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FIGHTING POVERTY IN ASIA AND THE PACIFIC

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MiniGrid Stability and RE Integration: Technical Challenges

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Effergy is a Renewable Energy Consultancy company created in 2009. Expertise lies mainly in the field of renewables, with a wide and extensive international experience in consultancy, research and capacity building.

Effergy's Minigrids Projects under ADB: Maldives, Sri Lanka and Bangladesh

Agenda

1. Why Minigrids?
2. RE Integration Challenges
3. Available Solutions

Towards high RE penetration Minigrids

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- Ambitious RE targets have been set worldwide
- High RE penetrations results in technical challenges for System Operators
- Minigrids are the ideal platform to start realizing tomorrow's energy technologies today.

Hybrid Minigrid Project Phases

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Feasibility Study → Detailed Engineering → Installation & Comissioning → Operation & Optimization

Feasibility Study	Detailed Engineering	Installation & Comissioning	Operation & Optimization
HOMER ENERGY	DIgSILENT, MATLAB The Language of Technical Computing	IEC International Electrotechnical Commission; Suppliers	MATLAB The Language of Technical Computing
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- Each system has its own optimal RE penetration rate. However, there is no technical limitation for 100% RE if we implement proper actions

Technical Challenges in Hybrid Minigrids

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Inherent volatility of renewable energy can compromise grid stability

The renewable energy integration solution must address requirements traditionally fulfilled by diesel generation (base load)

- Sufficient spinning reserve
- Sufficient active and reactive power supply
- Peak shaving and load leveling
- Load sharing between generators
- Frequency and voltage control
- Fault current provision

Renewable energy generation capacity should be sized to maximize ROI and fuel savings

Grid Stability Assessment

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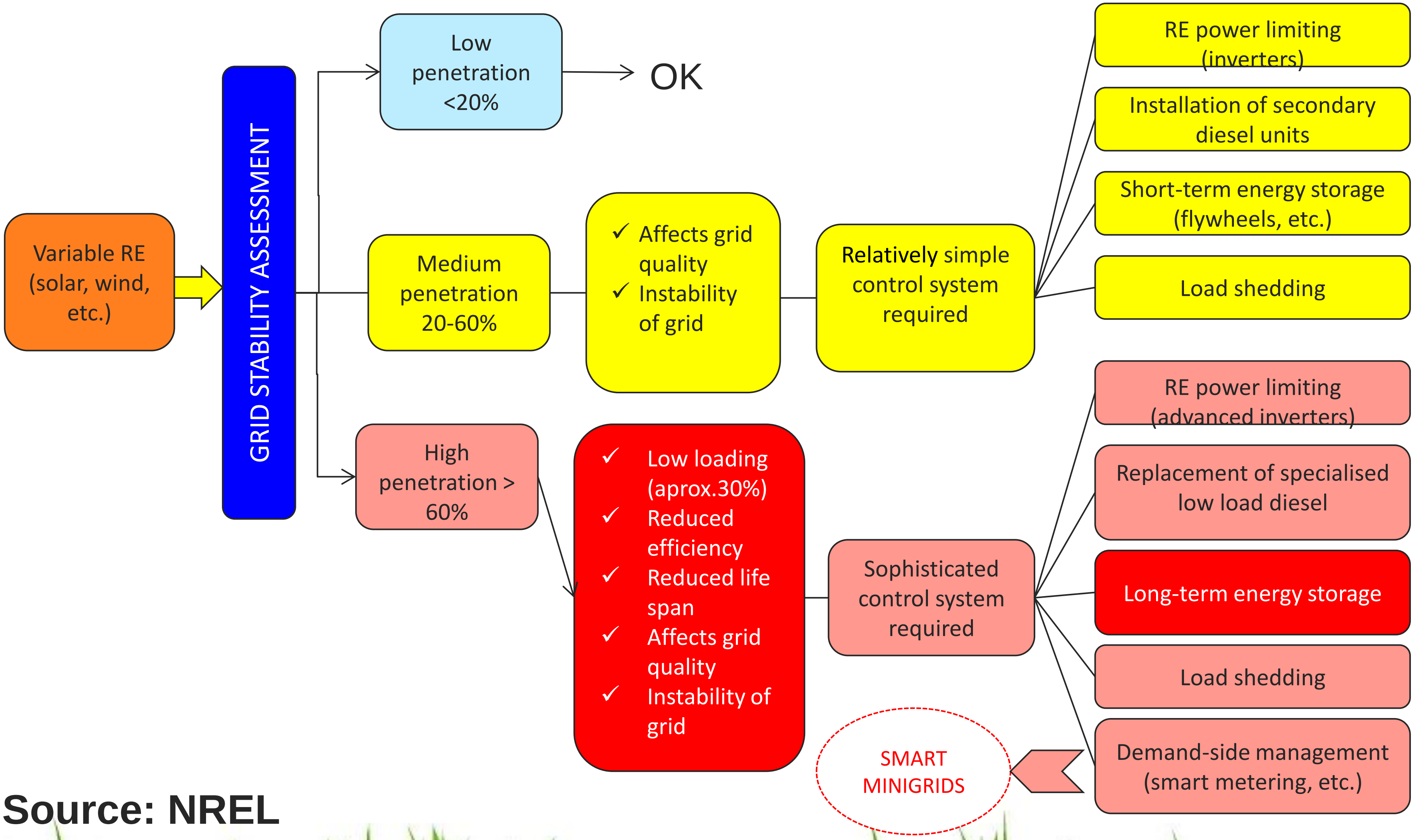
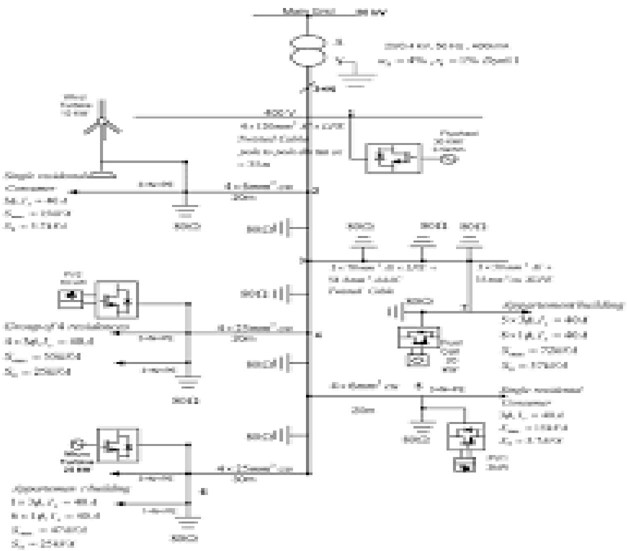
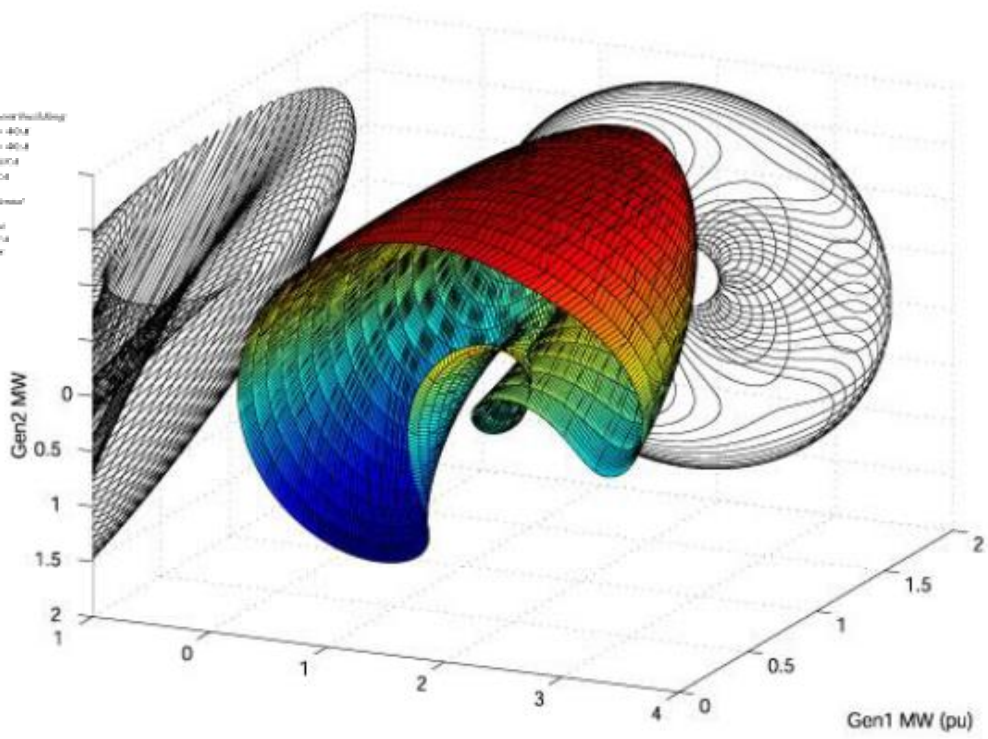


