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ESI Bulletin on Power Sector Decarbonisation Progress in Key Economies (Volume 19 / Issue 2 · June 2025)

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INTRODUCTION

The main theme of this issue is the power sector decarbonisation progress in key economies.

South Korea, Japan, the European Union (EU) and the United States (US) are the major advanced economies across the world that have ambitious targets to decarbonise their economies and achieve carbon neutrality by mid of this century. However, all of them face unique challenges in the decarbonisation process, and the power sector is one of the most hard-to-abate sectors. Their common thread is the commitment to scaling up renewable energy such as wind and solar, phasing out coal, and promoting energy efficiency. The EU and the US are at the forefront of policy-driven changes, with ambitious federal or regional targets, while South Korea and Japan are focusing on a mix of technologies, including renewables, nuclear and hydrogen, with facing a greater reliance on fossil fuels in the short term. The success of these efforts will depend on technological advancements, political will, public acceptance, and the ability to integrate new energy solutions into existing infrastructure. This bulletin issue discusses the success and challenges of the power sector decarbonisation progress of these four economies.

The first article, written by Dr. Son

In this issue ...

Minhee, gives a detailed and insightful overview of the challenges and policy efforts related to the integration of Variable Renewable Energy (VRE) in South Korea. Proactive steps are being taken to expand VRE integration by addressing the structural limitations of South Korea's power system. Policy initiatives such as the Decentralised Energy Act and reforms to the Renewable Portfolio Standard demonstrate a commitment to building a more flexible and sustainable energy framework. These efforts aim to foster a grid that can effectively accommodate the variability of renewable energy sources like wind and solar. However, substantial challenges remain. The economic feasibility of renewable energy expansion is hampered by distorted electricity pricing, inadequate grid infrastructure, and a power market still dominated by fossil fuel and nuclear baseload generation. To ensure a resilient and equitable energy transition, South Korea need to reform electricity tariffs to reflect actual system costs, enhance grid flexibility, and address institutional and financial barriers to VRE deployment.

Ms. Lin Jiaxin authored the second article on Japan's decarbonisation efforts in the power sector. Japan's renewable energy experience offers valuable lessons on power sector decarbonisation. The initial feed-in tariff (FIT) policy sparked rapid deployment but also created long-term financial burdens and grid congestion. In response, the shift to auctions and feed-in premium (FIP) introduced more disciplined, market-oriented tools. These mechanisms have improved cost control and encouraged better integration of renewables into the power system. Further, Japan's challenges underscore the importance of holistic planning. Grid modernisation, financing frameworks, and regulatory streamlining must go alongside with policy shifts. In addition, Japan's case illustrates that while strong incentives can jumpstart change, it is the careful calibration and coordination of policy instruments that determine the long-term success of power sector decarbonisation.

The third article discusses the EU's power sector decarbonisation issues, written by Mr. Ng Zu Xiang. The EU has made significant progress in power sector decarbonisation, propelled by ambitious policy targets, a variety of support mechanisms, and favourable market conditions. Yet, these advances risk being undermined by grid inflexibility and outdated infrastructure. Therefore, policy success hinges not only on renewable capacity targets but also on flexible and interconnected grids which are essential to absorb increasing shares of variable renewables. Policy coherence across EU institutions and Member States is critical for policy implementation. The EU's experience underscores that the transition to clean energy is not just about adding renewables—it is about reshaping the entire power system to fully harness their potential.

The fourth article is about the progress and challenges in the US power sector decarbonisation, produced by Ms. Wannaphaluk Tonprasong. President Trump's return to a fossil-fuel-first strategy marks a clear pivot away from the climate-centric approach of the previous administration. While these policies may deliver short-term benefits for traditional energy industries and help meet surging demand, they also cast doubt on the US's long-term climate trajectory. Nevertheless, all is not lost for low-carbon energy. Continued investment could be sustained by state-level initiatives, corporate net-zero commitments, and market-driven incentives. The US Climate Alliance and forward-leaning states like California and New Jersey offer a counterbalance to federal rollbacks. In places like Texas, pure economics—not climate ideology—is enough to support renewables.

We hope you find these articles interesting and welcome your comments and opinions.

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Challenges and Efforts to Expand Variable Renewable Energy in South Korea

Dr. SON Minhee, ESI Research Fellow

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The Need for VRE Expansion and the Limitations of Power System

South Korea's power system is designed with a centralised structure, primarily aimed at ensuring a stable power supply through baseload generation from coal, natural gas, and nuclear power. This structure was established to secure stability during economic growth. Nevertheless, it inherently has fundamental limitations in accommodating variable renewable energy (VRE), which is characterised by rapid fluctuations in power generation depending on natural conditions. VRE refers to renewable energy sources like solar and wind power, which are subject to rapid changes in output due to natural conditions, requiring robust measures to maintain energy supply stability. To effectively manage VRE, it is essential to secure both flexibility and stability in the power grid.

The existing power system lacks the necessary flexibility to manage such variability. This shortcoming stems from the structural limitations of a centralised power grid that prioritises reliability and stable baseload power supply. As a result, VRE expansion has faced significant challenges, highlighting the need for a structural transformation to achieve carbon neutrality.

