

WORLD ENERGY FOCUS

ANNUAL 2017

The energy transition: How innovation is driving change



INSIGHTS FROM ENERGY LEADERS

- › **Younghoon David Kim**, Chair of World Energy Council
- › **Jorge Sanches**, Portugal Secretary of State of Energy
- › **Kersti Kaljulaid**, President of the Republic of Estonia
- › **Li Yong**, Director General of the United Nations Industrial Development Organization (UNIDO)
- › **Dr Matar Al Neyadi**, Undersecretary of the UAE Ministry of Energy
- › **Leonardo Beltrán Rodríguez**, Mexico's Deputy Secretary for Planning and Energy Transition
- › **Andreas Kuhlmann**, Chief Executive of Deutsche Energie-Agentur (DENA)
- › **John Doyle**, Chief Executive of Marsh
- › **Badr Ikken and Zakaria Naimi** of the Research Institute for Solar Energy and New Energies of Morocco (IRESEN)
- › **Antonio Pietri**, Chief Executive of Aspentech
- › **Josu Jon Imaz**, Chief Executive of Repsol
- › **Ewald Hesse**, Chief Executive of Grid Singularity
- › **Christina Bu**, Secretary General of the Norwegian Electric Vehicle Association
- › **Ditlev Engel**, Chief Executive of DNV GL Energy
- › **Strive Masiyiwa**, Chairman and Founder of Econet
- › **Leonhard Birnbaum**, European Chair of the World Energy Council
- › **Philip Lowe**, Executive Chair of the World Energy Council's Energy Trilemma

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Brave new world

The energy sector is evolving rapidly and the stakes have never been higher, says Younghoon David Kim, Chair of the World Energy Council and Chairman and Chief Executive of Daesung Group



When my company was founded 70 years ago, energy was simple. For Korea, like many countries, energy has enabled our nation to grow prosperous and has underpinned a rapid industrial growth that has benefited our economy and our people. Technology and industry has been at the heart of this transformation providing prosperity for over 50m people. The energy sector has evolved from one where we produced coal for industry to one which today is much more diversified and looks to the future. Many of you will have experienced this transformation when you visited my home city of Daegu for the 22nd World Energy Congress in 2013.

Now as we look to the next 70 years we see a much more complicated and fast-moving landscape for the energy sector. There are many new technologies being utilised today and they are becoming more efficient and cost effective. This creates challenges for mature technologies and the economies that depend upon them. We see further technological developments on the horizon that will either grow strong or fade into memory. However, it is clear the speed of decision-making is raising the stakes to a greater level than ever before.

This is not unique to the energy sector. Many will remember the battle between the VHS and Betamax formats for supremacy of the video recording market in the 1980s. Now we have moved to a place where those machines have been tossed aside and we can stream live content from across the world directly to our homes or even on small hand held devices, often made in Korea, that can also act as a phone, a camera and a computer.

It is not as easy to envision the same level of transition in the energy sector due to the massive levels of investment that are required and the time taken to develop infrastructure. Yet this is what can be expected in the coming years. Our latest World Energy Scenarios, which we published at our World Energy Congress last year in Istanbul, highlighted disruptive trends are emerging “that will create a fundamentally new world for the energy industry”.

As stewards of this industry, we all have a role to play in helping to make the right decisions that will provide a sustainable energy future for all. This is true for developed economies, striving to decarbonise and provide efficient and secure energy supplies that respond to consumer demand. And it is true for developing

economies, where leaders and entrepreneurs are looking to unlock the potential of the population and free more than 1bn people who still lack access to modern forms of energy from the tyranny of poverty. We have a duty to learn from the past and prepare for the future.

When we look at how countries are responding to the triple challenge of the Energy Trilemma—how to provide secure, equitable and environmentally sensitive energy—we see great variation. However, I am pleased that in many energy ministries across the world, governments are using the Energy Trilemma principles to guide policy thinking. The Trilemma provides the framework for countries to work together, for industry leaders to collaborate around a common understanding and for thought leaders to share their insights and perspectives.

“As stewards of this industry we all have a role to play in helping to make the right decisions that will provide a sustainable energy future for all”

It is in this context that we have invited so many leaders and thinkers to contribute to this year’s World Energy Focus. I am grateful to all who have taken the time to provide their vision around the theme of innovation. This publication provides the ideal backdrop for our discussions in Lisbon and at our many other meetings around the world.

Our annual Executive Assembly in the historic city of Lisbon takes place at a time of unprecedented transition for the energy sector. As the principal impartial network of energy leaders, it is right that we gather to consider the implications of this transition globally, regionally and, most importantly, nationally. As the World Energy Council is comprised of member committees, this agenda speaks to the heart of who we are and, with our young leaders, where we want to go.

Each member country and each energy leader has an important role to play in contributing to an affordable, stable and environmentally resilient energy system for the greatest benefit of all. The next 70 years will be crucial for the energy sector as we look to a more complicated future than the simple system of our past.

Portugal's low-carbon revolution

The country has been at the forefront of renewable technology development and has transformed its energy mix, Secretary of State of Energy, Jorge Sanches tells World Energy Focus

Since the beginning of the 21st century, Portugal has been committed to the low-carbon energy transition. Through development of its abundant renewable energy resources—hydropower, wind, solar, biomass and geothermal—Portugal has become one of the world leaders in the development of low-carbon power.

As a decarbonised society is a guarantee for a habitable world for future generations, we have been applying an ambitious and successful plan to promote electricity production from renewable energy sources.

In May 2016, we achieved four days of continuous energy consumption which was 100% powered from renewable energy—proof of the success of Portugal's strategy.

This choice has yielded thousands of new green jobs, has brought an unprecedented dynamic to local installation companies and has given a decisive contribution to the €172m (\$204.3m) electricity exporting surplus in 2016. Moreover, this policy has reduced our dependence on energy imports by 16% in the last decade.

In the renewables sector, Portugal has enormous potential for expansion, and has committed to an ambitious target of renewables reaching 31% of the country's energy consumption by 2020. We are well on track, having already achieved 90% of this target. Likewise, Portugal's energy policy has contributed to the development of a highly skilled workforce and of a sector ready to deliver the most advanced renewable energy technology in the world.

By the end of 2016, Portugal had an installed power capacity of 13.3 GW from renewable technologies, accounting for 68% of the country's total. This is up from just 7.8 GW in 2007—most of which was hydropower installed during the second half of the 20th century. This evolution is a direct consequence of the development of public policies aimed at increasing the deployment of renewable energy capacity.



As well as social and economic benefits, these policies contributed to the development of renewable energy technologies. Adding to the impressive rate of technological progress and the exceptional natural conditions of Portugal, we are now ready to take a further step in the decarbonisation process.

This entails a market-based renewable energy investment strategy. Due to the significant cost reduction of solar PV technology as well as the high number of peak sun hours, we have already been able to license 500 MW of solar PV capacity in fully market-based projects.

As an example, in Alcoutim, in Portugal's Algarve region, the biggest European non-premium solar PV plant is currently under construction (200 MW).

To simplify and make the most of investment opportunities, we are reviewing the administrative procedures in place and setting clear targets for grid reinforcements, especially in the south of Portugal. In 2016, 62% of electricity production was from renewable energy sources. An increase of this share will require further flexibility of the electricity system, which will be achieved through three different policy axes.

Firstly, the interconnection capacity between the Iberian Peninsula and France should be increased. This is being actively debated among European Union (EU) member states, the Presidency of the bloc's Council and the European Commission. In the Clean Energy Package

framework, under negotiation in the Energy Council of the EU, Portugal proposed binding interconnection capacity targets of 10% by 2020, and 15% by 2030 for all member countries. Beyond that, Portugal has ordered a technical study for the construction and operation of an electrical interconnection with the Kingdom of Morocco.

Secondly, we will put into operation extra capacity of pumped-hydro in the next four years, to support production of variable renewable energy for grid balancing purposes.

Thirdly, we will announce a new legal framework for battery storage and aggregated decentralised grid balancing solutions.

Besides creating the opportunities to invest in renewable energy, we are also facilitating technological developments based on ocean energy resources, such as, floating wind turbines and wave energy.

Portugal intends to reinforce its position as a benchmark country with respect to the global energy transition process. Since we are already experiencing the broad positive socioeconomic effects of our energy transition model, we understand that keeping our frontrunner position will give us vast long-term opportunities with respect to the creation of new jobs, knowledge and investment.

We invite you to be part of our energy transition endeavour, and welcome you to Portugal for the 2017 World Energy Council's Executive Assembly week.

“We have a global consensus to act together in order to tackle the challenges we face in transitioning to a low-carbon economy. What we need is a blueprint for success”



New energies: Thermal plant in Tallinn, Estonia

Innovation nation

Advances in digital technology are the main driving forces behind rapid changes in the energy sector. But they are also a response to those changes, says Estonian President Kersti Kaljulaid



We are living in a period of rapid global population growth, which is complemented by constant change and improvements in people's standard of living. All over the world, people have access to better housing, education, healthcare and entertainment. This is a change for the better, but this rare situation in human history is creating a plethora of challenges for our planet—the growing demand for resources and energy is putting pressure on our ecosystems, existing infrastructure and the overall sustainability of the earth. Fortunately, the Paris Agreement serves as an overarching commitment from political, business and social leaders alike to move towards a low-carbon and sustainable future. We have a global consensus to act together in order to tackle the challenges we face in transitioning to a low-carbon economy. What we need is a blueprint for success.

Even though Estonia is one of the biggest greenhouse gas emitters in the European Union (EU), we are also one of the bloc's leading countries in terms of energy security, air quality, and the overall health of the environment. For us, it has been a difficult feat to achieve but a worthwhile one. Renovating and reconfiguring the existing ("old") energy system has, for example, resulted in a tenfold reduction of sulphur emissions from power production. Investments into the "new" energy system have resulted in more than a 1000% increase in the share of renewables in Estonia's power mix. Investments in "digital" energy have resulted in a 100% penetration of smart meters. All these are monumental changes that have required a lot of smart investment and innovation activities. For example, Estonia has a centralised datahub which enables consumers to easily switch their natural gas and electricity suppliers. Electricity consumers can also have a dynamic (hourly priced) contract and access smart apps which enable them to manage consumption in real time.

However, not all investments turn into success stories. Estonia was once a leader in electric transport; we made substantial investments in building up the charging infrastructure and into subsidising the sales of electric vehicles. Unfortunately, the initial investments did not create a spill-over effect and we did not see a significant change in the transport sector. Estonian companies are now starting to look into creating synergies between the electricity grid services and different transportation modes. There is an undeniable link between transport and grid services which should be

further enhanced and established with targeted support for innovation into developing the software and IT-solutions as well as the accompanying grid technologies.

