INTERNATIONAL RENEWABLE ENERGY AGENCY

IRENA

International Renewable Energy Agency

IRENA activities on innovation in energy access through renewables

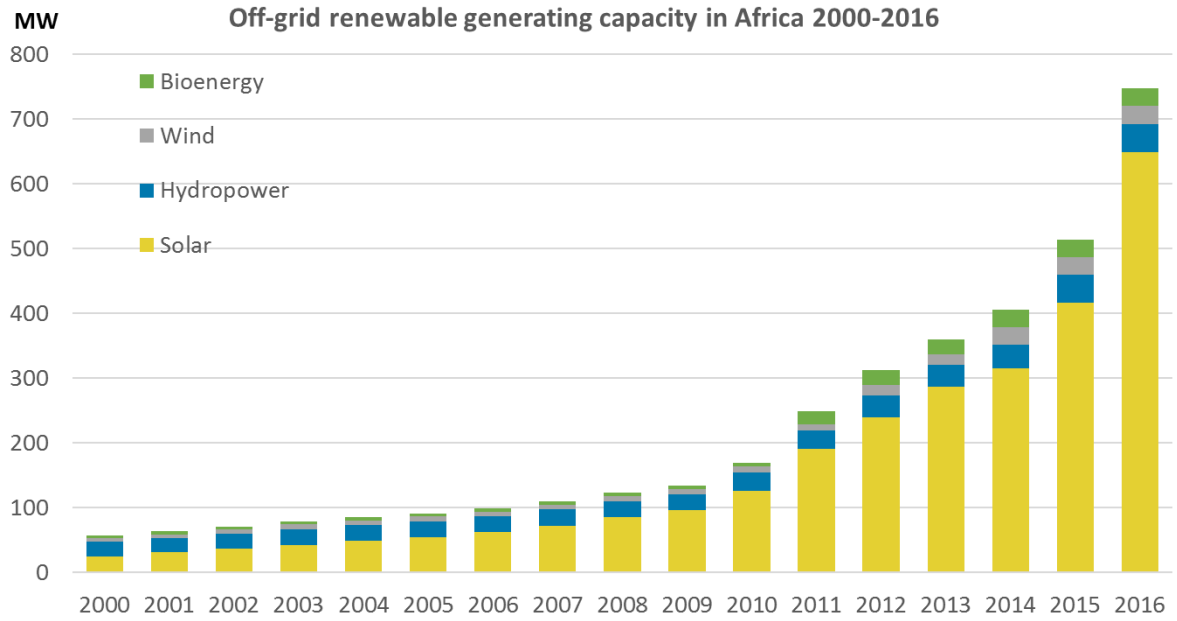
Emanuele Taibi

Mission Innovation Challenge 2 workshop

Paris, 12 July 2017

Opportunities for renewables in the off-grid

- Some 1.16 billion people without electricity access today
- 26 million households served through off-grid systems
- 50 – 250 GW potential to hybridise existing diesel generator capacity, 12 GW on islands
- 1 million telecom towers in South Asia and Sub-Saharan Africa



Source: IRENA (2017), Renewable Energy Statistics 2017

Scaling-up off-grid renewable energy deployment: the IOREC Platform

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IOREC
International Off-Grid Renewable Energy Conference & Exhibition

Objective

- Identify key barriers and drivers for stand-alone and mini-grid RE system deployment
- Platform to share experiences, lessons learned and best practices

