

Renewable energy in islands

Challenges and solutions

11 June 2015, Bonn

- April 9: REmap – Global Renewable Energy Outlook
- April 23: Renewable Energy Technologies and Innovation
- May 7: Renewable Energy: The True Costs
- May 21: The Transformation of Power Systems with the Integration of Renewable Energies
- **June 11: Island Lighthouses – Renewable Energies on Islands**
- June 25: Energy Planning and Renewable Energies in Africa

All lectures at Uni-Bonn, Main Building, Lecture Hall III and between 6-8pm

A certificate of attendance can be earned upon participation to the whole lecture series

(all 6 lectures)

The International Renewable Energy Agency



*The global Voice, Advisory Resource and Knowledge Hub for renewable energy
Currently 141 member countries, 31 Signatories / States in Accession*



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**

Structure and Membership

Headquarters:

**Abu Dhabi,
United Arab Emirates**

Three Programmes:

- **Innovation and Technology Centre (IITC) in Bonn, Germany**
- **Knowledge, Finance and Policy Centre in Abu Dhabi**
- **Country Support Programme in Abu Dhabi**

Foundation

26 January 2009 in Bonn

Agency established in April 2011

The only intergovernmental RE agency worldwide

Scope

Hub, voice and source of objective information for renewable energy

Mandate

Sustainable deployment of the six forms of renewable energy resources (Biomass, Geothermal, Hydro, Ocean, Solar, Wind)

- Official opening of IITC on October 2011
- Location: Bonn, Robert-Schuman Platz (BMU building)
- 40 staff
- Knowledge, advice, creating and supporting networks
 - Renewable energy roadmaps (REmap)
 - Energy planning (for Africa)
 - Technology information
 - Grids and storage
 - Standards and quality control
 - R&D advice
 - Bankable project preparation (navigator)
 - **Island transition planning (*this lecture*)**

Context

- Peculiarities of small islands and challenges for RE deployment
- Energy use in small islands
- Power generation in small islands
- Energy for transport in small islands
- Other energy uses in small islands

IRENA's work for islands

- The SIDS Lighthouses Initiative
- Planning for the energy transition in islands
- The global renewable energy islands network (GREIN)
- Renewable energy for island tourism
- A quick look at the future

CONTEXT: PECULIARITIES OF SMALL ISLANDS

Some peculiarities of small islands

- **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.. One airline... 1-3 times a week
- Etc.



- **Capacity**

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

- **Power sector**

- Lack of electrical interconnection
- Limited scale for cheaper fossil fuel generation options (e.g. natural gas and coal)

- **Transportation**

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

Some challenges for RE deployment 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 -> no grid, no RE generation, LCOE increases
- **Environment**
 - Often very aggressive environment for hardware: corrosion, humidity (in some)
 - Frequent extreme weather phenomena in many islands (e.g. cyclones/typhoons/hurricanes)
 - Sometimes limited space for deployment of RE (e.g. ground mounted PV in small atolls)

Some challenges for RE deployment in small islands



Some challenges for RE deployment in small islands

August 2013 – installation close to completion



Some challenges for RE deployment in small islands

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



Some challenges for RE deployment in small islands

August 2013 – installation close to completion

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



CONTEXT: ENERGY USE IN SMALL ISLANDS

Energy use in small islands

- Lighting: biomass -> kerosene -> electricity
- Cooking: biomass -> kerosene -> (LPG) -> electricity
- Electricity for lighting -> mobile phones (sometimes) -> entertainment
- Electricity for refrigeration (food 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



POWER GENERATION IN SMALL ISLANDS

Diesel as business-as-usual



Off-grid solar PV



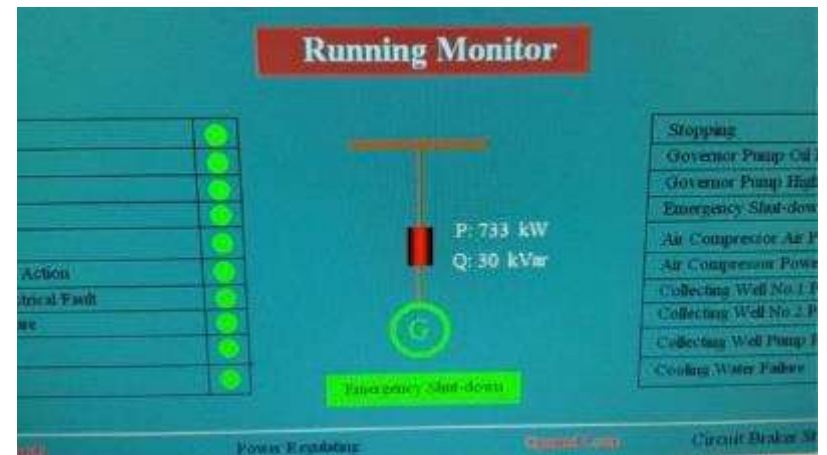
Wind



Hydro always best option, rarely available



Hydro always best option, rarely available



- **Coconut oil to replace diesel in generators:** some success stories, challenges on the supply chain and fuel quality
- **Geothermal:** few islands with potential, generally insufficient demand to cover exploration cost and investment
- **Ocean energy:** technology not commercial yet. Some expected challenges linked to maintenance capacity.

ENERGY FOR TRANSPORT IN SMALL 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



OTHER ENERGY USES IN SMALL ISLANDS

Other energy uses: communication, education and entertainment



Other energy uses: desalination



IRENA'S WORK FOR ISLANDS THE SIDS LIGHTHOUSES INITIATIVE

SIDS Lighthouses Initiative overview

Launched on 23 September 2014 at the 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 RE deployment in the power sector
- Well structured systems transitions
- Information Exchange
- Capacity Building

TARGETS by 2020:

- USD 500 mil mobilized
- 100 MW of new solar PV
- 20 MW of new wind
- Significant quantities of other RE technologies
- All participating SIDS have RE roadmaps



SIDS Lighthouses Initiative status



- **27 SIDS and 17 development partners**
- Antigua & Barbuda, Aruba, Bahamas, Barbados, Belize, Cape Verde, Cook Islands, Federated States of Micronesia, Fiji, Grenada, Guyana, Kiribati, Maldives, Republic of the Marshall Islands, Mauritius, Nauru, Niue, Palau, Saint Vincent & the Grenadines, Samoa, Sao Tome and Principe, Seychelles, Solomon Islands, Tonga, Trinidad and Tobago, Tuvalu, Vanuatu
- ENEL, New Zealand, European Union, Norway, France, SE4ALL, Germany, United Arab Emirates, Indian Ocean Commission, United States of America, IRENA, UNDP, Japan, World Bank Group, Carbon War Room, Rocky Mountain Institute, Clinton Climate Initiative

Progress since Climate Summit

German VC

- Lighthouses facilitation team
- Assessment of existing financing gaps
- Project development facilitation
- Financing for pre-feasibility studies
- Island navigator module

Norwegian VC

- Grid assessments
- RRA and roadmaps
- Caribbean lighthouses: coordinator and workshops



RE for tourism event ITB Berlin 4 March 2015 with the Government of Germany

Martinique event June 2015 with the Government of France

- Focus RE resource assessment (wind, marine and geothermal)
- RE desalination, biomass and waste-to-energy systems

Honolulu event in July 2015 with the Government of the United States of America and SPC

Bangkok event with the Government of Japan

Aruba, Barbados, Belize, Carbon War Room, Clinton Climate Initiative and Rocky Mountain Institute
joined, more in the process of joining

SIDS Lighthouses Initiative

Quick Scan

Objective:

- Assess the current situation in terms of enabling conditions for RE deployment
- Gather available information and identify information gaps
- Identify priority areas for action
- Involve government and private sector players

