
Off-grid Energy Access: Regulatory Issues and Experiences
Focus: Electrification
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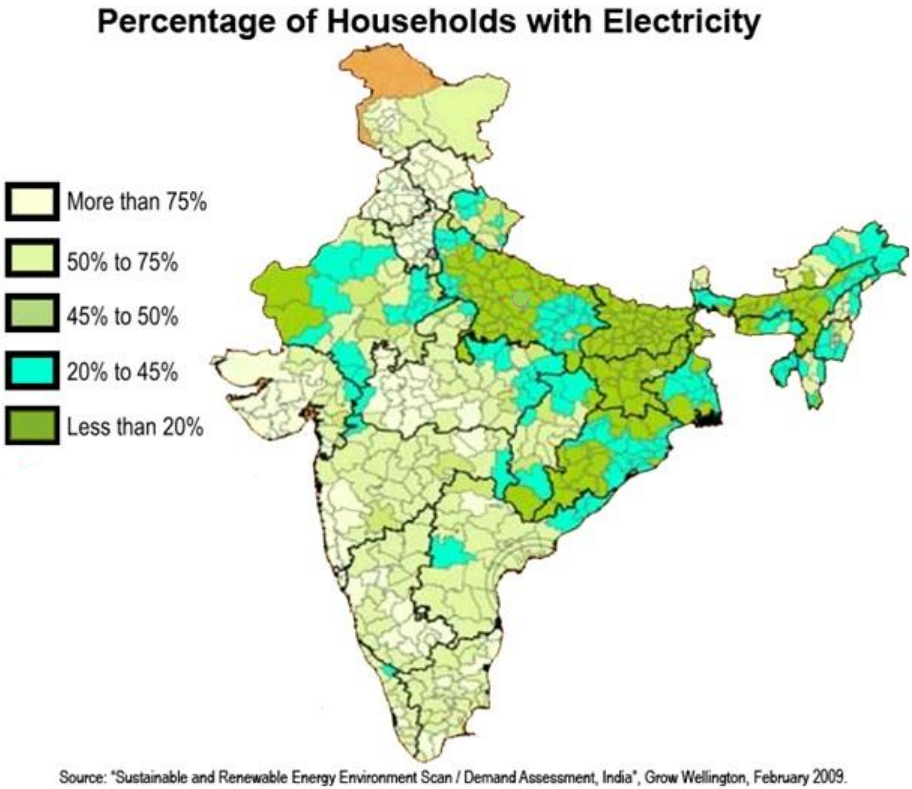
Context

- Requisite Energy Resources a must for economic development
  - Important policy goal; recognized as a key facet for success on the Millennium Development Goals
  - Conventional approach has been 'Grid' oriented
- Electricity access – Limited progress in 20 years !
  - **409** million w/out electricity in 2011 compared to **490** million in 1991
  - Bulk of these are in Rural areas
  - 18,000 villages are yet to connect with grid
- Rural electrification measures: **Electrification without Electricity !**
  - Centralized grid infrastructure outlook : Massive investment through RGGVY
  - Augmentation of supply is not in sync: almost 40% of Households without electricity
    - Even supply in many places is only single phase and thus unable to cater to productive loads



Source: "Sustainable and Renewable Energy Environment Scan / Demand Assessment, India", Grow Wellington, February 2009.

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Evolution of RE /DRE

- DRE, such as biogas based projects deployed in Industries and Communities for last several decades
- Some of the initial electricity oriented DRE projects
  - Mini-grid based
    - Solar PV based plants in Sunderbans
    - Woody biomass in Bihar; more recently rice husk based (Desi Power, Husk Power)
  - Individual systems: Solar Lanterns
- Small scale electricity generation systems have typically played a peripheral role
  - Initial view: To be deployed only in Off-grid areas
  - Under-developed regulatory environments
  - No clear framework to mainstream decentralized systems in the national planning process
    - Most approaches limited to pilot scale implementation models
  - Historical high costs associated with the technologies → lately the technologies have matured though pricing is still on the higher side for less than 250 KW systems
  - Demand broad but shallow - uncertainty around contiguity of demand leading to sustainability issues
  - Under-developed industry and financing infrastructure to drive growth...capability and appetite constraints to support the scale
  - Lack of clarity and adequate recognition around ability and willingness to pay
  - Sustained O&M – profitability and trained manpower

