INTERNATIONAL RENEWABLE ENERGY AGENCY

IRENA

International Renewable Energy Agency

Integration of Variable Renewables into Island Grids – Technical Aspects

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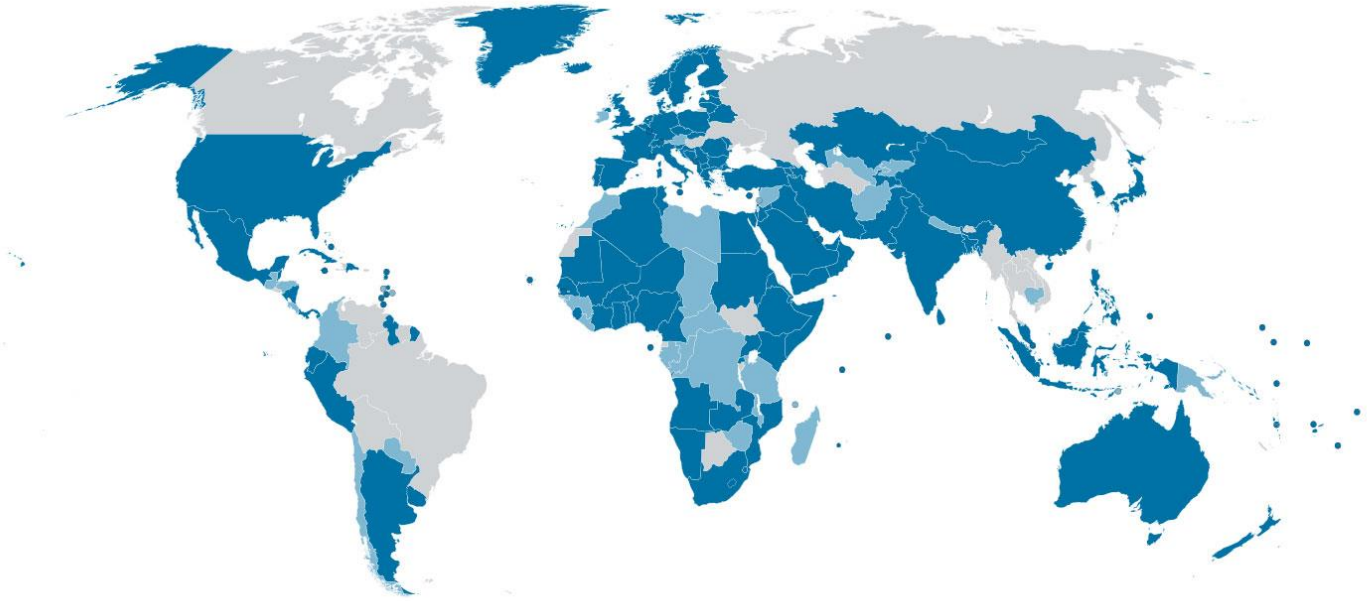
Munich, 12 June 2015

The International Renewable Energy Agency

The Voice, Advisory Resource and Knowledge Hub for 170 Governments



Renewable energy can:

- Meet our goals for ***secure***, ***reliable*** and ***sustainable*** energy
- Provide ***electricity access*** to 1.3 billion people
- Promote ***economic development***
- At an ***affordable cost***

