IRENA
International Renewable Energy Agency

Grid Stability Assessment for Islands



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Palau, 10 April 2013

Why consider renewable energy for islands?

- Islands power cost are high and diesel must be imported
- **RE is cheaper**:
  - Oil products are comparatively expensive; economies of scale for gas and coal plant are often lacking
  - No exposure to international fossil fuel market shocks
  - RE technology cost are falling worldwide
- **RE is available locally**: wind, geothermal, solar, hydro etc
- **RE is a political fact**: Many islands with ambitious RE objectives
  - Some have completed a transition or are on their way
- **RE is part of sustainable island development** worldwide
  - Reduce currency account deficits
  - Create jobs and economic development for all
  - Strengthen communities

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IRENA engagement for islands RE transition

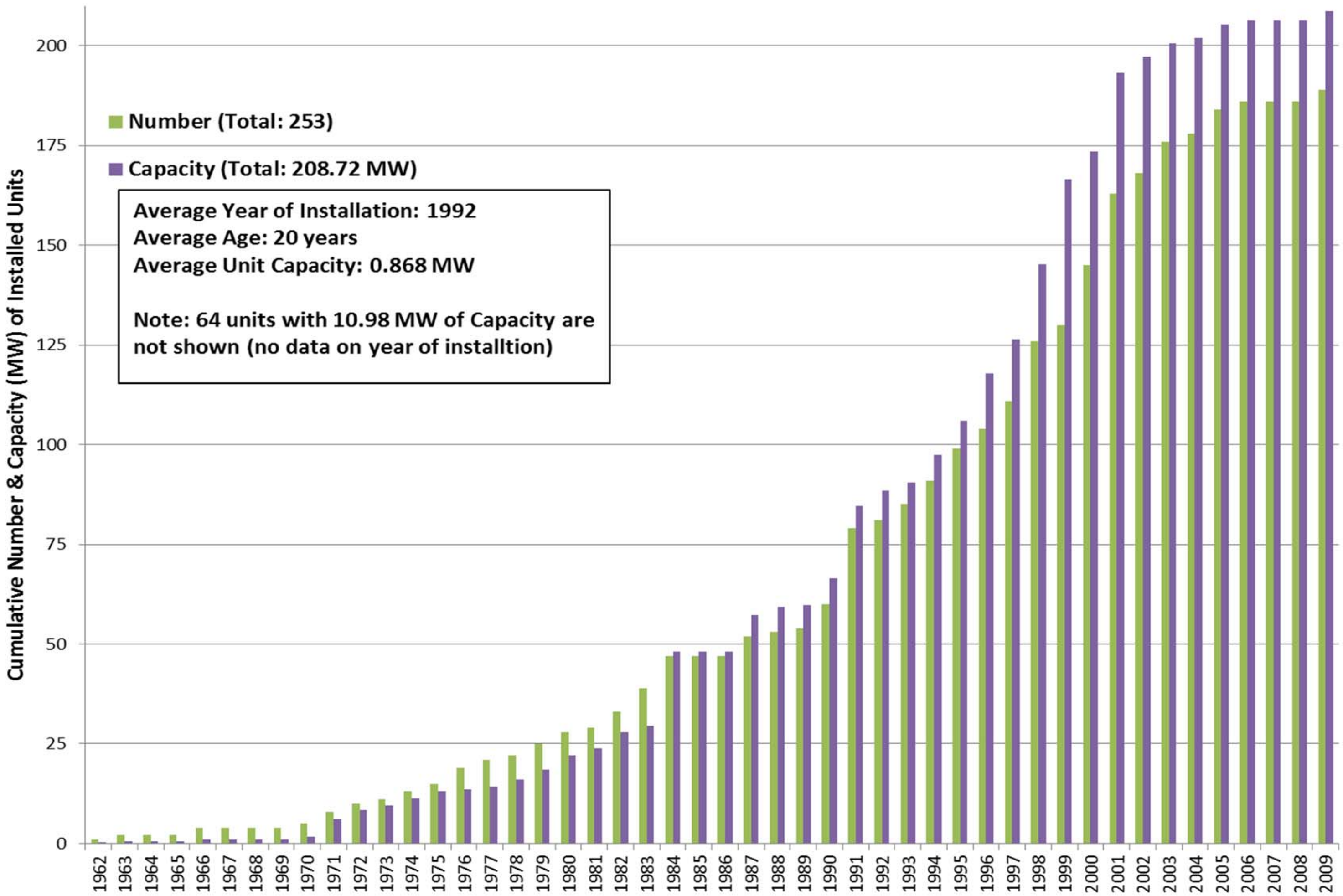
- Starting with the Pacific region in 2012
  - ➢ Pacific Leaders Meeting, 13 January 2012, Abu Dhabi (Communiqué)
  - ➢ 3 technology expert workshops for international best practice technology and energy transitions (Sydney, Okinawa, Vanuatu)
  - ➢ Renewable energy readiness assessment (RRA) (Kiribati)
  - ➢ Grid stability assessment in collaboration with PPA
  - ➢ Support island energy roadmap development (Tonga, Nauru)
  - ➢ Installed a Pacific Coordinator (Ms. ‘Apisake Soakai, hosted by SPC, Fiji)
- Identify global best practice: Malta Summit, September, 2012, Malta (Communiqué)
  - In 2013, expanding to Caribbean and other islands regions
- 24 March 2013: Launch of the Global Renewable Energy Islands Network (GREIN) initiative, Auckland
- Various publications document the outcomes and recommendations

