DNV·GL

TRANSITION FASTER TOGETHER

Power grids solutions, strategies and policies for a clean energy future

SAFER, SMARTER, GREENER

DITLEV ENGEL

CEO, DNV GL – ENERGY

"Decarbonizing the energy system means that renewable energy sources, such as wind and solar, are increasing their share of the total energy mix. But for each country to transition to a clean energy future, we need the infrastructure in place to power all parts of our future societies.

Huge investment is required to reimagine existing power grids, driven by the need for renewables integration, energy storage facilities, system expansion, the promise of digitalization and increased energy security. But barriers stand in our way. Insufficient interoperability between systems and technologies, lack of collaboration between industry stakeholders and the mindset required are all challenges that must be overcome - quickly.

As the structure of the power system becomes more decentralized, and our grids become more complex, operators, owners and investors will need to prepare for the integration of ancillary services to support balancing and flexibility markets, while ensuring that standards are maintained. The industry needs to work together to implement solutions that safeguard the future of our power system. Not only do we need to integrate new technologies more quickly, but we desperately need policies that back climate goals, regulatory frameworks and value creating markets that also encourage grid investment to help us to transition much faster."

Ditlev Engel

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THE TRANSITION CHALLENGE – FAST BUT NOT FAST ENOUGH

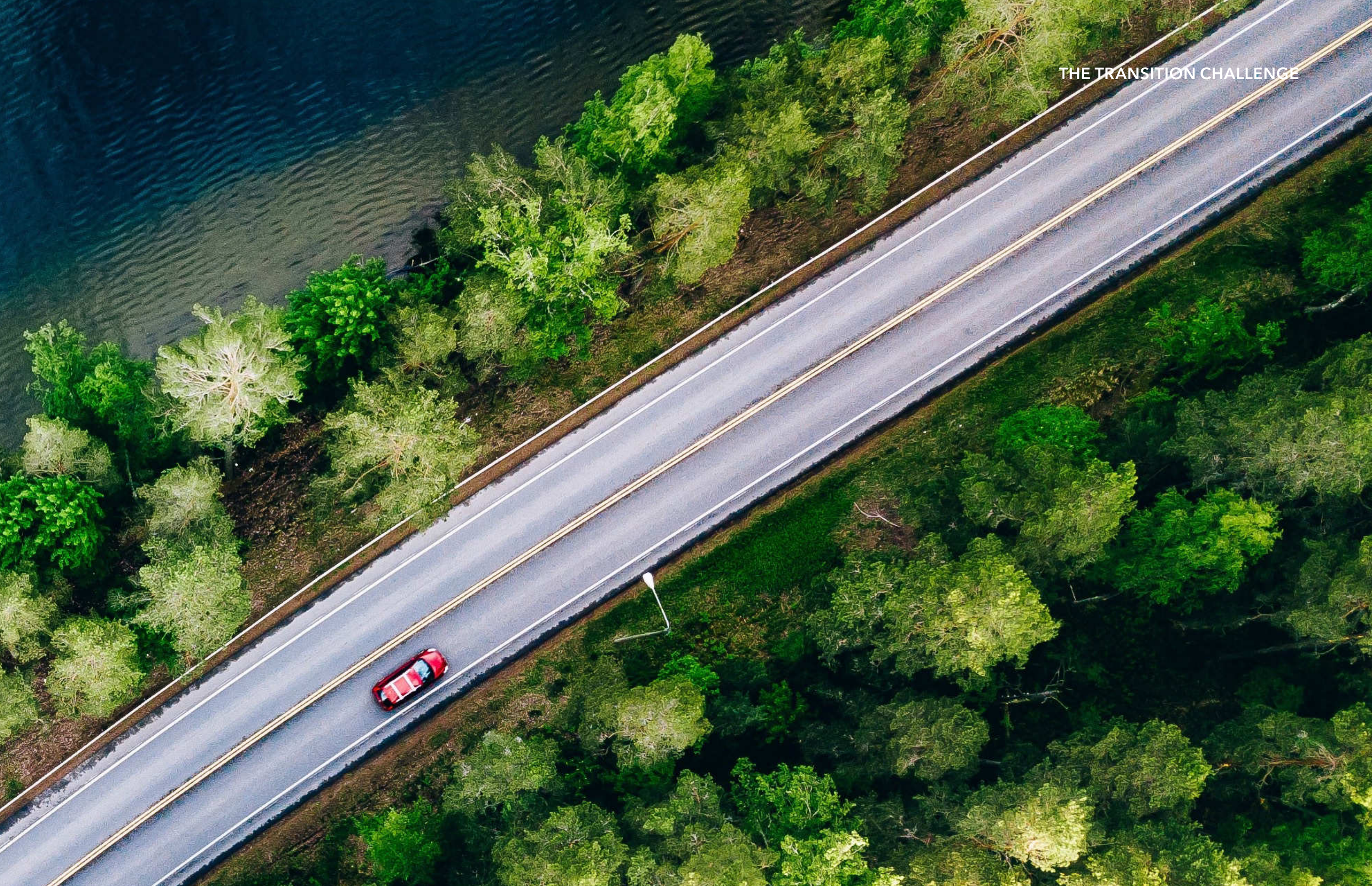
The energy industry is evolving dramatically. Prior to the coronavirus pandemic profoundly impacting all countries, all industries, all companies and individuals with immense human and economic suffering, electricity consumption was growing and renewable energy sources, such as wind and solar, were increasing their share of the total energy mix. In the 2019 edition of our *Energy Transition Outlook* (ETO), we predicted that in 2050, renewables would account for 66% of global electricity production and that total global energy demand will reach a peak in 2033.