Outline

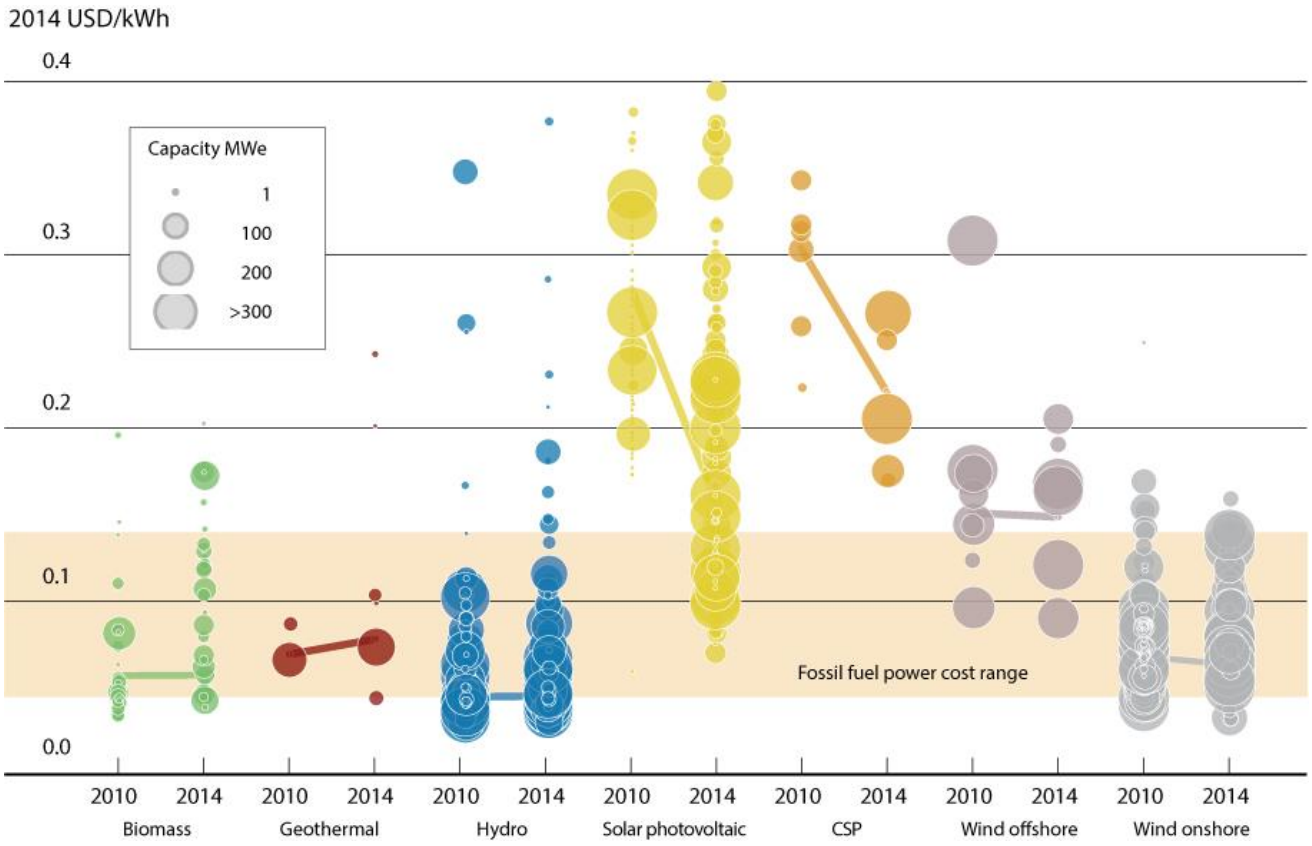
The worldwide deployment of RE

Integration of VRE in island grids – Technical Aspects

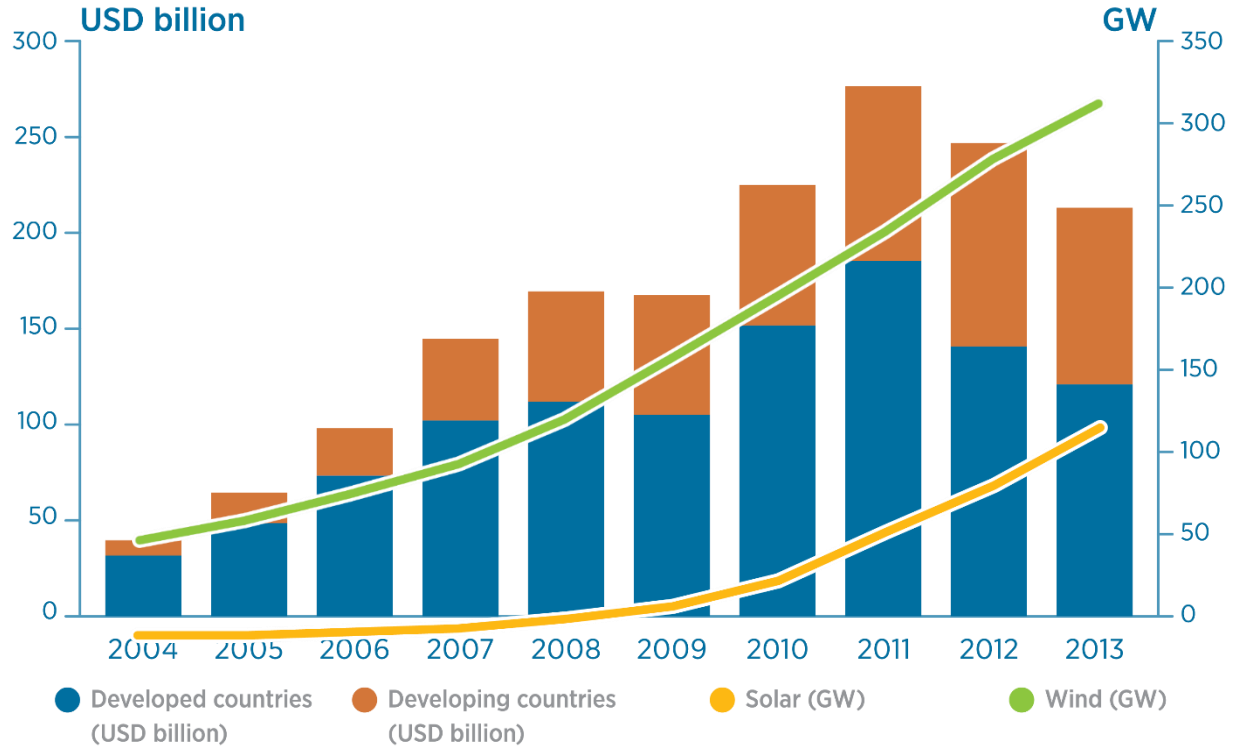
Study Case

THE DEPLOYMENT OF RENEWABLE ENERGY RESOURCES IN POWER SYSTEMS

Renewables competitiveness continues to improve …

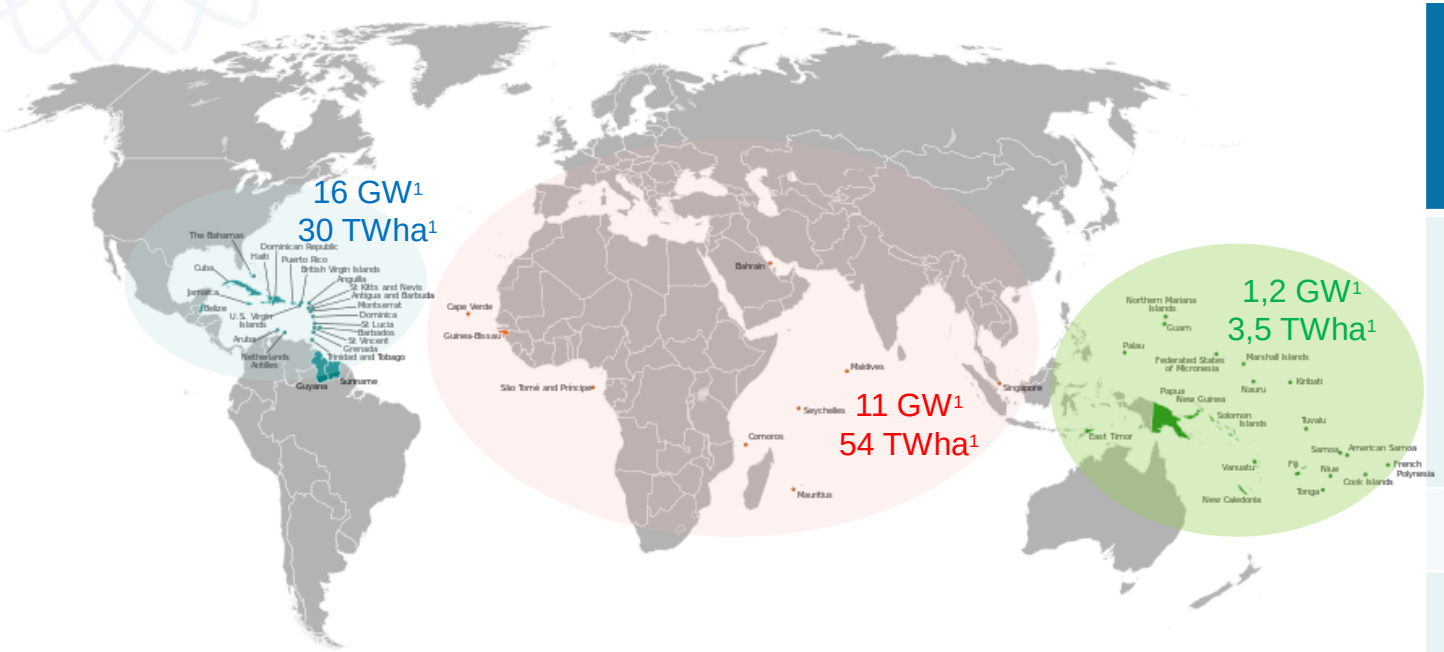


… and their share in the total electricity production is increasing



