Renewable Energy Mini-grids for Energy Access
Load Management Strategies and Grid Interconnectivity

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Energy Access

Over 1.3 billion people lack access to electricity

Source: IEA 2011

Population without access to electricity in 2009 (millions)

- World: 1,317
- Developing Asia: 675
- Africa: 587
- Latin America: 31
- Middle East: 21
- Transition Economies & OECD countries: 3

Lawrence Berkeley National Laboratory
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Why Mini-grids

Renewable Energy mini-grids offer possibilities for improved energy access

- Utilize local renewable energy resources
- Typically offer greater levels of energy access compared to Household Solar Systems and Off-grid Lighting
- Provide power for commercial and agricultural applications (not just residential use)
- Create local jobs
Why Mini-grids

Renewable Energy mini-grids offer possibilities for improved energy access

- Mini-grid developers as generation and distribution franchisees
- Have the potential to access capital beyond the traditional power sector
- Have strong incentives to pursue demand side management
Renewable Energy-based Mini-grids

Mini-grids vary by technology and fuel type, diurnal and seasonal variation, battery storage and power versus energy limitation
Challenges with Mini-grids

- Lack of standards + monitoring & verification
- Demand exceeding supply – Brownouts
- Central grid extension

Abandoned micro-hydro in Thailand: central grid extended

Source: Chris Greacen

Abandoned solar PV plant in India

Source: Ranjit Deshmukh

- High upfront costs for RE
- Poor consumer base
- Lack of technical capacity for O&M
- Institutional and governance issues
Brownouts occur when peak loads exceed generation capacity.
Load Management Technologies

- Simple load limiter based on current
- Smart load limiter like GridShare
- Conventional and Prepaid metering
- Prepaid meters combined with centralized communication

Bushlight India
http://catprojects.squarespace.com/bushlight-india

SharedSolar
www.sharesolar.org
GridShare Load Management Technology

Developed by Humboldt State University team
Funding from the US EPA, partnership with Bhutan Power Corporation and Bhutan Department of Energy

Source: Schatz Energy Research Center
GridShare Load management results

- Electrical data indicated a reduction of over 90% in severe brownouts

- Reduced spoiled rice, residents stated the grid was more predictable

- Community decided to keep GridShares installed

Source: Schatz Energy Research Center
Mini-grids and Central Grid Extension

- Governments usually pursue central grid extension programs for rural electrification
- When the central grid is or planned to be extended, viability of existing mini-grids comes under question
- Even after central grid extension, no guarantee of reliable electricity supply if utilities face generation shortages

How can mini-grids co-exist with central grid extension & provide reliable access to electricity?
Central grid and off-grid decentralized mini-grids

Central Grid

Large Plants

Mini-Grid

Small Power Producer
Mini-grids and Central Grid Extension

Central grid extension

- Large Plants
- Central Grid
- Mini-Grid
- Small Power Producer
Grid interconnection and feed into central grid
Mini-grids and Central Grid Extension

Islanded mini-grid operation during interrupted central grid supply

Central Grid

Supply Outage

Large Plants

Mini-Grid

Small Power Producer
Energy Pathways in Mini-grids Connected to Central Grid

Resources
- Wind
- Water
- Biomass
- Solar

Capture and conversion technologies
- Wind turbine
- Micro-hydro turbine
- Biomass gasifier + Engine
- Photovoltaic modules

Electric Generators
- AC Synchronous or induction generator
- DC generator
- Inverter

Energy Flow:
- Primary energy from resources to capture and conversion technologies
- Kinetic energy from wind turbines
- DC Power from photovoltaic modules
- AC Power from generators
- On-site AC loads

Main grid connection through inverter and converters.
Policy and Regulations

Well-designed mini-grid policies and regulations are essential to enable sustainable, equitable and affordable access to electricity

- Appropriate subsidies – capital and ongoing
- Effective financing mechanisms
- Consumer and wholesale tariff structures
- Technical standards
- Monitoring and verification – Quality of service, equipment
- Community participation
- Capacity development
- Mechanisms to address consumer and developer grievances
A Guidebook on Grid-interconnection and Islanded Operation of Mini-grid Power Systems up to 200 kW

Review of Strategies and Technologies for Demand-side Management on Isolated Mini-grids

Framework for Regulations and Policies for Sustainable Renewable Mini-grids
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