Powering the future with grid innovation

In this insightful PES interview, Laura Fleming, Country Managing Director UK & Ireland, Hitachi Energy, explores the urgent need to modernize our power grids as electrification and decentralization accelerate. From AI and digital twins to energy storage and supply chain resilience, she outlines the technologies and strategies driving a smarter, more sustainable energy future.

PES: Laura, thank you for joining us. With increasing electrification and decentralisation, the challenges in grid integration are mounting. Which areas demand the most urgent attention and where are the most promising innovations emerging?

Laura Fleming: The urgent challenge lies in managing the growing complexity of decentralized energy sources, like solar, wind and others, and integrating them efficiently into the energy system. This calls for critical upgrades of existing power grid infrastructure and investments into building new transmission systems that can support the growing demand for energy from applications like data centers, electric transportation and electrification of industry.

There is also the challenge around the speed at which the grid needs to scale up so that it is future-proofed for our electricity demands of 2050 and beyond, which are likely double the capacity we have today.

To address these, we must focus on enhancing grid flexibility, particularly in balancing demand and supply. Promising innovations such as digitization, AI and machine learning for real-time optimization, advanced energy storage solutions and demand-side management will be key. Innovations like these will help ensure that as more variable renewable energy sources are integrated, the grid can maintain stability and reliability, ensuring electricity flows to where it needs to be.

PES: AI and automation continue to advance at pace. Over the next decade, where do you see their greatest influence on grid operations?

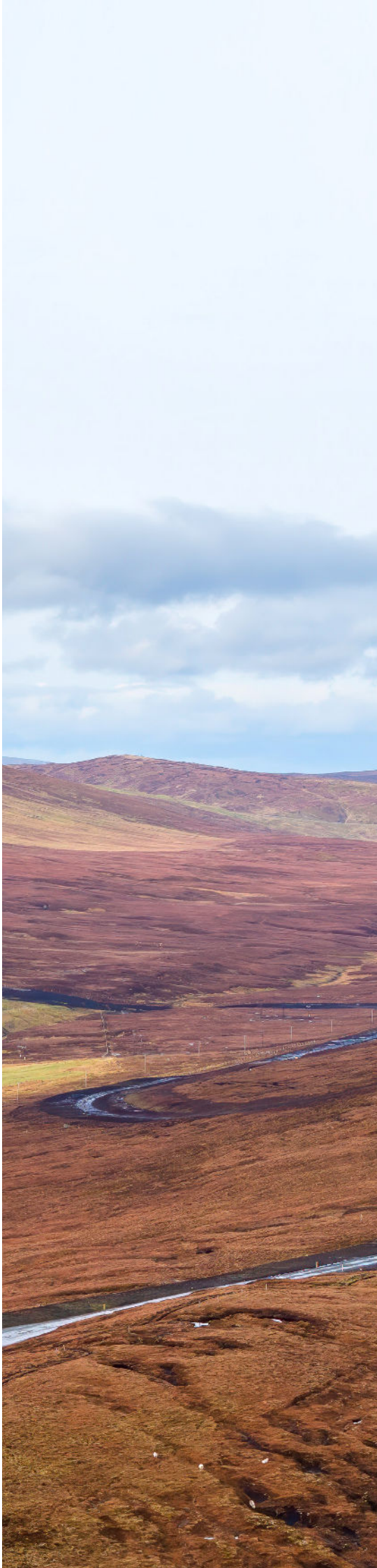
LF: AI and automation are set to revolutionize grid operations in the coming decade, particularly in predictive maintenance and real-time grid management. The ability to use AI to predict equipment failures, optimize load distribution and dynamically adjust to changing energy flows will significantly reduce costs and improve reliability. Additionally, AI will enable greater integration of renewable energy sources by forecasting weather patterns and energy generation, allowing for smarter grid balancing and less reliance on fossil fuels.