The transformation is not only happening in large power systems

57 **S**mall **I**sland **D**eveloping **S**tates (SIDS), 38 UN members in 3 geographical zones



Why Renewables in islands?

- **Hedge against price and supply volatility of fossil fuels**
- **Cost effective**
- **Sustainable**

[1] Data only for UN Members

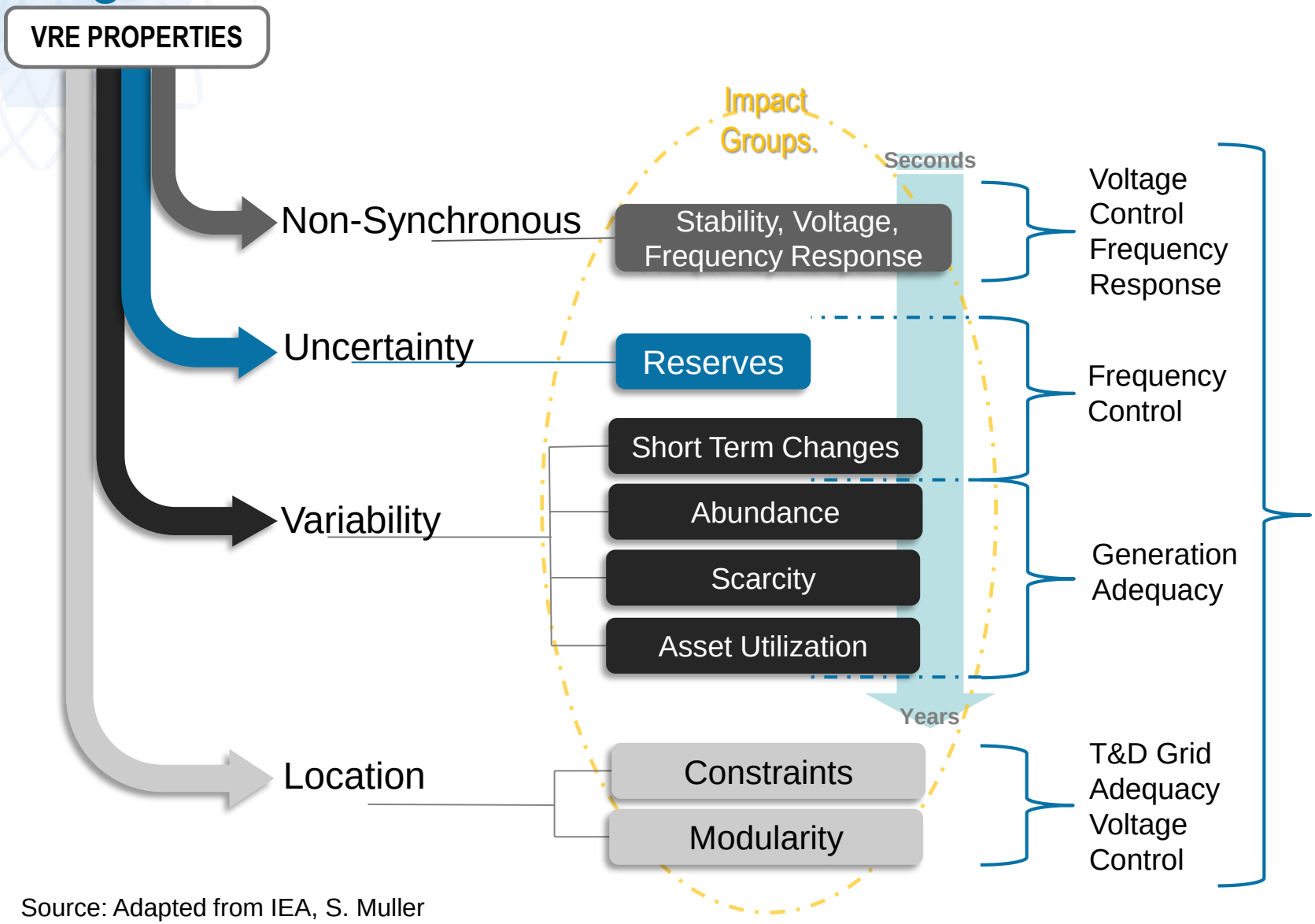
Over 60 million people, 90 TWh electricity consumption per year, 29 GW of installed generation (only in UN members)

