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WEBINARS

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

THURSDAY, 29 OCTOBER 2020 • 05:00 – 06:30 CET

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WEBINARS

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

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

If you encounter any technical issues, please write your issue in the **chat box**

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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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05:00 – 05:05	Welcoming remarks
05:05 – 05:15	Scene setting
05:15 – 05:35	Member countries' perspectives
05:35 – 05:50	Key takeaways from transforming small islands
05:50 – 06:00	Partner organisation's perspective
06:00 – 06:15	Key insights into grid assessment studies
06:15 – 06:25	Panel discussion with Q&A from the audience
06:25 – 06:30	Closing remarks

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1 Welcoming remarks

Welcoming remarks

Roland Roesch

Deputy Director

IRENA Innovation and Technology Centre

Overview IRENA

MANDATE

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

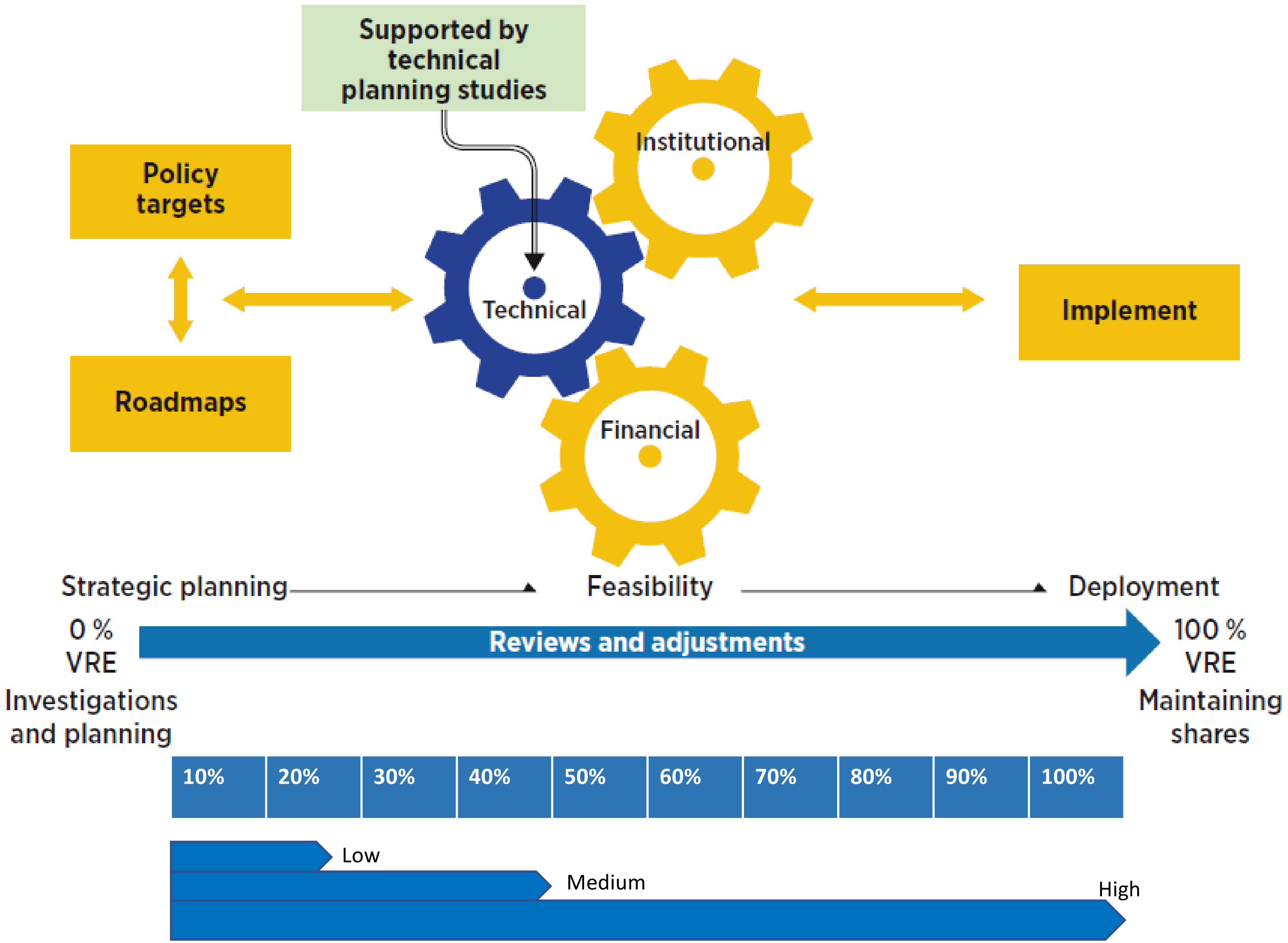
OBJECTIVE

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

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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

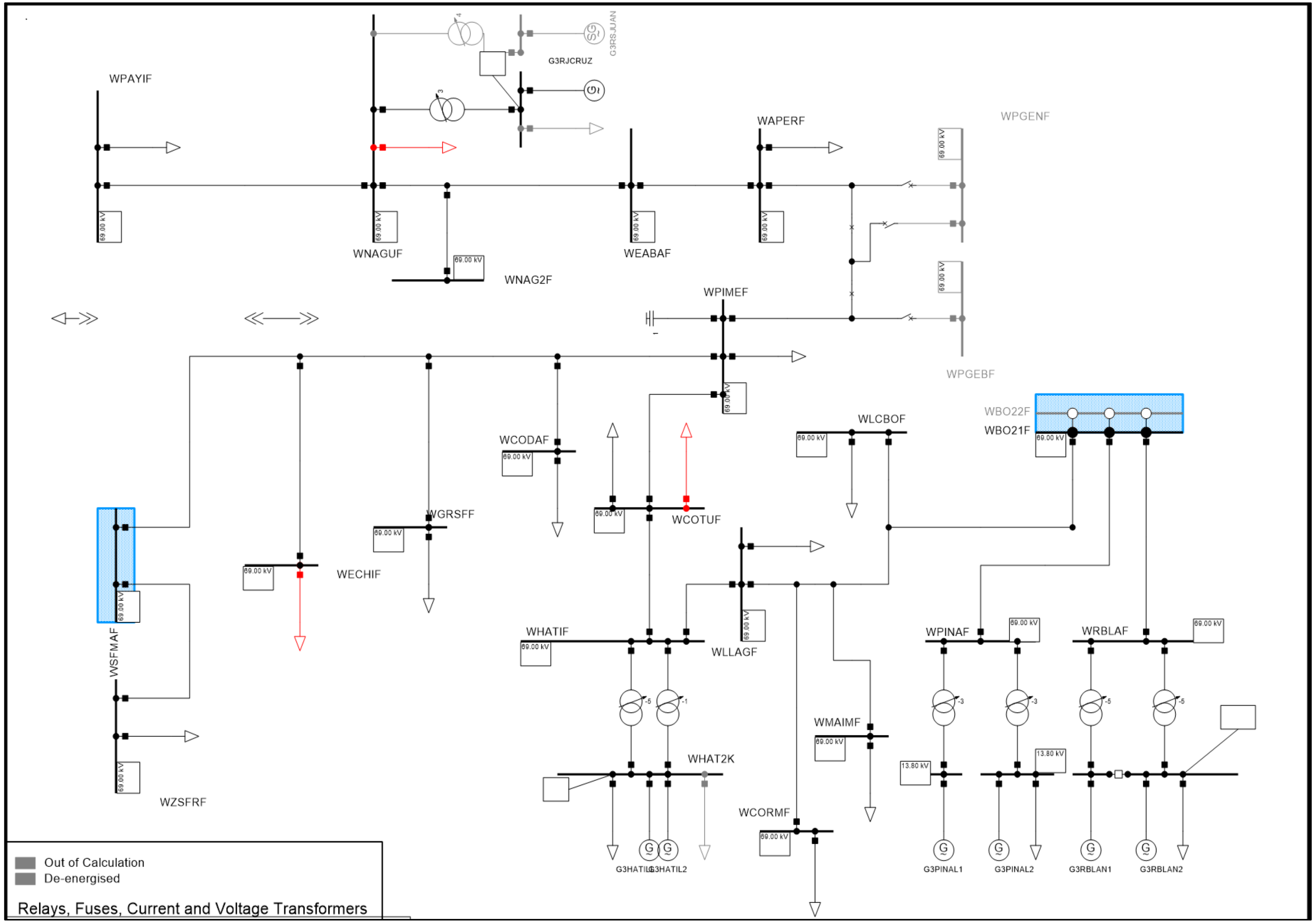
based on specifications and priorities

Requirement

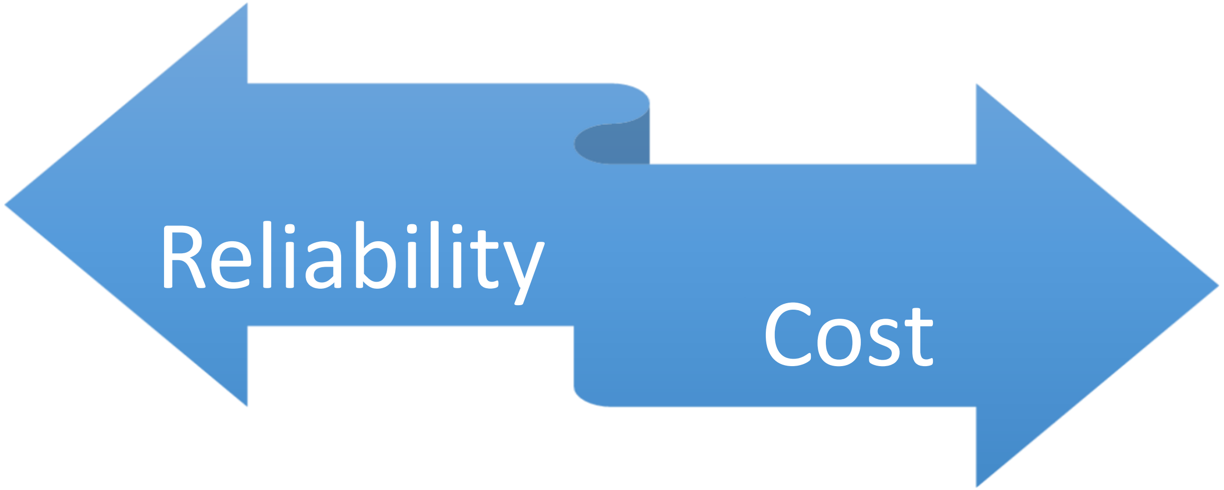
- Accurate and detail information
- Engagement with stakeholders

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 – IRENA's report

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TRANSFORMING SMALL-ISLAND POWER SYSTEMS

TECHNICAL PLANNING STUDIES FOR THE INTEGRATION OF VARIABLE RENEWABLES

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

2 Scene setting

Scene setting

Arieta Gonelevu Rakai

Programme Officer

SIDS Lighthouses, IRENA

SIDS Lighthouses Initiative

Supporting Small Island Developing States in Energy Transformation

SIDS and Partners

SIDS LIGHTHOUSES

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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

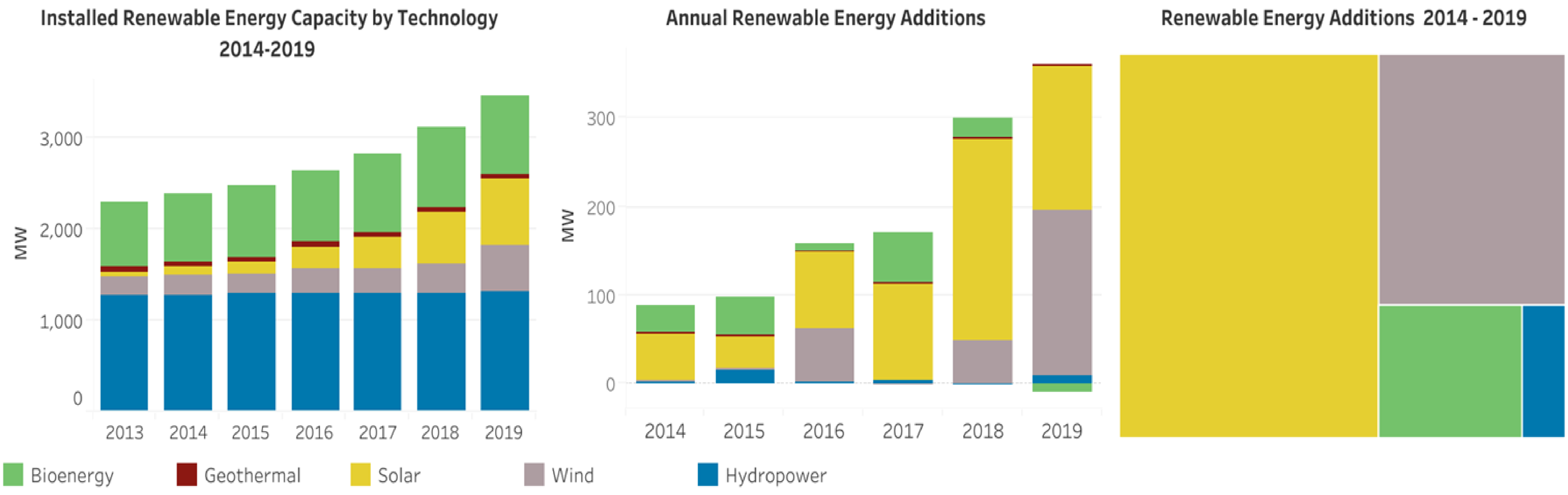
1. Denmark
2. France
3. Japan
4. Italy
5. Germany
6. Italy
7. New Zealand
8. Norway
9. United Arab Emirates
10. United States of America
11. Association of the Overseas Countries and Territories of the European Union
12. Caribbean Electric Utility Services Corporation
13. Clean Energy Solutions Center
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**
7. Expand focus beyond power generation to include **transportation and other end-use sectors**
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

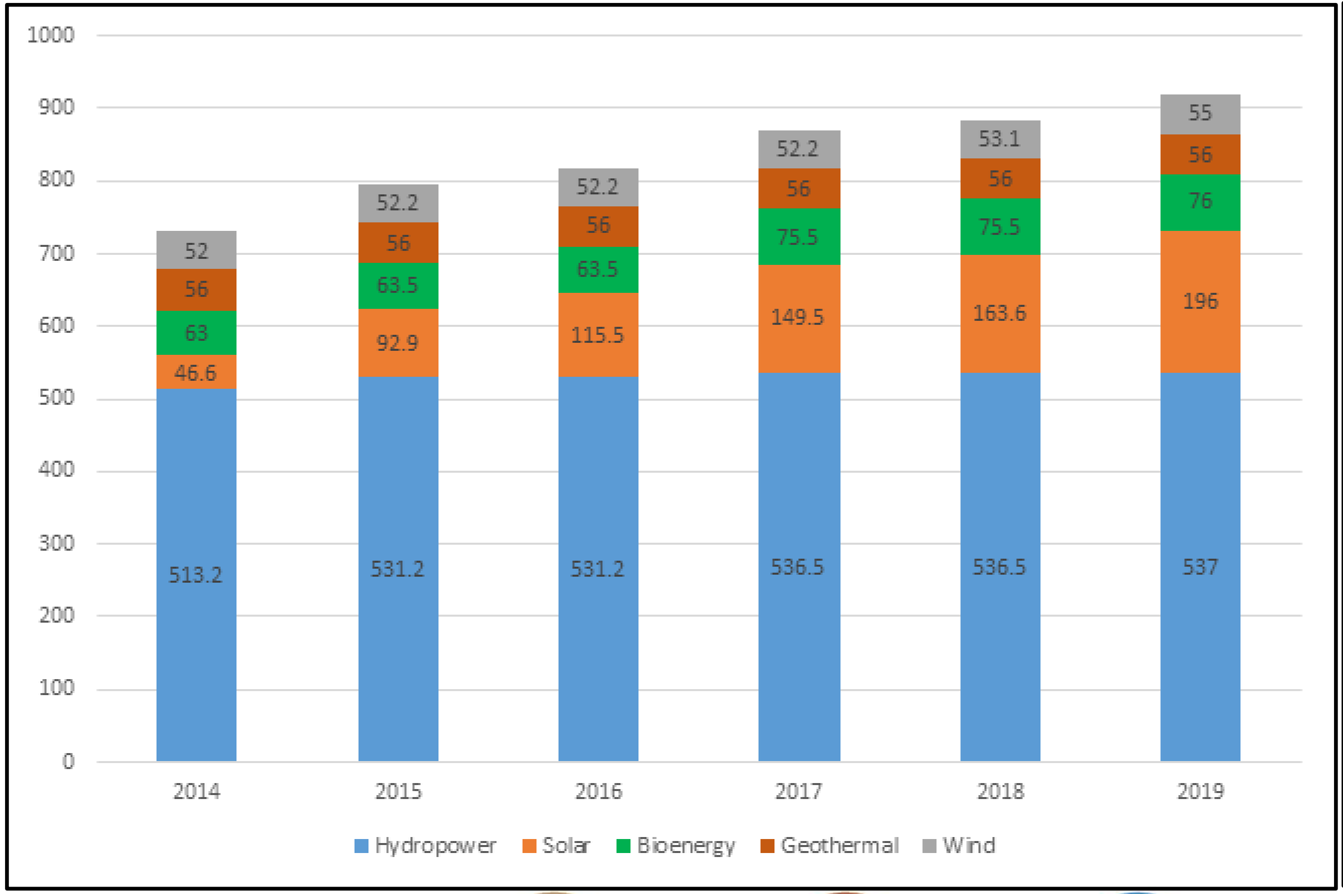


Note: This dashboard illustrat rogress made by SIDS partners of the Lighthouses Initiative based on latest renewable energy statistics.