Approach: desktop review, phone interview plus 2-day visit when necessary

Quickscans progress

- Finalized the methodology
- Ran for Mauritius, Bahamas, Fiji, New Caledonia, Kiribati, Nauru, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu
- Ongoing for Barbados, Cook Islands, FSM, Palau and RMI.
- Requested by Belize and St. Kitts and Nevis

Timeline: complete assessment of SIDS partners before COP 21

IRENA'S WORK FOR ISLANDS PLANNING FOR THE ENERGY TRANSITION IN ISLANDS

IRENA's programmatic work relevant for Lighthouses

Lighthouses builds on existing IRENA work

✦ Renewables Readiness Assessment

- Starting Antigua and Barbuda, the Bahamas
- Completed Kiribati, Grenada, Fiji, RMI, Vanuatu

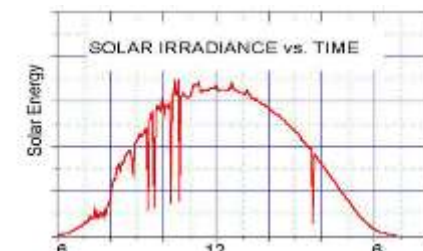
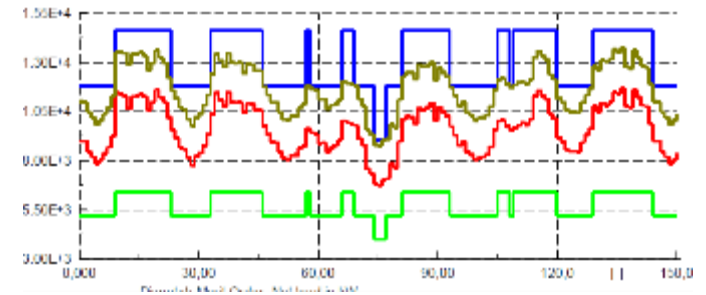
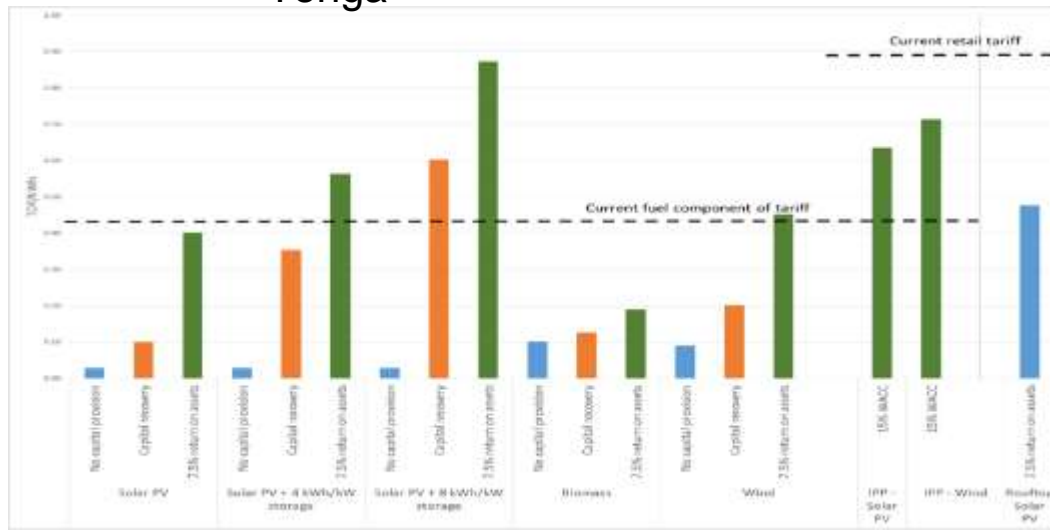
✦ Grid stability

- Antigua and Barbuda, Barbados, Cook Islands, Palau, Samoa, Fiji

✦ Studies on tariff impact of RE

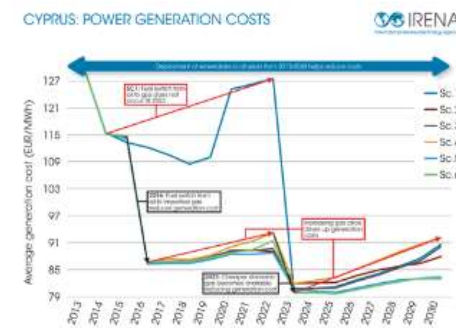
- Tonga

SERVICE	Renewable energy resource					
	Bioenergy	Geothermal	Hydro	Marine	Solar	Wind
On grid - electricity	✓	✓	✓	✓	✓	✓
Off grid - electricity	✓	✓	✓		✓	✓
Off grid - motive power			✓			✓
Thermal energy*	✓	✓			✓	
Transport	✓					



RE roadmaps for islands

- Roadmapping Baseline Report for Pacific SIDS:
 - [Pacific Lighthouses: Renewable Energy Roadmapping for Islands](#)
- Nauru Energy Road Map completed (with GIZ, SPC)
- Cyprus completed
- Mauritius ocean energy roadmap completed
- Maldives under completion
- Started Barbados and Kiribati
- Roadmap deployment support Cap Verde, Vanuatu (with GIZ)
- Island roadmap blueprint workshop planned for 2015