SIDS LIGHTHOUSES

SIDS already started the transformation of their power systems
IRENA is supporting this efforts with concrete and practical actions

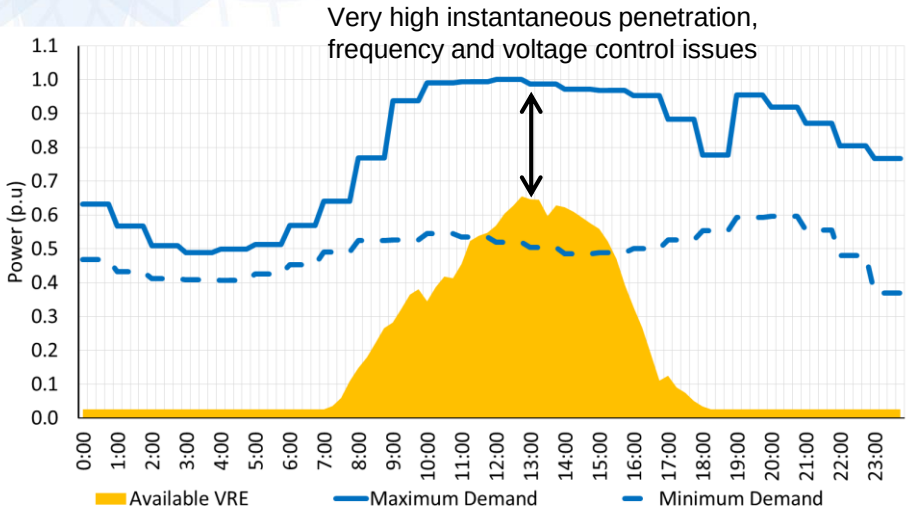
INTEGRATION OF VRE IN ISLANDS – TECHNICAL ASPECTS

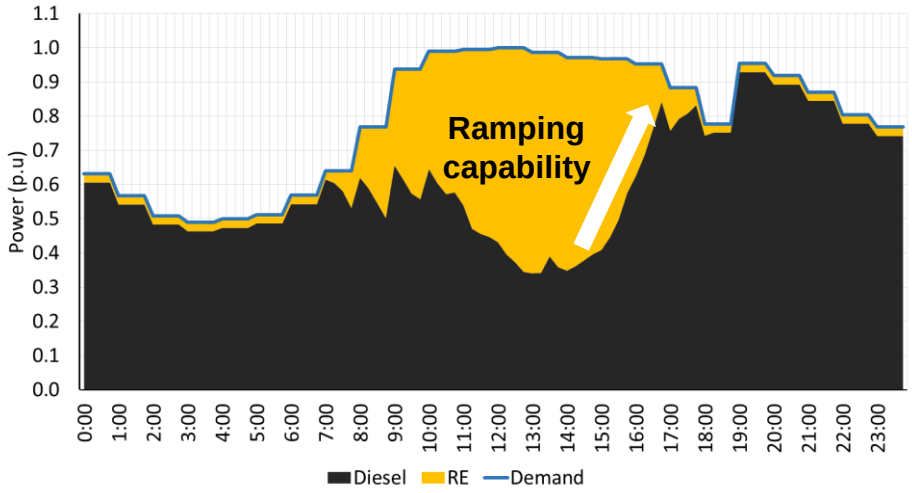
Properties of VRE and challenges for the integration

