs make up approximately 30% of the electricity bill for households, a bit less for industrial customers with 26%. The energy component in the bill is still slightly low, representing only 28% of the final bill for households, and less than 50% for industrial consumers. Retail contracts available for electricity include products with and without price guarantees, products with automatic price changes, renewables contracts, contracts with rebates in other products and services, products with Austrian electricity and dynamic pricing contracts (if a smart meter is installed). Customers have wide access to several types of contracts based on their profile, and E-Control provides a Tariff calculator to choose the best option[5].

5 https://www.e-control.at/en/konsumenten/service-und-beratung/toolbox/tarifkalkulator

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BELGIUM

A fragmented energy landscape between Belgian regions creates an uneven landscape for customers living in different parts of the country. Three different regions exist in Belgium: Flanders, Wallonia and the Brussels-Capital region. Each of them has their own regulator and significant differences in the end-consumer bill. Overall, however, Belgium is characterised by high tax pressure on electricity consumption, combined with a high energy term in the bill. A network tariff regime almost completely based on a volumetric term, together with an almost non-existent smart charging infrastructure, leaves a very reduced manoeuvring space to fully exploit consumers' flexibility.

Infrastructure

Smart meter deployment was non-existent in Belgium until very recently. In July 2019, the Flemish region began to install smart-meters with a planned roll-out period of 15 years. Priority is given to new and renovated buildings and solar prosumers. The CBA performed for the roll-out of smart meters considers grid benefits like cost savings from reduced peak load and the avoidance of physical readings.

The Walloon region will start the deployment in 2023 and expects to substitute 80% of meters by 2029, even though some of the existing meter installations are already ready to supply 15-minute measurements. The network tariffs structure includes a specific tariff for the meter's management costs. The grid user is expected to pay an annual fixed fee for meter costs that will depend on the metering system used automatic meter reading in 15-minute periods (AMR), monthly meter reading (MMR) or yearly meter reading (YMR).

The Brussels-Capital region has opted for a framework enabling a smart meter deployment by segments (replacement, renovation, new buildings, injection of electricity into the grid -including flexibility, large consumers and on demand). This deployment has begun in 2019. A complete roll-out has not been decided and a CBA is ongoing.

Network Tariffs

General Aspects

The absence of dynamic tariffs and a volumetric-heavy network tariff reduces the consumers' optimisation of consumption. Transmission network tariffs are uniform for the whole high voltage network (36-380 kV) owned by the TSO Elia System Operator. The tariffs are identical for all technologies, although exemptions for storage assets are applicable, under specific conditions, but not yet used. No significant changes in transmission tariff structures are planned for the next regulatory period of 2020-2023.

At the distribution level in the Flemish region, a new tariff structure for small and large consumers will be implemented in the coming regulatory period (2021-2024). Their impact on innovative technologies is still undergoing assessment as of writing.

In the Flanders region, 11 DSOs run under the umbrella of the Fluvius System Operator. Since the Flemish regulator, VREG, decides on most tariff elements, the differences between distribution tariff structures and policy are kept to a minimum, even though DSOs' costs can vary significantly.

At the transmission-level, a volumetric injection tariff exists for net generators to recover part of the costs for ancillary services. Net consumers pay a capacity and volumetric tariff. At the distribution level, grid users that only generate also have to pay network charges. The injection tariffs for system management, metering services, and net losses are equal to the consumption tariffs. Both producers and consumers pay surcharges for supplementary pensions and communal retributions. The fixed tariff for metering services depends on the metering type, either AMR or MMR, while all other terms are volumetric. Unlike consumers, grid users that are purely generating do not pay for general grid management costs.

In Flanders, there is also a specific solar PV charge at the DSO level to cover the net metering regime for prosumers with a DER under 10 kW. This tariff comes in the form of an annual payment that depends on the capacity of the power inverter, it also depends on the metering regime applied and the voltage level.

The Flemish government made legislative changes in 2019, allowing local and regional "sandboxes" where new and innovative tariff structures can be used. No such sandbox has been approved yet, due to the very recent approval of the legislation.

Households and SMEs

Belgian households can only influence their electricity bill by reducing their electricity consumption, due to a tariff design that is mostly volumetric, with little room for optimisation.

Connection costs to the low voltage grid in the Flemish region amount to 836 €, VAT included, for a connection of 9.2 kVA. For an average household in the Flemish region with a yearly consumption of 3500 kWh, the volumetric term is 98.8% of the distribution network charges, and the remaining 1.2% is the fixed term. On the volumetric term, net-metering is applied with both flat and static day-night rates. Tariffs vary between DSOs. The fixed term depends on the metering system used: AMR, MMR or YMR.

DERs under 10 kW get an added charge depending on the inverter capacity, destined to support the net-metering regime. An injection tariff is not applied due to the lack of separate access points for the injection of prosumers.

Industry

Industrial consumers on the other hand have a better control of their network costs, due to a more balanced tariff design that takes into account different peak consumptions.

The connection charges for industrial customers at transmission level are shallow, covering only the administrative costs and local connection costs (installations between customer and substation), without making distinctions regarding congestions around the connection point. There are no specific tariff regimes for the industrial sector, but degressive tariff regimes are in place for some Public Service Obligations tariffs (PSO), covering non-grid related costs. In the Brussels region degressive tariffs do not exist, but the PSO tariffs are lower for the high and medium voltage customers. Transmission network charges are divided between the volumetric and capacity terms at 50% each. The transmission tariff structure is based on several core principles such as efficiency, cost-reflectiveness, transparency and simplicity. There are three components to the capacity tariff. 50% corresponds to the contracted demand in kVA, 20% to the measured peak during the month, and 30% by the measured peak during a specific period (synchronic peak time, 17:00-20:00 weekdays from November to March). The volumetric term is flat and applied on net-metering. Non-TSO related costs (mostly related to renewable support schemes) are added to the tariffs structure through dedicated tariffs, together with specific taxes and levies.

At the distribution level, the 300 kVA connection to the medium voltage level costs 12.771€ (plus VAT), and connection charges are deep, although the payment to reinforce the grid is only applied after a certain distance from the nearest connection point. The tariffs for industry are lower than for households due to the cascading principle that assigns partial costs of the medium voltage grid to the low voltage grid. There are also tariff reductions for network management with a set price ceiling. For an average company with a peak load of 100 kW and a consumption of 160 MWh, the capacity term is 58,4% of the distribution network charges. The volumetric term is 29,4% and the fixed term 12,2%. The measured peak defines the capacity term, independent of when it occurs, with a monthly or yearly granularity. For the volumetric term, the accounting of energy either withdrawn or injected is calculated separately and both flat and time-varying (day-night) tariffs are applied. The fixed term depends on the metering system used. Additionally, an injection tariff is applied for medium voltage network users.

Differences between TSO and DSO tariffs

DSO and TSO tariffs are shown separately in the electricity bill. TSO costs and DSO costs are recuperated through separate tariffs so specific DSO terms are not recovered in the TSO tariff and vice versa. As mentioned earlier, non-grid related costs are included in both DSO and TSO tariffs. DSO public service obligations reflected in the tariffs include green certificates, rational energy use,

Taxes

Proportion of taxes and levies vary between all three regions, but remain high across the country with above 40% for households, blunting the effects of tariff design in the final electricity bill. Four different taxes and levies are recovered at the transmission level. The Federal contribution and a tax for public space occupation exists for the three regions. A 21% VAT is applied on every tariff except the Federal contribution. Specific tax regimes are not accounted for grid-connected generators, while losses for storage assets are not tax-exempt. There is also no tax exemption for self-consumption. While no specific environmental charge exists, some of the Public Obligation tariffs mentioned above are related to environmental targets.

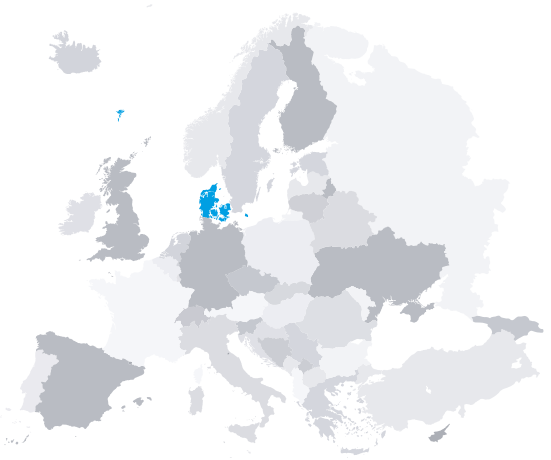
At the DSO level in the Flemish region, some taxes are applied to cover the federal, energy, and energy fund contribution (Bijdrage energiefonds). In the Flemish region taxes and excises together amount to around 49% of the final household consumer electricity bill and 39.9% for SMEs. In the Walloon region, taxes and levies amount to 43.35% of the average household bill and 32.97% for SMEs. In the Brussels-Capital region the average household pays 40.3% in taxes and levies and SMEs 26.94%. Specific energy poverty schemes apply at the DSO level only, but the federal regulator CREG is responsible for fixing the maximum price and for whom it applies. Average industrial consumers across the country pay on average a 27% of taxes and levies in their final bill.

Contracts and pricing

While consumers have a varied choice of contracts, dynamic pricing contracts are not available as of writing, due to the missing roll-out of smart meters. Additionally, Belgian households pay on average the third highest energy bills across the EU, with 290 €/MWh. Industrial users on the other hand pay significantly less, around 90 €/MWh on average, which places them closer to the EU average. Grid users can choose between bundled retail contracts offered by suppliers, or a specific contract for network use if they source directly from the energy market or if they self-generate. Customers can choose between a standard or single rate (contracts with fixed prices), a dual day/night rate or a night-only rate (contracts with indexed or variable prices). Belgian consumer bills are clear and very detailed, with all information on different tariffs and taxes depicted and explained.

For an average household, the transmission tariffs, excluding non-grid related costs, represent around 5% of the total electricity bill. In the Flemish region, including distribution tariffs and non-grid related costs, the network tariffs amount to 27.86% of the average household's bill, and 34.03% for SMEs. In the Walloon region the share of network tariffs for the average household is 34.03% of the final bill, and 41.2% for SMEs. In the Brussels-Capital region the average household pays 32.75% in network tariffs, while SMEs pay 41%.

For industrial consumers connected at the transmission level, the weighting of network tariffs in the electricity bill differs significantly according to user profiles and connection level. The weighting of network tariffs (excluding non-grid related costs) lies between 5% and 10%.



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DENMARK

Denmark features the highest amount of specific energy taxes and charges in the electricity bill, amounting to 37%. VAT and charges for RES support are also added, meaning that 65% of the bill correspond only to taxes blunting the consumer price. Nevertheless, Denmark has some interesting aspects, such as highly developed smart metering infrastructure and favourable regimes for RES and EV charging. Denmark needs to confront some weak points, like net-metering, and a volumetric-heavy tariff design, in order to move forward. No smart tariff design will be enough if the electricity bill continues to be distorted by high taxes and charges, permitting the energy price to amount to only 14% of the bill.

Infrastructure

Denmark has achieved a high percentage of smart meter roll-out, with over 80% of households already being equipped with smart meters, being one of the highest rates across the EU. The DSOs are required to upgrade the remaining meters to smart meters by the end of 2020, at the latest. All industrial customers (customers with an annual consumption of more than 100 000 kWh) already have smart meters installed. The legal requirements of smart meter functionalities are i.a. registration of time-of-use metering data every 15 minutes, which is a prerequisite for time-of-use tariffs and dynamic pricing. Dynamic pricing will be available to all households in Denmark by the end of 2020, when the roll-out of smart meters is expected to be completed by all DSOs.

The DSO covers the initial costs of the installation and hardware, which are transferred to the customer through a subscription fee. Metering costs are not included in the network tariff.

The CBA performed for the initial roll-out considered the benefits of smart meters on the grid, where due to a better understanding of grid load profiles, the savings on expansion costs were included. The CBA also considered the change in consumption patterns that would allow consumers to react to price signals, thus moving away from consumption at peak hours and resulting in less ancillary services required, reducing congestion and grid losses.

Network Tariffs

General Aspects

The network tariff design in Denmark is mostly reliant on a volumetric structure, while including design aspects that allow for an optimisation in the use of certain innovative technologies.

44 different DSOs are operating in Denmark, each with their own cost structures and operating areas, creating diverse tariff structures. For the TSO tariffs, only one area exists.

Renewable production is exempt from connection fees by law. Prosumers do pay a fee and tariff for network availability, however. There is also a generation charge (G-Charge) for which PV, wind turbines and decentral power plants with a capacity of less than 100 MW are exempt. Grid users that only generate energy have priority access, whereas the rest must pay the G-Charge, which is calculated based on net production with their corresponding balancing party. The current price is 0,3 øre/kWh.

Some tariffs in Denmark incentivise the use of innovative technologies. For example, some DSOs have a time differentiated tariff, as opposed to a flat tariff, which supports EVs to charge at appropriate times. Through lower marginal night tariffs, certain flexible technologies are being incentivised for smart use.

However, other structural elements are still posing a hurdle for certain technologies, like batteries, as charges have to be paid both when charging the battery and again when selling the same electricity back to the grid. Distortions are created also by net metering for prosumers, given that tariffs are paid according to the meter reading. For example, a household that generated 1 MWh and consumed 1 MWh and has a meter reading of 0 MWh would not pay network tariffs, even though there was network usage.

DSOs and the TSO are currently working on a redesign of the tariff structure to prepare for a bigger share of renewables in the energy system.

Households and SMEs

At DSO level, tariffs are mostly formed by the volumetric term, with a small fixed component. This does reduce the possibility for users to take advantage of their flexibility at peak times of congestion in the grid. The new offerings by some operators will not allow customers to properly maximise their flexibility if subject to an almost exclusive volumetric tariff. The connection cost for an average household, with a capacity of 25 A in 2019 is 14 500 DKK. SMEs pay a standard connection fee of 14 500 DKK and an additional 1 700 DKK per ampere above 25 A.

For a regular household with an annual consumption of 4 000 kWh, the split between the variable and fixed terms is 75% and 25% respectively, which includes the TSO tariffs. Of the total amount, around 55% corresponds to the DSO kWh-tariff. For SME's with a yearly consumption of 100 000 kWh, the split is 96% variable and 4% fixed term.

