An aerial photograph of a modern building at dusk. The building features several large, circular skylights with a radial pattern. In the foreground, there is a large array of solar panels. The building is surrounded by lush greenery and a winding path. The overall scene is illuminated by warm, low-angle light, creating a serene and modern atmosphere.

# THE VALUE OF THE GRID

Why Europe's distribution  
grids matter in decarbonising  
the power system

# The Value of the Grid

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Why Europe's distribution grids matter in decarbonising the power system

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

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

We stand for

The vision of the European power sector is to enable and sustain:

- A vibrant competitive European economy, reliably powered by clean, carbon-neutral energy
- A smart, energy efficient and truly sustainable society for all citizens of Europe

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

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

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

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

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

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

Dépôt légal: D/2019/12.105/12

**WG Business Models & Network Customers**

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# The Value of the Grid: Why Europe's distribution grids matter in decarbonising the power system

Eurelectric position paper

June 2019

## KEY MESSAGES

The energy transition is on fast-forward. A decade from now, the European power sector will look very different from the way it does today. By 2030, more than half of all electricity is expected to come from renewable assets and the recently agreed transport legislation will bring over than 40 million electric cars onto the road in the same period<sup>1</sup>. At the same time, electric heat pumps, batteries and other grid edge technologies are also expected to advance significantly. Distribution System Operators (DSOs) are the linchpin of this future system, which is increasingly decentralised and interactive. This shift will require substantial additional investments in the grid and a review of regulatory principles. DSOs can accommodate and will facilitate the transition, but how fast they can adapt depends rather on political will than on technology or economics. In order to facilitate this switch, Eurelectric puts forward the following recommendations. Specifically, Eurelectric calls on policymakers and regulators to:

- Acknowledge the key role DSOs are playing in achieving the EU climate and energy objectives and in enabling a cost-efficient transition towards a fully decarbonised economy. Over 90% of all distributed RES generation is and will most likely continue to be connected at distribution grid level. Investments will also be required to enable electrification in transport and buildings. DSOs need to embrace their new role as market facilitators shifting away from the old 'connect and forget' paradigm<sup>2</sup>. Failure to act in a timely manner could jeopardise this innovative and customer-driven development. Any deferral might also impact quality of supply and disproportionately drive up future costs for maintaining a secure grid service.
- Recognise the value the grid has for all its users. Access to the grid provides customers with a range of services that go beyond the mere delivery of electricity. Security, reliability, efficiency, high-quality electricity delivery are clearly identified by consumers as key benefits provided by the distribution grid. The grid also enables individuals to reap the financial value of selling self-generated electricity and of participating in demand side response.
- Take into account the fact that economies of scale strongly suggest that using off-grid solutions will continue to be more costly than being connected to the grid. Such off-grid solutions will typically need to be overscaled to offer a service with the same level of quality and long-term efficiency, which is today provided by the main distribution grid. In addition, if customers start leaving the grid on a significant scale, distribution tariffs would substantially increase for the remaining customer base, which usually consists of customers unable to finance capital-intensive renewables energy solutions for their homes.

<sup>1</sup> European Commission's Long-Term Strategy [A Clean Planet for All](#), 2018

<sup>2</sup> Eurelectric's vision for DSOs: [From pipes to platforms](#) and EY report on: [The future role of DSOs](#)

- Make Citizens' Energy Communities (CEC) a success through embracing all related duties and responsibilities (especially balancing responsibility) when acting either as a supplier, as an active customer, as a DSO, or as any other system user<sup>3</sup>, according to the Clean Energy Package. Eurelectric recognises that the development of CECs plays a key role in electrification and decarbonisation as they can provide value to consumers, as well as flexibility and efficiency to the system.
- Ensure that grid costs are shared in an equitable and non-discriminatory way among grid users thus avoiding cross-subsidisation between different types of customers. It is critical that all parties using the distribution grid directly or as a back-up pay an adequate price for the service provided by the DSOs or for the option of using the grid when needed.
- Acknowledge that the electrification efforts needed to achieve deep decarbonisation of the EU economy require an increased reliance on electricity networks and thus a more resilient grid. In this context DSOs are expected to embrace new roles while facing more complex grid operations. It is therefore crucial for DSOs to invest in adequate skills within their organisations to adapt to new developments and to the required modernisation.
- Incentivise smart and future-proof network investments to mitigate networks cost increases, both in terms of assets and services. With this in mind, ensure adequate incentive schemes for DSOs to innovate and to handle the increasing complexity, including solutions and activities to meet future demand for grid services. This will empower customers to take centre stage in the energy transition while allowing DSOs to perform their function as neutral market facilitators and enablers of smart grid services. In this regard:
  - Regulators need to make decisions on the optimal allocation of risks and associated costs of stranded assets. The greater risks arising from investments in new elements and innovative technologies should be considered an unavoidable cost in asset remuneration parameters. A return on investment below an adequate level would jeopardise the ability of DSOs to secure the investments needed for the overall energy transition.
  - The current grid tariff model should be reviewed to reflect the diversity of needs of different types of customers (e.g. EV charging or electric heating). In this respect, and in line with the 'Clean Energy for All' package, new types of network tariffs with different elements should reflect grid costs more effectively and incentivise an efficient network use.
- National Regulatory Authorities (NRAs) will accordingly need to adapt and develop the right skills to accompany and regulate DSOs in their renewed role. Dedicated support could be required for national authorities availing themselves of less financial and technological resources, e.g. via tailored training programmes or specific funding in order to develop required skill sets.

<sup>3</sup> Eurelectric [recommendations](#) on Citizens Energy Communities, May 2019