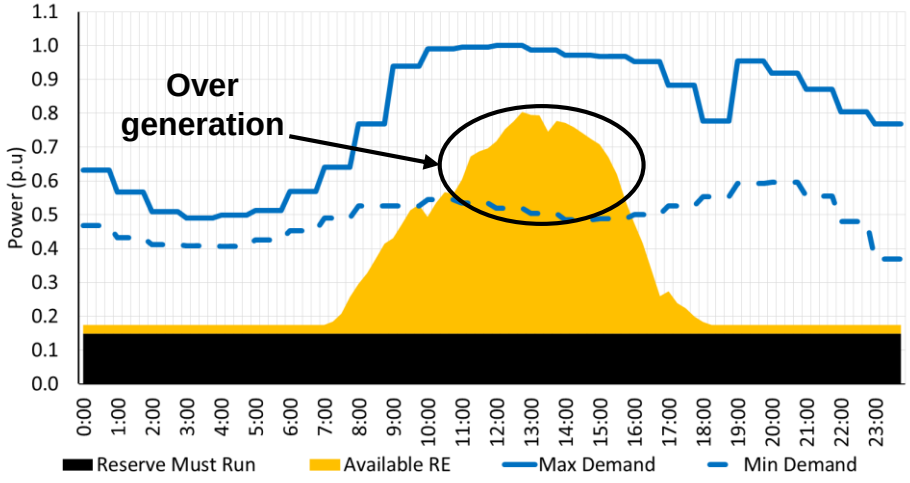


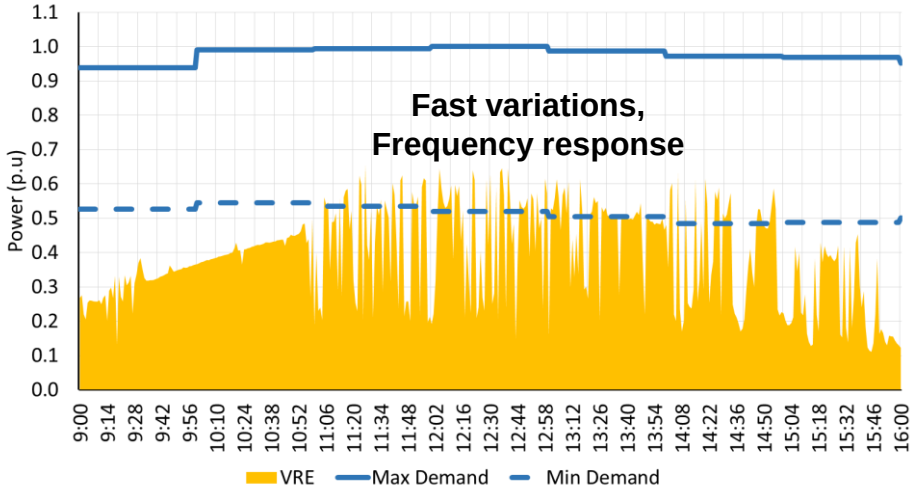
Source: Adapted from IEA, S. Muller

Properties VRE and technical challenges for the operation in islands

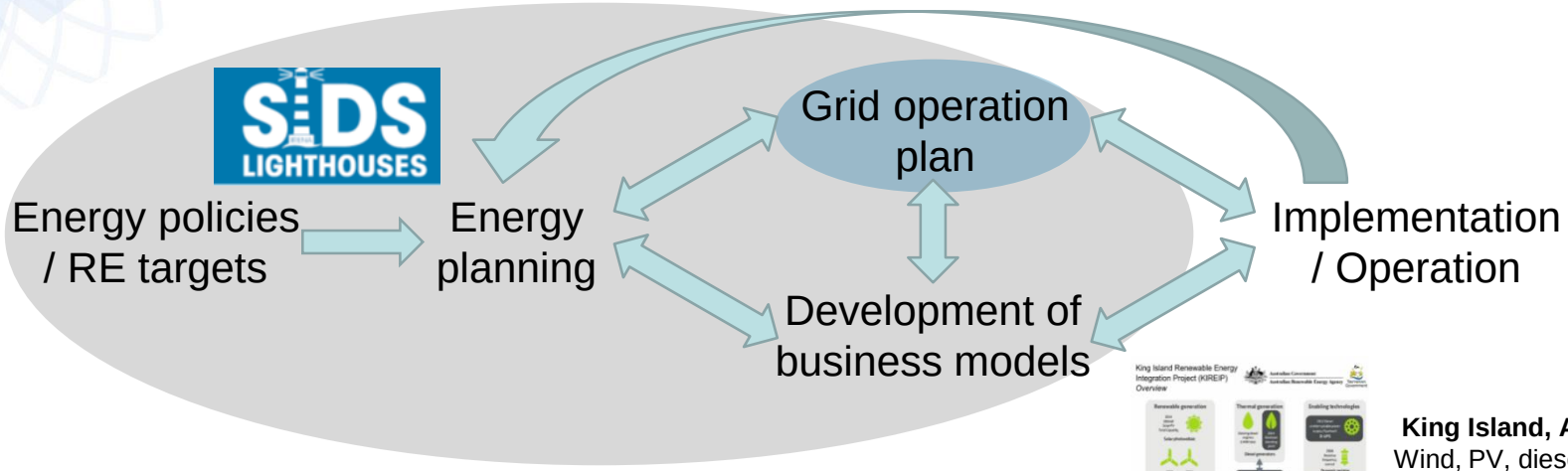








Planning the operation with high shares of VRE



How challenging is it?
What are the challenges?
How to overcome them?
…

Grid integration assessment = Plan the secure and efficient operation with high shares of VRE

- Identify and understand threads
- Develop concepts for solutions

Source: Hydrotasmania

King Island, Australia
Wind, PV, diesel, BESS, flywheel, demand side management, control


Source: NZMFAT

Tokelau
PV, Lead Acid Batteries, control


Source: ABB

El Hierro, Spain
Hydro (pump. storage), wind, diesel, control sys.

Planning the operation with high shares of VRE

Complexity:

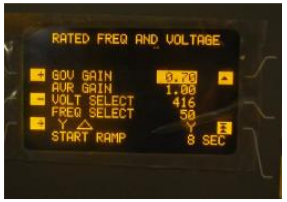
- Generation fleet
- Demand profile
- Energy policies, RE targets & expansion plans
- Network size / complexity
- Stakeholders
- Operational rules
- Available resources

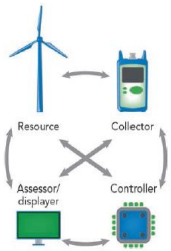
Plan the secure and efficient operation with high shares of VRE

- Identify and understand threads
- Develop concepts for solutions
  - Voltage and loading assessment
  - Power quality
  - Power system stability
  - Generation dispatch constrains

Simple or complex assessments?
Brownfield or Greenfield?
Integration or transformation?