IOREC 2012
Accra, Ghana

IOREC 2014
Manila, Philippines

IOREC 2016
Nairobi, Kenya

Conference info and outcome papers available at: **iorec.irena.org**

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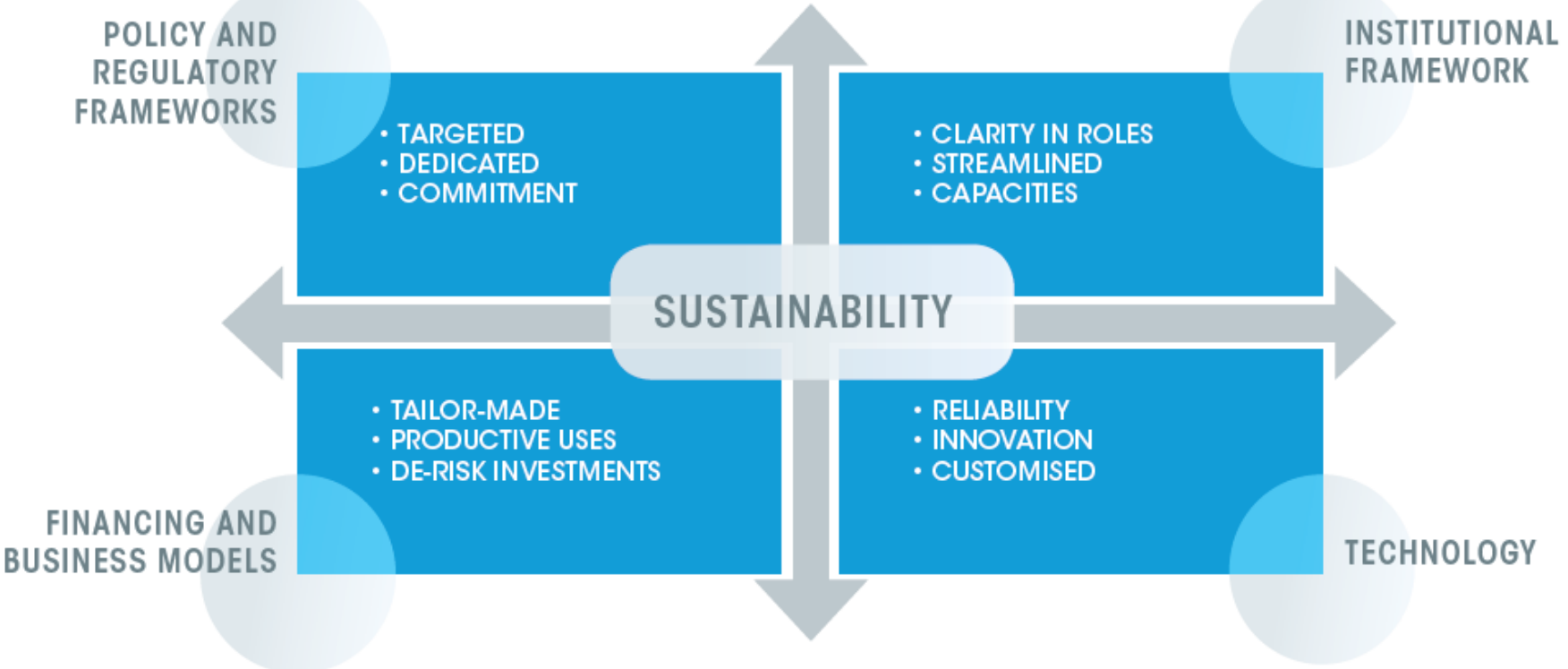
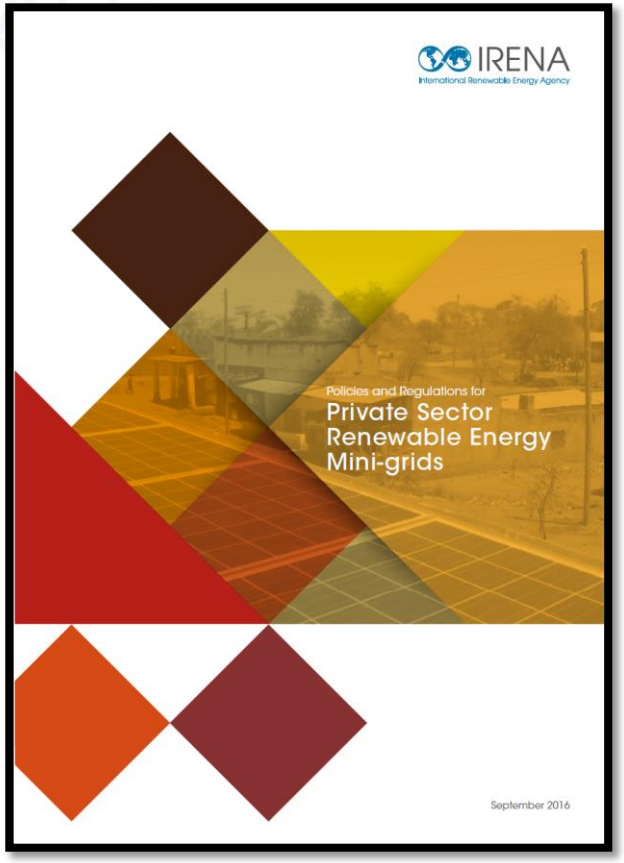
Key Elements of an Enabling Environment for off-grid renewable energy



IOREC outcome paper

Cooperation between public and private sector is essential

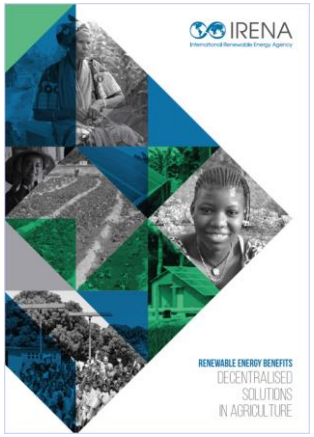
Policies and Regulations for Private Sector Renewable Energy Mini-grids



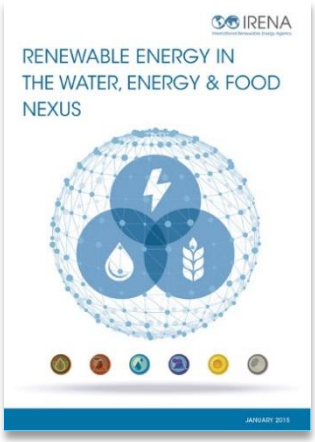
Download at www.irena.org

Agriculture and energy

- Access to affordable, reliable, sustainable and modern energy can help
  - Reduce the cost of inputs
  - Improve yields and quality
  - Reduce losses, and
  - Increase overall income and welfare
- Decentralised renewable energy technologies well-suited for meeting energy demands in an affordable, reliable and environmentally-sustainable manner



IRENA's *Renewable energy in the water, energy and food nexus* (January 2015) report discussed opportunities for renewable energy deployment in the agriculture sector.

