Where does change start if the future is already decided?

DSOs must keep pace with the new ways to generate, distribute and consume energy… and become catalysts of these changes.

A collaboration between

EY Building a better working world

eurelectric powering people

Disclaimer:

This report, drafted by EY with input from Eurelectric DSO members, aims at mapping out the challenges and opportunities linked to the future role of DSOs in Europe. Assessing how the DSOs' operating model will change as they become pivotal to the energy transition, the report seeks to initiate informed debates on the new competences and roles of DSOs and the regulatory framework that will allow them to act in a fully decarbonised power sector.

Eurelectric DSO members contributed to the making of this report through a series of C-level interviews, a dedicated survey and member workshop. The report does however by no means represent a formal Eurelectric position and should instead be treated as a White Paper.

Authors:

Serge COLLE – Global Power & Utilities Leader, EY
Paul MICALLEF – Global Digital Grid Leader, EY
Anthony LEGG – Head of Power & Utilities, Economic Advisory, EY
Andrew HORSTEAD – Global Power & Utilities Lead Analyst, EY
John BREAKELL – UK&I Energy & Resources, EY

Download a QR code scanning app and scan this code.
This way you will enjoy the reading and help save the environment.

Dépôt légal: D/2019/12.105/1

Where does change start if the future is already decided?

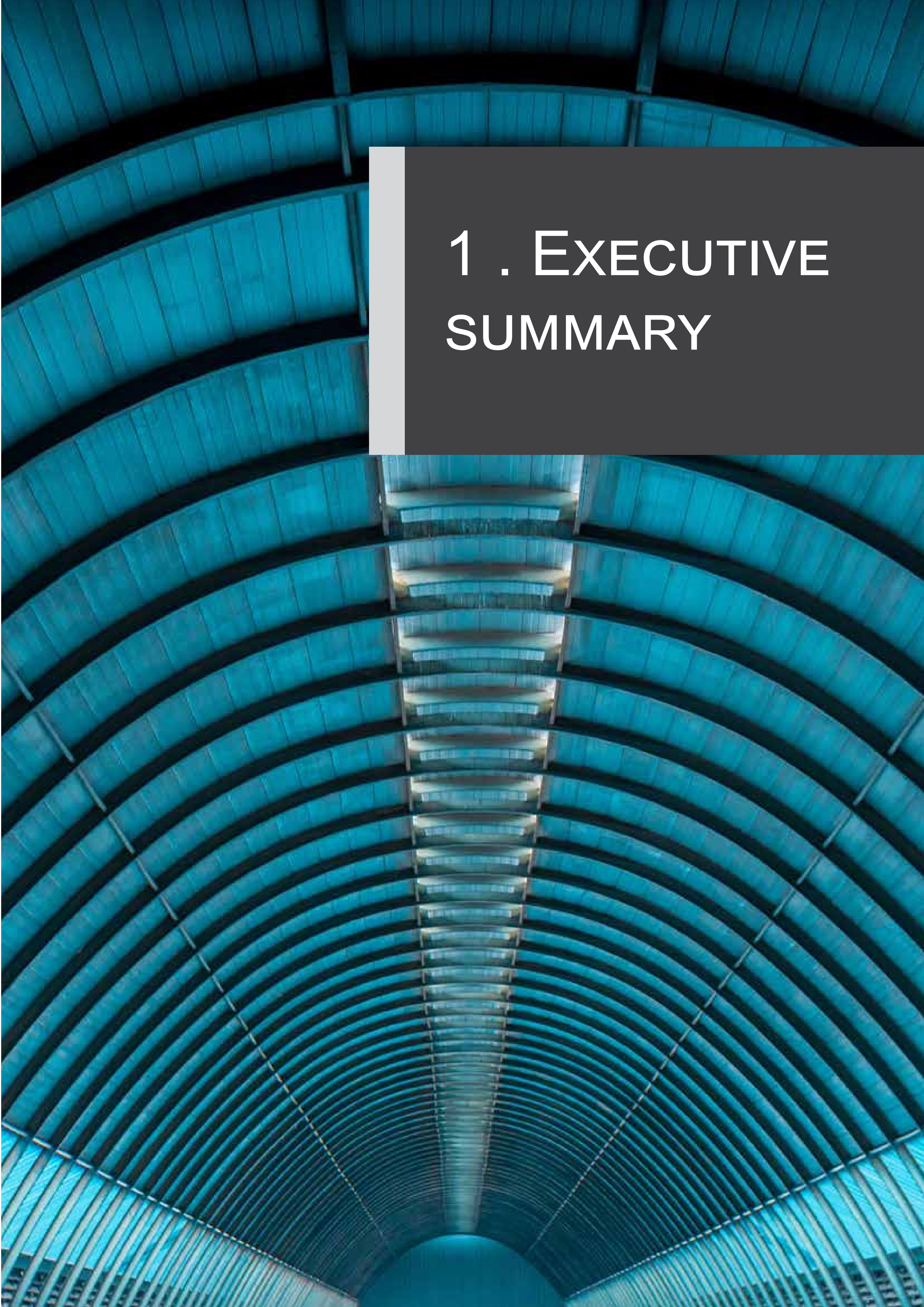
Distribution system operators must keep pace with the new ways to generate, distribute and consume energy… and become catalysts of these changes.

An EY report with technical support from Eurelectric

EY Building a better working world

Table of contents

1 . Executive summary



1. Executive summary

Energy future will be decarbonised, decentralised and electric

Decarbonisation of Europe's power sector is achievable by 2045[1] and will underpin deep decarbonisation of the EU economy through electrification. This ambitious objective necessitates, however, substantial investment, innovation in 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 640GW, with offshore wind expanding to 470GW.[2] Solar PV capacity is set to increase seven-fold to 950GW. 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 120GW-150GW of flexible load available by 2045. Some 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.[3,4,5]

Most of this generation capacity and new load will be connected to the existing distribution grid.

DSOs at the heart of the energy transition

Enabling the energy transition and guaranteeing network stability in the context of distributed generation make the role of distribution system operators (DSOs) crucial.

DSOs are responsible primarily for timely connections of new capacity to the grid and improving system resilience through appropriate reinforcement. Secondly, they are required to help transform energy systems by accelerating investment in innovation and digitalisation. This investment means that network planning and operations can be optimised, by using, for instance, distributed energy resources (DER) and digital technologies to regulate power flows and voltage and by harnessing the flexibility of DER.

Investment to date means that Europe's networks are regarded as some of the most reliable in the world.[6] So far, DSOs have been able to deal with rising volumes of distributed generation due to the strength of the grid and the manageable number of new connections. Over time, further growth in large-scale distributed generation will challenge DSOs, affecting their ability to keep the network running smoothly and the grid infrastructure maintained and upgraded.

The next five years will be critical. Harnessing flexibility in the power system will be a key enabler to meeting Europe's long-term decarbonisation goals. As DER technologies become increasingly affordable and more widely adopted, greater penetration of distributed generation from wind, solar and storage solutions is anticipated. EVs are becoming increasingly competitive with light-duty vehicles, including passenger cars, reaching cost parity in many European countries no later than the mid-2020s.[7]

1 Decarbonisation Pathways, Eurelectric.
2 Ibid.
3 Global EV Outlook 2018, IEA.
4 Decarbonisation Pathways, Eurelectric.
5 European Automobile Manufacturers Association.
6 Germany's electricity grid stable amid energy transition, Clean Energy Wire.
7 Global EV Outlook 2018, IEA.

If the regulations and technologies are aligned, millions of EVs will equate to millions of batteries that can be integrated into the system, providing short-term storage and grid services, and potentially minimising the need for grid reinforcements.

Inevitably, building and upgrading the grid will continue to be a solution — given the need to replace ageing assets, and further electrification of heat and transport — but it is capital-intensive and has long lead times. On the other hand, the need for flexibility must be assessed on a continuous basis, and investments in smart technologies and innovation should be prioritised and scaled to meet the ongoing requirements of the system. A balance needs to be found between grid reinforcement and the use of market-based flexibilities based on the better business case.

For DSOs, the need for flexibility warrants greater interaction with network customers. This will help to garner the significant economic value from an optimised relationship between investments in conventional grid reinforcements and better interplay with local flexibility resources. However, this step will require a radical change in business processes, pricing and tariff-setting for network services. This can only happen if the right regulatory frameworks are developed.

Getting ready: DSO 2.0

The current model of 'connect and reinforce' is not an efficient solution for the future. After connection the relationship between the DSO and network customer becomes passive. This is because the distribution network is designed to allow all network customers to use the grid as they choose, within the capacity rights allocated at the time of connection.

Europe's ageing network means substantial investment is now needed in new grid capacity, as well as in refurbishment and replacement of existing assets.[8]

Against the backdrop of variable renewables integration and the expected penetration of e-mobility, DSOs need greater visibility, advanced monitoring and more control over the electricity flowing across their grids. Investment is needed in breakthrough technologies that will accelerate digitisation of the grid and facilitate the interactions of all network customers, flexibility providers and prosumers within the market.

DSOs will have to continuously develop and operate the network in a reliable, affordable and sustainable way, while building a grid that is fit for the future.

The simultaneous onslaught of these factors means that the role of Europe's DSOs has to evolve, while regulation must acknowledge the industry's increasing and changing investment needs.

Core functions will remain geared around delivering system security, integrating renewables and ensuring service quality. However, the DSO operating model will need to change; internal processes will require transformation and new competencies will have to be developed across different functional areas as DSOs become pivotal enablers of the energy transition.

But the industry also acknowledges that there is no one-size-fits-all DSO model.[9] Outcomes will be shaped by local circumstances, maturity and dynamics. Some will be characterised by high EV adoption; others by low technology implementation and lower levels of DER. Some will serve buzzing urban communities; others will support mainly rural users. Some markets will be home to multiple DSOs; others to one or two. Though every circumstance is different, it is clear that DSOs will be at the centre of the energy transition.

The magnitude of this transition will impact DSOs' investment and capability priorities. Much of the investment in tools, people and infrastructure is needed within the next few years.[10] DSOs will also require a new cultural mindset and partnership models if they are to meet the energy transition head on.

