

# MINI GRIDS IN UTTAR PRADESH

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## A CASE STUDY OF A SUCCESS STORY



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## ESMAP Mission

The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance program administered by the World Bank. It provides analytical and advisory services to low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Denmark, the European Commission, Finland, France, Germany, Iceland, Italy, Japan, Lithuania, Luxemburg, the Netherlands, Norway, The Rockefeller Foundation, Sweden, Switzerland, and the United Kingdom, as well as the World Bank.

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# PREAMBLE

The Global Facility on Mini Grids of the Energy Sector Management Assistance Program (ESMAP) hired Castalia to study the regulation of mini grids in six jurisdictions in Sub-Saharan Africa and Asia (Kenya, Tanzania, and Nigeria; and Bangladesh, Cambodia, and the state of Uttar Pradesh in India). The study's objective is to understand what regulatory settings governments may adopt to scale up electrification through private development of mini grids, drawing on the experience of these six jurisdictions; provide technical assistance to four countries that want to further develop their mini grids framework; and disseminate findings and recommendations globally to inform successful mini grids regulation.

The study focuses on mini grids defined as small, privately-owned and operated systems with generation of up to 10 megawatts (MW) capacity and a network that distributes power to several customers. The study includes small mini grids of less than 1 kilowatt (kW) capacity, also known as 'micro' or 'pico' grids.

The six case studies are intended to be combined in one report. The report is to provide a cross-country comparison of these topics: it examines side by side how each of the countries studied have responded to a specific regulatory question, and presents a decision-tree approach to developing regulatory frameworks for mini grids.

This case study is based on in-depth interviews with a number of key stakeholders in Uttar Pradesh, conducted during and after a research trip in August 2017. We supplemented the insights gained from these interviews with extensive background research. Several experts in the India context and mini grids more broadly reviewed this case study for accuracy and clarity, and we have incorporated their comments while retaining a neutral fact-based position.

Like the other five case studies, this document is structured as follows:

- A brief introduction (Section 1 | ),
- A brief description of the context of the state of Uttar Pradesh (Section 2 | ),
- An overview of the power sector (Section 3 | ),
- Main aspects of the policy setting for mini grids (Section 4 | ),
- Technologies and business models used in the mini grids sector (Section 5 | ),
- The process to authorize mini grid operators (Section 6 | ),
- Technical and service standards for mini grids (Section 7 | ),
- Tariff setting, financing, and subsidies (Section 8 | ),
- Handling the relationship with the main grid (Section 9 | ), and
- A summary of lessons learnt from the experience of the country (Section 10 | ).

# 1 | INTRODUCTION

Uttar Pradesh, the most populous state in India, has among the lowest levels of electricity connection in the country.<sup>1</sup> Over 100 million people, at least half of the rural population, lack a formal connection to a distribution grid.<sup>2</sup>

The level of electricity services remains low despite the physical extension of the state-owned grid to all official villages. Unelectrified households are reluctant to apply for grid connection because they expect electricity supply to be unreliable, and they would have to spend money on coping strategies to replace electricity. In addition, connecting individual households in each village is costly to the state-owned distribution utilities. Highly regulated tariffs and a high cost of servicing remote areas mean that rural connections promise few returns to the utilities.

Electrification has been a public policy priority for decades of successive state and central governments across the political spectrum. Public policy has maintained ambitious objectives to expand grid services from the state-owned medium-voltage (MV) distribution grid to rural areas. The state-owned grid has electrified all cities and surrounding towns. The high-voltage (HV) transmission grid extends throughout most of the state, in contrast to other energy-poor countries in Asia such as Cambodia, Indonesia, and Sri Lanka.

Private mini grid operators have occupied a small but growing space in the rural electricity market in Uttar Pradesh since around 2010. Several small companies, as well as individual entrepreneurs, are now providing electricity services in almost 1,900 settlements (villages and hamlets) in the state, and have made about 37,000 connections (and growing).<sup>3</sup> This is an impressive achievement for a young and innovative sector. But it represents only a tiny fraction of consumers: about 0.2% of the population.

Independent mini grid operators in Uttar Pradesh have proven they can earn rural customers' trust and their business. Rural consumers' simple energy needs can absorb up to a third of households' monthly expenditure without an electricity connection.<sup>4</sup> Kerosene lighting is expensive, and has damaging impacts on health and the environment. Pay-per-use phone charging is both costly and inconvenient for a household. At the same time, rural residents and businesses tend to distrust the state-owned power supply. Electricity delivery from the conventional grid is highly unreliable: in 2016, there were almost 500 hours of power cuts in only 4 months (from May to August).<sup>5</sup> Mini grid operators are addressing these gaps in service through renewable-based systems that deliver power to underserved villages. They have gained credibility as a more reliable service than the state-owned grid in rural areas by providing a reliable solution to residents' and businesses' lighting, phone charging, and appliance-powering problems.<sup>7</sup> They provide basic light-emitting diode (LED) home lighting and a mobile phone charging

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<sup>1</sup> The population of Uttar Pradesh was projected to be almost 220 million people in 2017 (Census of India, 2011)

<sup>2</sup> Government of India (2016), "Garv Dashboard," [www.garv.gov.in/garv2/dashboard/garv](http://www.garv.gov.in/garv2/dashboard/garv); Mudaliar, Jena, Gupta (2016), "Renewable Energy Base Mini Grids," *Policy Framework* 1:1

<sup>3</sup> Meetings with private operators in Uttar Pradesh, August 2017

<sup>4</sup> Times of India (2013), "Poor in villages live on Rs 17 a day, in towns on Rs 23 a day: Survey," accessed on 17 August 2017 at [timesofindia.indiatimes.com/india/Poor-in-villages-live-on-Rs-17-a-day-in-towns-on-Rs-23-a-day-Survey/articleshow/20690610.cms](http://timesofindia.indiatimes.com/india/Poor-in-villages-live-on-Rs-17-a-day-in-towns-on-Rs-23-a-day-Survey/articleshow/20690610.cms)

<sup>5</sup> Government of India Ministry of Power (2017), "Urja Dashboard," accessed on 10 November 2017 at [urjaindia.co.in/stats.php?id=33&type=state&level=saidi\\_analytics](http://urjaindia.co.in/stats.php?id=33&type=state&level=saidi_analytics)

<sup>6</sup> The Indian Express (2016), "All villages electrified, but darkness pervades," accessed on 15 August 2017 at [indianexpress.com/article/india/india-news-india/electricity-in-india-villages-problems-still-no-light-poverty-3030107/](http://indianexpress.com/article/india/india-news-india/electricity-in-india-villages-problems-still-no-light-poverty-3030107/)

<sup>7</sup> Sachiko Graber, Tara Narayanana, Jose Alfaro, Debajit Palit (2018), "Solar microgrids in rural India: Consumers' willingness to pay for attributes of electricity." *Energy for Sustainable Development* 42, 32–43

outlet to a household for a scheduled 6 to 8 hours a day. Some companies offer packages with longer hours of service, up to 24 hours a day.

Independent mini grid services have thrived in Uttar Pradesh within a liberal policy setting. Licenses are not required, and a nascent registration system is not yet implemented. There are efforts to encourage strict service standards, but these are not strictly enforced and rather left to the incentive that quality of service represents. Tariffs of private mini grids are not regulated. The main commercial operators charge a flat tariff of 120 Indian Rupees (INR) a month (just under US\$1.50) for basic services. These tariffs are an order of magnitude above public utilities' tariffs, which do not recover costs. Table 1.1 shows some key metrics related to mini grids in Uttar Pradesh.

**Table 1.1: Key Metrics for Mini Grids in Uttar Pradesh, 2017**

<b>Penetration of mini grids</b>		
Number of mini grids	Number	Approx. 1,850
Customers served by mini grids	Number	37,000
	% of total population	0.1%
	Of the population with access to electricity, % connected to a mini grid	0.2%
Average growth in connections 2010 to 2017	Thousand/year	2.2
<b>Tariffs and Rates, tier 1<sup>(1)</sup></b>		
Cost of connection <sup>(2)</sup>	US\$	47
	% of GDP/Capita	5%
Average subsidy per connection <sup>(3)</sup>	US\$	5
	% of GDP/Capita	0.5%
Monthly bill	US\$	1.86
	% of Monthly GDP/Capita	2.53%
Average tariff <sup>(4)</sup>	US\$/kWh	1.18
<b>Quality of Service</b>		
Availability of electricity, all tiers	Hours per day	7-24, scheduled

Sources: Meetings with private mini grid operators in Uttar Pradesh, August 2017

Notes: (1) Tier 1 electricity access is service that meets basic needs for a household for 4 to 8 hours a day, at up to 50 Watts; and provides lighting and basic communication (mobile, radio). See World Bank/ESMAP (2015), *Beyond Connections – Energy Access Redefined*. Rates of operators providing service at higher tiers was confidential and not provided.

(2) The cost to the mini grid operator of connecting a new tier 1 customer. In general, new customers do not pay for connection in a separate upfront connection charge; however, this varies depending on the operator.

(3) The state government offers mini grid developers a subsidy of 30% that comes with certain conditions of pricing and service hours.

(4) Average tariff for residential tier 1 services, assuming maximum usage of a scheduled capacity-based service. Most rural residential customers pre-pay a flat monthly fee rather than paying on a metered per kWh basis.

## 2 | COUNTRY CONTEXT

Table 2.1 presents summary demographic and economic statistics for Uttar Pradesh, as well as governance statistics and indices for India.

**Table 2.1: Uttar Pradesh Summary Statistics**

		1995	2005	2014
<b>Demographics</b>				
Population	Million	149	179	211
Population growth	Annual average	1.8%	1.9%	1.9%
Rural population	Million	120	141	163
Rural population growth	Annual average	1.6%	1.7%	1.7%
Population density, National	People/sq. km	614	735	868
<b>Economy</b>				
GDP	PPP, 2011 US\$ million	23,916	61,778	161,100
GDP per capita	PPP, 2011 US\$	160	345	883
Real GDP per capita growth	5-year compound rate	3.3%	1.5%	11.3%
Debt to GDP ratio	%	34%	52%	31%
<b>Governance (India country rankings)</b>				
Ease of Doing Business rank	See Note (1)	N/A	N/A	134
Corruption Perceptions Index	See Note (2)	2.6	2.9	3.8
World Bank Governance Indicator	See Note (3)	-0.20	-0.17	-0.21
<b>Electricity Sector</b>				
Electricity connection rate, national	% of population	25	37	49
<i>Urban</i>		70	77	83
<i>Rural</i>		14	26	45
Electrification growth rate	% change in population with a connection, 5-year compound rate	3.8	3.9	1.7
Population with electricity connection	Million	38	65	113
<i>Urban</i>		21	29	40

<i>Rural</i>		<b>17</b>	<b>36</b>	<b>73</b>
Electrical power consumption	kWh/person/year	N/A	310	472
	kWh/person with an electricity connection/year	N/A	833	956
Customers served by the grid	Thousands	6,140	8,844	17,169

Source: World Bank Development Indicators (2016), Transparency International (2016)

Notes: (1) The Ease of Doing Business Index ranks countries from one to 190. The closest a country is to one, the more conducive its regulatory environment is to starting and operating a local firm.

(2) The Corruption Perceptions Index ranks countries on a scale of zero to 10, with zero indicating very high levels of corruption and 10 indicating very low levels of corruption.

(3) The Worldwide Governance Index assigns scores to countries from -2.5 to 2.5, with higher values indicating higher quality of governance

## Demographics

Uttar Pradesh is one of 29 states in the Republic of India, but it has the proportions of a country in its own right. With an estimated population of almost 220 million in 2017, Uttar Pradesh is the most populous state in India and would be the fifth most populous country in the world if it were a sovereign nation (about the same size as Pakistan).<sup>8</sup> It is the most populous country subdivision in the world, and is India's fifth largest state by area, accounting for 7.2% of the land mass. It covers much of the fertile plain of the upper Ganges. Its annual population growth rate is nearly 2%, with population density of over 850 people per km<sup>2</sup>.<sup>9</sup> The population density of Bangladesh is around 1,250 people per km<sup>2</sup> by comparison, and Cambodia has only 90 people per km<sup>2</sup>.<sup>10</sup>

Literacy rates, as of the 2011 national census, were below 68% on average in the state, well below the national average of 74%.<sup>11</sup> The most commonly spoken language is Hindi.