The International Energy Agency (IEA) categorises VRE integration into six stages, reflecting its impact on the power system and the operational challenges at each stage:[1]

- Stage 1: Minimal impact on the power system
- Stage 2: Mild impact on system operations
- Stage 3: Determines operational patterns of the power system
- Stage 4: Meets almost all power demand during certain periods
- Stage 5: Significant VRE surplus throughout the year
- Stage 6: Power supply almost entirely dependent on VRE

Currently, South Korea is positioned at Stage 1, where the impact of VRE on the power system remains minimal.[2] According to the 9th Basic Plan for Long-term Electricity Supply and Demand, Korea's VRE share is projected to increase to around 21% by 2034, reaching Stage 3 of VRE integration and under the Announced Pledges Scenario outlined in the World Energy Outlook 2021 by the IEA, the VRE share is expected to rise to around 50% by 2035, placing Korea in Stage 5.[3] This transition will significantly impact power system operations, requiring increased flexibility from all sources, including dispatchable power plants, the national grid, energy storage systems, and demand response mechanisms.

Limitations of Renewable Energy Expansion

South Korea has rapidly electrified to support economic growth, relying primarily on coal and nuclear power. This energy structure was established with a focus on ensuring a stable power supply. At the same time, it poses fundamental challenges in accommodating renewable energy sources that exhibit high variability. The dependence on fossil fuel-based baseload power generation hinders the expansion of renewable energy. Even with the transition of coal thermal power plants to LNG, the presence of nuclear power as a baseload generation source poses challenges in designing grid systems that can effectively integrate higher levels of renewable energy, as nuclear power plants operate at a constant output and cannot easily ramp up or down in response to changes in renewable energy supply.[4] As a result, to facilitate the expansion of renewable energy, it is crucial to develop electricity grids that are adaptable to the variability of renewable energy sources. However, the existing grid infrastructure is not yet prepared to accommodate such changes.

A further critical challenge is the integration of renewable energy into the power grid. Between 2018 and August 2023, out of 48,182 MW of renewable energy connection applications submitted, only 62.8% were successfully connected to the grid.[5] This means approximately 17,901 MW of renewable energy capacity remains unconnected, highlighting the urgent need for grid enhancement and more efficient interconnection systems.

Geographical and regulatory constraints also pose significant challenges. South Korea's mountainous terrain makes it difficult to install large-scale solar power facilities, while offshore wind projects face complex permitting processes and strong local opposition. In particular, the lack of designated sites for offshore wind development forces developers to independently identify suitable locations and obtain permissions.[6] As a result, projects are frequently delayed or halted, further impeding renewable energy expansion.

Compounding these challenges, electricity prices in South Korea have remained relatively low due to government controls aiming at ensuring public affordability. Retail electricity prices have been set below wholesale prices, primarily driven by political considerations rather than market principles. This pricing distortion has not only exacerbated the financial strain on the Korea Electric Power Corporation (KEPCO) but has also undermined the long-term sustainability of the power sector. Retail electricity prices should ideally reflect wholesale generation costs, transmission and distribution expenses, and other supply-related factors. However, the current pricing structure fails to capture these elements adequately, resulting in growing deficits for KEPCO. Without meaningful reform of the electricity pricing mechanism, there is rising concern that expanding renewable energy while maintaining grid stability will be increasingly difficult.

Policy Efforts to Increase VRE Integration

Effectively expanding VRE requires moving away from the traditional centralised power grid structure and strengthening decentralised power systems. The centralised grid, designed around large-scale baseload power plants, inherently has structural limitations in accommodating variable renewable energy due to its focus on a stable power supply. To address this issue, the government has introduced the Decentralised Energy Act to revitalise small-scale power plants. Decentralised power systems enable local production and consumption of electricity, thereby reducing the burden on transmission and distribution networks and enhancing grid flexibility. Additionally, by ensuring local energy self-sufficiency, these systems can maintain the continuity of power supply even during natural disasters that may damage the main grid.

To promote the expansion of VRE, robust policy support and enhanced incentives are essential. While the Feed-in Tariff system, implemented from 2001 to 2011, and the Renewable Portfolio Standard (RPS), introduced in 2012, have significantly contributed to increasing renewable energy adoption in South Korea, both schemes have faced challenges related to financial burdens and policy effectiveness. The government is currently restructuring the RPS scheme to incorporate government-led competitive bidding for facility capacity, aiming to improve cost efficiency and market competitiveness.[7] In addition, the government is reviewing new incentive schemes to further support renewable energy development. In response, reforming electricity tariffs to better reflect actual generation, transmission, and distribution costs has become inevitable. Alongside tariff reform, structural changes within KEPCO are also being discussed to enhance its financial soundness and adaptability to the evolving energy landscape. These efforts aim to create a more sustainable power market framework that can support the large-scale integration of renewable energy.

Conclusion

Proactive steps are being taken to expand VRE integration by addressing the structural limitations of the centralised power system. Through policy measures such as the Decentralised Energy Act and reforms to the RPS, efforts are being made to create a more flexible and sustainable energy system. Despite these efforts, challenges persist, particularly regarding economic feasibility and the need for electricity pricing reform. To ensure a resilient energy transition, policies must go beyond technical integration and directly confront the financial and institutional barriers to renewable deployment. Redesigning pricing mechanisms to reflect real costs and fostering a market environment where low-carbon technologies can compete on a level playing field.