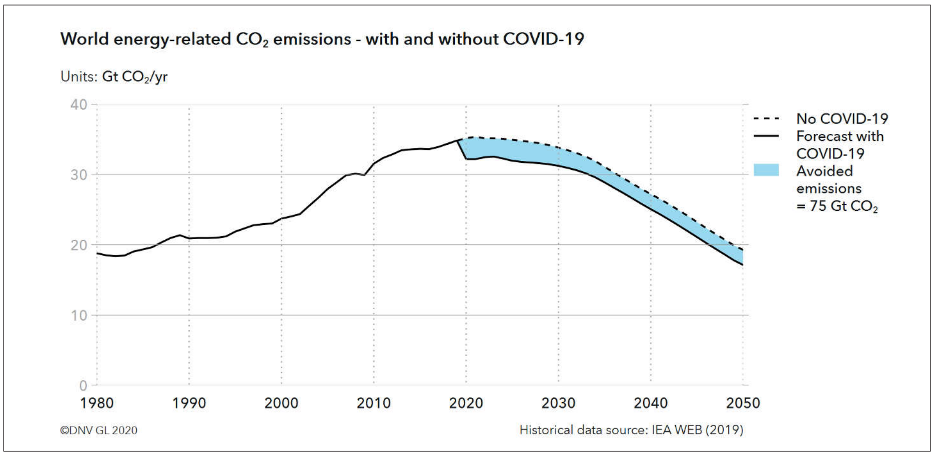
COVID-related lockdowns and restrictions on business activity have resulted in significant and rapid drops in electricity demand particularly in commercial consumption; in contrast, residential use increased slightly in areas with more people working from home. As restrictions ease for some countries, electricity consumption is increasing, although not to the same historic levels as we saw pre-coronavirus.

Our modelling now shows that the pandemic will reduce energy demand through to 2050 by 8%.[1] This means that the resulting energy demand in 2050 will be at almost exactly the same level as in 2018. Improvements in energy intensity will remain the most important factor in reducing energy demand in the coming decades, and the contraction due to COVID-19 comes on top of this. That is as a result of the brakes applied to economic activity generally by the pandemic, as well as some specific sectoral impacts.

The rapid and sustained cost reductions achieved by wind and solar power generation give rise to renewable energy sources being viewed as more favourable for some investors. During the coronavirus crisis renewables have demonstrated their reliability with higher proportions of variable renewables supplying power demand, for example, for two months in the UK, no coal-powered electricity was generated – the longest period since the 1880s.

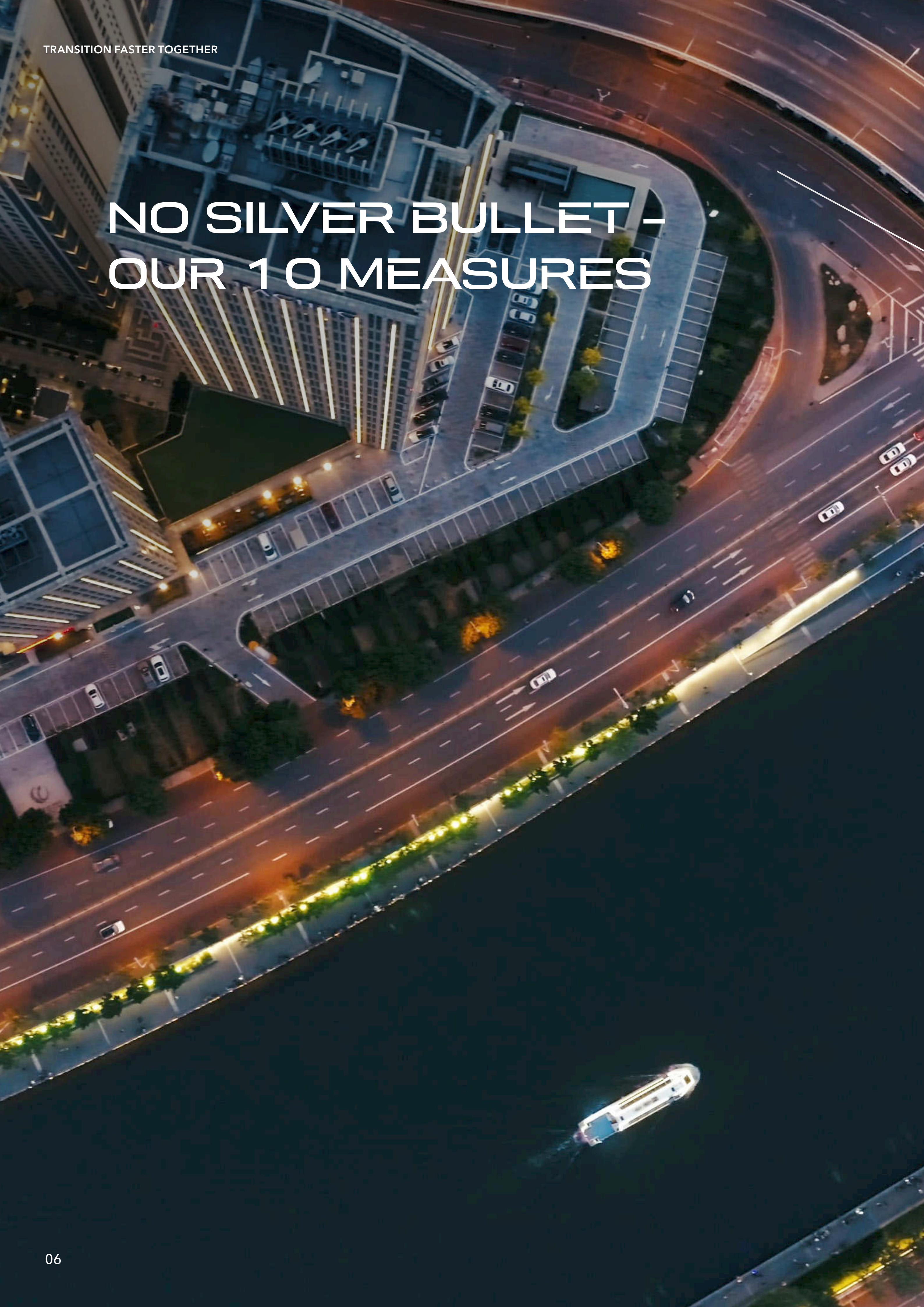
[1] 'The impact of COVID-19 on the energy transition', DNV GL, June 2020





With the earlier than anticipated plateauing of oil and the continued decline in use of coal, the preview into the 2020 results of our ETO forecast, which will be released in early September, shows that CO_2 emissions have most likely already peaked, as shown above.

This is welcome news from a climate goals perspective. However, the current decrease in carbon pollution is a short-term consequence of our current situation, and the climate crisis will be with us for a very long time, meaning that the transition is still not fast enough. To reach the 1.5°C 'safe' upper limit for a global temperature rise, we would need to repeat the decline in emissions we've seen in 2020 so far, every year from now on. Put simply, the impact of the coronavirus crisis on energy demand only buys humanity another year of 'allowable' emissions before the 1.5°C target is reached in 2029.



