Rural Electrification and Solar PV Programs: Experiences from South Asia

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What is TERI

- A not-for-profit Research 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 & Addis

Working Areas

- Renewable Energy & Decentralized Electricity
- Power Sector Regulation
- Environmental Science and Policy
- Climate Policy
- Resources and Global Security
- Water and Natural Resource Management
- Bio technology and Agri Technology
- Social Transformation

Scope of Presentation

- The OASYS Project
- Current trends of Solar PV for rural electrification
- Comparative analysis to exploit cross learning potential
  - Policy and regulatory architecture
  - Technical design and sizing
  - Service delivery models
  - Pricing of systems
  - Access to Finance
  - Monitoring and maintenance
- Challenges & Way forward
- The Rural Electrification Boosters

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.info

Review of programs & projects

- **India**
  - Rajiv Gandhi Grameen Vidyutikaran Yojana
  - Remote Village Electrification
  - Village Energy Security Programme/Biomass gasifier projects
- **Bangladesh**
  - Palli Bidyut Samities/Rural Electrification Board
  - IDCOL Solar Home Systems Program
- **Nepal**
  - Energy Sector Assistance Programme (ESAP)
  - Rural Energy Development Programme (REDP)
  - Community based Rural Electrification
- **Sri Lanka**
  - Solar home systems program in Sri Lanka
  - Small hydro power experience in Sri Lanka
  - Power Fund for the Poor (ADB)

South Asia

- Home to 1/5th of global population in 4% of world land mass
- Accounts for 42% of global population w/o electricity access
- Average electrification rate is 60% (global average ~78%)
- One out of every two people in the rural areas - 614 million people – w/o access to electricity

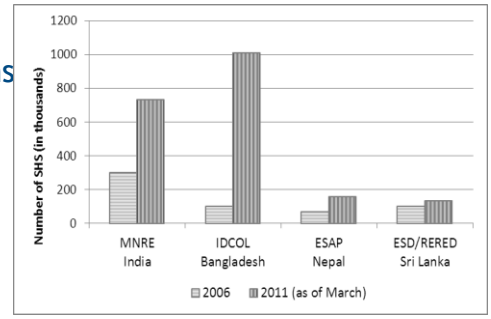
Country	Total population (millions)	Population without electricity (millions)	Rural electrification (%)
Afghanistan	28.4	23.8	12.0
Bangladesh	156	95.7	28.0
Bhutan	0.69	0.2	40.0
India	1166	403.7	52.5
Nepal	28.5	16.5	52.5
Pakistan	176	68.0	46.0
Sri Lanka	213	4.7	75.0

Rural Electrification – Some facts

- India & Bangladesh - 93% & 57% of villages served through grid, while rural HHs connection levels at 53% & 28%
- Un-served population are mainly of two types:
  - Communities with inability to pay for connection charges
  - Residing in isolated/off-grid communities
- Solar PV is preferred option for RE after grid extension
  - All the government policy is based on an *a priori* judgment that renewable energy serve only marginal areas
  - SHS not considered as rural electrification in India & Bangladesh

Solar PV in South Asia: Current Trends

- Mostly donor/subsidy supported projects, Also combination of free market and grant based models
- Decentralized solutions
  - Solar Home Systems (SHS) & Solar Lanterns (SL)
- Centralized solutions
  - Solar Mini Grids
  - Solar Charging Stations

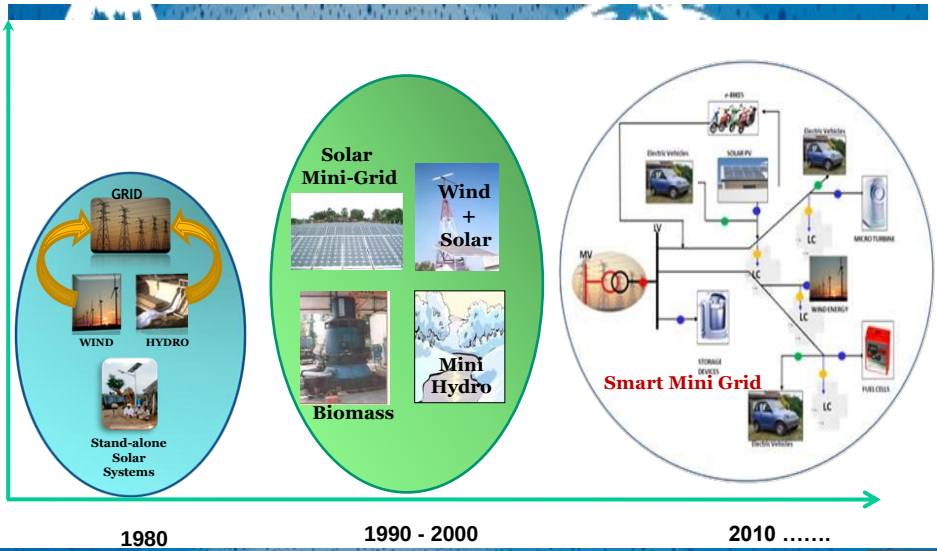


South Asia: Technologies & Business Models

Country	Technologies implemented	Business models	SHS pricing $/Wp
India	SHS, SMG, SL	Consumer financing, leasing, VEC, fee-for- service	7.5
Bangladesh	SHS	Consumer financing	6.5
Nepal	SHS, SSHS	Credit Sales	11.6
Sri Lanka	SHS	Consumer financing	9.6