## Economy

Uttar Pradesh is the third largest Indian state by economy, with a GDP of over US\$160 billion in 2014.<sup>12</sup> However, it is one of the poorest states by GDP per capita.<sup>13</sup> The state's gross domestic product (GDP) per capita is five times lower than Pakistan's, and six times lower than Nigeria's, which have a similar population size.<sup>14</sup>

Service industries, such as hospitality and Information Technology Enabled Services (ITES), make up the largest portion of the state's GDP.<sup>15</sup> The state has sanctioned 20 special economic zones in the state, of which 16 are reserved for IT and ITES.<sup>16</sup>

<sup>8</sup> Population estimate based on Census of India data, 2001 and 2011

<sup>9</sup> India Brand Equity Foundation (2017), "About Uttar Pradesh: Tourism, Agriculture, Industries, Economy & Geography," accessed on 25 August 2017 at [www.ibef.org/states/uttar-pradesh.aspx](http://www.ibef.org/states/uttar-pradesh.aspx)

<sup>10</sup> World Bank Group (2016), accessed on 15 November 2017 at [data.worldbank.org/indicator/EN.POP.DNST](http://data.worldbank.org/indicator/EN.POP.DNST)

<sup>11</sup> Census of India 2011

<sup>12</sup> India Brand Equity Foundation (2017)

<sup>13</sup> World Bank (2016), "Uttar Pradesh - Poverty, growth and inequality," India state briefs. Washington, D.C.: World Bank Group

<sup>14</sup> World Bank Development Indicators (2016), accessed on 30 June 2017 at [data.worldbank.org/indicator](http://data.worldbank.org/indicator)

<sup>15</sup> India Brand Equity Foundation (2017), "Uttar Pradesh: A Rainbow Land," *State Reports*, [www.ibef.org](http://www.ibef.org)

<sup>16</sup> India Brand Equity Foundation (2017)

The primary sector remains a major share of the economy.<sup>17</sup> Agriculture is the state's leading occupation.<sup>18</sup> Uttar Pradesh farmers produced around 20% of India's total milk and food grain output in 2015. Wheat and sugarcane are the main commercial food crops.

The state has become a key hub for IT and ITES, including software, captive business process outsourcing and electronics.<sup>19</sup> State industries also include locomotive plants, manufacturing of engineering products, electronics, steel, leather, textiles, jewelry, and transport vessels for road, railway, and shipping.

## **Governance**

Uttar Pradesh was created under the British Administration in 1937 as the *United Provinces*, in the historic region of the 16<sup>th</sup> century Mughal and 18<sup>th</sup> century Maratha kingdoms. The state is governed through a parliamentary system, with elected representatives from each of the 75 administrative districts. The districts are organized around nodal towns, which serve to administer local government, public services, and economic activities.

India has a federal system of government. The Government of Uttar Pradesh, in the state capital of Lucknow, holds important decision-making authority over the state's laws and policies, including for the energy sector and the economy. The President of India appoints the Governor of Uttar Pradesh for a 5-year term.<sup>20</sup> The Chief Minister is the leader of the publicly-elected majority party or coalition of the Legislative Assembly (lower house of parliament). The day-to-day governing body of the state is called the Council of Ministers, whose members are appointed by the Chief Minister.

Uttar Pradesh borders Delhi, as well as nine other states and Nepal to the North. It has well-developed connections with these areas, including four national highways, six airports, and rail links to all major cities.<sup>21</sup> Figure 2.1 shows a map of the state's roads, railways, and boundaries.

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<sup>17</sup> Government of Uttar Pradesh (2013), "Social Demography," accessed on 14 August 2017 at [www.up.gov.in/Social-Demography.pdf](http://www.up.gov.in/Social-Demography.pdf)

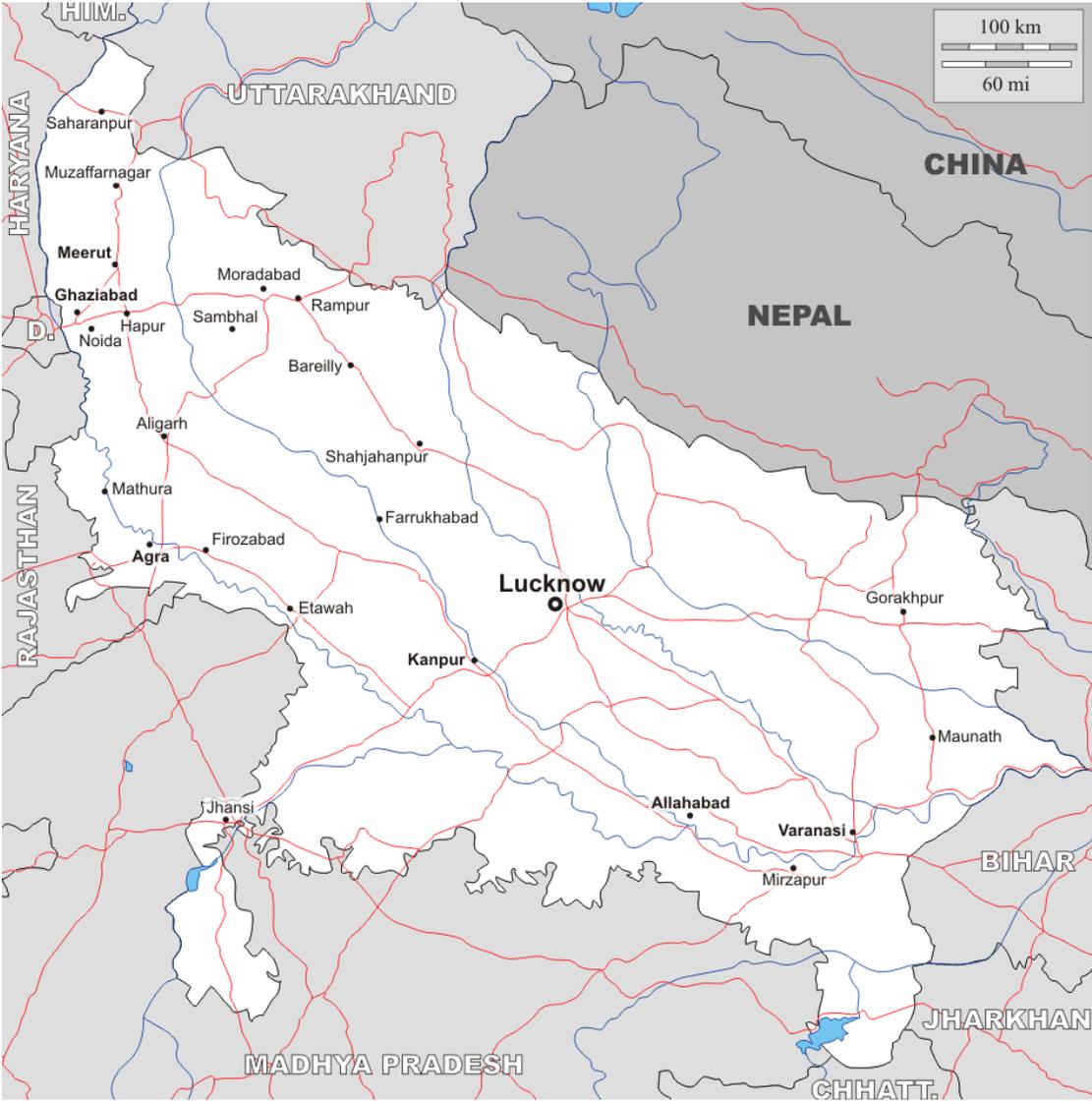
<sup>18</sup> Quartz India (2017), "Akhilesh, Mayawati or Modi: Can anybody actually fix Uttar Pradesh's economy?" accessed on 15 September 2017 at [qz.com/891969/akhilesh-mayawati-or-modi-can-anybody-actually-fix-uttar-pradeshs-economy/](http://qz.com/891969/akhilesh-mayawati-or-modi-can-anybody-actually-fix-uttar-pradeshs-economy/)

<sup>19</sup> India Brand Equity Foundation (2017)

<sup>20</sup> Governor of Uttar Pradesh, "Role of The Governor," accessed on 26 September 2017 at [upgovernor.gov.in/upgovernor.gov.in/roleofgov.htm](http://upgovernor.gov.in/upgovernor.gov.in/roleofgov.htm)

<sup>21</sup> India Brand Equity Foundation (2017)

Figure 2.1: Map Uttar Pradesh

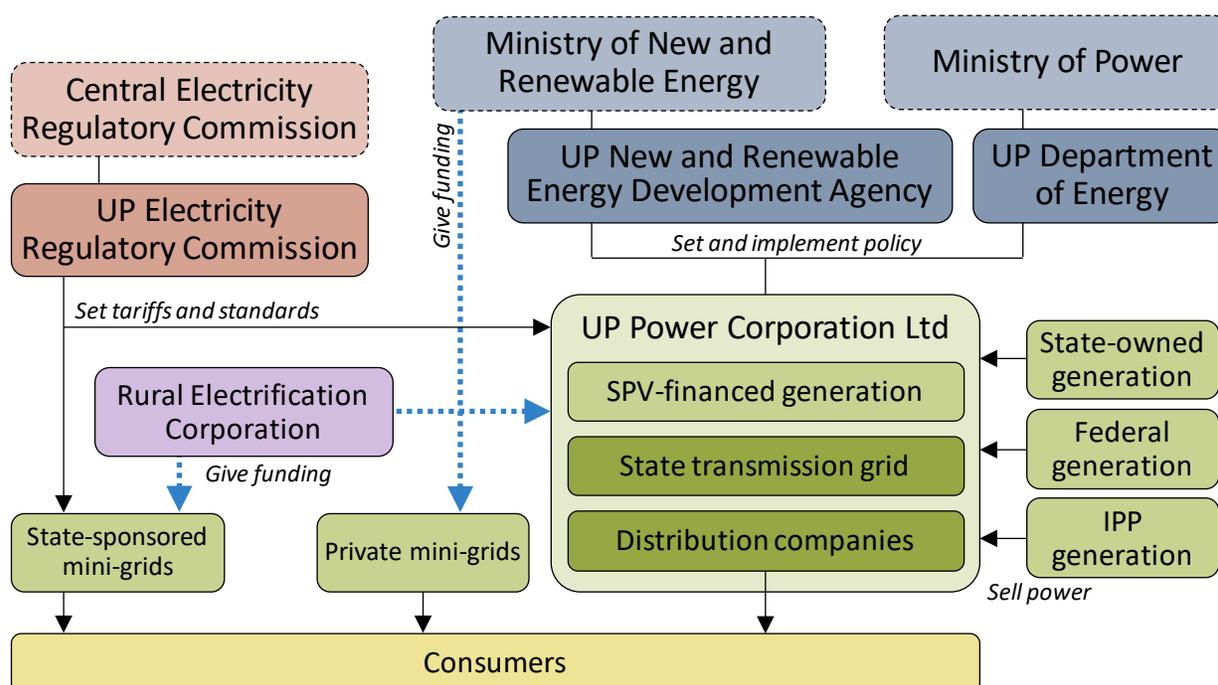


Source: D-Maps.com, accessed at [d-maps.com/m/asia/india/uttar/uttar17.gif](https://d-maps.com/m/asia/india/uttar/uttar17.gif)

## 3 | OVERVIEW OF THE POWER SECTOR

The Government of Uttar Pradesh began a program of power sector reforms from 1998 to 2000, in the context of the reforms initiated by the Government of India.<sup>22</sup> These reforms established the state regulator and unbundled the electricity utility.<sup>23</sup> Figure 3.1 shows the structure of the power sector in Uttar Pradesh since 2000.

Figure 3.1: Uttar Pradesh's Power Sector Structure



### 3.1 MAIN ACTORS

Three public bodies oversee setting policies and regulations in the state's power sector, including for rural electrification, subsidies, and service standards:

- The Uttar Pradesh Department of Energy (UPDOE) defines electricity policies specific to the state's needs and priorities, and in line with national power sector legislation.
- The Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) outlines policies, service standards, and subsidies specifically for rural electrification and promoting renewable energy in the state.
- The Uttar Pradesh Electricity Regulatory Commission (UPERC) sets tariffs and implements public policies and laws for the sector.

<sup>22</sup> Debajit Palit, Bandyopadhyay, K. (2017), "Rural electricity access in India in retrospect: A critical rumination," *Energy Policy* 109

<sup>23</sup> Navroz K. Dubash, Rajan, S. (2001), "The Politics of Power Sector Reform in India," World Resources Institute

The Government of India has a separate, central structure to define nation-wide energy policies. The Ministry of Power sets national policy and proposes legislation governing the power sector, focusing on large-scale grid electrification, conventional generation, and distributed generation for remote areas. The Ministry of New and Renewable Energy (MNRE) creates policies and programs to foster development of renewable power as well as for supporting rural electrification.

### **State utility, Uttar Pradesh Power Corporation Limited (UPPCL)**

The electricity sector reform program in 1999 unbundled the Uttar Pradesh State Electricity Board (UPSEB) into three publicly-owned power companies:

- Uttar Pradesh Power Corporation Limited (UPPCL) manages transmission, distribution, and retail operations.<sup>24</sup> UPPCL has five distribution subsidiaries geographically arranged throughout the state.
- Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL) manages the state's thermal generation assets.
- Uttar Pradesh Jal Vidyut Nigam Limited (UPJVUNL) manages its hydropower assets.<sup>25</sup>

UPPCL procures power from four types of generators:

- State-owned generators UPRVUNL and UPJVUNL.
- Central government-owned generators.
- Independent power producers, mostly privately-financed power companies, through tendered or negotiated power purchase agreements (PPA).
- Project-financed power plants owned by UPPCL.

