



# Ethiopia Consumer Segmentation

Prepared by Fraym  
July 2021





# Table of Contents

---

**01** **Scope of Work**

---

**02** **National Context**

---

**03** **Mapping Target Consumers**

---

**04** **Data Sources & Methodology**

01

---

# Scope of Work



# Scope of Work

---

**The Clean Cooking Alliance commissioned Fraym to produce consumer segmentations for Kenya, Nigeria, Ghana, Ethiopia, Rwanda, and Uganda.**

Assessments include an overview of demographic and socioeconomic characteristics and use of energy at the national and urban/rural level, national maps of four consumer segments, and market sizing and hyperlocal mapping at the subnational level for each consumer profile.

Fraym worked with the Clean Cooking Alliance to identify four target consumer groups: urban early-adopters, peri-urban and rural early-adopters, fast-followers, and secondary-followers.

Fraym then identified where there are pockets of high demand within the country by generating hyperlocal maps of the four target consumer segments. Initially, these maps can provide a snapshot understanding of where different customers and overall demand are concentrated.

# How it works

Fraym uses advanced machine learning models to produce unprecedented, local information on human and population characteristics in critical geographies around the world – down to 1 km<sup>2</sup> even in remote areas.



## ACQUIRE DATA

Geo-tagged household surveys

Satellite imagery

Partner datasets



## HARMONIZE DATA

Validate

Clean

Geospatially enable



## MACHINE LEARNING

Proprietary algorithms

Human-centric QA/QC

Automation



## GEOSPATIAL INSIGHT

Predictive modeling

API enabled

Analytic services

Front-end tools

02

---

# National Context



# Household Characteristics

**There are roughly 19 million households in Ethiopia, with only 11 percent living in cities and the remaining 89 percent in peri-urban and rural areas.<sup>1</sup>**

Education attainment is a challenge nationwide, with clear disparities between urban and rural households. About half of urban household heads have completed primary school, compared to only 9 percent of their rural counterparts.

Financial inclusion differs significantly between urban and rural areas. While urban households have a relatively high rate of bank account ownership at 67 percent, only 19 percent of rural households have a bank account.

**Note 1:** Urban areas were defined using the EU Global Human Settlement Layer (GHSL). Urban centers, dense urban clusters, and semi-dense urban clusters are classified as urban. Suburban or peri-urban and all rural areas are classified as peri-urban and rural.

**Note 2:** The source of all population data in this report is WorldPop.

**Note 3:** High quality housing materials are defined as durable materials like concrete, metal, brick, or finished wood. All housing refers to the roof, wall, and floor.

**Note 4:** Urban/rural disaggregation is not possible for the mobile money indicator.

**Source:** Fraym, Ethiopia 2016 DHS, Ethiopia 2017 Findex

## Ethiopia Snapshot

### Demographics

	National	Urban	Rural
Population <sup>2</sup>	104M	10M	94M
Number of households	19M	2M	17M
Female headed household	27%	38%	23%
Household head completed at least primary education	19%	50%	9%
Household head completed at least secondary education	9%	30%	3%
Household head completed higher education	2%	8%	0%
All high-quality housing material <sup>3</sup>	6%	22%	1%
Bank account	31%	67%	19%
Mobile money account <sup>4</sup>	< 1%	-	-

# Cooking Fuels

**Only 6 percent of households nationwide use clean cooking fuel, with electricity being the most common.**

Wood is by far the most common fuel nationwide in both urban and rural settings. In urban areas, charcoal is the second most common cooking fuel, used by 32 percent of all urban households.

Households spend similar amounts on wood and charcoal per month, with spending on wood being slightly higher in rural areas.

There is a stark contrast in electrification rates between urban and rural areas.

**Note 1:** Clean cooking fuel is defined as LPG, natural gas, electricity, and biogas.

**Note 2:** Other solid cooking fuels include straw, agricultural crops, and dung.

**Note 3:** Spending data is in 2016 Birr and includes spending on the fuel for cooking, heating, and lighting.

**Source:** Fraym, ESS 2016, DHS 2016.

## Ethiopia Snapshot

### Household energy use

	National	Urban	Rural
Primarily use clean cooking fuel <sup>1</sup>	6%	23%	1%
Primarily use LPG to cook	<1%	<1%	<1%
Primarily use natural gas or biogas to cook	<1%	1%	<1%
Primarily use electricity to cook	6%	21%	0%
Primarily use wood to cook	74%	40%	85%
Primarily use charcoal to cook	10%	32%	2%
Primarily use kerosene to cook	1%	2%	<1%
Primarily use other solid fuels to cook <sup>2</sup>	10%	4%	12%
Average monthly spending on charcoal (Birr) <sup>3</sup>	100	110	80
Average monthly spending on kerosene (Birr) <sup>3</sup>	30	40	20
Average monthly spending on wood (Birr) <sup>3</sup>	110	100	130
Average total monthly spending (Birr)	2,000	2,600	1,800
Access to electricity	29%	92%	8%



# Cooking Fuels – MTF

**According to the 2018 Multi-Tiered Framework (MTF) survey, 13 percent of households use clean cooking fuels at least once throughout the year.<sup>1</sup>**

The MTF survey also shows that electricity is the most common clean cooking fuel used. However, 42 percent of households using electricity also commonly use charcoal.

Wood is used by almost all rural households for cooking at some point in the year, and most often with a stone/fire stove. Only 10 percent of rural households use a manufactured stove for cooking.

In urban areas, charcoal is predominant and manufactured stoves are much more common.

**Note 1:** Clean cooking fuel is defined as LPG, natural gas, electricity, and biogas. In the MTF survey, households are asked about all cooking fuels used in the past year. This is different from the DHS survey used in the previous slide, which only asks households about their primary cooking fuel.

**Note 2:** Other solid cooking fuels as defined here include animal waste, dung, plant biomass, sawdust, and byproducts.

