ENERGY DIVISION

Advancing Distributed Energy Resources (DER) Development in SIDS to Support Energy Transition

ESCAP
Economic and Social Commission for Asia and the Pacific

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Abstract

Clean energy, including decentralized renewable energy solutions, plays a central key role in building a future based on sustainable development in Small Island Developing States (SIDS). Integrating Distributed Energy Resources (DERs) into small island grids presents unique challenges that must be addressed, including establishing appropriate technical standards and interconnection requirements. Regulators have an important role to play in the energy transition in managing energy systems and supporting their development. The implementation of modern technologies creates new challenges that the regulators must respond to.

Energy regulators in SIDS tend to be small and often relatively young organizations, grappling with the new challenges posed by the energy transition. Across global regions, the challenges faced by SIDS in are similar. To help address this, a series of knowledge exchange workshops have been developed between Caribbean and Pacific SIDS, aiming to share experiences and increase collaboration, with a focus on strategies to accelerate sustainable power system development. The first two knowledge exchange sessions focused on the deployment of Distributed Energy Resources (DER) in island nations.

This working paper provides an overview of the issues discussed and the outcome of the first knowledge exchange sessions between Caribbean and Pacific SIDS. It includes relevant technical standards and requirements for DER interconnections, along with potential challenges that SIDS may encounter. The document also presents recommendations and solutions to these challenges, as well as best practices and examples from various island countries that have already implemented DERs in their energy systems.

Ensuring the compatibility of DER systems with the grid is essential to facilitate seamless integration and minimize disruptions. Safety considerations, high power quality and reliability are paramount to protect utility employees, customers, and the public. One approach to minimize interconnection issues is to connect solar panels and batteries directly to the power station's main source of electricity generation. This strategy reduces the distance between DER installations and other load and generation sources, minimizing potential issues and the need for infrastructure upgrades.

Battery storage and voltage control systems such as advanced inverters play a vital role in mitigating technical issues associated with DERs. Effective communication between various parts of the system and data aggregation are essential to maximize their benefits and ensure optimal system performance. Implementing managed "blocks" of DER interconnection involves permitting a limited number of DERs within specific periods. This approach enables monitoring and data collection, providing valuable insights into grid performance, costs, and capacity expansion planning.

When designing tariffs for customers with DERs, considerations such as metering, billing, sell rate, and retail rate designs must be taken into account. Fair compensation for the grid services encourages the adoption of DERs and

incentivizes participation. Interconnecting DERs can lead to new costs that need to be distributed fairly among stakeholders. Additionally, process improvements can streamline interconnection times and enhance overall system efficiency, thereby reducing costs for customers.

It is also important to emphasize that DERs can provide services beyond energy production, for example capacity and ancillary services. Regulators must consider aspects such as DER registration, exclusivity of services, and curtailment volumes to effectively aggregate DERs. DER ownership and management models include first-party ownership and third-party ownership models such as Energy Service Companies (ESCOs) and Integrated Utility Services Models. Each model has its advantages and considerations, necessitating careful evaluation and selection.

In conclusion, integrating DERs into small island grids requires technical standards, robust interconnection requirements, and a strong regulatory framework. By ensuring compatibility, safety, and power quality, and addressing tariff design and ownership models, SIDS can benefit from DER development while maintaining system reliability and stability. Fair cost distribution and process improvements further enhance the viability of DER integration in small island grids, facilitating a sustainable and resilient energy future.

Abbreviations

Customer Energy Resources	CER
Distributed Energy Resources	DERs
distributed energy resources management system	DERMS
Distributed generation	DG
Economic and Social Committee for Asia Pacific	ESCAP
Energy Service Company	ESCO
Green Grids Initiative	GGI
greenhouse gas	GHG
kilowatt	kW
Low Frequency Demand Disconnection	LFDD
megawatt	MW
megawatt hour	MWh
Net energy metering	NEM
Photovoltaics	PV
Regulatory Authority	RA
Regulatory Energy Transition Accelerator	RETA
Small Island Developing States	SIDS
Virtual Power Plants	VPPs

