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Editorial Office
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Oops! . . . I Grid It Again: [In]Coherency in UK Energy Transition and Security

*By Miguel Colebrook and Iona Gilby**

Using the grid as a working example, the authors of this article argue that a refreshed framework for understanding energy security, which prioritizes investment in domestic infrastructure and secure international partnerships, and incentivizes private investment, will balance the competing aims of Energy Security while streamlining the UK's approach to energy transition and increasing renewable energy domestically produced.

“Energy security and net zero are two sides of the same coin.” This – the opening line of the UK government’s “Net Zero Growth Plan,” published in March 2023 – leaves no doubt as to its perception concerning the interplay between energy security and energy transition. It is evident that energy security and net zero are a commingled high priority focus when, in February 2023, the Department for Energy Security and Net Zero (DESNZ) broke away from the Department for Business, Energy & Industrial Strategy. Declining North Sea reserves, energy majors with interests in the UK divesting (in no small part, as a response to the target of net zero by 2050), and geopolitically precipitated disruptions in the global traditional energy supply chains, inter alia, is important context to situate the foregoing twin aims. The urgency for an adaptable system is felt and reasonable, but is the framing in which the discussion is being had – which will orient the analysis and animate policy prescriptions – correct?

The International Energy Agency (IEA) defines energy security as “the uninterrupted availability of energy sources at an affordable price.” We have conceptualised this in two limbs: uninterrupted availability as “Limb I (Sustainability)” and affordable prices as “Limb II (Affordability).” However, in many industry and policy conversations about the UK’s energy ecosystem, energy independence is often included too (we call this “Limb III (Independence)”). For example, when the Energy Act 2023 received Royal Assent in October, DESNZ itself lauded it as a way to ensure that “energy is affordable for households and businesses” and that it would make the UK “more energy independent in the long-term.” In the UK, there is a clear and conscious decision to marry the concepts of energy security and energy independence. Consequently, the full construct of our conceptual framework for understanding the UK’s approach to energy security includes all three limbs (Energy Security).

* Miguel Colebrook (mcolebrook@velaw.com) is a partner in the Mergers & Acquisitions and Capital Markets practice at Vinson & Elkins RLLP. Iona Gilby is a trainee solicitor at the firm.

The UK government hopes that, as the economy is increasingly electrified, renewable energy domestically produced (REDp) will provide its energy needs. The government alleges that REDp will provide a secure, uninterrupted supply of energy that will be clean and protected from volatile international energy markets and can be offered at lower cost to wholesale and end-consumers, and will, therefore, achieve net zero and Energy Security for the UK. These aims are legitimate, but there is cause for scepticism. The April to June 2023 Energy Trends Release, published by DESNZ, and the Crown Estate's plans for Celtic Sea floating wind, set out the UK's increasing renewable electricity generation capacity. In October 2023, the IEA published its report on "Electricity Grids and Secure Energy Transitions," a first-of-its-kind global stock-take of the world's electricity grids. It branded grids, including the UK's, "the weak link in clean energy transitions." While the IEA's comments are a rebuke, the situation can be turned around provided the UK adopts a more realistic and coherent approach to REDp and Energy Security.

The UK needs to recalibrate its approach to Energy Security by (i) deconstructing its limbs, (ii) accepting that its constituent elements can be incompatible, and (iii) creating a coherent but malleable hierarchy that allows for balancing and trade-offs. This involves asking itself several questions. Is it the uninterrupted availability of energy sources, or is it achieving energy supply at an affordable price? Are these targets mutually exclusive? Can it "afford" the negative outputs associated with this rushed transition away from fossil fuels? Can it guarantee an uninterrupted availability of energy sources as an island with limited critical minerals supply and increasing interconnectedness with other countries? And, given the UK's geography, can it ever be energy independent?

This article will argue, using the grid as a working example, that a refreshed framework for understanding energy security, which prioritizes investment in domestic infrastructure and secure international partnerships, and incentivizes private investment, will balance the competing aims of Energy Security while streamlining the UK's approach to energy transition and increasing REDp. Additionally, it will reflect some of the aspects of UK policy that are already succeeding – increased generation capacity, successful partnerships with European neighbors through interconnectors, and investment in grid networks. It will also enable policymakers to make thoughtful decisions about how best to pursue energy transition in a way that is coherent and that lights the way for private investment, both in the technologies and infrastructure of the future, as well as those we continue to rely on.

