



Empowering India
Renewable Energy for Rural Electrification

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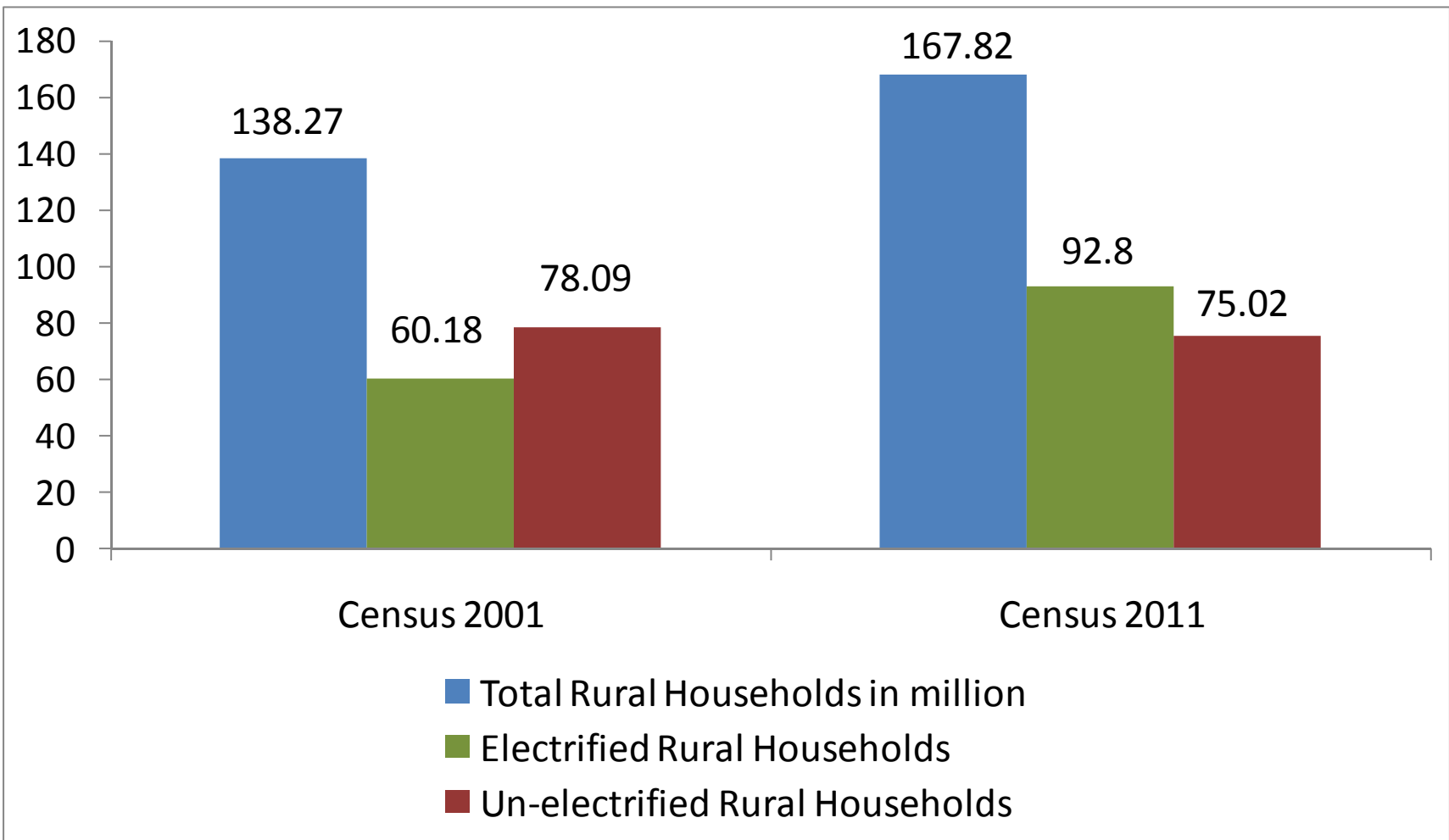
The size of the challenge

India has a 400 million energy poor population.....