Solutions:

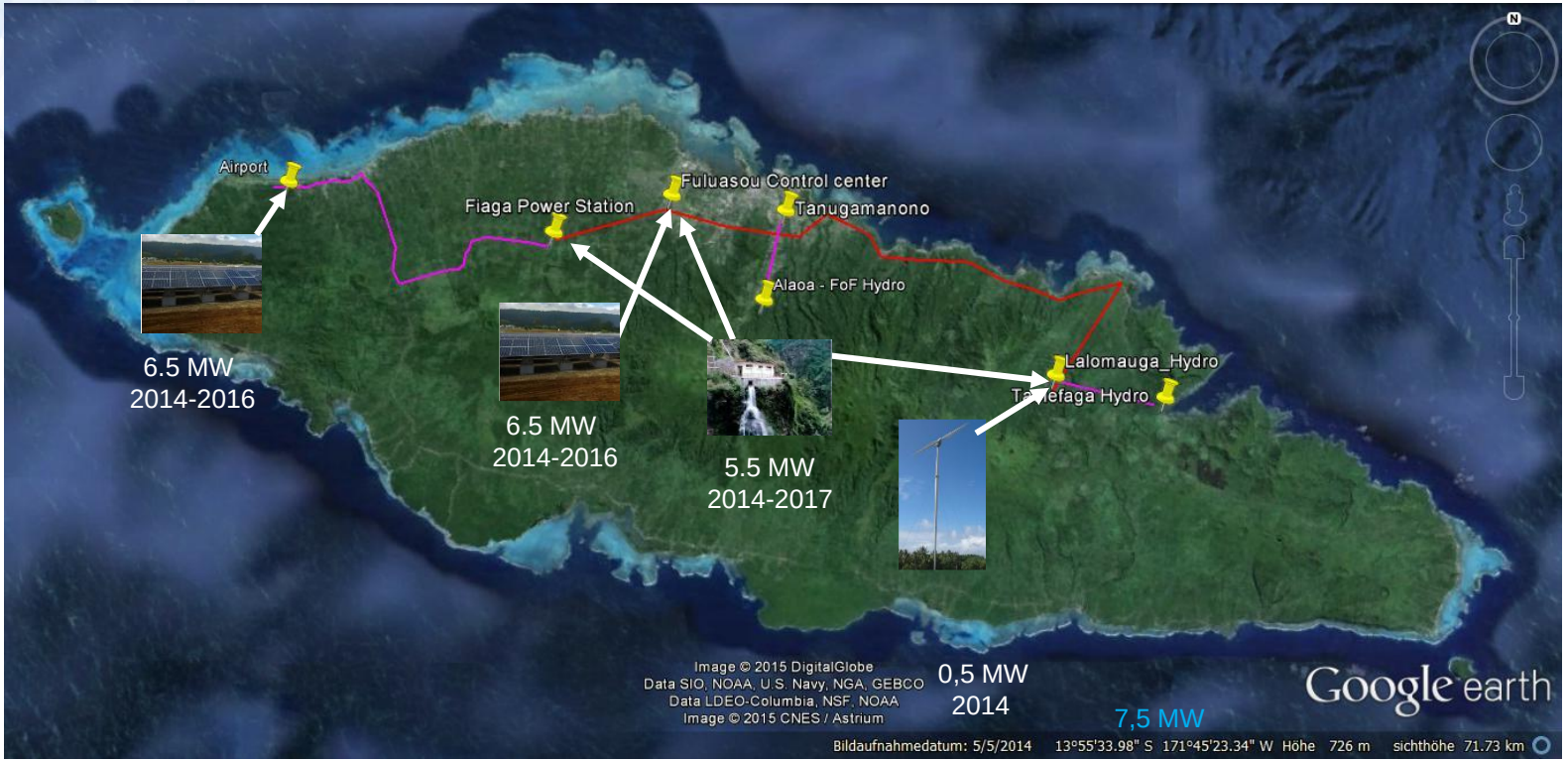




Type of assessments and solutions depend on the complexity of the system

STUDY CASE SAMOA

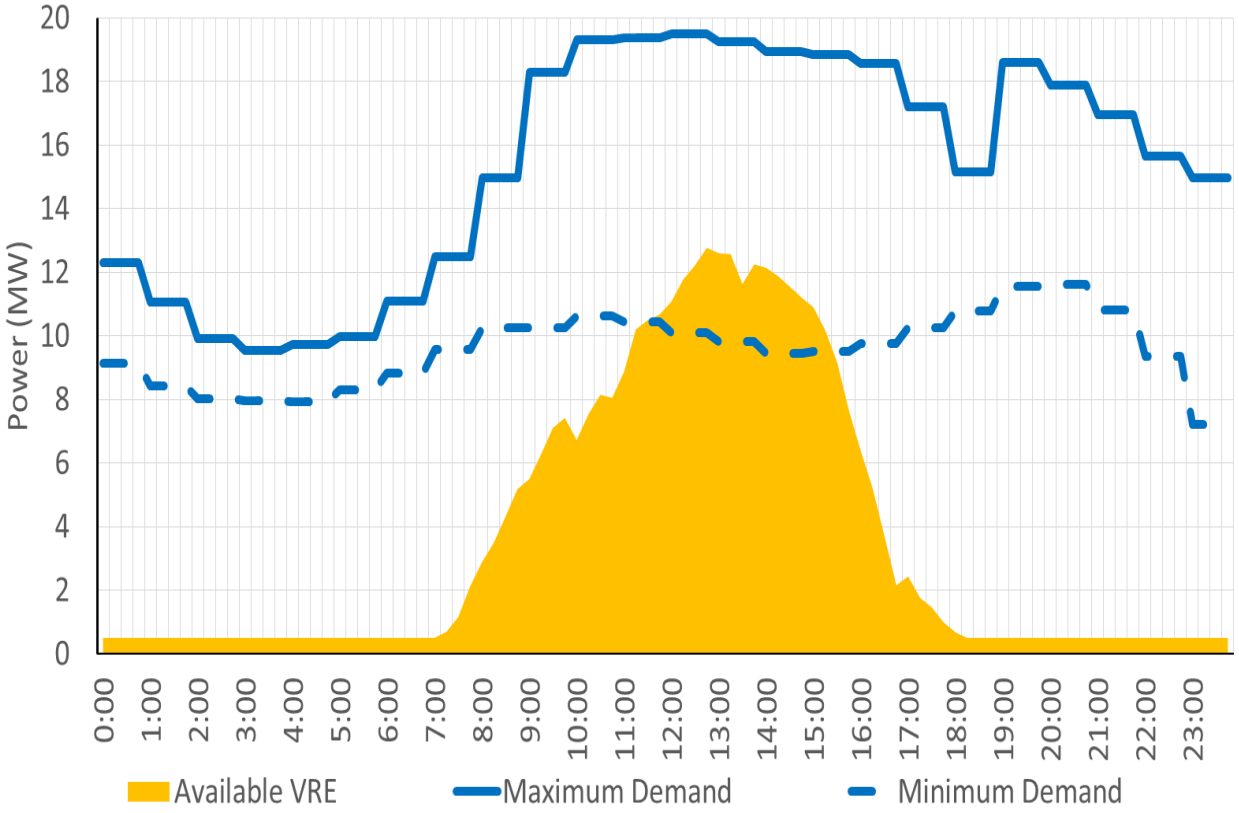
Study Case: Power system transformation Upolu Samoa



