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WHITE PAPER / **ON THE ROAD TO ZERO IN THE U.K.**

UNSETTLED FUTURE: TRENDS AND OPPORTUNITIES IMPACTING ENERGY NETWORKS

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In June 2019, the U.K. became the first member of the G-7 to commit to a 100% zero-carbon emissions goal. The U.K. has created a requirement to cut carbon emissions by 100% from 1990 levels by the year 2050. This will require unprecedented coordination across interconnected energy vectors.

The U.K. is showing unquestioned leadership in striving to become the world's first major economy to achieve net-zero carbon emissions.

Moving from the previous 80% target to 100% reduction from 1990 carbon levels by 2050 will require major investments in all aspects of energy infrastructure, as well as revision of current energy regulatory regimes. Though the difference between 80% and 100% may seem insignificant, it is not. Achieving this goal will require a wide range of innovative engineering solutions.

The U.K.'s Road to Zero Strategy and Industrial Strategy are guided by the principle that market forces must be harnessed to meet carbon reduction goals. The 42% reduction in carbon emissions achieved to date is strong evidence this was correct. Utilities are becoming energy platforms that enable competition, and consumers now have unprecedented choices among energy suppliers. Ultimately, network owners will perhaps simply become the backbone for an "energy internet," providing a platform for service providers to bolt on end-customer solutions and solve traditional problems with innovative approaches.

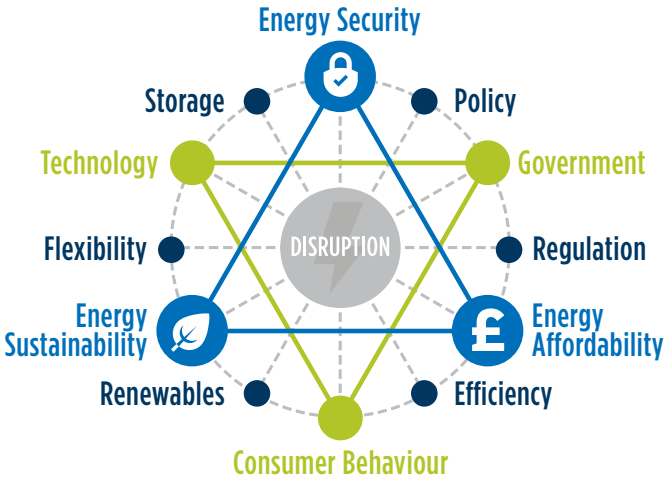
But utilities are likely to face even more uncertainty in the future as consumer demands continue to evolve, the RIIO-2 plan is implemented, and technology innovation accelerates. These forces will exert more pressure on utilities as the U.K. challenges itself to meet zero-carbon goals.

KEY STEPS IN THE MARCH TOWARDS NET ZERO

Society currently faces an energy trilemma, working to achieve energy affordability, energy security and sustainability of energy resources.

These imperatives come at a time when utilities confront an even more uncertain future. Now, with heightened zero-carbon goals, a new sense of urgency is required. The way forward will require an even stronger partnership among all the players — Ofgem, the U.K. Department of Business, Energy and Industrial Strategy (BEIS), the investment community, equipment manufacturers, power generation developers, as well as transmission network operators (TNOs) and distribution network operators (DNOs). All must adopt a fully integrated approach to dealing with the energy trilemma that encompasses increasingly interconnected energy vectors.

THE ENERGY TRILEMMA



LOOMING THREAT OF RENATIONALISATION

To achieve net-zero goals, one of the first items on the docket must be resolution of a proposal by the Labour Party to renationalise the energy sector. As noted, market forces clearly have been effective in achieving carbon reduction to this point. Turning back from a market-oriented approach makes little sense.

Renationalisation would bring with it a clear set of challenges. From the 1940s through the 1980s, the U.K. energy sector operated as a national utility, with questionable results. There was a lack of material efficiencies and misalignment of risks across the board in all sectors, exacerbated by lack of a plan to address them. Is this the right road to journey down again at a time when the power sector must confront monumental changes on all fronts?

