Comparison and Evaluation of Mini Grids Regulatory and Subsidy Systems and Power Purchase Agreements

Energy Sector Management Assistance Program

21 November 2017
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• Comparative Analysis and Lessons
  – How Location is Decided
  – Regulation of Entry
  – Retail Tariff Setting
  – Subsidies
  – Service Standards
  – Technical Standards
  – Relation with the Main Grid – Distribution
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• Key Takeaways
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  – Service Standards
  – Technical Standards
  – Relation with the Main Grid – Distribution
  – Relation with the Main Grid – PPAs
• Key Takeaways
Overview of Case Studies and Mini Grid Success

- **Nigeria**
  - 10,300 people served
  - $0.36/kWh
  - Mostly 24 hours/day

- **Uttar Pradesh**
  - 205,000 people served
  - $0.25-1.18/kWh
  - 7 hours/day

- **Bangladesh**
  - 20,900 people served
  - $0.38/kWh
  - 24 hours/day

- **Cambodia**
  - 4.7 million people served
  - $0.29/kWh
  - Mostly 24 hours/day

- **Kenya**
  - 4,400 people served
  - $0.67-$0.80/kWh
  - 24 hours/day

- **Tanzania**
  - 35,250 people served
  - $0.13-$1.30/kWh
  - 16-24 hours/day
**Cambodia**

**Number of mini grids**

<table>
<thead>
<tr>
<th>Access Provided by mini grids</th>
<th>327</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population (million)</strong></td>
<td><strong>People served by mini grids (million)</strong></td>
</tr>
<tr>
<td>15</td>
<td>4.7</td>
</tr>
</tbody>
</table>

**Affordability**

<table>
<thead>
<tr>
<th>GDP per capita (PPP, 2011 US$)</th>
<th>Annual household bill for 73kWh/year (US$)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,291</td>
<td>21.4</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

**Mini grids regulatory regime post 2001:**

- Location determined by a bottom-up approach
- License required
- Tariffs for isolated mini grids regulated at individual cost recovery level
- Tariff subsidies allow uniform tariffs for grid-connected mini grids
- Interest-free loans for connections
- Subsidized finance for distribution line extension based on viability of the area
- When the main grid arrives, entrepreneur investment is protected

**Dominant technology:** diesel, grid-connected

**Tariff (US$/kWh)**

<table>
<thead>
<tr>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15 (&lt;50 kWh/month)</td>
<td>0.29</td>
</tr>
<tr>
<td>0.20 (&gt; 200 kWh/month)</td>
<td></td>
</tr>
</tbody>
</table>

**Hours of service of the main grid (hours/day)**

<table>
<thead>
<tr>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Mostly 24</td>
</tr>
</tbody>
</table>

**Electricity Law of Kingdom of Cambodia**

Introducing regulation for all mini grids

Laissez-faire
Regulation not present or not enforced

- 3.6 million people served by the main grid
- 6.7 million people without electricity
**Uttar Pradesh**

### Number of mini grids

<table>
<thead>
<tr>
<th>Access Provided by mini grids</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (million)</td>
<td>People served by mini grids (million)</td>
</tr>
<tr>
<td>211.2</td>
<td>0.21</td>
</tr>
</tbody>
</table>

### Affordability

<table>
<thead>
<tr>
<th>GDP per capita (PPP, 2011 US$)</th>
<th>Annual household bill for 73kWh/year (US$)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>876</td>
<td>61.6</td>
<td>7.0%</td>
</tr>
</tbody>
</table>

### Tariff (US$/kWh)

<table>
<thead>
<tr>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>0.25-1.18</td>
</tr>
</tbody>
</table>

### Hours of service of the main grid (hours/day)

- Urban: 20-24
- Rural: 9
- Mostly 7

### Number of people served by mini grids

- 99.6 million people served by the main grid
- 107 million people without electricity

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**Mini grids regulatory regime:**