1. Introduction

Small Island Developing States (SIDS) face unique energy challenges due to their limited land area, small populations, heavy dependence on imported fossil fuels, and vulnerability to climate change impacts. They tend to have limited natural resources, narrow economies, and are vulnerable to external shocks such as natural disasters, all of which can affect economic growth, increase poverty and have often led to a high degree of economic volatility. Traditional grid development is challenging in the context of island nations due to the territorial dispersion and climate conditions; extreme weather events such as hurricanes, typhoons, cyclones, tsunamis, etc. create high risks for long-distance grids. Most remote areas currently rely on power generators which work on fossil fuels. However, island countries have a huge potential of developing renewable energy including distributed energy resources to increase energy security, lower the dependance on fossil fuels and accelerate the energy transition. The development of Distributed Energy Resources (DERs) such as solar photovoltaics (PV), wind turbines, and energy storage systems, offers greenhouse gas emissions reduction, increases energy independence, and contributes to global efforts to combat climate change.

SIDS typically have smaller populations and, consequently, lower electricity demand compared to larger countries. DERs are well-suited for meeting this smaller-scale demand. They can be easily scaled to match the specific energy needs of individual islands, communities, or even single facilities, allowing for greater energy self-sufficiency and reduced reliance on centralized power generation.

Developing DERs can help diversify the energy mix and reduce dependence on expensive and environmentally harmful fossil fuels. By generating clean energy locally, SIDS can enhance energy security, reduce vulnerability to fuel price fluctuations, and mitigate the economic impacts of fossil fuel dependence. Imported fossil fuels are subject to global market dynamics, making their prices unpredictable and prone to sudden increases. This volatility poses significant financial risks for SIDS, which often allocate a significant portion of their budget to fuel imports. Developing DERs enables SIDS to hedge against rising fuel prices and achieve greater price stability in the long run. Moreover, DERs can provide cost savings by reducing transmission losses and the need for extensive grid infrastructure.

Similar challenges provide an opportunity for countries to cooperate and share possible solutions. Different islands have different available resources, and as such have taken different approaches to accelerating a safe and clean energy transition. Fostering collaboration on decarbonization between energy regulators from Small Island Developing States is a flagship project for the Regulatory Energy Transition Accelerator (RETA) and the Economic and Social Committee for Asia Pacific (ESCAP), working under the Green Grids Initiative (GGI).

The Green Grids Initiative and partnership with India’s ‘One Sun One World One Grid’ (GGI-OSOWOG) aims to accelerate the construction of the new infrastructure needed for a world powered by renewable energy. Launched by the Prime Ministers of India and the UK in 2021 during the COP26 World Leaders' Summit, GGI-OSOWOG brings together a global coalition of national governments, international financial and technical organizations, legislators, power system operators, and knowledge leaders.

ESCAP leads the GGI Asia-Pacific Working Group, which brings together stakeholders from across the region to accelerate prioritized energy transition projects. One of the identified projects is the knowledge exchange between SIDS, aiming to share experiences and increase collaboration with a focus on strategies to accelerate sustainable power system development for their specific context.

As part of the project, a series of knowledge exchange workshops have been developed in partnership with the Regulatory Energy Transition Accelerator (RETA), a platform for energy regulators to collaborate on decarbonization. Energy regulators in SIDS tend to be small and often relatively young organizations, grappling with the new challenges that the energy transition brings to their roles. Challenges faced by the Pacific region are similar to those faced in the Caribbean. While regional cooperation within both the Caribbean and Pacific is helping energy regulators learn from their peers, extending this knowledge exchange between the two regions helps deepen the learning. The first two knowledge exchange sessions, facilitated by RETA delivery partner RMI, focused on the deployment of Distributed Energy Resources (DER) in island nations.

Countries have implemented various initiatives, including the installation of solar PV systems in remote islands and the introduction of net metering schemes to encourage the adoption of DERs by households and businesses. This knowledge exchange was organized to share best practices among island states on how they have integrated DERs into their power systems, as well as identify shared challenges for further integration and the possible ways to overcome them. This working paper includes some of the valuable knowledge that was shared between workshop participants during these two sessions.

2. Technical Standards and Interconnection

All island grids vary in size, complexity and number of customers; however, the interconnection of DERs poses a more significant challenge for small grids relative to larger grids. In order to ensure safe and stable operating conditions, technical standards, interconnection requirements and capacity limitations must be established and regulated.