Source: NREL

Technical Challenges in Hybrid Minigrids

Stability Region for Safe Operation





Technical Challenges in Hybrid Minigrids

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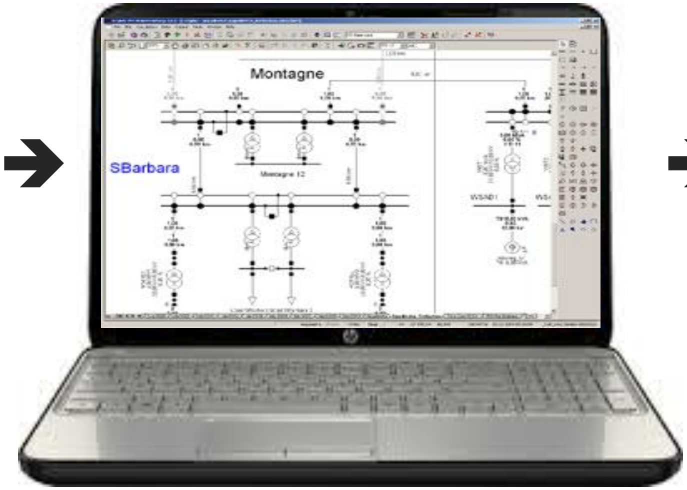
Input Data ➔ Minigrid Model ➔ Output Data

➔



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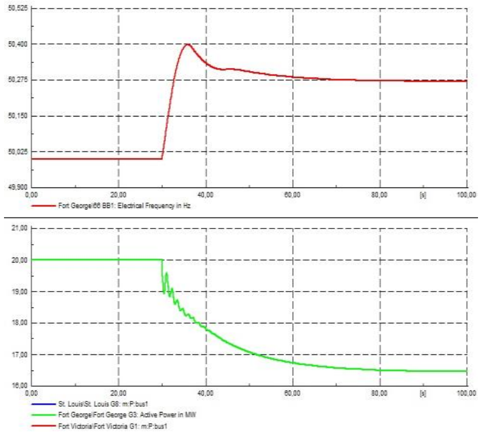
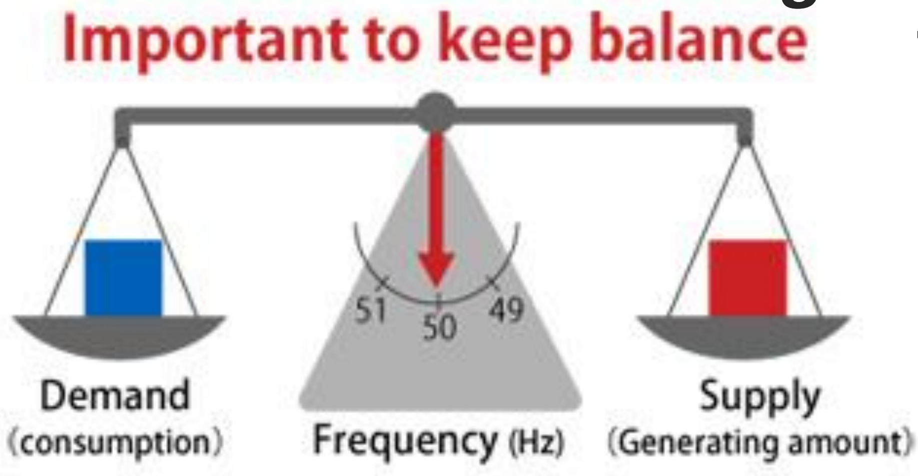
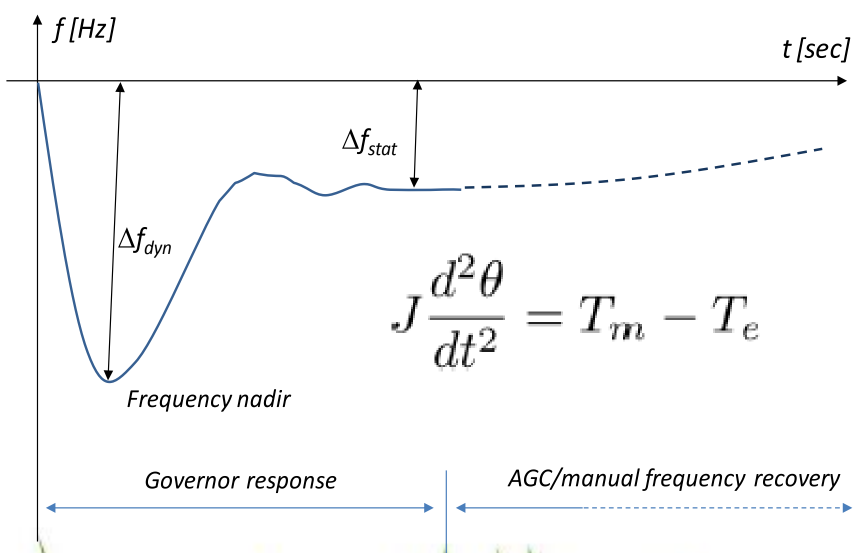