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Japan's Renewable Energy Policy: The FIT-to-FIP Transition and Its Ongoing Hurdles

Ms. LIN Jiaxin, ESI Research Associate

Introduction

Japan's push for renewable energy accelerated after the 2011 Fukushima disaster, driven by an ambitious Feed-in Tariff (FIT) launched in 2012. While the FIT spurred rapid solar expansion, it also led to high costs, speculative project approvals, and grid inefficiencies. In response, Japan transitioned to competitive auctions in 2017 and a Feed-in Premium (FIP) system in 2022 to enhance cost-effectiveness and market integration. However, challenges remain. This article explains Japan's evolving renewable energy policies, their lessons, and the ongoing efforts to balance affordability, grid stability, and decarbonisation goals.

Japan's Early Renewable Energy Policies: The FIT Boom and Its Side Effects

Japan's post-Fukushima push for clean energy was spearheaded by an aggressive FIT scheme launched in 2012. The FIT guaranteed renewable generators a fixed, above-market price for each kilowatt-hour (kWh) of electricity, sparking a solar power boom. In the first 16 months of the FIT, Japan added nearly 5.7 GW of solar capacity – a 97% share of the total renewables installed.[1] By 2023, renewables accounted for 25.7% of power generation, with solar being the leading contributor at 11.2%. Japan now ranks among the top countries for solar capacity density, utilising its limited land intensively for PV farms and rooftops.

Meanwhile, Japan's FIT burden is passed to households in electricity bills through a Renewable Energy Power Promotion Surcharge, based on annual renewable energy purchase quotas for suppliers. The early success of FIT came at a significant cost, with market inefficiencies. Firstly, the high tariff rates, while jump-starting investment, locked in expensive 20-year purchase contracts. By 2016, this renewable surcharge had reached 2.25 JPY per kWh – far above the government's initial estimate of at most 0.5 JPY by 2020.[2] For the second point, lucrative tariffs prompted a rush of project applications, many of which stalled or never materialised as developers delayed construction to lock in early rates, leaving projects idle and tying up grid capacity without producing power. Moreover, Japan's utility monopolies-controlled grid access limits solar integration. Transmission constraints and priority dispatch for nuclear and fossil power further curtailed renewables, despite most nuclear plants being offline post-2011. In summary, the FIT era achieved rapid renewable energy deployment but at the cost of soaring subsidies and structural inefficiencies, including cost overruns and grid bottlenecks.

Evolution of Policy Tools: Transition to Auctions and FIP

Recognising the drawbacks of its initial approach, Japan over the past decade has progressively retooled its renewable energy policy to improve cost-effectiveness and grid integration. A major shift was from administratively set FIT prices to competitive auction mechanisms. Under the FIP introduced in April 2022, renewable generators sell into the market and receive a premium on top of the market price, exposing them to market signals.

Starting in 2017, Japan introduced auctions for large-scale solar PV, later expanding to wind and biomass, to drive down prices. By late 2020, five solar PV auctions had contracted 574 MW out of approximately 1.66 GW offered, with lower-than-expected participation. However, average awarded solar tariffs fell by over 35%, promoting cost-reflective pricing and reducing consumer burden.[3]

Despite this, Japan's solar costs remained above global averages due to high installation expenses. Auctions curbed windfall profits from the FIT system, introduced price competition, and enforced timelines, thereby preventing project developers from locking in high tariffs and delaying execution to take advantage of falling panel costs. Crucially, reforms were made to address the backlog of dormant FIT projects: from 2022, the government gained the authority to revoke FIT certificates for projects that have not started operation within a specified period.[4]

Besides, Japan's FIP encourages better grid integration by rewarding renewable operators for supplying power at peak hours, as the premium is structured to encourage generators to store energy (utilise energy storage systems) when the market price is low and release it during periods of higher price to amplify systems' revenue. Japan's FIP system is expected to gain more traction with a growing trend in certified capacity and project numbers since late 2023.

The Slow Uptake of FIP: Regulatory, Financial, and Grid Hurdles

The FIP rollout introduced complex regulations and a phased implementation, initially applying to larger projects (≥1 MW solar in FY2022) while smaller ones retained FIT or were exempt from bidding. In early 2022, investors adopted a "wait-and-see" approach, delaying solar investments until FIP rules became clearer. As of September 2024, a key goal identified by the Ministry of Economy, Trade and Industry is to convert 25% of all FIT/FIP projects to FIP in the next two years.[5] Hence, developers face new certification and auction procedures under tight deadlines. For instance, many solar projects that had secured FIT quotas faced deadlines to either commence operation or switch to FIP to retain support, straining both bureaucratic capacity and developer readiness. Moreover, transitioning thousands of pre-approved FIT contracts into the FIP scheme entails significant paperwork, regulatory approvals, and coordination among stakeholders.

Financially, the shift from fixed tariffs to auctions/FIP introduced more revenue uncertainty for developers, which could raise the cost of capital or make financing harder to secure for less-established players. Lenders worry that price volatility or periods of low market prices could impair a project's ability to service debt. In some cases, strict auction conditions, such as high bid bonds or short completion deadlines, may have deterred participation or led to awarded projects struggling to financial close. This is reflected in Japan's offshore wind sector, which continues to face auction delays and financial challenges, exacerbated by the inability to adjust electricity prices to reflect increased generation costs after auction applications.[6] The positive side is that this is driving innovation in risk mitigation – for instance, developers are increasingly seeking corporate power purchase agreements alongside FIP support to lock in stable long-term prices for a portion of their output. Challenges remain as the government has to balance reducing subsidies while ensuring projects still attract investment.