IT-solutions are something that is often overlooked. Estonia pioneered the concept of e-government, now we have come so far that one rarely needs to go to a government building and wait in line. These e-government services are also available for people outside of Estonia, all they need to do is apply for e-residency. This kind of innovation might not look as significant as new electric cars or solar panels, but it might just be that these kinds of small tweaks have a larger combined effect on our energy consumption and our environmental footprint. This same kind of action and dedication is needed on a global level. The next few years will be a key period for developing a coherent framework and incentives for the Paris Agreement parties to jumpstart the transition towards reaching the ambitious global and national goals. We have seen firsthand that these changes are possible and provide a lot of positive side effects.

Firstly, there needs to be more funding provided for research, development, and deployment of cleaner and smarter technologies. Secondly, there needs to be a change in the mindset and behaviour of people. Thirdly, it is equally important that the global institutional, financial and economic framework supports the development and enhanced implementation of efficient innovative technologies. The EU is increasingly providing financial support to innovative technologies as well as developing an institutional framework to regulate the energy sector in a coherent cross-border initiative.

These underlying principles should be used all over the world. We need to ensure that renewable energy is produced in areas with the best conditions, while the cost is determined via reverse auctions. One of the ways of facilitating cost-effective renewables production is cross-border cooperation in subsidy schemes or undertaking joint ventures. Only in a fully opened and truly competitive (taking into account externalities) market can efficiency prevail enabling consumers to reap the benefits of cheap, sustainable energy.

Innovation is the key to a low-carbon economy. To facilitate it, a strong, coherent and flexible institutional framework is needed, alongside minimal bureaucracy. Only then can society enjoy the positive knock-on effects from new and smart technologies and a transformed energy sector.



World Energy Council
Secretary General
Christoph Frei



New solutions: emissions are being targeted

Past performance is no guarantee of future success

The global energy system is digitalising rapidly and leaders must be prepared, says World Energy Council Secretary General Christoph Frei

The one thing above all else that is keeping energy leaders awake at night is the impact of digitalisation on the future of the global energy system. The reality is that the energy system of the past is changing and this is not only a challenge for developed economies who are struggling to come to terms with integrating new approaches into existing infrastructure. In emerging markets, new opportunities lead to choices that have little history to base important judgments upon. Industry leaders and policymakers across the globe are considering the impact of innovation with a mixture of excitement and unease.

A world where big data, machine learning, and artificial intelligence enable automated system analytics and instant demand response is very different from the analogue world where many leaders started their careers. Predictive maintenance and supply chain management can dramatically decrease outage times and offers greater efficiency with traffic and congestion

management. The world in which the internet of things and blockchains will enable direct and low cost transactions between parties and between appliances is fast approaching, with at its core precisely recorded transactions in unfalsifiable ledgers that also open new opportunities for supply chain tracing and product labelling by origin, materials used or emissions caused.

These new technologies not only change the way we operate the energy system but revolutionise the potential for a sharing and leasing economy through new platform solutions, which also will affect traditional business models in energy. Mobile technology and cloud support already enable new financing models, such as micro-leasing schemes in the developing world, greater customer choice and control for all. The price of the digital revolution for infrastructure and companies is increased exposure to cyber risks and planning uncertainty as a result of lowering entry barriers for new players.

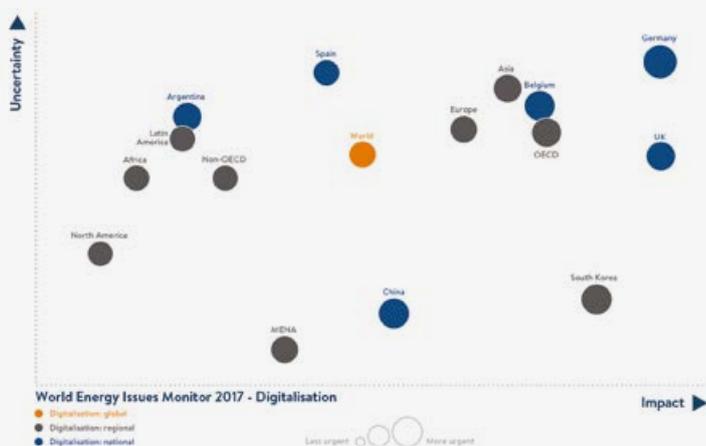
RAPID PENETRATION OF ELECTRIC VEHICLES

Electric Vehicles Share of Light-duty Vehicle Fleets



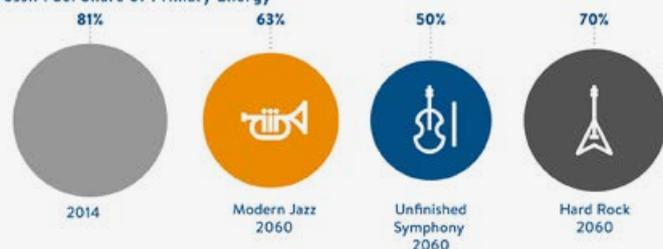
Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy

WORLD ENERGY ISSUES MONITOR 2017—DIGITILISATION



FOSSIL FUEL SHARE WILL FALL

Fossil Fuel Share of Primary Energy



WORLD ENERGY ISSUES MONITOR 2017—GLOBAL



Source: World Energy Council

Energy leaders clearly believe that technology innovation, unleashed by effective trade and guided by coordinated climate action, is the key to a decarbonised energy future. We will see an electrification of final demand, with electricity rapidly becoming the ‘new oil’. Advances in electric storage and renewable energy, both empowered by digital capabilities, are key areas that have the potential to dictate the pace and the scale of the energy transition.

The dramatic increase of renewable energy capacity across the globe, notably for wind and solar PV, will continue and further advance the role of renewable energy in the global energy mix.

“Industry leaders and policymakers across the globe are considering the impact of innovation with a mixture of excitement and unease”

Natural gas is the only fossil fuel for which we don’t see demand peaking over the next few decades. However, there is a cloud of uncertainty hanging over the “golden age of gas” and our future demand scenarios vary widely. Natural gas comprised 22% of electricity supply globally in 2014. By 2060 this could change to anything between 17–32%—an absolute increase of between 300–1500bn cubic metres. It is well known that Asia is set to dominate global gas demand rises over the coming decades. The question is at which point a heavy dependence on imported gas will be perceived as a risk.

Overall, fossil fuels will still play a significant role in the energy mix over the next few decades but the question of how rapidly e-mobility and other alternative fuels can ramp up is an issue being discussed in the boardrooms of the world’s oil companies. We have recently seen significant announcements from mainstream car manufacturers about the future direction of their product development and countries such as Norway are leading the way with electric vehicles comprising 20% of their total fleet today.

The new energy world is one with more stakeholders playing by different rules in new markets. What are great opportunities for some, represent new risks for others. As the finance community often reminds us, past performance is no guarantee of future success. This is now most relevant for the energy sector. We need to be open to the future and its new realities so we can build a new energy system that provides prosperity for all.

This is why we have adopted the theme of “Energy for Prosperity” for our next Congress in Abu Dhabi with a firm focus on innovation. As an organisation, and with our members in 100 countries, we need to invest heavily in understanding innovation and the necessary enabling ecosystem so we can not only face the future, but successfully shape it.



Legend (all projects are existing unless stated)

- hydropower
- onshore wind farm
- solar - CSP¹/ STP²
- solar - PV³
- geothermal

1 CSP Concentrated Solar Power
 2 STP Solar Thermal Power
 3 PV Photovoltaic

Country classification

Based upon BP Statistical Review of World Energy 2016 primary energy consumption mix as follows;

- country with greater than 0.05% renewable energy (excluding hydro)
- country with less than 0.05% renewable energy (excluding hydro)
- country with no data currently available

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Dr Matar Al Neyadi is
Undersecretary of United Arab
Emirates' Ministry of Energy

Delivering energy innovation in the United Arab Emirates

Change is coming rapidly to the UAE's energy sector, Dr Matar Al Neyadi, Undersecretary of the federation's Ministry of Energy, tells World Energy Focus

The pace of innovation within the energy sector has rapidly risen over the past decade. Following the same transformative narrative as other industries, such as telecommunications or transportation, the energy sector's pace of change has accelerated rapidly and created new opportunities.

Two decades ago, it would have been difficult to believe that houses or factories could be transformed into independent electricity generating units, capable of storing their energy, charging their electric cars, and even selling their power through smart grids.

Today, this vision is already happening, and so the question for us, as policymakers in the field of energy is: how can we adapt to this new reality in a way that maximises the productivity of our sector and ensures a seamless transition for all stakeholders?

Innovation and its impact on the energy sector is at the forefront of the minds of most stakeholders. Innovation-related issues, such as digitalisation, decentralisation, innovative market design or electric storage have become the most significant issues on the minds of energy stakeholders, according to the 2016 Issues Monitor of the World Energy Council.

The impact of rapidly-evolving innovation within the energy sector has been immediate and has affected all stakeholders; from consumers to utilities, to regulators and policymakers. Innovation, whether in the form of technological breakthrough, or new market improvements, has tested the resilience of the entire energy sector and many nations around the world.

In the UAE, innovation has become a central component of the government's energy strategy. In October 2014, the federation's government launched a *National Innovation Strategy* with the aim of making the UAE one of the most innovative nations in the world by 2021.

The strategy identifies seven key sectors where innovation is key to excellence and performance. The first of these seven sectors is renewable energy. To achieve innovation in renewable energy, the strategy plans to launch new legislation and policies, as well as to invest in specialised skills, and incentives to foster international partnerships, and trigger an innovation drive within government.

The drive for innovation within the UAE's renewable energy sector is a first step to the transformation of the federation's entire energy spectrum. This process is guided by the *UAE Energy Plan for 2050*, which was launched in January 2017 and outlines the UAE's strategy to ensure the diversification, sustainability and security of its energy sector for the next three decades.

However, we understand that the success of this plan relies on the participation of all institutions and bodies in the UAE energy sector, as well as the engagement of our society and energy consumers.

“The drive for innovation within the UAE's renewable energy sector is a first step to the transformation of the federation's entire energy spectrum”

The path ahead is certainly challenging, but the UAE is a nation where innovation and creativity meets a positive attitude towards change and improvement. This applies in particular to the UAE's energy sector, which has played such an instrumental role in the federation's growth in the past. It has forged some of the most innovative partnerships between the public and private sectors to modernise the sector.

We are confident in the ability of the UAE energy sector, along with our international partners, to continue at the forefront of this exciting drive towards innovation. We will achieve this through visionary leadership, intelligent energy policy-making, and with the involvement of our international partners, such as the World Energy Council.

The 2019 World Energy Congress in Abu Dhabi will come at a crucial crossroad for the global energy sector, as well as energy-dependent industries. We look forward to showcasing the achievements of the UAE in the field of innovation and learning from other nations and partners to continuously improve the state of the energy sector.

“35% of Mexico’s power generation will come from clean energy sources by 2024”



Clean energy: The La Yesca dam on the Santiago river



Leonardo Beltrán Rodríguez is Mexico's Deputy Secretary for Planning and Energy Transition

Mexico's energy transition

The country has overhauled its energy sector to encourage clean energy and investment, explains Leonardo Beltrán Rodríguez, Mexico's Deputy Secretary for Planning and Energy Transition

One of the premises of Mexico's energy reform was to revolutionise the sector by implementing international best practices and move to a model open to private investment that stimulates competitiveness and incorporates sustainability across the entire value chain.

