



BEYOND OFF GRID: INTEGRATING MINI GRIDS WITH INDIA'S EVOLVING ELECTRICITY SYSTEM

26 May 2017, India Habitat Centre, New Delhi

The Need.....

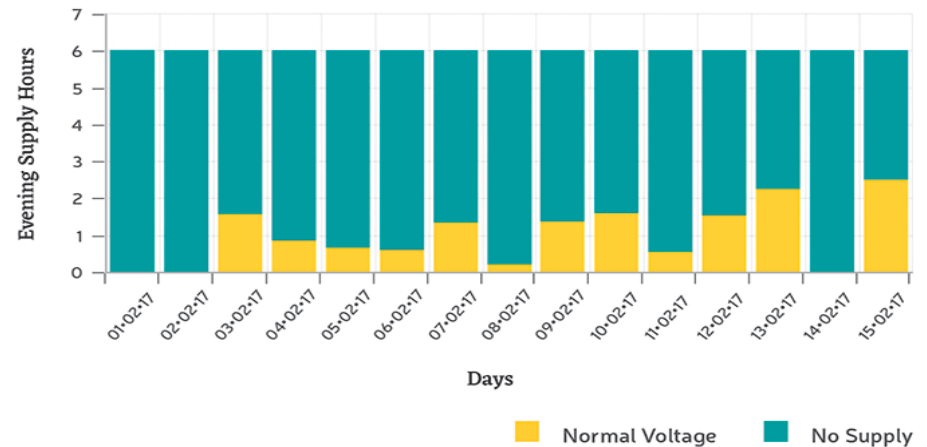


We talk about grid access, people want quality power.

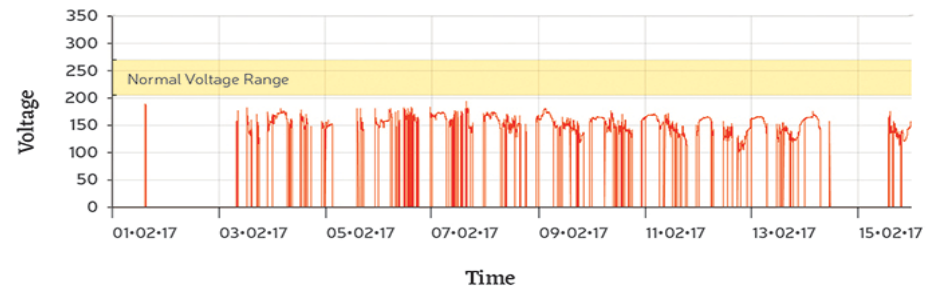
Now.

For home, business, and productive use.

Average Availability during 6 hours of evening (5pm—11pm)



Voltage Profile



source: www.warcnyourpower.org

26 May 2017

Mini grids look like part of the solution



- Development trajectory suited for low base, rapid growth
- Innovation pathway:
 - ▣ Agility in technology for generation – no lock-in
 - ▣ Smarter demand side management, metering, customer interface
- Alternative pathway for adding renewable energy
 - ▣ Alternative risk profile as sector evolves
 - ▣ New class of local investors/entrepreneurs
 - ▣ Time to prepare for transmission/grid management
- Community-aligned incentives: local ownership, customized pricing, expansion on-demand.
- Potential for distributed, high-quality employment opportunities

How to keep the space open for all options?

