# Module Overview

## Introduction to the Module
- Learning objectives
- Module requirements
- Agenda

## Part 1: Productive Use

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<td>Why does PU matter?</td>
<td>PU business categories</td>
<td>PU best practices</td>
<td>Appliance financing</td>
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## Part 2: Demand-side Management

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<td>Supply-demand imbalance</td>
<td>DSM strategies</td>
<td>Choosing DSM strategies</td>
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## End of Module
- Case studies
- Module recap
- Further reading
Learning Objectives

- Learn about the importance and challenges of productive use (PU) of electricity around mini-grids.
- Learn about the different categories of productive user and how to support them.
- Learn about the options for appliance financing.
- Learn about the importance of demand-side management for mini-grids.
- Learn about the different DSM interventions and when they should be applied.
- Learn how to develop an appropriate DSM strategy.

Module Requirements

- This module is targeted at mini-grid developers and operators at all stages of development.
- They are expected to have a basic understanding of rural, off-grid energy markets and community dynamics in developing countries.
- No prior knowledge of productive use of electricity or demand side management is required.
Part 1 – Productive Use
1. Definition of PU
2. Why does PU matter?
3. PU business categories
4. PU best practices
5. PU appliance financing
6. Case Study: REDP Tanzania

Part 2 – Demand-side Management
1. Introduction to DSM
   - Definition
   - Challenges and Role
2. Supply-Demand Imbalance Scenarios
   - Peaks, Valleys, Offset Demand, Excess Demand, Excess Supply
3. DSM Strategies
4. Choosing DSM Strategies
   - Process map
   - Constraints & mitigations
5. Case Studies
Part 1: Productive Use (PU)
No single definition of Productive Use

- **Livelihoods focus** - agricultural, commercial and industrial activities that generate income through consumption of electricity

- **Energy focus** - income generating activities that increase consumption of electricity

- **Socio-economic focus** - livelihood activities plus other activities related to health, education, connectivity, e-mobility etc

This module => Livelihoods and Energy definitions
Why Do Productive Users Matter?

Enhanced social and economic impact

- Increase productivity
- Capture larger portion of value chains locally
- Increased diversity

Increased sales from PU energy consumers are critical for the viability of mini-grids

Photo: Productive use customers - bakery, welding, movie theatre, and cafe
## PU Business Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-categories &amp; examples</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Small village businesses      | ▪ **Primary** e.g. agriculture, fishing, livestock  
▪ **Light manufacturing** e.g. carpentry, welding, ice-making  
▪ **Commercial and retail** e.g. grocers, hair salons, phone chargers | ▪ Most common in rural areas  
▪ More diversified customer base  
▪ Greater scope for local economic development  
 ▪ Jobs creation: expanding existing & new businesses  
 ▪ “Multiplier Effect”: workers spend most of their income within the local economy | ▪ Smaller individual off-take of energy, which is less reliable / stable  
 ▪ Appliance ownership can be low in remote areas, so schemes to provide customers with suitable appliances (selling / financing / grants) must be set up and managed |
| Large anchor clients          | Examples: telecom towers, flower farms, tourist lodges, banks | ▪ Large, reliable off-take of energy  
▪ More stable, predictable & long-term revenues | ▪ Limited number of such clients in remote areas  
 ▪ Need to provide more competitive tariffs to anchor clients, and often have onerous service requirements |
PU Best Practices

- There is **no standard business model** for developing PU in mini-grids, but many models have been tried.

- Key success factors include:
  - Focus on the **business needs of local entrepreneurs**
  - Focus on **existing value chains** and increasing their productivity
  - Targeted **business support** for local entrepreneurs
  - **End user finance** for income generating equipment / appliances
  - **Demand side management** to ensure peak operation at peak sun hours

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Photo: Saw mill at KIS, a mini-grid in Uganda
Enable customers to
- Buy appliances that they cannot afford outright
- Benefit from increased income during loan period

Appliance financing may be provided in form of loans or grants

Customers can pay off loans for some PU appliances in less than 12 months

But grants may still be needed – some donor programmes fund up to 70% cost of appliances