The financial situation of UPPCL is precarious, despite having received a healthy balance sheet when it was created by the state government in 2007. The Government of Uttar Pradesh wrote off INR19 billion of liabilities of the former UPSEB when it was unbundled to give it an easier starting point.<sup>26</sup> UPPCL's five distribution utilities have challenging financial situations, with collection losses averaging about 35%. The state issued government-backed bonds worth US\$1.5 billion against the distribution companies' losses in 2017.

### **State agency for rural electrification, UPNEDA**

UPNEDA, or 'the agency', is an arm of the state Government responsible for rural electrification and renewable energy development. The agency defines and implements policies for those portfolios. It also disburses funds, subsidies, and other financial incentives for operators to carry out these duties.

UPNEDA supports both private and public financing and development of mini grids through two strategies:

- Developing Uttar Pradesh's flagship Mini Grid Policy of 2016 (the 2016 Policy): this incentivizes mini grid development by the private sector through a subsidy structure.

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<sup>24</sup> Anjula Gurtoo and Rahul Pandey (2001). "Uttar Pradesh Power Sector: Past Problems and the Initial Phase of Reforms," Indian Institute of Management, Lucknow

<sup>25</sup> UPERC, "The Journey So Far," accessed on 10 August 2017 at [uperc.org/html.aspx?FormName=html/Achievement.htm](http://uperc.org/html.aspx?FormName=html/Achievement.htm)

<sup>26</sup> Times of India (2012), "Government affirms 1.9 lakh crore discom loan recast," accessed on 15 September 2017 at [timesofindia.indiatimes.com/city/delhi/Government-affirms-1-9-lakh-crore-discom-loan-recast/articleshow/16535258.cms](http://timesofindia.indiatimes.com/city/delhi/Government-affirms-1-9-lakh-crore-discom-loan-recast/articleshow/16535258.cms)

- Planning fully subsidized mini grids with funding from the central Government’s rural electrification program:<sup>27</sup> the agency has procured 16 solar-powered mini grids on an EPC basis; residential customers pay nothing for electricity services from state-owned mini grids. The electricity is offered as a free service for bottom-of-pyramid consumers. UPNEDA has previously implemented mini-grids with funding from MNRE.

### **State regulator, UPERC**

The Electricity Reforms Act (1999) of Uttar Pradesh set up the state’s independent regulator, UPERC.<sup>28</sup> Its objectives are to:

- Oversee a cost-efficient, high quality supply of power to support economic development in the state,
- Enable the power sector to become financially viable, and
- Protect the interests of consumers.

UPERC sets tariffs and service standards based on power sector policies and laws from both state and central government levels.<sup>29</sup> UPDOE and UPNEDA set the policy direction on service standards and pricing. These form the policy backbone of UPERC’s regulations. UPERC interprets policies issued by the central Government as suggestions rather than instructions. The Central Electricity Regulatory Commission (CERC) provides guidelines and frameworks on regulating technical and commercial aspects of the power sector for state-level regulators to adapt to their needs.

UPERC regulates the tariffs of all electricity providers except those of private operators of mini grids that offer services in deprived, under-served rural areas (tariffs of state-subsidized isolated mini grids are regulated through the subsidy contract with the State Government). State-owned distribution utilities are regulated along with their franchisee companies, which distribute electricity from the main distribution grid. Following the Electricity Act of 2003, and consistent to the 2016 Policy, private operators delivering privately-generated electricity in rural areas are not subject to tariff regulation.

### **Rural Electrification Corporation (REC)**

The Rural Electrification Corporation (REC) is a central government-owned infrastructure finance company.<sup>30</sup> It offers grants, loans, and subsidies to entities that provide electricity services to rural areas across India. Its clients include publicly-owned utilities, rural electricity cooperatives, non-governmental organizations, and private developers of generation, transmission, and distribution in designated rural areas.

REC administers the national rural electrification scheme, known as Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), since its launch in 2015.<sup>31</sup> DDUGJY receives funding from the Government of India, state distribution utilities, private lenders, and additional grants from the central government if prescribed milestones are achieved.

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<sup>27</sup> DDUGJY, described on next page.

<sup>28</sup> UPERC, “About UPERC and its Mission,” accessed on 12 August 2017 at [uperc.org/html.aspx?FormName=html/Uperc\\_ItsMission.htm](http://uperc.org/html.aspx?FormName=html/Uperc_ItsMission.htm)

<sup>29</sup> UPERC, “Functions,” accessed on 12 August 2017 at [uperc.org/html.aspx?FormName=html/Functions.htm](http://uperc.org/html.aspx?FormName=html/Functions.htm)

<sup>30</sup> REC India, “Business Profile,” accessed on 23 October 2017 at [www.recindia.nic.in/business-profile](http://www.recindia.nic.in/business-profile)

<sup>31</sup> The DDUGJY scheme subsumed the Government of India’s prior rural electrification scheme, Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), which was initiated in 2005. The REC administered the RGGVY scheme.

## Mini grids

Most mini grids in Uttar Pradesh are privately financed and operated. Mini grid entrepreneurs often receive development financing, grants, and equity from non-governmental sources. The handful of publicly-financed mini grid projects procured by UPNEDA do not run on a commercial basis.<sup>32</sup>

Privately financed mini grids may set their own tariffs as long as they do not connect to the grid, or hold any funding agreement that sets pricing conditions. The Electricity Act of 2003 exempts rural electricity service providers from price regulation and licensing requirements. When Government agencies hold no financing or subsidy agreements with private developers, they have no means to impose tariff or service standards. Such privately financed mini grids may sell directly to consumers through unregulated distribution agreements.

UPNEDA has financed 16 publicly-funded mini grids.<sup>33</sup> It procures EPC contractors under 5-year build-operate-transfer arrangements, after which it runs a new procurement for operation and maintenance. Operations and maintenance costs are funded by UPPCL's budget, while capital costs are provided by UPNEDA and some funding from DDUGJY. These state-owned mini grids currently provide services free of cost to rural residents and micro-enterprises. In future, they may charge a rate regulated by UPERC.

## 3.2 EVOLUTION OF THE SECTOR

The Power Policy of Uttar Pradesh, released in 2009, fueled public and private investment in power generation that satisfied latent demand from 2010 to 2012.<sup>34 35</sup> The state now has over 22.7GW of installed generating capacity, including a share of the central government-owned generation resources allocated to Uttar Pradesh.<sup>36 37</sup> This year, the state expects to have an energy surplus for the first time in its history.<sup>38 39</sup> The governments of India and of Uttar Pradesh have also accelerated power sector investment since the late 1990s through reforms in the sector. Figure 3.2 shows the change in power consumption (left axis) and generation (right axis) in Uttar Pradesh from 1999 to 2015.

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<sup>32</sup> Meeting with Director of UPNEDA, August 2017

<sup>33</sup> Meeting with Director of UPNEDA, August 2017

<sup>34</sup> Uttar Pradesh Power Policy, 2009

<sup>35</sup> Business Standard (2014), "Corporates commit Rs 35,000-cr investment to Uttar Pradesh," accessed on 23 September 2017 at [www.business-standard.com/article/economy-policy/corporates-commit-rs-35-000-cr-investment-to-uttar-pradesh-114061201048\\_1.html](http://www.business-standard.com/article/economy-policy/corporates-commit-rs-35-000-cr-investment-to-uttar-pradesh-114061201048_1.html)

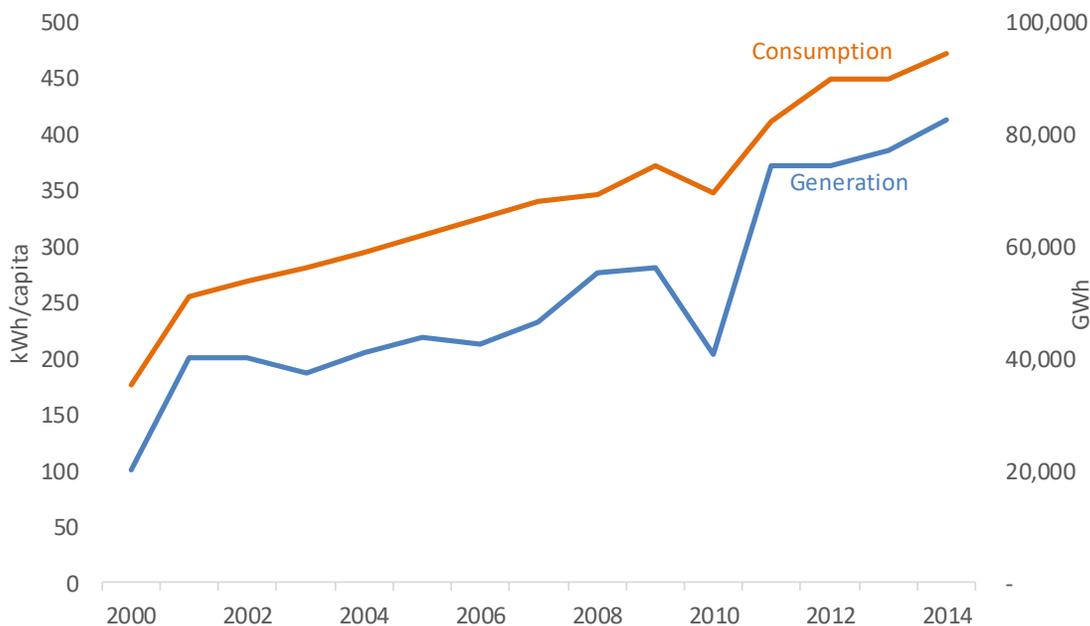
<sup>36</sup> Governments of India and Uttar Pradesh (2017)

<sup>37</sup> Bloomberg New Energy Finance, "Climatescope 2015," accessed on 15 August 2017 at [2014.global-climatescope.org/en/download/reports/countries/climatescope-2015-in-up-en.pdf](http://2014.global-climatescope.org/en/download/reports/countries/climatescope-2015-in-up-en.pdf)

<sup>38</sup> Economic Times, Times of India (2017) "India Likely to be Power Surplus Nation in FY 2018," accessed on 20 October 2017 at [economictimes.indiatimes.com/industry/energy/power/india-likely-to-be-power-surplus-nation-in-fy18/articleshow/59093054.cms](http://economictimes.indiatimes.com/industry/energy/power/india-likely-to-be-power-surplus-nation-in-fy18/articleshow/59093054.cms); Hindustan Times (2017), "For the first time in history, Uttar Pradesh may become a power surplus state," accessed on 12 October 2017 at [www.hindustantimes.com/lucknow/for-the-first-time-in-history-uttar-pradesh-may-become-a-power-surplus-state/story-T7MBBAjW1RFMIhexTGVrUM.html](http://www.hindustantimes.com/lucknow/for-the-first-time-in-history-uttar-pradesh-may-become-a-power-surplus-state/story-T7MBBAjW1RFMIhexTGVrUM.html)

<sup>39</sup> Central Electricity Authority (2016), *Load Generation Balancing Report 2016-2017*

**Figure 3.2: Evolution of Power Consumption (kWh per Capita, left) and Electricity Generation (GWh, right), 1999 to 2015**



Source: Governments of India and Uttar Pradesh (2017), *24x7 Power for All Uttar Pradesh*

Power generation in Uttar Pradesh is a combination of central government-owned, state-owned, and privately-owned assets. In 2017, 76% of capacity is from thermal generation; 13% is from hydropower; 10% is from variable renewables, biomass, and small hydro; and 1% is from nuclear.<sup>40</sup>

Poor and unreliable power supply has historically been a persistent problem in the state that hampers industrial investment and economic development.<sup>41</sup> Power cuts remain common, as well as prolonged periods of low voltage.<sup>42</sup> During peak times, electricity demand frequently exceeds supply by over 10%, sometimes reaching over 40%.<sup>43</sup>

Uttar Pradesh has a low installed generating capacity per capita of population compared to the all-India average.<sup>44</sup> It trails behind neighboring countries Pakistan, Myanmar, and Bangladesh;<sup>45</sup> and has the second-lowest installed capacity per capita among the six case study countries (Bangladesh, Cambodia, Kenya, Nigeria, and Tanzania).<sup>46</sup> Figure 3.3 shows the national installed capacity per population in Uttar Pradesh (orange) compared to the two other case studies in Asia (Bangladesh and Cambodia, in light blue), as well as to all India and neighboring countries (Nepal and Pakistan, in dark blue).