8 Electricity distribution investments : What regulatory framework do we need?, Eurelectric.

9 EY interviewed C-suite executives at some of Europe's leading energy companies. Their insights are complemented by the DSO survey, EY, 2018 and on-the-ground experiences of heads of operations, innovation, regulation and network strategy.

10 DSO survey, EY, 2018.

Together with transmission system operators (TSOs), DSOs will need to co-design relevant and value-creating markets, in which all network customers can connect and exchange energy services. The challenge is to create a market that combines and optimises local peer-to-peer interactions, and provides access to regional, national and cross-border trade. It will be a phased journey to the future energy system:

- Phase 1: This step will involve investment to make the grid robust, resilient and intelligent enough to accommodate the increase in DER, EV-charging infrastructure, data centres and electrification of heat and other large-scale users of energy. At the same times, it will allow demand profiles to be adjusted to the supply peaks in renewable generation, boosting the overall capacity of the power system. Success will depend on organisations' ability to enhance visibility across multiple connection points, and to evaluate and plan for their likely impact on the network.

- Phase 2: The second stage of the journey will see investment in digital solutions and in technology, such as the wide deployment of sensors to automate and control the network. This will include, most likely, the ability to value flexibility from different kinds of generation and demand sources; develop platforms for streamlined customer enquiries, connections and installations, and trial and prototype solutions across the network. In parallel, DSOs and TSOs will jointly develop new market frameworks for ancillary services that encourage participation from DER owners and aggregators accompanied by new, fairer and cost-reflective tariffs. Increasingly, by managing platforms, the DSO will become the neutral facilitator of markets, enabling the sale and purchase of energy between participants, irrespective of technology.

- Phase 3: This will be the point, at which investment translates into enhanced systems and optimised networks that enable the energy transition and secure the future of DSOs for the years ahead. The phase will include embedding active network management capabilities across all power systems in the EU to ensure grid stability, deployment of advanced distributed grid intelligence and control systems, and creation of platforms for energy trading and micro-grid service strategies.

Making regulation work

Europe's energy sector is on the brink of a technology-enabled transition, but compromised by the absence of a relevant and adaptive regulatory and policy framework.

DSOs are responsible for the deployment of smart grids, which will facilitate the energy transition in the EU. But they can only undertake their responsibilities if the right regulatory framework is in place. Aside from recognising the role of DSOs, the framework should be flexible enough to encourage and reward investments in a high renewables-based system.

Financial incentives for innovation should be designed to encourage DSOs to adopt and embrace new technologies and activities. Increased research and development support, focused on technological innovation, will allow DSOs to perform their function as neutral market facilitators and enablers of smart grid services.

Timely and national implementation of the Clean Energy for All Europeans package is vital for executing high-level European principles and facilitating distributed generation and flexibility services at a local network level.

Policymakers need to ensure that investors, many of whom have sunk their investment into legacy assets, get a fair return. Regulatory frameworks need to provide long-term stability. They should be less about short-term cost cutting and more forward-looking. This means:

- Being mindful of the pace of technology change and the degree of customer participation, and rewarding innovation where it is needed
- Facilitating predictable and stable returns, as far as specific national conditions allow
- Setting feasible and long-term targets and outputs for DSOs to meet

The rewards from expenditure and investment in innovation and organisational transformation only become visible over the mid to long term. European and national legislations should work as enablers, whereby policymakers recognise the long-term paybacks of innovation and the overall ‘smartening’ of power networks. Incentives should apply neutrally to both CAPEX and OPEX, to acknowledge that the deployment of innovative technologies generally means a shift from a higher share of CAPEX to OPEX over time.

Any investment, especially in new or emerging technologies, such as digital, carries inherent risks. Policymakers need to ensure that these risks, and the shorter depreciation periods associated with these technologies, are appropriately reflected in future remuneration models. If this is not taken into account, incentives to invest in digitisation could be weakened significantly.

As the level of generation increases, particularly in variable DER, rule changes will be required to ensure that there is sufficient flexibility to guarantee current reliability levels going forward. It is important, therefore, that regulation recognises the roles of different regulated and market agents, such as distributed generators, flexibility providers, self-consumers and communities, and creates a level playing field, in which no business model is prioritised over another.

It is vital, however, that all users contribute fairly to their share of network and other policy costs. Commonly applied volumetric network tariffs, for instance, can lead to an imbalance between the contributions that different user groups make to recovering grid operating costs. This happens where consumers who generate their own electricity do not pick up the costs that would be recovered ordinarily in unit pricing, but continue to have access to network services. If energy pricing is not cost reflective, there is a risk of distorting decisions by both producers and consumers, leading to inefficient decision-making and higher overall costs to the energy system.

Failure to anticipate oncoming changes to generation and technology, and delays in reacting to the red flags that are waving today, risk undermining the affordability of the energy transition, and jeopardising energy security and supply going forward.

We are on the brink of a very different energy world. Change is imminent; delay is not an option.

What the industry says…

This report is based on one-on-one interviews with C-suite executives at some of Europe’s leading energy companies.

Their insights are complemented by on-the-ground experiences of heads of operations, innovation, regulation and network strategy.

Finally, an online survey, among 117 electricity sector professionals in December 2018, provided consensus and validation on the challenges facing future DSOs.

The substance of this report comes from the people who keep the networks flowing. It is curated and augmented by insights from EY professionals with extensive experience in transformation in the energy industry.

2. Energy future will be decarbonised, decentralised and electric

2. Energy future will be decarbonised, decentralised and electric

Europe's power system is undergoing major changes, with increasing reliance on renewable generation, greater focus on energy efficiency and a firmer push towards electrification of transport, buildings and industry.

Decarbonisation pathways

The 2015 Paris Agreement sets out an ambitious undertaking to combat climate change. It aims to limit the increase in global average temperature this century to well below 2 degrees Celsius above pre-industrial levels. It pledges to pursue efforts that will limit the increase to 1.5 degrees.

To reach this goal, European policymakers have committed to cut greenhouse gases by at least 40% by 2030, compared with 1990 levels, aspiring to achieve approximately 80%–95% reductions by 2050.[11] In its new long-term strategy, published in November 2018, the European Commission raised the ambition to net zero emissions in Europe by 2050.

Europe's power sector has pledged its commitment to the agreement. It stepped up to say that decarbonisation of electricity is achievable by 2045.[12] Achieving this ambition, however, means transitioning to a very different energy system than the one in operation today, placing electricity networks and DSOs right at the heart of the energy transition.

Transitioning Europe's energy system

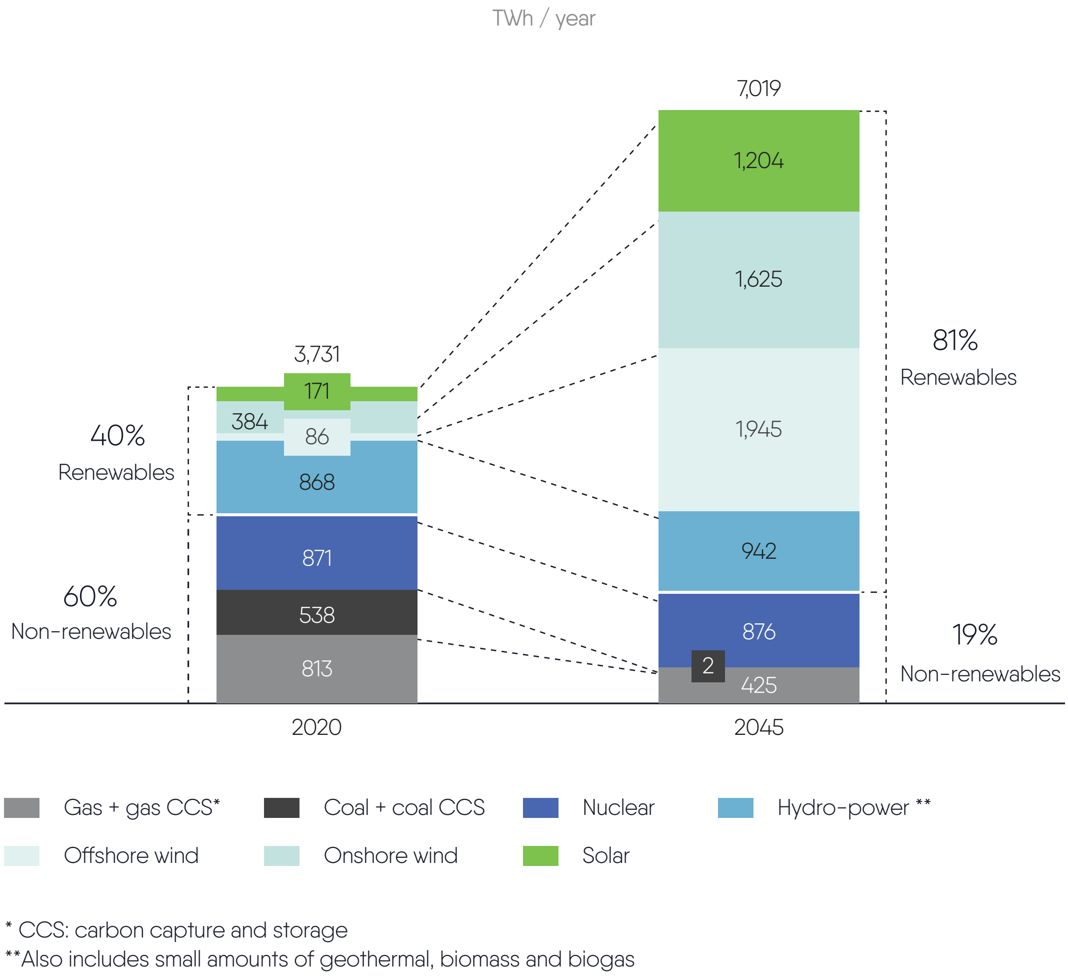
Technology developments have driven significant cost reductions and efficiency improvements in DER over recent years. As wind and solar PV becomes increasingly competitive with conventional sources of electricity, further cost reductions are expected.[13] Energy storage applications are becoming more widespread as battery costs fall. Recent forecasts indicate that demand for batteries, both in the EU and globally, will grow exponentially over the next few years.[14]

11 2030 climate & energy framework, European Commission.
12 Decarbonisation Pathways, Eurelectric.
13 World Energy Outlook 2018, IEA.
14 EIT Inno-energy, Innoenergy.

