Lessons learned on mini-grid projects in India

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What is TERI

- A not-for-profit research & development and policy think tank;
- Established in 1974 in New Delhi;
- More than 1000 professionals, with centers spread across 5 cities in India; Overseas presence in London, Washington DC, Tokyo, Dubai and Addis Ababa

Working Areas

- Energy & Power
- Regulatory practices
- Habitats and transport
- Environment
- Water and NRM
- Climate policy
- Bio technology
- Social Transformation

Off-grid Access System in South Asia

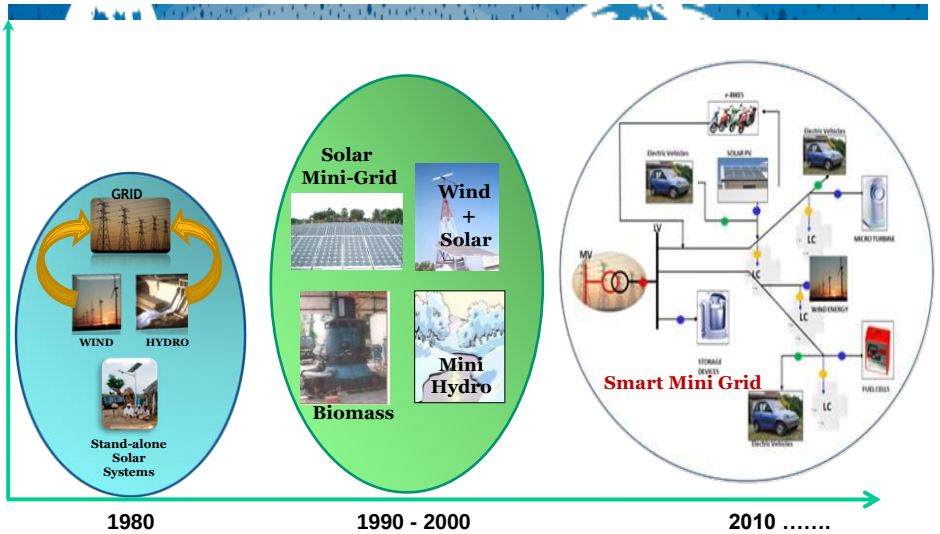
The OASYS Project Objectives:

- ✓ Are there cost-effective and reliable off-grid electricity supply solutions that can meet the present & future needs, are socially acceptable, institutionally viable and environmentally desirable?
- ✓ Do these local solutions have the scaling-up and replication potentials and can these solutions be brought to the mainstream for wider electricity access in the developing world?

OASYS South Asia

www.oasyssouthasia.dmu.ac.uk

Off-grid Technology Transition in India



Conducive Policy framework

- REST Mission (2001)
  - Acknowledged the role of distributed generation/mini-grids
- Electricity Act-2003
  - Universal service obligation to provide electricity by both central and state Government
  - No license required for generation and distribution - tariff can be determined based on mutual consultation with consumers
- Rural Electrification Policy (2005)
  - Decentralized Distributed Generation (DDG) to be considered where grid extension is not feasible
- National Rural Electrification Scheme (2005)
  - Decentralized Distributed Generation (DDG) and Supply
- National Solar Mission (2009)
  - 1000 MW by 2017 and 2000 MW by 2022 of off-grid capacity

Mini-Grids in India

- Pioneer of Mini-Grid system
  - First solar mini-grid commissioned in nineties in Sunderbans Islands
- State-of-the-art system designs available during implementation & use of components
- Mostly cooperative model of service delivery
  - Involvement of local community from planning stage
- Policy enablers from time to time
- Around 5000 villages covered through mini-grids, serving more than 50,000 HHs
- Multiple technology adopted

What is Mini/micro Grid

- A mini-grid is an electricity distribution network operating typically below 11 kV, providing electricity to a localized community and derives electricity from a diverse range of small local generators using renewable energy technologies with or without its own storage.

Mini-grids

- Either AC or DC
- Typically Wp to kWp
- Technologies
  - Solar PV
  - Biomass gasifiers
  - Mini/micro hydro
  - Biogas/bio fuel
- Usually community managed
- Covers around 10 to 500 households, shops, productive micro enterprises etc.