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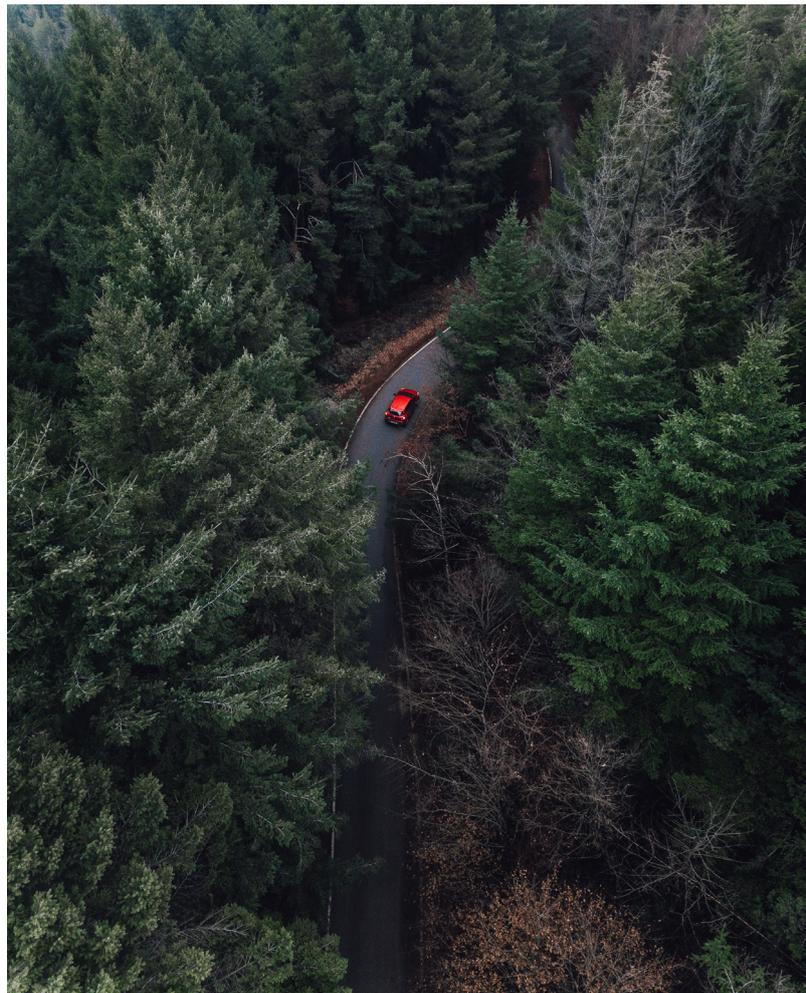
# I. THE VALUE OF THE GRID FOR CUSTOMERS

The distribution grid is one of the pillars of the economic, cultural and scientific progress of modern society, given that it brings electricity to all citizens who want to be connected to it without exception or discrimination. It is a critical infrastructure, which provides security, stability, comfort, progress to customers as well as industrial competitiveness. The grid and the electricity it delivers is generally perceived as a ubiquitous and universal good. However, as any other public service of this type (Internet, public lighting, water), customers only realise its necessity in its absence. That's the reason why it is usually not a topic of daily concern to consumers.

As outlined in the recent Eurelectric Decarbonisation Pathways Study<sup>4</sup>, the decarbonisation of Europe's power sector is achievable by 2045 and will underpin the wider decarbonisation of the EU economy through electrification. This ambitious objective necessitates, however, substantial investments in innovation for smart grid technology, and new business models to improve the functioning of electricity distribution networks. Massive deployment of variable renewable generation – predominantly solar photovoltaic (PV), onshore and offshore wind – is expected over the coming years. By 2045, in a scenario where electrification reaches 63% across the EU economy, new load will come from the transport, heating and industrial sectors. In this scenario onshore wind capacity is expected to triple from its current levels to more than 640 GW, with offshore wind expanding to 470 GW. Solar PV capacity is set to increase seven-fold to 950 GW. Ultimately, renewable generation is expected to meet more than 80% of Europe's future energy needs.

At the same time, more and more consumers are expected to provide demand-side flexibility, with 120 GW-150 GW of flexible load available by 2045 according to our study results. Most of these will be households, commercial or industrial consumers, connected to the distribution grid. In the transport sector, a combination of technology improvements, public policy (e.g. the Clean Vehicles Directive), ambitions set by cities and societies to improve air quality and political mandates, is driving Europe's take-up of electric vehicles (EVs). The penetration of EVs is still low but rising quickly, with adoption expected to accelerate given the increasing economic viability of battery technology and rollout of EV charging points. EVs accounted for roughly 2% of new vehicle sales in the EU in 2018, but this number is expected to reach 33% by 2030, equivalent to around 6.8 million EV sales that year alone. Most of this generation capacity and new load will be connected to the existing distribution grid.

<sup>4</sup> Eurelectric [Decarbonisation Pathways](#) and EY report on [the future role of DSOs](#)



## 1) WHAT DOES THE GRID OFFER TO ITS CUSTOMERS (INDIVIDUALS, BUSINESSES)?

Eurelectric has identified a range of services<sup>5</sup> provided by the grid, that are often not obvious but which offer to customers more than the delivery of electricity.

### a. The grid ensures a secure and available supply regardless of the conditions

The grid provides customers with the ability and freedom to perform their tasks, obligations and business operations, by adapting to their changing demands throughout the day, so as to avoid power outages and provide them with a reliable and affordable supply of electricity when needed. Customers can lead their lives according to their own schedule and without the need to compromise their quality of life regardless of whether on-site generation is inoperable due to equipment maintenance, unexpected physical failure or prolonged overcast conditions (i.e. use of backup service). Grid operators are also responsible to ensure that electricity is safely made available to the customers' premises.

### b. The grid provides high-quality electricity supply through guaranteeing voltage quality and continuity of supply

Thanks to voltage quality services, DSOs enable the safe operation of home appliances and industrial facilities. Voltage quality is ensured when deviations in voltage frequency and in voltage magnitude are kept within boundaries and when distortions of the voltage wave shape are minimised. Voltage quality is becoming an increasingly important issue due to the increasing susceptibility of end-user equipment, industrial installations and distributed generation to voltage disturbances. A large interconnected grid naturally delivers a voltage wave quality that enables safe, secure and efficient use of the connected equipment. For instance, by preventing automatic shut-down of automated industrial machines, which are becoming more vulnerable to voltage quality variations or by preventing damage in sensitive assets such as computers and high-end electrical devices present e.g. in hospitals and data centres.

The continuity of supply refers to the availability of electricity to the grid user. The duration and frequency of electricity supply interruptions, as measured by the SAIDI<sup>6</sup> and SAIFI<sup>7</sup> indices, are a good indication of the reliability of the grid. The challenge for DSOs is to maintain a high level of continuity of supply, without incurring excessive cost increases. It is worth noting that, over the past 15 years, the reliability of the power distribution network has increased in all European countries thanks to the continuous efforts from DSOs to better serve their customers as shown on the graph<sup>8</sup> below representing the average outage duration for each customer served (SAIDI).