- Nearly 400 million people (75 million rural households, 6.5 million urban households) without grid connectivity nationally
 - *With the vast majority of these-over 90%- being concentrated in rural India*
- Another 33% of the population may be facing under-electrification
 - *Accessing less than 50 kWh of electricity per month/household*
 - *Many electrified villages also face shortage of electricity*
- Residents of off-grid villages resort to burning kerosene in basic wick lanterns to produce light at night and biomass for cooking



Rural Household Electrification in India



Ensuring access to electricity to all Indians is a national priority....

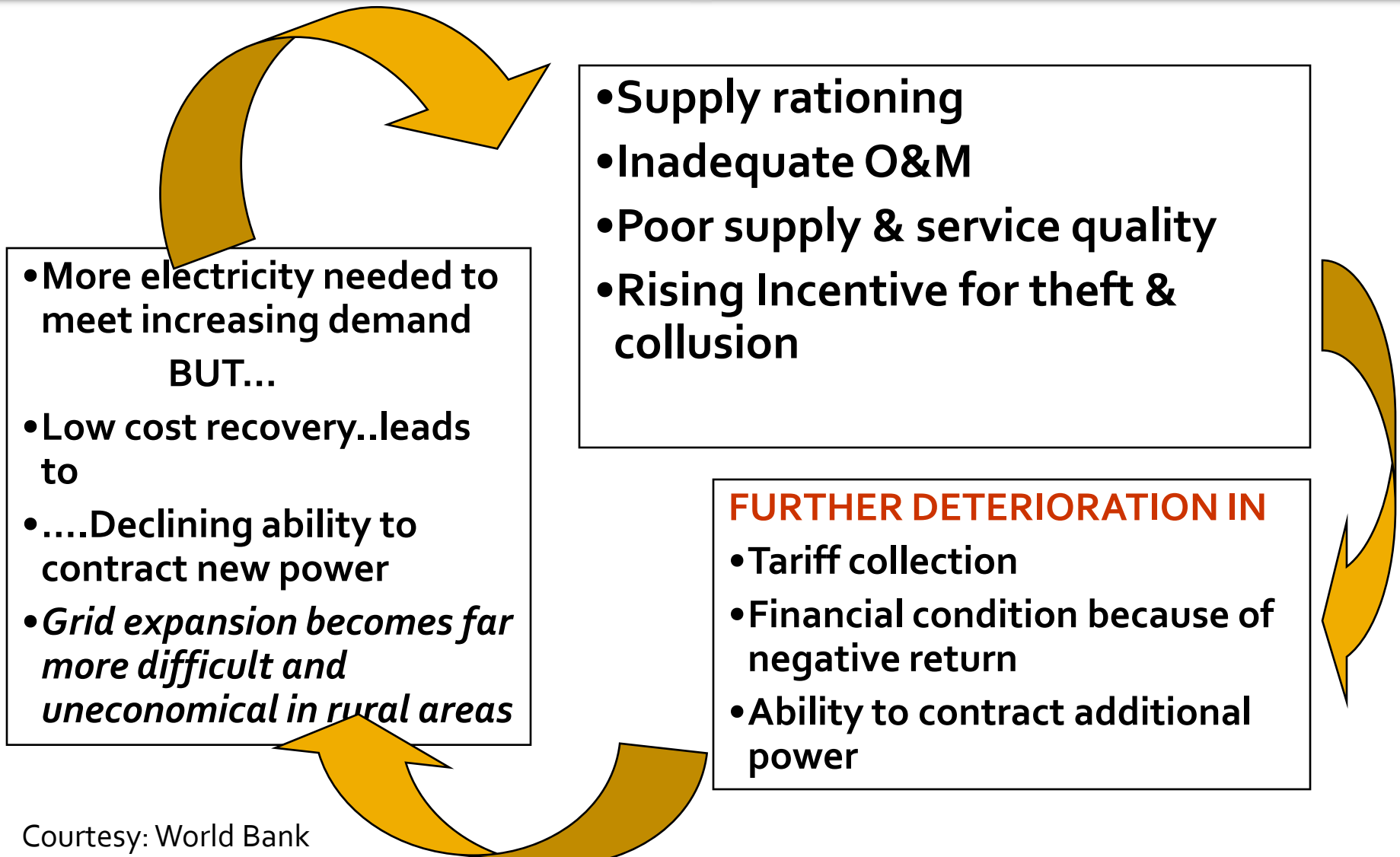
Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

