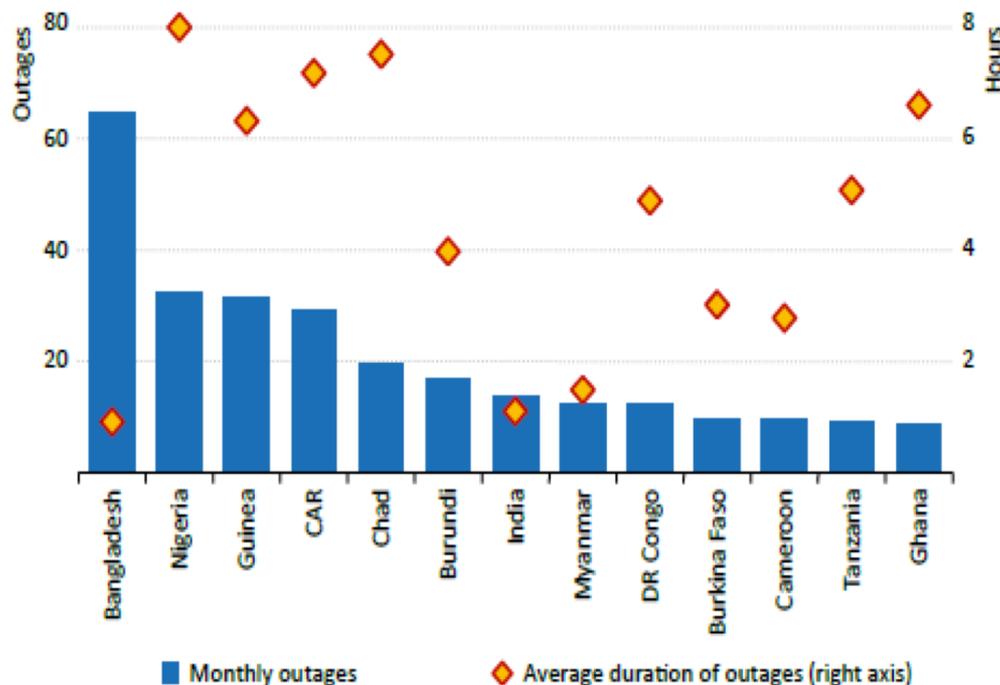


Modular and discrete: Opportunities for alternative power system planning, expansion and operation in developing countries

Luis Munuera, Timon Dubbeling, Simon Mueller

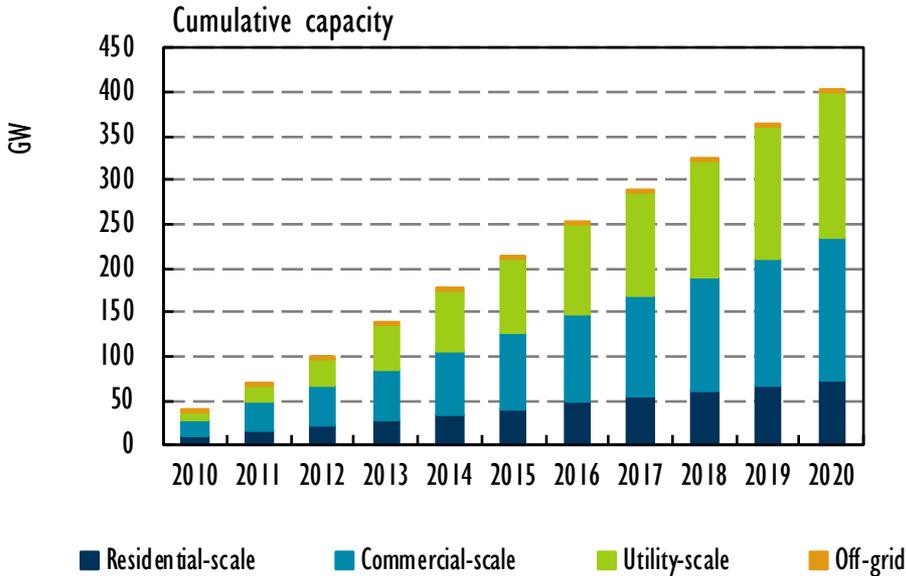
Context and aims

- 1.2 billion without electricity access, 84 million less than last year. At current rates, it would take 50 years to get to get the number under 100 million.
- An additional billion suffer from poor power quality
- And yet, around 7 of every 8 units of new electricity demand occur in developing and emerging economies



