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NIGERIA POWER SECTOR PROGRAM (NPSP)
PRODUCTIVE USE STIMULATION IN NIGERIA VALUE CHAIN & MINIGRID FEASIBILITY STUDY

MAY 2020

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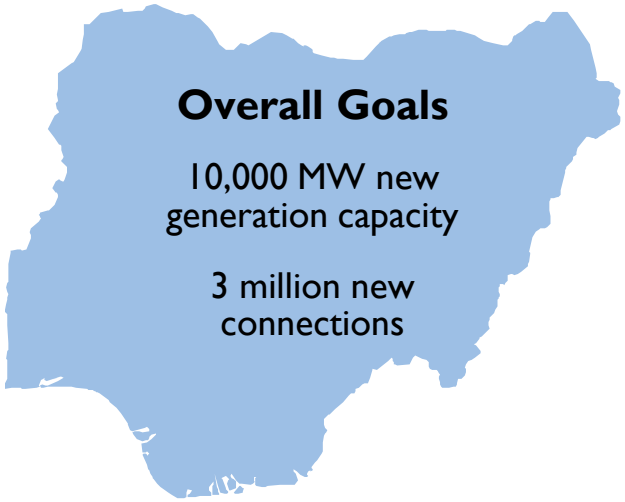
NPSP is a 5-year program to increase electricity availability and access in Nigeria

5 Years

ACTIVITY DURATION
April 2018 – April 2023

IMPLEMENTED BY
Deloitte, *with support from* McKinsey, WorleyParsons, Cliffe Dekker Hofmeyr (CDH), Manitoba Hydro (MHI), and CrossBoundary



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TARGET OUTCOMES

1. Private Sector Investment
2. Off-grid Connections
3. Improved Enabling Environment
4. Energy Sector Liquidity

Contact Information	Program Funding
Mary Worzala Chief of Party, USAID NPSP **Dave Rogers** Contracting Officer Representative, USAID/Southern Africa	NPSP is funded by the United States Agency for International Development (USAID), in support of the US Government's Power Africa Initiative. To date, Power Africa's more than 130 private and public sector partners have committed more than $52 billion to mobilize and organize international efforts to electrify Africa. USAID supports Power Africa through programs that bring together technical and legal experts, the private sector, and governments from around the world to work in partnership to increase the number of people with access to power.

STUDY SUMMARY

The *Productive Use Stimulation: Value Chain and Minigrid Feasibility Study*

- ✓ **Identifies priority electrification opportunities** within key agricultural value chains and productive use cases,
- ✓ How to develop them through **commercial business models**, and
- ✓ **Strategies to overcome barriers** to deployment.

The study includes survey and data collection in rural communities and synthesizes data collection along **value chains** and **recommended programs** to electrify priority value chain components

Study Partners

Implementing Program

Study Lead

Data Collection Partner

AGENDA FOR TODAY'S DISCUSSION

1. **Approach and Methodology**
2. **Priority Productive Use Activities**
3. **Economic Results**
4. **Key Considerations & Commercial Business Models**
5. **Next Steps**

1. APPROACH & METHODOLOGY

DATA COLLECTION

*Study assessed **12 agricultural value chains** across Nigeria's Kaduna and Cross River states through **more than 250 field interviews** with farmers, processors, and traders in **over 40 rural communities** as well as an extensive literature review and interviews with sector experts*

Crops were selected based on their **prevalence in rural Nigerian communities appropriate for mini-grids.**

The following factors were also considered:

- **Crop production characteristics**, including local yields, seasonal production, etc.
- **Market potential** – i.e. in what form the end products are consumed locally, existence of local demand/markets, etc.
- **Value chain activities required** to bring to market – i.e. key value-add steps between harvest and consumption, etc.
- **Productive use integration potential** – identifying process steps best suited for electrification

2. PRIORITY PRODUCTIVE USE ACTIVITIES

ACTIVITY PRIORITIZATION

*Study **prioritized productive use activities** to identify activities with the highest near-term impact*