Why mini grids in India

- Technically, mini-grids have been preferred in many cases for remote areas over other options such as SHS,
  - as mini-grids provide electricity services for lighting & for powering various appliances, whereas SHSs typically provide only lighting services
  - Can support small productive applications
- Organisationally, managing mini-grids are easier compared to individual systems due to their centralised operation through a proper institutional arrangement

Solar PV AC Mini-grid

Source: CREDA and TERI

Control Room, Battery Bank, Grid

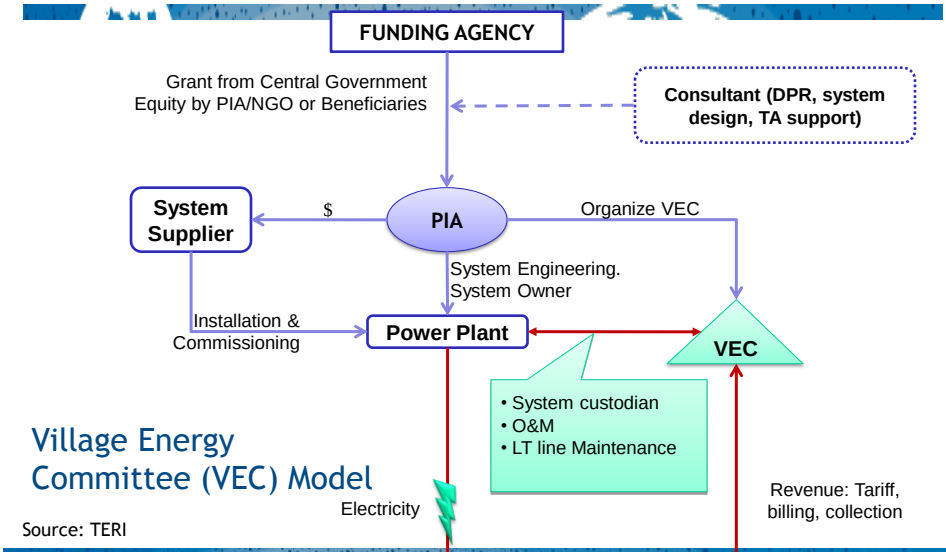
Source: TERI

Biomass Gasifier Power System

- Fuel Preparation
- Biomass Gasifier
- Cooling cleaning train
- Engine – Alternator
- Biomass drying
- Power evacuation

Source: TERI

Managing Mini Grids: Earlier Model



Village Energy Committee (VEC) Model

Source: TERI

Some Lessons from early Mini grids

- Decentralized, low capacity, covering remote areas
- Usually domestic loads served
- Limited by capacity and duration of supply
- Community as stakeholder
- **Tariff based on flat rate**, locally decided, depending on O&M cost and WTP
- Non commercial in nature
- **Clustering of projects more successful**
- Inability to meet increased demand**, no smartness**
- Single energy resource catering to fixed load for fixed time
- **Battery - vulnerable**, overdrawl by most consumers
- Generation not as per design – quality issues of solar panel
- Difficulty in O&M because of remoteness
- Not linked to any productive enterprise/irrigation pumpset – **viability ??**

