Improving the Economics and Reliability of Rural Electricity Service

Interconnected Minigrid Acceleration Scheme Stakeholders Workshop

30 April 2019

ROCKY MOUNTAIN INSTITUTE

AGENDA

1. Background
2. Interconnected Minigrids for Undergrid Communities
3. The Business Case for Distribution Companies
4. Opportunity for Developers and Communities
5. The Path Forward
6. Discussion

Rocky Mountain Institute (RMI) has been transforming energy systems since 1982

- **Impartial NGO** grounded in technical and economic analysis with a whole-systems approach and focus on market-based solutions
- **Staff of 200+** scientists, engineers, and business, and policy leaders
- **Global operations** collaborating with governments, development partners, utilities, and the private sector – including the US, China, India, sub-Saharan Africa, and the Caribbean
- **37-year history** of transforming energy systems to increase efficiency, sustainability, and resilience (electricity, buildings, transportation, industry)
- **Sustainable Energy for Economic Development** (SEED) program drives **affordable, efficient, and resilient** energy systems that incorporate emerging distributed energy resources to **rapidly provide energy access and increase economic development**

SEED receives generous support from:

The Rockefeller Foundation · Virgin unite · Nationale Postcode Loterij · gef · Good Energies Power for a better world

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Nigeria's rural electricity customers, who compose nearly half of all consumers, are significantly un- and under-served

- **41% of rural customers are connected** to the main grid, but they often lack access to reliable service
- Nearly all rural customers rely on non-grid alternatives to meet basic energy needs
- Rural **customers spend N200/kWh or more** for energy alternatives
- **Options to improve electricity service** include:
  - Grid extension/improvement
  - Minigrids
  - Solar Home Systems
  - Diesel/petrol gensets

Undergrid customers today rely on expensive generators to run their businesses and homes

Sources: World Bank, 2016;
RMI and EMRC, "Under the Grid", 2018. http://rmi.org/insight/under-the-grid/

Minigrids are a cost-effective option for serving rural communities with reliable electricity

Rural connections may not be best served by the traditional grid due to remoteness and low consumption levels—often ~1kWh/day.

Minigrid definition

- **Self-contained power generation system serving multiple customers** through distribution network
- Up to 1MW capacity
- More reliable than the main grid in much of rural Nigeria

Ideal minigrid communities

- **Remote**—long transmission/ distribution distances make traditional grid uncompetitive and/or loss-making
- **Dense** connections—limiting distribution cost and losses
- **High daytime electricity demand**—to justify and support a standalone system providing 24h service including commercial/ productive use customers
- Community ability and **willingness to pay**—usually driven by high cost of alternatives today

Interconnected minigrids (IMGs) are an option to provide better electricity service to undergrid communities

IMGs create a ‘win-win-win’

1. Reduce DisCo losses and demonstrate an early model for sub-franchising of DisCo responsibilities
2. Provide reliable, affordable electricity to undergrid communities
3. Open a new market for minigrid developers to scale and reduce cost

IMGs create a **bridge to the future** when the main grid becomes reliable

IMG market size potential

- **4,000 viable communities** across Nigeria
- **₦400 billion** ($1 billion) annual minigrid revenue opportunity