**Source:** Fraym, MTF 2018.

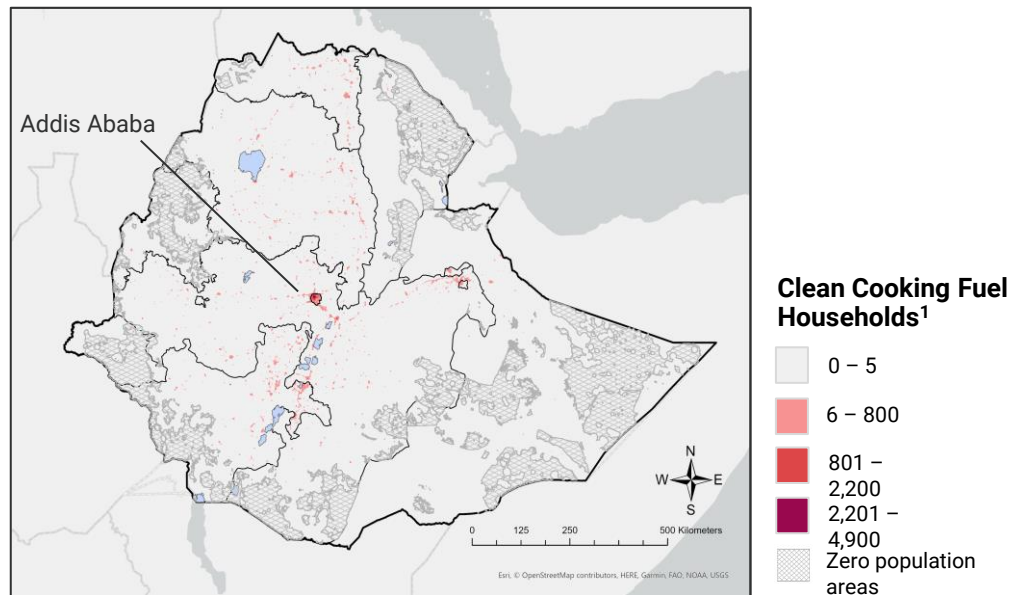
## Ethiopia Snapshot – MTF

### Household energy use

	National	Urban	Rural
Use clean cooking fuel at least once a year	13%	44%	5%
Use LPG, natural gas, or biogas to cook at least once a year	4%	3%	4%
Use electricity to cook at least once a year	9%	41%	<1%
Use wood to cook at least once a year	89%	58%	97%
Use charcoal to cook at least once a year	30%	86%	16%
Use kerosene to cook at least once a year	1%	3%	<1%
Use other solid cooking to cook at least once a year <sup>2</sup>	35%	7%	43%
Use electricity and wood for cooking	4%	27%	ND <sup>3</sup>
Use electricity and charcoal for cooking	26%	42%	ND <sup>3</sup>
Use electricity and LPG, natural gas, or biogas for cooking	4%	4%	ND <sup>3</sup>
Use a stone/fire stove at least once a year	74%	44%	82%
Use another self-built stove at least once a year	24%	17%	26%
Use a manufactured stove at least once a year	23%	72%	10%

# Clean Cooking Fuel

The roughly 1 million households that use clean cooking fuels are concentrated in Addis Ababa and predominantly use electricity as their primary cooking fuel.



**Note 1:** This map shows the estimated number of households that use clean cooking fuel per 1km<sup>2</sup>. Clean cooking fuel includes electricity, LPG, natural gas, and biogas.

**Source:** Fraym , Ethiopia 2016 DHS

**1M** Households use clean cooking fuel

**34%** of households are headed by a woman

**3.7** Average household size

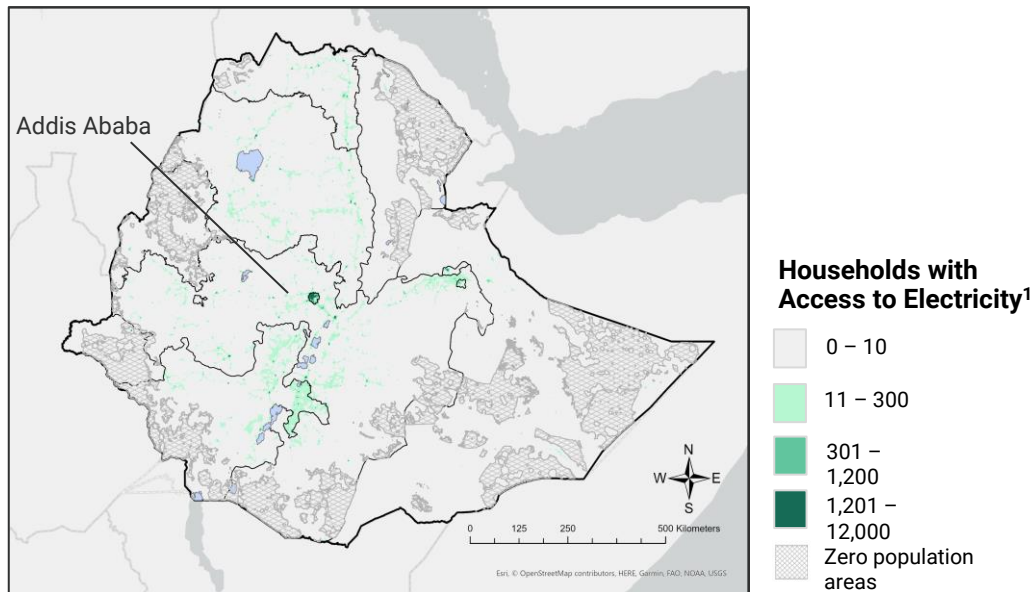
**48%** of household heads have completed secondary education

**91%** use electricity as their primary cooking fuel

**5%** use LPG as their primary cooking fuel

# Electricity Access

Around 25 percent of all households have access to electricity, and they are mainly concentrated in Addis Ababa. Nearly half of all electrified households still use wood as their primary cooking fuel.



**Note 1:** This map shows the estimated number of households that have electricity access per km<sup>2</sup>. Estimates for Northern and Upper West regions failed to pass Fraym standard quality checks and should thus be interpreted with caution.

**Source:** Fraym, Ethiopia 2016 DHS

**5M** Households with access to electricity

**35%** of households are headed by a woman

**3.7** Average household size

**3%** of household heads have completed secondary education

**44%** use wood as their primary cooking fuel

**28%** use charcoal as their primary cooking fuel

**19%** use electricity as their primary cooking fuel

# Identifying key characteristics

**Most households that use clean cooking fuel own a high-cost asset and have access to electricity and a bank account.**

Households that use clean cooking fuel are concentrated in cities and have more educated household heads.

A small proportion of solid cooking fuel households own high-cost assets, live in households constructed with all high-quality materials, and have access to bank accounts and electricity. These indicators are suggestive of relatively high consumption power.

**Note 1:** Clean cooking fuel households are households that use liquified petroleum gas (LPG), electricity, natural gas, or biogas as the primary cook fuel.

**Note 2:** Bank account ownership is defined as any household member having a formal bank account. Mobile money accounts are not included. Data is from the Ethiopia 2016 DHS.

**Note 3:** High quality housing materials are defined as durable materials like concrete, metal, brick, or finished wood. All housing refers to the roof, wall, and floor.

**Note 4:** A high-cost asset is defined as a television, refrigerator, or car.

**Source:** Fraym. , Ethiopia 2016 DHS

## Ethiopia Snapshot

### Characteristics by cooking fuel type

	Clean Cooking Fuel Households <sup>1</sup>	Solid Cooking Fuel Households
Number of households	1M	18M
Urban	92%	20%
Female headed household	34%	26%
Access to electricity	94%	24%
Primary cooking fuel	Electricity (91%) LPG (5%) Natural gas or biogas (4%)	Wood (80%) Charcoal (10%) Dung (7%)
Bank account <sup>2</sup>	86%	27%
All high-quality housing material <sup>3</sup>	41%	3%
Own at least 1 high cost asset <sup>4</sup>	83%	12%
Own a radio	56%	26%
Household head completed at least secondary education	48%	7%

# Communications

**Radio and television ownership is relatively low, particularly in rural areas.**

Only 27 percent of rural households tune into a radio at least once a week and only 11 percent watch television.