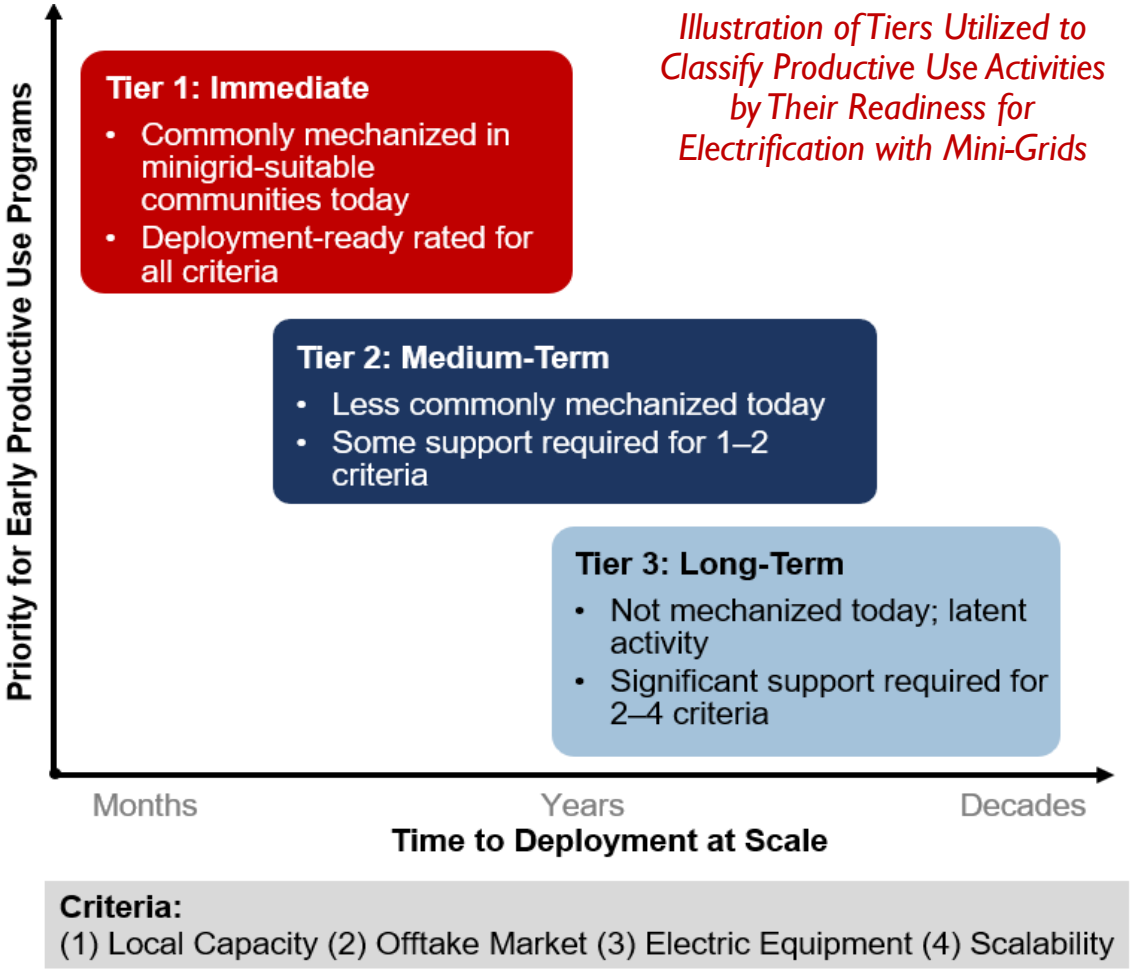
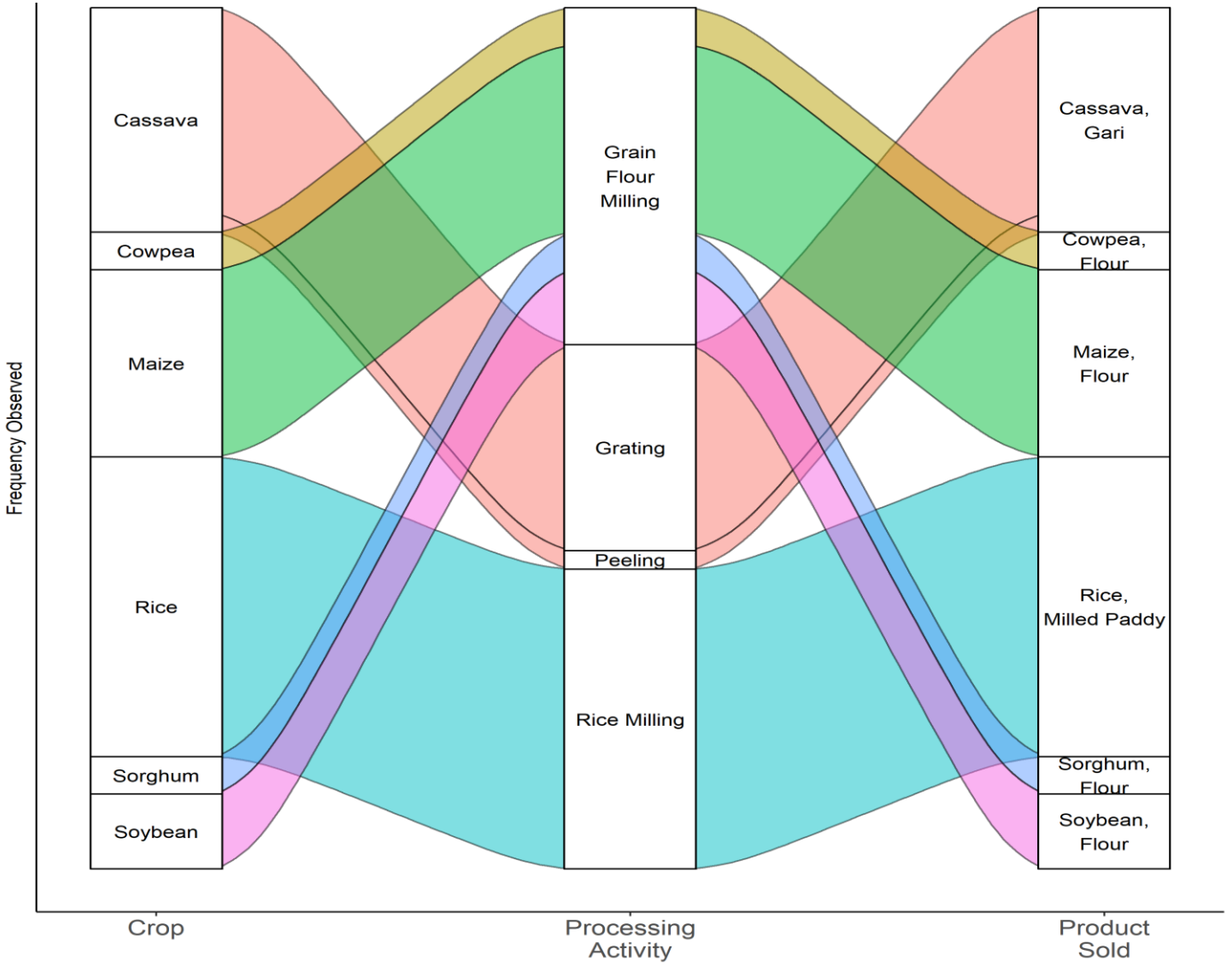


Illustration of Tiers Utilized to Classify Productive Use Activities by Their Readiness for Electrification with Mini-Grids

Four criteria help rate productive use activities on a sliding scale from "deployment ready" to "significant support required"

1. **Local Capacity.** Technical knowledge and skill of local communities
2. **Offtake Market.** Strong local markets support immediate productive use activities.
3. **Electric Equipment.** Deployment will be easier where mini-grid-compatible appliances are available on the market.
4. **Scalability.** Widespread and high-volume value chains can be scaled more efficiently than specialty products.

