

Island Energy Transitions

IRENA - University of Bonn Lecture Series

9 November 2017

Lecture Series Schedule

- 12 October: Accelerating the Global Energy Transition
- 26 October: Planning for the Transformation of Power Systems
- **Today, 9 November: Island Energy Transitions**
- 23 November: Approaches to Sustainable Bioenergy
- 7 December: Innovation Driving the Energy Sector Transformation
- 21 December: Improving Energy Access with Renewable Energy Project Facilitation
- 25 January 2018: The True Costs of Renewables

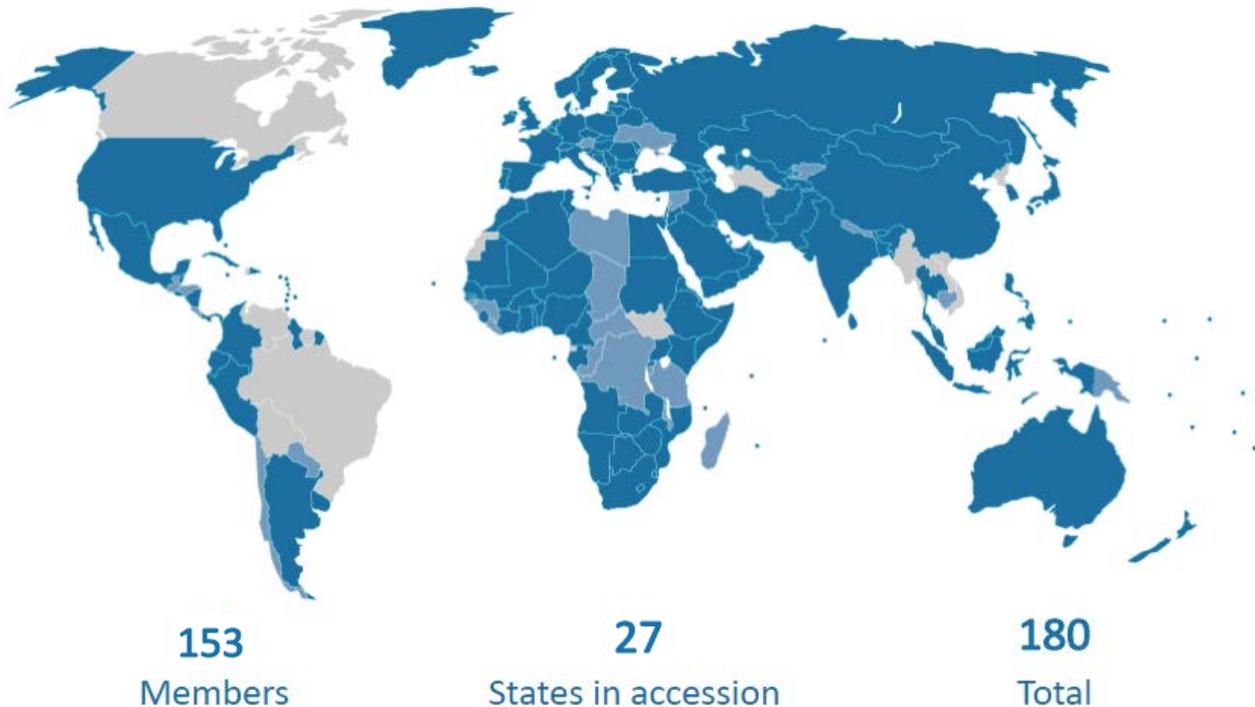
All lectures take place from 18:00 to 20:00 in Lecture Hall IX
of the University of Bonn Main Building

The International Renewable Energy Agency (IRENA)



Our **Mission** Supporting countries in their transition to a sustainable energy future

Our Members



Our Goals

Provide authoritative information, analyses and data on renewable energy
Advise and support countries in their national and regional efforts
Promote the economic, social and environmental benefits of renewables
Develop collaborative stakeholder partnerships for energy transformation

- Context
 - *Islands characteristics and challenges to renewables deployment*
 - *Energy use in islands*
 - *Power generation in islands*
 - *Energy for transport in islands*
 - *Other energy uses in islands*
- IRENA's work in islands
 - *The SIDS Lighthouses Initiative*
 - *Lighthouses Quickscan*
 - *National energy roadmaps*
 - *Grid studies*
 - *Project Navigator for islands*
 - *Sustainable Energy Marketplace and IRENA-ADFD Project Facility*
 - *Looking forward*

CONTEXT:

Islands characteristics and challenges to renewables deployment

Small islands characteristics

- Logistics

- *Max travel time by plane door to door?*
- *Longest time to the next properly equipped hospital?*
- *Longest time without fresh tomatoes?*
- *Ever been in a place only accessible by plane, served by one airline with one flight per week?*



- Local capacity

- *Number of staff in the Ministry, number of people in the energy division, etc.*
- *Qualifications and retention of trained people in the local utility*

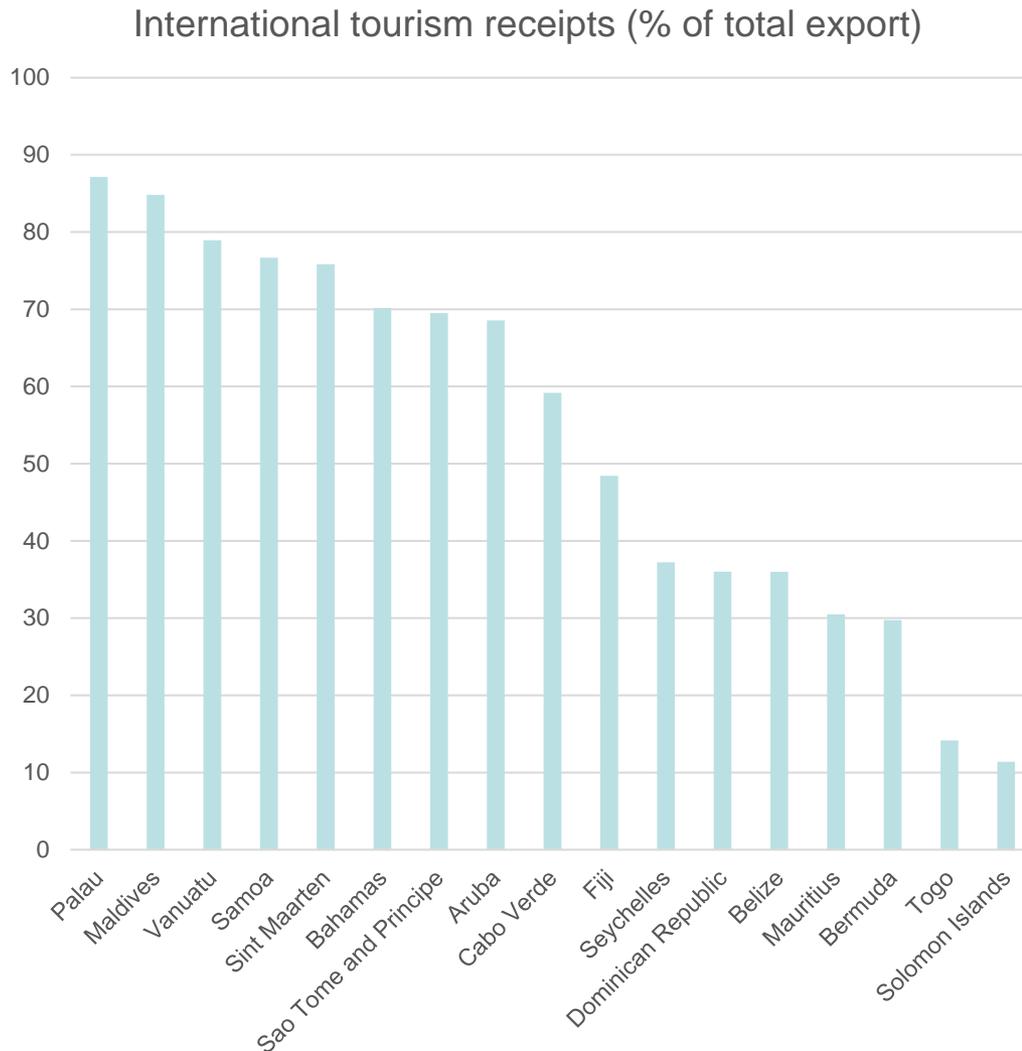
- Power sector

- *Lack of electrical interconnection to mainland electricity grids*
- *Limited access to cheaper fossil fuel generation options (e.g. natural gas and coal)*

- Transportation

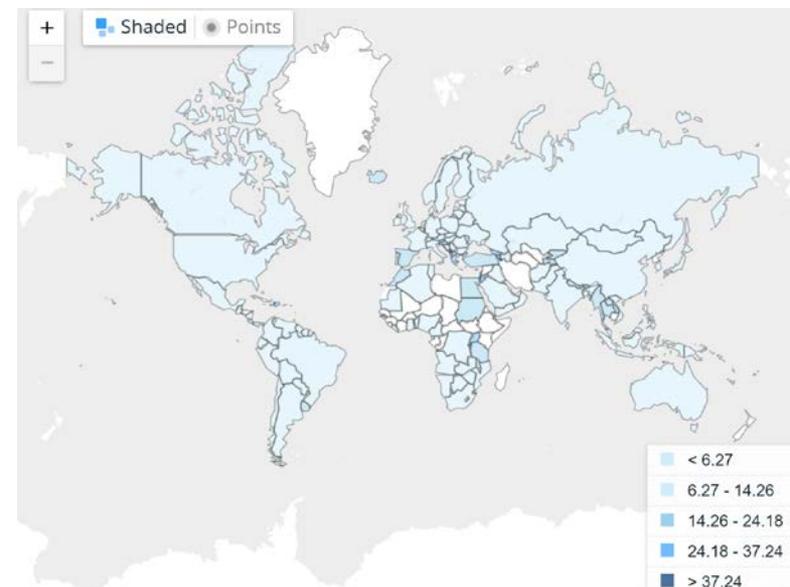
- *High reliance on sea shipping for goods and flights for passengers*
- *Limited space for road infrastructure and frequent use of end-of-life imported vehicles*

