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Regulation for Renewable Energy based Mini-grids:

How to balance the Interests of Stakeholders?

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STEPs
Sustainable Thermal Energy Service Partnerships

Contents

- The rationale for RE based mini-grids in Caribbean countries
- Regulatory principles for mini-grids
- Two short case studies of regulatory frameworks
- Main lessons

Why RE mini-grids in the Caribbean? Few basic facts…

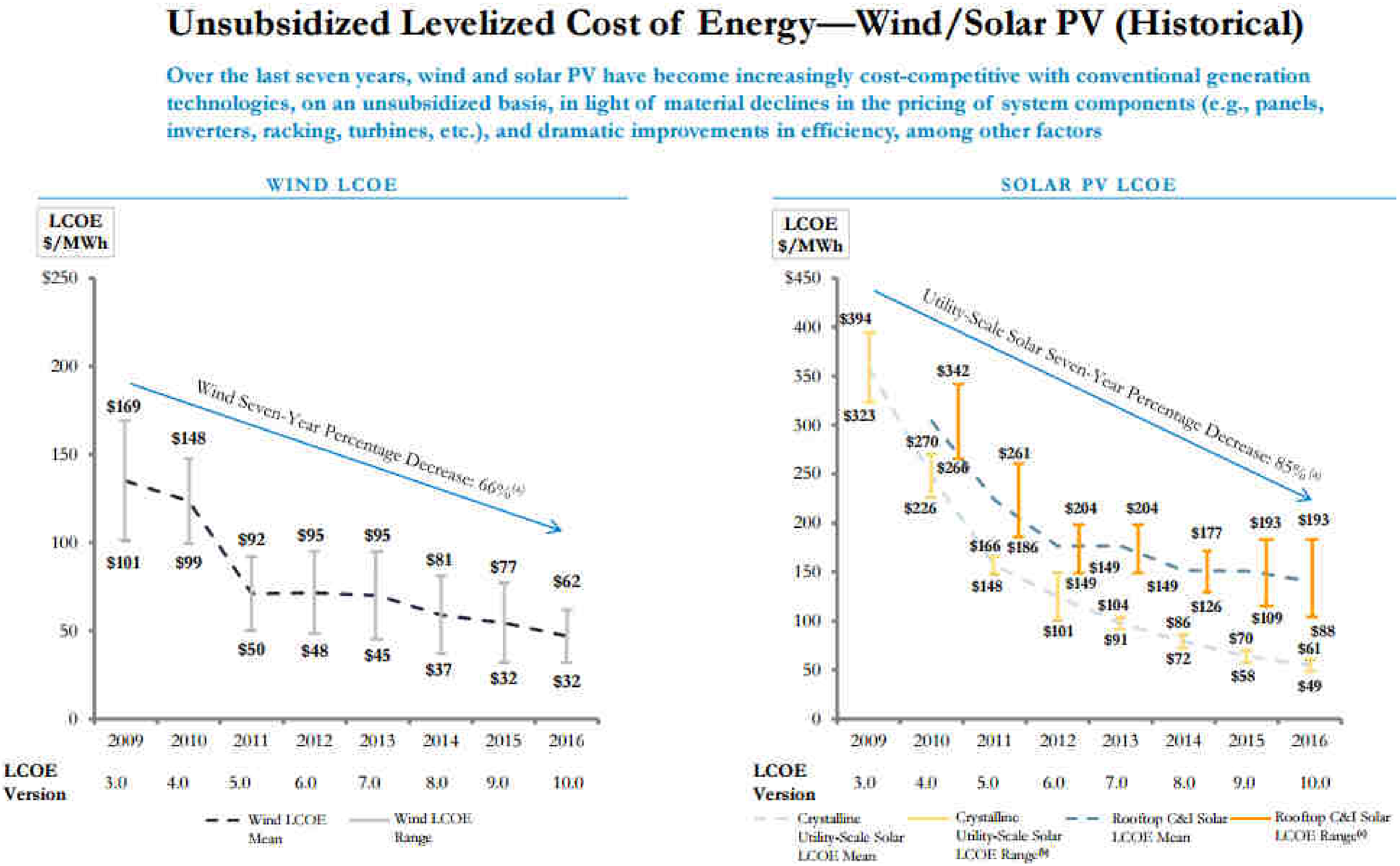
Renewable energy technologies are:

- Mature technologies
  - “New” RETs like solar photovoltaic and modern wind turbines are now mainstream
- More and more often cost-competitive
  - Capital costs have been going down steadily
  - Low level maintenance & running cost
- Very low environmental impact

