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WEBINARS

SIDS Lighthouses Initiative: Technical Webinar Series Transforming Small Island Developing States Power Systems through Variable Renewable Energy - Part 2

THURSDAY, 10 DECEMBER 2020 • 16:00 – 18:00 CET

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You are all **muted** to avoid background noise

If you have **Questions** to the speaker please use the **Q&A**

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The slides will be shared via email after the end of the webinar

A **recording** of the webinar will be available on demand on irena.org/events website within 48 hours

Tell us how we did in the **survey** to help us improve

AGENDA

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16:00 – 16:15	Welcoming remarks
16:15 – 16:30	Scene setting
16:30 – 16:45	Member countries’ perspectives
16:45 – 17:00	Transforming Small islands
17:00 – 17:15	Partner organisation’s perspective
17:15 – 17:30	Key insights from Grid assessment studies
17:30 – 17:45	Launch IRENA “Quality Infrastructure for Smart Mini-Grids” report
17:45 – 17:55	Q&A panel discussion
17:55 – 18:00	Closing remarks

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1 Welcoming remarks

Welcoming remarks

Roland Roesch

Deputy Director

IRENA Innovation and Technology Centre

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Transforming Small Island Developing States Power Systems through Variable Renewable Energy
An Overview

Presenter: Roland Roesch
Deputy Director, IRENA Innovation and Technology Centre, Bonn. Germany

Thursday, 10 December 2020 • 16:00-18:00 CET

Overview IRENA

MANDATE

To promote the widespread adoption and sustainable use of **all forms of renewable energy** worldwide

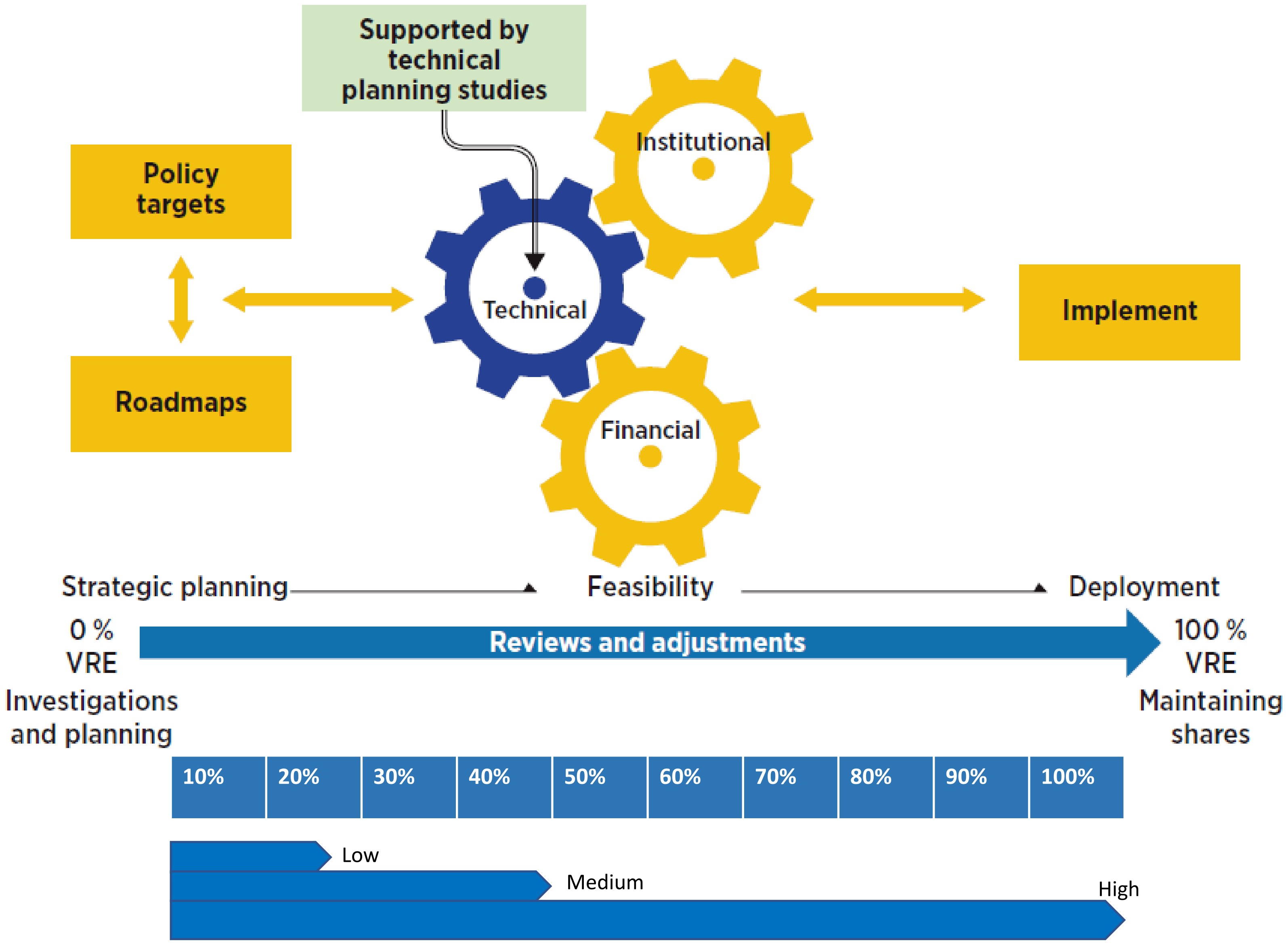
OBJECTIVE

To serve as a **network hub**, an **advisory resource** and an **authoritative, unified, global voice** for renewable energy

SCOPE

All renewable energy sources produced in a **sustainable manner**

Transformation of power systems



Specificities of Small Island Developing States (SIDS)

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Fossil fuel dependency

- Price volatility

Policy

- RE Targets not supported by clear policy/roadmap and financing plans
- Bankable RE projects

Technical capacity

- Lack of technical capacity
- External support required to integrate higher shares of VRE
- Limited primary resource
- Small size of the system
- Higher costs for energy
- Compliance with environmental constraints
- Uncertainty in demand growth

Impact of climate change

- Extreme weather conditions
- Fragile natural environments
- Need for resilient systems

Characterized by Isolated networks ranging from hundreds of kW to few hundreds of MW.

Challenges of VRE Integration and why we need grid assessment

Challenges of VRE

- **Variability**
- **Uncertainty**
- **Inverter based**

Objectives of the study Steps

Analyse and recommend

- Optimum VRE share without major investments
- Feasibility and impact on power system
- Mitigation measures

Steps

- System modelling and analysis

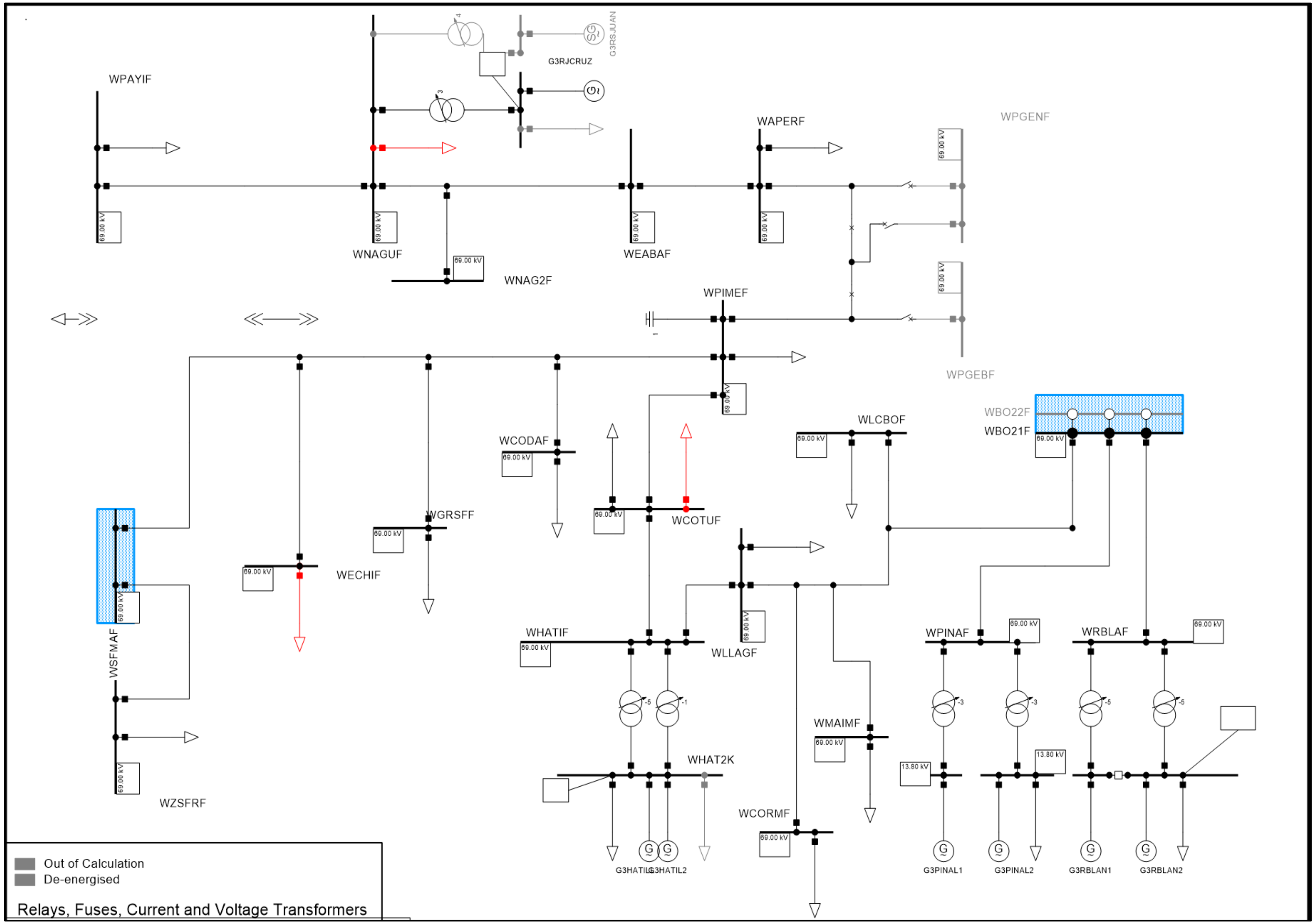
based on specifications and priorities

Requirement

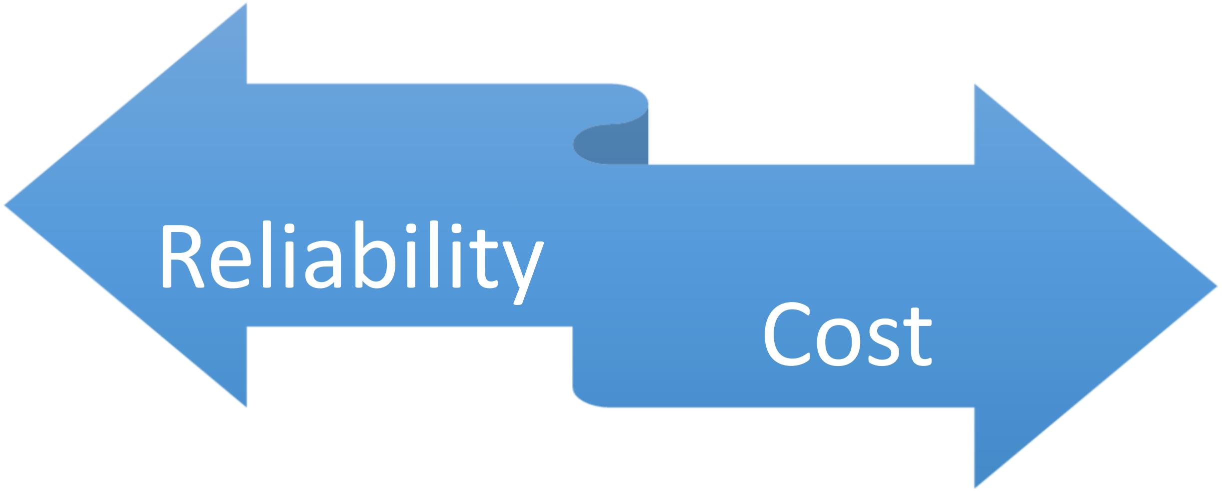
- Accurate and detail information
- Engagement with stakeholders

Software

- DigSILENT PowerFactory
- PSSE



Planning Reliable and Efficient Power Systems With High Shares of VRE In SIDS



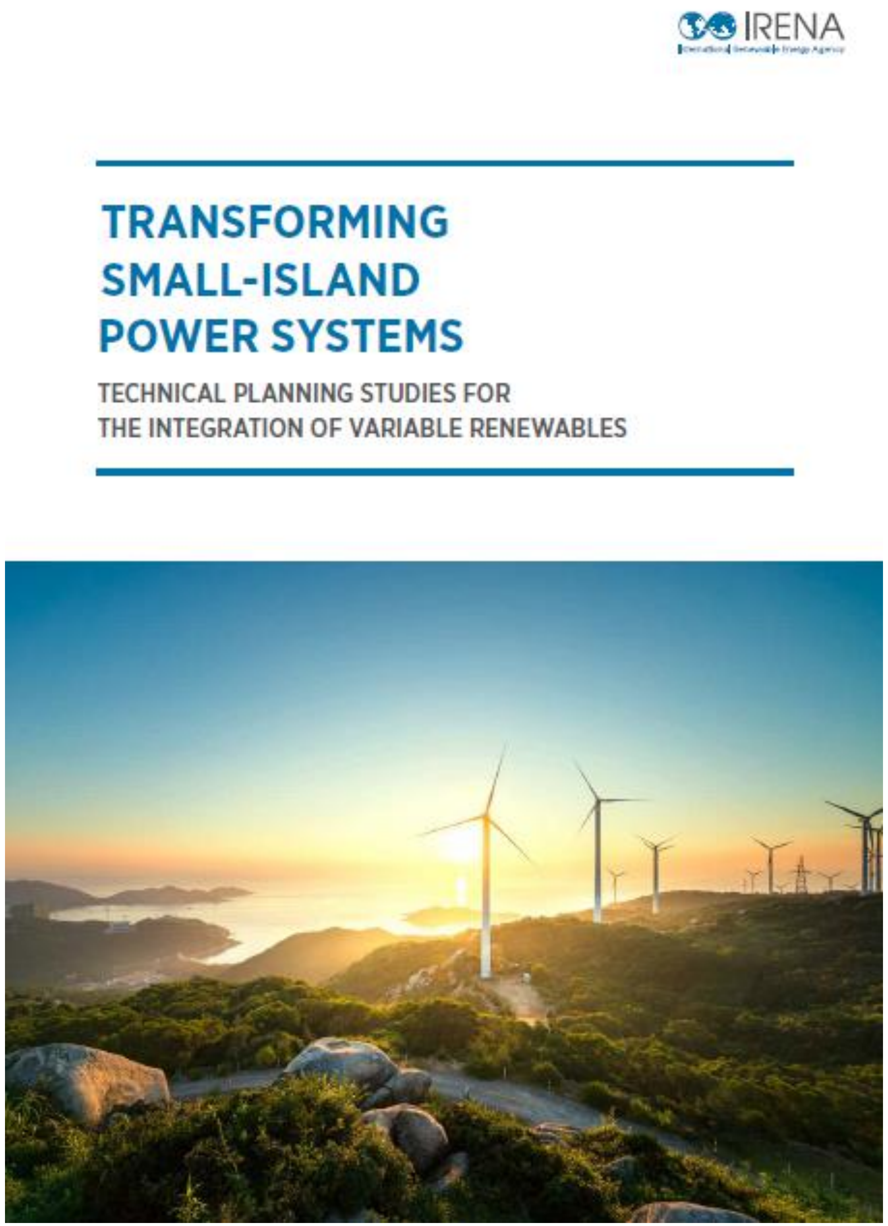
- Compliance with physical limits
- Ensuring sufficient firm capacity
- Addressing flexibility needs
- Ensuring system stability
- Ensuring effective functioning of protection systems
- Maintaining power quality

Grid studies to date

- **Antigua and Barbuda**
  - Island of Antigua (2015)
- **Cook Islands**
  - Island of Aitutaki (2015)
- **Samoa (independent state)**
  - Island of Upolu (2014, 2016)
- **Palau**
  - Island of Palau (2013)
- **Vanuatu**
  - Island of Espiritu Santo (2018)
- **Fiji**
  - Island of Viti Levu (2019)
- **Dominican Republic**
  - National power grid (2019)
- **Mozambique**
  - Two asynchronous systems (ongoing)
- **Tonga**
  - Nine islands (ongoing)

Disclaimer: ***Boundaries and names shown on this map do not imply any official endorsement or acceptance by IRENA. The term "country" as used in this material refers, as appropriate, to territories or areas.***

Transforming Small-Island Power Systems-The publication



Expected challenges associated with VRE in SIDs

↓

VRE integration planning for the technical challenges

↓

Technical studies needed to analyse and quantify challenges

↓

Solutions required to overcome VRE integration challenges

https://www.irena.org/publications/2019/Jan/Transforming-small-island-power-systems

Supporting the enhancement and implementation of climate action plans

Innovation and Technology NDC

Support for the LAC region:

- Antigua and Barbuda,
- Dominican Republic,
- El Salvador,
- Cuba,
- Saint Kitts and Nevis,
- Belize,
- Nicaragua,
- Ecuador,
- Uruguay.