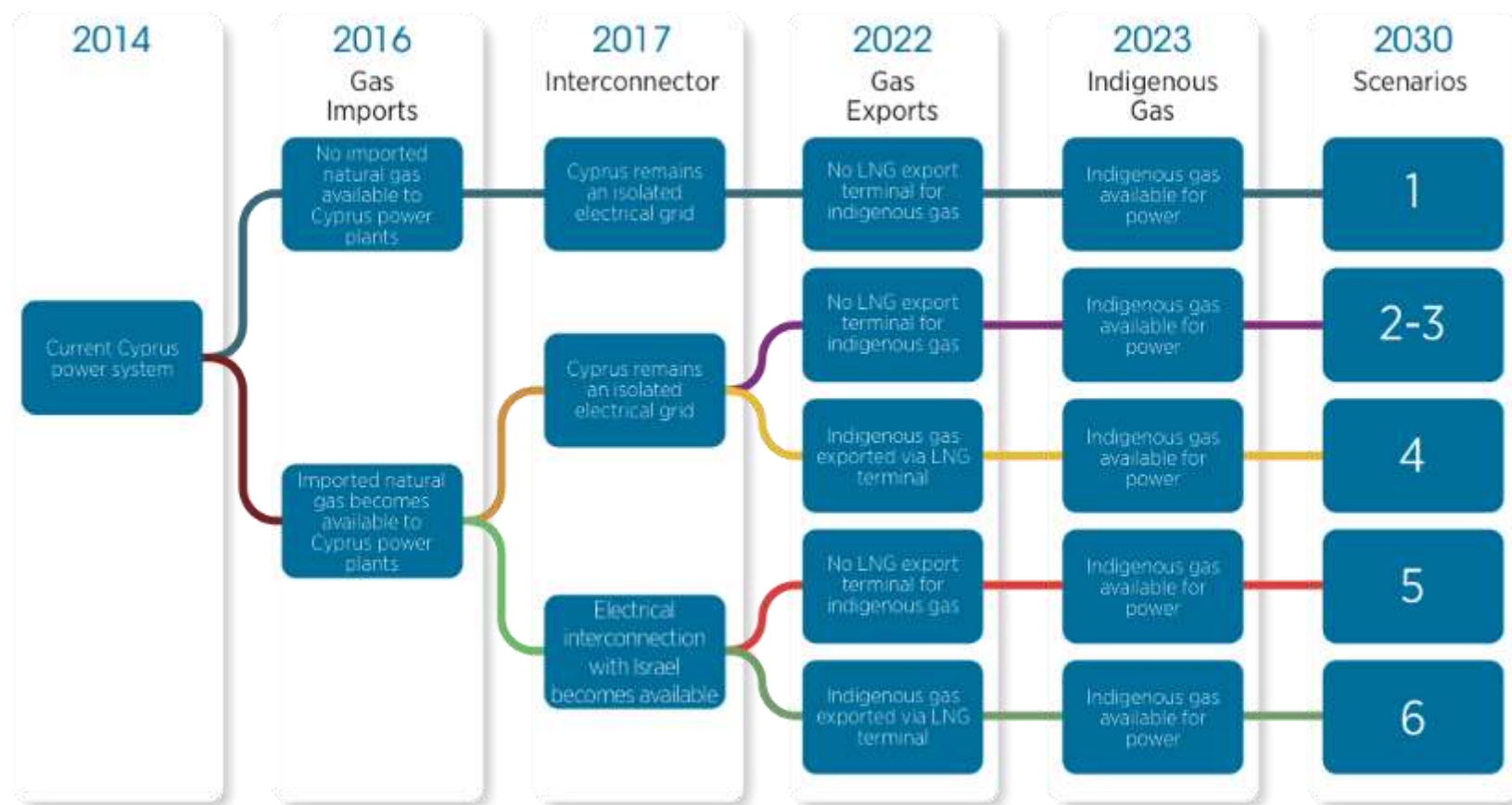


RENEWABLES IN CYPRUS: PV AND WIND DRIVE DEPLOYMENT



RE roadmap for Cyprus

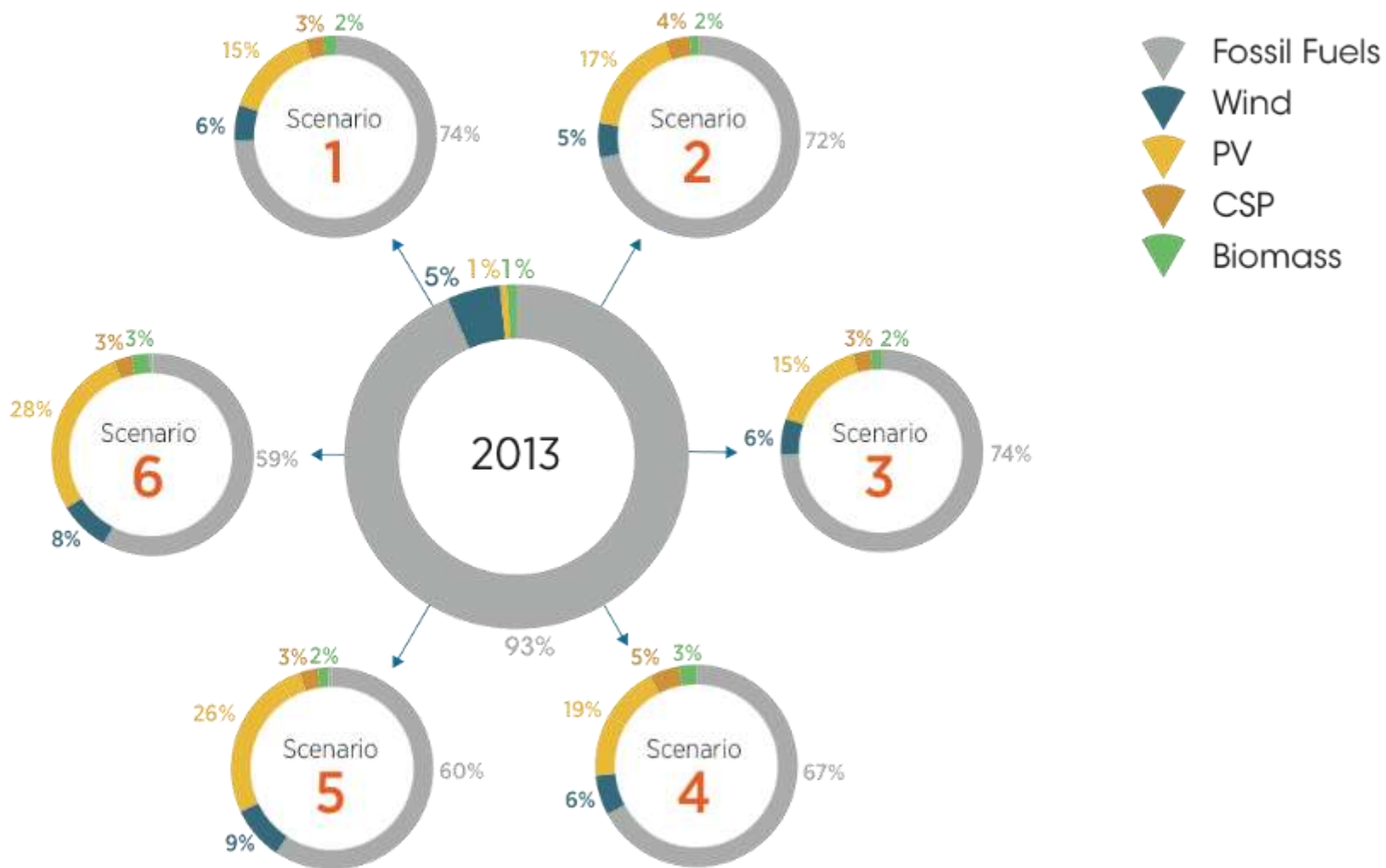
CYPRUS: ENERGY DECISIONS AND SCENARIOS



Energy policy decisions driving the Cyprus roadmap analysis and six resulting scenarios.