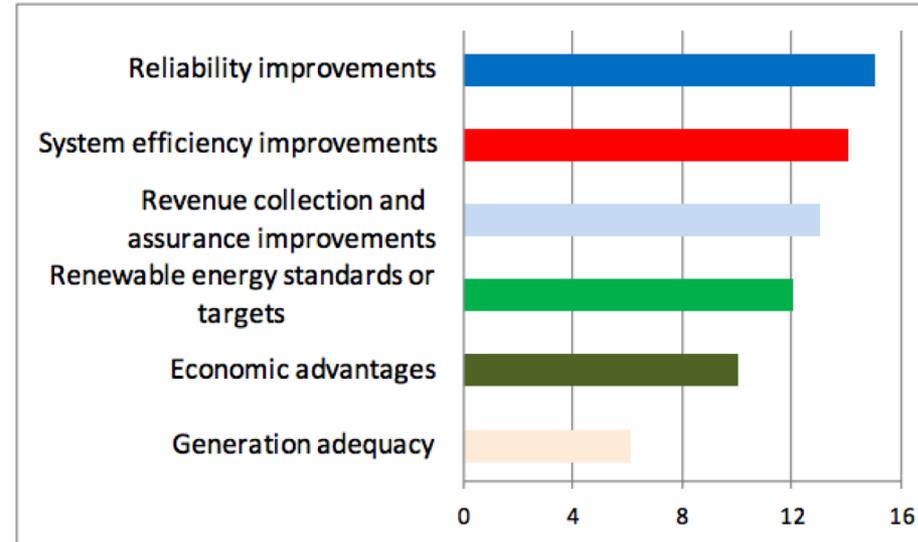
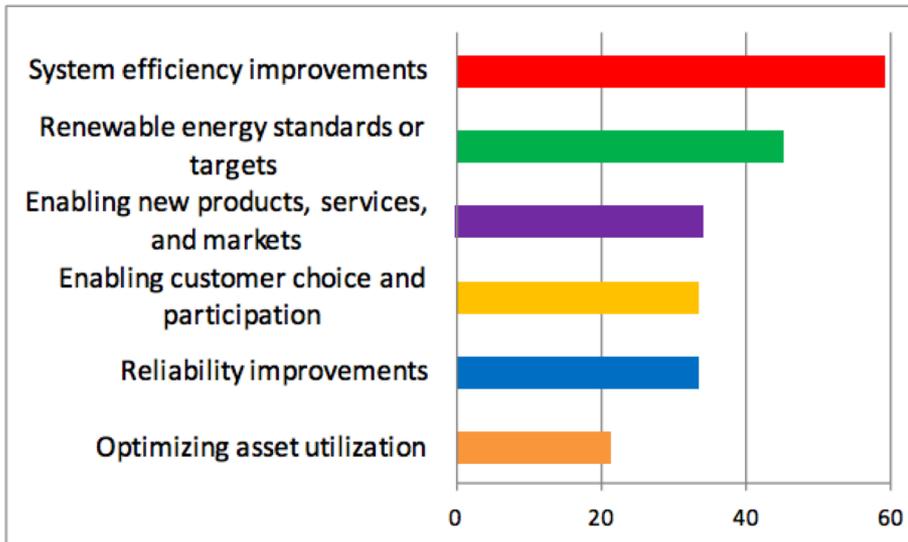
- Classical grid expansion and planning failing or insufficient in many areas.
- IEA estimates 220 GW of decentralised electrification to 2040
- But global knowledge gaps in new grid and decentralised technologies – early deployments, lack of visibility, standards, interoperability
- **What are the fundamental issues surrounding new opportunities for improving build-out of power systems maximising decentralised energy and smart grids?**
- Identify SOA best practice planning/deployment in developed economies
- Identify opportunities for developing countries for early adoption or leap-frogging