International cooperation partners

IRENA provides high level technical assistance at country level to support the design, update and implementation of member countries climate action plans in the context of the Paris Agreement:

- Development and dissemination of climate-related knowledge, data, tools, products and solutions gateways on renewable energy
- Ensure that sectoral and horizontal strategies are supported towards the enhancement, revision and/or implementation of climate action plans including NDCs, LTS and NAPs.

Supporting the enhancement and implementation of climate action plans

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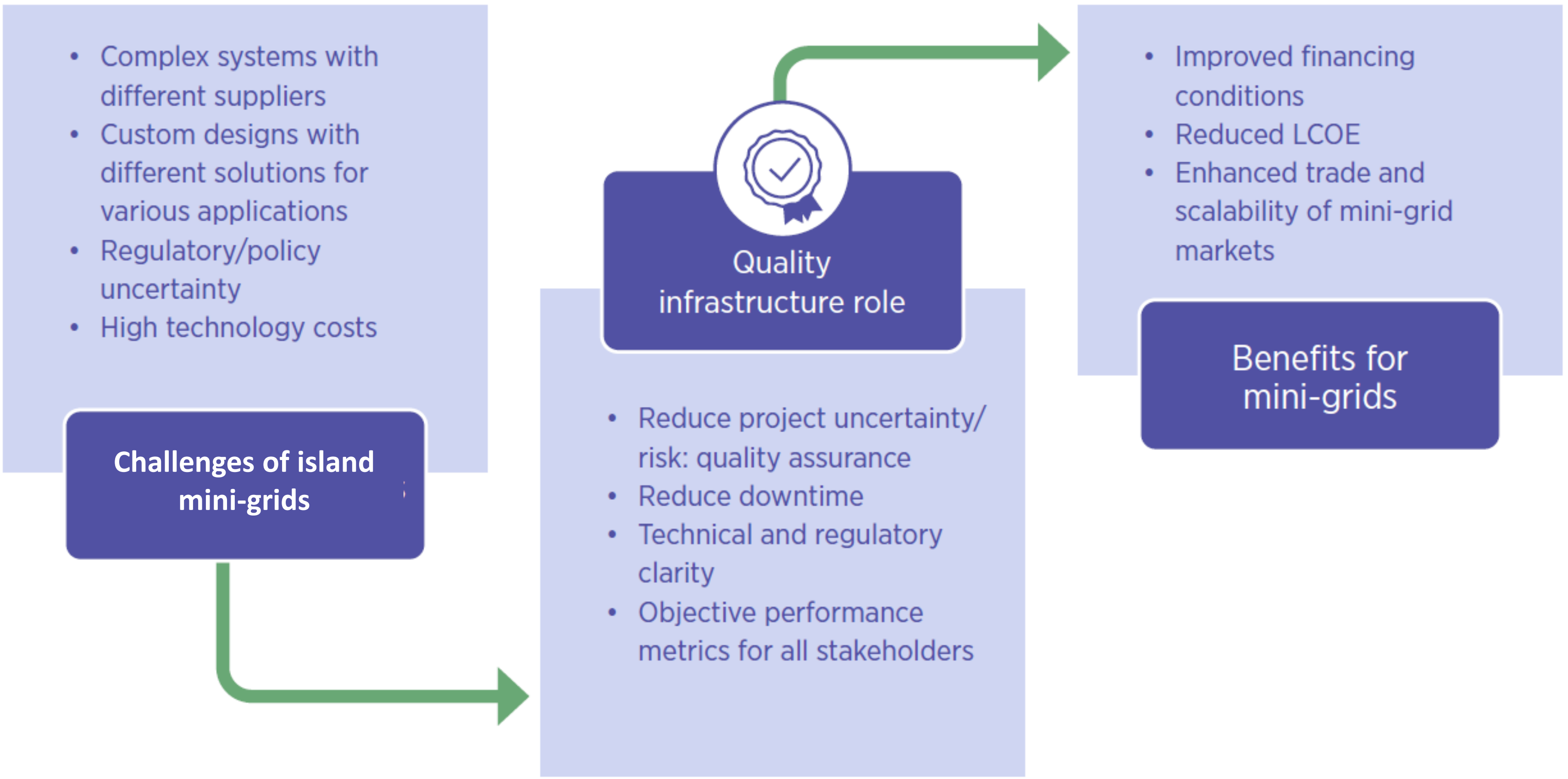
Opportunities for collaboration for climate action

- Support the enhancement and implementation of climate action plans in SIDS, including NDC, LTS and NAP,
- Development of cost-benefit analysis to support and strengthen national climate action plans,
- Providing insights, advice and tools to enhance RE targets, including dispatchable and variable renewable energy sources,
- Technical support for the integration of technology development and transfer in national climate plans,
- Strengthening in-country expertise through capacity building.

Mini-grids in islands – sound quality control for resilient energy systems

New report launched today
Free download:
www.irena.org/publications

Figure 7 Goals and results of QI for mini-grids



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Thank You

Roland Roesch
Deputy Director
IRENA Innovation and Technology Centre
Bonn, Germany

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Scene setting

Scene setting

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Carlo Starace

Associate Programme Officer

Energy Access, IRENA

SIDS Lighthouses Initiative

Supporting Small Island Developing States in Energy Transformation

SIDS LIGHTHOUSES

SIDS and Partners

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Caribbean

1. Antigua & Barbuda
2. Aruba
3. Bahamas
4. Barbados
5. Belize
6. British Virgin Islands
7. Cuba
8. Dominican Republic
9. Grenada
10. Guyana
11. Montserrat
12. St. Lucia
13. St. Vincent and the Grenadines
14. Trinidad and Tobago
15. Turks and Caicos

Atlantic, Indian Ocean and South China Sea

1. Cabo Verde
2. Comoros
3. Maldives
4. Mauritius
5. Sao Tome and Principe
6. Seychelles

Pacific

1. Cook Islands
2. Federated States of Micronesia
3. Fiji
4. Kiribati
5. Republic of the Marshall Islands
6. Nauru
7. New Caledonia
8. Niue
9. Palau
10. Papua New Guinea
11. Samoa
12. Solomon Islands
13. Tonga
14. Tuvalu
15. Vanuatu

Non-SIDS countries and Partner Organisations

1. Denmark
2. France
3. Japan
4. Italy
5. Germany
6. Italy
7. New Zealand
8. Norway
9. United Arab Emirates
10. United States of America
11. Association of the Overseas Countries and Territories of the European Union
12. Caribbean Electric Utility Services Corporation
13. Clean Energy Solutions Center
14. Clinton Climate Initiative
15. ENEL
16. European Union
17. Greening the Islands
18. Indian Ocean Commission
19. International Renewable Energy Agency
20. Organisation of Eastern Caribbean States
21. Pacific Community
22. Pacific Islands Development Forum
23. Pacific Power Association
24. Rocky Mountain Institute - Carbon War Room
25. Solar Head of State
26. Sustainable Energy for All
27. Sur Futuro Foundation
28. United Nations Development Programme
29. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and SIDS
30. World Bank

Priority Areas

1. Support SIDS in reviewing and implementing **NDCs,** with **technical assistance** and **capacity building**
2. Expand from assessment and planning to **implementing** effective, innovative solutions.
3. Promote **all renewable sources**, including geothermal and ocean energy, and step up work on wind and PV
4. Support the development of bankable projects, **access to finance** and co-operation with the **private sector**
5. Strengthen **institutional and human capacity** in all segments of the renewable energy value chain
6. Expand focus beyond power generation to include **transportation and other end-use sectors**
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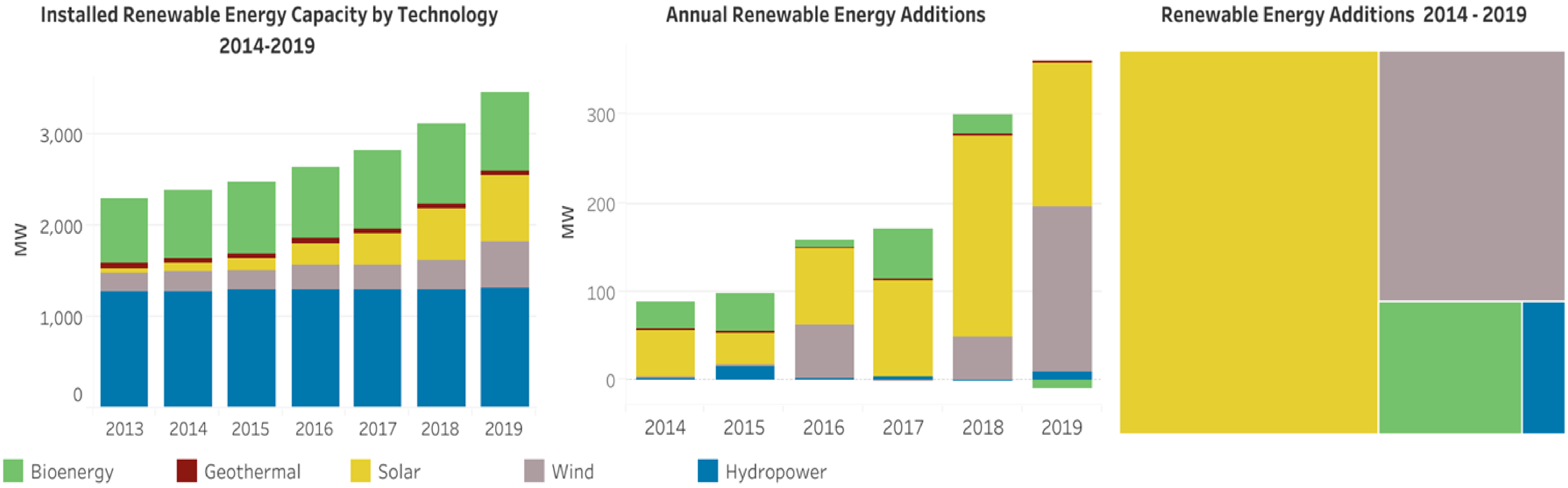
8. Leverage synergies between renewables and **energy efficiency**
9. **Nexus** between RE and agriculture, food, health and water – to foster broad **socio-economic development: job creation**, **gender** equality and **women's empowerment** through renewables.
10. Link renewable energy uptake to climate resilience and more effective disaster recovery.
11. **Enhance collection and dissemination of statistics, supporting informed decision-making**
12. Reinforce and expand partner engagement, leveraging synergies with other SIDS initiatives
13. Boost renewable power deployment, aiming for a target of 5 GW of installed capacity in SIDS by