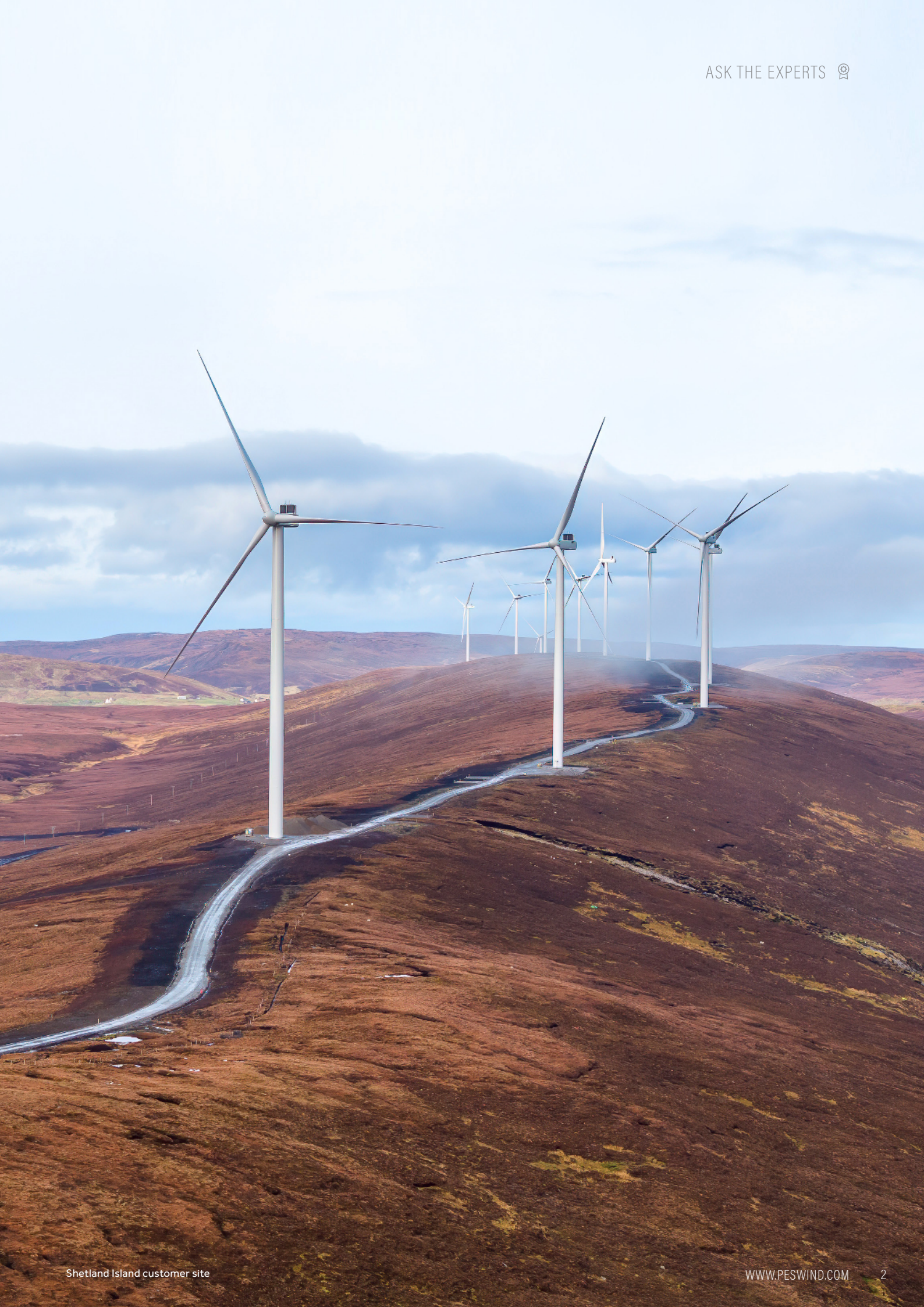
PES: Digital twin technology and predictive analytics are evolving rapidly. Which developments hold the greatest potential for transforming grid management by 2030?

LF: This technology, which allows for the real-time virtual modeling of the grid, will provide unparalleled insight into grid behavior and performance. By 2030, we expect digital twins to become essential tools for simulating potential disruptions, optimizing asset performance, reducing faults, extending asset life and enhancing planning for grid upgrades.

Predictive analytics, powered by advanced algorithms, will further support this by forecasting energy demand patterns, potential faults, and optimizing resource allocation. Together, these technologies will transform grid management by making operations more proactive and data-driven, leading to improved resilience and efficiency and more sustainable practices having positive impacts on asset life and longevity.