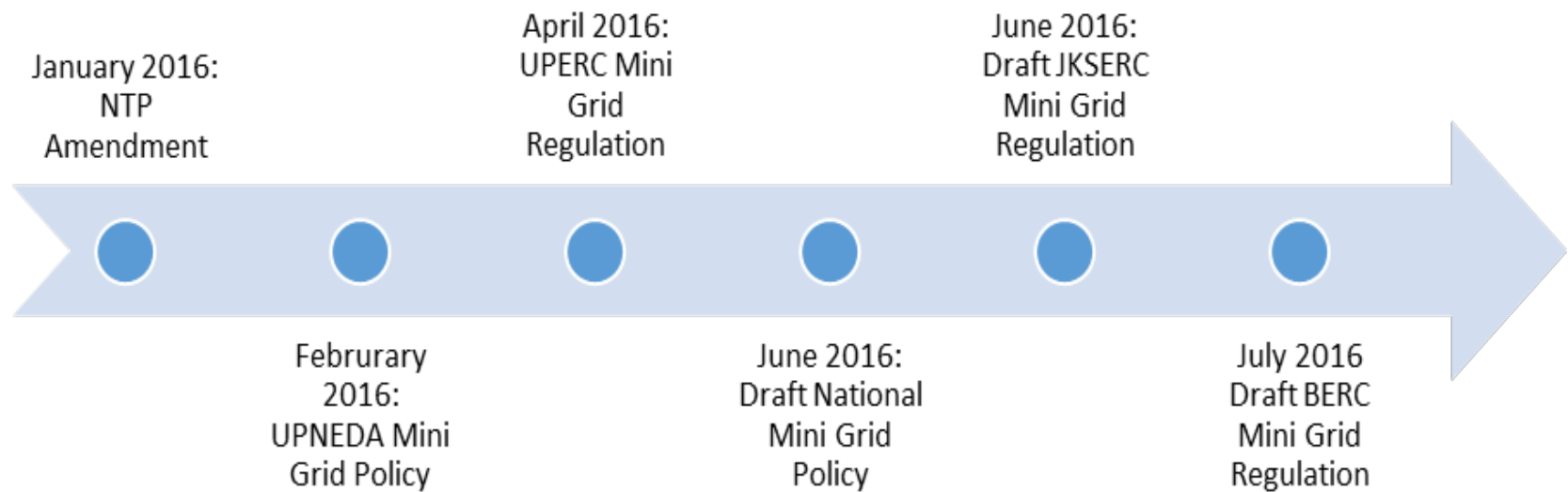
Initial Thinking: Why Interconnection?



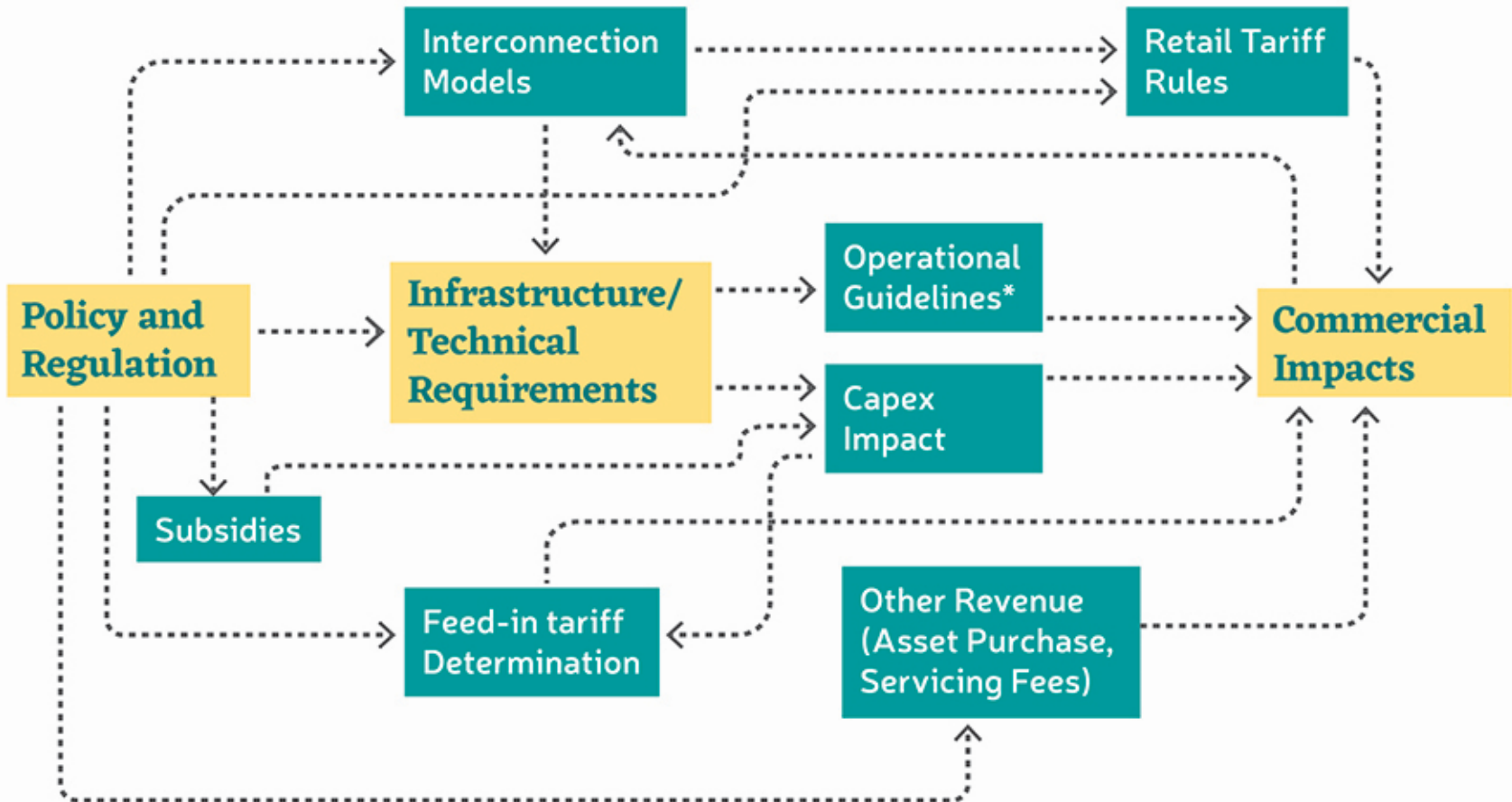
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- Mutual gains to be had for mini-grid and utility: grid storage, innovative technology, discom innovations, smarter consumer interface, etc.
- Clarifies the “exit” for mini-grids when cheaper central grid comes along => could attract additional capital investment required for performance, scalability.
- Enables private investment to be leveraged for system goals – mini-grids become part of overall system.
- Procurement policy selects for the best – the ones who can take the exit