Tourism brings great benefits... to some islands

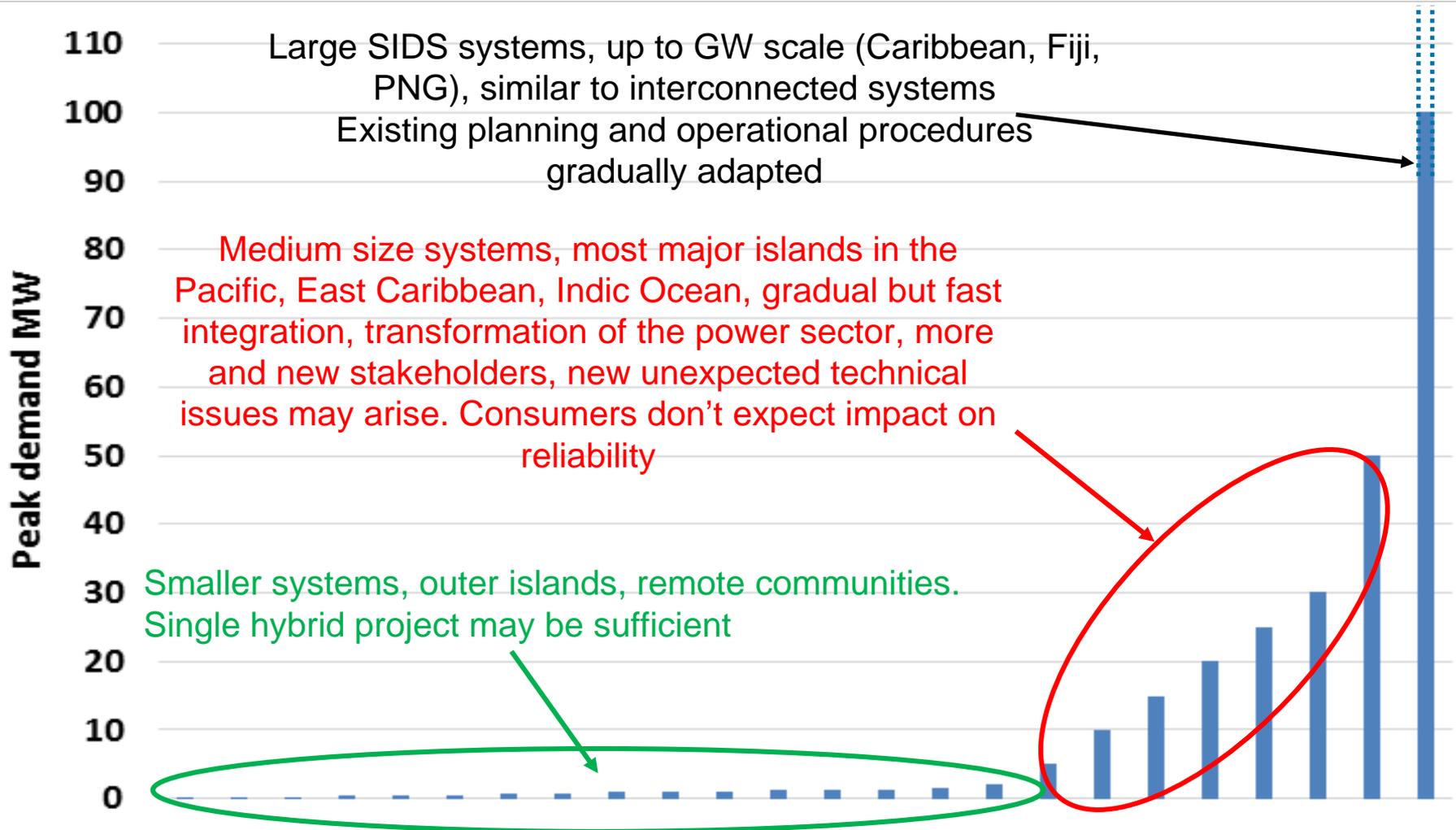


Source: World Bank data, 2015

- Tourism brings significant income to some islands, often accompanied by a surge in electricity demand
- Reliance on tourism also brings volatility to the economy (and to the energy sector) and environmental challenges (energy, water, land use)



Different sizes, different pathways



Renewable energy deployment challenges in small islands

- Logistics
 - *Cost of delivering equipment*
 - *Availability of infrastructure to receive and install RE technologies (e.g. large wind turbines need cranes, trucks, straight roads; lead-acid batteries for large systems are very heavy)*
- Capacity
 - *Capacity for planning the development of the energy sector, set the right policy framework for investment, etc.*
 - *Capacity to design, install and maintain RE systems (and not only)*
- Power sector
 - *Tendency to have unreliable grid or no grid, limited or no RE generation, high LCOE*
- Environment
 - *Often very aggressive environment for hardware: corrosion, humidity...*
 - *Frequent extreme weather phenomena in many islands (e.g. cyclones/typhoons/hurricanes)*
 - *Sometimes limited space for deployment of RE (e.g. for ground mounted PV in small atolls)*
 - *It is crucial to ensure that a contractual arrangement is in place for removal and recycling of equipment that reaches end of life*

Renewable energy deployment challenges in small islands



Renewable energy deployment challenges in small islands

August 2013 – installation close to completion

31 March 2015 – Super Typhoon Maysak (cat.5)



CONTEXT:

Energy use in islands

- Lighting: biomass, kerosene, electricity
- Cooking: biomass, kerosene, LPG, electricity
- Electricity for lighting, mobile phones (sometimes), entertainment
- Electricity for refrigeration (food and medicine preservation)
- Electricity for cooling: fans, air conditioning
- Electricity for productive uses (not frequently)
- Wind for fishing and inter-island transport, (mixed) gasoline for fishing
- Wind for inter-island transport, airplanes and diesel boats
- Walking on land, old imported cars

Energy use in small islands: Lighting



Energy use in small islands: Lighting



Energy use in small islands: Cooking



Energy use in small islands: Cooling and refrigeration



CONTEXT:

Power generation in islands

Diesel as business-as-usual



- Diesel generation is the most common source of electricity
- Generators and grid infrastructure are often in need of maintenance

Off-grid solar PV



Wind generation



Hydro good (best?) option, but unavailable on many islands



Numerous pathways support shares of renewables close to 100%

	<p>Hydro power with reservoir is the easiest and most common option for high shares of renewables</p>
	<ul style="list-style-type: none"> • Biofuels can be used in existing or new dispatchable thermal generation • Some success stories • Challenges relating to supply chain and fuel quality • Sugar cane bagasse by far the largest bioenergy contributor to electricity in (large tropical) islands
	<ul style="list-style-type: none"> • Geothermal can cover significant baseload demand • Generally insufficient demand to cover exploration cost and investment • Good option for islands with resource and larger demand
	<p>Solar and wind are the least-cost generation options in many islands They require an update of the operational procedures (<i>see previous lecture from Francisco Gafaro</i>)</p> <p>Because of lack of interconnection and limited geographical area, in islands solar and wind require energy storage earlier than in large interconnected power systems to</p>
	<ul style="list-style-type: none"> • Cover variability • Supply electricity when they are not available <p>Options for solar and wind integration: PHS, BESS, DSM, Flywheels, Thermal Storage, power-to-X</p>

Most pathways require combination of several renewable resources, energy storage and advanced control systems

CONTEXT:

Energy for transport in islands

Energy for transport in small islands



Energy for transport in small islands



Energy for transport in small islands



Energy for transport in small islands



CONTEXT:

Other energy uses in islands

Other energy uses: communication, education and entertainment



Other energy uses: desalination



IRENA'S WORK FOR ISLANDS:

The SIDS Lighthouses initiative

SIDS Lighthouses initiative:

Outline

- Partnership between Small Island Developing States (SIDS), IRENA and other development partners
 - *Launched September 2014 at New York Climate Summit*
- Strategic objective:
 - *Enabling a sustainable energy transformation for people on the front line of climate change on small islands around the world*
 - *Enhancing energy independence and economic prosperity on SIDS*
- Main elements:
 - *Accelerated renewable energy deployment in the power sector*
 - *Well structured systems transitions*
 - *Information exchange between partners*
 - *Capacity building in SIDS*



SIDS Lighthouses initiative: 2020 Targets

- Mobilize USD 500 million
- Deploy 100 MW of new solar PV power
- Deploy 20 MW of new wind power
- Deploy significant quantities of small hydropower, geothermal power and some ocean energy projects
- Ensure that all participating SIDS have renewable energy roadmaps