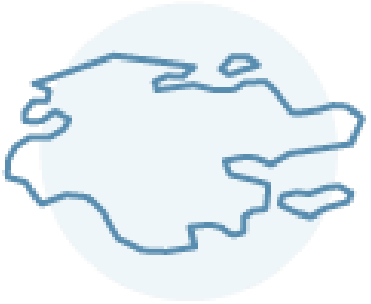


Transition or transformation?

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

BARBADOS

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Capacity expansion

Least-cost capacity expansion plan 2015-2030

Dispatching

Production cost modelling of 2014 and 2030 scenarios

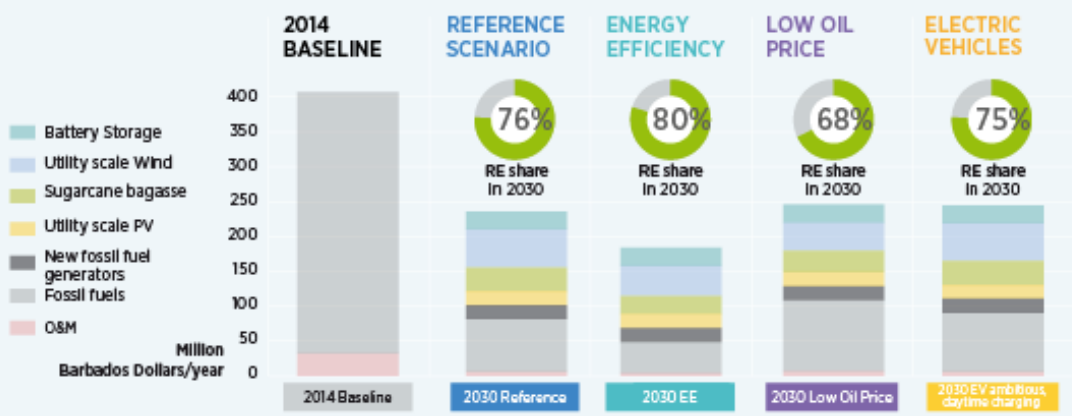
The Prime Minister of Barbados, in an interview with Barbados Advocate, 11 November 2016:

"[…]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".

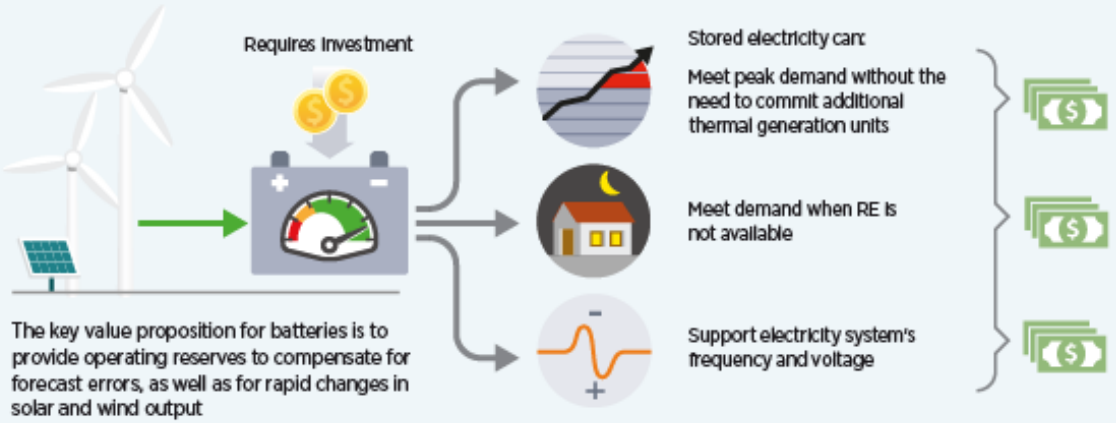
"The report has been prepared and has confirmed our local analysis that there can be an exponential increase in the renewable energy penetration level in the electricity supply."

"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".