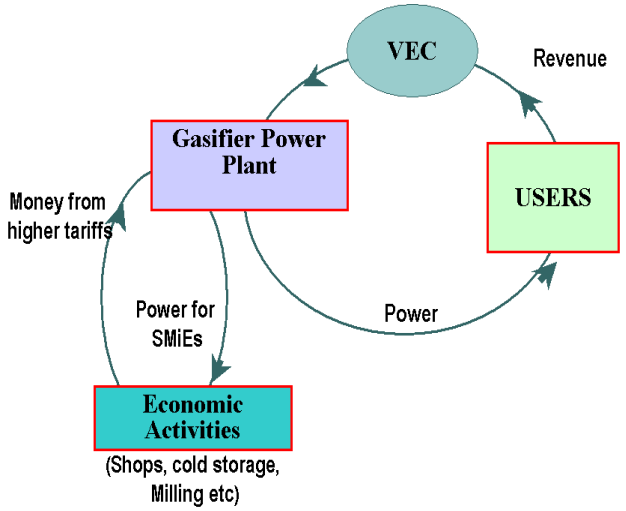
Hybrid System

55 kW Solar and 3.5 kW Wind Electric Generator based hybrid system

Wind Diesel Hybrid system

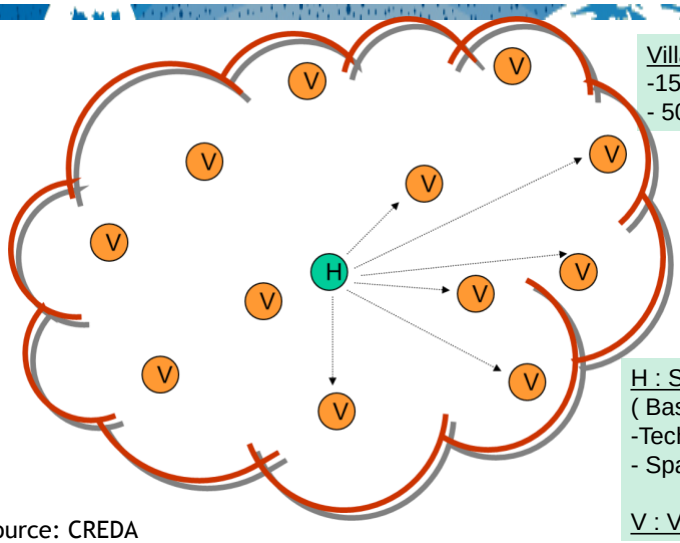
Source: TERI

Managing Mini Grids: Addressing low load



Source: TERI

Cluster Based Service Delivery



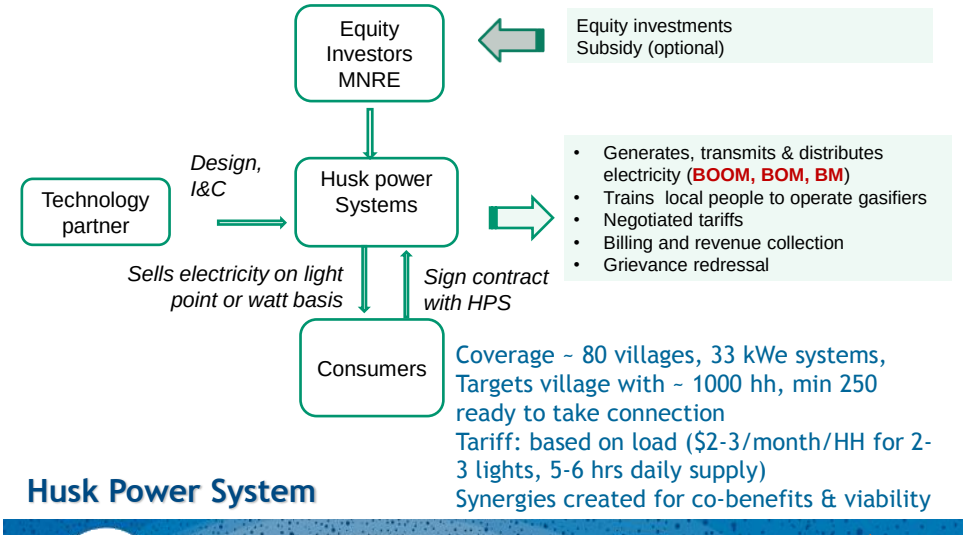
Village Cluster
-15 Villages
- 50 Customers / Village

H : Service Hub
(Base station)
-Technician / Helper
- Spares / Consumables

V : Villages in the Cluster

Source: CREDA

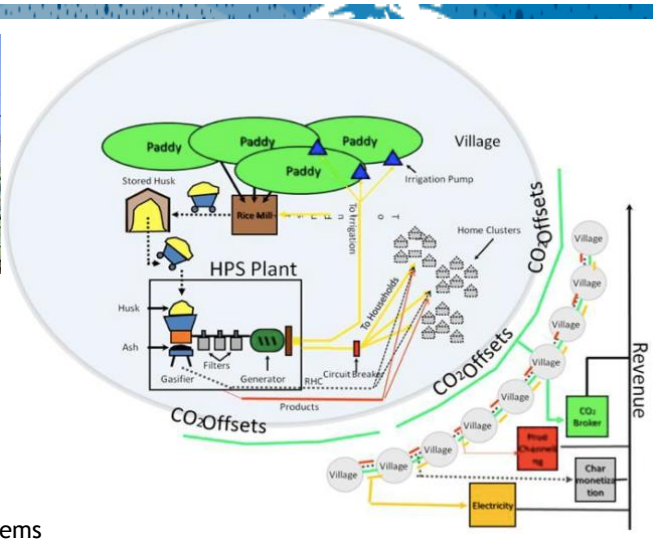
Mini Grid - Private Sector



Coverage ~ 80 villages, 33 kWe systems,
Targets village with ~ 1000 hh, min 250 ready to take connection
Tariff: based on load ($2-3/month/HH for 2-3 lights, 5-6 hrs daily supply)
Synergies created for co-benefits & viability

Husk Power System

HPS Ecosystem

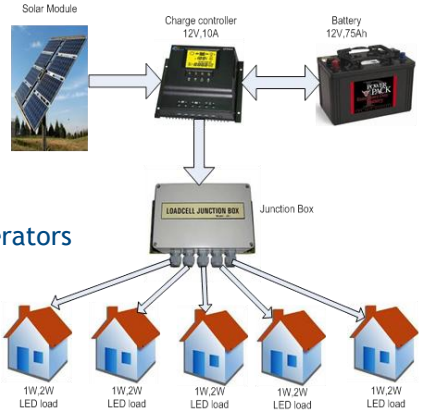


Source: Husk Power Systems

New technical and delivery models

Solar DC micro grid

DC distribution lines (voltage varies depending on distance) run along rooftops from the battery bank to households over a short distance to power lights, mobiles etc.