Urban households use radio and television more often. Over half of these households listen to the radio or watch television at least once a week.

Mobile phone ownership rates also vary between urban and rural areas. Around 87 percent of urban households own a mobile phone, compared to less than half of rural households.

**Note 1:** Regular use of a media form is defined as the adult household head (age 15-49) using the media at least once a week.  
**Source:** Fraym, Ethiopia 2016 DHS

## Ethiopia Snapshot

### Household communications access<sup>1</sup>

	National	Urban	Rural
Television ownership	16%	58%	2%
Radio ownership	28%	42%	24%
Mobile phone ownership	57%	87%	47%
Regular print media readership	11%	25%	7%
Regular television viewership	23%	66%	11%
Regular radio listenership	32%	53%	27%

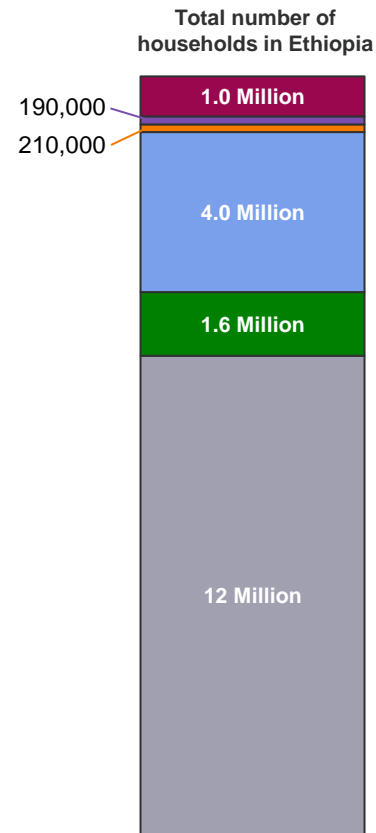
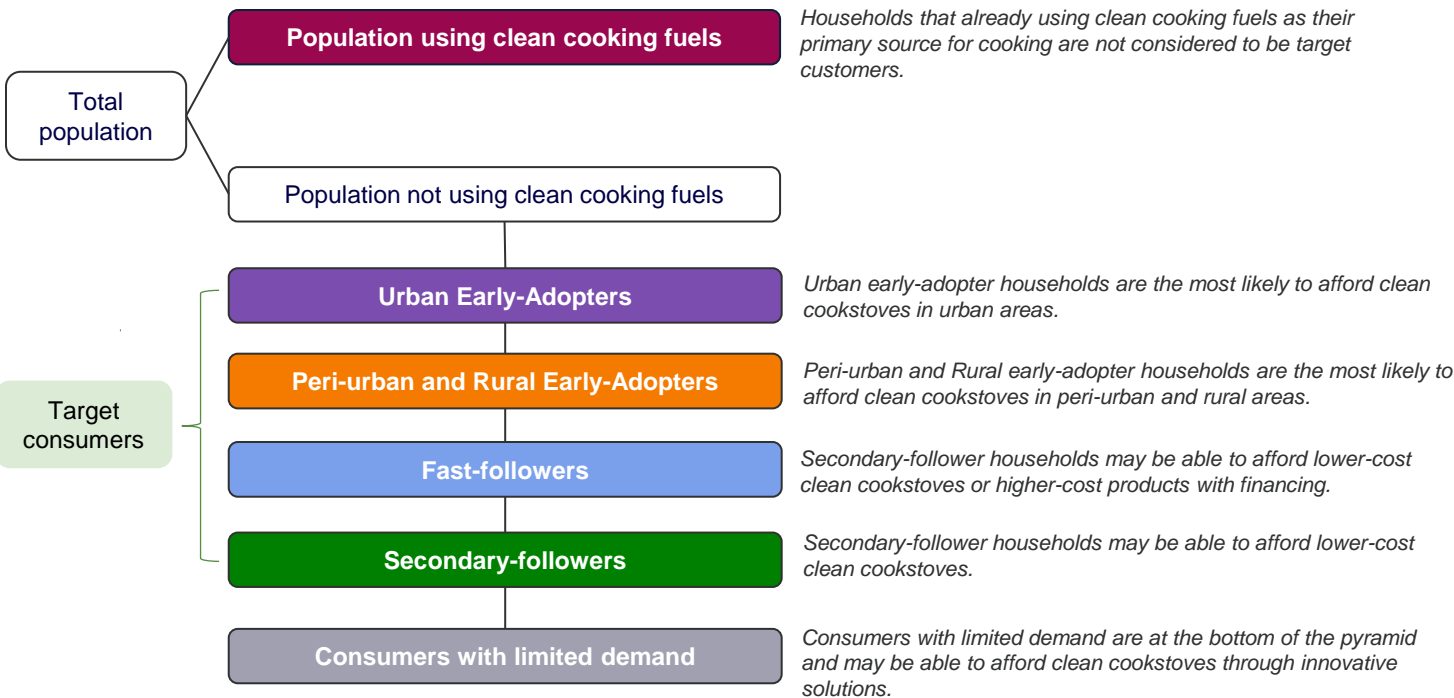
03

---

# Mapping Consumer Segments



# The total population is segmented into six groups, with four target consumer segments.



**Note 1:** The same segment criteria was applied across the six countries examined by Fraym, which resulted in significant variations in segment sizes across countries.

Source: Fraym

# Overview of Target Consumers

**Urban Early-Adopter Households** are those with the highest ability to afford clean cooking technologies. Only households that live in urban areas were included in this group. They own high-cost assets, live in homes made of high-quality materials, and have access to electricity. These households are expected to be the consumer segment most able to afford clean cooking technologies.<sup>1</sup> There are an estimated 190,000 urban early-adopter households in Ethiopia.

**Peri-urban and Rural Early-Adopter Households** are wealthy households with a high ability to afford clean cooking technologies. These households own high-cost assets, live in households made of high-quality materials, and have access to electricity. Only households that live in peri-urban or rural areas are included in this consumer group.<sup>1</sup> There are roughly 210,000 peri-urban and rural early-adopter households in Ethiopia.

**Fast-Follower Households** are any remaining households that own high-cost assets that did not fit the early-adopters profiles. Also included in this group are households with homes partially constructed from high-quality materials and with formal bank accounts, making these households better positioned to maintain savings and/or take out loans for the purchase of household assets. There about 4 million households in Ethiopia are fast-followers.