More challenges came from the grid structure. Japan faces difficulties in adapting its grid to accommodate the increasing share of renewable energy in its energy mix. Built without large-scale solar and wind in mind, the grid struggles to absorb variable generation, leading to increased curtailment, as happened in regions like Kyushu. The problem is both technical and institutional. Technically, solar generation peaks midday and in spring when demand is low, while storage and load-shifting remain insufficient. Japan's fragmented grid and its dual electrical frequency system with minimal HVDC connections prevent efficient power transfers. Institutionally, recent reforms have introduced a balanced market and improved grid operations in the real-time electricity market. Transmission and Distribution IT & OT Systems LLC, a joint venture, was established in September 2023. The joint venture signed contracts with Hitachi to develop a next-generation nationwide load dispatching system. However, this system is still missing, which further hinders full grid adaptability.

Applying Japan's Insights: Calibrating Policy Instrument is the Key

To wrap up, Japan's decarbonisation journey offers a rich case study in what to emulate and what to avoid. Carefully calibrated policy instruments are key: Japan's shift from an expansive but expensive FIT to auctions and FIP improved outcomes. It avoids overly generous subsidies, ensures project deliveries and active market participation. At the same time, Japan's challenges underline the importance of holistic planning – coordinating regulatory reforms, financing, and grid upgrading. It is noteworthy that upgrading the physical grids and their operation is a prerequisite for the sustainable expansion of renewable energy.

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The EU's Power Decarbonisation Journey: From Initial Success to Current Challenges

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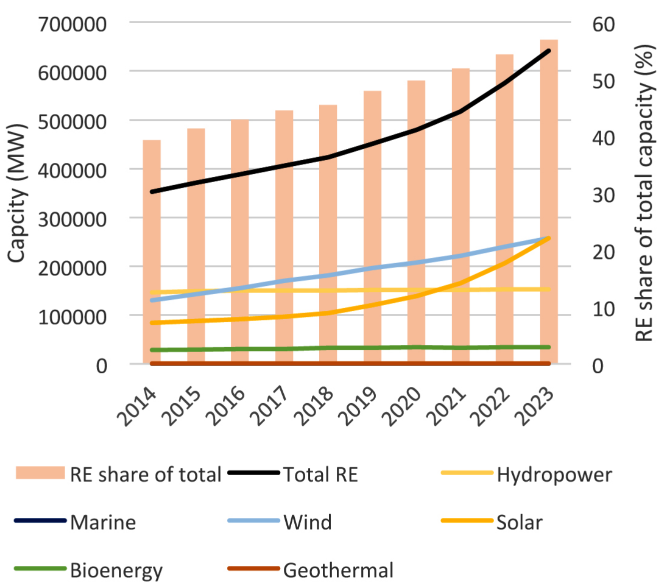
Introduction

Renewable electricity capacity in the European Union (EU) has risen by about 82% between 2014 and 2023, such that renewable energy accounts for about 57% of total electricity capacity in 2023. This increase was led primarily by wind and solar energy (Figure 1). A similar trend is observed for renewable power generation, which accounted for 46.9% of total electricity production in 2024. The EU has made commendable progress in decarbonising its power sector. That said, there are also emerging issues of grid stability that need to be addressed such that this renewable capacity can be taken in and properly made use of. This article will first discuss how the Renewable Energy Directive served as a cornerstone of EU power decarbonisation policy. A discussion on the EU's grid issues will follow, as well as current measures in place and the challenges faced. Lastly, a summary of key points and takeaways will close off the article.

Figure 1. Renewable electricity capacity in the EU



Source: Author's illustration based on data from IRENA (2024).[1]

Renewable Energy Directive up to 2020

First introduced in 2001, the Renewable Energy Directive mandated Member States to set renewable electricity consumption targets and to report on the measures taken. Some regulatory direction was given on renewable generation, transmission and distribution, but the provisions were loosely worded, allowing Member States flexibility. This bottom-up approach resulted in uneven policy implementation across Member States.

A more stringent directive was introduced in 2009 to achieve a mandatory EU-wide target of 20% renewable energy in final consumption by 2020. This regional target was broken down into prescribed national targets that varied according to national income and renewable energy deployment levels. Cooperation mechanisms were also introduced to help Member States meet targets, such as statistical transfer of energy consumption, joint project schemes to allow co-development of renewable energy projects, and joint support schemes where countries can co-fund and adopt incentive schemes like a feed-in tariff. The deployment of such support schemes was still up to individual Member States though the introduction of mandatory national targets moved the directive in a more top-down direction.

In 2018, the directive was revised to set a more ambitious EU-wide target for 2030, but Member States could set their own targets against an established baseline, representing a shift back to a bottom-up policy approach. By 2020, the EU had reached its regional target while all but one Member State, France, met their national targets. An assessment by the European Commission found that cooperation mechanisms were important to help the EU achieve targets, especially statistical transfers.[2] During the policy period, Member States also adopted a mix of support policies that adapted to market changes—feed-in premiums replaced feed-in tariffs, auctions were preferred over direct support schemes, and net metering and quota schemes were also important. External factors also played a significant role in achieving the targets. For example, the cost of renewable technologies decreased, interest rates fell to increase access to finance, and the COVID-19 pandemic lowered energy consumption in 2020.