Technical Challenges in Hybrid Minigrids

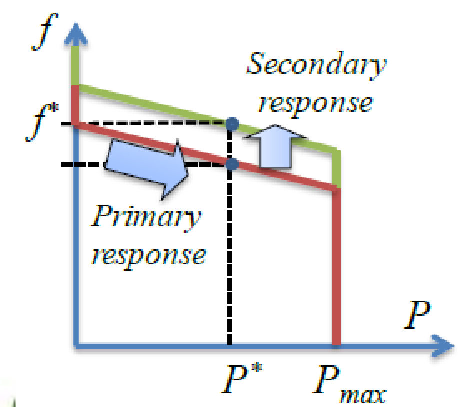


Technical risks:

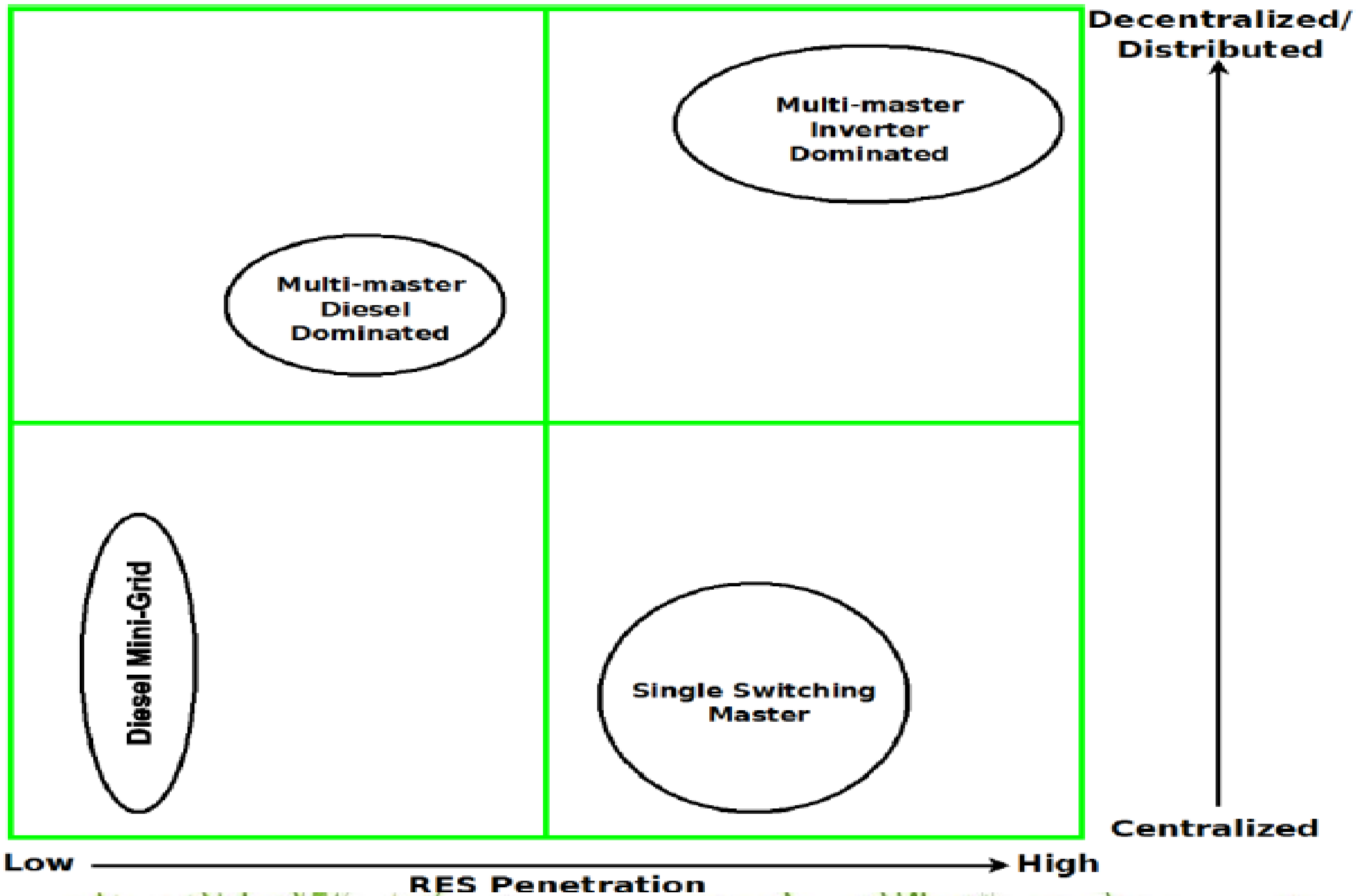
- Secure Operation
- System Stability
- Power Quality



Primary Control: Droop control
Secondary Control: Power Plant Controller.



Frequency Control Strategies



Available Technology for High RE penetration

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- Energy Storage for Grid Support
- Active Control Power Balance of Variable Resources
- More flexible Diesel GenSets
- Enhanced EMS: Improve Wind & Solar Forecasting
- Demand Response to handle RE

High Resolution Battery Cycling Simulation Tool

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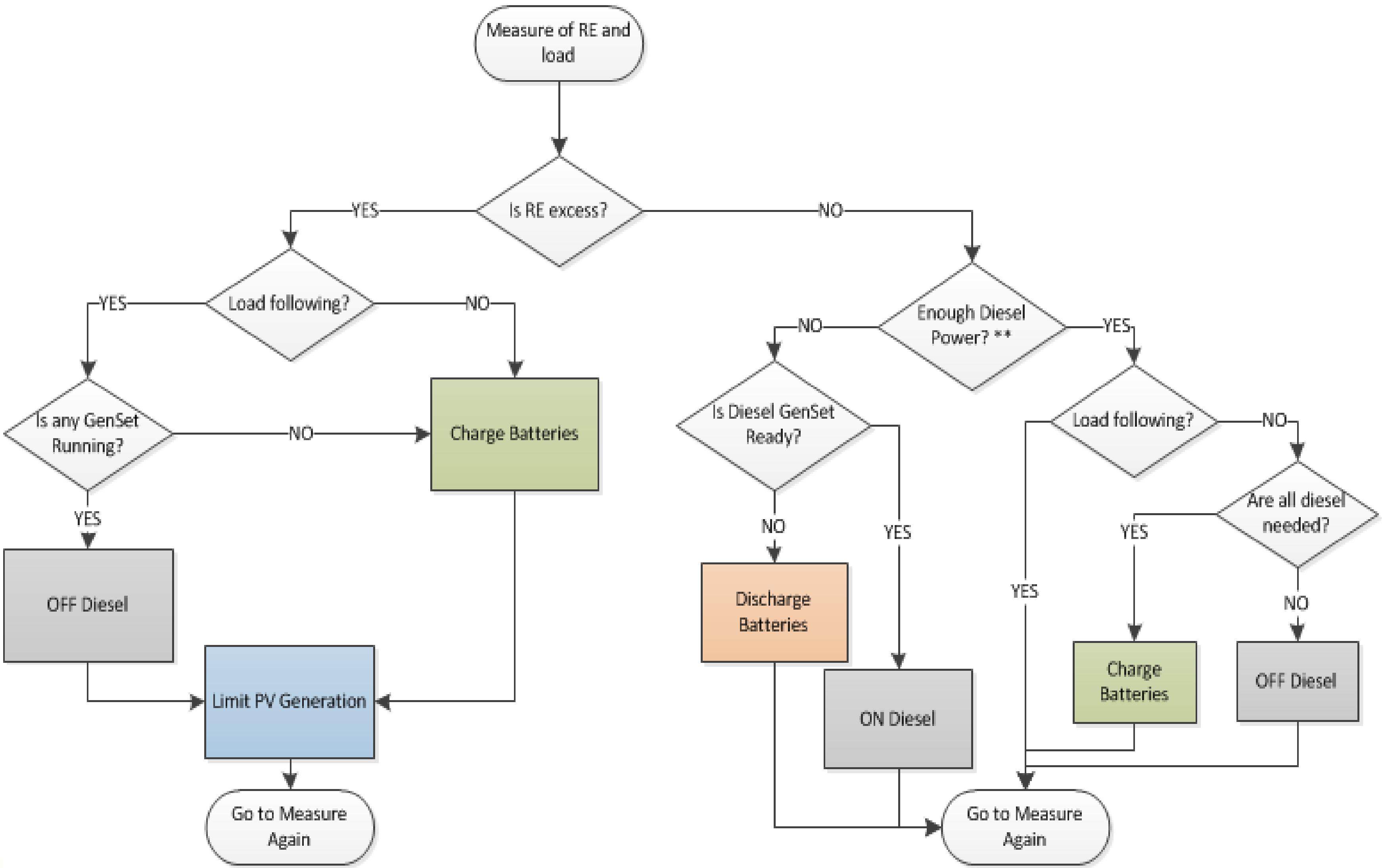