Historical Perspective on DRE and Rural Electrification

- Renewables (other than Hydro) started emerging on the Indian scene only in early 80s
- MNRE has been engaged in shaping schemes to electrification concerns in remote and far flung villages of the country
- Some early attempts at rural electrification
  - Minimum Needs Programme in the 5th Five Year Plan
  - Rural Electrification Supply Technology (REST) Mission, 2002 with an objective of 'Power for All by 2012
    - Renewable energy based decentralised generation technologies considered as key options for mainstream rural electrification efforts
  - In 2003, Gokak committee recognised the potential role of decentralised energy options in addressing India's rural electrification challenges
- Electricity Act 2003 (amended in 2007)
  - Intent to be a game-changer (move towards sustained schemes) for **Electrification definition** and **Thrust towards renewables**
  - Earlier (October 1997) : "A village will be deemed to be electrified if the electricity is used in the inhabited locality, within the revenue boundary of the village, for any purpose what-so-ever"
  - New Definition (2004-05): Certification by the Panchayat
    - Basic infrastructure such as distribution transformer and distribution lines to be provided
    - Electricity provided to public places like schools, panchayat offices, community centres etc.
    - No. of households electrified to be at least 10% of the total number of households in the village

Snapshot of different relevant distributed generation technologies in India

	Biomass		Small Wind	Solar	Micro-hydro	Diesel
	Dual fuel engine	**100 percent producer gas-engine system**				
Maturity	Mature	Mature	Developing (less mature than large wind)	Mature	Mature	Mature
Estimated life	>10 yrs	>15 yrs	20-25 yrs	20-25 yrs	20-25 yrs	3 yrs
Levelized unit cost of electricity(Rs/ kWh),	>6.09	4.19	44.17-6.30	17.3	4.56-8.31	14.44
Capital cost of equipment (Rs/kW)	122,000-44,000	95,000-60,000	203,000-67,000	200,000-150,000	124,000- 216,000	35,000-16,500
Range of unit capacity (kW)	5-40	9-75	1-50	2.5-25	5-40	10-100
Fuel availability	Regional, dependent on harvest and forestry		Regional and site specific	Availability across India. Seasonal diurnal variation	Few sites and regions where relevant	Reliable if distribution network is strong
Advantages	• Diesel can be used as back-up fuel • Continuous power production if fuel is available • Generates local employment	• Productive use of waste biomass • Continuous power production if fuel is available • Generates local employment	• No air pollution • No fuel cost • Low maintenance	• No air pollution • No fuel cost • Low maintenance	• No air pollution • No fuel cost • Low maintenance	• Well-established technology • Technically skilled labor readily available for maintenance • Low capital expenditure
Shortcomings	• Technically skilled labor required for maintenance not readily available	• Technically skilled staff required for operation and maintenance not readily available • Uninterrupted biomass feedstock supply not assured	• Unpredictable wind speeds affecting output power, continuous power production not possible	• High capex, • Risk of theft: equipment/panels • Battery replacement every 3 to 4 years • Continuous power production not possible	• Size of stream may restrict future site expansion • Power output may be lower in summer months	• Extremely polluting • Volatile fuel prices
Installed capacity (distributed)	128 MW		1.07 MW	4.42 MW	10 MW	-

Before a deep dive, some snippets from International Landscape

- Developed vs Developing
  - Developed: Outlook manifests investment in future and sustainable energy technologies
  - Developing: Enabler of rural communities
- DRE for Energy Access and Rural enablement
  - Tanzania
    - Regulations in 2009
    - Dedicated Rural Energy Authority
    - 4 Projects commissioned; Another 10 underway
    - World Bank has established a facility to support the same
    - Lack of Renewable Energy Policy
  - Thailand
    - Now Generation Cost FIT regime (Utility's avoided cost + FIT adder since 2006); In existence for just under a decade
    - Significant ramp-up since mid 2010
    - Renewable based only including Waste to Energy and Cogeneration
    - Standardized PPA, Principle of Cost Allocation
    - Soft funding catalyzed by Govt. (Interest rate of 4%)
    - Comprehensive Technical standards
      - Protective relays – 1-line diagrams for all cases: Induction, Synchronous, Inverters
      - Connecting at different voltage levels (LV or MV)

