Presentation for Minigrid Workshop

Addis Ababa

October 29th, 2019

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Contents

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Off-Grid Power Generation in Ethiopia

Background on Off-grid Power Generation in Ethiopia

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Current View

- In Ethiopia grid access is approximately 33%.
- About **96% of urban** households are connected to grid.
- Only **27% of rural** households have access to electricity services, most of them though off-grid solutions.
- Thus far, only one private operator has received a business license for operating a mini-grid.

Going Forward

- In 2017, the Government of Ethiopia (GoE) launched the National Electrification Program (NEP), the action plan for **achieving universal electricity access nationwide by 2025**.
- By 2025, 65% of access provision is targeted with grid solutions and 35% with off-grid technologies (solar off-grid and mini-grids).
- The 35% off-grid connection is planned to be achieved though the efforts of **public, private,** as well as **public private partnerships.**

Tariff Structure and Private Sector Developers

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- There are 285 sites identified by EEU where it will operate minigrids. i.e. the 50 sites currently being validated by Veritas.
- Private sector developers could charge higher than the national rate with approval by the EEA,
- EEA has suggested that an ABC approach be taken by developers to consider as part of their business model when considering tariff rates:

Anchor (A) customers	• Substantially large customer (a group of customers) with significant power demand within a specific geographic location. • Ability and willingness to pay market rates. • Platforms such as ACC and MCC can be anchor customers in this case.
Business (B) customers	• Public and private enterprises with power needs: they can pay market rate tariff. • Businesses, schools, health facilities, MSMEs, government entities, etc.
Community (C) customers	• These are private households who use electricity for domestic needs. • In the interest of equity, government stipulates these population have par tariffs to the grid. • Household customers will be cross-subsidized by anchor and business customers.

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Determining Productive Use Investment Opportunities

Inputs for site selection across the country

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Two approached were employed in identifying potential sites for minigrid investment.

Bottom-Up Approach

A plethora of data sources were utilized as input data for the selection process with over 1,500 potential sites identified.

Solar Irradiation Data	• Solar irradiation per kilometer
Shallow Ground Water Data	• (From ATA)
Social Amenities	• Location of schools, clinics, etc
Base Transceiver Stations	• Telecom towers
National Grid Line	• Triangulated from BTS data, Black marble technology and other sources

Top-Down Approach

Larger initiatives with potentials for productive uses.

ACCs	• Agriculture Commercialization Clusters
MCCs	• Milk Collection Centers clusters – Provided by USAID Feed the Future program

Bottom-Up Approach – Overlaid Data

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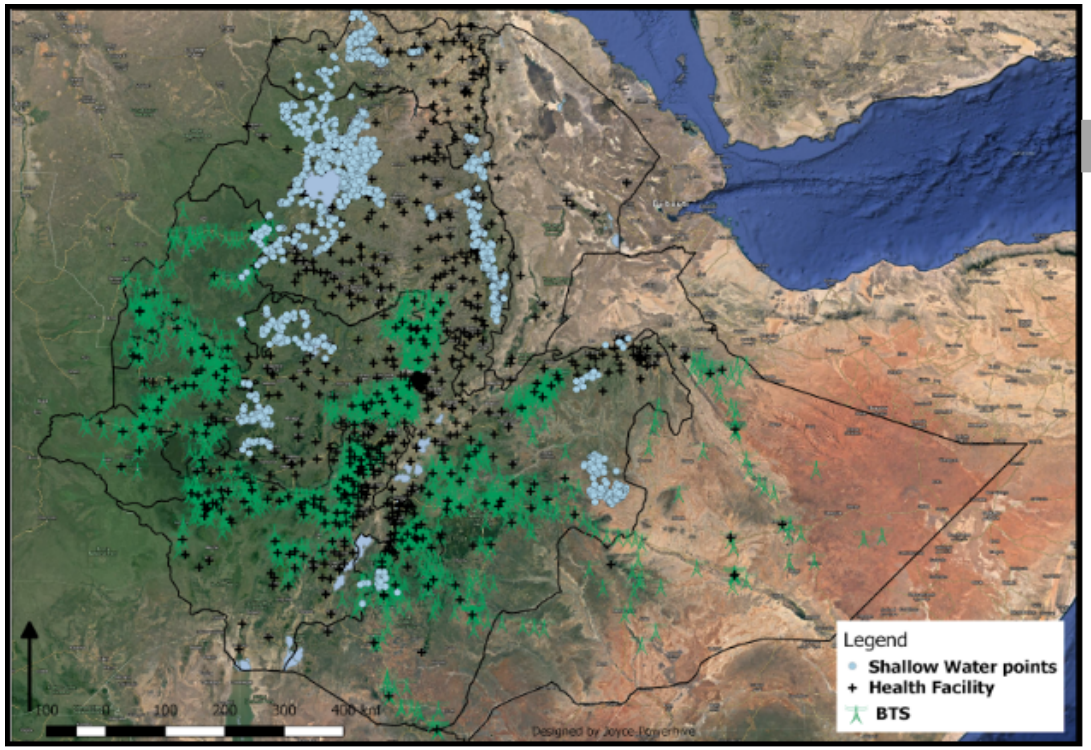
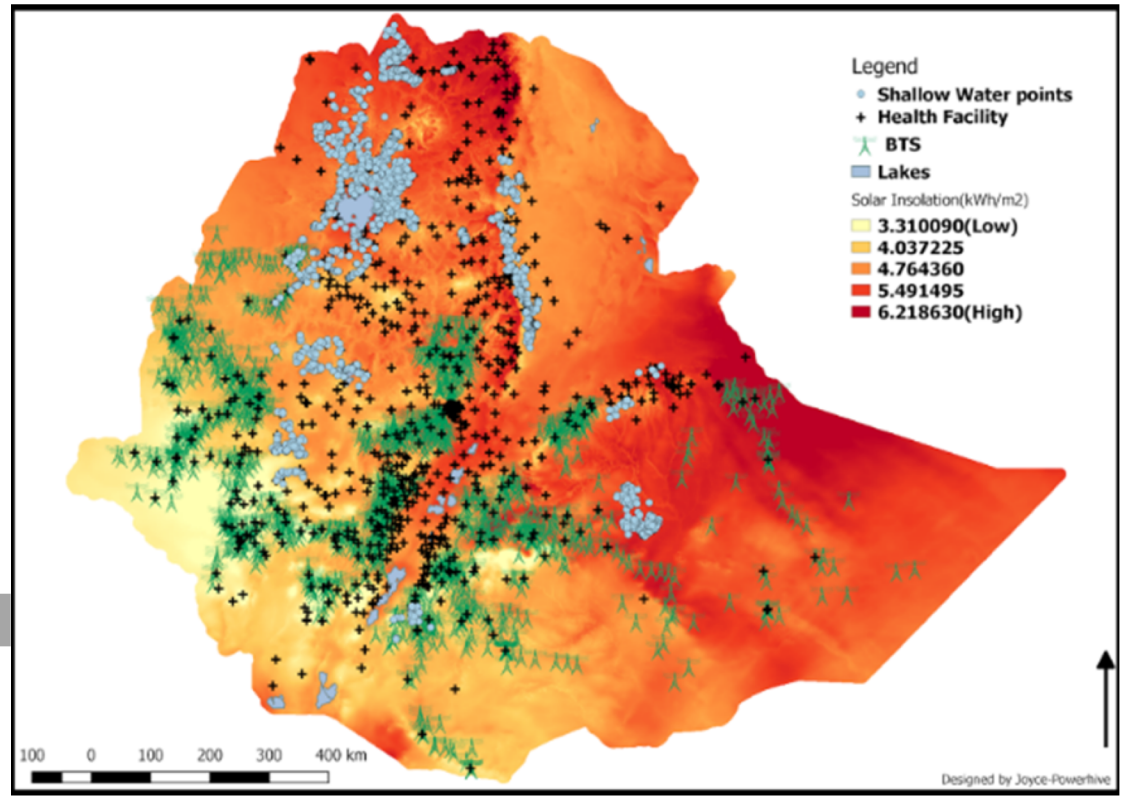