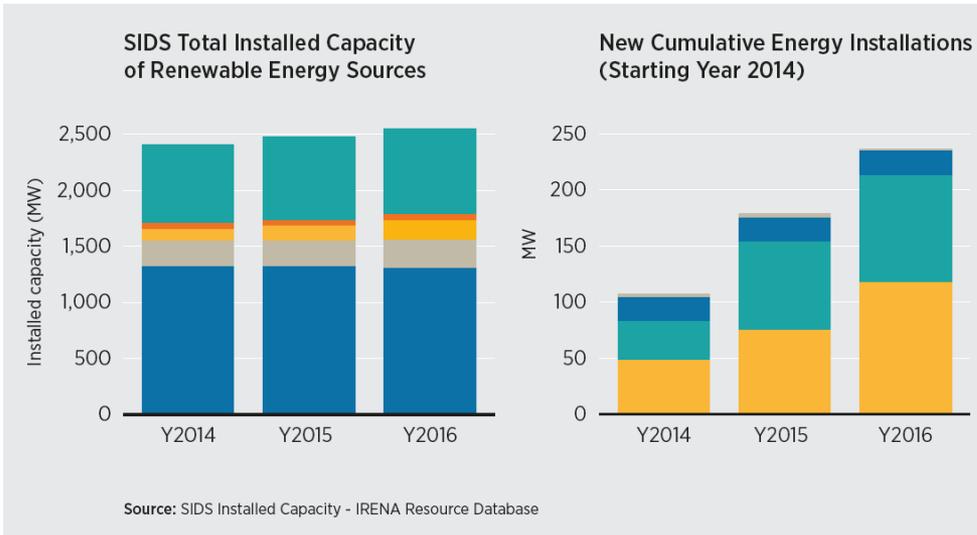
SIDS Lighthouses initiative: Partners

- The SIDS Lighthouses Initiative currently has 36 SIDS partners:
Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, British Virgin Islands, Cabo Verde, Comoros, Cook Islands, Cuba, Dominican Republic, Federated States of Micronesia, Fiji, Grenada, Guyana, Kiribati, Maldives, Marshall Islands, Mauritius, Montserrat, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, St. Lucia, St. Vincent and the Grenadines, Samoa, São Tomé and Príncipe, Seychelles, Solomon Islands, Tonga, Trinidad and Tobago, Turks and Caicos, Tuvalu and Vanuatu
- There are 19 additional partners of the Lighthouses initiative:
European Union, France, Germany, Italy, Japan, New Zealand, Norway, United Arab Emirates, United States of America, Indian Ocean Commission, IRENA, Association of the Overseas Countries and Territories of the European Union, United Nations Development Programme, World Bank, Enel, Clean Energy Solutions Center, Clinton Climate Initiative, Rocky Mountain Institute – Carbon War Room and Sustainable Energy for All (SEforALL).

SIDS Lighthouses initiative: Partners

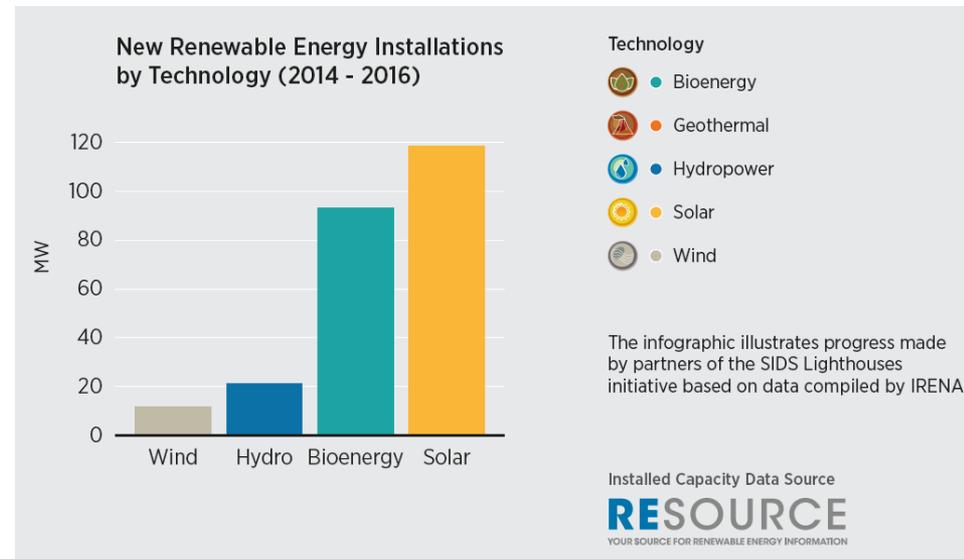


SIDS Lighthouses initiative: Renewables deployment in SIDS



Since the inception of the Lighthouses initiative in 2014 there has been significant deployment of renewables in SIDS

Solar PV has been dominating new generation capacity and already achieved the target. Significant bioenergy (bagasse) addition in large SIDS (Cuba, DR, Fiji)



Quickscans

The Quickscan is a tool designed to assess the readiness of a Small Island Developing State (SIDS) to deploy renewable energy within the power sector. Designed as a questionnaire that encompasses seven critical factors for a successful deployment of renewable energy, the Quickscan yields communicable needs of SIDS within a very short period of time. These identified needs in turn allows SIDS governments and development partners to prioritise the areas of support towards accelerated renewable energy deployment.

NATIONAL ENERGY ROADMAPS FOR ISLANDS

Roadmaps support an Island's transition to renewable energy by providing clear pathways for the deployment of renewables that cover the necessary technical, economic and policy elements. The roadmap analysis is usually centred on identifying the least-cost power system for the future, with additional assessments of how this system would be optimally dispatched. This analysis can be supported by an examination of the potential for renewables in end-uses and other sectors such as: heating, cooling and transportation. The roadmap also contains specific policy recommendations to enable its implementation.



Grid studies for islands

Grid studies support planning for the power sector transformation. Results of grid studies allow the evaluation of costs and other efforts required to deploy a flexible power system with the capacity to host the planned shares of variable renewable energy (VRE). On islands, grid studies strengthen the coordination between long-term, policy-driven renewable energy integration targets and their actual deployment in power systems. This means policy makers can plan more accurately for resources required to attain envisioned targets. They also allow power utilities to identify the most suitable technical measures to host the planned VRE shares, without affecting the system's stability and reliability.

Project Development Support



IRENA Project Navigator

IRENA Project Navigator is an online platform providing comprehensive, easily accessible, and practical information, tools and guidance to assist in the development of bankable renewable energy projects. In particular, the Project Navigator has introduced a component to assist project developers in Small Island Developing States (SIDS). Within this islands module, the Project Navigator will help islands assess and address project development issues to enable stronger, sustainable development and smart integration of renewables.



Global Atlas

The Global Atlas for Renewable Energy is a free online resource-assessment tool inclusive of maps on solar, wind, marine and bioenergy resources. It facilitates a first screening of areas of investment opportunity.

Finance and Transactional Support



The Sustainable Energy Marketplace

The Sustainable Energy Marketplace is a virtual platform that gathers project developers, financiers, service and technology suppliers to work together to realize projects related to renewable energy sources. The Marketplace provides a visibility to renewable energy projects and facilitate investment opportunities.



ADFD

IRENA and the Abu Dhabi Fund for Development (ADFD) have collaborated to create a joint Project Facility to finance transformative and replicable renewable energy projects in developing countries. The facility involves IRENA selecting and recommending promising renewable energy projects in developing countries. ADFD then offers soft (concessional) loans to these projects worth USD 350 million over seven annual cycles. The first selection cycle commenced in November 2012.

Policy Support



The Renewables Readiness Assessment

The Renewables Readiness Assessment (RRA) is a comprehensive tool for assessing the conditions existing in a country for the development and deployment of renewables along with the actions required to improve those conditions. RRAs for island countries: Antigua & Barbuda, Fiji, Grenada, Indonesia, Kiribati, Philippines, Republic of the Marshall Islands, Vanuatu



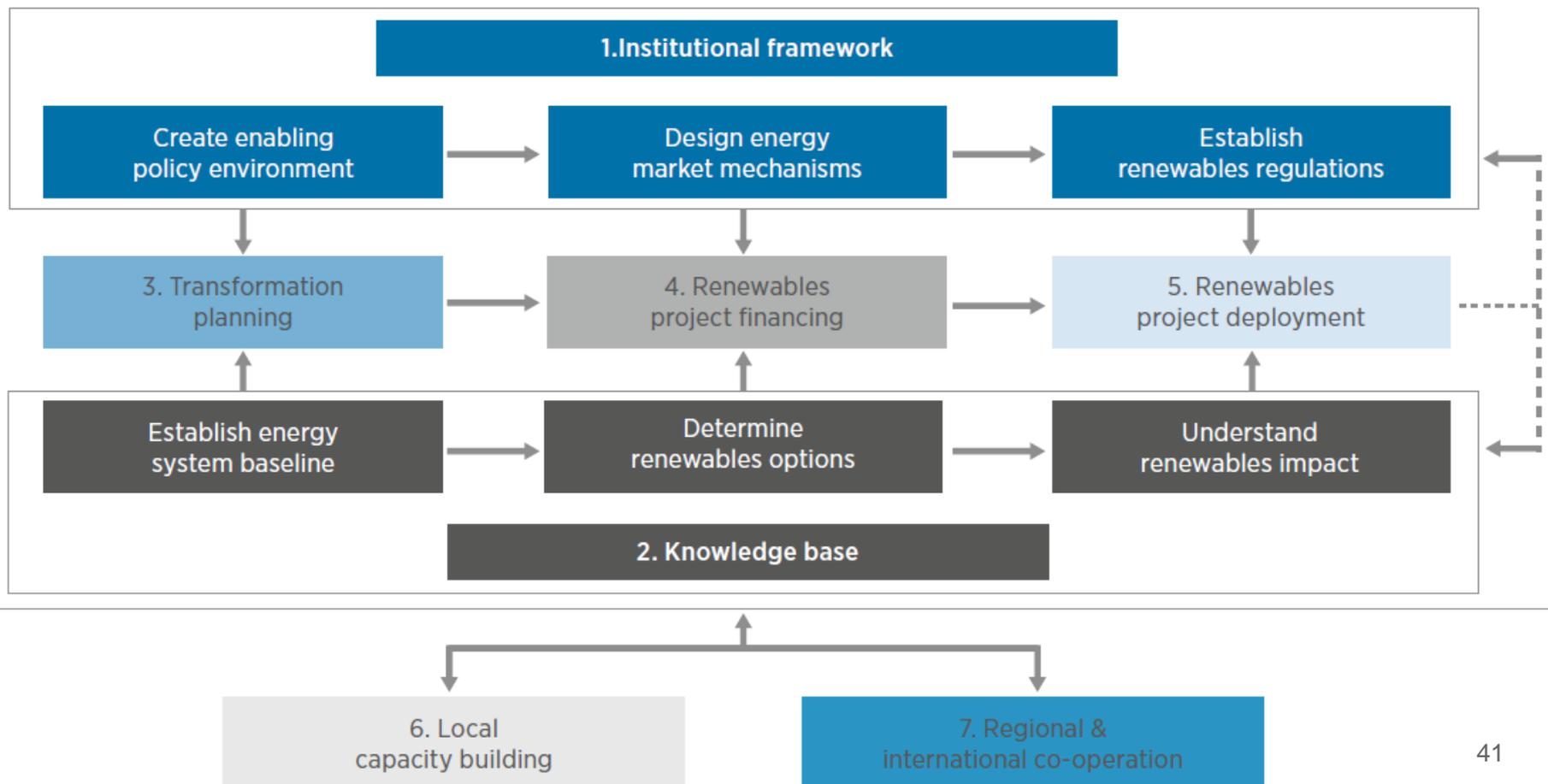
REmap

REmap determines the realistic potential for countries, regions and the world to scale up renewables in order to ensure an affordable and sustainable energy future.