Key Legal Provisions

- Guiding Law: Electricity Act 2003; Amended in 2007 (Section 6)
  - Thrust on Universal Service Obligation and Govt.'s focus on Rural Electrification
  - License exemption for Generation
  - License exemption for distribution in Rural Notified Areas
- Key Policies
  - Rural electrification policy
  - National tariff policy
  - National electricity policy (Section 3 of EA provides for development of power system including renewable sources of energy)
- Rural Electrification Policy 2006
  - Para 8.1 of the Policy mandates that every state has to notify un-electrified areas; rural areas mean all areas identified pursuant to 73rd Amendment to Constitution
  - Initially MNRE and MOP subsidies for de-centralized renewable projects only apply to rural notified areas
    - **Implication of recent enhancements in DDG and RVEP unknown on this facet**
  - Mandates subsidy benefits should e passed onto the end consumer
  - Sets an indirect expectation of tariffs to be equitable
    - Most License exempt models being deployed are on negotiated tariff basis; much higher than Discom tariff
    - Fails to acknowledge the extent of subsidy in the end user tariff charged by Discoms

Key Legal Provisions for enabling DRE micro-grids

- Section 4 – Laid the ground for stand alone systems to be operate in rural areas
- Section 5 – Provides for bulk purchase of power and management of local distribution in rural areas to support rural electrification effort
  - Panchayat Institutions, users' associations, co-operative societies, non-Governmental organisations or **franchisees**
- Section 6: Sets an expectation for Universal Service Obligation
- Section 14, Eighth provision provides the framework for 'License exempt' generation and distribution of electricity in Rural Areas
- Several other provisions (Section 61, 86) shape role of renewable in tariff, RPOs etc.

Reflections….

- **Opportunity**
  - Most market observers estimate potential market for Distributed generation and supply systems ~ USD 2bn + yet minimalistic engagement of Private Sector
  - Actual deployment ~ $ 20 mn over the last 2+ years (includes DDG disbursements by Rural Electrification Corporation)
- Micro-grids an emerging area
  - Very few Players
  - Most deployments under governmental / semi-governmental ownership
  - Different models: Only Lighting (sub 1 KW to 32 KW); Lighting + Micro-enterprise
  - **Micro-grid interventions present a potential opportunity to address the rural electrification needs through an Infrastructure standard solution**
    - Limited private sector engagement till date
    - Issues around the lack of scale so far, issues of bankability and perhaps most critically potential for local governments to play a disruptive part on the tariff front and impact core of the business models.
    - Ambiguity / opacity in regulation with regards to the operating framework for distribution of electricity, particularly with regards to opportunities for private investment.
- REP 2006 states **grid connectivity exclusively as the 'normal' way of electrification** of villages and advocates off-grid stand-alone system (up to 1MW maximum capacity) where the former is infeasible.

MNRE schemes for Off-grids

Remote Village Electrification Programme (RVEP)

- Focus
  - Lighting requirements of far flung remote villages (Target about 25,000 villages /hamlets)
  - Villages with a population of 100 HHs not covered under RGGVY
- Enhanced scheme – initial draft March 2012; amended in August 2012
  - Includes un-electrified as also electrified where supply is less than six (6) hours
  - 58 W/HH (2 x9 W light points + 40 W electric socket)
  - Potential for Generation based incentives to accommodate
- Progress till date
  - Launched in 2003
  - 8000 + villages /hamlets have been covered till date (sanctioned for about 12000+ villages /hamlets)
- Implementation
  - State Nodal agency shortlist the prospective areas; Requires verification by Rural Electrification Corporation for approval of MNRE support
  - Competitive bidding process for selection of developers
  - For micro-grids, Contract awarded on Build, Operate, Maintain and Transfer basis
  - Initial term – 5 years; can be extended for another term or awarded to another party

MNRE schemes for Off-grids

Remote Village Electrification Programme (RVEP)

- Ownership
  - State Government.
- Financing
  - 90% capital subsidy
- Tariff
  - Fixed by the State notified implementing agencies every year

- **Linkage of RVEP to JNNSM (National Solar Mission)**
  - Limited focus on off-grid but ambitious target – 200 MW by 2013 and 2000 MW by 2022
  - Off-grid covers small utility scale power plants in the rural areas and providing solar lanterns to households.
  - Implemented through RVEP

MNRE schemes for Off-grids

Village Energy Security Programme (VESP)