NO SILVER BULLET – OUR 10 MEASURES

We want to change the forecast of a rise in average global temperature to 2.4°C above pre-industrial levels. To do so, we need to transition to a clean energy future faster, much faster. We need extraordinary policies, along with solutions and strategies across the three vital areas of more renewables, future-proofed power grids and more energy efficiency.

Although there is no silver bullet, there are steps that governments, businesses and society can take to close the gap between our most likely forecast of 2.4°C down to 1.5°C?

The 2019 edition of our *Energy Transition Outlook* identified a combination of important measures to meet this target, two of which have specific implications for the transmission and distribution industry.

1 Grow solar power by more than ten times to 5 TW and wind by 5 times to 3 TW by 2030, which would meet 50% of the global electricity use per year.

2 Instigate a 50-fold increase in production of batteries for the 50 million electric vehicles needed per year by 2030, alongside investments in new technology to store excess electric energy and solutions that allow our electricity grids to cope with the growing influx of solar and wind power.

3 **Create new infrastructure for charging electric vehicles on a large scale.**

4 **Invest more than $1.5trn annually for the expansion and reinforcement of power grids by 2030, including ultra-high-voltage transmission networks and extensive demand-response solutions to balance variable wind and solar power.**

5 Increase global energy efficiency improvements by 3.5% per year within the next decade.

6 Use green hydrogen to heat buildings and industry, fuel transport and make use of excess renewable energy in the power grid.

7 For the heavy industry sector: increased electrification of manufacturing processes, including electrical heating. Onsite renewable sources combined with storage solutions.

8 Heat-pump technologies and improved insulation.

9 Massive rail expansion both for city commuting and long-distance passenger and cargo transport.

10 Rapid and wide deployment of carbon capture, utilization and storage installations.

But how close are we to meeting these targets? What are the drivers pushing us forward and what are the barriers holding us back?

DRIVERS AND BARRIERS OF THE TRANSITION

Relevant from a power grids perspective

DRIVERS

1. **THE NEED FOR RENEWABLES INTEGRATION**
The drive to decarbonize the energy system means that renewable energy sources, such as wind and solar, are increasing their share of the total energy mix. In the 2019 edition of the *Energy Transition Outlook* (ETO), we predicted that in 2050, renewables would account for 66% of global electricity production. Renewable power sources are often located in remote areas away from load centres as with offshore wind or distributed in many small generation units as in the case of solar PV. These renewables need to be integrated into the power system, driving the need for investment in and transformation of the transmission and distribution (T&D) system.

2. **SYSTEM EXPANSION TO DEAL WITH LOAD GROWTH**
The power system is facing a capacity challenge because of growing peak loads. A future load increase can result from the massive deployment of electric vehicles, or conversion to electric heating, even for developed countries without load growth at present. This will force energy suppliers to invest in new generation capacity, while aiming for the lowest levelized cost of energy (LCOE). When reaching a significant penetration level, the system operation procedures and related processes will need to be adjusted in order to allow a further increase of the renewable energy share.

3. **DIGITALIZATION TO ENABLE THE MANAGEMENT OF DECENTRALIZED RESOURCES, DATA AND INFORMATION**
A seamless and efficient information exchange is necessary at various stages, between an increasing number of companies – Transmission System Operators (TSOs), Distribution Network Operators (DNOs), generators and new players such as aggregators. Such information exchanges have become indispensable in network planning, power system operation and market facilitation. Standardization of communication such as in the Common Information Model (CIM) or communication based on IEC 61850 and other standard protocols provide interoperability between systems and new required modular functions.

4. **ENERGY TRADING BETWEEN MULTIPLE STAKEHOLDERS**
Flexible, stable and transparent energy markets are a precondition for a faster energy transition. The balance of supply and demand in real-time must be enabled for appropriate energy products. This requires cooperation between established platforms for wholesale, retail, balancing, and specific day-ahead and intraday energy markets.

5. **ENERGY SECURITY**
The need for energy security has never been greater. Renewables can strengthen energy security by exploiting distributed, domestic resources and diversifying the energy mix, reducing reliance on imported fossil fuels and exposure to external market forces. Digitalization of network operation, to improve the flexibility and resilience of the grid, can ensure the energy security of critical infrastructure. As we emerge from the current crisis, flexibility and resilience of the grid will become a key parameter to secure critical energy infrastructure in the future.

BARRIERS

1. **A LACK OF APPROPRIATE UTILITY BUSINESS MODELS AND THE FEAR OF STRANDED INVESTMENTS**
The more renewable energy sources that are integrated in the power system the less conventional generation is required. Generation companies based on fossil fuels are losing market share quickly; in some countries traditional assets are already a minority. An increasingly low-margin business environment combined with the fear of stranded assets makes it is difficult to plan long-term investments.

2. **LACK OF COLLABORATION BETWEEN STAKEHOLDERS**
More collaboration is needed when developing the sustainable energy system of the future to ensure reliability standards can be maintained. The European system operation handbook addresses some aspect by encouraging TSO-TSO and TSO-DNO cooperation. But national implementation remains at different levels and needs to accelerate. Collaboration needs to go far beyond just grid operators. To transition faster an unprecedented cooperation between grid operators, utilities, traditional and renewable generators as well as with the mobility, housing and industrial sectors is required. Artificial boundaries from the past need to be removed.

3. **INSUFFICIENT INTEROPERABILITY OF HVDC SYSTEMS**
Conventional power grids were designed for traditional fossil-based resources and not renewables. The grids of the future will need to enable the transmission of renewable energy from remote places to load centres. To strengthen these backbones, interconnected hybrid grids with high-voltage, direct current (HVDC) technology for long-distance energy transmission are needed. Improving interoperability will be key for establishing meshed HVDC grids.

4. **MASSIVE INVESTMENT NEEDED**
Substantial investments in power systems are required to enable the integration of renewables and the rapid increase in demand resulting from electrification of transport and heat. Investment will be needed to strengthen the grid, for example, with ultra-high-voltage transmission networks, to incorporate digital technology to enable reliable operation in an increasingly complex system and in extensive demand-response solutions to balance variable wind and solar power.

5. **WORKFORCE SKILLS**
The energy sector needs to recruit aggressively in the next decade to enable its workforce to keep pace with the energy transition. Data from National Grid in the UK shows that one-fifth of people working in the energy sector are set to retire by 2030. A gap in experienced employees and skills can cause innovation to stall. To speed up the energy transition the workforce needs be agile, diverse, technologically and digitally adept to adjust and keep pace with changes, and constantly develop knowledge and apply this to business operations.