- Lower system cost in Bangladesh & India due to local assembly & manufacturing

Technology Transition



Financing of Solar PV

- Large bouquet of financing mechanisms
  - micro-credits schemes
  - interest rate buy-downs
  - fee-for service
  - with or without any subsidies
- Majority availed micro-credit/consumer credit, a quarter used state or donor funded subsidies and only few (5%) used cash purchases
- Financing mechanism used related to organization type
- Lack of suitable financing mechanism regarded as most significant barrier to the uptake of SHS

Maintenance of Systems

- Critical determinants for limited success of many programs in the region
- Wherever responsibility outsourced to equipment suppliers (such as govt. programs) dissatisfaction with timeliness of the maintenance reported
- IDCOL (single window model) reported more success than ESD (two window model)
  - Loan repayment directly impacted by improper service
- Technology Resource Centers model
- An option for responsive repair of decentralized systems

Policy: Challenges & Way forward

- No long term policy instruments for solar PV in countries
- Dissemination suffers from uncertainty in the political framework conditions
- Absence of standard set of guidelines for implementation

✓ Proper policy enablers at country level
  - National Solar Mission in India

✓ Regional level policy cooperation & sharing knowledge

✓ Robust institutional structure for implementation

Financing: Challenges & Way forward

- Credit provided independent of income level
  - Financial assistance from government programs not reaching the lower income HHs
  - Financial mechanisms are not in line with income level of poor HHs (the section w/o electricity access)
  - Assessing finance from rural banks is sometimes tiresome due to long approval process
- ✓ Rationalizing of the micro-lending interest rate to cover poorer households
- ✓ Creating mechanism for easy access to credit & financing through simpler process & better accountability mechanisms

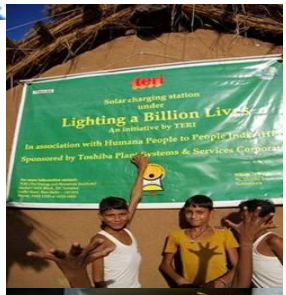
Technology: Challenges & Way forward

- High cost of technology and/or service
  - Not within the reach of lower strata of society
- ✓ Fee-for-service model may be closer to need of poorer HHs
  - **Renting of lantern from a SCS**
  - Providing only lighting service from solar micro grid
- Use high efficient LEDs to bring down cost
  - Reduced panel size, freight & storage cost
  - Around 30% cost reduction achieved in terms of lumen-hour under TERI's LaBL
- ✓ Hybrid model of Solar Charging Station – DC micro grid
  - An ideal enterprise based model for providing lighting & value added energy services

Lighting a Billion Lives

A commitment to improving the quality of lives of rural communities

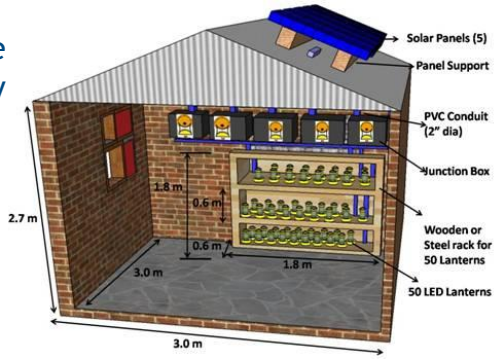
- Sets up solar charging stations in energy poor villages that offer certified, bright, solar lanterns for rental to the local people.
- A trained local entrepreneur operates and manages the charging station and rents the solar lanterns every evening for a affordable fee.



Technical Model

Charging stations are expandable to solar energy hubs providing :

- Battery charging
- Mobile charging
- Lantern charging
- Water purification



A typical Solar Charging Station

Innovating at LaBL

- CONTINUOUS IMPROVEMENTS in solar lantern designs, driving down cost, improving efficiency & quality
- CHARGING STATIONS EXPANDABLE TO SOLAR ENERGY HUBS, providing services like water purification, mobile & battery charging
- TECHNOLOGY RESOURCE CENTRE, an after-sales service network for responsive repair services through local community representatives

Journey so far……

Laltini **represents the goal of rural enlightenment through LaBL**

350 000 lives impacted

70 000 solar lanterns

1200 villages covered

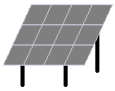
17 states in India

6 countries

> 1200 green jobs created

> 60 NGOs involved

New Technology: Solar DC Micro Grid



Renewable Power Generation: 100 households would require 500-700 watts-peak of solar panels. Panels are installed on the rooftop of a village house.

Battery Bank: 100 households would require around 500 Amp-hours of storage capacity. Batteries are stored in a cabinet inside the same house or distributed battery storage at individual households

Power Distribution: DC distribution lines run along the rooftops from the battery bank to households within the village. Power is distributed for 8 hours each night at 24 volts.