What we know: Trends in decentralised energy, storage and smart grids

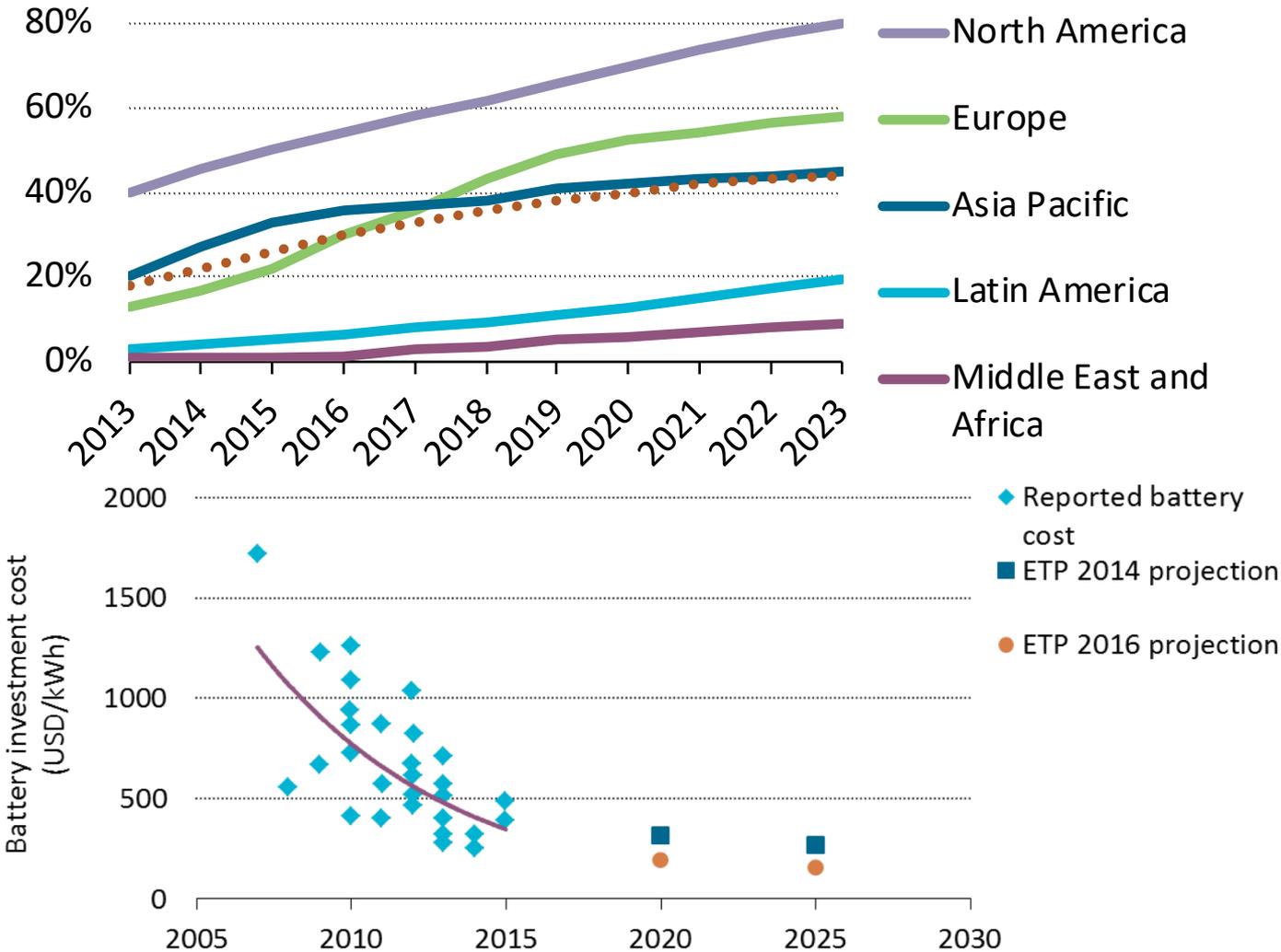


- Decentralised energy taking off – and geography shifting
 - Non-OECD countries overtake distributed PV in OECD in 4-5 years