To distribute the costs, meter and administrative costs are included in a fixed term, while grid losses, operational expenditures, and depreciation of grid assets remain included in the tariffs. Foreseen reforms to network tariffs currently being tested will alter the distribution of costs, with more weight placed on the fixed term. In the current tariff design, there is no capacity term. For small prosumers, the volumetric term includes a fixed fee of 65 DKK for grid availability as well as for the regular tariffs on consumption. Larger prosumers pay an availability tariff on self-consumption and the regular tariff on grid consumption.

Time-varying tariffs are currently offered by some operators, with Danish operators offering them by the end of 2020. The fixed term depends on the voltage level of the connection point. There are variations between DSOs depending on their cost structure, but within one DSO all customers pay the same fixed term.

There are no specific injection tariffs for DERs at the DSO level, but at the TSO level, customers injecting must pay 0,003 DKK/kWh. Solar parks, windmills, and other decentralized renewables are exempt.

Some non-TSO costs are included in the tariffs that cover governmental duties. The total TSO tariff is 0,008 DKK/kWh, with 0,0044 DKK/kWh corresponding to the pure transmission tariff while the non-TSO costs in the tariff amount to 0,0036 DKK/kWh.

Industry

Industrial customers are classified as a "B-high" customers when connected at the 10-20 kV level, or as an "A-low" customer when connected to a 50/10 kV transformer station at the 10-20 kV level.

At the DSO level reaching up to 100 kV, the connection costs are 14.500 DKK for the first 25 A and 1.700 DKK per ampere above that if connected as a "B-high" customer. Connection levels to the transmission grid are super shallow with some minor symbolic costs. There is no differentiation for load, generation or DSOs, and the costs are mostly socialized through the tariffs.

Due to the cascading principle in Denmark, the costs corresponding to the industry are shared by the customers connected to the lower level of the network. There are five major classifications for the connection point level in Denmark.

B-high customers pay a fixed fee of 2.500 DKK and a DSO tariff of 0,0828 DKK/kWh, also a TSO-tariff of 0,08 DKK/kWh. With an average yearly consumption of about 2 GWh, the weighting of the fixed fee would be 1,5% and 98,5% for the variable DSO tariff. The capacity term is not currently used at the industry level, but it might be implemented soon in order to differentiate customers based on their amperes contracted. The same principles apply for the industry as for households and SMEs on the volumetric and fixed terms (see above).

Differences between DSO and TSO tariff

Suppliers are not required to show DSO or TSO tariffs separately in the consumer's bill, with only the subscription fee to the supplier and the DSO being mandatory to show. The DSO then pays the TSO for its network usage. There are no specific terms in the DSO tariff to cover the TSO cost. Currently, a scheme is in place to fund energy savings, which is split 50% between the variable and the fixed terms in the DSO tariff, but this scheme is to be phased out.

Taxes

Taxes for the average household amount to around 66% of the electricity bill with most of this corresponding to energy taxes and charges (37%) other than VAT. This has a clear blunting effect on the final electricity prices. Industrial customers on the other hand barely pay 20% of their electricity bill in taxes.

The general consumption of electricity is taxed at 0,884 DKK/kWh, plus a 25% VAT. Electricity used to heat homes above 4.000 kWh annually is taxed at 0,259 DKK/kWh to incentivise the electrification of the heating sector. Only energy consumed gets taxed and no tax is applied to assets behind the meter or on self-consumption. There are specific tax regimes for electricity used in industrial processes that receive a reduced rate.

Public Service Obligations to fund renewables are collected through taxes, which could be viewed as an environmental charge. The current programme will be phased out by the end of 2021 and any renewables programme will be financed by the state.

Contracts and pricing

Danish household customers pay one of the highest electricity prices in the EU, second only to Germany. This is mainly due to their high tax rate, with an average 295 €/MWh. Industrial customers on the other hand pay around 80 €/MWh, just around the average of EU prices for industrial customers.

Customers can choose between fixed price and variable price products, including dynamic pricing contracts that have recently started to be offered by a small number of suppliers. As of today, 7,5% of contracts are dynamic pricing contracts, but several suppliers are beginning to offer such contracts to consumers with a smart meter installed. All of the dynamic pricing contracts are linked to the Nord Pool Spot exchange.

The weighting of the distribution network tariff is around 18% of the electricity bill for an average household customer, with an additional 3% corresponding to transmission network tariffs. This is at one of the lowest in the EU, the result is that network usage and energy price fluctuations barely have any impact in the final bill of Danish customers.

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ESTONIA

Estonia has one of the most developed smart metering infrastructures in the EU. This is accompanied by a low electricity price and a healthy offer of different contract options for consumers, including dynamic price contracts. While the tariff design still has a heavy volumetric component, it also includes a fixed and capacity term. Available infrastructure would make it possible to balance out the volumetric and capacity terms and move to a more cost-reflective tariff design, that also takes into account the needs of the system, as is already being used by the Estonian industry.

Infrastructure

Estonia is one of the most advanced European countries concerning smart metering infrastructure. It reached 100% penetration in January of 2017. Meter costs are covered by the TSO and DSOs, but no dedicated component for metering is included in the network tariff. For the roll-out, a CBA was performed that considered the benefits of smart meters for the grid and noted fewer congestion issues and fewer network costs.

Network Tariffs

General Aspects

No technology-specific network tariffs exist in Estonia, but the current mix of network tariff structures can facilitate the use of flexibility services.

Estonia has 33 DSOs, each with its own area of activity and different network tariffs based on its own cost structures. However, one DSO controls most of the activity and has the biggest market share, with 87% based on sales volume. The next two largest DSOs jointly have a 6% market share and the remaining 30 DSOs control 7% of the market. Grid users that only generate energy do not pay a specific G-Charge to connect to the network which incentivises the use of DERs to inject into the grid. Changes in the network tariff structure are not foreseen.

Households and SMEs

Network tariffs for households and SMEs exhibit a fair balance between components. With a capacity term partly based on measurements of consumption, the consumer receives adequate signals for a flexible use of the network.

Network tariffs in Estonia are divided between a volumetric, a capacity and a fixed term. The volumetric term takes up 77% of the share. 21% rests with the capacity term and 2% on the fixed term of the network tariff. The principle followed for allocating costs between the terms is to avoid high capacity and fixed terms, to not become too burdensome for the customer.

The volumetric term is calculated through net-metering, and flat and time-varying (static day/night) tariffs are available. Two different capacity terms are applied. The first is based on the size of the connection measured in amperes and the second is based on the measured peak, independent of when it occurs, indicating the consumer's largest consumption in a given hour per month. The fixed term varies from household to household, depending on the voltage level of connection.

Network charges also take into account the distance of the connection point to the low-voltage substation. When the connection point is less than 400 meters from a low-voltage substation, the connection costs for the low voltage grid are 130 € per ampere (excluding VAT). If the distance to the nearest low-voltage substation is further away than 400 meters, the connection cost is calculated based on the actual costs to connect, including equipment, materials, and labour costs.

Industry

For medium (20 kV) and high (400 kV) voltage connected industrial consumers, the connection charges are deep, that is, they depend on the actual costs to establish the connection, including the cost of equipment, materials, labour, and any other administrative costs. There are no special tariff regimes for the industry in Estonia.

The different terms in the network tariff are split up as 43% volumetric term, 49% capacity term and 8% fixed term. The main principle followed for industry sector connections is that all fixed costs, including capital costs, must be included in the fixed or capacity term.

The volumetric term is calculated using net-metering, which is beneficial for the individual customer with DERs, but not cost-reflective of the grid usage. Flat and time-varying (static day/night) tariffs are available for the volumetric term. Two different capacity terms are used. The first is based on the size of the connection measured in kW. The second is based on the measured peak, independent on when it occurs, which is the consumer's largest consumption in a given hour per month. The fixed term is the same for all industrial customers.

Differences between TSO and DSO tariffs

The electricity bill for low voltage connected customers does not differentiate between DSO and TSO tariffs. But even if not separately represented, there are no DSO related costs in the TSO tariff and vice-versa. There are also no non-TSO costs included in the TSO tariff. No non-grid related costs are included in any tariff since other costs are recovered through taxes or paid through the state budget.

Taxes

Taxes and levies in Estonia amount only to 26% of the average household's electricity bill, with an even lower percentage for industrial customers that average a 20% of taxes. This amount adequately reflects the energy price and the network costs included in the electricity bill. Electricity taxes include a support mechanism for renewables that is calculated yearly by the TSO, containing an excise tax on electricity plus 20% VAT. Estonia's taxation scheme is completely technology-agnostic, with no differences for grid-connected generators, DERs or storage assets. There is also no environmental charge and no tax applied to self-consumption. This means that double taxation can be an issue for storage assets and that energy losses are still taxed as having been consumed rather than being considered as an energy cost to run a storage asset. Estonian customers' electricity bill includes 26% of taxes and other excises like RES charges.

Contracts and pricing

The share of transmission and distribution network tariffs in the household and SME electricity bill adds up to 36%, which supposes a faithful representation of the network costs in the bill. The weight for industrial customers is slightly lower, around 25%, giving more weight to the energy component. Estonia has one of the lowest electricity prices in the EU with approximately 125 €/MWh for the average household. Industrial customers pay an average 75 €/MWh. There are several types of contracts available for customers, including dynamic price contracts and time-varying contracts (day/night), which they can freely choose, based on their consumption profile. The network contract and electricity contract are not bundled but presented separately.

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FINLAND

Finland's strength lies in its almost 100% coverage of smart metering which has provided hourly pricing schemes offers for Finnish customers. The tariff design has a balanced structure, between cost-reflectiveness and fairness, with a relevant role of the fixed and capacity terms and a smaller, yet still important, weight of the volumetric term. Outstanding issues for the Finnish market are offering products with real-time pricing and tariffs that take into account the particularities of storage and EVs and the services they provide to the grid.

Infrastructure

When it comes to smart meters, Finland is one of Europe's most advanced countries with 99% penetration of the market, and it is expected to reach 100% by the end of 2019. The meters supply hourly readings, while household smart meters can be easily changed into 15-minute measurements where needed. The same applies to TSO connection-point meters for industrial consumers. Fingrid, the Finnish TSO, includes metering infrastructure costs in the transmission tariff with no specific metering fee within the tariff.

A CBA was performed for the roll-out on the DSO level, whereas at the TSO level, only minor calculations were performed.

Network Tariffs

General Aspects

Network tariffs in Finland are mostly volumetric, with some exceptions. With the new available infrastructure, allowing for detailed measurements in the customers' consumption patterns, a growth in tariffs with a more cost-reflective approach can be foreseen.

There is only one transmission level region in Finland, plus around 80 DSOs, with 3 of them covering most of the customer base. Each one sets its own tariffs based on internal cost structures and the area of influence. The Energy Authority monitors the pricing of network operators as a whole in periods of four years. The Energy Authority has confirmed to the electricity and natural gas operators the methods on the basis of which the monitoring will be carried out for eight years (2016–2023). The monitoring is based on electricity and natural gas market legislation, regulatory methods to guarantee reasonable pricing confirmed by the Energy Authority on the basis of electricity and natural gas market legislation, and legal praxis.

There are no technology-specific tariffs in Finland and demand and generation are treated equally. The only difference between them is the different weights assigned to the components of the tariff. At the time of writing, demand covers 85% of the transmission grid costs.

All production units above 1 MW are treated equally, paying the same production fee without differentiating between the source of the electricity. Generators under 1 MW are not charged a production fee. The TSO G-Charges cover around 15% of the main grid transmission costs.

Unwanted effects due to tariffs have not been observed in relation to technology development, like EV batteries, with the main reason being that the TSO tariff is very small when compared to the overall costs of those technologies.

Households and SMEs

As mentioned, with around 80 active DSOs in Finland, each has its own cost structure and different connection costs that are linked to the actual costs of establishing a connection to the customer.

Most DSOs only have a volumetric term. But some DSOs are offering more varied tariffs, on which around 50% corresponds to the fixed term and the rest is split between the volumetric and capacity terms.

There are some non-TSO related costs included in the TSO tariff for customers. These are related to maintaining the peak load reserve, which consists of both power plants, DERs, and Demand Response capable facilities. Finextra, a subsidiary of Fingrid Oyj, manages the administrative duties for this public service. The costs depend on the electricity consumption during weekdays, and during the winter weekday (1.12.2018 - 28.2.2019), with day-time hours from 7.00 a.m. - 9.00 p.m., which is equal to the grid service daytime consumption invoiced. The last calculated peak load capacity fee was 1,443 €/MWh.

Industry

Grid connection charges to the high voltage grid (400 kV) are shallow. Fingrid is responsible for building the connection from its grid to a substation, while the customer is responsible for connecting its facilities to the nearest substation. Connection costs for a 400 kV substation amount to 2 MM€, whereas for a 200 kV substation, the cost is 1.2 M€ and 0,6 M€ for a 110 kV substation.

There are no specific network fees for industry, but Fingrid created a voluntary market for reserves and balancing products that industrial customers are actively participating in.

No specific volume or capacity tariff is charged to customers if the connection size is over 250 MW. The connection is carried out on the 400 kV and the above-mentioned connection prices apply.

Differences between TSO and DSO tariffs

The transmission tariffs are billed separately from the supplier's bill, with all components displayed on the bill. As such, no specific DSO costs are included in TSO tariffs.

Taxes

Taxes are below the average weight in the EU, minimising the distortion of the final electricity price. Together, taxes and levies, amount to 33% of the final electricity bill for the average household, and less than 10% for the average industrial consumer.

Taxation in Finland is based on an energy-based fee. Different to many EU countries, no significant levies are collected for specific support schemes, that are covered by the general state budget. Only a small RES fee that amounts to 3% of the bill is applied. A VAT rate of 24% is applied to the energy component.

Storage assets, that are combined with a power plant, can account its energy losses as part of the power plant's consumption, avoiding paying taxes for the energy losses. If the storage asset is part of the industrial site, it can be registered as an "electricity storage keeper" and be subject to differentiated taxation for the use of the storage asset.

Contracts and pricing

Electricity prices for the average Finish household are around the European average, with 160 €/MWh. For industrial customers they are on the lower end of European countries, with around 62 €/MWh. The energy-, network tariff- and tax-components in the bill are in line with EU averages. This particular balance allows network tariffs and the energy component of the bill to provide significant signals to consumers. Especially for industrial customers, the energy component in the bill has a significant weight, around 66%, allowing them to adapt to price signals efficiently. For households and SMEs the weight of the energy component is 37% of the bill. The average weighting of the network tariffs in the total bill is 30%. The TSO tariff makes up 2,5% of the bill's total consumption.