- Focus
  - Total energy needs of rural communities which don't have access to grid connectivity (Target: 1000 remote and inaccessible villages)
    - Domestic, commercial, agricultural, industrial and motive power
  - Solution to be shaped using local available biomass /bio sources
  - Village of minimum 50 and maximum of 400 HHs; Central Financial Assistance of CFA of Rs. 20000/- per household
- Implementation
  - Coordinated by State Nodal agencies;
  - Developers were typically NGOs and cooperatives
    - Constitution of village energy committees through Gram Sabha/ Gram Panchayat was an essential feature
  - Requirement of fallow land was also essential to produce required biomass for the project.
- Financing
  - 90% capital subsidy
  - Project cost includes maintenance cost of project; Balance cost by implementing agency
- Tariff
  - Mutually agreed between VEC and project implementing agencies

MNRE schemes for Off-grids

Village Energy Security Programme (VESP)

- Progress till date
  - Launched in 2005
  - 65 number of projects have been commissioned as of last financial year
  - No new VESP projects expected going forward

- Barriers to success
  - Lack of business case for implementation agencies as also developers
  - Inadequate biomass supply /management
  - Lack of supply chain /support from technology suppliers
  - Non existent training and /or operational capacities at the last mile
  - Lack of private ownership

Ministry of Power (MoP) schemes for Off-grids

Decentralized Distributed Generation (DDG)

- Focus
  - Lighting only
  - Remote villages where grid connectivity is either not feasible or not cost effective
  - Villages where population is more than one hundred
  - Project Developer to provide power for 6-8 hours per day for at least 25 days per month
    - Penalties for non-compliance
- Implementation
  - State Nodal agency shortlist the prospective areas in consultation with State utility
  - Service charges @8% of the project cost will be provided to the implementing agencies
  - DPR costs are financed
  - No project from private sector has been proposed under the scheme
- Financing
  - 90% capital subsidy from central funds
  - Cost of spares for 5 years after commissioning (excluding cost of consumables and labour) is included as project cost.
  - Reimbursement of gap between O&M cost and revenue recovery to the project developer (after adjusting for the collected tariff) paid out of the service charges of Implementing Agencies (@ 8% for State Govts. and 9% for CPSUs). If still in excess., the same may be funded out of the subsidy.

Ministry of Power (MoP) scheme for Off-grids

Decentralized Distributed Generation (DDG)

- Enhancements in January 2011 and March 2011
  - Enhanced to include areas considered which are connected to the grid but have no electricity supply and have un-electrified clusters
  - Projects with excess electricity generation can be fed into the grid; the cost of the extra capacity and necessary transmission system is to be borne by implementing agency
  - Load per household enhanced from ~ 58 W to 100 W
- Tariff
  - Decided by the Implementing Agency; to be aligned to neighborhood tariff
- Progress till date
  - Launched under RGGVY in 2009; Amended twice subsequently Limited progress: Less than 20% of the budgeted Rs 540 crores has been sanctioned till date
  - Budget expected to be enhanced to Rs 900 crores in the 12th Five Year Plan

Reflections…The Horizon Ahead

MoP vs MNRE

- MoP
  - Focus and preference for Centralized Grid but no comprehensive pathway for assured energy supply
  - Limited interest in off-grid renewable /stand-alone projects
  - Key influencer on CEA matters and hence ‘Grid Interconnection’

- MNRE
  - Historically a technology enabling ministry
  - Have not looked at /nor equipped to manage Scale
  - May play a more substantive role as DRE based micro-grids emerge

- MNRE is targeting 3,250+ MW of installed off-grid renewable energy projects in next 5 years
  - Needs significant ecosystem change; current position: ~ 750 MW exists and only a small fraction in rural areas