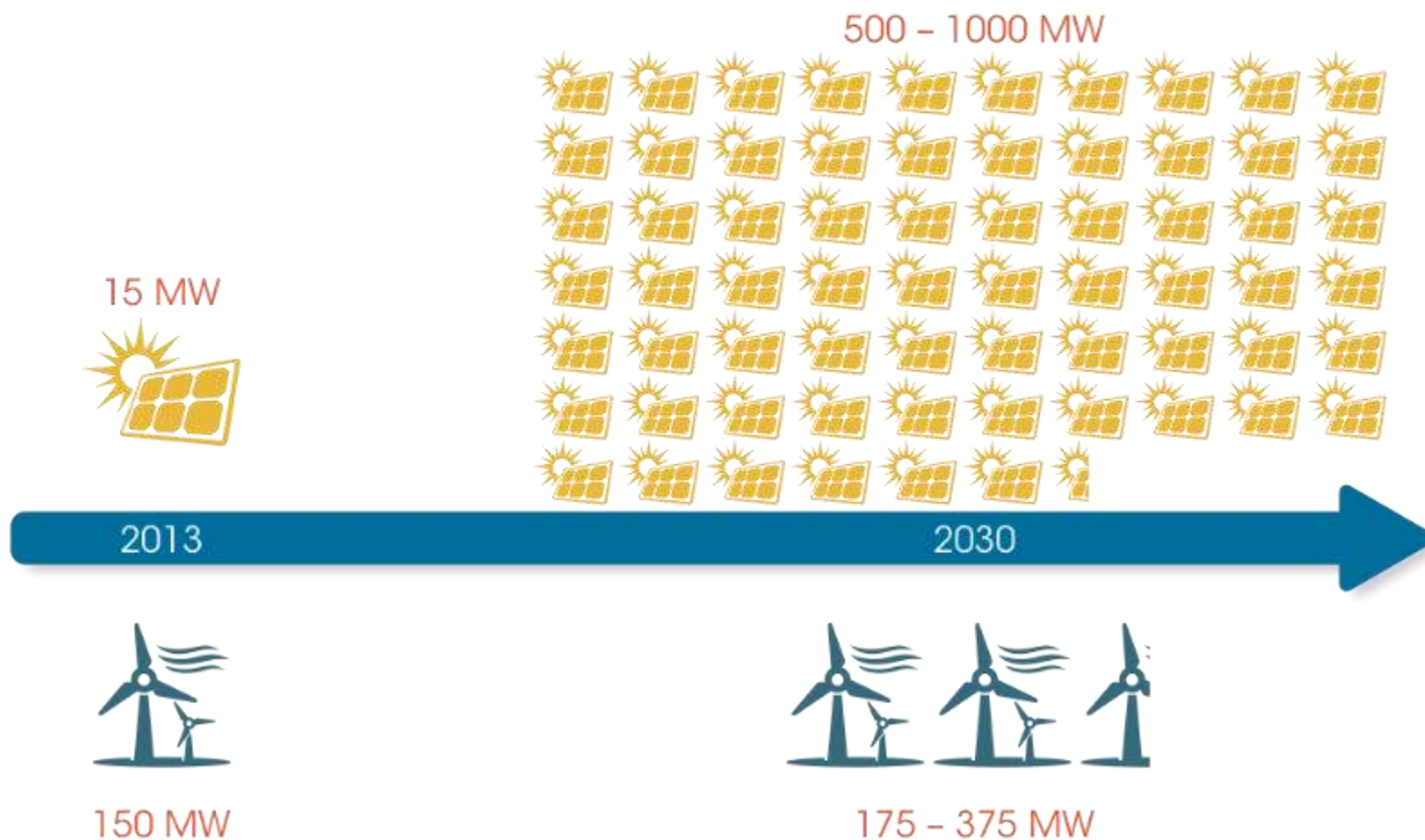
RE roadmap for Cyprus

CYPRUS: POWER GENERATION SCENARIOS, 2013 VS. 2030



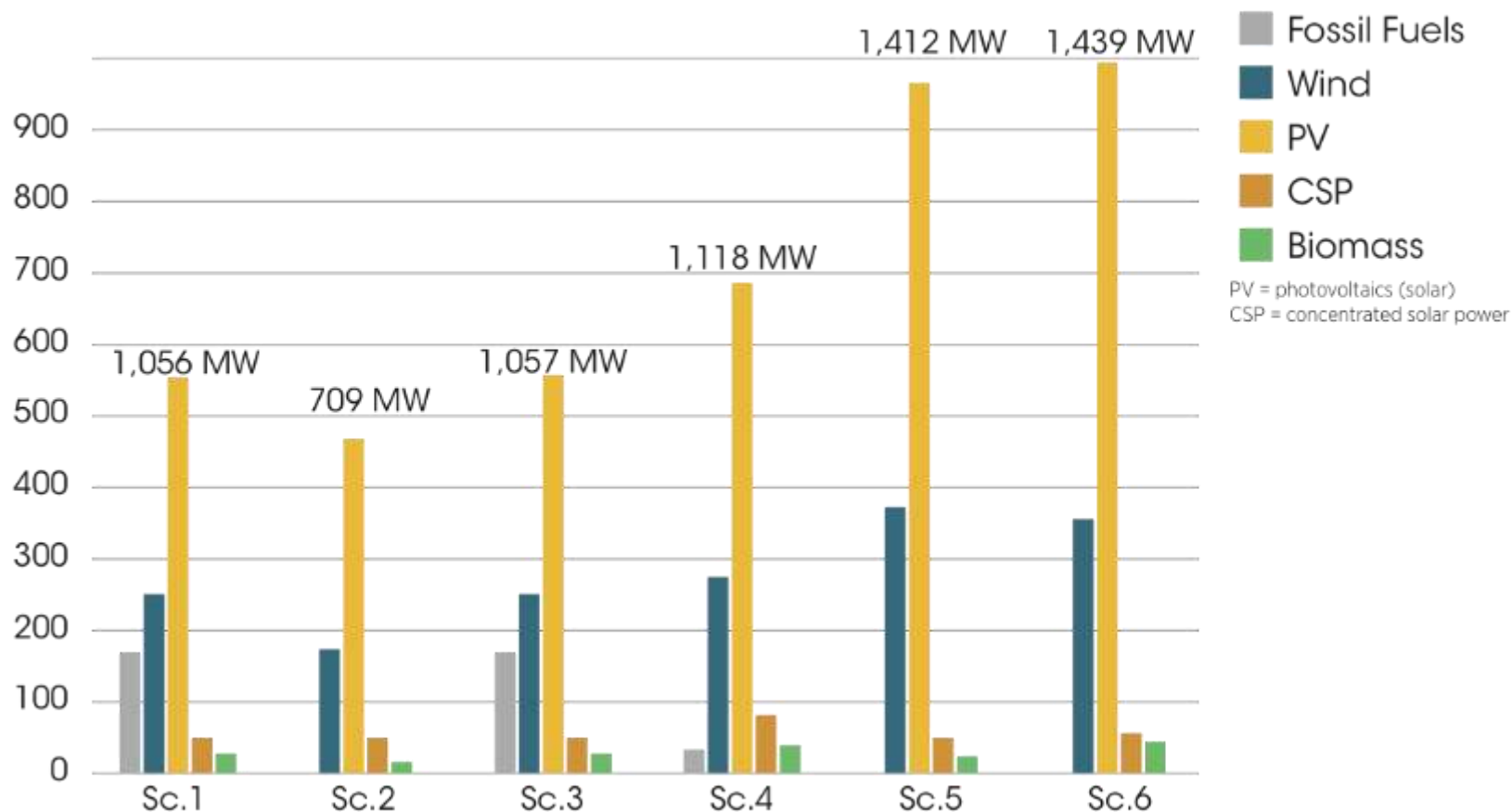
RE roadmap for Cyprus

RENEWABLES IN CYPRUS: PV AND WIND DRIVE DEPLOYMENT



RE roadmap for Cyprus

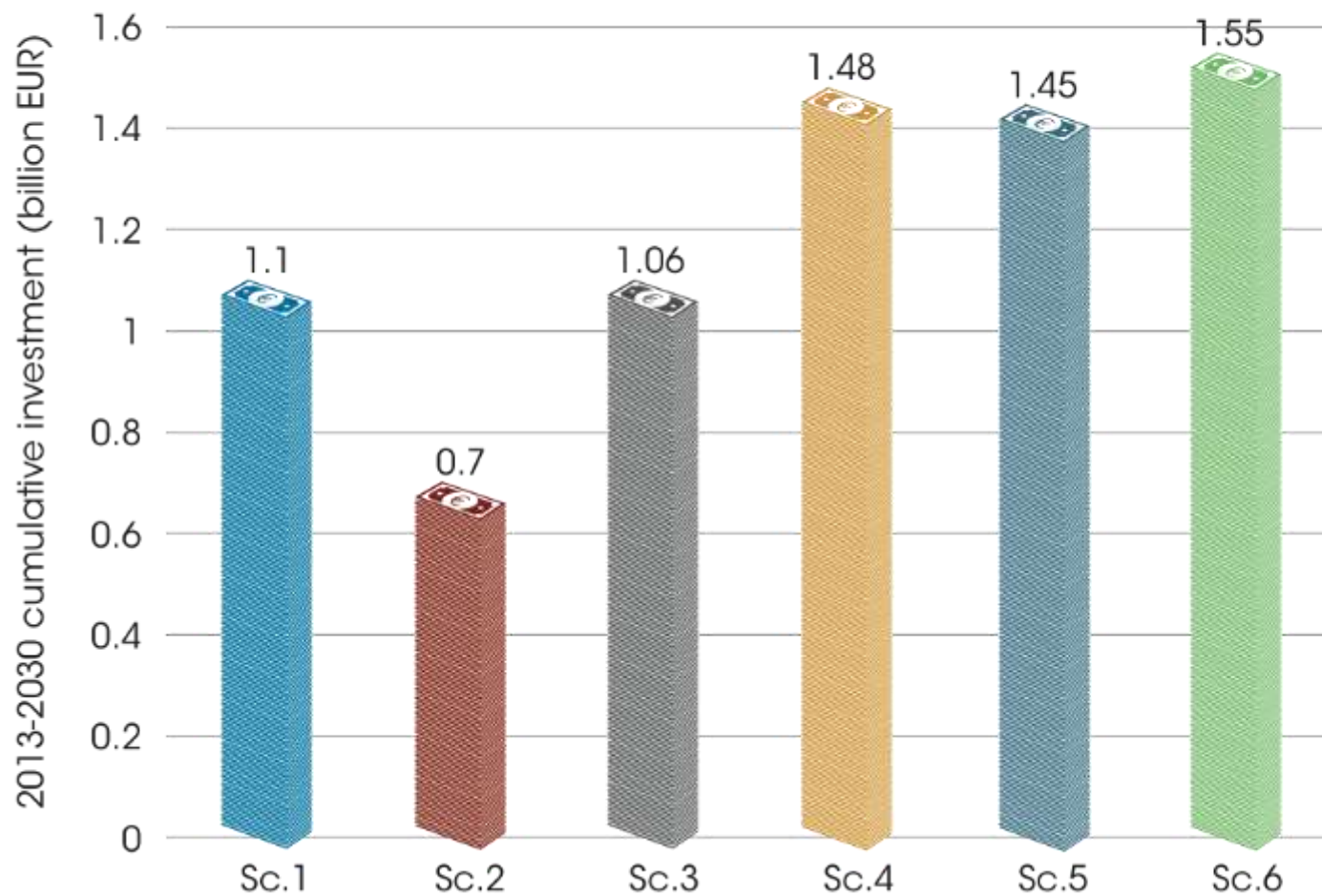
CYPRUS: POWER GENERATION CAPACITY ADDITIONS



Every scenario assumes 566.72 MW of fossil-fuel power generation capacity will be decommissioned between 2013-2020.