### PU Appliance Financing

<table>
<thead>
<tr>
<th>Sector</th>
<th>Activities / Appliances</th>
<th>Power required (kW)</th>
<th>Cost from supplier ($)</th>
<th>Payback period (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary industries</td>
<td>Egg incubator</td>
<td>80 to 160W</td>
<td>$50 to $100</td>
<td>1 to 3</td>
</tr>
<tr>
<td></td>
<td>Grinder for pulses and beans</td>
<td>5.2 kW</td>
<td>$1,500 to $4,000</td>
<td>6 to 12</td>
</tr>
<tr>
<td></td>
<td>Water irrigation pump</td>
<td>3.7 to 22.4 kW</td>
<td>$200 to $1,000</td>
<td>3 to 6</td>
</tr>
<tr>
<td></td>
<td>Sterilizer (for dairy processing)</td>
<td>3 to 6kW</td>
<td>$600 to $2,000</td>
<td>1 to 3</td>
</tr>
<tr>
<td></td>
<td>Packager</td>
<td>250W to 3kW</td>
<td>$500 to $1,000</td>
<td>6 to 12</td>
</tr>
<tr>
<td>Light manufacturing</td>
<td>Electronic welding machine</td>
<td>3 to 7.5 kW</td>
<td>$200 to $300</td>
<td>6 to 12</td>
</tr>
<tr>
<td></td>
<td>Jigsaw</td>
<td>400W</td>
<td>$100</td>
<td>3 to 6</td>
</tr>
<tr>
<td></td>
<td>Electric drilling machine</td>
<td>400W</td>
<td>$20 to $50</td>
<td>3 to 6</td>
</tr>
<tr>
<td></td>
<td>Popcorn maker</td>
<td>1.5 to 2.1 kW</td>
<td>$50</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Commercial and retail activities</td>
<td>Computer</td>
<td>15 to 100W</td>
<td>$250 to $800</td>
<td>3 to 6</td>
</tr>
<tr>
<td></td>
<td>Printer/scanner for stationery</td>
<td>0.5 to 2kW</td>
<td>$150 to $250</td>
<td>3 to 6</td>
</tr>
<tr>
<td></td>
<td>Sewing machine</td>
<td>200W</td>
<td>$30 to $100</td>
<td>3 to 6</td>
</tr>
<tr>
<td></td>
<td>Television for local cinemas and bars (including decoder)</td>
<td>50 to 200W</td>
<td>$100 to $200</td>
<td>1 to 3</td>
</tr>
</tbody>
</table>

Source: ESMAP, Alibaba, Inensus.
Table source: ESMAP (2019)
Case Study: REDP Tanzania

- Energy 4 Impact provided PU support to 349 entrepreneurs in 59 rural villages in Tanzania that had been newly electrified by the national grid. Dec 2017 - March 2019
- Conducted assessments of villages, identified PUs, selected local champions and ran awareness campaigns
- Each entrepreneur was given technical training, business mentorship, and support to access customers, finance, and small-scale PU appliances
- No subsidies for appliances were provided. Most took out informal loans from family and friends rather than formal loans

*Rural Electrification Densification Programme
Case Study: REDP and Value for Money

- **Excellent returns**: annual benefits = 187% of public investment
- **Benefits** (at current tariffs) => **community**, not power supplier

PROJECT HIGHLIGHTS

1. *Increased Profitability* by Entrepreneurs by +87%
2. *Increased Awareness and Knowledge* on PUE
3. *Market Linkages* with equipment suppliers and financial institutions
4. *Increased Electricity Consumption* by +80%
5. *Access to Finance for PU Appliances* – 121 loans from local FIs
6. *Job Creation* - 214 permanent jobs
7. *Gender* (40% were women compared to typically below 30% women participation)

Source: Energy 4 Impact, Rural Electrification Densification Programme
Part 2: Demand-side Management (DSM)
Demand-side Management (DSM) is the planning, implementation and monitoring of activities to encourage (and sometimes force) customers to alter their electricity consumption habits, in respect to time of use, peak consumption levels and overall energy consumption.
Challenges and Role of DSM

Developers need to balance electricity supply with demand.