Installed RE Capacity in SIDS

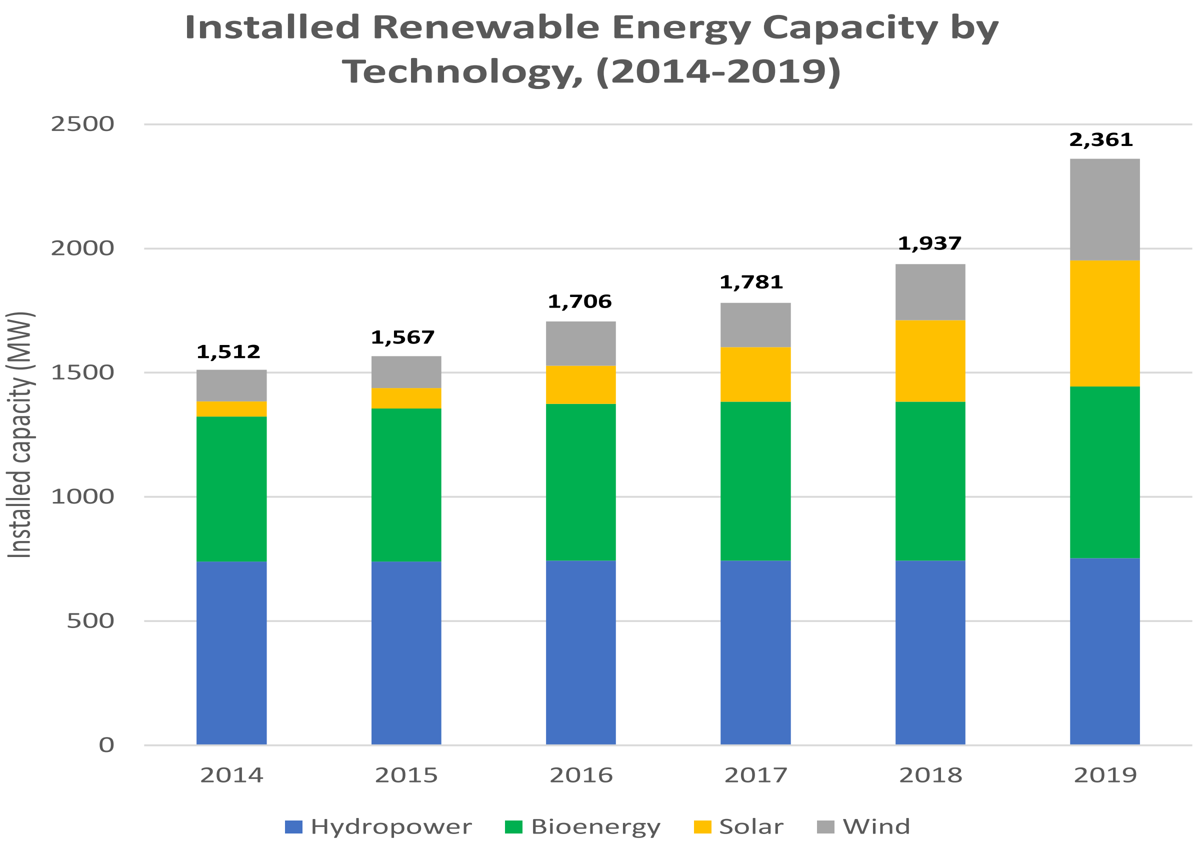


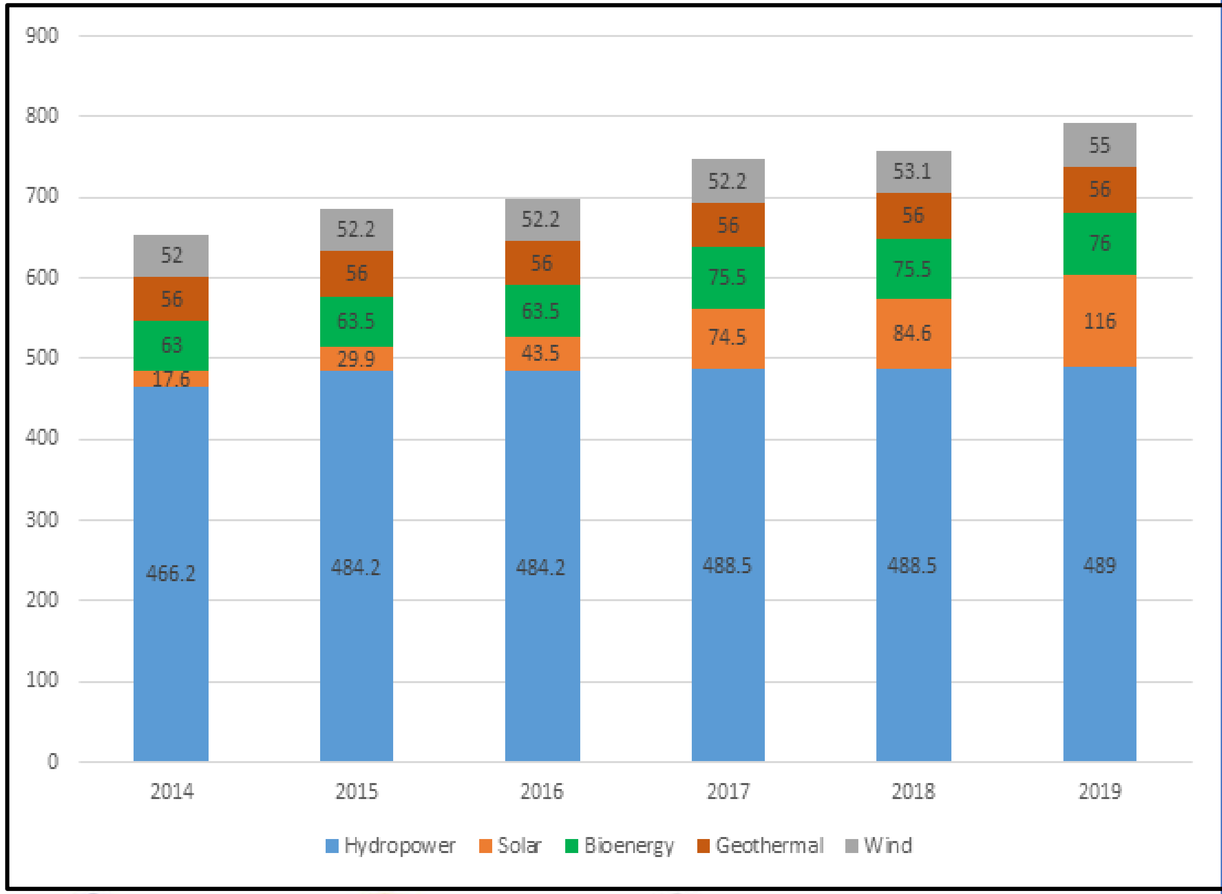
Note: This dashboard illustrat rogress made by SIDS partners of the Lighthouses Initiative based on latest renewable energy statistics.

Source: IRENA Statistics www.irena.org/statistics

Installed RE Capacity in Caribbean SIDS

LHI Partners





Capacity Building on Design of Bankable Power Purchase Agreements in the Pacific SIDS
November 2019

Capacity building for preparing bankable concept notes for the Green Climate Fund
November 2019

COP25- Synergies in RE Adaptation and Mitigation Measures in SIDS
December 2019

COP25 - Facilitating Planning and Financing of RE Projects in SIDS
December 2019

SIDS Ministerial – IRENA 10th Assembly
January 2020

AOSIS-IRENA SIDS Ministerial
Accelerating Energy Transition in SIDS to Stimulate Post-Pandemic Recovery
June 2020

NDC Support – Papua New Guinea Energy Sub-Technical Working Committee Meeting
September 2020

IRENA-Denmark Webinar
Energy Transformation in SIDS towards Sustainable and Climate Resilient Post-Pandemic Recovery
September 2020

SIDS LHI Technical Webinar Series – Transforming SIDS Power System through VRE in the Pacific
October 2020 ⇒

Support for SIDS NDC enhancement and implementation

Renewables/E-Mobility Roadmap
- Antigua and Barbuda

Renewable Readiness Assessment
- Antigua and Barbuda
- Barbados
- Grenada

Monitoring, Reporting and Verification
- Guyana
- Saint Kitts and Nevis
- Saint Vincent and the Grenadines
- Dominica
- Grenada
- Dominican Republic
- Belize

End-Use sectors
- Antigua and Barbuda
- Barbados
- Dominica

Capacity building
- Dominican Republic

Energy Transformation Tools and Services

Quickscans

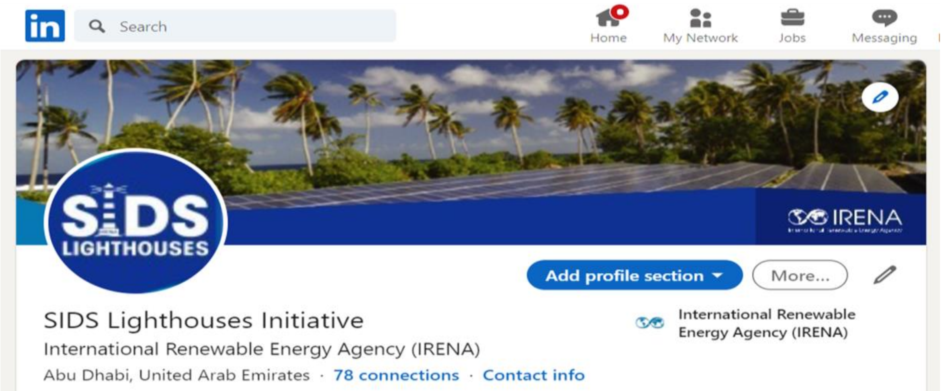
NDC Enhancement and Implementation Support

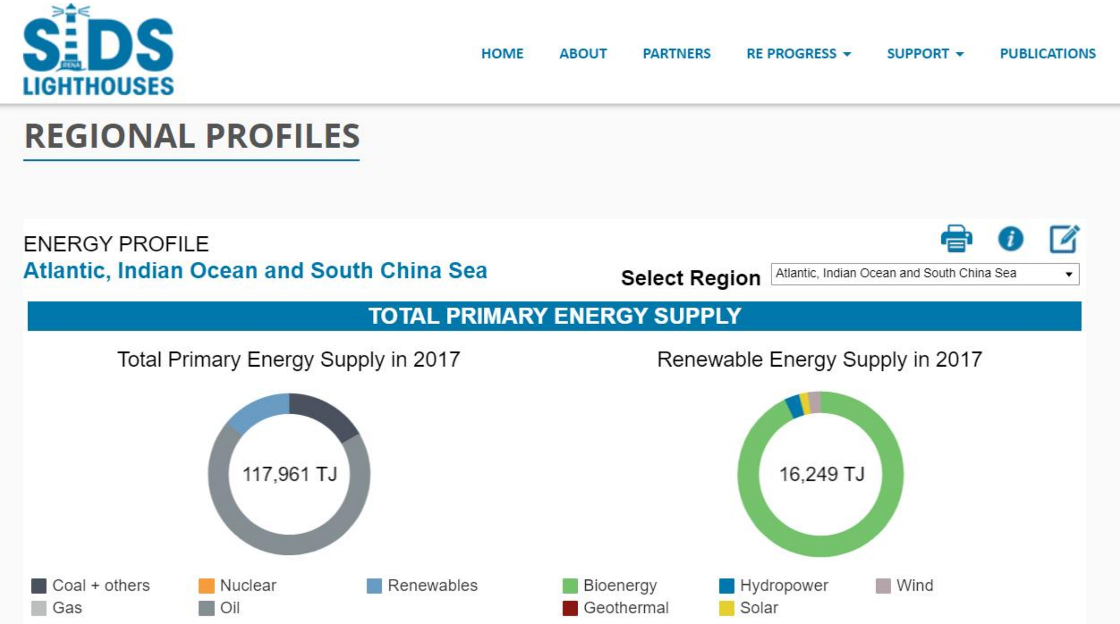
Renewable Readiness Assessment

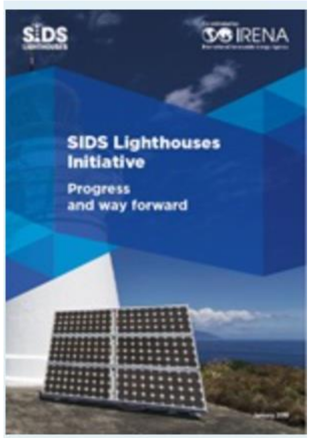
Grid Integration Analysis

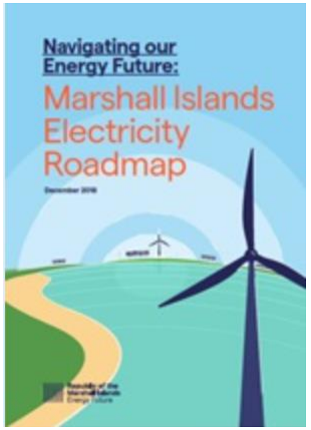
Renewable Energy/E-Mobility Roadmaps

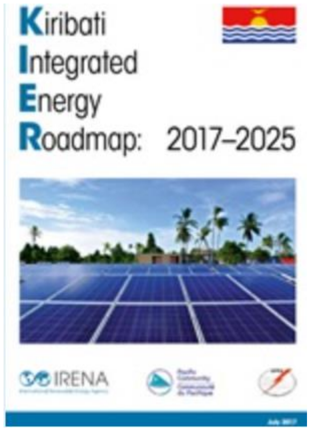
Knowledge Hub and Dissemination



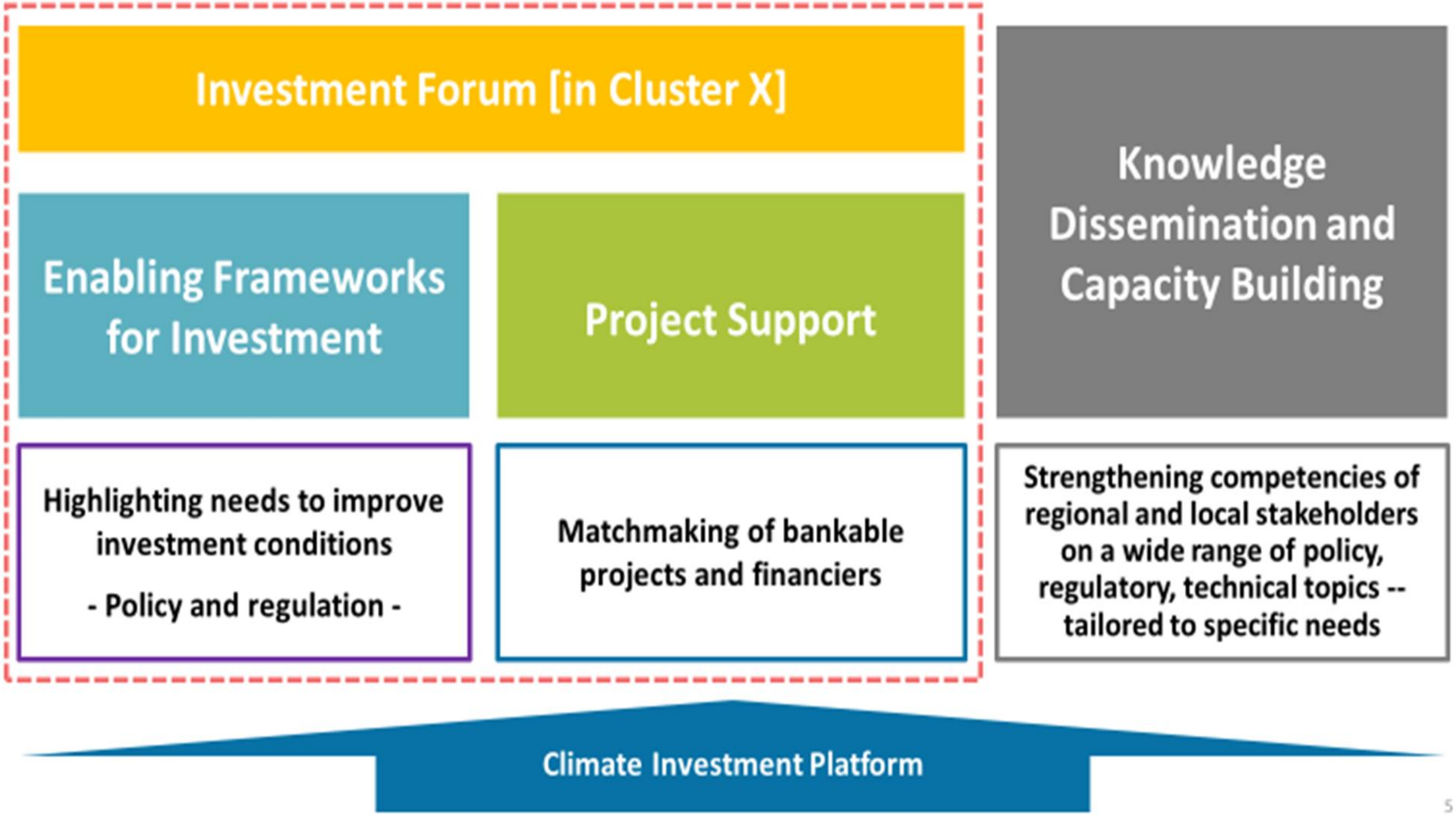








Climate Investment Platform
Investment Forums



More Support Needed for Energy Transformation

Provide assistance to overcome obstacles in **legal and regulatory barriers**

Increase efforts towards **greening of the transport sector**

Increase efforts towards renewable energy in the **agriculture and water sectors**

Revise **ODA eligibility rules** to better support SIDS

Increase efforts in **multilateralism, partnerships**, and **international solidarity**

Facilitate **large-scale investments** and **funding** in the renewable energy sector, on all fronts

Support financing options that are **tailored for SIDS**, such as **blended finance** and **de-risked investments**

Support the review and development of **emergency response** and **recovery protocols** for key players in the energy sector

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Acknowledgement of Support

- Denmark
- France
- Japan
- Germany
- Italy
- New Zealand
- Norway
- United Arab Emirates

Website: http://islands.irena.org/

Email: islands@irena.org

3 Member country' perspectives

Antigua and Barbuda perspective

Andre Matthias

Electricity Business Unit Manager

Antigua Public Utilities Authority (APUA)

Antigua and Barbuda

Technical Issues and solution RE Integration into the Antigua and Barbuda Power Grid

Generation Capacity

* Installed Capacity in Antigua
* APUA - 27MW (2x6MW in 1996 and 2x7.5MW in 2003) of Diesel/HFO Engines
* IPP – 50 MW (1x17MW in 2007 and 3x11MW in 2010) of Diesel/HFO Engines
* Solar - 8.7MW (3MW, 4MW, 1.7MW) Ground mounted. 3.5MW roof top
* Wind – 4MW

Generation Demand Needs

* Peak Demand of 57MW and minimum demand in the Day 45MW
* N-2 Planning margin requires Firm Generation of Peak demand plus the two largest Gen-sets (85MW)
* Present shortage of generation is 8MW (85 – 77)
* 40MW LNG Power Plant to be added in mid 2022 to meet Planning Margin

Energy VS Demand

* Without storage, VRE does not provide consistent demand needs.
* VRE provides only Energy needs without Storage
* APUA presently does not have a generation energy problem but a generation demand problem
* Firm, dispatchable generation is needed to address the current demand problem

Generation Capacity in Barbuda

* Present peak load in Barbuda of 350KW
* Generation Capacity of 2000KW (All diesel)
* New Power Plant to be constructed in 2021 with 2x400KW Diesel Generators, 720KW solar and 863KWH battery
* There would be a total Green Energy solution during the day in Barbuda as of 2022

T&D Network

* Antigua
* 60KM of 69KV transmission ring
* Seven 69/11KV Substations
* 25 11KV Distribution Feeders, extending for 350KM
* T&D Network 97% overhead
* Barbuda
* Two 11KV Distribution Feeders
* One Substation
* 20KM of 11KV Distribution lines

IRENA stability study in 2015

* Criteria for stability evaluation
* Frequency excursions shall not lead to system collapse (blackout)
* 10-minute fluctuations in the VRE generation shall not lead to the activation of the first stage of the UFLS scheme (at 59 Hz).