Today, planning in the sector is done through participatory exercises with industry, civil society and government to define policies, programmes, and metrics to advance towards the development of a greener and more sustainable energy economy.

The energy transition is the gradual increase of the use of clean technologies, while ensuring the sustainable use of energy to strengthen the competitiveness of the economy, promote regional development and, at the same time, contribute to reducing the environmental footprint of the energy sector.

In December 2015, the Energy Transition Act (ETA) came into force in Mexico. This mandated the creation of the Consultative Council for Energy Transition, with the participation of civil society, private sector, academia and the legislative and executive powers. The purpose was to design the pathway to transit towards a sustainable energy future. Within the Council, the Transition Strategy to Promote the Use of Cleaner Fuels and Technologies was created as a road map that allows for the sustainable use of natural resources, to promote the development of new markets, and to increase the efficiency and competitiveness of Mexico's energy system.

To take advantage of the country's renewable resources, the Strategy reinforces the mandate of the ETA: 35% of Mexico's power generation to come from clean energy sources by 2024, then rising to 50% by 2050. The main features to reach the targets are:

- › Wholesale electricity market. The market started operations in 2016 and

empowers the customer to choose and purchase electricity with the best conditions of price, quality and service.

- › Clean energy certificates. This instrument guarantees that market participants consume a minimum of clean energy and provides certainty of demand increase with a progressive goal: 5% in 2018, 5.8% in 2019, 7.4% in 2020, 10.9% in 2021, and 13.9% in 2022.
- › Long-term clean power auctions. Market instrument with international standards that ensures demand for several years, and provides certainty to private investment (the first two auctions resulted in \$6.6bn of investments over the following two years, and the most competitive prices for solar power globally).
- › Independent power system operator. To ensure open access and an adequate operation of the wholesale electricity market, an independent power system operator was created and named the National Center of Energy Control.
- › Strengthening of the regulatory body. The Energy Regulatory Commission (CRE by its Spanish acronym) was endowed with technical, financial and operational independence to ensure that the rules of the game reinforce the market model, promote competitiveness, and guarantee compliance of the renewable portfolio standard.
- › Public policy consolidation. The Secretariat of Energy retakes its role as public policy designer to work towards energy security and environmental sustainability, especially the renewable portfolio standard.

A nationwide energy efficiency goal was established to reduce the use of energy per unit of gross domestic product. The goal was to reduce energy intensity by 1.9% per year between 2016–2030 and then reduce it by 3.7% per year from 2031–2050.

The following actions were implemented to achieve this goal:

- › Strengthening of the regulatory system. There are 30 Mexican Official Energy Efficiency Standards in force, a conformity assessment system in charge of compliance, eight certification bodies, 71 test laboratories and 205 verification units.
- › Implementation of energy management systems. To promote the sustainable use of energy across all high consumption pattern users, the use of the ISO-50001 industry standard is being promoted.
- › Accelerated adoption of efficient technologies. To foster the use of lower energy consumption appliances, innovative financial instruments and energy incentives are designed tailor-made for industry, commercial, households, and municipalities' needs.

With the implementation of Mexico's energy reform, a competitive market has been designed throughout the value chain, which together with innovative public policy and regulation, is driving the transition towards a low-carbon future. With a gradual increase in the use of clean technologies, which strengthen the competitiveness of the economy, promote regional development and, at the same time, contribute to reducing the environmental footprint of the sector.

The Energy Reform is the landmark where Mexico as a nation decided to move towards a market based energy economy. The power of the energy reform is based upon the adoption of international best practice, resource availability, and a sound and robust legal framework to provide certainty. These conditions along with transparency, a thriving domestic economy, and a highly skilled labor force have drawn the attention of the private sector to invest and promote one of the most attractive energy markets in the world.





Moving forwards: UNIDO
Director General Li Yong

Empowering talent is the key to a successful global energy transition

Now a global climate agreement is in place, we must give local communities the tools they need to implement the transition, says Li Yong, Director General of the United Nations Industrial Development Organization (UNIDO)

The adoption of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals, as well as countries' commitments to the Paris climate agreement, have provided a strong impetus for accelerating the global energy transition. Indeed, in recent years we have witnessed promising growth in the production and use of renewables and an increase in energy efficiency around the world. This has created the potential for new jobs and improved living conditions.

New technologies are now available, helping to ease the transition. However a number of challenges remain for countries moving towards the decarbonisation of the energy sector alongside greater security of supply.

The particular needs of countries depend on their level of development, electrification rates and development plans. Some countries need support in developing infrastructure that allows the integration of energy from new and variable sources, while others strive to ensure energy access for basic economic activities and services. What most countries have in common is the need for capacity building as a key to a successful energy transition. The question that naturally follows is: in what areas do these capacities need to be built?

TRAINING AND CAPACITY BUILDING NEEDS

The first prerequisite for a successful energy transition is effective energy planning, coupled with the right set of policy instruments that encourage the development of the market for

sustainable energy products and services. Supporting policymakers with building the required skills and tools, as well as with platforms to exchange best practices and foster learning, will allow countries to move faster towards their energy goals.

“Providing policymakers with the skills and tools required, as well as with the platforms for the exchange of experiences and to foster learning, will allow countries to move faster”

A second area where capacities need to be strengthened—particularly in developing countries—is the development of new business models to deliver energy services in both urban and rural areas. Business developers need training to improve their technical capacity, develop their businesses and create innovative models for financing. Furnishing service providers with adequate skills and establishing schemes to ensure high quality of services are critical to boost consumer confidence and to develop an effective market for energy supply.

Third, innovation must be supported at all levels, and appropriate and relevant technologies and solutions that aid the energy transition should be pushed to the market. For this to happen, innovators

need to acquire the knowledge and support to further develop their ideas and bring them to the market.

UNIDO'S ROLE

The United Nations Industrial Development Organization (UNIDO) has the mandate to support its member states in achieving inclusive and sustainable industrial development. In line with this mandate, our programme delivery puts a strong emphasis on capacity building and empowering local talents, be it at the policy level or for the purposes of technology deployment and financing.

For example, one of our existing programmes, the Global Cleantech Innovation Programme, mentors startups to develop their business plans and provides them with opportunities to link up with local and international investors. Similarly, our efforts to encourage industrial companies to act as “prosumers”—producers and consumers of energy—gives these companies opportunities to generate additional income and provide energy to local communities, thereby improving access and supply.

UNIDO will continue its efforts to deliver capacity building to countries around the world in order to support the global energy transition and achieve inclusive and sustainable industrial development. We will also continue to seek partnerships with other organisations to ensure more effective and sustainable results. UNIDO's new partnership with the World Energy Council will ensure a broader outreach of our capacity building efforts across the globe and will thereby contribute to the global energy transition.

Smart connections

The global energy system is entering a new, more collaborative phase. And Germany is leading the change, explains Andreas Kuhlmann, Chief Executive of the Deutsche Energie-Agentur (DENA).



Andreas Kuhlmann, Chief Executive of Deutsche Energie-Agentur

Energy transition is entering a new phase. This is especially apparent in countries like Germany, where renewable sources of energy have already gained a considerable foothold in the market. The question now is, how do we get all the different parts of the energy system connected in a smart way? And how do we foster innovation that serves this cause?

The term “energy transition”—or *Energiewende* as we say in German—refers to a major change in our energy system. In Germany, it started at some point in the 1980s, through developing alternative energy scenarios and producing power from wind and solar. A real push came in 2000, when Germany passed the feed-in tariff law—known as the Renewable Energy Sources Act—which made it much easier to connect alternative electricity to the grid. At the same time, Germany decided to abandon nuclear power.

In the beginning, the energy transition was focused on taking wind and solar power from niche fuels into the mainstream, and phasing out nuclear power.

But things are changing. The energy transition is a concept which is in transition itself. Today, Germany has one of the most diversified energy supply systems in the world. Bringing more solar and wind power into the grid is still important. But in the new phase of the transition, the real challenge is to bring the decentralised components of all sectors of energy production and consumption together in a system that is convenient, affordable, secure, and free of CO₂ emissions. In

“The real challenge is to bring the decentralised components of all sectors of energy production and consumption together in a system that is convenient, affordable, secure, and free of CO₂ emissions”

order to achieve this, we have to think across the established sectors—power, heat, mobility, industry—and pave the way for energy efficient technologies and renewables in an integrated energy system. More and more players from different sectors, among them many start-ups and joint ventures, are beginning to see the opportunities that this development brings for businesses.

In Germany, a lot of things have already been set in motion to get ahead, but there are areas where we could be bolder. Energy efficiency is one of them.

Despite being a driver of innovation, energy is often very sporadically distributed. There is still too little being done in the transport field, but that will change. As well as this, we must consider whether the regulatory and legislative framework we constructed during the first phase of the energy transition will still support what we have in mind for the future. This may be the greatest challenge for energy politics in Germany in the coming years.

How policy will develop over the coming decades can't be foreseen now. But what is clear is that in the future energy policy has to set a framework that provides the right incentives for innovation within the sector and allows all suitable technologies to prove themselves on a level playing field. It should also strengthen international partnerships.

After all, more and more countries are committing themselves to the goal of climate protection and sustainable energy development, especially in the wake of the Paris Agreement.

This dynamic is a great opportunity for a global energy transition and innovation is one of the key factors for success. Without innovation, everything comes to a standstill. And we cannot halt anthropogenic climate change if progress towards the energy transition is standing still.

