Written evidence submitted by Xlinks Limited

Executive Summary

We welcome the opportunity to respond to the Environmental Audit Committee's Call for Evidence *Technical innovations and climate change: onshore solar energy*. We are the developer of an innovative project to bring reliable renewable energy generation from Morocco to the UK. We believe that while further technological advancement will make solar energy even more attractive, no technical innovation is required to enable solar energy to play a crucial role in the UK's transition to Net Zero. This is particularly true when the solar facility is located in a region with high and consistent solar irradiation, and the land is not suitable for agricultural purposes. The Morocco-UK Power Project has been designed to utilise only existing, proven technologies, given the vast solar energy potential available in the Moroccan desert.

Project Overview

Xlinks Limited (**Xlinks**) is developing the Xlinks Morocco-UK Power Project (**the Project**). The Project will create 3.6GW of power. It will comprise 10.5GW of solar and wind power generation in Morocco combined with a 5GW/20GWh battery storage facility. To transfer the electricity to Great Britain, Xlinks is installing a High Voltage Direct Current (HVDC) system from the generation site in Morocco. The 3.6GW of dedicated electricity will be delivered through two independent rigid bi-pole systems, each delivering 1.8GW. The Project has secured two 1.8GW connections with National Grid. The system is designed to ensure maximum resilience, comprising 4 cables (2 cables per bi-pole laid together in a bundled pair) to avoid a single point of failure across the project. Initial routing will ensure that appropriate separation distances are maintained and appropriate cable protection measures are taken.

Once complete, the Project will be capable of supplying 8 percent of Great Britain's annual electricity needs. The cost of generation in the Project's renewable energy rich location in Morocco is very low thereby offsetting the cost of connection to the UK.

Responses

What role can developments in solar panel technology play in the UK's transition to net zero?

Solar panel technology in its present state will play a significant role in the UK's transition to net zero. Existing technology enables projects across a range of scales and geographies to provide low-carbon power to the UK. For smaller-scale installations, MCS (2022)[1] data shows that 3GW of solar panels have already been installed on UK homes, and the number of installations increased 71% from 2020 to 2021. In total, Solar Energy UK has calculated the total installed solar capacity to be 14.7 GW in 2021, demonstrating that solar technology is already mature, bankable and commercially attractive.

While solar generation is already providing a significant contribution to the UK's transition to Net Zero, further technological advancements in solar panels and enabling technologies will unlock additional potential.

Increased efficiency

The efficiency and power output of solar panels have improved substantially over the last few decades and this positive trend is expected to continue through to 2030.
NREL (2020)[2] report that since 2010, the efficiency of monocrystalline modules has increased 0.3%-0.4% each year in absolute terms. The continuous improvement in efficiency will result in further reduced demand for materials, cost reductions and the ability to generate more power with less land usage.

Technological developments like sun-tracking technology can further improve efficiency by tracking the position of the sun by day and by season, to maximise energy output. Likewise, agrivoltaics technology allows solar to be built in additional locations. Agrivoltaics co-locates PV and agricultural production to provide benefits to both systems, increasing land-use efficiency and preventing the value of agricultural land from declining.

Alongside technological improvements, developments to business models and a continued decrease in cost will aid solar panel technology in playing a significant role in the UK's transition to net zero.

Continued decrease in cost

The LCOE of Solar PV projects has decreased significantly from $0.417/kWh in 2010 to $0.048/kWh in 2021. Although this is due to improvements in costs throughout projects, IRENA attribute 45% of the reduction to the decreased cost of solar modules (which decreased in price by 93% between 2010 to 2020 according to IRENA (2021). [3] This reduction in cost has led to an increased number of solar PV projects that can deliver power to the UK network at a competitive price.

[1] https://mcscertified.com/annual-uk-solar-pv-installations-hit-output-milestone/.
[2] U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 (nrel.gov)
[3] Renewable Power Generation Costs in 2021 (irena.org)

Advancements in enabling technologies

-BESS

Advancements in enabling technology have presented new opportunities for innovative business models to emerge. Increasingly, utility scale solar PV in the UK is being collocated with Battery Energy Storage Systems (BESS). This reduces constraints on the distribution networks and allows the power generated by the solar facilities to be exported at times when the UK most needs it. However, BESS systems are only able to shift the generation within a relatively short time period and do not correct for seasonal discrepancies between solar generation and electricity demand.

-HVDC

Intermittency of solar energy in the UK is a challenge that prevents the resource from directly contributing to security of supply, particularly during the winter. This is demonstrated by solar PV's de-rating factor of 3.32% in the upcoming Capacity Market T-1 auction. This indicates that a 100MW standalone utility scale solar PV facility would only be expected to contribute 3.32MW to GB's de-rated margin during a Capacity Market event. In contrast, a 100MW hydro project would be expected to contribute 91.13 MW to the de-rated margin.