Results of the Study

* Increased risk of voltage and frequency collapse after a contingency
* All VRE generation shall have voltage control capabilities (minimum required is a power factor range of ±0.95)
* All utility-scale VRE generation shall support network during disturbances (i.e. faults) and avoid disconnection. It shall also be able to reduce the output power in case of over-frequency
* Distributed PV generation shall be installed proportional to the feeder consumption (relative to the total demand).
* Protection settings of VRE generation shall be consistent with existing diesel protection characteristics

Results of the Study

* Increased risk of load disconnection in case of a sudden loss of generation due to reduced system inertia and not sufficient provision of spinning reserves
* It is recommended to update the current procedure to allocate spinning reserves, so that the loss of the largest unit being dispatched is also considered for the definition of the spinning reserves.

Results of the Study

* Integration of VRE generation will tend to impact diesel operation, with lower average loading and higher loading cycles (high operational and maintenance costs)
* APUA should investigate if there is any potential conflict regarding existing agreements between APUA and the IPPs concerning the minimum amount of energy that the diesel plants shall provide.
* APUA should discuss with the diesel manufacturers the potential implications and/or limitations. These could be considered in future studies as additional technical performance criteria.

Results of the Study

* Insufficient measurements from solar resources and from the operation of Antigua's power system
* Additional measurement and recordings shall be provided in order to increase the reliability on the network model

Results of the Study

- Increased complexity for the definition and implementation of the unit commitment and generation dispatch
- It is recommended to implement an automatic and centralized system to perform the unit commitment and generation dispatch attending to all the constraints related to, for example, minimum and maximum operational levels of the diesel units, current PV and Wind generation, minimum spinning reserve requirement

Implementation of Study

* Interconnection Policy only allows 15% RE penetration on each Feeder
* Had discussions with IPP on Dispatching schedule, minimum Unit load and frequency control
* All RE systems in excess of 10KW must have voltage and frequency ride-through
* Will install LNG Power Plant with fast reaction to frequency variation
* LNG Plant will not have a minimum guaranteed energy to be purchased by APUA
* Installation of 11MWHs of batteries in Antigua
* Will install hybrid system in Barbuda in 2021 with the recommendations made by IRENA
* Will provide additional information to upgrade the 2015 study done by IRENA

Technical studies

* Load flow studies and Short circuit studies to be completed by APUA with RE
* Protection coordination study completed without RE. Study to be redone with RE
* Transient stability analysis
* Frequency stability analysis
* Grid Code

Resilient Issues to be addressed

* Solar Panels are susceptible to the elements of the weather and would have to be properly secured
* Roofs being damaged during an adverse weather condition
* Challenges of insurance coverage for large- scale Solar Plants

THANK YOU
AWAIT QUESTIONS LATER

Thank you

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4

Key takeaways
“Transforming Small islands: Technical planning studies for the integration of variable renewables”

Transforming Small islands: Technical planning studies for the integration of variable renewables”

Gayathri Nair

Associate Programme Officer

Renewable Energy Grid Integration, IRENA

International Renewable Energy Agency

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Key takeaways from the Publication “Transforming Small islands– Technical planning studies for the integration of variable renewables”

Presenter: Gayathri Nair
Associate Programme Officer
Renewable Energy Grid Integration
IRENA

Thursday, 10 December 2020 • 4:00-6:00 pm CET

Characteristics of VRE and its impact

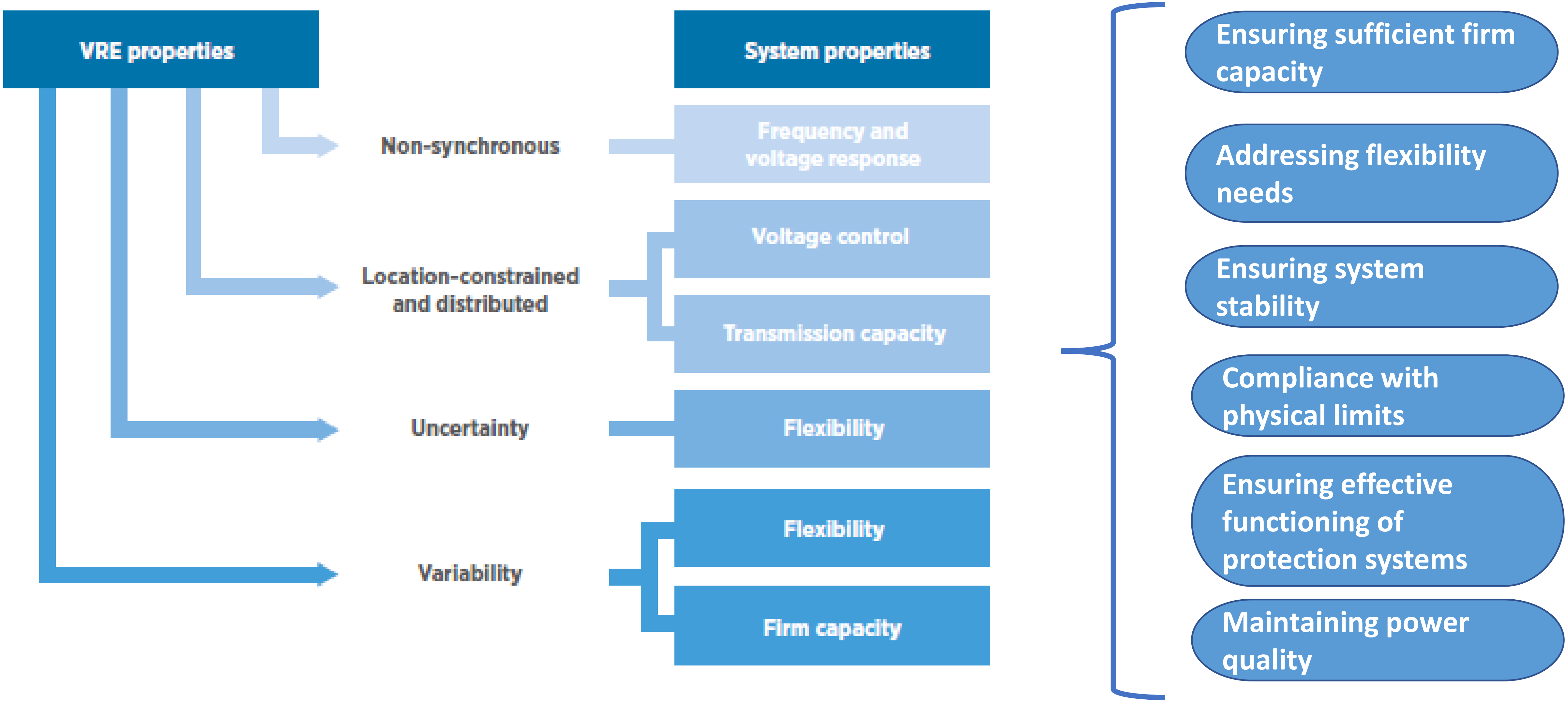

Fig. Key links between variable renewable energy, power system properties and planning

Essential steps in planning to overcome challenges in SIDS

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Characteristics of SIDS power systems for variable renewable energy integration planning

Flexibility of the existing and future power generation fleets	Demand and load profile	Structure and strength of transmission and distribution networks

VRE implementation strategy and generation expansion plans

Expansion planning-long /mid-term	Operational planning-short-term

Operational and planning practices of utilities in SIDS

Absence of dedicated long-/mid-term expansion planning	Absence of sufficient operating reserves	Inadequate set-up of load shedding schemes	Fully automated operation of diesel power stations	Absence of up-to-date grid-codes with clear definitions

The influence of governance on technical operations

Vertical integration	Vertical integration with IPP's	Some extent of vertical and horizontal unbundling	Power market

Different studies needed to support VRE integration

- *Generation adequacy*
- *Generation scheduling and reserve sizing*
- *Network studies*
  - *Static network analyses*
    - *Load flow*
    - *Short circuit*
    - *Security analysis*
  - *Dynamic network analyses*
    - *Stability assessments*
    - *Contingency analysis*
  - *Special network studies.*
    - *Grid connection*
    - *Defense plans*

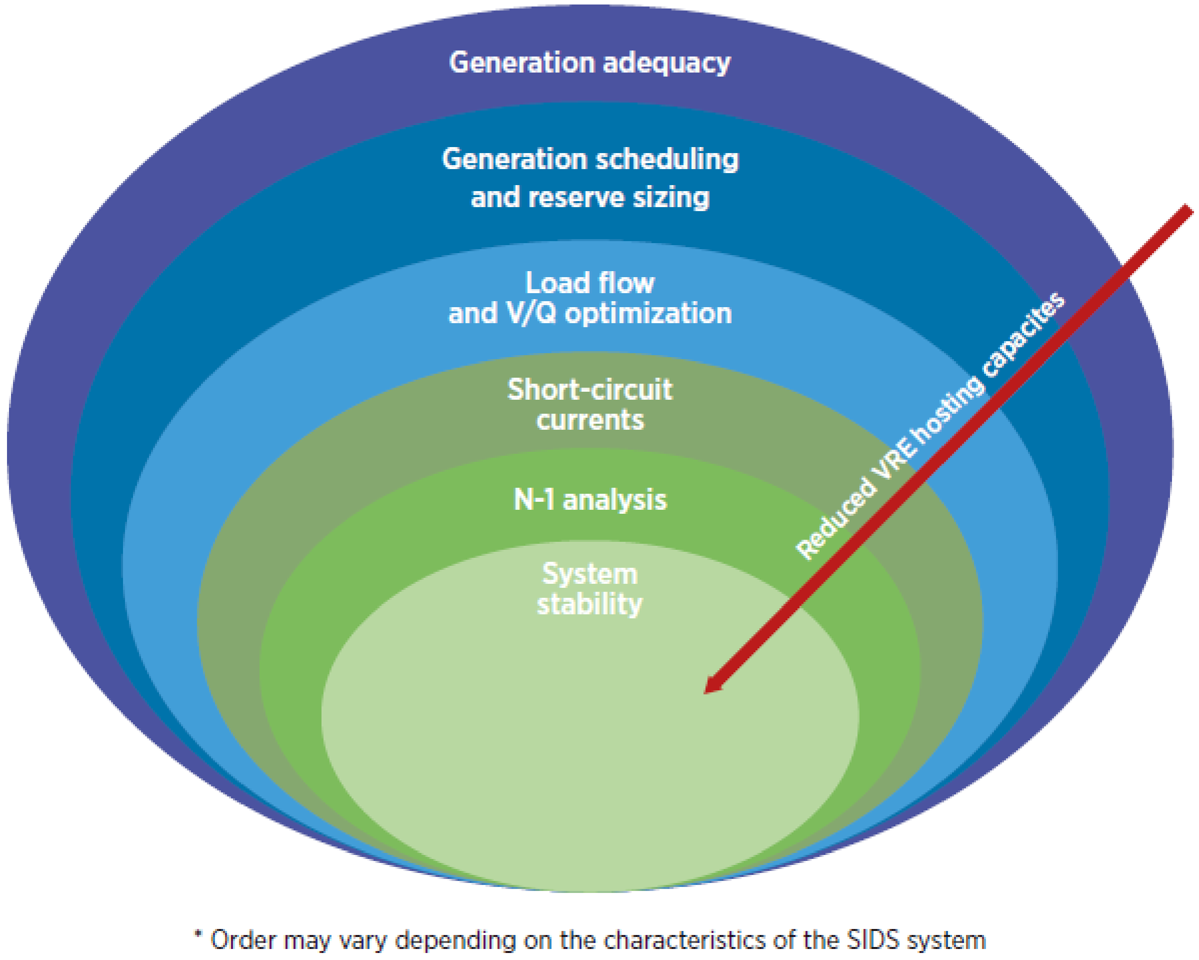
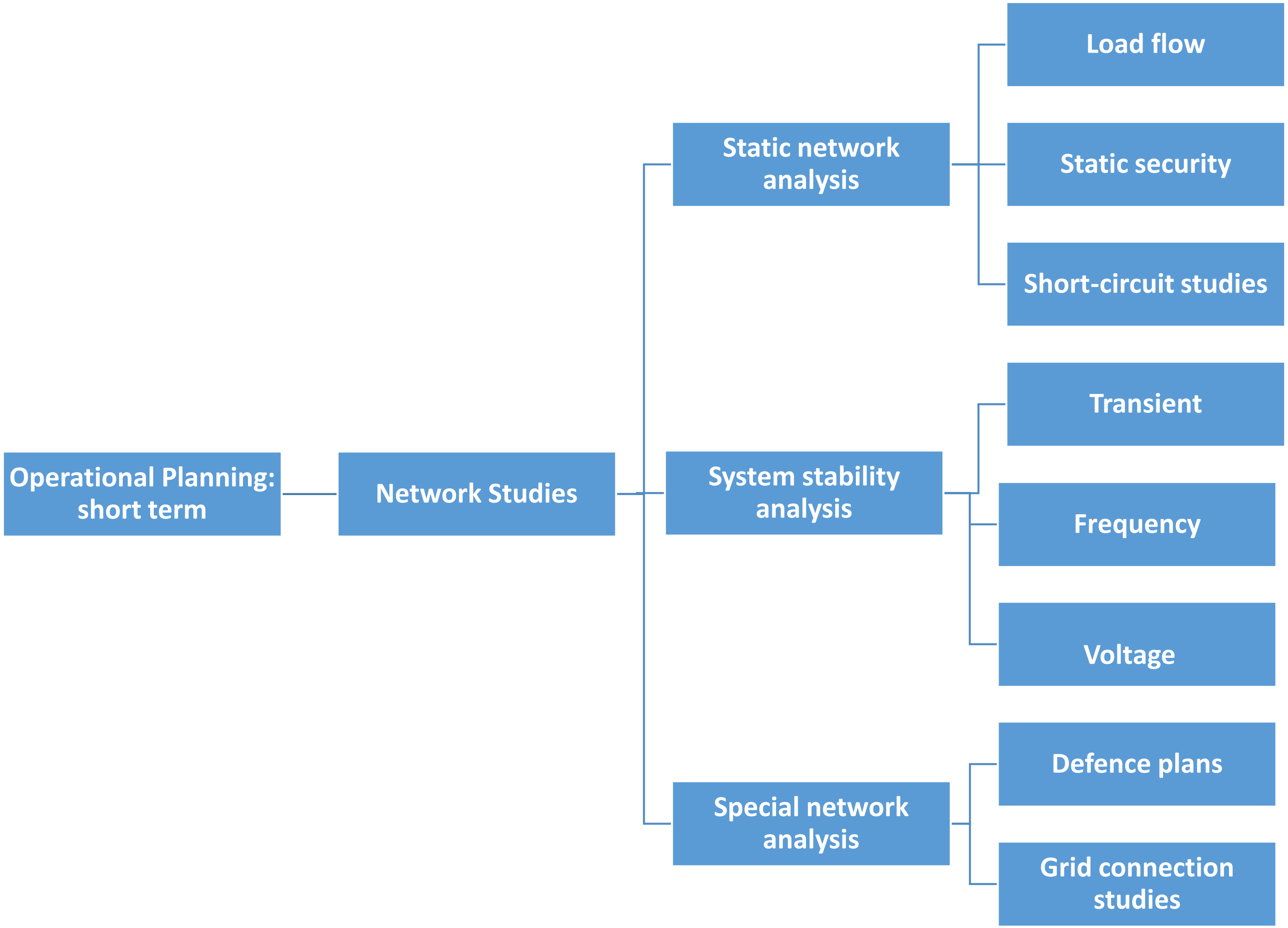


Fig. Limitations for VRE integration resulting from different technical studies

Technical network studies for VRE Integration



Static network studies

Load flow and static security assessment

Expansion Planning	• Determine the required network reinforcements
Operational Planning	• Generation rescheduling is needed (including VRE curtailment).