More definitions

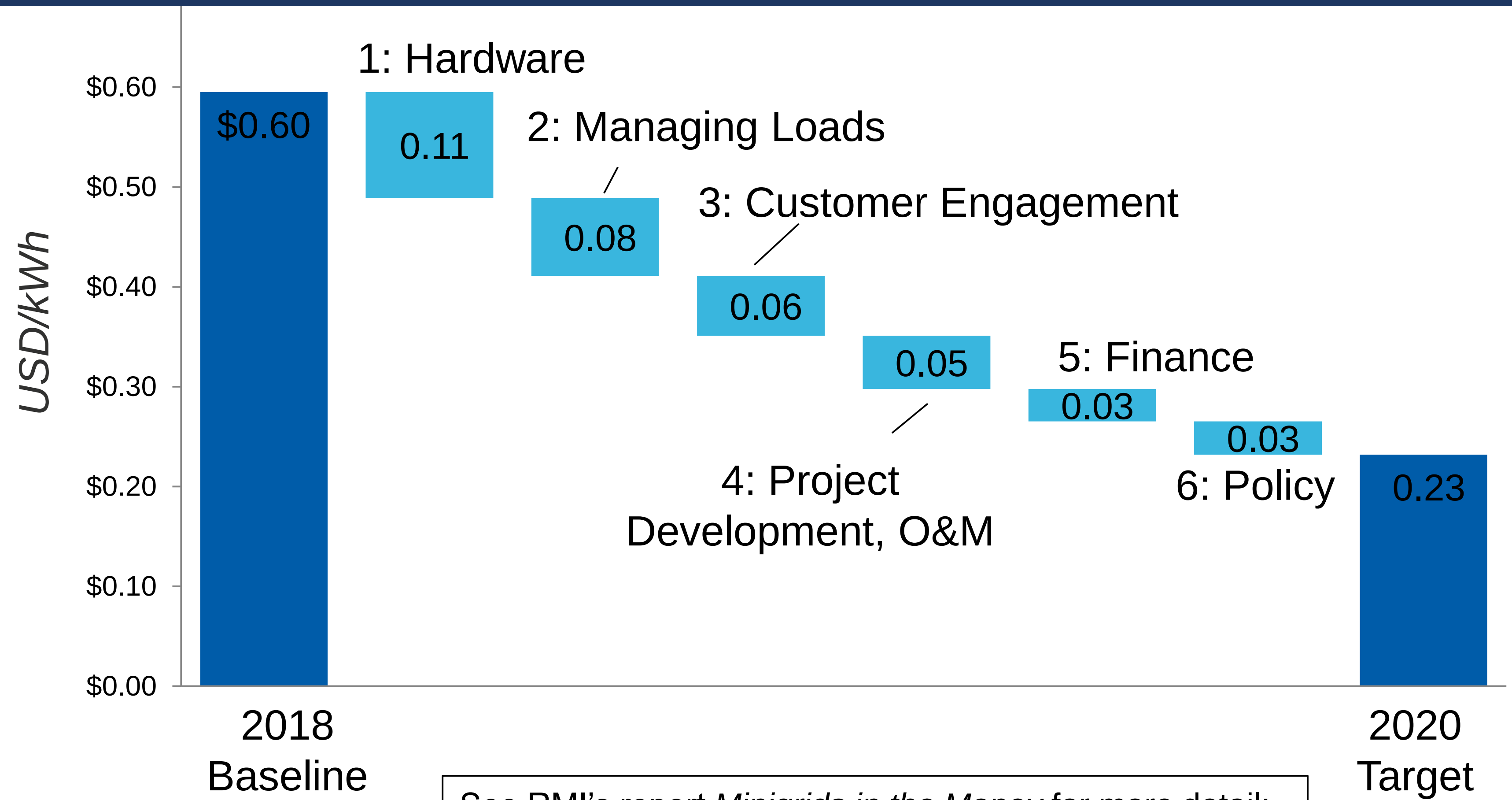
- ***Isolated minigrids*** serve off-grid communities without existing distribution infrastructure
- ***IMGs*** will serve ***undergrid areas*** in DisCo territory, with existing grid service or infrastructure but unreliable or no service
- IMGs can serve the community as an island, or connect to the grid for two-way power flow*

**Danger! We’ll return to this later*

Source: RMI and EMRC, “Under the Grid”, 2018. http://rmi.org/insight/under-the-grid/

Minigrid costs have the potential to rapidly fall to near $0.20/kWh (₦70, 60% reduction) by 2020

Cost reduction opportunities in six categories



See RMI's report *Minigrids in the Money* for more detail:
rmi.org/insight/minigrids-money/

