EXECUTIVE SUMMARY

This report defines insular power systems as territories that are geographically defined by conditions that makes interconnections with large power systems unattractive economically compared to alternatives based on the combination of endogenous energy, storage systems, and power electronics. They are uniquely positioned as global laboratories for transforming our energy future as many of them are the first to encounter the emerging perturbations in the earths' systems response to climate change. This unique combination of increasing vulnerability and decreasing reliability is driving many insular territories to accelerate the deployment of renewable energy systems for their future while experimenting with innovative solutions and best practices that are applicable to many other areas across the globe.

To mitigate detrimental impacts, system operators regularly focus on several actions including ongoing power system modifications, counterbalancing renewable energy fluctuations with flexible generation, curtailment of renewable systems, or load shedding. Insular power systems are also among the first to deploy advanced technologies that leverage the capabilities of fast-responding power electronics to enhance grid stability.

Solar PV is being deployed at an accelerating rate in insular power systems for a number of reasons including reduced cost, improved versatility in deployment scale, and ease of maintenance and operations. Many insular territories are located in areas with high solar irradiance, high population densities and significant rooftop space which helps preserve limited available land for other purposes. Distributed photovoltaics in particular are growing at an accelerated rate, and distributed PV systems increasingly include energy storage due to the increasing availability and the decreasing cost of battery storage.

Storage is the principal option for integrating large shares of non-dispatchable energy in insular power systems. As renewable generation sources increase on the grid, the inherent characteristics of synchronous generators that typically contribute significantly to grid stability diminish. Power electronics and fast frequency response are replacing the legacy of synchronous generators and the reliance on inertia and mechanical frequency response approaches to maintain system reliability.

This report summarizes the general attributes of insular power systems that support these territories emphasizing best practices and key insights that have accelerated their transformation, have impeded their progress and/or are relevant to more traditional power systems globally. The most important recommendations for insular power systems are the following:

- When deploying renewable technologies, performance specifications should take into account the likely future state of the insular power system, which may include greatly reduced conventional generation.
- All new renewable generation should be required to be capable of continuing to operate during (riding through) large voltage and frequency transient events, including fast rates of change of frequency.
- Small-scale distributed generation that is not under direct utility control can be more beneficial if equipped with the ability to autonomously respond to voltage and frequency events in a way that helps stabilize the system.
- Large-scale renewable generation should be capable of providing grid stabilizing services such as voltage regulation and fast frequency response in coordination with the local TSO. In systems where non-synchronous generation may in the future exceed 80% of instantaneous load at times, grid-forming capability should be considered for system relevant new generation.
- Maintaining an emphasis on grid resilience during all phases of planning, design, deployment and operation of large-scale renewable systems is critical to assure cost effective, reliable and efficient customer service and system response.