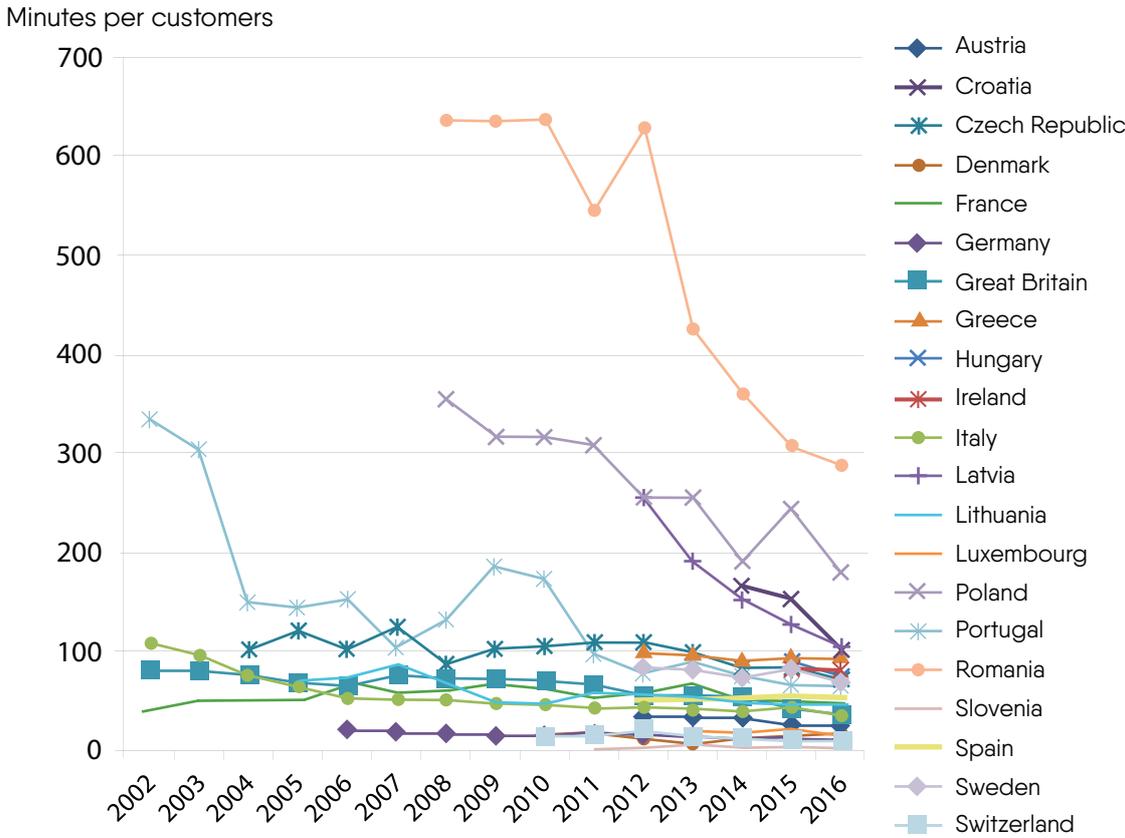
<sup>5</sup> Electric Power Research Institute study – the Integrated Grid, Realising the Full Value of Central and Distributed Energy Resources.

<sup>6</sup> System Average Interruption Duration Index measuring the average duration of interruption.

<sup>7</sup> System Average Interruption Frequency Index measuring the frequency of interruption.

<sup>8</sup> [CEER Benchmarking Report 6.1 on the Continuity of Electricity and Gas Supply](#), July 2018.

Figure 1 - Reliability of service has continuously improved over recent years in Europe. Average outage duration for each customer served, without exceptional events.



Source: CEER

### c. The grid enables customer participation in the electricity market

By allowing bi-directional electricity flows and becoming increasingly digitalised, the grid enables self-generating customers to be remunerated from selling their own excess electricity to the market, or even to local markets, either directly or through a third market party, ensuring the electricity is not wasted. Customers have also the potential to be remunerated for providing flexibility services to the system and create additional revenues for themselves.

In both cases, this will help to reduce the total cost of energy for society.

### d. Electricity is delivered in the most cost-efficient way in the electricity grid

Cost efficiency and economies of scale: Grids are considered as natural monopolies with the EU having a reliable and highly meshed power network that has been over a century in the making<sup>9</sup>. These grids are designed to meet peak demand based on contracted capacity of all connections including reliability reserves. In most cases consumers do not use this capacity, however it remains a legal obligation to deliver the energy to customers up to their maximal connection capacity. In this context economies of scale apply as the continuous connection of a rising number of users generating and consuming energy facilitates a more efficient and cost effective usage of the grid overall, ultimately resulting in benefits to all grid users.

<sup>9</sup> See also: Electricity Network Regulation in the EU, L. Meeus, JM. Glachant, 2018

**Effective and efficient management of the grid:** the electricity grid provides balance between generating and consuming power flows. This balance avoids inefficient investments and therefore leads to overall lower costs for the consumer. An effective management of grid infrastructure optimises the investments required to guarantee electricity supply.

**A highly efficient grid enables synergies and minimises environmental impacts:** the grid can reduce the need for additional energy sources and/or storage systems, thus minimising the environmental impact and space utilisation.

## e. Predictable grid deployment contributes to industrial and economic development

Grid development also drives industrial development and ensures investors predictability of the development trajectory of certain regions. Larger companies would choose sites for their production facilities based on the availability of reliable and secure grid supply.

### Case 1: EVN, Plovdiv, Bulgaria - How economic development is facilitated by a reliable grid infrastructure

The Trakia Economic Zone near Plovdiv is the largest industrial zone in Bulgaria and Southeastern Europe overall. Since the establishment of the zone, a total of 104.1 km of medium voltage underground cable lines have been built and constantly upgraded by EVN, one of the three Bulgarian DSOs. EVN stands for network solutions (substations, transformer stations, technical equipment) at highest technological standards, beyond the minimal requirements. The grid company anticipated the upcoming development and emerging needs of the economy in the region and decided to build a substation in Tsaratsovo in a greenfield land, which was the key enabler for the following economic boom. The substation was largely dimensioned and the possibility of a gradual expansion was foreseen from the beginning. In order to ensure safe and high quality power supply in the area, EVN chose to build a part of the medium voltage network ring-shaped and ensured compliance with EN50160 standards.

The high quality power deployed and the proactive network planning approach adopted by EVN made the area attractive for investors from the manufacturing, lighting and electronic industry, valuing the perspective of secure and reliable supply.

Since 1996, over 2 Bn EUR have been invested by 180 companies and 30 000 well-paid jobs were created. In 2018, the Trakia Economic Zone has become one of the most attractive investment areas in Europe and additional 1 Bn EUR of investments and the creation of 15 000 jobs are expected by 2025. EVN will keep pace with the fast economic growth and further facilitate it. A new 110/20 kv substation and 131.5 km underground cable lines will be built to cope with a 20% increase of electricity demand from 413 MW to 548 MW until 2025 (+33%).