- Drastically different needs, priorities and technical requirements



What we know: Trends in decentralised energy, storage and smart grids

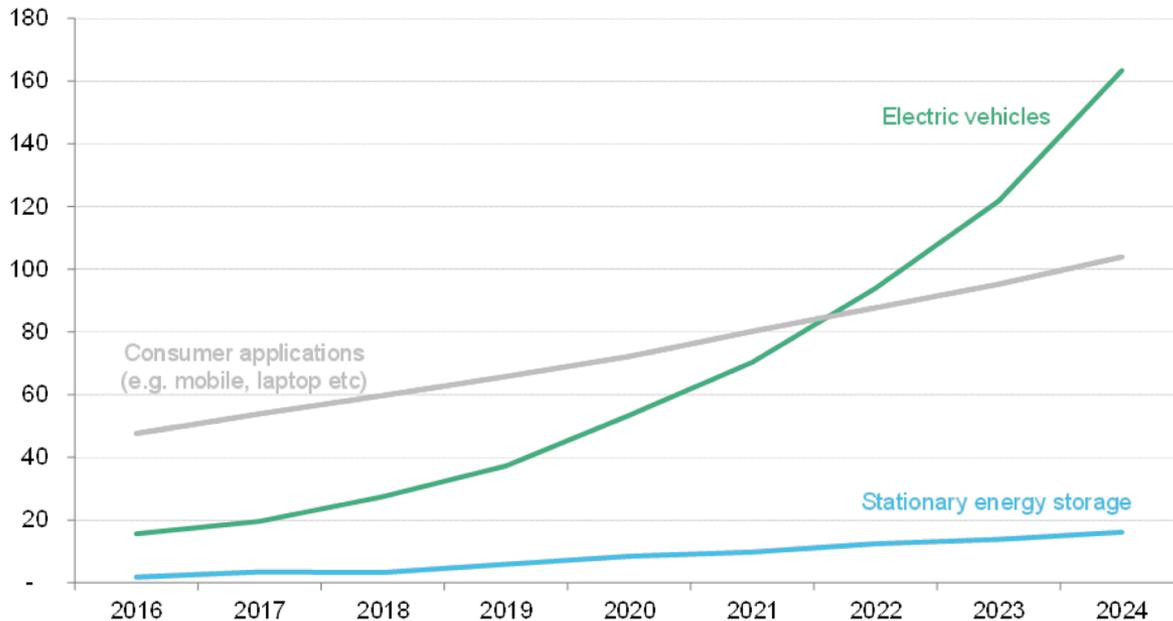
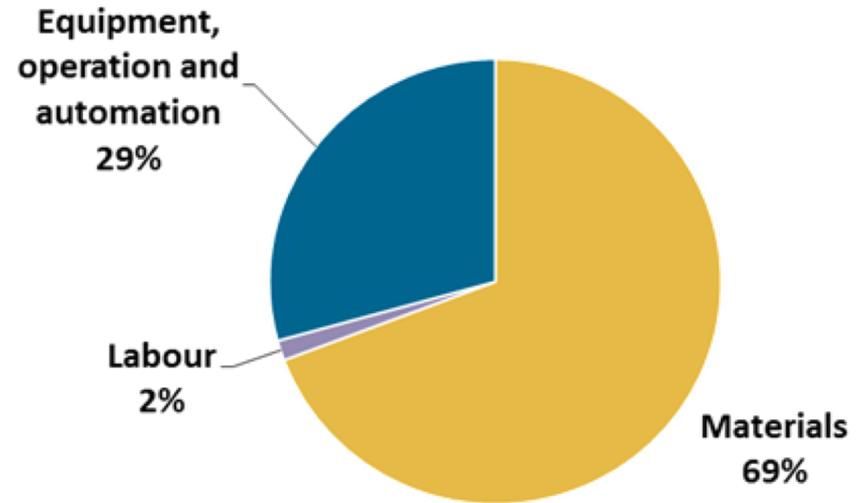


Smart meters

Batteries

Emerging opportunities for storage in developing countries

- Local expertise, supply chains, key for keeping costs down and enabling microgrids
- Lead acid - Li-ion have a higher initial cost, but taking into account local conditions lifecycle costs can be lower