Short-circuit currents

Expansion Planning	• Determine possible upgrades of existing equipment
Operational Planning	• network switching (change in the network topology), • protection co-ordination and selectivity.

System stability

Transient stability

Expansion Planning
- Assess the adequacy of the planned network structure and protection schemes

Operational Planning
- Generation re-dispatch (including VRE curtailment)
- Modification to the voltage set-points of the generating units

Frequency stability

Expansion Planning
- Implementation of synthetic inertia function to the VRE power plants,
- Automatic generation control scheme,
- Improvement of UFLS settings
- Deployment of energy storage

Operational Planning
- Generation rescheduling is needed (including VRE curtailment).
- Improvement of UFLS settings can be envisaged.

Voltage stability

Expansion Planning
- New investments in reactive power compensation

Operational Planning
- Review of the voltage/reactive power compensation scheme

Example workflow-Transient stability studies

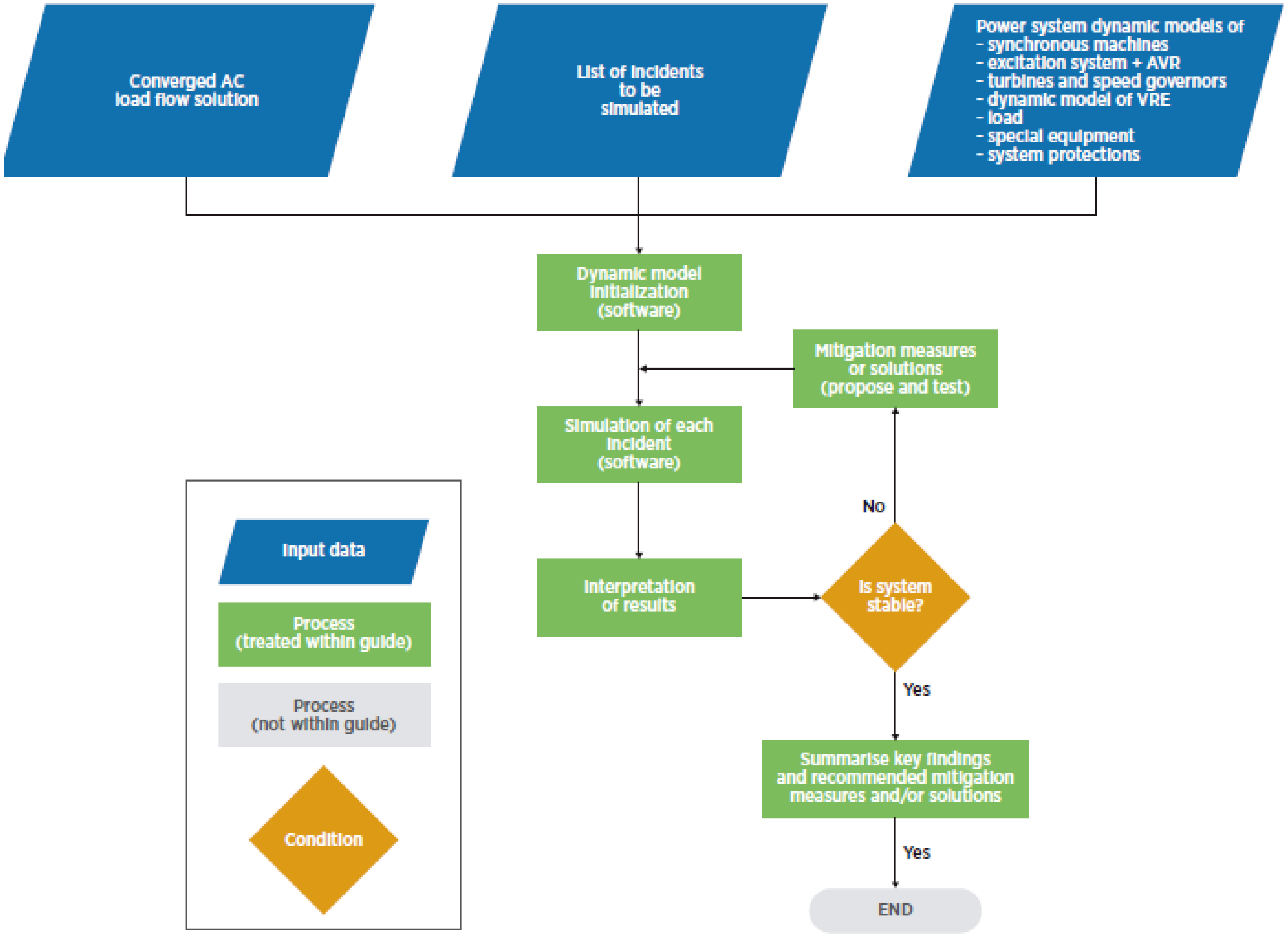


Fig. Workflow to perform transient stability studies

Other studies discussed

- *Workflow to perform generation scheduling studies*
- *Workflow to perform load flow studies*
- *Workflow to perform static security assessment studies*
- *Workflow to perform short-circuit studies*
- *Workflow to perform operating reserve sizing*

Details addressed in each study

- *Study results and evaluation criteria*
- *Methodology to perform the study*
- *Analysis of results and next steps*
- *Potential issues and solutions*

at the different planning stages

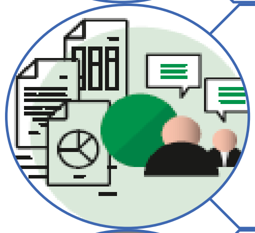
- *Workflow to perform the study*
- *Examples of study results*
- *References for further reading*

Solutions for better integration of VRE-Infrastructure investments

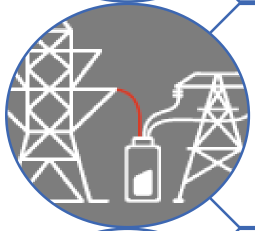
- Diversification of VRE installations
- Flexible generating units
- Energy storage systems
- Grid Reinforcements
- Distribution automation and smart grid technologies
- Interconnection with neighboring countries

Solutions for better integration of VRE-Operational Measures

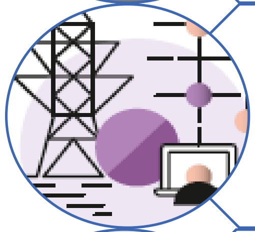
Demand response programs



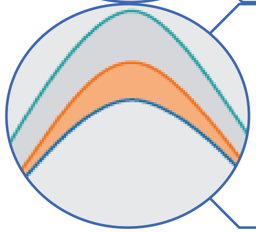
Enhanced generation dispatch and control



Enhanced defense plans



Automatic power controller and network monitoring



Short term VRE forecast

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5 Partner organisation’s perspectives

Partner organsiation's perspective

Jennifer DeCesaro
Director - Recovery and Resilience
U.S. Department of Energy (DoE)

ENERGY TRANSITIONS INITIATIVE
U.S. Department of Energy

IRENA's SIDS Lighthouses Initiative:

Technical Webinar Series

Transforming Small Island Developing States Power Systems through Variable Renewable Energy

Jennifer DeCesaro

Director, Recovery and Critical Energy Infrastructure

09 December 2020

DOE's Energy Transitions Initiative

ETI Mission

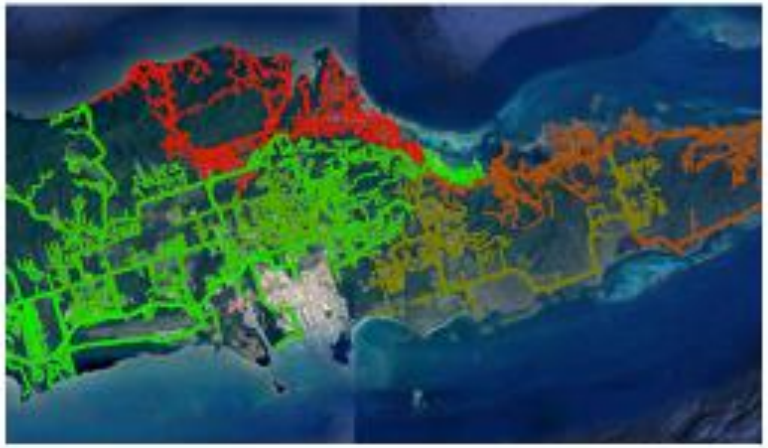
Advancing self-reliant island and remote communities through resilient energy systems.

Outcomes of interest:

- Local resource reliance
- Institutional, social, and economic resilience
- Enhanced institutional capacity
- Lower costs / cost predictability
- Replicable approach

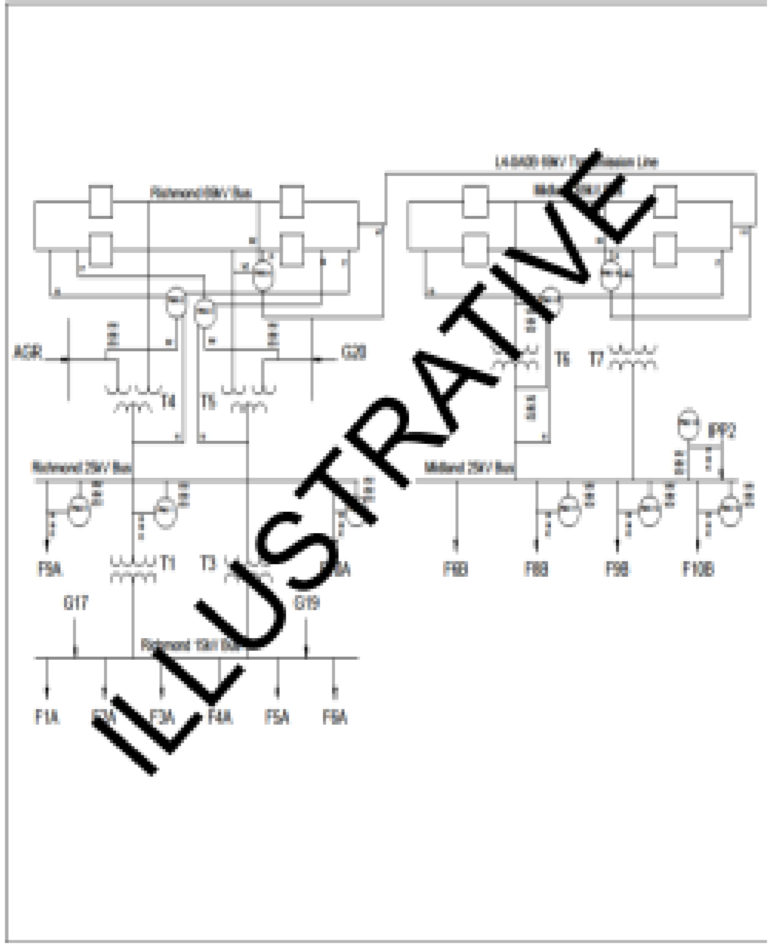
Example: USVI Net Energy Billing Program

- A multi-stakeholder effort to provide access to the energy-saving benefits of Distributed Energy Resources to grid-connected customers while ensuring VIWAPA maintains cost recovery for its fixed assets across the grid.
- Program components: Hosting capacity analysis, updated interconnection standards (aligned with IEEE 1547.9), streamlined interconnection/permitting procedures with online permitting portal



USVI System Study

- Power system model validation and data collection
- Develop an accurate baseline model of the existing system on St. Croix
- Update the power system models to include near term planned PV plants, battery storage, and other relevant system changes to the central plant and T&D system and convert to PSCAD
- Development of modeling scenarios
- Modeling to identify potential grid integration issues and mitigation strategies



Discussion and Dialogue Papers – High Penetration Renewables on Island and Remote Grids and Energy Burden

The overall goal of this project is to demonstrate the technical and economic feasibility (or infeasibility) of high penetrations of distributed generation in island systems. This will help enable the development of cohesive, novel, and stakeholder driven solutions to the challenges and opportunities of large amounts of distributed generation.

This work will focus on island and remote systems, which are typically small and so high distributed generation penetrations are quickly achieved, but the results of the work will be additionally applicable to larger grid systems which are also (but more slowly) experiencing increased penetrations of distributed generation.

The project will take a two-pronged approach: 1) development of a discussion briefing paper and presentation and 2) facilitated in-region dialogues.

FRONTIER - Framework for Overcoming Natural Threats to Islanded Energy Resilience

The tool will allow decision-makers, including local planners, asset owners and operators, and emergency management officials, to evaluate the cost-effectiveness of various electricity sector resilience pathways for utilities that are either physically or functionally isolated from neighboring communities and systems. FRONTIER is designed to be applicable across the unique range of conditions found in U.S. states, territories, and international island partners.

***Project Leads*: Argonne National Laboratory and Lawrence Berkeley National Laboratory**

Energy Resilient Critical Infrastructure Planning Support

The objective of this project is to provide training for island utilities, regulators, investors, and key end users on tools and techniques for identifying, evaluating, and strengthening energy resilience for identified infrastructure.

This project builds on lessons learned from ETI's microgrid training program as well as lessons learned from the technical support provided to the USVI and Puerto Rico post hurricanes Irma and Maria.

Project Lead: Sandia National Laboratories

Gentilly Resilience District

Blue/Green Parklands Concept

Energy Transitions Initiative Partnership Project

About ETIPP

ETIPP's network of experienced organizations works alongside remote and islanded communities to transform their energy systems and reduce risk.