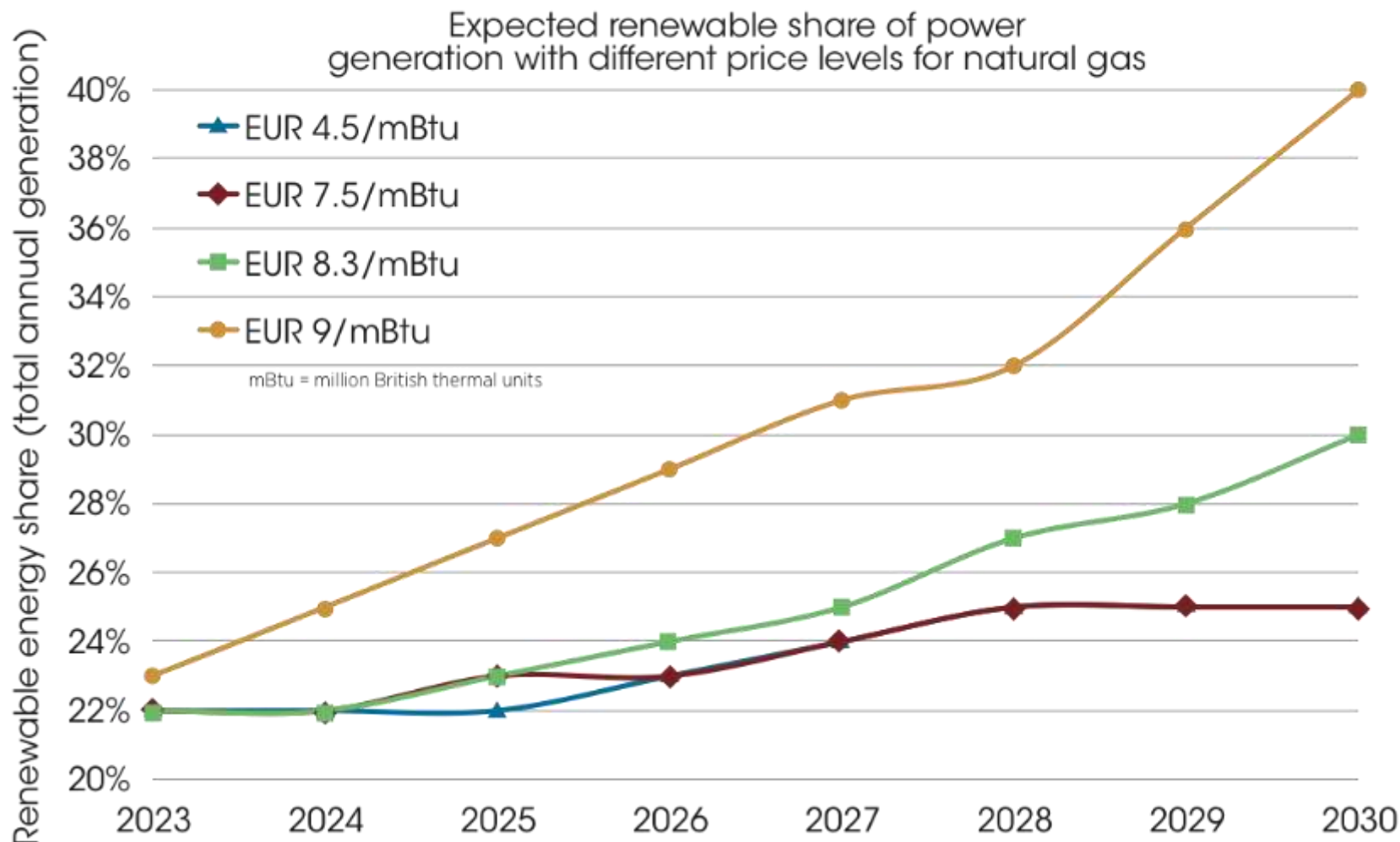
RE roadmap for Cyprus

CYPRUS: INVESTMENTS IN POWER GENERATION



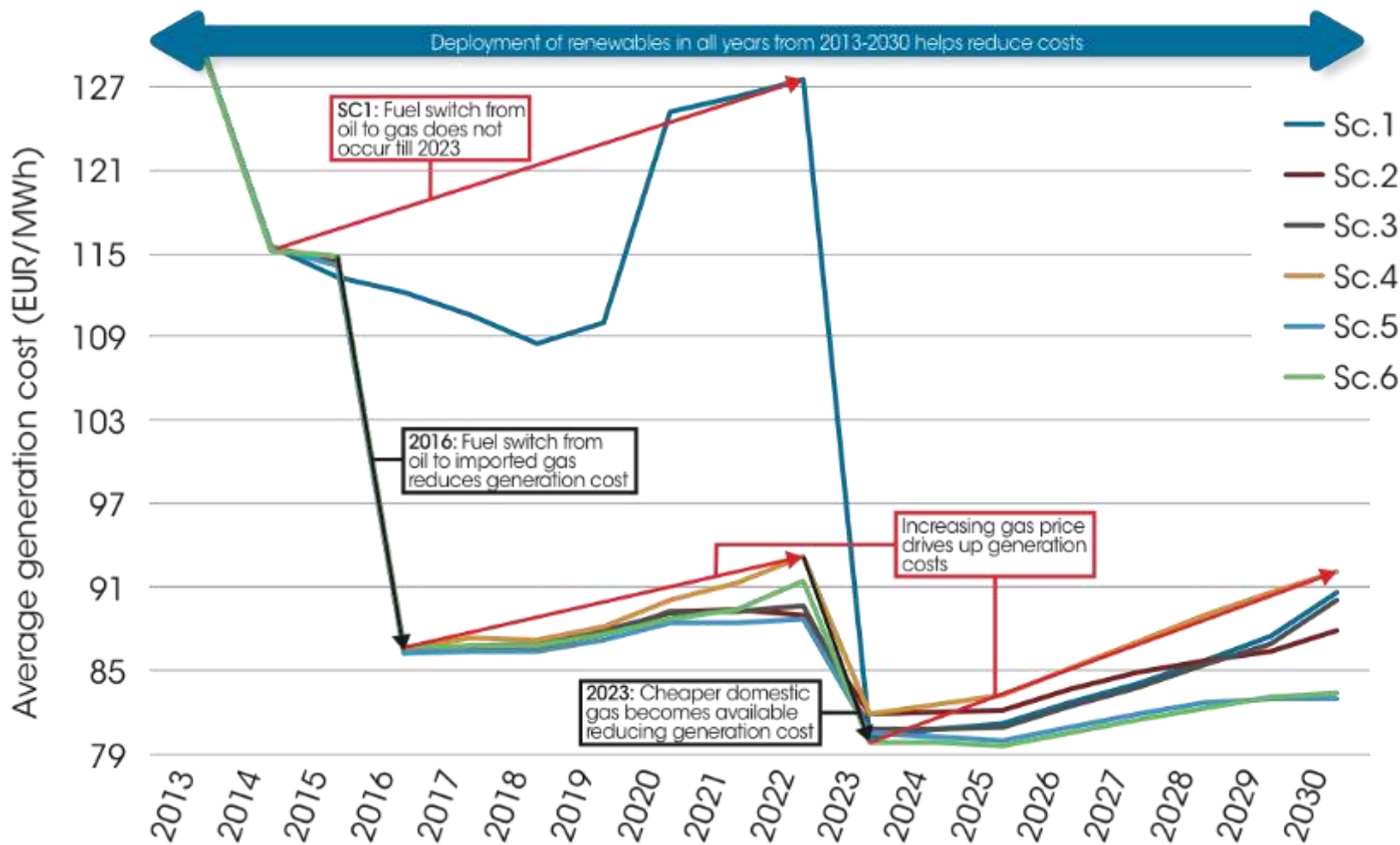
RE roadmap for Cyprus

CYPRUS: GAS PRICES AND RENEWABLE UPTAKE



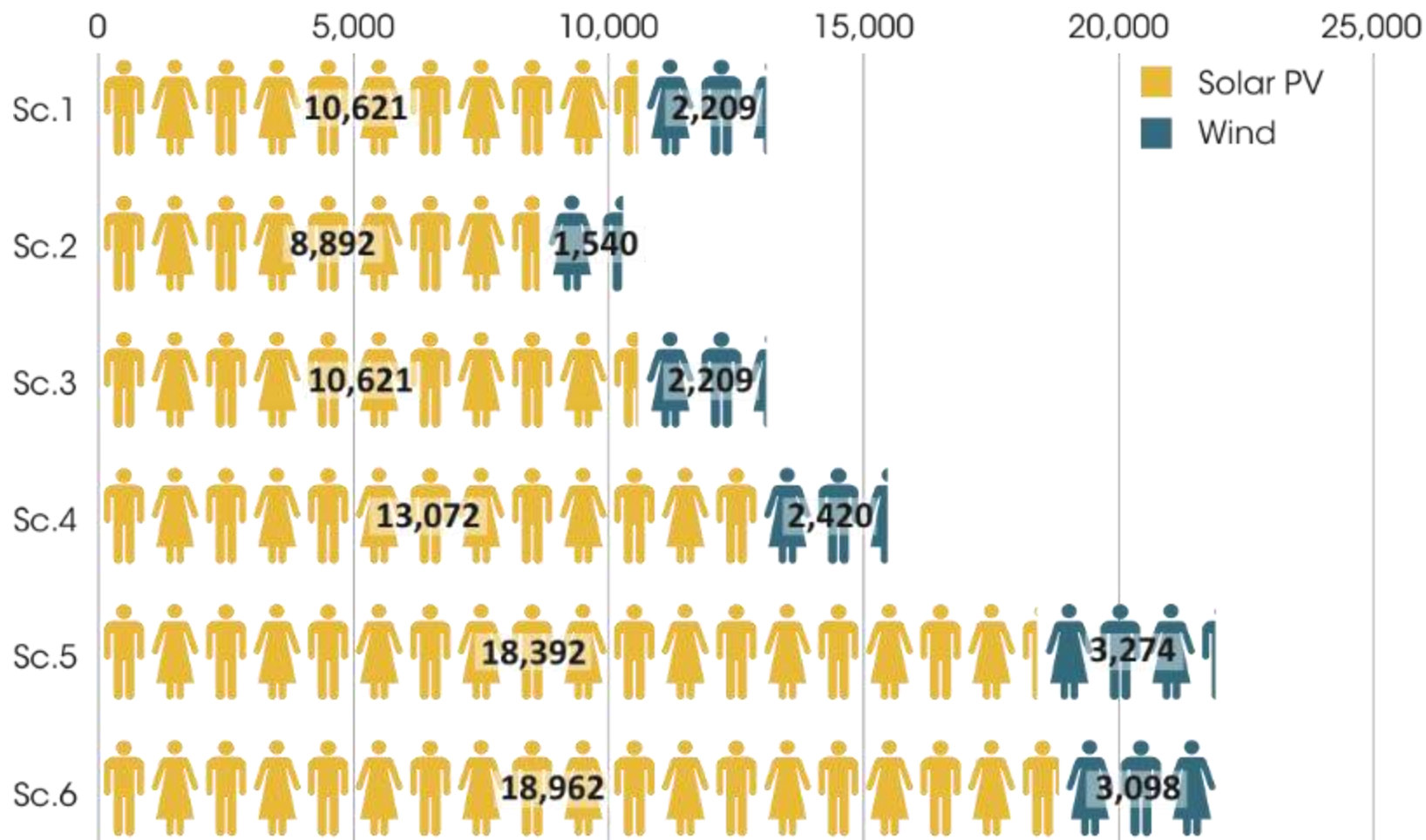
RE roadmap for Cyprus

CYPRUS: POWER GENERATION COSTS



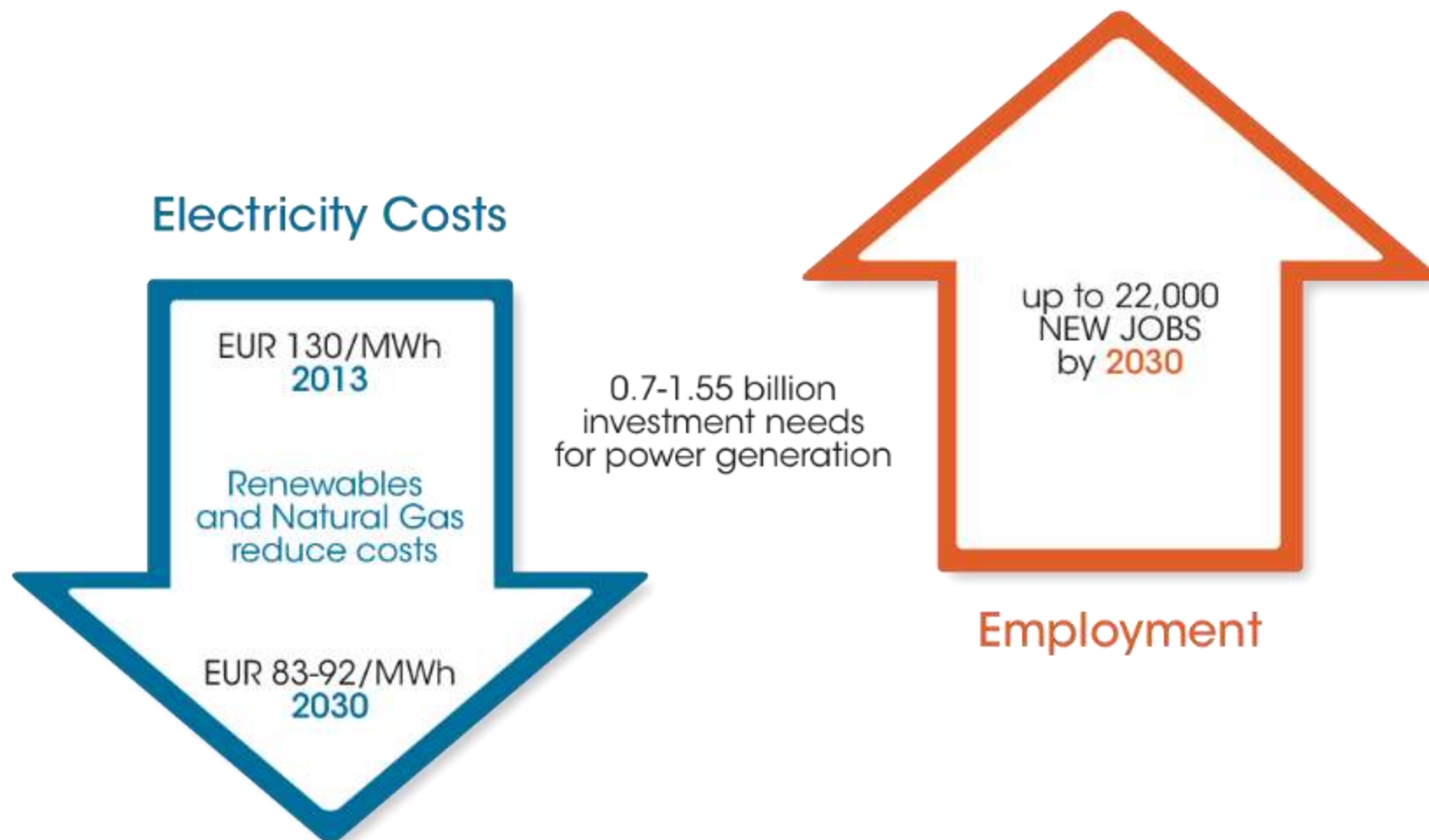
RE roadmap for Cyprus

CYPRUS: RENEWABLE ENERGY JOB CREATION



RE roadmap for Cyprus

CYPRUS: LOCAL BENEFITS FROM RENEWABLE ENERGY



**IRENA'S WORK FOR SMALL ISLANDS
THE GLOBAL RENEWABLE
ENERGY ISLANDS
NETWORK (GREIN)**


GREIN was created following the Malta Communique on Accelerating Renewable Energy Uptake for Islands, issued by ministers and other officials from 48 countries in September 2012. The Malta Communique called upon IRENA to establish GREIN to encourage the **sharing of knowledge and best practices to speed deployment of renewable energy on islands.**

www.irena.org/grein

Six active thematic clusters on RE for islands:

- Roadmaps for Deployment
- Power Grid Integration
- Tourism
- Resource Assessment
- Desalination
- Waste-to-Energy Systems

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IRENA

International Renewable Energy Agency

GREIN


GLOBAL RENEWABLE ENERGY ISLANDS NETWORK

[Home](#) | [Resource Assessment](#) | [Grid Integration](#) | [Tourism](#) | [Island Lighthouses](#) | [Roadmaps](#) | [Desalination](#) | [Waste to Energy](#)

About GREIN