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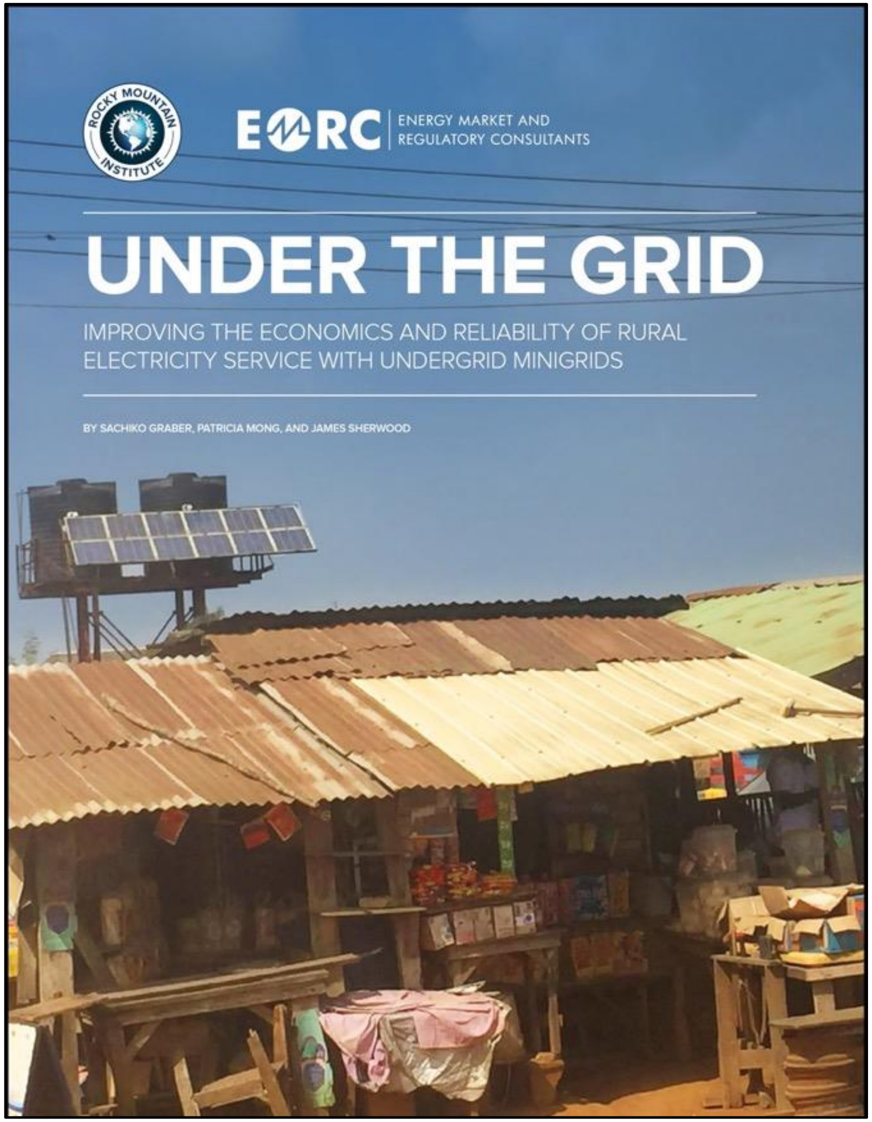
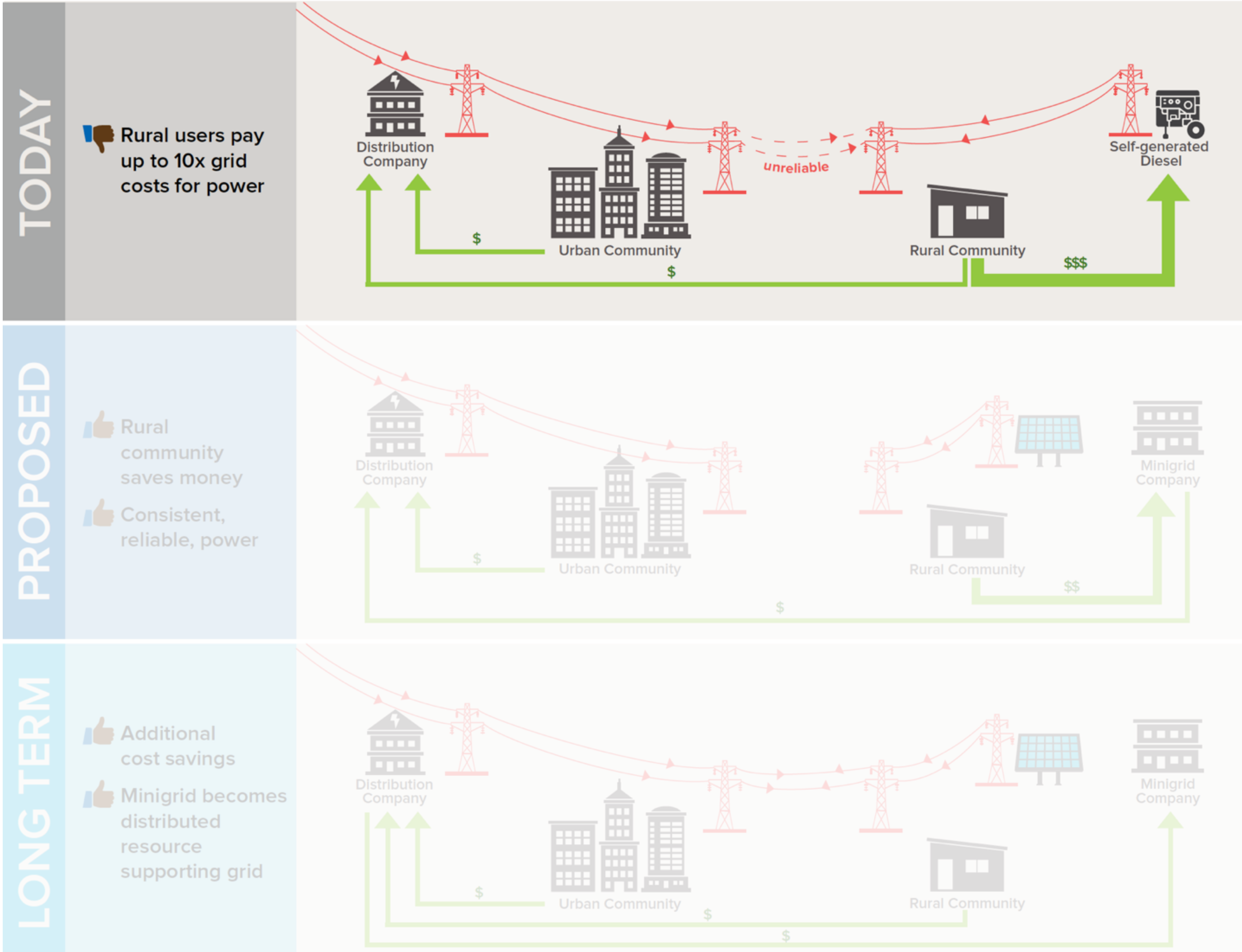
This content is largely from a report authored by RMI and EMRC: *Under the Grid*