Mini-grids

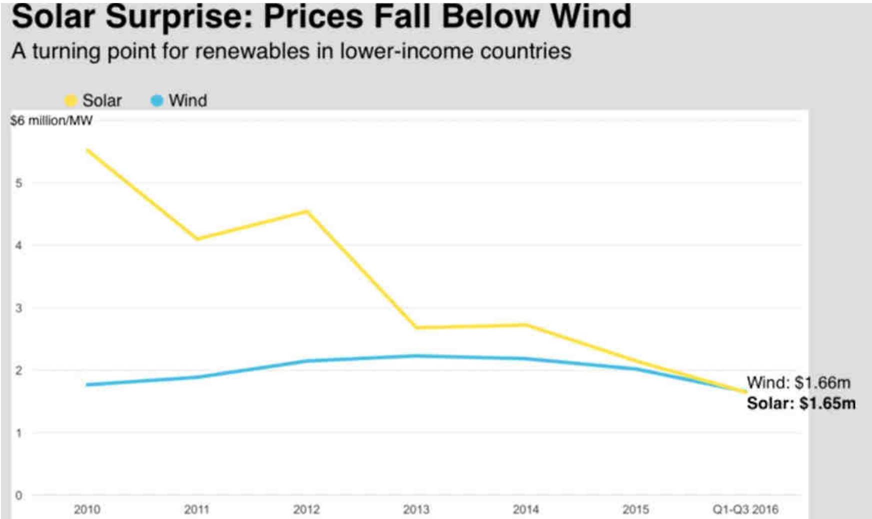
- More resilient electric systems
  - Mitigation and adaptation to climate change
- Can sometimes provide better quality of services than the central grid
- But still costly

“New” RETs are now getting cost-competitive



Source: Lazard. 'Lazard's Levelized Cost of Energy Analysis - Version 10.0'. December 2016.

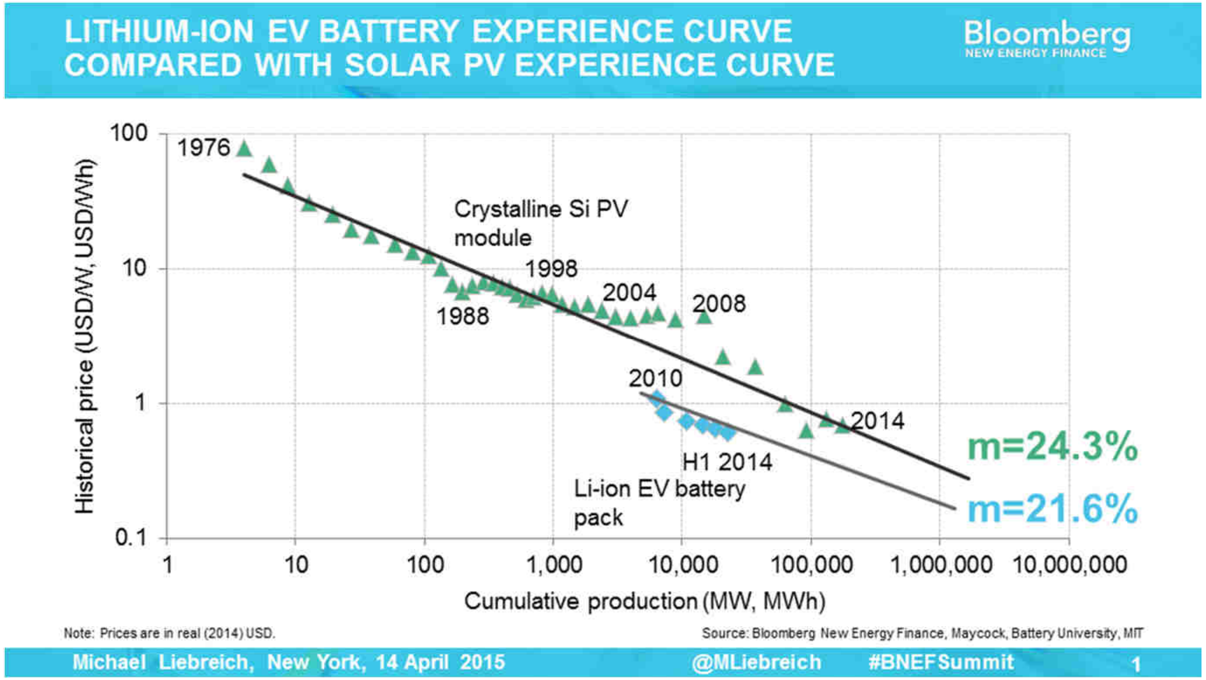
Not only cost of solar photovoltaic decreasing but also cost of storage



CAPEX solar photovoltaic even below wind?