Case Study: Maldives

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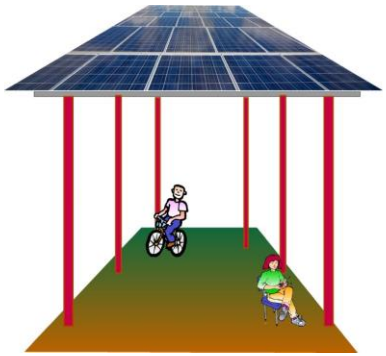
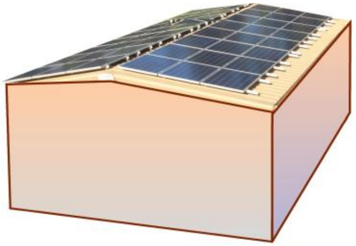
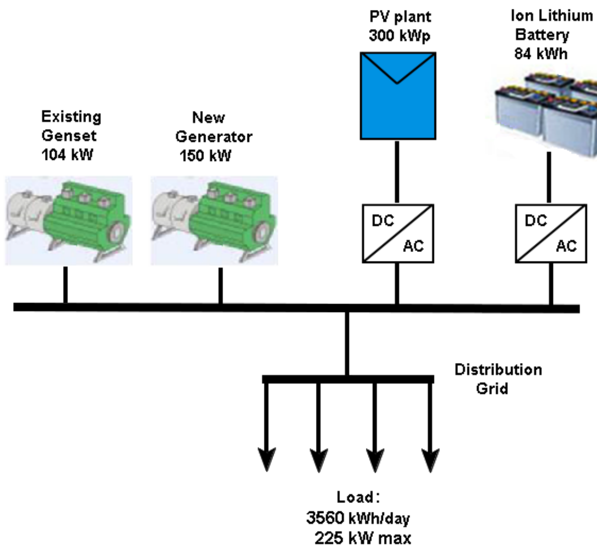
Case Study: Maldives







Island	*Data*
Electricity Demand	1,230 MWh/yr
RE penetration	35%
Solar Power	300 kW
Wind Power	0 kW
Storage Power	223 kW
Diesel Power	254 kW

Case Study: Maldives

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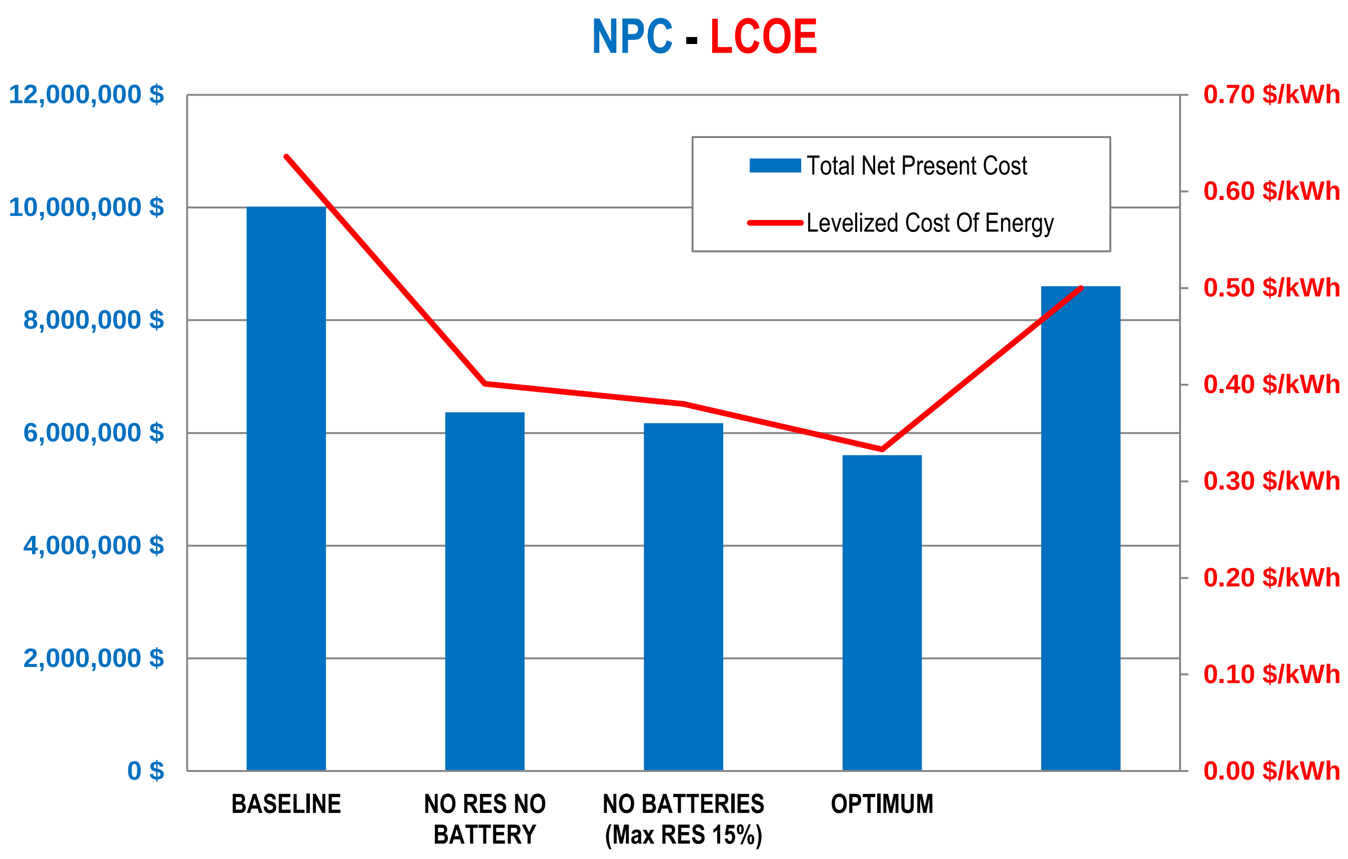