**Secondary-Follower Households** are any remaining households that own high-cost assets that did not fit the early-adopters profiles and fast-followers profile. They have homes partially constructed from high-quality materials and own radios, suggesting modest consumption power and some ability to afford clean cooking technologies. Their lack of access to services, like electricity and bank accounts, suggests a lower-middle class in both urban and rural markets. These households are mostly found in rural areas but have some presence in urban markets as well. There are about 1.6 million secondary-follower households in Ethiopia.

**Note 1:** High-cost assets are defined as televisions, refrigerators, and cars. High quality housing materials are defined as durable materials like concrete, metal, brick, or finished wood. All housing refers to the roof, wall, and floor. Urban areas were defined using the EU Global Human Settlement Layer (GHSL). Urban centers, dense urban clusters, and semi-dense urban clusters are classified as urban. Suburban or peri-urban and all rural areas are classified as peri-urban and rural.

**Source:** Fraym, Ethiopia 2016 DHS

**190,000** Urban Early-Adopter households

**210,000** Peri-urban and Rural Early-Adopter households

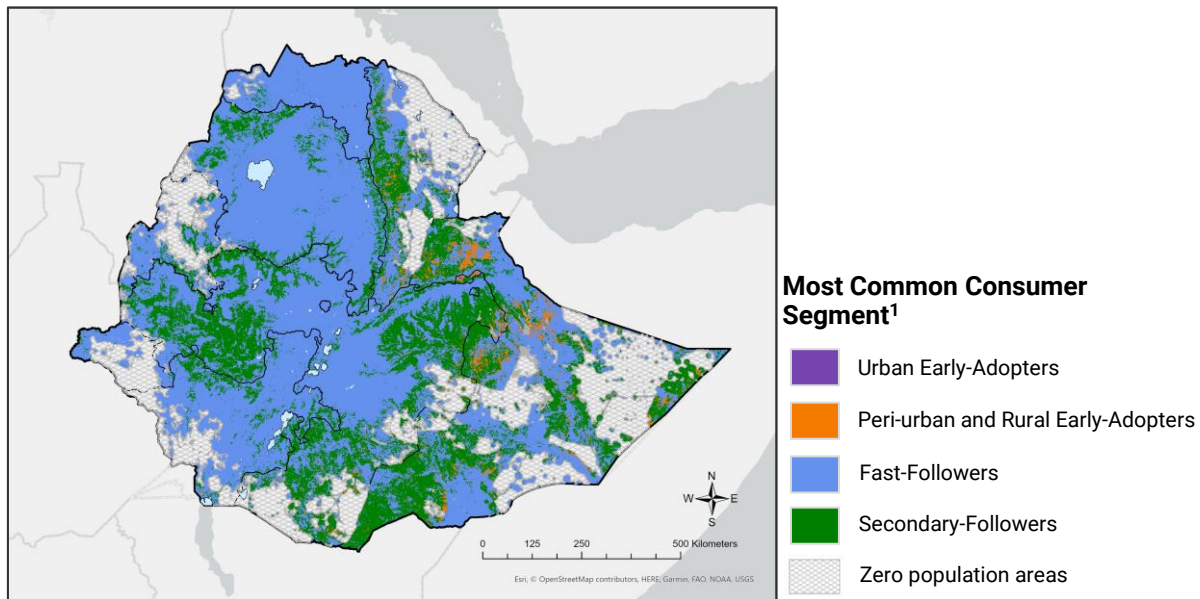
**4.0M** Fast-Follower households

**1.6M** Secondary-Follower households



# Consumer Segment Distribution

**Fast-followers are the most common consumer segment throughout populated parts of the country. However, some segments are more common in particular areas, requiring different market strategies depending on location.**



**Urban early-adopters** are rare, even in Addis Ababa.

**Peri-urban and rural early-adopters** are most common in a few areas scattered in the east.

**Fast-followers** are most common in every region, including Addis Ababa.

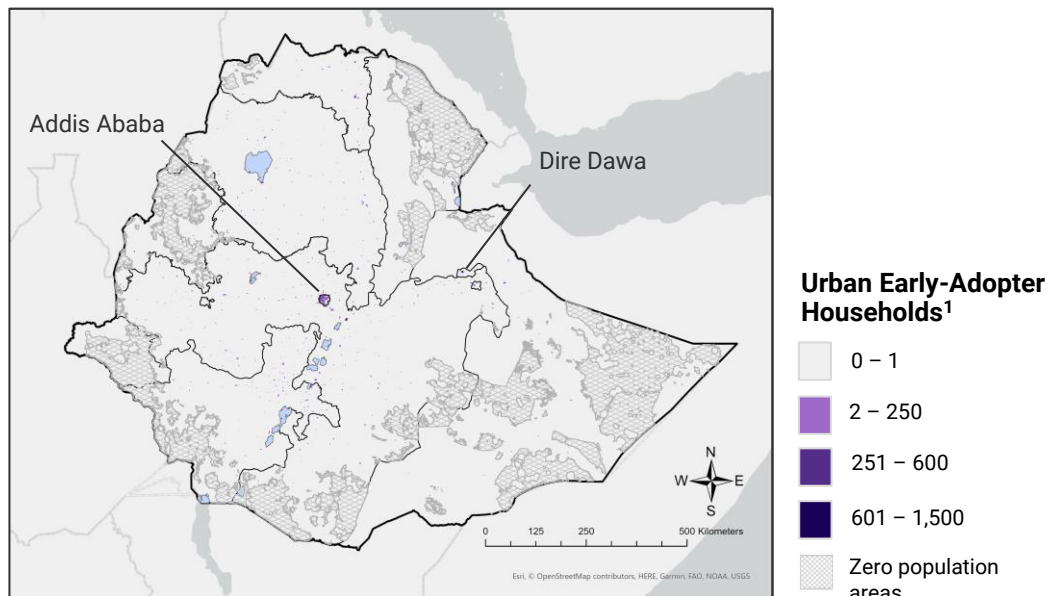
**Secondary-followers** are the second most common in every region and scattered in various rural areas.

**Note 1:** This map shows the most common consumer segment among all households per 1km<sup>2</sup> area. Each 1km<sup>2</sup> area varies in population density.

**Source:** Fraym, Ethiopia 2016 DHS

# Urban Early-Adopters

There are about 190,000 urban early-adopter households, representing only 1 percent of all households. They are heavily concentrated in Addis Ababa.



**Note 1:** This map shows the estimated number of urban early-adopter households per 1km<sup>2</sup>. Urban early-adopter households own at least one high-cost asset, have housing made of all high-quality material, have access to electricity, and live in urban centers, dense urban clusters, and semi-dense urban clusters according to the EU Global Human Settlement Layer.