VALUE CHAIN FLOWS FOR AGRICULTURAL PROCESSORS WHO USE MECHANIZATION



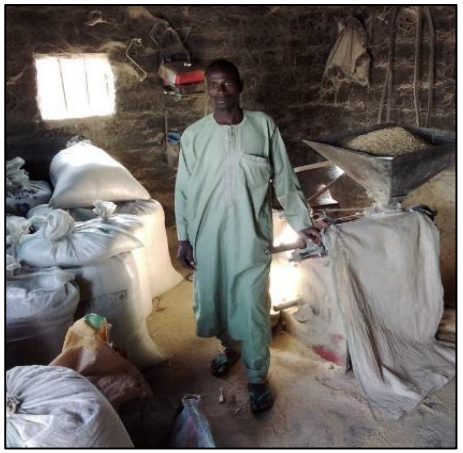
TIER I PRODUCTIVE USE ACTIVITIES

Cassava grating, rice milling, and flour milling are primed for immediate electrification and implementation in Nigeria

Value Chain Activities Analyzed, Including Tier Ranks and Scoring Summaries

SUPPORT REQUIRED: ● Deployment-Ready – ◕ Minimal – ◑ Moderate – ◔ Significant

	Activity	Value Chain	Local Capacity	Offtake Market	Electric Equipment	Scalability
TIER I	Grating	Cassava	●	●	●	●
	Flour Milling	Maize	●	●	●	●
		Sorghum	◕	◕	●	◕
		Cowpea	●	●	●	●
		Soybean	◕	◕	●	◕
	Rice Milling	Rice	●	●	●	●



Left to right: Grater, Rice Mill and Flour Mill

TIER 2 PRODUCTIVE USE ACTIVITIES

Threshing and Water Pumping are Tier 2 activities for electrification and implementation in Nigeria

Value Chain Activities Analyzed, Including Tier Ranks and Scoring Summaries

SUPPORT REQUIRED: ● Deployment-Ready – ◕ Minimal – ◑ Moderate – ◔ Significant

	Activity	Value Chain	Local Capacity	Offtake Market	Electric Equipment	Scalability
TIER 2	Threshing	Maize	◑	●	◕	●
		Sorghum	◑	◕	◕	◑
		Cowpea	◑	●	◕	◕
		Soybean	◑	◕	◑	◑
	Water Pumping	Aquaculture	◑	●	◕	◔

Tier 2 activities *have medium-term potential if provided with support to overcome one or more barriers to deployment, particularly regarding the capacity of local actors and economies to adjust to mechanization.*

A petrol maize thresher operating in a peri-urban zone outside Abuja.

TIER 3 PRODUCTIVE USE ACTIVITIES

Various Tier 3 activities are not recommended for immediate electrification and implementation in Nigeria

Value Chain Activities Analyzed, Including Tier Ranks and Scoring Summaries

SUPPORT REQUIRED: ● **Deployment-Ready –** ◕ **Minimal –** ◑ **Moderate –** ◔ **Significant**

	Activity	Value Chain	Local Capacity	Offtake Market	Electric Equipment	Scalability
TIER 3	Threshing	Rice	◔	●	◑	●
	Parboiling	Rice	◑	●	◔	●
	Shea Butter	Shea Nuts	◑	◔	◑	◔
	Drying	Maize	◔	◑	◔	◕
		Sorghum	◔	◑	◔	◔
		Cowpea	◔	◑	◔	◕
		Soybean	◔	◑	◔	◑
		Rice	◔	◑	◔	◕
		Cocoa	◔	◑	◑	◔
	Cold Storage	Aquaculture	◑	◔	●	◔
		Milk (chilling)	◔	◑	◕	◔
	Peeling	Cassava	◑	◕	◔	◑
	Chipping	Cassava	◕	◔	◕	◔
	Fish Smoking	Aquaculture	◑	◕	◔	◕
	Kernel Production	Cashew	◔	◔	◑	◑

Tier 3 activities have longer-term potential if extensive barriers are addressed.

For many activities, electric appliances do not exist, and may be challenging to develop.

Others need a rare combination of enabling conditions: milk chilling operations require collocation of dairy-producing communities and industrial dairy processors

3. ECONOMIC RESULTS

ECONOMIC RESULTS

A Economics of Productive Use Equipment

B Impact on Mini-Grid Economics

ECONOMICS OF PRODUCTIVE USE EQUIPMENT

Priority productive use activities are economically viable to electrify today

Two potential processor business approaches were considered in assessing economics of immediate deployment:

- A **buying raw material and selling the processed product (BnS),** or
- A **fee-for-service (FFS)** modality in which they process material for others.