Ongoing island power sector transitions

- IRENA analysis suggests hybrid diesel – RE power systems are technically feasible with existing diesel generators in the region
  - Retrofit of controllers may be needed in some cases
  - Grid stability issues can be resolved
- Islands worldwide show that transition is possible
  - Iceland (geothermal, hydro), Tokelau (solar, batteries), El Hierro (wind, pumped hydro), Graciosa (wind, PV, batteries), Tonga (PV, wind, wave), Aruba (wind), Fiji (hydro, biomass, wind), Cap Verde (wind, PV)
  - Easier for larger islands (hydropower) and volcanic islands (pumped hydro, geothermal)
  - Coral islands have usually fewer “baseload“ opportunities

- IRENA analysis of RE experience across 15 Pacific island countries and territories suggests mixed experiences so far

Cumulative capacity and age profile of current diesel generators (excludes Fiji, PNG)



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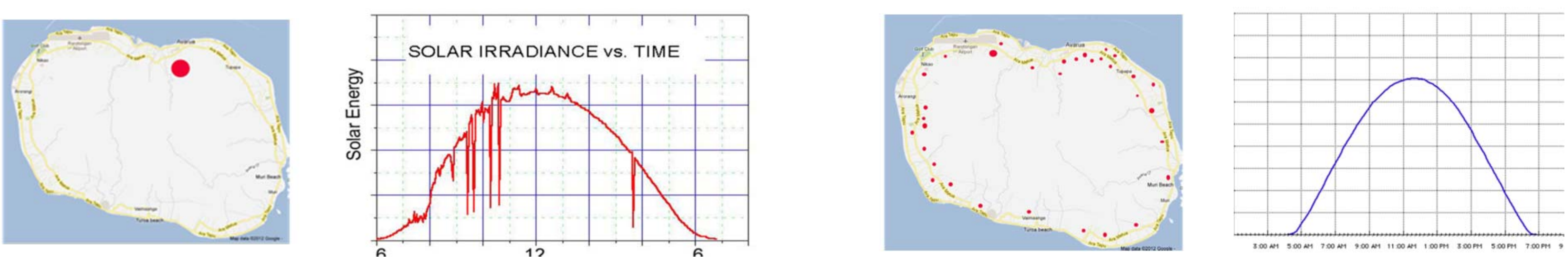
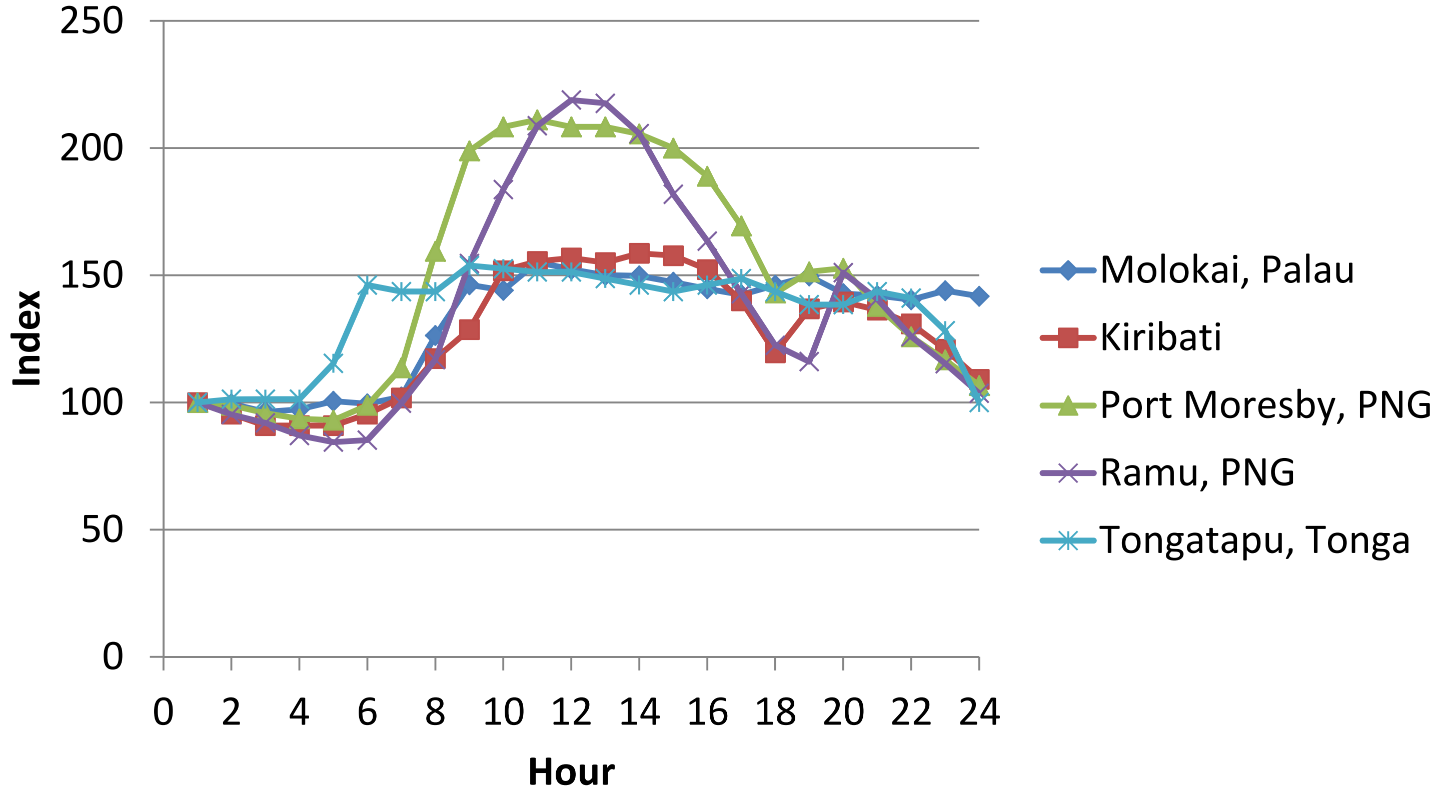
Grid stability assessment for higher shares of RE

- Grid stability becomes an issue when higher shares of variable RE is introduced in existing grids, especially for small island grids
- Wind power can be more “variable“ than photovoltaic power on short time scale where stability issues play
- Electricity supply must meet electricity demand at any moment in time
  - If not, blackouts will happen
- Frequency and voltage control are needed to fine-tune this equation
- Rapidly changing renewable power supply could create problems
- A range of technical solutions exist: *grid stability issues do not represent a show-stopper for a transition*



Spatial planning to deal with variability (example Rarotonga)