- Collaboration between RMI and EMRC with a focus on Nigeria's market
- Analyzes an alternative service model to use minigrids as a resource to supplement and strengthen the grid to the benefit of all
- Can be downloaded at **rmi.org/insights/under-the-grid** along with a blog highlighting key takeaways at **rmi.org/blog**




TODAY
Rural users pay up to 10x grid costs for power
Distribution Company
Urban Community
unreliable
Rural Community
Self-generated Diesel
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PROPOSED
Rural community saves money
Consistent, reliable, power
Distribution Company
Urban Community
Rural Community
Minigrid Company
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LONG TERM
Additional cost savings
Minigrid becomes distributed resource supporting grid
Distribution Company
Urban Community
Rural Community
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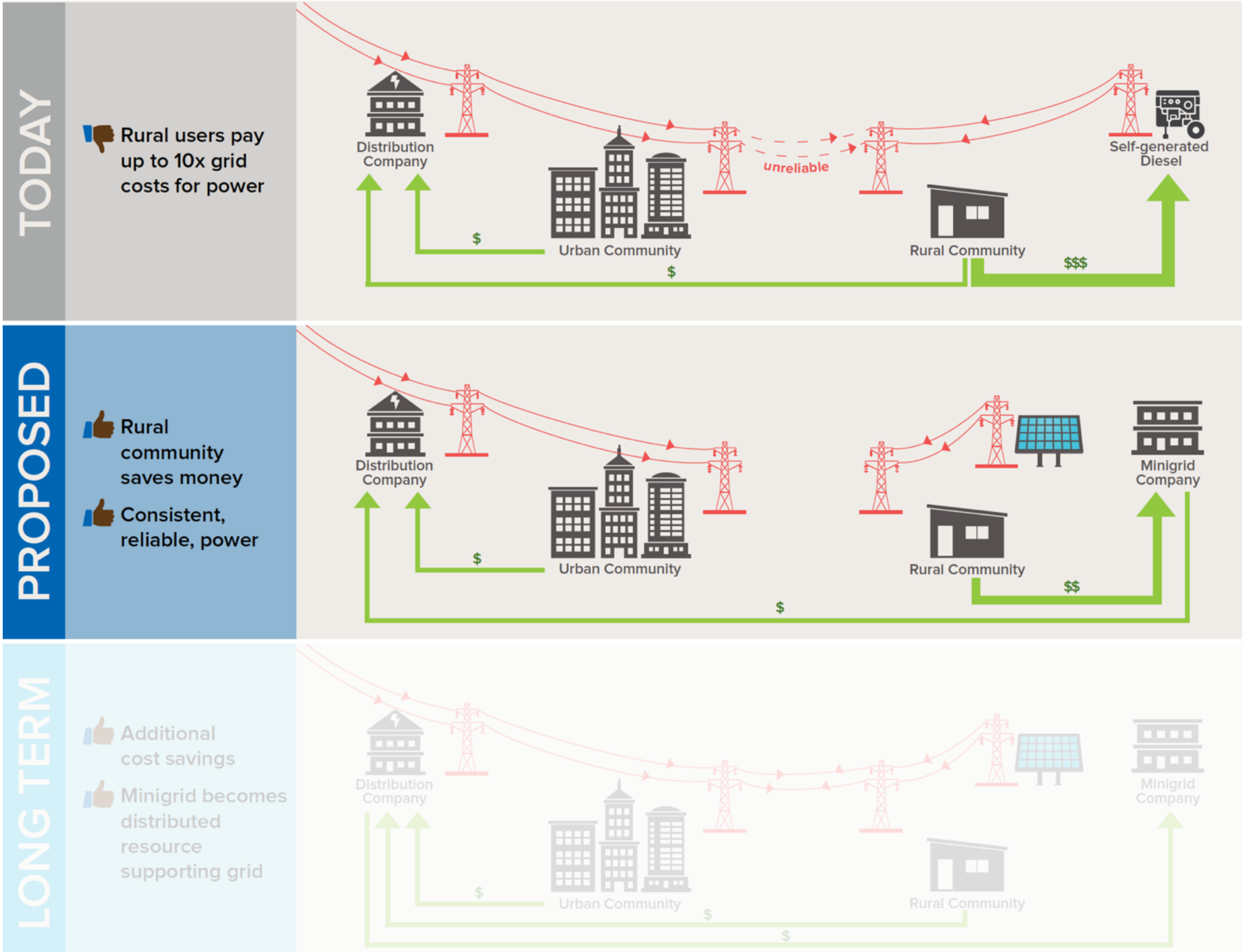
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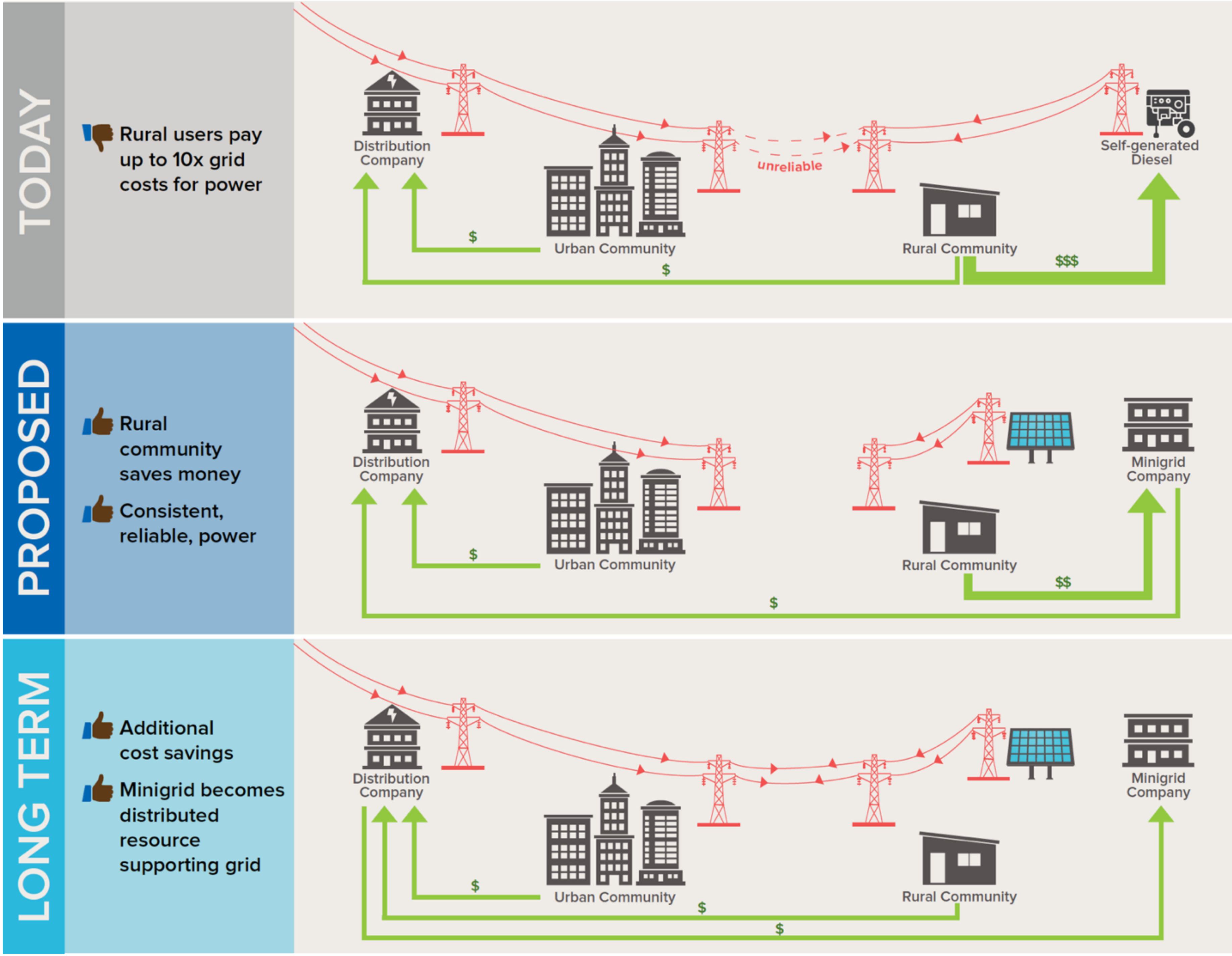