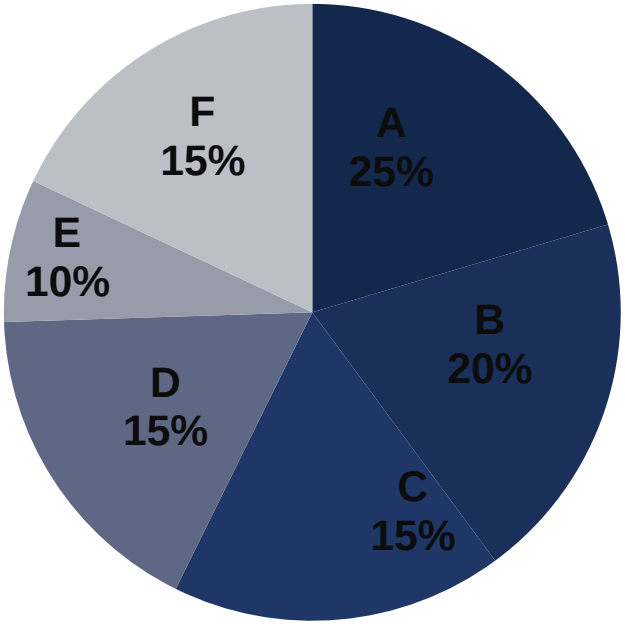
Reflections…

- Govt. programs schematically not designed for Private Sector engagement
  - DDG (Min. of Power)
  - RVEP and VESP (Min. of New and Renewable Energy)
  - Basic legal provisions exist but business case does not
  - Scale has not been a consideration
  - Subsidy tap-in structure skewed towards Public sector agencies and not aimed at supporting private sector
  - O&M viability gap assessment and mitigation not oriented towards supporting a private sector engagement (Threshold – 12% Project IRR)
  - Current guidelines do not provide for private ownership of assets
- Private Sector interventions on License Exempt models
  - Very few installations
  - No standard projects ; Performance unknown
  - Grid expansion under RGGVY seen as threat to existing and upcoming DRE units.
  - Low Capacity Utilization Factor (CUF) due to minimal local electric loads resulting in higher specific electricity costs
  - High consumer tariffs (as compared to subsidized grid levels) shapes concerns on potential socio-political disruption
  - Lack of financing options for DRE projects due to associated and perceived social, economic and technical risks

Reflections…Takeaways from Investor discussions

Barriers preventing Investment Flow

Survey Sample: 20 +



Barriers

- A: Risk mitigation concerns: Governance and Tariff concerns; Potential for business disruption
- B: Lack of interest in small ticket size investments
  - Uncertainty of technology and associated business models
  - Lack of exit options
  - Due diligence costs
- C: Structural bottlenecks as also lack of business case under govt. schemes
  - Assured off-take for the threshold business case
  - Lack of incentive for helping address Universal Electrification goals
- D: Bankability (linked to clients and ability of clients to pay)
- E: Leveragability of capital

Message: Capital Flow into Infrastructure level projects requires certainty of Returns and Sustainable Business Models

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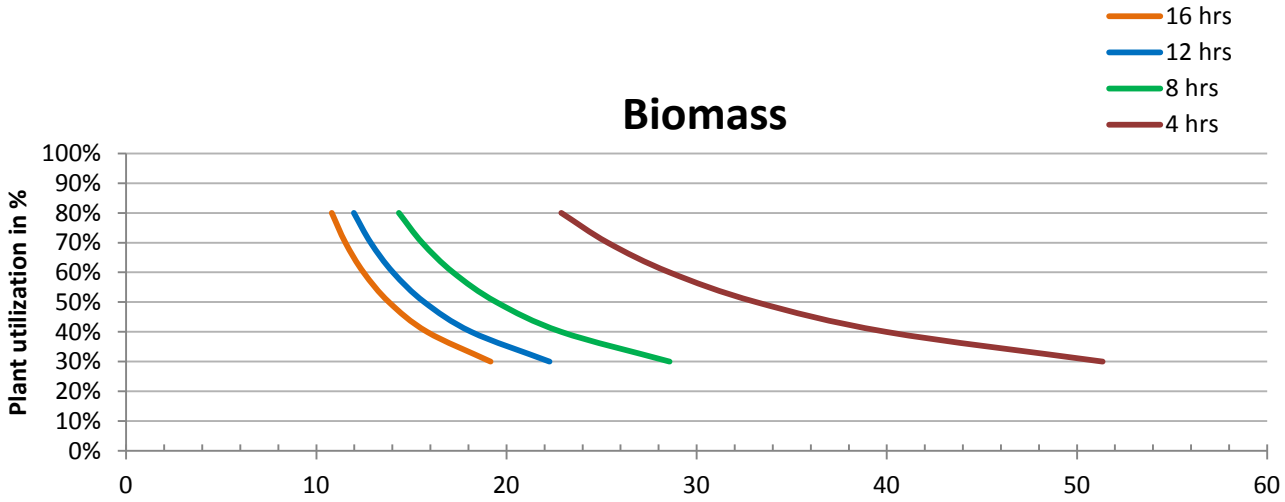
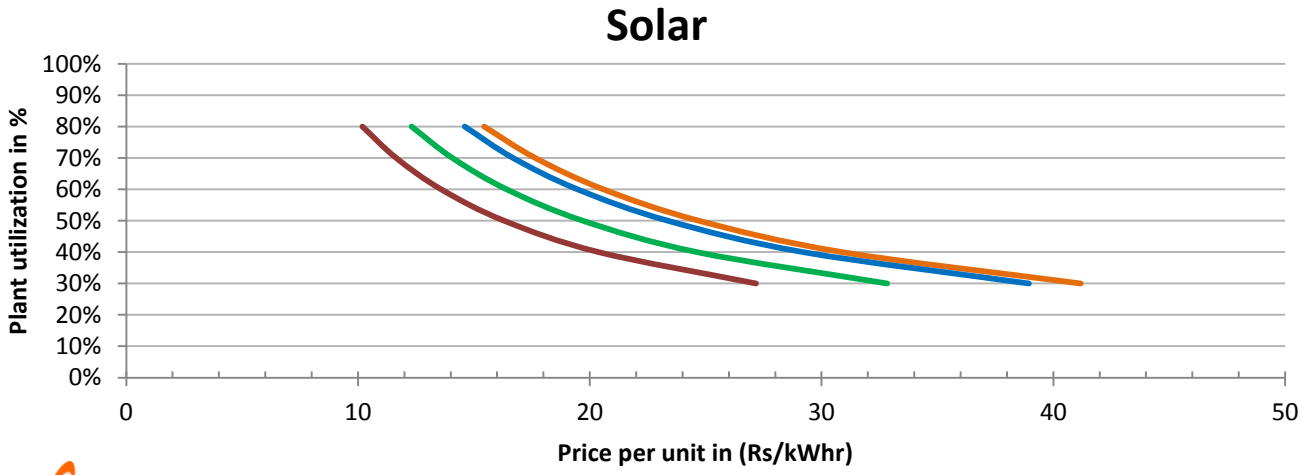
Reality check….Plant Economics