Crop	Activity	Processor Modality
Cassava	Grating	Buy raw material and sell processed product (BnS)
Cassava	Grating	Fee-for-service (FFS)
Maize	Flour Milling	FFS
Rice	Milling	BnS
Rice	Milling	FFS

Summary of Combinations of Crops, Activities and Processor Modalities Analyzed

Study included a **cash flow model** which calculates the **net present value ('NPV') of equipment investment**, including the following cost categories: capital cost of equipment, financing cost, operating and maintenance cost, facilitator fee and potential revenues from the processing business

Key Assumptions:

- ✓ Mini-grid electricity tariff is $0.60/kWh.
- ✓ 5-year loan with real interest rate of 30%, 100% debt financing with 25% facilitator fee on the loan amount
- ✓ Select specifications (capacity in kW) of equipment commonly found in Nigeria and that can meet current processing demand in a small-scale business

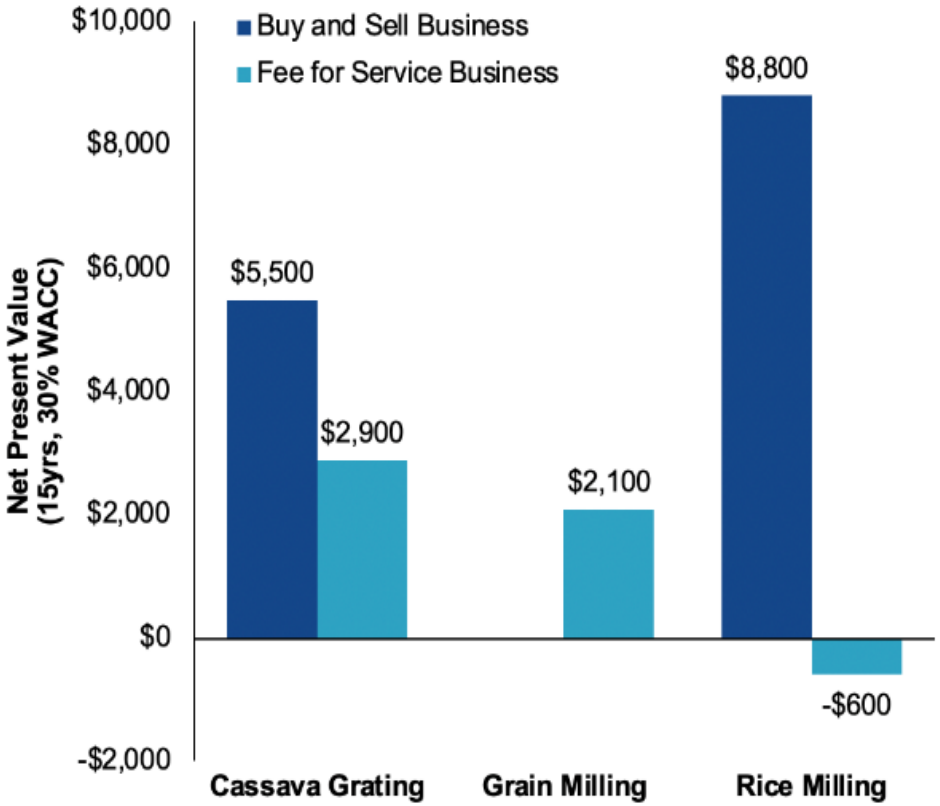
ECONOMICS OF PRODUCTIVE USE EQUIPMENT

Priority productive use activities are economically viable to electrify today

Analysis finds that there is a positive and compelling economic case for each Tier 1 activity analyzed, and with reasonable assumptions **all cases can demonstrate positive net present value (NPV)** under prevalent processor business approaches, either BnS or FFS model

While results are consistently positive, **the degree of economic viability is most contingent on the volume of crops processed**.

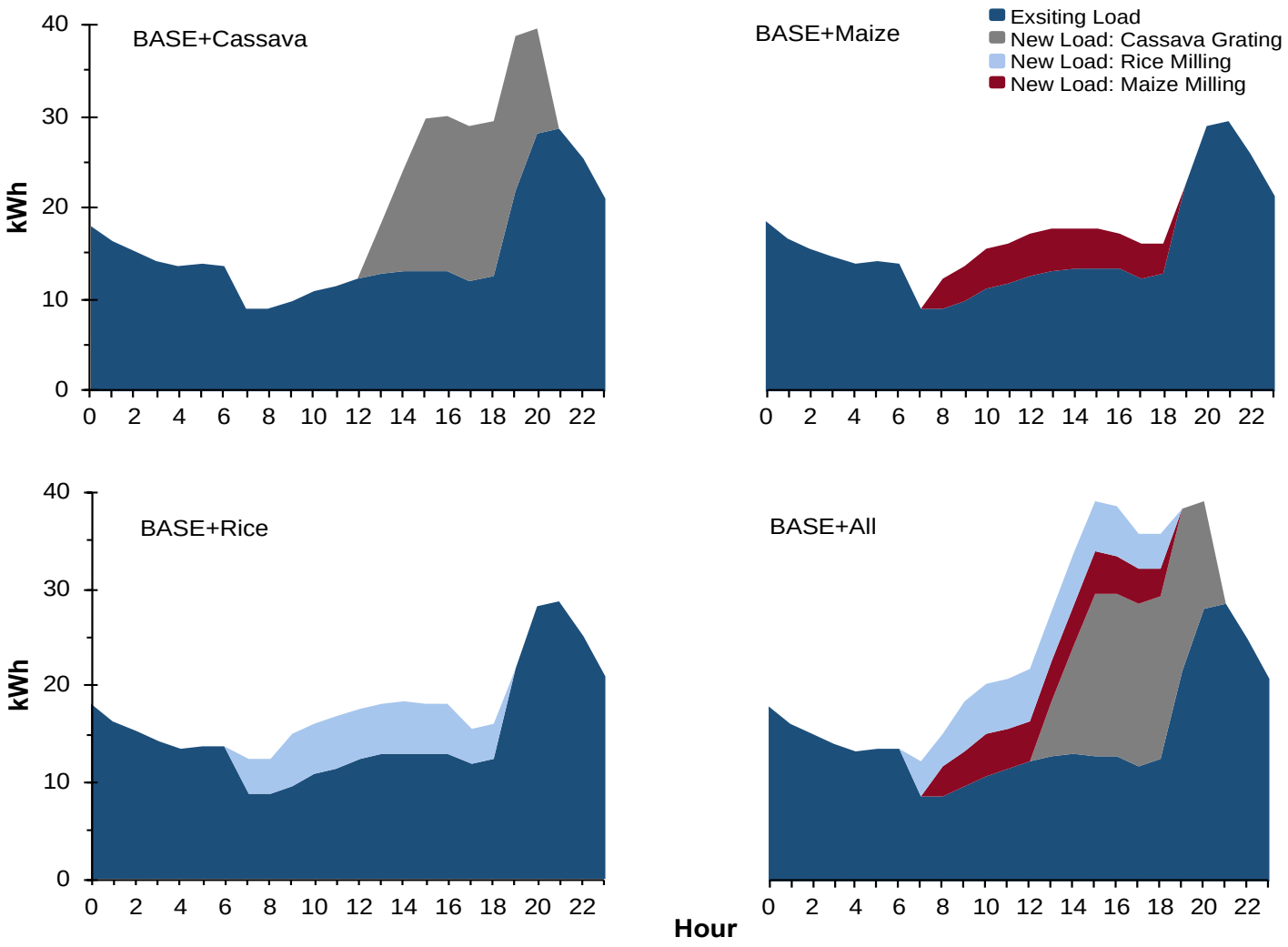
Comparison of Cash Flow Analyses for Tier 1 Processing Activities