WHAT'S NEEDED TO TRANSITION FASTER?

SOLUTIONS, STRATEGIES AND POLICIES

BUSINESS MODELS

Reimagining existing power grids is key to transitioning to a clean energy future. The power system is moving away from centralized generation facilities and is becoming increasingly decentralized. For example, domestic, commercial and industrial solar photovoltaics (PV) enables electricity to be generated closer to where the demand is, rather than being generated in remote power stations.

While the energy transition will drive change for power systems; grids and electricity markets will be essential enablers of the transition. Utilities and system operators will need to plan for changing revenue streams over the energy transition. Distributed generation and the trend of microgrids will result in some systems seeing less energy flow or even reversed energy flows. Operators will therefore need to consider mechanisms other than simply charging per kilowatt hour (kWh) for using their networks.

With their common interest in integrating more renewables, this will lead to closer collaboration between transmission and distribution operators; distribution network operators transitioning to distribution system operators and providing more grid services; and growth in cross-border ancillary services.

DIGITAL GRIDS TO ENABLE A MORE DECENTRALIZED GENERATION STRUCTURE

As our reliance on renewable energy increases, digitalization of power systems is required to ensure reliable operation. Monitoring of data from multiple sensors, increased connectivity, incorporation of artificial intelligence to predict behaviour and enable fast decision making will be essential to ensure renewable energy fulfils its full potential. To manage the increasingly complex energy system, smart grids will facilitate the exchange of real-time information for forecasting, scheduling and trading between multiple stakeholders.

The fluctuating nature of renewables needs the creation of functioning flexibility markets. Flexibility markets enable local ancillary services, demand-side response, including electric vehicles (EVs) and their associated demands, and behind-the-meter services. Consumers transforming into prosumers will also increase direct energy transfers and shift the power balance between providers and consumers as the two roles merge. Digitalization will give rise to new energy demand response solutions for industries, commercial businesses and households, for example being paid to use surplus energy when there is too much electricity generation or be rewarded for reducing their usage at certain times.

Network operators will be increasingly incentivized to help implementing markets and business models for distributed flexibility management in order to alleviate network congestion and reduce network costs.

THE DNO TO DSO TRANSITION

As the power system becomes decentralized, electricity will flow in two directions, from the large-scale power plants to towns and homes, but also from distributed sources of electricity such as community wind farms or solar panels or homes and businesses. To respond to this new challenge, distribution network operators (DNOs) must transition to become DSOs. New smart functionalities, embedded in Supervisory Control and Data Acquisition (SCADA) systems give DSOs visibility of what is happening on the network in real time, allowing the operation of the network to be optimized. This change will also bring benefits to customers, in the form of cheaper and faster connections. The changes to the energy system could provide new opportunities for businesses, communities and homes, where they can offer services to the DSO in return for financial benefits, as described in the section on new business models.

SOLUTIONS TO ENABLE THE ENERGY TRANSITION

For transmission and distribution systems to enable a faster energy transition it requires focus and commitment to meet all stakeholders' expectations.

The following points should be considered for success.

1. Active and proactive power system development and operations
2. Hybrid generation for optimization (e.g. combined heat and power; energy storage and generation)
3. Strengthen cyber security governance, cyber security practices, protecting personal data, and build cyber security capability
4. Harness and develop the power of digital technology
5. Develop and diversify the business portfolio in different business segments and geographies
6. Financial discipline and flexibility to grow, maintain and re-invest
7. Develop an agile, digitally adept and sustainable workforce

SPOTLIGHT INTERVIEW

NAME: Armando Martínez
ORGANIZATION: Iberdrola
POSITION: CEO Global Networks

ABOUT THE COMPANY

Iberdrola, one of the world's largest electricity companies, has invested EUR 100 billion in smart networks and renewables over the last 20 years, focusing on innovation and electrification. During this time; it has increased assets fivefold, and results and dividends fourfold, while reducing its emissions in Europe by 75%.

Iberdrola is proving that tackling climate change can create value for both shareholders and society. Continued success depends on policy frameworks and regulation, technologies and cooperation to speed electrification by investing sustainably in energy systems based on smart grids and renewables. Expanding electricity networks will enable increasing integration of renewables. Grids also need reinforcing for increasing flexibility and electrification of other sectors, and to withstand climate-change impacts on infrastructure.

Encouragingly, governments globally are setting net-zero targets, involving society, and working with private companies to tackle climate change. Network owners/operators need fair policies based on the 'polluter pays' principle to deploy competitive clean energies. They require stable, predictable regulatory frameworks to incentivize long-term investments enabling electrification in key demand sectors. 'Smart' regulation can allow network companies to include a fair value for societal benefits in project planning criteria. Guaranteeing rules for fair, sustainable competition will encourage newcomers and innovation. Red tape needs reducing to speed up investment. Regulatory uncertainty, especially retroactive measures, are some of the main barriers to investing in the transition. Subsidies for technologies or solutions should be transparent and limited. Governments should avoid hidden subsidies such as 'virtual' self-consumption.

We have increasingly cost-competitive technologies such as wind and solar for the transition. Other transition-enabling technologies include pumped hydro storage, heat pumps, and batteries that can store more energy and at a lower cost. Digitalization is key. It can boost the low-voltage grid's capacity to host distributed energy resources, helping to reduce carbon emissions while limiting investment needed for grid reinforcement. Hence, investment should focus on smart networks to enable the development and capital spend required for energy storage and renewables.

Reinforced, smart grids can avoid delays in integrating renewables and in consumer behavioural changes. Social costs of delay will greatly exceed the marginal cost of investing ahead of need. For example, lack of charging infrastructure delays the uptake of electric vehicles. Digital networks will allow flexible integration of new energy solutions and participation of new agents in the energy system; allowing end-users to provide demand side response solutions. Iberdrola is developing smarter, more-flexible network solutions to help mitigate the need for traditional reinforcement and reduce costs for our customers. We recognize that resources connected to our networks could solve network constraint challenges. We are therefore exploring flexibility markets with new and existing customers able and willing to control their generation, or who can modify their demand. Our UK business is seeking flexibility services through competitive tenders.