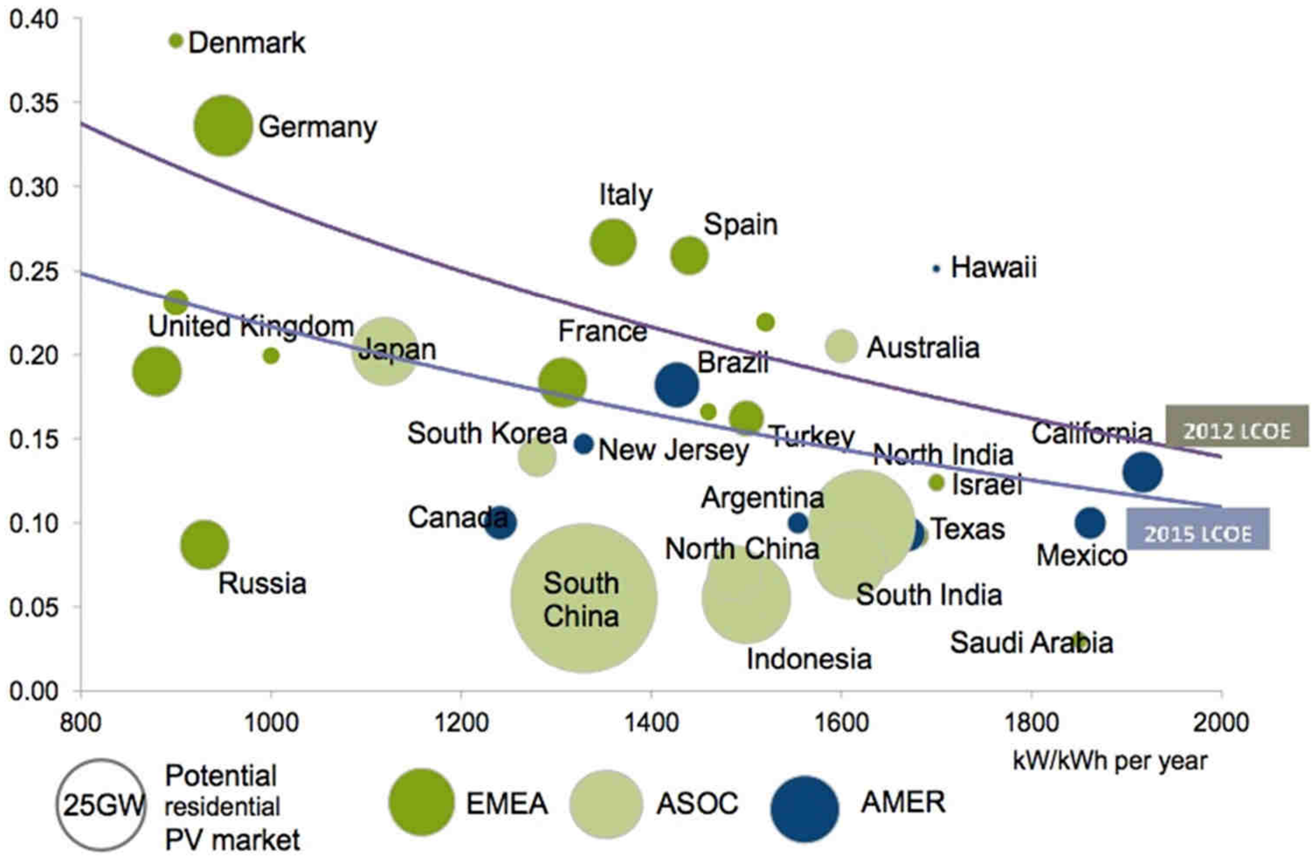
Source: BNEF, Climatescope, 2016 + update