GREIN is pooling knowledge and sharing best practices to accelerate the uptake of clean and cost-effective renewable energy on islands and reduce reliance on costly fossil fuel. GREIN has interest clusters on roadmaps, grid integration, tourism, resource assessment, waste-to-energy, and desalination.

[→](#)



Events

IRENA - Cyprus Event on Renewable Energy Applications for Island Tourism
30 May 2014

[→](#)

Tourism

GREIN is showing the business case for renewables in island hotels. Options include solar hot water for showers, solar chillers and sea water cooling systems for air conditioning, and photovoltaic rooftops for electricity.

[→](#)

Island Lighthouses

Island lighthouses point the way for renewable energy transition on islands through a mix of political commitment, market opening, planning, capacity building and other supportive measures.

[→](#)

Roadmaps

Roadmaps lay out practical steps for islands to invest in cost-effective renewable energy options. GREIN is sharing renewable roadmaps for islands and working to develop new ones.

[→](#)

Desalination

Many islands face a critical shortage of fresh water and so must desalinate seawater. GREIN is assessing renewable desalination at island scale.

[→](#)

Waste to Energy

GREIN is evaluating cost-effective options for islands to turn organic waste into locally generated electricity.

[→](#)

Resource Assessment

GREIN is developing guidelines for wind resource measurement that islands can use to show the likely output and revenue from pilot wind power projects and get such projects financed.