Plant Utilization vs. Price per unit for different plant running hours



CapEx including subsidy (Rs.)	27,32,836
Fixed annual OpEx for 12 hr. and 16 hr. running plant	96000
Fixed annual OpEx for 4 hr. and 8 hr. running plant	54000
Fuel consumption per kWh (kg/l)	1.55
Fuel price per kg/l (Rs./kg/l)	3
Efficiency	90%
Auxiliary consumption	15%
Subsidy per watt (Rs)	15,000



CapEx per watt without battery (Rs)	100
Fixed annual OpEx for 4 hr. plant (Rs)	43,300
Fixed annual OpEx for 8 hr. plant (Rs)	74,600
Fixed annual OpEx for 12 hr. plant (Rs)	1,17,900
Fixed annual OpEx for 16 hr. plant (Rs)	1,25,200
Battery considered for 8hr, 12hr and 16 hr. plant	12v 200 AH
Cost of a 12v 200 AH battery (Rs)	13,200
Subsidy as a % of capital cost	30%

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Recent Measures under consideration by the Forum of Regulators

- Seek to establish regulatory guidelines for 2 new models
  - Tail end generation plants linked to the Distribution Franchisee in a license area using a Feed-in-Tariff scheme(**ODGBDF**)
    - Franchisee Agreement
    - Power Purchase Agreement
  - **REC** for off-grid generation to address viability gap
- Attempt to introduce market mechanism to delink project viability from end user tariffs
  - Leverage the enabling provisions for universal service obligations and renewable purchase obligations
- The enhanced regime offers entrepreneurs the flexibility to operate:
  - Independently of Discom and serve the consumers at mutually agreed prices
  - or operate as a franchisee of the discom and as such help discom account for such generation towards its renewable purchase obligation (RPO).
- The RPO engagement helps provide the time horizon visibility critical for ensuring interest and uptake of these projects by the investment community
- Operational Challenge: **DF model has yet to take off….what can be done to catalyze it?**