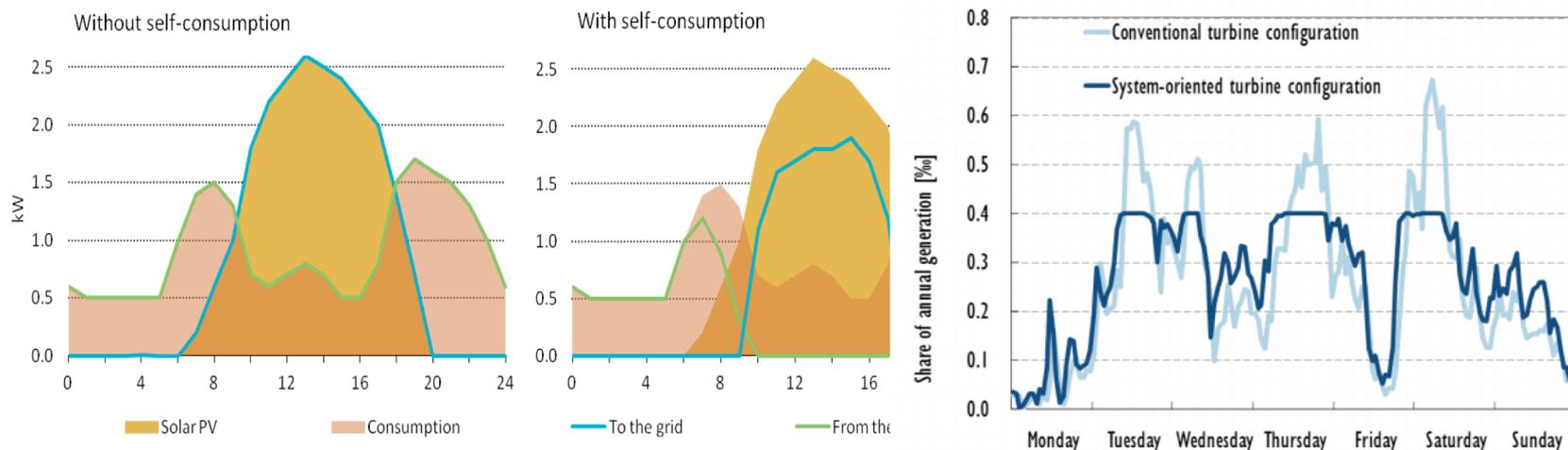


- As with crystalline PV – not the theoretically best technology (high floor costs, materials), **but soon a commodity**
- Low costs designs, recycled batteries from EVs

Making DER part of the solution

Smart Inverters and Storage

Main idea: minimise total system costs, not generation costs alone!



- **Smart meters and demand response open decentralised systems**
- **Benefit from technical capabilities of modern inverters**
- **Trade-offs with smartness along the grid value chain**
 - In many cases market-ready, low additional cost
 - TRLs: what to implement when, what to mandate ahead

➔ **Guidance on rolling out grid codes, prosumer storage, general framework for DSI**

What we know: Improved planning key enabler of decentralised energy

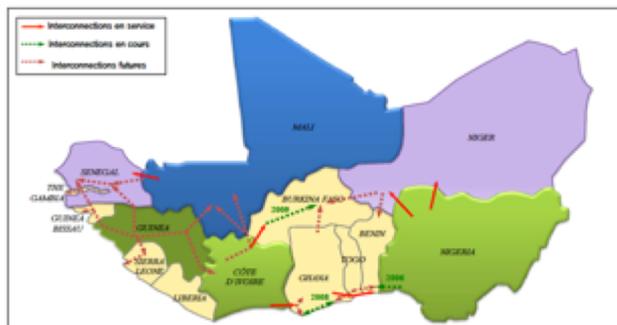
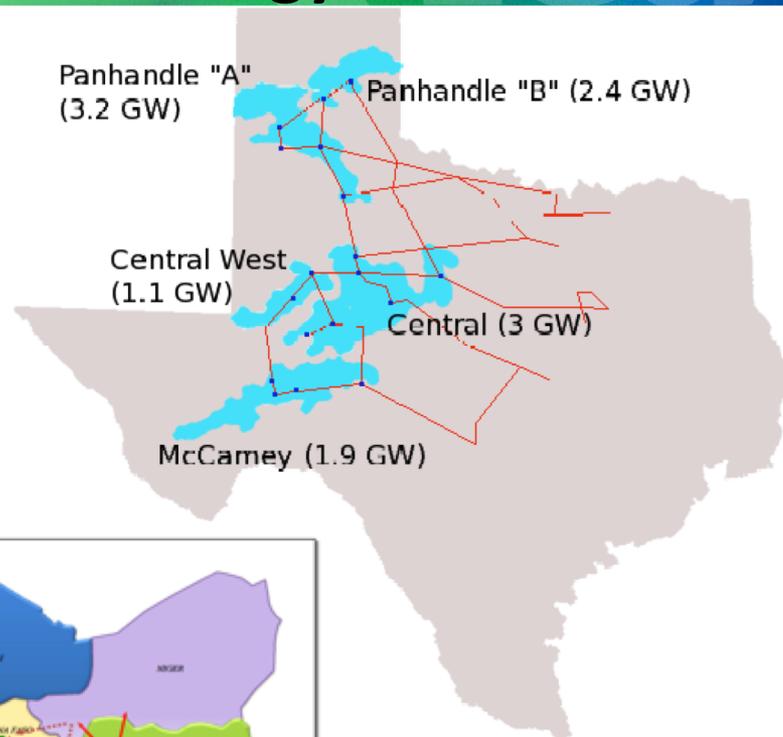
- Importance of coordinated development of grid and generation well understood

