INTERNATIONAL RENEWABLE ENERGY AGENCY

IRENA

International Renewable Energy Agency

IRENA Innovation and Technology activities on renewable-energy based mini-grids

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Abu Dhabi, 3 November 2016

IRENA mini-grid activities

International Off-grid Renewable Energy Conference & Exhibition (IOREC)*

Policy frameworks and business models

Analysis, design and project development

Regional and national implemen-tation

*www.iorec.org

Mini-grid Planning and Design Process

NREL's: Continuously Optimized Reliable Energy (CORE) Microgrids Concept

Evaluation

- Energy planning
- Objective setting
- Asset inventory
- Management systems

Data gathering

- Grid infrastructure
- Generator specs
- Demand profile
- Grid operations
- Cost estimates

Design analysis

- Detailed electricity model
- Power flow models
- Controls & communication
- Financial analysis
- Optimisation

Installation and monitoring

- Request for proposal
- System integration selection
- Construction oversight
- Verification and validation

Source: http://www.nrel.gov/docs/fy13osti/57744.pdf

Tariff Studies

Island and Mini-grid Roadmaps

Mini-grid Innovation & Technology Outlook

Smart Grids + Energy Storage Outlook

Mini-grid Costing Analysis

Grid Studies

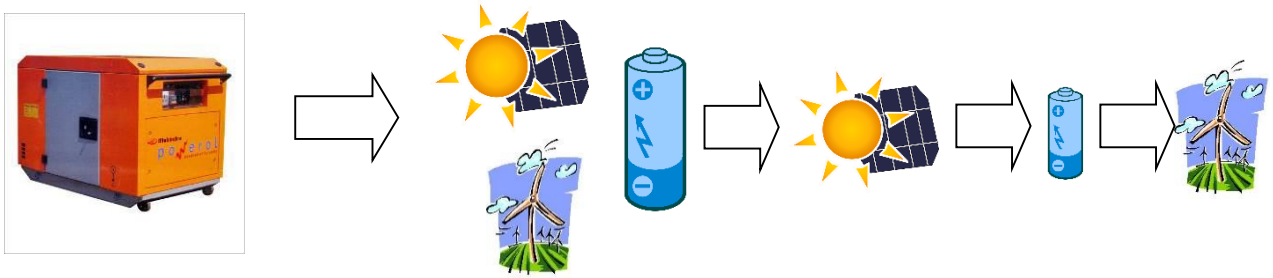
Project Navigator

Valuing Energy Storage

1. Mini-grid and Island Roadmaps

IRENA's renewable energy roadmaps for islands can support private sector engagement in mini grids deployment by offering:

- Options for policies, regulations and market structures that support private sector involvement in RE mini grid deployment, e.g. net-metering and feed-in-tariffs, power purchase agreements (PPAs), etc.
- Identification of technologies that are specifically suited for minigrids deployment in tourism facilities (e.g. off-grid resorts)
- Successful pathways based on best practices for transition from diesel-grids to mini grids with large share of renewables
- Analysis that helps potential investors to understand which technologies and services are most valuable to mini grid deployment
- The roadmap process encourages governments to engage all energy sector stakeholders including customers, IPPs, installers, project developers, etc.



Mini-grid and Island Roadmaps

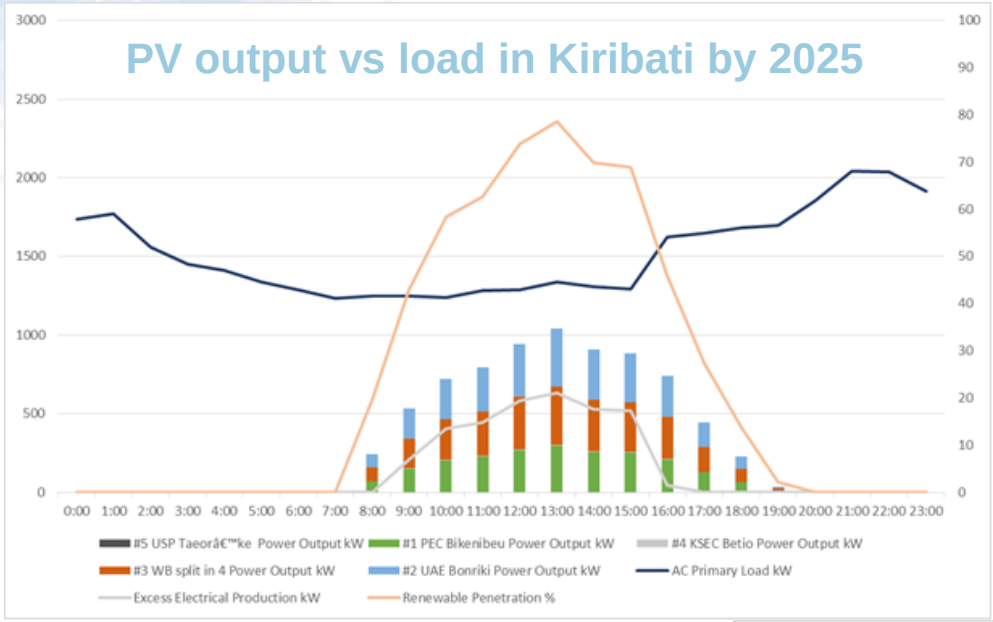
Goal: develop a comprehensive, quantitative, action oriented plan supporting a transition to renewable energy for islands and mini-grids