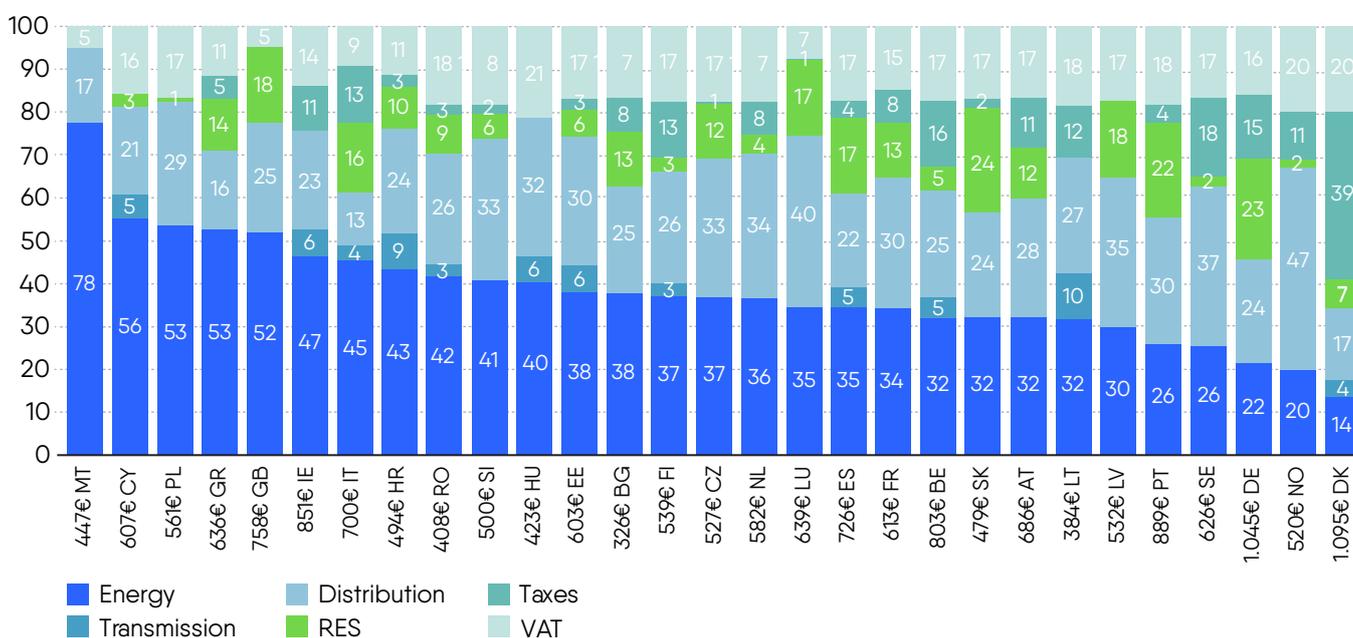


## 2) WHAT IS THE GRID'S COST FOR THE CUSTOMER? WHAT IS THE CUSTOMER PAYING FOR?

In most EU countries, network tariffs are regulated and monitored by National Regulatory Authorities, according to EU guidelines and national law. Customers have therefore a justified expectation that tariffs are cost-reflective and transparent.

Grid costs are only part of the total electricity costs for a consumer, which also consist of energy costs, energy taxes, policy costs (e.g. RES subsidies), and VAT (as shown in the below Figure 2<sup>10</sup>). Grid costs (i.e. transmission and distribution grid costs) vary greatly among the EU, ranging from a relatively small share of the overall costs of electricity for the consumer (Cyprus, Greece, Italy, Malta) up to a significant share of these costs (Portugal, Czech Republic, Luxembourg). This can in part be explained by the age of different networks across Europe and costs of renewal.

Figure 2 – Breakdown of electricity offers for households in capital cities– November/December 2017 (%)



Source: ACER/CEER

Over the last decade (2008–2017), total electricity prices paid by households in the EU have grown steadily<sup>11</sup>, by 2% annually. This growth was driven by many factors, mostly taxes (including VAT, Taxes and policy costs which grew by up to 6% annually), followed by network charges (+ 2.5% annually) while the energy component declined (-1.5 % annually) and eased overall price growth. 2017<sup>12</sup> marked a reversal of the decade-long trend of increasing electricity costs, as the EU household electricity price fell for the first time. Also in 2017, both network charges and taxes decreased on average, in addition to the energy component.

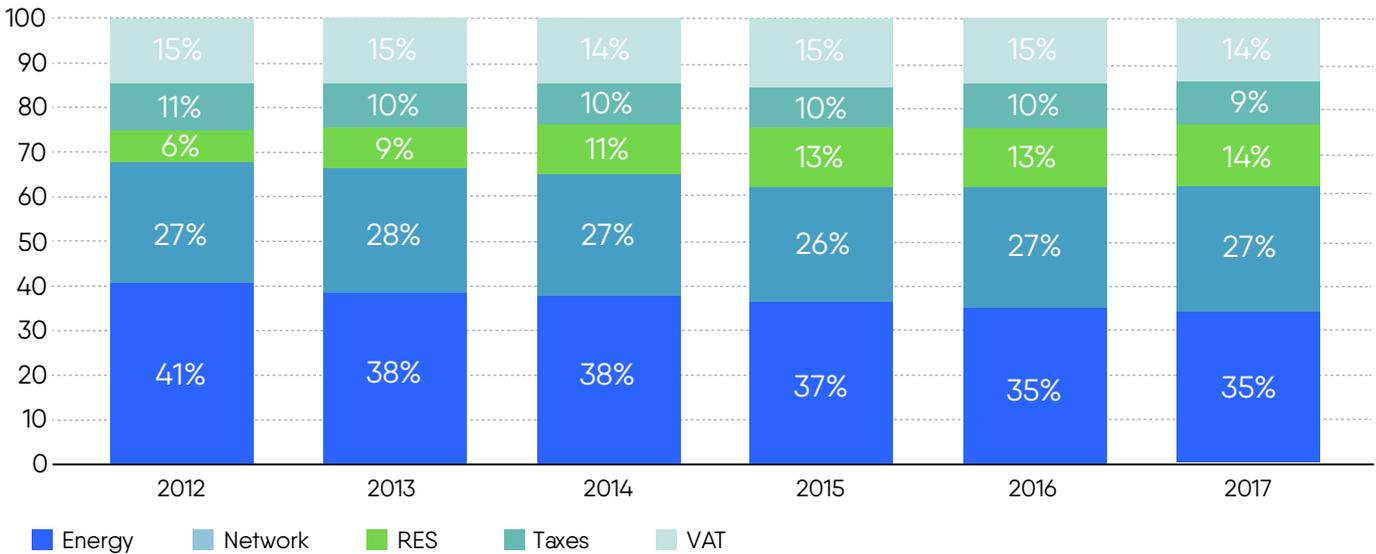
<sup>10</sup> ACER/CEER [Annual Report](#) on Electricity and Gas Retail Market Volume, 2018.

