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Small and remote islands are subject to an array of energy challenges. As they are often isolated from mainland power grids, many face difficulties balancing supply and demand. They tend to be heavily dependent on imported fossil fuels, which can lead to high costs and energy security risks. And, despite their limited contributions to global emissions, they are disproportionately affected by the impacts of climate change, including extreme weather events.

These dynamics create major inequities. Electricity generation on islands can cost 10 times more than on mainland territories and countries. In 2021, island nations had the most expensive average cost of electricity in the world; in the Solomon Islands, for example, electricity cost almost seven times more than in the United States, while electricity tariffs in Caribbean countries are more than double the US average. This can negatively impact socio-economic development. In Pacific island countries, fuel imports accounted for up to 13% of GDP in 2019.

With more than 730 million people living on 11 000 permanently inhabited islands across the world, and with the number of natural disasters rising sharply in recent decades, it is crucial to find solutions to these issues and meet the energy needs of island residents in a secure, sustainable and affordable manner. Expanding the deployment of clean energy technologies, including renewables, therefore presents a major opportunity, while increasing the efficiency and digitalisation of energy systems could also deliver major benefits if harnessed.

Distributed energy resources - or small-scale energy resources that are usually situated near sites of electricity use, such as rooftop solar - could play an important role in boosting the deployment of renewables on islands, increasing the security, resilience and affordability of power systems while accelerating decarbonisation.

However, this will also require complementary technologies, such as an expansion of battery energy storage systems (BESS). These systems can help facilitate the integration of variable renewable energy sources (which is particularly complex on islands due to limited grid infrastructure), maintain grid stability, and provide intraday flexibility - supporting not only single households, but also larger configurations of distributed energy resources and even utility-scale renewable plants.

Microgrids, or decentralised energy systems that can be isolated from the main grid because they have their own sources and loads, and Virtual Power Plants (VPPs) - networks of decentralised power generating units, storage systems and flexible demand - can also help optimise the allocation of distributed energy resources, while promoting energy efficiency and improving resilience.

Efforts are underway to deploy these technologies on some islands already. In Adjuntas, Puerto Rico, 1 000 solar panels are set to power 17 small businesses as part of a battery-supported community microgrid, bolstering the local economy and standing ready to provide electricity in the event of fresh natural disasters.

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Meanwhile, the VPP4ISLANDS project is integrating virtual energy storage technology, as well as digital twin and distributed ledger technology, to enable enhanced VPPs and the creation of smart energy communities on G?k?eada Island in T?rkiye and Formentera in Spain.

Electricity systems on small islands are frequently over-sized, with high reserve power generation capacity and ancillary services needed locally to respond to daily and seasonal fluctuations, such as changes in demand resulting from high and low tourist seasons.

Digitalisation therefore offers opportunities to optimise electricity systems at the local level through better planning, management and operation. Geospatial databases, such as the UNDP Data Platform for Small Island Developing States, can help policy makers leverage data and analysis to make more informed decisions. Artificial intelligence can also deliver benefits. Cura?ao is testing the use of AI for renewable energy forecasting and the predictive maintenance of electricity infrastructure.

Meanwhile, digitally-enabled demand response can help leverage local resources to optimise or defer grid investment. For example, implementing direct load control mechanisms targeted at high-consuming appliances, such as water heating and cooling in commercial and residential buildings, can help reduce peak consumption. Islands such as Barbados, King Island, Guadeloupe and La R?union and Hawaii are already testing demand response approaches.

Many small island countries and territories have ambitious climate goals. Antigua and Barbuda, Fiji and the Maldives are among those that have set net zero targets via pledges, declarations, policies or laws. However, implementation is often lagging due challenges in attracting the necessary investments. Full implementation of the current Nationally Determined Contributions (NDCs) for Small Island Developing States would require up to USD 6 trillion to be invested in adaptation measures and clean energy technologies.

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