- Flagship program for rural electrification in India - launched in 2005 aiming at 100% electrification
- Works on Grid extension (GE) model
 - *Decentralized Distributed Generation (DDG) only where grid supply is not feasible or cost effective*
 - *'Remote' villages supported through RVE as a 'temporary' measure*
- 90% of the capex is a grant is provided by Govt. of India

...but there are roadblocks and difficulties

- Nearly 28000 villages yet to be electrified
- Nearly 7-8000 villages declared unsuitable, non-economic for grid extension
- 6000 Villages electrified but not yet energised
- Many of the electrified villages still get very limited electricity supply- that too late in the night
- Disincentives
 - High cost of grid extension
 - Poor economic health of utilities
 - Poor revenue realisation from the users

A vicious cycle, where a consumer is a liability.....



Is the grid-extension and centralized power supply model the best option for rural electrification?

The decentralisation advantage....

- Cost

- Cost of grid extension to 12 km and beyond is broadly comparable with solar power*
- For villages beyond 3 km from the grid (hills) and 7 km(plains) solar is a cheaper option on NPV basis*
- No transmission losses-lower costs*

- Reliable

- Demand driven and tailored to local needs-Scalable as per local requirements
- Low gestation periods
- Local employment and enterprise opportunities



Have renewable based decentralised systems worked in India ?

The technology ladder- *Solar Home Lighting Systems*

- Individual systems- ranging from 40 watts to 1 kw
- A typical system comprises a 100 watt panel to power 2 -3 CFL lights and a mobile charging point
- Larger systems can support fans, television viewing too
- Incentivised through a capital subsidy of 40% and loan for the remainder of the cost
- Some banks insist on a small margin money by the user
- A strong retail network and good after-sales-service important criterion
- Nearly half a million systems installed so far



Central Charging Station based Solar Lighting systems

- A typical setup consists of a 50 lantern charging facility 300 Watts of solar panels
- Can also charge up to 10 mobile phones
- Villagers own the lantern, or pay rent for lantern plus a fee for charging lantern on a daily / monthly basis
- Model driven by NGO/rural entrepreneur at the village level
- Micro-financing for purchase of lanterns by the poor
- Federal Capital subsidy up to 40% and even 90% in some special areas



The first mini grids

Sunderbans, Bengal, India, 1997

- The 'beautiful forest' – 10,000 sq km. of forest and salt water swamp
- Ideal candidate for renewable decentralised systems
 - *Geographically isolated islands*
 - *No grid-connectivity*
 - *Unreliable and very expensive diesel supply grid*
- 15 solar PV mini-grids (900 KW), 3 biomass gasifier based mini-grids (1500 KW), 6 wind solar hybrids (24 KWp) installed
- Nearly 70% as grant; 30% user charges to cover opex and maintenance
- Strong community participation through *Panchayats*
- Supplementary support via stand alone HLS and PV based street lighting systems

Biomass Based Mini Grids

Husk Power Projects

- Biomass based power plants that uses rice husks/agricultural residues
- 32 kv capacity system with producer gas engine
- Current scale- 60 mini-power plants in 250 villages /hamlets powering ~ 25,000 households
- Micro-grid/Mini-grids to supply electricity
- Distribution network over an area of about 2 to 3 km
- Each system serves about 400 households and commercial users for 6-8 hours daily



Husk Power System...