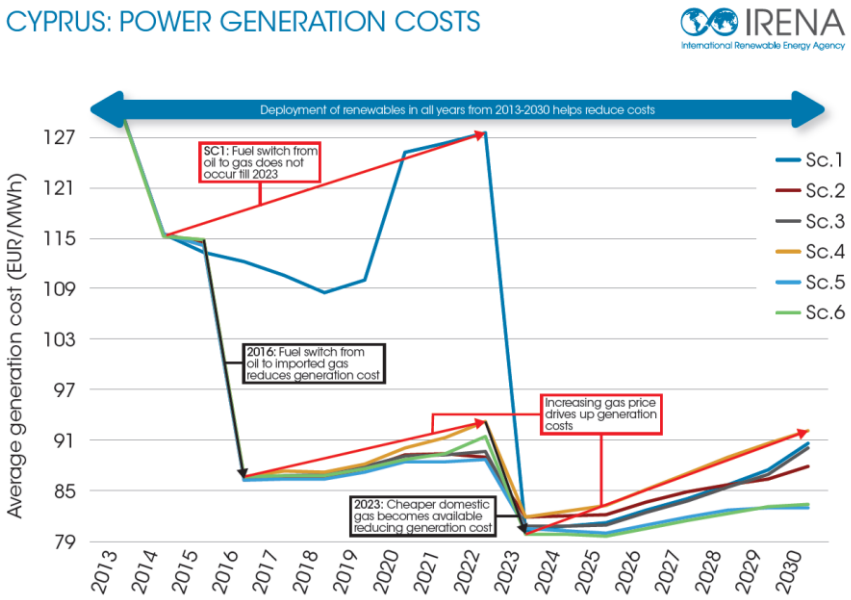
- Country driven process: focus varies depending on country's needs
  - The whole country (national) or specific islands or off-grid resorts
- Analysis that helps potential investors to understand which technologies and services are most valuable to mini grid deployment
- Different quantitative tools used, depending on approach, sectoral focus, data availability, etc. (e.g. HOMER, MESSAGE, PLEXOS, LEAP, etc.)
- Provides specific recommendations to policy makers for implementation

Progress to date:

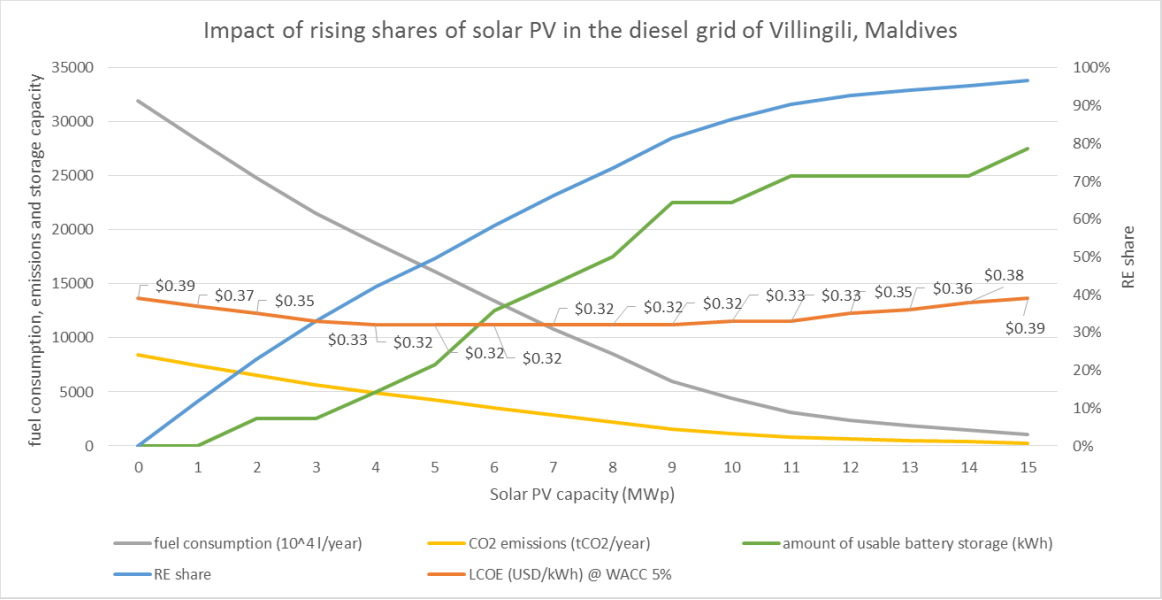
- Roadmapping Baseline Report for Pacific SIDS
- Four Renewable Energy Roadmaps completed, two ongoing
- Roadmap deployment support for three islands