IMPACT ON MINI-GRID ECONOMICS

Serving the loads of productive use activities can improve economics of a mini-grid and reduce tariff

24-Hour Load Profiles Under Different Scenarios

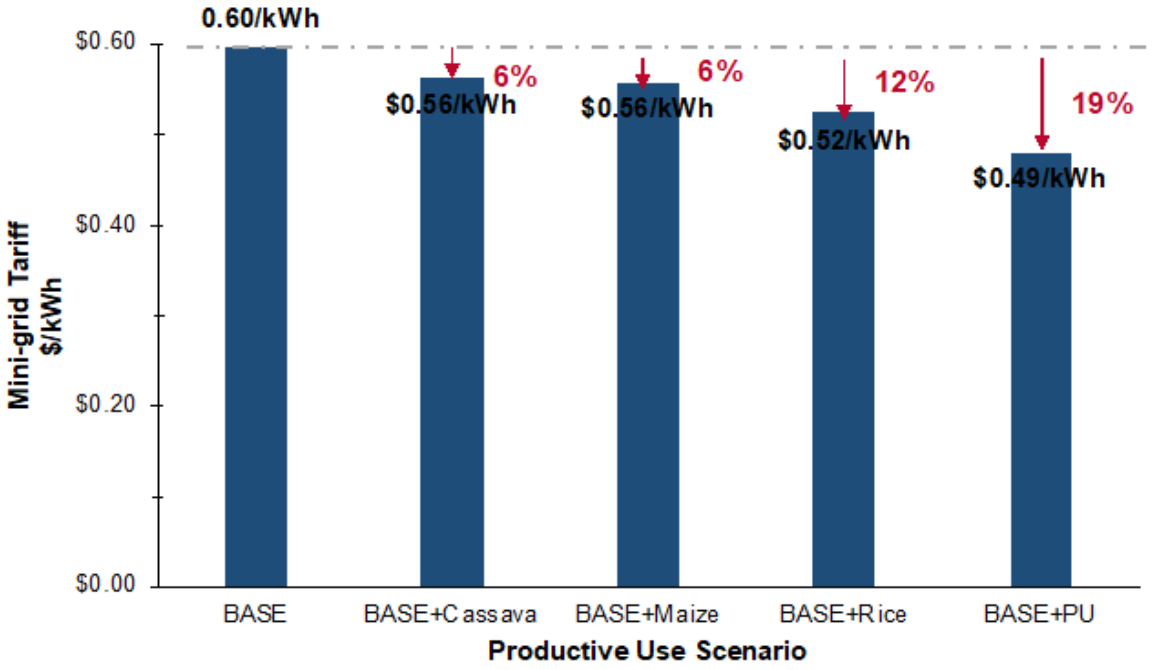


IMPACT ON MINI-GRID ECONOMICS

Serving the loads of productive use activities can improve economics of a mini-grid and reduce tariff

Simulation results find that expected loads from Tier 1 activities can improve mini-grid economics and enable lower cost-reflective tariffs for customers. Additional productive use loads improve the mini-grid's economics **by increasing the system utilization rate** and **increasing sales**

Mini-Grid Tariff to Achieve 15% IRR For Investors Under Different Scenarios



This figure shows that, relative to a baseline scenario with a 77 kW PV-diesel hybrid mini-grid without added productive use, mini-grid electricity tariffs in communities with electrified cassava grating, rice milling, and maize flour milling can be 8–14% lower while still earning a 15% internal rate of return (IRR) for mini-grid investors.