<sup>40</sup> UPPCL data, 2016

<sup>41</sup> Times of India (2013), "Power crisis looms over UP," accessed on 15 October 2017 at [timesofindia.indiatimes.com/city/delhi/Power-crisis-looms-over-UP/articleshow/19485158.cms](http://timesofindia.indiatimes.com/city/delhi/Power-crisis-looms-over-UP/articleshow/19485158.cms)

<sup>42</sup> Governments of India and Uttar Pradesh (2017), "24x7 Power for All Uttar Pradesh"

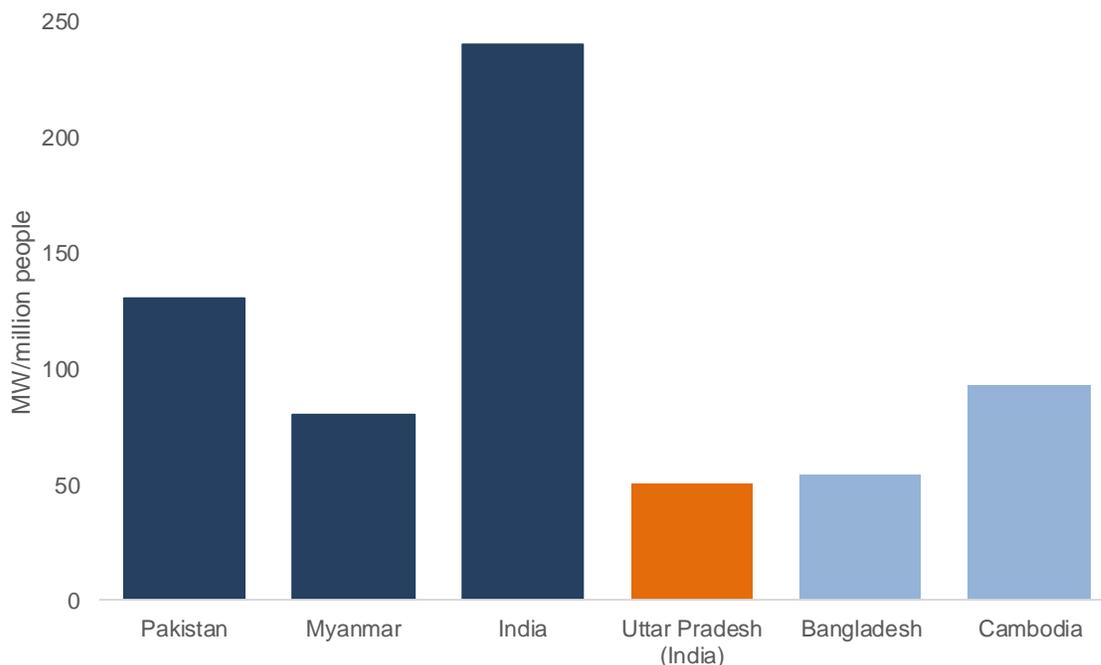
<sup>43</sup> Times of India (2013)

<sup>44</sup> Governments of India and Uttar Pradesh (2017)

<sup>45</sup> Export.gov (2017), "Burma – Energy," accessed on 21 November 2017 at [www.export.gov/article?id=Burma-Energy](http://www.export.gov/article?id=Burma-Energy)

<sup>46</sup> Energy Information Administration, International Energy Statistics: Generation, [www.eia.gov/beta/international/data/browser](http://www.eia.gov/beta/international/data/browser), accessed July 23, 2017

**Figure 3.3: Electricity Capacity per Capita in Uttar Pradesh and Neighboring Countries (MW per million people)**

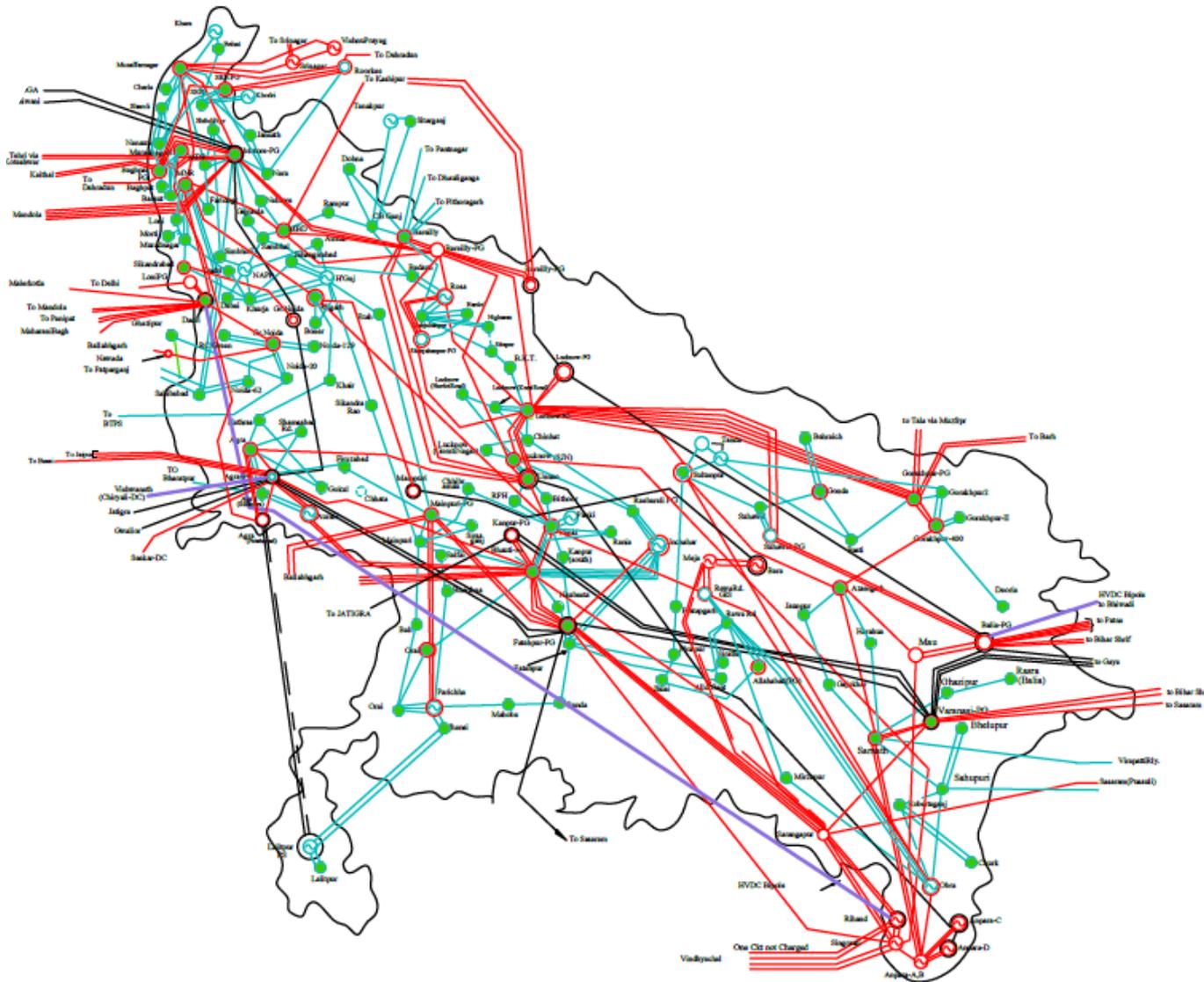


Source: Energy Information Administration, *International Energy Statistics: Generation*, [www.eia.gov/beta/international/data/browser](http://www.eia.gov/beta/international/data/browser), accessed July 23, 2017

Uttar Pradesh’s electricity grid has been part of the Northern Grid of India since the 1960s, when Indian state grids were interconnected to form five regional links.<sup>47</sup> The Northern Grid of India was interconnected through HVDC transmission lines with other regional grids in 2006, as part of an initiative to form a National Grid. This interconnection enabled national transport of electricity between all states in the union. Figure 3.4 shows the remarkably dense network of transmission lines interconnecting Uttar Pradesh with its nine neighboring states. HV lines crisscross the state to and from Delhi, Uttarakhand, Bihar, Chhattisgarh, and Rajasthan.

<sup>47</sup> Power Grid Corporation of India Ltd., “One Nation One Grid,” accessed on 15 October 2017 [www.powergridindia.com/one-nation-one-grid](http://www.powergridindia.com/one-nation-one-grid)

Figure 3.4: Uttar Pradesh's Transmission Grid



Source: Uttar Pradesh Power Transmission Corporation Ltd., 2017. "UP Transmission Network (220 KV & Above)"

### 3.3 ACCESS TO ELECTRICITY: MAIN GRID AND MINI GRIDS

Private mini grids first emerged in Uttar Pradesh less than a decade ago. To date, almost all electricity consumers in the state are still connected through the state-owned grid, which has been developed since the incorporation of the UPSEB in 1959.<sup>48</sup>

Over three quarters of households in Uttar Pradesh are in rural areas, totaling about 163 million people, and about half of them lack a connection to electricity services.<sup>49</sup> Of those with grid connections, many remain illegal and unmetered, and supply is unreliable.<sup>50</sup> Many rural households resort to using kerosene lamps as their main source of lighting, and a significant proportion now use solar lamps.<sup>51</sup>

The overall rate of electricity connections in Uttar Pradesh is close to 60%, while only 60% of those connections are metered. Data suggest a 28% increase in electricity connections since the last census in 2011.<sup>52</sup> UPPCL distribution companies have officially electrified 120,000 villages and hamlets.<sup>53</sup> However, to qualify as being officially electrified a village need only have 10% of households connected (as well as public services and street lighting).

About half of all rural households in the state are connected to UPPCL distribution services; of those, an estimated 40% receive unmetered, informal electricity connections.<sup>54</sup> Consumers in underserved communities often connect to the distribution grid illegally, adding losses that worsen the utility's fragile financial position.<sup>55</sup> Newly-connected households in remote communities often do not receive a meter at the time of installation, which also poses a billing challenge. Theft further complicates state efforts to collect data on electricity services.<sup>56</sup>

Many rural consumers with a connection to the main grid have chosen to switch to mini grid electricity services when the option was available.<sup>57</sup> Although mini grid tariffs can be over 20 times higher than the main grid, they provide reliable service at predictable hours.<sup>58</sup> Rural consumers are willing to pay higher prices in exchange for reliability and supply that meets a predefined level of demand.<sup>59</sup>

Increasing electricity connections through the main grid in Uttar Pradesh has followed a growth trajectory similar to the India-wide average since the 1990s (see Figure 3.5).<sup>60</sup> However, before then, the power system had developed less than in other Indian states, due to its relative economic weakness. The state electricity companies have operated at a loss despite Government efforts to relieve the financial pressure by writing off liabilities. The expansion of electricity access in India has been funded through central and state-government investment in large centralized fossil fuel power plants and

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<sup>48</sup> Anjula Gurtoo and Rahul Pandey (2000), "Uttar Pradesh Power Sector: Past Problems and the Initial Phase of Reforms," Indian Institute of Management, Lucknow

<sup>49</sup> Census of India, 2011

<sup>50</sup> Governments of India and Uttar Pradesh (2017), "24x7 Power for All Uttar Pradesh"

<sup>51</sup> EUEI PDF (2013), "Mini Grid Policy Toolkit Case Study: India (Husk Power Private Operator Model)"

<sup>52</sup> Census 2011

<sup>53</sup> Governments of India and Uttar Pradesh (2017), "24x7 Power for All Uttar Pradesh." Note that official sources provide conflicting data.

<sup>54</sup> Ibid.

<sup>55</sup> Sachiko Graber, Tara Narayanan, Jose Alfaro, Debajit Palit (2018), "Solar microgrids in rural India: Consumers' willingness to pay for attributes of electricity," *Energy for Sustainable Development*

<sup>56</sup> The Hindu Business Line (2017), "Uttar Pradesh plans to step up crackdown on power theft," accessed on 16 November 2017 at [www.thehindubusinessline.com/news/national/uttar-pradesh-plans-to-step-up-crackdown-on-power-theft/article9920206.ece](http://www.thehindubusinessline.com/news/national/uttar-pradesh-plans-to-step-up-crackdown-on-power-theft/article9920206.ece)

<sup>57</sup> Meetings with mini-grid operators and customers in HarDOI district, Uttar Pradesh, August 2017

<sup>58</sup> Graber et al., (2018).

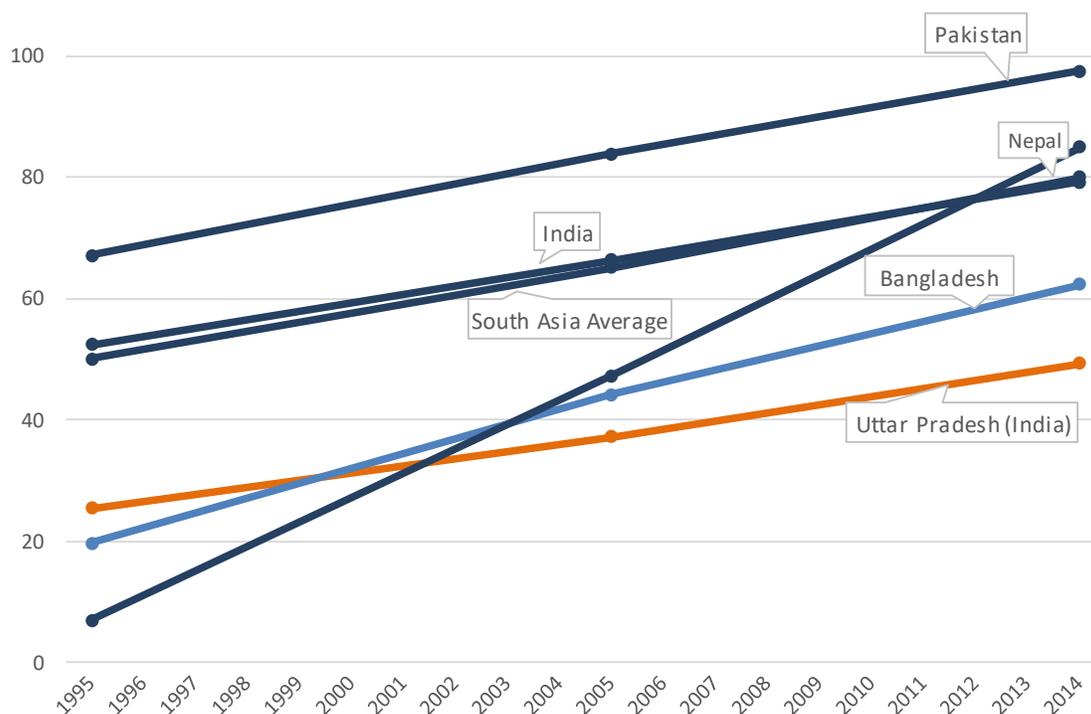
<sup>59</sup> Ibid.