<sup>11</sup> Retrieved from "Energy prices and costs in Europe", 2018 Full report – European Commission Staff Working Document.

<sup>12</sup> Idem

However, between 2012 and 2017 (as shown in Figure 3) DSOs and TSOs have worked hard to keep the grid costs at stable level, as the share of network charges paid by the consumer only increased moderately in terms of total volume. Besides that, the fraction of network cost remained constant representing about a quarter of total electricity household price.

Figure 3 – Weighted average breakdown of incumbents’ standard electricity offers for households in capital cities – 2012–2017 (%)



Source: ACER/CEER

Grid costs are collected through regulated charges and network tariffs. Apart from connection charges, which correspond to the costs relating to the connection of customers to the grid, network tariffs generally recover the DSOs’ CAPEX, for capital expenditures due to investments in assets, and OPEX, for operations, including system services and maintenance<sup>13</sup>.

The network tariffs relating to the use of the grid usually consist of an energy charge, a power charge (depending on the contracted capacity of the connection) and, in some cases, a fixed charge. In order to ensure efficient network customers behaviour and long-term cost recovery, it is important that the overall tariff structure corresponds to the cost drivers’ structure.

Income adequacy for the distribution networks can potentially be ensured by the Regulator, assuming that tariffs can be set at a level sufficient to recover regulated costs and that tariff structure reflects the grid’s cost structure. On the other hand, badly designed tariffs can incentivise inefficient network users’ behaviour and inefficient investments in the grid, as well as jeopardising the network costs’ recovery, resulting in higher costs for society overall.

<sup>13</sup> Eurelectric Position paper, Network Tariffs, March 2016.

### 3) EMERGING TRENDS

Various trends are emerging with regards to electricity connectivity but these need to be carefully examined to be an alternative to the main grid or if they remain dependent on it, and, assuming they are indeed an alternative, if they truly provide a reliable and economically beneficial solution for the customer.

#### a. Micro-grids and citizen energy communities connected to the grid

Overall, Eurelectric recognises the development of micro-grids<sup>14</sup>, Citizens' Energy Communities (CEC)<sup>15</sup> and other new forms of consuming, producing, storing and distributing electricity as a key driver for decarbonisation and consumer's empowerment. To make it a success, CEC should endorse all related duties and responsibilities (especially balancing responsibility) when acting as a supplier, active customers, DSO, or as any other system user already defined.

Eurelectric believes these communities can be useful flexibility sources for distribution grid, and there are ways for partnership to be further developed and to achieve benefits from mutual cooperation<sup>16</sup>.

Currently, most of the micro-grids and Citizens Energy Communities, which remain connected to the distribution grid, rely on the services provided by the grid and provide services back to the grid in return. Citizens Energy Communities or micro-grids could possibly sustain their own needs most of the time but rely on the grid in key situations:

- When their own generation fails. Staying connected to the grid provides an insurance for the continuity of supply;
- When customer demand exceeds own generation;
- When electricity produced locally exceeds local needs. The surplus can be fed into the grid and sold. The connectivity provides opportunity for local prosumers to participate in the market;
- When own generation provides flexibility or system services to the grid.

In order for the consumer to properly value the service provided and, importantly, to avoid market distortions, Eurelectric considers that some principles<sup>17</sup> should apply, once there is a connection point.

<sup>14</sup> A micro-grid is generally composed of one or more generators (from renewable generation facilities, but also conventional production facilities), energy storage facilities, loads, control means, compensation system and information systems. All of these technologies must allow the micro-grid to disconnect from the grid and to operate independently by some time of the main network.

<sup>15</sup> Citizens Energy Communities, as regulated under the European Directive, is a community open to all categories of entity, however, the decision-making power is limited to those members or shareholders that are not engaged in large scale commercial activity and for which the energy sector does not constitute a primary area of economic activity. Citizens energy communities are deemed a category of citizens' or local actors' cooperation that should be subject to recognition and protection under the Union law. The definition of citizen's energy communities does not prevent the existence of other citizen initiatives such as those stemming from private law agreements. Therefore, it should be possible for the Member States to choose any form of entity for citizens energy communities, for example an association, a cooperative, a partnership, a non-profit organisation or SME, as long as such an entity may, acting in its own name, exercise rights and be subject to obligations.

<sup>16</sup> Eurelectric recommendations on citizens energy communities, May 2019

<sup>17</sup> Idem.

## b. Off-grid solutions

Numerous studies analyse the sheer value of connectivity to the grid. For instance, the Electric Power Research Institution (EPRI), published a case study<sup>18</sup> that compares on-grid and off-grid power for residential customers. Its main conclusion is that staying off-grid/being connected to an isolated micro-grid is still not a cost-efficient option. It showed that installing solar PV and storage to go off-grid while maintaining 99.99% of load served with the same quality would cost the individual customer about 10 times as much per kWh consumed than drawing power from the grid. For those customers ready to make significant lifestyle changes and willing to accept only 80% of their load needs being met, power from an off-grid system would still cost about 5 times more per kWh than drawing power from the network.

Even adding a diesel generator –which would have environmental impacts– in order to significantly improve power availability to the off-grid consumer would result in significantly increased cost compared to staying connected to the grid. The combined cost of solar PV, storage installations and generators with 99.97% load served is similar to the cost of solar PV and storage installations with 80% load served (i.e. almost 5 times more than drawing power from the network).

These costs are caused by the need to overscale the isolated facility to secure the same quality and reliability level provided by the grid. In any case, by staying off-grid, the customer loses the opportunity to sell their excess electricity (when remuneration schemes exists).

Moreover, in case of a harmful weather event (storms or floods for instance), the recovery of electricity supply takes much longer for an off-grid system compared to an interconnected system, where the DSO will always reconnect people as soon as practicable.

However, there may be exceptional situations where being isolated can be a cost-effective solution due to certain geographical specificities, such as mountains, remote areas or isolated island systems which abound also in the EU.



<sup>18</sup> EPRI, Residential Off-Grid Solar and Storage Systems, A Case Study Comparison of On-Grid and Off-Grid Power for Residential Consumers, Technical Update, August 2016.

Mitigating risks to the electric grid stemming from extreme weather events and temperature fluctuations is becoming an increasing challenging task for DSOs. Resilience will continue to be a major factor influencing the design and operation of transmission and distribution power systems. Long-term metrological predictions for Europe do not only foresee an increase in mean temperatures with warmer summers, more heatwaves and fewer cold spells but also an increase in number of severe storms. DSO therefore need to keep up exploring solutions to mitigate damage to the grid and power outages. Currently, strategies are currently divided in two categories: system hardening and resilience measures.