Emerging Issues in the Power Sector

In 2024, Europe saw a record 4,838 instances of zero or negative prices in day-ahead power markets, nearly double the number in 2023.[3] This indicates that grid system imbalance issues are becoming increasingly prominent. While instances of zero and negative prices due to excess supply and lacking demand are expected in freely functioning power markets with volatile prices and variable generation, their higher occurrence can dissuade investments in renewable power due to uncertain or even lost revenue. Moreover, curtailment—removing the excess supply of power—is needed to address imbalances. In countries where coal is still dominant, this means cutting solar generation as happened in Poland.[4] Fossil fuel thermal plants have large start-up costs such that grid operators could choose to curtail renewable generation, mitigating the benefits of clean power in such circumstances.

Grid issues are compounded by the urgent need to add more renewable capacity to bolster the EU's energy security in the wake of the Russia-Ukraine war and the ensuing energy crisis. The Renewable Energy Directive was amended to increase the 2030 target (42.5% renewable energy in final consumption), streamline permitting procedures, encourage joint projects between Member States, and improve data sharing between transmission system operators, distribution system operators, battery systems and battery electric vehicles for grid flexibility, among other provisions. An emergency temporary council regulation was also introduced that accelerated the deployment of renewable energy by streamlining the permitting process. This was to allow Member States to readily take up acceleration measures during the national transposition period of the Renewable Energy Directive.

Current Grid Measures and Challenges

Power system flexibility measures are needed, including grid digitalisation, expansion and interconnection, innovative pricing models, demand response management, storage systems, and better grid planning to balance future demand and supply. The EU had adopted some legislations to implement flexibility measures, such as introducing smart metering systems and dynamic price contracts to promote demand side management and requiring Member States to provide regulatory frameworks for distribution system operators to enable and incentivise flexibility services, through provisions in the Electricity Market Directive and Regulation and the Renewable Energy Directive as mentioned above. A 2024 assessment report of six selected Member States (Austria, Bulgaria, France, Germany, Poland and Spain) found that some countries had missed the national transposition deadline of certain provisions in the aforementioned legislations due to a variety of reasons—availability of smart metering technologies, broad provisions that need clarification at the national level, and still rigid views of centralised energy systems that do not accommodate flexibility services.[5]

While developments in battery energy storage systems are led more by market players, grid expansion and updates need more government involvement to ensure that transmission and distribution network plans align with national targets, expected additional renewable capacity and public funding, though currently this does not seem to be the case.[6]

Summary and Takeaways

The EU has made strides to decarbonise the power sector, led by EU-wide targets for renewable energy consumption and support mechanisms and schemes. External factors as well as changes in economic conditions have also helped the EU achieve its renewable energy targets. However, these efforts could be undermined by grid issues that do not incorporate and make full use of the benefits of renewable energy. The EU's experience shows that power sector decarbonisation is more than just adding renewable power. Modern digital grid infrastructure, interconnections and flexibility measures should also be rolled out alongside to support the expansion of renewable energy.

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Power Shift: Rising Energy Demand and the Clean Energy Crossroads Under President Trump

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Introduction

Since the start of President Trump's second term in 2025, the United States (US) energy sector has undergone a dramatic policy reversal, marking a return to fossil fuel expansion and deregulation. Reviving his "energy dominance" agenda from 2017 to 2020, President Trump has rolled back clean energy subsidies, expanded drilling rights, and loosened environmental regulations to boost the domestic fossil fuels industries. Meanwhile, US energy demand is surging, driven by industrial growth and the AI race with China. This article explores the recent US energy policy, the implications of Trump's second-term agenda, and its potential impact on the clean energy sector.

The Changes of US Energy Policy and Energy Demand

Despite Trump's stance against clean energy and push for fossil fuel expansion, natural gas capacity—the largest US power source at 42%—is expected to remain unchanged in 2025-2026, according to the US Energy Information Administration (EIA). Meanwhile, solar power has surged since the Biden administration, driving growth in renewable energy. In 2024, the US added 30 GW of utility-scale solar energy, making up 61% of new capacity. This trend is set to continue, with 32.5 GW expected in 2025, nearly half of which is projected to come from Texas (11.6 GW) and California (2.9 GW).[1] However, this growth faces potential headwinds: in early July 2025, President Trump signed the "One Big Beautiful Bill," which included cuts to the Inflation Reduction Act (IRA)'s clean energy investment and production tax credits.

Shifting energy policy alone is not enough, as US energy demand is expected to rise, particularly from industries like AI and data centres. According to the US Department of Energy (DOE), data centres consumed 4.4% of US electricity in 2023, projected to reach 6.7–12% by 2028. Demand from this sector was around 25 GW in 2024 and is estimated to increase to 74–132 GW by 2028.[2] Growth is concentrated in states like Virginia and Texas, where large-scale computing facilities are expanding, relying primarily on natural gas for power. Given the rising demand, natural gas is expected to remain a key energy source due to its affordability and reliability as a baseload power source—crucial for always-on data centres. Additionally, power availability and delivery speed have become essential factors in site selection.