But the scale of the transition ahead is immense. Massive deployment of variable renewables generation — predominantly solar PV, onshore and offshore wind — is expected. 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 current levels to over 640GW, with offshore wind reaching 470GW.[15] Solar PV capacity is set to increase seven-fold to 950GW. From 30% today, renewable generation is expected to meet over 80% of Europe's future energy needs.[16,17]

Meantime, fossil electricity supply will be phased out gradually, dropping to around 5% of total supply by 2045. Coal-fired generation capacity will be almost fully decommissioned.[18]

Figure 1: Electricity generation in the 95% EU economy decarbonisation scenario



* CCS: carbon capture and storage
**Also includes small amounts of geothermal, biomass and biogas

Source: Decarbonisation Pathways, Eurelectric.

15 Decarbonisation Pathways, Eurelectric.
16 Renewable Energy Statistics 2017, IRENA.
17 The second Renewable Energy Directive from EU, a part of the Clean Energy for All Europeans package, sets a binding renewable target of 32% by 2030.
18 Decarbonisation Pathways, Eurelectric.

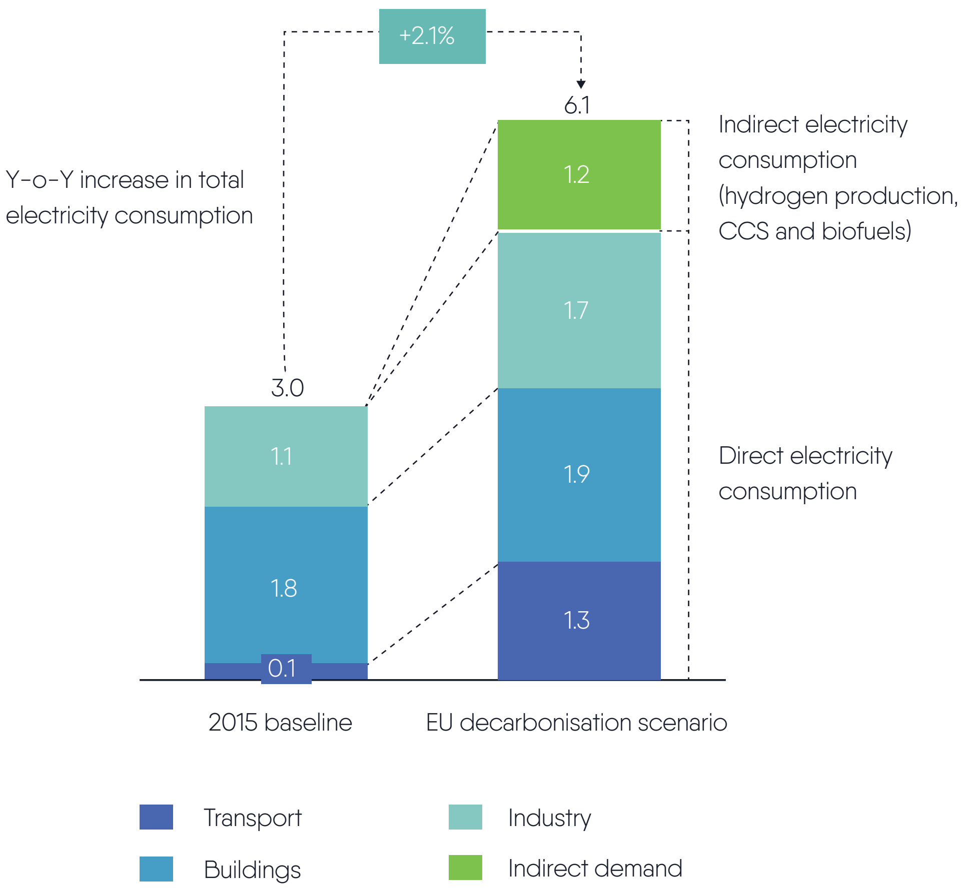
Achieving carbon neutrality

As Europe's electricity system becomes cleaner, cheaper and more efficient, electrification of transport, heating and cooling, and other energy-intensive sectors, will accelerate.[19] This will add considerable new load to the system. Combined, electrification of the transport, buildings and industry sectors could boost year-on-year demand to 2.1%, which, in absolute terms, is equivalent to double the current levels (figure 2 below).[20]

For DSOs, this may create issues around network capacity, inducing higher local peak demand periods, for instance, when clusters of EVs are charged at the end of each day. This may use up any spare capacity at a quicker rate, forcing DSOs to spend large amounts of money on reinforcing networks. Grid expansion costs will rise, driven by the relative increase in peak load.

Digitalisation, however, is enabling demand to be more flexible. Using control signals and financial incentives, demand profiles can be adjusted to coincide, for instance, with supply peaks in renewable generation. Together with households, commercial and industrial consumers are expected to provide 120GW–150GW of flexible load by 2045.

Figure 2: Total electricity consumption in transport, buildings and industry to 2050 (in 1,000 TWh)



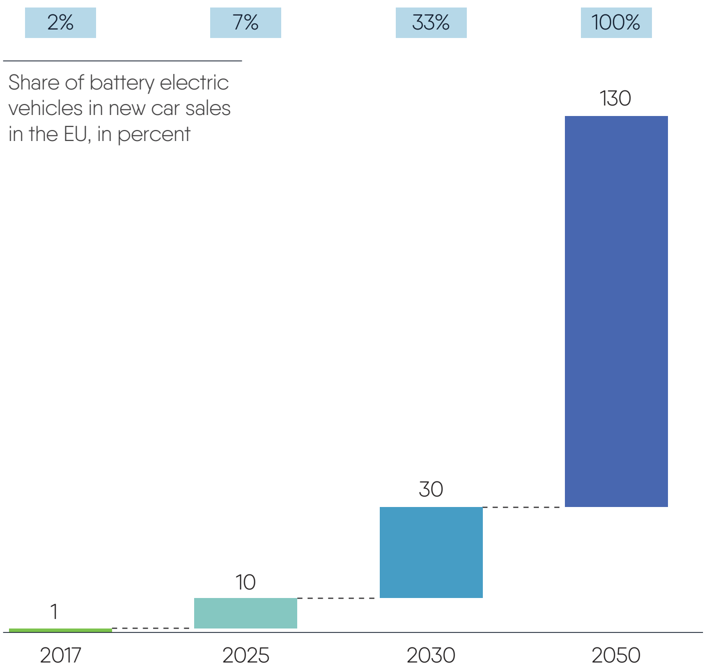
Source: Decarbonisation Pathways, Eurelectric.

19 Decarbonisation Pathways, Eurelectric.
20 Ibid: Calculated against a 2015 baseline of 2,923 TWh. Demand includes direct (power used in transport, buildings, industry) and indirect consumption (hydrogen production).

Today, the transport sector uses little electricity — approximately 2% of total electricity use, of which rail accounts for two-thirds — but usage is set to get much bigger, especially from the road component.[21]

Currently, penetration of EVs is low. With an estimated 1.4 million EVs on Europe's roads, they represented just 2% of all new cars sold in the EU in 2018.[22] But, in many European countries, light-duty electric vehicles, including passenger cars, are projected to reach cost parity with petrol and diesel vehicles before the mid-2020s.[23] Backed by the rising economic viability of battery technology and greater availability of EV charging points, EV adoption, including passenger cars, commercial vehicles and buses, in Europe is expected to grow to 33% of new vehicle sales by 2030. That is equivalent to 6.8 million EVs sales that year alone. By 2030, Europe's total vehicle fleet will have risen to approximately 30 million.[24]

Figure 3: Total electric vehicles in Europe's car fleet (in millions)



Source: Decarbonisation Pathways, Eurelectric.

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 already improving the outlook for EVs. Governments and cities across the EU have announced bans on the future sale of internal combustion engine vehicles. Paris, Madrid and Athens say they will remove diesel cars and vans by 2025. Norway will phase out conventional cars by 2025, followed by France and the United Kingdom in 2040 and 2050, respectively.

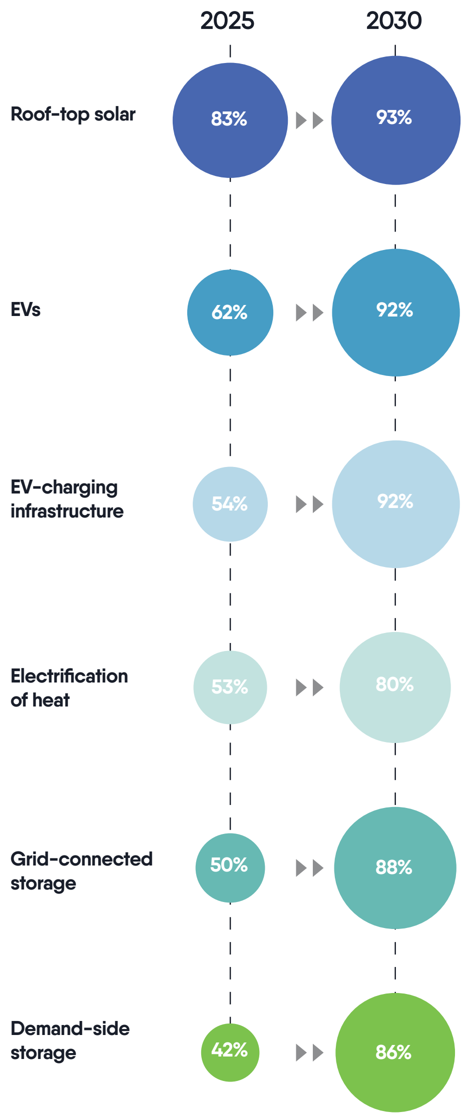
EU countries have also set a bold ambition to reduce carbon-dioxide emissions from new cars by 37.5% by 2030, compared with 2021 levels, with an interim target of 15% reductions for cars and vans by 2025.[25] The effects are hastening change across the automotive industry. In the past two years, car makers have rushed to rollout plans to electrify their vehicles.[26]

21 Overview of electricity production and use in Europe, EEA.
22 Europe Plug-in Vehicle Sales for Q3 of 2018, EV-volumes.
23 Global EV Outlook 2018, IEA.
24 Decarbonisation Pathways, Eurelectric.
25 EU reaches car and van CO2 emissions deal, Politico.
26 Nine countries say they will ban internal combustion engines: none have a law to do so, Quartz.