## **Case 2: ESB Networks, Ireland - Planning, restoration, and impact management measures taken by ESB Networks to cope with the ex-hurricane Ophelia.**

While western Atlantic cities in the US, Mexico and the Caribbean have experience dealing with the impact of hurricanes on transmission and distribution systems, Europe does not. The tropical storm Ophelia made landfall in Ireland on 16 October 2017. At its peak, the storm left 385000 (17 % of total customers) customers without power supply equating to 11.7 million customer hours lost and almost 4500 outages. Approximately 90% of these faults were caused by falling trees. Three following features were applied by Ireland's DSO ESB Networks to the planning and impact management plan: national coordination, dedicated information channels and safe restoration after the storm.

A Storm Emergency Management Team (SEMT), established in advance, coordinated closely with the national government agencies and local authorities, to ensure a safe and effective restoration process. There was close coordination with the national TSO EirGrid and key transmission stations were staffed by DSO ESB Networks personnel to have approved staff on site if required. During the storm and after, a detailed communication was developed. ESNB communicated important public safety messages and updates on the restoration efforts through television, radio, online video, and social media. An interactive, map-based fault information system called Powercheck was set up. It communicated the safety risks to the public and updated estimated restoration time for all faults relatively close to the real time.

The public were requested to contact ESNB and report any outage that was not logged on the Powercheck. This process aided the restoration effort and helped to narrow the focus of resource allocation. Lastly, ensuring protection of DSO staff and public was instrumental during the restoration phase. A dedicated phone line and online reporting system was widely used in this context to highlight substantial risks to the public from grounded conductors when restoration was in progress.



## II. THE GRID AS KEY CONTRIBUTOR TO THE ACHIEVEMENT OF THE EU ENERGY POLICY OBJECTIVES

Distribution networks are essential to achieve the EU objectives for 2030 and beyond. Decarbonisation, decentralisation and digitalisation will change roles and responsibilities of utilities in general, and for the DSOs in particular.

### a. To increase RES based energy from 27% to 32% by 2030

Distribution system operators are increasingly at the centre of the energy transition, as they have to ensure the integration of an increased amount of RES from distributed generation. According to Eurostat (the statistical office of the European Union), around 17% of EU energy consumption in 2016 was provided by renewables. In order to achieve 32% by 2030 in Europe, an additional installed capacity of 670 GW VRES<sup>19</sup> (solar and wind) is needed. Therefore, distribution system operators have to reinforce their networks and increase the capacity where necessary.

This requires significant investments in the grid compared to previous years, including new and innovative technologies that will be mandatory to manage this development in a cost efficient and secure way.

### Case 3: Viesgo, Spain – How 100% renewables generation was integrated seamlessly

Spanish DSO Viesgo operates its distribution grid in areas with excellent wind speeds located in the North of Spain (Galicia, Asturias, Cantabria and the north of Castilla León), serving 695 000 consumers and 2.650 MW of RES generation connected. In 2011, Viesgo launched a project to optimise the integration of the huge amount of renewable energy (mainly wind and hydro) connected to its grid, while avoiding grid reinforcements and curtailment.

During 7 years Viesgo has deployed dynamic line rating technology – composed of sensors (temperature metrological stations and grid analysers) and driven by algorithms – along its grid and obtained significant results. Grid capacity has increased by 50%, and 100% of energy produced by RES generators is currently integrated. Curtailments have been practically eliminated providing a value to customers in the north of Spain equivalent to additional 1,200 hours of wind power plant operation without curtailments. 1.6 GW of RES generators benefit from this system.

Worth noting is that the cost of the technology deployed represents merely 0,5% of the cost of the necessary grid reinforcement to achieve similar capacity increase, providing significant savings to the power system and customers. In 2019 the whole HV grid (1.100 km) will be operated with a new feature called Dynamic Grid Operation System (Dynelec).

<sup>19</sup> Based on data retrieved from the European Commission Long Term Strategy – [A Clean Planet for All](#) 2018

## b. To increase energy efficiency up to 32.5% by 2030

Through the continuing development of smart grids, DSOs will improve the operation of the network. The digitalisation of the infrastructure comes with predictive maintenance, live monitoring and self-healing capabilities. All of this will help reduce electrical losses.

The roll out of smart meters, which in most Members States is under the responsibility of DSOs, as well as the related smart meter data and analytics, will enable smart energy efficiency solutions for households as well as for industrial customers. By providing detailed consumption data, consumers' awareness on their energy consumption will increase and might lead to changing consumption practices and encourage energy savings. They could further drive more energy efficient behaviour if sufficient incentives are there (e.g. allow customers to contract personalised offers based on their consumption).

Additional savings could be further encouraged by adapting grid tariff structures by foreseeing grid access tariffs based on connection capacity and revising grid tariff models dominated by quantity of energy distributed component.



## c. To reach 40% reduction target for CO<sub>2</sub> emissions by 2030<sup>20</sup>

DSOs play an essential role in reducing CO<sub>2</sub> emissions from the generation mix, by allowing an ever increasing RES penetration. Distribution grids are enablers for the electrification of the society through sector coupling (linking heat and transport with power generation). Firstly, electrification of the transport sector will develop rapidly in the near future and, secondly, heating appliances based on fossil fuels will be replaced step by step by power based solutions such as heat pumps regardless if they are used as small scale solution in houses or as central heating systems in large buildings. Moreover, electrification in district heating sector, where the heating part could be provided by electricity coming from renewables, should also be taken into account.

The electrification of the transport sector, and therefore CO<sub>2</sub> emissions reductions, depends, among other factors, on the availability of the right charging infrastructure. Apart from super chargers, which are installed along the major transportation axis and connected to the medium or high voltage grid, most of the charging will take place in the low-voltage grids.

<sup>20</sup> The new regulatory framework includes an energy efficiency target for EU for 2030 of 32.5% with an upwards revision clause by 2023.

Once more, the distribution grid will be at the heart of a significant change. In the past, DSOs previously dealt successfully with large consumption increases or fast developing solar PV or wind power generation. DSOs can also make EV charging comparatively simple by providing the required load, managing the short, mid and long term planning while minimising the impact on tariffs and adapting the network accordingly without jeopardising the quality of service.