One of the primary risks facing a renationalised energy industry is politicisation of key strategic decisions needed to enhance grid efficiency and allow new players into the market. Unfortunately, the government sector's track record is poor when it comes to doing a better job of managing budgets and projects than the private sector.

Also, how would customer service fare under nationalisation? It's unlikely the consuming public would be patient with waiting lists to get service restored.

Finally, who would pay for a renationalised energy sector and how much would they pay? It would clearly cost billions, and current shareholders will not take a discount. Lessons of the Tony Blair government still resonate, when it agreed to pay £2.50 a share for the rail network operator, then spent years fighting shareholders who wanted £9.15 a share.

The proposed sale of Electricity North West could be in doubt for this very reason. Potential bidders have been alarmed by Labour's plans to renationalise network operators, creating further risks at a time when investment is needed. Network performance won't come from private or public ownership. It comes from the right incentive structure, governance and regulatory construct. No matter what, certainty in the future helps businesses make key investment decisions.

Many forecasters have assured utility investors they will be protected from steep losses on their investments in the event of utility nationalisation because of international laws that would still be in force. Nonetheless, this risk doesn't exist in many other markets. It is an unnecessary worry for investors, and this potential reality is a growing concern that inevitably will hamper investment. Lastly, it drives the perception that the U.K. government is not friendly to business.

MANAGING RISK

All components of the U.K. power market continue to deal with risk arising from types and location of future generation. Greater electrification in heating and transportation will create a substantial need for new generation capacity that is flexible and better able to match supply with demand. These new generation sources will include a greater share of renewables — solar, wind and hydro — as well as grid-scale energy storage.

For storage to help propel the U.K. towards a zero-carbon future, regulators must get policies right to provide adequate compensation for the benefit it offers networks. Storage is both a generating resource — supporting periods of peak demand — and a technology resource, regulating frequency and maintaining system reliability. It can even be utilised to shift peak demand to defer investments in hard assets like wires, transformers and substations.

However, current regulatory frameworks do not encourage developers to assume the risks involved in deploying energy storage systems. It is still an immature and emerging market and will not develop until misaligned stakeholder interests are identified and brought into alignment. For example, DNOs are currently prevented from owning or operating storage because of an assumption that their monopolistic structures would corner the market and stifle innovation and creativity. The reality is this approach is hampering development, not because of anti-competitive behaviour but because private-sector investors cannot make the numbers work. With guaranteed cash flow spanning only two to three years on assets that have a design life of eight to 10 years, it is not hard to understand why energy storage has accounted for a minuscule share of recent U.K. capacity auctions. Ofgem and BEIS must develop policies that reward this new technology appropriately.

RENEWABLES ARE KEY

Despite challenges in other areas, progress in developing renewable energy is quite encouraging. The U.K. is quickly becoming the world leader in offshore and onshore wind power, as recognised within the industry, and it now seems probable that it will achieve its stated goal of receiving at least one-third of its power supply from wind by 2030.

In the recently concluded third Contracts for Difference (CfD) round, BEIS received bids at record-low prices between £39.65 and £41.61 per megawatt/hour (MWh) for total offshore capacity of 5.5 gigawatts (GW). This pricing reflects a dramatic drop of more than 30% from pricing in the 2017 CfD round and as much as 66% from the first round, held in 2015. At the current downward trajectory, could the wholesale market price of power approach zero in a mere 10 years? It isn't out of the question that piecemeal renumeration and stacked revenue models could become a thing of the past amid at a simple balancing market for the U.K. power sector.

In addition to the offshore wind capacity, an additional 500 MW was awarded for projects that convert waste to energy and onshore wind projects on remote islands off the coast of Scotland. Now the Crown Estate is launching Offshore Wind Leasing Round 4, for rights to develop at least 7 GW of additional wind power in waters around England and Wales.