- Datasets of BTS towers, social amenities and shallow ground water points were overlaid.
- BTS towers and health facilities mostly overlap.
- But shallow groundwater points overlap little with the health facilities and BTS towers.



- Then, solar irradiation data was added to the data that had been overlaid.
- Higher insolation was registered in northern, middle and eastern parts of the country and numerous overlap points were found in those areas.

Bottom-Up Approach – National Grid and Rooftop data

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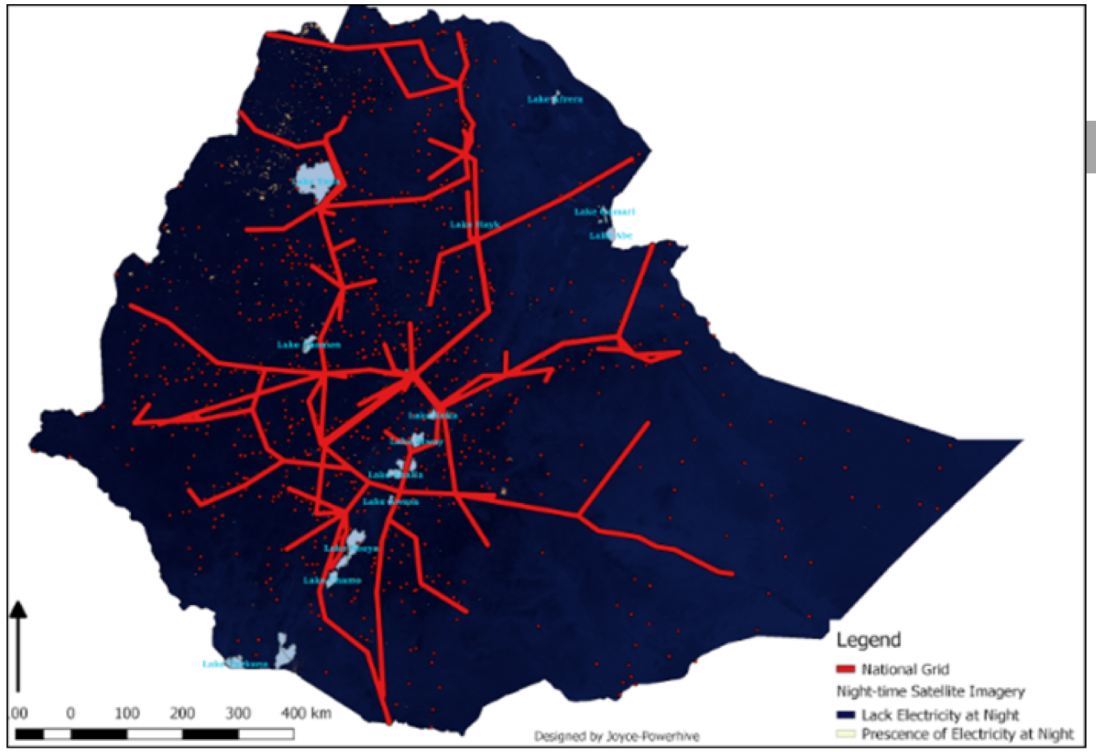
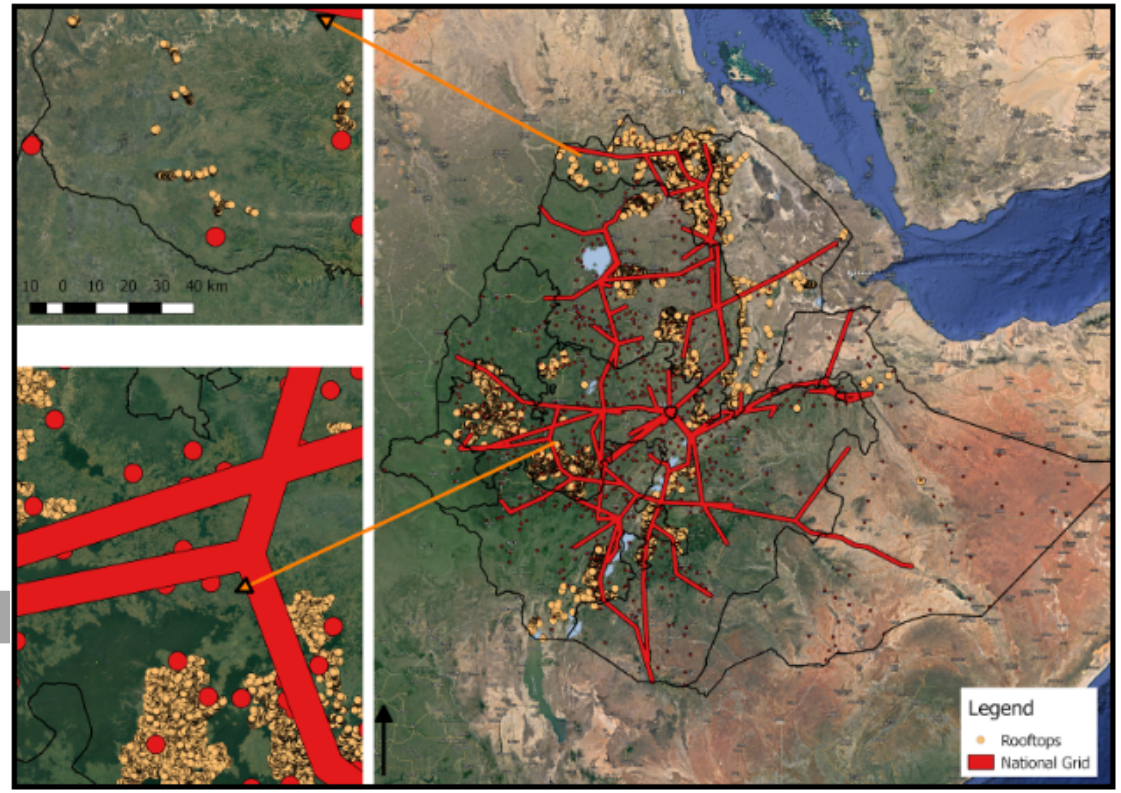