- ✓ Registration required
- ✓ Tariffs are unregulated
- ✓ State-subsidies trigger tariff regulation and service standards
- ✓ Ad hoc concessional financing available
- ✓ When the main grid arrives, entrepreneur investment is protected

**Dominant technology:** solar

**Electricity Act**

- Allowing private operators to provide services in rural areas without license

**Mini Grid Policy**

- Establishing subsidy system and promoting decentralized generation of clean energy
### Bangladesh

**Number of mini grids**: 10

<table>
<thead>
<tr>
<th>Access Provided by mini grids</th>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population (million)</strong></td>
<td>0.8</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>People served by mini grids (million)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>159</td>
<td>0.021</td>
<td>0.01%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Affordability</th>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP per capita (PPP, 2011 US$)</strong></td>
<td>3,133</td>
<td></td>
</tr>
<tr>
<td><strong>Annual household bill for 73kWh/year (US$)</strong></td>
<td>26.7</td>
<td></td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td>0.9%</td>
<td></td>
</tr>
</tbody>
</table>

**Mini grids regulatory regime:**
- Location determined by indicative planning approach
- Quasi-regulation of entry via contract with IDCOL
- Uniform tariffs across mini grids imposed by contract with IDCOL
- Standard package of capital grants and concessional loans provided by IDCOL
- When main grid arrives, entrepreneur investment is protected

**Dominant technology**: solar with diesel back-up and batteries

### Tariff

<table>
<thead>
<tr>
<th>Tariff (US$/kWh)</th>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Hours of service of the main grid (hours/day)</th>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-22</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

- 72.1 million people served by the main grid
- 59.8 million people without electricity

#### Renewable Energy Policy
Exempting mini grids up to 5MW to obtain a license (never translated into law or regulation)

#### BERC Act
Making illegal to develop mini grids unless authorized by a license

#### Guidelines for the Implementation of Solar Power Development Program:
Implementation of 2008 Policy
**Tanzania**

**Number of mini grids**: 109

**Access Provided by mini grids**

<table>
<thead>
<tr>
<th>Population (million)</th>
<th>People served by mini grids (million)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.5</td>
<td>0.035</td>
<td>0.07%</td>
</tr>
</tbody>
</table>

**Affordability**

<table>
<thead>
<tr>
<th>GDP per capita (PPP, 2011 US$)</th>
<th>Annual household bill for 73kWh/year (US$)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,491</td>
<td>52.6</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

**Mini grids regulatory regime:**

- Location determined by indicative planning approach
- Registration and license required above 100kW
- Tariff approval not necessary for systems between 100kW and 1MW, but can be regulated if complaints
- Tariffs for mini grids above 1MW regulated at individual cost recovery level
- Grants for pre-investment studies
- Concessional loans through commercial banks
- Results-Based Financing (RBF) grants for connection
- When the main grid arrives there is uncertainty as to whether assets would be completely protected

**Dominant technologies**: hydro, biomass, solar

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<table>
<thead>
<tr>
<th>Year</th>
<th>Main grid</th>
<th>Mini grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>8,963</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>35,250</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>5,000</td>
<td>10,000</td>
</tr>
<tr>
<td>2012</td>
<td>15,000</td>
<td>20,000</td>
</tr>
<tr>
<td>2013</td>
<td>25,000</td>
<td>30,000</td>
</tr>
<tr>
<td>2014</td>
<td>30,000</td>
<td>35,000</td>
</tr>
<tr>
<td>2015</td>
<td>30,000</td>
<td>40,000</td>
</tr>
</tbody>
</table>

**Tariff (US$/kWh)**

- Main grid: 0.14
- Mini grid: Between 0.13-1.30

**Hours of service of the main grid (hours/day)**

- Main grid: 16-23
- Mini grid: 16-24

**Number of people served by mini grids**

- 1.7 million people served by the main grid
- 43.8 million people without electricity