Sample roadmap outputs



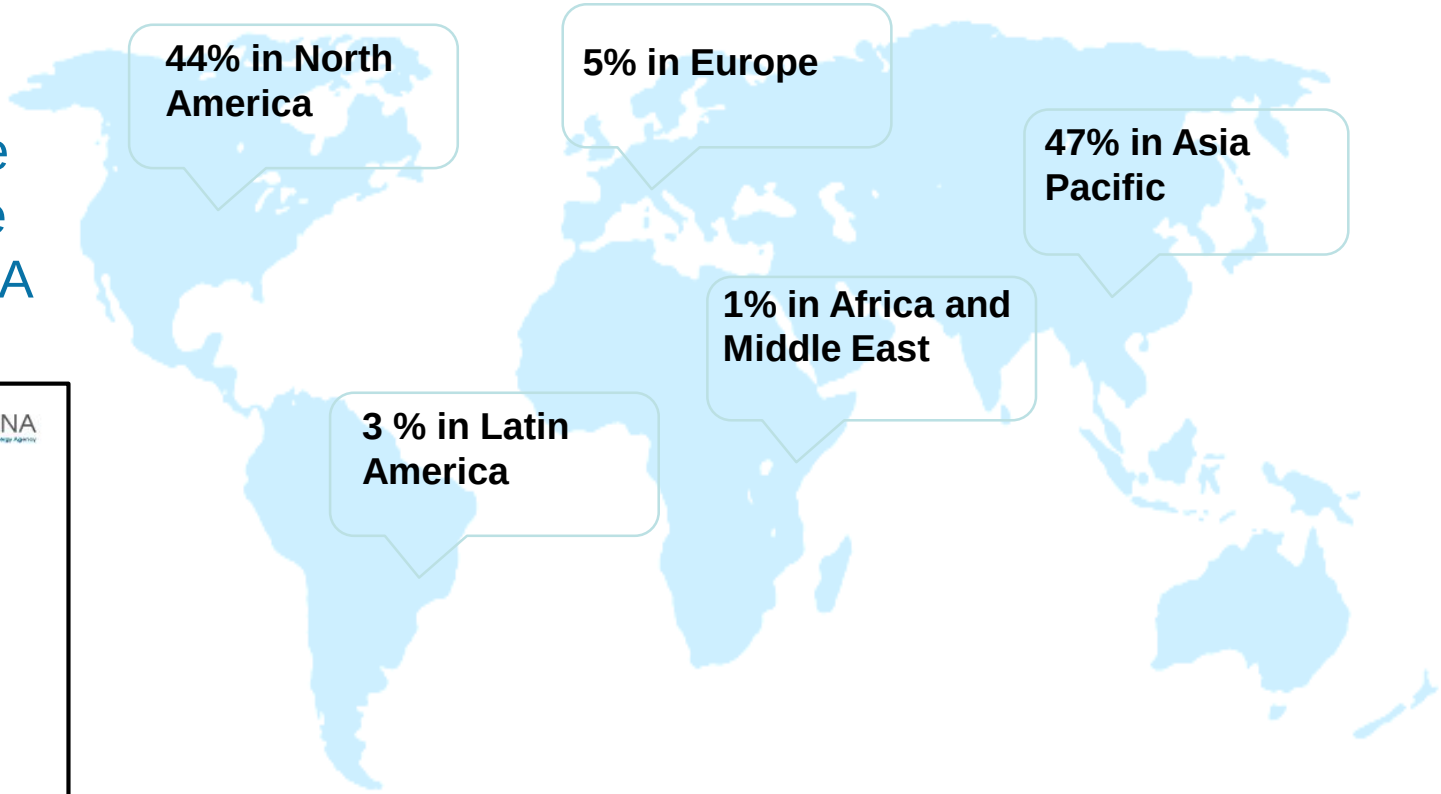


- Assessment of the impact of RE deployment in both technical and economic terms
- Explore the impact of different assumptions to develop policies resilient to external shocks
- Direct link with the technical assessment of grid operations with the identified generation mix



2. Innovation Outlook: Renewable mini-grids

Download the report for free from the IRENA web site



12 GW of mini-grids installed worldwide

50 - 250 GW of diesel mini-grid hybridisation potential

Source: Navigant (Asmus and Lawrence, 2015)

Deployment today

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Limited	Pilots	Emerging	Mature
●	●	●	●

Region	Autonomous Basic	Autonomous Full	Interconnected Community	Interconnected Large Industrial
Canada and USA	●	●	●	●
Caribbean, Central America, Mexico	●	●	●	●
South America	●	●	●	●
Europe	●	● ● ●	●	●
North Africa	●	●	●	●
Sub-Saharan Africa	● ●	●	●	●
Central and North Asia	● ●	●	●	●
East and South Asia	●	● ● ●	●	●
Middle East	●	●	●	●
Oceania	●	● ●	●	●
Antarctica		●		