- The national grid was was compiled using medium voltage and low voltage lines, data on population density and ongrid BTS towers, NASA's black marble technology to capture artificial lightening.



- The grid data was then used to identify areas with higher concentration of rooftops.
- Many of the concentration points were found in Afar, Tigray, Amhara and Oromia regions.

Preliminary Site Validation Survey

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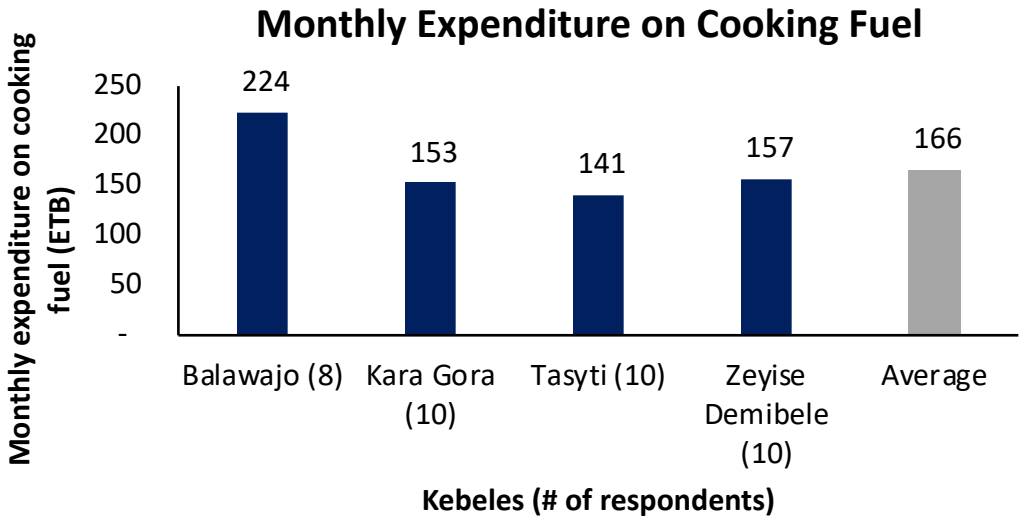
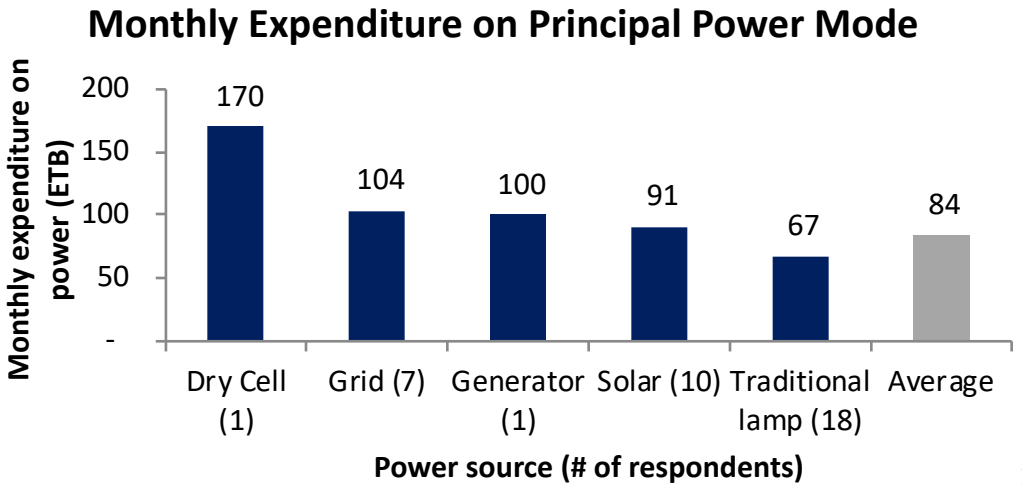
- **In September, using our bottom up approach we identified 4 sites ideal for investment. We subsequently validated these four Oromia and SNNP sites:**
  - ✓ Provided a picture of the typical off-grid community.
  - ✓ Provided examples and lessons for the validations currently underway and the ones yet to be conducted.

The kebele office in Kara Gora, Kersa





Preliminary Site Validation Survey – Some Findings

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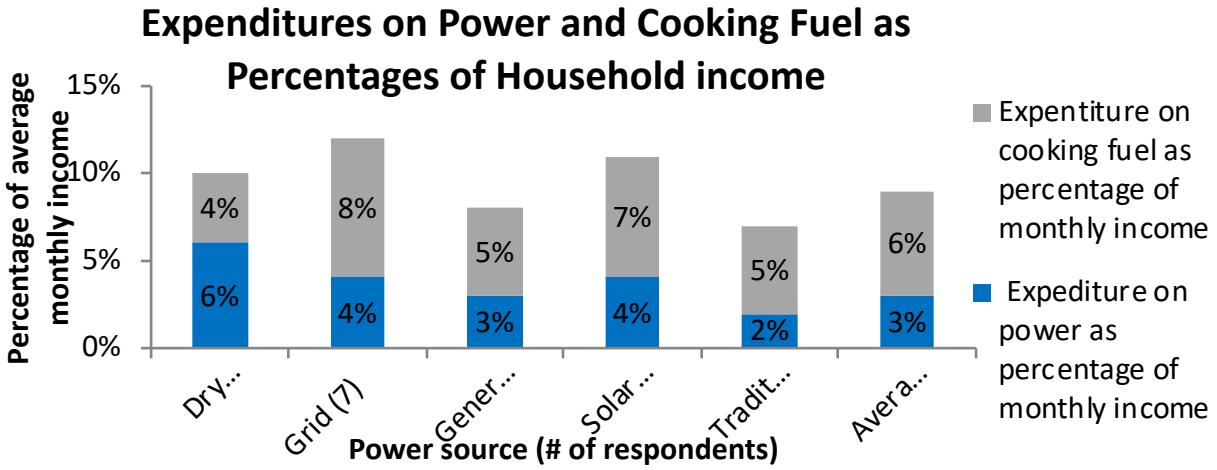