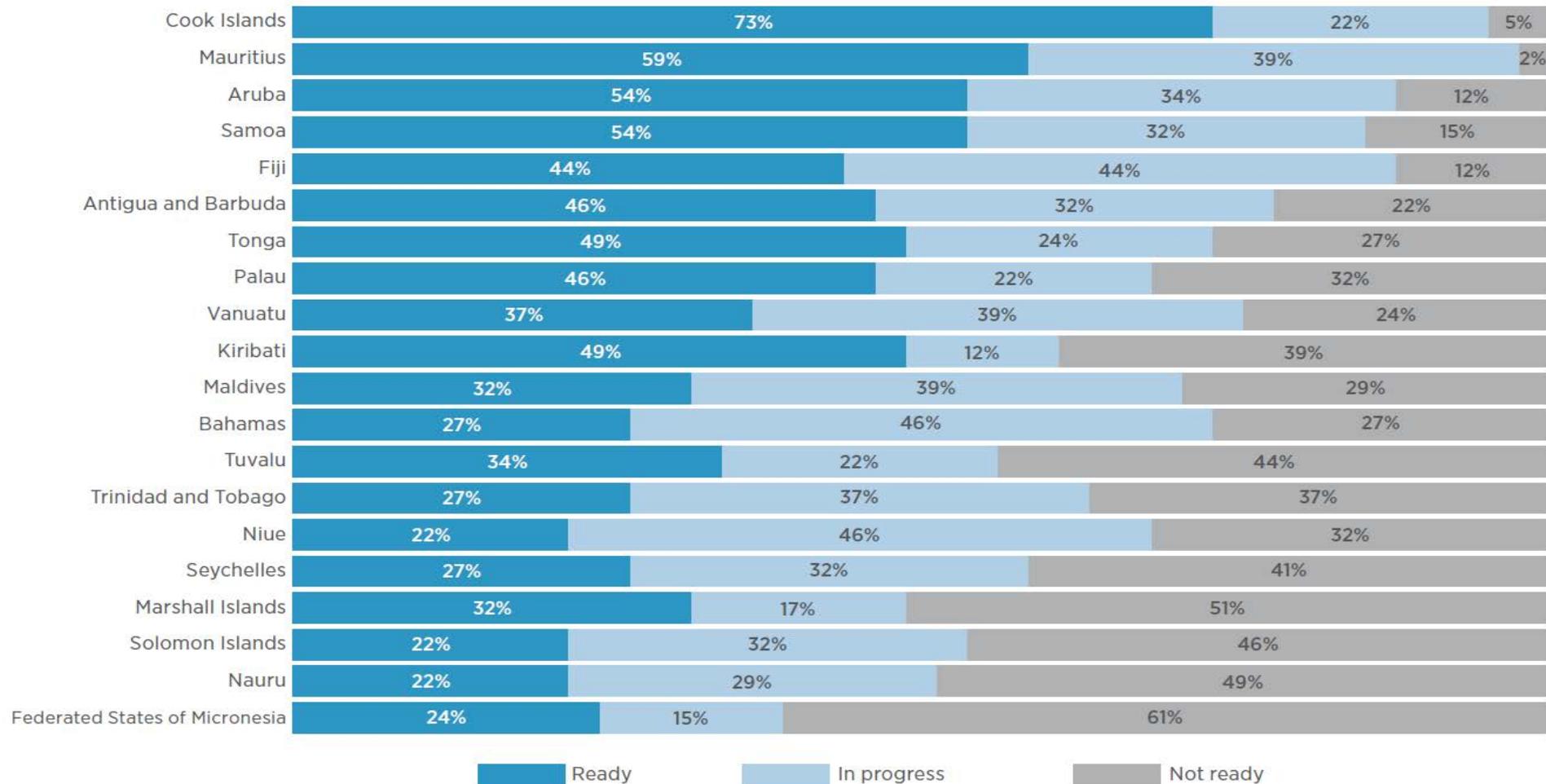
IRENA'S WORK FOR ISLANDS: SIDS Lighthouses Quicksan

SIDS Lighthouses Quickscan: Island energy transition process

- Based on extensive work in islands IRENA has identified 7 key elements in the process of transitioning to reliance on renewable energy

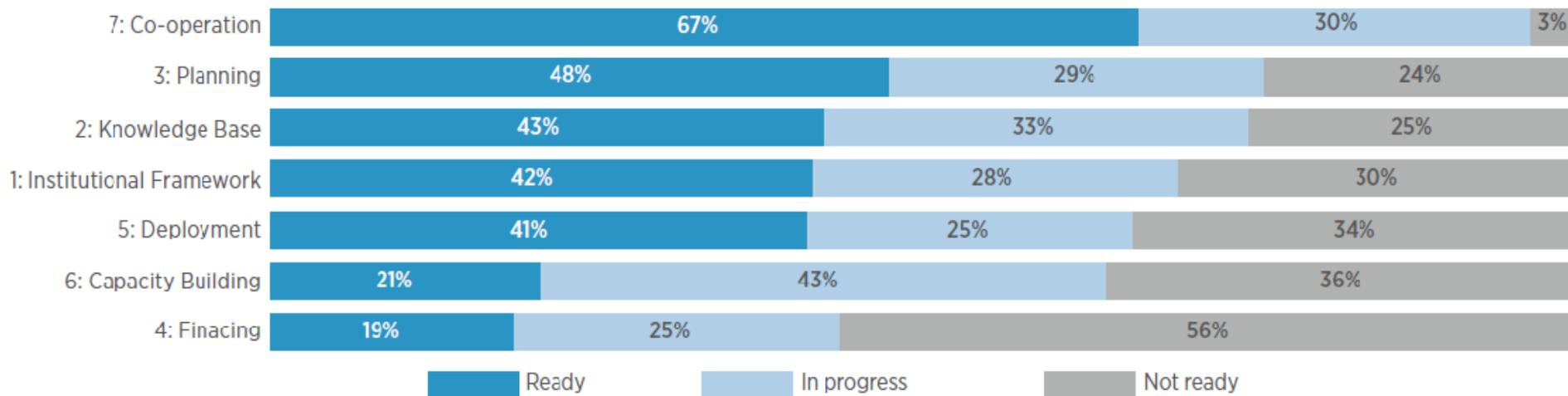


IRENA Quickscan analysis: Scoresheet by island



- Questionnaire response for 20 SIDS graded ready, in progress or not ready
- Provides high-level view of the each SIDS readiness for transition to renewables

IRENA Quickscan analysis: Scoresheet by element



- Access to finance a major issue: Local funding not sufficient to achieve renewable energy goals, framework to attract foreign investments into renewables not in place / not effective
- Lack of adequate plans and budgets to operate and maintain public and donor-funded renewable energy projects
- Capacities to plan and operate grids with a high share of variable renewables a critical need
- National energy roadmaps covering renewables developed by most SIDS in the Pacific still needed for some SIDS in the Caribbean and AIMS regions

IRENA'S WORK FOR ISLANDS:

