Grid Stability with High Share of Renewables - Transforming Small Island Power Systems

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TUESDAY, 18 FEBRUARY 2020 • 10:00 – 10:30 CET
Grid Integration – What we do?

Assist Member States and stakeholders in addressing key questions on integration of Renewable Energy/Variable Renewable Energy:

- Technical constraints in the power system for integrating VRE
- The enablers and advanced technologies
- Hosting capacity of the existing power system
- Resource diversity
- Pathway to 100% renewable power system
- Improving power system resilience
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)

- Tonga
  - Nine islands (ongoing)

- Mozambique
  - Two asynchronous systems (ongoing)
Grid Integration – Transforming Small-Island Power Systems

Highlights

• the expected challenges associated with Variable renewable energy (VRE) integration in Small Island Developing States (SIDs);
• the VRE integration planning required to overcome technical challenges,
• the technical studies needed to analyse and quantify such challenges, and how to carry out these studies;
• the solutions required to overcome VRE integration challenges.

Transformation of the SIDS power systems - The strategy

- Policy targets
- Roadmaps
  - Strategic planning
  - Investigations and planning
- Technical
- Financial
- Institutional

Supported by technical planning studies

Implement

Reviews and adjustments

- 0% VRE
- 10% VRE
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%

Low
- Medium
- High

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VRE Integration and why we need grid assessment

System Specific Challenges

• Limited primary resource
• Uncertainty in demand growth
• Small size of the system
• Compliance with environmental constraints

VRE Challenges

• Non-synchronous- affects frequency and voltage response and control
• Location constrained- needs more transmission capacity
• Uncertainty- needs more flexibility
• Variability-affects firm capacity and therefore needs more flexibility and
Technical studies for VRE Integration in the different planning time frames

Expansion Planning: long/mid-term
- Load and Generation Balancing studies
  - Generation adequacy
  - Sizing of operating reserves
  - Generation scheduling

Operational Planning: short term
- Network Studies
  - Static network analysis
  - System stability analysis
  - Special network analysis
  - Load flow
  - Static security
  - Short-circuit studies
  - Transient Frequency and Voltage
  - Defence plans
  - Grid connection studies
Solutions for better integration of VRE-Infrastructure investments and Operational Measures

- Diversification of VRE installations
- Flexible generating units
- Energy storage systems
- Grid Reinforcements
- Distribution automation and smart grid technologies
- Interconnection with neighboring countries
- Demand response programs
- Enhanced generation dispatch and control
- Enhanced defense plans
- Automatic power controller and network monitoring
- Short term VRE forecast
Grid Integration – Grid study for the Island of Viti Levu, Fiji

Achievable generation mix

- Diesel: 100 MW
- Hydropower: 130 MW
- Distributed solar PV: 100 MW
- Utility-scale solar PV: 25 MW

Technical studies conducted

Feeder level:
- Instantaneous and sequential power flow analysis
- Short-circuit analysis.

System level:
- N-1 contingency analysis;
- Transient stability study;
- Frequency stability study; and
- Voltage stability study.

Recommendations

- Grid reinforcement
- Fault ride through of PV systems
- Curtailment and grid code
- Corrective measures

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**Grid Integration – Grid study for the Island of Espiritu Santo, Vanuatu**

**Dispatch at Peak Demand**

- **2016**
  - Diesel (1.6 MW): 71%
  - Hydropower (0.6 MW): 29%

- **2030**
  - Diesel (n/a): 0%
  - Hydropower (existing): 17%
  - Hydropower (new): 8%
  - Utility-scale PV (1.4 MW): 40%
  - DPV (1.2 MW): 35%

**Achievable dispatch at peak demand**

**Renewable Shares (%) Achievable By 2030**

- No major enablers: 84%
- Highest renewables: 98%
- Lowest cost case: 87%
- Base case: 39%

**Technical studies conducted**

- Frequency stability analysis
- Voltage stability
- Transient stability analysis
- Contingency analysis

**Recommendations**

- Installation of batteries/storage
- Diesel UPS
- Solar PV
- Hybrid control system

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Grid Integration – Grid study for Dominican Republic

Technical studies conducted:
- Frequency stability analysis
- Voltage stability
- Transient stability analysis
- Contingency analysis
- Peak demand
- Mean demand
- Low demand

Recommendations:
- Wind \( \uparrow 36\% \)
- Gas \( \downarrow 25\% \)
- Solar \( \uparrow 24\% \)
- Coal \( \downarrow 15\% \)
- Fuel \( \downarrow 26\% \)

vs. 2018 base year

Snapshots considered for study:
- 2020 (17% Renewable)
- 2025 (25% Renewable)
- 2030 (45% Renewable)

Battery storage capacity
Grid reinforcement
Parallel transmission lines
Corrective measures

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Questions & Answers

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Next webinars

- **TUESDAY, 3 March 2020 • 10:00 – 10:30 CET**
  “Planning for the renewable future: improving use and development of long-term energy scenarios”

- **TUESDAY, 17 March 2020 • 10:00 – 10:30 CET**
  “Innovations for 100% renewable power: a systemic approach”
Thank you!

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