**Source:** Fraym, Ethiopia 2016 DHS

**190,000** Urban Early-Adopter households

**37%** of households are headed by a woman

**4.3** Average household size

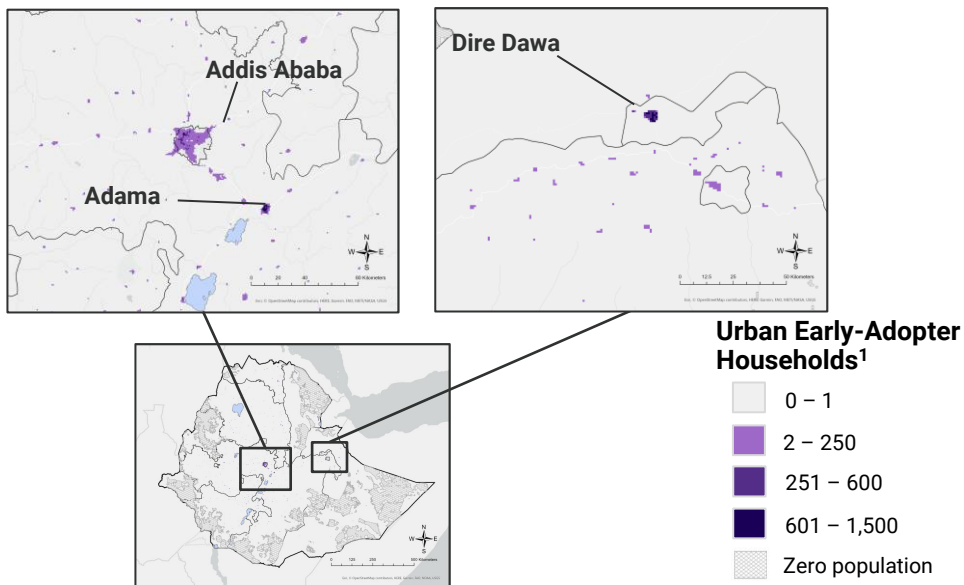
**29%** of household heads have completed secondary education

**70%** use charcoal as their primary cooking fuel

**26%** use wood as their primary cooking fuel

# Urban Early-Adopters

One fifth of all urban early-adopter households live Addis Ababa. Despite this concentration, only 6 percent of households in Addis Ababa are urban early-adopters.



**Note 1:** This map shows the estimated number of urban early-adopter households per 1km<sup>2</sup>. Urban early-adopter households own at least one high-cost asset, have housing made of all high-quality material, have access to electricity, and live in urban centers, dense urban clusters, and semi-dense urban clusters according to the EU Global Human Settlement Layer.

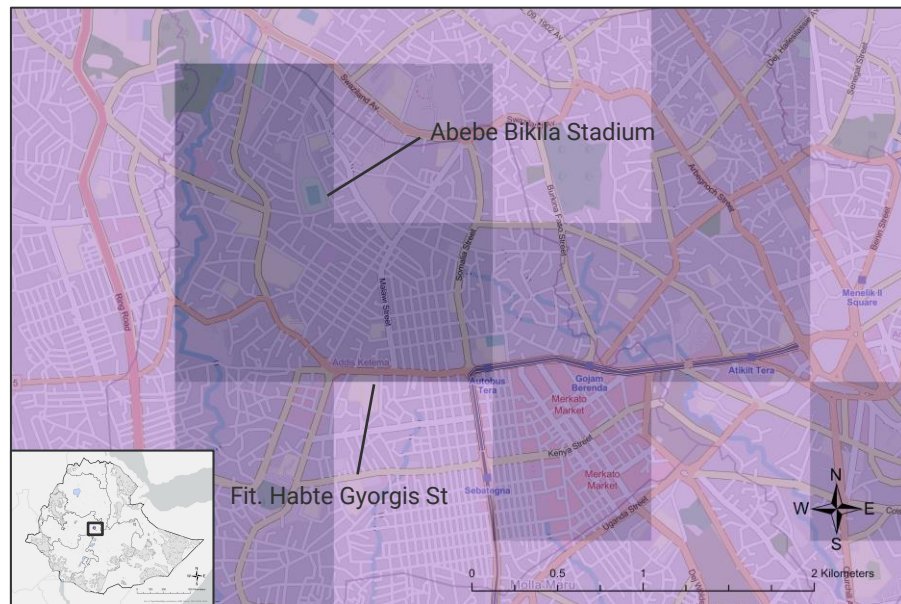
**Source:** Fraym, Ethiopia 2016 DHS

## Top Local Government Areas with Urban Early-Adopters

Region	Woreda	Number of Urban Early-Adopter Households
Addis Ababa	Addis Ababa	44,000
Dire Dawa	Dire Dawa	17,000
Oromia	Adama	16,000
Tigray	Enderta	8,000
Southern Nations	Awasa Town	7,000
Somali	Jijiga	5,000
Amhara	Bahirdar Zuria	4,000
Oromia	Shashemene Zuria	4,000
Amhara	Kalu	3,000
Southern Nations	Arba Minch Zuria	3,000

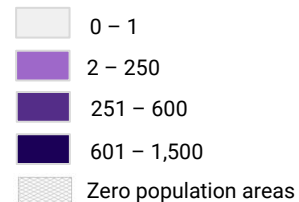
# Urban Early-Adopter Households

Neighborhoods at the center of Addis Adaba have the highest concentration of urban early-adopter households.



Neighborhoods north of Fit. Habte Gyorgis St and near the Abebe Bikila Stadium have a high density of urban early-adopters.

## Urban Early-Adopter Households<sup>1</sup>

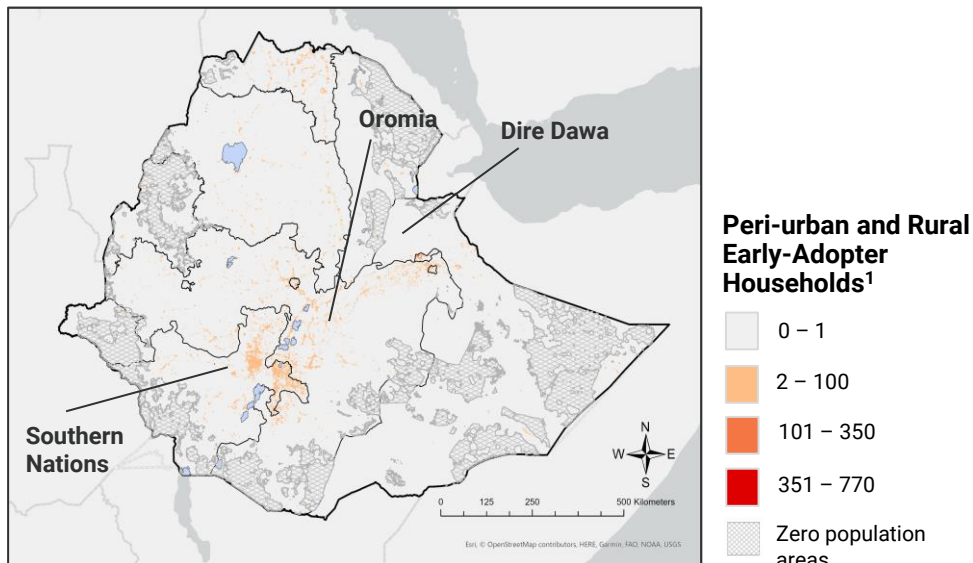


**Note 1:** This map shows the estimated number of urban early-adopter households per 1km<sup>2</sup>. Urban early-adopter households own at least one high-cost asset, have housing made of all high-quality material, have access to electricity, and live urban centers, dense urban clusters, and semi-dense urban clusters according to the EU Global Human Settlement Layer.