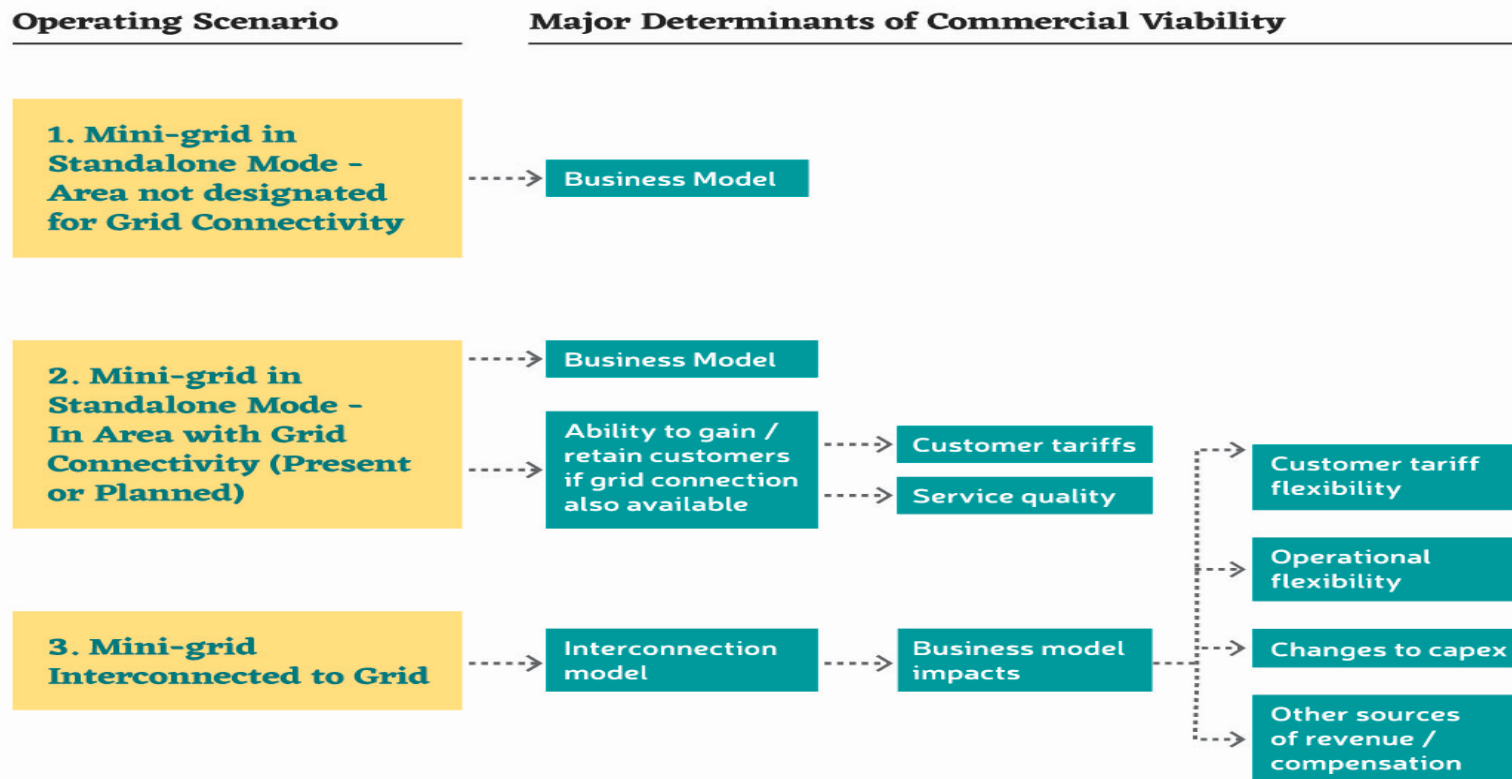
Evolving Policy



But lots of interdependencies



Operating Scenarios



Interconnection Models: Overview



Model	Description
Parallel Operation	Prior to physical interconnection, in areas where the grid supply is unreliable and/or unpredictable, there may be areas where both the grid and mini-grid are operating. Some customers may have both connections.
Interconnection with Partial Export	The ESCO interconnects its mini-grid to the main grid and exports only the excess power generated, beyond that which is consumed by its customers, to the main grid.
Interconnection with Full Export	The ESCO transitions into the role of an IPP. The ESCO PDN is either scrapped, moved to another location, or could be purchased by the DISCOM and potentially integrated into its existing network in some manner
Interconnection with Import	The ESCO becomes a bulk customer of the DISCOM and imports power to charge its battery bank, while continuing to supply to its customers through its own PDN.
Interconnection with Import, Mini-grid PDN	When the grid reaches an area where a mini-grid is already established, rather than establish its own PDN, one of two scenarios for utilising the mini-grid's PDN may occur.

Interconnection: Implications



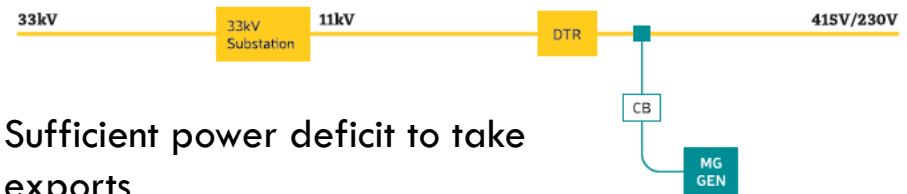
Model	Policy/ Regulatory Clarity	ESCO Capex Change	Retail Tariff Flexibility	Potential for other Revenue / Compensation to ESCO		
				FiT	Asset Purchase	Franchisee Agreement
Parallel Operation	√	[unchanged]	√	[N/A]	[N/A]	√
Interconnection with Partial Export	√	Depends ↑/↓	√	√	[N/A]	√
Interconnection with Full Export	√	Depends ↑/↓	[N/A]	√	√	√