The US-China AI race makes speed-to-power and cost reduction crucial for data centre investment. DeepSeek's success, with lower costs and energy needs, raises US national security concerns, as fears grow that China's AI products could outcompete America's most advanced but more expensive alternatives. Amid this, Trump's pro-natural gas policies could further cement its role as a primary energy source. With booming production and increased supply, natural gas prices are expected to decline, reinforcing its dominance. In the near term, the affordability and reliability of natural gas could make it the most viable option for powering the AI industry. Meanwhile, nuclear power is gaining traction, with tech giants investing in commercial deals that signal its future role, although large-scale impact remains post-2030.

As AI and data centres expand, the US faces growing tension between rising energy demand and shifting policies. Under Trump, reliance on fossil fuels may slow progress toward renewable energy, raising concerns about net-zero goals. The challenge lies in whether clean energy growth can be sustained amid policy reversals. With federal support uncertain, the future of US clean energy may depend on state policies, corporate commitments, and market-driven adoption.

The Future of Clean Energy

The shift in energy policy under the new administration, coupled with an aggressive tariff policy aimed at addressing economic and national security concerns, poses significant risks to the clean energy industry, as these changes could drive up overall renewable project costs.[3] Since the IRA was enacted in July 2022, investments in clean energy technologies and infrastructure have surged to 493 billion USD—a 71% increase from the two years prior.[4] This has fuelled more than half of the growth in total US private investments and laid the foundation for long-term decarbonisation.

However, under Trump's second presidency, the rollback of the IRA's clean energy incentives could risk slowing the pace of decarbonisation by reducing demand for clean technologies and deterring investment in the area. Given more barriers being created and insufficient federal support, the trajectory of the US clean energy sector and its decarbonisation efforts will largely depend on whether states and private-sector companies committed to net-zero targets can fill the policy gap. This scenario is not unprecedented. After President Trump withdrew the US from the Paris Agreement in 2017, the US Climate Alliance—a bipartisan coalition of governors representing nearly 60% of the country's economy—was formed, and the member states reduced net greenhouse gas emissions by 19% between 2005 and 2022.[5] States can drive clean energy adoption through incentives like tax credits, renewables targets, and renewable energy certificates. For example, New Jersey launched initiatives such as the Solar Act and Successor Solar Incentive Programme to expand solar capacity and incentivise new projects, aiming for 100% clean electricity by 2035. Even in states without strong climate policies, renewable energy can thrive when it makes economic sense. Texas exemplifies this trend—despite its historically weak political support for renewables, the economic benefits have driven the rapid growth of the renewable energy sector. In 2023, Texas became the second-largest solar power producer in the US, after California. This underscores how market forces, rather than just policy, can sustain clean energy expansion.

In addition, as of 2023, nearly half of the US's leading listed companies had set net-zero targets, with thousands joining America Is All In, a coalition of US businesses, local governments and other entities committed to climate action, aligning with the Paris Agreement and aiming for net-zero emissions. However, as Trump's second term began, his decision to abandon Biden's net-zero target may have influenced the private sector, as many tech firms were absent from the coalition's 2024 open letter reaffirming support for the Paris Agreement. This suggests some corporations, particularly in the tech sector, may be less aggressive or vocal about climate commitments. If AI's energy demands outpace clean energy adoption, decarbonisation efforts could be at risk. The hope now lies in hyperscalers and large players maintaining their commitments. With surging energy demand, sustaining corporate clean power goals will be crucial to balancing technological growth with sustainability.

Conclusion

The Trump administration's push for fossil fuels marks a major shift in US energy policy, benefiting traditional industries in the short term but potentially undermining the climate agenda. Despite reduced federal support, renewables may still expand, driven by state policies and corporate net-zero commitments. If tech giants and data centres continue prioritising their climate goals, they could help sustain clean energy demand. While Trump's policies introduce uncertainty, the state-level energy transition, particularly within the US Climate Alliance, is unlikely to be reversed. However, AI-driven energy demand may shape the next phase of US energy projects.

The US experience also highlights how inconsistent energy policies can create market uncertainty and scare off the private sector's climate commitments. For countries like Singapore, this underscores the importance of clear and consistent energy strategies. Such an approach would give investors and industry stakeholders the confidence to commit to green technologies while supporting research and development in clean energy.

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2 Shehabi, A. et al., *United States Data Center Energy Usage Report* (Berkeley, CA: Lawrence Berkeley National Laboratory, 2024), 5-6.

3 Thomton, M. et al., "Proposed US Tariffs Could Increase Onshore Wind Costs by Up to 7%, Says Wood Mackenzie", *Wood Mackenzie Press Release*, February 11, 2025. https://www.woodmac.com/press-releases/2024press-releases/proposed-us-tariffs-could-increase-onshore-wind-costs-by-up to-7-says-wood-mackenzie.

4 Bermel, L. et al., *Clean Investment Monitor: Tallying the Two-Year Impact of the Inflation Reduction Act* (Rhodium Group LLC and MIT Center for Energy and Environmental Policy Research, 2024), 4.

5 Darley, J, "US Climate Alliance Defies Trump Paris Agreement Withdrawal", *Sustainability Magazine*, January 24, 2025. https://sustainabilitymag.com articles/us-climate-alliance-defies-trump-paris-agreement-withdrawal.