- BOOM- Build, Own, Operate and Maintain model
- Rice husk purchased locally from rice mills
- Households pay fixed monthly charges; Commercial users, irrigation pumps pay more
- Prepaid meters to ensure payments, prevent overloads
- Central Financial assistance of about 40% besides support for distribution network, training and capacity building
- Saran Renewables, DESI Power, Gosaba in Sunderbans are other biomass mini grids with broadly similar models

Solar powered mini-grid models

Meerwada Project-Guna, India

- 14.3 KW Solar system with battery bank
 - **Designed for** 140 CFLs, 75 Fans, 15 TVs- all for 8 hours daily
 - **Actual usage-** 60 households 70 lights, 15 fans and 1 TV
 - **Excess energy** used to draw water from 4 HP pumps for 4 hours daily, solving the water problem in the area.
- Local Ownership
 - Established local Leadership Council
 - Volunteer Leader for every 10 Households to collect dues, protect system, resolve Issues
- Private initiative
 - Seeks to access federal support
 - Company CSR funding
 - Expansion plans



Community Hall with a rooftop solar power plant



Household connections



Pole mounted meters

Solar powered mini-grid models

Indo-Norwegian effort- Scatec Solar

- Mini grids of capacity between 5-30 Kw in 28 villages
- Set up with support from Indian and Norwegian governments
 - as a demonstration and learning experience
- Implementation and management through local NGOs and village communities
- Promote income generating activities
- Fixed charges plus user based on actual usage charges as revenue



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Economic Impact

Electricity generates enterprise and enterprise fuels the demand for electricity



*What challenges do mini
grids face?*

.....Is there a way out ?

Market failure at the Bottom of the Pyramid- *lack of demand and limited ability to pay*

Local commercial loads are limited



- In rural areas, commercial activities that need power are limited
- Typical commercial loads :
 - Agro-processing such as rice and pulses mills – load is **20-25 units/ton**
 - Irrigation pumpsets – typical load is **18 units/hr**
 - Shopkeepers and marketplaces – for lighting



As are the household loads



- The major usage of mini-grid power is for lighting purposes, mobile charging and ,in some cases, television viewing
- This typically translates into a load usage of 1 kwh/day/HH



Also Rural Loads are *"peaky"*

- There are variations in demand on a seasonal, daily and even hourly basis
- usage of high-powered irrigation pumps typically takes place in early mornings and evenings

Viability of the mini grid gets severely constrained as a result of its high costs and low demand- a vicious cycle

Costs of alternatives are critical...