As the share of electric vehicles grows<sup>21</sup>, EV charging may create constraints on distribution grids at certain times, which can be alleviated with smart charging. Cars are parked 95% of the time, which gives quite some flexibility when charging, and EV batteries can be used to help stabilise the grid while their owners are remunerated for this service. By doing so, it is possible to significantly limit the additional investments required in electricity distribution grids. When it comes to managing the peak electricity demand and the low-voltage grid, smart charging can solve most challenges at the local level and in residential areas.

Current EV customer behaviour indicates that early adopters rely largely on home and office charging<sup>22</sup>. This trend will continue in the future, as we expect that 85% of charging will happen at work place and at home as millions of EVs hit the roads in the next decades. To make smart charging is implemented, incentives but also financial support are needed for market parties to spur investment in smart charging solutions and services. New types of tariffs reflecting grid costs more effectively and incentivise network use are strongly recommended<sup>23</sup>.

#### Case 4: Norwegian DSOs to facilitate a fully electric transport sector

A thorough rollout of EVs is becoming a reality in Norway, where every tenth vehicle is already fully electric. In January 2019, Norway passed 200 000 EVs and from 2025, all new sales shall be emission free. Norwegian DSOs are instrumental to facilitate this transition, since they upgrade the existing grid and dimension new grid components accordingly while managing the grid so that costs do not increase more than strictly necessary and accepted by the NRA.

Local DSOs like Ringerikskraft or Skagerak Energi are testing solutions to improve load forecasts, the potential for flexibility and the systematic load transfer in an attempt to limit investments into the grid. In details, they are testing how to combine EV batteries, large solar installations, hot water geysers to nearly halve the capacity needed at low-voltage level. One of the main challenges for DSOs are currently occurring in recreational areas when all EVs are plugged at the same time during rush hours (fast charging on Friday and Sunday) and in urban areas where infrastructure is ageing and grid reinforcements are due anyhow.

It is estimated<sup>24</sup> that EVs will increase the load in the local distribution networks in a range from 0% (if charged outside peak hours) to 5% (+750 MW assuming that charging takes place during the afternoon between 17–20h). In an extreme scenario, where the bulk of charging takes place during peak hours, the load is expected to increase by up to 2.4 GW. In such a scenario, it will be necessary to invest Euro 1.5 billion to reinforce grid until 2040, though nearly a third of these investments will be in connection with replacing older components. While the Norwegian power sector remains confident that full electrification of its transport sector is economically and technically feasible at reasonable cost, these findings underline the value of smart charging and load shifting.



<sup>21</sup> See also: [EV charging Infrastructure: Myths and Reality](#) , Eurelectric, 2019.

<sup>22</sup> [Smart charging study](#), Eurelectric, 2015.

<sup>23</sup> [EV Public charging infrastructure Factsheet](#), Eurelectric, 2019.

<sup>24</sup> Estimating costs of the transition is challenging, since they depend on the charging technology, charging habits, utilisation of existing components, network tariffs and EV's penetration.

### III. ACHIEVING THE ENERGY TRANSITION IMPLIES SIGNIFICANT CHANGES IN THE WAY THE GRID IS OPERATED, MANAGED AND BUILT

To achieve the EU climate and energy objective and facilitate the transition towards a fully decarbonised economy, **DSOs are committed to providing a fit for purpose and stable distribution system**. However, adapting to this new environment and facing related challenges require changes in the way DSOs perform their core tasks (operate and plan networks) as well as new responsibilities.

#### a. Facilitating the cost efficient integration of distributed power generation

Currently, there is a lack of information on how big real power demand is and how much back-up needs to be reserved since there is more and more 'behind-the-meter' generation. With the ever increasing uptake of prosumers, more bi-directional power flows at distribution level will occur which in turn will have an impact on network usage and mid to-long term network investment requirements.

In order to avoid delays of projects, minimise curtailments and finally reduce the cost of RES integration, DSOs will seek to reinforce the grid while adopting the following approach:

- Anticipating the development of further needs and integrating them in network planning. Further reinforcement needs include the timely knowledge of the development of distributed energy resources (DER) which should be combined with actual DSO grid reinforcement needs. A strong co-operation with relevant stakeholders and municipalities is needed to provide an early understanding of each other's needs.
- Securing resources needed to realise planned projects. It implies re-invigorating apprenticeship schemes for the required skills and providing long term contracts with service providers.
- Ensuring efficient network investment in order to mitigate current problems, considering that the timescale involved in planning requires third party decisions and sometimes imply considerable uncertainty.

#### b. Minimising congestion and harnessing the full potential of flexibility resources

Due to an ever increasing penetration of variable RES generation into the distribution network, DSOs are facing more complex grid operations. When large amounts of variable RES generation are being geographically concentrated, local power surges may occur. This in turn might lead to over voltages which cause a faster ageing of the lines and substations, as well as an increase of losses in the grids. Grid reinforcements might be an efficient solution to avoid congestion by building a stronger and bigger network but is rather capital intensive.

On the other hand, flexibility services provided by new assets and grid users (such as active consumers engaged in demand response and electric mobility, distributed generation, self-generation, storage) are expected to increase. They provide DSOs with additional tools to better cope with congestion and manage their network at reasonable cost. On a long term perspective, the use of flexibility services will rightly compete with traditional investment options for grid reinforcement or upgrades<sup>25</sup>.

<sup>25</sup> See also [DSO-TSO report on Active System Management](#), April 2019



Therefore, in the future, DSOs will need to adapt their development plans and include available sources of flexibility among others as an alternative to standard network investments.

In order to sensibly exploit the potential of flexibility management, curtailment and re-dispatch, a conducive regulatory framework and coordination mechanisms are needed. With this objective, coordinating the use of flexibility between DSO and TSO to optimise the use of the grid<sup>26</sup> will be a major achievement.

### **c. Providing services and service levels responding to the needs of the customer**

The shift towards a smarter and more decarbonised power system also implies new interactions with a broad diversity of stakeholders (such as demand aggregators, providers of EV charging stations, etc.). New interactions with new players imply different and more complex power and information flows where DSOs should be involved.

DSOs are therefore committed to reinventing the way they serve their customers and better understand their growing

expectations. DSOs will adopt a more customer centric approach and create new services that account for customer needs: in this context DSOs will need to investigate where value pools for the customer can be generated within their regulated assets (physical as well as data driven), while facilitating market solutions.

### **d. Digitalising the grid and using operational data for efficient operation**

The digitalisation of the grid requires significant investments in advanced sensors, protections to control voltage and frequency to better stabilise the network, new algorithms for load flows and weather predictions.

Through the collection of data all over the grid, digitalisation allows predictive maintenance, live monitoring and reporting of outages that give a better quality of supply to customers in a more cost-effective way. These technological developments could be particularly successfully implemented in grids with significant modernisation needs, leap-frogging certain grid development stages. But for this to materialise, NRAs must see the future value of incentivising such investment programmes today through adjusted regulatory frameworks and tariff structures.