Case Study: Maldives

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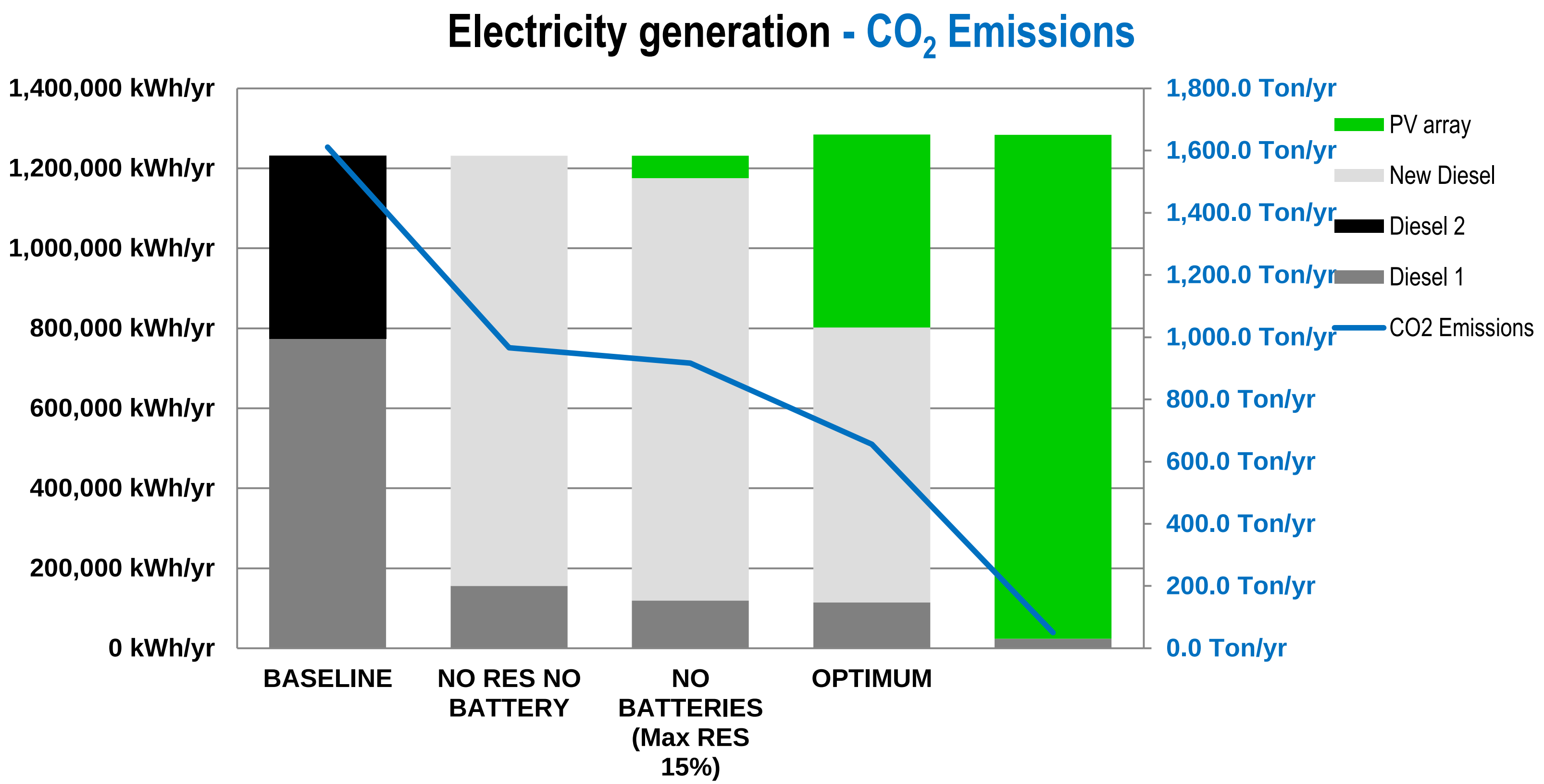

Case Study: Maldives

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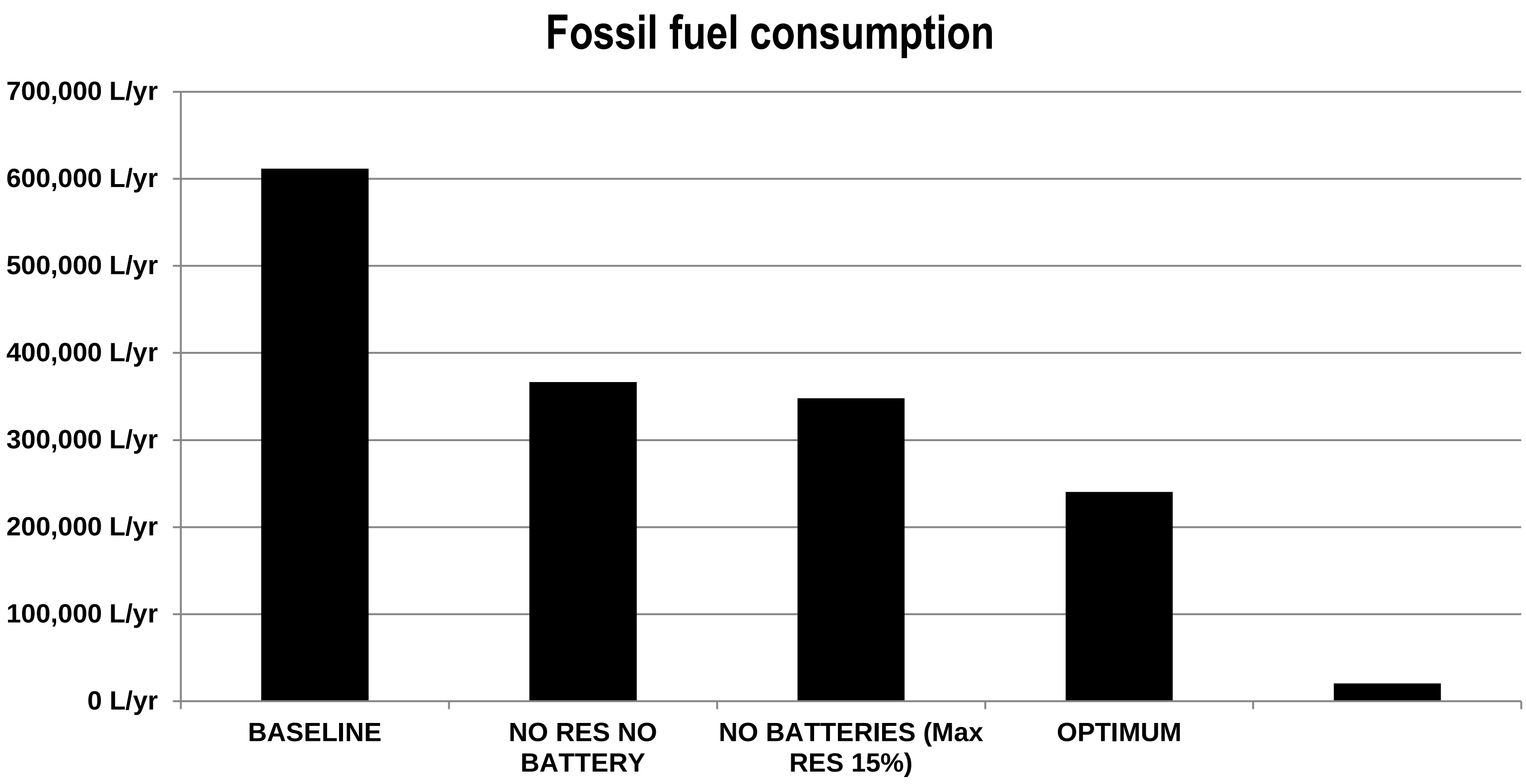