Elsewhere, electrification will boost demand in other sectors of the economy. In buildings, up to 63% of energy consumption could be electrified given greater adoption of electric heat pumps. The rate of electrification is likely to accelerate once stricter regulations from EU countries, such as mandatory retrofitting and new-build requirements, come into effect.

Up to 50% direct electrification is possible for some industrial processes. The relative competitiveness of electricity, compared with other carbon-neutral fuels, and technological breakthroughs, will drive this shift. Hydrogen, and other carbon-neutral alternatives, will also play a role in driving indirect electrification.[27]

Figure 4: According to the survey respondents, when will the technologies become economically viable?

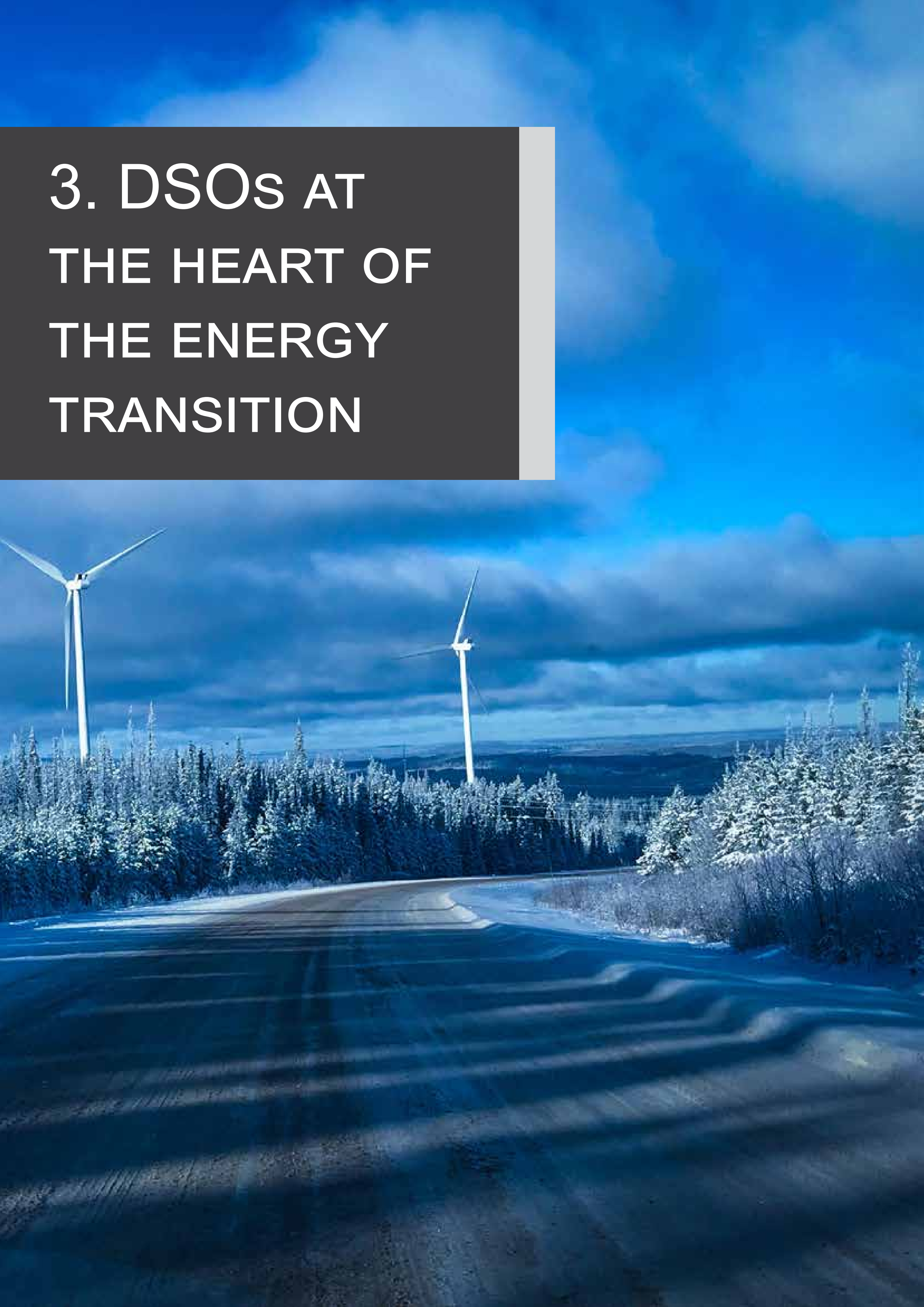


Guidance for reading: 83% of respondents estimate that roof top solar technology will become economically viable by 2025. 93% of respondents believe this will happen by 2030. From 2025 to 2030, the industry expectation to see several technologies becoming economically viable (such as demand-side storage, grid connected storages, EVs, or EV-charging infrastructure) rises significantly.

Source: DSO survey, EY, 2018.

27 Decarbonisation Pathways, Eurelectric.

3. DSOs at the heart of the energy transition



3. DSOs AT THE HEART OF THE ENERGY TRANSITION

From keeping the lights on and managing local system constraints, to demand forecasting and providing other real-time system services, tomorrow's DSOs will play an even more sophisticated role in the energy ecosystem.

Critical role of the DSO

Today, DSOs are responsible for maintaining a safe and reliable grid, connecting new generation and identifying the most cost-effective solutions for energy customers.

Though these responsibilities are also core to the future DSO operating model, adaptations are needed as the energy system changes around them. The challenge for DSOs is to develop and operate their network in a reliable, resilient and sustainable way, providing customers with fair and cost-effective distribution network access. Capacity needs to be provided in an efficient, economic, coordinated and timely manner, while enabling the energy transition, facilitating the market in a neutral way and meeting customer needs. This needs to be done in a way that both optimises the whole energy system and benefits all of society.

Current ways of working will need to be modified, new capabilities developed and investments prioritised. Given the changing energy dynamics, the current model of 'connect and reinforce' will need to overcome the passive relationship between the DSO and network customer. This is because the distribution network is designed to allow all network customers to use the grid as they choose, within the capacity rights allocated to the customer at the time of connection.

Significant amounts of renewable energy sources are already connected and substantial investment in new variable generation is expected over the next few years. With much of it connecting at the local network level, DSOs will also need to develop the means to operate active distribution systems, comprising networks, demand, generation and other flexible DER.

The industry says...

93% of network leaders say DSOs will need to take on a more active role in the management of DERs at the local level.

Source: DSO survey, EY, 2018.