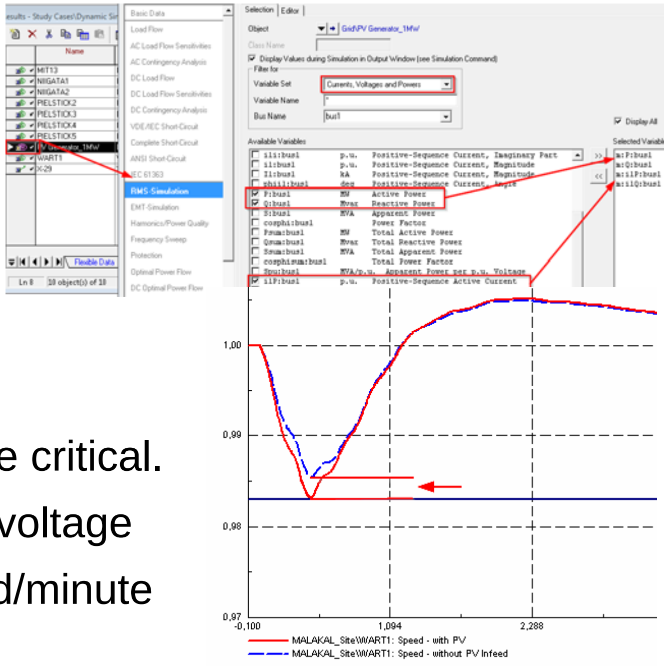
Example of Pacific load curves
Day peak fits well with PV



Source: IRENA, 2012

Using models for the assessment of grid stability with a greater share of renewable power

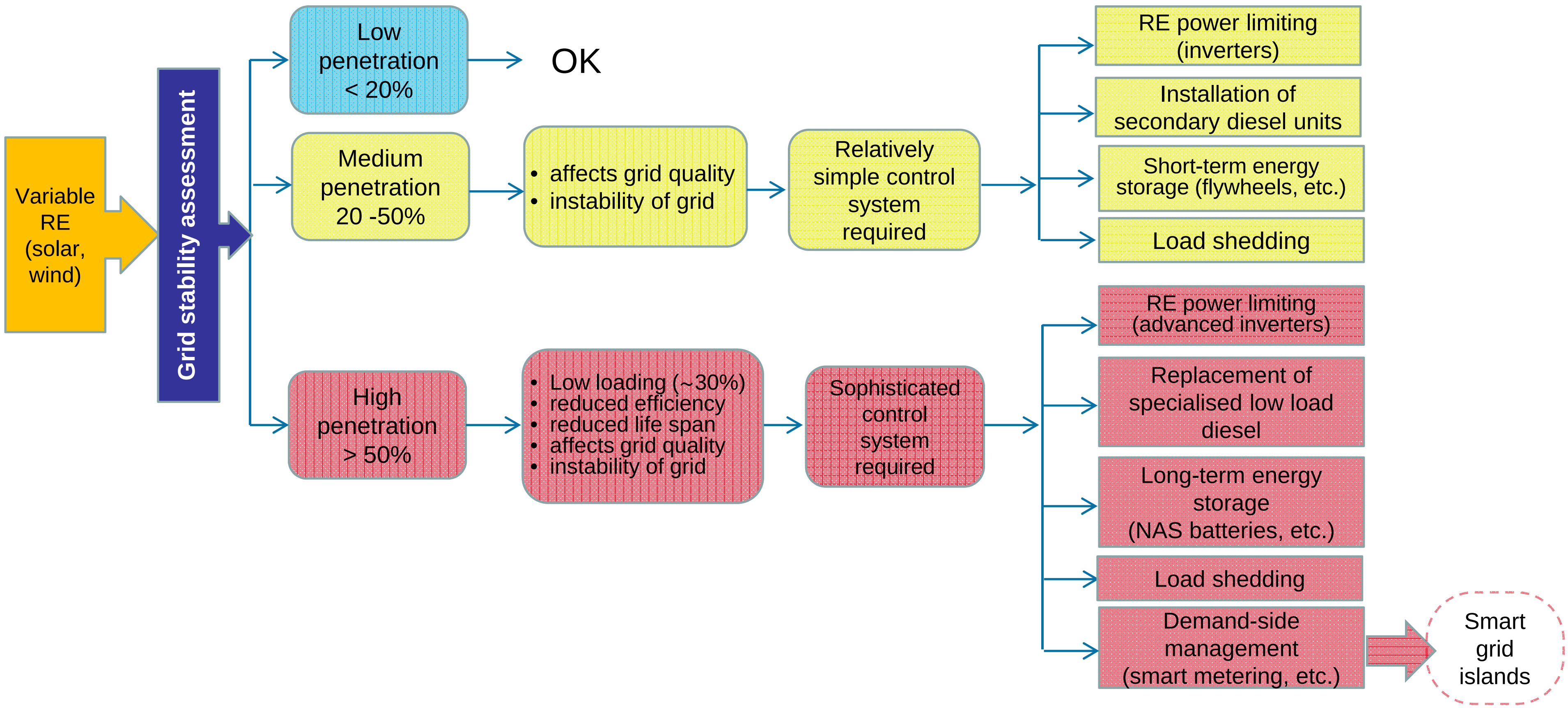
- Models can help assess such potential problems by identifying the levels of RE integration and find solutions ahead of time
  - IRENA has assessed various suitable models
  - *PowerFactory* is one of these models
- Software training: 26-28 February, Bonn