Who We Are

ETIPP leverages the experience and expertise of a broad coalition of federal offices, national laboratories, and community-based organizations.

What We Do

ETIPP provides resources and technical support for remote and islanded communities seeking to address community energy challenges and build capacity.

https://www.energy.gov/eere/about-energy-transitions-initiative-partnership-project

Coastal Studies Institute
A Multi-Institutional Research Partnership

Island Institute

HNEI
Hawai'i Natural Energy Institute
University of Hawai'i at Mānoa

ACEP
Alaska Center for Energy and Power

REAP
Renewable Energy Alaska Project

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6 Key insights from grid assessment studies

Key insights from grid assessment studies

Laura Casado
Associate Professional
Renewable Energy Grid Integration, IRENA

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SIDS: Technical Webinar Series - Transforming Small Island Developing States Power Systems through Variable Renewable Energy- Caribbean Session
Case studies

Presenter: Laura Casado Fulgueiras
Associate Professional
Grid Integration
IRENA

Thursday, 10 December 2020 • 4:00-6:00 pm CET

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1

Grid assessment for Antigua

Grid Integration Assessment for Antigua

Objective

- Determine the contribution of VRE generation to meet annual demand
- Level of reduction of diesel generation

Methodology

- Solar and wind variability included
- Typical load profiles considered
- 8 generation expansion scenarios
- Analysis with VRE and peak demand at noon time
- Analysis of maximum penetration of VRE at peak demand
- Analysis of highest penetration of VRE with minimum demand
- Model developed

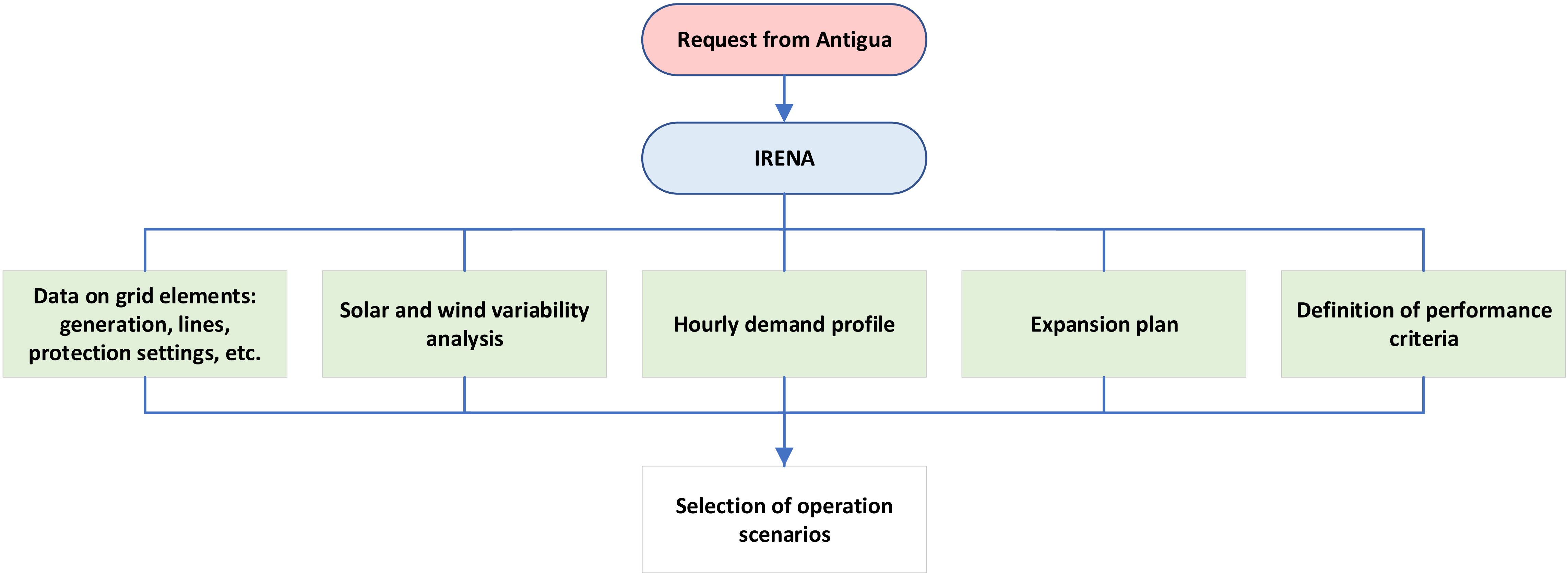
Technical studies

- Calculation of power reserve requirements
- Unit commitment and generation dispatch
- Steady state analysis
- Frequency stability analysis
- Contingency analysis
- Assessment on the PV and wind absorption capacity

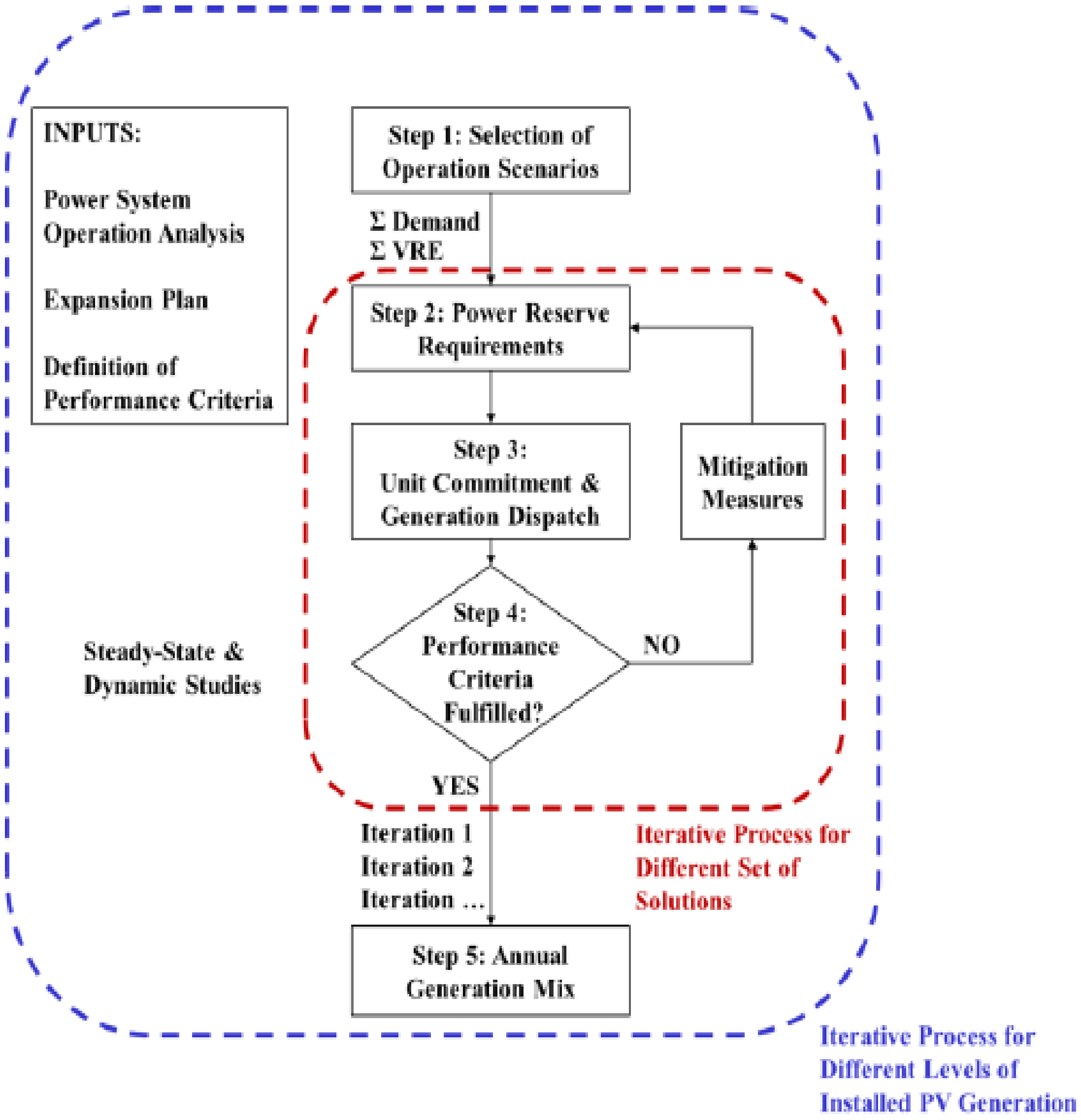
Outcomes

- PV and wind cover 4.2% and 11.8% of the total demand
- Diesel consumption reduced from 100% to 84%
- Possible to integrate at least 37.5 MW of PV generation
- Going beyond 37.5 MW of PV will require the installation of storage devices

Grid Integration Assessment for Antigua- Methodology of study Findings and Recommendations



Grid Integration Assessment for Antigua- Methodology of study Findings and Recommendations, cont..



Contingencies

- VRE generation to have voltage control capabilities with power factor range of ±0.95
- Protection settings of VRE to be consistent with diesel and hydro power generation
- Update and re-define spinning reserves

Voltage stability

- VRE generation to have Fault ride through (FRT) and inject reactive power to contain the low voltage to local areas

Unit commitment and dispatch

- To implement an automatic and centralised unit commitment and generation dispatch

Impact on diesel generation

- Assess performance of diesel generators
- Curtailment

2

Dominican Republic

Grid Integration Assessment for Dominican Republic

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Objective

- 25% of VRE by 2025 and higher shares of VRE by 2030
- Techno economic study
- Production cost analysis

Methodology

- VRE site selection
- Development of solar and wind generation profiles and forecasts
- Collection of historical data
- Development of scenarios
- 12 Scenarios and sub-scenarios-Peak, mean & valley
- Nº of units connected, VRE generation, Spinning reserve, Inertia, Power output of largest unit
- Definition of transmission capacity between nodes
- Modelling the power system and perform the technoeconomic studies

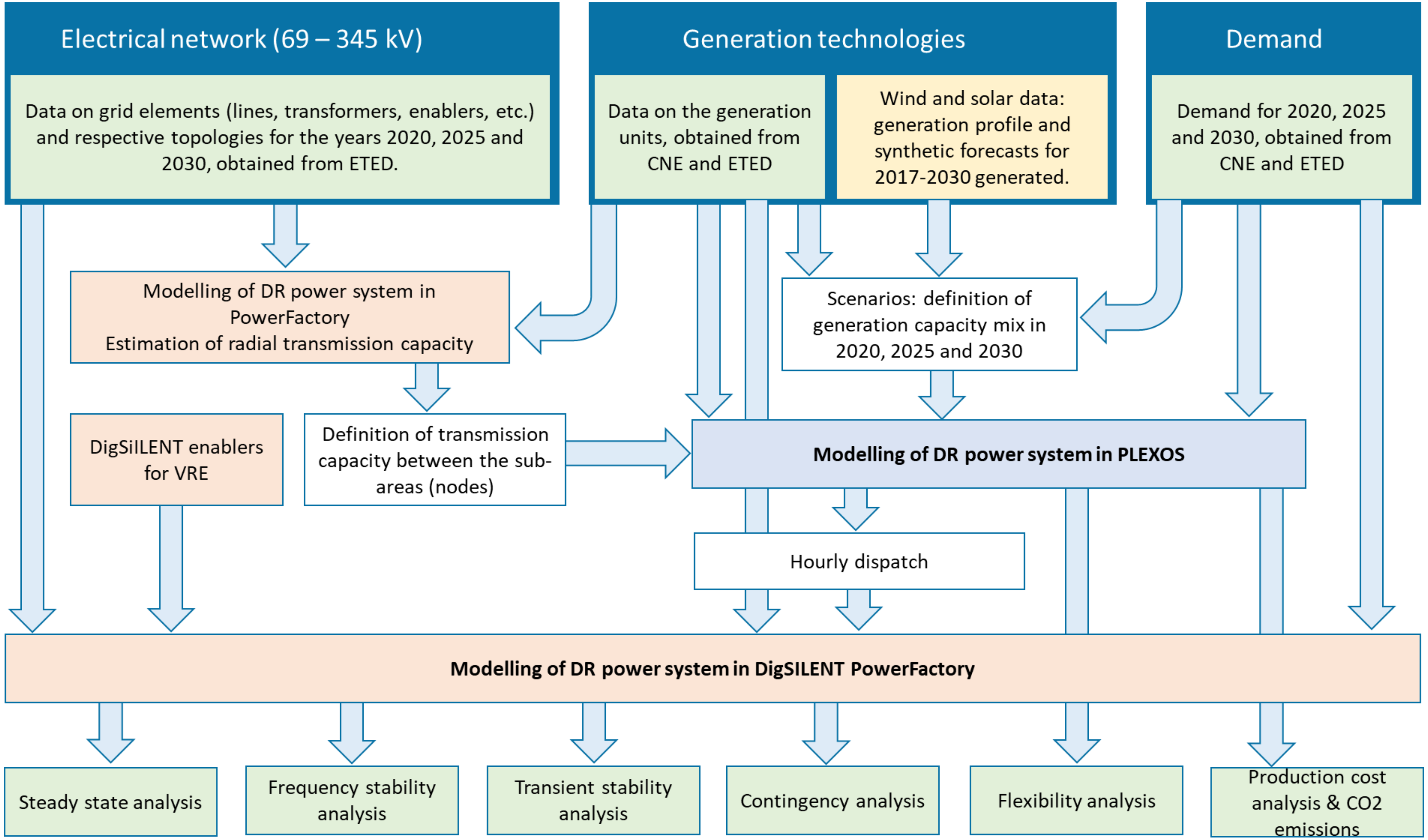
Technical studies

- PLEXOS analysis
- Economic dispatch
- Co2 emissions calculation
- Production cost
- Frequency Stability
- Voltage stability
- Transient stability
- N-1 contingency analysis

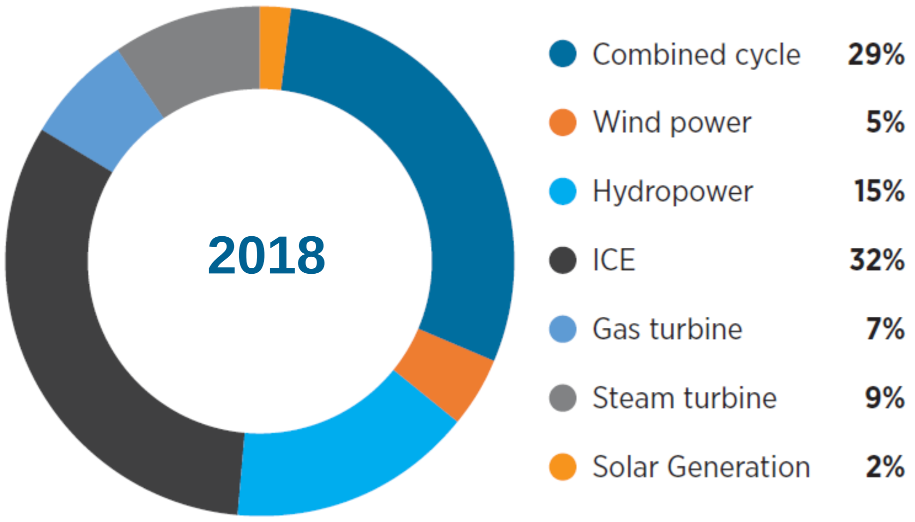
Outcomes

- By 2030 DR could be using 34% more wind and 22% more Solar
- Almost 63% of the instantaneous demand could be provided by VRE in the 2030 remap scenario
- 45% reduction in CO2 emissions by 2030
- Production cost in 2030 Remap is 60% lower than base case