New regulations on island power systems should describe the general provisions and technical requirements for connecting renewable generation systems (DERs) to the publicly regulated power system, inclusive of transmission and distribution. These requirements should ensure:

1. The compatibility of the DER systems with the grid;

2. The safety of the DER system operating in parallel with the grid;

3. The safety of the electric utility employees, agents, customers and the public; and,

4. High standards of power quality and reliability

Interconnection of solar/battery installations to the generation bus at the power station eliminates 99% of interconnection issues. This is key for very small islands. The further that these solar/battery installations are from wider load and generation, the greater the potential for interconnection issues and required upgrades. Battery storage and advanced inverters can mitigate many technical issues, but communication and data aggregation is key. This means that there may be additional costs to implementing these solutions.

To help manage DER interconnection, two further key considerations are:

1. Allowing DER interconnection in managed "blocks". This means only allowing a minimum number of DERs for a given period of time. For example, allowing up to 50kW DERs per installation capped cumulatively at 500kW of DERs on the public power system in the first year. This gives the govt, regulator and the utility a set of technical parameters to model prior, during and after the DERs are installed, better informing the grid's performance, costs and any technical issues or advantages.

2. Using the monitoring data from the block, the regulator can expand or retract capacity caps for rate classes (industrial, commercial, residential), which allows for safe DER interconnection and operation that the utility can monitor and manage before opening up more capacity.

2.1 Over the horizon: VPPs

Virtual Power Plants, or VPPs, are the aggregation of many DERs on a power system to replace older fossil fired generation.

For example, instead of replacing a diesel engine at the end of its warranty, or useful life, a utility can model the dispatch of DERs to replace that engine using software and advanced controls. This is a very advanced stage of small island energy transition and it is only being piloted now in a few jurisdictions like Hawai'i. But experts predict that VPPs will be much more common later this decade due to cost savings.

3. Regulatory Considerations

3.1 Distribured Generation (DG) Tariff Design

Distributed generation (DG) [1] tariff design refers to how customers with DG are charged for the services they require from the grid and how they are credited for the services they provide.

DG tariff mechanisms include three primary components:

1. **Metering and billing arrangements** – how DG system generation is measured and billed (e.g., net energy metering, net billing, and buy all, sell all);
2. **Sell rate designs** – what DG system owners earn for exporting power to the grid (e.g., avoided cost rate, wholesale market rate, value of solar rate);
3. **Retail rate designs** – what customers pay for power consumed from the utility grid (e.g., volumetric energy charge, fixed charges, non-bypassable charges, etc.)

Table 1 **Metering and Billing Arrangements**

Metering and Billing Arrangement	Description	Benefits	Drawbacks
Net energy metering (NEM)	The DG system owner can consume electricity generated and export excess generation to the grid at the utility's full retail rate. Generation can be used to offset future consumption.	• Strongly encourages DG adoption • Can facilitate access to financing through a predictable payback period • Relatively simple to understand and administer	• Can reduce volumetric rate fixed cost recovery and lead to unintentional cost shifting • Weak incentive to install storage (if volumetric rates are flat) • Does not encourage larger DG systems even where they may benefit the grid (unless surplus generation is compensated highly)
Net billing	The DG system owner can consume electricity generated and	• Can more accurately reflect the value of DG to the grid	• Weaker driver of DG adoption than NEM (if the sell rate is below the retail rate)

[1] Throughout this working paper, the term "DG" is used to refer to distributed generation and, where appropriate, associated behind-the-meter storage. The phrase "DG tariff" refers to the compensation rates for DG and potentially storage.

	export excess generation to the grid at the specified sell rate. Generation cannot be used to offset future consumption.	• Can be used to encourage self-consumption (if the sell rate is below the retail rate) • Can encourage storage adoption (if the sell rate is below the retail rate or time-varying)	• Can reduce volumetric rate fixed cost recovery and lead to unintentional cost shifting (though to a lesser extent than NEM)
Buy all, sell all	Self-consumption is not allowed. The DG system owner exports all generation to the grid at the sell rate and pays for all grid-supplied electricity consumed at the full retail rate.	• Can more accurately reflect the value of DG to the grid • Relatively simple to understand and administer • Fixed cost recovery is not reduced (e.g., mitigates against cost shifting) • Can encourage storage adoption if a time-varying sell rate is used	• Weaker driver of DG adoption than NEM (if the sell rate is below the retail rate) • Customer may be incentivized to manipulate system wiring to enable self-consumption

Source: Author's compilation

DG tariff design is a complex topic with changing geographic, customer demographic, regulatory, and technology variables. Careful attention is needed to understand DG tariff approaches, their connection to other policies and utility programs, and the effects they have on DG adoption rates and other outcomes.