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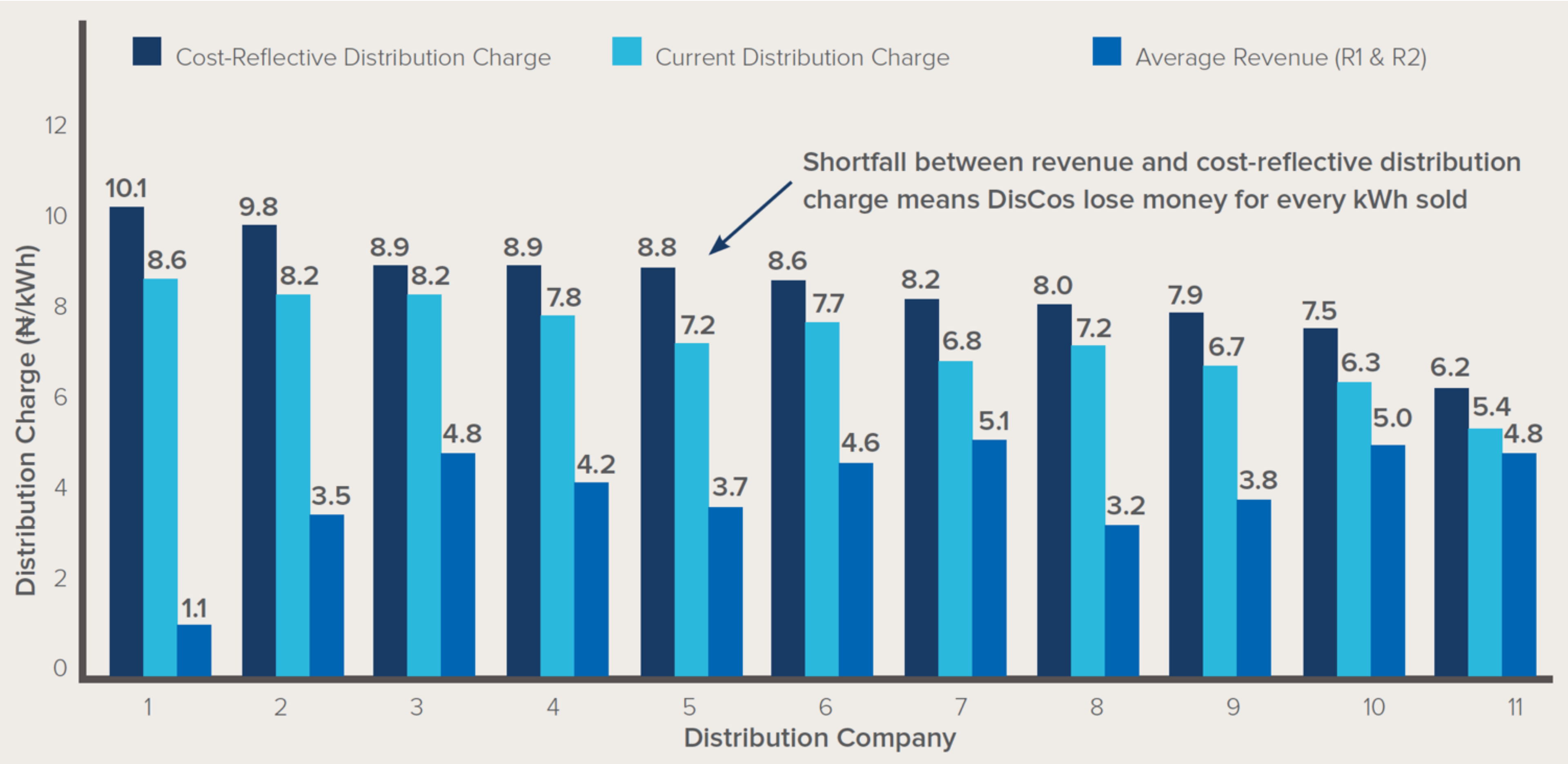
What's the financial situation today for DisCos to serve rural communities?