Customers can choose between a wide range of contracts and suppliers depending on their profile. Contracts vary from fixed energy price contracts and long-term contracts with durations of maximum two years, to dynamic price contracts with hourly spot prices and very short-term contracts, with the shortest of only two weeks duration. The offer has adapted itself to the possibilities of smart meters, with contracts based on hourly energy prices available to customers.

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FRANCE

France has recently started the roll-out of smart metering devices and is advancing at a fast pace, with the 95% target by the end of 2020 seeming reachable. Consumers in France pay a relatively low price for electricity, based on a fine balance between the different components of the bill that enables network tariffs to be a clear influence in the final price. This should encourage future experimentation with different terms to adapt to the capabilities of new technologies and to be able to reflect the costs of the grid. Remaining challenges for France are taxes that are not directly related to energy consumption, blunting the price signals.

Infrastructure

France has committed itself to a 95% smart meter deployment by the year 2020 and so far, has installed over 19 million smart meters until May 2019. By 2020 28 million smart meters will have been installed in France. In France, all customers connected to a power level above 36 kVa already have smart meters. 18 million other consumers in the low and medium voltage range already have a smart meter and the rollout is ongoing. The French TSO, RTE, has a metering fee in place that covers metering, meter reading, control, and data transmission. The cost for the individual consumer lies between 1€ and 2€ monthly for 10 years. RTE handles the installation costs and all RTE meters are ready for dynamic pricing since their customers are industry and distributors. The DSO applies a tariff for metering, 9.36 €/year for a residential customer who owns his metering device, and 19.80 €/year otherwise. Performed by the French regulator CRE, the CBA for the smart meter roll-out has considered the benefits to the grid.

There is no specific smart-charging infrastructure roll-out currently, but any new infrastructure must be able to be remotely controlled and receive tariff signals through the meter.

Network Tariffs

General Aspects

Network tariffs in France have a mixed design including in it a mix of capacity, volumetric and fixed term. Although the volumetric term is still predominant, the inclusion of a capacity term that depends on measurements, can allow for a more efficient use of the network.

The RTE network includes a single area with the same tariffs for all customers. There is no specific usage tariff for different assets, but instead a tariff for injection and withdrawal for the different voltage levels. The injection tariff is only applied at HTB2 (between 150 kV and 225 kV) and HTB3 (400 kV) levels. The basic design principle of transmission network tariffs in France is to exclusively recover costs, so no specific tariff regimes and no incentivising or capping of new technologies exist. The French regulator is not in favour of specific tariffs for EVs and recommends other ways of incentivising their uptake, for example through easy connection to charging facilities, simplifying legal aspects and efficient use of the current network. However, the implementation of off-peak tariffs means an incentive for the development of electric off-peak water heating.

Grid users that generate energy only pay G-Charges at HTB2 and HTB3 levels. The rest of the generators connected to other grid levels only pay management and metering fees. The grid component for those generators is set at 0 €.

For DSO tariffs, price levels and the structure of tariffs are the same for all regions, but “time of use” schedules vary for clients across different regions. The peak/off-peak period depends on the load curve of the actual substation the client is connected to. In general, 4 different peak/off-peak periods are applied downstream a given substation.

Some changes in the regulatory framework are currently being discussed and ongoing studies are taking place under the regulatory review named TURPE 6.

After the public consultation of 2018-H1 conducted by the French regulator, CRE, it decided to move forward by applying specific local tariffs to only specific consumption schemes.

Households and SMEs

Distribution network tariffs for households comprise the following:

- a fixed term, in € per year
- a capacity term, expressed in €/kVa with time-of-use prices for clients above 36 kVA
- a volumetric term, in €/kWh with time-of-use prices available for all clients with smart meters and peak/off-peak meters

The weighting given to these components is on average: 10% on the fixed term, 20% on the capacity term and 70% on the volumetric term, however, this can vary depending on the consumption patterns of the client.

All households have the choice between a network tariff with a single price or a night/day tariff. Households with smart meters can have seasons combined with the day/night tariff. SME clients above 36 kVA all have tariffs combining seasons with day/night tariffs. The fixed term paid out depends exclusively on the level of connection and the metering equipment and administrative costs required.

No net metering is performed for households, except for the one-minute granularity of the metering clock. However, for eligible local communities with self-consumption (the so-called *autoconsommation collective*) the tariff is technically a net-metering scheme with 30-minute intervals, which is the granularity of the synchronised load curves.

Industry

The connection costs for industrial customers to the 400 kV level depend on the actual costs to set up a physical connection. Connection costs are shallow, only administrative costs and local connection costs, for consumers and generators. Generators pay 100% of the connection cost, except for RES installations that are exempted, while consumers only 70%. For certain new development projects of renewable generators, connection costs are deep, which includes the reinforcement of the grid in their areas of activity (S3REnR process). Certain energy-intensive industries receive a special grid fee reduction. No locational differentiation is taken into account for the connection.

The biggest share of the transmission network tariff goes to the capacity term with 65%, followed by 35% of the volumetric term, while the fixed term is mostly negligible. A CRE methodology that follows the Shapley allocation method[6] is used to distribute the different tariff weightings. The capacity term is defined based on the contracted demand and size of the connection. The volumetric term uses net-metering with seasonal tariffs.

Differences between TSO and DSO tariffs

RTE sends a specific network bill for transmission tariffs to its industrial and distribution customers. In the TSO tariff, non-TSO related costs are not included. The DSO bill, on the other hand, includes the transmission tariffs that the DSO pays RTE. Non-grid related costs are not included in the billed tariffs, while public programmes are financed directly from the state budget.

6 Joint-cost allocation method based on the Shapley value, that takes into account the benefits of all the participants in the system.

Taxes

Including the RES charges, taxes amount to 36% of the electricity bill for the average household consumer, and 25% for the industrial customer. For households this implies an amount of rigid taxes above the EU average. Taxes and charges in France consist of the 'Internal tax for final electricity consumption', called the TICFE (22.5 €/MWh), the "Contribution tarifaire d'acheminement" (CTA), a charge intended to cover energy sector pensions and social programs, that amounts to 27.04% of the fixed term of the grid tariff, and the VAT that is paid by final consumers, a 20% for the energy part and a 5.5% to the fixed term and contracted capacity. TICFE is only paid on the energy term and CTA on the fixed term. A 20% VAT is applied to the TICFE, the CSPE, and on the consumed energy and a 5.5% is applied on the CTA. There are also two local taxes for consumers under 250 kVA which vary up to a maximum of 3 €/MWh and 9 €/MWh respectively.

There is no specific tax regime for storage assets, but energy losses are not taxed. Self-consumption is also exempt if the generation has

- less than 1 MW capacity
- or less than 240 GWh/year and 100% of the generation is self-consumed.

Contracts and pricing

Overall the prices for electricity supply in France remain affordable at around 160 €/MWh for the average household and 78 €/MWh for industrial customers, with possibilities for contracts with real-time pricing. Even though it is technically possible to sign two contracts, one for access to the network and one for supply of electricity, in practice all households and SME clients have one contract with their supplier including the network access. Only 3% of industrial customers have chosen to work with separate contracts with the supplier and the network. There are currently five different models of tariffs for households, two for SMEs, and four for industrial customers. Contracts available include time-of-use energy pricing and critical peak pricing.

The DSO smart meters are ready to supply critical peak pricing (CPP) contracts and real-time pricing (RTP). With CPP, prices are known in advance, but the days on which the highest critical peak prices apply are announced with a short-term notification (usually, a day ahead). This is available for retail pricing with all smart meters. For network tariffs, a contract exists for medium voltage clients (20 kVa); for households, it is technically possible, but not ready for roll out yet. RTP determines prices at very short notice which requires a load curve with the same time step as the setting of prices. Obtaining the load curve requires prior consent by the customer. This is available upon request for all customers with smart meters.

For residential customers, the weighting of the transmission network tariff in the final bill amounts to 8,3%. The weight of all network tariffs is around 30% of the whole bill, being 34% the energy component and the other 36% third corresponding to taxes and charges.

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GERMANY

German consumers pay the highest price for electricity in the EU, with the largest part of it being fixed taxes and charges that blunt possible market and network price signals. The high cost paid to encourage the uptake of solar PV and other RES through feed-in-tariffs was financed through a special surcharge on electricity consumption. While RES technologies are becoming more competitive and support has significantly decreased for new installations, the surcharge remains to pay for older installations for a duration of 20 years. A redesign of the surcharge and tax structure will therefore be necessary to allow for a tariff design that encourages the efficient use of the network.

Manoeuvring space for tariff design is limited, all the more so due to an almost non-existent smart-meter penetration in Germany. With a roll-out that is currently stagnating due to a delayed certification process, Germany faces a challenging transition period.

Infrastructure

Overall, smart meters are still an exception rather than the rule in Germany, and charging infrastructure for EVs is scarce, leaving important room for improvement on infrastructure.

Germany did not go through with a mandatory rollout of smart meters for households over the past years, following a negative outcome in the CBA performed by the regulator to set targets for 2020. Smart metering took a step back and is only offered voluntarily. The current target for Germany is a 23% penetration of smart meters by the end of 2020. The voluntary installation statistics are unknown, but in any case, less than 50.000 smart meters were installed by mid 2019. One of the reasons for this delay is the stringent certification process for smart meter gateways. Following the current law, customers with a yearly consumption of over 6.000 kWh and generators with a capacity above 7 kW have to be equipped with smart meters. This has not happened yet due to a delay in the roll-out caused by certification issues from the hardware.

Meter installation and maintenance costs are typically managed by the DSO, plus a metering charge that the customer covers. The metering point operation charge for smart meters ranges between 23 € and 100 € annually. However, the law on Digitisation of the Energy Transition, which is addressing all smart meter-related details, opened the role of the metering operator to competition. Despite the DSO being the default operator, customers can choose another operator and obtain a smart meter when there is not standard rollout.

Network Tariffs

General Aspects

Overall, network tariffs in Germany are largely volumetric with significant blunting effect on cost reflection. Several counter-incentives to flexible consumer behaviour exist, but some efforts for improvements are underway.

There are four TSOs in Germany and around 900 DSOs that each charge different tariffs depending on their internal cost structures. TSO tariffs are currently being harmonised stepwise, targeting equivalent TSO tariffs by the end of 2023.

The tariff methodology encourages users connected to the low voltage grid to provide demand-side flexibility services, amongst other objectives, through a series of discounts. With the transition towards renewable energy sources, grids are facing new challenges and very different energy flows and load profiles. The tariff methodology aims to facilitate the use of both implicit DR (consumers' reaction on price signals) and explicit DR (committed, dispatchable flexibility usually activated by a third party), although the physical network expansion is still in progress. For energy-intensive industrial consumers consuming over 7 000 hours' worth of demand, exclusive discounts are available. This instrument, aimed at incentivising a stable consumption profile, is controversial as it incentivizes industrial consumers to not participate with their flexibility in the markets for fear of dropping below the 7 000-hour threshold and thus losing the subsidy. Some smaller incentives, like tariff-design geared to incentivize electrical heating with some DSOs, also exist.

Different options for a redesign of the tariffs are being evaluated by the Federal Ministry of Economic Affairs and Energy, and discussed by the NRA and research institutes, focusing the future tariff design on a load-oriented structure as well as exploring the current tariff design effects on innovation and the transition to sustainable, renewable energy sources. So far, information about these preparatory studies is not yet public.

Several projects are currently experimenting with new tariff structures that provide a compensation, but no proper sandboxes are in place to test new

approaches to the network tariff structure.

A special local tariff applies to rental properties, called "Mieterstrom", incentivising the consumption of locally produced electricity that does not require the use of the public network. Network usage charges and the concession levy are not applied for these cases.

G-Charges are prohibited in Germany by law, but grid users with a capacity of over 5 MW that are purely generating have to pay a network charge that includes a net-usage tariff, a net loss-tariff as well as balancing costs.

Households and SMEs

All DSOs have individual connection charges that can vary significantly from one to the next. There are no averages available.

DSO network tariffs are generally composed of a fixed price and a volumetric term based on the annual consumption price (ct./kWh). The weight of the components depends on the user's peak load occurring simultaneously with the network's annual peak load. For users exceeding 2 500 hours of consumption, the fixed term will be higher and the consumption prices lower, and vice versa for consumers under the 2 500-hour threshold.

There is almost no smart metering at the low-voltage level, only on a voluntary basis by some households. To adjust for the lack of detailed metering, and because there is no possibility to record the annual peak load, for households, and other users consuming less than 100 000 kWh/year, the DSOs may charge an adequate basic price (instead of the abovementioned capacity charge) together with the commodity price to adjust for the lack of accuracy.

The standard size of connection for households, including water heating, is 30 kW. All households are measured with a static *H0 profile* - the standard demand profile- and there are no measured peaks. The energy that is withdrawn is accounted for separately from the energy that is injected. This can result in a barrier for new innovative services if additional metering and energy producer categorization is required. Most of the tariffs used for the volumetric term are flat with some very reduced use of day/night tariffs.

Industry

Connection costs to the high voltage level are shallow or super shallow depending on the actual costs of the connection line and substation. If grid reinforcements are required, these are mostly socialized via the transmission tariff. A "Baukostenzuschuss", a one-time additional payment for new connections, might be applied to customers with a connection above 30 kW.

The network tariff is composed of a capacity charge (€/kW) and a consumption price (ct./kWh), the weight of each is different depending on a network usage under or over 2 500 hours/year (except for consumption at the low voltage level with an annual consumption below 100 000 kWh, see above). Only industrial customers with consumption above 100 000 kWh pay capacity charges. DSOs have the option to calculate a fixed basic fee. However, this fee is not linked with the contracted capacity of a customer. There is a lack of transparency on how this basic fee is calculated, without any specific formula and with little regulatory oversight.

Differences between TSO and DSO tariffs

DSO and TSO tariffs are aggregated and presented together in one network tariff, for users connected to a DSO. Charges that the DSO must pay to the TSO are included in its revenue cap as "permanently non-influenceable costs". They are part of the costs for the network tariff calculation that is aggregated into the electricity bill. According to law, the revenue caps can only include grid-related costs.