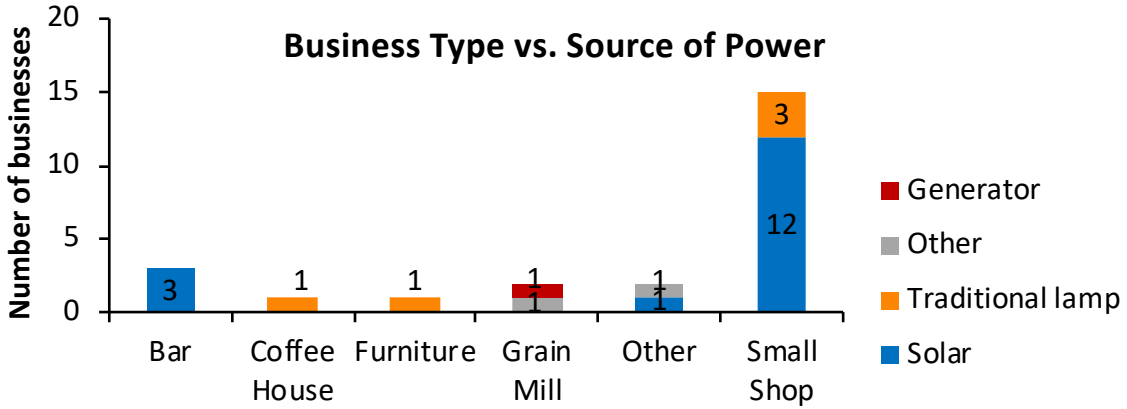

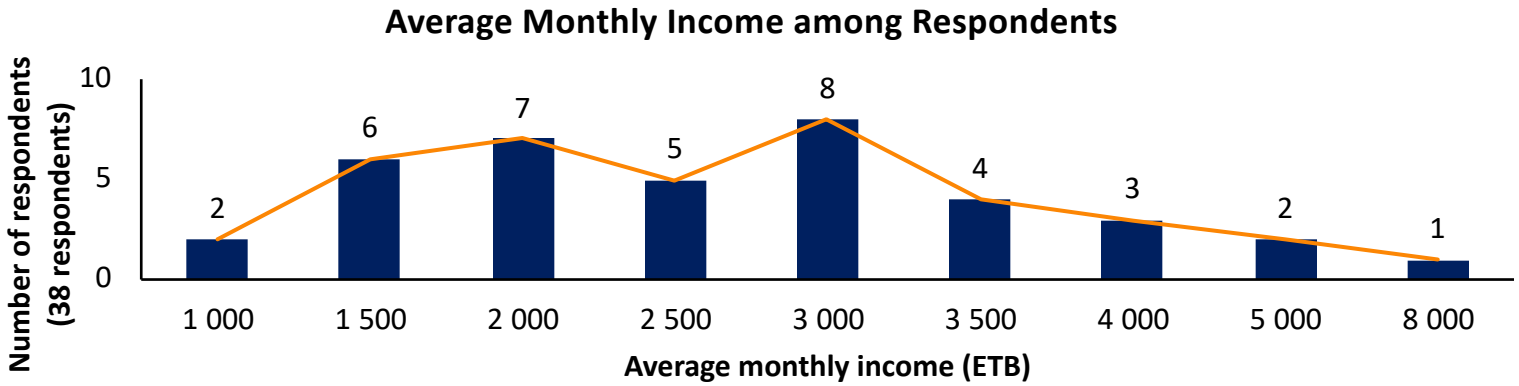

- Households, businesses, farms and local transportation service providers were included in the survey.
- The outputs of the survey, besides painting an image of a typical off-grid kebele, provided data on power needs, current usage trend, willingness and ability to pay for power, etc.

A Variety of Validations will Help Better Understand Load Profiles

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Veritas is presently validating 50 sites that MoWIE is considering for upcoming EPC engagements.

- Site selection principally by population density and distance from grid.
- conduct site by site geo-tagging and assessment of consumer and commercial user loads.
- 33 are complete and the balance will be complete within two weeks

Ten additional sites will be validated in December for potential private sector private investments

- These will be in the Agriculture Commercialization Clusters.
- The focus will be on horticulture clusters which are particularly aided by irrigation.
- These are intended to aid the development of specific investment cases for each site.

By December, around seventy site validations will have been completed.

- Baseline data on:
  - ✓ Potential willingness to pay,
  - ✓ Typical load profiles for various types of communities,
  - ✓ Specific user profiles for communities with agriculture clusters
  - ✓ Use case modalities for irrigation centric communities

Top Down Approach

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An essential task in the process of building a mini-grid investment with the 'ABC' model is identifying sufficient buyers of electricity that are **willing to pay cost reflective rates**. Such willingness stems from the productive utility power provides in income generation activities.

PUs and the 'ABC' Model

- Productive Uses of Energy (PUs) are the major drive behind the ABC model.
- Anchor and Business customers will pay higher tariffs only **because they can achieve significant increment in income** by making use of power.

Potential PUs for off-grid Investments

- Most potential PUs in off-grid areas are related to agriculture.
- PUs in off-grid areas can be:
  - ✓ Irrigation, water pumping for cattle, ploughing
  - ✓ cold storage,
  - ✓ drying,
  - ✓ milling and small-scale processing, etc

The Issue of Scalability

- What ideas are scalable national projects that we can leverage?
- Which entities do we engage? And how do we engage them?