Locating solar generation in alternative geographical regions with uncorrelated renewable resources and installing long-distance HVDC cables can result in a more reliable and consistent supply. Subsea HVDC cables have undergone several advancements that enable long distance cables to be technically achievable at a cost that is beneficial to UK consumers. In recent years, the voltage of systems has increased, the cross-section of conductors has increased, new insulation technologies have been proven and the efficiency of converter stations has improved.

Accessing generation further south decreases the seasonal variation experienced in the UK. For example, Morocco has excellent solar resources due to its consistent daylight hours. Morocco has the third highest Global Horizontal Irradiance (GHI) in North Africa, 20% greater than Spain (highest GHI in EU) and more than twice that of the UK. Morocco also has high solar intensity (34% solar load vs 11% in UK).

The location of the Xlinks Morocco-UK Power Project generation site in Morocco, combined with the wind and BESS resources, enables the Project to deliver for an average of 20+ hours a day. The 7GW solar PV farm will have increased output early in the morning and late in the afternoon, providing the most consistent generation profile to Great Britain. The increased solar resource of Morocco means that the same PV panels generate approximately three times more power than they would in the UK. Importantly, the solar panels will generate as much as five times more power from January to March than those in the UK.

To what extent is the contribution of solar technologies to the UK's renewable energy mix limited by storage and distribution capacity?

There is a high degree of variability in solar output across the UK, particularly on a seasonal basis and within a single distribution network. As a result, periods of high solar irradiance can lead to constraints on the distribution networks which can lead to curtailment or increased reinforcement costs. Locating BESS behind the meter (BTM) can alleviate some of these constraints by redistributing the export onto the distribution network to periods outside of peak generation. Furthermore, challenges associated with constraints on the distribution network can be eliminated if the solar generation is connected to consumption BTM, reducing imports from the distribution network rather than leading to exports.

Whilst BESS and site configurations can enable solar to contribute more to the UK's renewable energy mix, they cannot address the seasonality of UK based solar PV generation. There are currently no technically and commercially viable electricity storage technologies that enable electricity generated in summer months to be stored and exported back onto the electricity network during winter months. The UK already experiences higher electricity demand in the winter, and the electrification of heating will further increase winter demand. Therefore, there is currently a significant barrier to the contribution of solar PV to the UK's renewable energy mix during winter months.

However, solar PV in more southerly geographies is not exposed to the same level of seasonal variations in generation output. The Xlinks Morocco-UK Power Project will be able to maintain a reliable generation profile, increasing the contribution of solar to the UK's renewable energy mix. Locating the solar panels in another geography closer to the equator also minimises intermittency and therefore minimises the long duration storage required. Connecting to the transmission network prevents the Project from contributing to constraints on the distribution network.

How significant are current technological developments in energy storage and distribution networks for the potential contribution of onshore solar to the UK's renewable energy mix?

The necessary technology already exists and is at a level of maturity that allows a significant portion of the UK's energy supply to come from solar generation. However, ongoing technological advancements in energy storage and distribution networks will make solar resource more competitive. The largest challenge to increasing the contribution of onshore solar (located in the UK) to the UK's renewable energy mix is the absence of technically and commercially viable seasonal storage. Current technologies, such as hydrogen storage, are subject to large capital investments and large roundtrip efficiency losses. Together, these would have a significant impact on the LCOE of power generated during summer months and delivered during peak electricity demand in the winter.

When the Xlinks Morocco-UK Power Project is operational, over 5% of the UK's electricity needs can be supplied by the solar component of the Project. The 3.6 GW of capacity that Xlinks has secured to connect to the UK's transmission network means the Project will not contribute to constraints on the distribution network. Furthermore, analysis based on the location of the connection and the generation profile shows that the Project will reduce transmission system constraint costs in scenarios where the UK achieves its net zero target.

Does the concentrated global distribution of solar panel supply chains (80% manufacture in China) pose a risk to solar technology expansion in the UK? If so, how could this be mitigated?

The concentrated global distribution of any supply chain can create risks to projects utilising that technology. In the case of solar generation, the concentration of the solar panel supply chain within China may pose a risk to projects in the UK. These risks may be related to events such as the Covid-19 pandemic which led to a diverse range of responses across different economies. The supply chain for solar panels was heavily impacted by the response to the pandemic in China. Had the supply chain been more globally distributed, the impact may have been reduced. However, GW scale projects command significant buying power and allow for planning and manufacturing over multiple years. This can decrease the risk of specific events impacting the overall project timeline. It also enables projects to explore opportunities for manufacturing in new regions, with supply chain risk being a key consideration to the viability of the option.