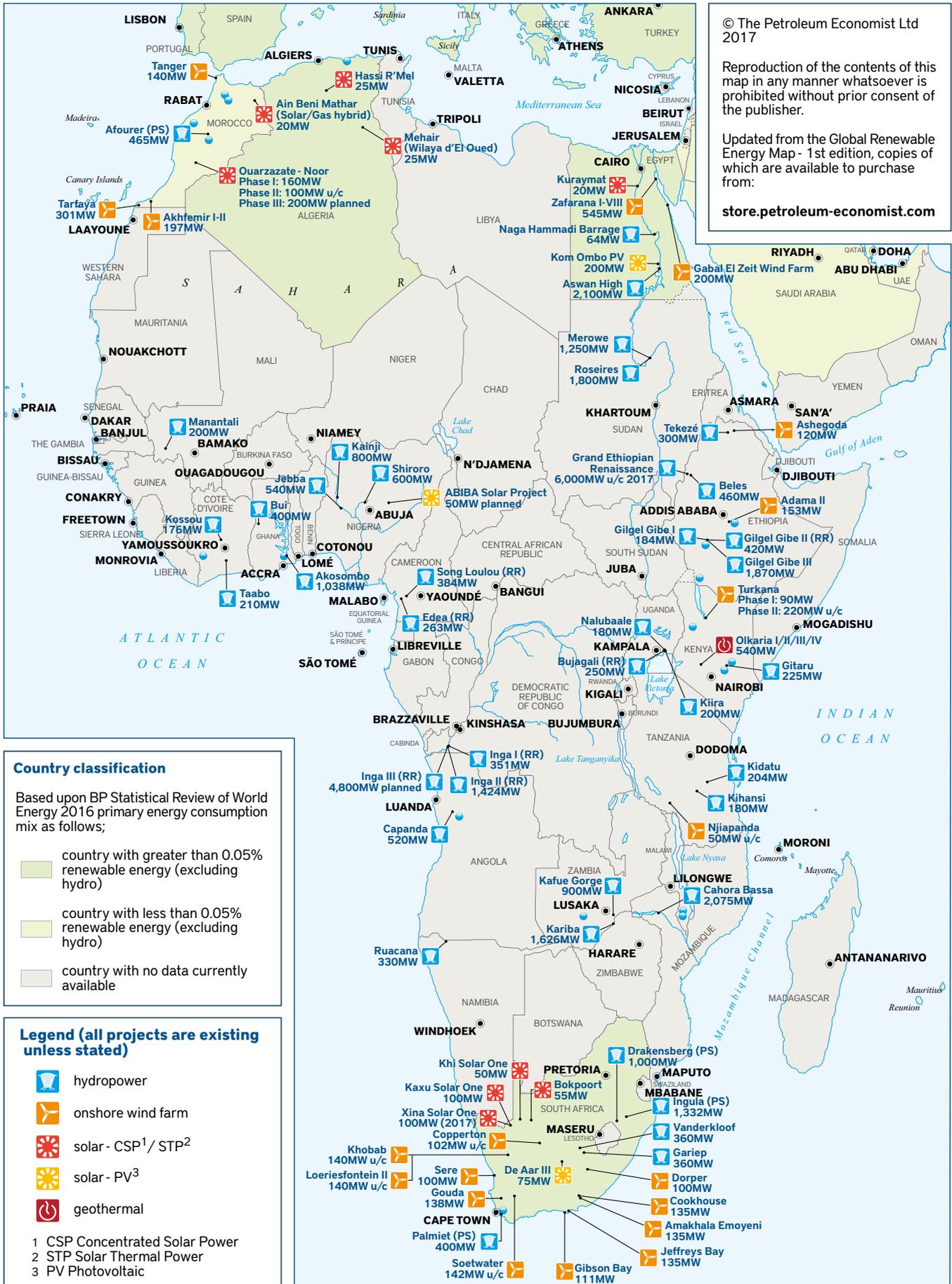
Energy transition has long since ceased to be something that only concerns established energy providers. It's a project that spans a multitude of sectors and branches of industry. More and more innovative companies and smart ideas are springing up. Digitalisation offers a strong tool to develop new business models that match the needs of both consumers and climate protection at the same time. In order to connect entrepreneurs and stakeholders of the global energy transition, the German Energy Agency (DENA) started the initiative Start Up Energy Transition (SET), which aims to provide a global platform linking like-minded people from various fields to promote innovation and to make global energy transition a success.

The SET Award identifies the most promising start-ups worldwide that are working towards energy transition and brings together international venture capitalists, investors and partners in the public sector.

With over 540 applications from 66 countries for the award in the first year, the initiative has already gained a global platform and identified start-ups in various ecosystems worldwide. We will continue to strengthen innovation for a global energy transition with our initiative, together with partners like the World Energy Council. The next SET Award will be launched at COP23, the 23rd Conference of the Parties of UNFCCC in November 2017.

540

applications for the SET Award in its first year



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 Updated from the Global Renewable Energy Map - 1st edition, copies of which are available to purchase from:
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Country classification

Based upon BP Statistical Review of World Energy 2016 primary energy consumption mix as follows;

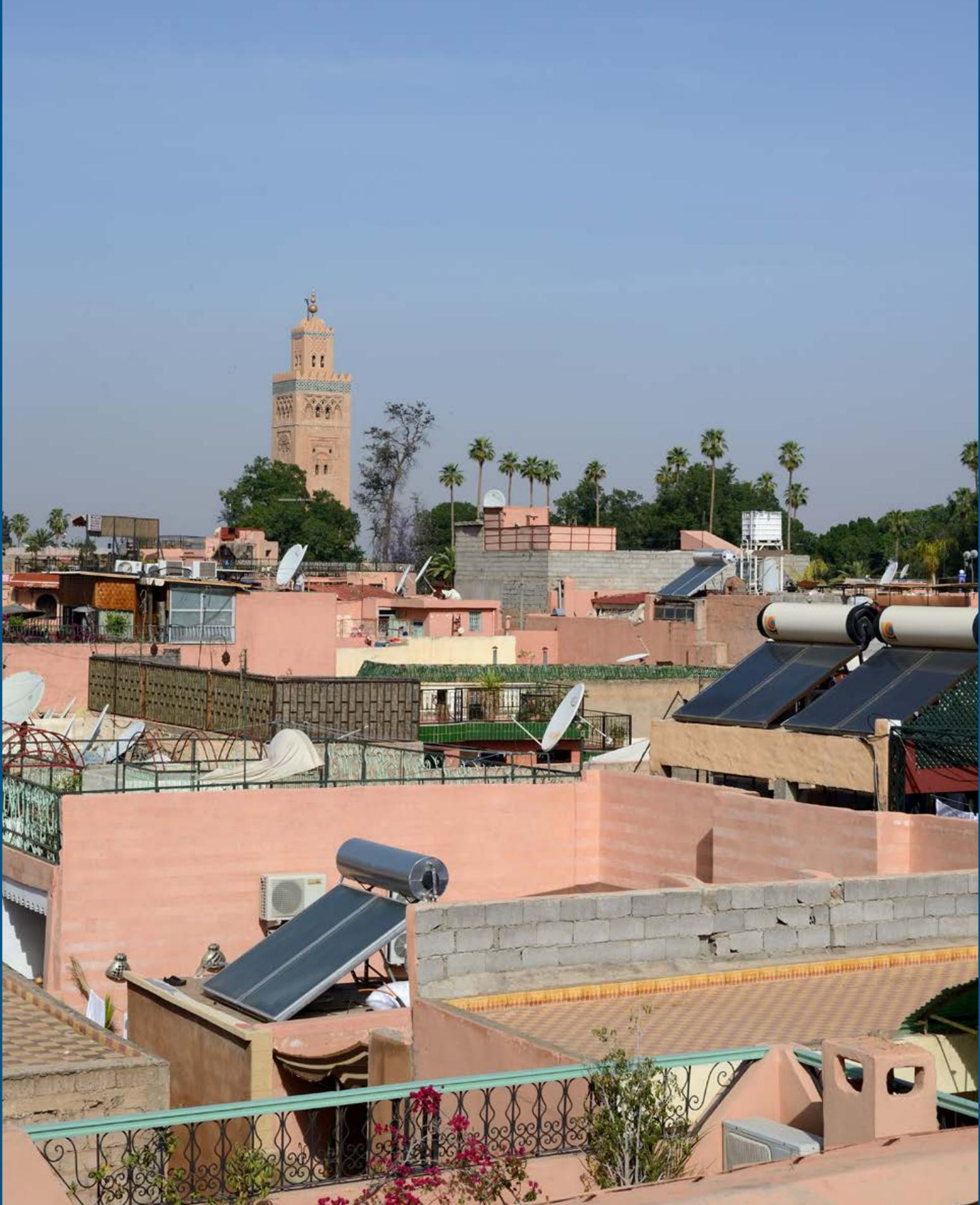
- country with greater than 0.05% renewable energy (excluding hydro)
- country with less than 0.05% renewable energy (excluding hydro)
- country with no data currently available

Legend (all projects are existing unless stated)

- hydropower
- onshore wind farm
- solar - CSP¹/STP²
- solar - PV³
- geothermal

1 CSP Concentrated Solar Power
 2 STP Solar Thermal Power
 3 PV Photovoltaic

Source: Petroleum Economist



Morocco's renewables revolution

The kingdom is expanding its use of solar and wind power rapidly through research and innovation, say Badr Ikken General Director of the Research Institute for Solar Energy and New Energies of Morocco (IRESEN) and Zakaria Naimi, its Director of Photovoltaic and Electric Systems

Today, most of Morocco's energy supply comes from imported fossil fuels.

By 2030, the kingdom expects its primary energy demand to triple, from 2008 levels. Electricity demand alone will quadruple. To meet this increasing demand, Morocco implemented a new energy strategy in 2009, aiming to secure its supply, to ensure power was priced competitively and to protect the environment by using local energy resources, including renewables. Morocco, under the leadership of His Majesty the King, Mohammed VI, has committed to increasing the share of renewables in its energy mix to 42% by 2020, then rising to 52% by 2030.

For the first time in its history, Morocco will have a share of electricity produced from renewable sources that outweighs the share produced from fossil energy sources. This will be largely achieved by using its wind and solar resources. Between 2016–2030, Morocco aims to create an additional 10,100 MW at least of electricity from renewables. Around 4,560 MW will come from solar power while 4,200 MW will come from wind and another 1,330 MW from hydropower.

Alongside other key institutions to lead the national energy strategy, the Research Institute for Solar Energy and New Energies, IRESEN, was created in 2011, by the Ministry of Energy, Mining, and Sustainable Development, with the participation of key players of the energy sector in Morocco. Research and innovation is fostering the energy transition by addressing optimally the energy needs in Morocco while including economic development through local manufacturing of new products and offering specific new services.

IRESEN, as a leading research organisation in the field of renewable energy, is facilitating and coordinating the setting up of adapted research and development infrastructure projects as well as national and international partnerships focused on knowledge acquisition and innovation. To reinforce innovation across Morocco in the field of renewable energy and to promote human resources development, IRESEN developed and set up the first innovation network in the African continent, called the FARABI Network. It is built around regional platforms for testing, research and training in the field of renewables. This territorial network is set around universities and education institutions while developing technology knowhow transfer mechanisms to local industries. It addresses strategic needs and challenges in relation to energy to position Morocco as a gamechanger

in innovation in the field of renewable energies and sustainable development. In addition to the medium and long-term scientific vision, the network will enable the local industry, in close collaboration with academia, to seize market opportunities to expand renewable energy use.

The genesis of this network was marked by the creation of the Green Energy Park (GEP), the international platform for testing, researching and training in solar energy. The GEP, which is a unique platform in Africa, covers the entire research and development value chain, from basic research until proof of concept is reached. Built on an area of eight hectares, the GEP has an internal research platform of more than 3,000 square meters, which includes several labs with cutting-edge technologies in the field of solar photovoltaic and thermal energies. Topics such as treatment and desalination of water using solar energy, development of desert modules, design of innovative thermal and electrical storage solutions and development of industrial applications of solar thermal energy are considered major concerns of the GEP.