Taxes

Rigid taxes and charges, including the surcharge to support RES, make up for 54% of the electricity bill, having a significant blunting effect on power prices. Germany thus has one of the highest shares of non-energy related price-components, surpassed only by Denmark.

Up to seven different taxes and surcharges are applied to the German Electricity bill. An energy tax and a 19% VAT are applied to the energy consumption. Several other surcharges are in place to cover for different RES technologies (EEG-Umlage) in general and specific taxes to support CHP (KWK-Umlage) and offshore wind (Offshore-Haftungs-Umlage). Other surcharges cover funding to local governments (Konzessionsabgabe) and interruptible load agreements (AbLaV-Umlage). No differentiated taxing of the different tariff terms exists, and the use of the network is not taxed.

Double charging of storage assets remains an issue for their development. No other taxation exists for self-consumption, but an EEG surcharge (40% of the usual amount) is paid for self-consumed energy. In 2017, this surcharge it amounted to 2.752 ct/kWh.

Contracts and pricing

Although customers have the choice between different contracts, dynamic pricing contracts are practically non-existent due to the lack of smart meters today. Electricity contracts are bundled, but the smart meter roll-out might allow for specific metering contracts to appear.

In 2018, the weight of network tariffs for an average household with consumption between 2 500 and 5 000 kWh/a was 23% of the whole bill. Taxes amounted to 22.9%, 1.1% metering, 30.7% other fees (mainly for RES), and finally, 22,4% for the actual energy consumed. German household consumers pay the highest bills out of the EU, with around 310 €/MWh.

GREAT BRITAIN

Great Britain stands out for its efforts and the regulator's interest to reform its network tariff design to include new technologies and adapt them for the flexibility services they can provide. While these reforms are not yet in place, they will be introduced in the coming months.

Whether Great Britain will reach its smart meter rollout targets by 2020 remains to be seen, but a significant effort has been carried out over the past year to move forward with installations, despite doubts raised about smart metering devices that do not work or do not have the latest technical capabilities. The range of contracts available to customers also reflects a dynamic market, with smart dynamic price contracts already available.

Finally, another positive point for Great Britain is the low taxes consumers pay for electricity, leaving room for network tariffs to send the appropriate consumption signals.

Infrastructure

Ambitious targets on infrastructure stand in contrast with a slow roll-out and in some cases outdated smart-meters.

Great Britain set a target to reach 100% smart meter penetration for households and small businesses by the end of 2020. As of March 2019, around 9 million electricity smart meters were installed in British households and small/medium businesses. All high voltage connected customers already have smart metering capabilities. This is still far off the target set for 2020, with well under 50% of the estimated target of 30 million sites to be equipped with smart meters. It is unlikely that the government's ambitions can be met by 2020, and a more reasonable 75%-80% penetration rate should be expected.

Additionally, a series of first-generation smart meters were installed at the beginning of the rollout in 2011, and in some cases are still being installed, which lack some of the capabilities required by the latest European regulation. In some cases, it has been reported that they are not even functioning properly, with latest research suggesting 2 million units are affected. Issues have also been reported for self-generation metering through solar PV.

Most of the smart meters being installed can offer 30-minute measurements and a move to a lower, 15-minute granularity is not planned.

No upfront payment or special metering tariff is used for the roll-out, but the costs of installation and maintenance are included in the electricity bill as an operational cost for suppliers.

Network Tariffs

General Aspects

The current tariff design in Great Britain is focused on volumetric and fixed costs. While this approach is not the best solution for an active customer participation, because of the lack of a capacity term based on measured capacity used, the inclusion of different programs for specific technologies and the upcoming tariff design is promising for a tariff design that properly valorises flexibility.

Great Britain has three different Transmission Network Owners and one overall system operator responsible for operating the networks of the three TNOs and all offshore transmission owners. The system operator is responsible for setting and collecting charges for the operation, maintenance and upgrades of the transmission network. Six DSOs of different sizes operate fourteen tariff zones on the distribution level.

Until April 2019, a feed-in tariff was in place in the UK, targeting mostly solar PV, wind and CHP plants of up to 5 MW capacity (2 kW for CHP). This program has stopped taking in new participants, with some exceptions, for the foreseeable future. No other technology-specific tariffs exist in Great Britain.

G-charges are applied to purely generating transmission network users in what is called the Transmission Entry Capacity program (TEC). Generators connected directly to the distribution network do not pay G-charges. Opposite to other EU countries, GB does not follow the same restrictions of a maximum 0.5 €/MWh and can run up to an average of 2.5 €/MWh. TEC is applied to all generators over 100 MW capacity. Generators are also required to pay demand charges if they consume during the Triad periods . Intermittent generators pay a lower generation tariff that does not include a peak charge. Additional tariffs can be applied to generators, for example, local substation tariffs (£/kW), an onshore local circuit tariff (£/kW) or a local offshore tariff (£/kW) depending on their connection point and type of asset.

Generators and suppliers pay an additional Balancing Services Use of System Charges (BSUoS) tariff which is charged half-hourly on a £/MWh basis.

Ofgem is currently undergoing a tariff redesign aiming at adapting the network tariffs to the new energy landscape where RES, DER and flexibility services play an integral part. The focus is on smart tariffs that take advantage of the half-hourly settlement, but also on innovative tariffs like time of export tariff for small-scale low-carbon generation and flexibility services. A market-wide settlement reform will kick-off in the second half of 2019.

Storage is perceived to be double-charged and has remained a contentious issue over the past years. The NRA is currently assessing a series of modifications to the charging methodologies for transmission and distribution charges. In 2019, storage assets will be able to hold a generation licence that will allow them to avoid double payment of consumption levies (FCLs). The electricity supplied to generation assets is exempt when calculating the costs of Renewables Obligation (RO) and Feed-in Tariff (FiT) and other charges.

Households and SMEs

Households can take advantage of the volumetric-heavy network tariff to valorise their flexibility, with time-of-use options readily available. The lack of a capacity term in the network tariffs for households might leads to a limited cost-reflectiveness of the tariff design.

On the transmission level, there are two different tariffs depending on the measurement available. In the case where 30-minute measurement is available, the customer pays a capacity tariff (£/kW) depending on the utilised demand over the three Triad periods.[7]Customers without half-hourly measurement pay a volumetric tariff (c€/kWh) depending on their annual consumption, between 4 pm and 7 pm. These tariffs vary between all fourteen zones. Half hourly settled tariffs correspond in general to commercial users while non-half hourly settled tariffs are generally for household customers or small non-domestic premises.

Distribution tariffs on the other hand have a volumetric and a fixed term. The volumetric term is defined based on the voltage of the connection and charged based on the total consumption in c€/kWh. The volumetric term is charged based on time of use, voltage of connection and losses/proximity to substation. Fixed capacity charges also apply to larger (half hourly) sites who have agreed a maximum import capacity with their local DSO.

Industry

The same principles as for households are applied to industrial customers, but the capacity term has a more representative weight in the transmission tariff.

Connection charges for the industry at transmission level are shallow and have two components, the capital component and the non-capital component. The capital component consists of the costs of installing and commissioning the connection assets and is charged over the depreciation period of the asset. The non-capital component covers maintenance and transmission costs. At distribution level the connection charges are deep, covering all upgrade works required to facilitate the connection.

The same structure explained under Households and SMEs applies to the transmission level tariffs applied for industrial consumers that are directly connected to the transmission grid. In this case, they all have a half-hourly measurement available.

Differences between TSO and DSO tariffs

Both DSO and TSO tariffs are presented in the final consumer bill aggregated into a generic rate by the supplier. The TSO and DSO charge the supplier for the network costs and the supplier decides how to pass on the costs to the consumer and what amount to charge. Non-energy related costs are not included in the tariffs since the metering costs are part of the supplier's cost structure and costs for green certificates and other schemes are recuperated through taxes rather than tariffs.

The overall total amount to be recovered by the transmission tariff is calculated beforehand. After the revenues from the half-hourly (HH) charges are reported, the non-half-hourly (NHH) charges are adjusted so that all costs within a demand charging zone are recovered. At distribution level tariffs are set in advance in a similar fashion, but without reconciliation. Any over- or under-recovery is picked up in future charging years.

7 Triad periods are the three half-hours period with the highest net system demand between November and February.

Taxes

Great Britain is one of the few countries where taxation for households and SMEs is lower than for industrial customers. This allows for the energy component and network use to provide clear price signals.

In addition to a reduced 5% VAT rate on electricity consumption, the British pay three more taxes and levies in their bills:

- These levies are all related to RES and environmental support schemes;
- The Energy Company Obligation, targeted to reduce carbon emissions and to finance energy poverty schemes, amounts to an average of 20 €/year for the average household;
- The Climate Change Levy, only affects businesses and high voltage connected customers, and amounts to 0,639 c€/kWh;
- The Renewables Obligation is intended to support the large scale renewable subsidy scheme which amounts to an average 2,096 c€/kWh.

Some industrial customers and specific sectors are exempt from certain parts of the taxes that are targeted to support generation from RES. Additionally there is also a Feed-in-Tariff, charges for the Capacity Market and Contracts for Difference schemes, and a subsidy for users in a remote location where their distribution charges would otherwise be very high, Assistance for Areas of High Electricity Distribution Costs.

Taxes and charges amount to 23% of the final electricity bill for the household and small consumer. According to the British regulator, Ofgem, 18% of the final electricity bill corresponds to charges supporting the different RES schemes. Taking this into account, electricity in Great Britain is one of the least taxed from the countries studied in this report. For industrial consumers, the rate is higher, around 26% of the electricity bill.

Contracts and pricing

British households and SMEs pay an average 155 €/MWh yearly, which is well below the EU average, with a varied offer of contracts, including dynamic pricing contracts. Industrial customers on the other hand pay the fourth highest price for electricity in the EU, with 120 €/MWh.

Customers have a wide range of contracts available, and usually they come in the form of dual contracts for electricity and gas supply. They receive one single invoice with a final energy price that includes all energy and non-energy costs. For customers connected to the low and medium voltage grid, all contracts are bundled network and supply contracts. Those clients that already have a functioning smart meter can opt for dynamic pricing contracts, with a time-of-use energy price. There are currently around fifteen different tariffs taking advantage of the use of smart meters.

After a continuous and significant rise in retail electricity prices, British regulators had to establish a price cap in 2017 through a limitation on the prices that can be charged for customers using a domestic prepayment meter. Additionally, a vulnerable customer program was set up in 2018, providing low-income homes with a £140 discount on the yearly bill. The price caps are only applied to residential customers.

Network tariffs take up around 25% of the average electricity bill for households and SMEs. This means that the energy component has the highest weight out of the different countries analysed in this report, taking up more than 50% of the final bill. The spread for industrial customers is similar than for households and SMEs.

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ITALY

Italy was a pioneer in smart meter deployment but is now facing the challenges of outdated infrastructure in need of a second-generation roll-out. This roll-out began in 2018 and goes hand in hand with a redesign of the network tariffs, especially at the distribution level. Italy is moving away from its unique progressive tariffs to a horizontal approach for all levels of energy consumption. Electricity prices still remain higher than the average EU country for industrial customers, mainly due to taxes, and poses a challenge for the country to move towards a more cost-reflective tariff design.

Infrastructure

An advanced smart-meter development with an ongoing update of outdated infrastructure will allow Italian customers to control their consumption and interact with the grid. Italy was one of the first countries to start with smart meter installations across the EU beginning in the early 2000s. They reached 100% coverage well before 2017. But most of the smart meters from the first roll-out are now reaching the end of their lifecycle and are not of a standard to offer the same services as modern smart meters. For this reason, Enel Distribuzione initiated a new roll-out in 2016 with the installation of modern second-generation smart meters with the necessary functionalities required by the new EU Regulation. The new metering devices are capable of 15-minute measurement, have easy data access for consumers and market operators and allow a quick switch of suppliers. By the end of 2019, 13 million second-generation smart meters will be installed. In July 2019 the target was set by the Italian regulator, ARERA, to equip all households with second generation smart meters by the end of 2026, an estimated 41 million units.

Network Tariffs

General Aspects

The network tariff design in Italy is based on a cost-reflective principle, where the tariff is divided into a capacity, a volumetric and a fixed term. Nevertheless, the volumetric term is predominant, and the capacity term is based on the size of connection rather than measurements. This reduces the incentives for customers to maximise their smart meters and take on an active role in their consumption.

Italy's network tariffs used to be strongly progressive. Contrary to most EU countries, the higher the yearly consumption is, the higher the price of the kWh was. Network tariffs and metering costs for households under 1 800 kWh were very reduced and could go from less than 25% of the bill to 57% for consumers above 4 000 kWh yearly. With the 2018 reforms, a move towards a less progressive tariff has started, with the objective to have the same tariff applicable to all consumers by the end of 2019. Tariffs are updated yearly by the Italian regulator, ARERA.

Prosumers, with a cumulated power generation below 500 kW, have the option to use net-metering, in Italian called "scambio sul posto", to measure their injection and consumption from the grid. If they don't use net-metering they also have the option to participate through a feed-in-tariff to guarantee a minimum price through a program called "ritiro dedicato". This program allows prosumers, at regulated administrative costs and simplified imbalance costs, to sell energy produced at an hourly market price. Alternatively, they can stipulate a bilateral agreement with a counterpart, a trader, to sell the energy produced.

There is no G-charge applied to generators that are only injecting electricity at any level into the grid. Energy withdrawals to feed auxiliary services of power plants are also exempt from transmission and distribution tariffs under certain conditions, for example, for hydro pump storage plants.

Households and SMEs

Italian customers are not incentivised for an active participation in the network,

responding to congestion issues, mainly due to a tariff structure highly dependent on the volumetric term. A cascading principle is applied in Italy, so households contribute to covering the costs of all level networks. The network tariff is divided into a capacity, a volumetric and a fixed component. The capacity tariff (€/kW) is used to cover the costs of the distribution network, while the volumetric term (c€/kWh) covers the transmission costs. The fixed component, which is a set amount for each point of connection, includes the metering and maintenance costs.

The weight of the different terms varies between the consumer type, but for the average consumer with a 3 kW connection and 2 700 kWh yearly consumption, the fixed and capacity term amount to around 25% and the volumetric term to around 75%. A "social bonus" program exists to support low income households. For the average household the network costs represent around 19% of final bill and system costs (oneri) are approximately 24%.