PES: Cross border energy flows and interconnectors are central to the future grid. As integration increases, are regulatory frameworks keeping pace, or is further adaptation needed?





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LF: As cross-border energy flows and interconnectors and hybrid interconnectors become more prevalent, regulatory frameworks must evolve to keep up with the complexities of an increasingly interconnected energy system. While there has been significant progress in areas like market integration and harmonization of grid codes, further adaptation is necessary to ensure that regulatory bodies can accommodate the dynamic nature of energy flows.

Key areas requiring attention include standardized grid codes across borders, improved coordination between national regulators, appropriate regulation for hybrid interconnectors and ensuring that market mechanisms are flexible enough to handle the increasing volatility in energy generation and demand.

PES: As industries transition to electrification, grid flexibility must scale accordingly. Is the current infrastructure on track to meet the demands of a shifting energy landscape?

LF: While significant progress has been made in modernizing the UK's grid, current infrastructure is still evolving to meet the full demands of electrification. In the UK, we are working towards decarbonising the power system by 2030 with the CP2030 plan. Whilst we have this short-term deadline, we must continue to invest in our energy future and shape this beyond 2030 to give us greater flexibility in the future.

As industries move towards electrification, we need to continue scaling up grid capacity, modernizing, upgrading and enhancing grid flexibility and investing in digital grid technologies to be able to maintain them with greater efficiency.

There are ongoing projects to modernize the network and increase resilience, but the pace must accelerate to match the demands of electrification, especially with the rapid growth of electric vehicles and industrial electrification. The upgrade requires more investment, more people and everyone working in the same direction to achieve this transformation, which is challenging but a huge opportunity to shape the energy transition.

PES: Energy storage plays a crucial role in balancing supply and demand, particularly as renewables scale up. Do you see current solutions as sufficient, or is further evolution required?

Laura Fleming

LF: Current energy storage solutions, such as BESS, have provided significant advancements in balancing supply and demand, particularly in mitigating the intermittency of renewables. However, as we scale up renewable energy generation, the demand for longer-term and more efficient storage systems is increasing.

Control protection software

Approaches that not only secure the physical supply chain and the digital one but also align with environmental sustainability goals.

Switzerland Collaboration Center

To keep up with this demand, further evolution in storage technologies, such as solid-state batteries, hydrogen to power and large scale pumped hydro, will be critical to ensure we can store excess energy during periods of high generation and release it when needed.

PES: Global supply chains remain a significant challenge for the energy transition. In securing critical infrastructure projects, where do the biggest risks lie and how can resilience be strengthened? Are there particular areas where constraints are likely to be most disruptive?

LF: It's true that global supply chains offer both risk and opportunity. Scaling up to meet the requirements of the energy transition will require a new way of thinking, one that looks at global supply chain solutions to offer flexibility and best practices to create the energy system of the future that is needed for 2030 and beyond. This will involve, for example, taking learnings so far on large scale critical infrastructure projects across collaborators and using these to move to a more programmatic approach that can manage the existing and new capacity, flexibly.

To strengthen resilience, we must diversify supply chains, invest in local manufacturing capabilities, and implement stronger supply chain risk management strategies. Additionally, the circular economy model, which emphasizes the reuse and recycling of critical materials, can help mitigate the risks associated with raw material shortages.

PES: Local manufacturing and circular economy principles are increasingly in focus. To what extent can these approaches help secure the supply chain for key grid components?

LF: Local manufacturing and circular economy principles are pivotal in securing the supply chain for key grid components. By focusing on local production, we can improve supply chain security against geopolitical events and look to increase resilience around transportation and tariffs. There are benefits to the local economy through the creation of local jobs and in highlighting the UK as an investment location of choice, which is important in a globally competitive market.

Moreover, circular economy principles, such as reusing, refurbishing, and recycling components like wind turbine blades and electric vehicle batteries, will reduce the pressure on raw material extraction and provide a more sustainable solution for the energy transition. We need to bring diversity and collaboration on all levels, with all stakeholders, to bring about an innovative approach, with new ways and solutions. Approaches that not only secure the physical supply chain and the digital one but also align with environmental sustainability goals.

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