High demand can exceed generation capacity, cause power outages and lead to customer dissatisfaction. Investment in more generation and storage may be required to meet demand.

Low demand means underutilisation of mini-grid, power is wasted if battery storage capacity is full, which means lesser than planned revenues resulting in a poor return on investment.

DSM manages the load of a mini-grid without:
1. needing to purchase generation assets (e.g. solar panels)
2. increasing dependence on diesel fuel

There is no “one size fits all” approach to demand-side management.

Different strategies must be employed depending on the scenario.
When can DSM be used?

**Scenario**

**Peaks**: Periods of high demand (peaks) which exceed the peak generation capacity.

**Valleys**: Periods of low demand (valleys) in which storage capacity is full and electricity generated is wasted.

**Offset demand**: Periods of peak demand which do not coincide with periods of peak generation.

**Demand-Supply Imbalance Scenarios**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Intervention</th>
<th>Scenario</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peaks</strong></td>
<td>Peak clipping</td>
<td><strong>Excess demand</strong></td>
<td>Demand reduction</td>
</tr>
<tr>
<td></td>
<td>Valley filling</td>
<td><strong>Excess supply</strong></td>
<td>Demand stimulation</td>
</tr>
<tr>
<td></td>
<td>Load shifting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scenario 1: Peaks

What happens?
Periods of high power demand (peaks) which exceed the generation capacity of the mini-grid system.

Why?
The generation system is undersized, due to inaccurate demand assessment.

High coincident peak as customers connect more appliances to mini-grid over time.

Impact
Brown-outs (poor quality power) and complete power outages.
Leads to customer dissatisfaction.

Energy storage (e.g. batteries) can be strained by high current draw at a peak.

Intervention:
**Peak clipping** – restricting/reducing consumption at peak
Scenario 2: Valleys

What happens?
Periods of low demand (valleys) in which storage capacity is full, but energy is still being generated.

Why?
There are times of the day where electricity use is lower, e.g. while farmers are out in their fields.
In most mini-grids, these valleys occur in the daytime.

Impact
Energy is generated, but not stored or used.
Lost revenue for the mini-grid.

Intervention:
Valley filling – stimulating demand in the valley
Scenario 3: Offset demand

What happens?
Periods of peak demand often do not coincide with periods of peak generation.

Why?
Renewable generation relies on sources of energy that are available at different times of day to when electricity is consumed. In a solar mini-grid, generation is highest around midday, while demand is often higher in the evening.

Impact
Large investment is required to store energy (batteries) or create hybrid generation systems (diesel generators) to meet the offset demand.

Intervention:
Load shifting – shift demand to the peak generation periods.
Scenario 4: Excess Demand

What happens?
Overall energy demand is more than what the system is designed to generate, even with secondary diesel generation.

Why?
The generation system is undersized due to inaccurate demand assessment or deliberate investment strategy by operator. Customer demand increases over time as number of connections rises and customers use more appliances.

Impact
Brown-outs (poor quality power) and complete power outages. Leads to customer dissatisfaction.

Intervention:
Demand reduction – reduce overall demand to within generation capacity.
Scenario 5: Excess Supply

What happens?
Energy generated over the day is much more than customers can use.

Why?
1. The system is oversized, due to inaccurate demand assessment.
2. Customer demand decreases over time due to poor relationship with the mini-grid operator.

Impact
System is underutilised. Lower revenues will impact profitability of the mini-grid.