**GDP per capita (PPP, 2011 US$)**

- 2,491

**Annual household bill for 73kWh/year (US$)**

- 52.6

**Electricity Act**

Providing mini grids developers with the legal framework for electricity supply

**First generation of SPP rules**

**Second generation of SPP rules**

**Third generation of SPP rules**
### Kenya

<table>
<thead>
<tr>
<th>Number of mini grids</th>
<th>&gt;21</th>
</tr>
</thead>
</table>

#### Access Provided by mini grids

<table>
<thead>
<tr>
<th>Population (million)</th>
<th>People served by mini grids (million)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.1</td>
<td>0.004</td>
<td>0.002%</td>
</tr>
</tbody>
</table>

#### Affordability

<table>
<thead>
<tr>
<th>GDP per capita (PPP, 2011 US$)</th>
<th>Annual household bill for 73kWh/year (US$)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,836</td>
<td>54.0</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

#### Energy Regulations

- Allowing generation and supply of electricity up to 3MW with permit
- Not specific to mini grids
- Regulation specific to mini grids expected

**Main grid**

| Hours of service of the main grid (hours/day) | 24 |

**Mini grid**

| Tariff (US$/kWh) | 0.67-0.80 |

| Number of people served by mini grids | 4,400 |

- 6.2 million people served by the main grid
- 28.7 million people without electricity

**Dominant technology:** diesel, hybrid, solar
### Nigeria

#### Number of mini grids
- **12**

#### Access Provided by mini grids

<table>
<thead>
<tr>
<th>Population (million)</th>
<th>People served by mini grids (million)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>182</td>
<td>0.01</td>
<td>0.006%</td>
</tr>
</tbody>
</table>

#### Affordability

<table>
<thead>
<tr>
<th>GDP per capita (PPP, 2011 US$)</th>
<th>Annual household bill for 73kWh/year (US$)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,671</td>
<td>26.4</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

#### Tariff (US$/kWh)
- **Main grid**: 0.08
- **Mini grid**: 0.36

#### Hours of service of the main grid (hours/day)
- **Main grid**: 9
- **Mini grid**: 24 for 8 mini grids

#### Number of people served by mini grids
- **10,239**

- **30.8 million people served by the main grid**
- **75 million people without electricity**

### Mini grids regulatory regime:
- ✓ Location currently determined by a bottom-up approach but top-down approach planned
- ✓ Registration required below 100kW, permit required above 100kW, license required above 1MM
- ✓ Community agreement required
- ✓ Tariffs can be set at cost recovery level using regulator’s methodology or by community contract for registered systems
- ✓ Tariffs regulated at cost recovery level for mini grids with permit or license
- ✓ No national subsidy program, but ad hoc subsidies including guarantees, grants, result-based financing
- ✓ When the main grid arrives, investment for registered mini grid is not protected, but investment for mini grid with permit or license is protected

### Dominant technology:
- Solar

### Electric Power Sector Reform Act
- License mandatory for systems above 1MW of generating capacity and 100kW of distributing capacity

### Mini grid regulation issued
- Completing the framework for authorizing mini grids
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  – Service Standards
  – Technical Standards
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  – Relation with the Main Grid – PPAs

• Key Takeaways
# How Location is Decided

## Bottom-Up

Entrepreneur chooses the sites where they see profitable opportunities

- ✓ Develop least cost sites
- ✓ No reliance on Government to solicitate bids, which can allow faster development of mini grids

**Cambodia**

**Uttar Pradesh**

## Indicative Planning

Government indicates where the developers are encouraged to develop mini grids

- ✓ Accelerate electrification in some areas
- ✓ No reliance on Government to solicitate bids

**Tanzania**

**Bangladesh** — subsidized MG

## Top-Down

Government decides where mini grids should be located and attracts developers in these areas

- ✓ Reduce development costs for developers, and increase viability of mini grids
- ✓ Accelerate electrification in some areas