Source: *PowerFactory*

- First pilot study for Palau in collaboration with PPA
  - Workshop 10-12 April, Palau
- For grid stability, *voltage stability* and *frequency stability* are critical.
- Dynamic modelling simulates the effects of frequency and voltage under the varying load conditions by renewables on second/minute scales.
- Modelling requires specific skills and experience.

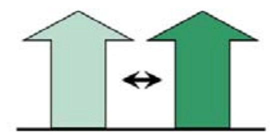
Strategies depending on the level of RE integration



Strategies to deal with variability

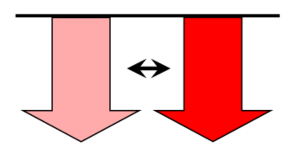
- ***Additive Generation:***
  - Application: for rare short-term peak
  - Possible technology solutions: Secondary/emergency diesel generators.

- ***Dispatchable Generation:***
  - Application: for frequent short, high peak
  - Possible technology solutions: Advanced controlled (inverters) diesel generators.

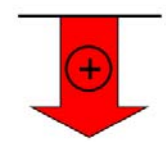


- ***Energy Storage:***
  - Application: daily cyclical balance of load and generation
  - Possible technology solutions: Decentralised batteries, flywheels.

- ***Dispatchable Load:***
  - Application: compensate for frequent short, high production peaks
  - Possible technology solutions: Air conditioning.



- ***Additive Load:***
  - Application: compensate rare production peaks
  - Possible technology solutions: District and local heating/cooling.