4. KEY CONSIDERATIONS & COMMERCIAL BUSINESS MODELS

PRIMARY BARRIERS TO DEPLOYMENT

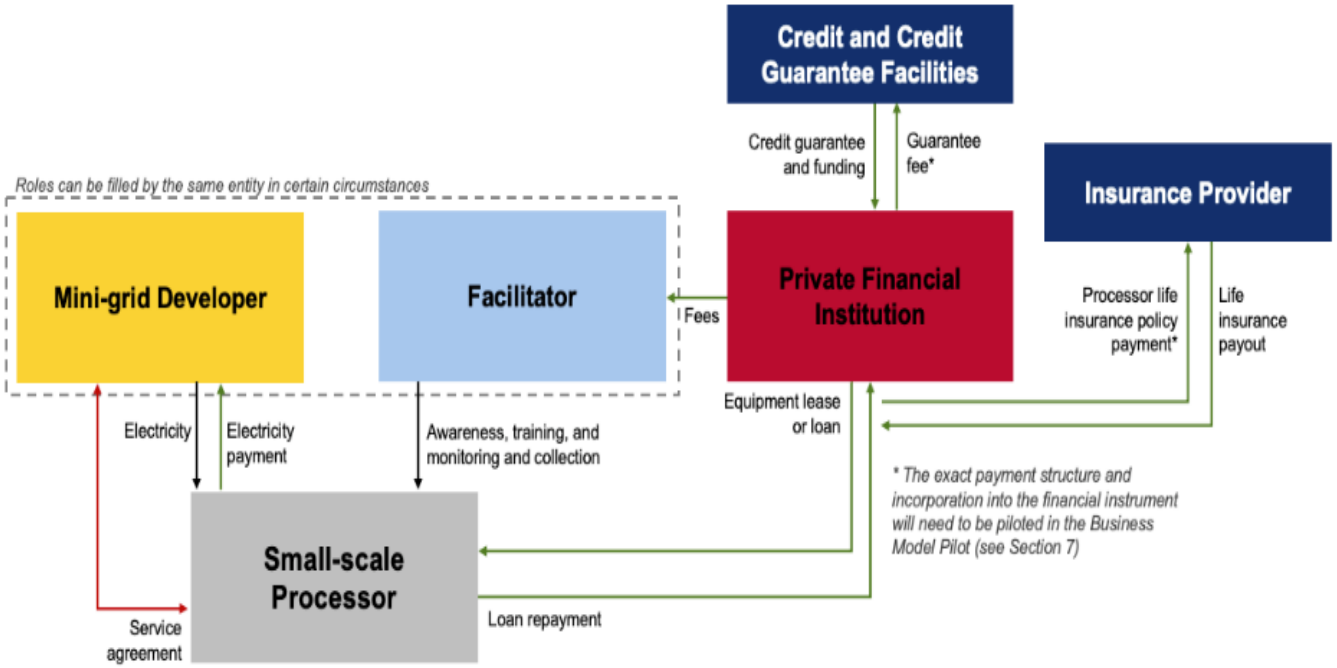
Five primary barriers limit the implementation of electrified agricultural productive uses at scale in Nigeria

1. **Access to credit for equipment purchase.** Up-front capital costs often prevent customers from purchasing equipment, electric or otherwise.
2. **Availability of reliable electricity**. Reliable electricity is needed to operate equipment in rural communities and often prevents customers from purchasing and using electric equipment.
3. **Awareness and education for would-be equipment purchasers and equipment and electricity providers** Local technical knowledge and skills will be critical to take advantage electric equipment for productive use.
4. **Access to market.** The potential for agricultural productive use is greatest where ready-markets exist with high demand for processed products.
5. **Access to equipment.** For electricity systems to serve agricultural productive use, drive economic development, and achieve financial viability, their customers must have access to electric equipment.

In grid-served communities, fee-for-service processors prefer electric mills but must often pause milling for days at a time when the lights go out.

COMMERCIAL BUSINESS MODEL #1 – "FACILITATOR"

The **Facilitator Model** is led by a facilitator who enables small-scale processors to invest in equipment by serving as their education resource and connection point to finance providers.