Roads to Commercial Viability

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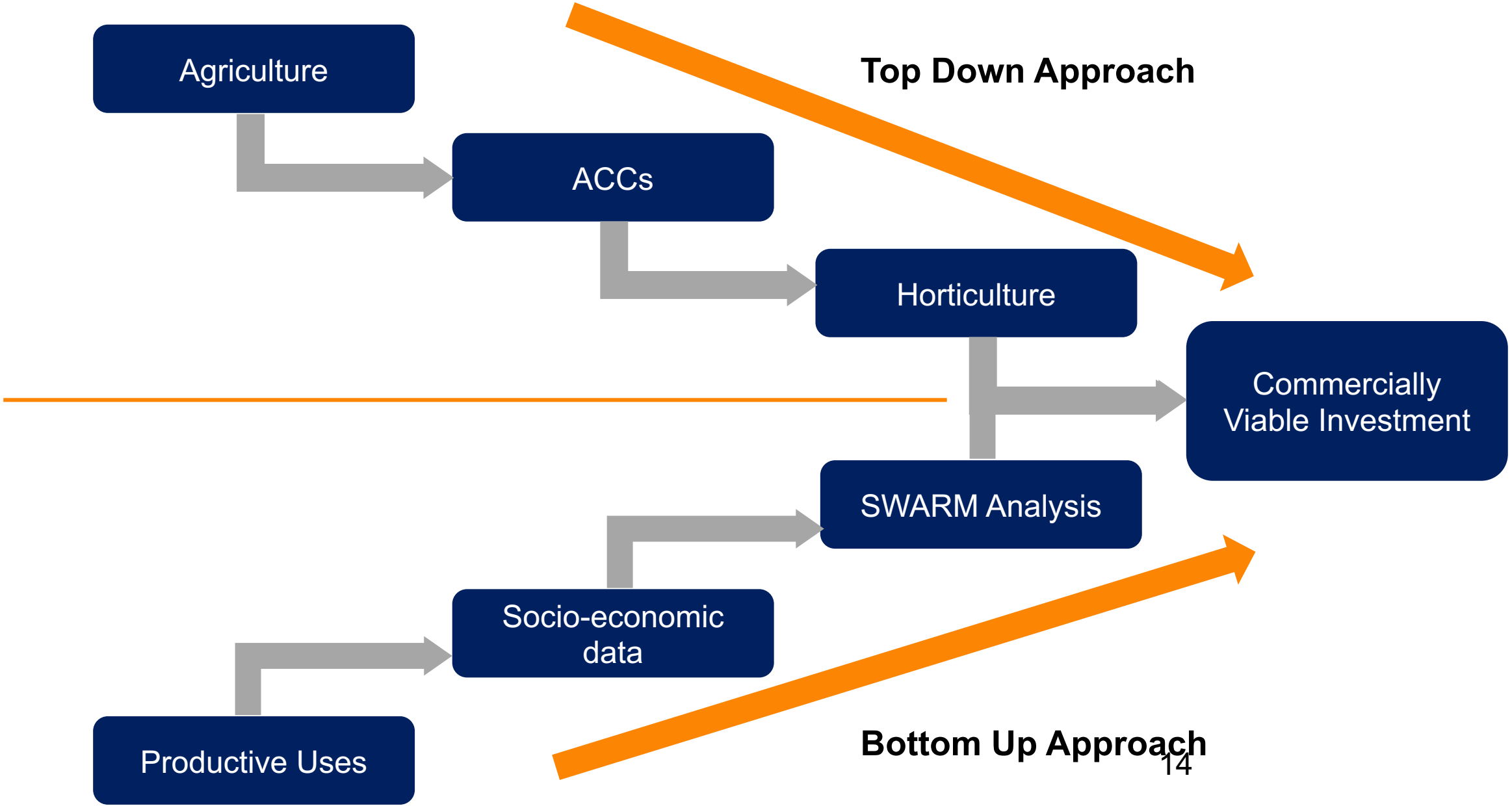

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Agriculture Commercialization Clusters (ACCs) - A Scalable Platform

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- The National Electricity Plan (NEP) 2.0, has identified the ACCs as the key conduit for product use expansion in off-grid power expansion
- The ACCs is a mechanism to integrate the interventions prioritized within specific geographies targeting a limited number of high-value commodities
- This integration allows smallholders and value chain actors to benefit from access to coordinated interventions
- It is a conduit for infrastructure development and for knowledge delivery, and it enables modern farm inputs to more easily reach the farmers

Summary of ACCs

- 60-200 farmers
- Producing the same product
- 284 clusters
- 1.6m farmers
- 284 woredas

Cereals	• Wheat • Maize • Sesame • Malt Barley
Horticulture	• Tomato • Onion • Banana • Mango • Avocado

Energy within the ACCs

Farmers can:

- ✓ Achieve economies of scale
- ✓ Maintain a proper post-harvest environment
- ✓ Collectively enter into contracts with service providers
- ✓ Engage in markets with greater strength
- ✓ Obtain better prices

The Case for Horticulture

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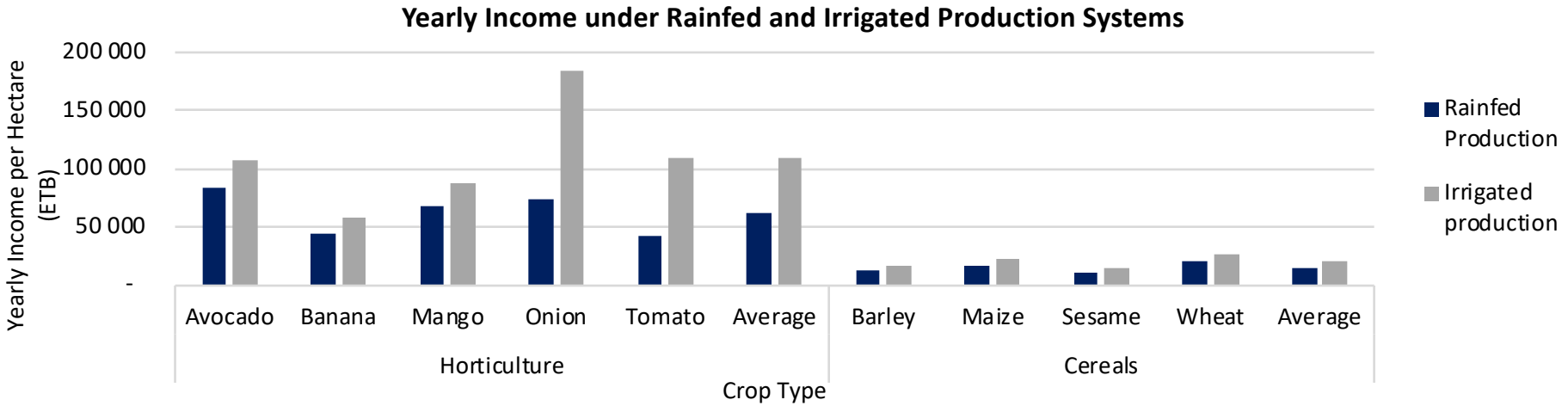
Five of the primary commodities in the ACC sites are horticulture crops. They have been chosen as focus crops over cereals due to the following reasons:

- **Income potential**
  - ✓ A horticulture farmer can earn up to 10x higher than cereal farmers under ideal circumstances
  - ✓ Farmers have much higher income to buy industrial level services, including electricity
- **Infrastructure**
  - ✓ Horticulture requires energy in pre-harvest, harvest and post-harvest seasons which means there is a high demand for energy
- **Sustainability**
  - ✓ The decision to grow perennial crops requires much higher levels of commitment and investment than it does for cereals
  - ✓ Once a farmer has planted a tree, it means s/he is in the business for 20 years, at least



- Perennials and cereals have typically higher yields with irrigation. The yield increase has been assumed to be 30% for both in this case.
- Onions and Tomatoes have, in addition to 30% and 25% yield increase (respectively), multiple (2) harvests under irrigation.