Staff Publications

Internationally Refereed Journal Articles

Yingzhu Li, Yingchao Lin, and **Bin Su**, "Analysis of China's Energy Consumption and Intensity During the 13th Five-Year Plan Period", *Energy Policy* 198 (2025): 114433. https://doi.org/10.1016/j.enpol.2024.114433.

Wei Jia, Zhiwei Zhang, **Bin Su**, Ya-Fang Sun, and Shiwei Yu, "Impact of Local Government Environmental Attention on Corporate Total Factor Productivity: Evidence from 288 Chinese Cities", *Journal of Environmental Management* 374 (2025): 124052. https://doi.org/10.1016/j.jenvman.2025.124052.

Lei Zhu, Zhuang Liang, Lizhong Zhang, Wenjun Meng, Xing Yao, **Bin Su**, and Shu Tao, "Assessing the Impacts of Coal-to-Electricity Transition in China's Regional Power System and '2+26' Cities", *iScience* 28 (2025): 111775. https://doi.org/10.1016/j.isci.2025.111775.

Guomei Zhao, Rui Xie, **Bin Su**, and Qunwei Wang, "CO_2 Terms of Trade and Its Determinants Based on Input-Output Models with Technical Differences", *Economic Systems Research* 37(1) (2025): 1-29. https://doi.org/10.1080/09535314.2023.2279898.

Jingxue Zhang, Shiwei Yu, Yue-Jun Zhang, **Bin Su**, and Ya-Fang Sun, "How Do Renewable Energy Policies Affect Energy Green Development", *Energy Economics* 142 (2025): 108154. https://doi.org/10.1016/j.eneco.2024.108154.

Shihong Zeng, Yuxiao Gu, **Bin Su**, and Tengfei Li, "Energy Consumption Transition and Green Total Factor Productivity in Chinese Prefecture-Level Cities", *Energy Economics* 142 (2025): 108156. https://doi.org/10.1016/j.eneco.2024.108156.

ESI Policy Briefs

Gao Xi and **Kim Jeong Won**, "Internal Carbon Pricing as a Strategic Tool for Corporate Decarbonisation", *ESI Policy Brief* 79 (31 March 2025). https://esi.nus.edu.sg/docs/default-source/esi-policy-briefs/esi-pb-79_icp-as-a-strategic-tool-for-corporate-decarbonisation.pdf.

Books and Chapter Contributions

Jeong Won Kim and Sungjin Kim. "International Agreements and Global Initiatives for Low-Carbon Cooling." In B. Shen, D. Azhgaliyeva and A.B. Leal (eds.) *Sustainable Cooling: How to Cool the World Without Warming the Planet* (Tokyo: Asia Development Bank Institute, 2024), 273-301. https://www.adb.org/sites/default/files/publication/971311/sustainable-cooling-how-cool-world-without-warming-planet-webfinal.pdf#page=314.

External Articles (Commentaries, Op-eds, and other pieces in non-academic publications)

Aisha Al-Sarihi, Ehsan Rasoulinezhad, and **Sung Jinseok**, "The Gulf Touts Hydrogen, But Is It Hype or Opportunity?", *Energy Oman*, February 2025. https://energyoman.net/wp-content/uploads/2025/03/EO-14-feb-issue-spread_lowres.pdf.

Staff Presentations and Moderating

29 April Roger Fouquet presented "Historical Energy Transitions" via internet at a *DESNZ History Seminar Series*, organised by the UK Department of Energy Security and Net Zero (DESNZ), London, United Kingdom.

28 April Kim Jeong Won presented "Working as a Climate Change Policy Researcher in Singapore" at the *Young Scholars Network Meeting*, organised by Institute of Comparative Governance, Korea University, Seoul, Republic of Korea.

23 April Sung Jinseok presented "Singapore's Electricity & Solar Market: Singapore-Australia Transboundary Electricity Trading Project" at the *PV Market Insights 2025*, organised by Korea Photovoltaic Society, Daegu, Republic of Korea.

8 April Sung Jinseok was a discussant in the panel "Challenges and Opportunities in Building a Regionally Integrated Electricity System and Market – EU and ASEAN Experiences" at the *1st Technical Workshop under the EU-ASEAN Energy Dialogue*, organised by the EU and the Ministry of Energy of Thailand, Bangkok, Thailand.

26 March Gao Xi presented "From Theory to Practice:

Implementing Internal Carbon Pricing for Sustainable Growth Results" at the *6th ESI Workshop on Carbon Pricing*, organised by Energy Studies Institute (ESI), National University of Singapore (NUS), Singapore.

26 March Kim Jeong Won presented "Evolution of Carbon Pricing Scheme Design" and "Relationship Between Internal Carbon Pricing and Corporate ESG Performance" at the *6th ESI Workshop on Carbon Pricing*, organised by ESI, Singapore.

26 March Li Hongyan presented "Carbon Pricing in Action: A Global Assessment of Emissions Reduction and Economic Impacts" at the *6th ESI Workshop on Carbon Pricing*, organised by ESI, Singapore.

14 March Kim Jeong Won was a panellist at the *Carbon Tax in an Evolving Carbon Economy Launch Event*, organised by the UNDP Global Centre Singapore and Institute for Environment and Sustainability, Singapore.

28 February Roger Fouquet was a panellist in the "Energy Transition Panel" at the *ABA APAC conference*, organised by American Bar Association (ABA) International Law Section, Singapore.