Opportunities for innovation

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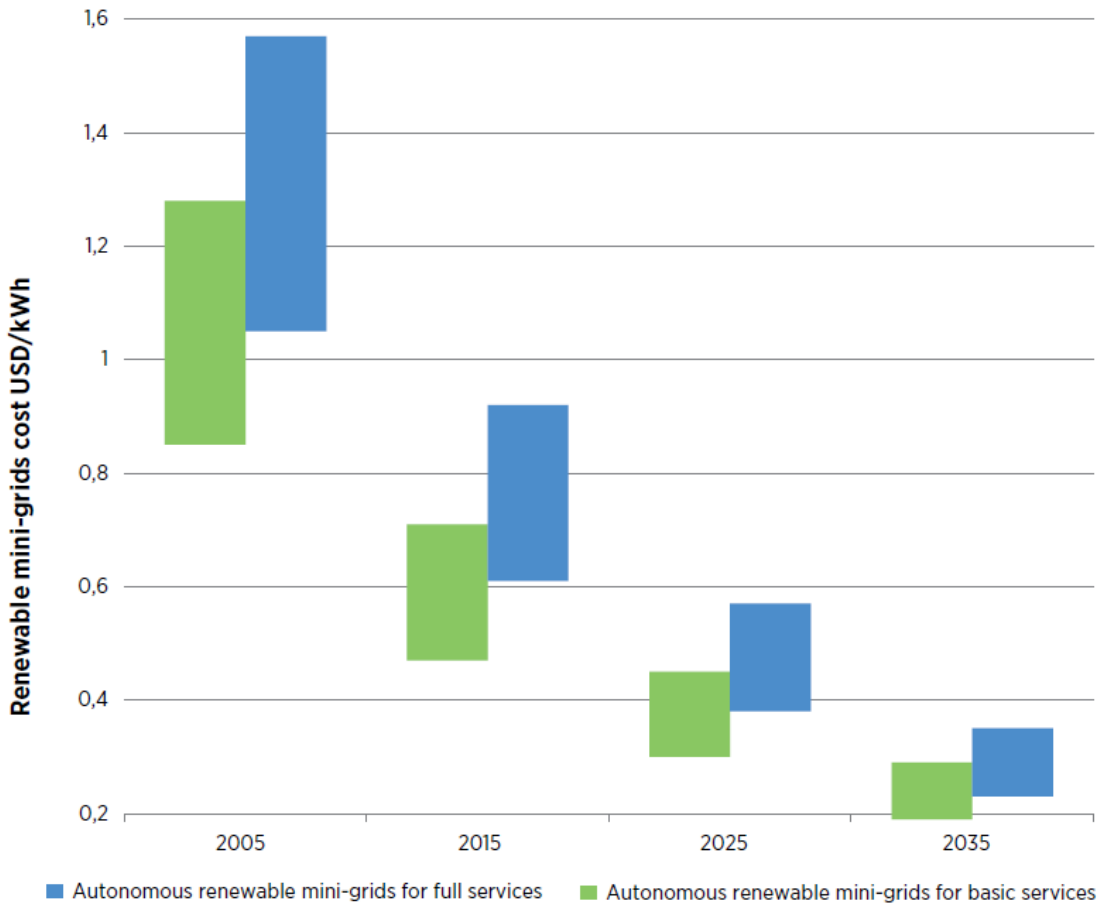
		Impact			
	Plan and Design	Cost	Reliability	Ease	Environment
1	Standardised planning and design	★★★★	★★	★★★★	★★
	Control, manage, measure (CMM)				
1	More intelligent controls	★★★	★★★★	★★★★	★★
2	Improved communications and standards	★★	★★★★	★★★★	★
3	Improved metering and monitoring	★★	★★★	★★★★	★★★
4	Simplify connecting equipment together	★★	★	★★★★	★
	Convert				
1	Lower capital costs of converters	★★★★	★	★★	★
2	Combine diverse function into inverters	★★	★★	★★★★	★
3	Improve efficiency, particularly at partial load	★★	★★	★	★★★
4	More converter options for diverse renewable mini-grid markets	★★	★★	★★★★	★
	Consume				
1	Increased commercial availability of efficient end-uses	★★★★	★	★★	★★★★
2	Better user tools for adapting consumption to energy supply (DSM)	★★★★	★★	★★★	★★★★

Innovation making renewable mini-grids competitive



Unsubsidised cost ranges for renewable mini-grids from 2005 to 2035 for a 100% renewable energy community system