[→](#)

Grid Integration

GREIN is sharing grid stability studies which show that islands can use a much higher share of renewable power while keeping service reliable. It also supports training to install and maintain renewable power properly.

[→](#)

IRENA'S WORK FOR SMALL ISLANDS RENEWABLE ENERGY FOR ISLAND TOURISM

Tourism accounts for a large share of Islands' GDP

Caribbean	Antigua & Barbuda	77%
Pacific	Cook Islands	75%
AIMS	Seychelles	63%
Pacific	Vanuatu	51%
Pacific	Palau	50%
AIMS	Maldives	49%
Caribbean	Bahamas	48%
AIMS	Cape Verde	44%
Caribbean	Barbados	39%
Caribbean	St. Lucia	39%
Pacific	Fiji	36%
Caribbean	Belize	34%
Caribbean	Dominica	30%
Caribbean	St. Kitts and Nevis	28%
AIMS	Mauritius	28%
Caribbean	Jamaica	27%
Pacific	Samoa	25%

IRENA study on RE for island tourism

The study assessed the **business case for** the deployment of Renewable Energy Technologies (**RETs**) in **island tourism** facilities.

The technologies analysed include:

- ✦ Solar Water Heaters (SWH)
- ✦ Solar Air Conditioning (SAC)
- ✦ Sea Water Air Conditioning (SWAC)
- ✦ Solar Photovoltaic (PV)



The report is available on line at www.irena.org/publications

- Tourist arrivals in small islands have increased by over 30% in the last decade.
- Over the last decade, energy prices have increased dramatically
- Energy consumption in island hotels is represented primarily by air conditioning, lighting and refrigeration.