14 February Roger Fouquet presented "Long Run Perspective on Energy and Climate Change" at the *12th Asian Youth Leaders Travel and Learning Camp (AYLTLC 2025)*, organised by AYLTLC, Singapore.

13 February Sita Rahmani was a panellist in the "Sector Deep Dive: Carbon Capture" at the *1st ASEAN Regional Investment Promotion Action Plan Implementation Workshop*, organised by UN Economic and Social Commission for Asia and the Pacific, Kuala Lumpur, Malaysia.

Staff Media Contributions

Hoy Zheng Xuan was interviewed by XMUM Postgraduate Student Council on Navigating the Path from Postgraduate Studies to a Career in Clean Energy, 25 April 2025. See https://www.xmu.edu.my/2025/0324/c16257a492190/page.htm.

Kim Jeong Won was quoted in "Singapore Inks Carbon Trading Agreement with Peru", *The Straits Times*, 2 April 2025. See https://www.straitstimes.com/singapore/environment/singapore-inks-carbon-trading-agreement-with-peru.

Kim Jeong Won was quoted in "分时段电力配套 鼓励家庭高峰时段少用电多省钱", *Lianhe Zaobao,* 31 March 2025. See https://www.zaobao.com.sg/news/singapore/story20250331-6083171.

Su Bin was interviewed by 8world on LIVE Discussions of Budget Announcements in relation to Climate Change, 4 March 2025. See https://www.8world.com/in-depth/hello-singapore/tott-climate-voucher-energy-efficient-appliances-cost-saving-2723116.

Sung Jinseok was quoted in "South Korea Updates Energy Goals in 11th Electricity Plan", *ICIS*, 25 February 2025. See https://subscriber.icis.com/news/energy/news-article-00111077626.

Roger Fouquet, Ho Hiang Kwee, and **Zhong Sheng** were quoted in "Singapore's 2035 Climate Targets Feasible, But Govt Support and Geopolitical Stability Key", *The Straits Times*, 18 February 2025. See https://www.straitstimes.com/singapore/singapores-2035-climate-targets-feasible-but-govt-support-and-geopolitical-stability-key-experts.

Recent Events

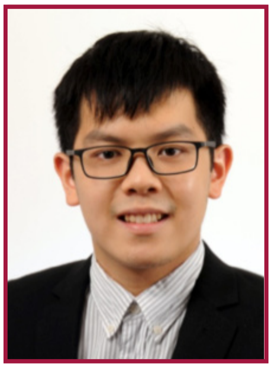
26 March, 6th ESI Workshop on Carbon Pricing

ESI hosted its 6th Workshop on Carbon Pricing on 26th March 2025. This workshop was organised as the project closing workshop for an ESI's carbon pricing research project, Carbon Pricing Strategies of Other Key Economies. Dr. Kim Jeong Won, the project lead, introduced the objectives and scope of the research. Subsequently, the project team (Dr. Kim Jeong Won, Dr. Li Hongyan, and Mr. Gao Xi) delivered four presentations summarising key findings from their 3-year research: (i) Evolution of carbon pricing scheme design, (ii) A global assessment of emissions reduction and economic impacts of carbon pricing, (iii) Implementing internal carbon pricing for sustainable growth, and (iv) Relationship between internal carbon pricing and corporate ESG performance. Around 65 people attending the workshop discussed the challenges and opportunities of carbon pricing, the importance of raising awareness of the private sector, and the internal carbon pricing trends in Singapore.

Photo by ESI staff

New Staff

TSANG Fan Lok
Research Associate



Mr. Tsang Fan Lok joined the ESI as a Research Associate in April 2025, where he focuses on power sector and power transmission modelling, with respect to Singapore and ASEAN. He holds a Bachelor's degree in Chemical Engineering (June 2021) and a Master of Engineering by Research (October 2024), both from the National University of Singapore (NUS). His Master's research focused on the optimization of liquid organic hydrogen carrier (LOHC) dehydrogenation through heat integration with liquefied natural gas (LNG), aiming to reduce overall energy requirements and recover power through synergistic thermal matching of heating and cooling demands. Prior to joining ESI, Fan Lok was a Research Engineer at the Department of Chemical and Biomolecular Engineering at NUS. In that role, he contributed to mathematical modelling, cash flow analysis, and supply chain studies for the development of hydrogen supply chains in Singapore and the ASEAN region. This work was conducted under the Low-Carbon Energy Research Funding Initiative (LCER FI) supported by A*STAR.

YEO Lip Siang
Research Associate

Mr. Yeo Lip Siang earned his Master's in Engineering (by research) from Swinburne University of Technology Sarawak Campus, Malaysia, in August 2023. He also holds a Bachelor's in Mechanical Engineering from the same university, awarded in August 2020. His master's research focused on the circular economy, specifically waste lubricant re-refining and biorefinery pathways. He specialises in applying mathematical optimisation to complex decision-making problems related to process integration pathways and supply chain network design. Currently, Lip Siang is a Research Associate at the ESI, where he focuses on hydrogen economy strategy. Before joining ESI in February 2025, he was a Research Engineer at the NUS Environmental Research Institute (NERI). At NERI, he contributed to atmospheric simulation research for the urban environment of Singapore, a government project funded by the National Environment Agency (NEA).

Contact

- Collaboration as a Partner of ESI (research, events, etc.)
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