ISSUES WITH THE GRID

The IEA warns that global annual investment in grids needs to double to more than US \$600 billion a year by 2030 to meet national climate targets and support energy security. In the UK, the queue to connect to the transmission grid is clogged (TG Congestion), with over 547GW of generation projects on the Transmission Energy Capacity (TEC) Register as of September 2023. Of the 143GW with distribution contracts, only 39GW is ready to connect to the network. This is only worsening, with 1GW of new generation capacity joining the queue each day and a quarter of all grid connection staff expected to retire in the next 2-5 years. Connection dates for generation are now as late as 2038.

National Grid ESO (the energy system operator in England and Wales, ESO) is responsible for providing onshore grid upgrades. However, rather than singularly focusing on building more infrastructure which (we acknowledge) would increase short-term costs for consumers, ESO also opts for constraint payments – i.e., payments made from ESO to generators as compensation for reducing their output when the network can't physically transfer the power from one region to another – to minimize price rises and thereby, ESO boasts, promote Limb II (Affordability). In ESO's own words, "to date, these constraint payments have been the most cost-effective option to operate the electricity system securely." However, a more nuanced assessment reveals that constraint payments are suboptimal (and not cost-effective) because they deploy funds that could otherwise be used to improve infrastructure, reduce TG Congestion, and expand grid access. In fact, constraint payments, arguably, crystallize a "tall" as opposed to "wide" customer base (i.e., lower access); which, in the context of a good with inelastic demand, necessarily leads to higher long-term pricing.

In 2023, ESO made over £590m in constraint payments, nearly 5x 2019's total of £130m, according to research by the Renewable Energy Foundation and figures provided by the think tank, Carbon Tracker. However, when we consider that ESO, National Grid Electricity Transmission (the transmission owner in England and Wales) and Ofgem approved plans in November 2023 to speed up the TEC Register queue, it is likely these constraint payments, and the subsequent increase in end-consumers' bills, will only grow if they are not accompanied by large-scale grid investment. In the Spring Budget 2024, the government announced plans for ESO to introduce delivery milestones in over 1,000 connection contracts to remove stalled projects from the queue, to make way for connection-ready projects from Autumn 2024. It also boasted that, since November, over 40GW of energy projects have been offered earlier grid connection dates. In light of this decreasing TG Congestion, ESO itself estimates that constraint payments could reach as high as £5bn per year in the late 2020s. Carbon Tracker also estimates that the cost of constraint payments

for an average UK household's electricity bill will nearly quadruple by 2026. It cautions that, even under current investment plans, wind generation capacity in Scotland alone is set to be 4x greater by 2030, but cabling will only double in that time.

The upshot? Attempts to support Limb II (Affordability) incentivize policymakers to crowd out infrastructure investment and detract from achieving Limb I (Sustainability), which ultimately (and ironically) undermines the current conception of Energy Security. Can we do better? Arguably, yes.

INVESTMENT IN DOMESTIC INFRASTRUCTURE

The UK is looking to transnational interconnectors to relieve some of these grid pressures. They help to balance the grid by exporting surplus electricity when demand is low or there is excess generation and can import electricity when the inverse is true. They also diversify the mix of electricity generation by connecting the UK to countries with a different energy balance, such as hydro power in Norway and nuclear power in France. However, the extent to which these interconnectors can reduce costs for end-consumers is contingent on private and public investors being aligned with respect to aims and outcomes.

One such interconnector project, which is real-world and actively ongoing, aims to bring renewable electricity from the African continent to Devon (the A Project). Its 3,800km underwater HVDC cable is estimated to cost £22 – 24 billion (having already increased from £20 billion) and is reported to be able to generate power at £15 per megawatt hour (£15/MWh) in today's prices. However, the UK's assessment of A Project's feasibility largely hinges on the cost of transporting electricity from the Sahara – yes it can be generated cheaply, but these savings must be sufficiently retained after transportation. The A Project cable itself accounts for nearly half of the project capex, which will likely increase due to supply chain pressures, and it is estimated that over 15% of the electricity generated would be lost en route. The government's advisory Climate Change Committee also warns of "integration costs" rising as the proportion of renewables on the grid increases, which could add a further £20/MWh. Reasonably, £15/MWh now becomes £41.18/MWh.