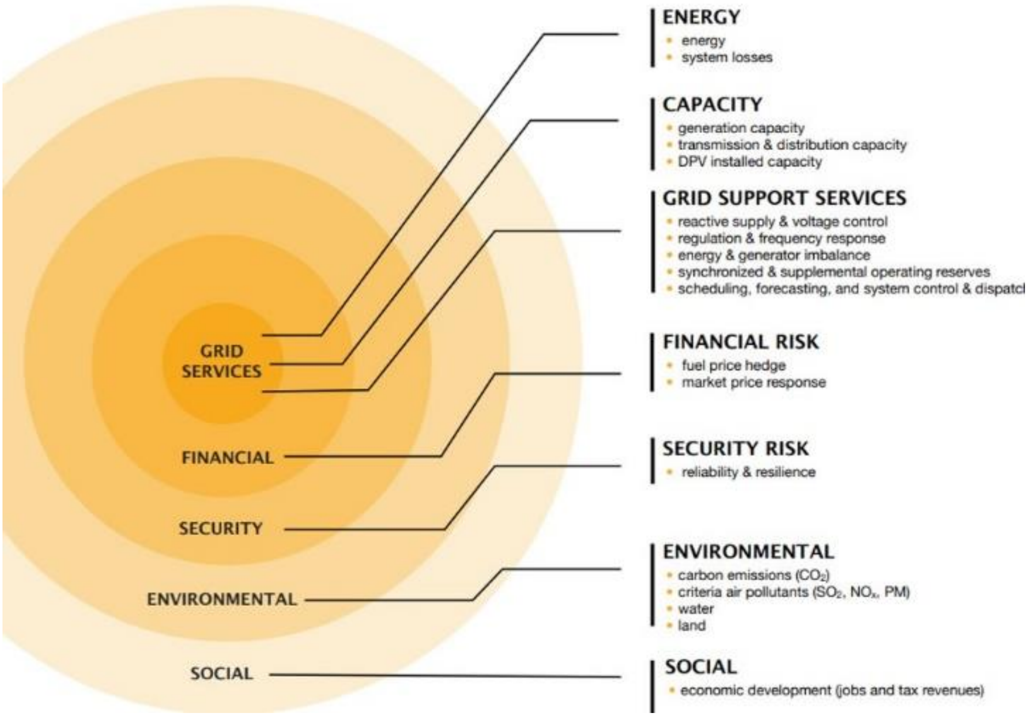
Table 2 displays a set of seven goals and three principles commonly considered in designing DG tariffs, which regulators can adapt to fit the needs of their given jurisdiction. In practice, DG tariff design is often an extensive process that requires iteration over time as circumstances evolve.

Table 2 Goals and Principles for DG Tariff Design

Goals *What DG tariffs can be designed to achieve (these often require trade-offs)*	**Principles** *Parameters for tariff development*
1. Support customer energy affordability 2. Promote local economic development 3. Promote cost-effective DG deployment 4. Reduce utility disincentives to embrace DG 5. Be fair to both DG and non-DG customers 6. Be simple, predictable, and manageable 7. Reduce greenhouse gas (GHG) emissions and support decarbonization	1. Compatible with other policies 2. Forward-looking 3. Adaptable

Source: Author's compilation

Figure 1 Assessing the Value of DG



Source: RMI, 2013

3.2 Case Study: Bermuda

Bermuda has gone through several iterations of its DG tariff design. Initially, it had a net metering program before transitioning to the current net billing program. The net billing mechanism's sell rate is determined by a feed-in tariff methodology, which is updated every three years. This methodology takes into account the avoided cost of generation, as well as economic benefits like carbon emissions reduction, economic development, ancillary services, and network considerations. To develop and refine the feed-in tariff methodology, the Regulatory Authority (RA) of Bermuda has conducted research on global jurisdictions and held extensive public consultations. However, designing the tariff has presented challenges, particularly in accessing relevant data for sell rate calculation and raising public awareness. The RA has addressed these challenges through information campaigns and engagement with homeowner associations and the solar industry. The RA's main objective in DG tariff design and deployment is to ensure a fair and sustainable transition to renewable energy in Bermuda that benefits both DG and non-DG customers. See **Annex 1** for more information.