- More important for DERs

- CREZ, Texas
- Irish gate system
- India green corridors
- West Africa RGP
- ASEAN PGI

- Transparency, cost recovery makes or breaks

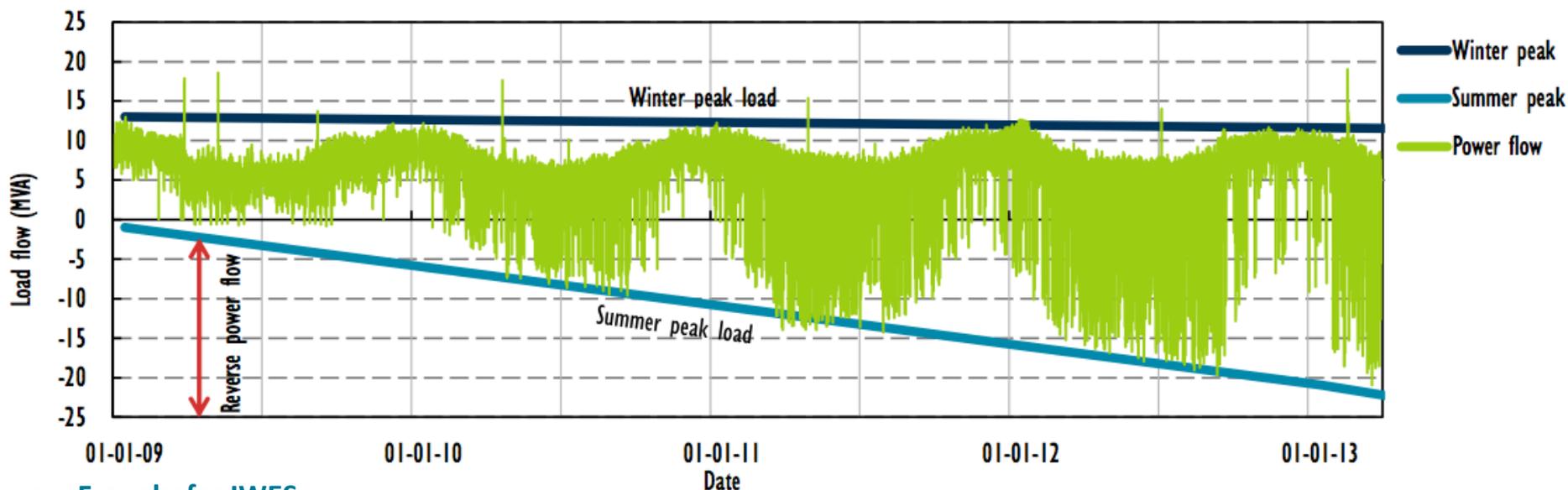
- New technologies can benefit developing countries