National energy roadmaps

ROADMAPS COMPLETED TO DATE

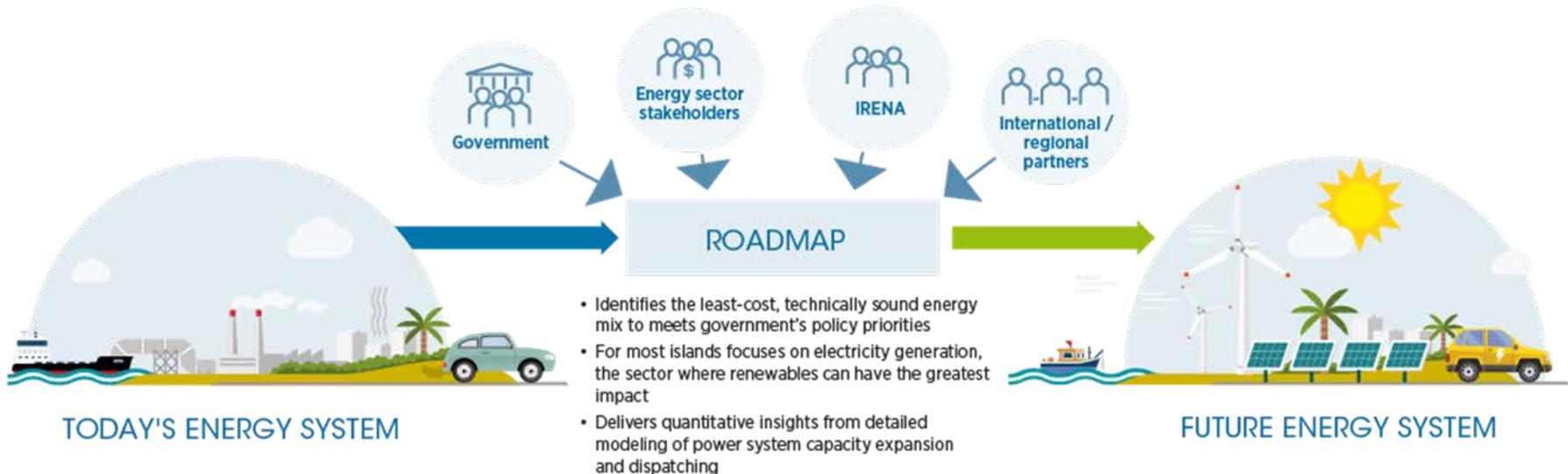
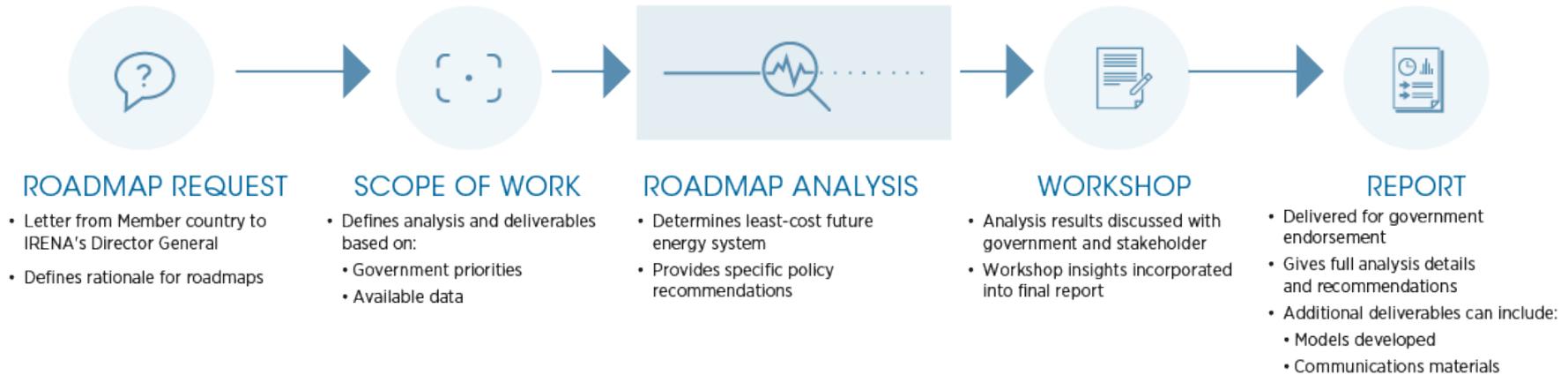
- Nauru Support to Members on roadmaps Joint work with GIZ on roadmap implementation in Cape Verde and Vanuatu
 - Cyprus - Tonga
 - Maldives - Mauritius
 - Kiribati REmap analysis for islands
 - Barbados - Dominican Republic
- 38 Quicksans completed: incl. mapping of roadmaps, provides inputs for roadmap development

SUPPORT FROM MEMBERS

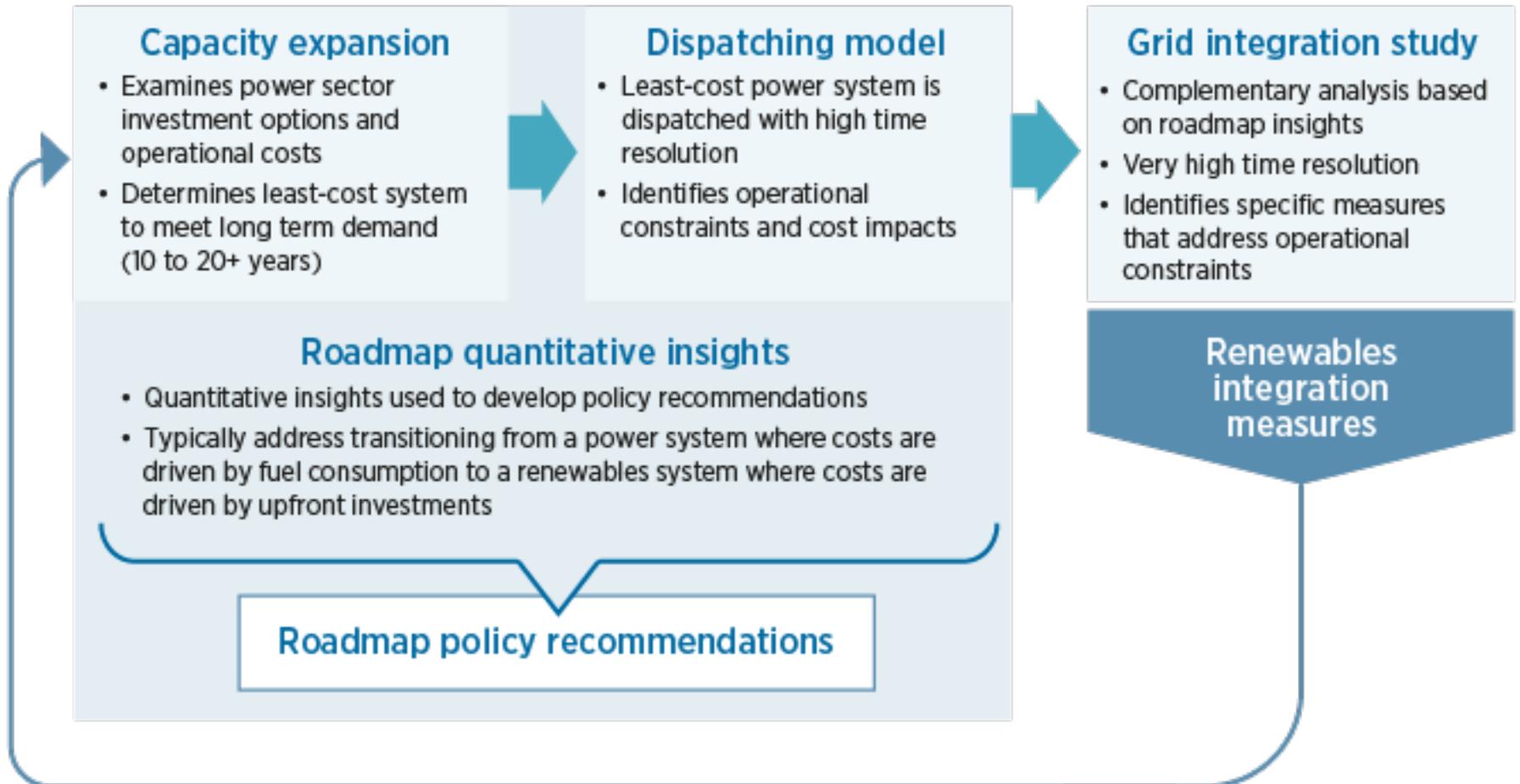
- All completed roadmaps for islands have been supported through voluntary contributions from the German Federal Ministry of Environment (BMUB)
- Ongoing work supported by voluntary contributions from New Zealand and Norway



ROADMAP PROCESS



ROADMAP ANALYSIS



ROADMAP INSIGHTS

SMALL ISLANDS

- Capacity expansion and dispatching analysis can be combined to deliver an optimal system
- Limited total investment: Optimal system can be installed as a single project replacing the existing electricity system



BIG ISLANDS

- Optimal generation mix too costly for one project
- Analysis provides project time-line of investments to meet demand over period of roadmap
- Dispatching investigates the impact of each project to ensure optimal evolution of power system





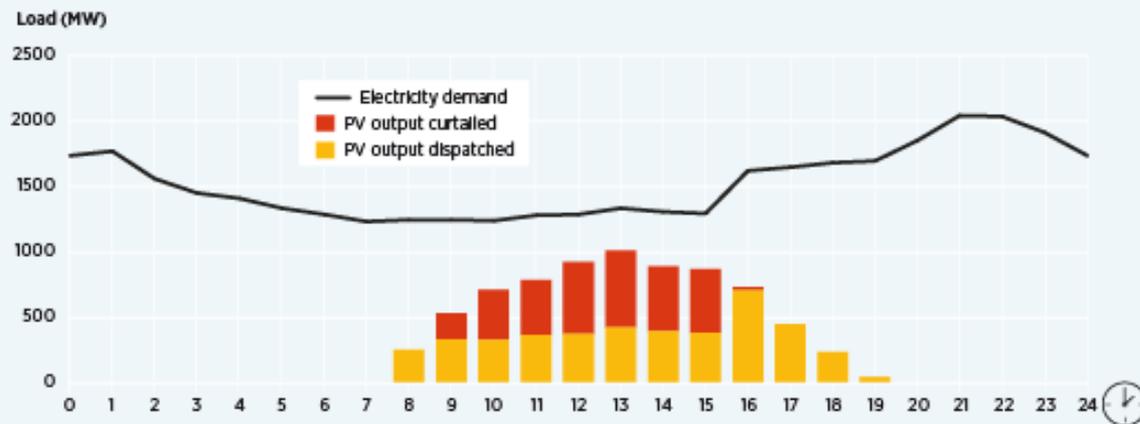
Capacity expansion

Least-cost system design and modular deployment 2015-2025 for two main islands

Dispatching

Optimized dispatch of 2014 and 2025 least-cost system for two main islands

Roadmap shows that PV curtailment is a potential issue and identifies specific measures to boost RE share.

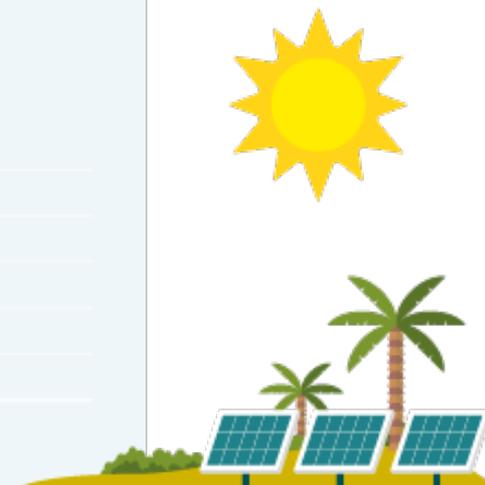


Significant solar PV capacity is already in place in Kiribati.

The roadmap highlighted a pathway for modular deployment of further solar PV and battery storage that is compatible with currently identified resources.

Government and utility are discussing how to further increase the ambition and raise the target.