While 80% of PV manufacturing is in China, other countries are looking to manufacture elements of the supply chain. The US department of Energy report that outside of China, there is 90-100 GW of module manufacturing capacity. A large portion of this is in Asia, but increasingly within Europe and the United States, particularly in areas located near large PV demand.[4]

[4] EERE Technical Report Template (energy.gov)

Are there opportunities for solar energy generated abroad (e.g. in the Sahara desert) to be delivered to the UK via interconnectors?

Solar energy generated abroad presents a considerable opportunity to deliver consistent and reliable energy to the UK via long-distance HVDC cables (reducing transmission losses to a minimum). The reliability of the solar resource closer to the equator, on a seasonal basis, allows solar in other countries connected via an HVDC system to fulfil a different role on the network to domestic solar installations. Careful selection of the generation site can minimise the environmental and social impact of the project, including the impact solar PV could have on global food production.

Long-distance HVDC cables use the same technology as interconnectors but also enable far more beneficial structures where the generated power is dedicated to the UK. Interconnectors facilitate the efficient cross-border trading of electricity. However, there is no certainty that generation connected to other countries' electricity networks via interconnectors will be available to British consumers at an affordable price when required and this approach does not necessarily guarantee security of supply. Remote generation and HVDC connection between distant geographic regions with inversely correlated weather systems will be more effective at addressing imbalances of supply and demand over longer time periods. Projects that are dedicated solely to delivering power to the UK increase energy security due to higher availability.

The Xlinks Project will provide energy that is dedicated to the UK market through long-distance HVDC technology. The Project's 7GW PV solar farm will track the sun from east to west throughout the day to increase the output early in the morning and late in the afternoon, providing the most consistent generation profile to Great Britain. The increased solar resource of Morocco means that the same PV panels generate approximately three times more power than they would in the UK and as much as five times more power from January to March than those in the UK.

Accessing generation further south decreases the seasonal variation experienced in the UK. For example, Morocco has excellent solar resources due to its consistent daylight hours. Morocco has the third highest Global Horizontal Irradiance (GHI) in North Africa, 20% greater than Spain (highest GHI in EU) and more than twice that of the UK. Morocco also has high solar intensity (34% solar load vs 11% in UK).

The 3.5GW wind farm will utilise the reliable daily convection currents in the region, which are driven by the temperature differential between the Atlantic Ocean and African continent. The windspeed at the generation site increases throughout the late afternoon and evening, enabling power to be delivered to Great Britain during times of peak demand and is also a perfect complement to the solar resource. Alongside the consistent output from its solar panels and wind turbines, an onsite 20GWh/5GW battery facility will provide sufficient storage to reliably deliver each and every day, a dedicated, near-constant source of flexible and predictable clean energy for Britain, designed to complement the renewable energy already generated across the UK.

The HVDC system from the generation site to Great Britain will use proven technologies, similar to those used in existing international interconnector projects -e.g., the NEMO interconnector, connecting the UK and Belgium. HVDC technology is mature, reliable and more cost competitive for a large volume of electron transfer across longer distances, than the High Voltage Alternating Current (HVAC) technology typically used for transmission systems within countries. Using DC cables rather than AC cables significantly reduces the electricity losses associated with transferring the power.

-HVDC Cable Manufacturing

HVDC cable is required to provide the connectivity required for renewable power to meet future global energy needs. Wind farms are increasingly aiming to use HVDC connections and it has also been considered for delivering nuclear power around the country through offshore bootstraps. There is currently a global shortage of HVDC cabling and manufacturing capability with the existing manufacturers boasting a 4–7-year order back log.

Xlinks' cable supplier, XLCC, will therefore create a new, green, export led manufacturing capability for HVDC cable in the UK. It is intended that once built, the XLCC factory will be able to produce cable for long-distance HVDC projects, UK interconnectors, offshore wind farms etc. XLCC's first customer will be the Xlinks Morocco-UK Power Project, and as such the factory build will progress with the Project development. The development of the factories will support the creation of thousands of highly skilled jobs both during construction and ongoing operation.

XLCC is investing in at least one state-of-the-art Cable Laying Vessel (CLV), designed to manage all aspects of cable handling, from protection during export through to installation. The CLV will have the capability to deploy the cables individually or in a bundled pair configuration. XLCC will also be capable of providing customers with cable repairs in the event of a cable failure or during periods of preventative maintenance.

UK based subsea HVDC manufacturing and installation capabilities will ensure that the UK can benefit from solar energy generated abroad through the Xlinks Project and future developments.

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