Battery Storage for Grid Support: Buruni

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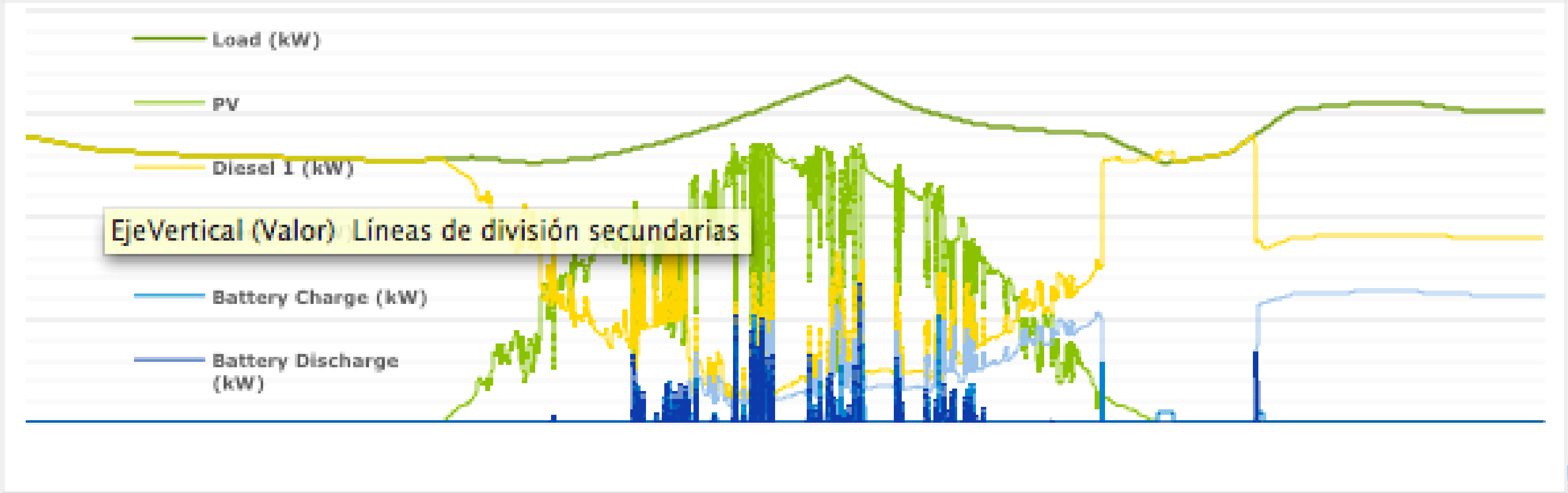
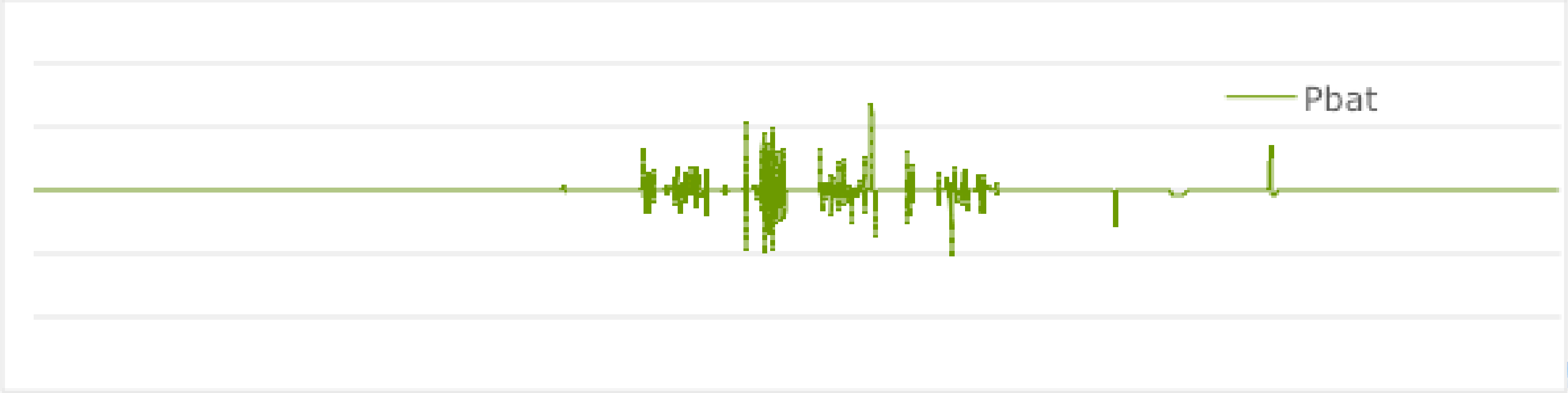
- Battery Performance