Grid Integration of DRE projects : Concerns and Issues

- Concerns
  - Impact on Grid Stability: Earlier this year instability in TN grid due to Wind
  - Frequency control and Harmonization
  - Reactive Power Support
  - Power Quality
- Why Grid Integration
  - Help shape increased Capacity Utilization, Viability and additional sustainability in the business model for existing off-grid DRE projects
  - Integrates the electricity access efforts and harmonizes various segments of grid based energy suppliers
  - Relevant not only for Rural but also urban decentralized settings
- Interconnection is technically possible for any size power plant
  - Some Rooftop PV units (few kWs) connected to the grid currently
  - There is some cost associated with this and technology innovation can bring these down
- Islanding not permitted under CEA norms
  - Feed into the grid when the grid is live. When the grid is not live , plant has to be shut down
  - These regulations designed from a centralized grid perspective but extremely limiting for off-grid interaction
- In context of DRE projects, defeats the very purpose of assured energy access to rural communities
  - Grid code needs to factor in these critical imperatives and should support Islanding
  - Feed into the grid when grid is active but continue supplying power to the local area when grid is down (isolated micro-grid concept); needs deployment of smart grid tools
- On a related note, Islanding has just been devised for Delhi (previously part of Mumbai and Kolkatta)

Reflection on Grid Integration for DRE

- Definition of Inter-connection point
  - line isolator on outgoing feeder on HV side of the pooling sub-station (Solar, Wind) vs. HV side of generator transformer (Biomass, Micro Hydro)
- Connectivity Issues
  - Draft CEA standards for connectivity of the Distributed generation resources, 2010
  - Connectivity to transmission system or distribution system of Appropriate Licensee
    - Roles and Responsibilities of Parties
  - What voltage levels:
  - Verification and Certification
  - Issues around subsequent capacity additions
- Wheeling Charges and Losses
- Renewable Purchase Obligation Aspects
- Scheduling Requirements
  - Capacity (kWp) restrictions /Thresholds for scheduling requirements to be triggered (IEGC: Solar > 5 MW, Wind >10 MW)
- Metering Arrangement
  - Core Guideline : Central Electricity Authority Installation and Operation of Meters Regulations 2006
    - Does this suffice for off-grids?
  - Separate Import and Export Meters vs. Single Meters
  - Role of meters in M&V and communication of the same
- Energy Accounting Issues
  - Meter reading, issuance of credit notes
  - View on Line losses (Inter-connection point to consumer meter)

Operating Parameters

Business operating framework	Variant	Scope of Services	Resource requirements	Customer types
A. Stand-alone	Integrated generation and distribution entity	Power generation and distribution	Power plant management capability, EPC capabilities, financing for plant and micro-grid, manpower for plant as well as grid O&M, revenue collection, load management, fuel linkage management system etc.	Anchor loads (Telecom tower), Microenterprises, Irrigation, Households, Public amenities etc.
	Generation entity	Generation only (either bulk supply to an anchor load & a local distribution micro-grid)	Power plant management capability, EPC capabilities, financing for plant, manpower for plant O&M, fuel linkage management system etc.	Anchor loads (Telecom tower), Micro-grid
	Distribution entity handling distribution and sales	Distribution through micro-grid only	Financing for micro-grid, revenue collection, manpower for micro-grid maintenance	Anchor loads (Telecom tower), Microenterprises, Irrigation, Households, Public amenities etc.
B. DG&S	Integrated generation and distribution entity	Generation and supply to customers, back up supply to grid	Power plant management capability, EPC capabilities, financing for plant and micro-grid, manpower for plant as well as grid O&M, revenue collection, load management, fuel linkage management system etc.	Anchor loads (Telecom tower), Microenterprises, Irrigation, Households, Public amenities and the state distribution company
	Generation entity	Supply to grid	Power plant management capability, EPC capabilities, financing for plant, manpower for plant O&M, fuel linkage management system etc.	State distribution company, Distribution franchisee
C. "BOOT" construct in off-grid that transit to DG&S within a time period	Integrated generation and distribution entity	Generation and supply to customer	Power plant management capability, EPC capabilities, financing for plant and micro-grid, manpower for plant as well as grid O&M, revenue collection, load management, fuel linkage management system etc.	Anchor loads (Telecom tower), Microenterprises, Irrigation, Households, Public amenities etc.