“For the first time in its history, Morocco will have a share of electricity produced from renewable sources that outweighs the share produced from fossil energy sources”

The investigation and understanding of solar technologies and how they fare in desert conditions will allow manufacturers to develop new products which are suitable for these conditions and thereafter enter a market which is difficult to penetrate. Project developers, investors and grid operators will be able to implement successful business plans and to deliver electricity with specified quality at least cost. The GEP will address markets worldwide with innovative, reliable and cost-effective technologies, solutions, testing facilities and services and will position the local community as regional leaders making markets more competitive and flexible. Learning and innovation go hand in hand. IRESEN is offering through workshops and training courses at the GEP a know-how transfer programme for local communities on various levels. Partners from both academia and industry will gain enough knowledge to create the big next innovation in renewable technologies.



Marsh CEO John Doyle

The industry's cyber problem

With increased digitalisation, cyber-attacks are getting more frequent and becoming more sophisticated. The energy industry must be prepared, says John Doyle, CEO of insurance and risk management firm Marsh

Q. Is the energy industry behind other industries when it comes to cybersecurity?

A. The energy industry is certainly a preferred target: 41% of cyber-attacks are targeted at oil and gas companies in particular, according to the World Energy Council's Issues Monitor 2017. However, the fact that the energy industry is considered critical infrastructure under many cyber security regulations, reflects that it is often a key target and requires a heightened level of protection. One could argue this means the energy industry may be "ahead" of some industries in awareness preparedness but, in many countries, security and regulations may still not be keeping pace with the rapid evolution of attacks.

Q. What can the sector learn from the way other industries approach the issue?

A. The new reality of cyber risk is that all industries are challenged by a dynamic cyber threat environment, so new approaches to managing cyber risk are necessary. Many organisations are developing more robust cybersecurity governance models to ensure defined cyber risk management roles and coordination between IT departments, operations and plant management, the Chief Information Security Officer, risk management, and senior business leaders.

Other critical practices include cyber event simulations to test and improve an organisation's

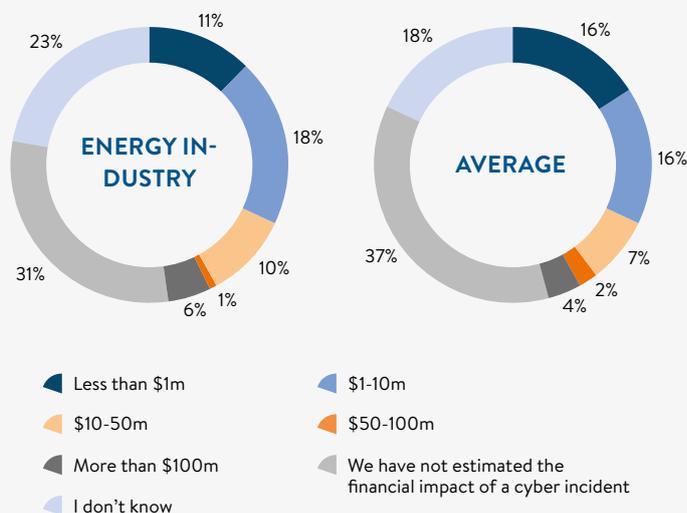
response capabilities and to develop robust response and recovery plans. By simulating an attack, companies can validate the speed and efficacy with which they are able to react and gauge the potential impact, including financial losses, of events of different scales. Finally, it's important to share information about incidents and best practices with industry peers and the authorities.

"Training is a critical component as it helps organisations develop a cyber risk management culture that becomes second nature for all employees"

Q. What is the cost of cyber-attacks to the industry every year? Is this set to increase?

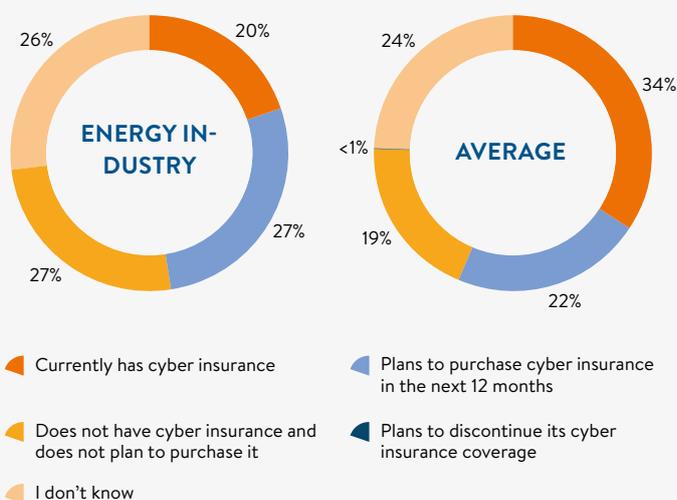
A. A 2016 Ponemon survey ranks the cost of cyber-crime to the global energy and utilities industry at \$14.8bn—second only to the cost to the financial services industry. And incident response costs, such as IT forensics, data recovery, and business interruption restoration, are rising. While absolute clarity on cost remains elusive, our assessment is that increasing digitalisation and

IF YOUR ORGANISATION HAS ESTIMATED THE FINANCIAL IMPACT OF A CYBER INCIDENT, WHAT IS THE WORST POTENTIAL LOSS VALUE IN \$?



Source: Marsh survey 2017

WHAT IS YOUR ORGANISATION'S STATUS WITH REGARD TO CYBER INSURANCE?



Source: Marsh survey 2017

interconnectedness of systems will undoubtedly cause the cost of cyber-attacks to the energy industry to rise.

Q. How has the nature of cyber threats changed in the past decade?

A. The potential for a cyber-attack to cause physical damage has always made the energy industry a prime target for hackers. Over the years, the motivation and persona behind cyber-attacks has grown darker, shifting from the so-called “happy hacker,” to the serious cybercriminal, and now to a more malicious hacker, potentially with nation-state sponsorship.

The proliferation of technology through social media, mobile devices and the Internet of Things (IoT) have also expanded the landscape for cyber-attacks, providing many more avenues for hackers to cause harm.

Q. What is the frequency of these attacks and which other factors have increased the risk?

A. The overall trend is that cyber-attacks are increasing in number. In fact, companies may be subjected to many thousands of attacks daily, though the majority are unsuccessful.

One prominent factor for this increase in frequency is the burgeoning IoT. Many new industrial control systems and machines can be monitored remotely, not only by their users but by their manufacturers. On one hand, this offers huge potential cost savings, such as reducing the need for onsite inspections. At the same time, it also dramatically increases the exposure of equipment to outside interference. By connecting business systems and devices to the internet, IoT has opened new doors to hackers and malicious actors that did not exist before.

Q. What can go wrong if industrial control systems are attacked?

A. Industrial control systems are used throughout the energy industry and form the backbone of any integrated control and safety system (ICSS) where equipment is controlled remotely. If compromised, the ICSS—which might include supervisory control and data acquisition, distribution control systems, and emergency shutdown systems—can lead to a plant operating in a dangerous and potentially unstable condition.

Q. What are some examples of best practices?

A. Some easy-to-implement best practices include blocking the use of all USB sticks, encrypting emails, updating software to decrease malware exposure, changing passwords frequently, and raising employee awareness of phishing emails. Training is a critical component as it helps organisations develop a cyber risk management culture that becomes second nature for all employees, from boards of directors to the front line.

At a strategic level, best practices include taking a risk-based approach to cybersecurity, such as assessing potential attack scenarios, mapping security controls to best-in-class practices, quantifying potential losses and costs, and prioritising mitigation measures and risk transfer; viewing cybersecurity as a management imperative instead of as a compliance exercise; and having a written cybersecurity policy with a chief information security officer directly responsible for its implementation.

Sharing cyber threat information among organisations, as well as with government entities, can also help keep risk managers informed about the latest cyber threats.

The time is right for reliability

Technology can boost efficiency and profitability across the entire energy value chain, says Aspentech chief executive Antonio Pietri



Aspentech chief executive Antonio Pietri

Advances in software technology and process automation over the past few decades have driven both efficiency gains and added value to the global process industries—oil, gas and chemicals—and the engineering and construction firms that serve them.

Despite the investments in these areas, companies operating in complex, capital-intensive environments have reported \$20bn in combined annual losses due to unplanned downtime, according to analysts at technology research firm ARC Advisory Group. While companies have spent millions trying to resolve this issue, until now they have only been able to address wear and age-based failures because they lacked insight into the reasons behind the issues which cause over 80% of unplanned downtime.

As a result, asset reliability has been rising rapidly to the top of executive agendas and a new class of technology tools has arrived to bring predictive and prescriptive power to process manufacturing and beyond. These tools fall under the category of asset performance management and they promise a new level of insights in asset and process performance to improve reliability and to capture additional value and productivity. Such tools use big data, advanced analytics and machine learning to help the industry operate smarter.

The first step in asset performance management is to look at the process and assets as they really are—a system. The

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next phase is to ask the questions: how is the process affecting the asset? How is the asset affecting the process? And how are both the process and asset affecting overall system availability? When looking at the challenge in this way, companies can predict and prevent future failures by discovering issues early, before they become problems, and prescribe specific actions to avoid them.

Maximising uptime with actionable data is the next wave of performance improvement for companies in complex, capital-intensive industries.

IF THIS IS A \$20BN PROBLEM, WHY IS IT ONLY COMING INTO FOCUS NOW?

Firstly, the macroeconomic environment of the last three years is forcing owner-operators in the oil and chemicals industries to improve their return on capital employed by higher operational performance and extending the life of their assets; this is achievable through reliability improvements. Second, enabling technologies and computing performance now exist that can leverage the volume of process data available to understand how operational conditions lead to process equipment degradation, or the root cause of mechanical failure from machine wear. These are mostly caused by process issues which are invisible to experienced operators since they are so deeply embedded in the process.

HOW CAN SOFTWARE PROVIDERS, SUCH AS ASPENTECH, HELP INDUSTRY CREATE A WORLD THAT DOESN'T BREAK DOWN?

The competitive environment that has emerged in just a few short years requires a more holistic approach: asset optimisation. Optimisation was initially considered a bonus to help generate the

last percentage of profit. However, with the increasing scope and complexity of the energy, chemical and other industries, it is no longer just an option, but a business necessity. We are using our 35-plus years of software, technology and industry expertise and combining it with the latest machine learning and analytics capabilities to create the next generation of asset optimisation.

It is an entirely new approach to getting at the critical insights necessary to avoid process-induced disruptions and failures. These insights include the all-too-common occurrences of running equipment longer than expected to meet increased market demand, or degradation due to varying raw materials or usage.

The disruptive nature of this approach to industrial reliability—a combination of process optimisation expertise in tandem with the best and most advanced data analytics and machine learning technology—is significant.

Proper asset management can improve both the operation and performance of an entire system, such as an oil refinery, chemical plant or railroad locomotive. By identifying the precursors to performance degradation or failure points through the implementation of purpose-built applications, the available performance improvement will separate the future leaders from the laggards.

We have entered a new age when the unique combination of model-based and data-driven analytics will make the difference to companies in complex, capital-intensive environments. Significant value has been captured over the last 35 years from optimising design and operations. The next wave of value creation will be derived from using existing investments and enhancing them with insights from machine learning and analytics to deliver holistic improvements in reliability performance and profitability.