**Source:** Fraym, Ethiopia 2016 DHS

# Peri-urban and Rural Early-Adopters

There are about 210,000 peri-urban and rural early-adopter households, representing about 1 percent of all households in Ethiopia. Many of these consumers are in Oromia, Dire Dawa, and the Southern Nations



**Note 1:** This map shows the estimated number of peri-urban and rural early-adopter households per 1km<sup>2</sup>. Peri-urban and rural early-adopter households own at least one high-cost asset, have housing made of all high-quality material, have access to electricity, and live in suburban or peri-urban rural areas according to the EU Global Human Settlement Layer.

**Source:** Fraym, Ethiopia 2016 DHS

**210,000** Per-urban and Rural Early-Adopter households

**11%** of households are headed by a woman

**5.5** Average household size

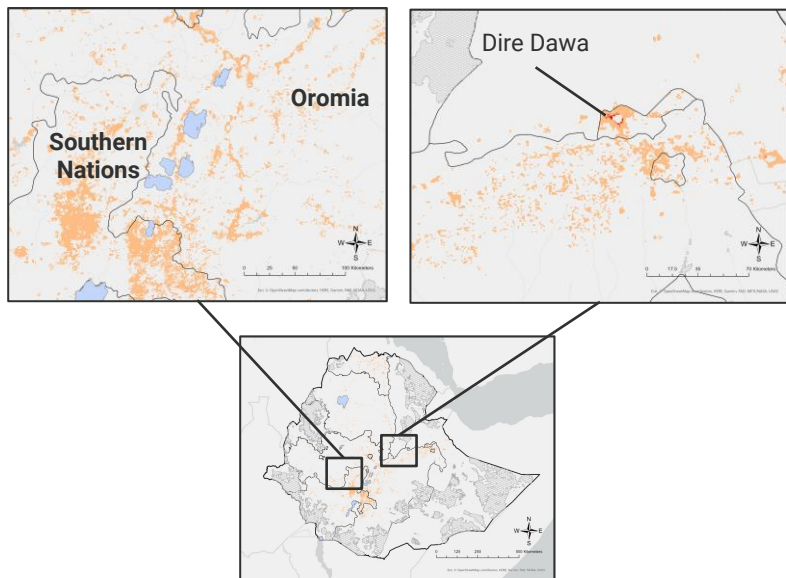
**16%** of household heads have completed secondary education

**69%** use wood as their primary cooking fuel

**21%** use charcoal as their primary cooking fuel

# Peri-urban and Rural Early-Adopters

More than two thirds of peri-urban and rural early-adopter households are in Oromia, Southern Nations, and Dire Dawa. In Dire Dawa, 14 percent of households are peri-urban and rural early-adopters.



**Note 1:** This map shows the estimated number of peri-urban and rural early-adopter households per 1km<sup>2</sup>. Peri-urban and rural early-adopter households own at least one high-cost asset, have housing made of all high-quality material, have access to electricity, and live in suburban or peri-urban rural areas according to the EU Global Human Settlement Layer.

Source: Fraym, Ethiopia 2016 DHS

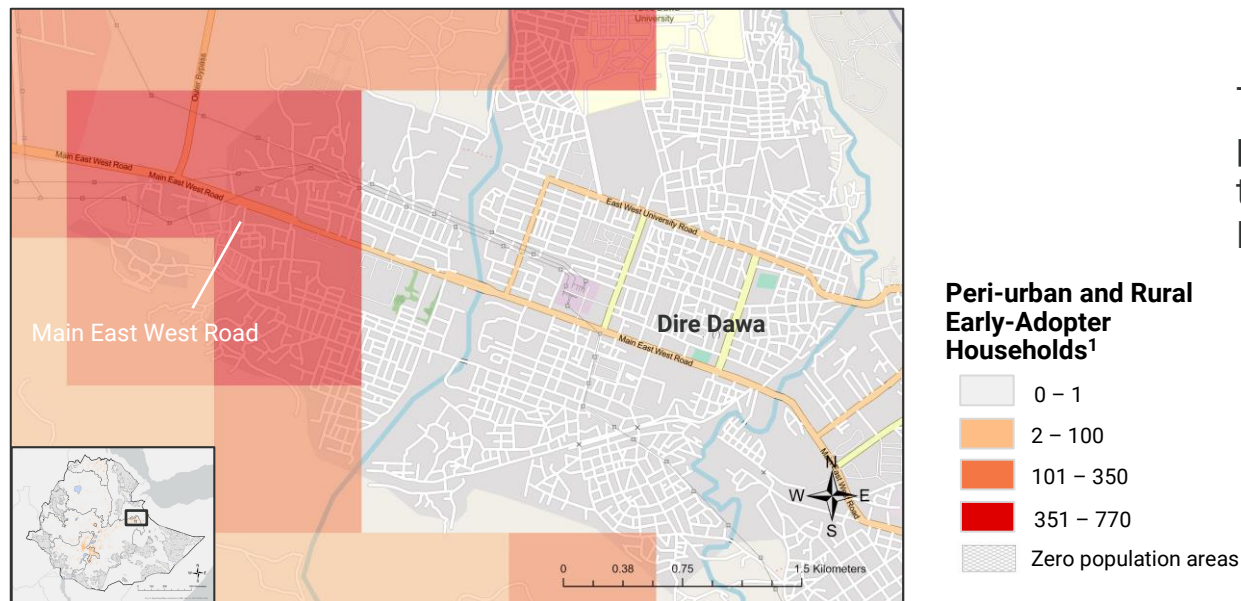
## Top Local Government Areas with Peri-urban and Rural Early-Adopters

Region	Woreda	Number of Peri-urban and Rural Early-Adopter Households
Dire Dawa	Dire Dawa	11,000
Oromia	Adama	3,000
Southern Nations	Arba Minch Zuria	3,000
Addis Ababa	Addis Ababa	3,000
Southern Nations	Awasa Town	3,000
Tigray	Enderta	3,000
Dire Dawa	Dire Dawa/Town	2,000
Oromia	Adami Tulu Jido Kombolcha	2,000
Somali	Jijiga	2,000
Amhara	Dessie Zuria	2,000



# Peri-urban and Rural Early-Adopters

Peri-urban and rural early-adopters are heavily concentrated in the western edges of Dire Dawa city.