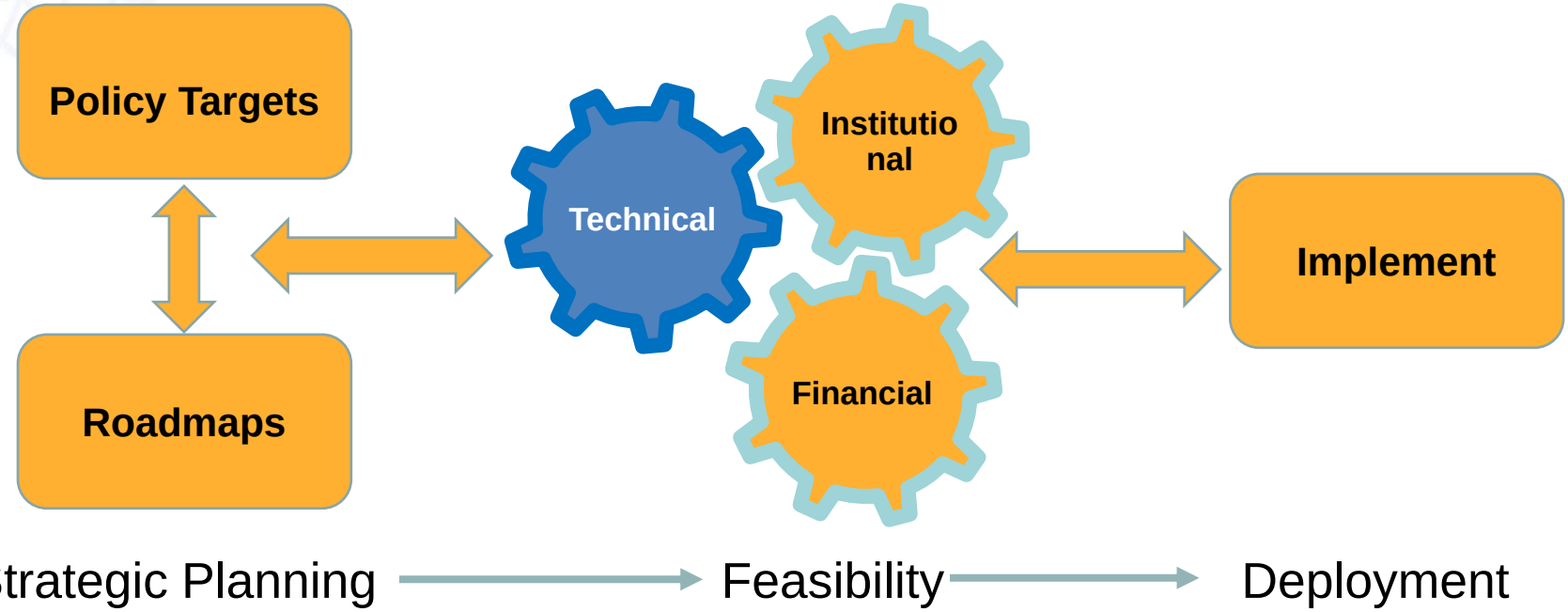
Roadmap gives detailed insight on how renewables can reduce power sector costs.



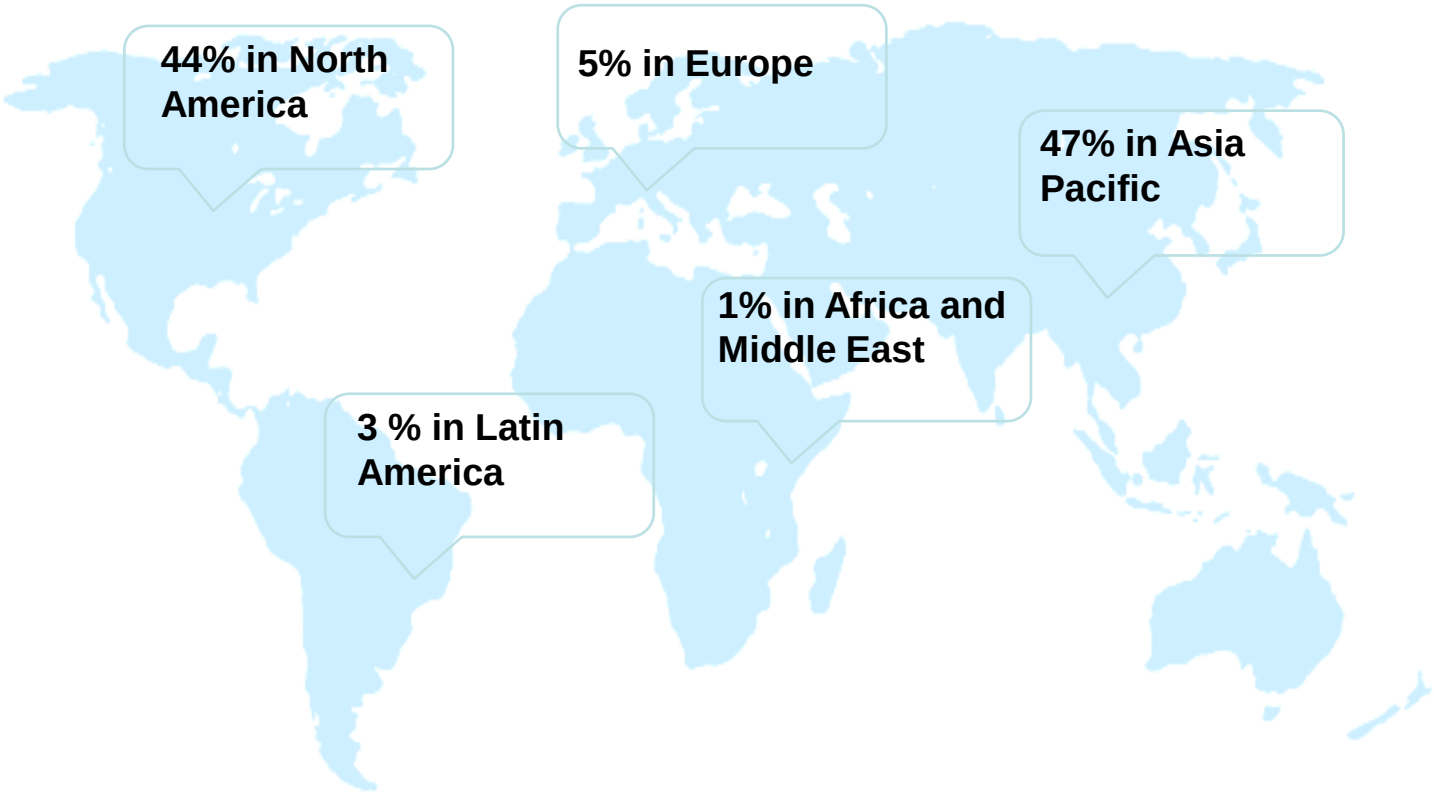
Roadmap identifies options to support battery storage deployment.