THE ROLE OF TRANSPORTATION

There is no question that electricity demand will grow as more and more electric vehicles (EVs) hit the roads. Even though U.K. sales of EVs showed some signs of slowing in 2019, the long-term forecast still points to alternatively powered vehicles commanding a significant market share. In a recent forecast, National Grid now predicts there will be at least 35 million EVs in the U.K. by 2050, creating an additional 6.5 GW of peak power demand and increased annual demand of approximately 88 terawatt-hours (TWh).

This might be the biggest challenge facing the energy industry, and it is time to pay attention to the charging infrastructure. Though the system is currently able to handle the demands of the more than 200,000 EVs now on U.K. roads, that is likely to change as market penetration climbs above 25%. At that level, there will be a need for widespread deployment of smart charging technology to control times of day when vehicles may charge. This technology is already being deployed and demonstrated as part of NIC/NIA-funded projects from the DNO perspective.

Technology is advancing to enable faster charging cycles, and consumer acceptance is likely to accelerate when recharging times approximate the time it takes to refuel at a petrol station. Of course, both battery and charger technology have a long way to get to that point.

Ultrafast charging means very high load factors at any commercial access point. This could be addressed by installing high-capacity services directly from the transmission network or reinforcements to distribution networks. As levels of EV penetration approach the 50% level, investments in electricity networks will be required, with higher-capacity distribution networks, substations, transformers and advanced capacitors, inverters and other power quality equipment.

These investments will be essential if we as a society agree that we must maintain present levels of reliability and security of supply.

EVs are undeniably a crucial part of the "road to zero." A recently released report by National Grid outlines at least one scenario in which millions of EVs equipped with vehicle-to-grid (V2G) charging technology could actually store enough power to support the grid during periods of high demand. According to these projections, 35 million EVs, each equipped with a relatively small 40-kilowatt-hour battery, could provide enough storage to run the current electricity system for 36 hours.

This emphasizes the need for a national strategy based on input from manufacturers of vehicles and charging equipment, transmission and distribution system operators, and the national system operator.

SPACE HEATING AND COOLING

Of course, electricity won't be the only energy source. Hydrogen is likely to play a key role in heating and commercial transportation. Hydrogen is a plausible alternative to natural gas for home and business heating because it produces no carbon emissions when burned. It is a fuel that can be stored and thus can be produced through electrolysis during periods of surplus power from renewable energy sources. But there are significant barriers that must be overcome.

The first barrier is that there is no dedicated hydrogen transmission or distribution infrastructure currently available that could safely deliver this energy source to homes and businesses. The physical and chemical properties of hydrogen would require a re-engineering of delivery infrastructure simply because hydrogen atoms are so small that they can penetrate the walls of steel and many other pipeline materials. Naturally, this could create the need for massive conversion of delivery infrastructure, boilers and appliances.

Part of the solution could be conversion to 80/20 blends of natural gas and hydrogen. Demonstration projects underway are proving the feasibility of this approach. In addition, much of the gas transmission infrastructure currently being built is being installed with materials that are compatible with hydrogen chemistry.

Transitioning to a hydrogen economy would take significant investment, but it is plausible and must be part of the plan. A whole-system approach to gas, heat and electricity must be the underlying principle of the zero-carbon strategy, unlocking the needed flexibility spanning across multiple energy systems.

TECHNOLOGY WILL PLAY A VITAL ROLE

New technology platforms are bound to emerge as the U.K. advances towards its carbon goals.

The energy market is transitioning towards two-way power flow as peer-to-peer energy trading becomes more commonplace and distributed energy resources are installed on the distribution grid. The role of DNOs in this scenario remains unclear, but at least some questions could be answered through

blockchain-based technologies that would serve as a foundation to this digital grid economy of the future. The DNOs would take an active management role, in this scenario, and serve as unbiased third-party arbiters of electricity flowing through their networks.

Blockchain technology has the potential to transform the traditional infrastructure that distributes and, crucially, tracks electricity. It has the power to connect energy consumers with energy producers via new markets — enabling real-time energy trading transactions to revolutionise the energy market.

While it primarily has been applied in the financial sector for applications such as Bitcoin and other cryptocurrencies, blockchain's decentralised ledger system records transactions made between peers in a verifiable fashion. With its core capabilities of security, resilience, consistency and accuracy, it is easy to envisage how it could be applied to energy trading markets by enabling disparate suppliers and consumers to trade distributed energy resources.