Interconnection with Import	[uncertain/ TBD]	[likely unchanged]	[uncertain/TB D]	[N/A]	[N/A]	[uncertain/TB D]
Interconnection with Import, Mini- grid PDN	[uncertain/ TBD]	↑	[uncertain/TB D]	[uncertain /TBD]	[uncertain/TBD]	[uncertain/TB D]

“It Depends”



- Power pricing
- Recognition, procurement, pricing of other services
- Process delays & complexity
- Broader limits – e.g. penetration limit for given areas

Interconnection



- Sufficient power deficit to take exports
- Sufficient infrastructure to manage additional generation
- Rural feeder lines live.



Looking Ahead



- **Private sector partnerships between technology and equipment providers and ESCOs:**
 - Will stimulate technology innovation to reduce costs of interconnection and
 - Will signal confidence to policy-makers and regulators in the quality of mini-grid infrastructure.

- **Business model innovation among ESCOs + compensation for services/infra as well as power from interconnected mini-grids:**
 - Will instill confidence for continued support of mini-grids.
 - Total costs incurred by ESCOs far outweigh the tariffs (both retail and feed-in) charged by them.

- **Sector-wide experimentation and learning around interconnection pilots:**
 - to build confidence among DISCOMs and regulators on the feasibility of mini-grid interconnections.

- **Establish national guidelines for intentional islanding of interconnected mini-grids:**
 - Interconnected mini-grids provide greater stability in rural areas with intentional islanding.
 - international standards for intentional islanding do exist and simply need to be customized for Indian conditions.