**Kenya** — planned

**Nigeria** — planned (one round of call for tenders)
How Location is Decided - Lessons

✓ Bottom-up approach used in most successful countries

✓ Bottom up approach can be a good response to low Government administrative and financial capacities
  → Cambodia’s early expansion of mini grids despite being a fragile, conflict-affected state

✓ Nigeria and Kenya are planning to shift to a top down approach to accelerate expansion of mini grids. The success of this approach will depend on:
  ▪ The financial returns available to entrepreneurs
  ▪ The number of entrepreneurs able to respond to achieve the scale targeted
  ▪ Government financial and administrative to manage the program
Regulation of Entry

Laissez-faire  Registration  Permitting  Licensing

Level of Government intervention

Cambodia pre 2001

Uttar Pradesh (in practice)

Bangladesh – quasi regulation by contract by IDCOL

Tanzania – MGs <100kW

Tanzania – MGs > 100kW and < 1MW

Nigeria – Isolated MGs < 100kW of distributed power

Kenya – MGs < 3MW

Kenya – MGs > 3MW

Bangladesh – law requires license but ignored in practice

Tanzania – MGs > 100kW and < 1MW

Nigeria – MGs >100kW of power and <1MW of generation capacity

Nigeria – MGs > 1MW (considered IPPs)
Regulation of Entry – Lessons

✓ Absence of regulation seems to favor initial mini grid penetration and permitting requirement and regulation can deter entry
  ▪ **Cambodia** and **Uttar Pradesh** have the highest MG penetration rates, and:
    - Loose and poorly enforced regulation in Cambodia when mini grids started to develop
    - No regulation in Uttar Pradesh
  ▪ In **Nigeria**, all mini grids are below 100kW, the threshold for permitting. Developers avoid permitting which triggers regulation on technical standards, tariffs, and restrictions on MGs location.

✓ Permitting/licensing may work best once the mini grid market has already started developing. **Cambodia** continued to experience a strong penetration of MGs after the regulation in 2001 when licensing was introduced.

✓ Minimal regulation of entry avoids the need for high degree of administrative capacity
  In **Uttar Pradesh**, where there are now about 1,900 MGs, the minimal regulation limited the administrative burden
## Retail Tariff Setting

<table>
<thead>
<tr>
<th>No regulation</th>
<th>Quasi regulation</th>
<th>Legal regulation</th>
</tr>
</thead>
</table>
| **Cambodia** – pre 2001 | **Uttar Pradesh** – subsidized MGs, uniform tariff imposed by subsidy contract | **Cambodia** – post 2001:  
  - Individual cost-recovery tariff for isolated MGs  
  - Uniform tariff for grid-connected MGs |
| **Uttar Pradesh** – unsubsidized MGs | **Bangladesh** – uniform tariff for all MGs (higher than main grid) imposed by implementation agreement with IDCOL | **Tanzania** – MGs > 100kW and <1MW  
  - Tariff approval not required  
  - Regulator can change it if there are complaints from 15% of customers  
**Tanzania** – MGs > 1MW  
  - Tariff approval required  
  - Individual cost-recovery tariff with a reasonable rate of return  
**Kenya**  
  - Individual cost-reflective tariffs  
  - IRR limited to 18% |
| **Tanzania** – MG <100 kW | **Nigeria** - Isolated registered mini grids can set cost-reflective tariffs, either:  
  - Using regulator’s MYTO methodology  
  - Agreeing the tariff with the community (Regulator can exert ex-post tariff regulation) | **Nigeria** – Isolated mini grids with permit:  
  - Must use regulator’s methodology to set cost-recovery tariff (MYTO)  
  - Tariff must be approved by regulator |
Retail Tariff Setting - Lessons

✓ Unregulated tariffs used in most successful countries:
  ▪ Cambodia before 2001
  ▪ Uttar Pradesh

✓ In several cases, regulation of tariff is deterring entry of mini grids:
  ▪ Nigeria: all developers are staying below the 100kW threshold which triggers regulation on tariff
  ▪ Uttar Pradesh: tariff regulations for state-subsidized mini grids make the business model unviable; and no private operator has used the state subsidies