Grid Studies in the Energy Transition



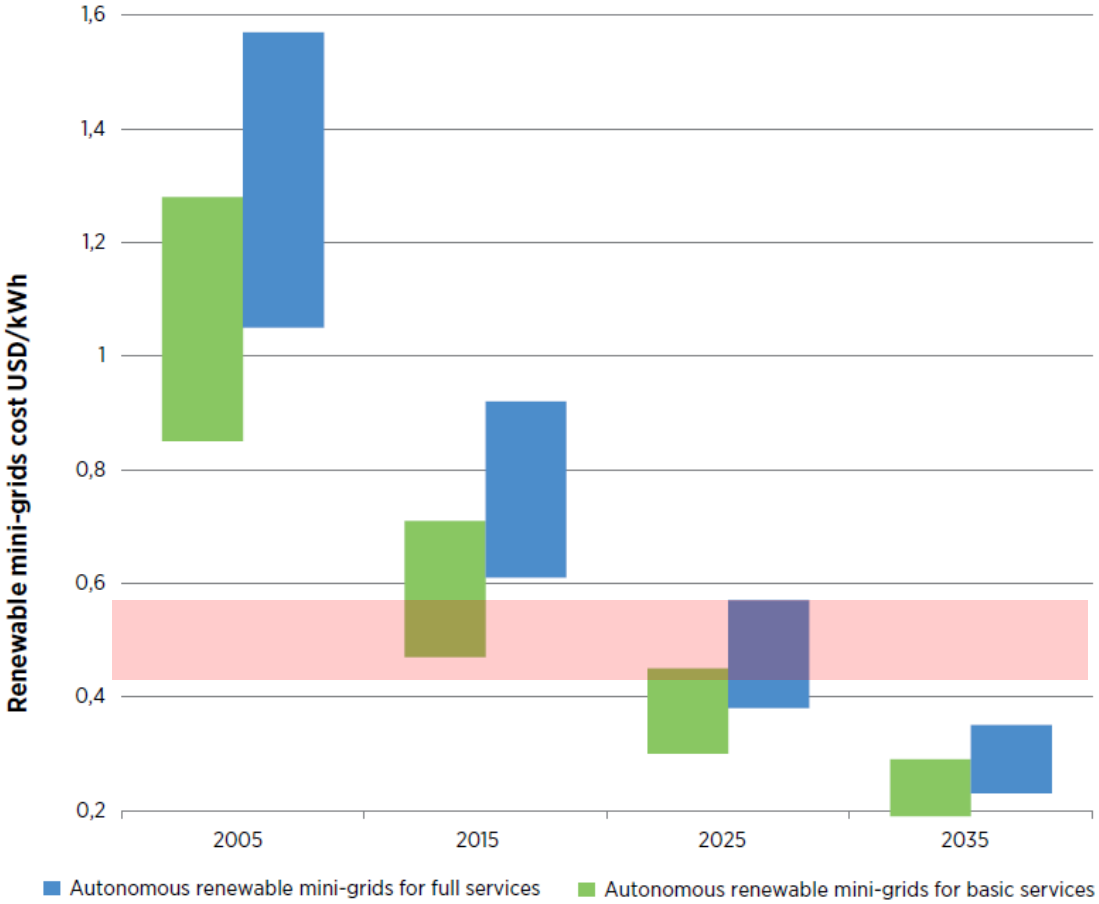
Renewable energy mini-grids: deployment by region



Great untapped potential in Africa and Latin America

Source: Navigant (Asmus and Lawrence, 2015)

Innovation making renewable mini-grids competitive



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

Opportunities for innovation in renewable mini-grids

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		Impact			
PLAN AND DESIGN		**Cost**	**Reliability**	**Ease**	**Environmental**
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	**	*	****	*
STORE					
1	Use less expensive, more abundant and less resource-intensive materials	****	**	*	***
2	More robust, lower-maintenance technologies to reduce life-cycle costs for storage	***	****	***	**
3	Improvements in long-term storage capability	**	**	**	****
4	Improvements in high power output capability	**	***	**	***
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)	****	**	***	****

Conclusions

- ✓ Ongoing innovation in technologies, business models and policies is supporting deployment of renewable energy in off-grid areas, accelerating access to modern energy services

- ✓ In the next two decades innovations will:
  - decrease costs of energy
  - drive an increase of renewable energy share in mini-grids
  - make mini-grids an increasingly attractive alternative to traditional centralized grid planning and SHS

- ✓ Enabling policies and adjustment to regulatory frameworks designed for centralized electricity supply are necessary to support deployment of renewables in off-grid areas