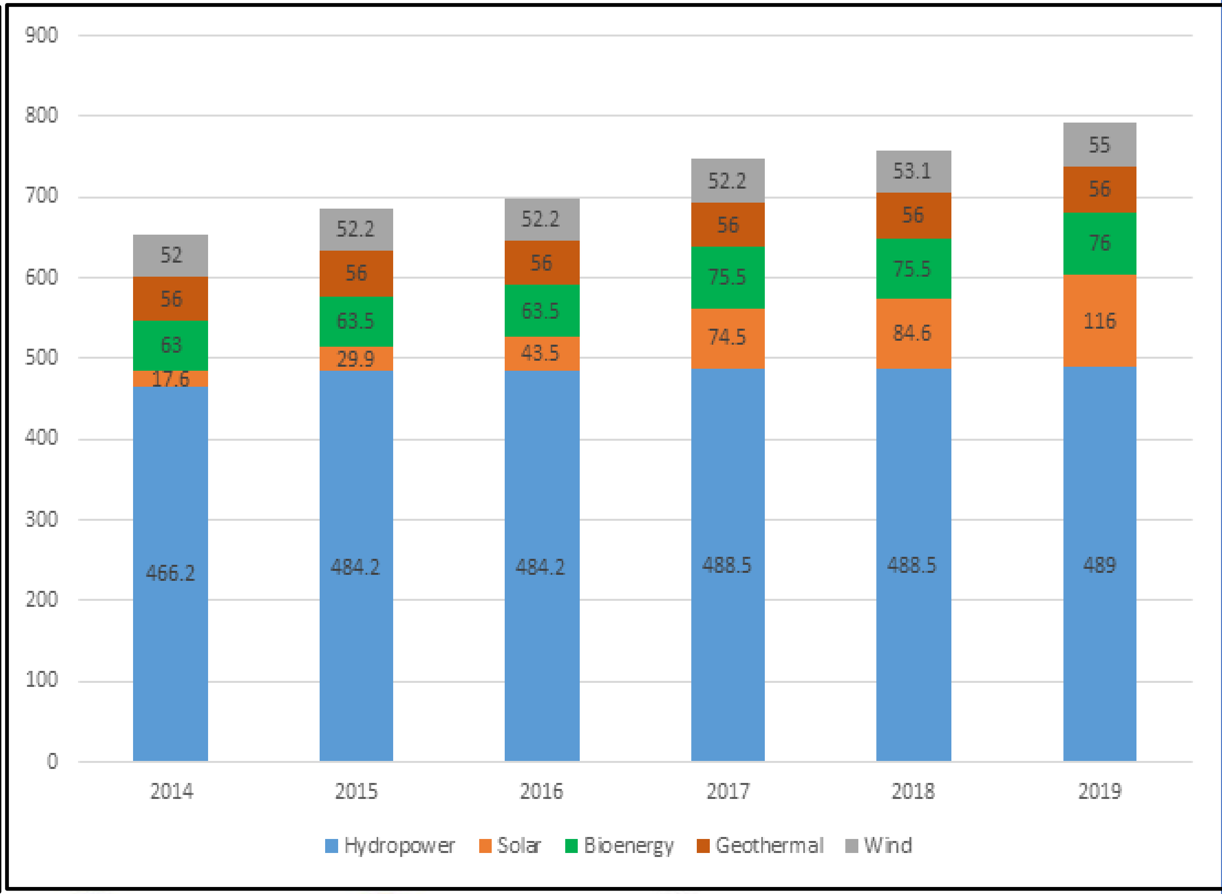
Source: IRENA Statistics www.irena.org/statistics

Installed RE Capacity in Pacific SIDS

All Pacific SIDS



LHI Partners








SIDS LIGHTHOUSES

Strengthening Dialogue, Capacity and Partnerships

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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

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

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

SIDS Ministerial – IRENA 10th Assembly
January 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 ⇒

SIDS LIGHTHOUSES

Energy Transformation Tools and Services

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Quickscans

Grid Integration Analysis

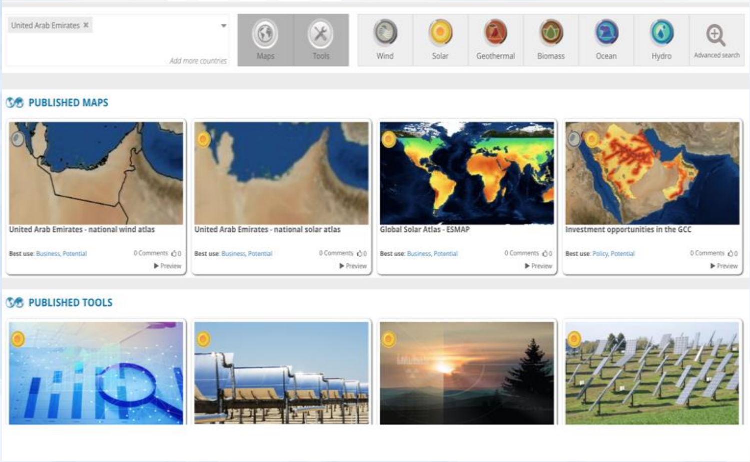
NDC Enhancement and Implementation Support

Renewable Energy/E-Mobility Roadmaps

Renewable Readiness Assessment

Knowledge Hub and Dissemination

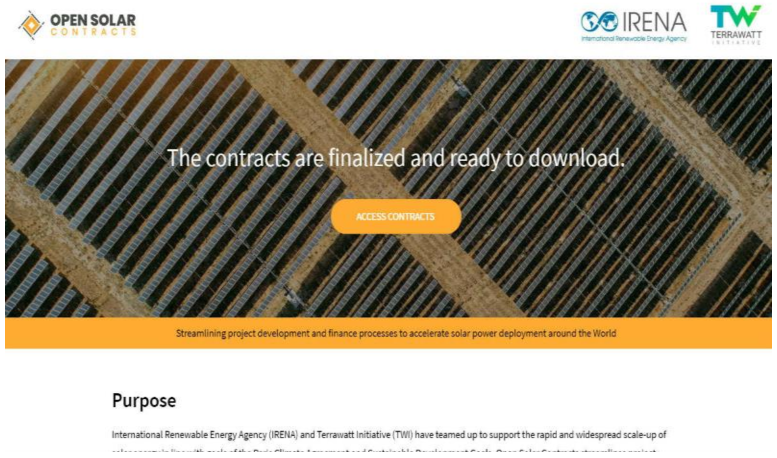
Project Facilitation Tools



Global Atlas

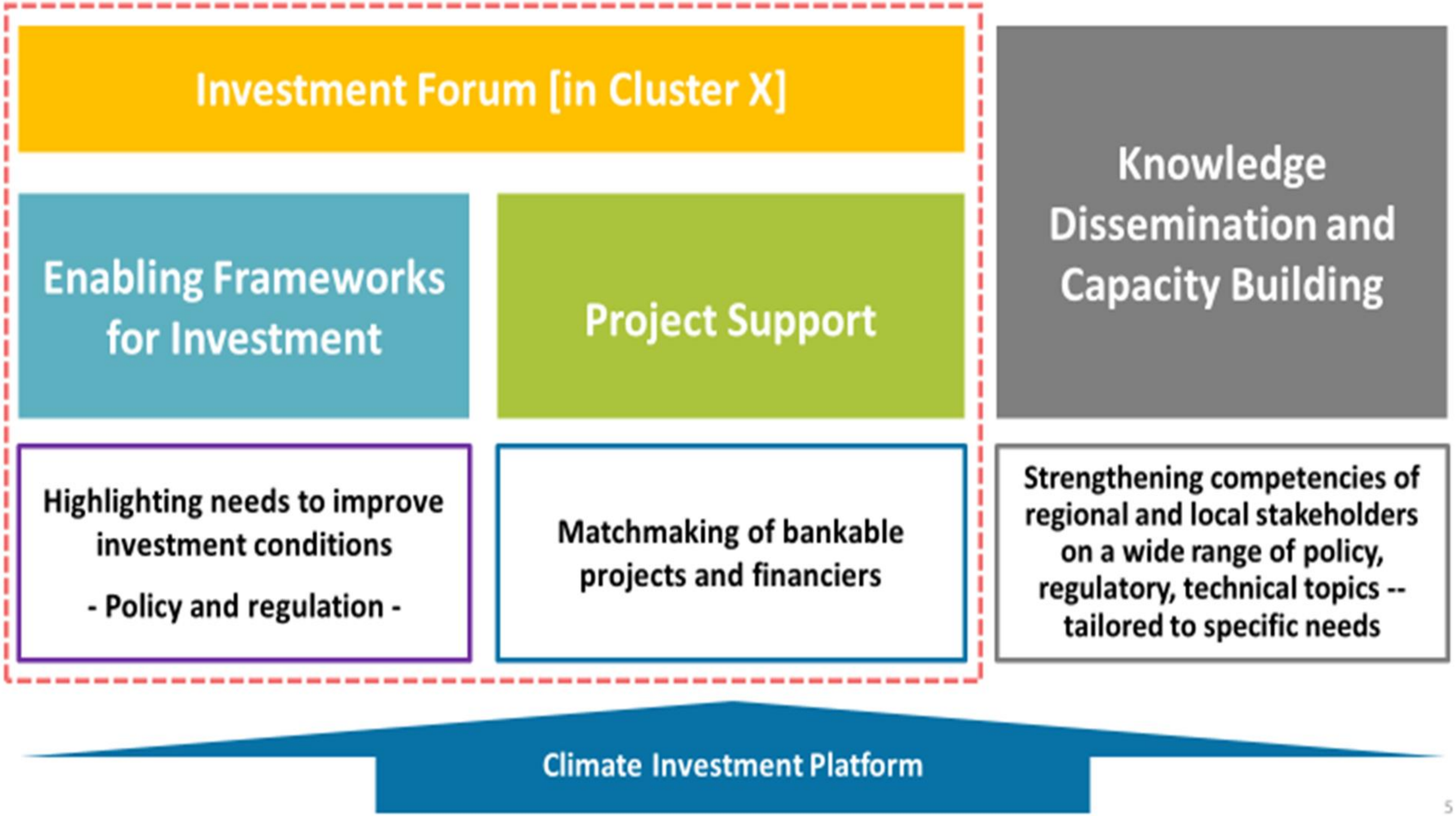
Project Navigator

IRENA/ADFD Facility



Open Solar Contracts

Climate Investment Platform
Investment Forums



More Support Needed for Energy Transformation

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

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

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

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

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

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

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

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

Acknowledgement of Support

- Belgium (Walloon)
- Denmark
- France
- Germany
- Netherlands
- New Zealand
- Norway
- NDC Partnership
- UNDP

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

Email: islands@irena.org

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3 Member countries' perspectives

Vanuatu perspective

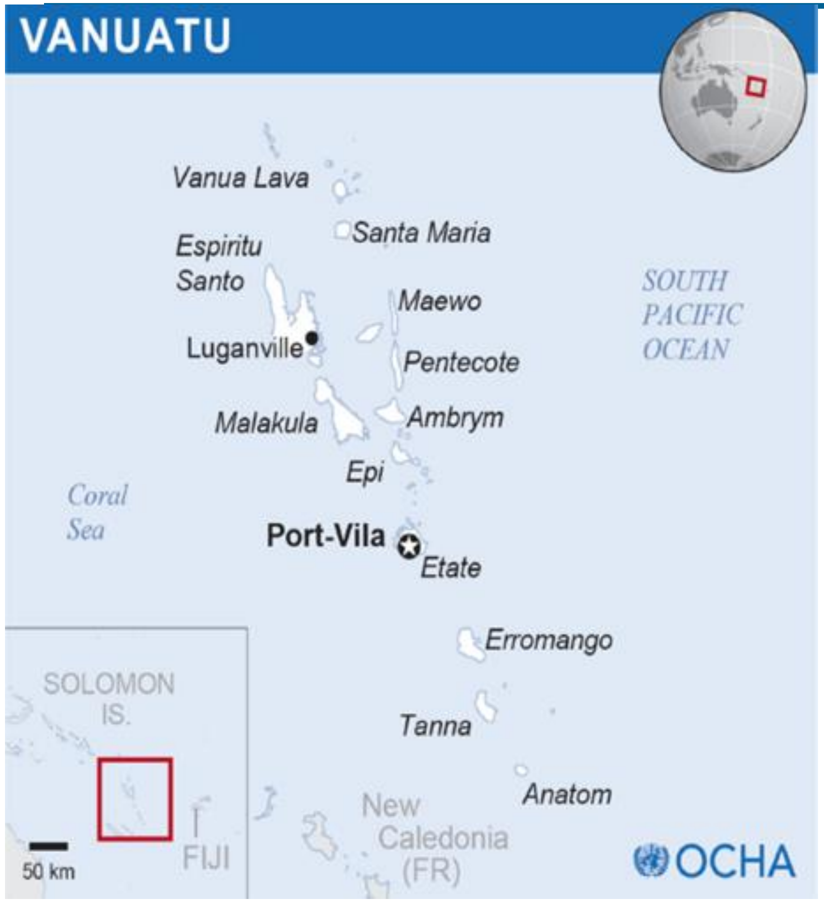
Antony Garae
Director
Department of Energy, Vanuatu

Transforming Small Island Developing States Power Systems through Variable Renewable Energy - Vanuatu Experience

29th October 2020

Antony Garae
Director, Department of Energy
Ministry of Climate Change
Vanuatu

Country Context



Island nation in South Pacific Ocean - more than 80 islands - 65 inhabited.

Population 272,000 in more than 53,000 households

Around 28 % of the population lives on the main island of Efate - 75 percent live in rural areas

Key economic Sectors: subsistence agriculture, tourism, offshore financial services, and raising cattle.