✓ In most countries, subsidies trigger tariff control, even though there is not a national regulatory system:
  ▪ Legal regulation:
    - Cambodia: tariff subsidy grid-connected mini grids that charge a uniform tariff
  ▪ Quasi regulation:
    - Bangladesh: implementation agreement with IDCOL
    - Kenya, Nigeria: soft control for GIZ supported mini grids (with GIZ financial model)
    - Uttar Pradesh: subsidy contract
### Subsidies

**Unsubsidized private finance**
- **Cambodia** – pre 2001

**Ad hoc subsidies**
- **Uttar Pradesh**
  - Soft loans and grants from investment funds and international donors
- **Tanzania** – MGs > 1MW
  - Grants for pre-investment studies
  - Concessional loans channeled through a commercial bank, at 5.6%
  - Results-Based Financing (RBF) for connection grants (50-63% of cost)

**National Subsidy Program**
- **Cambodia**:
  - Interest-free loans of 117US$/connection through licensee
  - Interest-free loans, guarantees, and capital grants for distribution lines, depending on viability of area
  - Tariff subsidy for grid-connected MGs to cover difference between uniform and cost-recovery tariff
- **Uttar Pradesh**: State subsidy triggering tariff and standard regulation
- **Bangladesh** – subsidies by IDCOL, standard package for solar MGs:
  - Grants up to 50% costs
  - Concessional loans at 6% rate up to 30% costs
- **Nigeria**
  - Concessional loans at 7% interest rate
  - GIZ support through split-asset model
- **Kenya**
  - Ad hoc subsidies from international donors, including guarantees, grants, result-based financing
  - Financing 120 mini grids by KPLC under PPP, funded by World Bank
  - Connection subsidy
Subsidies - Lessons

✓ Successful national subsidy program in Cambodia
  ▪ Switch from grants to zero interest loans to finance connections
  ▪ Amount of subsidy provided depends on the viability of areas based on population density:
    - Guarantees: area with high density of population having economic efficiency
    - Interest-free loan: “area with medium density of population, where doing electricity business may not be profitable” and “area with low density of population, where doing electricity business is not viable”
    - Capital grants: “area with low density of population, where doing electricity business is not viable”

✓ Mini grids can develop and be affordable without Government subsidies:
  ▪ Uttar Pradesh: Consumers can afford private mini-grid power at the basic tier without state subsidies

✓ Unsuccessful models:
  ▪ Bangladesh:
    • system not working because the subsidy is not trying to set a level based on what is needed, and instead provides uniform practice and subsidy
    • If want to maximize access, customers need to pay as much as they can and the subsidies are only used to close the viability gap
    • need for mini-grid developers to provide 100% collateral to IDCOL loans, might be refraining mini-grid system expansion in Bangladesh
  ▪ Uttar Pradesh: subsidy conditions make the business model not viable

✓ Kenya model will only work if KPLC can sustain financing
Quality of Service Standards

- **None**
  - Cambodia – pre 2001

- **Hours**
  - Cambodia – post 2001

- **Reliability**
  - Cambodia – post 2001

- **Voltage /frequency stability**
  - Cambodia – post 2001

- **Billing and Metering**
  - Cambodia – post 2001

- **Customer Service**
  - Cambodia – post 2001

**Cambodia – post 2001**
- Uttar Pradesh – state-subsidized MGs
- Bangladesh
- Tanzania – for MGs receiving result based financing
- Tanzania
- Kenya

**Uttar Pradesh – unsubsidized MGs**
- Bangladesh

**Uttar Pradesh – state-subsidized MGs**
- Tanzania – for MGs receiving result based financing

**Bangladesh**
- Nigeria – MGs with a permit or license

**Nigeria**
- Nigeria – registered MGs (through community contract) or MGs with permit or license

**Kenya**
Mini grids can develop without service standards and following what the market wants:

- **Cambodia** before 2001: no service standards and poor quality of service (4 hours/day)
- **Uttar Pradesh**: no mini grid required to follow service standards in practice. The quality of service is variable depending on the mini grids (6 to 24 hours/day) but higher than the main grid, at least in rural areas (2-8 hours/day), where mini grids developed as an alternative to the grid.

