Powering the Future: The Evolution of Sustainable Technology and Economic Impact

Energy markets have undeniably always had a pivotal role in global economic performance. Historically the oil industry has been at the forefront of these effects, as seen through the impact of the Iranian Revolution, Arab-Israel War, the inflation during the 1970s oil price shocks or more recently, the Russia-Ukraine War impact on living standards. However, recently, global energy needs previously served by fossil fuel industries, are now being replaced by renewable technologies. This shift is not merely a technological one, but an economic one as well, with far-reaching implications for both industries and economies alike.

In recent years, particularly in the past 10-15 years, significant progress has been made in wind and solar energy, both seeing rapid cost reductions as a result of sustained investment into research and development. Figure 1 illustrates this trend for solar panels; price per watt declining, making solar energy increasingly accessible. A key driver in the reduction of costs for solar panels has been economies of scale and new panels types, such as bifacial panels which increase efficiency of panels and expand their geographical feasibility into regions previously considered unattractive for harnessing solar energy like the UK, particularly the South-West, in comparison to sunnier regions like the Middle East and Southern Europe. Already, UK's installed solar capacity has increased by 18,000% since 2010, alongside solar PV capacity growth of 5.3% in 2022, whilst installed base solar power is estimated to nearly triple from its 2023 estimates of 15GW to 43GW by 2028.

Similarly, increasing size and capacity of turbines has helped halve prices of wind electricity generation in the past 15 years seen by figure 3. As a result, onshore and offshore wind now accounts for 28% of UK electricity generation in 2023. Floating offshore wind is the latest development in this ongoing progression of technologies. The prospect of floating offshore wind technology provides an opportunity for the UK to further establish itself at the forefront of innovation in offshore wind. To date, offshore wind has been led by fixed bottom foundations, where the foundation is built directly on the seabed, working better in shallower waters. However recent developments of floating offshore wind, where the platform floats on the sea but is anchored to the seabed via cables, more suited for deeper waters, for use in UK and further locations like Japan, Korea and Taiwan which previously have been unsuitable for fixed foundation technology are promising. Already, the UK has a number of small pilot projects, believed to account for more than a third of installed global capacity, demonstrating a gap in the market. Industry leaders believe floating offshore could account for more than half of the 100 gigawatts target set by the UK government for offshore wind power generation by 2050, a promising prediction.

While solar and wind dominate discussions on renewables, nuclear energy and green hydrogen also have promising futures, particularly in meeting firms needs to diversify energy sources. Nuclear energy, with zero carbon emissions, is increasingly seen as a viable option for companies like Amazon and Google to power data centers requiring reliable, high-capacity energy sources. Nuclear's potential impact on technology sectors, particularly in powering data-intensive applications like AI, could be transformative. However, strict regulatory hurdles and high upfront costs remain a significant barrier to wider adoption in

the industry. Green hydrogen, produced through electrolysis powered by renewable sources, offers another promising pathway to decarbonize sectors that are hard to electrify, such as heavy industry and shipping. By leveraging solar and wind farms, green hydrogen production can reduce dependence on fossil fuels. However, this technology also faces substantial challenges; the land, labour, and capital costs associated with hydrogen production, as well as high transportation and storage expenses, limit its scalability. Hydrogen infrastructure is still in its infancy, requiring both private and public sector investments to bridge these gaps. Meanwhile other approaches to decarbonisation e.g. CCS (carbon capture storage) and DAC (direct air capture) are also being pursued, but to date, are yet to achieve commercial viability.

Transitioning to a renewable-based economy is not without challenges. Renewable sources like solar and wind require heavy land and labour investments which can drive up costs and strain local economies, whilst green hydrogen's storage and transport needs pose economic and logistical hurdles. Addressing these challenges would require sufficient support from the government for each industry and its supply chain, "priming the pump", which could be done via CFD Auctions, by providing tax credits for hydrogen infrastructure or grants for nuclear research to reduce regulatory delays.

Whilst ensuring our planet has a future is essential, accommodating the global transition towards renewables has implications for economies relying heavily on fossil fuels. This is particularly relevant for highly specialised economies such as Venezuela and Angola whose exports are largely comprised of crude oil/petroleum products (95% and 89% respectively), whilst these products make large proportions of total GDP. As demand for oil declines, these economies may face budgetary shortfalls, potentially destabilizing social programs heavily funded by oil revenues. For example, under Hugo Chavéz, Venezuela used oil revenues to fund the Bolivares Missions, a series of social programs aimed at improving literacy, healthcare, and overall productivity. Shifting away from oil will therefore require economic diversification and development of new revenue sources, but will ultimately insulate such economies from supply-side shocks as suffered from in the past. Conversely, this transition provides opportunities for countries investing in renewable technology and infrastructure such as China. Whilst known for its large contribution to carbon emissions, China's leading role in manufacturing of solar panels, and looking to the future, equally in wind turbines, positions itself to overtake European manufacturers and overall benefit economically from the shift towards renewables as demand grows, thus exemplifying how the rise of green industries could reshape international economic power dynamics, with nations investing greenly reaping long-term economic rewards.

However, it is worth noting the impact the political landscape in the US, recent election of Trump, will have on global progress towards implementation of sustainability given his plans. His vow to pull out of the Paris Accords (once again) does not bode well for other progress Biden made through legislations such as the Bipartisan Infrastructure Law, the CHIPS and Science Act as well as the Inflation Reduction Act, a policy which provided significant incentives for green initiatives. Will Trump's plans to reverse/loosen climate regulations deter US firms, already wary of the costs of implementing sustainability plans, to

abandon them completely? Furthermore, if a global leader such as the US pulls out of such commitments, other nations, particularly high emitters such as Russia and India might follow suit, potentially stalling global climate action at a critical phase. However, influential figures such as Elon Musk's continued advocation for electrical vehicle policy adoption and sustainable energy could counteract political opinions, encouraging green technology investment. The commercial success of Tesla and similar companies illustrates the economic viability of sustainable industries, potentially inspiring other sectors to follow suit.

As the global economy shifts towards sustainability, industries and economies must adapt to new realities. The economic benefits extend beyond environmental gains, also including reduced vulnerability to fossil fuel price shocks and the creation of new jobs and industries. However, there still remains opportunities for countries like Britain to lead efforts in sustainability, particularly looking to COP29. As the British Energy Secretary stated, "The only way to keep the British people secure today is by making Britain a clean-energy superpower, and the only way we protect future generations is by working with other countries to deliver climate action." The path to a sustainable future has challenges, but the economic and environmental rewards make this journey worth taking.