<sup>60</sup> Census of India 1991, 2001, 2011

expensive long transmission lines across the subcontinent (as noted, Figure 3.4 shows the existing transmission grid and interconnections with neighboring states).

Uttar Pradesh’s rate of adding new electricity connections has been slower than bordering countries and states. In the past two decades, the proportion of people connected to grid services has doubled from below 30% to about 60% (including unmetered connections).<sup>61</sup> Across the border to its north, Nepal has increased the rate of electricity connections by a factor of eight, from 10% in 1995 to over 85% since 2013.<sup>62</sup> Bangladesh meanwhile, tripled its connection rate in the same period. Figure 3.5 shows the evolution of electrification in Uttar Pradesh, India, neighboring countries, and the South Asia average.

**Figure 3.5: Access to Electricity (% of population)**



Source: World Bank, Electricity Access, <http://data.worldbank.org/indicator>, accessed 10 July 2017

The wide urban-rural disparity in electricity connections has narrowed in the past two decades. In 1995, the rate of connections in urban areas was five times higher than in rural areas. However, by 2015, the gap between urban and rural access had reduced to less than two times: in urban areas, over 84% of the population is connected to the main grid; in rural areas, over 50% have an electricity connection (although many remain illegal and unmetered).<sup>63</sup> Urban customers receive day-long, albeit unreliable, electricity service.<sup>64</sup> Service to rural customers tends to be less reliable, with only around 9 hours of service a day at irregular times.<sup>65</sup> Table 3.1 summarizes service data for grid and mini grid electricity

<sup>61</sup> Ibid.

<sup>62</sup> World Bank Development Indicators (2016)

<sup>63</sup> Governments of India and Uttar Pradesh (2017), “24x7 Power for All Uttar Pradesh.”

<sup>64</sup> Ibid.

<sup>65</sup> Graber et al. (forthcoming)

services. Several mini grids customers also have a main grid connection, but no data is available on them.

**Table 3.1: Electricity Summary Statistics, 2015**

		<b>Main Grid</b>	<b>Mini Grids</b>
<b>Customers served</b>	Thousand	17,169	37
<b>Share of total customers served</b>	%	99.8%	0.2%
<b>Average tariff for Tier 1 services</b>	US\$/kWh	0.04	1.18
<b>Electricity Service Quality</b>	Hours of service/day	<i>Irregular</i>	<i>Regular</i>
<i>Urban</i>		18 to 24	N/A
<i>Rural</i>		9	6 to 24

The population served by the grid has almost tripled in the past two decades. Average annual population growth in Uttar Pradesh is 1.8% (slightly above the Indian average of 1.7%).<sup>66</sup> At the same time, the proportion of households with a grid connection has increased from 25% in 1995 to about 50% in 2015. Table 3.2 shows the change in electricity connections compared to population growth. It also shows how mini grids suddenly appeared in the late 2000s to provide electricity services to over 350,000 rural residents and counting.

**Table 3.2: Electricity Connections Through Main Grid and Mini grids (millions)**

		<b>1995</b>	<b>2005</b>	<b>2015</b>
<b>Population</b>		<b>149.4</b>	<b>178.9</b>	<b>215.2</b>
<i>Urban</i>	Million	29.7	38.2	49.2
<i>Rural</i>		119.7	140.7	165.9
<b>Population served by the main grid</b>	Million	<b>37.6</b>	<b>65.4</b>	<b>113.3</b>
<b>Population served by mini grids</b>	Million	<b>N/A</b>	<b>N/A</b>	<b>0.21</b>

Sources: Census of India 2011, 2001; Governments of India and Uttar Pradesh, 2017, "24x7 Power for All Uttar Pradesh"

<sup>66</sup> Census of India, 2011

## 4 | POLICY SETTINGS FOR MINI GRIDS

Electricity in India is a ‘concurrent subject,’ where both federal and state rules apply. Electricity services have been promoted since the 1950s as a need and a right for all residents, and used as a bargaining chip to meet political objectives.<sup>67</sup> Both politicians and the public see electricity as key to foster agricultural growth and reduce poverty. The promise of providing electricity connections has proven to be a powerful vote-garnering tactic to win rural support.<sup>68</sup> In 2017, the Government of India announced that all residents living below the poverty line would receive free connections from state governments.<sup>69</sup>

UPPCL’s distribution utilities still lack the capacity to provide reliable services to remote areas. Power theft and unmetered connections cause distribution losses of around 35% on average.<sup>70</sup> Utilities’ finances are worsening, and heavily cross-subsidized tariffs mean that small rural customers are very expensive to serve. The cross-subsidies that have been in place for decades are insufficient to earn utilities sufficient return.

The following sections outline:

- The bottom-up and top-down events that spurred growth in the mini grid sector
- How policy addresses mini grid tariffs, and
- The top-down approach to expansion planning.

### 4.1 BOTTOM-UP EFFORTS (AIDED BY TOP-DOWN PROGRAMS) TO CREATE MINI GRID GROWTH

Mini grids have emerged in an early *laissez-faire* environment. The Electricity Act of 2003 allowed private operators to provide electricity services in rural areas without tariff regulation or licensing requirements.<sup>71</sup>

The Government of India launched the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) in 2005, a ‘National Rural Electrification Program’ that targeted universal electricity access. The program aimed to provide connections for 32 million below-poverty-line (BPL) households, focusing on decentralized distributed generation as a tool to achieve those aims.<sup>72</sup> RGGVY introduced the distribution franchise (DF) model, in which a private operator generates or buys power wholesale from the grid to distribute

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<sup>67</sup> Hindustan Times (2017), “Should we live in darkness’: Why much of power-rich Uttar Pradesh remains without electricity,” accessed on 12 August 2017 at [www.hindustantimes.com/india-news/should-we-live-in-darkness-why-much-of-power-rich-uttar-pradesh-remains-without-electricity/story-NHjoneKcoPn9g7KNB2ygzH.html](http://www.hindustantimes.com/india-news/should-we-live-in-darkness-why-much-of-power-rich-uttar-pradesh-remains-without-electricity/story-NHjoneKcoPn9g7KNB2ygzH.html)

<sup>68</sup> Swarajya Magazine (2017), “How the Yogi Plans to Light Up Uttar Pradesh by 2019,” accessed on 18 October 2017 at [swarajyamag.com/politics/how-the-yogi-plans-to-light-up-uttar-pradesh-by-2019](http://swarajyamag.com/politics/how-the-yogi-plans-to-light-up-uttar-pradesh-by-2019)

<sup>69</sup> Times of India (2017), “Free electricity connections to 842 BPL families,” accessed on 18 October 2017 at [timesofindia.indiatimes.com/city/bareilly/free-electricity-connections-to-842-bpl-families/articleshow/59734405.cms](http://timesofindia.indiatimes.com/city/bareilly/free-electricity-connections-to-842-bpl-families/articleshow/59734405.cms); The Hindu Business Line (2017), “PM launches ‘Saubhagya’ scheme to provide power to all,” accessed on 18 October 2017 at [www.thehindubusinessline.com/news/pm-launches-saubhagya-scheme-to-provide-power-to-all/article9872678.ece](http://www.thehindubusinessline.com/news/pm-launches-saubhagya-scheme-to-provide-power-to-all/article9872678.ece)

<sup>70</sup> NDTV (2017), “A Woman IAS Officer’s Battle Against Power Thieves In Uttar Pradesh,” accessed on 12 August 2017 at [www.ndtv.com/business/a-woman-ias-officers-battle-against-power-thieves-in-uttar-pradesh-1749119](http://www.ndtv.com/business/a-woman-ias-officers-battle-against-power-thieves-in-uttar-pradesh-1749119)

<sup>71</sup> Electricity Act 2003, s.7. “Any generating company may establish, operate and maintain a generating station without obtaining a licence under this Act if it complies with the technical standards relating to connectivity with the grid.” s.14. “[W]here a person intends to generate and distribute electricity in a rural area to be notified by the State Government, such person shall not require any licence for such generation and distribution of electricity, but he shall comply with the measures which may be specified by the Authority under section 53.”

<sup>72</sup> Akanksha Chaurey, P.R. Krithika, Debajit Palit, Smita Rakesh, Benjamin K. Sovacool (2012), “New partnerships and business models for facilitating energy access,” *Energy Policy* 47

to rural customers at retail prices.<sup>73</sup> The DF would conduct all metering, billing and collections on behalf of the distribution utility at the local level, creating better financial outcomes and customer service.

While the DF model never took off, in around 2009 private entrepreneurs saw an opportunity to generate and sell small-scale renewable power at commercially viable rates to *unserved* and *underserved* rural populations (those with a connection to the main grid that does not meet their electricity demand).<sup>74</sup> Several mini grid companies started up to take advantage of this potential market of last-mile (remote) populations.<sup>75</sup>

The Government of Uttar Pradesh also recognized the benefits of using private mini grid developers to offer services in last-mile areas, and began to develop policy efforts for the sector.<sup>76</sup> Developing policies would provide more regulatory certainty and structure to the growing market and the investment community. In 2016, the Government of Uttar Pradesh adopted its flagship Mini Grid Policy, designed to operate for 10 years. UPNEDA is working with mini grid advocates, civil society, and industry groups to define implementation guidelines for the 2016 Policy.

The 2016 Policy targets mini grid projects of a maximum capacity of 500kW. It states as its first three objectives:

- Promoting decentralized generation of clean and green power by harnessing renewable energy;
- Creating a conducive investment climate to stimulate private sector participation in decentralized generation of renewable power; and
- Providing reliable power supply to nearly 20 million households to meet basic needs of power (such as lighting, fan, and mobile charging).

The agency does not see a long-term role for mini grids to deliver electricity services in rural areas. Rather, it believes that mini grids represent an important interim solution for rural electrification.<sup>77</sup> A top priority for Uttar Pradesh policy-makers is to develop centralized power infrastructure for delivering electricity services. In June 2017, the agency released a draft Solar Power Policy for developing large solar projects of over 5MW.<sup>78</sup>

## 4.2 POLICY APPROACH TO STATE-WIDE TARIFF

There is no uniform tariff required, or tariff ceiling imposed for private mini grids. The Electricity Act of 2003 exempts independent electricity providers in rural areas from tariff regulation.

Operators that accept subsidies from the state would no longer be considered private, and must comply with government tariff policy. The 2016 Policy described above offers a 30% state subsidy to private developers to install mini grids in “remote and economically weaker areas.” The state subsidy is conditional on specified service standards (8 hours per day), and on limiting monthly tariffs to INR60 (US\$0.91) for a load of 50 Watts, and INR120 for 100 Watts. No commercially-operating mini grid

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<sup>73</sup> Meeting at The Energy and Resources Institute (TERI), August 2017

<sup>74</sup> Huffington Post (2013), “Meet Uttar Pradesh, India’s Next Distributed Solar Hotbed,” accessed on 18 October 2017 at [www.huffingtonpost.com/justin-guay/meet-uttar-pradesh-indias\\_b\\_2152777.html](http://www.huffingtonpost.com/justin-guay/meet-uttar-pradesh-indias_b_2152777.html)

<sup>75</sup> The Climate Group (2015), “The Business Case for Off-grid Energy in India,” Finance Report in partnership with Goldman Sachs

<sup>76</sup> Ashok Kumar Srivastava (2013), “Solar Minigrids in Rural Areas of Uttar Pradesh,” *RE Feature*, 12:4, Government of India Ministry of New and Renewable Energy

<sup>77</sup> Meeting with Director of UPNEDA, August 2017

<sup>78</sup> Uttar Pradesh Solar Power Policy 2017 (Draft), accessed on 26 October 2017 at [upneda.org.in/sites/default/files/all/section/Uttar\\_Pradesh\\_Solar\\_Power\\_Policy-2017\\_\\_\\_Final\\_Draft\\_.pdf](http://upneda.org.in/sites/default/files/all/section/Uttar_Pradesh_Solar_Power_Policy-2017___Final_Draft_.pdf)

operators are currently accepting state subsidies, as the tariff limitations are too low to be commercially viable.