OTEC is expected to contribute significantly, with a project already underway, funded by the Government of the Republic of Korea



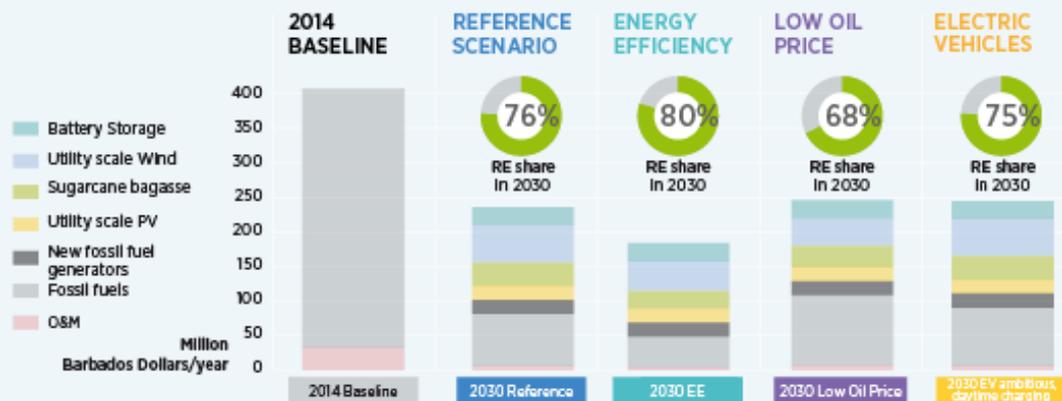
Capacity expansion

Least-cost capacity expansion plan 2015-2030

Dispatching

Production cost modelling of 2014 and 2030 scenarios

Roadmap gives detailed insight on how renewables can reduce power sector costs.



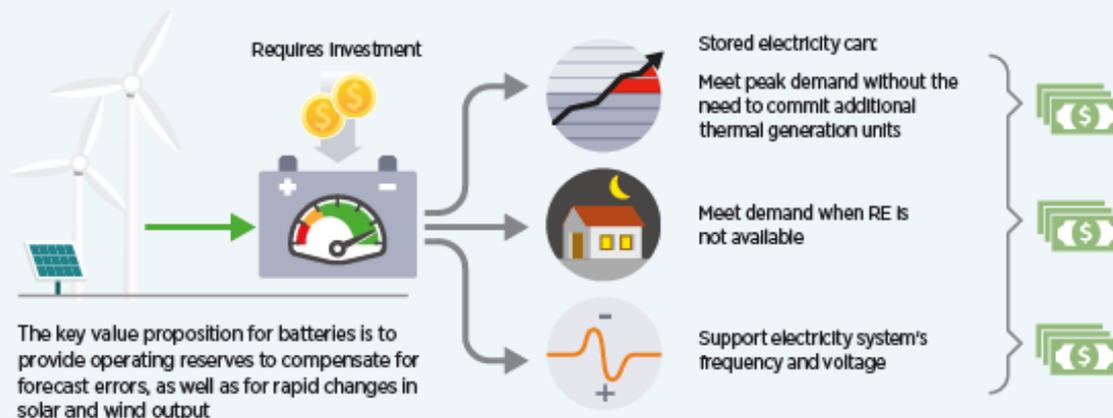
The Prime Minister of Barbados, in an interview with Barbados Advocate, 11 November 2016:

"[...]key step in the process of achieving energy independence is to have a Road Map. In this regard, the Division of Energy and Telecommunications engaged the International Renewable Energy Agency to prepare this "Map".

"The report has been prepared and has confirmed our local analysis that there can be an exponential increase in the renewable energy penetration level in the electricity supply."

"It indicates that the island can increase the renewable energy penetration level in the electricity supply to a target of 76 per cent of peak generation. The Cabinet will therefore, in 2017, review and increase the allocation of licenses for intermittent renewable energy generation connected to the national electricity grid".

Roadmap identifies options to support battery storage deployment.





Capacity expansion

REmap analysis identified the potential for RE in the energy mix by 2030

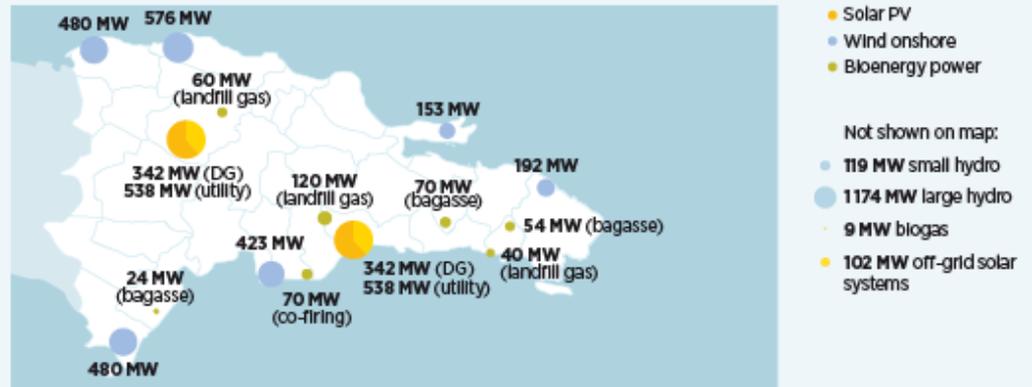
Dispatching

VRE penetration and transmission bottlenecks estimated based on projected VRE generation and duration curves

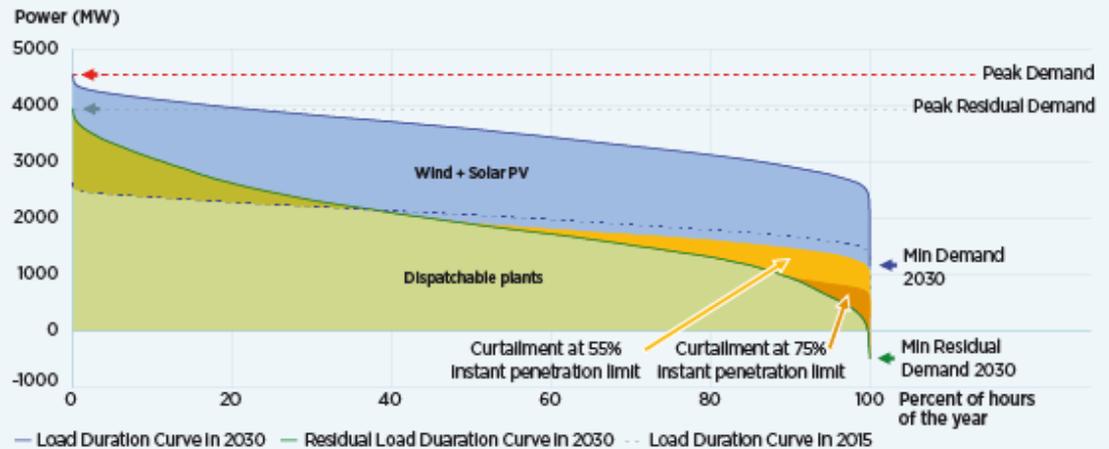
The identified renewable energy capacity for 2030 is based on the methodology used for IRENA's global renewable energy roadmap, REmap. Implementing the identified additional renewable options would increase the 2030 renewables share to 27 percent in the total final energy mix and 44 percent in the power sector.

The REmap analysis for Dominican Republic included the first quantitative assessment to determine the technical challenges of integrating the identified PV and wind systems.

Dominican Republic REmap 2030 analysis shows significant renewables capacity expansion is possible.

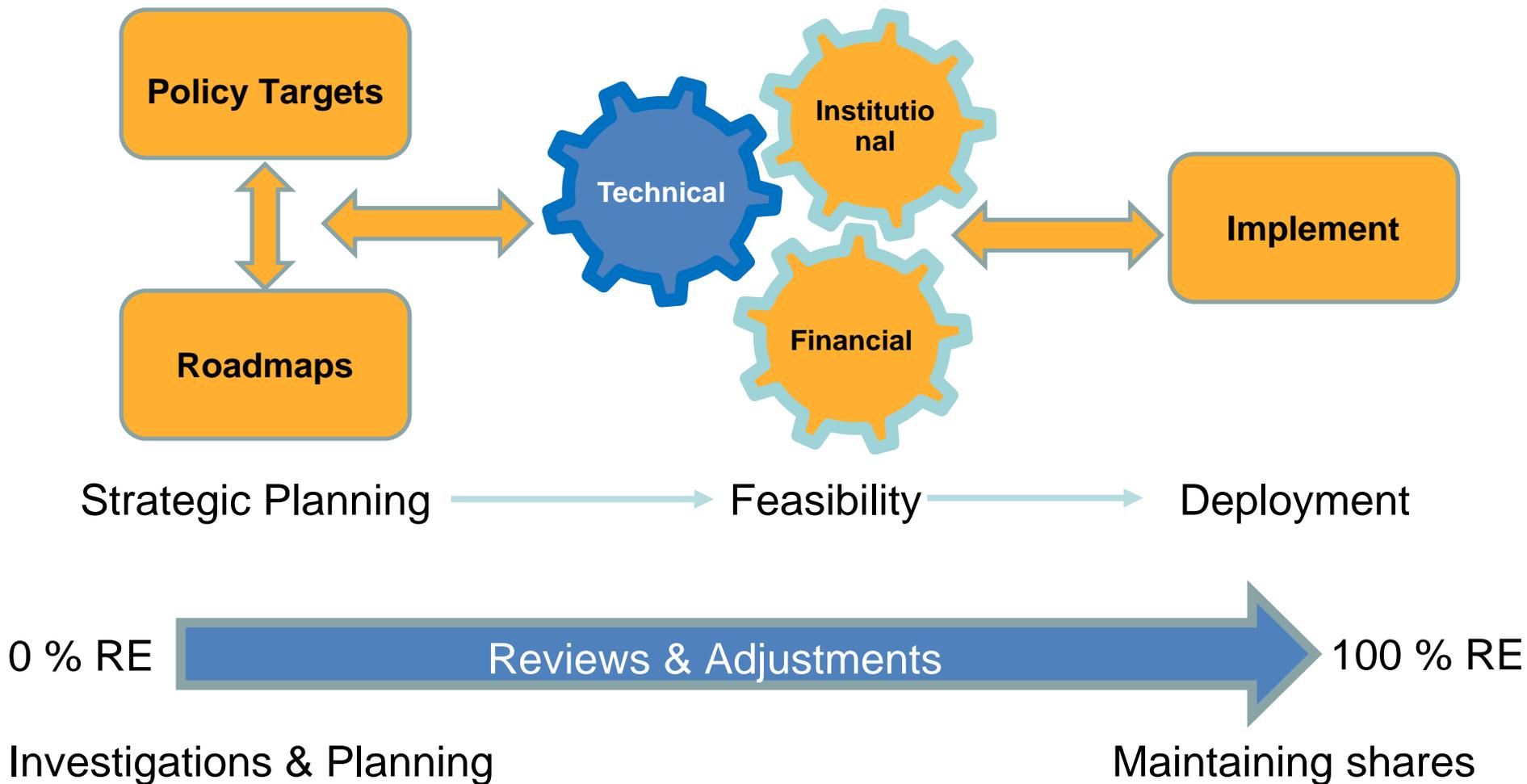


REmap analysis provides insight on integrating higher shares of PV and wind.