Batteries similar experience curve than solar photovoltaic



Grid parity for roof-top solar

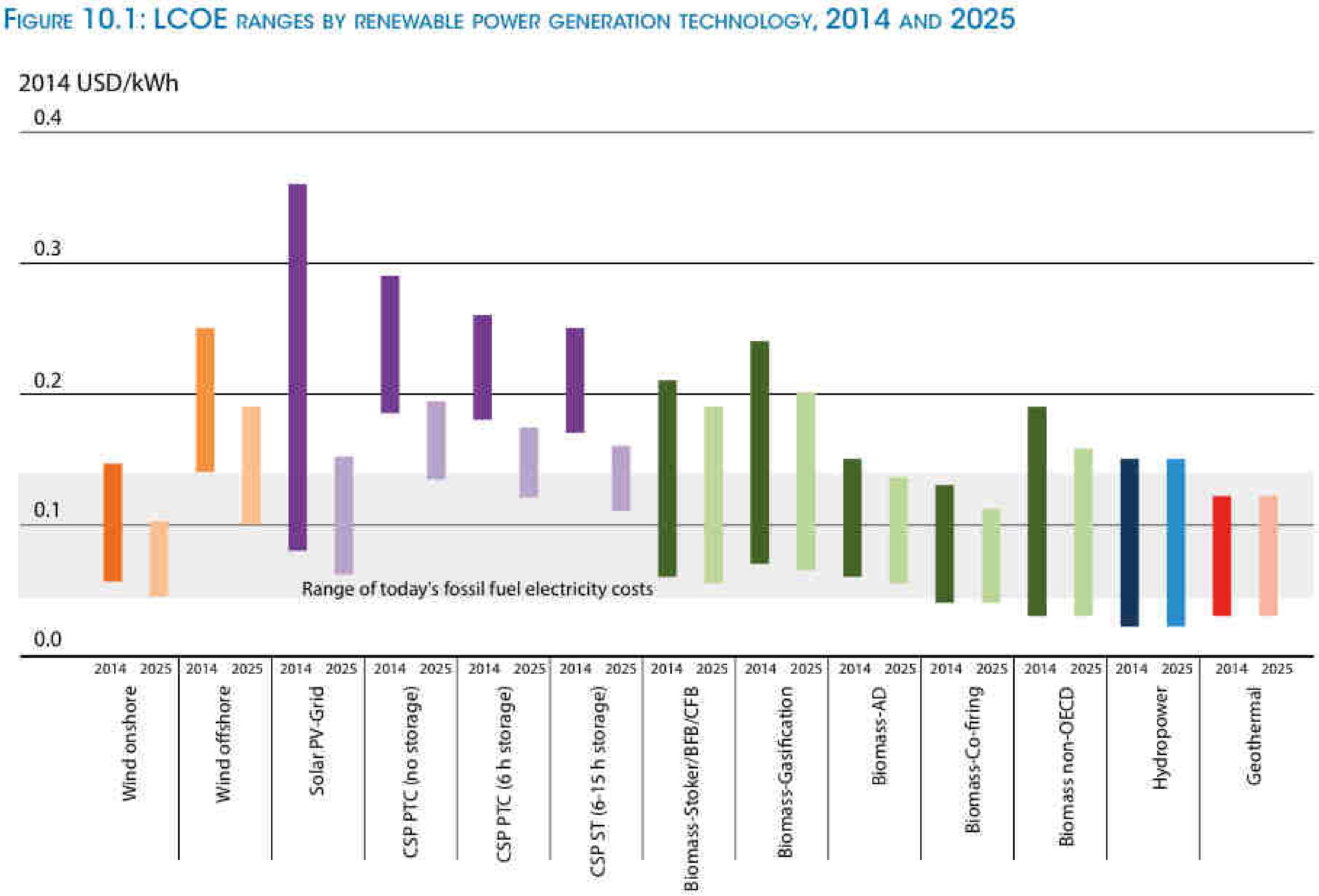
FIGURE 39: ESTIMATED RESIDENTIAL PV PRICE PARITY IN 2012 AND 2015, $ PER KWH



LCOE based on 6% weighted average cost of capital, 0.7%/year module degradation, 1% capex as O&M annually. $2.65/W capex assumed for 2012.

Source: Bloomberg New Energy Finance

LCOE of most RETs compete with fossil fuels for electricity generation



Source: IRENA, 2015

Local distribution with RETs and mini-grids can be more resilient

- Most solar panels are certified to withstand winds of up to 2,400 Pascals, equivalent to approximately 140 mile-per-hour winds (category 3 hurricane)
  ➔ In Japan
    - Market for solar panels typhoons resistance category 4
    - Typhoon proof wind turbines

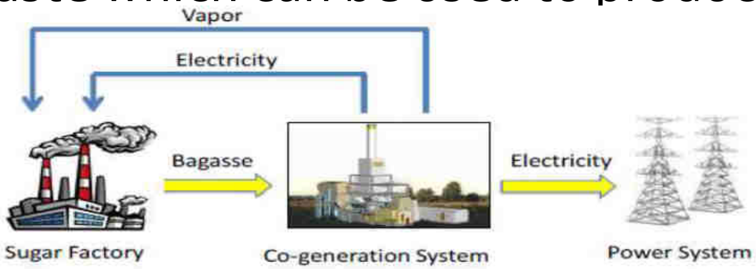
- Panels can be removed before hurricanes

Micro-utility Sigora Haiti
8,000 customers 219 KW – power restored after 10 hours after Irma
Source: http://www.renewableenergyworld.com/

- Small mini-grids with PV/wind generator and battery storage can be spread over large areas with less risk to be hit simultaneously : a micro-grid can potentially isolate itself from the central distribution system (i.e. islanding) when a fault occurs in the latter

Local distribution with RETs and mini-grids can use local resources

- Biomass e.g. bagasse = waste which can be used to produce steam + electricity



Source: Emmi, M. et al., Performance Evaluation of Bagasse Unit in a Sugar Industry: a Review , *IJERST*, 2017.