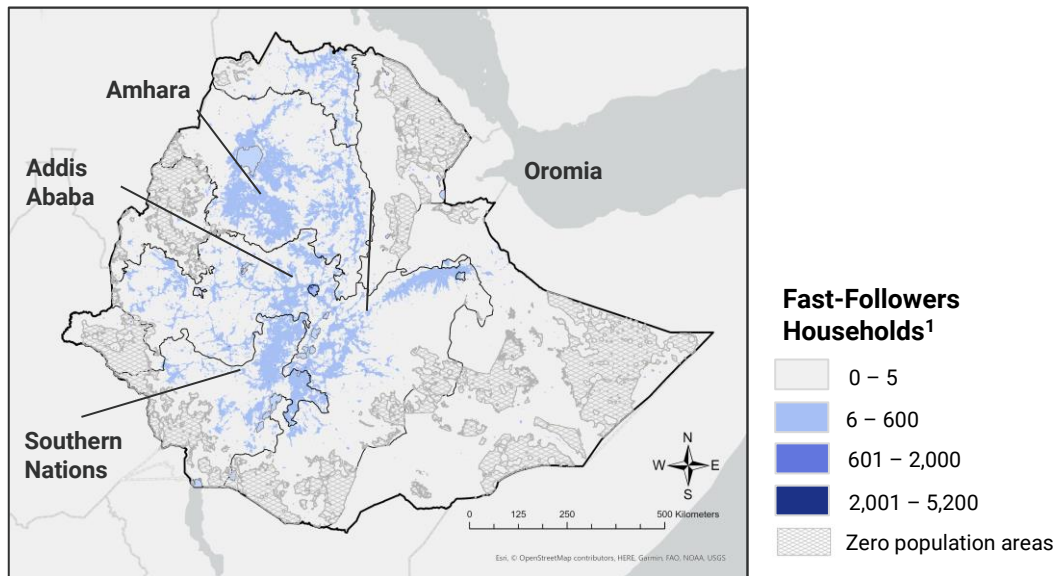
There is a high concentration of peri-urban early-adopters around the Main East West Road, outside Dire Dawa.

**Note 1:** This map shows the estimated number of peri-urban and rural early-adopter households per 1km<sup>2</sup>. Peri-urban and rural early-adopter households own at least one high-cost asset, have housing made of all high-quality material, have access to electricity, and live in suburban or peri-urban rural areas according to the EU Global Human Settlement Layer.

**Source:** Fraym, Ethiopia 2016 DHS

# Fast-Followers

There are roughly 4 million fast-follower households, representing around 21 percent of all households in Ethiopia. Addis Ababa, Oromia, Amhara, and the Southern Nations regions have the largest number of fast-follower households.



**Note 1:** This map shows the estimated number of fast-follower households per 1km<sup>2</sup>. Fast-follower households own at least one high-cost asset or have access to a bank account and have housing made of at least one high-quality material.

**Source:** Fraym, Ethiopia 2016 DHS

**4M** Fast-Follower households

**26%** of households are headed by a woman

**4.3** Average household size

**20%** of household heads have completed secondary education

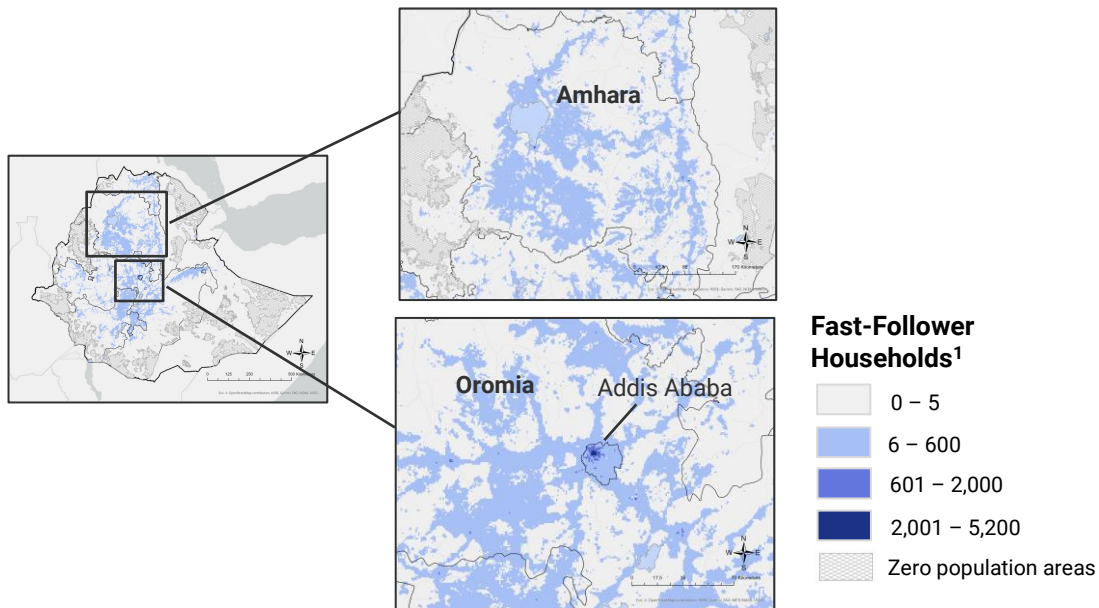
**66%** use wood as their primary cooking fuel

**25%** use charcoal as their primary cooking fuel



# Fast-Followers

About 70 percent of all fast-follower households live in either Oromia, Amhara, or Addis Ababa. In Addis Ababa, almost one third of all households are fast-followers.



**Note 1:** This map shows the estimated number of fast-follower households per 1km<sup>2</sup>. Fast-follower households own at least one high-cost asset or have access to a bank account and have housing made of at least one high-quality material.

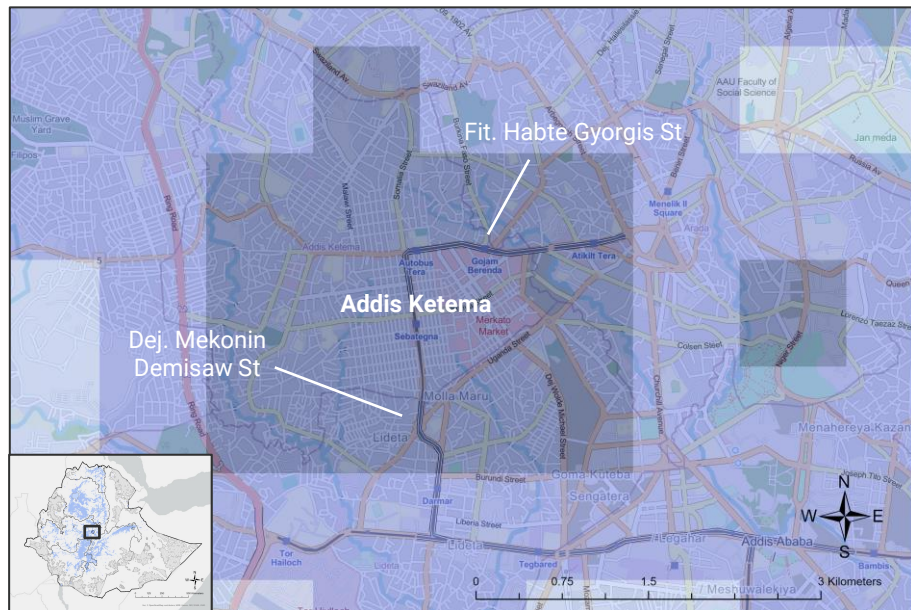
**Source:** Fraym, Ethiopia 2016 DHS

## Top Local Government Areas with Fast-followers

Region	Woreda	Number of Fast-Follower Households
Addis Ababa	Addis Ababa	240,000
Amhara	Bahirdar Zuria	40,000
Amhara	Gonder Zuria	40,000
Oromia	Shashemene Zuria	32,000
Oromia	Adama	32,000
Amhara	Dessie Zuria	30,000
Oromia	Ada'a	29,000
Amhara	Kalu	28,000
Southern Nations	Awasa Town	26,000
Oromia	Haro Maya	25,000