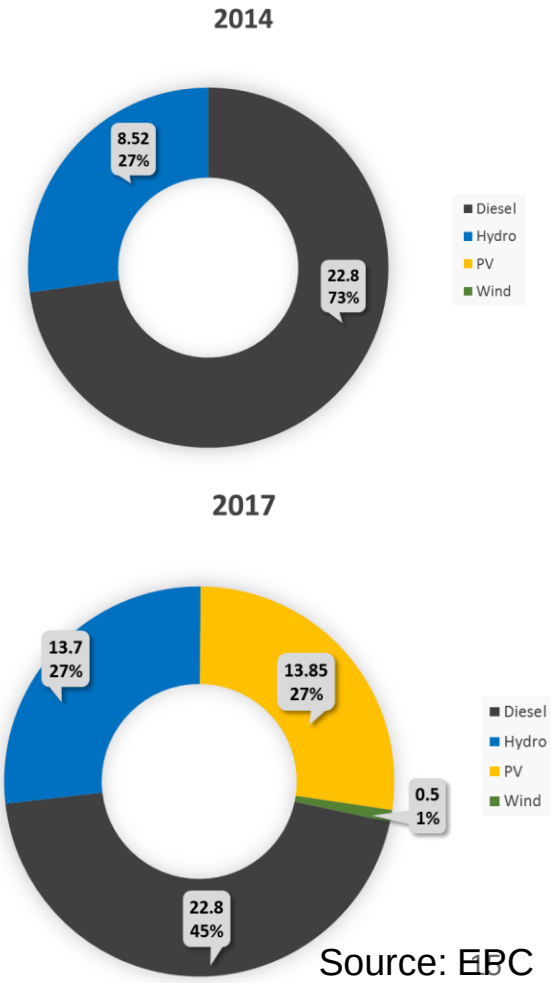
Estimated population 140.000 habitants
Annual electricity production 112 GWha (estimated 2014)
Around 75 % of electricity currently from diesel generators
Abundant hydro resources
Target 100 % RE

Study Case: Power system transformation Upolu Samoa

VRE Generation vs Demand



Evolution of generation mix in Upolu (MW and %)