- ✓ Particular care is necessary while transitioning existing isolated power system to high shares of solar and wind: innovation in planning methodologies

- ✓ Sound techno-economic studies are necessary for cost-effective deployment of the most appropriate technology mix in off grid areas, to ensure reliable, affordable and environmentally friendly access that is maintained in the long term

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Francisco Boshell (fboshell@irena.org) — *Mini-grid technology outlook*

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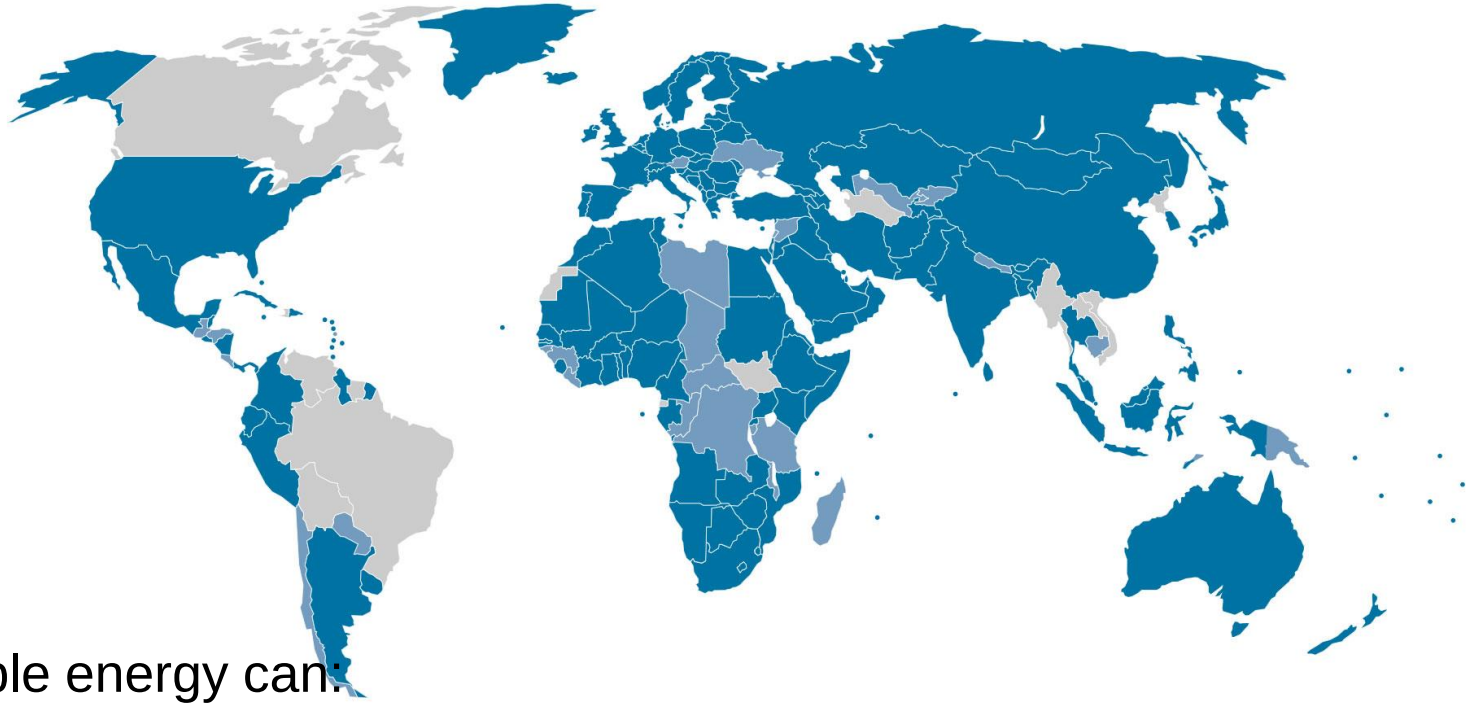
BACKUP

The International Renewable Energy Agency

The global Voice, Advisory Resource and Knowledge Hub for renewable energy
Currently, IRENA has 151 Members and 29 States have started the formal process of becoming Members.



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***

IRENA off-grid activities

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

Policy frameworks and business models

Analysis, design and project development

Regional and national implementation

*www.iorec.org

Outline

1. International Off-Grid Renewable Energy Conference
2. Renewable Energy in the agri-food chain
3. Roadmaps for isolated systems and islands
4. Grid Studies for isolated systems and islands
5. Mini-grid Innovation and Technology Outlook

Numerous pathways support shares of renewables close to 100%

	Hydro power with reservoir is the easiest and most common option for high shares of renewables
	Biofuels can be used in existing or new dispatchable thermal generation
	Geothermal can cover significant baseload demand
	Solar and wind require measures to • Cover variability (increased reserves requirement) • Supply electricity when they are not available Options for solar and wind integration: PHS, BESS, DSM, Flywheels, Thermal Storage, power-to-X
	

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

GRID INTEGRATION STUDIES FOR SIDS

- ✓ Planning tools, analytical assessments, help to answer the following questions usually asked by policy makers and utilities:
  - **How much VRE can be integrated without major system upgrades?**
  - **Is it feasible to achieve the target shares of VRE?**
  - **What is required to achieve the target shares of VRE?**