### 4.3 EXPANSION PLANNING

As mentioned, successive central and state governments have prioritized universal electricity access since power sector reform in the late 1990s, using joint initiatives to electrify Uttar Pradesh. The Governments of India and of Uttar Pradesh signed a Memorandum of Understanding in February 2000 to cooperate on grid expansion and investments in power generation.<sup>79</sup> The agreement was designed to support Uttar Pradesh's broader sector reform program. Despite the optimism of both governments, the distribution utilities' finances continued to suffer losses in the following years.

UPPCL and its subsidiary distribution companies continue to plan and carry out grid extension funded by loans from the REC. However, where rural villages have been connected to central distribution grids, they seldom receive reliable or stable power supply. Distribution utilities lack the financial and operational capacity to deliver services to remote areas where billing and collection is difficult, costly, and brings few revenues.

The current governments have adopted a liberalization program to define their infrastructure policies. In 2017 the central and state governments established "24x7 Power for All Uttar Pradesh," a joint initiative to expand reliable electricity services to all residents of the state.<sup>80</sup> Specifically, it envisages a financial and operational turnaround of the state's transmission and distribution utilities. The turnaround plan highlights the need to invite more private participation in grid investments through, for example, tariff-based competitive bidding.

Mini grid companies have carved out a space for themselves in rural areas, in parallel to the governments' efforts. To develop a new mini grid project, the private operator studies a district's geography and existing grid system.<sup>81</sup> Field operators conduct field visits and surveys to gauge potential new markets.

Mini grid companies' expansion into new villages and districts remains limited by the availability of financing to install new systems and serve new locations. Any funding they might receive from the REC could put them at risk of heavy-handed tariff regulation.

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<sup>79</sup> Government of India, Ministry of Power (2000), "Memorandum of Understanding Between Ministry of Power, Government of India and the Government of Uttar Pradesh," accessed on 10 September 2017 at [powermin.nic.in/en/content/uttar-pradesh](http://powermin.nic.in/en/content/uttar-pradesh)

<sup>80</sup> Governments of India and Uttar Pradesh (2017), "24x7 Power for All Uttar Pradesh"

<sup>81</sup> Meetings with executives of OMC Power and Mera Gao Power, August 2017

## 5 | OVERVIEW OF THE PRIVATE MINI GRID SECTOR

Private operators have been running mini grids businesses in Uttar Pradesh for almost a decade. This section outlines the common technologies and different business models implemented in the state.

### 5.1 MINI GRIDS TECHNOLOGIES

Mini grids in Uttar Pradesh rely primarily on renewable sources of power, especially solar PV and biomass.<sup>82</sup> Larger systems use diesel generators as a backup to insure against the variability of solar power and limited availability of biomass.<sup>83</sup> The technology used in each case varies depending on the operating business model of the mini grid.

### 5.2 BUSINESS MODELS

The business models of commercial mini grids range in scope, from systems that can provide only basic household needs, to those able to support productive loads. Larger mini grid models work with telecommunications or other industrial customers as an anchor load; these models offer a wide range of options to customers, from basic lighting packages to full 24-hour service.<sup>84</sup> Other smaller models provide only lighting and phone charging services with small loads. Existing companies develop mini grids in one of three broad categories:

- The 'ABC' model developed by OMC Power (OMC),
- The 'tier 1' model developed by Mera Gao Power (MGP), and
- Mini grid models that provide productive power at a micro-enterprise scale (as well as services for households), such as Husk Power and TARA Urja.

The commercial mini grid systems are built, owned, operated, and maintained by the company and its agents in the field. Batteries and storage technologies are sourced from Bangalore (India) and Europe, and solar panels are sourced from China and Bangalore.<sup>85</sup> At least one local company is developing its own low-cost smart meter technology.

#### OMC Power's 'ABC' model

The ABC model developed by OMC Power depends on large commercial or industrial users to serve as anchor customers for each mini grid system of 18kW to 270kW.<sup>86</sup> OMC identifies three categories of customer. The 'A' category are the anchor customers: industrial users, usually telecommunication towers, that have predictable and reliable demand for OMC's electricity services; there are typically one or two for each system. 'B' customers are businesses, including small enterprises, shops, banks, and fuel stations. 'C' customers are residential.

OMC Power was one of the first to develop mini grids as a commercially driven business in Uttar Pradesh. The company founders describe their vision to grow a business that provides 24/7 electricity

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<sup>82</sup> Institute for Transformative Technologies (2016), "Achieving Universal Electrification in India: A Roadmap for Rural Solar Mini-Grids," report for Tata Power

<sup>83</sup> Subhes Bhattacharya (2014), "Viability of off-grid electricity supply using rice husk: A case study from South Asia," *Biomass and Bioenergy* 68

<sup>84</sup> EUEI PDF (2013)

<sup>85</sup> Site visits and meetings at mini-grid projects in Hardoi District, Uttar Pradesh, August 2017

<sup>86</sup> Interviews with executives and field operators of OMC Power, August 2017

services and attracts large private capital to unserved and underserved populations. This represents a next-generation model compared to their original business line, which focused on solar home systems and solar-charged batteries delivered to households at scheduled times.

OMC builds systems in large rural villages, which offer thriving commercial and industrial markets for selling electricity services. They have attracted larger investors, and have a financial payback of around 6 years. In the first years of developing solar-powered mini grid systems, they applied for and received subsidized funding from the Government of India's Ministry of New and Renewable Energy. The effort to obtain the subsidy outweighed its benefits, however; the company focuses exclusively on attracting private capital today.

OMC's systems often sit in mainstream (less remote) villages alongside the state-owned grid (which provides unreliable service). Such infrastructure would normally be a natural monopoly, so it is striking to see the doubling of lines and poles that occurs in some OMC villages. OMC's infrastructure can often be identified by observing the streetlights that OMC offers as part of its package to a village.

OMC offers Tier 1 to tier 4 service, with prepaid and postpaid options depending on the type of customer. The company's groundwork led to a careful segmentation of the ABC market, with further segmentation of the C customers, and a standard package offered across all the villages where they operate. The details of their offer (including rates and any initial interconnection charges) remain confidential. This is probably due to the relatively high per-kWh tariffs that would emerge from those, in spite of customers showing high degrees of satisfaction for quality service and even savings on energy costs.

OMC staffs conduct village meetings before building a plant to garner attention, demand, and support from customers. Their mini grids have roughly 9,000 customers in the small business and residential sectors. They have around 130 anchor customers, each located within 1km of one of their 85 small power plants. The company builds underground lines to connect each anchor customer. They also lease energy-efficient equipment to residential and commercial customers, such as light bulbs, fans, fridges, and televisions. This helps create demand growth for smaller customer categories.

### **MGP's 'tier 1' model**

MGP has built its 1,700 solar DC mini grid systems using a basic tier 1 model, offering only lighting and phone charging services.<sup>87</sup> The company's small size gives it a high degree of flexibility in selecting locations for their operations. To set up a mini grid, MGP surveys rural hamlets of up to 50 households, where no main grid connection exists, and where it is unlikely to arrive within 2 to 3 years. Their customers are remote, poor households and micro-enterprises, in villages with limited local industry.

MGP field operators survey a village and make an agreement with 10 to 50 households to offer mini grid services. They then identify a suitable centrally-located private rooftop where they install two to four 120 Watt-peak solar panels, feeding to a simple DC system connected to each customer. The placement of the panels is presented as an honor or a convenience to villagers, who do not charge for use of their roof space.

MGP offers customers 7 hours of reliable daily service at tier 1 standards. This includes two LED lights and a phone charging outlet. It provides the services at a fixed charge of INR30 (US\$0.46) per week to

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<sup>87</sup> Interviews with executives of Mera Gao Power, August 2017

each customer, with an initial connection charge of INR100 (US\$1.54). Customers are billed on a prepayment basis using community-based collection methods, modelled on microfinance methods.

This model targets a smaller customer size but allows the operator greater flexibility and range in the locations where it can offer services. By providing only tier 1 electricity, the operator cuts their capital costs dramatically, to about US\$980-US\$1,000 for a 30-customer system. This provides a shorter pay-back period of 30 to 36 months. However, this model is less likely to stimulate higher levels of local economic activity from productive uses of electricity, and the operator would not benefit from the presence of an anchor customer like a telecommunications tower near the village. Without the possibility of greater loads, this model has limited applications for small enterprises and none for industries such as telecommunications.

The company is also developing smart meters in-house, to deploy at each of their connected customers, for an added cost of US\$10 per connection that it intends to absorb and offer for free to its customers. MGP do not plan to offer consumption-based metering immediately, but they are installing the devices to allow other commercial options in the future.

### **Other operators**

Other private developers in Uttar Pradesh's mini grid market have various models based on biomass and solar PV generation. Those that provide energy for productive loads are supported by Smart Power for Rural Development, the Rockefeller Foundation's advocacy group for mini grids in India.<sup>88</sup>

Husk Power Systems (HPS) develops small biomass power plants of 30kW to 50kW that run on agricultural waste for baseload generation.<sup>89</sup> In 2015, the company also introduced solar-biomass hybrid plants to provide day-long power.<sup>90</sup> HPS started their business in 2008 in the neighboring state of Bihar. They now have 85 plants, with about 12 in Uttar Pradesh.

HPS mini grids connect over 400 subscribers in each village, using insulated wires strung from bamboo poles.<sup>91</sup> Some plants now have solar panels as a complement to biomass for meeting daytime demand. The levelized cost of running the biomass plants on waste is low enough for rural customers to afford the electricity. The company trains local workers to operate the plants.

TARA Urja is a social enterprise that sets up solar PV mini grids with productive load in rural Uttar Pradesh. They have developed a social and commercial growth model they call Community Engagement, Load Acquisition, and Microenterprise Development (CELAMeD).<sup>92</sup> This is based on creating demand growth in rural villages by helping to grow local businesses and increasing customers' buying power. Providing the reliable electricity services would stimulate the small-scale commercial and industrial

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<sup>88</sup> Rockefeller Foundation (2017), "Understanding the Impact of Rural Electrification in Uttar Pradesh and Bihar, India: Evidence from The Rockefeller Foundation's Smart Power for Rural Development Initiative"

<sup>89</sup> Power for All (2017), "Virtually battery-free, 100% renewable, remotely-managed rural utility is coming," accessed on 10 August 2017 at [www.powerforall.org/blog/2017/7/13/virtually-battery-free-100-renewable-remotely-managed-rural-utility-is-coming](http://www.powerforall.org/blog/2017/7/13/virtually-battery-free-100-renewable-remotely-managed-rural-utility-is-coming)

<sup>90</sup> Business Standard (2017), "Husk Brings Electricity to Power-Hungry Indian Villages," [poweringag.org/news-events/news/husk-brings-electricity-power-hungry-indian-villages](http://poweringag.org/news-events/news/husk-brings-electricity-power-hungry-indian-villages); Power for All (2017), "Virtually battery-free, 100% renewable, remotely-managed rural utility is coming," accessed on 15 November 2017 at [medium.com/energy-access-india/virtually-battery-free-100-renewable-remotely-managed-rural-utility-is-coming-be4d1b7f3db6](http://medium.com/energy-access-india/virtually-battery-free-100-renewable-remotely-managed-rural-utility-is-coming-be4d1b7f3db6)

<sup>91</sup> Knowledge@Wharton (2011), "Husk Power Systems: Generating Electricity from Waste just about anywhere for India's Rural Poor," accessed on 10 November 2017 at [knowledge.wharton.upenn.edu/article/husk-power-systems-generating-electricity-from-waste-for-indias-rural-poor/](http://knowledge.wharton.upenn.edu/article/husk-power-systems-generating-electricity-from-waste-for-indias-rural-poor/)

<sup>92</sup> Smart Power India (2017), "Smart Power: A new value proposition for village communities," Parts 1 to 3, accessed on 29 August 2017 at [www.smartpowerindia.org/2017/08/16/tara-urja-focuses-on-rural-economic-development-by-smart-power/](http://www.smartpowerindia.org/2017/08/16/tara-urja-focuses-on-rural-economic-development-by-smart-power/)

growth. TARA's mini grids are funded through corporate social responsibility (CSR) and customer payments.<sup>93</sup>

Several mini grids have been set up as humanitarian projects by private donors, providing power free of charge. Tata Power operates two mini grids in Western Uttar Pradesh through its CSR investments.<sup>94</sup> These may prove to be valuable pilots for the power company, which is considering creating a joint venture with MGP.<sup>95</sup>

## 6 | AUTHORIZING MINI GRID OPERATORS

No licenses are required as a result of central legislation combined with the 2016 Policy's interpretation of it. As noted, privately-owned, financed, and operated mini grids are exempt from distribution licenses per the Government of India's Electricity Act 2003.<sup>96</sup> The 2016 Policy gives mini grid operators broad flexibility in interpreting what areas are eligible for installing a mini grid: it defines areas of operation for mini grids as "un-electrified habitations/hamlets and ... contiguous undeveloped and backward rural/urban areas deprived of conventional grid or with relatively less supply of electricity."<sup>97</sup> No state or federal rule explicitly designates rural areas. Defining mini grid areas by their lack of existing supply was a deliberate choice, according to UPERC. It allows mini grid operators flexibility to enter any area that offers them a market.<sup>98</sup> Moreover, consumers need not suffer the limitations of the main grid if another entity is willing to provide better services (even at higher costs).