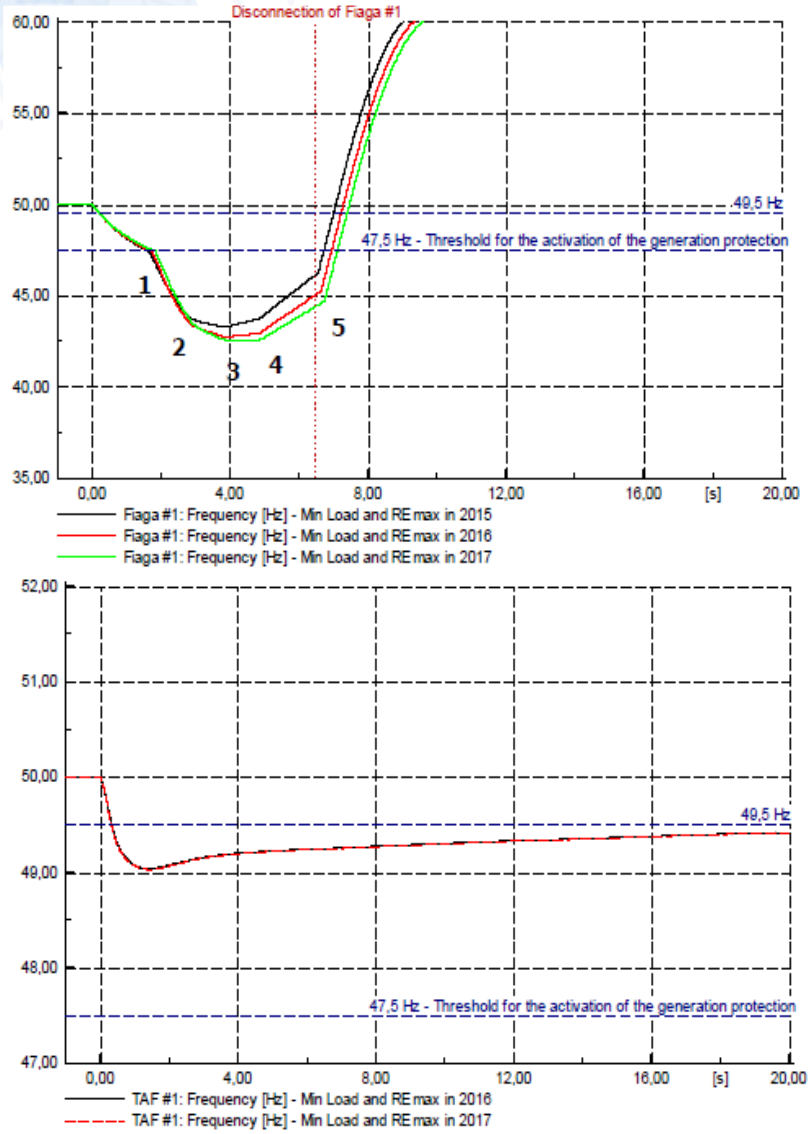


Very high instantaneous penetration of VRE

Challenges for secure grid operation !

Source: EPC November 2014

Study Case: Power system transformation Upolu Samoa



Issues with:

- Voltage Control
- Frequency stability

Two alternatives of mitigation measurements to meet reliability criteria

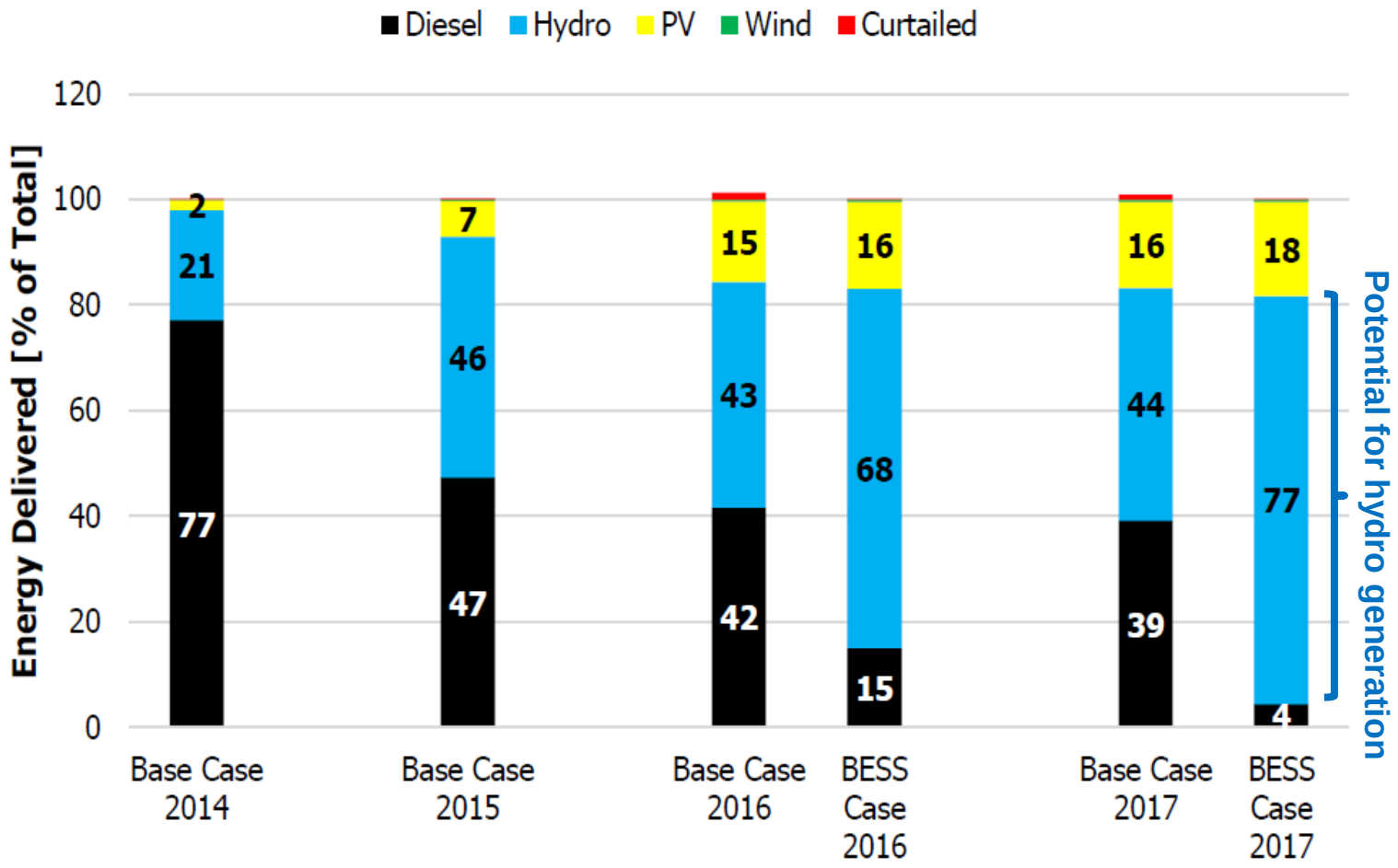
1- Base Case

- Must run diesel units for voltage control and frequency regulation
- Short term energy storage for frequency stability support
- Basic grid support functions from PV inverters (FRT, reactive power control, power output reduction by over frequency)

2- BESS based system

- BESS to provide spinning reserves
- Reactive power compensation / Automatic voltage control
- Basic grid support functions from PV inverters

Study Case: Power system transformation Upolu Samoa



Hydro Power Share depends on available water recourses. In plots 100% availability of water resources assumed

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