Example: Maldives-Buruni

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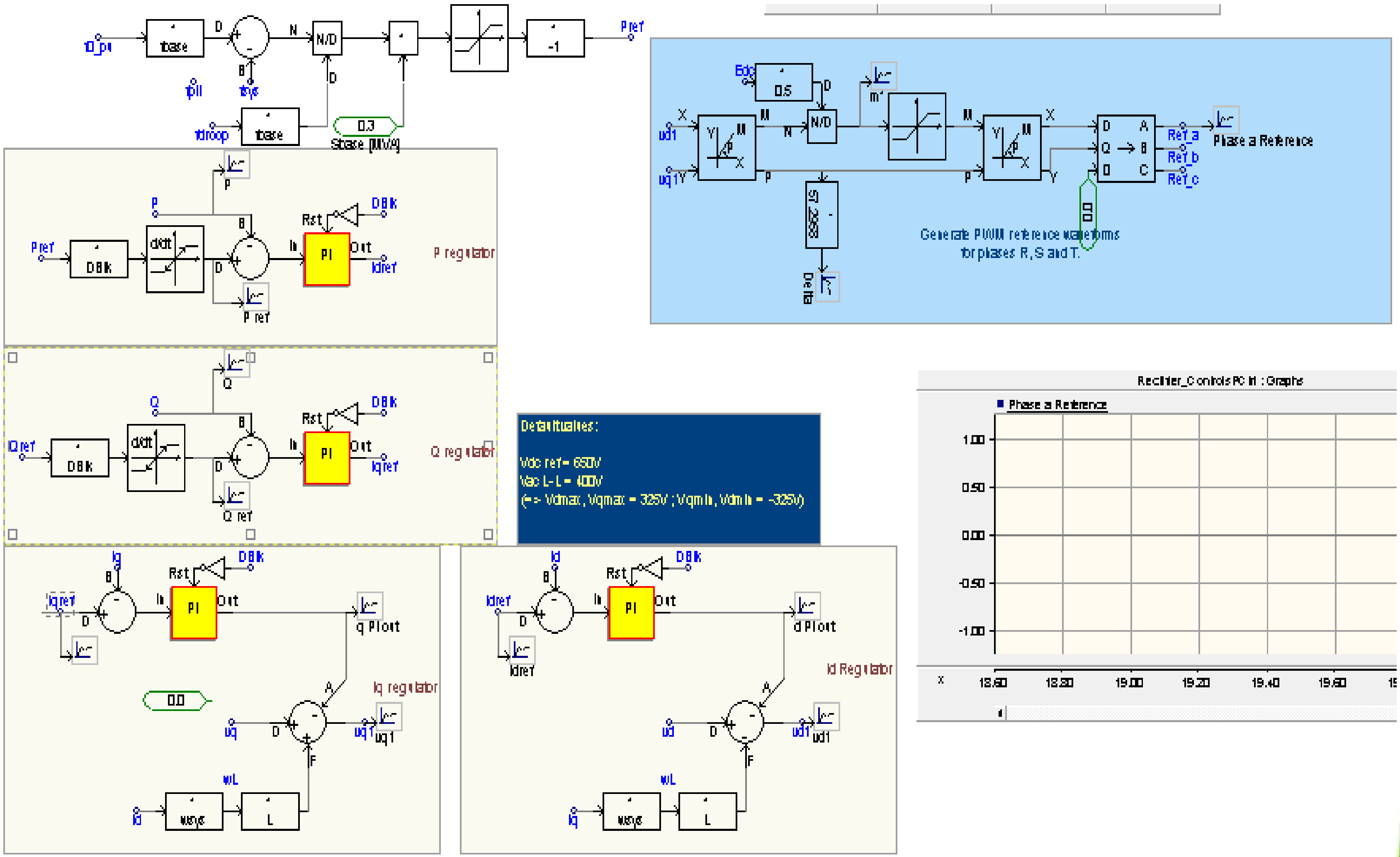
- Battery Performance

Before	After
P= 150 kW	P= 150 kW
Q=112.5 kVAr	Q= 112.5 kVAr
Irradiance=1000 W/m2	Irradiance=200 W/m2
Diesel 1 Switched on	Diesel 1 Switched on
Diesel 2 Switched off	Diesel 2 Switched off

Example: Maldives-Buruni



Example: Maldives-Buruni

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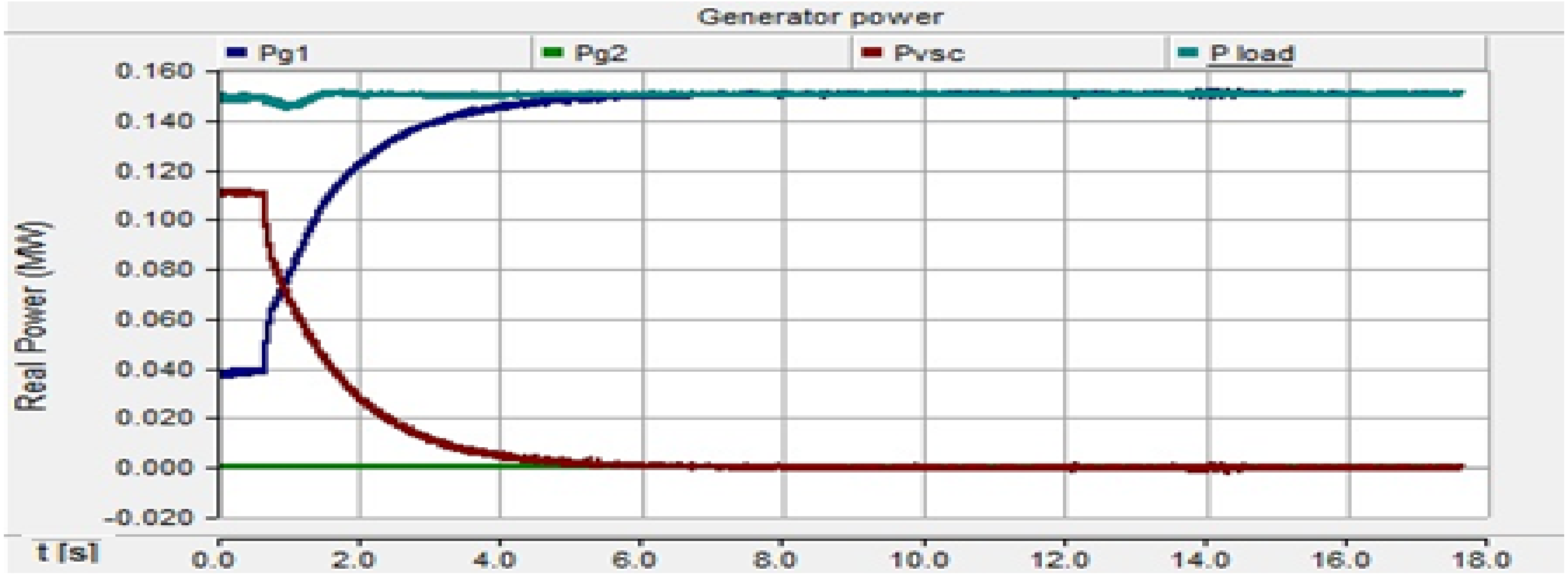

