SUSTAINABLE MINI-GRID

A MODEL FOR INDIA

NAYANJYOTI GOSWAMI
Energy Access - India

- Electricity: 67.25%
- Kerosene: 31.43%
- Solar: 0.44%
- Biomass: 0.20%
- Other Oils: 0.20%
- No Lighting: 0.47%
Energy Access – Urban India

- Electricity, 92.70%
- Kerosene, 6.50%
- Other Sources, 0.50%
- No Lighting, 0.30%
Energy Access – Rural India

- Electricity, 55.30%
- Kerosene, 43.20%
- No Lighting, 0.50%
- Other Sources, 1.00%
## Six states – pathetic statistics

<table>
<thead>
<tr>
<th>States</th>
<th>Rural 2011</th>
<th>Total Households</th>
<th>2011</th>
<th>Electricity</th>
<th>Kerosene</th>
<th>Other Sources</th>
<th>No Lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bihar</td>
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<tr>
<td>Rural</td>
<td>16,926,958.0</td>
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<td>88.4</td>
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<tr>
<td>Urban</td>
<td>2,013,671.0</td>
<td>1,322,583.0</td>
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<td>32.2</td>
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<td>Total</td>
<td>18,940,629.0</td>
<td>13,982,590.0</td>
<td>16.4</td>
<td>82.4</td>
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<td>West Bengal</td>
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<tr>
<td>Rural</td>
<td>13,717,186.0</td>
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<td>85.1</td>
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<td>15,715,915.0</td>
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<td>1.5</td>
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<td>Assam</td>
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<td>992,742.0</td>
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<td>15.2</td>
<td>0.5</td>
<td>0.3</td>
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<td>Odisha</td>
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<td>Rural</td>
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<td>0.6</td>
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<td>15.3</td>
<td>0.4</td>
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<td>Total</td>
<td>9,661,085.0</td>
<td>7,870,127.0</td>
<td>43.0</td>
<td>55.3</td>
<td>0.6</td>
<td>1.1</td>
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<td>Jharkhand</td>
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<tr>
<td>Rural</td>
<td>4,685,965.0</td>
<td>3,802,412.0</td>
<td>32.3</td>
<td>66.4</td>
<td>1.2</td>
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<td>1,060,178.0</td>
<td>88.0</td>
<td>11.4</td>
<td>0.5</td>
<td>0.1</td>
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<tr>
<td>Total</td>
<td>6,181,607.0</td>
<td>4,862,590.0</td>
<td>45.8</td>
<td>53.1</td>
<td>1.0</td>
<td>0.1</td>
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<tr>
<td>Uttar Pradesh</td>
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<tr>
<td>Rural</td>
<td>25,475,071.0</td>
<td>20,590,074.0</td>
<td>23.8</td>
<td>75.0</td>
<td>1.1</td>
<td>0.1</td>
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<tr>
<td>Urban</td>
<td>7,449,195.0</td>
<td>5,170,527.0</td>
<td>81.4</td>
<td>17.2</td>
<td>0.9</td>
<td>0.4</td>
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<tr>
<td>Total</td>
<td>32,924,266.0</td>
<td>25,760,601.0</td>
<td>36.8</td>
<td>61.9</td>
<td>1.0</td>
<td>0.2</td>
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</tbody>
</table>
Why mini-grid make sense?

- Increasing gap between demand and supply – Rising imports
- Over dependency on fossil fuel – serious climate change concerns
- Acute energy poverty in rural India – cause of low HDI index
- Rapid growth in the power sector will not serve the poor
- RE potential – opportunity to leapfrog from polluting fossil fuel to clean energy
- A huge rural market beginning to unfold
What is Mini-Grid?

- Grid – High voltage backbone system of interconnected transmission lines, substations and generating plants.
- Mini-grid – Smaller version of a grid
- But how small it is?
  - 1.5 kW serving 200 customers?
  - 32 KW serving 400 customers?
# Rural household requirement

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Load (W)</th>
<th>Quantity (No)</th>
<th>Hours of consumption</th>
<th>Consumption/day (Wh)</th>
<th>Consumption/month (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL lamps</td>
<td>11</td>
<td>2</td>
<td>6</td>
<td>132</td>
<td>3.96</td>
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<tr>
<td>CFL lamps</td>
<td>8</td>
<td>1</td>
<td>6</td>
<td>48</td>
<td>1.44</td>
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<tr>
<td>Ceiling fans/table fan</td>
<td>75</td>
<td>1</td>
<td>12</td>
<td>900</td>
<td>27</td>
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<tr>
<td>Mobile charging</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>24</td>
<td>0.72</td>
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<tr>
<td>Television</td>
<td>80</td>
<td>1</td>
<td>5</td>
<td>400</td>
<td>12</td>
</tr>
<tr>
<td>VCD drive/set-top box</td>
<td>30</td>
<td>1</td>
<td>5</td>
<td>150</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Total: 212 7 37 1654 49.62
## Requirement for 50 households