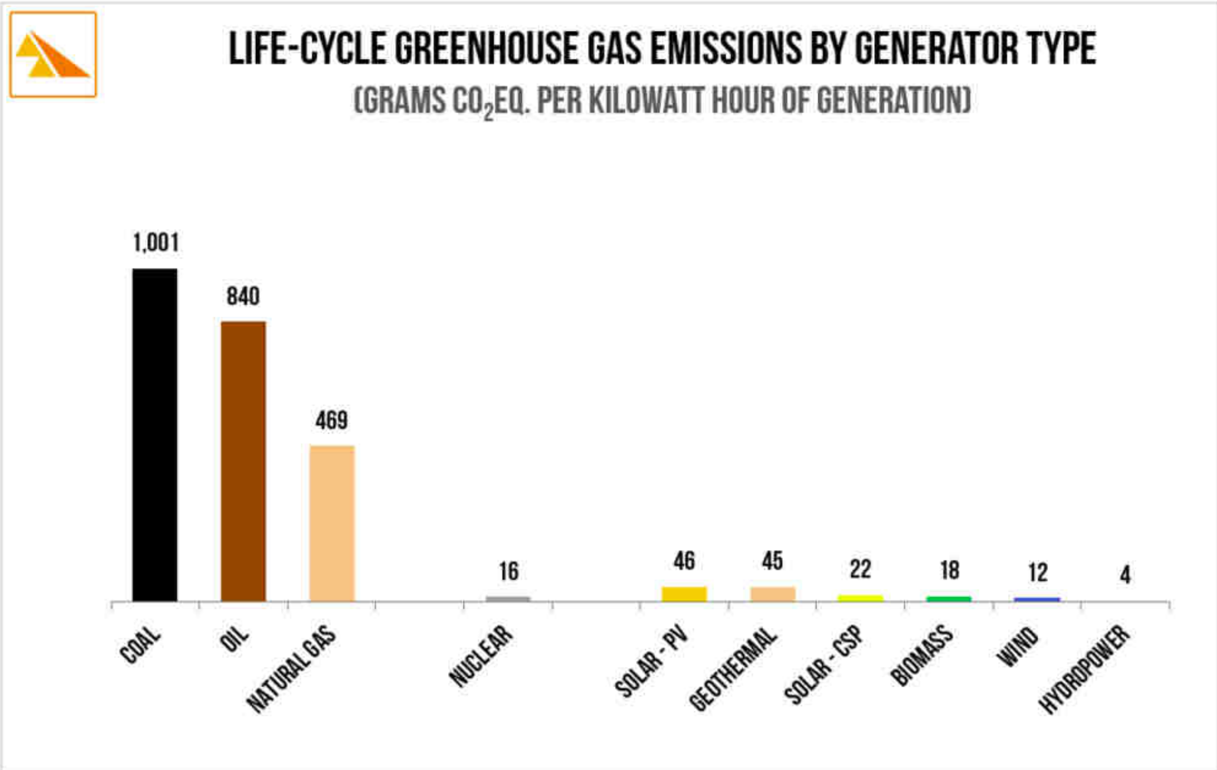
- Electricity for factory but also local area or even feeding the grid

  ➔ imply obligation for utility to make connection (standard guidelines for Small Power Producers; who pays what), a contract (Standardized Power Purchase Agreement) with (regulated) tariff

- Countries with experience either:
  - large-scale since 1980s: Mauritius 20% of its electricity generation from bagasse
  - or recently rapid expansion of small-scale: e.g. some mini-grids in Tanzania

- In each case, <u>specific regulations</u> have helped to reduce waste, produce energy & add a substantial source of income for plantations.

Low emissions of GHG of RETs compared to fossils fuels



Source: Intergovernmental Panel on Climate Change. 'Special Report on Renewable Energy Sources and Climate Change Mitigation. 2011 reprinted 2012. Life Cycle Analysis of GHG Emissions from Electricity Generation Technologies. Annex II, Table A.II.3 (50th Percentile), page 190.

Different kind of mini-grids

Mini-grids vs micro-grids (and nano-grids)?

- Several MW vs several hundreds KW
- Terms can be interchangeable

Off-grid mini-grids

- Start of electrification in industrial countries beginning 20th century
- Remote rural areas (of the developing world) … with possible connections to the grid at some point?

➔ Framework for sustainable rural electrification

Grid-tied mini-grids

- Urban and rural areas of industrial countries (USA, …)
- Connected to the central grid with options of islanding
- Provide electricity but also thermal services (cooling and heating)