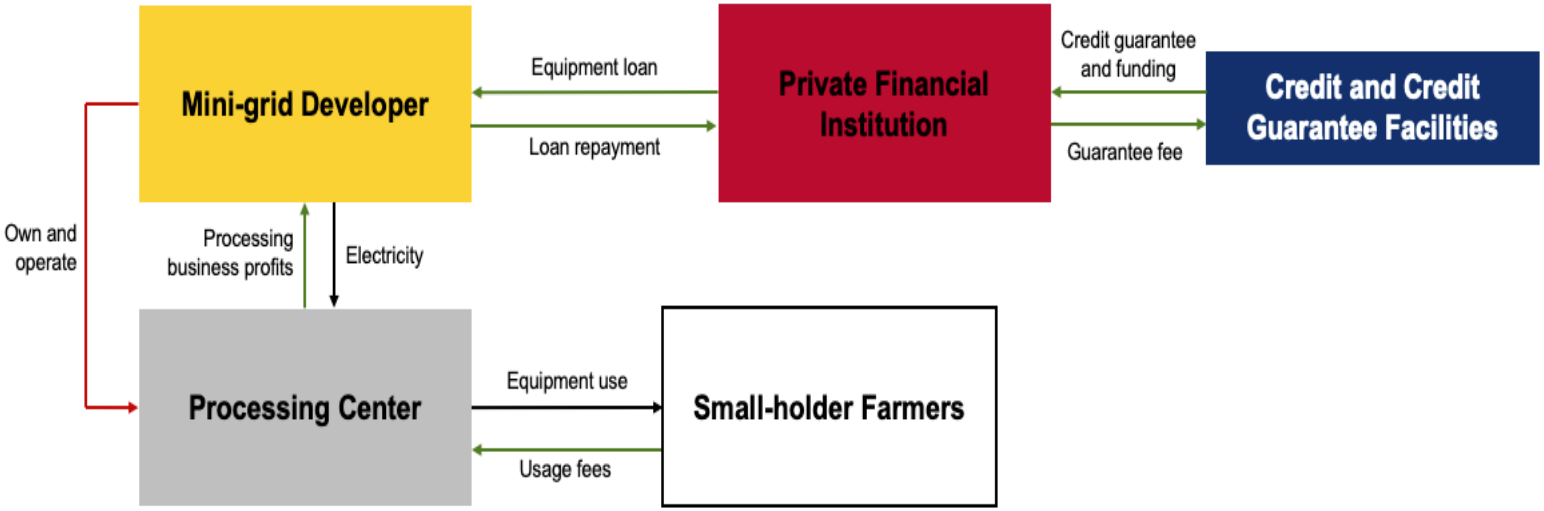


Considerations:

- While the small-scale processor is ultimately responsible for the credit and operational risk, the 'facilitator' builds awareness about the investment opportunity and supports loan applications and equipment selection
- Once the viability of lending to small-scale processors is proven, role of the facilitator would be phased out or reduced and the private financial institution assumes the role of identifying and selecting would-be processors
- One key benefit of the Facilitator Model is that it de-risks participation by third parties to provide financing and capacity building, which enables equipment purchases and reduces the burden on the mini-grid developer

COMMERCIAL BUSINESS MODEL #2 – "PROCESSING CENTER"

The **Processing Center Model** relies on a mini-grid developer based in a rural community to invest in, own, and operate the equipment for a new processing service that existing entrepreneurs are not able to provide



Considerations:

- Under this model, mini-grid developer is ultimately responsible for the credit and operational risk – this is only appropriate for activities where there is proven demand for the product, but the activity is not prevalent in the local community.
- Using these criteria to determine when the Processing Center Model is appropriate can ensure that local entrepreneurs are not displaced by the mini-grid developer

ADDRESSING THE BARRIERS

Both the Facilitator and Processing Center models address most barriers, and deployment should be determined based on the particular situation in a given community.

A petrol maize thresher operating in a peri-urban zone outside Abuja.

Use the Facilitator Model for Tier 1 activities because

- ✓ It will not displace local small-scale processors already engaged in these activities and is simple to implement.
- ✓ It does not impose an operational burden and credit risk on the mini-grid developer.
- ✓ It has a relatively simple design and still addresses the key barrier that would-be processors face—access to credit.

Use the Processing Center Model for Tier 2 activities because

- ✓ It would reduce the size of investment needed.
- ✓ It would not displace local entrepreneurs.
- ✓ It helps the mini-grid developer with lower investment costs by leveraging their existing operational capabilities.

KEY DRIVERS FOR EFFECTIVE DEPLOYMENT

Results vary on a site by site basis, but a few core principles can guide developers to effective deploying productive use equipment

Volume is the key to profitability in mechanized agricultural processing: Operators must be confident they can pay back the upfront cost for new equipment.

Minimize risk by selecting activities that are already mechanized and consult value chain experts: The surest measure of market demand for mechanization is its current prevalence in the target community.

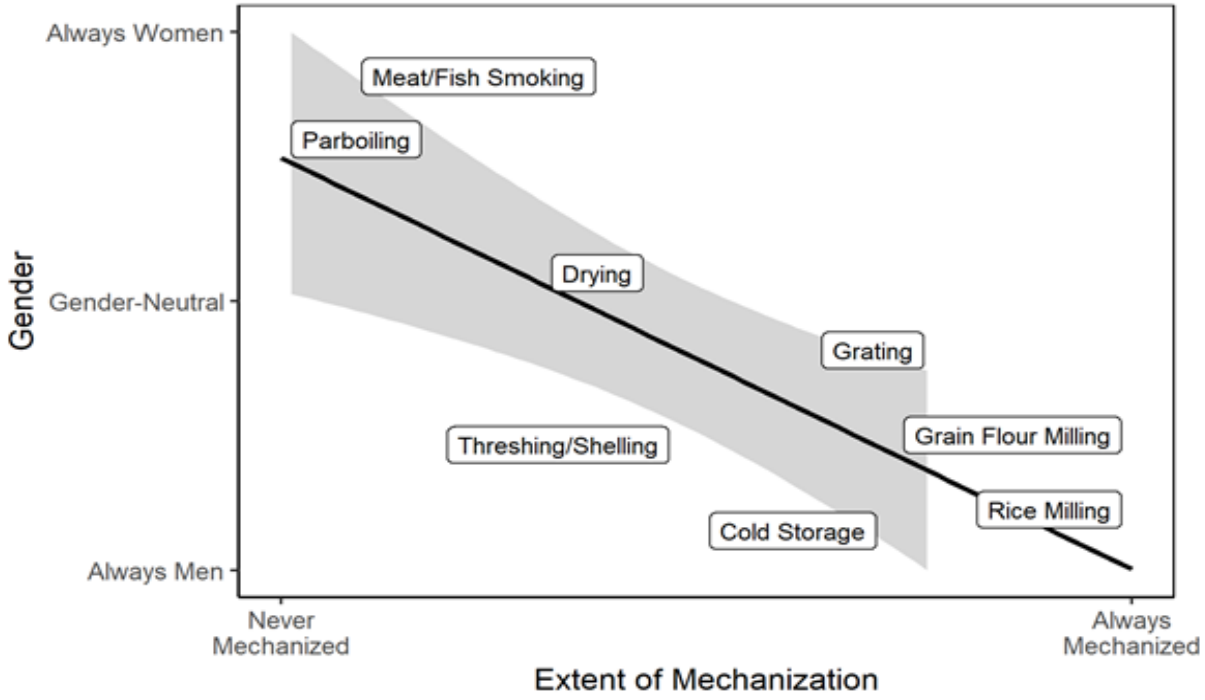
Use electricity for what it does best: Electricity has a comparative advantage over fossil fuels and firewood when its highly ordered potential is used to efficiently drive motors and pumps.