3.3 Microgrids and DER Grid Services

In addition to payments for energy produced (energy services), DERs are able to provide a range of other services. In sum, DERs can support energy services, capacity services, and ancillary services.

Energy services are those which provide a measured output at a given point in time, and are measured in kWh; capacity services are changes that allow the grid to maintain its ability to deliver outputs, measured in kW; and ancillary services are those that maintain the safety of the grid, and are also called operability service.

In turn, each of these categories can be further split between services agreed and made available ahead of time (planning timescales) and those which are agreed, enacted and delivered only near real-time operational timescales).

The table below outlines the range of services DERs can provide.

Table 3 **DER Grid Services**

	What this is:	**Planning timescales (days to weeks ahead of real-time):**	**Operations timescales (hours ahead to real-time):**
Energy services (MWh)	**Output at a given point in time**	Wholesale, export and DER tariffs	Frequency management (i.e. Low Frequency Demand Disconnection *) Balancing
Capacity (MW)	**The ability to allow grid outputs**	Network constraint management/ curtailment ahead of time Reinforcement deferral	Thermal management
Ancillary (operability service)	**The safety and operations of the grid**	Grid code design	Voltage management/power quality Inertia services Blackstart from DER

Source: Author's compilation

Regulators may wish to make a range of considerations to support DER service provision, which include:

- **Registration and visibility of DERs** - Regulators may choose to require registration and utility visibility of DERs, so that they can establish their grid impacts, and ensure ongoing operability.

- **Exclusivity of DER services** - Multiple service opportunities may require coordination, so that DERs providing a range of services do not come into conflict, for example being asked to increase outputs to balance the system whilst also being asked to reduce output to manage local grid constraints. This co-optimization is something that regulators may require utilities to manage.

- **Curtailment volumes** – where there is extensive curtailment of DERs, regulators may wish to stipulate the allowable utility interruptions to DER generation, so that business cases can be established for these DERs.

- **Enabling VPPs to aggregate DERs -** Regulators may seek to enable VPPs to control DERs, in coordination with utilities

3.4 Case Study: Hawai'i

Hawai'i has a large penetration of DERs, which they refer to as Customer Energy Resources (CER). The strategic framework for CERs is built on three levels of customer participation: Choice, Coordination, Collaboration, which are enabled through pricing, programs, and procurement (Hawaiian Electric, 2021).

Choice: At the choice level, based on their energy usage patterns, customers can determine what tariff within the advanced rate design pricing structure is best for them. Some examples of available tariffs are Net Energy Metering, Shared Solar, and Smart Export.

Coordination: At the coordination level, customers choose a rate and enroll in a utility CER program, where they can be compensated for allowing the utility to directly control their CER with the grid. Most of the CER programs available at present are based on load control and demand response.

Collaboration: At the collaboration level, an independent aggregator operates like a Virtual Power Plant (VPP), providing additional offerings to customers and managing a portfolio of aggregated CERs to provide contracted grid services to Hawaiian Electric. The aggregators are procured by Hawaiian Electric through a competitive process.

This strategic framework allows customers a multitude of options, and is directly informed by an iterative Integrated Grid Planning Process (Hawaiian Electric, (n.d.), Integrated grid Planning), which identifies grid needs and seeks solutions through a combination of customer energy resources and grid-scale providers. It also allows the grid operator to have asset visibility. To date there have been no curtailments of CER assets, but the curtailment process ensures that CERs are the last assets to be curtailed, with priority on curtailment of grid-scale assets as needed (Hawaiian Electric, (n.d.), Distributed Energy Resource (DER)).

3.5 Ownership and management stuctures

There are two primary types of DER ownership and management structures: first-party ownership and third-party ownership.

With first-party ownership, the customer owns, finances, and maintains the system. With third-party ownership, which is more common, a third party owns, finances, and maintains the system, with the possibility of ownership transferring to the customer after a predetermined time period. The third party could be an energy service company (ESCO) or the utility, depending on whether utilities are allowed to own DERs.