Digital energy

The rise of digitisation, data analytics especially, will help to meet rising energy demand, Repsol's CEO Josu Jon Imaz says



CEO: Repsol's
Josu Jon Imaz

The energy industry is currently facing important challenges. As the global population continues to grow—predicted to increase by 2.7bn through to 2050—much more energy will be needed to guarantee everyone has access to the same living standards that developed countries enjoy. This situation may be exacerbated by other factors, such as rapid urbanisation or middle-class growth in Asia and Africa. This will ultimately lead to an increase in global energy demand. Even taking into account gains in energy efficiency, demand is expected to rise by around 30% globally by 2040.

Furthermore, the energy industry is being called on to meet that growing energy demand in an environmentally acceptable manner. The Paris Agreement is a clear step towards reaching climate-neutrality before the end of the century, which will shape a transition to an energy mix that ensures robust economic development and sustainable levels of social and environmental welfare.

This transition will demand that energy suppliers develop their existing businesses by maximising the use of the digital-age tools at our disposal, making the industry more resilient and efficient, both environmentally and financially. But the energy industry must also apply these new tools to the search for new solutions that are not yet fully developed but which must help meet the evolving needs of society.

We believe that innovation and anticipation are key to success. Our experience with technology data analytics shows us that it is a powerful tool to help

us search for, produce and supply energy resources in a cost and environmentally-efficient way.

In the oil and gas industry, the operating environment for the exploration and production business is one of increasing complexity. Many business decisions must be taken under high levels of uncertainty, partially derived from imperfect knowledge of the subsurface as well as from the inability to access and analyse data.

There are ongoing research and development programmes focused on mitigating both sources of uncertainty. As a result, digitalisation and data analysis have become more important than ever to determine the potential of reservoirs and optimise the production plan for each exploratory project.

A deeper understanding of the complex interactions between the rock matrix and fluids contained within the pore space help us to be more successful. Now we are capable of seeing the characteristics of rocks on millimetric to nanometric scales based on extremely small samples. We can acquire data on the characteristics of the subsoil that was previously impossible to obtain and to then construct digital 3D lithology models.

Developing synergies between the energy sector and other industries will help us to better evaluate oil fields. Software from the videogame and financial industries allow us to assess exploration and production projects up to 1,000 times faster. We can construct 3D geological models to study the characteristics of an oilfield and afterwards apply numerical optimisation algorithms will increase the probability of success in aspects as important as where to find accumulated crude oil or where to drill wells.

In the era of digitalisation, the Pegasus project has become the first cognitive system and artificial intelligence

“This transition will demand that energy suppliers develop their existing businesses by maximising the use of the digital-age tools at our disposal”

application for the exploration and production industry. Developed by Repsol in conjunction with IBM through Watson Research, the objective is to create a much more effective interaction between humans and computers. Pegasus is capable of analysing hundreds of thousands of documents, reports and data, looking for trends and connections between them to propose the most appropriate hypotheses and solutions at each moment. We are bringing together both human intelligence and artificial intelligence to make decisions as accurately as possible.

Beyond the focus on high-cost, high-uncertainty exploration activity, digitalisation and data analytics allow us to develop very specific solutions for very specific problems throughout the energy value chain which are also very much worth exploring. These can range from having a much more accurate picture of consumer needs and desires to the fine-tuning of the operation of industrial installations or to coping with the increasing real-time information flow to manage supply networks more efficiently.

The energy industry has, since its inception, faced great problems with imagination and determination, and the digital age provides us with tools more powerful than we have ever had at our disposal to find smart solutions.

Energy demand is expected to rise by around 30% globally by 2040

Green building blocks

Blockchain technology is helping to expand the uptake of renewables worldwide, Ewald Hesse, CEO of Grid Singularity tells World Energy Focus



Q. What is Grid Singularity, and why did you decide to start the company?

A. I was a mechanical engineer, and worked for the energy group ABB in Austria for six years. I first dived into blockchain five years ago, working with bitcoin mining, and then I supported the development of Ethereum which received \$18m in crowdfunding and then took one and a half years to build. It is still so far the most advanced blockchain platform. Two years ago, we decided to open a new company, Grid Singularity, with the purpose of further developing the blockchain technology suitable for energy markets.

Q. Can you explain how a blockchain transaction works, from beginning to end?

A. Bitcoin, which is a currency, was the first use of blockchain technology and is the most well-known. With bitcoin, you are simply moving numbers in a transaction from left to right. Blockchain technology reduces transaction costs by keeping a single logical copy of transaction records. Once a transaction is requested, it is broadcast to a network of computers, verified by a series of validators, and then once complete, it is added to the existing blockchain of transactions, where it can never be removed or altered.

Q. Is blockchain 100% secure, and can we be sure of that?

A. The decentralised character and consensus engine makes it the most secure system in the world. Single entity driven systems require a trust premium.

Q. How would it work for an energy consumer?

A. Think of it like the internet—the average person will just download an app, they don't have to understand how

it works. The app will trade for them and get them the cheapest locally-produced energy. Every single device—from air conditioning systems to batteries—can become a trader with blockchain.

Q. How can big energy companies benefit from adopting blockchain technology?

A. We decided to set up the Energy Web Foundation (EWF) together with the Rocky Mountain Institute. Many big utility and energy companies such as Shell, Statoil and Engie have joined it. It is a non-profit organisation whose mission is to accelerate the commercial deployment of blockchain technology in the energy sector and fund the

“This technology is the last piece of the puzzle which will finally allow a 100% renewable world”

development of core technology. The challenge is how to embed regulation with this “decentralised computer”. In our system design, the EWF members become validators and thereby they are the authorities, so while anyone can use the network, only the authorities can validate transactions. Regulation is further being enabled through white-listing of smart contracts, apps and identities.

Q. How far off are we from seeing blockchain widely adopted across the energy sector?

A. The Ethereum network is usable now, and the enhanced EWF blockchain will be launched in Alpha in the third quarter of 2017. An energy web development hub has been established in Berlin. We plan to go live officially in February 2019.

Q. What are the challenges?

A. In some countries, energy markets are very nationalised, and in others they are very much privatised, and separate the grid from the free market. The biggest problem we have is creating something which can be used by all.

Q. Will it be greener?

A. This technology is the last piece of the puzzle which will finally allow a 100% renewable world. The resilience aspect is built into the code.

Q. What should policymakers and energy companies start doing now to prepare for this new technology?

A. For utilities, this is the only way forward, you can't stop it. Most are pretty excited. There are about 20% or maybe fewer who are aggressively going forward and creating things themselves.

Q. Is the energy sector behind when it comes to the take up of new forms of technology?

A. In the past 15 years, look at what has happened in the energy sector. Energy prices have fallen drastically, and the 15 largest energy companies in the European Union are all losing profits. Meanwhile, start-ups are coming into the field at an exponential rate. The change is happening right now, and it is only going to accelerate.

Q. Is it fair to call this a revolution?

A. It will be at least as impactful as the internet. The internet is only a copy of existing business models, but blockchain means you can exchange information or contracts peer-to-peer, it's a direct challenge to companies like Google. It will change the business model for everything, not just the energy sector.



Leading the charge for change: electric vehicle use is set to grow rapidly

Electric charge

The electric vehicle market is expanding rapidly in Europe but a lack of sufficient infrastructure remains a problem. Christina Bu, Secretary General of the Norwegian Electric Vehicle Association explains all to World Energy Focus

Q: Why has Norway managed to expand its fleet of electric vehicles (EVs) so rapidly since the 1990s?

A. Norway has taken a very simple measure, of creating demand through changes in our tax system. The country has very high car taxes, especially for new vehicles, and VAT (value added tax) is 25%. We have had that [tax level] for many years, and people are used to it. It's an important source of income for the state. So the government removed taxes and VAT on electric cars.

Now, they are more or less the same price as fossil fuel cars. You can't expect consumers to pay more for a car when they are unsure of the technology. On top of that, there are quite a few local incentives. Electric car drivers don't have to pay toll roads, and electric car sales are the highest in areas where we have toll roads. They have access to bus lanes, parking in cities and can take their vehicles on ferries. It's a whole package. When they try the cars, consumers love them, and say they don't want to go back to a diesel or petrol car. We have a market



“Norway will reach 100% electric power generation from renewables in a couple of years, and there is going to be a surplus”



Christina Bu is Secretary General of the Norwegian Electric Vehicle Association

share of 19% of new car sales, and 15% plug-in hybrids in Norway. In the city of Oslo, it is close to 50%. This has happened really quickly. We have seen that in about five or six years, it can happen. In Norway’s second biggest city, Bergen, one in ten cars is electric.

Q. What climate benefits has Norway experienced from this expansion?

A. If you replace a fossil fuelled-car with an EV, that saves two tonnes of CO₂ in a year. Last year we had 100,000 EVs—200,000 tonnes fewer emissions. Norwegian politicians have decided on the goal of selling only zero emissions cars by 2025. It is ambitious, but if you reach that goal, 40–50% of cars in 2030 will be zero-emissions vehicles. That will mean a more than 2m-tonne reduction by 2030.

Q. What can other countries learn from Norway’s experience?

A. The most important lesson is that this can happen very fast. It will probably happen even more quickly in Europe. Most people who come to Oslo are pretty amazed at seeing EVs everywhere. It helps them to understand that this is not some far-off, futuristic thing. It is happening now. Seeing is believing. A lot of policymakers, oil companies, petrol station companies and car

manufacturers—not only from Europe, but worldwide—are learning from Norway.

Q. Is there anything on the horizon in terms of technology that can solve the problem of impractical charging infrastructure?

A. The charging issue is high on the agenda here in Norway. The normal way is for people to charge their electric car at home, by plugging it in at night and removing it in the morning. One of the challenges is that a lot of people in cities live in apartments. The City of Oslo is taking that on with street chargers, but it is going to be an issue in the big European cities. Private companies are interested in taking on the challenge and developing new technologies.

To accommodate the increase in demand, Norway has stipulated one fast charger per 100 cars, so if we have 400,000 electric cars by 2020, we need 4,000 chargers. We have 850 now.

Q. How is Norway’s generating capacity suited to cope with the massive load increase that EVs will bring? And how would the UK and France need to adjust theirs?