Even if the anticipated cost savings at the point of generation (and transportation) are realized, they may be minimized when we consider that wholesale costs only account for c.35% of end-consumers' electricity bills. The remaining 65% is made up of VAT, supplier operating costs, government ESG obligations, supplier pre-tax margin, network costs and other direct costs, all of which the government controls but does not fully invoke when considering how best to facilitate interconnectors for the benefit of end consumers.

The A Project's UK Contract for Difference (CfD) is pending. However, in September 2023, the government designated the project of "national signifi-

cance,” which will streamline planning. Given the world’s longest undersea and land power cable – the 765km Viking Link interconnector between the UK and Denmark – started commercial operations on 29 December 2023, these super interconnectors are a real part of UK energy infrastructure, today. Yet, as ever, if we agree that such projects will lower prices for end consumers, to achieve this beneficial investment we must sacrifice one limb of Energy Security for another – energy independence (i.e., Limb III (Independence)) for affordable pricing (i.e., Limb II (Affordability)).

SECURE INTERNATIONAL PARTNERSHIPS

If transnational interconnectors are long-term low cost, and for that reason desirable, it is unhelpful to develop policy concerning the same in the context of a framework that is hostile to promoting international partnerships. The UK both seeks to encourage interconnector projects whilst promoting a theory of Energy Security that conceives of interconnectors as [negatively] increasing the UK’s energy dependence on external countries. To achieve any potential cost savings through interconnectors, we by definition must “sacrifice” Limb III (Independence) and thereby undermine Energy Security *in pleno* (as conceived by the UK government).

To be sure, the current framing of Energy Security, reasonably, highlights weaknesses associated with [over]reliance on third countries. If, for example, the UK is reliant on French nuclear energy, then France – in similar fashion to Russia in 2022 – can simply turn off the taps (or rather, cables), which would undermine Limb I (Sustainability). The precedent for weaponizing energy supplies has been set. It is also not just subsea cables. In April 2024, the EU launched an anti-subsidy probe into Chinese turbines amid concerns that Europe is simply swapping its dependency on Russian gas for one reliant on Chinese clean energy equipment.

Undersea cables and pipelines form part of the UK’s critical national infrastructure. These types of infrastructure are soft targets, which, in light of their proliferation, creates a significant strategic advantage for adversaries by expanding their opportunity set to threaten the UK’s energy, internet and financial systems (i.e., there are more fronts to be guarded, which are open to attack). The effects of such vulnerabilities have been felt recently with the as-yet unexplained explosions that crippled the Nord Stream 1 and 2 pipelines in September 2022, as well as the damage caused to the Baltconnector gas pipeline, which connects Finland and Estonia, in October 2023. Whether these incidents were intentional, unintentional, or due to bad seafaring, their impact on energy prices demonstrates how significantly physical vulnerabilities can impact domestic and global energy security. Just two days after the Nord Stream

explosions, European gas benchmark, the Dutch TTF, jumped more than 10% to approach €210/MWh, following a 7% rise the day before.

Notwithstanding the foregoing, securing compatible international partnerships as opposed to viewing them with suspicion is the best path forward. In early-2022, France announced that it was developing a seabed warfare strategy, and in February 2023 NATO set up a Critical Undersea Infrastructure Coordination Cell to boost the security of undersea infrastructure. Similarly, following Russia's invasion of Ukraine in 2022, the UK accelerated the procurement of ships for the Ministry of Defence's Multi-Role Ocean Surveillance (MROS) programme. The first MROS ship, RFA Proteus, was launched in October 2023. It was docked proudly alongside HMS Belfast on the River Thames for its official naming ceremony. The foregoing demonstrate that the UK and its international partners are not shy about advertising their collective concerns about, and strategy for, combatting these physical vulnerabilities, which, among other things, and pointedly through collaboration, bolsters energy security.