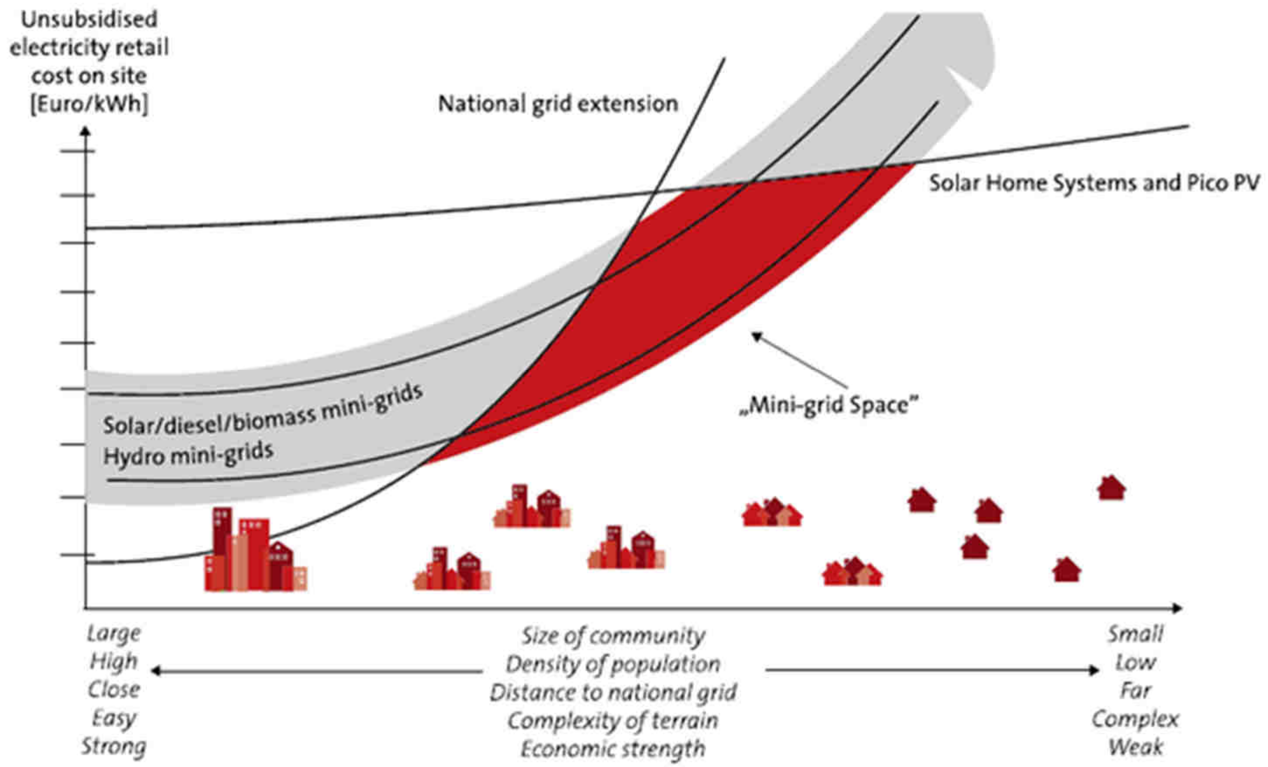
➔ Framework for their 'internal market' as well as a framework for the grid connection

➔ Caribbean countries: both types could be developed

- Non-connected small islands or remote areas
- Rebuilding networks after hurricanes

“Natural” technical-economic space for mini-grids

Another dimension to be added: energy service delivered



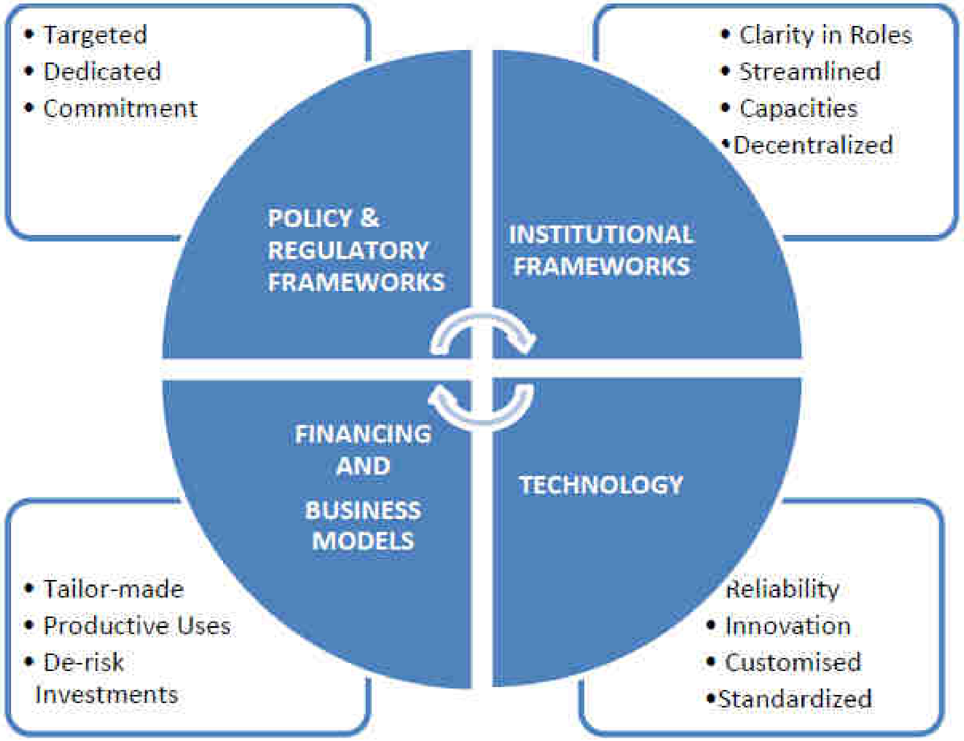
Source: https://energypedia.info/wiki/Mini-grid_Policy_Toolkit

Mini-grid regulations: why?