A. Cars can deliver electricity back to the grid. Government agencies are now looking at how they can be charged only when the electricity is available. But we have to build

Battery electric and plug-in hybrid passenger vehicle stock, 2015 and new registrations, 2015

| | Total fleet ('000) | New registrations ('000) |
|--------------|--------------------|--------------------------|
| Canada | 18.45 | 6.96 |
| China | 312.29 | 207.38 |
| France | 54.29 | 22.79 |
| Germany | 49.22 | 23.19 |
| India | 6.02 | 2 |
| Italy | 6.13 | 2.14 |
| Japan | 126.4 | 24.66 |
| Korea | 4.33 | 2.81 |
| Netherlands | 87.53 | 43.77 |
| Norway | 70.82 | 35.61 |
| Portugal | 2 | 1.18 |
| South Africa | 0.29 | 0.24 |
| Spain | 5.95 | 2.29 |
| Sweden | 14.53 | 8.59 |
| UK | 49.67 | 27.81 |
| US | 404.09 | 113.87 |
| Others | 44.89 | 25.3 |
| Total | 1256.9 | 550.57 |

Source: IEA EV Outlook, 2016

more capacity in the years to come. EVs will have a major role to play in helping us managing the peaks. Norway is one of the countries which can test this, as we already have so many. If it works in Norway, it will definitely work in other countries, as electricity is very cheap here.

Q. What proportion of the electricity needed for charging stations will be produced by renewables in a) Norway, b) the rest of the world?

A. Norway will reach 100% electric power generation from renewables in a couple of years, and there is going to be a surplus. Even if every single one of our 2.6m personal cars in Norway were electric, charging them would still take up only 5–6% of our total electricity requirements, so the proportion globally is less than people often imagine.

Q. How will EVs affect the electricity supply over the next 10, 15 and 20 years?

A. That is difficult to answer. The short answer is, it is not going to be a problem. You can store energy in cars, and deliver it back to the grid. Storage is an issue for renewables in the long-term, but it's a global challenge. This is a positive story, and something people can do about emissions. If we are to succeed, we have to have people with us.

Q. What are the biggest obstacles to the expansion of EVs?

A. What is going to be a challenge is that demand is going to increase ahead of supply. In Norway, some models you can order now won't be available until 2019. At the moment, global demand is low, but it is still increasing in other locations at the same rate as it did in Norway five years ago. Charging is going to be a challenge on a global basis. But there is a lot of money being poured into this. There is a race to be part of this new industry, and there is lots of money to be made in offering fast charging facilities for all. The biggest challenge is going to be in the most remote areas. Globally, we have to learn while this industry is still developing.

Q. Outside of Europe, how do you see the EV industry expanding? Where will be the areas of fastest growth?

A. India and China have ambitious targets, but in India, more than 1m people die from [air] pollution every year, so they have a lot of reasons to make this shift. It's going to be pretty interesting to see how this will develop in the years to come.

Q. What kind of investment will be needed?

A. It will be private as well as public money going into that. We are seeing more and more competition coming into this area, more new players entering into the market. We are just at the beginning of a huge change.

Q. What more can and should governments be doing to speed up the expansion of EVs?

A. Governments should do what they can, as we really need to hurry when it comes to reducing our CO₂ emissions. Consumers also have to adapt. In Norway, we have high car taxes which we can remove, and in Germany for example, subsidies have been introduced for EVs. Perks such as free parking or access to bus lanes can help. They don't have to be forever, only to introduce the new technology and help it happen as fast as possible. It is smart to be in the lead, otherwise your country will be lagging behind when it comes to the creation of new jobs. It is foolish not to embrace the transition to electric cars—for economic reasons as well as for the environment.

Q. When will EVs take over from fossil fuel vehicles in sales? Can we expect to see that happen over the next 10, 15 or 20 years?

A. A good comparison is smartphones, which happened very quickly. Eventually, electric cars will be cheaper than fossil fuel cars—though cars are a bigger purchase than phones. Bloomberg New Energy Finance says this will happen by 2025. It will certainly happen in some markets more quickly than in others.



DNV GL's CEO
Ditlev Engel

Making a swift transition

The rapid uptake of renewables, energy storage and electric vehicles is changing demand patterns for consumers, infrastructure needs and risk, says DNV GL Energy CEO Ditlev Engel

What surprises many in the energy industry is the speed at which change is taking place. In terms of rapid transition, no sector has been as surprising as renewables, where the pace of reduction in costs has seen wind and solar dominate new capacity additions in the power generation landscape over the last year.

“Probably the biggest change that has occurred is that we have now moved into auctions, which has reduced the cost of energy,” says Ditlev Engel, CEO of DNV GL’s energy division. “Most people have been surprised by the speed of reduction in the cost of electricity from renewables—there seems to have been a number of times in 2017 where we have broken the world record for the cost of solar, onshore or offshore wind.”

“Technology is moving at a speed that is sometimes a bit hard for us to comprehend as individuals”

Improving economics, coupled with favourable low carbon policies, resulted in 161 GW of new renewable capacity (including wind, solar, hydro and biomass) being added in 2016, according to the International Renewable Energy Agency. This accounted for more than half of total global net capacity additions. Solar photovoltaic (PV) represented around 47% of the capacity added globally, followed by wind power at 34% and hydropower at 15.5%.

The popularity of wind and solar power especially is understandable when considering the pace at which costs have plummeted, and Engel believes there is more to come. “If you look at the cost of produced energy, it’s fair to say that neither solar nor wind—on or offshore—will ever be as expensive as it is right now.”

The rise of wind and solar can also be attributed to two other important factors. Firstly, wind and solar capacity can be added quickly if more is needed. Secondly, decommissioning costs are quite low and predictable. This means the technologies are attractive from both a generation and lifecycle point of view.

Engel further notes that the changing attitude of consumers to energy also has a part to play.

“The consumers and the business-to-consumer [sectors] are sometimes overlooked. We tend to believe that their preference is always [driven by] cost. If that were the case, Apple would not sell a single iPhone.”

he said, “This shows that there are other things that interest the consumer... what we are seeing in the electricity agenda is that the consumer’s expectation and interest in how energy is being generated and consumed is changing. And this is also driving different behaviour.”

A NEW APPROACH

Yet the uptake of renewables is only part of the changing energy picture. At the same time the cost of batteries, essential for storing energy from intermittent renewable sources such as wind and solar, is also falling faster than expected. This, says, Engel is starting to drive a new approach.

“The recent announcements we saw from Volvo and from France on electric vehicles puts pressure on the type of infrastructure that needs to be built in order to service that,” says Engel.

While an entirely different energy infrastructure is needed, Engel is careful to point out that the development of technology does not happen on an “entirely linear” basis.

“Technology is moving at a speed that is sometimes a bit hard for us to comprehend as individuals. If you look at how fast things are digitalising, such as the smart meter rollout and storage, we are in the process of shaping a new system. Nobody is 100% sure of how it will pan out.

“There are a number of races going on: a digital race, a battery race, a renewables race and a centralised versus decentralised race. The only certainty is that the wish to decarbonise is a common goal for most.”

AN EYE ON SECURITY

As all of these technologies become more widespread, Engel says it is crucial not to forget that energy security is all-important.

“We have to remember that power is absolutely critical to society and therefore reliability, verification, testing and technical competence in building these new energy systems are still very important,” he said. “As the way we generate energy changes, we have to remember that it is pivotal that society has to function well. The predictability and performance of an energy system is as important as it ever was.”

The energy industry, among others, was reminded of this with the global cyber-attacks seen just a few months ago. “As we make all these integrations and transform in the energy transition, it hasn’t changed the fundamental DNA of a well-functioning energy system,” adds Engel. “Energy security is now also about making sure someone is not disrupting it.”

Energising Africa

Africa's energy suppliers of the future will be more integrated and offer a diverse range of services.

Strive Masiyiwa, chairman and founder of telecoms firm Econet, explains all to World Energy Focus



Strive Masiyiwa is chairman and founder of Econet

As an entrepreneur my philosophy is about reaching out to meet the needs of the people by asking: what do people need and how can we respond to those needs?

More than ever, people in Africa need energy. At Econet, we have set out on a journey of innovation and experimentation to meet those energy needs. What we have discovered on that journey is that the old rules don't apply anymore. The new economy, that exists today, requires a new energy economy and therefore a new approach to providing that energy.

The new economy in Africa is more global—investment holding firm Tencent is the most valuable company in Africa, and it's from China. The new economy is more mobile, due to the rise of apps such as M-PESA and Ecocash. In Kenya, for example, more than 60% of people use their mobile phones for financial transactions. And the new economy is focused on a new type of client which is looking to combine its energy needs with other services and a new type of marketplace, where a wireless internet provider can also supply clean energy and a smart building.

Our journey has also led us to discover that out of crisis comes opportunity. Africa faces many challenges, and the continent is not always unified in tackling those challenges. Econet has had much experience in providing solutions to those challenges. The company was created in Burundi, after the civil war, to allow foreign investment to find its way to those that needed it most. When we decided to expand this business opportunity in

Zimbabwe, we realised that the poor no longer had access to small denominations of money. Ecocash could be the solution. Ecocash mobile money transfer service is currently used by over 6.8m Zimbabweans with over \$23bn worth of transfers transacted over the past five years.

“We need to remember that we are not just selling electrons, but meeting the needs of our people”

Business needs to be principled. The Pope told all of us gathered at the Vatican: “Seek ever more creative ways to transform our institutions and economic structures so that they may be able to respond to the needs of our day and be in service of the human person, especially those marginalised and discarded.” We need to remember that we are not just selling electrons, but meeting the needs of our people.

With all this in mind, we created Distributed Power Africa (DPA). Africa has an energy crisis, people's needs are not being met, and we have a duty to solve the problem. Our solution will look to use our pan-African history as a trusted provider of wireless, fiber optic and money services to provide energy to the mid-sized market that powers the African economy—schools, clinics, businesses and others struggling to serve their communities. By providing a full service—

installation, maintenance and ownership—we will help to provide a much-needed source of reliable energy, at a stable and competitive price for at least 10 years. Furthermore, due to the strength of our business we will cover the upfront cost of the hardware and software so that there are no upfront costs, or risks, for the customer. This innovation will make energy more accessible for all.

Due to innovative energy monitoring systems, DPA will be able to go further and ensure that efficiency is built into the system by providing energy efficiency technologies. This will help to avoid energy waste, and manage the costs for the consumer. We will be able to work with our existing clients and we will initially do this in 10 African countries.

But we cannot do it alone. Competition is good, but it has to be bolstered by cooperation. Two-thirds of sub-Saharan African economies are growing faster than the global average, and three African countries are among the world's top 10 fastest growing economies. These leading economies and their neighbours will be able to build more profitable energy markets if they cooperate across their borders. Innovative energy products and services should be able to move beyond borders to the people that need them and this requires leadership at every level. Econet is therefore looking to government, regulators and business to all partner together to ensure that we create a healthy market for innovative energy services across Africa so that we can bring essential life changing services to millions of people.