IRENA'S WORK FOR ISLANDS: Grid Studies

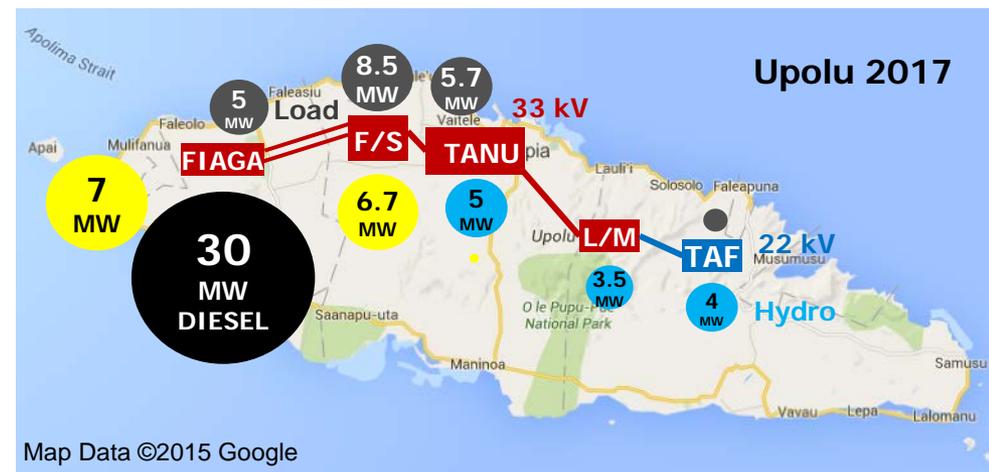
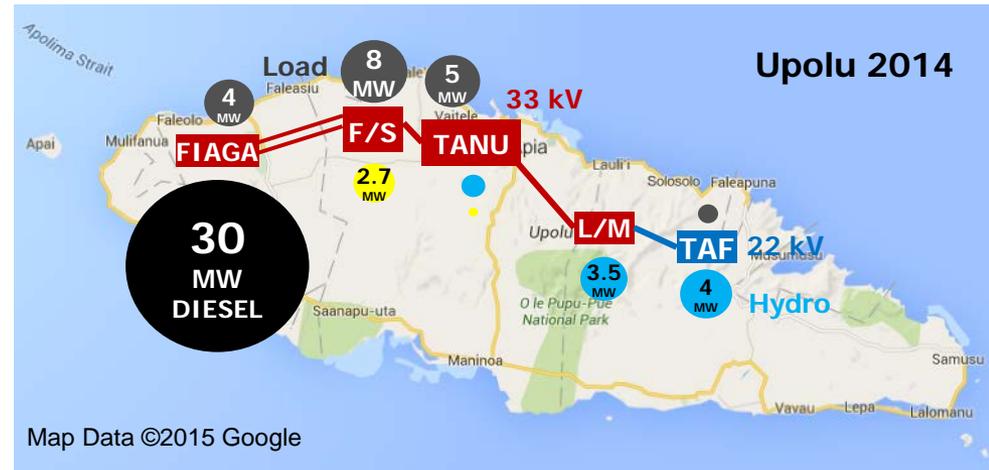
Grid studies in the renewables planning process



- Integration of VRE affects system operation at different levels and time horizons
- The operation of a power grid is a complex task requiring a sound planning process
- Customers expect reliable and affordable supply of electricity
- Diesel generation has provided off-the-shelf, reliable and easy to operate solution
- Penetration level of VRE may affect:
 - *System operation*
 - *Grid capacity*
 - *Stability*
- Solutions for all these challenges exist and grid studies help to identify the most effective options

Grid study for Upolu, Samoa

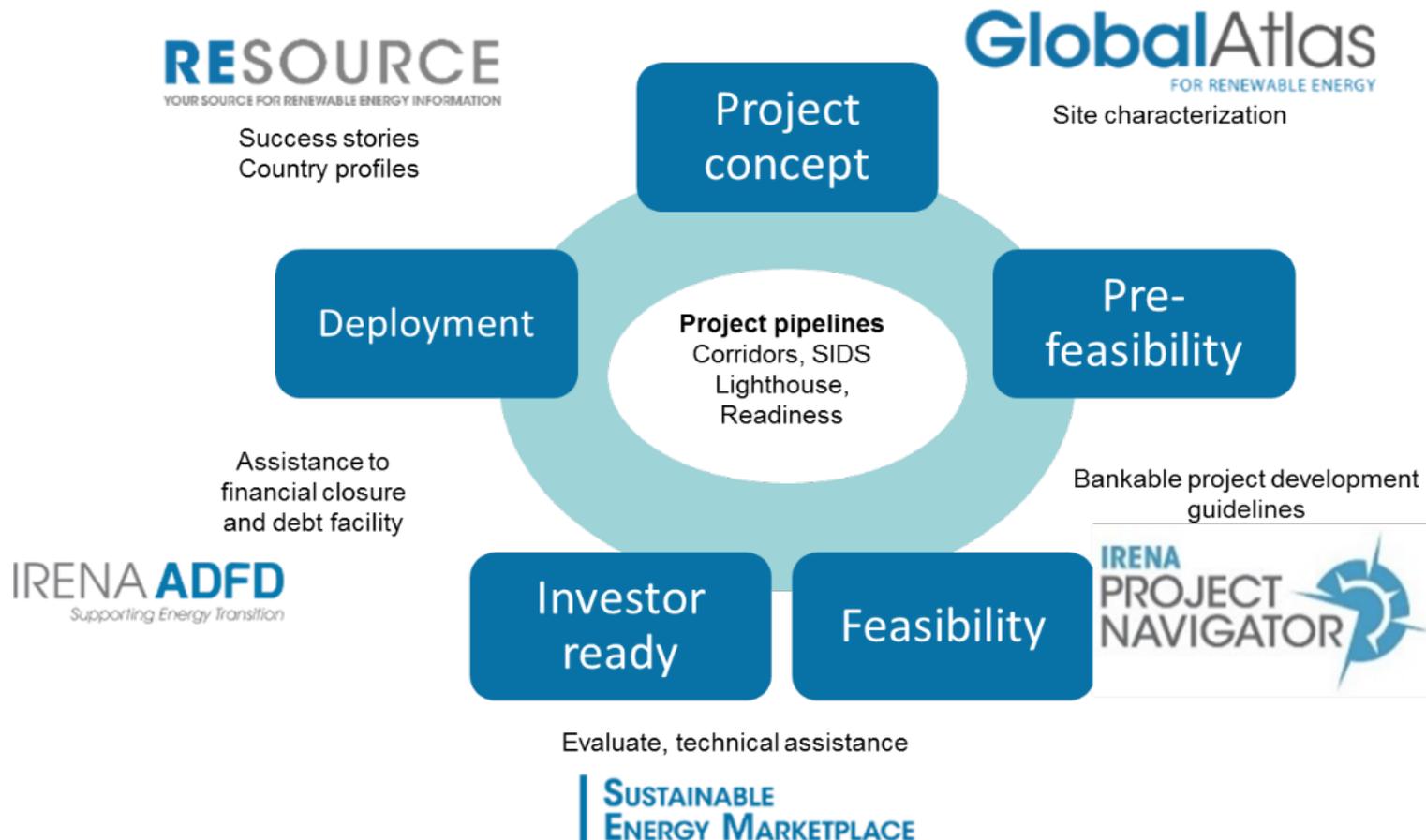
- Technical constraints associated with the implementation of the PV and wind generation projects planned by the utility (EPC) to achieve the national target of 100% renewable energy were identified
- The power utility is implementing the recommendations of the study to achieve stable operation with 14 MW of solar PV
- Through funding from a development partner the utility procured an energy storage system
- The technical assessment and the models prepared by IRENA are being used as technical references in the procurement process
- More aggressive scenarios with further projects to achieve 100% RE target were also assessed



IRENA'S WORK FOR ISLANDS:

Project facilitation

IRENA supports project stakeholders in the design, development and financing for successful renewable energy projects in SIDS.



Project Navigator

The IRENA Project Navigator is a free online platform providing comprehensive, easily accessible, and practical information, tools and guidance to assist in the development of **bankable renewable energy projects**



LEARN

Renewable energy project guidelines with tools & templates



DEVELOP

Interactive online workspace to develop bankable project proposals



FINANCE

Curated search engine of renewable energy financing instruments

The platform provides *easy-to-access knowledge materials* for major renewable energy technologies **relevant for SIDS stakeholders** featuring *real-life case studies and practical tools such as project evaluation models, checklists or evaluation forms* that can be applied to help structure bankable project proposals and **access renewable energy financing**.