Highly vulnerable to natural disasters, such as cyclones, flooding, earthquakes, landslides, tsunamis and volcanic eruptions

Energy Sector Background

- Characterized by low access, high relative prices
- Significant reliance on imported fuels
- Limited access to a permanent source of electricity for rural households.
- Key energy sector public and private institutions: Ministry of Climate Change and Natural Hazards (Department of Energy) Utilities regulatory Authority and Electricity Utility Companies (UNELCO & VUI) and Private RE Companies.
- Renewable energy sources (Solar, Geothermal, Hydro, Wind) are substantial, although not yet utilized according to its potential.
- Solar has been shown in Vanuatu and other parts of the Pacific to be a reliable and cost effective approach to basic electrification for rural areas

Vanuatu's Energy Mix

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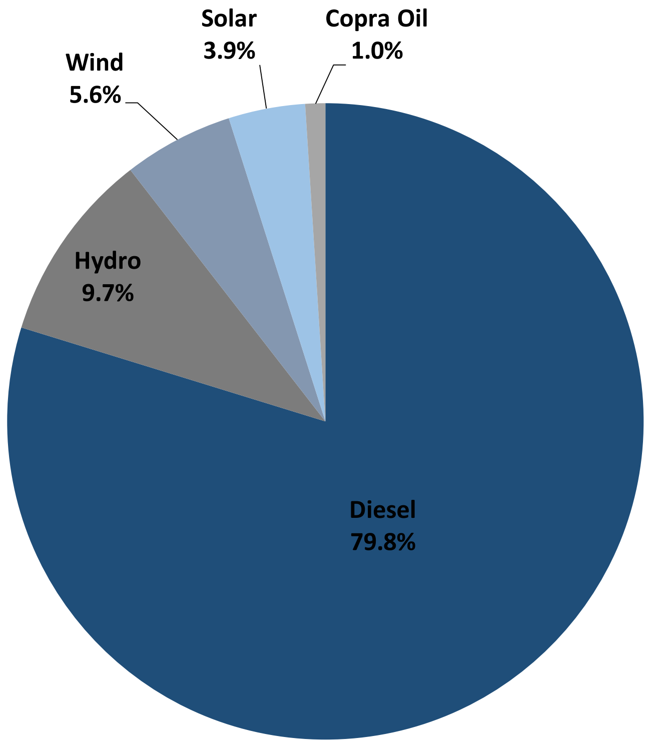
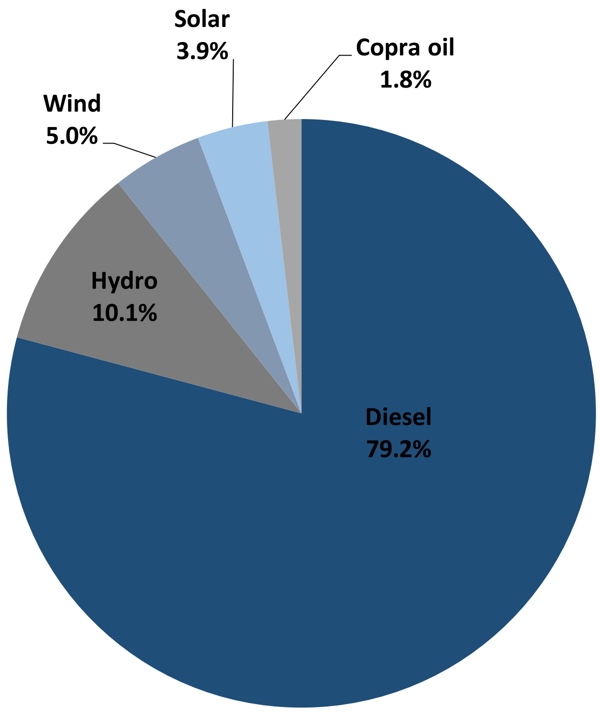


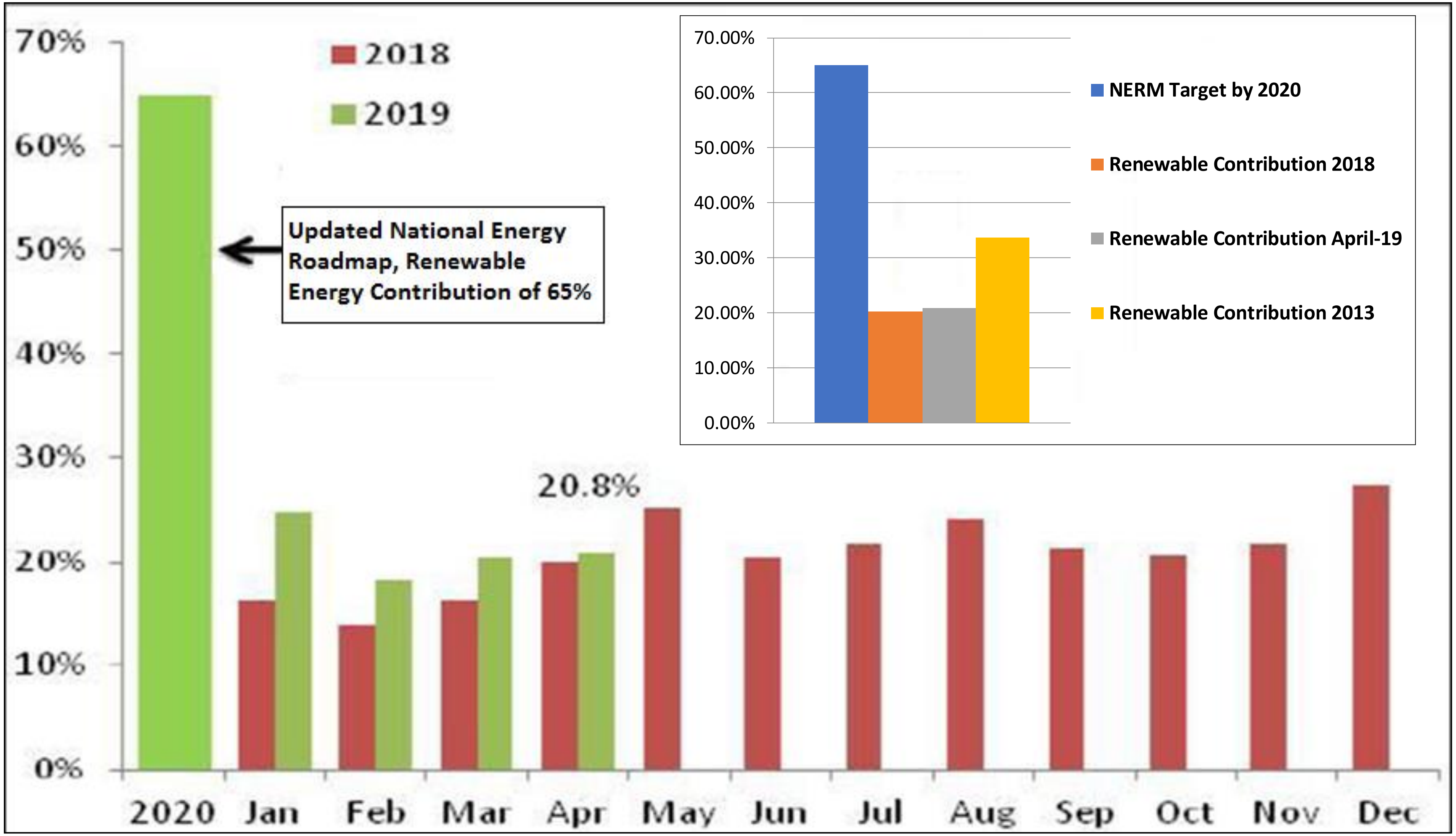
Energy Mix As At End of 2018



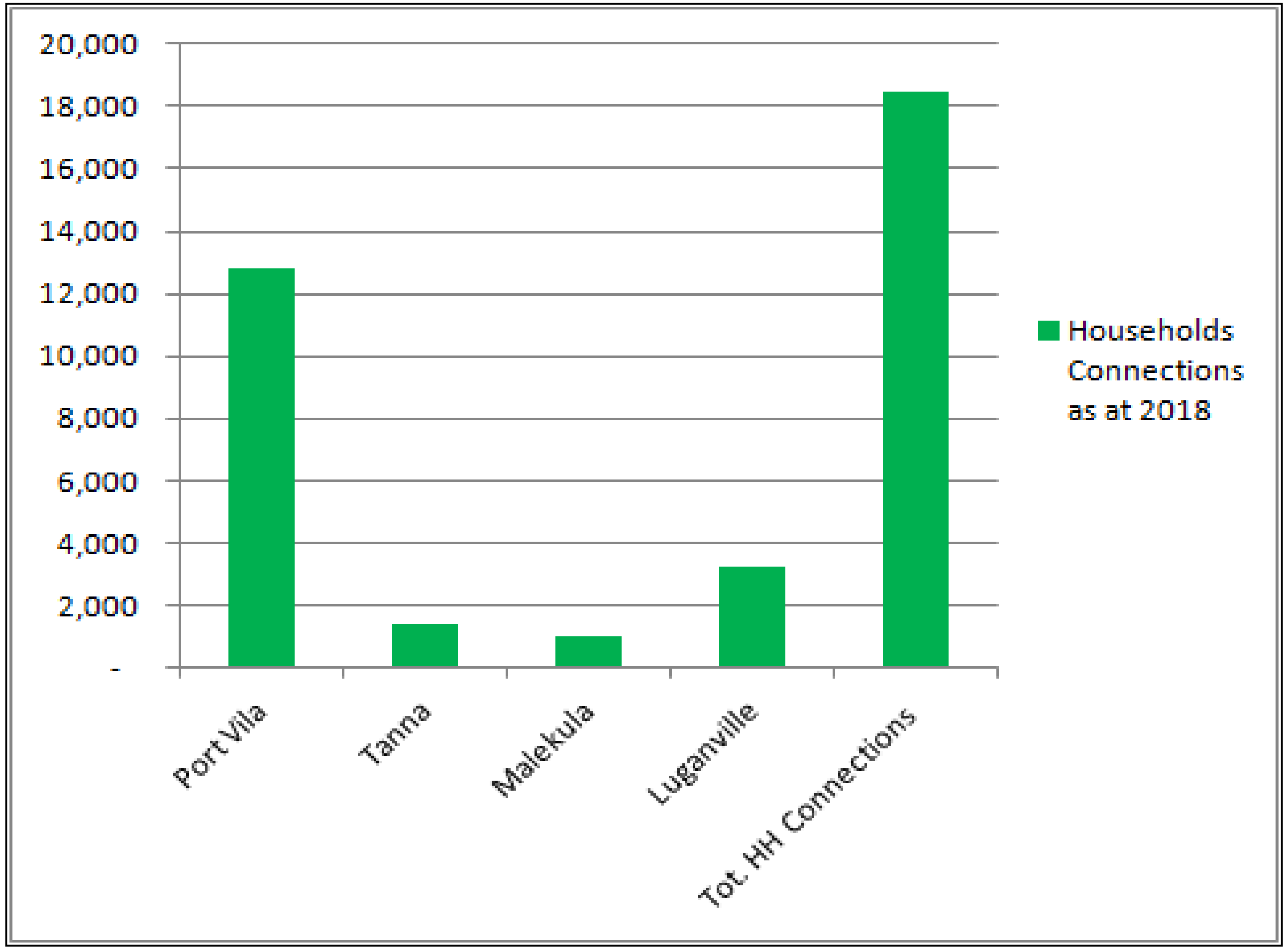
Energy Mix As At April 2019

2018/2019 – Renewable Penetration to overall generation mix is approx. 20%

Renewable Contribution in Concession Areas Vs National Energy Road Map (NERM) Target by 2020



Household Access as at 2018



VNSO Mini-Census 2016 Report:
Tot. No. Of HH within Concession Areas is approx. 23,500 HH.

Total HH connection as at end of 2016 is 16,300.

70 % of HH connected to grid (2016).

As at end of 2018, HH connections stands at approx. **18,500.**

NERM's target, by 2020 for HH connection is 75%.

IRENA Grid Integration Study – Espiritu Santo

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- Carried out with assistance from IRENA during 2018/2019
- Study presents a high-level assessment of the wide variety of renewable energy possibilities for expanding the Luganville grid on Espiritu Santo, Vanuatu.
- The study was conducted on the basis of a defined set of scenarios, which include hydropower options, potential grant funding for a 300 kilowatt (kW) hydropower plant, and the impact of Port Olry grid extension.
- The study recommends the best configuration for system achieving 87% renewable energy contribution in 2030 would be:
  - a grant funded 800 kW of new hydropower with grant funded 300 kW of new hydropower,
  - 2 MW of solar PV, a 1 MW/2 MWh battery,
  - 0.5 MW of diesel UPS and
  - a comprehensive hybrid control system at current equipment costs

Grid Integration Study – Espiritu Santo

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- The study also recommends development of:
  - ➢ a detailed "grid code" and generator performance standards
  - ➢ a hybrid control system to comprehensively co-ordinate all generation and supporting equipment.
- Other recommendations from the study include:

➢ Review of the configuration of the entire existing power system to verify acceptability at expected 2030 load levels.

➢ Detailed studies and design should be undertaken to determine equipment requirements prior to any significant procurement

Moving towards NERM Goal (including VRE Systems)

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- During 2019, the Department of Energy (DoE) also updated the NERM Implementation Plan (NERM-IP), which is a key component of the NERM 2016-2030. The implementation plan lists key activities aiming at achieving the targets of the NERM.
- Since launching of the NERM, the Government through the Department of Energy has implemented (a number of energy sector projects in the country which include:
  - Soalr PV mini-grid (73kW) for the Wintua and Lorlow communities, Malekula
  - Phase 1 and 2 of the Vanuatu Rural Electrification program;
  - the United Arab Emirates and European Union funded solar photovoltaic projects,
  - Kawene solar farm (1 MW) and Undine bay Solar (500kW) - UNELCO
  - bio-fuel projects in Saratamata, in Ambae and Sola in Vanuatu Lava;
  - Talise hydro on Maewo;
  - institutional biogas systems at Onesua and agricultural college
  - solar refrigeration for rural tourist bungalows

Moving towards NERM Goal (including VRE Systems)

- Some of the on-going/planned initiatives include:
  - Vanuatu Energy Access Project – Brenwe hydro (400 kW) on Santo; Grid extension on Santo and Malekula
  - Swarm technology based RE electrification of Lelepa island, around 100 households (Powerblox, Switzerland)
  - Solar/RE hybrid mini-grids under VREP phase 2
  - Revision of Electricity Supply Act and Coconut for Fuel Strategy
  - Expansion of solar PV on Efate by 7.6 MW to achieve the total installed capacity of 10 MW, in combination with storage capacity. (As per NDC roadmap)
  - Addition of 5.1 MW of wind generation on Efate, in combination with storage capacity. (As per NDC roadmap)
  - Exploration study on using the "Distributed Energy Generation" by installing micro/mini-grids in concession areas (Efate, Santo, Malekula & Tanna) in locations where grid extension is hard to reach or very expensive.

Future Collaboration with IRENA and Support Needed

- Assistance needed on carrying out techno-economic feasibility studies for installing distributed energy generation mini/micro grids
- Support on to develop and implement a robust Coconut for Fuel Strategy which is our immediate priority intervention identified under Vanuatu's NDC roadmap in order to move towards 100% RE in electricity generation sector.
- Technical hand-holding and capacity building support for the DoE staff on all aspects of VRE system.
- Availability of funding is one of the key factors which would assist in achieving our NERM and NDC targets. Any support in terms of mobilizing financial support for the planned initiatives would be appreciated.