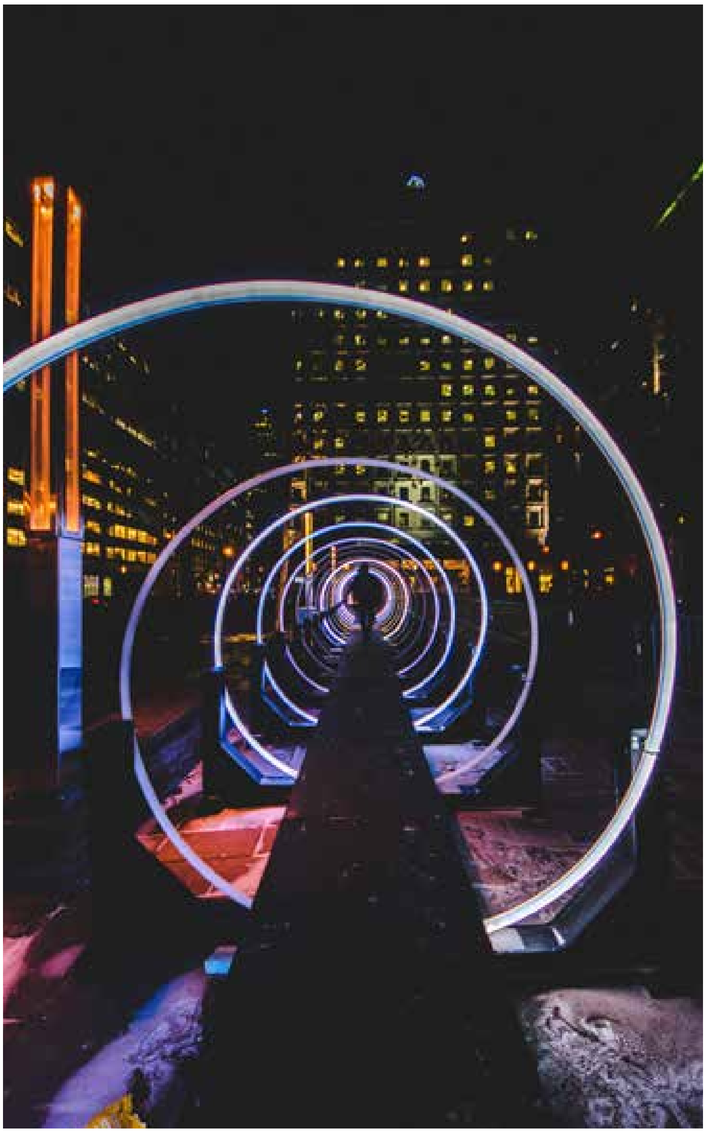
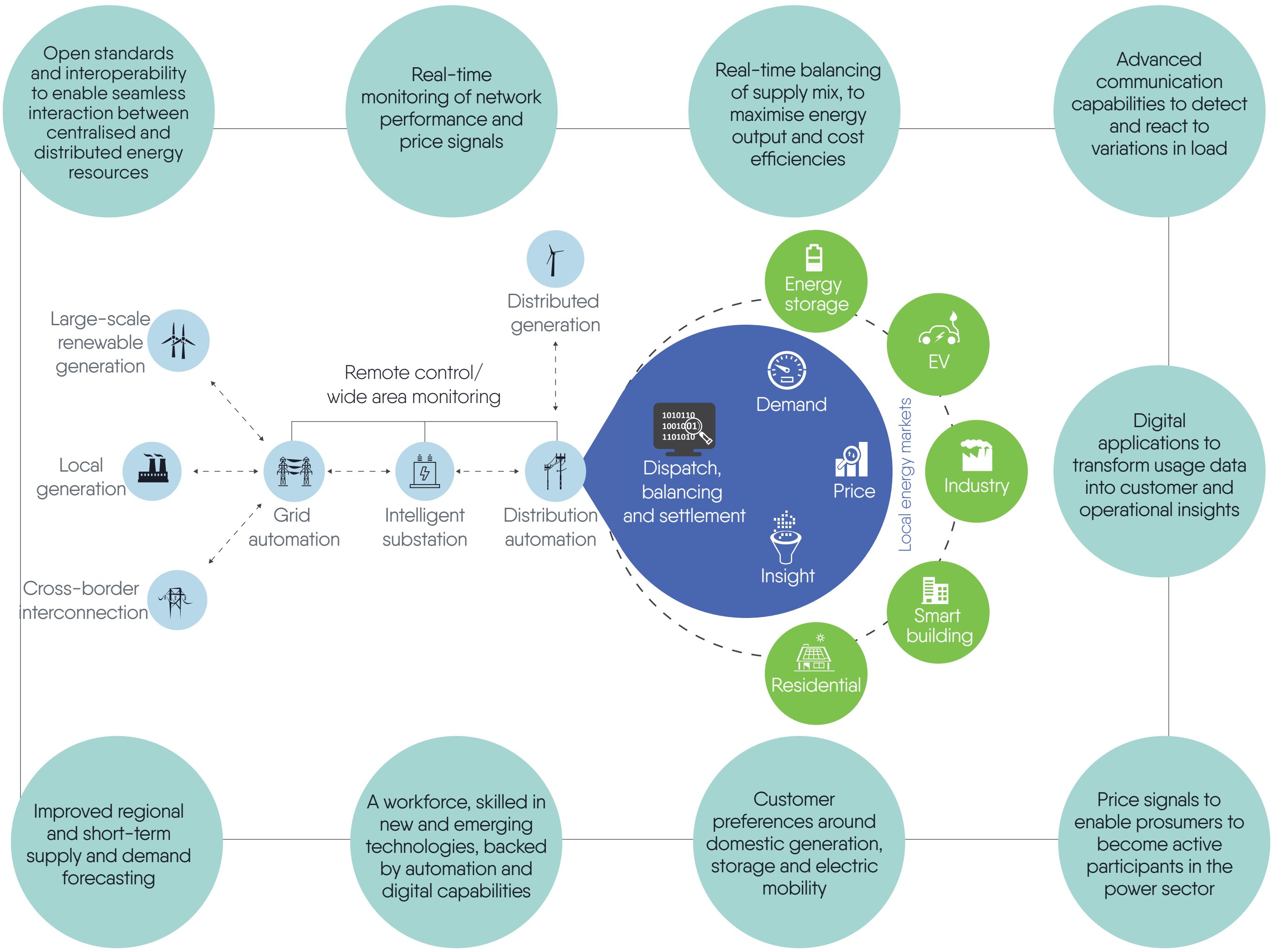


Figure 5: Operation of the energy system has to change, which will require new capabilities. It has to become more dynamic and flexible enough to cope with multidirectional power flows and an influx of customer connections.



Source: EY

In this more dynamic environment, DSOs will identify and plan capacity requirements of the distribution network, and coordinate investment and operational decisions with the TSO. They will put intelligence into the networks and enhance digital competencies in their own organisations, while assessing and mitigating cyber risks. They will also introduce commercial protocols to enable new local markets and new flexibility options, all without jeopardising the resilience of the network or security of supply.

To deliver these outcomes, DSOs must deploy smart systems and accelerate investment in innovation and into their workforces. DSOs will need to deepen their understanding and skill sets in particular technology issues such as data management, systems architecture, robotics, artificial intelligence and cybersecurity. This investment will enable integration of distributed generation, maintenance of quality of supply, and optimisation of network operations via smart grids and smart metering.

By strengthening the grid and investing in smart technologies, the network can be sized technically and optimised economically to meet future demand growth. These steps will also help in managing the network proactively to improve its ability to balance load.

Figure 6: Guiding principles for tomorrow's DSO

Maintains a safe and reliable grid

- Securely develops and operates an active distribution system comprising networks, demand, generation and other flexible DER.
- Takes into account two-way energy flows and greater supply intermittency.
- Coordinates information exchange between the DSO and TSO to balance the whole system.
- Procures, uses and coordinates flexibility services to balance the local grid.

Enables the energy transition, facilitating customers' conversion to a low-carbon future at the lowest cost

- Creates a level playing field for new and existing flexible technologies, providers and solutions and access to a wide range of revenue streams.
- Integrates all types of generation and prepares and facilitates the uptake of EVs.
- Optimises network investment decisions using alternative flexible solutions.

Identifies the most cost effective solutions for energy customers

- Contributes to the design of markets that combine local, regional, national and international solutions that offer 'whole system outcomes' that are best for customers.
- Enables new local markets for peer-to-peer trading giving all participants, whether prosumers, aggregators, traditional players or third parties, equal access to the energy market, without jeopardising the resilience of the network or security of supply.

Today's DSO | Tomorrow's DSO

Source: EY

New dynamic energy system

Today's conventional energy system is constructed mostly around centralised generation. Energy flows predominantly in one direction, through the transmission system into the distribution network, and into homes and businesses. Investment to date means Europe's networks are regarded as some of the most reliable infrastructures in the world.[28] Output is pretty much guaranteed.

So far, at a local level, DSOs have been able to deal with rising volumes of distributed generation due to the strength of the grid and the manageable levels of new connections. Now, DSOs face a rapidly changing and increasingly complex operational landscape. It is impacting their ability to maintain the smooth operation of the network and to make timely upgrades to grid infrastructure.

The system-wide shift from dispatchable generation to variable renewable generation will see differences between load and net load becoming more noticeable and the imbalance between supply and demand more pronounced. This requires a step change in the need for flexibility from other electricity sources to ensure security of supply.

In a high-renewables future, advanced technical solutions are needed. In some cases, substantial curtailment or enhanced flexibility may be required. This may well be acquired from electrification of transport or other end-use sectors, through increased demand-side flexibility.

28 Germany's electricity grid stable amid energy transition, Clean Energy Wire.

Assessing system needs and planning ahead for flexibility are critical. DSOs can explore existing flexibility options, while identifying where future investment is needed in smart grid technologies. They may turn to new flexibility products, provided by new flexibility resources such as storage and demand-side management.

Figure 7: What distinguishes today's energy system from tomorrow's?

Current energy system	Future energy system
Centralised generation	Energy flows in multiple directions
Few connections	Rising demand from new sectors (such as EVs, heat pumps and data centres) and huge increases in distributed assets connected at the distribution level
Reactive management	Advanced network automation and control
Limited visibility of connections at the distribution level	Coordination and information exchange between the DSO and TSO
Limited customer engagement	Need to build relationships and to facilitate competition and innovation
Network sized to meet peak demand	Optimised network-investment decisions, using alternative flexible solutions

The time to act is now — the next five years are critical

Changes to Europe's energy system are underway. Five years from now, it will look and behave very differently. Technology advances and improved economics mean wind, solar PV, batteries and EVs are already taking hold. As costs decline and economic parity is reached, greater numbers will connect, testing the operation and capacity of the grid. Meanwhile, smart systems will allow consumers to play a more active role in energy delivery and supply.

These developments are happening now. The grid is confronted with the dual challenge of increased demand and increased supply. DSOs have to take into account market dynamics and customer appetite, and plan for the adjustments that are needed now to create an energy system that is fit for the future. Delay is not an option.

Inevitably, building and upgrading the grid has high upfront costs and long lead times. It is estimated that around €11 billion is needed per year to reinforce distribution grids.[29] Investments in smart technologies and innovation should be prioritised and scaled to meet the ongoing needs of the system. Assessing ongoing flexibility requirements has to be a continuous process, evolving with energy policy and local market conditions.

For DSOs it warrants greater interaction with network customers. This will help to garner significant economic value from an optimised relationship between investments in conventional grid reinforcements and better interplay with local flexibility resources. This step will require a radical change in business processes, pricing and tariff-setting for network services in overall market design. Managing organisational change will be a critical factor.

At the same time, new regulatory frameworks are needed to encourage innovation and offer revenue guarantees and investment mandates. If the regulations and technologies are aligned, millions of EVs will equate to millions of batteries that can be integrated into the system, providing short-term storage and grid services. And, if they unlock existing flexibility options, DSOs can potentially avoid unnecessary costs and keep network charges low.

Large-scale smart electrification, and the gradual decarbonisation of the power sector, mean that many countries will need to transform their power systems. Though these are long-term climate-change aspirations and will take years to fully implement, DSOs need to prepare now for this future eventuality.

29 Impact assessment support study on: Policies for DSOs, distribution tariffs and data handling, European Commission.

4 . Getting ready: DSO 2.0

4. Getting ready: DSO 2.0

As the dynamics of energy change, the underlying system model will have to evolve too. What capabilities must DSOs acquire and which investments should they prioritise?

> ### The industry says…
>
> **The future role of the DSO:**
>
> - Manages and coordinates distributed generation at the local distribution level
> - Acts as a neutral facilitator of open markets
> - Enables easy access to the transmission and distribution networks
>
> Source: DSO survey, EY, 2018.