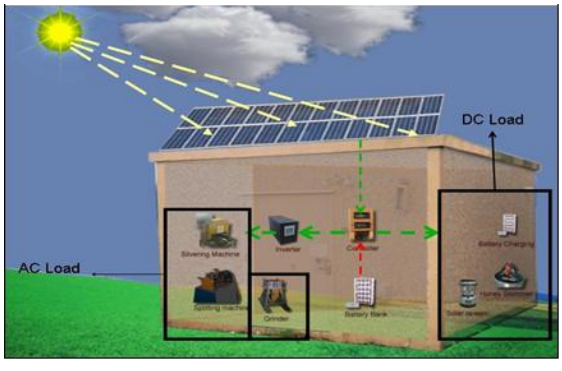


Running time : 5-6 hours

Installation Cost: $ 65 – $ 80 per HH

Tariff: $ 2-3 per month, charged by operators

Solar Multi Utility



Multiple Energy Sources

- Solar PV
- Wind Aero Generators
- Biomass Gasifier
- Hybrid Systems

Multiple Applications

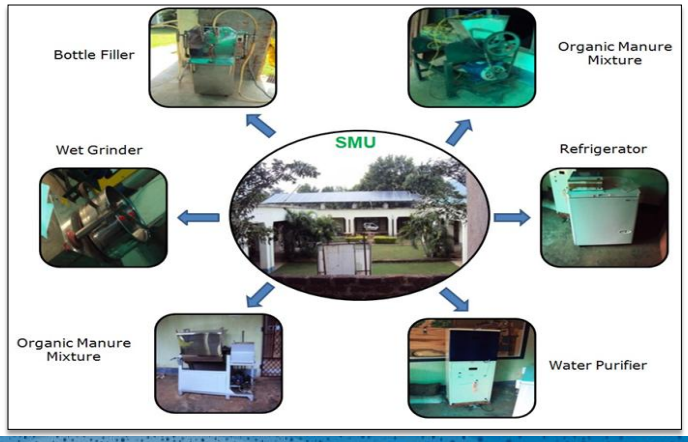
- Charging lanterns
- Powering computers,
- Charging cell phones
- Water purification
- Micro enterprises

Located near the energy utilization points in a village to provide electricity services as per the community's need

Source: TERI , 2012

Solar Multi Utility

Self Help Groups, Farmer's Associations & Individuals from the surrounding villages access the SMU & utilize services for a fee.



Key Lessons

- Optimizing design – **Adapt to local context**
  - ✓ Instead of one technical solutions, number of solutions depending on local demand can be designed to optimally cater to domestic as well as micro enterprise and community load
  - ✓ Using the right metric for energy delivery
  - ✓ Negotiated tariff – usually flat based
- Top-down approach /**Organized delivery model**
  - ✓ Opposed to popular approaches "let the community handle" - Each entity sticks to what it does best
  - ✓ Scaling up may need differentiated responsibility
- Effective maintenance - **Cluster based service delivery**
  - ✓ Fruitful partnership between project proponent and System Integrators (penalty –incentive approach)
  - ✓ Structured communication channel

Key Lessons

- Strong govt. support - **Political will**
  - ✓ A maintenance subsidy of Rs 25/household in Chhattisgarh
  - ✓ Right political framework - removing uncertainty
  - ✓ Mix of subsidy driven and commercial model
- Creating an eco-system - **Learning from doing**
  - ✓ Support to local manufacturing and development
  - ✓ Transition from ACMC to long-term CMC
  - ✓ Differential and focused capacity building

Takeaways

- Service delivery models to be structured considering the uniqueness of the region within which the plant is to be installed -*Today off-grid, grid-connected tomorrow*
- Contrary to prescribed models of off-grid electrification, *top-down approach/organized structure* seems to be working better than community model
- Designing variable tariff structures considering both *ability to pay as well as operational expenses*
- Strong regulatory & policy regime supports development of projects – *Viability gap funding/Results based aid*
- Need to *build local capacity and adopt clustering* for effective maintenance & viability of operation

Framework for Mini Grid