The first duty of mini grid operators, according to the Regulations, is to register every mini grid project with UPNEDA, UPERC, and the local distribution utility. However, no mini grid has been registered to date. UPNEDA is developing Implementation Guidelines to outline the procedure and requirements for registering mini grid projects.

The Draft Implementation Guidelines for Mini Grid Projects, dated November 2017, envisage a routine registration process through an online platform that will be set up for the purpose.<sup>99</sup> The goal of creating the registration process is to simplify and speed up the existing approvals procedures. UPNEDA plans to act as a single-window clearance facility, liaising with relevant state authorities to process each mini grid's approvals and clearances.

The single-window clearance facility proposed by UPNEDA would help mini grid operators with the administrative burden of obtaining approvals to set up a system. The single-window clearance facility can help reduce the administrative requirements for mini grid operators, which will need to deal with only one authority. On their end, UPNEDA will establish systems to engage with their Government counterparts to speed up the permitting process.

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<sup>93</sup> Meeting with TARA Urja staff, August 2017

<sup>94</sup> Meeting with Tata Power Director of Business Development, August 2017

<sup>95</sup> Institute for Transformative Technologies (2016)

<sup>96</sup> Electricity Act of 2003, section 14, "[W]here a person intends to generate and distribute electricity in a rural area to be notified by the State Government, such person shall not require any license for such generation and distribution of electricity."

<sup>97</sup> Uttar Pradesh Mini-Grid Policy 2016, section 3

<sup>98</sup> Meeting at UPERC, August 2017

<sup>99</sup> Draft Implementation Guidelines for the Mini-Grid Projects in the state of Uttar Pradesh (Confidential), November 2017

Today, mini grid operators must obtain their approvals and clearances from various public authorities to lease land, build the small power plants, and set up the distribution network. The authorities process their relevant clearances individually, which can be a cumbersome process. Experienced operators note that it takes them 3 months to obtain approvals for each new project. The mandatory approvals and clearances depend on the type of mini grid, and include permissions regarding land usage, pollution control, fire safety, right of way for the distribution system, and electrical safety.

## 7 | TECHNICAL AND SERVICE STANDARDS

UPERC defines mini grids as projects that produce electricity through renewable energy-based generation systems of up to 500kW capacity, and supply electricity to consumers through a power distribution network (PDN). The definition includes the option for a mini grid project to sell electricity to the Distribution Licensee in rural areas with inadequate electricity supply, as defined by the Government. Non-renewable systems would not be required to register, but then again registration is not a strict requirement that authorities are willing to enforce even for renewable systems; also, a diesel system would entail higher costs, and as a matter of fact none are offered.

UPERC defines a set of technical standards for setting up a mini grid PDN, depending on the size of the project. The Mini Grid Renewable Energy Generation and Supply Regulations of 2016 ('the Regulations') require that all mini grids of above 50kW peak capacity comply with stringent technical and safety standards: either UPPCL guidelines (for design and construction of distribution lines), or the Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010.

The Regulations also require all mini grids to follow any standards that may be prescribed by the State of Uttar Pradesh. This would include standards cited in the future publication of Implementation Guidelines for Mini Grid Projects. To interconnect with UPPCL's grid, the mini grid PDN must follow UPPCL's own distribution network code and comply with CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013.

Technical standards are simplified for mini grids of less than 50kW. The PDN must have poles made of Portland cement concrete (PCC), with aluminum cable covered by polyvinyl chloride (PVC) and supported by galvanized iron. Connections to customers must be made through junction boxes mounted on the pole.

Maintaining safety standards depends largely on companies' incentive to ensure reliable and high-quality services for customers. UPERC enforces technical and safety standards through a simple grievance mechanism. This relies on consumers to lodge a complaint with UPERC or the relevant public authority if they are dissatisfied with any safety or technical aspect. Regulatory action could be triggered if an operator fails to meet service standards. Although UPERC does not issue operating permits that it may subsequently revoke, it can instruct action to a Government authority. According to the current Draft Implementation Guidelines, UPNEDA may conduct inspections of the mini grid voluntarily or based on consumer complaint. If the operator fails to meet safety standards, UPNEDA could cancel the project or "blacklist the mini grid operator and update [the Government of India Ministry of New and Renewable Energy]."

The 2016 Policy defines service standards specifically for state-subsidized mini grids. Projects receiving those subsidies must comply with these standards within 6 months of commissioning the plant. These mini grid project developers are required to:

- Run the project on a build-own-operate-maintain basis, with 10 years' operations and maintenance by the developer;
- Organize land for the project;
- Supply electricity for at least 3 hours in the morning and 5 hours in the evening to all interested households in the mini grid area, depending on demand;
- Provide 6 hours of electricity supply daily for other production and commercial needs; and
- Supply the remaining energy to other customers.

Formal procedures to enforce service standards will not be defined until official Implementation Guidelines are released. The Draft Guidelines outline a Grievance Redressal Mechanism for disputes between the mini grid operator and UPNEDA. UPNEDA or the Funding Agency would have the option to “cancel disbursement of any remaining amount of funding support” if the mini grid operator fails to keep the terms of the contract, which include complying with the service standards.

## 8 | TARIFFS, FINANCING, AND SUBSIDIES

Tariffs are not regulated for mini grid operators unless the operator receives funding or subsidies from the Government of Uttar Pradesh, or acts as a franchisee of the electricity distribution companies. Subsidized funding from the central Government or from non-governmental sources, such as development banks, does not subject privately-financed operators to UPERC tariff regulation; most operators benefit from such sources of capital. On the other hand, if a mini grid operator buys power from the grid to resell to customers, it is considered a distribution franchisee; such a system would be subject to UPERC regulations on retail tariffs.<sup>100</sup>

UPERC's priority is to leave mini-grids to operate through market forces, and—as reflected by the 2016 Policy, which its staff drafted—sees no reason to regulate mini grid operators when they are independent of public money.<sup>101</sup> UPERC staff recognize that it serves public policy interests to allow mini grids to offer electricity services to underserved consumers, even if they charge higher rates than the state distribution companies. They also noted that regulations should not prevent private electricity companies from offering quality services that consumers are willing to pay for.

As mini grids make up less than half of 1% of all electricity connections in the state,<sup>102</sup> they do not pose enough of a concern or a burden to the public to warrant setting and enforcing tariff regulation. The state's power system has over 20GW capacity, while mini grids have at most 3MW, a negligible fraction of the overall system. UPERC foresees mini grid capacity could reach up to 11MW by 2020, which is equally unlikely to threaten the stability of the distribution grid from a technical standpoint, in the event they interconnect.

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<sup>100</sup> UPERC (Mini-Grid Renewable Energy Generation and Supply) Regulations, 2016

<sup>101</sup> Ibid.

<sup>102</sup> Meeting with Director of Distribution, UPERC, August 2017

Promoting competition through market forces may also have been a premise for the policy not to regulate mini grid tariffs, to help keep them low;<sup>103</sup> however, different operators have largely operated in parallel with different business models, without actual competition. OMC Power’s model is described as market-driven, with freely negotiated tariffs.<sup>104</sup> In practice, OMC offers standard packages that customers can take or not, without actual negotiation.

State-owned distribution utilities differentiate their tariffs according to consumer categories. Across sectors, tariffs vary between rural and urban customers, metered and unmetered customers, as well as by categories such as industry, load, and consumption.

In August 2017, UPPCL filed a rate case to increase tariffs by 23% on average.<sup>105</sup> In September, UPERC approved an increase of 12% for domestic customers, and from 6% to 12% for industrial, commercial, and agricultural customers.<sup>106</sup> Table 8.1 compares tariffs for residential customers of UPPCL’s distribution utilities under the ‘Rural Schedule’ with corresponding tariffs from private mini grid operators. These tariffs assume an average daily load of 8 Watts for each type of service, for 6 to 9 hours a day (which depends on the package offered).

**Table 8.1: Rural Residential Tariffs of Distribution Utilities vs. Mini Grids**

Assumptions for Tier 1 service 2017-2018		Metered UPPCL	Unmetered UPPCL	MGP	OMC (basic)	Alternatives (1)
<b>Consumption</b>	kWh/month (2)	2.19	2.19	1.70	1.46	N/A
<b>Average load</b>	Watts (3)	8	8	8	8	
<b>Daily hours of service</b>	Hours	9	9	7	6	5
<b>Peak load</b>	Watts	20	20	<15	<15	N/A
<b>Estimated tariff</b>	INR/kWh	3	2	76	75	
	US\$/kWh	0.05	0.03	1.18	1.17	
<b>Estimated monthly bill</b>	INR/month	7	4	130	110	270
	US\$/month	0.10	0.06	2.02		1.71

Notes: (1) This column shows the most common alternative to paying for electricity connection. Average household uses 5 liters of kerosene and pays for 15 phone charges at a market kiosk per month.

(2) This is an assumption of how much electricity a customer would receive under each scheme.

(3) This is an assumption of average load for tier 1 consumption.

Source: UPERC tariff order, 2016, field meetings with Mera Gao Power and OMC Power, August 2017

## 8.1 SETTING RETAIL TARIFFS

The 2016 Policy defines maximum tariffs for state-subsidized mini grids. Tariffs for privately-financed mini grids remain at the discretion of their operators. Table 8.2 breaks down the tariffs charged by mini grid operators, distinguished by load and by the financing source.

<sup>103</sup> Meeting at TERI, August 2017

<sup>104</sup> Meeting at OMC Power, August 2017

<sup>105</sup> Times of India (2017), “Unmetered rural consumers face 300% rise in power tariff,” accessed on 18 September 2017 at [timesofindia.indiatimes.com/city/lucknow/unmetered-rural-consumers-face-300-rise-in-power-tariff/articleshow/59980386.cms](http://timesofindia.indiatimes.com/city/lucknow/unmetered-rural-consumers-face-300-rise-in-power-tariff/articleshow/59980386.cms)

<sup>106</sup> Business Standard (2014), “UP regulator approves increase in power rates,” accessed on 18 September 2017 at [www.business-standard.com/article/economy-policy/up-power-tariffs-increase-by-12-114100100777\\_1.html](http://www.business-standard.com/article/economy-policy/up-power-tariffs-increase-by-12-114100100777_1.html)

**Table 8.2: Tariffs for Publicly Subsidized and Private Mini Grids (Cost per Unit)**

Customer type, Typical load		Publicly subsidised (1)	Not publicly subsidised
<b>Residential</b> <b>10 to 50 Watts</b>	INR/kWh	< 25	< 76
	US\$/kWh	< 0.38	< 1.18
<b>Residential</b> <b>50 to 100 Watts</b>	INR/kWh	< 10	Information unavailable (operator’s discretion)
	US\$/kWh	< 0.16	
<b>Residential</b> <b>100+ Watts</b>	INR/kWh	Operator’s discretion	Information unavailable (operator’s discretion)
	US\$/kWh		
<b>Commercial</b> <b>1000+ Watts</b>	INR/kWh	Operator’s discretion	< 29
	US\$/kWh		< 0.45

Note (1): Prices are given as a maximum for both types of mini grid. Residential mini grid customers are charged a prepaid monthly bill for a specified load, not based on actual consumption.

Source: UPERC Tariff Order 2016; Meetings with mini grid operators OMC and MGP, August 2017

## 8.2 TYPE OF SUBSIDIES AVAILABLE

Most mini grids in the state are privately financed, with various levels of capital subsidies from private sources, as well as occasional public funding. Private subsidies include soft loans and equity investments from development funds such as the Rockefeller Foundation, and impact investors such as Insitor Management Funds and Acumen Investing.<sup>107</sup> Most private mini grid operators have also received grants from international development organizations, such as the Canopus Foundation and the United States Agency for International Development (USAID). Other mini grids run entirely on CSR funding, such as those of Tata Power.<sup>108</sup>

The Government of India’s MNRE has offered subsidies to various private mini grid developers in Uttar Pradesh. OMC received a 30% capital subsidy from MNRE for several of its projects, through a process that company representatives say took 18 months to organize.<sup>109</sup> The subsidy represented about 10% of their total capital outlay. Husk Power Systems receives around 50% of capital subsidy from MNRE to build its plants, and may also receive some operational subsidy under the RGGVY program.<sup>110</sup> Neither of these two companies seems to consider the MNRE funding a sustainable source of capital with which to expand their businesses.<sup>111</sup>

The state’s 2016 Policy offers private developers a subsidy of 30% of project development cost through viability gap financing (a one-time grant to support infrastructure projects that are economically justified but not financially viable). The state subsidy triggers significant tariff restrictions and service standards, as shown in Table 8.2.