Evolving the DSO operating model

DSOs will continue to serve their local distribution network customers and retain their core responsibilities.

However, the growing remit to harness flexibility, and encourage transparent and non-discriminatory market access, will demand new and enhanced functions and activities, as illustrated in Figure 8 below. These will be dictated by developments within the electricity marketplace, by policy, the economy and the pace of technology innovation.

Far from a one-size-fits-all DSO model, outcomes will be shaped by local circumstances, maturity and dynamics.[30] Some will be characterised by high EV adoption; others by low technology implementation and lower levels of DER. Some will serve buzzing urban communities; others will support mainly rural users. In some markets, network customers and market players will face multiple DSOs; in others there will be one or two. Though every circumstance is different, it is clear that the DSO will be at the centre of the energy transition.

Figure 8: DSO 2.0 functions and activities

System coordination	Network planning	System and defence restoration	Data management	Procurement of flexibility
Operate local and regional balancing areas to meet customer needs and promote whole system integration.	Operate the electricity distribution network to maintain a safe and secure system.	Maintain whole system security through the provision of local and regional flexible services.	Operate the exchange of data from smart metering and other data sources.	Coordinate or host the platform for the provision of flexibility in the distribution grid.
Service provision	**Investment planning**	**Connections and access rights**	**Service market facilitation**	**Network charging**
Coordinate services on behalf of the wider network in order to maximise whole system efficiency.	Identify and secure capacity requirements of the electricity network.	Provide fair and cost effective distribution network access.	Interface with the TSO to enable the development of local network service markets, and whole system optimisation.	Develop charging arrangements, which enable the market to efficiently respond to physical constraints ahead of any need for DSO intervention.

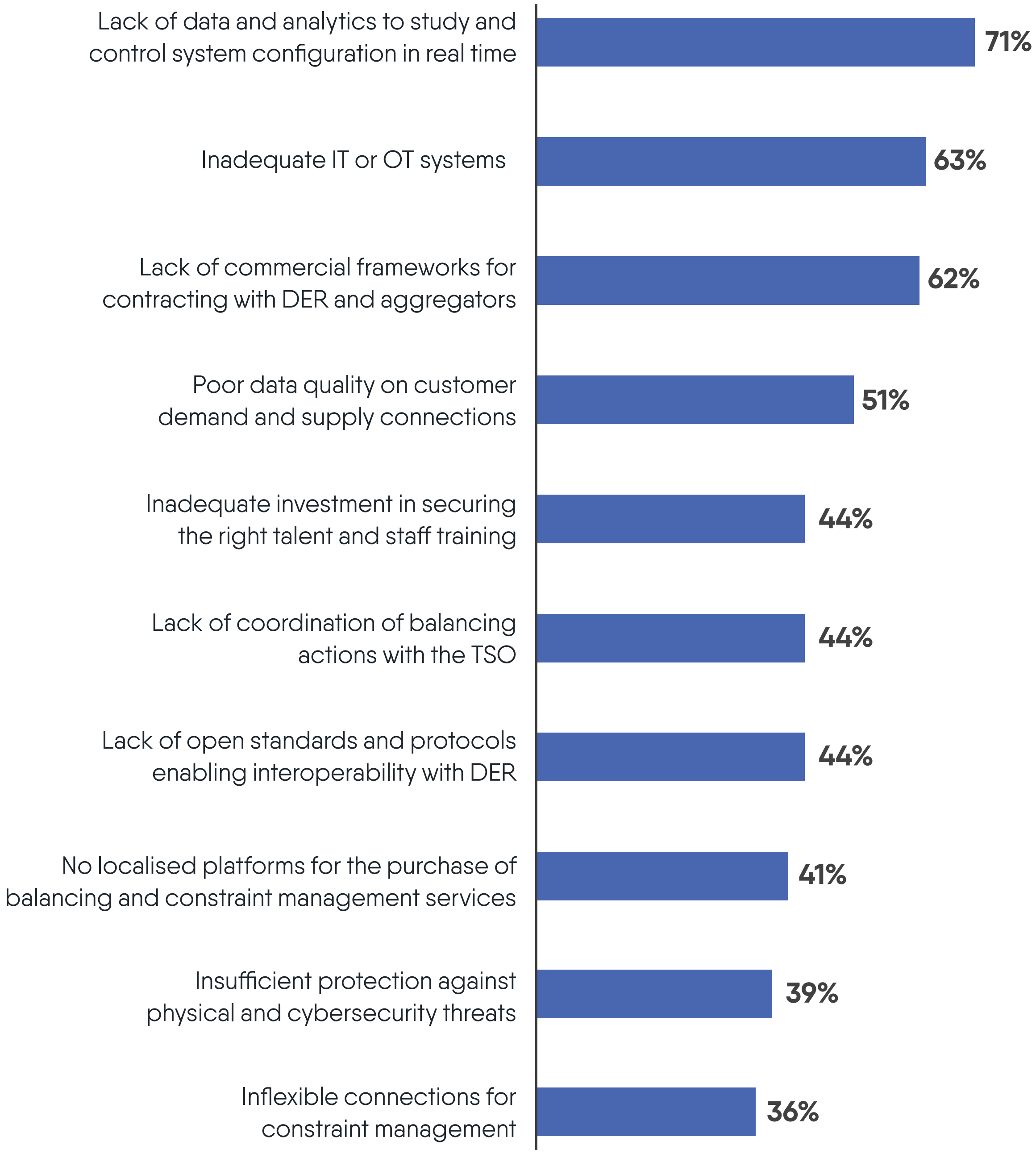
Source: Open Networks Project, Energy Networks Association

30 EY interviewed C-suite executives at some of Europe's leading energy companies. Their insights are complemented by an expert market survey and on-the-ground experiences of heads of operations, innovation, regulation and network strategy.

Transitioning to DSO 2.0

The magnitude of transition will impact the internal processes, capabilities and investment priorities of DSOs. Operationally, the need for real-time visibility over the grid, and the development of adequate arrangements to manage energy flows with market participants — including better coordination with TSOs — are key issues for DSOs to overcome. Respondents to the EY DSO survey 2018 also cited system inadequacies and lack of data and analytics as hurdles to transition. Investment in IT, changes to the cultural mindset and partnership models are among the much-needed agents of change.

Figure 9: Operational barriers DSOs need to overcome



Source: DSO survey, EY, 2018.

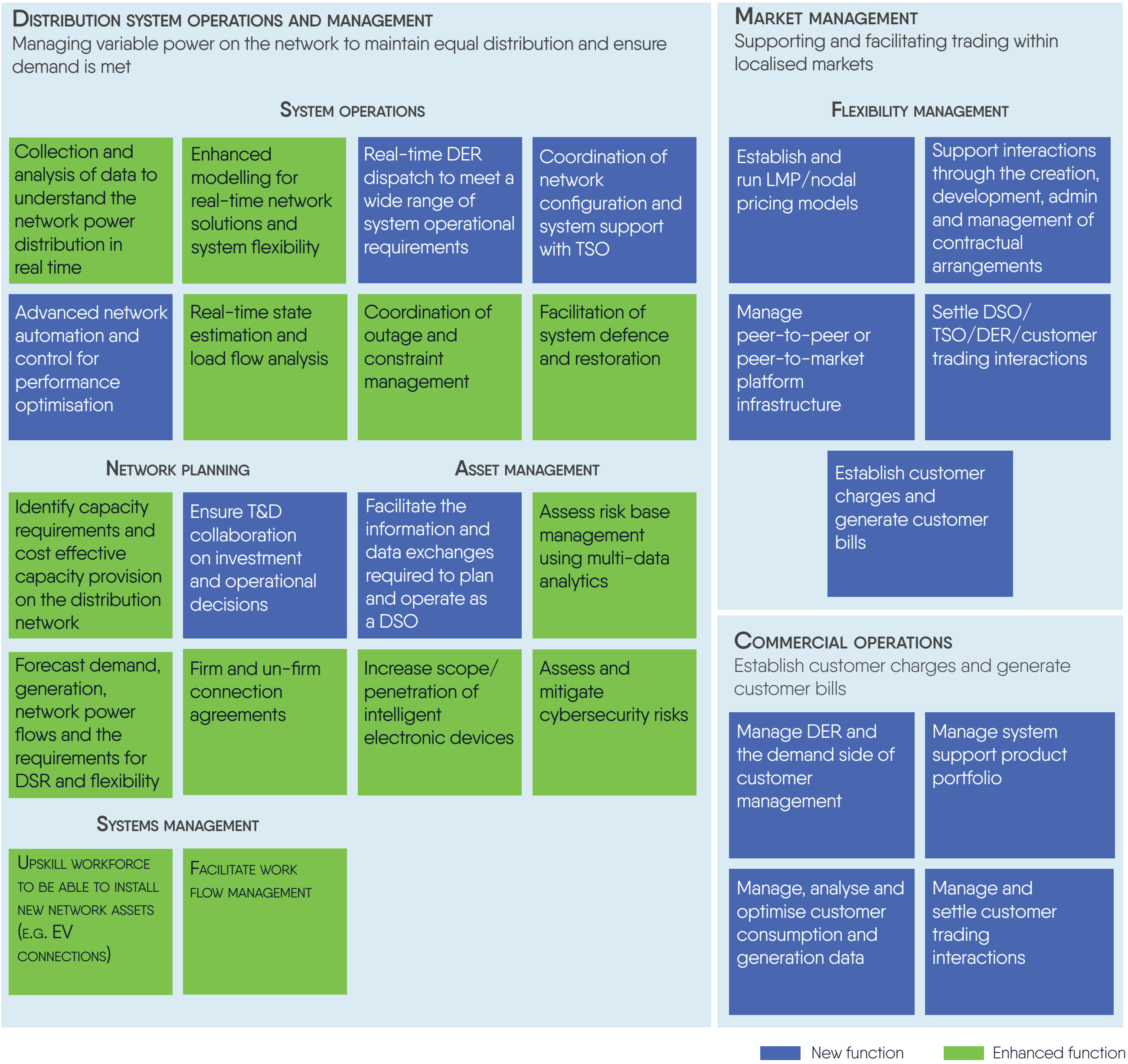
Transitioning to DSO 2.0 will mean engaging with policymakers and regulators to define new DSO roles and functions. These new functional areas call for new approaches to traditional applications and capabilities:

1. **System operations:** This will create visibility over power flows, loads and connections at the distribution level. Smart grid solutions will enable data visualisation, dispatch simulation and long-term asset optimisation. At the same time, DSOs will need to expand the deployment of sensors across the network to monitor DER at all voltage levels, including remote monitoring, controls and automation of data exchanges.
2. **Network planning:** This process will establish an integrated suite of advanced network planning models and DER-service evaluation methods. A coordinated approach to system operations, information exchange and planning at the transmission level will help to keep energy flowing across the entire system, not just the local network.
3. **Asset management:** DSOs will need to trial and validate a full suite of advanced network operation tools across different DER scenarios. This will require advanced communication capabilities to detect and react to variations in load and real-time monitoring of network performance.