Fiji perspective

Mikaele Belena

Director of Energy

Ministry of Infrastructure and Meteorological Services

Fiji

Ministry of Infrastructure
& Meteorological Services

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SIDS Lighthouse Initiative: Technical Webinar Series

Transforming Small Island Developing States Power System through Variable Renewable Energy (VRE)

Mikaele Belena
Director Energy

SDG target and its Linkages

Linkages

5 & 20 year National Development Plan

Draft National Energy Policy 2014 -2020

Green Growth Framework (2014)

NDC Implementation Roadmap (2017-2030)

Other Relevant Planning Documents

- Maritime and Land Transport Policy -2015
- National Climate Change Policy -2018 -2030
- Low Emission Development Strategy (LEDS)-(2018-2050)
- National Adaptation Plan -2018
- National Disaster Risk Reduction Policy 2018-2030

5-YEAR & 20- YEAR NATIONAL DEVELOPMENT TARGETS

2021

- 100% Electricity Access to all Fijians

2036

- Increase renewable target to 100% in the overall electricity Supply mix

FIJI's NDC TARGET

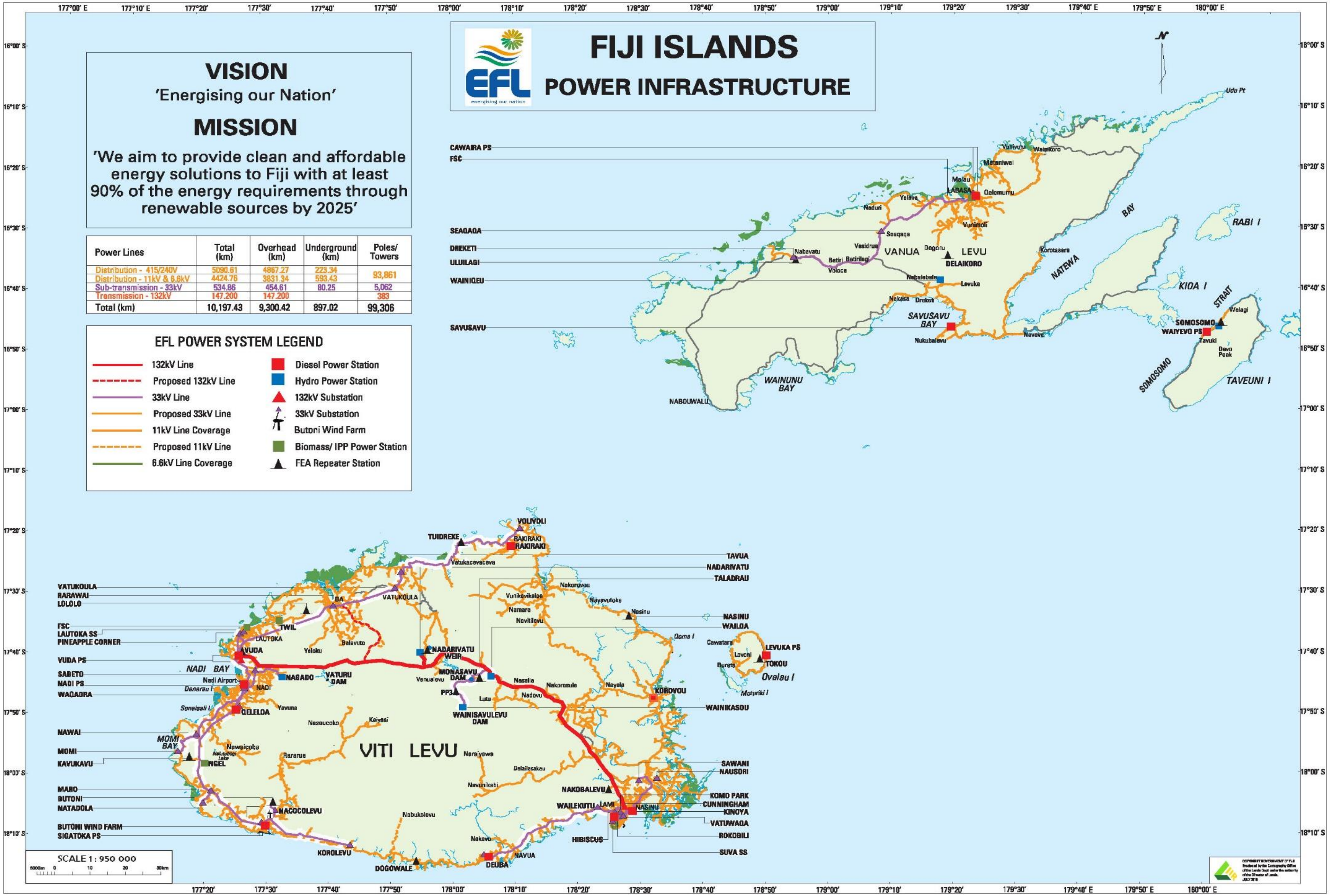
10% through Energy Efficiency

20% Achieved through Renewable Energy

Reduce GHG Emission by 30% by 2030

Key Players in the Power Sector

Government- Department of Energy
Energy Fiji Limited
Fiji Competition and Consumer Commission (FCCC)
Private Sector



Power Lines	Total (km)	Overhead (km)	Underground (km)	Poles/ Towers
Distribution - 415/240V	5090.61	4867.27	223.34	93,861
Distribution - 11kV & 6.6kV	4424.76	3831.34	593.43	
Sub-transmission - 33kV	534.86	454.61	80.25	5,062
Transmission - 132kV	147.200	147.200		383
Total (km)	10,197.43	9,300.42	897.02	99,306

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Strategic Assets

Line Type	Route (km)	Towers/Poles
Transmission Line 132kV	147.2km	383 Steel Towers
Sub-transmission 33kV	534.86km	5,062 poles
Power Distribution 11kV & 415V/240V	9,969km	93,861 poles

Demand Supply Statistics

- Consumer Growth – Last 8 years average growth rate is around 2.97%

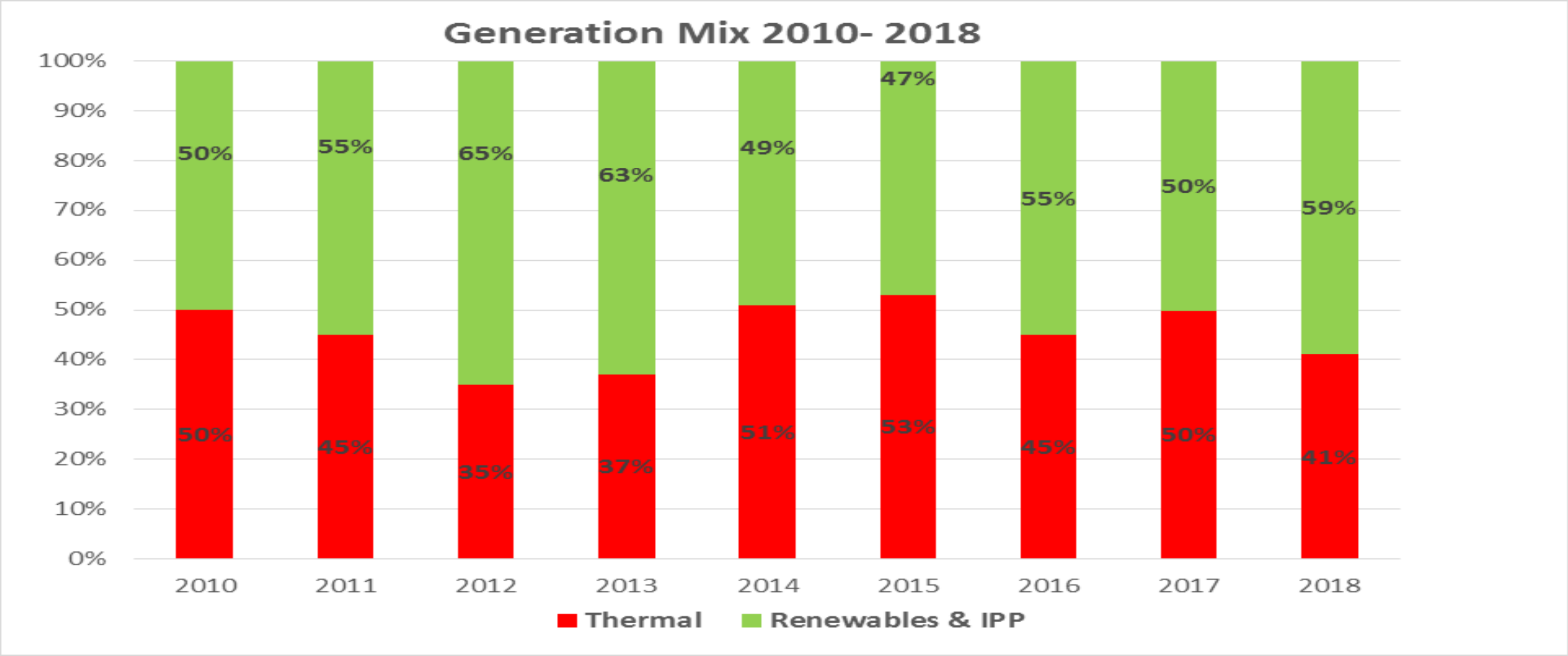
Years	2010	2011	2012	2013	2014	2015	2016	2017	2018
Customer Numbers	150,724	155,912	159,017	162,656	167,017	171,939	174,530	182,439	194,404
Annual Growth		3.44%	1.99%	2.29%	2.68%	2.95%	1.51%	4.53%	4.37%

- 2018 Peak Demand, Installed & Available Capacity (Renewable & Thermal)

Individual Systems	Peak Demand (MW)	Installed Thermal (MW)	Available Thermal (MW)	Installed Renewable (MW)	Available Renewable (MW)	Total Available Generation Capacity (MW)
Viti Levu	171.57	140.90	126.91	146.5	125.18	252.085
Labasa	7.6	15.50	11.10	-	-	11.10
Savusavu	2.3	4.50	3.70	0.80	0.80	4.50
Ovalau	1.8	2.80	2.30	-	-	2.30
Taveuni	0.38	2.00	1.60	0.70	0.70	2.30
Total	**183.65**	**165.70**	**145.61**	**148.00**	**126.68**	**272.29**

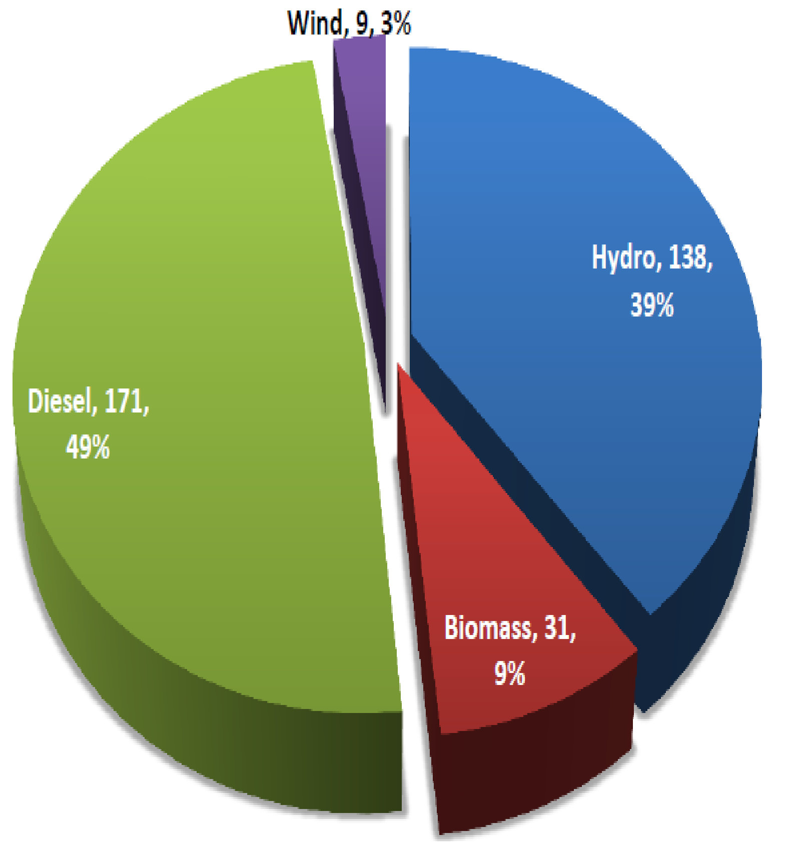
- Fiji Sugar Corporation supplies during the crushing season only in Labasa & Lautoka
- Tropik Wood supply has been erratic over the last few years due to operational issues
- Nabou Green Energy Limited started exporting to the grid from late July, 2017

Where Are We Now with our Power Generation Mix?

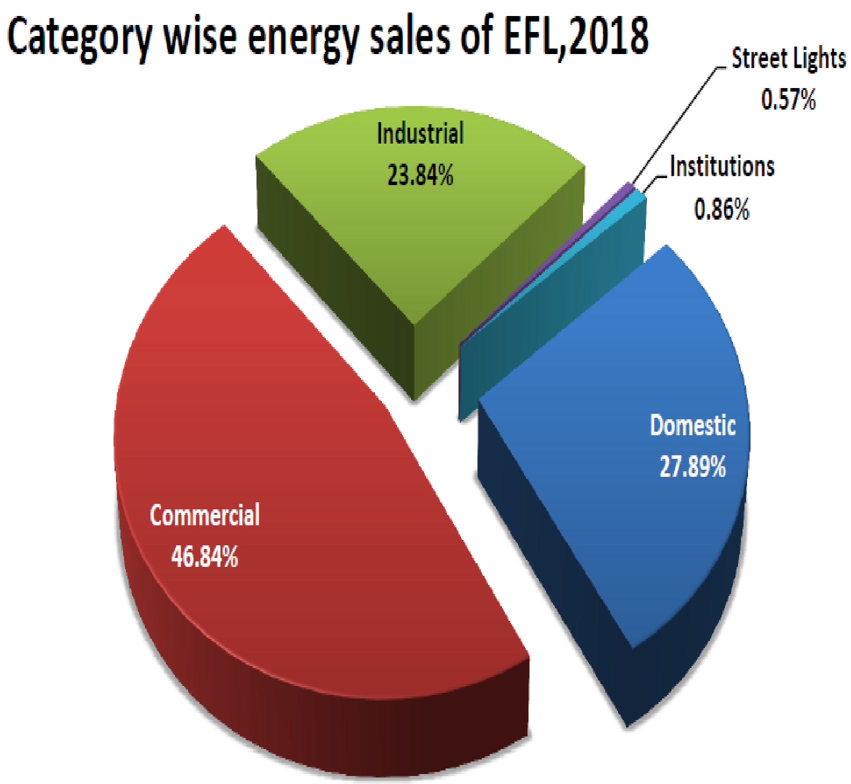


- **EFL Renewable Power Stations**
  - Monasavu Hydro Electric Scheme – 72MW with anticipated generation of 400GWh/annum
  - Nadarivatu Hydro Electric Scheme – 44MW with anticipated generation 101GWh/annum
  - Butoni Wind Farm – 9.9MW with anticipated generation of 5GWh/annum
  - Wainikasou Hydro Electric Scheme – 6.6MW with anticipated generation 26GWh/annum
  - Nagado Hydro Electric Scheme – 2.8MW with anticipated generation of 12GWh/annum
  - Wainiqeu Hydro Electric Scheme – 0.8MW with anticipated generation of 2GWh/annum
  - Somosomo Hydro Electric Scheme – 0.7MW with anticipated generation of 2GWh/annum

Fiji's Energy mix and Sales per sector 2018 (Status and shares of VRE)



Installed generation mix in EFL (MW, %)