A successful approach seems to set service standards to improve quality of service once the mini grid market is already developed:

98% of Cambodia’s mini grids now provide electricity 24 hours/day
### Technical Standards

<table>
<thead>
<tr>
<th></th>
<th>Equipment and Design</th>
<th>Safety</th>
<th>Voltage – Frequency level</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uttar Pradesh</td>
<td>Uttar Pradesh</td>
<td>Uttar Pradesh – state-subsidized MGs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Bangladesh</td>
<td>Bangladesh – for registered and licensed operators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanzania – for registered and licensed operators</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kenya</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigeria – MGs with a permit or license</td>
<td></td>
<td>Nigeria – MGs with a permit or license</td>
<td></td>
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<tr>
<td>Nigeria – MGs with a permit or license</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
In many countries, technical standards are too stringent compared to what is really necessary, and can increase significantly developers’ costs:

- **Tanzania**: some developers pointed out that there were unreasonable requirements in terms of distance from the road and height of the poles
- **Bangladesh**: some developers pointed out that standards for poles were too stringent, and compliance with standards accounted for 25% of their capex. The developers were not allowed not develop cheaper DC mini grids.

**Enforcement mechanisms include**:

- **Cambodia** has a successful but resource intensive penalty and incentive mechanism:
  - **Penalty**: if the licensee’s assets do not comply with regulator’s standards, they are not allowed in the asset base used to calculate the tariff
  - **Incentives**: length of license is conditioned on meeting service standards; licensees receive subsidies and technical assistance to comply with standards.

  These standards are enforced, regulator visits mini grids once or twice a year.

- **Tanzania**: licensed and registered operators must comply with the standards to receive compensation when the main grid arrives – mechanism has not been used yet
- **Uttar Pradesh**: regulator enforces technical and safety standards through a grievance mechanism by customers. If operators does not respect standards, project subsidy could be cancelled or operator could be blacklisted – mechanism has not been used yet

Standards can be used to ensure that connection of mini grid to the main grid is possible once the grid arrives:

- **Tanzania** requires its mini grids to use TANESCO-approved meters to later connect the mini grid to the main grid.
### Relation with the Main Grid – When grid arrives

<table>
<thead>
<tr>
<th>Country</th>
<th>Information on grid expansion</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>• Neither EDC nor transmission licensees share their expansion plans</td>
<td>Yes: license automatically transformed into distribution license</td>
</tr>
<tr>
<td></td>
<td>• MGs informed in advance that will be connected to grid</td>
<td>Yes: Keep selling to customers at usual tariff + sell excess to utility at State FIT</td>
</tr>
<tr>
<td></td>
<td>• UPPTCL publishes information on maps, infrastructure plans and tenders</td>
<td>• Sell all energy to utility at State FIT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Option to sell distribution assets at depreciated value at agreed price, if utility refuses must compensate at RPO level</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>With indicative planning approach, IDCOL finances mini grids only in areas where the main grid not expected within 4 to 5 years</td>
<td>Yes: if the grid extends after 5 years, mini grid allowed to feed the electricity generated from renewable energy sources into the grid for rest of the project period</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>TANESCO requests every year to submit expansion plans for next 12, 24, and 36 months</td>
<td>Unclear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In theory four options for mini grids: become SPP, SPD, SPP+SPD, asset buy-out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In practice, uncertainty as to whether assets would be completely protected</td>
</tr>
<tr>
<td>Kenya</td>
<td>• REA published and follows a grid-extension plan</td>
<td>No: There is no regulation that clarifies what happens when the main grid reaches a village powered by a mini-grid</td>
</tr>
<tr>
<td></td>
<td>• KPLC: also extends the grid, according to its own plan</td>
<td>• Yes: asset buy out or conversion into SPP, SPD or SPD+SPP for mini grids with permits and license</td>
</tr>
<tr>
<td>Nigeria</td>
<td>• Provided to mini grid by NERC on request</td>
<td>• No: registered mini grids must decommission assets</td>
</tr>
</tbody>
</table>
✓ Successful approach in **Cambodia**:  
  - Distribution assets → becomes SPD with regulated tariff