4. **System management:** This function undertakes sensitivity analysis to understand the magnitude and impact of DER and EV adoption on the network and the risk mitigation required. This will help to establish and prioritise investment in skills.
5. **Flexibility management:** This capability will develop platforms for procuring flexibility services for most cost-efficient system operation. It will include new market frameworks for ancillary services to encourage participation by DER owners and aggregators, in coordination with TSOs.
6. **Commercial operations:** DSOs will need to build digital information channels for customers and suppliers and to develop digitised platforms for streamlined customer enquiries, connections and installations.

The core capabilities required for the future DSO, across systems operations and management, network planning, asset management, commercial and customer operations, are illustrated in Figure 10. Some will be enhancements or extensions to existing activities as local network operators; others will be new to the role of DSO 2.0.

Figure 10: Core capabilities of tomorrow's DSO



Source: EY

The data-driven grid, along with related technologies and information flows, present new risks and vulnerabilities for DSOs. As IT systems converge with operational technology systems, the attack surface for cyber threats expands exponentially, risking critical infrastructure and assets within utilities' ecosystems. This calls for a fundamental rethink of how cybersecurity is positioned at an enterprise level and how it is understood by DSOs.

Resilient and secure systems, with robust response and recovery procedures, will protect the network in the event of cyberattacks and other disruptive events, such as storms and hurricanes. They ensure that critical assets, including hospitals and defence operations, are kept up and running.

How to reach the DSO destination

Developing these new capabilities will require investment in tools, people and infrastructure. Much of this is needed within the next few years, if DSOs are to be ready to meet the energy transition head on. Specifically, investment is needed to:

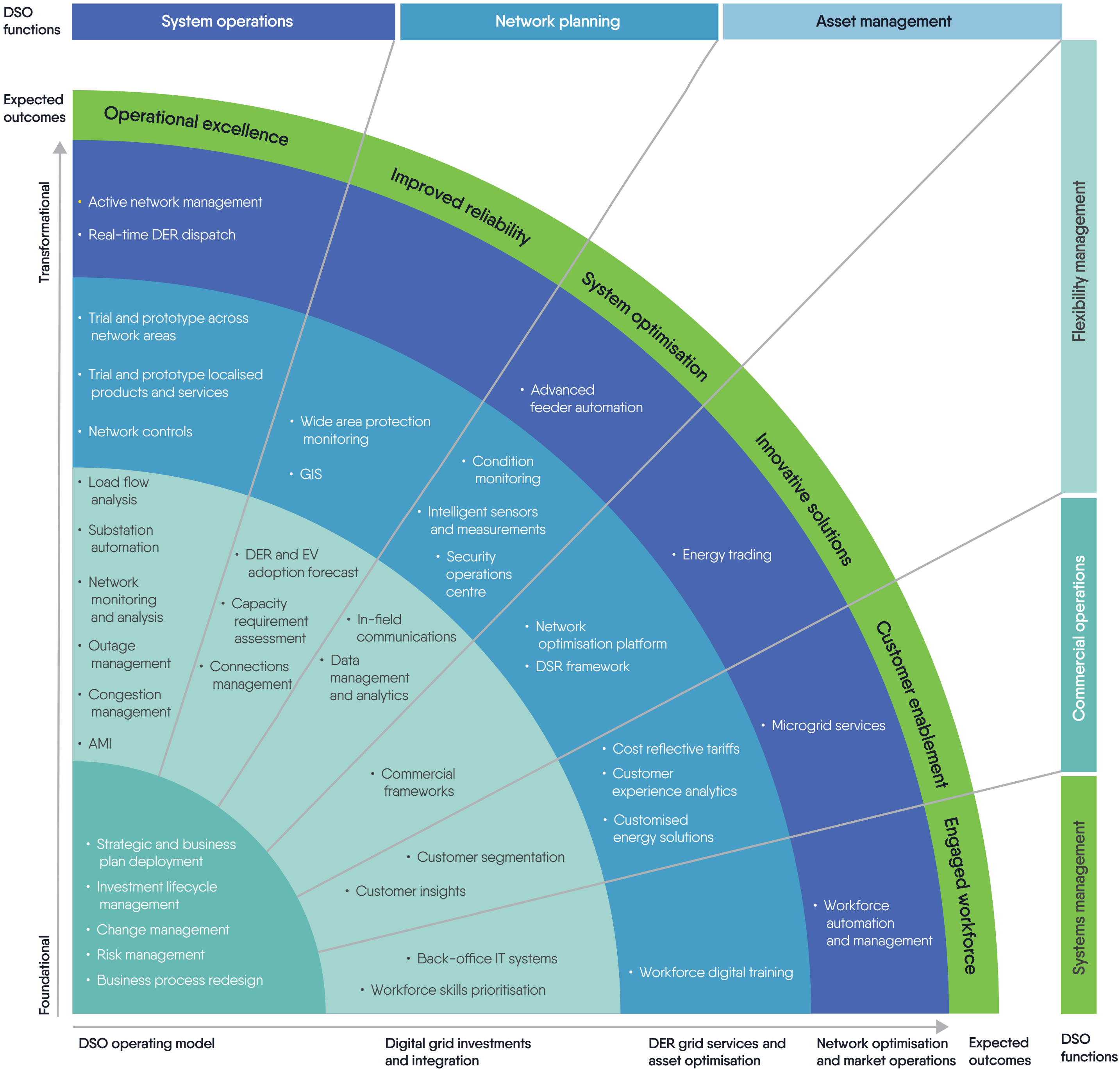
- Monitor DER across all voltage levels
- Create visibility over power flows, loads and connections at the local distribution level
- Enable the integration of flexible solutions across the network
- Develop platforms for procuring flexibility services to balance the local grid

The DSO model is all about integration and flexibility. Some requirements are immediate — developing a DSO vision statement, identifying the operating model and business design, and establishing skills and investment priorities — and will set the business on the course to transformation. Others will be a condition of DSO model maturity over time.

Together with TSOs, DSOs will need to co-design relevant and value-creating markets, in which all network customers can connect and exchange energy services. The challenge is to create a market that combines and optimises local peer-to-peer interactions, and provides access to regional, national and cross-border trade. It will be a phased journey to the future energy system:

- **Phase 1:** This step will involve investment to make the grid robust, resilient and intelligent enough to accommodate the increase in DER, EV-charging infrastructure, data centres, and electrification of heat and other large-scale users of energy. At the same, it will allow demand profiles to be adjusted to supply peaks in renewable generation, boosting the overall capacity of the power system. Success will depend on organisations' ability to enhance visibility across multiple connection points, and to evaluate and plan for their likely impact on the network.
- **Phase 2:** The second stage of the journey will see investment in digital solutions and in technology, such as the wide deployment of sensors to automate and control the network. This will include, most likely, the ability to value flexibility from different kinds of generation and demand sources; develop platforms for streamlined customer enquiries, connections and installations, and trial and prototype solutions across the network. In parallel, DSOs and TSOs will jointly develop new market frameworks for ancillary services that encourage participation from DER owners and aggregators and create new, fairer and cost-reflective tariffs. Increasingly, by managing platforms, the DSO will become the neutral facilitator of markets, enabling the sale and purchase of energy between participants, irrespective of technology.
- **Phase 3:** This will be the point, at which investment translates into enhanced systems and optimised networks that enable the energy transition and secure the future of DSOs for the years ahead. The phase will include embedding active network management capabilities across all power systems in the EU to ensure grid stability, deployment of advanced distributed grid intelligence and control systems, and creation of platforms for energy trading and micro-grid service strategies.

Figure 11: Investment priorities to deliver the core functions and capabilities that will define the DSO of the future