3. Energy Storage + Smart grid Outlook

	Pumped hydro	Lead-acid	Li-ion	Flow battery	Molten salt	Fly-wheel	Super-capacitor	CAES	Hydro-gen
Output (MW)	250 –1000	0.01 - 10	0.01 - 30	0.01 – 30	1 – 200	0.01 – 10	0.1 – 10	110 - 290	10 –100
Depth of discharge (%)	100	50	80	70 – 90	90	90	90	90	100
Discharge time	hrs	min - hrs	min - hrs	hrs	hrs	sec – min	sec	Min - Hrs	Hrs
DC Efficiency (%)	70 – 80	70 – 80	90	75 – 80	75 – 85	90	95	40 -70 (A)	70 – 80
Cycles	>50 000	300 - >800	1000 - >5000	>10000	>10000	> 50000	> 50000	> 50000	> 50000
Lifetime (years)	30+	3 – 10	8 – 15	10 – 20	10 – 20	10 – 20	10 – 20	30+	10 – 20
Investment (USD/kW)	2000 – 4000	500 - 1500	1500 - 5000	2000 - 4000	4000	300 - 1000	1500 – 2500	850 - 2000	650 - 2300
Storage costs (USD/kWh)	50 –150	150 –600	600 - 2000	500 – 850	500	4000 - 6000		100 - 1000	
Cycle costs (USD/kWh/C)	0.05 –0.15	0.2 – 0.5	0.15 – 0.50	0.1 – 0.25	0.06 – 0.12	0.05 – 0.11			

4. Solar PV in Africa: Costs and markets
"KEY FINDINGS"

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Latest proposed **utility-scale solar PV proj**ects are targeting competitive installed cost levels that are comparable to today's **lowest-cost projects**

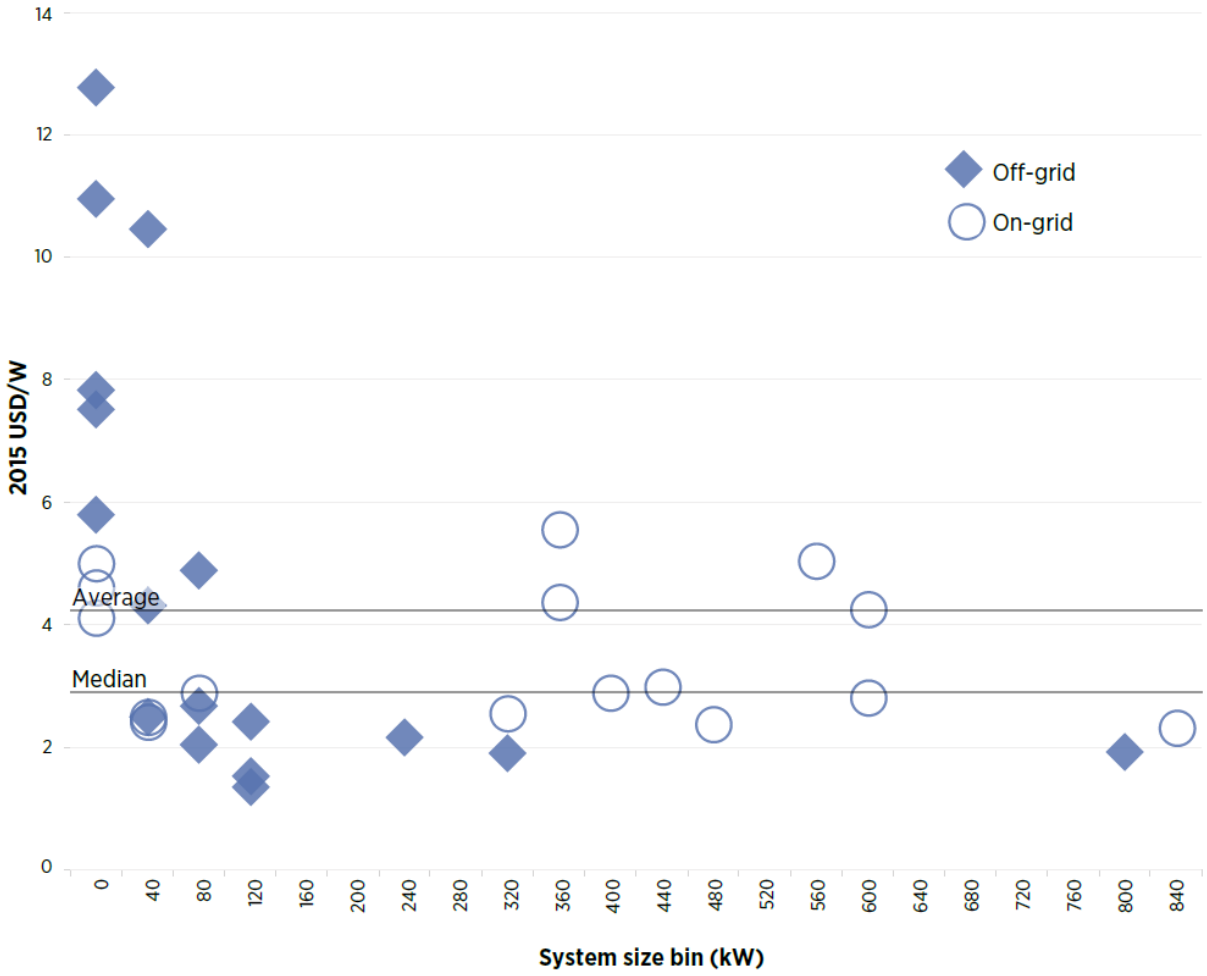
The installed costs of **solar PV for mini-grids span a wide range**, but recent and planned projects show examples of **competitive cost structures**