Ongoing Projects- Hydro & VRE

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Sl. No	Generation name	Storage (MWhr)	Type	Total capacity (MW)	Investment required (Million FJD)	commissioning schedule (for proposed)	Remarks
	VLIS						
1	Solar PV with Storage	1	Solar	5	9.8	2022	1x 5MW – Tavua (1hr storage)
2	Solar PV with Storage	1	Solar	5	9.8	2022	1x 5MW Rarawai (1hr storage)
3	Qeleloa solar		Solar	5	9.0	2020	
4	Qaliwana and Upper Wailoa Diversion		Hydro	22	499	2024	
5	Lower Ba		Hydro	28	249	2026	
6	Solar PV		Solar	5	9.0	2025	Proper feasibility is required for solar PV at Butoni
7	Namosi Hydro		Hydro	30	270	2023	
	Vanua Levu						
1	Solar IPP with Battery banks	2.5	Solar	5	11.05	2021	Assuming 50% storage of installed capacity
2	Solar IPP with Battery banks-1	0.5		1	2.21	2022	PRDC has proposed and assuming 50% storage of proposed installed capacity
3	Solar IPP with Battery banks-2	0.5		1	2.21	2024	
4	Solar IPP with Battery banks-3	0.5		1	2.21	2026	
5	Solar IPP with Battery banks-4	0.5		1	2.21	2028	
	Ovalu						
1	Solar PV with Storage of 4MWh	4	Solar	5	12.28	2023	11kV Loop requires to be closed, reinforcement required
	Taveuni						
1	Mua Solar Farm	0.5	Solar + BESS	1	2.21	2021	PRDC has proposed and assuming 50% storage of proposed installed capacity

IRENA Studies & Implementation

Grid Integration Study- Renewable Energy Strategy for Viti Levu

- **The study will highlight the capability of existing network (feeders) during the penetration of renewables. The study shows the case studies of best and worst scenarios.**
- **The study will also assist the utility company and the government to determine modification required in the network variable renewables are penetrated.**
- **The study will also assist in determining the total cost required in the network if modification is required.**
- **The study will assist in the formulation of different policies such roof top solar, solar farms , etc.**

Renewable Energy Readiness Assessment (2014)

Service- Resource Pairs

- **Grid-based power/geothermal energy.**
- **Grid Based Power/solar photovoltaic (PV)**
- **Grid Based Power/biomass-fuelled generation.**
- **Off-grid rural power supply/solar energy.**
- **More efficient vessels/renewable power for maritime transport.**

Collaboration & Partnership Program

- **UN Economic & Social Commission for Asia and the Pacific (UNESCAP)**
  - Evidence Based Policies for Sustainable Use of Energy Resources in Asia and the Pacific – study focuses on the viability of introducing electric vehicle in the transport sector
- **KOICA**
  - Funding for the 1MW Solar Grid Connect in Taveuni
  - Co-fund the installation of 4MW Solar Grid Connect in Ovalau
- **JICA**
  - Capacity Building Training on Solar-Diesel Hybrid for 5 Pacific Island Countries (~ 3 years) – Government & Utility

Future Collaboration

- **Research, Capacity Building on Renewable Energy Resources (Wave/OTEC/Solar/Wind), Power Systems Modelling**
  - Short & Long Term Training
- **Collaboration with our Institutions (FNU/USP)**
- **Demonstration Projects (Renewable/Solar Charging Stations etc.)**

Thank You !!!

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4 Key takeaways from "Transforming Small Islands: Technical planning studies for the integration of variable renewables"

Gayathri Nair

Associate Programme Officer

Renewable Energy Grid Integration, IRENA

Characteristics of VRE and its impact

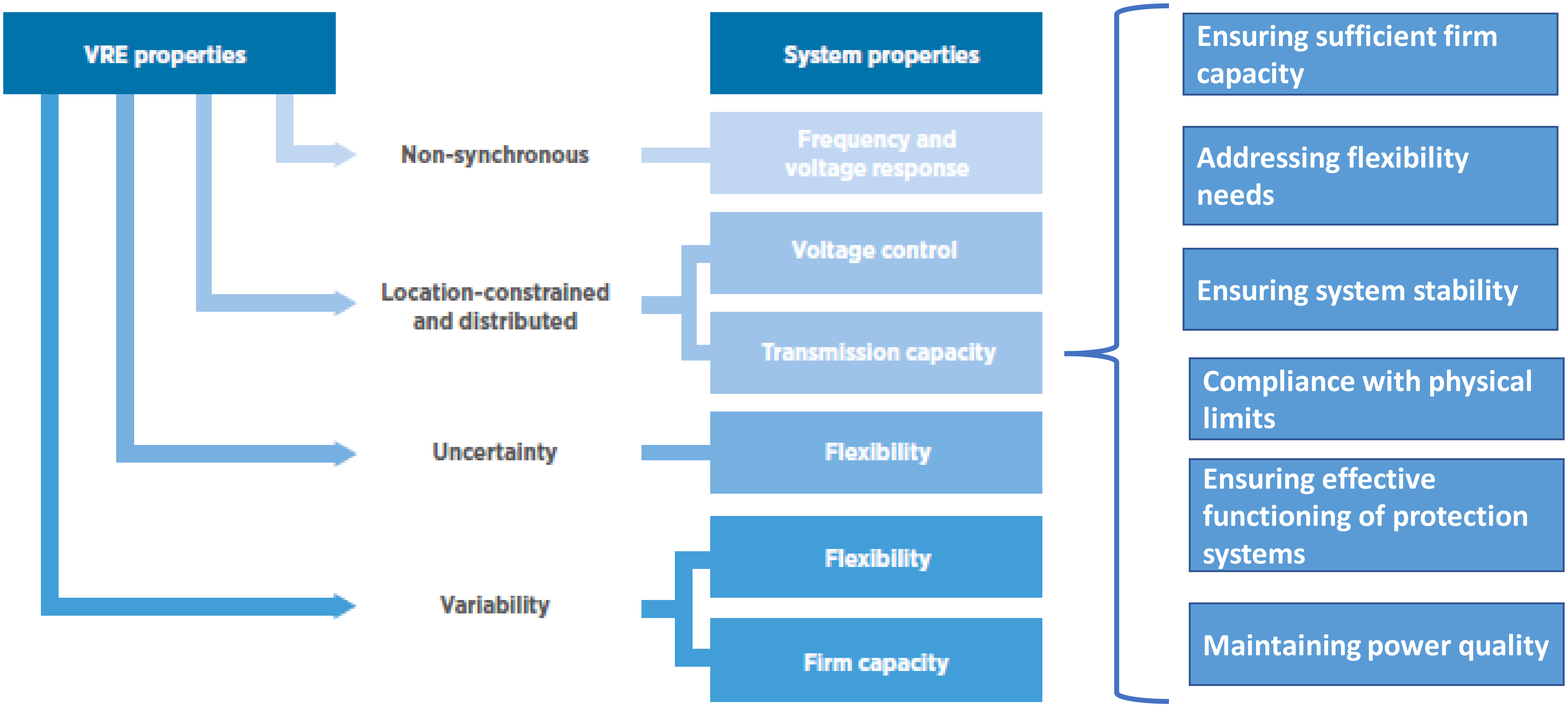


Fig. Key links between variable renewable energy, power system properties and planning

Essential steps in planning to overcome challenges in SIDS

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

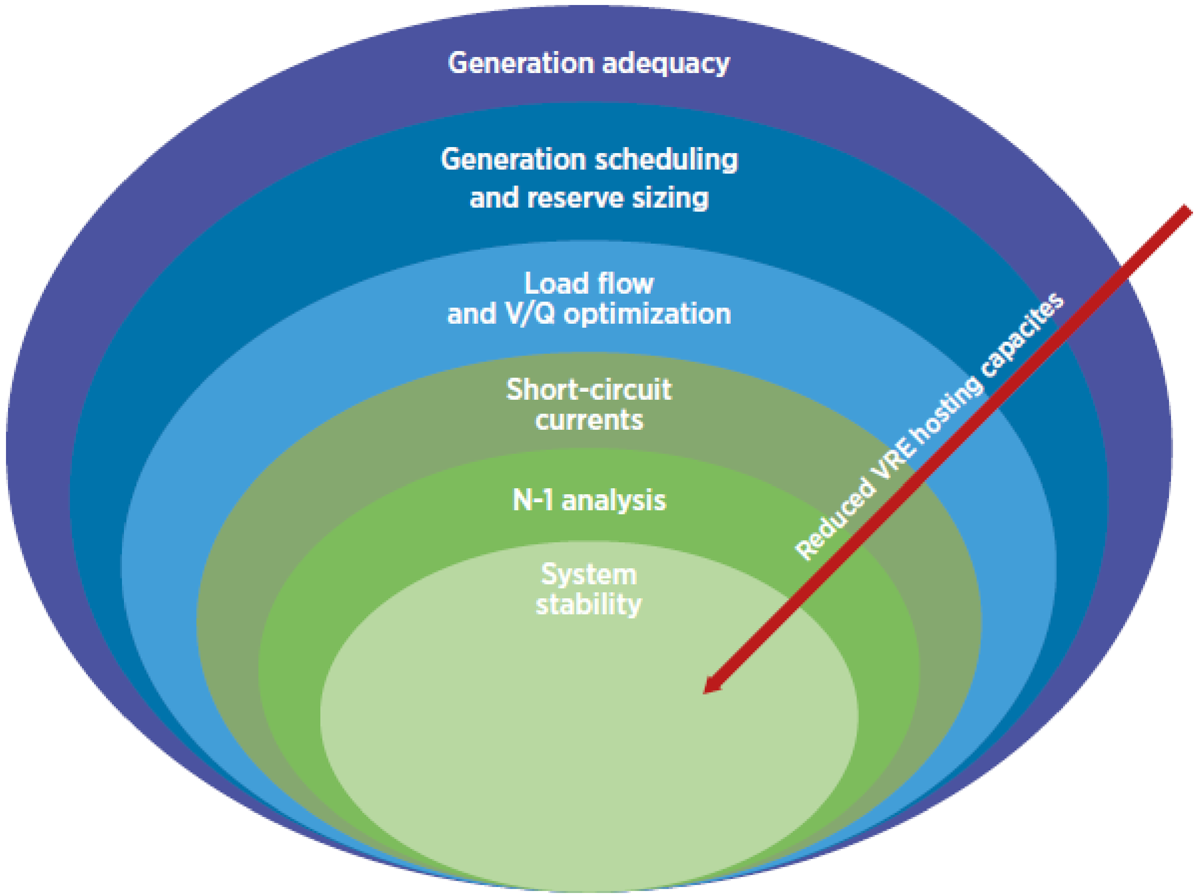
Absence of dedicated long-/mid-term expansion planning	Absence of sufficient operating reserves	Inadequate set-up of load shedding schemes	Fully automated operation of diesel power stations	Absence of up-to-date grid-codes with clear definitions

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

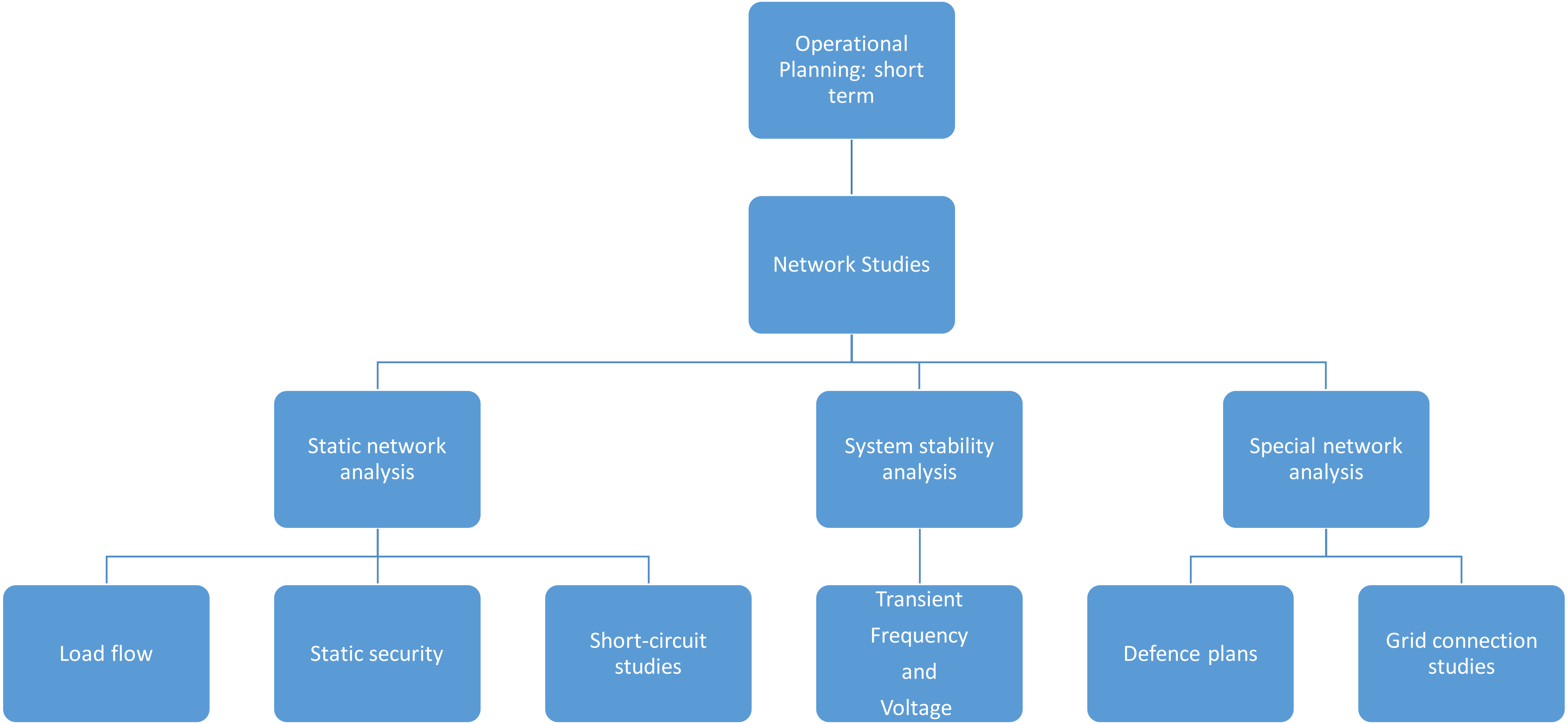
- *Generation adequacy*
- *Generation scheduling and reserve sizing*
- *Network studies*
  - *Static network analyses*
    - *Load flow*
    - *Short circuit*
    - *Security analysis*
  - *Dynamic network analyses*
    - *Stability assessments*
    - *Contingency analysis*
  - *Special network studies.*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