- **Income from rainfed horticulture production is on average 3x that of cereals without irrigation, it becomes 4.3x that of cereals with irrigation.**

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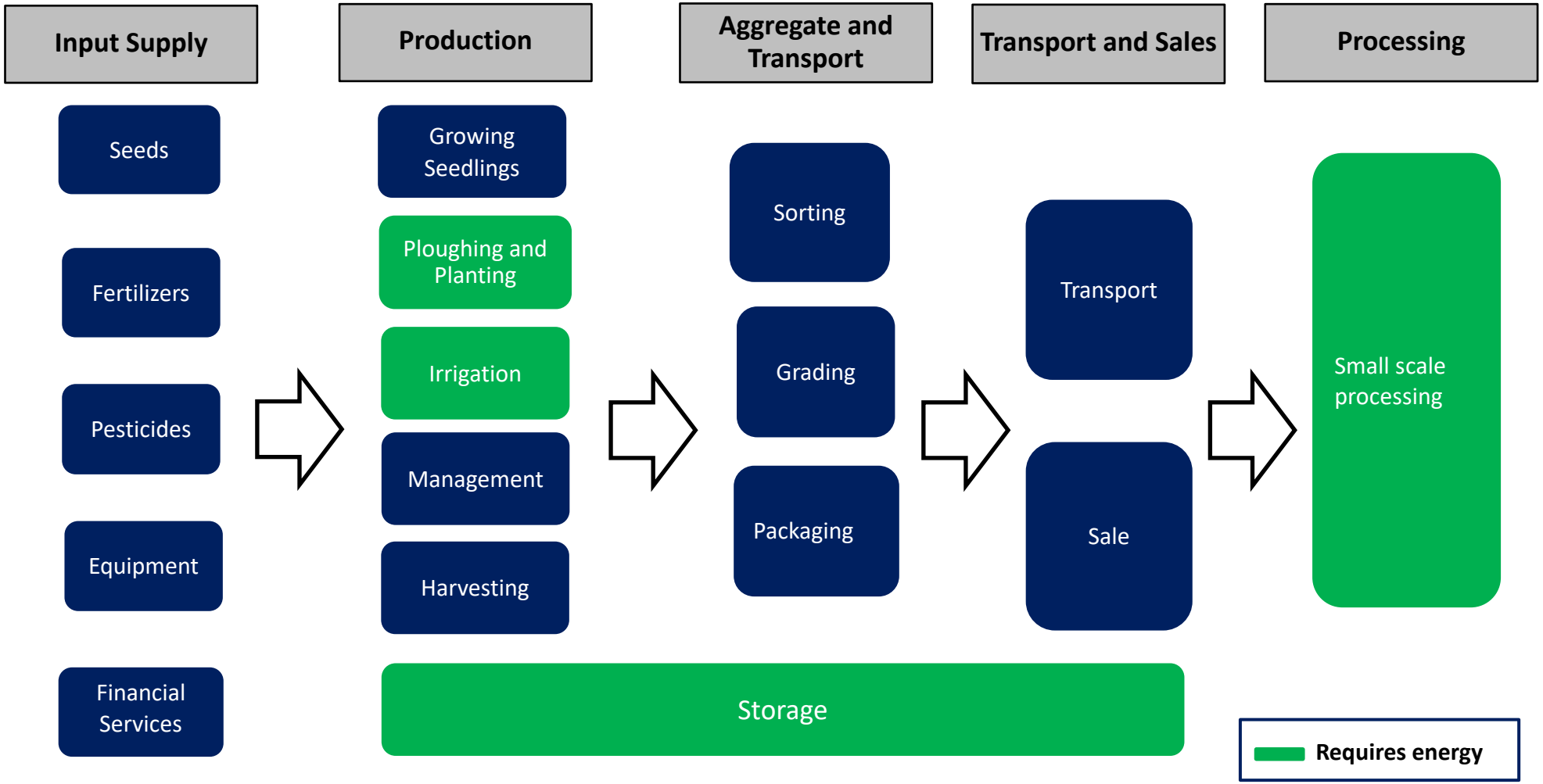
Use Case Scenarios

Horticulture Value Chain



The Impact of Irrigation on Horticulture Production

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Crops	Rainfed Yield (Kg/ha)	Irrigation Yield (Kg/ha)	No. of harvests under rainfed	No. of harvests under irrigation	Price (ETB)	Yearly income under rainfed (ETB)	Yearly Income under irrigation (ETB)	Percentage increase in Income
Avocados	-	8,300	-	1	10	-	83,000	-
Bananas	-	4,500	-	1	10	-	45,000	-
Mangoes	-	6,800	-	1	10	-	68,000	-
Onions	9,200	11,500	1	2	8	73,600	184,000	**150%**
Tomatoes	5,300	6,890	1	2	8	42,400	110,240	**160%**