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Load (W)</th>
<th>Quantity (No)</th>
<th>Hours of operation</th>
<th>Consumption/day (Wh)</th>
<th>Days /month</th>
<th>Consumption/month (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential needs for 50 households</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2481.00</td>
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<tr>
<td>Pump set</td>
<td>3000</td>
<td>1</td>
<td>4</td>
<td>12000</td>
<td>20</td>
<td>240.00</td>
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<tr>
<td>Livelihood (marketplace)</td>
<td>11</td>
<td>20</td>
<td>5</td>
<td>1100</td>
<td>30</td>
<td>33.00</td>
</tr>
<tr>
<td>Flour mill</td>
<td>5000</td>
<td>1</td>
<td>2</td>
<td>10000</td>
<td>20</td>
<td>200.00</td>
</tr>
<tr>
<td>Street lighting</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>1100</td>
<td>30</td>
<td>33.00</td>
</tr>
<tr>
<td>Community centre/anganwadi/hospital</td>
<td>500</td>
<td>1</td>
<td>4</td>
<td>2000</td>
<td>30</td>
<td>60.00</td>
</tr>
</tbody>
</table>

**Total demand per month** 3047.00

**Technical and commercial losses @ 20 per cent** 761.75

**Total number of units required to be generated per month** 3808.75 ≈ 3800.00
Definition of mini-grid

- A set of electricity generators, possibly with energy storage system interconnected to a distribution network that is capable of generating at least 3800 units per month in peak power condition to serve 50 households.
  - Technology neutral
  - A minimum size is defined
  - A minimum service parameter is defined
Challenges in the definition

- What will happen to the excess power if demand is less?
  - Interconnected to grid if available
  - If grid is not available – excess power is wasted
    - Proper assessment of demand & its growth
    - Scheduling of power based on demand
    - Economic activities - productive activities
    - Base loads
Amendments in policies

- **Electricity Act – 2003**
  - Define mini-grid
  - Direct NEP to formulate policies for DISCOMs to sell and purchase power from mini-grids
  - Energy equity – equivalent to kerosene replacement cost
  - Electricity supply code for mini-grids
  - Institute MVA for monitoring, verification and rating
  - Follow certain clause of EA part - VI
Amendments in policies

- **National Electricity Policy - 2005**
  - Redefine REDB
  - Lay down grid interconnectivity with mini-grids

- **National Tariff Policy – 2006**
  - RPO must include certain % of power from mini-grids
  - Mandate SERCs to decide preferential tariff for mini-grids

- **Rural Electrification Policy - 2006**
  - Shift the focus from grid extension to mini-grids
Renewable Energy

Amendments in schemes

- **DDG**
  - Mini-grids in grid connected villages where electricity is less than 12 hours

- **JNNSM**
  - Mini-grids in remote villages only through proposed REAP scheme
  - Off-grid applications like – solar pumps
Tariff Mechanisms

- **Mini-grids in grid connected areas**
  - Feed – in – Tariff from REC directly.
    - Sources – RGGVY, Kerosene subsidy
  - Tariff from served customers

- **Mini-grids in remote areas**
  - Generation based incentives from MNRE directly.
    - Sources – NCEF Fund, Green Climate Fund
  - Tariff from served customers
Capital Expenditure

- **Debt Finance**
  - Bank with soft loans – backed by credit guarantee from government for bankable projects
  - CSR Funds / Multilateral funds for non bankable projects

- **Equity Finance**
  - Mini-grid developer
The Model

**Bankable Projects**
- Credit Guarantee Scheme
- Banks
- CSR Funds
- Multilateral Funds

**Monitoring, Verification and Rating**
- MVA

**Proposed REAP Scheme**
- Mini-grid developer
- Flow of Electricity
- Flow of FIT/GBA

**DDG Scheme**
- DISCOM
- REC
- MNRE

**National Fund**
- RGGVY
- Kerosene Subsidy
- NCEF Fund

**Global Fund**
- Green Climate Fund

**Recipients**
- Customer
- Customer
- Customer

**Flow of Electricity**
- Flow of capital

**Flow of tariff**

**Flow of capital**

**Flow of tariff**

**Flow of Electricity**

**Flow of FIT/GBA**

**Flow of Capital**

**Flow of Tariff**

**Customer**

**Customer**

**Customer**

**Customer**
Features of the model

- Source and flow of funds defined
- Bankable and non bankable projects dealt separately
- MVA for monitoring, verification and rating
- Global fund for FIT / GBI
- Cluster approach
- Grid interconnectivity if grid is available
- Energy equity
Cap-ex requirement - India
Renewable Energy

FIT/GBI requirement - India

Rs. Crore

- 2014-15: 15,909
- 2015-16: 30,656
- 2016-17: 53,726
- 2017-18: 73,368
- 2018-19: 109,024
- 2019-20: 122,762
- 2020-21: 136,142
- 2021-22: 143,744
- 2022-23: 127,835
- 2023-24: 113,089
- 2024-25: 90,018
- 2025-26: 70,376
- 2026-27: 49,038
- 2027-28: 34,720
- 2028-29: 20,982
- 2029-30: 7,602
- 2030-31: -
Selection of mini-grid developer

- Bidding
- Bid preparation
- Financial eligibility
- Distribution of electricity – adhere to provisions
- O&M and capacity building