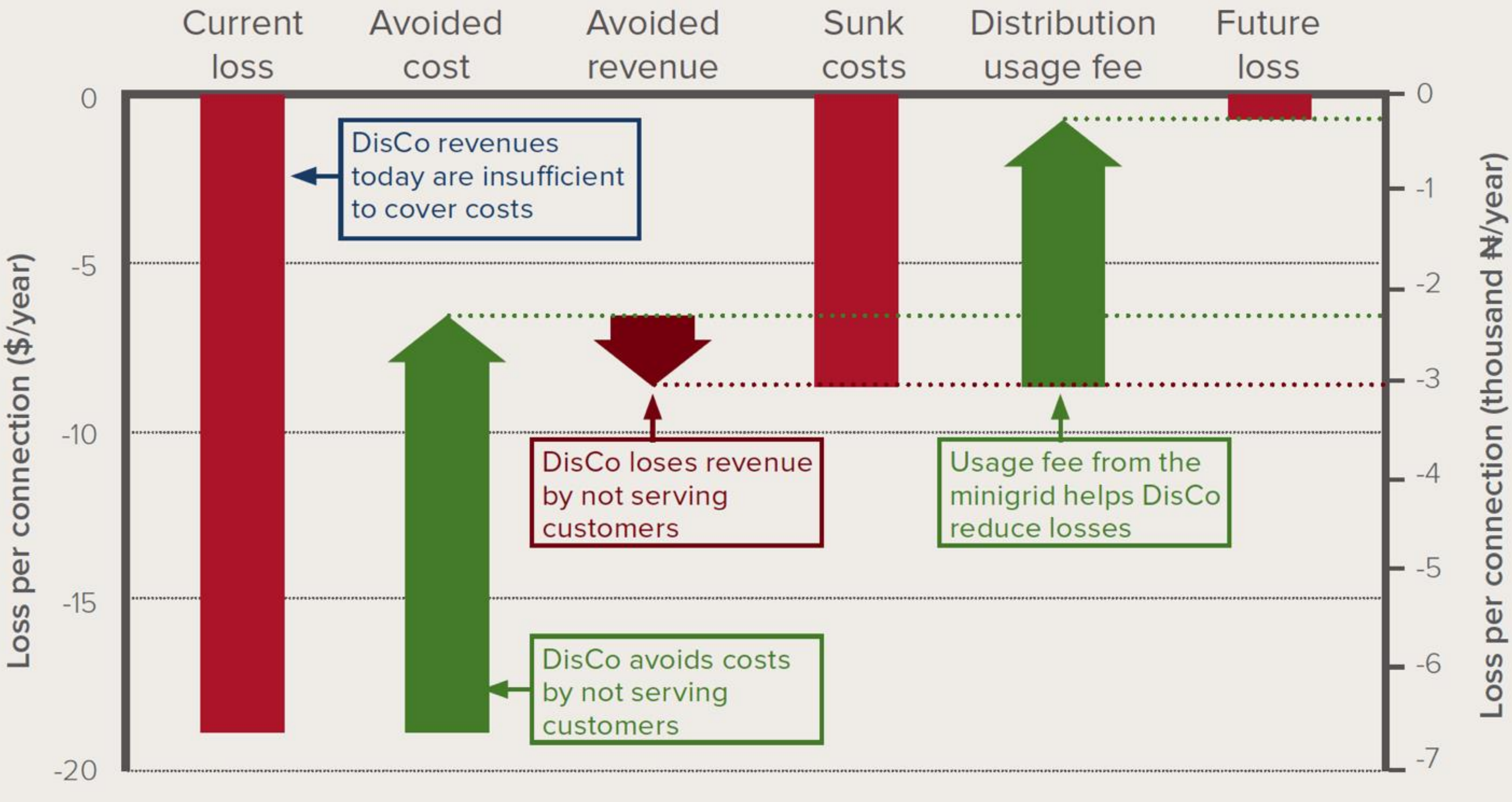


Source: RMI and EMRC, "Under the Grid", 2018. http://rmi.org/insight/under-the-grid/

How can undergrid minigrids help?

- Undergrid minigrids could help DisCos reduce these financial losses by **transferring the collections responsibility** (and risk) to minigrid operators
- NERC minigrid regulations allow DisCos to **collect a usage fee** for sharing distribution infrastructure with the minigrid
- Enable independent minigrid operator to charge a **cost-reflective tariff** and **install metering** solutions to minimize collections losses.
- Provide a **finite-duration bridge** (e.g., 10 years) to transfer service, allowing DisCo to focus efforts elsewhere while resuming service at the end of the contract

What would be the financial impact of undergrid minigrids?



Source: RMI and EMRC, “Under the Grid”, 2018. http://rmi.org/insight/under-the-grid/

Summary of the distribution company business case

Situation Today

DisCos are **losing money for every kWh they provide** to typical rural underserved communities

- DisCos are likely losing **average of ₦72 ($0.21) per kWh distributed**
- ₦7,000 ($19) per connection per year
- ₦7.8 million ($22,000) per community per year

IMG Opportunity

By transitioning 400 communities to undergrid minigrids, one DisCo can:

- **Reduce financial losses by ₦1 billion** ($3 million) annually
- Cut losses by ~60%, not including a distribution usage fee

Key Considerations

- This arrangement allows the DisCo to **focus on improving service to other areas** of their network
- **Risks to the DisCo** include lower than expected usage fees, and change in service expectations over time

Source: RMI and EMRC, "Under the Grid", 2018. http://rmi.org/insight/under-the-grid/

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What's the opportunity for developers?

Benefits

MARKET SIZE: ~40 million rural residents are underserved—35% could be served by over 4,000 undergrid minigrids, creating a nationwide revenue opportunity of ₦400 billion ($1 billion) per year

CAPITAL COST REDUCTION: Sharing distribution infrastructure could save $75,000 for a 100 kW site, decreasing capex by 12% and tariffs by $0.03/kWh

ATTRACTIVE COMMUNITIES: Serve communities with high potential for economic development and load growth, strengthening the economics over time

Risks

CONTRACT LENGTH: System lifetime (20+ years) may be longer than a tripartite contract—must account for this to ensure a return on investment

CUSTOMER WILLINGNESS TO PAY: Customers may be less willing to pay due to experience with DisCo service—developers must invest in sensitization and customer engagement

PARTNERSHIP NEGOTIATION: Negotiation with DisCo and community required—challenge to negotiate agreeable contract terms, and implementation may be slow in practice

Would communities benefit from interconnected minigrids?

₦205/kWh ($0.58)	Average **blended cost of electricity** today
₦55/kWh ($0.15)	**Average savings** of IMG customers, enabled by distribution sharing and daytime productive, excluding additional benefits of improved reliability
₦50,000 ($150)	Average **annual savings** of Tier 3 and 4 residential customers
₦60 billion ($170 million)	**Total customer savings** across Nigeria, per year, enabled by IMGs at scale

*In addition, IMGs will **unlock local economic growth and development** through reliable power and entrepreneurship*

Rapid implementation of key cost-reduction opportunities will further increase both minigrid affordability and customer savings

Source: RMI and EMRC, “Under the Grid”, 2018. http://rmi.org/insight/under-the-grid/

What risks would communities need to consider?