Solar home systems in Africa are providing better-quality energy services at the same or lower cost as lighting

from kerosene lanterns in off-grid situations

A sub-regional analysis for Africa could help identify the reasons for cost differentials, map out strategies to reduce them, and identify roles and responsibilities

Mini-grid cost in Africa



PV mini-grid system costs by system size in Africa, 2011-2015

5. IRENA Grid integration studies

RE Roadmaps

Grid Integration studies

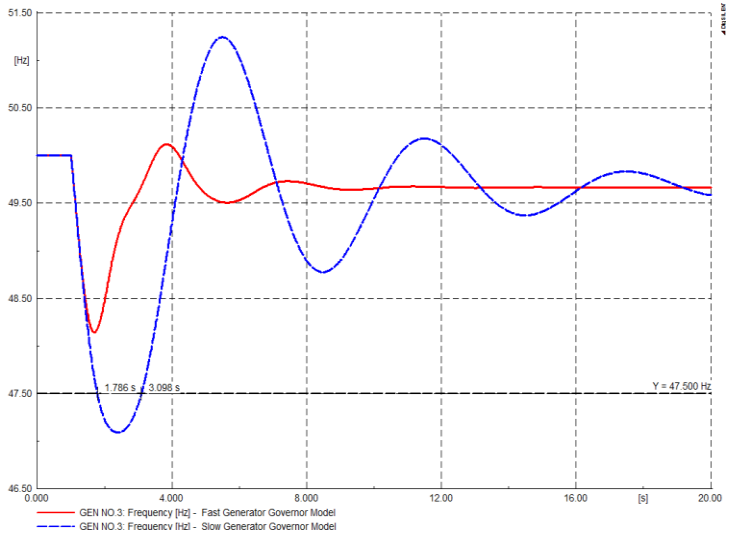
- Infrastructure investment requirements
- Grid Code requirements for VRE
- New grid operation procedures

Facilitate coordination between long-term, policy-driven RE targets and their actual deployment in the grid

Assessment of reliability and security of the system with planned penetration levels of VRE through statistical analysis and electricity grid modelling & simulation

Identification of technical solutions to maintain reliable grid operation

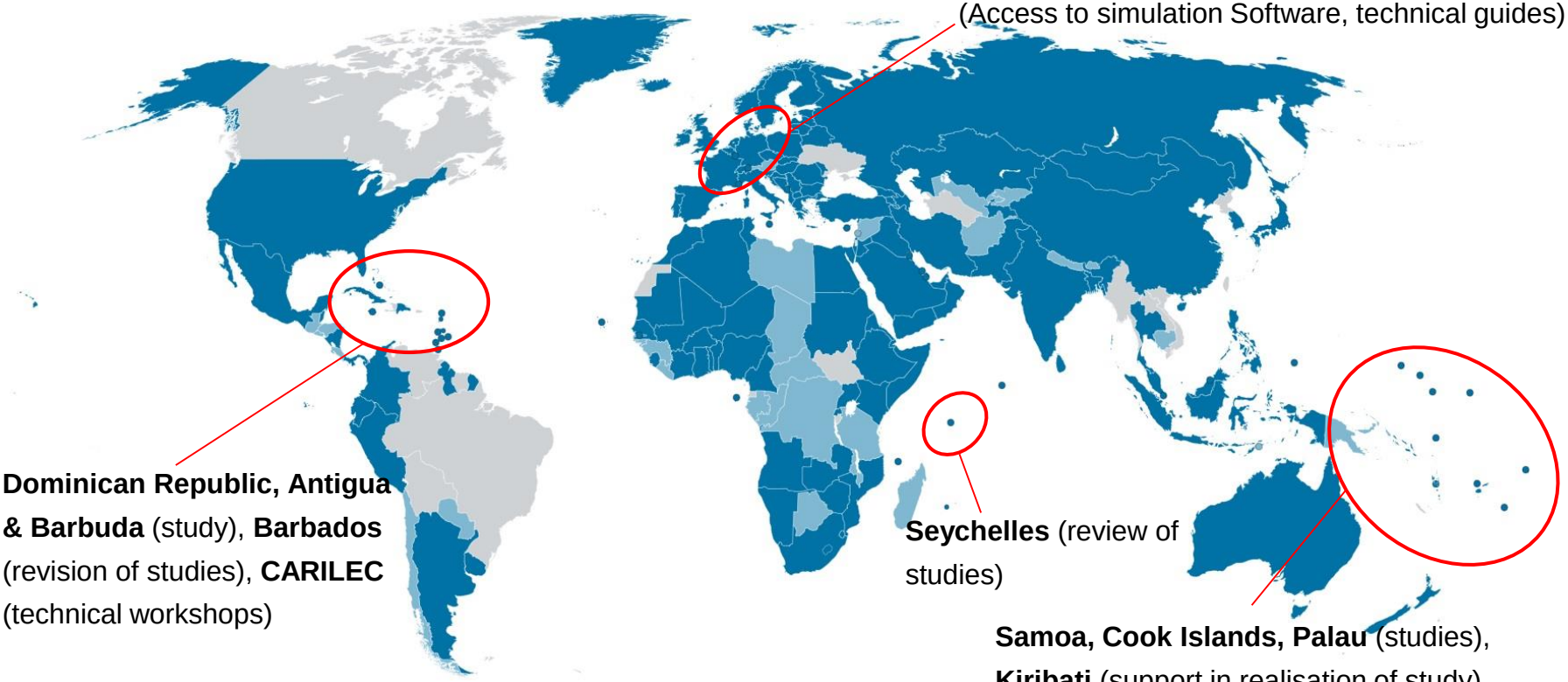
Provision of technical guides and assistance and online access to simulation software DIgSILENT *PowerFactory* to do grid studies with local human capacities