Cutting costs: prices for photovoltaic panels have plummeted



Necessity is the mother of invention

Technology both drives and is driven by consumers' needs for energy. But exactly how it will develop will vary from region to region, says Leonhard Birnbaum, World Energy Council European chair and member of the board of management at E.ON



Leonhard Birnbaum is European Chair of the World Energy Council and management board member at E.ON

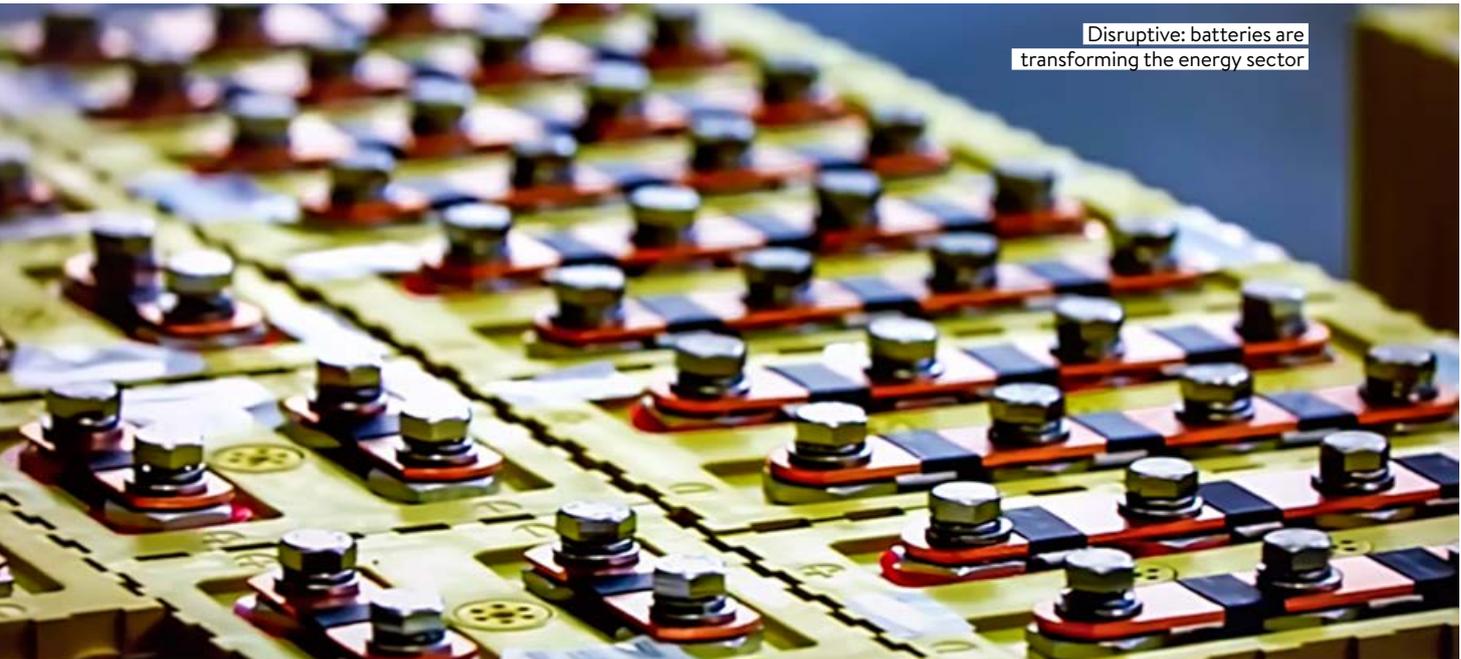
Globally, the energy sector is undergoing profound changes which every country or region is undergoing in its own, unique way. The specifics of each individual country's transformation depends on several factors including economics and climate, but in general the transitions are driven by the necessities of customers, leading to innovations in the energy sector.

Energy is a crucial backbone for a modern society. This was the case when western societies were going through their period of industrialisation, centuries ago, and it is still true today in the times of Industry 4.0.

The International Monetary Fund concluded, in a study on the relationship between energy consumption

and economic growth, that energy demand growth in low and middle-income economies is closely correlated with growth in per capita income. However, high-income economies can sustain GDP growth "with little if any increase in energy consumption", the study said.

As a result, we will still experience increasing energy consumption in developing countries such as China or India, but there won't be any large increases in energy consumption in older economies. Developing countries also benefit from advances in technology and might leapfrog Europe and the United States (US) in terms of renewable energy generation and digitalisation of their energy systems.



Disruptive: batteries are transforming the energy sector

However, in contrast to former times, there is one crucial change in today's energy sector: both technology and the needs of customers have changed rapidly. Consequently, energy companies must respond much faster to this constantly changing environment.

INNOVATION IS DRIVING THE TRANSFORMATION

We have already seen many technological innovations pave the way for the ongoing energy transformations.

Large scale investment in renewable energy has taken place over the past few years, leading to enormous cost reductions. Prices for solar photovoltaic (PV) panels in particular have plummeted by 20% every time cumulative production of them has doubled over the past three decades. For fossil fuels, we have seen dramatic changes

“In several developed countries today, it is cheaper to use electricity produced from PV systems—when it is producing— than it would be to buy it from the grid”

in the traditional energy supply-demand status quo over the past decade. Developments such as shale gas and tight oil production are turning the US from a net importer of the fuels to a leading exporter.

In the renewables sector, the disruption caused by solar PV systems has been enormous and we expect this to continue in the future. The main disruption to power markets has come from the price differential between the cost of producing power with PV systems and rising

electricity prices for the end user. This is, in large part, due to government incentives to promote PV systems and to bring cost reductions.

In several developed countries today, it is cheaper to use electricity produced from PV systems—when it is producing— than it would be to buy it from the grid. However, we know the sun does not always shine when you need it. So the overall benefit of the PV system will ultimately depend on how much power is consumed and the efficiency offered by innovative software and devices. In some areas, these will make the business case for off grid systems the best solution for starting an electrification processes .

Now comes the next disruptive technology: batteries. For years, people have been saying that the price for batteries for cars, the electricity grid and residential energy applications will fall. Now, we have achieved that and prices are continuing to fall. Today, market prices for batteries are already below previous estimates for next year. Further cost reductions can be expected. This will have significant implications for the entire energy sector, particularly for the residential market and the runtime of conventional generation, but it will also bring great opportunities for anyone who is ahead of the curve.

Further innovations will take place and they will continue to reshape the global energy landscape. But exactly how they will develop will depend on the location and economic prowess of a particular country or region.

These innovations will be comprised of smart technologies in use across the electricity grid and in homes in Europe, new payment methods to solve affordability issues in Africa, electrification of transport in North America and efficiency gains in consumption and production in Asia. In the end, all these innovations will be shaped by the needs of the customers in a particular region for a secure and affordable supply of energy.

The winds of change: renewable energy is changing the game for power providers



Business models for a decentralised world

Changing technology and consumption patterns mean traditional energy suppliers will have to compete with much more dynamic players, Philip Lowe, World Energy Council Executive Chair of the Energy Trilemma tells the World Energy Focus



Philip Lowe is the Executive Chair of the World Energy Council's Energy Trilemma and former Director General for Energy at the European Commission

The move to a world that has greater distributed energy resources (DERs)—whether in the form of rooftop solar PV, aggregated generating capacity or electric vehicles—is a challenging one. But as the existing electricity model—where traditional utilities transmit power to customers from large centralised generating facilities—comes under pressure in many countries, particularly in Europe, the industry is seeing innovative business models spring up to seize the opportunities presented by the new energy landscape.

This year's World Energy Council Trilemma Report, that will be launched in November at the UNFCCC's 23rd Conference of the Parties, identifies decentralisation as one of the '3 Ds' (along with decarbonisation and digitalisation) driving the ongoing transition. It looks at the energy transition from the decentralisation standpoint, focusing on distributed generation, one of the key enablers of decentralisation.

Philip Lowe, Executive Chair of the World Energy Council's Energy Trilemma says that increasing

Changing landscape: wind turbines in rural Scotland



decentralisation and ramping up the focus on how energy is consumed leads to greater competition on the consumer side. “If there are more sources of energy locally, there is more choice for the consumer,” he says. “With digitalisation, there is also the possibility to better measure how power is used, and to consume it when it is cheaper.”

The focus on consumers and local systems has seen companies turning their attention beyond just delivering energy to put greater emphasis on providing services to customers.

NEW PLAYERS AND SERVICES

The implication of this new focus is that traditional energy companies will not be the only ones in the game. Companies that have much more experience of dealing with consumer needs and taking care of the “last mile” to households or businesses will be part of the picture.

“Companies like Google and Amazon, or other companies providing other services to the home may decide that they will also provide energy by buying it wholesale and selling it on in a package or bouquet of services to consumers,” explains Lowe.

But the move towards DERs has its challenges. In a more decentralised set-up, the focus in the energy balance goes much more to the distribution network level. This is where the real challenges will be.

Lowe says: “It’s [about] how suppliers can provide everything the consumers need, as well as how consumers can choose best the services they need, including the energy they are buying.

“For example, a farmer in Scotland who with his neighbours has built a wind farm and/or a facility to use animal waste to produce electricity, has the opportunity to have more secure, competitively priced energy,” Lowe said. “But it may be that he and his neighbours also need to buy energy during periods where renewable sources are intermittent.”

He added: “He may also need a lot of advice on how to minimise use of energy but maximise its use when the price is low. So the second challenge in addition to the greater emphasis on local systems and local networks is to measure energy more effectively.”

NEW BUSINESS MODELS

The Scottish farmer is just one example of the new competitors that have been emerging from the woodwork to compete with traditional energy companies by utilising disruptive, innovative business models that take advantage of a market in transition.

Sonnen, a German solar-energy-storage maker, has created the SonnenCommunity, which allows peer-to-peer selling of electricity. Members pay Sonnen a monthly subscription charge (membership fee) to use a sonnenBatterie and solar PV to meet their own energy needs and feed into a ‘virtual energy pool’ that serves other members. This disruptive community, which essentially bypasses the traditional utility, has had marked success. In one year, it offered up over 14.7m kWh, more than half of which was purchased.

“The implication of this new focus is that traditional energy companies will not be the only ones in the game”

Although slow to react to the changing market, traditional utilities are now adjusting their business models.

In April last year energy giant E.On, which has also been looking at how to take costs out of its operations, launched the Aura proposition for German residential electricity customers. This is an ‘all-in-one’ system made up of solar, energy storage, energy management app and a tailored electricity tariff.

Dutch utility Eneco, meanwhile, has developed a smart home solution called Toon to create a daily customer interaction, which it hopes will result in increased customer satisfaction and therefore better customer retention.

RADICAL CHANGE

As a result of the trend to more decentralisation and a greater focus on consumer needs, the clearest message emerging from the 2017 World Energy Trilemma Report is that systems will be changing radically.

“Some will remain predominantly centralised but the vast majority will have a substantially increased share of distributed generation,” says Lowe.

But Lowe sums up: “The other thing that is coming out of the report is that governments will have to think about how they plan and regulate to deal with this diversity – not to frustrate it but to encourage it. At the same time, they must channel it toward the social and economic objectives they want to achieve.”



Innovation creates innovation

To be the global and integrated company we are today, exploring, producing and distributing energy is not enough. We always aim higher, inspiring people, companies and communities where we are present. In Brazil and Mozambique, where we are a part of world-class natural gas and oil discoveries, we work together with our partners to overcome new challenges and search for innovative solutions. We always look further, pushing for scientific and technological development, because innovation creates innovation.



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