- ✓ Depend on the characteristics of the island system and the target share of VRE
  - Target medium to large size islands (MW scale) where integration takes place gradually and multiple stakeholders are involved

- ✓ To do a study requires:
  - Accurate and sufficient input information
  - Tools
  - Engagement from authorities and the utilities

Mini-grid types

	Lower Tier of Service	Higher Tier of Service
Autonomous	**Autonomous Basic (AB mini-grids)** **Generation Sources:** PV, hydro and biomass **Tier of service:** less than 24 hour power **End-users:** Remote community without major commercial or industrial activity Added value: • Enable enhanced energy access • Alternative to grid-extension • Improve quality of life	**Autonomous Full (AF mini-grids)** **Generation Sources:** PV, hydro and wind **Tier of service:** 24/7 power **End-users:** Remote communities, islands, with major commercial or industrial requirements; Industrial sites disconnected from grid Added value: • Alternative to expensive polluting imported fuels • Diversification and flexibility of supply
Interconnected	**Interconnected Community (IC mini-grids)** **Generation Sources:** PV, wind and biomass/biogas **Tier of service:** High critical/ interruptible **End-users:** Medium to large grid- connected community (*e.g.* university campus) Added value: • Community control • Improve reliability • Response to catastrophic events	**Interconnected Large Industrial (ILI mini-grids)** **Generation Sources:** PV, wind and biomass/biogas **Tier of service:** Very high: Critical/ uninterruptible **End-users:** Data centres, industrial processing or other critical uses Added value: • High reliability for critical loads • Enhance environmental performance • Resiliency

Deployment by type

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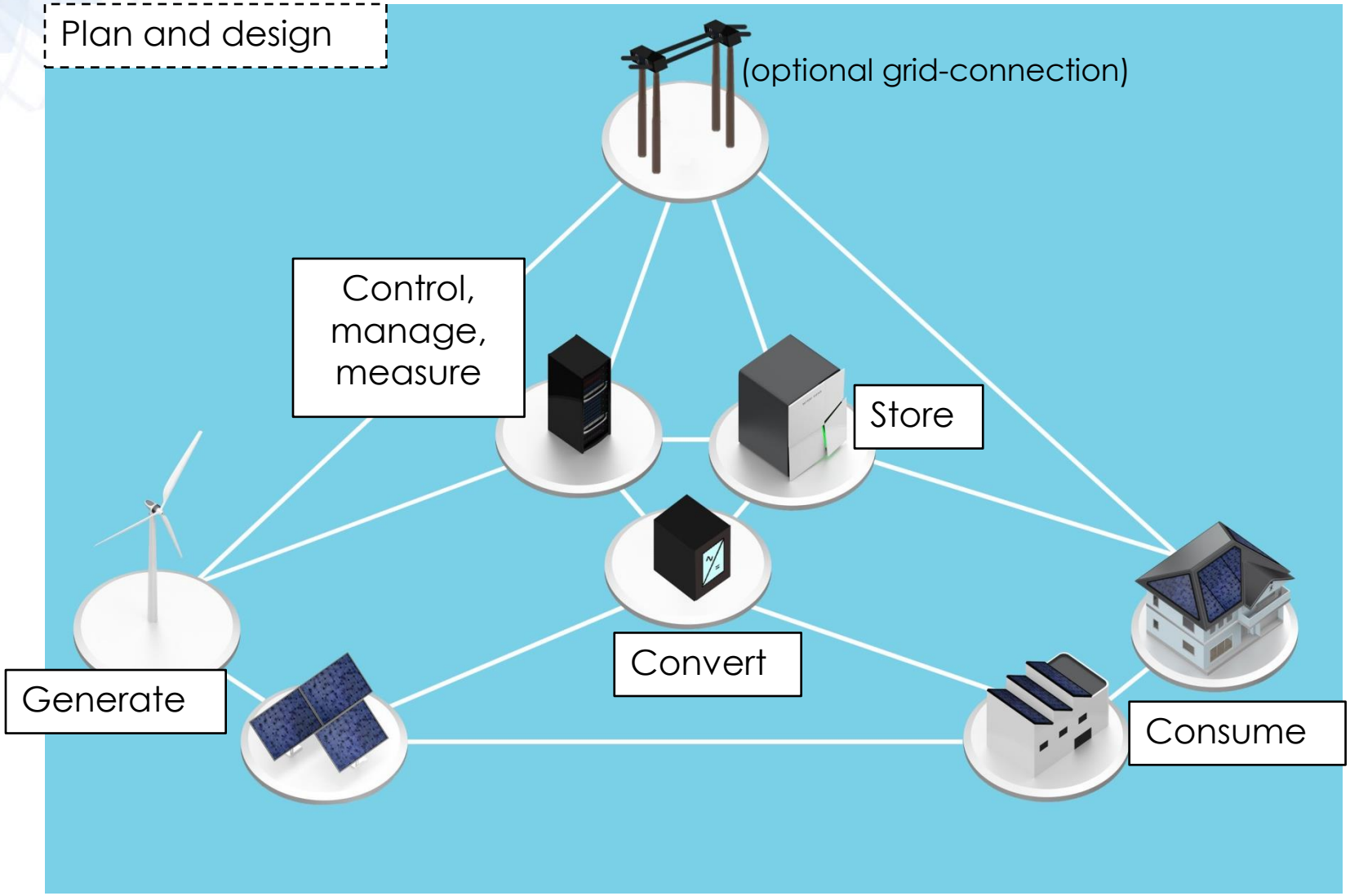
Limited	Pilots	Emerging	Mature
●	●	●	●