Intervention:
Demand stimulation – increase demand to match generation.
8 main strategies for DSM that developers can use:

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sell new (energy efficient) appliances to household customers.</td>
<td></td>
</tr>
<tr>
<td>Sell appliances to business customers to stimulate demand during the day.</td>
<td></td>
</tr>
<tr>
<td>Replace existing appliances with ones that are more energy-efficient.</td>
<td></td>
</tr>
<tr>
<td>Schedule commercial loads to match generation time.</td>
<td></td>
</tr>
<tr>
<td>Limit power consumption of customers.</td>
<td></td>
</tr>
<tr>
<td>Develop ancillary, energy-consuming businesses to create more demand.</td>
<td></td>
</tr>
<tr>
<td>Educate customers about the benefits of electricity, and technologies that increase productivity, stimulating demand.</td>
<td></td>
</tr>
<tr>
<td>Custom tariffs/pricing to increase, shift, or reduce demand as required.</td>
<td></td>
</tr>
</tbody>
</table>
# DSM Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Impact</th>
<th>How?</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sell household appliances to residential customers</strong>&lt;br&gt;e.g. lights, radios, TVs, fans</td>
<td>Increases general demand on the mini-grid, but especially in the evening when residential customers consume more.</td>
<td>• Sell directly or partner with appliance distributors&lt;br&gt;• Set up and sell appliances through a financing scheme with a third-party&lt;br&gt;• Educate customers about the benefits of appliances, and provide clear information on how they can be used and purchased</td>
<td>Demand stimulation</td>
</tr>
<tr>
<td><strong>Sell productive-use appliances to business customers</strong>&lt;br&gt;e.g. hair clippers, welding machine, power tools, milling/grinding machines, food processing</td>
<td>Increase in demand during business hours – usually during daytime.</td>
<td>• Survey businesses on mini-grid to understand value chains and activities that require powered machines&lt;br&gt;• Research alternative, electrically-powered appliances for those activities&lt;br&gt;• Offer appliances that speed up volume, create complimentary appliances and reduce operating costs&lt;br&gt;• Sell directly or partner with appliance distributors&lt;br&gt;• Educate customers about the benefits of appliances, and provide clear information on how they can be used and purchased</td>
<td>Valley filling</td>
</tr>
</tbody>
</table>
### Replace Existing Appliances

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Impact</th>
<th>How?</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| Replace existing, inefficient appliances with ones that are more energy-efficient | Reduction in demand and total energy usage, especially at peak times (peak clipping). This reduces the strain on energy storage and secondary generation (e.g. diesel) at peak times. | • Survey the customer-base to determine existing appliances on the grid  
• Determine appliances that can be replaced to reduce demand at the right time and to the target level  
• Offer customers replacements to their existing appliances that are of higher quality  
• Educate customers about the need for efficient appliances on the grid | Peak clipping  
Demand reduction |
## Schedule commercial loads

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Impact</th>
<th>How?</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| **Schedule loads which can run at any time of the day, during times of high supply and low demand** | Shifts demand to coincide with generation. Increase demand at times when there is surplus energy generated, and reduce demand at times when there is not enough. | • Identify loads which are not time-dependent (e.g. Irrigation pumps)  
• Enforce load scheduling by  
  • Creating incentives (e.g. Lower tariffs, Time of Use)  
  • Install time switches | |
## Limit Power Consumption

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Impact</th>
<th>How?</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| **Limit power consumption of individual customers, so that large appliances cannot be powered** | Limits load that can be on mini-grid at a single point in time. This is especially required for the evening loads as this will strain the battery. | • Restrict the power for each customer using either  
  • Load Limiters  
  • Smart Meters |  

![Peak clipping](image)
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Impact</th>
<th>How?</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| Developer owns and operates another business which consumes directly from the mini-grid | • Increased demand which can be timed to fill valleys in the day  
• Works as a flexible anchor load  
• Secondary source of income for the developer | • Perform an assessment of the business value chains especially the agro-value chains  
• Identify the current gaps in the value chain where electricity produced by the mini-grid can be an enabler  
• Design and procure appliances suited to the supply and demand  
• Obtain necessary permits  
• Community engagement to identify the best model for the ancillary business | Demand stimulation  
Valley filling |
### Customer Education

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Impact</th>
<th>How?</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educate customers about the benefits of electricity and electrical appliances that have productive uses. This could be done in conjunction with other strategies, like providing appliances.</td>
<td>• Increase in demand</td>
<td>• Survey customers to assess their understanding and perception of electricity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Increase awareness on using power responsibly by using efficient appliances</td>
<td>• Run an awareness session to educate customers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Increase day time load by supporting businesses</td>
<td>• Set a customer helpline</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have a strong business incubation programme to support business growth</td>
<td></td>
</tr>
</tbody>
</table>
# Tariffs (1)