Table 3 **Two types of Third-Party Ownership Models**

Model	Description	Benefits	Drawbacks
Energy Service Company (ESCO)	Third-party ESCOs own and operate DERs in conjunction with or distinct from utility programs.	• Competition among suppliers may bring down costs for customers • Financing typically comes from financial institutions, not ratepayers	• Less control for regulators over DER deployment • Potential loss of revenue for the utility
Integrated Utility Services Model	Utilities own and operate DERs, recovering costs through rates.	• Can incorporate public policy objectives into DER programs • Existing customer base lessens the burden of customer acquisition and billing • Can create new revenue streams for the utility, which may help maintain utility financial stability	• Can limit competition, given the utility's inherent incumbent advantages • Utility carries the risk associated with the system

Source: Author's compilation

4. DER Interconnection Challenges: Network Costs and Processes

The installation of DERs may result in new costs that need to be equitably distributed, as well as provide opportunities for process improvement to accelerate the interconnection times for DERs.

The costs of interconnecting DERs are increasing. This is driven by:

- Interconnection studies/grid impact assessments;
- Network upgrade costs across direct grid costs, labor, metering and monitoring equipment, data loggers, communication devices, and monitoring software;
- Interconnection Agreement and Legal Fees; and,
- Application fees

At the same time, interconnection queue periods have also increased. Regulators may seek to adjust cost allocations based on the ownership models for DERs, and the level of grid impact that they have. Regulators face questions on how much of the interconnection costs should be carried by specific parties (e.g., ESCOs and individual customers), and how much should be socialized across all customers. Costs can be reduced and efficiency of DER interconnection improved by streamlining the interconnection process. Improvements can cover:

1. Replacement of permits with a simplified online application process
2. Removal of unnecessary elements of the NEC code that make no discernable impact on the resulting safety and quality
3. Plan for and implement distributed energy resources management system (DERMS) or Virtual Power Plants (VPPs)

4.1 Case Study: Western Australia

Western Australia has seen significant increases in the interconnection of domestic solar, and has needed to streamline the process both to shorten interconnection times and reduce customer costs.

The state has legislated to require that utilities accept simple interconnection requests based on set standards, pre-qualified equipment, and automatic planning permitting for installation under set sizes unless they trigger further analysis (Western Power, 2021). Equipment manufacturers have proactively engaged in this process, to ensure that their equipment can be supported by the utility and to improve the customer experience.

Regulations and standards have also been updated for solar installation, ensuring safety, reliability and customer protections. Regulations extend to cover installer qualification, ensuring a smooth customer journey (Calhoun, Crofton, Goodman and McIntosh, 2014).

Further, the application process for interconnection has also be streamlined and simplified with an online portal, allowing for faster interconnection to the grid (Synergy, 2023).

5. Way Forward: Policy Responses and Recommendations

Distributed energy resources can be a solution to the decarbonization of island grids. The island nations of the Pacific and the Caribbean are endowed with many different types of renewable energy such as wind, solar, hydro power and others. However, in order to deploy these resources, the power systems should change, as some of the technologies provide variable renewable energy. These recommendations were discussed during the workshops and aim to address the unique energy challenges faced by Small Island Developing States (SIDS):

1. Establish clear technical standards and interconnection requirements. The development and enforcement of regulations that ensure the compatibility of DER systems with the grid, prioritize safety, and maintain high standards of power quality and reliability is crucial for the energy system development.

2. Implement managed "blocks" for DER interconnection. The development of DER interconnection should be organized in controlled phases, limiting the number of DER installations within a specified timeframe. This approach enables better monitoring, evaluation, and management of grid performance, costs, and technical issues.

3. Utilize monitoring data to adjust capacity caps. The use of data collected from DER blocks helps to expand or retract capacity caps for different rate classes (industrial, commercial, residential). This approach ensures safe DER interconnection and operation, allowing utilities to monitor and manage grid capacity effectively.

4. Promote interconnection of solar/battery installations to the generation bus. Connection of solar PV and battery installations directly to the power station's generation bus reduces interconnection issues, especially for very small islands, and minimizes the need for costly grid upgrades.

5. Support the development of microgrids. The implementation of microgrids in SIDS enhances the integration of DERs. Microgrids provide localized and self-contained energy systems that can operate independently or in conjunction with the main grid, increasing resilience and reliability.

6. Design DG tariff mechanisms. Development of tariff structures is an important component of DER development. Efficient tariff

mechanisms provide fair compensation to customers with DG systems for the services and ensure affordability and sustainability for both DG and non-DG customers.

7. Enable registration and visibility of DERs. Registration and utility visibility of DERs helps to understand their grid impacts and ensure ongoing operability. This information can help regulators make informed decisions and manage the grid effectively.