* Order may vary depending on the characteristics of the SIDS system

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

Sizing of operating reserves

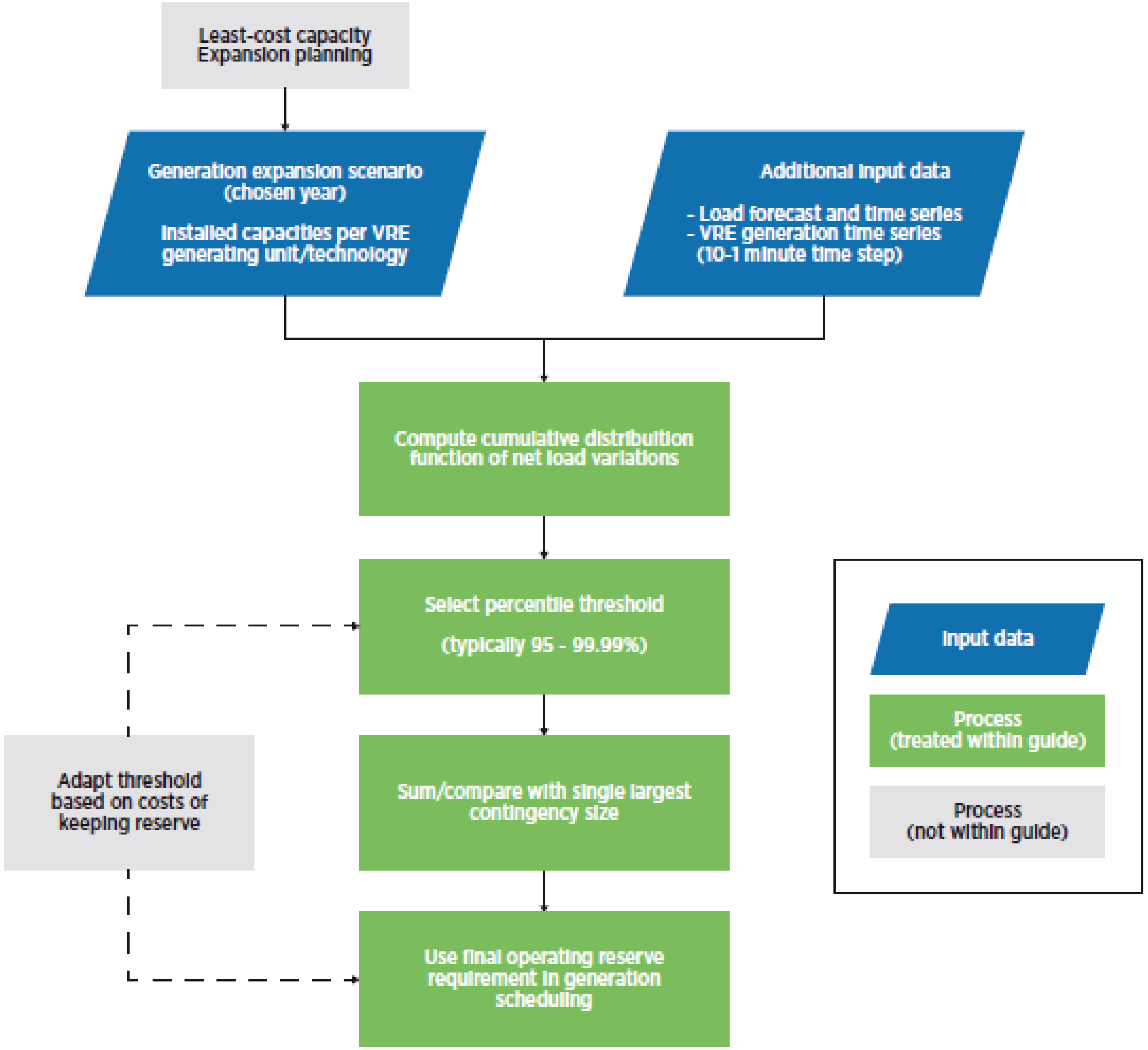


Fig. Workflow to perform operating reserve sizing

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 transient stability studies*

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

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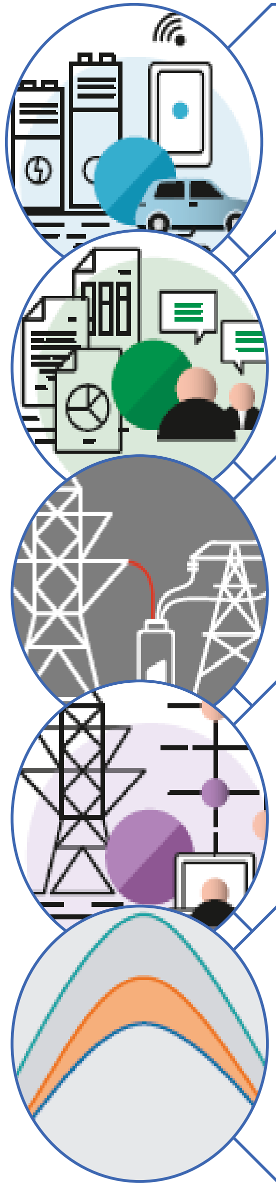
- Diversification of VRE installations
- Flexible generating units
- Energy storage systems
- Grid Reinforcements
- Distribution automation and smart grid technologies
- Interconnection with neighboring countries

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

Thank you for your attention!

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5 Partner organisations' perspectives

Partner organsiation’s perspective

Krishnan Nair
Electrical Engineer
Consultant for the World Bank Project
Pacific Power Association

Pacific Power Association

- The PPA is an inter-governmental agency and member of the Council of Regional Organizations in the Pacific (CROP) to promote the direct cooperation of the Pacific island power utilities in technical training, exchange of information, sharing of senior management and engineering expertise and other activities of benefit to the members.

- The PPA's objective is to improve the quality of power in the region through a cooperative effort among the utilities, private sector and regional aid donors.

Sustainable energy industry development project

- The World Bank has agreed to provide funding to the PPA as the Project Implementation Agency for the Sustainable Energy Industry Development Project (SEIDP.)
- The project development objective (PDO) is to increase the data availability and capacity in Pacific island power utilities to enhance their ability to incorporate and manage renewable energy technologies and long-term disaster risk planning
- Given the increasing support that the PPA is being asked to provide to its member utilities, particularly in their integration of renewable energy (RE) technologies in both on-grid and off-grid scenarios, there is a need to build capacity within PPA in order for them to better provide advice in this area.

Components

There are three components within the project:

- Component 1. Renewable Energy Resource Mapping
- Component 2. Technical Assistance
- Component 3. Project Implementation Support

- The project aim is to increase the information available in the region on RE resources, provide planning tools and training in their use to PPA and member utilities, and increase the capacity of PPA to develop and undertake a capacity development plan for member utilities.

COMPONENT 2: Technical Assistance

- Aims to increase capacity within the PIC power utilities on planning for and management of the integration of variable renewable energy in their systems, data collection and management, and knowledge sharing across jurisdictions.
- This program of activities include:

- acquisition of modeling software and consultancy services for renewable energy integration and capacity building
- development of an online power benchmarking platform
- development of industry guidelines and competency standards training/workshops

Planning Resources

- **Power Factory 2017, now upgraded to 2020 version**
- **Two License, Sever Based (available online).**
- **Accessible to PPA members**
  - Base Package
  - Contingency Analysis
  - Quasi Dynamic Simulation
  - Protection Functions (Time-Overcurrent & Distance)
  - Power Quality and Harmonic Analysis
  - Optimal Power Flow I (Reactive Power Optimisation)
  - Stability Analysis Function (RMS)
- **HOMER Micro grid Analysis Tool (Pro Edition)**

Capacity Building Training

- **Power Factory Basic training to PPA staff – 2017**
  - Power factory experts from Australia
- **Power factory RE integration training for PPA & WB member countries**
  - Power factory experts from Australia (2018) Venue: Fiji Islands
- **Second Power Factory training for Utility Engineers was scheduled to happen in November 2019 but now prisoned due to COVID-19 Pandemic.**
- **Assessment of Variable Renewable Energy (VRE) Grid Integration, and Evaluation of SCADA and EMS system design in the Pacific Island Counties**
  - Training on Network Modelling

Assessment of VRE Grid Integration and Evaluation of SCADA and EMS System Design in PICs

- **Ricardo Energy & Environment, were appointed to undertake the Assessment of Variable Renewable Energy Grid Integration and Evaluation of SCADA & EMS System Design**
- **The Assessment included,**

1. **Task 1. Grid Integration and planning studies**
2. **Task 2. Assessment of Energy storage and applications in power utilities**
3. **Task 3. Supporting the Develop or Revision of Grid codes and**
4. **Task 4. Assessment of the needs for Supervisory control and data acquisition (SCADA).**

Studies Complete

- Kosrae Utilities Authority (Grid integration and SCADA/EMS)
- Chuuk Public Utilities Corporation (Grid integration and SCADA/EMS)
- Yap State Public Service Corporation (SCADA/EMS)
- Samoa – Electric Power Corporation (Grid integration and SCADA/EMS)
- Tonga Power Limited (Grid integration and SCADA/EMS)
- Pohnpei Utility Corporation (Grid integration and SCADA/EMS)
- Marshalls Energy Company (SCADA/EMS)
- Tuvalu Electricity Corporation (SCADA/EMS)

Task 1: Grid integration & Planning studies

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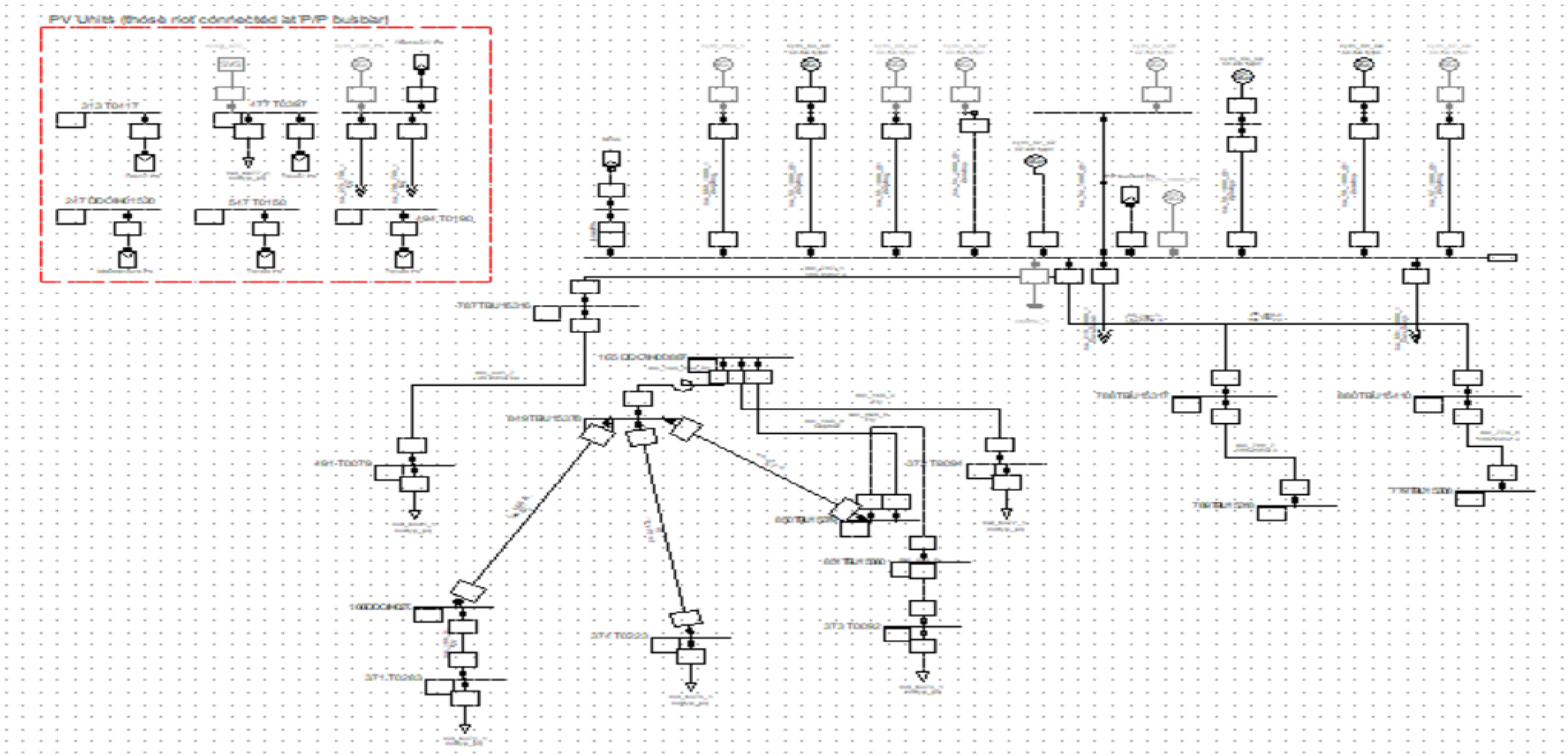
- **Task Carried out:**
  - Load Flow
  - Contingency
  - Fault Level
  - Stability studies

- **Studies were based on existing network topology, generation capacity and load demand patterns.**

- **Aim of the studies were to investigate steady state and dynamic performance of existing system to meet the demand needs. Given Generation capacity and generation mix an assess network adequacy for connection of additional renewable generation at potential locations.**

Case Study

- **Review of Tonga Power Grid integration Study (2020)**



Update Existing Grid Study

1) Update the base case network models using PSS SINCAL. Information such as line and equipment upgrade, new generator thermal and renewable power plant as well as battery storage system were update into the existing network model.

2) Perform load flow study to assess the steady state performance of the power system.

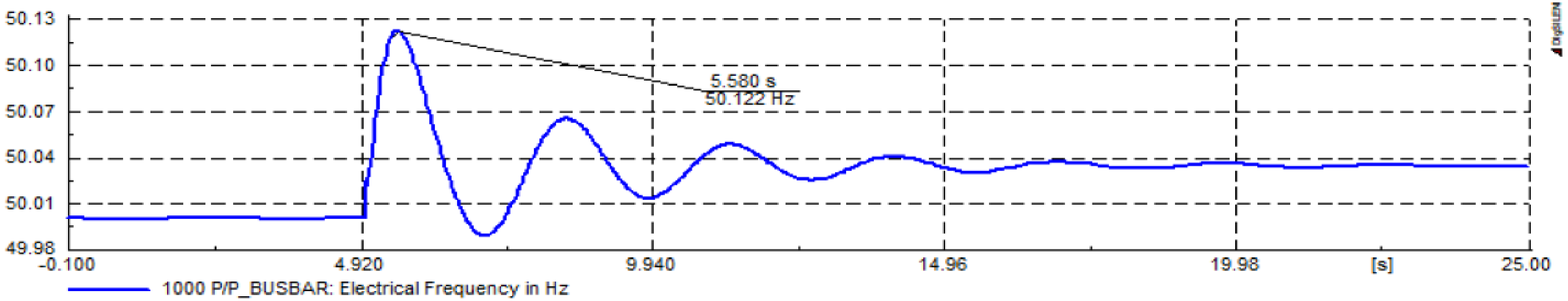
3) perform fault studies to assess fault levels at power station busbars and those nodes with proposed RE.

4) Perform stability studies to determine stability performance at power station bus for credible dynamic events and contingencies.