Grid integration studies – IRENA Engagement

Cooperation with decision makers, network operators and technical experts at a global level supporting exchange of experiences on grid operation & expansion – Until now focus on small isolated systems

DIgSILENT, TU Darmstadt, TRACTEBEL-ENGIE (Access to simulation Software, technical guides)



Dominican Republic, Antigua & Barbuda (study), **Barbados** (revision of studies), **CARILEC** (technical workshops)

Seychelles (review of studies)

Samoa, Cook Islands, Palau (studies), **Kiribati** (support in realisation of study), **Fiji, Vanuatu** (on-going studies, technical workshops)

6. IRENA Project Navigator

Objectives

- Increase the bankability of projects by:
  - Strengthening the project development base
  - Enhancing the quality of project proposals
  - Reducing costs and mitigating risks through proper planning and efficient use of funds
  - Facilitating effective implementation

Learning Section

- Project development and technical guidelines
- Best practices
- Tools, templates, examples
- Case Studies

Start a Project

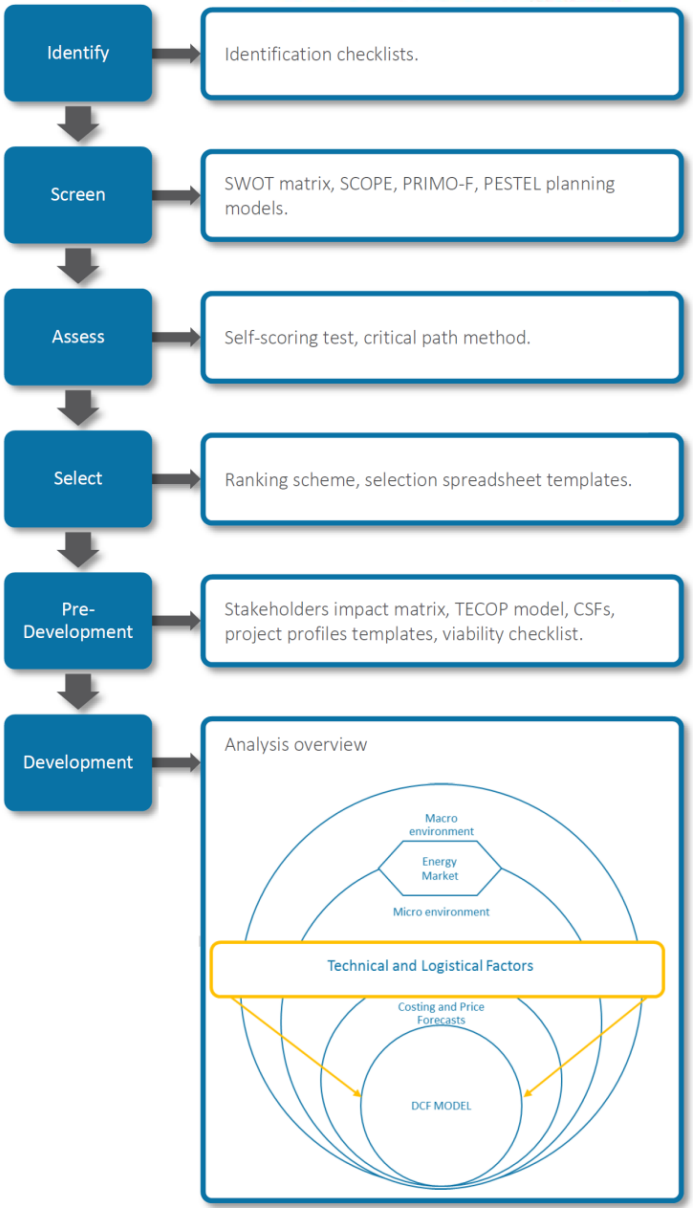
- Personal and private workspace
- Stepwise approach
- Track your progress
- Export documents