Source: NREL

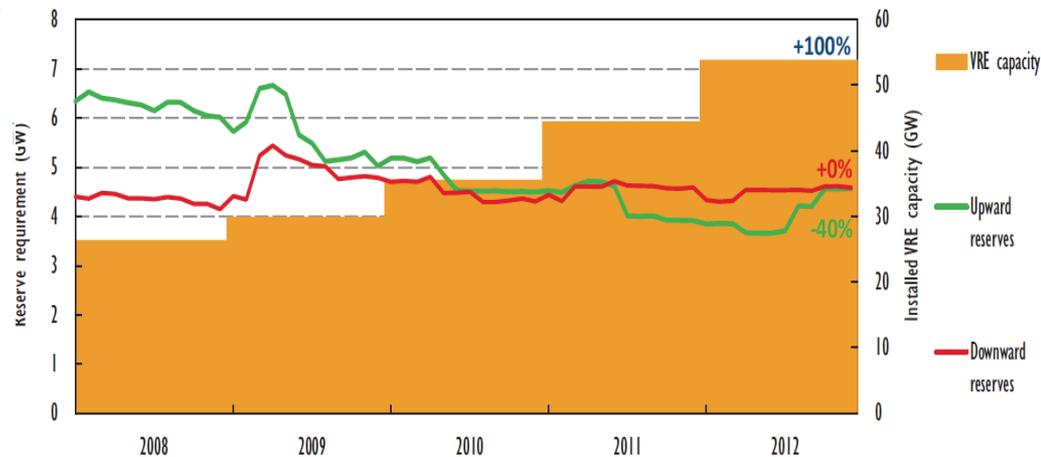
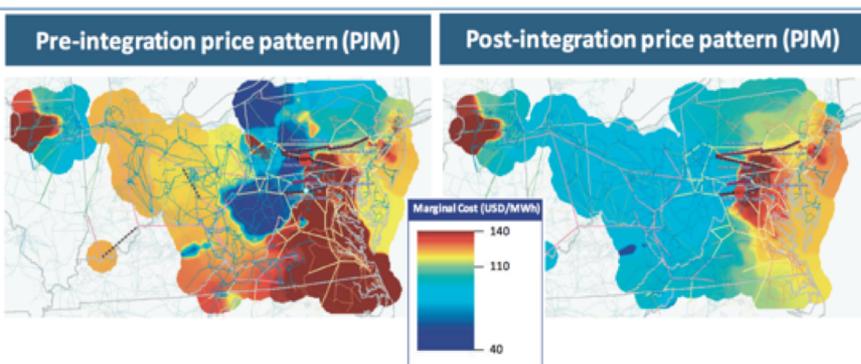
What we know: Improved planning key enabler of decentralised energy

- Role of distribution grids bound to change fundamentally with rise of distributed generation
- C/B can be very positive for adopting smart grid technologies in LIC contexts, but business case highly system-specific
 - Improving physical distribution grid planning
 - Enabling early DSO access to DER, smart metering capabilities
- Planning link with end-use and digital infrastructure



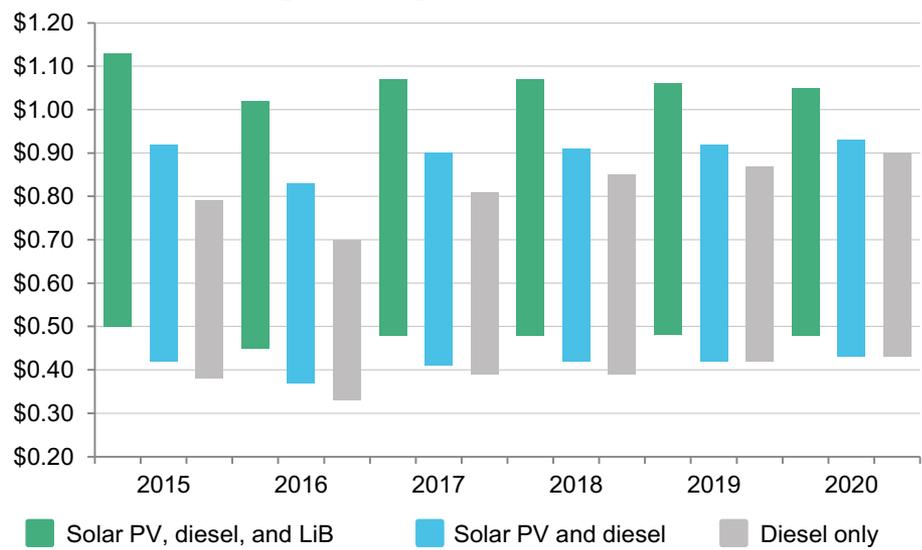
What we know: Improved planning key enabler of decentralised energy