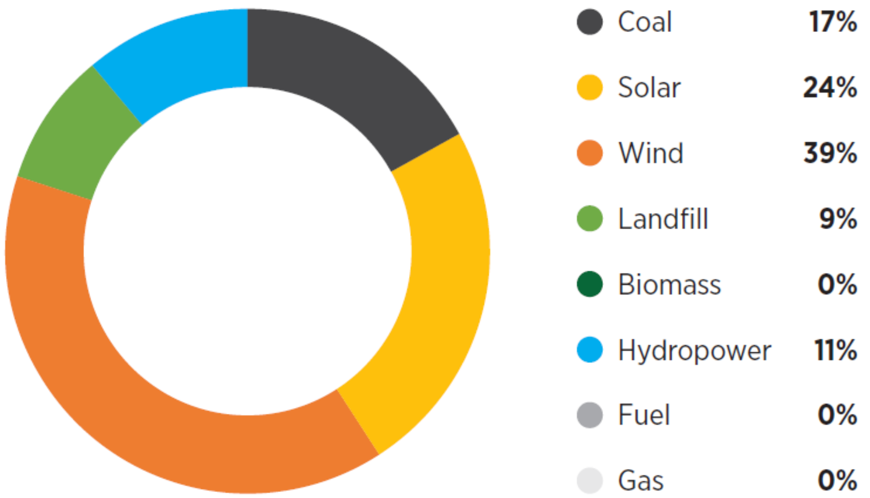
Grid Integration Assessment for Dominican Republic - Flowchart



Grid Integration Assessment for Dominican Republic – Findings and Recommendations



OPTIMAL 2030 GENERATION MIX (%)



Frequency support

- Installation of batteries for primary frequency support
- Must run units for frequency support- with fast response
- Frequency support from VRE generation by maintaining power reserve
- Change in droop values of synchronous generation units
- Modify Reactive power capabilities from VRE generation at connection point

Congestion

- Installation of batteries
- Ensure VRE generation are connected at points with transfer capacity available
- Reinforcing the grid by building new lines

Voltage control

- Installation of shunt devices
- Operational strategy for shunt capacitor banks/STATCOMS
- Analyse and revise voltage limits
- Ensure Fault ride through (FRT) from VRE generation

Operational procedures

- Re-configuration of grid
- Generation re-dispatch
- Use of advanced forecasting tools
- Merit order of dispatch of generation to be analysed to avoid transient stability issues.

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7

Launch and key insights from IRENA's report "Quality Infrastructure for Smart-Grids"

Francisco Boshell
Team lead
Renewable Energy Technology, Standards and Markets, IRENA

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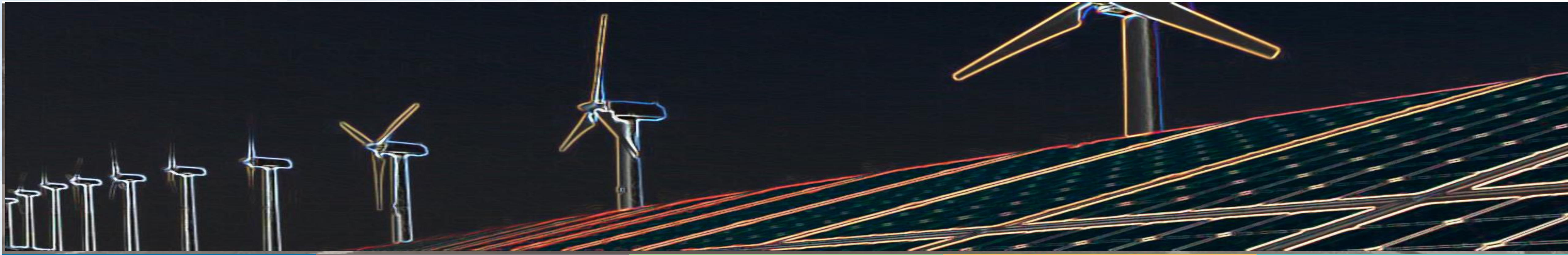


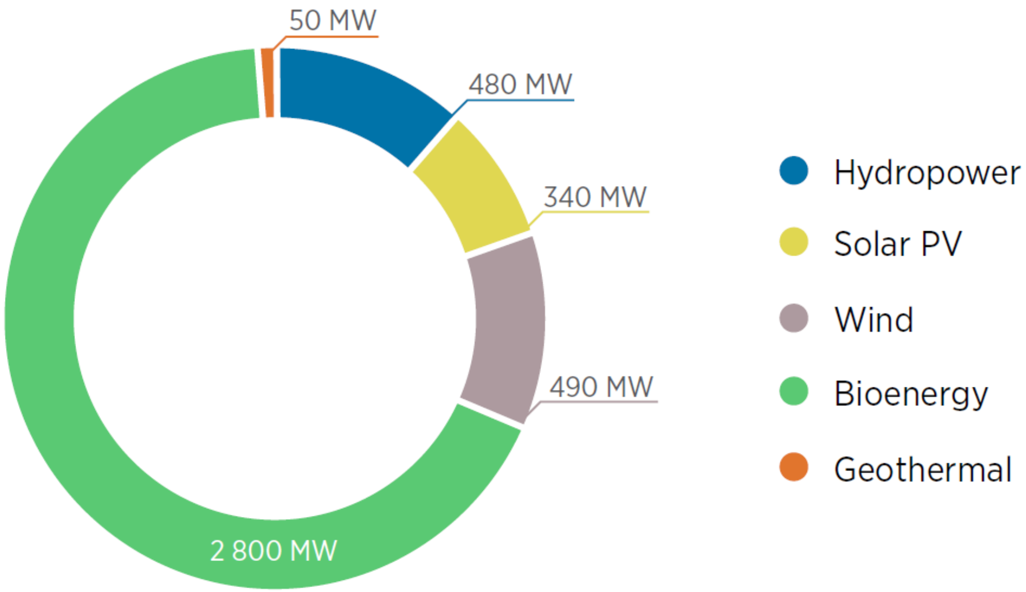
Quality Infrastructure for Smart Mini-Grids in Islands

Francisco Boshell

“Transforming Small Island Developing States Power Systems through Variable Renewable Energy”
10 December 2020

Renewable mini-grids market status

Total installed capacity RE mini-grids > 4.2 GW



Market per region and application

Indicator	Key facts
Regional share of mini-grid capacity	North America: 40% Latin America: 4% Asia-Pacific: 42% Europe: 10% Middle East & Africa: 4%
Mini-grid market share by segment	Remote, enabling energy access: 45% Commercial & industrial: 16% Utility distribution: 15% Community: 10% Institutions: 9% Military: 5%

Source: IRENA (2020), Quality Infrastructure for Smart Mini-Grids

Mini grids with assured quality = resilient energy systems for small islands

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Puerto Rico Regulation for Mini-grids

After hurricane Maria in 2017, Puerto Rico looked to implement more resilient energy systems in their communities.

The 2018 regulation defines 'renewable microgrids' as those that can generate 75 % of their energy from renewables. It identifies the applicable codes and standards.

Below, the Commission establishes the list of Codes and Standards with which all microgrids must comply. It remains the responsibility of each microgrid owner and operator to ensure that its microgrid system is in compliance with any and all Codes and Standards that may be applicable to it.

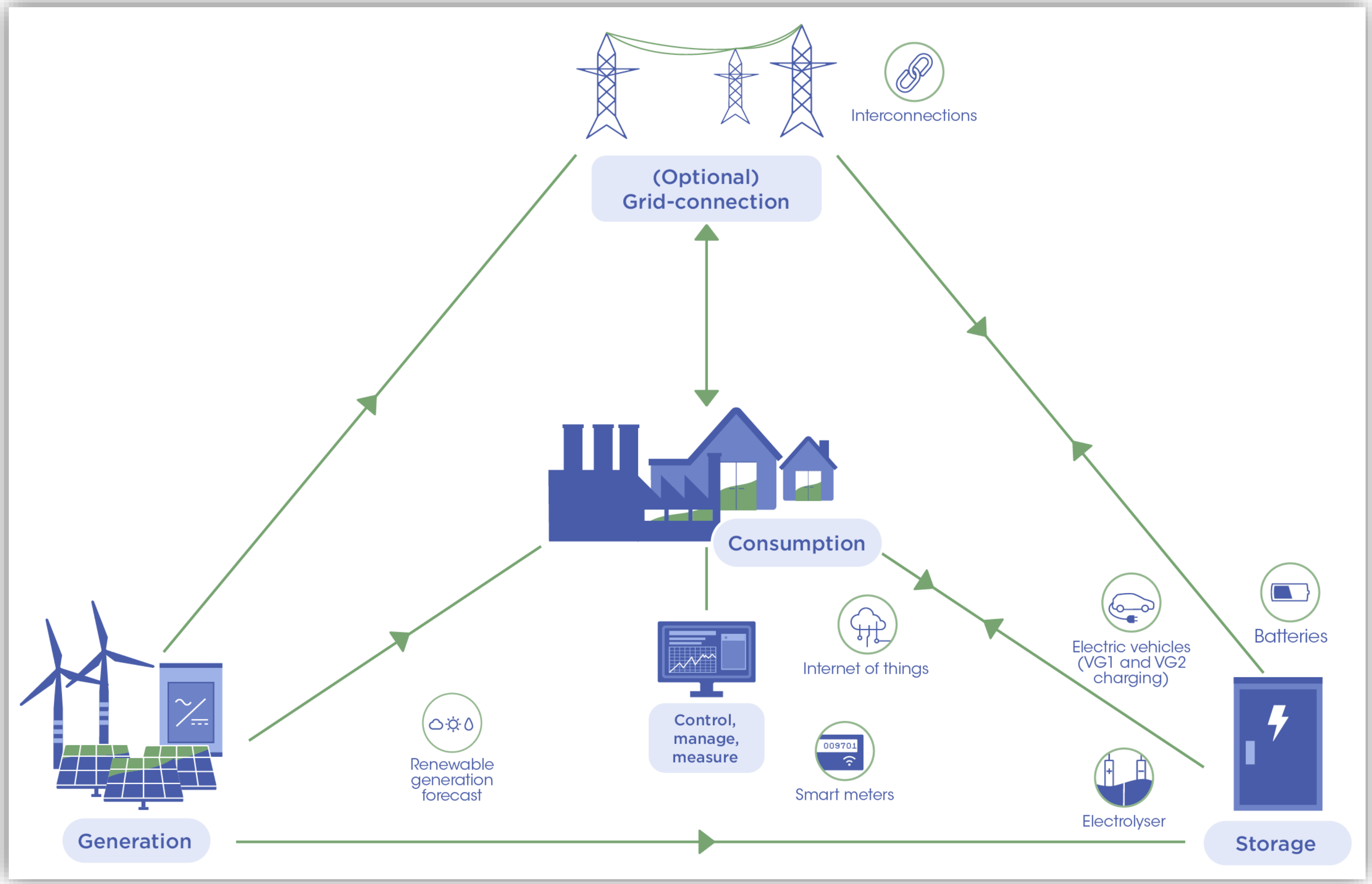
1. Latest National Electrical Code;
2. Latest National Electrical Safety Code;
3. IEEE Standard 1547-2014;
4. IEEE P2030.2, P2030.7;
5. IEC 61850-7-420; Power Utility Automation
6. IEC/TS 62898-1 and 62898-2; Guidelines for microgrid projects planning and specification

Source: NFPA, 2018; CEPR, 2018, WRI 2017, Magnaray International, African enterprise investor

Innovation – mini grid of the future

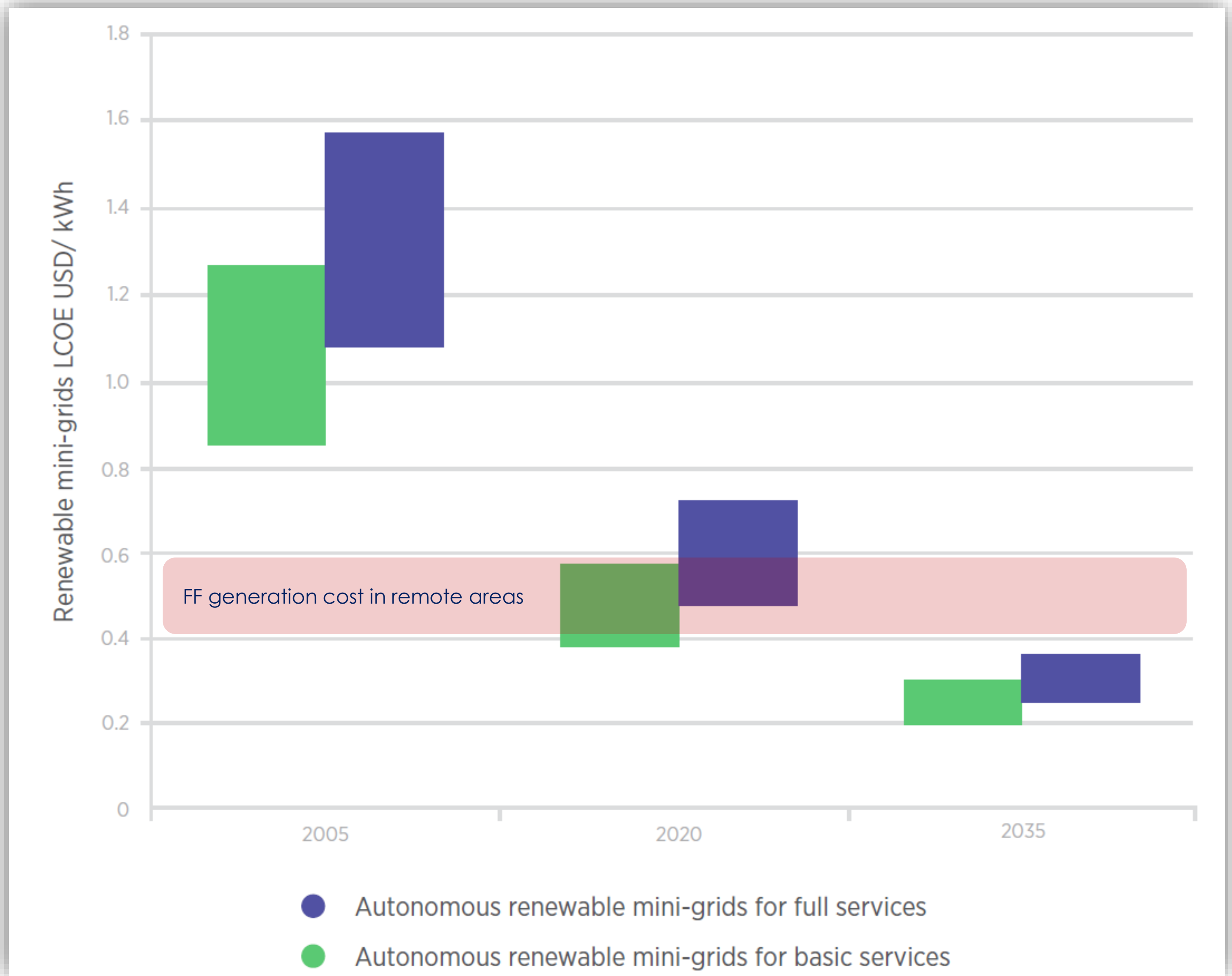
Major role of digital technologies:

- Interoperability standards
- Communication protocols
- Low-voltage direct-current standards