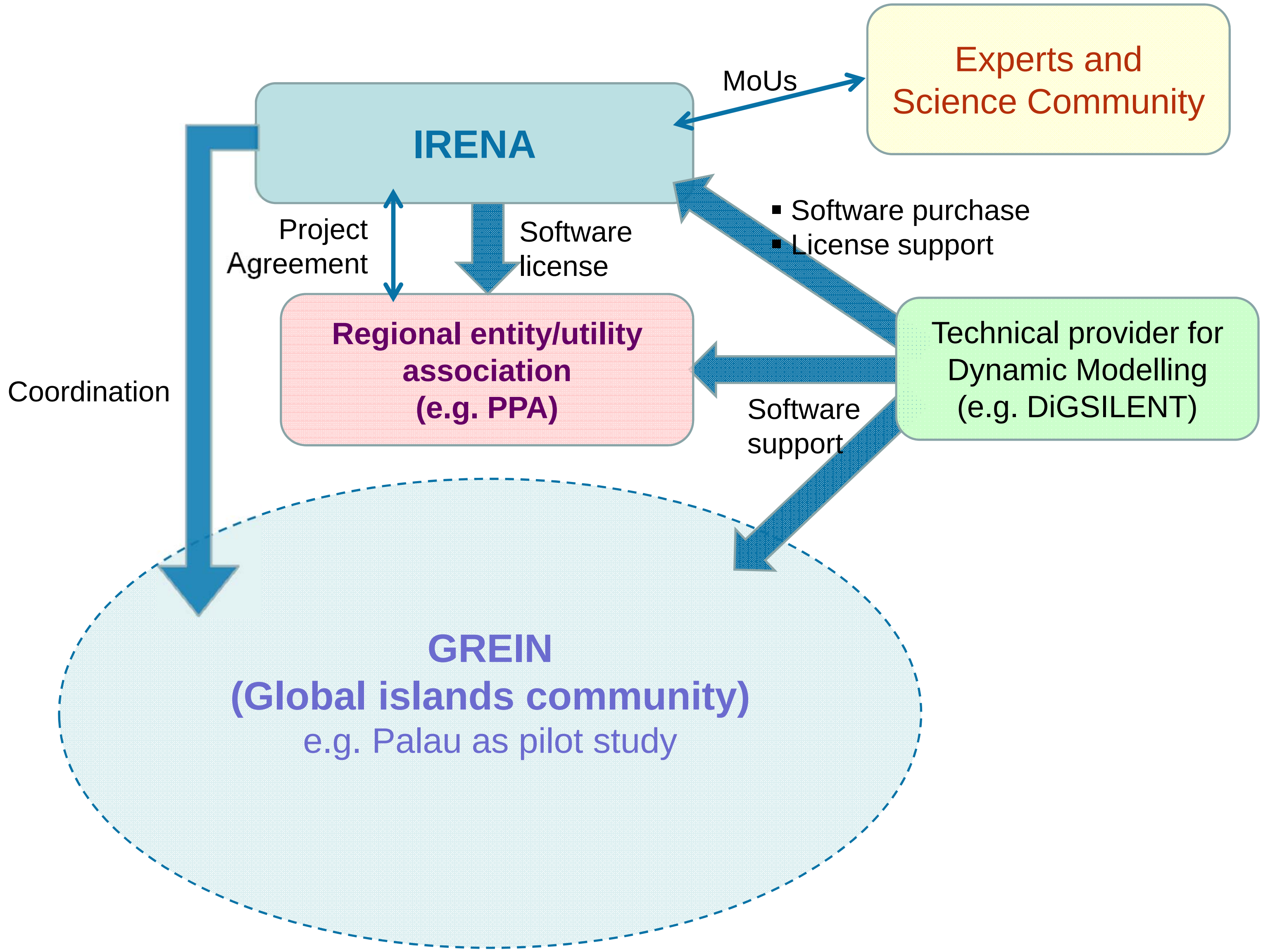


Sources: Adapted from Fraunhofer (UMSICHT), Hybrid urban energy storage, May 2012

Goals of the grid stability assessment

- Outputs of the IRENA study:
  - Provide islands with better understanding of the levels of variable RE integration without affecting the power quality (energy planning).
  - Develop capacity in islands to conduct grid stability assessment.
  - Develop a comprehensive methodology for the grid stability assessment.
  - Provide technological options for grid stability and RE integration.
- Four more case studies in 2013
  - Two in cooperation with Pacific Power Association
  - Two outside the Pacific region
  - Goal is to identify heuristics and to develop a ***methodology*** for the grid stability assessment

Project Framework



Grid stability methodology

A very first step for an island is to make a commitment on the assessment, considering the resource (cost and capacity)

Steps	Experts and Science Community	IRENA	Regional entity/utility (e.g. PPA)	Islands (e.g. Palau)	Technical provider (e.g. DiGSILENT)
Data collection				Data collection	
Build a model in the *PowerFactory*			Build the model or support (based on the capacity of an island)	Build the model (based on the capacity of an island)	Software Support
Dynamic model simulation/results		Support	Run the model or support (based on the capacity of an island)	Run the model (based on the capacity of an island)	Software Support
Validation of the model/results	Support	Support	Support	Validate the model/results	Software Support
Recommendations on strategies and technology solutions		Support	Assessment	Assessment	
Quality assurance of recommendation	Confirmation	Support			

THANK YOU !

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