- Better market operations and planning through IT:
 - Optimise across the entire plant portfolio, incl. VRE
 - Big data, forecasting technologies
 - Fast trading
 - Better flexibility markets
 - Price depending on location
 - Integration of neighbouring markets



What we don't know: Potential for alternative grid designs – mini- micro-grids and DERs

- Poor analysis of potentials and context-specific business cases – mapping, remote sensing, local costs and modeling of business models. Average LCOE higher for PV+Li-Ion
- Standards, interoperability – how to prepare and minimise costs for interconnection How can structured maintenance, standardised systems increase economics?
- Scaling up – falling DER costs, efficient appliances – gap for affordability of higher power appliances
- Grid below cost recovery, fee-for-service - what role for metering, differentiated tariffs, targeted support?
- What smart components key to help cushion power quality impacts, integrate demand side management?
- DC microgrids? – potential for big savings but need to reduce complexity



Link to paper on Smart Data Systems

■ Tracking DER, grid mapping initiatives, OpenEI

Ministries
Regulators
Rural electrification agencies



Primary source for
renewable off-grid systems



Finance institutions
Development agencies
Research institutions



Additional info on:
- Renewable mini-grids
- Hybridisation of existing diesel grids
- Residential off-grid applications



Marketing reports



Additional info on:
- Industry and institutional users

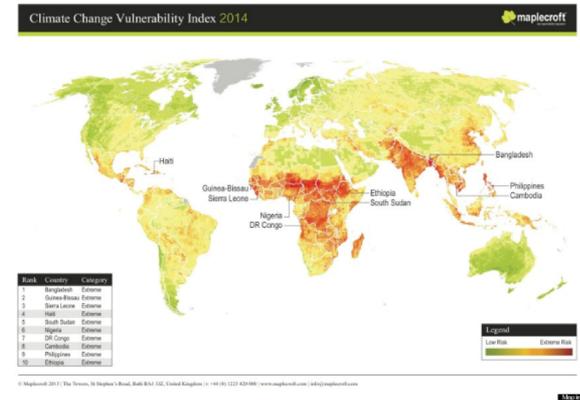
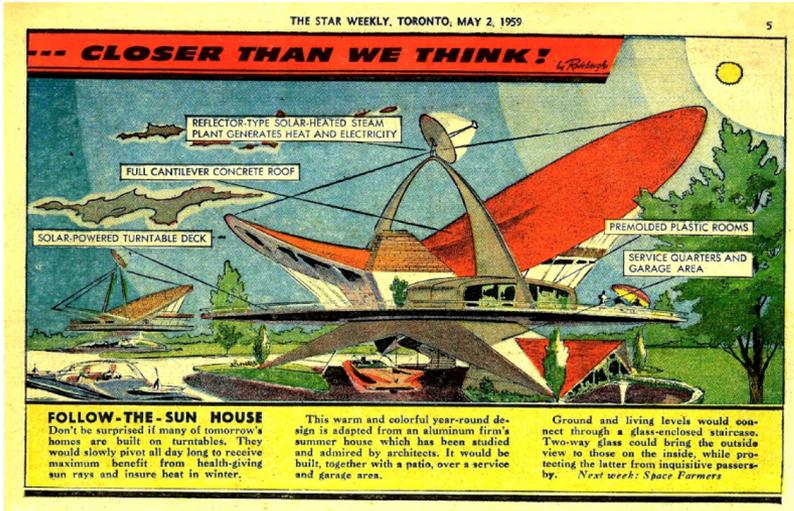
How EEG could bridge gaps

- **What is a best practice methodology for a low income country to develop a balanced approach between interconnection, upgrading national grids, and decentralized energy solutions?**
 - Roadmap-style pathway for developing a policy and regulatory toolkit for incentivising decentralised energy

- **What are appropriate designs for smart grid end-use and distribution network technologies in developing and low-income countries?**
 - Standards and appropriate designs, interoperability required to expand networks in a bottom-up fashion from very low local loads to local networks to regional or national grids
 - Consistent assessment methodologies (CBA, LCOE, value analyses)

Thank you

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2014



2050?