<table>
<thead>
<tr>
<th>Tariff Type</th>
<th>Description</th>
<th>Impact</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumption-based</strong></td>
<td>Customer pays per unit of energy consumed ($/kWh)</td>
<td>Reduced consumption, as customer will be wary of paying more.</td>
<td>Demand reduction</td>
</tr>
<tr>
<td><strong>Time of use</strong></td>
<td>Defined peak times and off-peak times. Lower tariff during off-peak period.</td>
<td>Shift of demand away from peak time to off-peak.</td>
<td>Load shifting</td>
</tr>
<tr>
<td><strong>Capacity-based</strong></td>
<td>Flat-rate subscription. Unlimited usage but with a cap on power consumption.</td>
<td>A set limit on individual and total power demand.</td>
<td>Peak clipping</td>
</tr>
</tbody>
</table>
## Tariffs (2)

<table>
<thead>
<tr>
<th>Tariff Type</th>
<th>Description</th>
<th>Impact</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>Subscription-based. Customer pays for access to electricity for an amount of time per day – usually unscheduled. This is combined with a power &amp; energy usage limit.</td>
<td>Reduced peak demands (power-limited), and reduced consumption overall (energy-limited).</td>
<td><img src="image" alt="Demand reduction" /> <img src="image" alt="Peak clipping" /></td>
</tr>
<tr>
<td>Energy use (progressive)</td>
<td>Pays per unit of energy. Price per unit increases as more energy is consumed.</td>
<td>Demand is reduced, as customers will be discouraged by higher tariff.</td>
<td><img src="image" alt="Demand reduction" /></td>
</tr>
<tr>
<td>Energy use (regressive)</td>
<td>Pays per unit of energy. Price per unit decreases as more energy is consumed.</td>
<td>Demand is increased, as customers will be encouraged to consume more by lower tariff.</td>
<td><img src="image" alt="Demand stimulation" /></td>
</tr>
<tr>
<td>Tariff Type</td>
<td>Description</td>
<td>Impact</td>
<td>Intervention</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
</tbody>
</table>
| Per device          | Customer pays flat fee:  
• Fee is determined from the amount of connected devices.  
• No metering required, tariff is prepaid.  
• Need to enforce.                                                                 | Reduced demand overall, as customers will be wary of connecting more devices. Limits peak power demand, as customers cannot connect more devices. | ![Demand reduction](image1) ![Peak clipping](image2) |
| Seasonal            | Price defined by seasonal availability of the renewable energy source. Higher tariffs during low season, lower during high season.                                                                           | Reduced overall demand in low-season. Increased overall demand in high-season.                                                                                                                           | ![Demand reduction](image3) ![Demand stimulation](image4) |
| Energy as a service | The operator sells services rather than electricity. For example a customer can buy 4 hours of use of a lightbulb, or per hour of use for a TV. This requires technology to monitor / control which appliances are used, and for how long. | Very transparent pricing is understandable for customers and leads to energy conservation.                                                                                                                 | ![Demand reduction](image5)                       |
Choosing DSM strategies: Process map

Map constraints
- Technology: generation & meters
- Stage of development
- Regulatory & financial
- Community culture & economy

Identify supply / demand imbalances
- Data collection and analysis
- Identify and characterise customer groups
- Identify supply / demand imbalances
- Understand reason for imbalance

Select DSM strategies
- Select strategy
- Check compatibility with constraints

Operationalise strategies
- Procure technology
- Engage the community
- Monitor impact of strategy