- Till yet regulation mainly for large conventional grid systems:
  - Little accommodation for independent (renewable) generation, even less for mini-grids
  - “Conventional” utilities limited interest and knowledge

- Mini-grids often implies to favour entrance of new actors:
  - **Licensing** procedure adapted for small players
    - In Tanzania, SPPs generating less than 1 MW are exempt from applying for a license. Instead, they register with the regulator so that the regulator knows of their existence
  - **Standardized power-purchase agreement SPPA** if connected
  - **Tariff** adjusted specific conditions of operation (remote areas,…)
  - Specific administrative and technical requirements for small networks
  - Find a balance between the necessity of minimum monitoring to protect consumers & burden put on SMEs:
    - Situation where small utilities are in position of monopoly – competition difficult to organise at a local level
    - Protect consumers from abuse from small local utilities with market power
  - Mainstream and protect their investment
    - Reduce uncertainty = reduce cost!

Enabling Environment for Off-grid: four dimensions



Source: Common Market for Eastern and Southern Africa, *Regulatory Framework on Off-Grid Electrification*, Oct 2016.

Regulatory framework for mini-grids

- Relations Regulators / Developers
  - Information Portal: on-line information available for all
  - Standard planning procedures (sizing, licensing, environmental impact)

- Technical standards and specifications of the mini-grid
  - Voltage, frequency, fault protection, …
  - Standards already exist for generation, batteries, inverters, distribution system
  - Quality and safety (technicians and consumers)

- Relations Operators / Utility or End-users
  - Purchase agreement / Metering (pre-payments,…)
  - Availability (number of hours/day; delays to put power back;…)
  - Quality of service - which implies community involvement/feed back
  - Appliances efficiency standards to reduce overload

- Relations Operators / Regulators
  - Standard reporting procedures
    - Technical data: performance, system losses, ….
    - Commercial data: number of connections,…

Technical, economic and political choices

- Level of subsidies
  - Cross-subsidies, feed-in tariff for off-grid,…
  - Higher tariff or same tariff than on-grid? Balance between making profit / poor end-users

- Boundaries off-grid/on-grid
  - Mini-grid only remote areas?
    - Protect business models of operators against extension of the grid?
    - Or be "grid-ready": plan for new business models where operators can sell electricity to the grid
  - Future : mini-grids interconnected with the grid

- Ownership
  - PPP (new entrants) or utility (incumbent) or community-owned?

- Technology / industrial choices
  - Building capacity and know-how in targeted technologies
    - The more technologies are implemented– the more complex to maintain

Case mini-grids India

Main features

- Community-based models or private sector led models
- Cluster managers to manage between 5 and 10 plants / 10-15 villages
  one technician + one assistant: visit once a month
  + one operator daily operations
- Revenue collector different person from operator
- Private RE mini-grid developers are free to set their own tariffs in India, since setting up a rural mini-grid system does not require a license under India's Electricity Act 2003
- Draft National Policy on RE based Mini/Micro grids (2016)

Solar Mini-grid in Kaylapara village – Sagar Island, Sunderban, India. Source: Palit, Sarangi, The Mini-grid experience from India, 2014.