✓ Condition for success is the need for regulatory credibility and stability  
  - **Uttar Pradesh**: not clear how the tariff is set, history of not charging cost recovery tariff  
  - **Tanzania**: many changes in regulation makes it hard for mini grids to predict what will happen when main grid arrives

✓ If no approach protecting entrepreneur’s investment is created, risk of creating no man’s lands:  
  - **Nigeria**: buffer around the main grid without mini grids, that tend to develop further away to avoid getting caught up by main grid  
  - **Tanzania**: mini grids try to stay as far as 20 km away from the grid
## Relation with the Main Grid – PPAs and Assets Sale

### Sale of Power to Main Grid via PPA

- **Cambodia**
  - Decommissioning of generating assets
  - Progressive decrease of tariff between cost recovery and uniform retail tariff to compensate value of stranded asset

- **Uttar Pradesh**
  - MGs built alongside the main grid: MG can sell excess supply to utility at FIT (after 6 months of operations), and all supply (after 3 years of operations)
  - Isolated MGs have the right to become SPP and sell power at FiT

- **Bangladesh**
  - Sale of electricity to utility at tariff based on operational, maintenance and administrative costs of the mini grid, and a 15% return on equity

- **Tanzania**
  - For SPPs: price at which sold to grid: technology-specific RE FiTs if 100kW-1MW, and competitive bidding if 1MW-10MW (for solar and wind).

### Sale or Decommissioning of Generating Assets

- **Uttar Pradesh**
  - Isolated MGs have the right to sell their assets to utility, based on mutual consent of depreciated value of assets
  - If utility refuses, must pay a compensation equivalent to the amount of renewable purchase obligation credits to MG

- **Nigeria**
  - Option to converted into small power producer and/or a Small Power Distributor

- **Nigeria**
  - Transfer of mini-grid assets to disco, against a compensation:
    - if less than 5 years, depreciated assets value + 1yr revenue;
    - if more than 5 years, value of assets as defined during the tariff definition + 1yr revenue

- **Tanzania**
  - Asset buy-out (valued according to Rural Energy Agency’s average capital cost method), but unclear
✓ Decommissioning of generating assets is a good approach when the asset loses value when the main grid arrives:

  - **Cambodia:**
    - High operating costs of diesel generators make them uncompetitive with electricity from the main grid.
    - Operator compensated for value of stranded asset through a progressive decrease of tariff between cost recovery and uniform retail tariff.

✓ Two options for generating assets from renewable sources, that maintain their value when the main grid arrives:

  - Selling power to utility via PPA
    - **Uttar Pradesh, Bangladesh, Tanzania, Nigeria,**
  - Sell assets to the utility for fair compensation
    - **Uttar Pradesh, Tanzania, Nigeria**
CONTENTS

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  – Relation with the Main Grid – PPAs

• Key Takeaways
✓ Hands-off approaches have been successful in scaling up mini grid penetration

✓ Well-designed regulation and subsidy has been successful in countries with high level of administrative and financial capacity, where mini grid industry exists

✓ Gradual development of sophisticated regulation as the industry develops can work well, but overly sophisticated rules or excessive changes in regulation can deter entry

✓ When main grid arrives, successful approaches are:
  ▪ For operators to keep working as SPDs,
  ▪ For RE generators to sell to the main grid via PPAS,
  ▪ For diesel generators to be decommissioned and for owner to be compensated for the value of stranded asset