More information in slide notes.
## DSM Constraints & Mitigation

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Constraint</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing ancillary businesses</td>
<td>Identifying appropriate new business opportunities and managing a new revenue line</td>
<td>Personnel and capital: Requires different skills and experience, different regulatory compliance, local community support</td>
</tr>
<tr>
<td>Educating customers</td>
<td>On ground support is resource intensive and the impact of the strategy is lesser than others</td>
<td>Personnel: developing training material, on-the-ground trainers, intensive business support for potential high-consumers</td>
</tr>
<tr>
<td>Replacing existing appliances</td>
<td>A detailed assessment of the appliances to be replaced and the desired effect after replacing</td>
<td>Managing supplier relationship, sales personnel and monitoring replacements.</td>
</tr>
<tr>
<td>Selling new appliances (residential and business)</td>
<td>Setting-up and monitoring financing</td>
<td>Managing supplier relationship, sales personnel and monitoring assets.</td>
</tr>
<tr>
<td>Scheduling commercial loads</td>
<td>Identifying time-dependent loads and enforcing change</td>
<td>Hardware to record time of use and personnel to enforce scheduling</td>
</tr>
<tr>
<td>Limiting power consumption</td>
<td>Reducing demand on residential customers will have limited desired effect</td>
<td>Current limiters or smart meters</td>
</tr>
<tr>
<td>Tariffs</td>
<td>Tariffs too complex for customers to understand</td>
<td>Transparent community engagement to explain the different tariffs</td>
</tr>
</tbody>
</table>
Case Study: Rafiki Power – Sale of Appliances

Developer: Rafiki Power
Location: Tanzania, ~1,000 customers
Generation: Solar PV-battery hybrid

DSM strategy / technology:
1. Distributing and financing of appliances for households & businesses. 300+ appliances sold.
2. Customer education: 50+ business customers reached through workshops, and information material distributed to nearly all customers.
3. Smart meters integrated into mobile money platform. Data collection/analysis through the AMMP system.

Impact of strategy / technology:
Selling efficient appliances and educating customers has increased overall demand by 20-30%, and spread it over more connections, without significantly increasing peak demand.
Productive-use appliances have increased consumption during daytime when electricity production is cheaper.
Data from smart meters has given Rafiki Power visibility over consumption on their mini-grids and helped them to design DSM solutions from what they observed.

(Source: Rafiki Power)
Case study: Jumeme – Ancillary Business

Developer: Jumeme
Location: Lake Victoria, Tanzania
Generation: PV-diesel hybrid
Scenario: Low demand in the day.
Irrigation pumps used in early morning and evening to protect seeds.
Large fishing community in village which sells only to local markets.

DSM strategy / technology: Ancillary business: fish freezing and trading business (KeyMaker model, developed by Inensus).
Jumeme purchases tilapia from local fishermen at a set rate, stores them in freezers, then transports them to the capital city Dar es Salaam to sell in wholesale. An ice machine powered by the mini-grid is used to make ice for transporting the fish.

Impact of strategy / technology: Local fishermen have a secure customer to whom they can sell their fish at a fixed price.
The ancillary business has increased overall demand, especially during the day. It now consumes about 10% of the total electricity produced, and generates revenues that are the same, or greater than, the electricity sales made to all other customers on the mini-grid.
Productive use customers use energy to generate income and are important for the economic viability of mini-grids.

Successful strategies to increase PU focus on the business needs of the customers, increasing productivity in existing value chains and targeted business support for entrepreneurs.

End user financing is often necessary for customers to afford the upfront cost of PU appliances.

Demand side management influences the electricity demand of customers to fit the generation profile of the energy source. It is generally cheaper to change demand than supply e.g new generation or battery storage.

DSM is used when there is an imbalance between electricity demand and supply e.g peak demand is too high, demand is at wrong time of day (e.g during evening rather than daytime when solar generation is high), overall demand or supply is too high.

There are many technical and commercial demand strategies for addressing these imbalances e.g introduction of energy efficient appliances, load scheduling, load limiting, time of use tariffs, and consumer education.
Further Reading (1)


http://repositorio.ul.pt/bitstream/10451/30607/1/ulfc121584_tm_Catarina_Augusto.pdf


https://www.energy4impact.org/file/2039/download?token=8ardN8he

https://greenminigrid.se4all-africa.org/sites/default/files/afdb_gmg_dsm_report_final_draft_cb.pdf

http://pubs.iied.org/16632IIED/


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https://openknowledge.worldbank.org/handle/10986/17538


Further Reading (3)