Find more information at <http://navigator.irena.org>

Project Navigator: SIDS action plan

Putting best practices into action, IRENA will organize in 2018 with partners, several training workshops for project developers in the **Caribbean, Africa, Indian Ocean, Mediterranean, South China Sea, and Pacific islands**, in applying practical steps for increasing bankability of renewable energy project proposals.



IRENA's training workshops will identify island renewable energy projects and support them into preparing bankable renewable energy project proposals — bridging the gap between studies and financing through practical deployment mechanisms.

These training workshops are designed to help project developers systematically and thoroughly plan projects and avoid pitfalls that jeopardize project success.

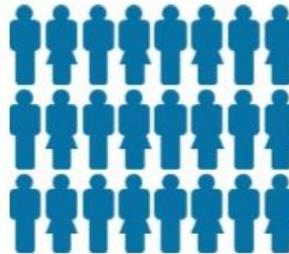
SIDS project developers can already register their interest for the project development training workshops **by sending an email to the IRENA Project Navigator at navigator@irena.org**

Project Navigator: outreach

The IRENA Project Navigator supports project developers in applying best practices to transform their power sectors with renewable energy and address the challenges of affordable energy and climate change.



4,500 users
registered on the platform



700 developers
trained in workshops



3,000 people
reached through webinars

IRENA Project Navigator outreach outcomes in 2017



users from
190+ countries



1,300 projects
created on the platform



7 Technologies
and a SIDS module

Global Atlas Services

Data downloading and zoning



To contribute data, expertise or to promote the Global Atlas initiative, please reach out to us at:

GlobalAtlasContributors@irena.org

To request for zoning/suitability analysis, please reach out to us at: GlobalAtlasServices@irena.org

Global Atlas Site appraisal service for wind sites in Comoros and Cape Verde

The Site Appraisal Service - The service is an innovative and cost effective approach to screen sites earmarked for solar and wind development in countries. This service efficiently expedites the development process and increases the likelihood of success with finding economically viable sites for further investments.

Technology configuration covered

Wind

Solar stand-alone (Utility scale)

Solar and battery hybrid system

Solar and diesel hybrid system

Work for SIDS:

- 2 wind sites for Cape Verde
- 4 wind sites for Comoros
- More sites in the pipeline

To request for site appraisals,
please contact:

GlobalAtlasServices@irena.org

IRENA Tools: Project Facilitation

Marketplace & RE Project Financing Facility with ADFD

SUSTAINABLE ENERGY MARKETPLACE



“ We have real evidence of the increasing worldwide consensus that a sustainable energy future powered by renewables is within reach. ”
Adnan Z. Amin - Director General



NEW
The Sustainable Energy Marketplace will soon expand to Asia, Southern and Eastern Europe and the Pacific region. If you are seeking to find support or finance projects, please fill out the contact form [available here](#) to be notified when the global platform is open for registration.

ACCESS TO
CARIBBEAN PORTAL

ACCESS TO
LATIN AMERICA PORTAL

ACCESS TO
AFRICA PORTAL

Online platform to support project initiation, development and access to financing

IRENA ADFD

Supporting Energy Transition



Navigation: About | How it works | How to apply | Funding | Projects selected | Latest updates | FAQ | Contact us

About the Project Facility
IRENA and the Abu Dhabi Fund for Development (ADFD) have collaborated to create a joint Project Facility to finance transformative and replicable renewable energy projects in developing countries.
[Read More](#)

Latest updates
New! Fifth Cycle webinar presentation
[Read More](#)

Projects selected
IRENA ADFD
15 144 14 67,6

How it works
IRENA carries out its project screening and recommendation process as detailed out in the Guidelines for Applicants.
[Read More](#)

Funding
The ADFD provides sovereign funding to governments of developing countries in the form of concessional loans to support their...
[Read More](#)

How to Apply
LOGIN
Username:
Password:
[Login](#) [Forgot Password?](#) [Register](#) [Forgot Password](#)

FAQ ?

Concessional financing for innovative renewable energy projects

Sustainable Energy Marketplace: Online platform



Welcome
Marketplace Administrator
Log off

edit
help
contact

- HOME
- ABOUT
- BENEFITS FOR USERS
- MEDIA
- MARKETPLACE
- USER PROFILE
- IRENA REPORTS
- OTHER MARKETPLACES

Sustainable Energy Marketplace

25

Number of projects in the market place

167.86 MW

Combined capacity of projects in the market place (power generation projects only)

0.38 bn US\$

Total investment need



LATEST PROJECTS

Nigeria	Solar - PV - rooft...
Green Village Ele...	17.8 MW electricity
Ghana	Solid Biomass - ...
Kwamoka	6 MW electricity

THE SUSTAINABLE ENERGY MARKETPLACE: a new horizon

As part of IRENA's objective to sustain and facilitate the spread of renewable energy technologies, IRENA has implemented a virtual

NEWS

- 12/08/2015 - COP21 Day 9: 'BASIC' nations turn up the heat...
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- 12/08/2015 - Morocco Set to Bring 160MW of Concentrating Solar Power...
- 12/08/2015 - African Investment Fund CrossBoundary Energy Raises \$8 Million For...

see more...

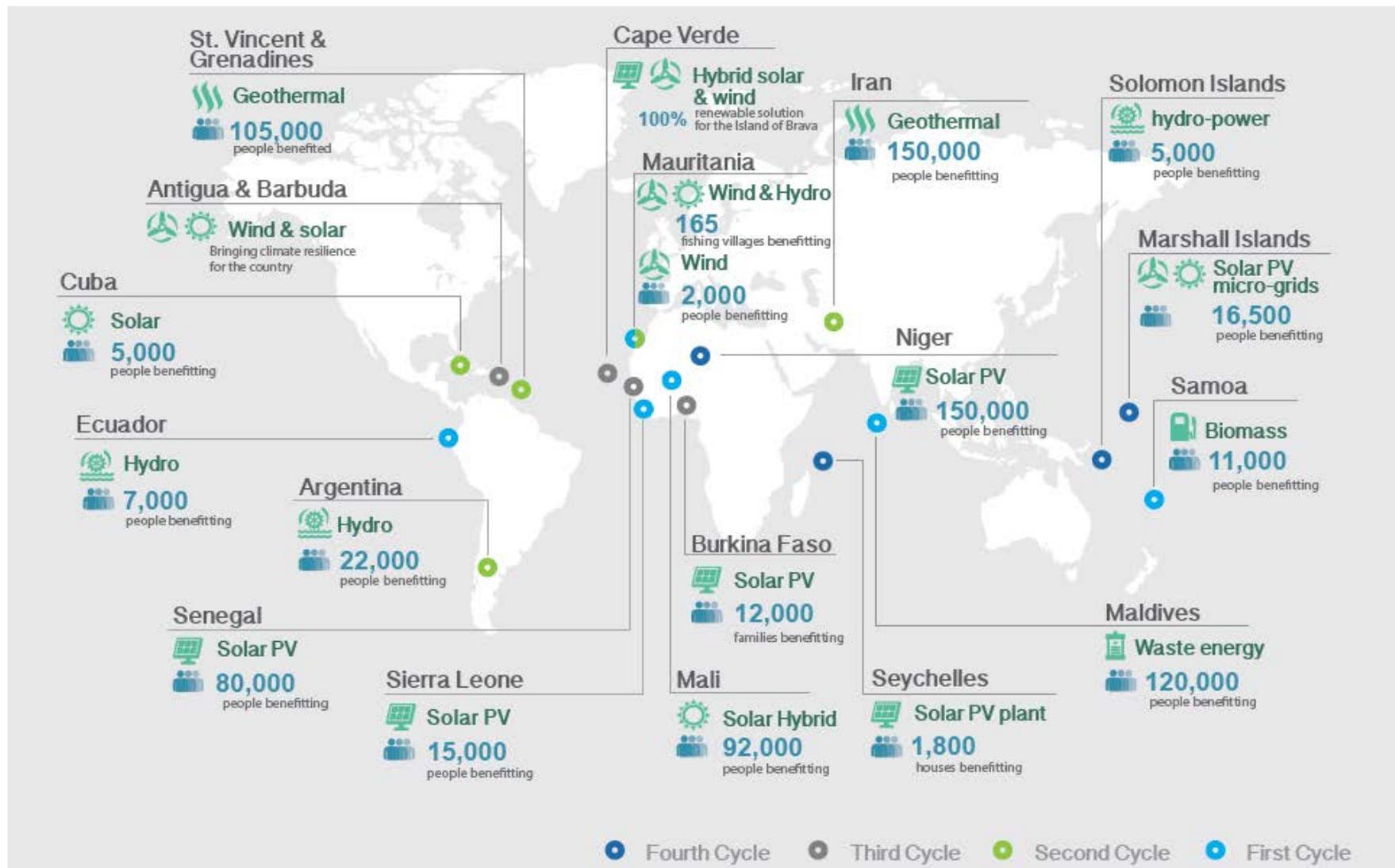
EVENT CALENDAR

- COP21
Paris, France
- World Future Energy Summit 2016
Abu Dhabi National Exhibition Centre
- Second Meeting of the UN Environm...
Nairobi, UNEP Headquarters

see more...

A marketplace facilitated by IRENA and partner institutions

Fifth cycle projects will be announced at the IRENA Assembly in January 2018



Renewable energy for islands at COP23

- UNFCCC COP 23 in Bonn 6 to 17 November 2017
 - *Fiji has the presidency of COP23, 1st time for a SIDS*
- IRENA organizing a SIDS Energy Day side event
 - *13 November 2017 at the IRENA Pavilion – Bonn zone*
 - **Session 1: Transforming the energy landscape in SIDS**
 - **Session 2: Strengthening resilience and facilitating implementation of NDCs**
 - **Session 3: Supporting SIDS energy sector transformation**



SMALL ISLAND DEVELOPING STATES LIGHOUSES INITIATIVE



Emanuele Taibi

Power Sector Transformation Strategies

ETaibi@irena.org