Industry

Industrial consumers receive more incentives for an active participation in their consumption due to a transmission tariff heavily reliant on the capacity term. At transmission level, customers pay a volumetric and a capacity tariff in addition to a one-off shallow grid connection charge. The connection cost is 2 500 € plus 0.5 €/kW. The customer is responsible for building the infrastructure required for the connection and costs of reinforcement are embedded in the transmission tariff. For the medium voltage consumer the connection cost amounts to 55.71 €/kW plus a cost related to the distance between the connection point and the substation of the DSO. For a high voltage connected consumer the connection cost is 50% of the TSO's total cost related to the needed infrastructure. On top of this, customers have to build the infrastructure on their site.

The volumetric term averages 0.074 c€/kWh for the high voltage consumer and amounts to 15% of the tariff. The capacity component amounts to around 1 600 €/MW per month and covers approximately 85% of the transmission costs.

Some non-grid related costs, especially system security-related ones, are included in the transmission tariff but are only paid by dispatching users.

Differences between TSO and DSO tariffs

All network costs, both distribution and transmission tariffs, are aggregated into one network tariff that is distinguishable in the bill that the customer receives. The DSO passes the TSO costs on to the customer through the so called TRAS component. This component includes both a volumetric and a capacity term. DSOs pay an additional infrastructure charge to the TSO called the CTR component (infrastructure component of Transmission Tariff) which also contains a volumetric and a capacity term. Costs for metering are included in the DSO tariff.

Taxes

Electricity taxation in Italy is high, especially conditioned by non-energy related levies producing a blunting effect on the electricity prices. A reduced VAT rate of 10% is applied to electricity consumption in the industrial sector. Overall taxes, excluding VAT, amount to approximately 40% of the electricity bill for households. Over 80% of the overall taxes correspond to taxes and levies dedicated to RES schemes.

Levies are included in the so called Asos and are applied with different criteria to energy intensive consumers and to non-energy intensive consumers. Energy intensive consumers benefit from a reduction of the levy. This mechanism is applied until 2020, and its continuation has not been confirmed yet after that year. Since 2016 a levy destined to finance the public television, the "Canone RAI", is included in the electricity bill. In 2018 the amount of this levy was set at 90 €/year.

Contracts and pricing

The massive roll-out of smart meters has not translated into varied contract offers for household consumers. Customers can choose between a fixed and a variable price contract. The variable price offer is limited to a "bioraria" tariff, based on two time slots (the peak hours from 8 a.m. to 7 p.m. on weekdays and off-peak all other times and weekends). The price differences between the two time slots are very narrow and do not incentivise active customer participation. The variable price available fluctuates with the wholesale price of electricity, but is only updated every three months. This, while it protects customers against price surges, does not allow for an optimal use of the grid. Industrial consumers typically have more offers available, have access to liberalised market conditions, trading platform prices and portfolio management solutions. These result in considerable price reductions.

Contracts and bills reflect the costs of the grid and the details of the consumption, including peak power withdrawn in each month and historical data from the past 12 months.

Electricity prices in Italy used to be relatively high compared to other similar EU countries up to 2016, mainly due to an energy component price that takes up 45% of the electricity bill. Since 2017 Italian household electricity prices have decreased and are now in the average of the EU with 216 €/MWh. Industrial customers still pay one of the highest electricity prices in the EU, second only to Germany with 130 €/MWh.

All liberalized electricity (and gas) market suppliers must include also the so called "Placet offers" (Italian acronym of Prezzo Libero A Condizioni Equiparate di Tutela), which are intended to help customers enhance their ability to choose their supplier and facilitate comparison within the liberalised market. Thus, they have been designed as an innovative end-customer protection instrument to guarantee greater simplification and comparability.

The energy component amounts to approximately 44% of the final bill for the average household, network tariffs represent 19% of total, system costs (oneri) 24%, and taxes amount to 13% of the final bill.

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THE NETHERLANDS

The Netherlands has one of the most advanced smart meter roll-outs combined with a good balance between energy price and taxation. A specific feature of the Dutch tariff design is the focus on a capacity-based term, without a volumetric term in the tariff for households. However, the capacity term is based on the physical connection capacity rather than on the capacity used by the customer and thus does not provide targeted incentives for a flexible use of demand. Relevant highlights in the Netherlands are a low tax pressure and the partial reimbursement on the energy taxes. Room for improvement is still there since double taxation of storage assets can be prevented, and the smart meter roll-out is also not yet completed. A better balance could be found between the capacity and fixed term in the network tariff. Finally, more transparency could be encouraged with a clearer definition of network costs in the customer bill.

Infrastructure

The penetration of smart meters in the Netherlands is at an advanced stage. Currently, around 2/3 of households and SMEs have a smart meter installed with an ongoing roll-out that will reach 80%-90% coverage by the end of 2020. Industrial customers (> 100kW) are equipped with smart meters too. All household and SME smart meters have a measurement granularity of 15 minutes and are prepared for dynamic pricing. A small metering charge is applied in the network costs.

Network Tariffs

General Aspects

Tariff design in The Netherlands provides incentives for DERs, through net-metering schemes, and reduced tariffs for generators and especially homes with solar PV. Each regional network operator in the Netherlands has a unique tariff based on its cost structures, but differences between them are minimal and they follow the same tariff structure. There are currently seven DSOs operating in The Netherlands, with the largest share of customers, 95% of the market, belonging to Liander, Enexis and Stedin.

Tariff design in the Netherlands incentivises certain technologies like EVs, with a reduced tariff for households or SMEs with solar PV that do not pay additional fees if they require a bigger connection. Additionally, energy generators do not pay an energy transport tariff. This does not apply to storage assets when injecting into the grid, they must pay fees as a regular consumer. Grid users that only generate energy but who do not consume energy do not have to pay any G-charges, except for the connection fee based on the actual connection costs involved.

The OTE *(Overlegtafel Energievoorziening,* an informal body where all major stakeholders discuss necessary changes for the transition towards a sustainable energy system) has initiated a working group to identify which changes are needed in the grid tariff mechanisms. In its final report[8], six obstacles in the current mechanism have been identified that are conflicting with the principles of cost-reflectiveness, fairness and/or incentivising efficient grid utilisation.

Redesigns of the network tariffs are being developed and discussed. It is to be expected that within a few years the current LV-capacity tariff (based on the technical connection capacity, e.g. 3*25A) will be replaced by a tariff based on the real measured load (kW).

8 "Belemmeringen in nettarieven", May 2018. http://www.energie-nederland.nl/app/uploads/2018/06/OTE_-Belemmeringen-in-nettarieven.pdf

Households and SMEs

While distribution network tariffs are based on the capacity term, this is not based on actual measurements of consumption but rather on the connection size. This means that most customers pay virtually the same, and not reflecting the changes in consumption patterns. It is expected that this tariff will move to actual measurements in the coming years. Household connection costs are shallow, based only on administrative costs and the local connection costs. The network tariffs for low voltage connected customers are only based on the size (the capacity) of the connection (the main fuses, e.g. 3*25A). So, for the initial costs and maintenance of the connection, only the size of connection is relevant. The same fee is paid by all customers up to and including 3*25A capacity levels (i.e. 95% of all LV customers); if the customer needs to increase the capacity further, the fee also increases. The tariff not being linked to the actual capacity used by the customer means that there is hardly any incentive to avoid high loads at any point in time. No volumetric term exists for households and SMEs. DERs are not charged for injection of excess energy into the grid.

One of the considered low voltage options for the future is a subscription-based model in which the customer subscribes for a symmetric kW-band, e.g. a +/- 4 kW band (i.e. a band between -4 kW and +4 kW, negative values when feeding into the grid) or a +/- 10 kW band. The broader the band, the higher the fixed monthly fee. Exceeding the chosen band is still possible, but this exceedance will then be charged with an additional tariff, based on the level of exceedance (in kW) and the duration (e.g. in blocks of 15 min) of it. This additional tariff should be an incentive to keep the load and the feed-in within the boundaries of the band.

Industry

Contrary to households, industrial customers' capacity tariff depends on the measured peak, allowing for a more active approach of energy consumption for customers. Industry-level tariffs for all connection points are shallow, covering only administrative costs and local connection costs. Like households, the size of the connection is relevant only for the initial connection charge. The capacity term depends on the measured peak, measured on a weekly or monthly basis depending on the voltage level. No net metering is used for industrial customers when calculating their volumetric term, on which a flat rate is applied without any time-varying components.

Differences between TSO and DSO tariffs

All network costs, both distribution and transmission tariffs, are aggregated into one network tariff that is distinguishable in the final bill that the customer receives. Non-grid related costs are not included in either the TSO or DSO part of the tariffs. DSO tariffs do not include any TSO related cost in them.

Taxes

Electricity taxation in The Netherlands is low for all consumer types. There is also a fixed refund that households receive yearly, lowering the overall energy tax pressure on the consumer, but with no effect on the price signals to consumers. This, in addition to tax exemptions for certain DERs, can provide adequate signals to consumers based on the network needs and the wholesale energy prices. A tax on electricity and gas called the Opslag Duurzame Energie (ODE), in force since 2013, is used to finance renewable energy development in The Netherlands and it is digressive after 10 MWh, for the first 10 MWh, the amount is 1.32 c€/kWh (2018). Taxation is only applied to consumption measured by the meter. Injections into the grid from small customers (max. 3*80A) are netted with their consumption. The energy tax, 10.458 c€/kWh in 2018, and the ODE charges are only applied to direct energy consumption. VAT applied to the energy consumed, the energy tax and the ODE has a rate of 21%. This adds up to almost 16 c€/kWh taxes and is more than half of the electricity price for a household or SME. Because every household also receives a fixed tax refund of 308.54 € per year, the actual taxes amount to approximately 29% of the electricity bill for the average household, including the RES tax that takes 4% of the share. Electricity taxation has been further decreased in the past year, and the taxes on gas increased, to incentivise a move towards electrical heating and cooking in Dutch homes. A reduced energy tax exists for public charging stations, but this program will be terminated after 2020.

Generators do not pay any taxes or levies other than a VAT. However, the tax exemption is not applied to storage assets. The netted consumption of the storage asset is taxed as usual, but energy losses are considered as consumption and are not exempt. Dutch Ministry of Finance is currently conducting an inquiry to assess the possibility of exempting consumption of storage assets from taxes.

There is no energy poverty scheme in the Netherlands, but all households receive an annual fixed refund on the energy tax of 308.54 € (in 2017).

Contracts and pricing

With a significant weight of the energy component in the final price, Dutch industrial customers have a clear advantage over the average EU countries. Electricity prices for households and SMEs are below the EU average at 160 €/MWh, and 95 €/MWh for industrial customers. Large customers have a wide array of contract options available. Thanks to the advanced smart-metering infrastructure, dynamic pricing contracts are offered, both time-of-use contracts and real-time energy pricing (15-minute intervals) are available. For household customers these types of contracts are very rare. Although the wholesale processes have been modified to support these concepts and smart meter coverage is at an advanced state, the large energy suppliers (mainly incumbents) are not offering these types of contracts to their customers. Network tariffs must be bundled with a supply contract and amount on average to 20%-25% of the electricity bill for households. Energy taxes and VAT amount to 50% and 21% respectively, of the monthly electricity bill, but given the yearly refund of the energy tax, the actual tax amount paid is much reduced. The Energy price represents 36% of the bill, in line with the average of the countries studied in this report. For industrial customers taxes amount to 22% of the final bill, network tariffs 25% and the energy component 53%.

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NORWAY

Norway is one of the countries displaying the most innovative change in tariff design over the past years. A move towards more cost-reflective capacity tariffs is being implemented by the Norwegian network operators to encourage the deployment and profitability of RES and use more efficiently the grid. The widespread penetration of smart meters will reduce the need for future investments and help customers to monitor and value their flexibility. Negative distributional effects and fairness remain a question, but given the low electricity prices, these are less of a problem than would otherwise be in other countries. The new system is not well suited to deal with real-time congestion which might impact negatively the development of demand-side flexibility.

Infrastructure

Since January 2019 Norway has completed its smart meter roll-out with a 100% penetration across all customer types. The smart-meters installed provide 15-minute measurements and have allowed the Norwegian tariff design to move towards capacity-based tariffs in the last year. This has turned to a more cost-reflective tariff structure where customers can valorise their flexibility potential.

Network Tariffs

General Aspects

Network tariff design in Norway is currently transitioning into a new structure that will put the focus on a capacity-based tariff based on regular measurements. This is an effort to improve the use of the network and have a more cost-reflective tariff design as well as to attend to the current needs of the network. But this move in tariff design could have adverse effects on the potential flexibility services provided by customers. Currently the network tariffs are divided between a volumetric term, that is calculated hourly, and a fixed component.

Norway has one transmission network tariff for the whole country. There are no geographical differences applied but network tariffs offer some degree of information according to the location, based on the marginal loss and the degree of production or consumption.

Around 130 DSOs exist in Norway, all with their own distribution network tariff according to their cost structures that often vary significantly.

While technology-specific tariffs are not applied currently for differentiating between assets or technologies, a move towards an exclusively subscription-based capacity tariff could be damaging for demand side flexibility if not combined with other tariff models. The smart charging of EV and a low capacity subscription for solar PV installations are also encouraging. These facilitate the use of demand side flexibility to deal with real-time congestion, the biggest blind spot for capacity-based tariffs.

A G-Charge is used for grid users purely generating based on the volume produced, without any differentiation in the technology used. The tariff has two components: a fixed element of 1.2 €/MWh, and a “loss element” based on the feed-in volume, the marginal loss rate and the power price.

Households and SMEs

Current tariffs in Norway are heavily slanted towards a fixed component, leaving very little room for an active participation with the grid. Households under 22 kW will be transitioning from volumetric (kWh) o capacity-based (kWh/h) tariffs in the coming years. They will pay for a fixed subscription price depending on their capacity needs, with an energy charge equal to the marginal cost. If the capacity subscribed is passed at any point of the day, an additional overspending charge is paid by the consumer. This is one of the most cost-reflective tariffs available in Europe right now.

Currently, the traditional mix of a volumetric and fixed term tariff is still applied to many consumers, but a move towards a purely capacity-based tariff is planned for 2021. This could make it challenging to deal with real-time congestion in the grid. Some areas are already including a capacity component in their distribution tariffs. In general, the fixed term covers most of the tariff, with almost 95% of the weight, leaving the rest to the volumetric term and in some cases the capacity term.