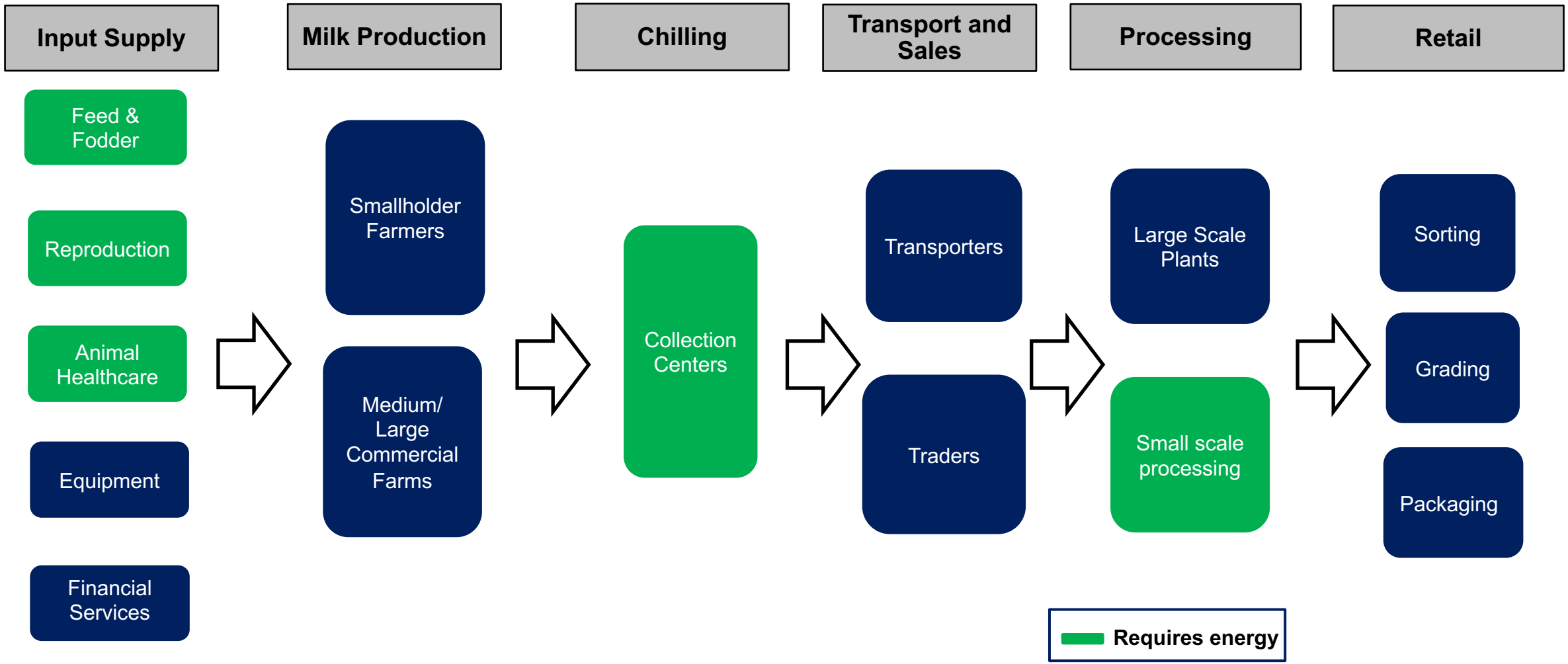
Onions and Tomatoes

- Ready for harvest 90 days after planting. Thus, multiple harvest is viable with irrigation.
- Power can also be utilized for **ploughing/planting, and storage (cold storage)**.

Avocado, Bananas and Mangoes (Perennial Crops)

- Production is water intensive. Thus, Irrigation is mandatory for production in areas where rainfall is seasonal; Production is concentrated in the southern parts of Ethiopia that get all year-round rainfall.
- Cold storage is also of prime importance for the shelf life of these crops.
- Additionally, power can be used for the production of **avocado oil, banana chips and dried mangoes.**

Dairy Value Chain



Dairy

Ethiopia has the largest livestock population in Africa

- 56.7 million cattle, including 12.65 million milking cows,
- Lowest yield in the world at **1-2/liters** per cow.
- The average daily milk production per cow in **Kenya** is **8-10 liters** and that of **South Africa** is **12.7 liters**.
- Shortage of milk supply in urban areas

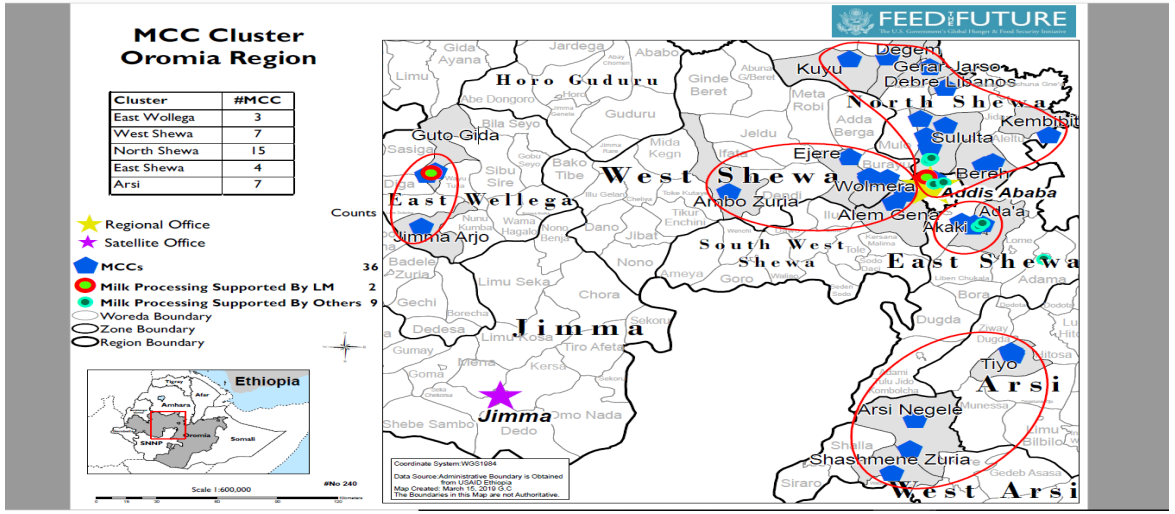
Water need

- Cows, in rural areas, tend to get enough water to drink during the rainy season,
- milk is over 85% water

Cold storage

- Critical factor to ensure that the milk is preserved adequately

FINTRAC, one of the implementing partner of USAID's Feed the Future program, has identified and are supporting **100 MCCs** across four regions: Amhara, Oromia, Tigray and SNNP. These MCC all require power with only 30 location currently being on grid and the other **70 locations requiring continuous off grid solution.**



Example of the MCC cluster for Oromia region

Dairy – Potential PUEs and power needs

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Activity	Power needs	Details	Power Consumption	No of hours/day	Evening hours
Feed & fodder	Mixer	Mixing and grinding of feed together	2.2kw/day	1	No
Reproduction/AI	Refrigeration	Storage for artificial insemination	0.3kw/day	24	Yes
Vaccination/Antibiotic	Refrigeration	Storage of various vaccines/antibiotics	0.3kw/day	24	Yes
Collection centers	Refrigeration	Collection/aggregation point for a group of farmers	1.5kw/day	24	Yes
Small scale processing	Cream separator	Separates the cream from the milk	3hp/motor	1	No
Reproduction/AI	Refrigeration	Storage for artificial insemination	0.3kw/day	24	Yes
Vaccination/Antibiotic	Refrigeration	Storage of various vaccines/antibiotics	0.3kw/day	24	Yes

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Regulatory Review and Recommendations

New Regulations – Licensing

In January 2019, Regulation No. 447/2019 was ratified that aims to govern the following:

- Licensing and certificate of competency of companies
- Generation, transmission, and distribution of energy
- Tariff rate structures
- Energy efficiency and conservation

The regulation licensing structure is segmented to power generation levels of

1. up to 10MW and
2. above 10MW.