Interconnectors, like the global renewable energy supply chain, cannot guarantee electricity supply or reduced prices for end-consumers. At the same time, government policy and investor confidence suggests that the UK needs these countries – whatever politicians say about energy independence. With limited natural resources, an increasing population and global moves away from carbon-rich generation, the UK needs external assistance for its energy supply. Should Energy Security and related government policy not instead focus on diversifying energy supplies and supporting transnational partnerships, rather than promoting an isolationist rhetoric which undermines investment and which crumbles on contact with real policy based on international collaboration?

INCENTIVIZING PRIVATE INVESTMENT

To incentivize private investment and promote Energy Security, the UK government must guard effectively against industry risk.

In July 2023, Vattenfall halted work on the Norfolk Boreas scheme. It blamed surging costs, which made the project unviable given the record low strike price locked in for its electricity in June 2022 – £37.35/MWh in 2012 prices. Similarly, in October 2023, shares in Ørsted nosedived after it abandoned two key US projects and announced a higher than expected write-down of its portfolio. It too blamed supply chain delays, high interest rates and problems with construction permits. Significantly, it also blamed changes to its assumptions around tax credits available under the US' Inflation Reduction Act. The UK government should heed this warning and ensure that

investors achieve reasonable contract prices, and that any domestic incentives regime is unambiguous and provides investors with certainty for their decisions.

One source of these rising costs is steel. In tonnes per MW, steel accounts for 90% of offshore wind. The price of steel rose 50% over 2020 and 2021, and has increased further due to the war in Ukraine. This trend is set to continue with the introduction of the EU's Carbon Border Adjustment Mechanism (CBAM), the transitional phase of which entered into application on 1 October and applies to, inter alia, steel imports. CBAM equalizes the price of carbon between domestic products; producers of which face a carbon price for their emissions under the EU Emissions Trading System, and imports, which disincentivizes importing carbon-intensive products as a replacement for what were previously more expensive, greener, EU-produced alternatives. Of course, this does not apply to the UK. However, the UK is set to introduce its own CBAM by 2027. Until this date, UK energy and infrastructure projects will have to comply with EU CBAM reporting, registration and verification requirements, particularly if they hope to export electricity to the EU through interconnectors. The UK does have its own carbon pricing regime, so the impact of a CBAM is reduced. However, additional costs and penalties for incorrect estimates of expected embedded emissions must now be factored into investment decisions for UK projects. Investors must also consider whether the costs of green imports and compliance outweigh the costs of sourcing less green alternatives.

This being said, renewables are significantly cheaper than gas. This is particularly evident given the increase in gas prices relative to their pre-crisis level, and remains true even when we consider that the cost of offshore wind has increased by as much as 40% in the past year (and is predicted to stay high). According to Energy Monitor analysis, the average cost of a 1MW turbine increased 38% from \$0.86m in 2020 to \$1.18m in 2022. However, figures from the International Renewable Energy Agency show that the global power sector saved \$520bn in 2022 thanks to already installed renewables, which demonstrates their cost-saving capabilities.

With the UK's marginal pricing model, this cost differential has attracted investors. Marginal pricing is based on the marginal cost of production for every MWh. The last technology needed to supply the demand for every spot market period sets the wholesale price, which is typically natural gas in the UK. Renewables are very low-marginal technologies as they have no fuel costs, whereas electricity produced from natural gas is a high-marginal technology. Therefore, despite having lower marginal costs, electricity produced from renewable sources benefits from the high prices set by the more-expensive-to-produce electricity from natural gas, generating higher returns for investors.

This is particularly important when we consider that capex accounts for around 77% of project costs for renewables, compared with just 25% for conventional power projects. The comfort provided by the marginal pricing system is instrumental in obtaining this high level of up-front investment.

However, as investment in offshore wind increases, cannibalization can erode the benefits of marginal pricing. This occurs when increased volumes of renewables with the same generation profile (i.e., offshore wind projects in the North Sea) produce at the same time and depress power prices. With marginal pricing, the buyer carries the cannibalization risk and ‘overpays’ for the generation. However, as renewables make up an increasing proportion of the UK’s electricity generation capacity, they will set the wholesale price where they are able to satisfy demand for a given period. And, as there is no floor on how low energy prices can go in the UK, negative pricing caused by cannibalization poses a serious threat to the viability of renewables projects. In July 2023, EPEX SPOT hourly day-ahead market prices reached a record low of -£70/MWh and, at one stage, the intraday price dropped to -£120/MWh. The UK government’s plans must account for this disincentive for established offshore wind generators to develop more projects in the UK – why would generators want to increase generation capacity to the point where renewables set wholesale prices, thereby eroding their margins? To what extent this risk played a part in Vattenfall’s December 2023 decision to sell its rights to develop three of Britain’s largest wind farms – the Norfolk Offshore Wind Zone – is unclear. However, its chief executive, Anna Borg, noted the projects were not “appropriate to our current risk appetite.” Without correction, cannibalization could lead investors to withdraw, thereby reducing supply, increasing prices for end-consumers and forcing the UK to import more of its energy. Every limb of Energy Security is at risk.