LED: Each household having 2 or 4 LED lamps (3 levels)

New Technology: Smart Grid

Electricity delivery network modernized using latest digital/information technologies to meet key defining functions

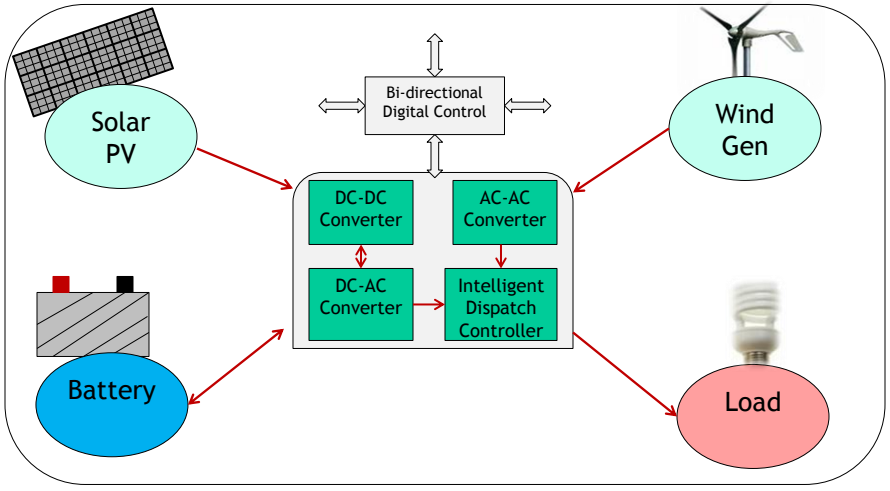
Enabling active participation by consumers	Enabling new products, services, and markets	Optimizing assets and operating efficiently	Access to quality power

The evolution of a smart grid will be one of continuous improvement

What is Smart Mini grid?

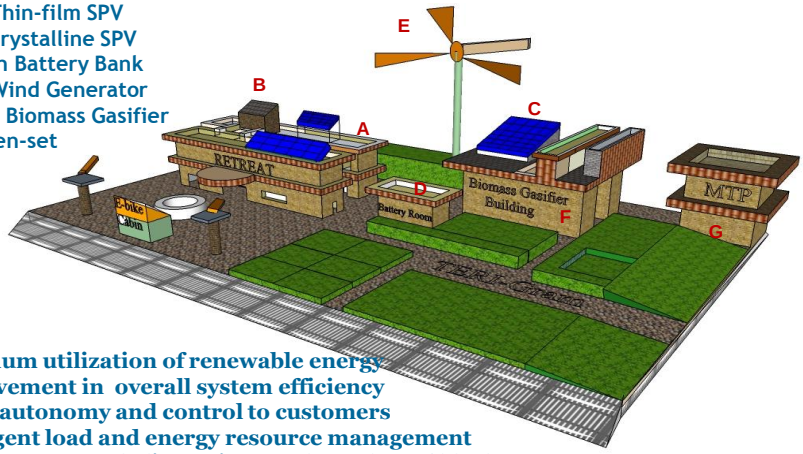
Mini grid	Smart Mini grid
• Grid involving one or more types of renewable energy sources • Operating Voltage level below 11kV • Islanded operation to power off-grid remote area	• Optimization of resources & intelligent demand management using state-of-art digital technology • Decentralized control makes the system efficient and modular

What is Smart Mini grid?



India's First Smart Mini-Grid at TERI

A. 10.5 kW crystalline SPV
B. 1.0 kW Thin-film SPV
C. 2.0 kW crystalline SPV
D. 28.8 kWh Battery Bank
E. 3.2 kW Wind Generator
F. 100 kWe Biomass Gasifier
G. Diesel Gen-set



Ensuring

- **Maximum utilization of renewable energy**
- **Improvement in overall system efficiency**
- **Better autonomy and control to customers**
- **Intelligent load and energy resource management**
- **Minimum network disruptions and number of blackouts**

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Rural Electrification Boosters

- How to improve the household electrification level?
  - Improve household connection level at a rate that exceeds the rate of households growth
  - Sri Lanka adopted targets and milestones to connect rural households & arranged micro-lending to achieve a high (90%) household connection level
  - India and Bangladesh with wide MFI network can micro-finance connection
- Do we need regulatory measures to ensure viability of mini-grid projects?
  - Low cash disposable income in off-grid areas
  - Cross subsidization/OBA can introduce viability

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Key Issues of Rural Electrification

- Can bundling reduce the access gap?
  - Concessionaire approach (e.g. QTP model)
  - Identify projects based on local energy resources and cluster (off-grid + grid) to ensure economics of scale
  - Twinning distributed power generation with a suitably structured rural distribution delivery model
- What institutional structure will be appropriate for sustainability?
  - Better organized structure for off-grid
  - Community centric - particularly successful where project also worked at improving the productive uses of electricity
  - Support system at the intermediary level - an integrating link between the national and local level

2012: International Year of Sustainable Energy for All

Let us together make a change