Digitalisation transforms the way DSOs manage the grid and their role. Thanks to the deployment of smart meters, DSOs become data operators. They are expected to manage all the operational data to respect data privacy and invest in enhanced cybersecurity. Therefore, it is important that all the competences required to fulfil this key role are recognised by regulators.

Threats stemming from cyber-attacks are real as society is highly dependent on critical services with the power grid standing out in its importance<sup>27</sup>. To achieve a high level of cyber security across the power grid, network operators strive for a well-structured cyber security strategy, based on risk assessment schemes with most up-to-date breach detection and response capabilities in place. However, it's not only about the right technology and procedures, but by making cyber security a top priority for all stakeholders involved in grid operation, facilitating its inclusion in the company's strategy and enabling proper investment to allow sufficient resources and awareness at all levels.

<sup>26</sup> See examples developed in the Eurelectric [report](#) on DSO-TSO cooperation, September 2016

<sup>27</sup> According to NATO estimates, there were on average nearly 400 serious attacks on energy infrastructure annually worldwide in the last decade, but only well under 200 attacks prior to 2000.

In line with the transformation of DSOs, NRA will need to develop the right skills to accompany and regulate DSOs with a different role. Dedicated supports schemes could be needed for national authorities equipped with less financial and technological resources, e.g. via tailored training programs or specific funding in order to develop required skill sets.

## e. Financing and securing revenues for the required investments

There will be more ‘behind-the-meter’ generation on industrial, commercial, and residential premises, and increased demand-side response. The distribution system operators’ tasks will become substantially more complex while energy flows across networks in total are changing.

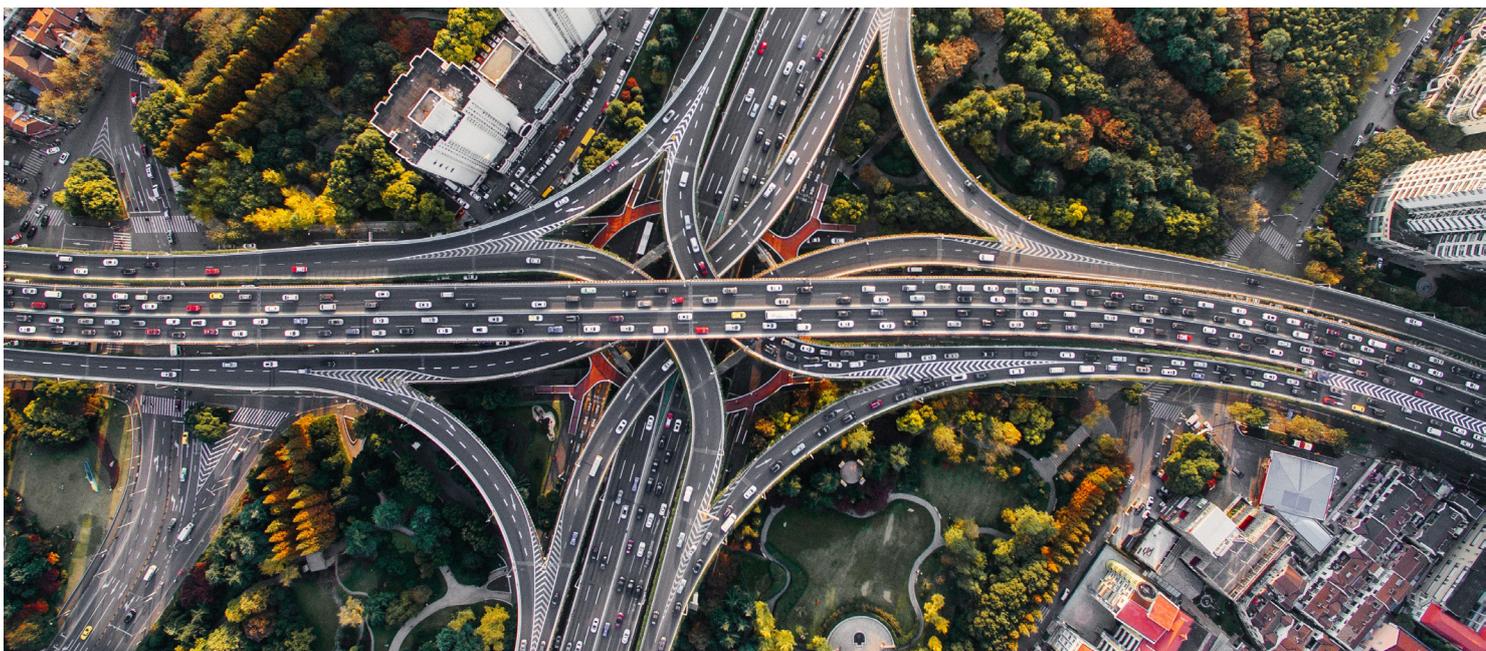
Current regulatory schemes do not provide sufficient incentives for innovation<sup>28</sup>, which could be a substitute for some of the network’s investments and thereby allow an overall lower cost of the grid for its customers.

It is important that regulators acknowledge the more complex operation of the distribution networks and incentivise DSOs to invest in innovation. The greater risks arising from investments in new elements and technologies should be considered in asset remuneration parameters. A return on investments below an adequate level will jeopardise the execution of a significant part of the network investments needed for the overall energy transition, wrongly considering they are not mandatory. Investment reductions, especially in digitalisation, will risk the energy transition and the EU’s objectives.

On the other hand, an efficient design of network tariffs structure for consumers is crucial. Currently, they do not accurately reflect the cost structure of the grid and therefore pose a risk to appropriate cost recovery and future capacity of the DSO to invest in the grid. Finding a new tariff scheme reflecting divergent needs of different types of customers (EV charging, electric heating) will be key.

In this respect, network tariffs should reflect total grid costs more effectively and incentivise an efficient network use. They should reflect the increased cost of a congested network and provide an incentive to shift load to off peak hours, thereby reducing the need for further network investments.

In this context, present net-metering schemes for prosumers pose another risk for grid cost recovery<sup>29</sup> and may even lead to cross-subsidies among customer categories, thereby decreasing the value that customers get from the grid.



<sup>28</sup> [Innovation incentives for DSOs – a must in the new energy market development](#), Eurelectric paper, July 2016

<sup>29</sup> [“Prosumers – an integral part of the power system and the market”](#), Eurelectric paper, June 2015

Eurelectric pursues in all its activities the application of the following sustainable development values:

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