Average commercial electricity tariffs in 2012

Islands

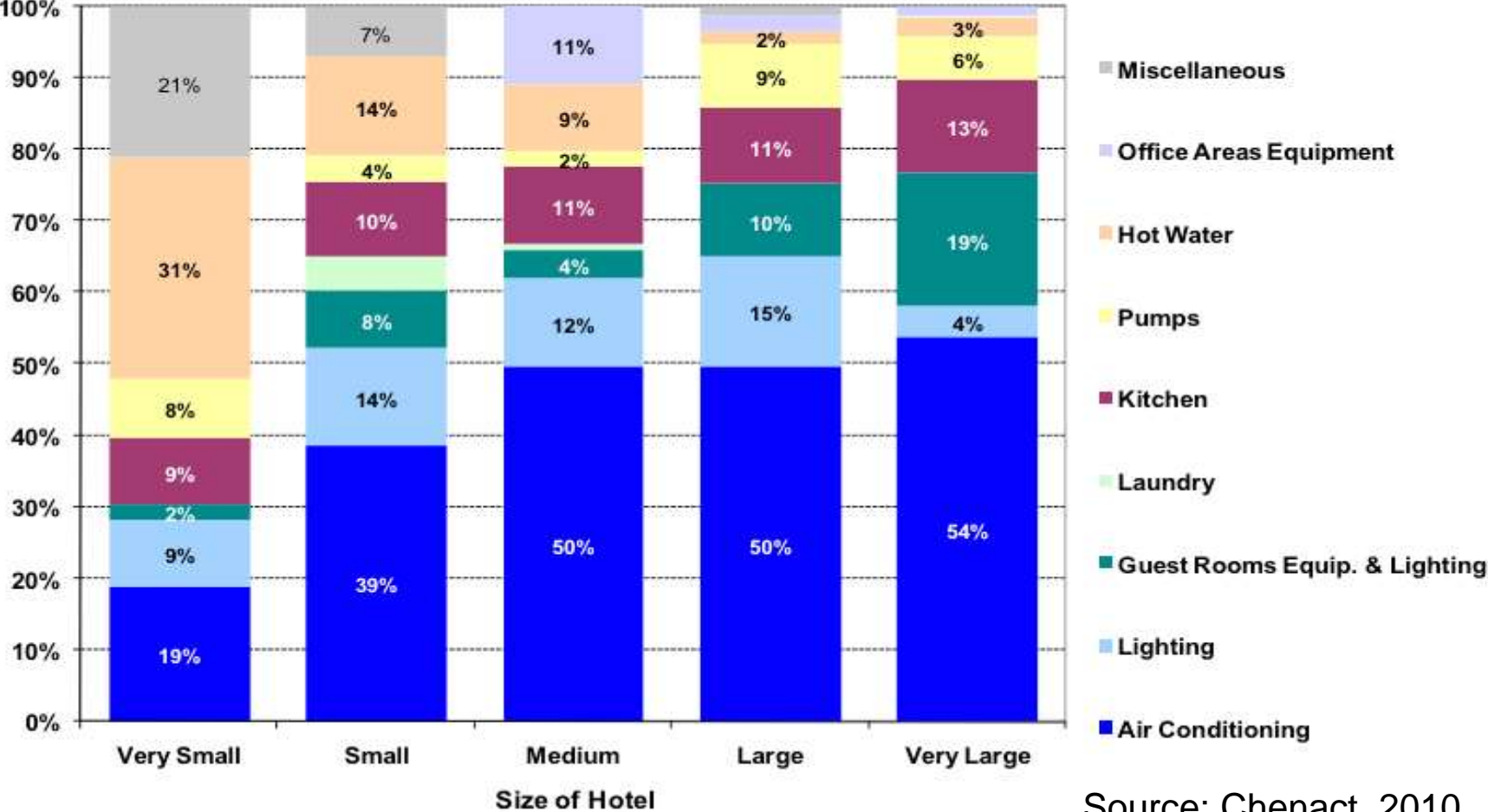
- US\$ 0.33/kWh in Caribbean islands
- US\$ 0.43/kWh in Hawaii
- US\$ 0.33/kWh in Mauritius
- US\$ 0.39 - 0.44/kWh in Pacific islands

Others

- US\$ 0.26/kWh in EU member states
- US\$ 0.09/kWh in China and Canada

Typical electricity use depends on hotel size

BREAKDOWN OF ELECTRICITY CONSUMPTION IN THE HOTEL SECTOR



Source: Chenact, 2010

Case Study: Turtle Beach Resort, Barbados

- **Hotel size:** 167 suites
- **RET:** SWH system with total capacity of 7,800 gallons (40 gallons of water per room plus 1,120 gallons for ancillary services)
- **Capital cost:** US\$ 200,000.
- **Payback time:** 8 years between 1997 and 2013 (less than 2 years at present electricity price)
- **Savings:** US\$ 1,484,811 between 1997 and 2013.



Case Study: Rethymno Village Hotel, Crete

- **Hotel size:** 110 rooms
- **RET:** SAC system with total capacity of 105 kW, powered by 450m² of rooftop mounted solar thermal collectors,
- **Capital cost:** US\$ 146,000
- **Payback time:** 5 years
- **Electricity savings for cooling:** 70,000 kWh/year
- **Diesel oil savings for heating:** 20,000 liters per year



Case Study: InterContinental Bora Bora Resort & Thalasso Spa, Bora Bora

- **Hotel size:** 83 large villas
- **RET:** SWAC system with 2,000 m long pipeline
- **Capital cost:** US\$ 7.9 million
- **Payback time:** 8 years (5 years considering incentives)
- **Savings from avoided electricity consumption :** US\$ 720,000/year



Case Study: Turtle Island Resort, Fiji

- **Hotel size:** 14 cottages
- **RET:** Off-grid solar PV system with 228kWp PV and 1.1 MWh storage
- **Capital cost:**
US\$ 1.06 million
- **Payback time:** 8.6 years
- **Savings from avoided diesel cost:**
US\$ 124,000/year



IRENA'S WORK FOR SMALL ISLANDS A QUICK LOOK AT THE FUTURE

COP 21 in Paris, France, 30 November – 11 December 2015

IRENA co-organizing RE day with the French Syndicate of Renewable Energy (SER) and possible additional partners

Lighthouses progress will be showcased

- At least three islands with tangible results (new projects)
- Project financing facilitation

100% solar country: Tokelau



Generation technologies

- Solar PV
- (bio-)Diesel backup

Storage technologies

- OPzS Lead-acid batt.



100% wind island: El Hierro (ES)



Generation technology

- Wind

Storage technology

- Pumped hydro



Floating Solar PV platforms for islands with limited land



- 15 + 28 kWp currently deployed in Maldives
- 50 + 100 kWp in the pipeline
- 150 MWp estimated potential, cost below 0.20 USD/kWh

Hi-Tec RE island: Pellworm (DE)

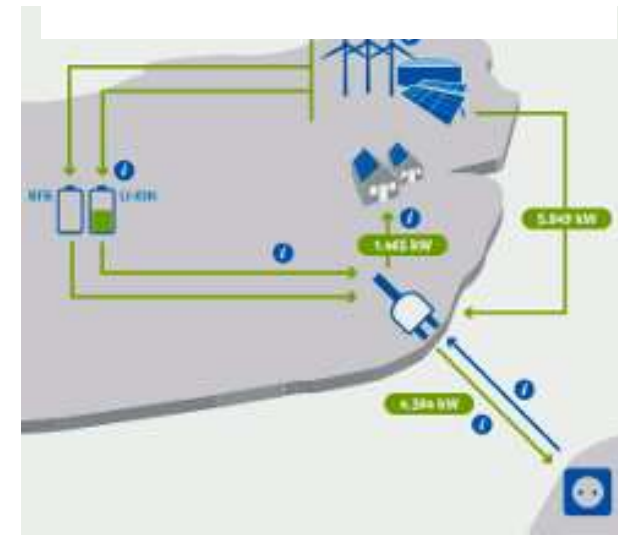


Generation technologies

- Solar PV
- Wind
- Biogas

Storage technologies

- Lithium-Ion
- Redox Flow
- Household storage



Objectives by 2020

SIDS Lighthouses Initiative targets by 2020:

- USD 500 mil mobilized
- 100 MW of new solar PV
- 20 MW of new wind
- Significant quantities of other RE technologies
- All participating SIDS have RE roadmaps





SIDS
LIGHTHOUSES

**SMALL ISLAND DEVELOPING STATES
LIGHTHOUSES INITIATIVE**



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