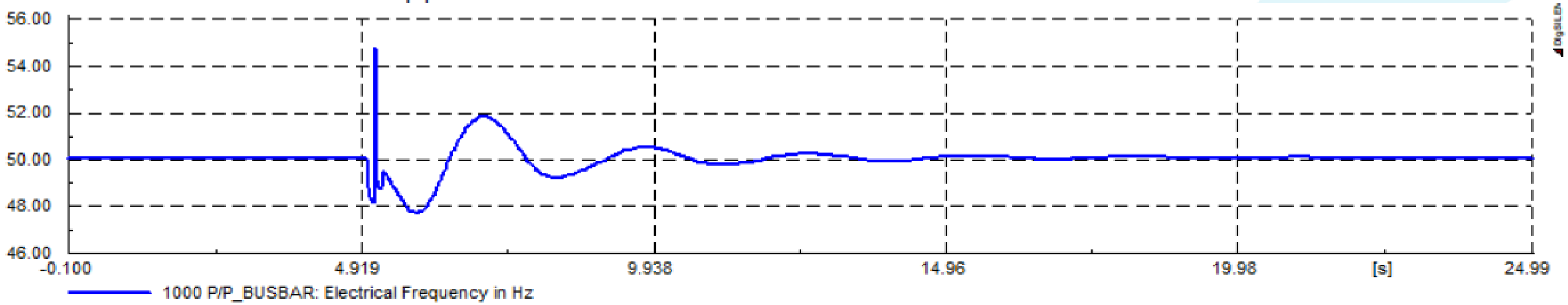
TPL System - Stability Study (1)

Loss of largest feeder

- Network able to cope with the loss of the largest demand feeder
- Frequency stays within deviation limits



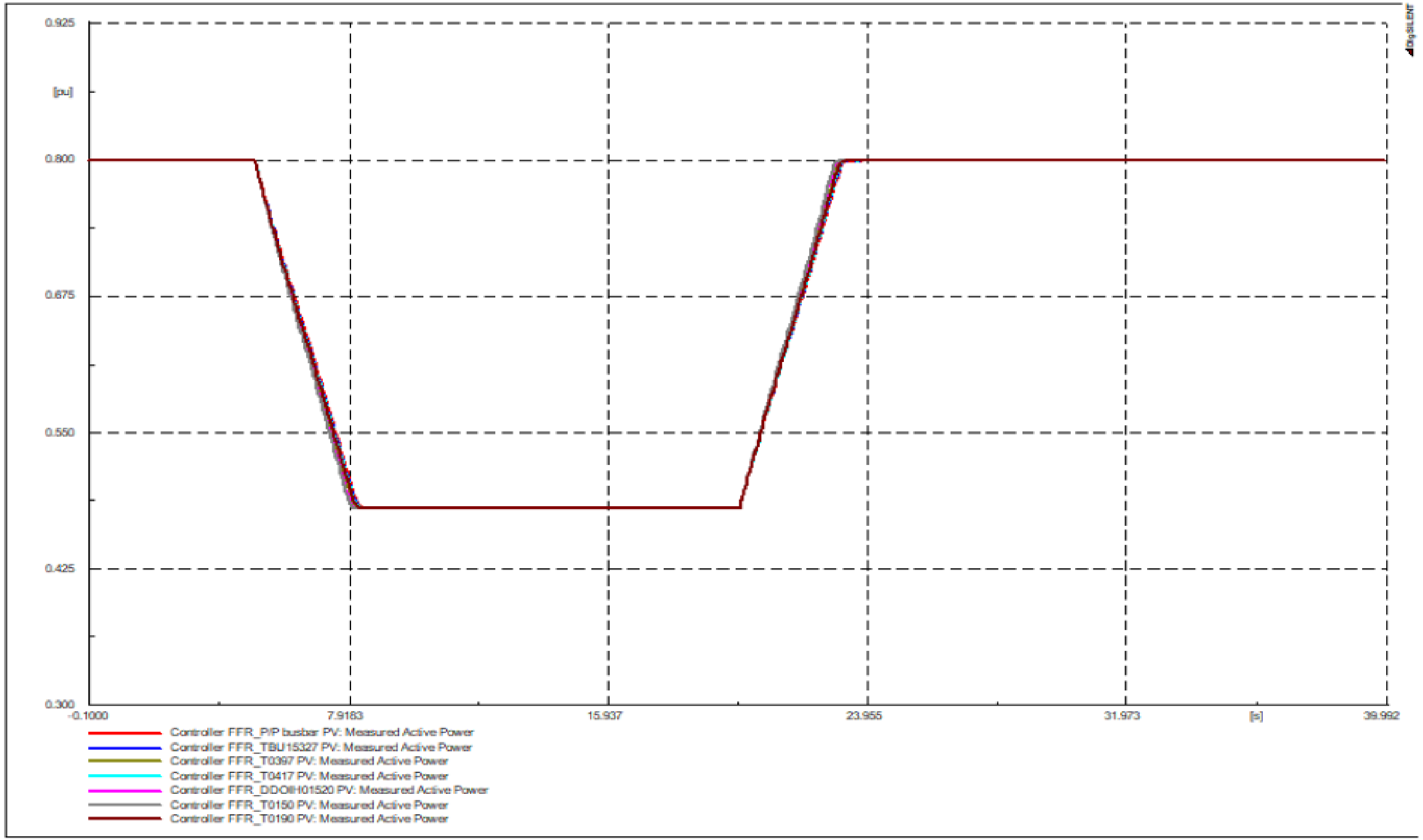
- However, the frequency exceeds limits after a 3 phase fault on the feeder following which the feeder is tripped



PL System - Renewable Generation Impact

With 4MW additional PV generation connected to the network:

- PV ramping up and down



TPL System Study Summary

- Recommended to improve robustness of the system through network reconfiguration, generation dispatch, battery storage etc

Study	1080 kW additional solar contribution	2540 kW additional solar contribution	4000 kW additional solar contribution
Loss of largest generator	System collapse; loss of second largest generator OK	System collapse; loss of second largest generator OK – marginally exceeds limits (f)	System collapse; loss of second largest generator OK – marginally exceeds limits (f)
Loss of largest demand feeder	OK	OK	OK
Fault at power station & subsequent loss of feeder	Out of limits (f)	Out of limits (f)	Out of limits (f)
Increase/Decrease PV response	2,336 kW solar output variation	2,190 kW solar output variation	2,336 kW solar output variation

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Thank you for your attention!

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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1

Espiritu Santo. Vanuatu

Grid integration assessment for the Island of Espiritu Santo, Vanuatu

Objective

- Grid assessment of Lugan Ville grid
- Extension to Port Olry
- A techno Economic analysis- with and w/o biofuels in HOMER

Methodology

- Generation profiles for solar were developed
- 16 Scenarios developed
- Base Case-diesel and hydro
- Lowest long-term cost case with renewables and batteries -800kW/1100 kW
- Highest renewables case- solar PV and Batteries both Utility scale and distributed
- No major enablers case- without batteries
- Model developed

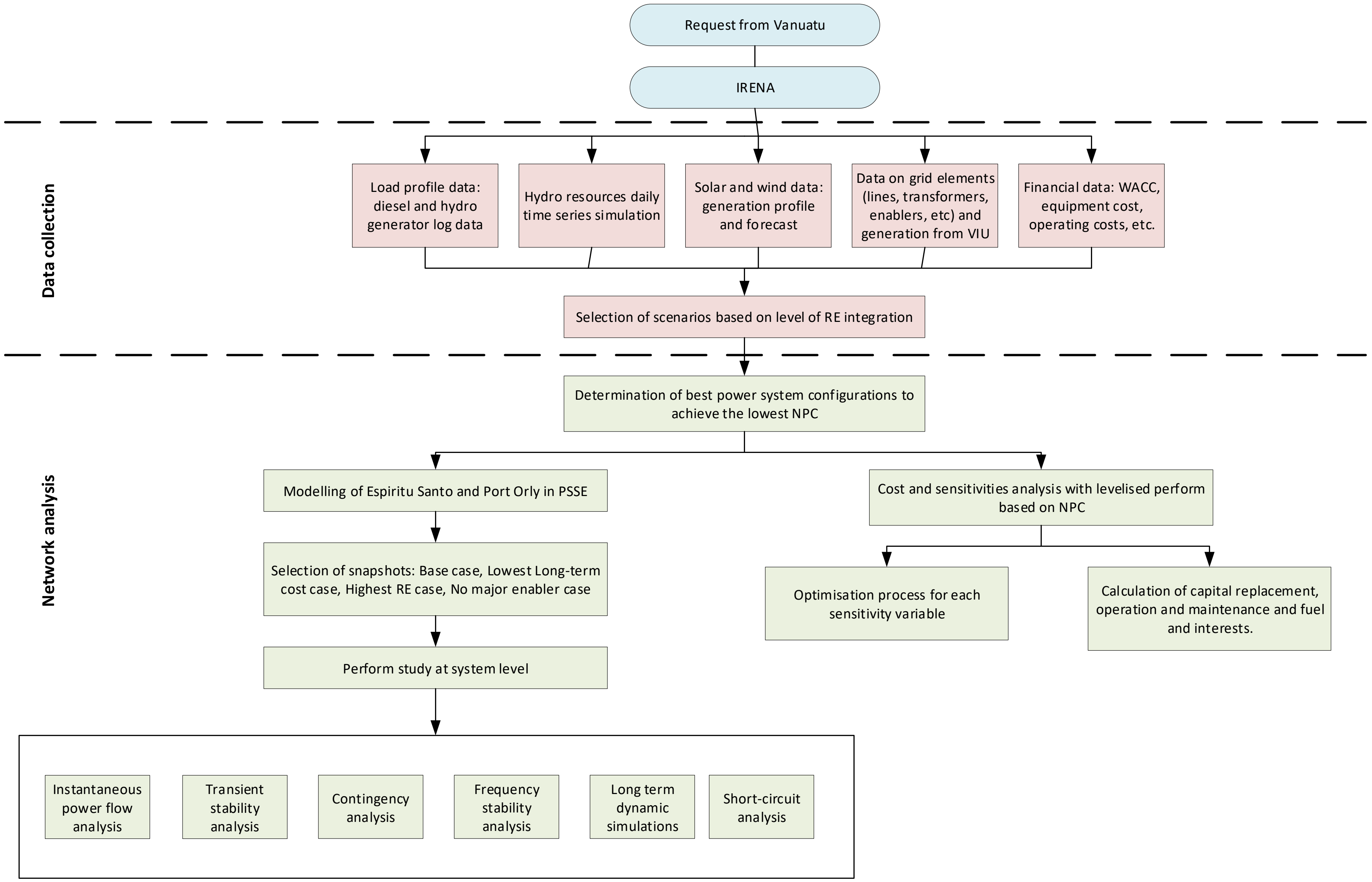
Technical studies

- Steady state analysis-Load flow
- Frequency stability analysis
- Voltage stability
- Transient stability analysis
- N-1 contingency analysis

Outcomes

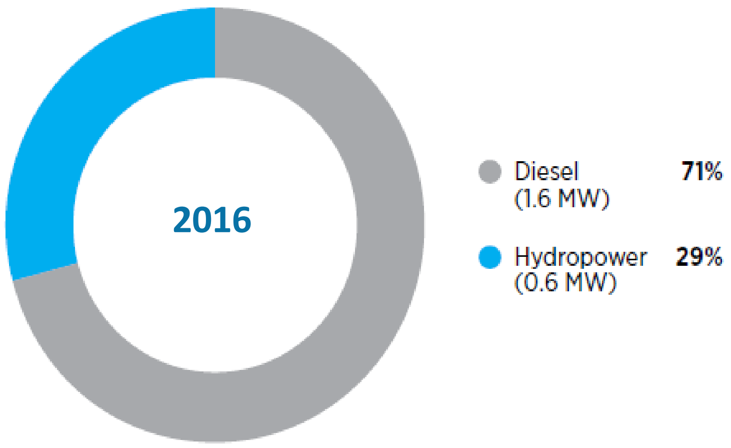
- Lowest long term cost case
- A new grant-funded 800 kW +300 kW(non-funded) run of the river hydropower station
- 2 MW of PV
- 1 MW/2 megawatt hour (MWh) of batteries,
- 0.5 MW of diesel uninterruptible power supply (UPS)
- A comprehensive hybrid control system,
- Achieving 87% renewable energy contribution in 2030

Island of Espiritu Santo, Vanuatu cont….

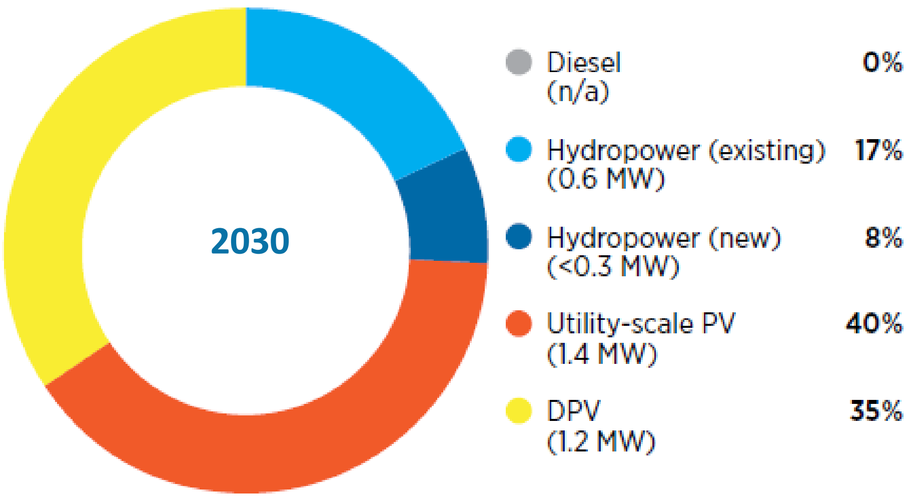


Island of Espiritu Santo, Vanuatu cont.…

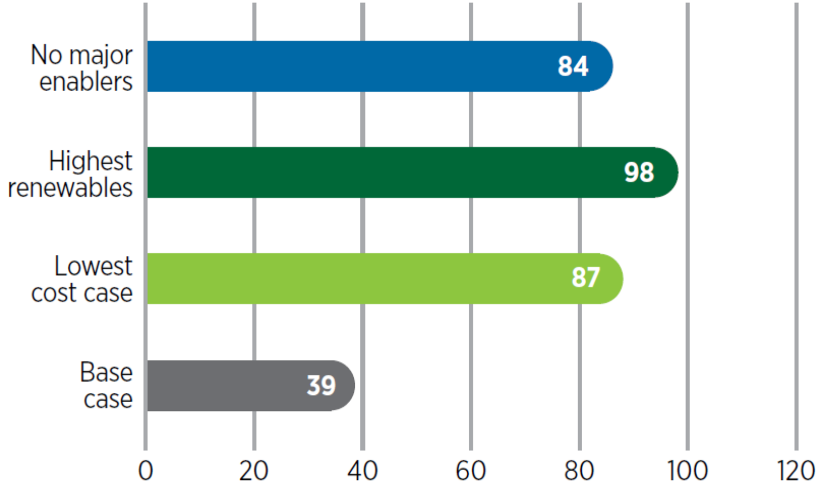
Dispatch at Peak Demand



Achievable dispatch at peak demand



Renewable Shares (%) Achievable By 2030, Espiritu Santo, Vanuatu



Infrastructure Measures

- Installing batteries
- Dynamic Resistor banks
- Hybrid control system
- Upgrading existing system
- Synchronous condensers and Diesel UPS

Operational measures

- Higher voltage settings using PV inverters to achieve better voltage regulation
- Siting the battery based on voltage and frequency support

2

Viti Levu. The Republic of Fiji Islands

Grid integration assessment for the Island of Viti Levu, Fiji

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Objective

- To integrate PV in the system without very high investments
- Technical study-System level and distribution level
- Hosting capacity analysis for the Viti Levu grid
- the potential locations for the deployment of solar PV.
- the type of solar PV (centralised and distributed).