Micro-grid based integrated rural ESCO Operational dimensions

Potential partners	Key activities	Key resources
▪ Local bodies (Village Energy Committee, Cooperative Association etc.) – distribution services, local O&M, community equity ▪ NGOs – Community engagement and mobilization ▪ Government – Financial assistance ▪ Corporate CSR arm, FIs – Grants, soft loan ▪ Technology supplier – Equipment provider, new R&D pilot testing	▪ Generation ▪ Distribution ▪ Load identification and development ▪ Address consumer grievance ▪ Providing lighting equipment ▪ Local enterprise development ▪ O&M	▪ Soft capital for projects ▪ Qualified management ▪ Local technical manpower ▪ Technical know-how of operating in rural environment ▪ Input resources – fuels, lands

Value propositions	Customer segments	Customer channels and relationship
▪ Offering energy as service package to power starved consumer (e.g. lighting) ▪ Solution to the last mile energy access issue ▪ For rural micro-enterprises, it offers reliable power ▪ For rural households, it offers energy services that provides basic amenities, at times act as grid back-up ▪ For related corporate activities (for e.g. telecom towers, cold storage), an alternative to polluting diesel generators	▪ Households ▪ Rural micro-enterprises ▪ Rural public amenities ▪ Agriculture activities ▪ Corporates	▪ Through village cooperatives or committees or associations ▪ Through rural entrepreneurs in franchisee form ▪ Direct engagement with corporates ▪ Customer relationship is often through third parties and noted as an area needing more focus ▪ Community engagement models ▪ Application of cellphone based automated systems

Policy enablement measures need to shape an economic value model to factor these enhancements

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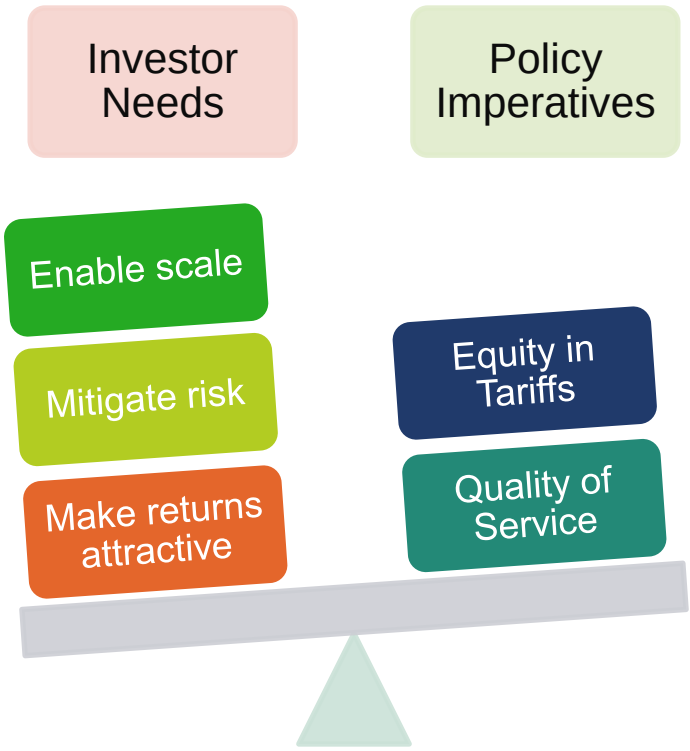
Commentary on the expected enhancements and perspective on the gaps

- Impact of Regulatory Jurisdiction in a nascent market can set back the market
- Grid Integration model is a potential outcome
  - Uncertainty around resolution of the Islanding aspects
  - Economics of 'smart grids' to address integration
- Norms for Off-grid REC a pre-requisite; uptake by State Agencies still unknown
- Uncertainty and divergence in feed-in tariffs approved by SERCs
- Viability Funding Gap instruments need to be made bankable
  - 5% ARR (Annual Revenue Requirement) of Discom in an Escrow



Some Concluding Remarks…

- Issue of Regulatory Certainty vs. Regulatory Jurisdiction
  - Role of Regulator
- Assurance of continued business operations at a predictable return for a defined period is a must for Private Capital Participation
- Challenges in the current incentive structures…
  - Primarily subsidy oriented ; Subsidies are set as certain percentages depending on technology
  - Benchmarked costs not in line with market scenario
  - **Direction desired: Complement subsidy regime with market instruments**
- Project Viability & Transparency
  - Selection of bidders on First Come First Basis with Reverse Auction may result in lowest price but with minimal control on technology and service performance
- Need for Public Private Engagement to shape financing
  - Donor: Fatigue is high though willing to engage as enablers (Guarantee schemes)
  - Public Finance is Limited so needs to be channeled effectively
  - Private Financing is key (currently Debt is minimal)
- Need for Directed Lending – Role of PSU Banks and Priority Sector Lending
- Role of REC as support mechanism seems suspect for DRE scenarios

Q & A