Source: IRENA (2020), Quality Infrastructure for Smart Mini-Grids

Innovation and assured quality – making mini grids more competitive

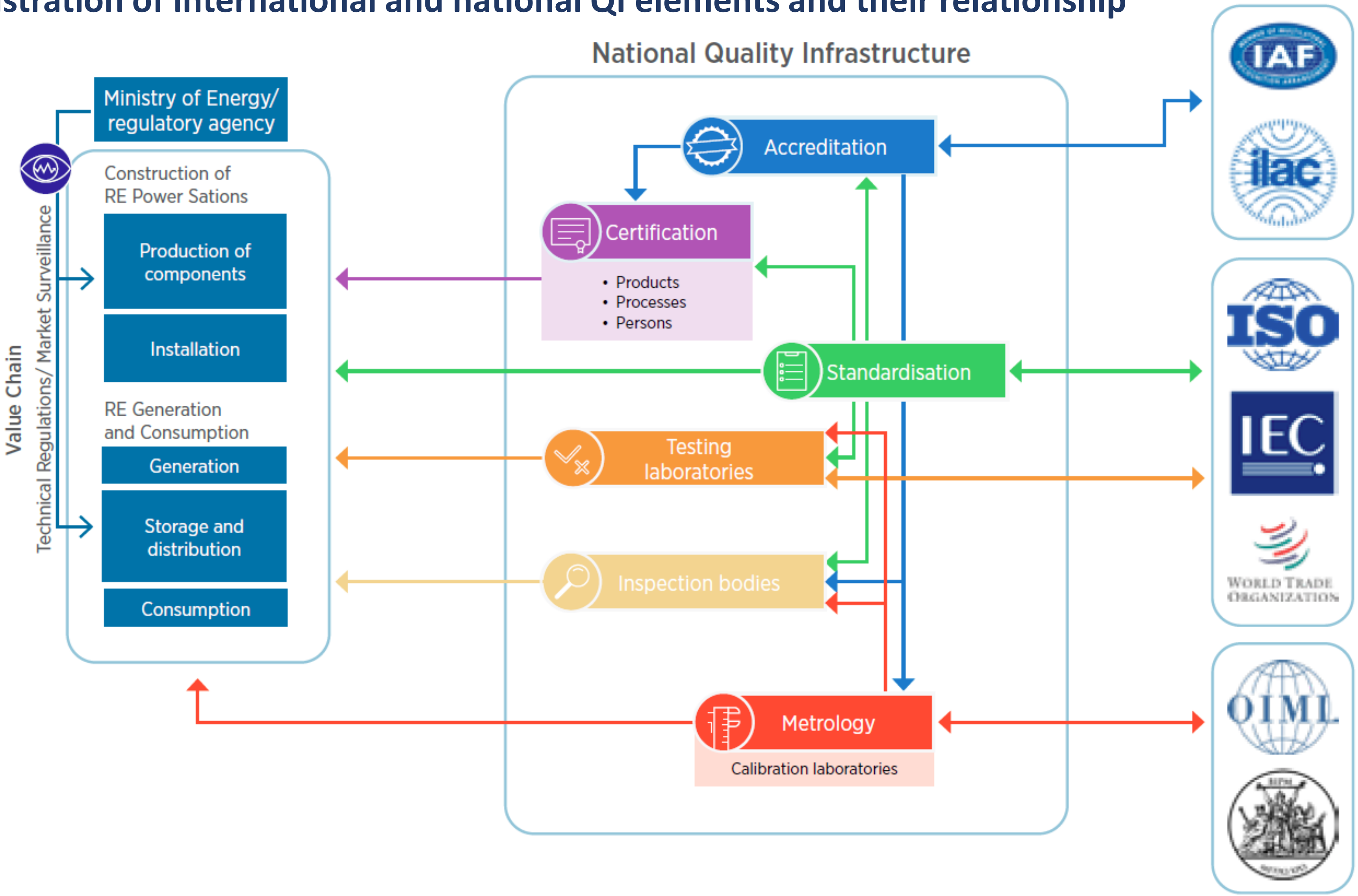


Renewable mini-grids already competitive in islands

Source: IRENA (2020), Quality Infrastructure for Smart Mini-Grids

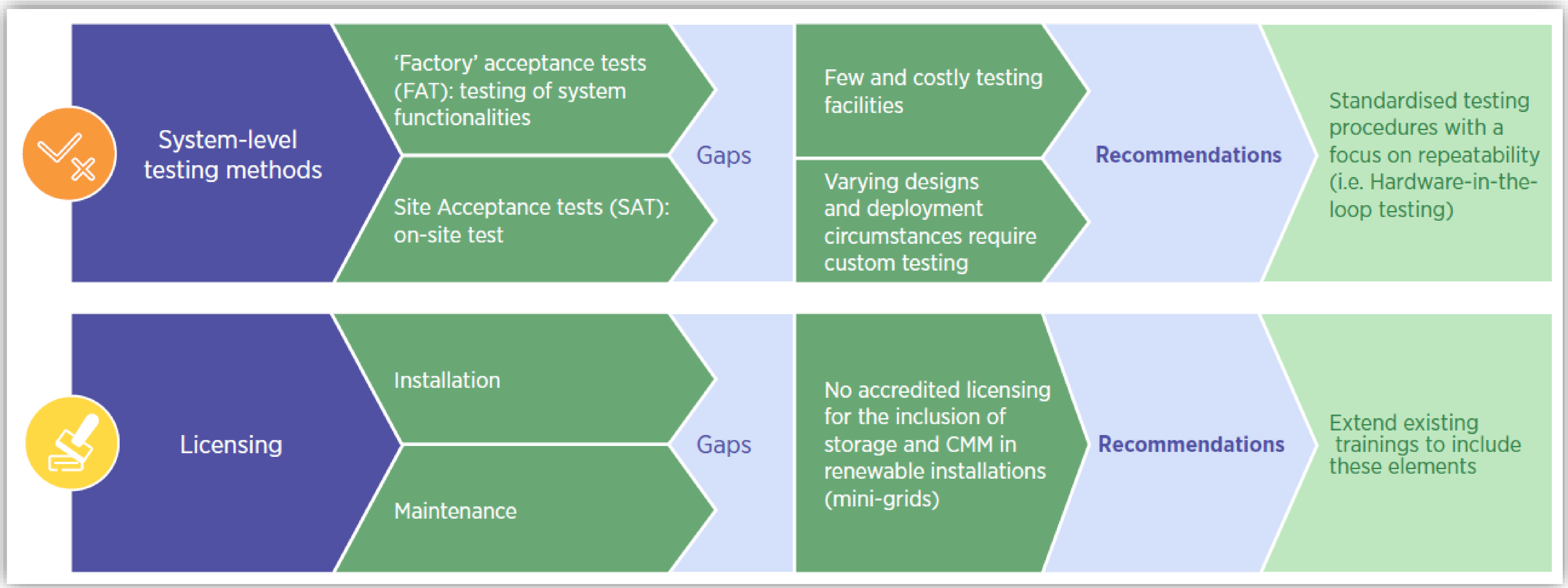
Quality infrastructure – crucial for robust mini-grids markets

Illustration of international and national QI elements and their relationship



Source: IRENA (2020

QI for mini-grids requires a component and a “system level” approach



Source: IRENA (2020), Quality Infrastructure for Smart Mini-Grids

Need to anticipate QI needs for the mini-grids of the future

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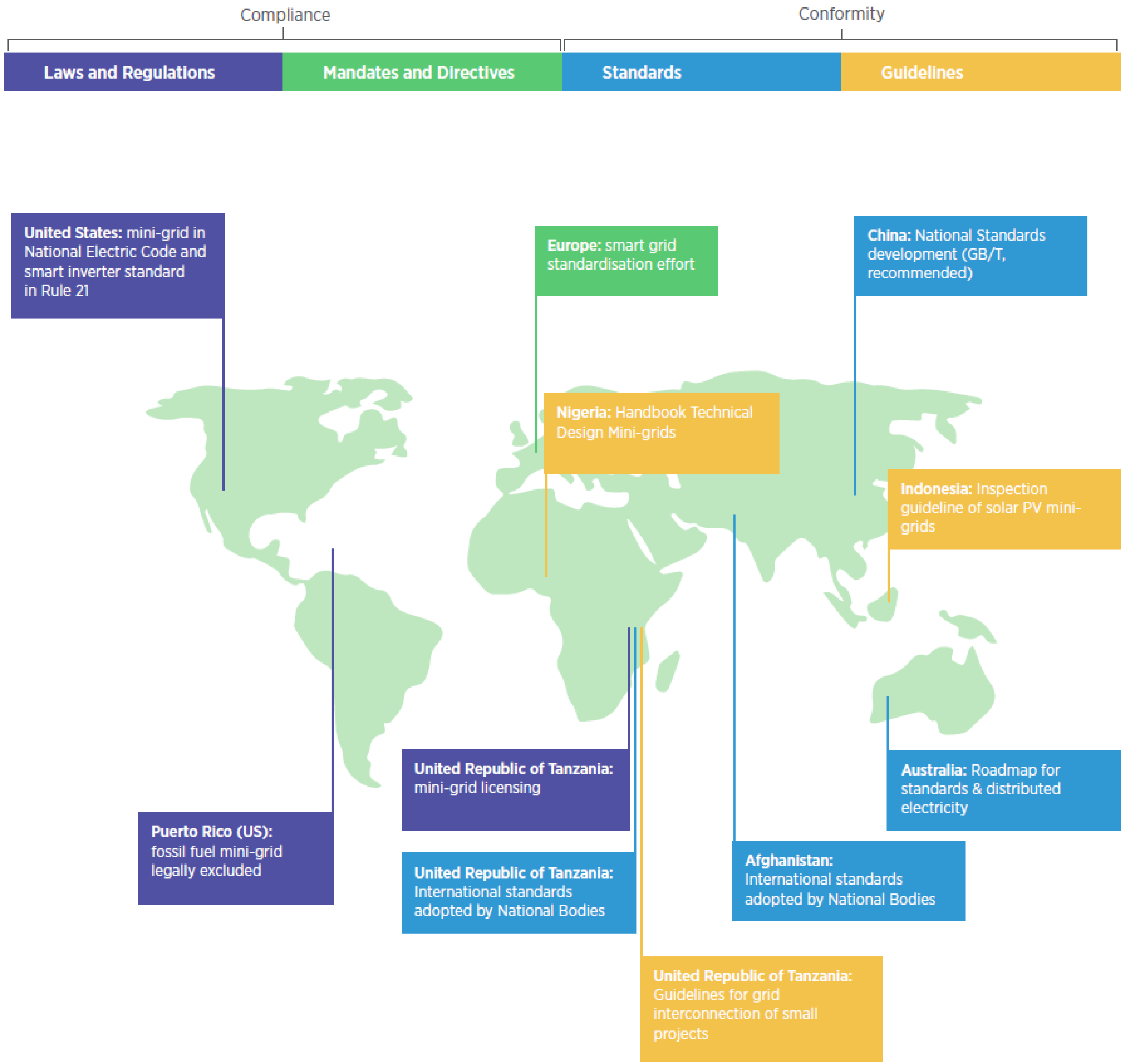
CMM — Gaps

Incompatibility of communication protocols	Standardised communication protocols facilitating mini-grid extensions	IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems
A lack of national standards, codes and regulations concerning the possible integration of mini-grids in a larger grid	Grid extension QI has to assure a return on investment in the case of a grid extension. Several schemes are possible	Interoperability standards (IEEE P2030.7 and IEEE P2030.8) Different layers of interoperability by the GridWise Architecture Council
Grid regulations not adapted to mini-grid service levels	Grid regulations and standardisation adapted to operational demand of the end users.	EN 50549 standards series covering the requirements for generating plants to be connected in parallel with distribution networks
Discrepancies in regulatory responsibilities between grid operators and mini-grid suppliers		Pre-standardisation activities regarding interconnection requirements of DER by European Distributed Energy Resources Laboratories (DERlab)
Short-term forecasting requires further QI development	Adapt to more irregular and dynamic load and production curves of renewable mini-grids	Meteorological models and simulations using satellite data and sky cameras
Roll-out of smart meter devices and introduction of new functionalities	A continuous quality assurance effort is required	ETSI Smart Meters Coordination Group (SM-CG)
QI for internet of things and cybersecurity	Development of open, comprehensive and preferably international standards will be required in the future, together with ongoing vigilance to ensure cybersecurity	EcoStruxure Microgrid Advisor cloud-based system by Schneider Electric

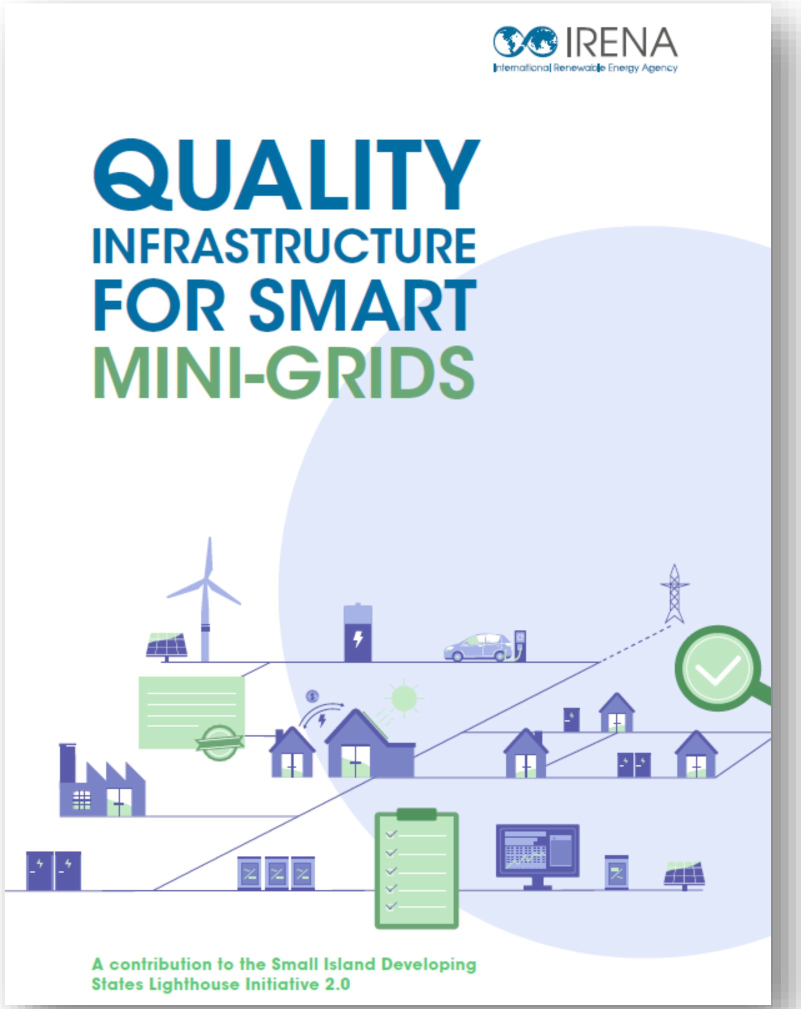
current mini-grids (yellow) — mini-grids of the future (green)

Source: IRENA (2020), Quality Infrastructure for Smart Mini-Grids



QI to be incorporated into policy and regulatory instruments

Source: IRENA (2020), Quality Infrastructure for Smart Mini-Grids



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Panel discussion

Panel discussion

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9 Closing remarks

Closing remarks

Roland Roesch

Deputy Director

IRENA Innovation and Technology Centre

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