Methodology

- Identification of sites for PV installation at utility and distribution scale
- High resolution profiles for solar PV
- Identify industrial, commercial and residential feeders
- Distribution level (11 kV)
- System level (33 kV)
- Model the system

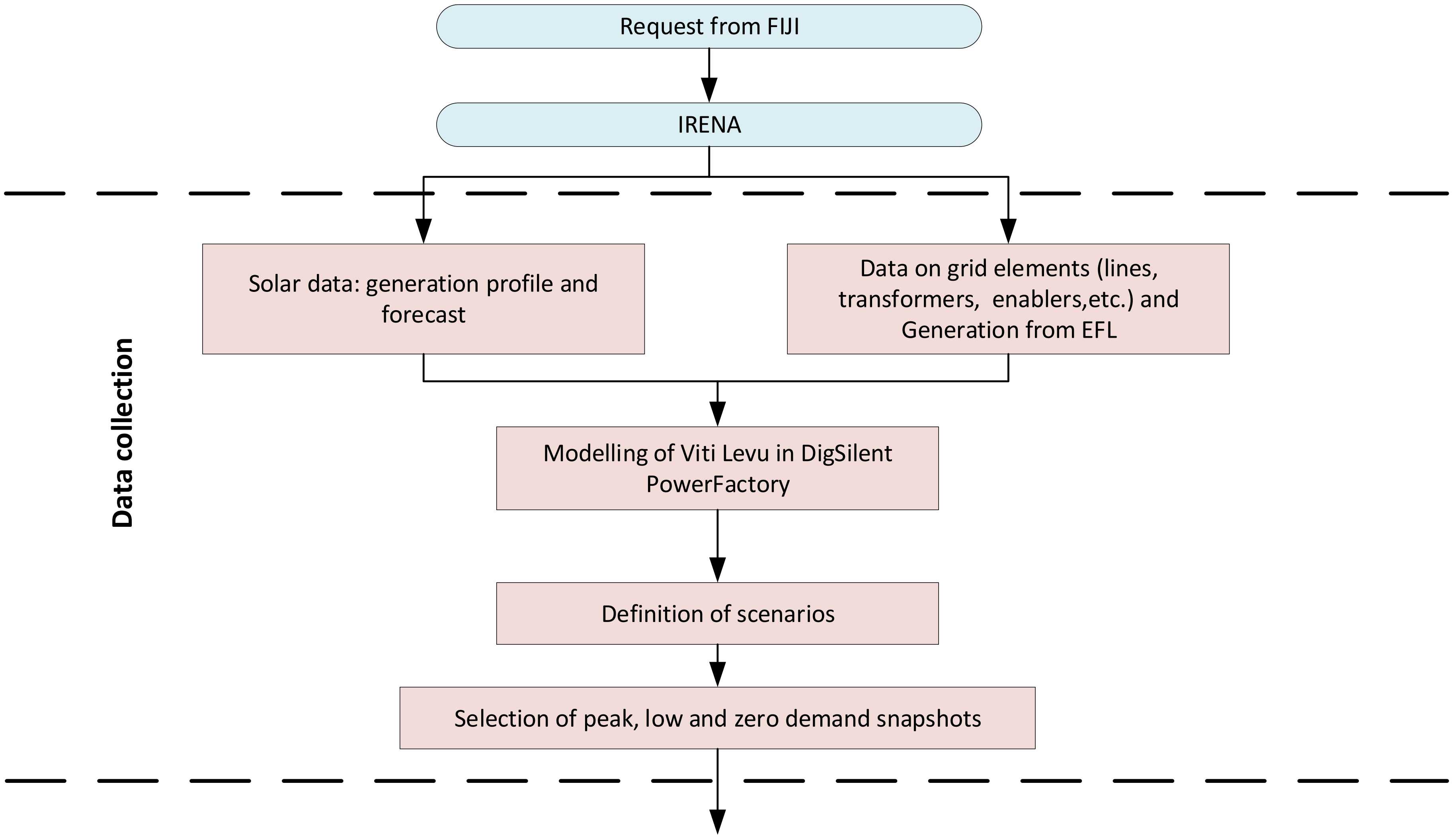
Technical studies

- Sequential power flow
- Instantaneous power flow
- Short circuit studies
- Frequency
- Voltage and
- Transient stability studies
- N-1 contingency analysis

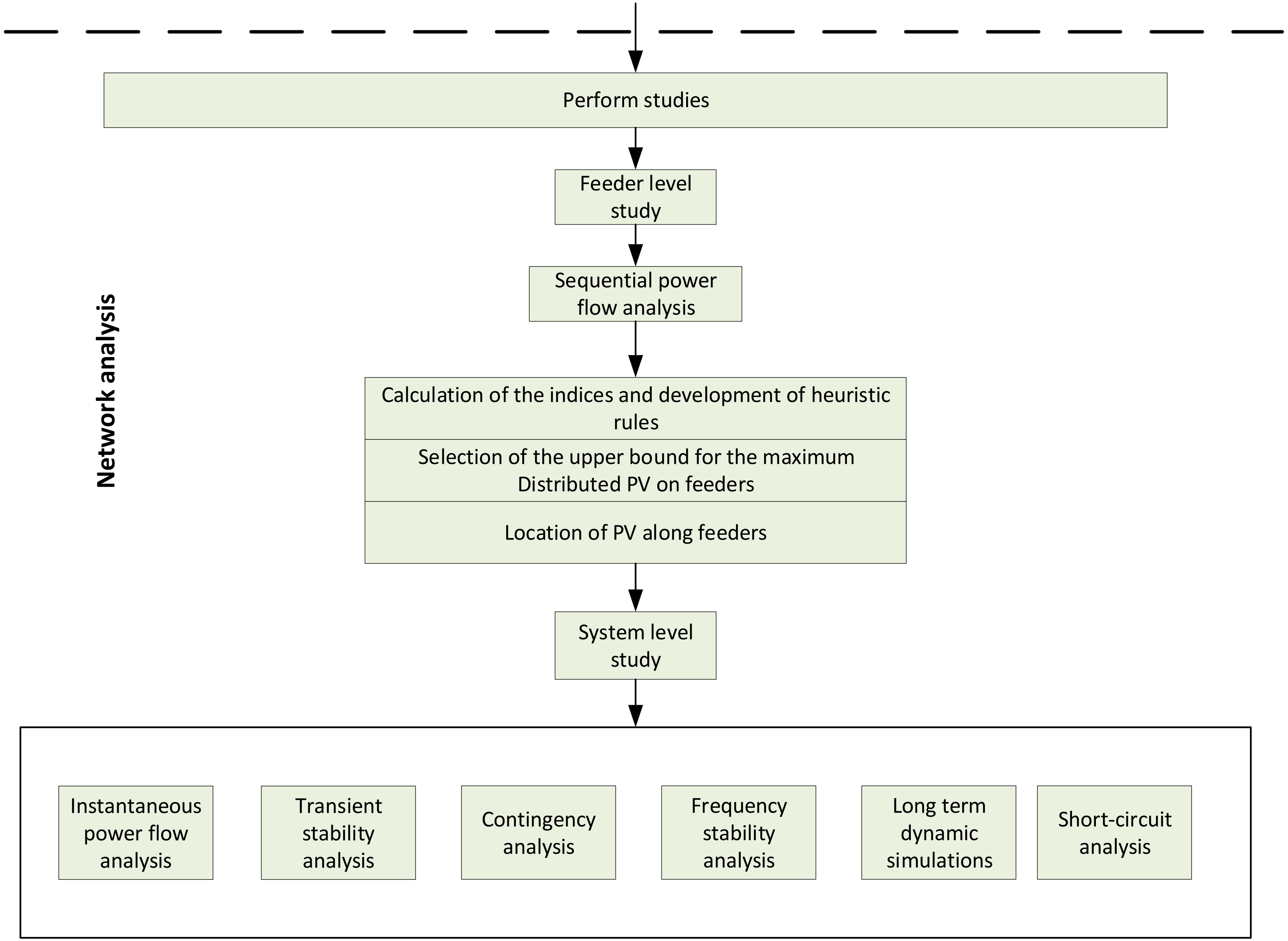
Outcomes

- Definition of heuristic rules for PV at distribution feeders
- 25 MW at system level and 40 MW at distribution level of PV without major investments

Island of Viti Levu, Fiji cont.....



Island of Viti Levu, Fiji cont…



Island of Viti Levu, Fiji cont…

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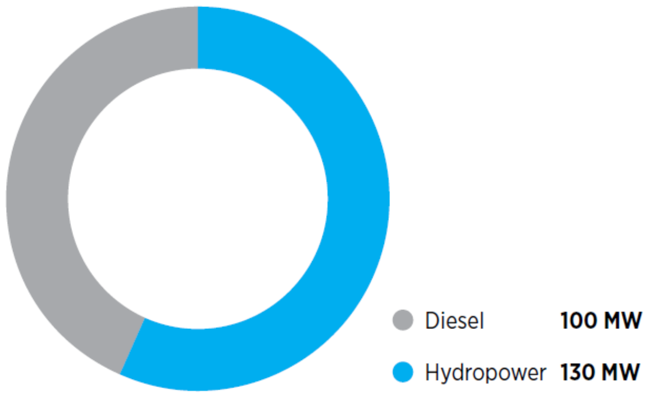
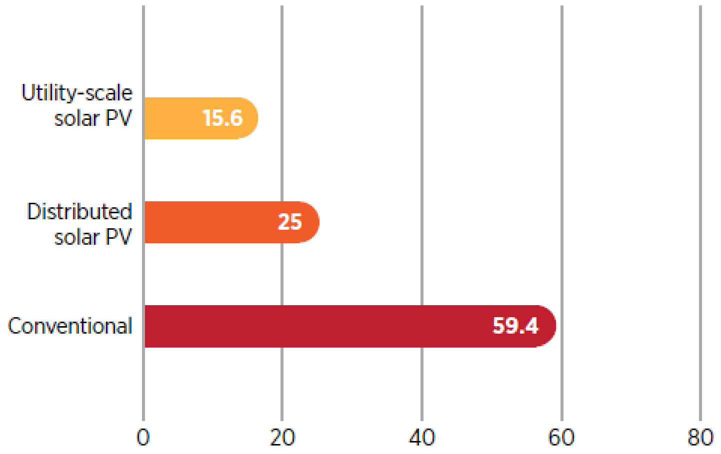
POWER GENERATION MIX (2017)

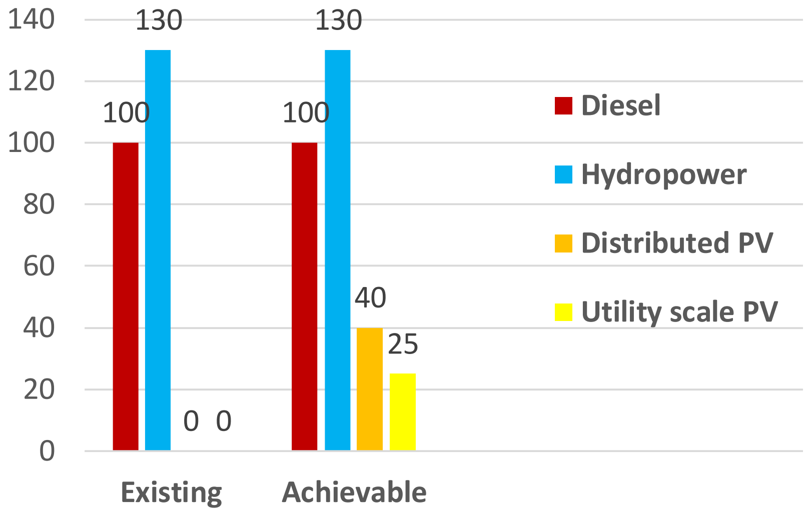


- Higher consumption for diesel

Achievable shares (%) at 160 MW peak demand



Achievable Power generation Mix in MW



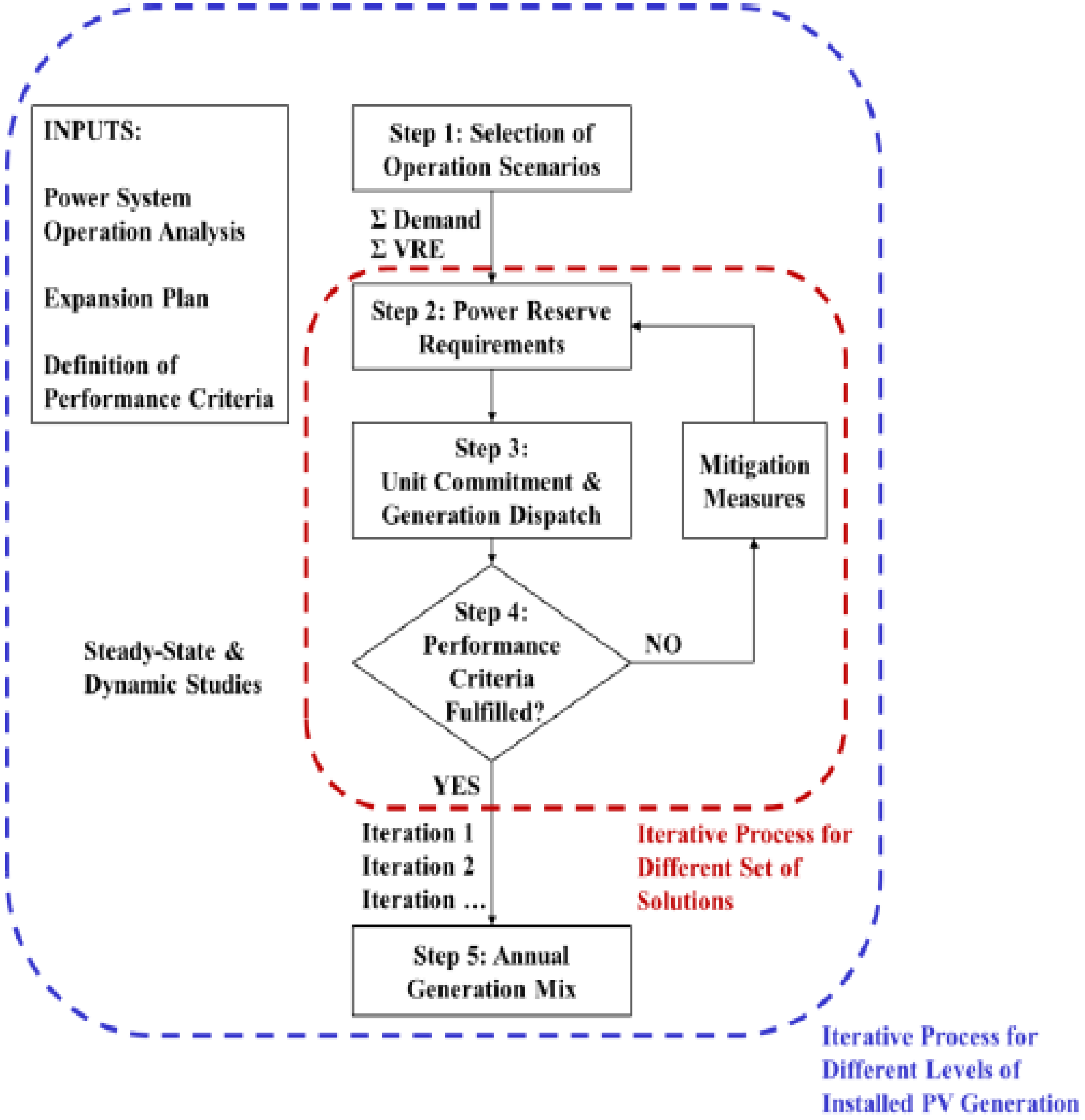
Measures

- Voltage regulation measures
- PV inverters providing reactive power support and LVRT
- Curtailment could help adding more PV
- Adapting ramp rate requirement for hydropower and diesel generators
- Grid code modification
- Siting of the PV systems according to distance from substation

3

Aitutaki. The Cook Islands

Aitutaki- Methodology of study



The Island of Aitutaki, Cook Islands

Objective

- Maximizing PV power production

Step1
- Selection of operation Scenarios
- Maximum PV and peak demand
- Maximum PV and minimum demand

Step 2
- Calculate power reserve requirements
- Frequency regulation (Up and down)
- Contingency regulation (Up and down)

Step 3
- Unit commitment and Generation dispatch
- Based on variable cost of unit
- Considering reserve calculation

Step4
- Performance criteria
- System security
- System stability
- Voltage and loading limits
- Frequency excursions
- Contingency analysis
- No system blackout
- No loss of synchronism

Step 5
- Annual generation mix

Aitutaki ,Cook Islands -Findings and Recommendations

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Increased risk of system blackout

- Define new protection settings , undervoltage protection (U<), but also U>, f< and f> protection functions in line with the current settings from diesel generation.
- Re-define frequency limits
- Implement Under frequency load shedding (UFLS) scheme
- Install battery energy storage system

Participation of PV generation in the frequency and voltage control

- Fault ride through (FRT) for PV
- Reactive power support to contain the low voltage to local areas
- All PV generation to have power factor range of ±0.95

Impact on diesel generation-Cost-benefit analysis to find an optimum solution

- Curtailment can be performed if the diesel generators are not operating between their required operational levels especially at low demand
- Decreasing the minimum loading of the diesel units down to 30% of the rated power increases the PV that can be installed
- Improve diesel governor settings-using standard governor settings,

Thank you for your attention!

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7

Panel discussion

Panel discussion

Antony Garae
Director
Department of Energy
Vanuatu

Mikaele Belena
Director of Energy
Min. of Infrastructure
& Meteorological
Services, Fiji

Krishnan Nair
Electrical Engineer
Consultant for the
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Arieta Gonelevu Rakai
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Laura Casado
Associate Professional
Renewable Energy Grid
Integration , IRENA

Moderated by

Martina Lyons
Associate Programme Officer
End Use sectors and Innovation
IRENA

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8 Closing remarks

Closing remarks

Roland Roesch

Deputy Director

IRENA Innovation and Technology Centre

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THANK YOU FOR JOINING US!

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