Equipment specifications matter: Mini-grid power systems and meters pose technical constraints on equipment design (e.g., phase, voltage, in-rush current).

Gender is a factor in electrification of productive use appliances: Mechanization of previously manual operations may exacerbate gender income imbalances.

GENDER CONSIDERATIONS

Mechanization of previously manual operations may exacerbate gender income imbalances if not countered with deliberate consideration of gender in program design



Trends in Mechanization and Gender Representation in Value-Add Activities Included in Field Surveys as Reported by Local Processors and Community Champions

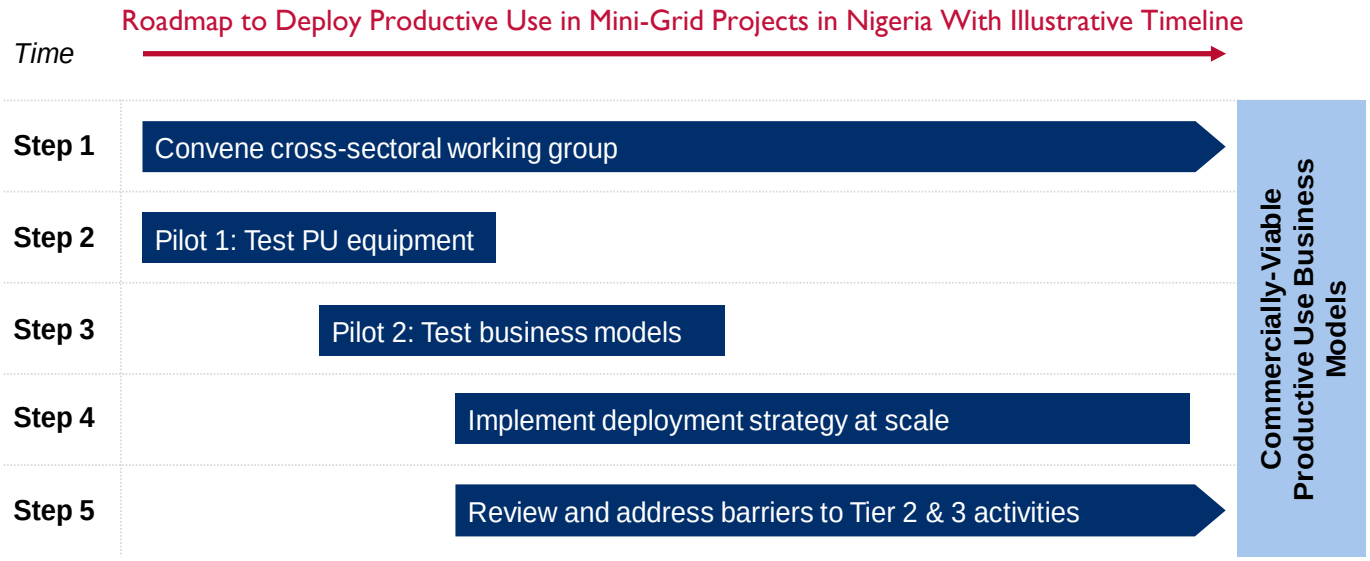
There is a clear relationship between the extent of mechanization and gender representation – the more mechanized the operation, the lower female participation tends to be

Activities associated with cooking-like work—such as fish smoking and parboiling of rice—tend to be conducted by women

5. NEXT STEPS

NEXT STEPS

Based on this study, there are a set of clear Tier 1 agricultural activities that can be implemented at scale



Roadmap includes five key steps:

1. **Convene a working group across agriculture and energy sectors** to coordinate, guide, and promote near-term activities required to achieve long-term commercial viability
2. **Implement phase-one pilots** to test equipment for Tier 1 activities and collect operational data to refine financial models
3. Design and implement **phase-two pilots** using phase 1 pilot data to **test recommended commercial business models** and develop financial instruments
4. Use lessons learned from both pilots to refine and implement the deployment strategy, formalizing the structures needed to **finance and support widescale equipment rollout for Tier 1 activities in mini-grid projects**
5. In parallel, **begin addressing identified barriers to Tier 2 and 3 opportunities** in partnership with stakeholders

CONTACT DETAILS

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Q&A AND BRAINSTORMING SESSION

IDENTIFYING PRODUCTIVE USE APPLICATIONS

- What other applications (outside of the Agriculture sector) should be considered high priority for stimulating productive use in current mini-grid sites? (i.e. for powering MSMEs) Have any of these been deployed previously?
- How can we ensure that we capture and understand consumer preferences in the selection of appliances for the design and implementation of pilots?

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QUALIFYING EQUIPMENT PROVIDERS & DRIVING QUALITY STANDARDIZATION

- How should equipment providers be qualified to participate in the AfDB subsidy program, alongside a developer or independently?
- How should quality of equipment be promoted/verified as part of the qualification process?

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WHERE CAN GRANT CAPITAL BE MOST CATALYTIC TO MARKET SCALING?

- Which cost component should grant capital finance in the broader program (post-pilot phase)? E.g., upfront capital cost, transportation, installation, operation & maintenance, etc.

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GENERAL QUESTIONS?

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