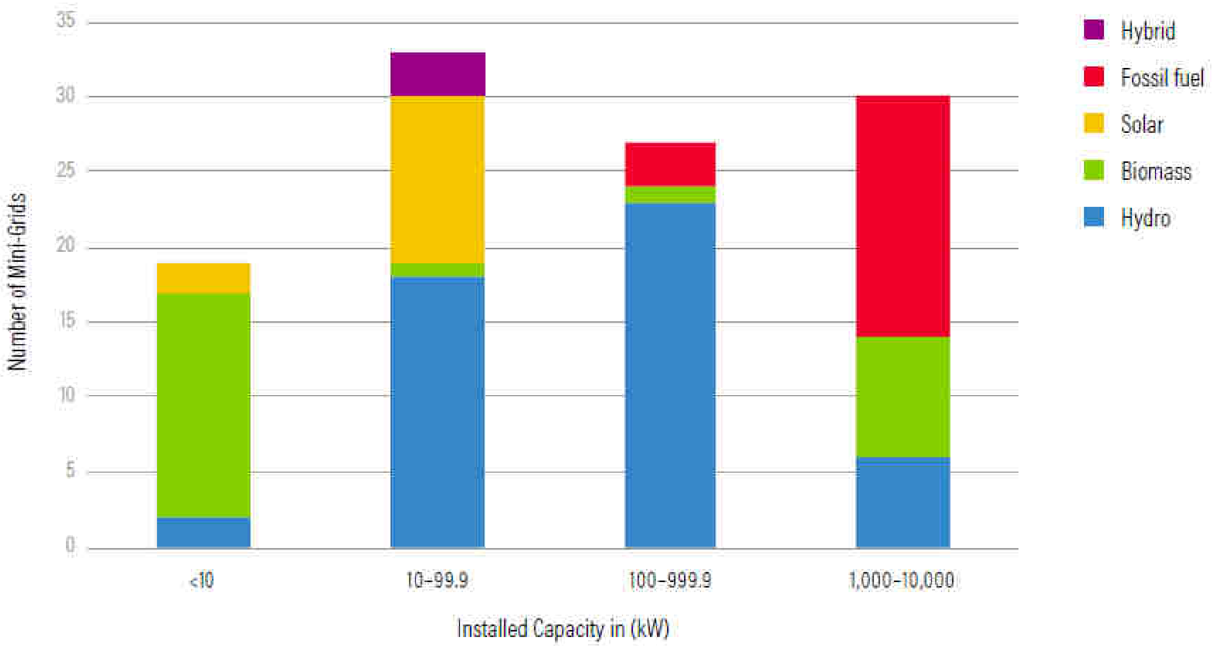
Hindrances

- Lack of clarity for interconnection
- Tariff non-regulated and no cross-subsidies possible for off-grid
- Poor consumer load = perceived high risk by investors
- Lack of standardisation and poor Monitoring & Verification

Case mini-grids Tanzania (1)

Tanzania has 1,358 megawatts (MW) of installed grid **generation capacity**

+ 109 mini-grids, with installed capacity of 157.7 MW serving about 184,000 customers.
- 16 plants are connected to the national grid;
- The remaining 93 operate as isolated mini-grids + mini-grids not registered



Source: Odarno et al., Accelerating Mini-grid Deployment in Sub-Saharan – Lessons from Tanzania, Tatedo – WRI, 2017.

Case mini-grids Tanzania (2)

Main features

- Ownership: national utility, commercial entities, faith based organisations, communities
- Electricity Act 2008 -> Energy and Water Utilities Regulatory Authorities
- Rural Energy Act 2005 -> Rural Energy Agency
- Tanesco: - vertically integrated utility
  - single buyer from IPPs (more 10 MW) and SPPs (less 10 MW)

- SPPs clear licensing process
- SPPs using RET benefit from a feed-in tariff Standard Power Purchase Tariff (SPPTs) with Standard Power Purchase Agreement (SPPA) when sale electricity to Tanesco
  - First generation 2008: 15-25 years – only for project above 1 MW; technology neutral
  - Second generation 2015: 100 kw – 10 MW; technology specific FiT

Limitations

- Issue of lengthy delays for land acquisition
- Technical and managerial capacity limited in rural areas
- Poverty of customers = revenue collection difficult

CONCLUSIONS (1)

"A major challenge for commercial micro-grids, however, is the lack of standardization and regulation regarding both the interactions between the micro-grid participants and the interactions of the micro-grid with the central energy system.

To allow the widespread integration of micro-grids in the central distribution network, technical standardization as well as a regulatory framework for micro-grids needs to be developed to allow scalability of a micro-grid network through a 'plug-and-play' approach"

Carmen Wouters & Katelijn Van Hende, The Role of Micro-grids Within Future Regional Electricity Markets
School of Energy and Resources, University College London, Australia (UCL Australia)

CONCLUSIONS (2)

Costs

- RET now cost-competitive for large-scale utility, residential PV, solar home systems, pico-PV in countries where market has been nurtured.
- BUT RET cost just one component of cost.
- Mini-grids can still be expensive if no standardisation and no regulatory framework is there to mainstream projects
  - "Plug and play" approach needed
  - Bundling of projects

Benefits

- Sometimes best or only way to electrify remote areas
- Islanding = resilience
- Tailored to consumer needs

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IRENA, *Policies and Regulations for Private Sector Renewable Energy Mini-grids*. International Renewable Energy Agency, Abu Dhabi, 2016.

Web based mini-grid tool from GIZ http://www.minigridbuilder.com/; http://minigridpolicytoolkit.euei-pdf.org/

Standards

- IEC technical specification TS/62257: *Recommendations for Small Renewable Energy and Hybrid Systems for Rural Electrification* (IEC 2005).
- IEEE Std.1547.4-2011 *Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems*, 2012.

THANK YOU!

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