Thank you!

26 May 2017

Parallel Operation



□ Model Rationale

- The mini-grid capacity is small and/or has minimal excess generation and/or the feed in tariff is at a level where it does not make economic sense to invest in equipment for interconnection
- Grid supply is unreliable and the mini-grid has a steady customer base such that a standalone commercial model continues to be viable

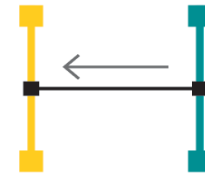
□ Revenue & Cost Implications

- Separate tariff and billing for mini-grid and grid connections.
- No incremental costs except in case of state specific standards for all mini-grids
- Avoids the cost of interconnection equipment

□ Interconnection Requirements

- No major technical or infrastructure requirements from either the mini-grid or the national grid perspective, state regulators, however may place such requirements (UPERC Mini Grid Regulation)

Interconnection, Partial Export



□ Model Rationale

- Larger mini grid capacity and excess generation compared to the demand. FiT sufficient to cover cost of generation
- Intentional islanding is permitted in areas with frequent load shedding and grid supply is continuous (but possibly low voltage)

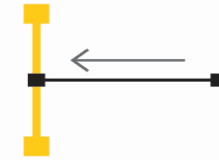
□ Revenue & Cost Implications

- Separate tariff and billing for mini-grid and grid connections
- ESCO receives FiT from DISCOM for power exported to the grid
- Per UPERC regulation, ESCO bears the cost of infrastructure and meters from its system up to the interconnection point, DISCOM bears the cost of metering at the interconnection point

□ Interconnection Requirements

- Grid compatible equipment and infrastructure required by mini grids for interconnection.
- DISCOM grid may require upgrade for managing additional generation source

Interconnection, Full Export



□ Model Rationale

- Reliable grid power supply, ESCO lacks a strong customer base.
- The FiT sufficiently covers cost off generation and interconnection borne by ESCO.

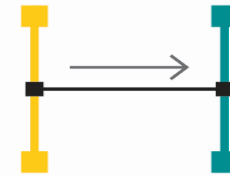
□ Revenue & Cost Implications

- ESCO receives FiT from DISCOM for power exported to the grid
- Per UPERC mini-grid regulation, mini-grid operator bears the cost of infrastructure and meters from its system up to the interconnection point, DISCOM bears the cost of metering at the interconnection point
- Reduced storage expenditure

□ Interconnection Requirement

- Requires installation of equipment and infrastructure to enable mini-grid generator to synchronise with grid as well as infrastructure to physically connect the systems and step up voltage to feed into 11kV network
- DISCOM grid may require upgrade to include control systems for managing additional generation source

Interconnection with Import



□ Model Rationale

- The mini-grid has storage capability (primarily solar PV systems) and a power deficit compared to the aggregate customer demand. Grid supply should be in excess to supplement this demand.
- The tariff rate for the ESCO is lower than its cost of generation.

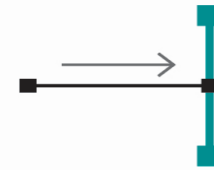
□ Revenue & Cost Implications

- Enables separate tariff and billing for mini-grid and grid connections
- ESCO pays DISCOM for initial connection and for power consumed (tariff to be determined)
- To be determined whether there would be any subsequent regulation of the retail tariff set by ESCO

□ Interconnection Requirement

- Requires the installation of meter and other equipment needed to establish grid connection for the ESCO (assuming storage capability)

Interconnection with Import, Mini Grid PDN



□ Model Rationale

- The revenue and cost implications will depend on the share of responsibilities for incremental costs and the magnitude of these costs to enable these models

□ Revenue & Cost Implications

If DISCOM feeds power into mini-grid PDN:

- Would DISCOM pay the ESCO for use of its PDN (wheeling charges)? Would ESCO need power purchase agreement (PPA) with DISCOM (in which ESCO pays DISCOM for bulk power supply)?
- Who bears the cost of any required system upgrades? Who defines retail tariffs?

If DISCOM purchases PDN and ESCO becomes an IPP:

- ESCO receives feed in tariff from DISCOM
- ESCO receives the depreciated PDN asset value from DISCOM

□ Interconnection Requirement

- ESCO may require equipment to manage dispatch of power supply from the grid and its own generation
- Upgradation of ESCO PDN to DISCOM standard conductor size