Where appropriate, we consider non-wires alternatives (NWAs) to investing in grids. For example, the New York Public Service Commission is set to approve installation and owner-ship of a battery to improve service quality in a rural part of New York state. In our view, public-private-societal cooperation is the only way to accelerate the transition through greater electrification based on smart grids and renewables. For instance, the Smart Cities project promoted by our i-DE electricity distribution subsidiary in Spain has agreed with local governments to promote a city model with more efficient and sustainable services. This includes a focus on electrical mobility, network infrastructures, energy efficiency and public awareness. In addition, Spanish distributors including i-DE have collectively launched the datadis.es digital platform giving consumers free, secure, independent access to data on their consumption and contracted power, no matter which companies they deal with, or where. This lets customers manage energy use better, save money, and apply energy-efficiency measures.

Our energy system has proved resilient during the COVID-19 pandemic. We have maintained quality of supply, assured employee safety, and supported contractors for supply-chain continuity. The crisis will accelerate the transition by creating even greater need for economically and environmentally sustainable economic growth.

Where possible, electricity network companies should accelerate planned investments. Every euro invested in distribution grids enables two euros of other investments in renewables and electrification. Spain's distributors plan to accelerate investment to support the European Green Deal which, analysts estimate, will create as many as 70,000 new, quality, stable jobs in Spain alone. This will cost Spanish electricity consumers less than EUR 0.50 per customer per year while mitigating pandemic-related economic effects that would otherwise delay Spain's 2030 National Energy and Climate Plan for at least three years.

SPOTLIGHT INTERVIEW

NAME: Dr. Richard Gort
ORGANIZATION: TenneT
POSITION: Director Grid Field Operations

ABOUT THE COMPANY

TenneT is a leading European electricity Transmission System Operator (TSO) working mainly in the Netherlands and Germany. In 2019, it invested EUR 3.1 billion in the energy transition and ensuring security of supply for 42 million end-users served by the company's 23,500-plus kilometres of high-voltage connections.

As a cross-border TSO that learns quickly we can help to accelerate the transition. For example, in our cross-border grid field operations, lessons from standardizing 380 kV and 220 kV grids in Germany are applied in the Netherlands. Work in the Netherlands with our supply chain is more integrated, cooperative, and performance and partnership-based, approaches we are transferring to Germany. For electricity, the transition should not only be about building new grids. It also needs to embrace systems thinking about how to integrate the grid into a green energy system, transport and store this electricity and convert power to hydrogen, using existing gas infrastructure.

To support Germany and the Netherlands' decarbonization targets, TenneT has to connect an increasing output of North Sea offshore wind power and decentralized sources of energy into the existing grid and expand it for the future. We are piloting innovative blockchain solutions to see if interconnected home energy-storage systems or EV-loading stations contribute to grid stabilization. Innovation like this helps reduce investment needs for hardware in the grid. We must balance all these needs to support the transition; to stabilize an increasingly connected grid for security of supply; and, to do everything affordably at a reasonable cost to end-users.

One element of our strategy is to provide more electricity through existing grids by applying Dynamic Line Rating and advanced conductors, phase shifters, modern control technologies for grid stability, and possibly batteries boosting transport capacity to increase the use of the existing infrastructure. We are replacing 50 to 60-year-old infrastructure, driving new thinking by standardizing installation in the field, and the project delivery train behind it. On digitalization, the key is to standardize data formats for digital interchange between TenneT and vendors. Another strategic thrust is to build the new grid with higher transmission capacity. Moving to 525 kV HVDC cabling technologies for our SüdLink and SüdOstLink projects in Germany involves much less cabling and footprint than 320 kV HVDC would.

In a world first, we will use 525 kV HVDC cables with 2 GW converter platforms for five connections to offshore wind farms in the Netherlands and Germany. This standardization will reduce costs and the spatial impact of the cable systems. We are building on the experience gained with our first series of nine operational HVDC connections and three more under construction in Germany. We have also already used this experience to highly standardize a series of eight 700 MW AC offshore platforms for competitively connecting Dutch offshore wind farms by 2027 (of which two are currently operational), a key enabler towards subsidy-free offshore wind in the Netherlands. Enabling flexibility takes international cooperation such as new cross-border power highways like BritNed, NorNed, NORD.LINK and COBRAcable. In the future, there may be a high-voltage 'wind interconnector' between the Netherlands and the UK, combining the offshore wind park connection with an interconnector function between both countries. We are also collaborating in the North Sea Wind Power Hub programme that could lead to a hub-and-spoke energy island offshore to connect countries and many offshore wind farms.

We participate in the PROMOTioN project analysing positive effects of a joint offshore electricity infrastructure based on meshed HVDC grid technology, and in MIGRATE [Massive InteGRATion of power Electronic devices] for improving grid stability. Our projects with vendors focus on new technologies to build the future grid and early planning so that facilities such as data centres can be near renewable energy sources. All this thinking and activity is about optimizing the energy system. Some sectors are hard to electrify. If they need green hydrogen, electrolysers will become part of the energy system. Hydrogen could be a cost-effective alternative to building even more electrical grid. We are exploring this with Dutch natural gas infrastructure and transportation company, Gasunie.

The market does not always provide for innovation. For example, integrated hydrogen/electricity infrastructure may need seed capital. Offshore wind is now almost subsidy-free. Regulation sometimes hinders us when considering new technologies. For example, batteries can in certain cases be seen as a functional component of the grid rather than as "electricity generation", which is not foreseen in the current regulation. Overall, though, I see signs of European governments pulling together to set directions and agree on stimulus packages, and am optimistic that Europe's grids can meet the challenges of the energy transition and following COVID-19, the European Green Deal can help us to 'build back better.'

TECHNOLOGIES

The power grid is a complex, interconnected system of generation, transmission and distribution facilities forming an important part of critical infrastructure. For decades it has served society's needs sufficiently. But today's power grids are facing a challenge like never before; they need to be massively modernized to cope with the integration of renewables, while ensuring reliability and power system stability. At the same time our growing dependency on electricity is putting pressure on an already stretched T&D sector, which needs to find innovative ways to deliver power to our cities and homes. This need has a knock-on effect for every aspect of the sector, from energy pricing to infrastructure and the services built on top of it. As well as ensuring that standards are maintained, operators, owners and investors all need to prepare for providing ancillary services and participating in balancing and flexibility markets.

One thing is clear the T&D sector cannot accommodate the aggressive targets of renewables without long-term planning and the agility to integrate new technologies more quickly. The following technologies are vital to ensuring a faster energy transition.