Facilitate coordination and co-optimization of DER services. Collaboration and coordination among DERs providing different services helps to avoid conflicts and optimize their contributions to the grid. Regulators can require utilities to manage the co-optimization of multiple DER services.

8. Foster collaboration and knowledge-sharing among SIDS. Collaboration between energy regulators from different SIDS to share experiences, best practices, and lessons learned in developing DERs is an important step towards energy transition. Platforms like RETA and the Green Grids Initiative can facilitate such collaboration and accelerate the energy transition in SIDS.

6. Conclusion

The development of Distributed Energy Resources provides opportunities for Small Island Developing States in addressing their unique energy challenges and driving forward the energy transition. DERs offer a decentralized and renewable energy solution that can significantly contribute to reducing greenhouse gas emissions, increasing energy independence, and mitigating the risks associated with fossil fuel dependence.

One key advantage of DERs is their scalability, which makes them well-suited for meeting the smaller-scale energy demand of SIDS. DERs can be tailored to match the specific energy needs of individual islands and communities, enabling greater energy self-sufficiency and reduced reliance on centralized power generation. This scalability also contributes to cost savings by reducing transmission losses and the need for extensive grid infrastructure.

Another crucial benefit of developing DERs is the diversification of the energy mix and the reduction of dependence on imported fossil fuels. SIDS heavily rely on imported fuels for electricity generation, which exposes them to price volatility and supply chain disruptions. By generating clean energy locally, SIDS can enhance energy security, reduce vulnerability to fuel price fluctuations, and mitigate the economic impacts of fossil fuel dependence.

Technical standards and interconnection requirements play a vital role in ensuring the safe and stable operation of DERs. SIDS should establish and regulate these standards to ensure the compatibility of DER systems with the grid, the safety of the DER system operating in parallel with the grid, and high standards of power quality and reliability. Regulatory considerations, such as DG tariff design, are essential for fostering the adoption of DERs. DG tariff design is a complex process that requires careful consideration of various factors, including geographic, customer demographic, regulatory, and technological variables.

Pacific and Caribbean Island countries share similar challenges and opportunities as remote island economies, which is why cooperation between energy regulators and knowledge exchange is an important tool to develop sustainable and more resilient energy systems and facilitate the energy transition.

References

Calhoun, K., Crofton, K., Goodman, J., & McIntosh, R. 2014. Lessons from Australia: Reducing Solar PV Costs Through Installation Labor Efficiency. Rocky Mountain Institute. Available at https://rmi.org/wp-content/uploads/2017/04/2014-11_RMI-AustraliaSIMPLEBoSFinal.pdf

Hawaiian Electric 2021, Customer Energy Resources for Hawaiʻi: A Customer-First CER Strategy for a 100% Clean Energy Future. (2021). Available sat https://www.hawaiianelectric.com/documents/products_and_services/customer_renewable_programs/20210503_customer_energy_resources_for_hawaii.pdf .

Hawaiian Electric (n.d.), Distributed Energy Resource (DER) asset effectiveness. Available at https://www.hawaiianelectric.com/about-us/performance-scorecards-and-metrics/distributed-energy-resource-(der)-asset-effectiveness

Hawaiian Electric (n.d.), Integrated grid Planning. Available at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning

RMI, 2013, A Review of Solar PV Benefit & Cost Studies 2nd Edition. In Rocky Mountain Institute: Electricity Innovation Lab. https://rmi.org/our-work/electricity/elab-electricity-innovation-lab/

Synergy 2023, Distributed Energy System (DES) application process. Synergy. Available at https://www.synergy.net.au/Your-home/Manage-account/Solar-connections-and-upgrades/REBs-and-DEBS-solar-application

Western Power (2021), Hale, R. Distribution customer connection requirements 5th edition. Available at https://www.westernpower.com.au/media/5894/distribution-customer-connection-requirements-20211223.pdf#page=26&zoom=100,72,76

Annex 1

- The Bahamas
    - RENEWABLE ENERGY POWER PURCHASE/INTERCONNECTION AGREEMENT
    - REQUIREMENTS FOR GRID INTERCONNECTION
    - GRID TIED SMALL SCALE RENEWABLE GENERATION (SSRG) APPLICATION

- Regulatory Authority of Bermuda, Tariffs, https://www.ra.bm/service-providers/electricity/tariffs