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		●		

Functionalities



Developing economies incubating tailored made solutions

Artificial intelligence for energy access

E.g. AZURI HomeSmart™: adaptive smart metering. Monitorinmg climatic conditions and automatically adjusting light brightness to meet the user's expected lighting duration

Image Source: ABB

New business models are emerging

New actors such as 'aggregators'

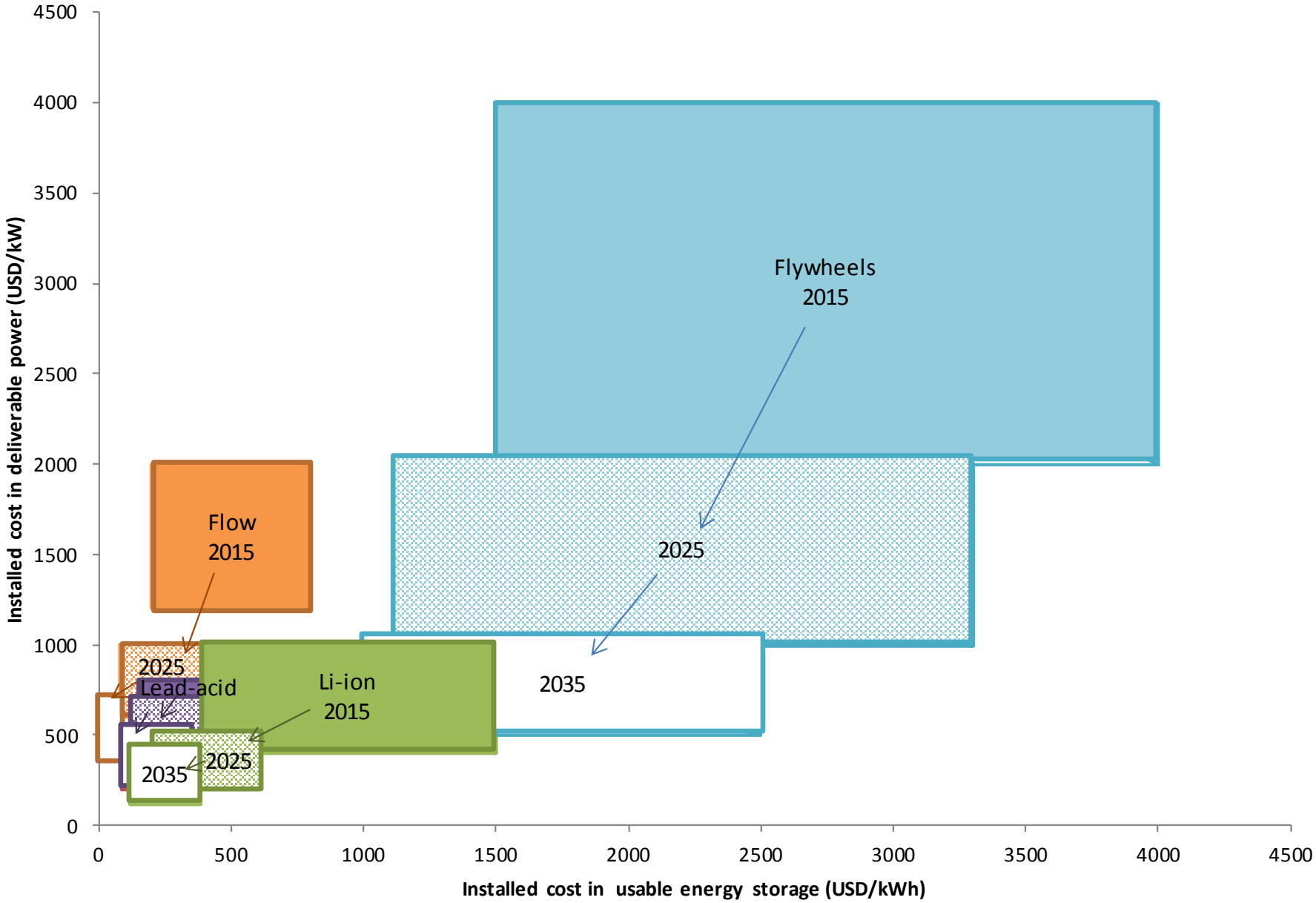
- Real life field trials of the "aggregator" business model, using PV, batteries, heat pumps and ICT in households to providing flexibility services to the utility.
- This can lead to the development of propositions for households as well as tailored services for grid operators and energy companies.

Heerhugowaard, NL

Hoog Dalem, NL

Source: https://usef.energy/Framework/Demonstration-projects.aspx

Storage


Installed cost in deliverable power (USD/kW)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Installed cost in usable energy storage (USD/kWh)
Flywheels
2015
2025
2035
Flow
2015
2025
Lead-acid
Li-ion
2015
2025
2035