Financial Navigator

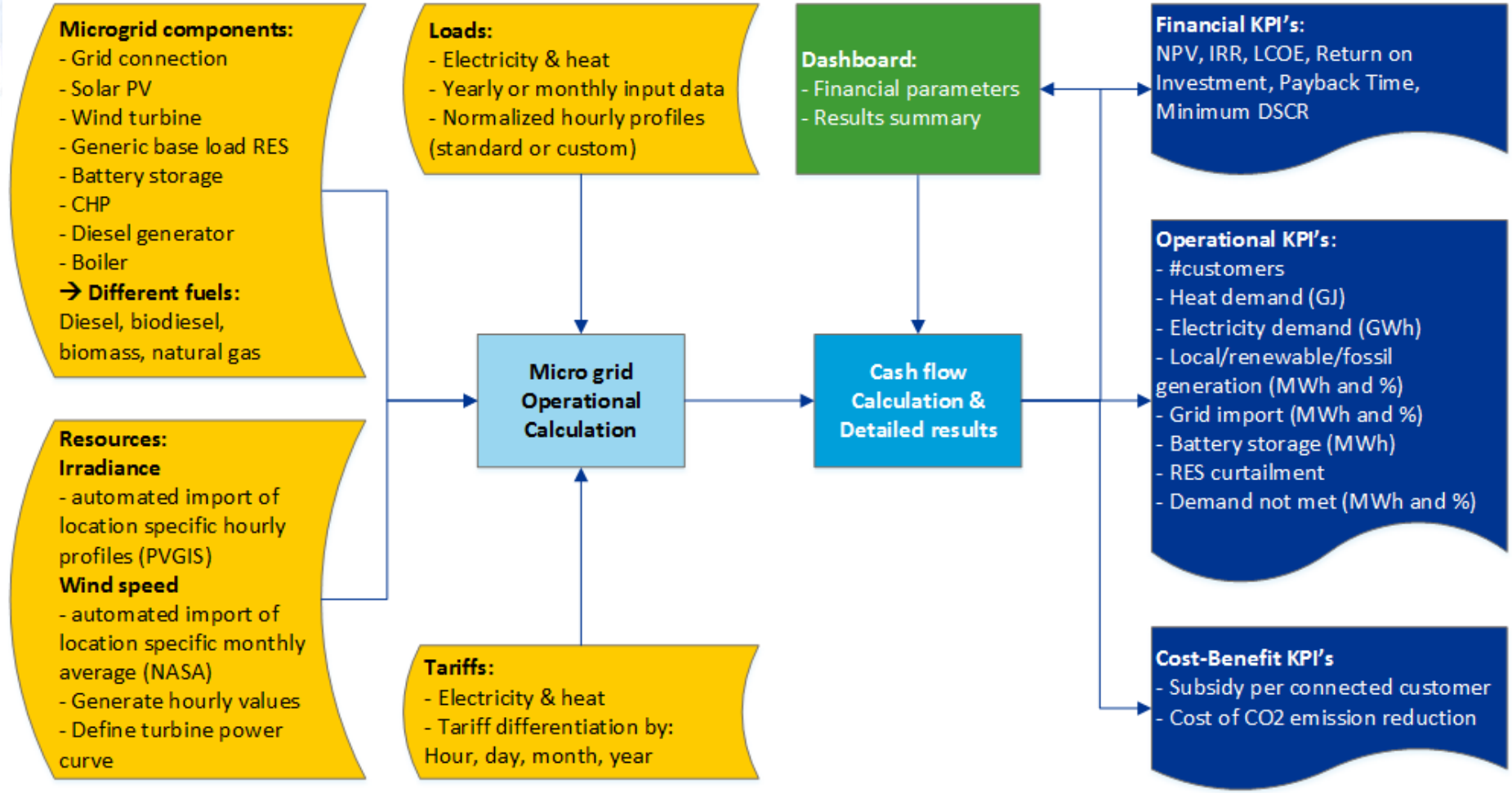
- Information on multiple funds
- Filter by region and technology
- Information includes fund types, requirements and contact details among others.

Technical Content

- The project consists of 5 aspects:
  1. Minigrid definitions and conceptual guidelines, introduction and background information
  2. Minigrid project development guidelines, detailed guidance on each of the 9 project development steps in the Project Navigator
  3. Microgrid operation and financial evaluation tool, prove the financial feasibility of the project
  4. Project case studies, lessons learned for different types of microgrids and locations
  5. Set of practical tools for project developers, guiding and structuring the process to develop a bankable and successful proposal.



Financial evaluation tool



7. Valuing energy storage

- Integrate variable renewables
- Reduce fuel consumption

- **Price at which the power generated is sold**
- **Reduction of generation operating costs**

- Lower need for flexibility due to lower variability

- **Reduction of grid operating costs**

- Increase distributed generation self-consumption
- Reduce demand charge and/or time shift energy consumption

- **Reduction of energy bills**

- Control the frequency of the grid
- Alleviate congestions

- **Reduction of grid operating costs**
- **Reduction of energy losses**

Get in touch!

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