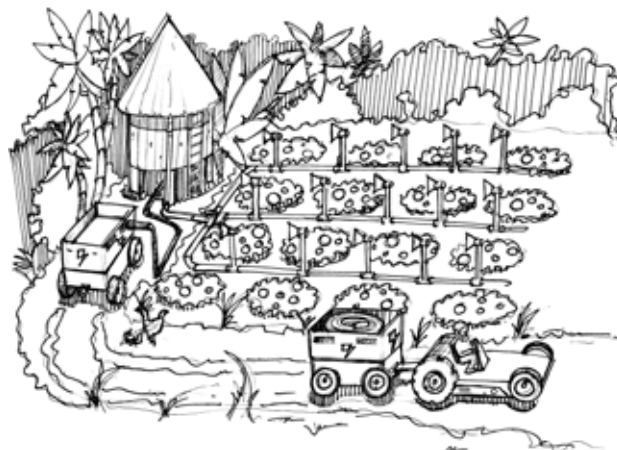
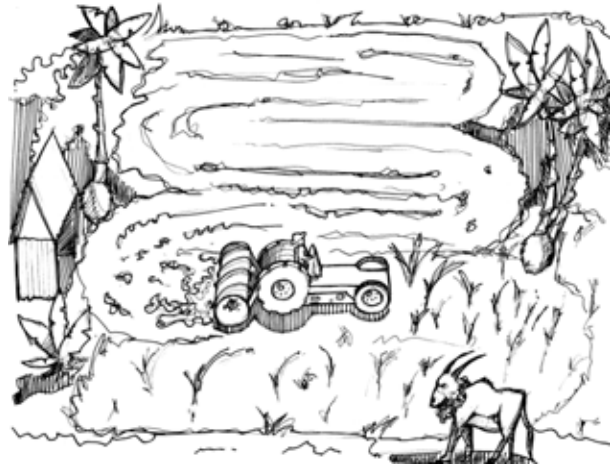
- Mini-grid systems also face an upper-bound on pricing for electricity
 - Due to the widespread use of diesel generators for electricity
 - That are being subsidized indirectly due to the subsidies on diesel, reducing the actual cost of generation
 - Compounded by the subsidies on kerosene (a much cheaper fuel) that is used to adulterate diesel or direct use for lighting
 - Comparison with cost of grid power- national policy

Why high capital subsidies are needed to make mini-grids viable....

- Nearly all the mini-grid developers have or are looking forward to availing of subsidies/support provided by the State and/or donor agencies
 - Husk's current breakeven is 2.5 years with capital subsidy support at nearly 40% of their plant cost
- Some models are fully or significantly state supported – Gosaba, Chattisgarh, UP
- Most models access support from more than one source- Husk, Scatec, DESI
- Private sector participation just beginning to pick up
 - Saran, Husk Power and DESI are all attempting market-based solutions
- Several private Solar PV based mini-grids are in an early stage
 - Mera Gaon Micro Grid Power, SCATEC Solar, Sun Edison etc.

...and enterprise and anchor loads are important

- All operators need enterprise loads-shops, irrigation pumps to be viable
- **Lack of low-tension grid connection rules out grid as an anchor load**
- Operators are looking at tying up with large commercial load users in their operational areas
 - Mobile phone towers that use a large amount of diesel
 - Indian Railways' network of stations, manned and unmanned rail crossings that need reliable and regular power
- DESI Power in collaboration with Rockefeller Foundation is working on a pilot project called SPEED to link their power plants with local mobile tower loads
- IFC and GSMA are piloting "Community Power from Mobile" which looks at providing off-grid communities from excess power generated by mobile telecom towers in their areas



Energy Interventions should prioritise livelihood generation activities. This will also increase purchasing power of villagers

Mini-grid models require extensive community engagement, resulting in high operating expenses

- **Need for extensive community engagement**

- Project planning –
 - customer surveys to understand community needs, typical loads required, load patterns and future loads
- Project running:
 - Monitoring of connections to guard against vandalism and power theft
 - Regular metering and bill collection
- Increasing anchor loads for the plant by promotion and creation of micro-enterprise activities by the community



- **Reducing costs...New operating models...?**
 - **BOOM** – Build, Own, Operate, Maintain.
 - **BOM** – Build, Own, Maintain
 - A local entrepreneur responsibility for operations and pays a royalty
 - **BM** – Build, Maintain
 - Husk will work on a turn-key basis with entrepreneurs who will invest their own resources
- Use of Pre-paid meters to reduce transaction costs
- Diesel generator operators and other entrepreneurs to act as “distribution franchisees”-DESI
- Village committees, local volunteer groups-Scatec, Sun Edison



Energy Intervention should be undertaken with host of other soft activities to ensure Inclusive Development

Local-level availability of human and other resources is a challenge...