Industry

Transmission tariffs for the industry are divided between large consumers (with a capacity over 15 MW or consumption over 5 000 hours) and for general consumers. Large consumers receive a reduced tariff rate. The industry tariff is based on a volumetric component and a fixed term that depends on the distance to the closest power generator. The fixed term can also be reduced depending on the possibility of activating interruptible loads at the site, which incentivises an active participation of customers in the grid.

Differences between TSO and DSO tariffs

The consumer's bill shows DSO and TSO tariffs. The DSO tariff includes terms to cover the TSO overhead network costs. Non-grid related costs are not included in the DSO or TSO tariff.

Taxes

Customers in Norway have one of the lowest tax rates across the countries studied in this report allowing customers maximise their flexibility through the market signals. An energy tax is applied that covers 20% of the electricity bill. An additional VAT of 25% is paid. There is also a levy for the support of RES programmes, but its amount is one of the lowest of the countries in this report, amounting to only 2% of the final average household consumer bill. Household consumers dedicate on average 33% of the bill to taxes and levies. Industrial customers on the other hand pay on average 28% of taxes out of their final bill.

Contracts and pricing

Norwegian customers have a wide range of contracts available depending on their consumption structures. The most innovative contract is a subscribed capacity model that was introduced due to an increase in capacity demand that was growing faster than the demand for energy. This contract model incentivises customers with active participation in the system, allowing them to contract a low capacity and use their flexibility to stay below the contracted capacity to avoid extra payments. Electricity prices in Norway are among the lowest in Europe. The average household and SME pay an average 100 €/MWh, while industrial customers pay 58 €/MWh. Contracts are bundled and have no option for separate supply and network contracts.

The current network tariffs applied suppose 33% of the final average household consumer bill. The energy component takes over another 33% of the bill. The expectations are that tariffs might rise around 30% if the change to the capacity-based tariffs is not performed. For industrial customers network tariffs average 30% of the final bill. The weight of the energy component is above 50% allowing for non-distortive price signals.

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PORTUGAL

Portugal is a latecomer to the smart meter roll-out and as such the possibilities for a smart network tariff design are reduced. Additionally, a high degree of taxes and levies in the bill reduce the impact of network tariffs on the final price paid by the customer. As a strong point, the tariff design already includes a combination of capacity, fixed and volumetric terms, which could be improved with a lower volumetric term. Additional plus points are incentives for solar PV and customers in the lowest voltage group. Nevertheless, the Portuguese pay a high price for their electricity, distorted especially due to high RES levies and other taxes and levies, with the weight of the energy component being one of the lowest in the EU.

Infrastructure

Smart meter deployment is still in its infant stage in Portugal, and the country will not reach the EU target of 80% smart meter deployment by 2020, limiting the options for customers, especially households and SMEs. Smart meter roll-out in Portugal is currently around 25% for household and SME customers and network operators are expected to reach 50% smart meter coverage by 2020. Smart metering devices are prepared for dynamic pricing and can register measuring-intervals from hourly to 15-minute blocks. All customers connected to the medium to high voltage network already have metering capabilities with a measurement capacity of 15-minute granularity. Two CBAs were performed for the smart meter roll-out by ERSE, the Portuguese regulator, both with a positive outcome.

No specific charge for metering is included in the network tariff. Costs of smart meters are not included in the regulatory asset base of DSOs, although the metering costs can be included as an operating cost to establish the possible revenues of DSOs.

Network Tariffs

General Aspects

Portugal is one of the countries exploring new options for network tariff designs, making sure they don't hinder the use of any technology. So far innovative developments are explored through sandboxes and pilot projects.

There is one network tariff region covering the country, including the island regions of Madeira and Azores. The only differentiating factor is the five different voltage levels according to the connection point. There is no differentiation for the technology used. As of today, no specific adjustments have been deemed necessary for EVs in Portugal, which are still at a very early stage. This means that double-charging of tariffs is an issue. However, ERSE has expressed interest to monitor developments and take actions if needed to avoid barriers of EV expansion due to a network tariff design.

Following the same guidelines, until 31 May 2019 ERSE performed a pilot project for customers connected to the medium to high voltage level to promote demand response and encourage more efficient use of the network. Regional time-of-use tariffs were introduced, also a new peak period and a change to the billing of variable-measuring peak power. No other special sandboxes or local tariffs for local consuming schemes exist in Portugal.

All grid users that only generate energy must pay G-charges, except for those connected to the low-voltage grid.

Households and SMEs

For customers connected to the low voltage grid, a variety of options are available that mix different tariff designs, in some cases taking advantage of smart meter measurements for the capacity term, allowing for an active participation of consumers. Two low voltage levels exist in Portugal. One for customers with a connection of up to 41.4 kVA, and one for those above 41.4 kVA. The connection costs depend on technical requirements for each installation, and in some cases can be deep, also covering costs necessary to reinforce the grid. The network

tariff consists of a volumetric and a fixed term.

A cost cascading effect is applied, so that households, and in general, users connected to the lowest voltage level, pay for the levels above, including transmission and distribution in the high, medium and low voltage levels.

The amount allocated to the fixed term is based on the cost of peripheral network assets in the low voltage distribution network. This assumes that investment in assets closer to the end consumers is driven by the maximum power (kVA) requested by the customer. Since customers in the low voltage are grouped into 13 power levels, from 1,15 kVA to 41,4 kVA, the incremental cost of peripheral network assets is translated from €/kVA into a fixed term €/day.

The volumetric term is based on the cost of central network assets of the transmission and distribution network, if investments in central network assets, used by many customers, is mainly driven by the energy consumed during peak hours.

The capacity term for normal low voltage of up to 41.4 kVA corresponds to the contracted power measured in kVA. Customers can choose out of 13 distinct levels ranging from 1.15 kVA to 41.4 kVA. The power supply will be interrupted if consumption exceeds the contracted power.

The capacity term for the special low voltage above 41.4 kVA is composed of two capacity terms measured in kVA. First, the contracted power, measured as the maximum individual demand over 15-minute intervals over the last 12 months, and second the peak power, measured as the average demand in kW over the peak period in a 4-period time-of-use schedule.

Solar PV installations, in self-consumption regime, with a capacity of up to 1.5 kW are not required to perform a separate measurement of the energy injected into the network, because of this, excess energy injected into the grid is not measured and therefore does not receive any payment. Installations with a capacity above 1.5 kW must perform a separate measurement of injected energy. New legislation regarding self-consumption and energy communities is expected to be approved during the 2nd semester of 2019.

Normal low voltage customers (up to 41.4 kVA) can choose between a volumetric term that is either flat or time-varying, with two or three different periods during the day. Special low voltage customers (above 41.4 kVA) have a time-varying volumetric term with four periods during the day. The time-of-use schedule also has a quarterly price differentiation. The time-of-use schedule for both low voltage levels can vary between weekdays and weekends.

No fixed term is applied to normal low voltage customers. For special low voltage customers, the fixed term depends on the contracted power level and is the same across Portugal.

No injection tariffs are applied to DERs connected to the low voltage grid. Medium and high voltage grid-connected assets, that are not participating in the feed-in-tariff scheme, must pay an injection tariff.

Industry

Industrial customers have access to tariffs focused on the capacity term, allowing for a more active management of their consumption.

For both medium and high voltage levels, the connection costs are deep, covering administrative and local connection costs, as well as the required investments for grid reinforcement. No special tariff regimes exist for industry or customers with high consumption. As stated in the household section, a cascading principle is followed to allocate network costs, so industry only pays for the upper levels of grid costs. The same principles apply for the industry as for households regarding the allocation for the capacity and volumetric terms.

The capacity term for special low voltage, medium voltage, high voltage and very high voltage connected customers corresponds to the contracted demand in kW, measured as the maximum individual consumption over 15-minute intervals over the last 12 months. For the volumetric term, no net metering is applied, but all injected energy is accounted for separately from consumed energy. No fixed term is applied above the medium voltage and for the special low voltage level.

Differences between TSO and DSO tariffs

The customer receives an aggregated network cost in their bill. A new legislative initiative will force suppliers to present separate information on what amount corresponds to the TSO and the DSOs in the electricity bill. ERSE already clearly states in their regulation which revenues are acceptable for the TSO and DSOs.

The supplier charges the customer a retail price that includes energy costs and network costs with taxes and levies. The supplier then transfers the network tariffs to the DSO, and the DSO does the same to the TSO for their respective costs. Thus, no specific term in the DSO tariff corresponds to TSO costs, but the DSO must pass along the TSO part of the tariffs.

All customers, including customers with end-user regulated tariffs and with free market offers, pay a network access tariff, which includes network costs and costs related to energy policy. The latter include, amongst others, power purchasing agreements, feed-in tariffs, capacity mechanism payments, payments for public land use, energy efficiency projects approved by ERSE as well as ERSE's annual budget.

Taxes

While electricity taxation is low in Portugal (22% of the bill, including VAT), the high level of levies applied to household and SME customers, that amount to another 22% of the bill (in particular RES levies introduced to support the development of solar PV and other technologies), make it difficult for customers to react to price signals. The energy bill includes a special consumption tax of 0.001 €/kWh, a levy for the funding of public broadcasting and a tax for funding for the Directorate-General for Energy and Geology.

A new taxation scheme, with differentiated tax rates for the different terms, was introduced on the 1st of July 2019. The fixed term is now subject to the lowest VAT rate possible: 6% for the Portuguese mainland. This reduced VAT is also applied to the levy for the public broadcasting funding. The rest of the electricity bill in the mainland is subject to the highest VAT rate of 23%. A reduced VAT rate is only applied to customers in the low voltage group with a contracted power that does not exceed 3.45 kVA.

An energy poverty scheme, called Social tariff, is applied to vulnerable household customers with a contracted power that does not exceed 6.9 kVA. This rate offers an average discount of 33.8% on the pre-tax electricity bill.

Contracts and pricing

Household and SME prices are one of the highest in the EU, at 225 €/MWh, mainly influenced by a high share of taxes and levies, since the energy component is below the EU average at 50 €/MWh. Industrial customers are at the EU average, paying 105 €/MWh, with more weight on the energy term. These price structures, especially for households, reduce the incentives for an active participation in the system. Contracts are bundled for networks and supply. The supplier oversees the redistribution of the appropriate parts to the TSO, DSOs and government. Consumers can choose between a selection of different price options, including flat tariffs and time-of-use tariffs. ERSE offers a price comparison tool with all the different options from all Portuguese suppliers who are mandated to provide this information to ERSE. There are currently no dynamic price contracts being offered, although there is one time-of-use tariff with three periods that are indexed to the spot market prices monthly.

Network tariffs assume 22% of the electricity bill for households with consumption between 2 500 kWh and 5 000 kWh - the consumption band (band DC) most representative for Portuguese households. For industrial consumers in the most representative group, band IB, with annual consumption between 20 MWh and 500 MWh, the network tariffs amount to 27% of the electricity bill, excluding VAT as it is tax-deductible for industrial customers. This leaves the energy component to only take 26% of the electricity bill.

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ROMANIA

While smart meter roll-out in Romania is still at an early stage, efforts are being made by network operators to move forward. Strong points for Romania are the low taxation of electricity, which would allow for an efficient and cost-reflective network tariff design, and low energy prices overall. As it stands right now, the tariff is mostly volumetric with limited cost-reflectiveness. Another aspect that leaves room for improvement is the taxation of self-consumption which is considered as a delivery of energy service by the government.

Infrastructure

Smart meter roll-out is at a very early stage in Romania, and the 2020 target of 80% coverage will not be reached. Currently around 8% of customers have a smart meter installed.

Reporting for Romanian smart meter deployment is limited, with information only available for one of the distribution areas, Distributie Oltenia. Around 44 000 smart meters are installed out of 1,4 million metering devices. The current target is to reach 400 000 smart meters installations by 2023. Around 700 000 smart meters have been installed so far in all distribution areas. The rollouts are supported by individual CBAs from each DSO. The installed smart meters are prepared for dynamic price contracts, both with a load curve measurement and for day/night differentiation. The DSO covers the cost of the metering device with no specific fee for it in the network tariff

Network Tariffs

General Aspects

Although the regulator is currently discussing new principles for future development for dynamic tariffs and a further capacity-component in the tariffs, so far, the Romanian tariff design is heavily reliant on the volumetric term and customers have little possibilities to play an active role in the grid.

One TSO oversees the entire Romanian transmission grid, which is then divided into eight regions, each with one primary DSO. There are also hundreds of small local DSOs. The eight main DSOs have tariffs that are approved by the Romanian regulator, ANRE, whereas the local DSOs have their own tariffs that, in most cases, are lower than the regulated offers.

The network tariff design is currently undergoing a reform that includes new principles for dynamic tariffs for both the TSO and DSOs. So far, no special tariff regimes are in place for different technologies, but some of the smaller DSOs have special local tariffs that can be applied to local energy communities.

Grid users only generating pay injection fees to the TSO only. No fee is paid to the DSO, even if they are connected in the distribution network.

Households and SMEs

Tariffs for households depend on the connection size and the volume consumed, but do not provide any incentive for consumers interaction, even with a smart meter.

The connection costs for households and SMEs amount to around 500 € and are in general shallow. The tariffs are mostly composed of a volumetric term and are specific to a value per MWh for each voltage level. They are different for each of the eight distribution areas. Tariffs are flat and based on the voltage level, and as previously mentioned, prosumers are not charged for injection to the grid. Customers also pay a small transport fee per MWh depending on the voltage level.

Industry

Industry customers' connection fees are set by the national regulator are mostly deep. A connection for 20 kV costs around 13 000 € per connection point. Upstream grid reinforcement is shared by the TSO and the customer for generators. For demand the costs are fully paid by the TSO. All the previous points in households and SMEs can also be applied at an industry level.

Differences between TSO and DSO tariffs

Tariffs in the consumer bill are presented in an aggregated way, but information on proportions corresponding to the TSO and DSO are readily available in the same bill or online at the regulator's website (ANRE). DSO and TSO tariffs are separate, and no TSO costs are included in the DSO tariff. The DSO pays the TSO for energy losses, which are included in the DSOs budget and included as operating costs in the tariff. Other non-grid related costs are not included in the network tariffs. Green certificates are included separately in the final electricity price offered by the supplier.