RISKS

GRID COST
Minigrids remain more expensive than grid tariffs—if the cost disincentivizes consumers from using power, this could constrain local economic growth

COMMITMENT
Entering into a tripartite contract with the DisCo and minigrid provider creates long-term commitment

MITIGATION STRATEGIES

EVALUATE TRADEOFFS
For example, on an economic basis a 10-year tripartite contract makes sense if the community expects to receive less than 40% reliability or 10 hours/day from the grid for at least three years

DE-RISK IMPLEMENTATION
To reduce risk, could allow pass-through of grid power at current costs and availability

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The undergrid minigrid opportunity is nascent—exploratory pilots should provide initial learning to inform scale

Increasing Maturity, Increasing Scale

Exploratory Pilot

- Test **technical feasibility**
- Test **cost-effectiveness** at small scale
- Test **customer interest**

Scalable Demonstration

- Test **business models** that can apply at scale
- Test whether market supports **commercial viability**
- Test continued **customer interest**

Phased Roll-Out

- Roll-out **proven model**(s)
- **Full-scale** deployment
- **Multi-phase** approach to refine between phases

Because undergrid minigrids have not yet been implemented, stakeholders should begin by pursuing exploratory pilots to test feasibility and determine what strategies are most effective

Source: RMI, "Pathways for Innovation", 2017. https://rmi.org/insight/pathways-for-innovation/

The IMAS program directly supports testing this opportunity, but stakeholders will need to take action to make it successful

DisCos

- Establish an **interdepartmental team** to support pilot development
- Map **ideal undergrid communities** focusing on underserved areas with low reliability and high ATC&C losses
- Evaluate **cost structure and revenues** in rural communities
- Share data from pilots and **document lessons learned**

Minigrid Developers

- Focus on **community outreach** to ensure buy-in and understanding
- Analyze **technical and financial implications** of IMGs compared to business as usual and with key tradeoffs
- **Share data** from pilots to assess viability

Government

- Support **community outreach** and sensitivity training
- Review proposed **tripartite agreements** to ensure they maximize probability of long-term success
- Evaluate pilots to ensure **key performance metrics** are achieved

In the longer term, if pilots are successful, there are additional actions to enable scalable demonstrations and roll-out

Government

- Facilitate **expedited processing** as tripartite agreements become standard
- **Integrate on- and off-grid** planning
- Work with DisCos and developers to develop an **exit strategy** if main grid investment and reliability improves faster than expected

DisCos

- Complete and **publish plans** for grid expansion and rehabilitation
- Create a **transparent process** for procuring additional projects
- **Collect data, document lessons learned,** and enable project bankability
- Explore alternative **business models**

Minigrid Developers

- Use pilot findings to **improve cost reductions** and **community engagement**
- Explore alternative **business models**

RMI, EMRC, Power for All, and All On are jointly researching and publishing the options for undergrid business models

Preliminary potential business models:

	1. Operator-led	2. SPV-led	3. Community-led
Identify site	Operator DisCo	DisCo	Community co-op DisCo
Invest or attract capital	Operator	SPV	Community co-op
Own generation	Operator	SPV	Community co-op
Own distribution	DisCo	DisCo	DisCo
Engage customers	Operator DisCo	SPV DisCo	Community co-op DisCo
Meter, bill, collect	Operator	Operator	Community co-op
Operate & maintain	Operator	SPV	Operator
Considerations	Limited DisCo ownership role	Attracting investment; Legal complexity of creating SPV; SPV technical capacity	Lack of co-op skills and experience; Political challenges within community

ILLUSTRATIVE

We welcome engagement on this topic, and plan to release a report later in 2019

Experience to date has highlighted several additional considerations that will be key for IMAS project success

- **Does it make sense to trade power with the main grid?**
  - *See next slide*
- **What is an appropriate usage fee?**
  - NERC regulation provides guidance on usage fees, but the exact calculation method is not prescribed
  - The distribution usage fee should recover lost profit to the DisCo but otherwise should be minimal
  - Usage fees should be fair without significantly impacting customer tariffs
- **Has the community been properly selected and adequately engaged?**
  - Data and community characteristics will need to be ground-truthed very early in the process—ensure it’s a good site for a minigrid
  - IMGs will be more expensive than current tariffs, have a long contract term, and collections rates are low—focus on community engagement early

Exchanging power between the IMG and main grid will be a key decision point for any project

Why interconnect?

Grid power must be **reliably delivered at agreed-upon time**

- Increases DisCo involvement, liability, and investment
- If reliable, can reduce overall cost and tariffs, since grid power is cheaper than minigrid power

Why not interconnect?

If timing of **grid power is not reliable**, then islanding will be the cheapest option

- Otherwise, the minigrid must be sized the same as if off-grid (or burn more diesel)
- DisCo can focus on serving core customers
- Exchanging power adds regulatory complexity in tariff and PPA setting

*This decision will require **careful economic analysis and realistic assumptions** about grid availability, including:*

- Total availability (h/dy)
- Reliability of service at given time of day
- Likely change in availability over time

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Thank You

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