Whatever the cause, the UK government must act now to reduce the risk profile of investing in UK renewable energy. Potential solutions include introducing a floor price for renewably-generated electricity, or incentivizing wind-plus-storage and going beyond the announcements in the Spring Budget 2024 to raise barriers to entering and remaining on the TEC Register, in modifying the rules to allow previously approved projects to introduce storage capacity without leaving the queue. The government could also adopt solutions from other countries, such as Japan, which is set to increase its fiscal loan and investment program by providing long-term and low-interest funding to investors.

CONCLUSION

Energy Security, by virtue of its currently confused agenda, hamstringing the UK. If we evaluate projects through the current framework, the UK is far

off-piste. Investment in grids may promote security of supply and enable the UK to utilize more of its domestically-generated electricity, thereby improving its energy independence. However, without extensive government subsidies, this unprecedented level of investment will undoubtedly push prices up for end-consumers; only two out of the three limbs are satisfied. Similarly, building interconnectors has the potential to lower costs for end-consumers and may secure future energy supplies to the UK, but it will certainly not make the UK energy independent.

Even projects that appear to improve energy independence – i.e., domestic offshore wind – do no such thing. In January 2024, it was announced that components for the new Inch Cape wind farm are to be built in China, and this is likely to continue, at least until the UK sufficiently course-corrects its industrial policies and promotes domestic manufacturing. However, without the discovery of component critical minerals under its soil and sea, the UK will always be dependent on other nations for its energy infrastructure. Perhaps the time has come not to fear relying on other countries, but to work with external governments and industry to ensure these partnerships are as robust as possible.

Through this discussion, it has never been said that renewable electricity generation is misguided, or that targets for decarbonizing the energy sector are wrong. We only need to look to the weather patterns of recent months to see the effect that climate change is beginning to have. However, what *is* misguided is allowing a pithy phrase to dictate how we think about and approach this transition. Energy Security does not appreciate the complexities of the energy industry. Energy Security reflects the UK's trauma: relying on countries such as Russia for its energy supply, being subjected to volatile pricing, and always needing to secure its next meal (or next influx of gas). What it *wants* is to not be in this position again. What it *needs* is to look to the future, rather than the past. Allowing the features of global oil and gas supply to color renewable energy's picture is unwise. The two are distinct and bring their own challenges, and industry and government must look to the future to appreciate the distinct landscape that is energy transition. Many of the problems the UK is experiencing boil down to its myopia. It needs unprecedented levels of grid investment, because little grid investment has been secured in the last 30 years. It has to rely on countries such as China to build and service its renewables assets, because the domestic manufacturing just isn't here. And, its planning framework needs overhauling, because past industry concerns were not heard.

A new strategy which prioritizes investment in domestic infrastructure and secure international partnerships will make the UK an attractive and reliable prospect for private investment. This new direction will reflect some of the aspects of UK policy that are already succeeding (despite often being incom-

patible with Energy Security) – increased generation capacity, successful partnerships with European neighbors through interconnectors, and investment in grid networks. It will also enable policymakers to make thoughtful decisions about how best to pursue energy transition in a way that is coherent and that lights the way for private investment, both in the technologies and infrastructure of the future, as well as those we continue to rely on.

Finally, a paradigm shift away from traditional geothermal power is not needed. What is needed is a second paradigm to emerge, based on renewables, which can coexist with traditional energy sources. This will enable coherent government policies to take hold, which reflect the reality of the domestic and global energy sectors. Pursuing oil and gas and renewable opportunities in tandem is key. A calm and targeted approach will ensure the UK gets it right and is not forced to play catch-up again.