Strategic priorities

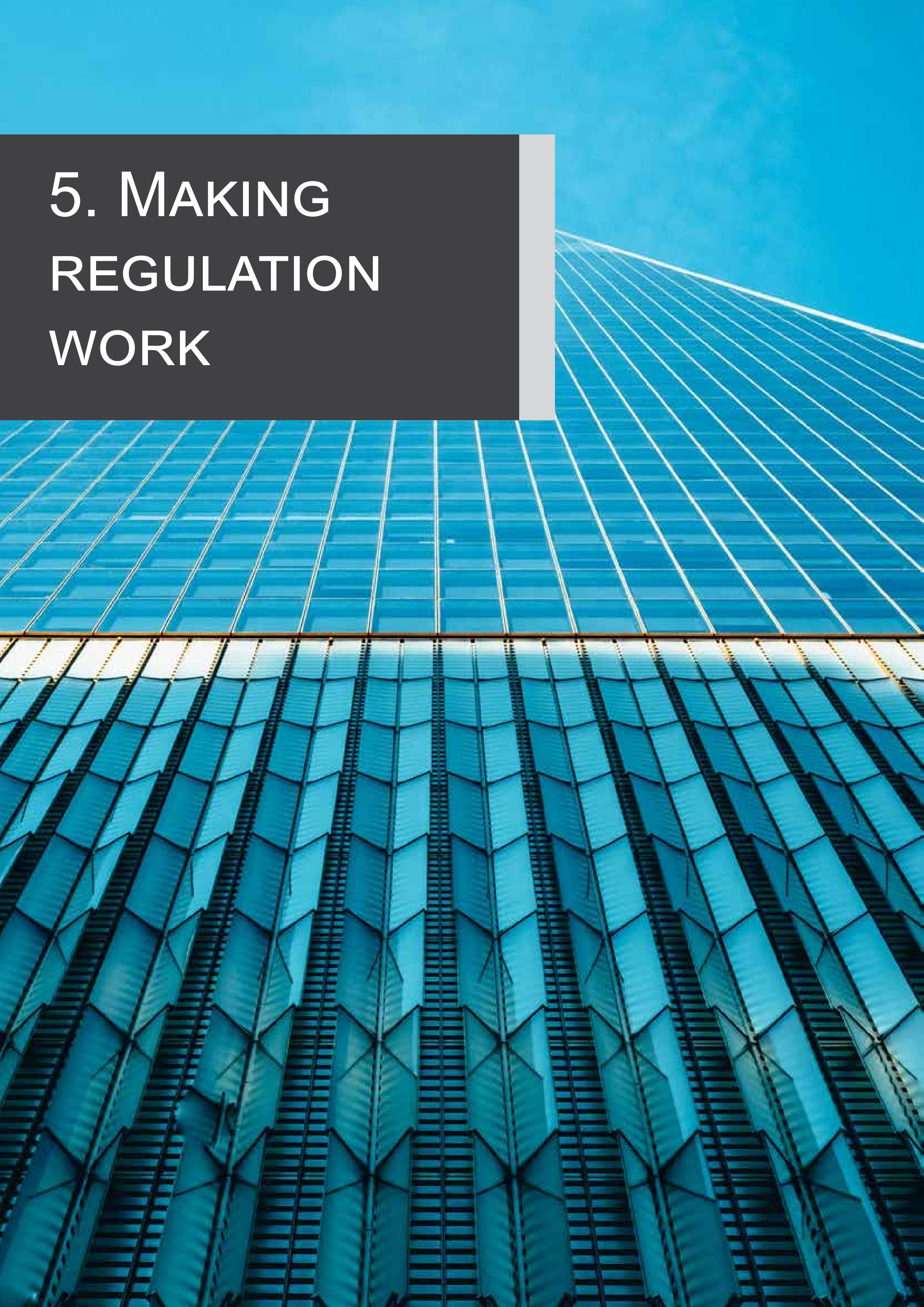
- Effective programme management
- Coordinated grid investments
- Customer programmes
- Regulatory compliance
- Common view of data

Outcomes

- Facilitate the decentralisation of energy (DER), maximising grid returns
- Improved decision-making and full system optimisation
- Strong relationship with customers – create recurring revenues
- Digitally enabled, engaged and motivated workforce

Source: EY

5. Making regulation work



5. Making regulation work

If regulation and policy are not adaptive and do not enable it, the energy transition will still happen… but just not fast enough.

Europe's energy sector is on the brink of a technology-enabled transition but compromised by the absence of a relevant and adaptive regulatory and policy framework.

The transition calls for major capital investment across Europe's networks. For that, the right regulatory framework needs to be in place to stimulate innovative solutions, provide fair returns on investments and enable DSOs to continue to deliver world-class networks for consumers.

Regulators and policymakers need to be mindful of the pace of technology change, and the degree of customer participation and reward innovation where it is needed. At the same time, they must facilitate predictable and stable investment returns, so far as national conditions allow, incentivising a higher quality service through meaningful and achievable targets and outputs for DSOs.

The industry says…

75% of network leaders say regulation is not moving fast enough.

Source: DSO survey, EY, 2018.

Financial incentives for innovation should encourage DSOs to adopt and incorporate new technologies and approaches, while minimising financial risk. Research and development support, which is focused on technological innovation, will allow DSOs to undertake their role as a neutral market facilitator and enable smart-grid services.

The right regulatory framework should incentivise and reward DSOs for facilitating new markets and for using new solutions to deliver the same level of quality output. These rewards might include, for instance, investments in infrastructure and new technology. The framework should create an environment more conducive to investment and keep the energy transition on track.

Urgent need for flexible regulatory framework

Though governments and regulators are the decision makers, the entire industry has a role to play in contributing to the direction and progress of regulation. The challenge, however, is that this transition is bigger than anything experienced before and there is uncertainty over how it will play out.

Given the difficulty of trying to pick technology winners and the risks of stranded assets or duplicated investments, an appropriate response from policymakers will be a flexible and evolving regulatory framework. It would allow the market to find the right solution, as already evidenced by the recent EU Clean Energy for All Europeans package. However, it must:

- **Define further the role of DSOs:** It is essential to explain how this role might evolve in future, ensuring appropriate alignment with TSOs and harnessing the potential for flexibility.
- **Protect customers:** Those including the fuel poor and those less engaged in the market need to be taken into account, to ensure they are not disadvantaged financially.
- **Enable investors to get a fair return:** Many investors have sunk their investment into legacy assets, beyond the initial recovery of investment and operational costs. Regulation needs to be less about short-term cost cutting and more forward-looking.
- **Enable DSOs to act flexibly and respond to changes in circumstances:** Setting targets and objectives for DSOs, rather than specifying actions and expenditure for particular projects or activities, will enable DSOs to have greater control over their specific environments.

- **Reward innovation by DSOs:** Necessary expenditure for innovation and digitalisation, related investments and organisational transformation can be costly and benefits only become visible over the mid-to-long term. European and national legislations should work as enablers, with policymakers recognising the long-term paybacks from innovation and the overall ‘smartening’ of power networks.
- **Determine the optimum allocation of risks:** Inherent risk in new investments, especially in new or emerging technologies, which may have a shorter lifespan, needs to be considered. If remuneration models fail to incentivise investments in new technologies, they could undermine much-needed investment in the energy transition.
- **Create a level playing field between all market players:** Regulatory bodies should consider the roles played by various stakeholders including suppliers, distributed generators, flexibility providers, self-consumers and communities. They should not prioritise one business model over another, but ensure that all users contribute fairly to their share of network and other policy costs.
- **Enable market intermediaries to act on behalf of customers:** Policies should take into account those customers who are either reluctant or ill equipped to manage the adjustment to a smart, tech-enabled, market-based, energy transition.

Priorities are clear, but can regulators move fast enough?

The pace of technological change is rapid. Europe’s energy system is evolving quickly, but the mechanics of policy making — characterised by occasional new pieces of legislation and periodic price control reviews — might not turn fast enough, risking the energy transition and EU objectives.

Industry contributors to this report identified some key regulatory priorities for EU policymakers:

- **Recognise the role of the DSO and support their request that innovation is rewarded by the regulatory framework:** This includes incentives to implement initiatives that support the transformation of the DSO and enables the energy transition.
- **Reward innovation with greater incentives:** They might include incentives for investment in emerging technologies or solutions to support distributed generation, EVs or battery storage and support for grid reinforcement and resilience. Incentives should apply to both CAPEX and OPEX, acknowledging the shift from a higher share of CAPEX to OPEX over time, where innovative technologies are deployed. Where returns might take decades to materialise, regulatory stability and a predictable framework for investments will help to phase in innovations as the energy landscape transforms.
- **Ensure the timely implementation of the Clean Energy for All Europeans package:** Apart from facilitating distributed generation and flexibility services at a local level, this will enable competitive procurement of flexibility services, including congestion management, in order to improve efficiencies in the operation and development of the distribution system.

- **Remove barriers to battery development:** This will allow greater access to storage capabilities within the regulatory framework of the recently adopted Clean Energy Package — which acknowledges that storage is a market-based activity and services can be procured by system operators. Based on this principle, DSOs should be in a position to operate grid-scale storage facilities to secure the technical operation of the grid within approved regulated activities and clearly defined regulatory boundaries.
- **Enable the implementation of standards and data management models:** Such a step will enable customers and market participants to access the information to engage in the market fully.

To accompany the energy transition, in the context of rising distributed generation, a 'rethink' of tariff design is needed. The challenge is to ensure grid and system costs are allocated fairly across different customers groups and consumption patterns, while promoting efficient technologies, such as renewable generation, demand-side response, battery storage and EVs, and provide revenue certainty and returns for investors. Options might include higher-fixed (membership) charges or disconnection fees (to discourage defection), but these should not be introduced in a regressive way.

Commonly applied volumetric network tariffs, for instance, can lead to an imbalance between the contributions that different groups of users make to recovering grid operating costs. This happens where consumers who generate their own electricity do not pick up the costs that would be recovered in unit pricing, but continue to have access to network services. If energy pricing is not cost reflective, there is a risk of distorting decisions by both producers and consumers, leading to inefficient decision-making and higher overall costs to the energy system.

Pricing methods need to be aligned with flexibility pricing and market platforms for the procurement of flexibility services. By developing strategies for future regulatory remuneration models and tariff-setting, DSOs can further ensure their role as neutral market facilitators.

Activating flexibility resources to optimise investment is not only about the technical operational model. It is also about developing comprehensive financial model that integrates permitted regulatory remuneration and optimal value creation for network customers, as well as for DSOs. This is not possible without further development of tariff and price-setting methods, including relevant regulatory models.

The industry says…

Regulation is out of sync with energy transition. The top three changes needed are:

1. Network tariffs to evolve to ensure distributed generation pays a price consistent with its contribution.
2. Micro-grids, local energy communities and prosumers to be subject to the same responsibilities as other DSOs.
3. Time-of-use tariffs to be introduced to provide maximum incentives for flexibility.

Source: DSO survey, EY, 2018.

Slow regulatory response risks destabilising energy transition

As advances in technology accelerate new ways of generating, valuing and trading energy, the policy and regulatory landscape has to adapt quickly or risk destabilising the transition.

A clear but evolving regulatory policy will define the new and wider role of the DSO in relation to the TSO and other communities involved in the generation, distribution and sale of electricity. And it will provide assurance over the incentives and returns that come from enabling the future of energy networks.

NOTES

NOTES