<sup>107</sup> Meetings with mini-grid developers, August 2017

<sup>108</sup> Institute for Transformative Technologies (2016)

<sup>109</sup> Meeting with TERI, August 2017

<sup>110</sup> Government of India Biomass Knowledge Portal (date unknown) “Husk Power System - Electrifying Rural India with Rice Husk,” accessed on 10 November 2017 at [biomasspower.gov.in/document/download-lef-tside/Case%20Study%20Husk%20Power\\_31%20March.pdf](http://biomasspower.gov.in/document/download-lef-tside/Case%20Study%20Husk%20Power_31%20March.pdf)

<sup>111</sup> Meeting with mini-grid developers, August 2017

### 8.3 ELIGIBILITY TO GET SUBSIDIES AND SOURCES OF MONEY FOR SUBSIDIES

Eligibility for subsidies is as broad as it is uninteresting for operators under the current policy framework. All mini grid projects of up to 500kW, and powered by renewable energy-based generation, are eligible for the 30% state subsidy outlined in the 2016 Policy. Mini grid operators may also receive other benefits or incentives provided in industrial policy for infrastructure support, where available. The pricing terms imposed by state subsidies are not viable for existing operators. Those running successful businesses today rather aim to attract CSR financing and grants from private sources, alongside commercial financing.

### 8.4 LEVEL OF SUBSIDIES

Levels of subsidies are subject to the same considerations made for eligibility: those offered by the state are generally insufficient to encourage private investment in Uttar Pradesh. Financing from the state triggers tariff regulations that make the mini grid business model unviable. Instead, private operators often receive grant financing or subsidized loans from special funding vehicles due to the positive social impacts of their business.

Importantly, consumers can afford private mini grid power at the basic tier in Uttar Pradesh without state subsidies, although private operators commonly receive subsidized money from private sources. Thanks to electricity services from OMC or MGP, households spend significantly less on their day to day energy costs. Tier 1 electricity from mini grids meets lighting and phone charging needs at 30% to 50% lower cost than the alternative. This is because before mini grid services arrive in a village, residents use kerosene (paraffin lamps) for lighting, and pay to charge their phones from private providers at a cost of 8 to 15 U.S. cents per charge.

Information gathered on the ground suggests that businesses equally benefit from more expensive but reliable service. They can reduce their power costs by up to 50% thanks to solar powered mini grids; and stay open several hours later and increase their daily revenues.<sup>112</sup> One impact study found that microenterprises that connected to mini grids gained 13% increase in their monthly revenues (on average).<sup>113</sup>

### 8.5 REGULATORY TREATMENT OF SUBSIDIES

The 2016 Policy's proposed subsidy is conditional on strict tariff limits. The 2016 Policy stipulates the maximum price by load, and requires a minimum 8 hours of daily service. Operators may charge INR60 a month for providing a service of 50 Watts; for a service of "up to 100 Watts," operators may charge INR120 a month. Beyond 100 Watts, tariffs may be set by "mutual consent," leaving the operator to stipulate a price at their own discretion.

UPERC issued the Mini Grid Regulations after the 2016 Policy was released. The Regulations state the performance, technical, and safety standards for mini grid operators, including both private and publicly-subsidized.

The 2016 Policy's service standard requires mini grid operators to provide continuous electricity supply for at least 5 hours uninterrupted between 17:00 and 23:00 each day to all connected customers, and

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<sup>112</sup> Meeting with commercial customer of OMC Power in Pipargaon village, Uttar Pradesh, 19 August 2017

<sup>113</sup> Rockefeller Foundation (2017)

for 3 hours in daylight times, totaling at least 8 hours daily. At least 10% of mini grid system capacity must be directed to residential customers.

## 9 | HANDLING THE RELATIONSHIP WITH THE GRID

Privately-owned mini grids in Uttar Pradesh have not connected with the grid to date. However, the 2016 Policy and UPERC regulations outline two possible pathways for such a connection: the mini grid operator could continue operating (by selling the power it generates to its customers and selling excess to the main grid), or for the mini grid to sell all power it generates to the main grid, and transfer its PDN assets to the local utility.<sup>114</sup> These options have not yet been used in practice.<sup>115</sup>

The central Government and UPERC consider that the main grid should be the primary source of electrification for rural consumers. This reflects the importance that rural electrification plays for the central government, with a US\$12 billion budget for extending the distribution network in villages.<sup>116</sup> Mini grids have an almost insignificant market share of electricity consumers in the state, at less than half of 1%. These privately-owned last-mile electrification companies are tolerated, and in more remote areas are encouraged, to play an auxiliary role before the state-owned distribution utilities have capacity to offer reliable services.

Where the option exists to interconnect, existing mini grid operators prefer to remain independent of the grid, and continue to provide reliable electricity services at unregulated tariffs. In the more remote locations, the prospect of receiving reliable grid services remains distant. For mini grid operators in all rural areas, the business offers fruitful possibilities of engaging with last-mile consumers and building trusting relationships.

Mini grid operators consider the possibility of buying cheaper power from the main grid in the future, but neither the 2016 Policy nor the Regulations offer this option. Unsurprisingly, operators are interested in the option of buying cheaper energy from the main grid as long as they may sell on to their customers at their usual rate (or close to it).<sup>117</sup> This strategy would work for operators if they could maintain viable tariffs. But it would mean charging more than the publicly-owned distribution utility, even if the mini grid operator purchased power from the main grid. UPERC opposes this option, noting that it would not be practicable; what is more, it would not be allowed under the current form of the Electricity Act 2003. While UPERC would have to regulate the retail price (albeit lightly, from the operators' perspective), the cost of service information that would be needed to carry out such regulation would be difficult to obtain, and probably not reliable.<sup>118</sup>

### 9.1 WHAT HAPPENS WHEN THE GRID ARRIVES

Several mini grids in larger villages exist directly alongside existing grid infrastructure, notably many OMC Power mini grids.<sup>119</sup> For those operators, the grid's presence is not yet a threat to their business.

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<sup>114</sup> See UPERC Regulations, Appendix B

<sup>115</sup> Meeting with Director of UPNEDA, August 2017

<sup>116</sup> Meeting at TERI, August 2017

<sup>117</sup> Meeting with executives of OMC Power, August 2017

<sup>118</sup> Meeting at UPERC, August 2017

<sup>119</sup> Ibid.

The public distribution utilities are still rebuilding their capacity to provide reliable service at predictable loads for customers in rural areas.

The 2016 Policy and Regulations outline two exit options for mini grid operators once the state-owned grid arrives at the site of the mini grid.<sup>120</sup> As noted, these options have not yet been tested in practice:

- The mini grid operator may continue to sell the electricity it generates to its local customers at its usual tariff, and sell the excess electricity to the local distribution utility at the feed-in-tariff (FIT) defined at the state level.
- The mini grid operator may sell all the electricity it generates to the utility at the FIT.

In either case, the mini grid operator may choose to sell its distribution assets to the distribution utility, at a mutually agreed price based on the “depreciated value of [the] assets.” The Regulations further state that if the distribution utility refuses to purchase the mini grid’s PDN, it must compensate the mini grid operator to the equivalent value of the renewable purchase obligation credits that the mini grid would have produced for the distribution utility. This still leaves significant risk to the mini grid operator, as it may fail recover the costs of its distribution assets.

If the local distribution utility refuses to enter into a PPA with the mini grid operator, the utility must compensate the operator with a value equivalent to the renewable energy credits generated by the mini grid. This forces the local utility to accept distributed generation from the mini grid. However, since the tariff for the mini grid is set at the state’s equivalent FIT, this would probably not be overly burdensome to the utility.

## 9.2 WHOLESALE TARIFF SETTING

Wholesale of power to mini grids does not occur in Uttar Pradesh today. UPERC would be obliged to regulate the wholesale tariff of such a transaction, and as a result would also regulate the mini grid’s retail tariff.<sup>121</sup>

If a mini grid operator wishes to sell excess electricity to the local distribution utility, the tariff is set at the state level according to the current FIT for the applicable generating technology.

## 9.3 OBLIGATION OF UTILITY TO PURCHASE OUTPUT

The utility is obligated to purchase output from mini grids if they sign an interconnection agreement, as outlined in the 2016 Policy (see Appendix A). The Regulations set the tariff for such a PPA at the applicable FIT for the mini grid’s generating technology. If the utility refuses to buy the mini grid’s energy, it must pay the mini grid operator an amount equivalent to the value of renewable energy credits that the mini grid project would provide under the Government’s renewable purchase obligation scheme (see Appendix B).

## 9.4 POWER PURCHASE AGREEMENTS

A mini grid is permitted to enter into a PPA to sell its power to the local utility once the local distribution grid extends to the mini grid area. If the distribution utility refuses to enter into a PPA with the mini grid

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<sup>120</sup> They also state the option for the mini grid operator to continue to supply all their electricity generated to customers, without selling any to the state-owned grid. This would not provide any protection to the operator if all their customers were to switch to the grid supply.

<sup>121</sup> Meeting with Director of UPNEDA, August 2017

operator, it must compensate the operator to the value of the renewable purchase obligation credits generated by the mini grid system.

A mini grid operator agreeing to purchase power from the distribution utility is not permitted in the mini grid framework today, given the exit strategies outlined above, and does not occur. Instead of adopting the unviable distribution franchisee option (first proposed in 2005), operators would prefer to enter into a PPA with the distribution utility to buy its cheaper power, and sell that to their customers at a tariff that is commercially viable (at most only lightly regulated). But, as noted, that option is not currently available to private operators in rural areas.

## 10 | LESSONS LEARNT

A regulatory framework favorable to rural mini grids, with no tariff regulation and relaxed authorization requirements, has helped new companies gain a foothold in India's energy-poor regions. Among those, Uttar Pradesh leads the charge to foster off-grid rural electrification efforts through its 2016 Mini Grid Policy and subsequent Regulations. Those provide greater policy certainty for commercial mini grid operators and promise to lighten the burden of approvals procedures, while allowing electricity services to arrive in underserved communities.

Privately-financed mini grid operators are capturing a growing share of a market of rural customers that is at the same time relatively small for Uttar Pradesh and huge for any operator. Tens of millions of customers remain without service, and millions more have unreliable, insufficient service. Commercial models, combined with subsidies from development organizations, are attracting outside investment and development loans. This financing has kickstarted rapid growth in new electricity connections, providing reliable and safe power to poor communities at virtually no cost to the public sector. Rural residential and commercial customers sign up to mini grid services at a rate of around 70% in each operator's existing catchment area.

Mini grid operators have successfully adopted different business models in Uttar Pradesh, all offering an alternative to state-owned distribution utilities where poor or no service exists. Larger mini grid generation systems rely on commercial and industrial customers to create predictable demand. Models based on smaller generation systems promise only simple lighting and phone charging services. These business models have a shorter payback period than the larger systems. Interviews on the ground suggest that opinions about which business service is best are at least as different as the business models themselves. There is probably no single right answer valid everywhere. Various market segments have allowed various models to thrive, and operators have shown foresight in capturing and fostering future market trends. OMC Power evolved from solar home systems and battery delivery to utility-level services in larger villages; MGP is thinking ahead with smart metering to adapt to higher tier service, and considering opportunities to expand their business through joint ventures.

However, the outlook for the mini grid sector in Uttar Pradesh remains uncertain. Mini grids' success to date has been predicated on their ability to provide reliable, higher-quality service in the face of public service failure. This success has carved out a space that some public authorities encourage, while others tolerate but dismiss as a minor and temporary solution. Encouragement is more successful when it consists of doing nothing: no tariff regulation, no licenses, and referring to service standards without strict enforcement. The exit strategies provided today remain dead letter: to mini grid operators, they are commercially unviable, as they entail heavy regulation; to distribution companies, they are unrealistic, as they would not consider buying out mini grid distribution systems). State government

funding comes with too many strings attached to be interesting. The opportunity to source lower-cost, centrally-generated power remains similarly out of reach, because it triggers the distribution franchisee model.

Whether public plans to make distribution utilities viable succeed or not could make or break the private mini grid sector. but that outcome is highly uncertain. The whole range of opinions emerged from our interviews on the ground, from full confidence to deep skepticism. If the truth lies somewhere in between, the public sector might recognize it cannot do it all, and there would be enough space for mini grids to play a part without having to count on the plan for utilities to fail.

In this sense, mini grids could benefit from policy makers acknowledging a clearer role for them in Uttar Pradesh's electrification. This might happen as competition among mini grid operators increases, possibly with an effect on reducing retail prices. It should certainly happen while bearing in mind the liberal approach that seems to have worked well in a context where public service has been lacking to bring private investment to supply essential infrastructure with important social, economic, and health outcomes for isolated communities.

*Appendix A: Uttar Pradesh Mini Grid Policy 2016*

[To be provided as part of final report/link on ESMAP website].

*Appendix B: Uttar Pradesh Electricity Regulatory Commission (Mini Grid Renewable Energy Generation and Supply) Regulations, 2016*

[To be provided as part of final report/link on ESMAP website].

*Appendix C: The Electricity Act, 2003 [No. 36 of 2003]*

[To be provided as part of final report/link on ESMAP website].