HIGH-VOLTAGE DIRECT CURRENT (HVDC)

Public resistance to overhead power lines has led to the application of long-distance transmission technologies based on HVDC and high-voltage cables, which will be vital in providing links to interconnect remote areas with load centres. This includes 525kV DC cables for onshore long-distance transmission. In view of the costs and acceptance issues connected with grid investments, grids will have to be operated closer to their thermal and stability limits. In Europe, interconnectors between large market areas will help to build the single European energy market. In Greater China, the India Subcontinent and the Middle East including Africa, expansion of grids to supergrids will allow to integrate more renewables into the markets.

FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

As the energy transition changes the power generation landscape and new decentralized models emerge, it is becoming more difficult for grid operators to maintain reliability and stability. Flexible AC Transmission Systems (FACTS) is a system composed of static equipment used for the alternating current (AC) transmission of electrical energy, which can increase the reliability of grids by improving efficiency and power quality.

REAL-TIME MONITORING AND SENSORS

While adapting to monumental changes, the power sector is also faced with keeping the electricity network reliable and affordable. With an increasing number of renewables and smart electronics added to the electricity network, the power grid must cope with more dynamic stress each year. Dynamic-line rating is a technique which uses real-time monitoring systems to constantly calculate the varying line rating of a transmission line. It is a grid reinforcement measure to increase the capacity of existing transmissions routes and an innovative way to provide congestion relief in an inexpensive way.

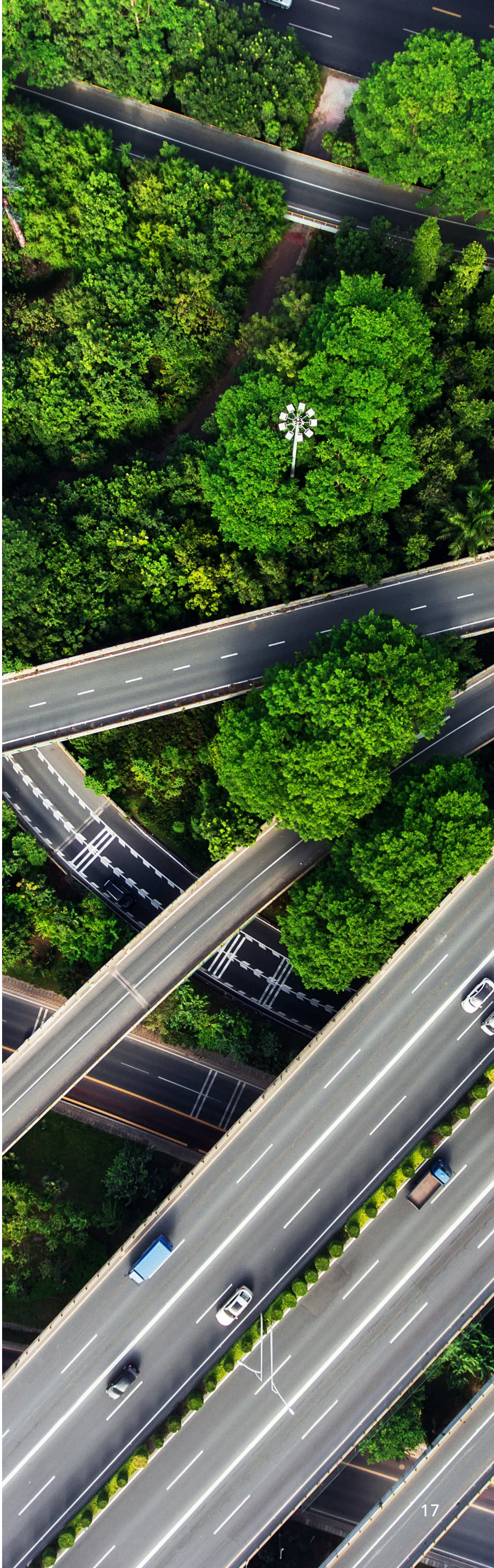
Reliability for grid operators means preventing outages and disruption to the power supply. To prevent outages from happening, it is essential that grid operators are able to locate and respond to faults in the grid quickly, and that they can repair weak spots before the grid fails. Automated systems that continuously monitor the health of cables and other power system components as well as algorithms that correlate real-time cable and component data with variables such as temperature and soil structure to predict long-term degradation across different networks, asset populations and grid configurations can reduce both the number and duration of interruptions. The reliability level expressed by the System Average Interruption Duration Index (SAIDI) varies still widely in Europe between 19 and 555 min per customer.

MULTI-VENDOR MODULAR SCADA/EMS SYSTEMS

The ongoing decentralization of generation structure requires more sophisticated Supervisory Control and Data Acquisition (SCADA) and related grid-operation tools. New functional modules are required for new system operation processes at TSO and DNO level. Functional modules for scheduling, trading and balancing need to exchange information in a standardized, interoperable way. To cope with the increased complexity of system operation, a next generation of SCADA systems will enable the management of a power system with many fluctuating resources. Based on the process coupling of connected renewable energy farms a reactive (N-1) management will be enabled, allowing line loadings closer to their thermal limits while rapidly adapting the farm's infeed in case of tripping events. Operational management of the grid means using information from many data sources such as market data, structural data, scheduled data, and real-time data. Monolithic systems from one vendor delivering the whole functional complexity belong to the past.

DIGITALIZATION AND THE COMMON INFORMATION MODEL (CIM)

Digitalization in the T&D industry isn't new. The power industry has a history of applying digital tools and upgrading old analog systems. This includes the automation of network operations, the emergence of sensors and data analytics to enable smart asset management leading to better utilization of main system elements. A seamless and efficient exchange of information is necessary at various stages, between an increasing number of companies, TSOs, DNOs and generators. Such information exchanges have become indispensable in network planning, power system operation and market facilitation. The importance of communication protocols such as the Common Information Model (CIM) for energy data exchange in the wider decarbonization agenda cannot be underestimated. Today, as we move from centralized fossil to distributed renewable generation and coupled with extending smart grid deployment, a significant increase of process data needs to be exchanged in real time between systems and applications of many different participants to actively manage the complexity of the network and energy balance. The IEC 61968, 61970 and 62325 series CIM-standards play a pivotal role in our energy transformation challenge and act as a common language for this data exchange across the utility and energy markets, enabling system interactions.



SYSTEM FLEXIBILITY

Integrated energy systems will have a huge impact on the energy transition. They represent technical solutions for satisfying local energy demand in a combined way (power and heat). Such systems include renewable and clean-fuel power generation, battery storage, heat storage and elements of sector coupling based on hydrogen.