Taxes

Taxation on electricity in Romania is one of the lowest in Europe, with very little levies attached to it. Taxes include renewable subsidies, like the green certificate mechanism, subsidies for cogeneration and other excises. There is also an additional tax to cover the regulator's financing contribution which all market participants must pay. A 19% VAT rate is applied to energy consumption. The RES levies amount to 9% of the bill, with taxes including VAT taking 21% of it. Overall taxation of energy is quite reduced compared to other European countries, especially when not considering the VAT.

Prosumers with consumption of less than 24 kWh are entitled to tax deductions. No specific exemptions have been established for technologies like storage or EVs. There is also no environmental charge or carbon certificates yet, but a small fee is dedicated to scraps and recycling related to the energy sector.

Self-consumption is taxed, following the interpretation of the legislator that sees it as service delivery.

Contracts and pricing

Electricity prices for Romanian customers are one of the lowest in the EU, but little offer exists for different types of contracts, mainly because of the lack of infrastructure and a tariff design to support them. Most contracts are offered by the suppliers bundling distribution and supply obligations, but industrial customers connected to the transmission network can opt for separate network and supply contracts. Legally, all customers have the option to have an individual contract with the DSO, but in practice, only the largest consumers set one up.

Dynamic pricing contracts are available for customers with a smart meter that can perform hourly measurements. For users without smart meters, a dynamic price contract can be applied with a standard load profile, but there is little market demand for this. The dynamic pricing contracts are mainly used by large consumers and public lighting, with only a variant for day/night tariffs with different prices within these timeframes.

Romanians pay one of the lowest electricity fees in the EU, with the price moving around 131 €/MWh for households and 86 €/MWh for industrial customers.

So far, no energy poverty schemes are in place, but discussions are taking place on how to address vulnerable customers, and a specific fee or deduction is foreseeable soon.

Network tariffs amount to 37% of the consumer bill for households, 33% for SMEs and 26% for large consumers. The energy price takes the forefront in the electricity bill, with a 42% share in the electricity bill of the average household consumer.

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SLOVENIA

Slovenia started off with a good smart meter roll-out plan, but it has grown stagnant over the last year without any sign of picking up before 2020. Targets for 2025 have been set by the government, however, without a clear plan, they seem difficult to be realised. The EV specific tariff in Slovenia stands out, as well as the low electricity prices and taxation. Network operators are quite active in a remodelling of the network tariffs that consider the capabilities of installed smart meters, and some pilot projects are being tested to assess new and innovative tariff structures.

Infrastructure

Smart meter penetration in Slovenia is advanced, but currently stagnant, which could limit the innovations taken in the tariff design. 66% of final customers have a smart meter installed already, of which all customers with a capacity above 43 kW have smart-metering capabilities. The objective is to reach 100% by the end of 2025, but no further roll-out is planned for now. All smart meters are ready for dynamic pricing offers, but there are still outstanding issues limiting their development concerning the technical availability of communication capabilities with the distribution dispatch centre in some areas. Costs for smart meter installation are covered by the customer, while the DSO minds the maintenance and replacement costs. Around 300 public charging points are installed in Slovenia, all with smart-charging capabilities.

A CBA was performed for the initial smart meter roll-out that noted benefits to consumers and the grid, like reduced electricity consumption, reduced meter-reading costs, and technical and non-technical losses. The CBA also assessed billing, reduced outages, required investments into the transmission and the distribution grid, as well as others.

Network Tariffs

General Aspects

Slovenia shows interesting developments in its tariff design with a capacity term based on measurements provided by the smart meters, upcoming changes in the next regulatory period, and new solutions to innovative technologies like EVs.

In Slovenia, a single region exists for network tariffs, which are subdivided into transmission and distribution network tariffs. Certain aspects exist depending on the type of user. For example, the capacity term in the network tariff is calculated differently for industrial and commercial customers compared to households. For industrial and commercial customers, the capacity charge is determined by the measured peak power methodology, while for households it is determined by the power of the main fuse, so according to the maximum allowed current.

Slovenia has an innovative tariff design specifically built with EVs in mind, with a separate tariff for the charging. For contemporary design, the regulator put a focus on the load profiles and a future scenario of electricity consumption.

A redesign of the network tariffs is being assessed for the regulatory period 2019-2021. Network operators are active in different pilot projects that will identify the potential impact and effects of demand response and self-consumption on the different tariff designs. In addition to the pilot projects, the regulator is collecting and monitoring data and information necessary to further develop the tariff design for the upcoming regulatory periods.

Local sandboxes are also used for testing innovative tariff structures. The methodology in the network tariffs legal act[9] allows network operators to introduce pilot projects that are currently testing different dynamic pricing schemes with different tariff designs.

Grid users that only generate energy but not use it do not pay a G-charge or injection charges.

9 Legal Act on the methodology for determining the regulatory framework and network charges for the electricity distribution system (Official Gazette of the Republic of Slovenia, No. 46/18, 47/18 – corr. and 86/18)

Households and SMEs

Overall DSO tariffs, where available, offer a balance between volumetric and capacity terms, but the capacity term is based on the connection size, rather than on measurements, which does not take completely advantage from the available smart meters.

Household customers pay a connection charge depending on the contracted power. They pay a second connection charge for each time they increase the contracted power. In the year 2019, connection charges for households amounted to 35.91 €/kW, for SMEs 63.92 €/kW and SMEs using measured peak load, 91.21 €/kW.

The network tariff is divided into a volumetric and a capacity term. Households are billed according to the contracted power of the main fuse, following the maximum allowed current in €/kW, which defines the capacity term. Additionally, they pay a tariff according to the monthly consumption, €/kWh, the volumetric term. The capacity term weighs around 32% of the network tariff and 68% for the volumetric term.

Net metering is available for prosumers with renewable energy production through a self-consumption scheme. The volumetric term can also be determined by time-varying tariffs, with the possibility of day/night schemes. There is no fixed term included in the network tariff.

The Energy Act applies a methodology that allocates costs between the different terms. Three methods are used:

- The so-called Postage-stamp methodology proportionally distributes the total costs of the customers according to their consumption. This makes the tariff geographically neutral and homogeneous for a consumer group and voltage level.
- The Cascading methodology, where the lowest level customers take over part of the costs of the high voltage connected customers on a proportional basis depending on individual client group's consumption.
- Or simply, a sharing of network costs for all voltage levels between all final customers in the same customer group.

Industry

Transmission tariffs for industrial customers are mainly based on a capacity term that is based on measurements of peak power consumption. This allows a more involved approach to their energy consumption and incentivises a flexible use of their assets.

All customers connected to medium and high voltage levels (20 kV – 400 kV) pay shallow connection charges. The connection charge also depends on the contracted power and it is paid a second time in the case where there are increases to the connection size. For the year 2019, the connection charges for medium voltage amounted to 76.49 €/kW. Other than this, no other industry tariff regime exists. For medium-voltage customers, the split in the tariff corresponds to 53% for the capacity term and 47% for the volumetric term. For high voltage customers, the split is 65% for the capacity term and 35% for the volumetric term. The guidelines for allocating costs are the same for households and SMEs. The capacity term for customers at the high and medium voltage level, as well as customers at the low voltage level with connections above 43 kW, is calculated based on an average of the maximum of three 15-minute measurements of peak power in the daily high tariff. If the calculated amount is below 25% of the average of the maximum of three 15-minute measurements of peak power in the low daily tariff, this capacity term is used instead.

Net-metering is only used for prosumers in a self-consumption regime and only if production comes from renewable sources.

Differences between TSO and DSO tariffs

DSO and TSO tariffs are presented in an aggregated way in the customer's bill. A price list is available at the NRA's, network operators' and suppliers' websites detailing the specific prices and tariffs for the distribution and transmission network tariffs.

The TSO tariff also includes some non-grid related costs, like the costs to cover ancillary services and a contribution to cover the NRA's costs.

Taxes

Taxes and levies in Slovenia are very low, which allows the energy component and tariffs to send reliable signals to customers. Taxes and levies in the customer's bill include:

- The renewable electricity production tax
- A contribution to the activities of the market operator
- The excise duty on electricity
- 22% VAT on the energy consumed

These taxes and levies amount to 26% of the standard household energy bill, but if VAT and RES levies are discounted, the taxes only amount to 2% of the energy bill, the lowest out of all the countries in this report. Taxation on self-consumption is calculated via net-metering, based on a one-year accounting period. Grid-connected producers do not pay tariffs or taxes for the produced and injected electricity, only for the withdrawn electricity. Energy-intensive consumers are exempt from renewable tax.

Contracts and pricing

The reduced level of taxes allows the energy component to dictate the price, and the tariffs to influence consumption patterns. Overall, electricity prices in Slovenia are below the EU average, with 160 €/MWh for households and SMEs and 70 €/MWh for industrial customers.

Consumers need to have two contracts in Slovenia, one for the supply of energy and another for the network connection. The contract with the network operator usually depends on the technical specifications of a customer's grid connection point. Contracts with the supplier vary depending on a wider range of variables, including the load profile of the customer and diverse offers presented by the supplier. Dynamic pricing contracts are not available at this moment, even in the case that the customer has a smart meter, but other contracts with a time-of-use energy price are available. The energy term corresponds to 41% of the energy bill for low voltage connected customers and more than 60% for industrial customers.

Network tariffs amount to 33% of the electricity bill for households and SMEs. Industrial customers depend on the voltage level they are connected to. For medium-voltage customers, the tariff can amount to less than 20% of the bill and for high voltage users, it can be even less.

Vulnerable customers are entitled to emergency supply under certain conditions depending on financial circumstances and living conditions. Called the "last-resort" supply, the DSO covers the costs in these cases.

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SPAIN

Spain is an interesting case in that it was one of the pioneers in the smart meter roll-out but is now lacking a real utilisation of this hardware. While a type of contract is being offered by suppliers that use the capabilities of smart meters, this contract is not publicised enough, as suppliers receive a lower profit margin from them. The lack of awareness in the customer base also contributes to the timid use of this tariff.

With a view to incentive structures, Spain has taken some important steps in the last months, with the removal of the so-called “sun-tax” on self-generation from solar PV. But taxes are still too high and take over the majority of the bill. Nonetheless, an upcoming tariff redesign might help in lowering the price of one of the highest electricity bills in the EU, one that takes into account all the possibilities the Spanish smart meters can provide.

Infrastructure

Spain is at the forefront of smart meter roll-out for households in the EU having reached a 100% coverage in 2018, providing a great opportunity for a cost-reflective tariff design that incentivises an active participation by customers. Smart meter penetration for industrial customers, both connected to the high voltage grid and medium voltage grid is still ongoing, not having reached full coverage yet. SMEs and commercial customers with a contracted power between 15 kW and 50 kW connected to the low voltage network have a 40% coverage of smart meters so far, and the roll-out is continuing steadily. Since the roll-out in Spain began more than ten years ago, smart meters already installed do not need to comply with all the requirements established in the EU Directive 2019/944/EU on common rules for the internal electricity market. However, new functionalities are expected to be introduced once older smart meters finish their lifetime, in order to adapt smart metering systems to incoming changes in the internal market for electricity. No CBA was performed for the household smart meters roll-out, but it was the intent of the Spanish government together with the DSOs to start the roll-out, aiming at increasing efficiency in energy consumption. Consumers rent the smart meter from the distribution company for a regulated fee. The DSO includes costs related to installation and maintenance in the fees. Customers can also buy their smart meter from an independent provider, but not from the DSO.

Network Tariffs

General Aspects

With a balanced mix of capacity and volumetric components in the tariff, and all customers covered by smart meters, Spain's tariff design would be a good setting for flexibility services to thrive.

Spain has one single network tariff area with four regions (one mainland and three non-mainland regions) using different seasonal calendars. There are no different tariff regimes according to the asset used but charges to self-consumption make a distinction between renewable and non-renewable generation.

SME and industrial consumers have tariffs with hourly discrimination. Household consumers can choose between tariffs with and without hourly discrimination (with two or three periods). The domestic three period tariff has limited penetration so far. This particular tariff would encourage EV users to charge during the night.

There are certain provisions and regulatory structures, that though inadvertently, are creating barriers for certain types of technologies. For example, the design of the fixed term in the network tariff is a barrier for EV public charging infrastructure. Also, former complex regulatory structures, such as the "Gestor de Cargas" (an agent created to circumvent the legal duty not to re-sell final electricity demand) have hindered the deployment of EV recharging facilities. Nevertheless, the "Gestor de Cargas" has been repealed by the royal decree RD 15/2018 on urgent measures for energy transition and consumer protection. Also, the existence of costs unrelated to the electricity supply in consumers' bills penalizes electricity compared to other energy alternatives, thus making it difficult to electrify final energy consumption.

A redesign of network tariffs is planned for 2020. In July 2019, the Spanish regulator has launched a public consultation for the new tariff methodology that gives a lot of weight to contracted capacity. Even though this tariff differentiated between periods, it does not take advantage of the full smart meters´ potential because the contracted capacity does not fully reflect the use of the network.

It fails to recognise that the real cost driver is the power demand coincident with high network use.

All generating facilities pay a variable regulated G-charge of 0.5€/MWh on energy injected into the grid, although the forthcoming new network tariffs design should eliminate this G-charge. The price does not vary according to the voltage level or location, but a correction factor applies to pump hydro facilities to account for both produced and consumed electricity. The regulated G-charge is just one part of a wider array of charges applying to producers to finance the network, system costs and public policies.

Policies increase the system cost with charges that are not directly related to the electricity supply, making electrification even further challenging. The current tariff structure does not reflect grid congestion at the low voltage grid and hinders the further development of flexibility services facilitating inefficient consumer behaviour.

Households and SMEs

Households and SMEs have access to tariffs that valorise the flexibility in their consumption patterns, basing off the capacity term on measurements of peak consumption. New tariffs for self-consumption facilitate the interaction of DERs with the grid, and act as a clear incentive.

Connection fees for households and SMEs in urban areas with connections up to 100 kV pay 17.37 €/kW and a 21% VAT. For other customers, even those connected to the low voltage grid, the connection costs vary depending on the voltage level, the reinforcement of the grid needed, distance to the closest substation, etc. There are other costs related to the connection that customers must also pay. A right to connection for the supplier to the network, 9.04 € plus 21% VAT, access rights to the network, 19.70 €/kW plus VAT, technical and safety compliance verification of the installation, 8.01€ plus VAT.