- **Lack of adequate operations and maintenance support**
 - Lack of capacity; shortage of trained staff
 - operators have to invest their time and money in capacity building of staff to ensure that operations and maintenance can be handled in-house
 - Lack of timely support from equipment manufacturer:
 - Remote locations, poor connectivity
 - equipment manufacturers cannot help in resolving technical issues

Which operators are trying to overcome through the piloting of new interventions

- **Several company-level interventions are being tried**
 - DESI Power trying to provide training to women on the gasifier technology as well as on other management skills such as book keeping, project management and micro-enterprises
 - HPS has its own set up to train skilled technicians as well as power plant entrepreneurs

Financing is a major barrier to scaling up

- Debt financing from banks difficult
 - Higher perceived financial and technology risks
 - Entrepreneurs lack history of profit making
- Private equity too is difficult to attract
 - Investors worry about scalability and that most companies are still in the early stages of experimentation and are yet to exhibit any viability
 - PE investors perceive thin margins / low financial returns due to high costs and long-payback period
 - Fewer exit options for investors because of low prospects of such start ups going public soon

Who shall finance the mini grids ?

Government Support-support by the centre and the states- *capital subsidy, refinance*

- This is going to remain a critical element
- Policy interventions

International Development and Finance Organisations

- Equity or debt support, risk guarantees, capacity building
- Integration with other agendas like MDGs, SDAs

Social entrepreneurs, Impact investments and patient capital

Dedicated VC/PE funds for cleantech- Climate Change Capital,

- Commercial investing but with a social or cleantech objective- Shell, Acumen, INFUSE

Companies trying to expand businesses in Rural Market

- **Electricity as the platform- Phillips, mobile companies, television companies**

Carbon Finance to increase financial viability- Husk and Desi power trying to sell carbon credits

Policy support can break the vicious cycle and lead to scale up

Capital subsidy support

- MNRE offers capital subsidies on all the key mini-grid technologies
 - e.g. INR 15000/KW for dual-fuel based gasifiers plus INR 100000 per KW for distribution support
 - Bank linked subsidy support for HLS
- Availability of capital subsidies has enabled quite a few players to enter the market with interventions

Regulatory approvals for mini-grids

- Post Electricity Act 2003 and Rural Electricity Policy 2006, Companies exempted from distribution license for distributed generation and supply in notified rural areas
- Freeing up of the approval process for mini-grids plants has enabled operators to start plants much more quickly

Taxation benefits

- Reduced import duties for RE components and systems
- Tax holidays for RE projects
- Accelerated depreciation benefits available; exemption from GST in some states
- Providers of finance to these projects get tax exemption on capital gains, dividends and interest incomes
- Exemption from excise duties for equipment
- Highly encouraging regulatory environment for manufacturers and investors (domestic and foreign) to enter the mini-grid market and scale-up activity
- Increases the viability of projects

Can policy support help break the vicious cycle

- RE off-grid projects to avail renewable energy certificates (RECs) ?
- RE based rural electrification projects to avail GBI from local utilities who in turn could use the power to meet RPO obligations ?
- Direct intervention from the government- market led GBI/VGF based support scheme
- Risk guarantee fund ?