As we move towards a system with more renewables, flexibility will become more important. Electric vehicles will help grid operators to cope with this increasing need for flexibility in the system. EVs represent a vast amount of battery storage capacity and are therefore the perfect companion to renewables.

A DNV GL study into whether it is possible to generate revenue with 'vehicle-to-grid' technology, i.e. using the batteries of EVs to provide flexibility to the power system, assumed that vehicles would be parked at home from 6pm to 6am and that their batteries could be charged and discharged during that time, and that they had to be fully charged by 6am. The findings showed that the benefits of EV integration turned out to be approximately €1,000 per year per car. However, these benefits were distributed among different stakeholders

Balancing-responsible parties could save money from vehicle-to-grid technology by reducing their balancing costs, in particular, the costs of frequency containment reserves. Energy suppliers on the other hand could save money through portfolio optimization, for example by optimizing charging and discharging cycles of the EV against intraday market price movements.

The real value will be in developing new business models that will capture these potential benefits. There are already energy suppliers offering products to consumers based on vehicle-to-grid schemes, such as free charging for owners of EVs. For the energy supplier it is also attractive, because it is a way for them to enter into long-term relationships with a group of high-end consumers.

Traditionally expanding the grid has meant the roll-out of wired infrastructure and power stations, but this is complex and expensive. Non-wires alternatives will increasingly be used to solve this problem. New technologies such as modern methods of energy efficiency, demand response, storage, and distributed generation are coordinated and used instead. This will have a positive impact on utilities, who can play a role in driving the market forward alongside generators and distributors. Currently this is a growing strategy for the US but it has important implications for the rest of the world.

As the volume of variable renewables grows, energy storage will become important for managing supply and demand. Apart from providing ancillary services, the impact of storage in wholesale energy markets greatly depends on how much and how quickly fossil-based power generation is phased out. Adding new storage technologies to the grid may result in different fault conditions, moving from classical short-circuit currents to short high-current pulses. Using flexible hydropower and pumped storage is on the agenda for large-scale storage, but commercial viability of this option is very country dependent.

SPOTLIGHT INTERVIEW

NAME: Stacey Doré
ORGANIZATION: Sharyland Utilities
POSITION: President & CEO

ABOUT THE COMPANY

Sharyland is an independent electric transmission utility fully regulated by the Public Utility Commission of Texas, US. Sharyland owns and operates 345 kV and 138 kV transmission networks and substations in Texas, and the 300 MW Sharyland DC Tie HVDC interconnector to the Mexican national grid.

As part of a family of companies whose mission is to 'impact humanity for the better, with energy,' Sharyland believes we are in the middle of an energy transformation that involves adding more energy resources to the mix rather than completely transitioning away in the near term from current energy sources.

This transformation is a tremendous opportunity for Sharyland. As a transmission service provider throughout the Electric Reliability Council of Texas (ERCOT) grid, we intend to develop, build, and operate transmission infrastructure enabling the continued rise of renewable energy and energy storage to meet ever-rising energy demand. The challenge for Sharyland and our industry is to keep up with changing technology in a regulated world where change is not always rapid. We try to meet this challenge by staying abreast of the latest trends and research and advocating for policy changes when appropriate.

Faster electrification is a key accelerator of the energy transformation. DNV GL predicts that electricity's share in the final energy demand mix will more than double within a single generation, and that half the light vehicles sold worldwide will be electric vehicles (EVs) by the early 2030s. We see broad consensus that electrification of society will increase exponentially in the coming decades, including renewables, storage, and other carbon-neutral generation technologies. Electrification of heavy and light vehicles, and greater adoption of distributed energy resources and utility-scale storage, will also be key factors in advancing the energy transition. Advanced charging technology and investment in infrastructure to drive the adoption of EVs would speed up the transformation.

It is also important that capital continues to be deployed to lower the cost of renewable power and storage technologies. Longer duration battery-storage technology, such as flow batteries, could make wind power storage more economically viable, thereby enabling more wind generation.

Investment in grid resilience and stability is critical to ensure that we can reliably transmit the renewable power that our world is demanding. Various smart-grid technologies could improve transmission capacity and reliability, making our business more efficient and effective.

We take a unique approach to partnering with renewable developers and enabling advanced technologies. For example, we are currently working on a project to connect a 200 MW battery energy storage system to one of our substations in South Texas, one of the largest battery projects underway in ERCOT. We have worked constructively with the battery developer to be responsive to their timeline and flexible on design issues to ensure the desired in-service date. Whereas some other utilities have opposed competitive development of energy storage, we embrace the opportunity that the competitive marketplace brings to us. We enable customer choice and technology advancement because we believe in expanding the pie rather than engaging in turf wars. We have partnered with battery developers to ensure their projects come online on time, but in a way that preserves grid reliability. Perhaps most importantly, we are nimble and responsive to those who partner with us. We believe in speed and agility, not utility bureaucracy.

Sharyland participates in various industry groups committed to leading a clean energy transformation – such as the Edison Electric Institute. This gives us invaluable access to worldwide peers on the leading edge of ensuring that the utility industry meets the needs of the energy transition. It keeps us abreast of developments and lends our voice to important issues.

In the near term, there is much speculation about COVID-19 impacts on the energy transition. We don't know how the pandemic will ultimately affect the pace of transformation, but we do know that COVID-19 will not stop it. The transformation continues, and we will continue to do our part to advance it. COVID-19 has taught us so much about the value of technology, efficiency, productivity, and crisis management. We have also learned to be more agile and adaptable as we have had to transform our businesses to survive the pandemic.

Those lessons will help us be better leaders. But I believe the most important lesson is that no matter what technology, policy, cost, environmental, or health challenges we face, we cannot advance any of our objectives without our people, our most important asset. The highly committed and tremendously talented workforce at Sharyland and in the wider energy industry will help us navigate and advance the energy transformation in a way that impacts humanity for the better.

POLICY & REGULATION

Policy is instrumental in deciding how the power industry progresses. A more decentralized system will drive a need for higher levels of regulation to define roles and interfaces between players. Currently, energy policy is highly localized and politicized, and fast changing framework conditions are not good for large investments in the energy industry with the fear of stranded investments.

The power sector must develop new business models as the conventional generation sector moves into a low margin business because of the surplus of energy caused by renewable resources. The coal phase out roadmaps in some countries on the one hand, and demand increase coming from faster EV adoption rates will further stress the energy system and its financial structure.