These transactions could take place among commercial and industrial facilities; microgrids; owners of renewables like wind, solar and energy storage; and even residential consumers.

This technology also has advantages in providing high levels of cybersecurity. The nature of blockchain builds in natural security through ledger distribution, minimises systemic risk and maintains the authenticity of transactions between parties. The encryption available in blockchain technology means that many security issues can be resolved in peer-to-peer transactions, enabling district grids or microgrids for the future electricity network.

OVERCOMING REGULATORY BARRIERS

Under the proposed RIIO-2, there is concern that utilities could come under intolerable earnings pressure that could create disincentives to making the investments necessary to support further advances in creating this robust energy platform. The U.K.'s water companies have responded to a tough stance by the Water Services Regulation Authority (Ofwat)

on the 2019 price review (PR19) with accusations that the expectations are unachievable, unrealistic and unfinanceable. With RIIO-2 following suit, these concerns are likely to flow into the electricity sector.

One example is the charging infrastructure that will be needed for the anticipated surge in EVs and ongoing increase in renewable energy resources. Under current regulations, utilities lack the ability to invest in their networks ahead of need, and this problem is not corrected under RIIO-2. Capital projects to upgrade both transmission and distribution networks could be of significant scale and complexity, requiring many years to engineer and build. Forcing network operators to wait until demand forces them to act will create needless delays and impediments in critical areas needed to support the generational changes coming with respect to EVs; renewable energy from multiple distributed points on the grid; bidirectional power flows; and further technology advances unimagined today.

WHAT IS NEEDED?

A first step would be developing revised regulations looking at a whole-system approach and procuring the services the customers and the networks need. Furthermore, the regulations must remove impediments that are distorting the market and crippling investment.

Industry analysts agree the regulatory regime is becoming less friendly to business interests; they point to lowered returns under RIIO-2 without a fundamental transfer of risk, placing equity returns near debt costs, as "exhibit A." Returns on investment that are far lower than the average of 9% that owners could earn in markets like the U.S. drive investment to more attractive markets. Given two utilities with similar fundamentals, with one in the U.K. and one in the U.S. or the EU, one can surmise where the money will flow. These market distortions are driven by relatively simple investor risk-and-reward decisions.

The second step would be to re-evaluate all incentives throughout the value chain, re-examining all the potential markets and lowering barriers to entry. Providing certainty in the market will drive investment and result in the desired outcomes — a reliable and resilient network.

The third step would be to stack value across the chain so all players have incentives. In the U.S., for example, storage owners can sell into the capacity market or into the frequency regulation market. There are many variables, but all provide reliable, long-term cash flow over a term needed to provide a reasonable expected return on investment. The U.K. market must allow stacking of financial resources to create a payback that makes sense.

A fourth step would be changes that promote openness and transparency. This would be key to resolving issues, reinforcing the traditional network and optimizing investment. For example, one simple measure would be to allow smart meters to be installed that share operational data instead of simply serving as billing outlets. Smart meters providing system performance data could allow operators to identify constraints and weaknesses that could be addressed with batteries and other technologies before power outages or voltage fluctuations could occur.

What can be done today to change the game and support the TNOs and DNOs? A good start would be to stop focusing on the wrong things and focus on appropriate business models for positioning the industry, namely revised regulation that allows developers to achieve the scale they need for investment.

AN EXCITING FUTURE

We are at a critical junction where important policy decisions need to be made, and in some cases revisited and corrected. Ofgem will undoubtedly continue its focus on removing cost from the industry to keep profit levels 'reasonable' and maintain important safety nets for consumers.

The industry has the engineers to solve any technical challenges, and the investment community stands ready to jump in. But they are only two legs of a three-legged stool. Ofgem and BEIS are the third leg, and the whole system will benefit as sensible policy and regulations are devised. The industry is ready to get to work and realise this bright future.

BIOGRAPHIES

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13238-TND-1019