Spain's network tariffs consist of a volumetric and a capacity term. The weight of these terms in the tariff for 2019 is 40% volumetric and 60% capacity term for households, 21% volumetric and 79% capacity for SMEs connected at 380V.

The capacity term is defined by the contracted demand in kW for customers with a capacity of up to 15 kW. For consumers with a capacity above 15 kW, the capacity term is defined by the contracted demand and measured peak (granularity 15 minutes) during each time-of-use period. The tariff also depends on the connection level and contracted demand, the various levels being for low voltage: ≤10 kW, 10-15 kW, >15 kW, and for medium voltage ≤450 kW, > 450 kW.

The volumetric term is defined depending on the connection size. Customers with a capacity of up to 15 kW can choose between a flat or time-varying (static) volumetric term. Customers with capacity over 15 kW have a time-varying volumetric term.

New tariffs for self-consumption will be approved in 2019, exempting self-consumed energy from renewables, cogeneration and waste from network tariffs and other regulated charges. A new network tariff will be introduced for self-consumed energy if it uses a local distribution tariff for nearby generation assets. Energy exported into the grid by prosumers is charged the regular G-charge of 0.5 €/MWh as other generators.

Industry

Transmission tariffs are mostly capacity-based, with advantages like interruptibility programs for large consumers to participate actively in grid stability.

Connection charges in Spain are deep. New customers in the medium voltage grid up to 20 kV (in parenthesis for high voltage connected customers > 72.5 kV) must pay for the grid extension necessary for their connection. For industrial customers using up to 250 kW in urban areas, a 15.72 €/kW plus 21% VAT (16.33 €/kW plus VAT) applies, whereas other customers make payments depending on voltage level, reinforcement required, distance to the nearest substation etc. Additionally, customers pay:

- connection rights for the supplier to the network: 79.49 € plus VAT (≤ 20 kV), and 374.54 € plus VAT (> 72.5 kV)
- access rights to the network: 16.99 €/kW plus VAT (≤ 20 kV), and 10.70 €/kW plus VAT (> 72.5 kV)
- technical and safety compliance verification of the installation: 54.87 € plus VAT (≤ 20 kV), and (125.99 € plus VAT (> 72.5 kV)

No specific tariff regimes exist for industrial customer, however, a tax reduction for energy-intensive industries is available.

Differences between TSO and DSO tariffs

Spanish customers pay the so called "access tariffs", an amount that includes all regulated costs, in which the distribution and transmission tariffs are included, together with other non-energy related regulated costs and costs to cover the support schemes for RES, cogeneration and waste disposal, and other system costs. Both transmission and distribution tariffs are shown separately in the electricity bill.

Taxes

A high level of taxes and levies burden the final electricity bill in Spain, blunting any possible signals provided by the network tariffs and the energy component. The electricity bill includes a 21% VAT and an excise tax of 5.1%. Industrial customers get an 85% tax reduction from the excise tax. Around 50% of the price paid by household consumers corresponds to taxes and levies. This proportion is much lower for industrial customers, who pay around 25% of their bill in taxes

A significant part of taxes corresponds to non-energy related costs. The regulated access tariffs finance policy costs (RES support, tariff deficit annuities, etc.). At the wholesale level, generators pay taxes related to energy sustainability. These include: a tax on the value of the energy generated (7%), a hydroelectric levy for water use, a nuclear tax on radioactive waste production, a tax on the storage of radioactive waste, an increase of tax rates on some hydrocarbon fuels (called the green cent). Additionally, they pay regional and local energy taxes for wind, pollutants, emissions, etc. There is no special treatment of storage assets, their energy acquisitions are treated in the same way as consumers' acquisitions, energy losses are also not taken into account.

An energy poverty scheme, called *"Bono social"*, provides discounts of 25%, 40% and 100% to vulnerable customers. This is based on family income and other social circumstances. Consumers that receive a 100% discount are consumers whose supply cannot be cut off and they are financed by the suppliers and/or by the social services.

Contracts and pricing

Electricity prices in Spain are among the highest in the EU for households and SMEs at 220 €/MWh and below the EU's average for industrial customers at 85 €/MWh. This situation is mainly driven by a high tax share for households, blunting any signals from the energy component and tariff design. Contracts usually bundle supply and network costs, except for those customers that acquire energy directly from the market. In case the customer acquires energy directly from the market, usually industrial customers, they will need a separate network contract.

Small electricity customers (up to 10 kW) have the right to be supplied, as a public service obligation, by a "reference supplier" under a dynamic price (PVPC). The PVPC is calculated considering the hourly energy cost in the day ahead of an intraday market, the applicable network charges and any other charges, such as the commercial margin of the reference suppliers. The energy supplied through the PVPC accounts for 11% of the total consumption in 2018 in Spain. According to the CNMC, 39.4% of domestic consumers have a PVPC contract. But every year this percentage is decreasing, as suppliers are more interested in offering their "free market" contracts, with higher profit margins for them. Contracts based on a regulated PVPC price are on average cheaper for the consumer, although in the last years a small number of contracts have appeared, including dynamic price contracts, that are cheaper than the regulated PVPC tariff.

The distribution tariffs' weight in the electricity bill is 22% for households and SMEs, with an additional 5% corresponding to transmission tariffs, and 14,5% for industrial customers.

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SWEDEN

One of Sweden's strong points is an already developed smart meter base. Even though it has quite limited capabilities, network operators are already able to provide some innovative contract options to customers. The tariff design for households and SMEs focusses on the fixed term, with room for improvement towards a more cost-reflective tariff if operators were to include a capacity term in the mix. A redesign of network tariffs is currently planned, and a first draft is expected in 2020.

Infrastructure

Infrastructure in Sweden is quite advanced, although it will need to be adapted to the capabilities of new smart meters. First-generation smart meters cover Sweden's entire customer base but are only able to provide hourly measurements. At the end of 2018, the government decided to start a renovation process to update the metering infrastructure. The second-generation roll-out started in 2019 with a plan to complete it by 2025. The CBA performed for both rollouts was in compliance with the European Commission's recommendations (2012/148/EU). DSOs and TSOs cover the initial costs of installation and maintenance for metering infrastructure, but other costs are passed on to the customer through network charges. No specific fee exists for metering in the tariffs.

Network Tariffs

General Aspects

Overall tariffs in Sweden will require an update to properly take advantage of their infrastructure, since the main indicator for the tariffs is currently the size of the connection, a mostly fixed tariff, which does not allow for much interaction with the grid.

Sweden has one TSO region with the same transmission tariffs for everyone connected to its grid. Around 160 DSOs are active in Sweden, all of which have designed a distribution tariff according to their cost structures. However, they must meet the Electricity Act requirements that dictate how tariffs are objective and non-discriminatory and are designed in a compatible way for efficient use of the electricity grid. In practice, there are no big differences between the various DSO tariffs, and most are based on a fixed term and variable term (SEK/kWh).

There are no technology-specific tariffs in Sweden, but in practice, higher consumption results in a lower total price because the fixed term of the tariff gets spread out over more kWh. DSOs can choose to introduce a specific pilot project with new incentives for different usages, but it must be in line with the current regulation and be approved by the regulator, Energimarknadsinspektionen (Ei).

Grid users purely generating energy must pay a G-charge depending on the size of their assets. Generators with a capacity below 1500 kW only pay charges corresponding to measurement, calculation and reporting. Generators above 1.500 kW pay the regular fixed, capacity and energy charges.

A redesign of the regulation covering network tariffs is currently being conducted by the NRA, Ei, to design a tariff that contributes to the efficient use of the electricity grid. The first drafts are expected in 2020.

Households and SMEs

The tariffs at distribution level are highly reliant on the fixed term, not allowing for individual customers to react to grid signals. As an upside, time-varying

tariffs are available as well as tariff exemptions for DERs. Connection charges for households and SMEs depend on the distance to the nearest connection point:

- Up to 200m to the nearest connection point: 28 200 SEK
- 200m – 600m: 28 200 SEK + 241 SEK/m
- 600m – 1200m: 124 600 SEK + 519 SEK/m

The tariff structure is composed of a fixed term that depends on the size of the fuse (10 A, 16 A, 20 A, 25 A etc.), and a volumetric term depending on the consumption expressed in SEK/kWh. The weight of each term is highly dependent on the connection size and annual consumption. Averages are as follows:

Households and SMEs	Fixed	Volumetric
Apartment 16A, 2 000 kWh/year	76.25%	23.75%
Single family house 16A, 5 000 kWh/year	72.56%	27.44%
Villa 20A, 10 000 kWh/year	70.60%	29.40%
Villa 20A, 20 000 kWh/year	55.43%	44.57%
Villa 25A, 20 000 kWh/year	60.84%	39.16%
Villa 25A, 30 000 kWh/year	51.16%	48.84%

Objectivity and non-discrimination are key principles applied to the design of the tariff. In practice, there is a significant difference between DSOs depending on whether they cater to clients in rural or urban areas. The capacity term is usually defined by the size of the fuse and, in a smaller part, the contracted demand from the DSO in kW. The measured peak, independent of when it occurs, is calculated based on an average of one to five peaks. The measured peaks during a specific period are calculated monthly and hourly. No net-metering is applied to the volumetric term. The energy that is withdrawn is accounted for separately from the energy that is injected. The volumetric term is mostly flat, but some DSOs are offering a static day/night tariff. The fixed term is the function of the size of the fuse (10 A – 63 A), but the fixed charge can vary between different DSOs.

Incentives for DERs exist in the form of a tariff exemption for the generation below 1.5 MW (or capacity under 43.5 kW (63 A)), which can only be charged for measurement, calculation and reporting.

Industry

Transmission network tariffs on the other hand have a heavy capacity component, based on the measured peaks of their smart-metering devices, allowing industrial customers to adapt to the network signals. Industrial tariffs are in general shallow but can be deep in the cases where grid reinforcement is needed, and the customer has no production of their own. Industrial customers have fixed, volumetric and capacity charges that are split according to the following percentages:

Industry	Fixed	Volumetric	Capacity
100 kW, 350 MWh/year	10.39%	25.44%	64.17%
1 MW, 5 GWh/year	2.90%	29.37%	67.74%
20 MW, 140 GWh/year	1,43%	28,10%	70,47%

The measured peak of the capacity term, independent of when it occurs, is calculated based on an average of one to twelve peaks. During a specific period, the measured peaks are calculated based on monthly and hourly peaks.

Differences between TSO and DSO tariffs

Customers receive an aggregated sum of both DSO and TSO tariffs in their bill without a clear distinction of the different costs. The TSO cost is included in the DSO tariff, which then reimburses the TSO for their portion of costs. Some minor fees for non-grid related costs also in the bill, include the electrical safety fee, the network monitoring fee, and the electrical preparedness fee. Costs for green certificates are not included in the bill since they are mandatory for suppliers.

Taxes

Taxation in Sweden for households and SMEs takes over 35% of the final bill, and below 10% for industrial customers. Especially for industrial customers the tax regime is one of the most beneficial in the EU. Taxation consists of a 25% VAT and an energy tax expressed in SEK/kWh that amounts to 13-19% of the average household electricity bill, depending on the electricity and network prices. The energy tax in 2019 amounted to 0.35 SEK/kWh, together with VAT it reached 0.43 SEK/kWh. The energy produced and consumed behind the meter is free of energy tax and VAT.

Users with a maximum 100 A fuse can opt for a tax reduction based on the amount of renewable energy injected into the grid during the year if the same amount was consumed from the grid during the same period. This is valid for 30 000 kWh annually and the deduction is 0.6 SEK/kWh. Environmental charges are only applied to fuel in the energy production, for example, the carbon dioxide tax and the nitrogen oxide tax.

Contracts and pricing

Electricity prices in Sweden for households and SMEs are in line with the EU average at around 200 €/MWh. For industrial customers on the other hand, they are one of the lowest prices across the EU with an average 65 €/MWh. Contracts are not bundled, and customers receive separate network and supply contracts. Customers in Sweden have several contract options, but given the current smart meter technology, only hourly energy pricing contracts are possible. The current split between contract types is as follows:

- Variable price contracts, 47 %
- Fixed price 1-year contracts, 14 %
- Fixed price 2-year contracts, 3 %
- Fixed price 3-year contracts, 13 %
- Other types of contract, 10 %
- Price for inactive customers, 13 %

Average bills for households are composed of 20% corresponding to the energy price, 45% to network tariffs and 35% to taxes. The weight of the network tariff can vary significantly between DSOs, taking over up to 50% of the total bill. For industrial customers the energy price is representative of the energy component, with an average weight of 55% in the bill, with taxes at 8% and tariffs at 37%.

List of Acronyms

ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserve
AMR	Automatic Meter Reading
BRP	Balance Responsible Party
BSP	Balancing Service Provider
CBA	Cost Benefit Analysis
CPP	Critical Peak Pricing
CTA	Contribution tarifaire d'acheminement
CHP	Combined Heat and Power
DER	Distributed Energy Resources
DSR	Demand-Side Resources
DR	Demand Response
DSM	Demand Side Management
DSO	Distribution System Operator
EC	European Commission
ENTSO-E	European Network of Transmission System Operators for Electricity
EV	Electric Vehicle
FiT	Feed-in-Tariff
FRR	Frequency Restoration Reserve
FSP	Flexibility Service Provider
G-Charges	Generation charges
GW	Gigawatt
GWh	Gigawatt hour
HV	High Voltage
HVDC	High Voltage Direct Current
GHVG	Grid High Voltage Grid
I-SEM	Integrated Single Electricity Market
kV	Kilovolt
kVA	Kilo (Volt X Amps)
kW	Kilowatt
kWh	Kilowatt hour
mFRR	Manual Frequency Restoration Reserve
MRR	Monthly Meter Reading
MS	Member State
MW	Megawatt
MWh	Megawatt hour
NRA	National Regulatory Authority
ODE	Opslag Duurzame Energie
PVPC	Precio Voluntario al Pequeño Consumidor
RES	Renewable Energy Sources
RTP	Real-time Pricing
SEM	Single Electricity Market
SME	Small and Medium Enterprise
TNUoS	Transmission Network Use of System
ToU	Time-of-Use
TSO	Transmission System Operator
TW	Terawatt
TWh	Terawatt hour
V	Volt
VAT	Value Added Tax
YMR	Yearly Meter Reading

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