The grid sector will largely remain in the regulated business segment. But with the arrival of new business models for flexibility markets and the provision of ancillary services, it remains to be seen how the business will be shared between TSOs, DSOs and other future stakeholders. TSOs will claim this market for their own but sharing might be required with the further decentralization of the generation sector. Apart from the traditional electricity supply model, further dropping investment costs for IT, renewable generation and storage applications will enable an increasing share of off-grid supply.

Policymakers can help in defining the more challenging climate goals and appropriate long-term energy scenarios. Regulators can then develop the new elements in the regulatory framework which ensure that reliability and sustainability targets are met based on functioning market models and conditions.

Coordinated multi-sectorial planning as initiated i.e. by European Network of Transmission System Operators (ENTSO-E) will enhance flexibility across various energy sectors and allows development towards a more energy- and cost-efficient energy system.

INVESTMENT

The race towards a greener, cleaner and smarter future is changing the game for energy investment. There are new players, new opportunities but also new risks. Cost reductions in renewables are leading to the fading out of subsidies and falling revenues for all types of generation. According to the IEA World Energy Investment 2020 report, 'investment in grids, which has been declining in a number of countries (especially in China), is set to fall again, by around 9% in 2020; despite its regulated nature. The impact will be larger in developing countries as most of the investment in networks is financed by state-owned utilities that were in a weak financial position before the current crisis, and will likely worsen, driven by more limited fiscal capacity from governments and higher financing costs as sovereign risks increase.

Despite a fall in grid investment in some countries, there is continued focus from grid operators around the world to invest in renewables integration, grid modernization, improving resiliency and digital transformation. The regulators and network operators have established long-term planning processes like the Ten-Year-Network-Development-Plans (TYNDP) in Europe. Those plans are based on energy scenarios as the first important step to capture the interactions between the energy (gas and electricity) systems, and the rest of the economy. The Scenarios will allow ENTSO-E to perform a sound assessment of European infrastructure requirements.

The investment challenges and opportunities will be different for every country, depending on its individual energy system, regulatory environment, generation mix and development needs.

CLOSING REMARKS

The energy transition is forcing fundamental change for the power system and the industries that manage it. Integrating variable renewable energy sources will require large-scale investment in network modernization and extensions. But grids today are not only defined by the so-called energy transition.

Irrespective of the climate agenda, grid operators face the challenges of ageing assets, an ageing workforce and societies increasing dependence on electricity. These are all challenges that need to be overcome if we're to transition to a clean energy future faster.

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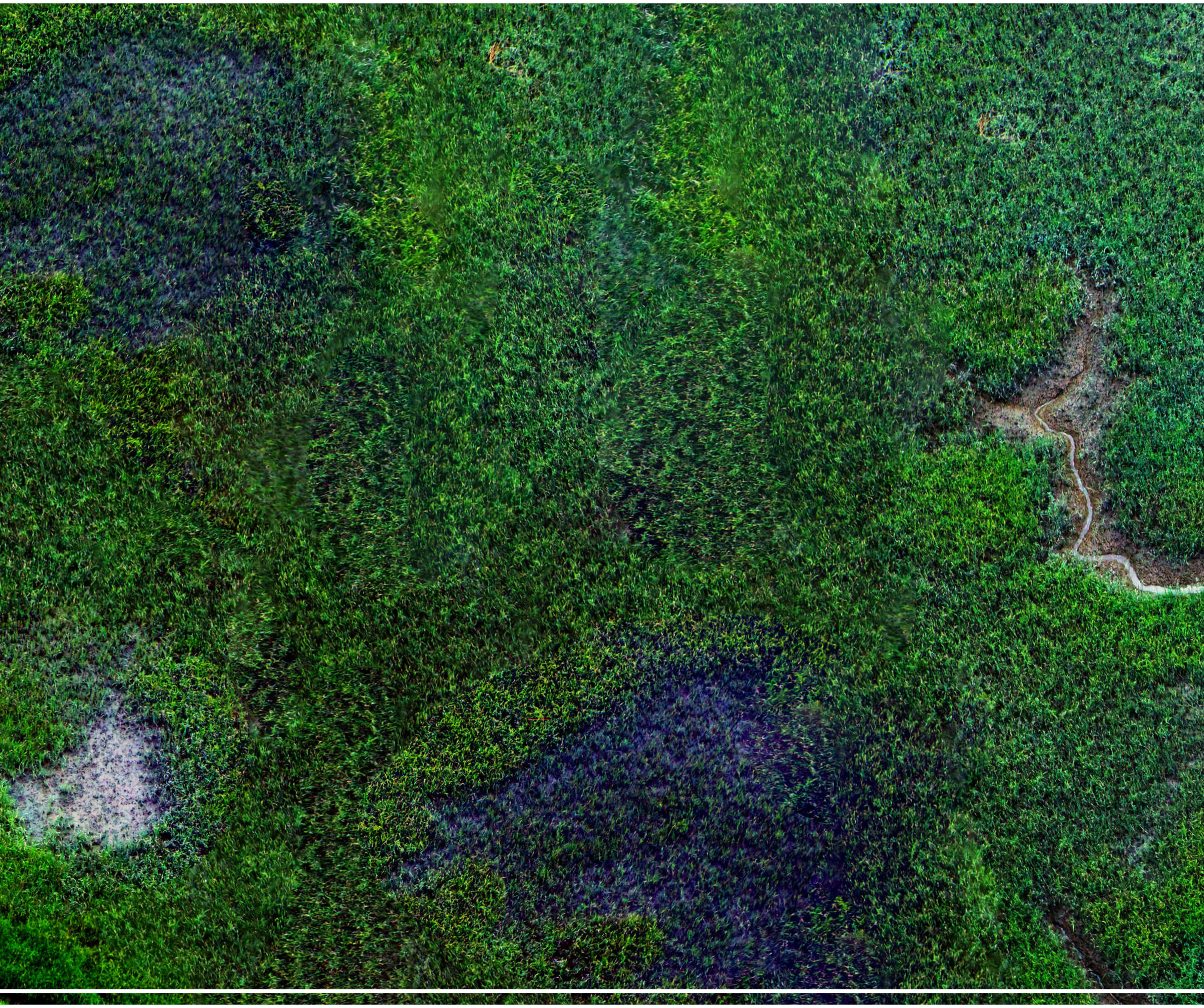

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