Private Rural Electrification Projects- lessons

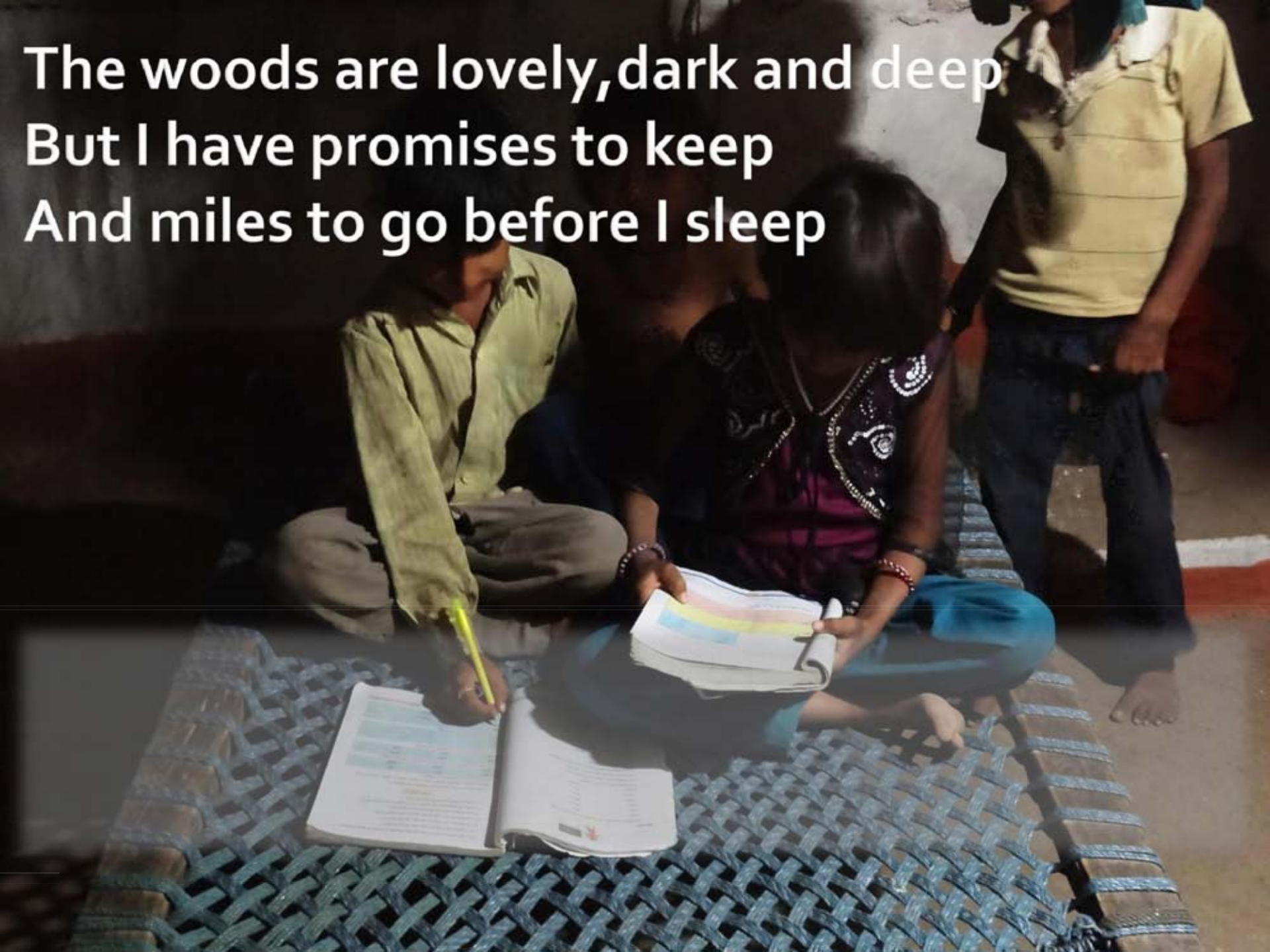
- Build Scale to cut costs and ensure bankability and commercial viability
- Government subsidy and bank finance/equity critical
- Battery & Grid drive costs –Hybrids-solar-biomass, others ?
 - technology neutrality- let economics and local conditions decide
- Load management- anchor/enterprise load and predictability important
- Community participation, capacity building and plant O&M
- Policy support- RECs, GBI, Tax benefits and regulatory



Private Rural Electrification Projects- Questions ?

- How do RE mini-grids coexist with traditional grids ?
- Does the regulatory mechanism allow you to charge a higher per unit price-national policy commitment
- Will the community accept it as a stop *en-route* grid power or is this the final solution ?
- Is BoP an attractive proposition for investors to put their dollars ?

The woods are lovely, dark and deep
But I have promises to keep
And miles to go before I sleep



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