Draft directives are currently underway to fill the gap in the regulation to be issued by EEA. Two are of particular relevance.

Rural electrification minimum design standards directive

- Design standards for the grid
- Prescribes a cost-effective **minimum standard**

Licensing requirements for off-grid directive

There are two tiers to this directive:

1. For **on-grid** systems above 50kw
2. For **off-grid** systems below 50kW, which is pertinent to **mini-grids**.

New Regulations – Tariff Structure and Regulatory Challenges

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ABCs allow commercial investment in minigrids

- Household tariff equity with grid is paramount.
- Need to formalize scalable engagements with productive uses as anchors.

Identified Regulatory Challenges	Possible Resolutions	Potential Workarounds
Long and tiresome approval process involving many stakeholders	• Streamline the consultative approach with community, EEA and regional EEU	• Engage strong government stakeholders to intervene in key instances
FDI is restricted from retail activities; cannot collect revenue from end users	• Regulatory resolution by MoWIE and EEA to allow investors to directly collect	• Create partnerships with local payment partners
Offering assets such as pumps for irrigation would require a separate set of investment licenses	• Regulatory solution through MoA or ATA	• Engage MFIs as 'middlemen'
Repatriation of capital and profits could be a challenge for mini-grid investors	• Ensure that the ministry of finance guarantees repatriations on a timely basis	• Tap into insurance programs to de-risk investment

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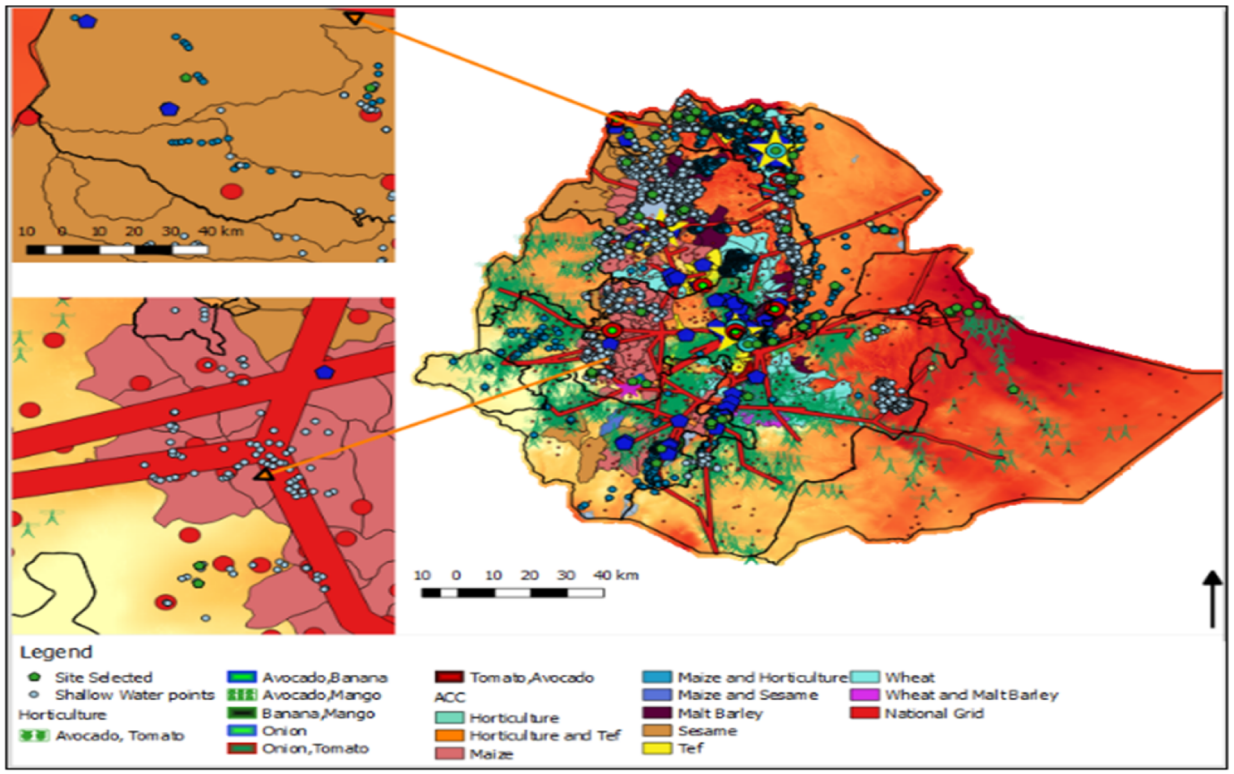
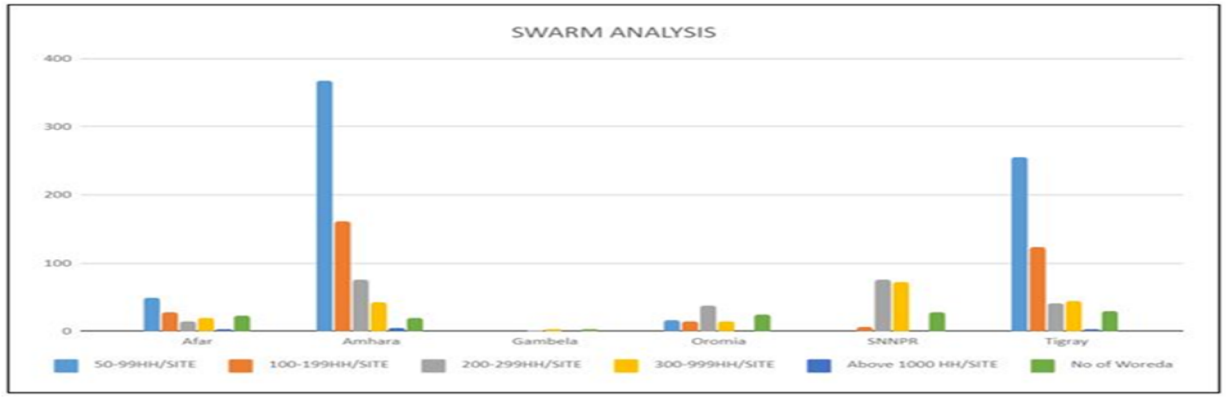
Annexes

Annex I: SWARM Analysis





- SWARM, Powerhive's programming software, was run to select sites with rooftops indicating at least 200 households within a radius of 1 km.
- All the parameters identified above were included in the analysis. The process identified over 1,471 sites as potential areas for minigrid development.