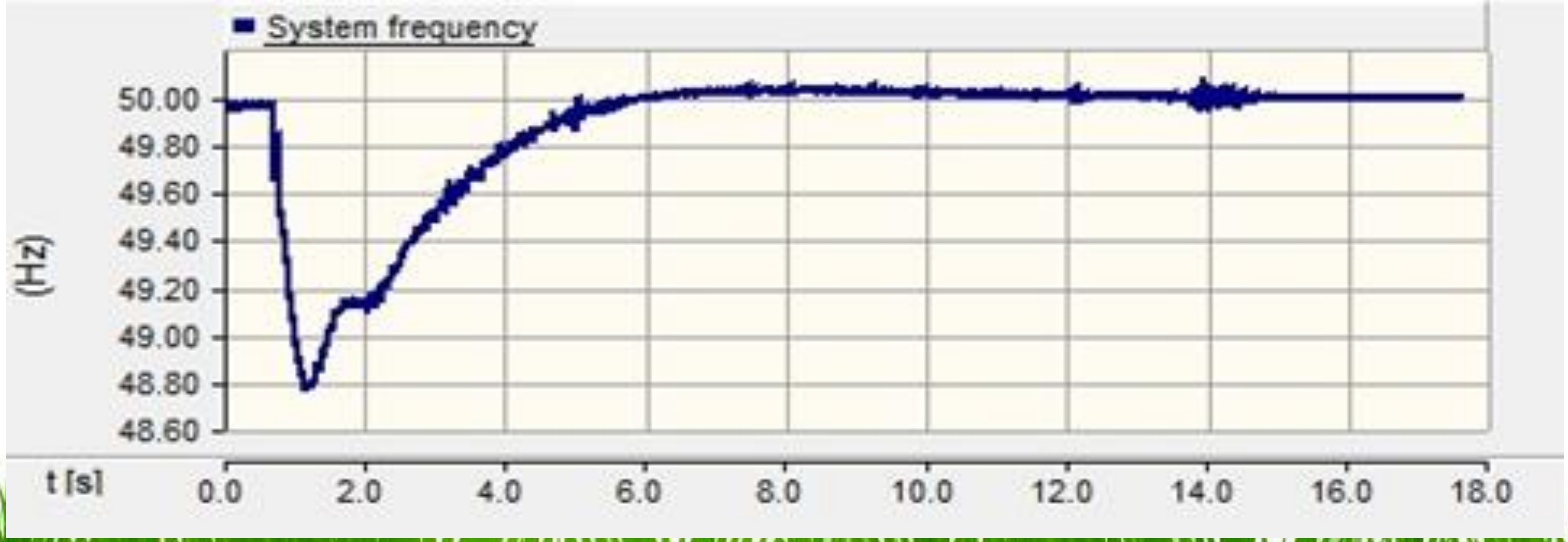

Example: Maldives-Buruni

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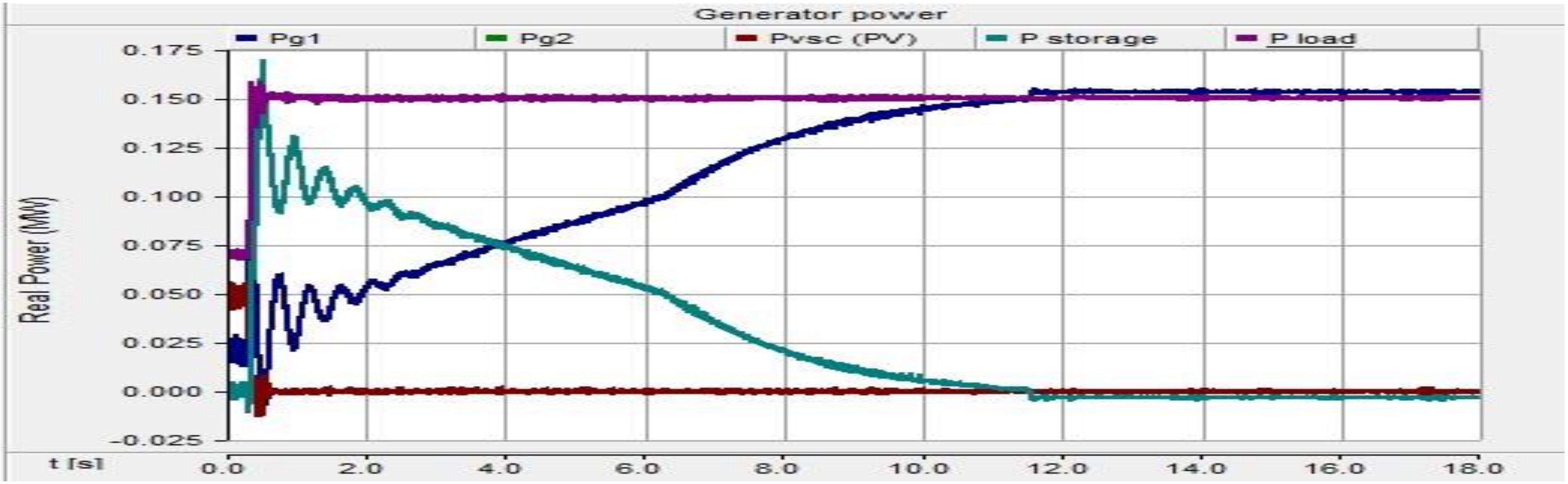

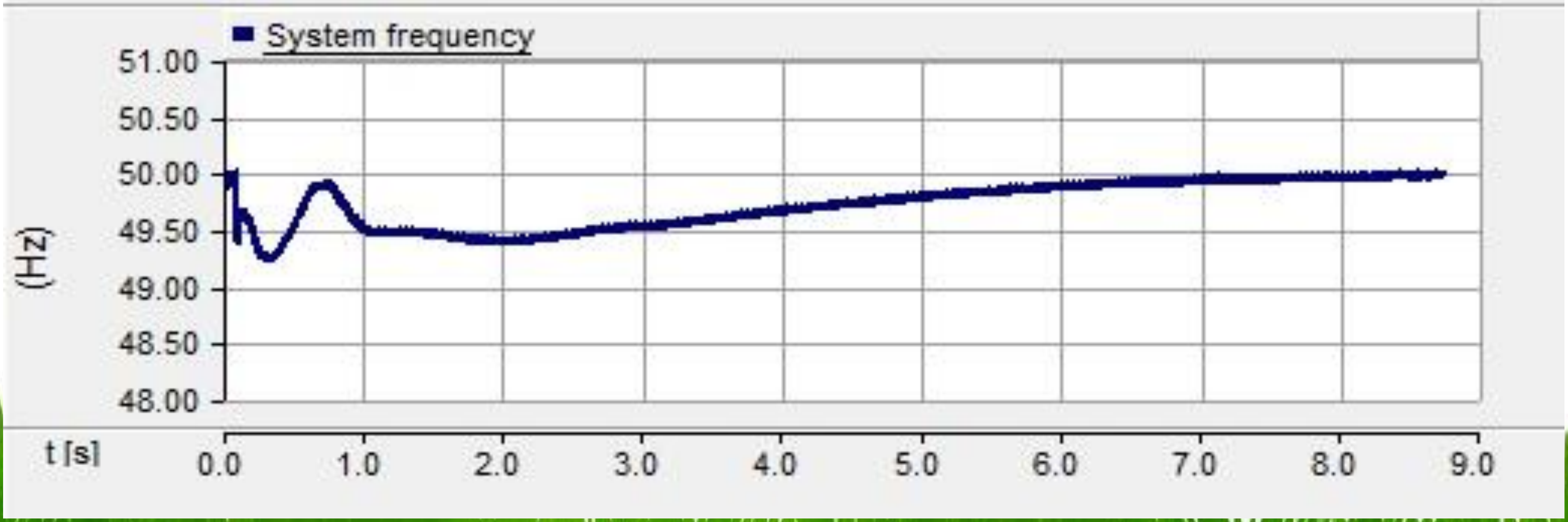

Final Remarks

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High RE minigrids poses technical challenges that have to be understood

Technology to install and operate minigrids with high renewable energy contribution is now proven and commercially available

Extensive simulations and experience are requiered to optimize and engineer the systems using verified models

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High RE penetration Minigrids, Looking Ahead !

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Grid Stability Assessment

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20%	60%	>60%
• Ok	• Simple Controls	• Enhanced Controls