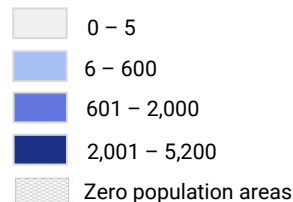
# Fast-Followers

There is a large concentration of fast-followers in the center of Addis Ababa, particularly in Addis Ketema.



Neighborhoods in Addis Ketema, especially to the west of Mercato market, have high concentrations of fast-followers.

## Fast-Followers Households<sup>2</sup>

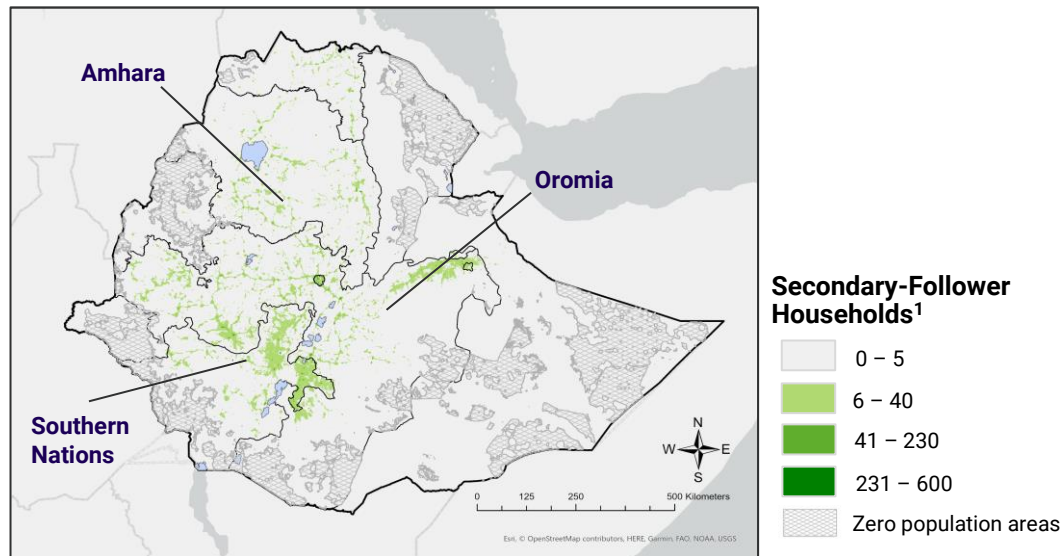


**Note 1:** This map shows the estimated number of fast-follower households per 1km<sup>2</sup>. Fast-follower households own at least one high-cost asset or have access to a bank account and have housing made of at least one high-quality material.

**Source:** Fraym, Ethiopia 2016 DHS

# Secondary-Followers

There are about 1.6 million secondary-follower households, representing about 8 percent of all households in Ethiopia. Secondary-follower households are more dispersed compared to other consumer segments.



**Note 1:** This map shows the estimated number of secondary-follower households per 1km<sup>2</sup>. Secondary-follower households own at least one high-cost asset or own a radio and have housing made of at least one high-quality material.

**Source:** Fraym, Ethiopia 2016 DHS

**1.6M** Secondary-Follower households

**17%** of households are headed by a woman

**5.1** Average household size

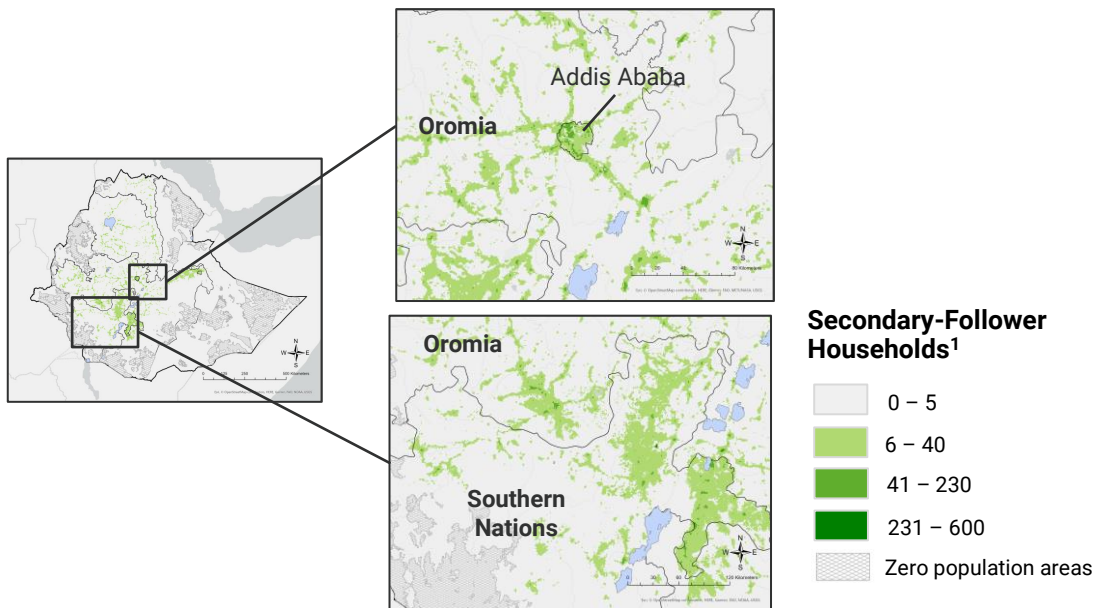
**3%** of household heads have completed secondary education

**83%** use wood as their primary cooking fuel

**6%** use charcoal as their primary cooking fuel

# Secondary-Followers

Almost 70 percent of all secondary-follower households live in either Oromia or the Southern Nations. Around 10 percent of all households in Oromia and the Southern Nations are secondary-followers.



**Note 1:** This map shows the estimated number of secondary-follower households per 1km<sup>2</sup>. Secondary-follower households own at least one high-cost asset or own a radio and have housing made of at least one high-quality material.

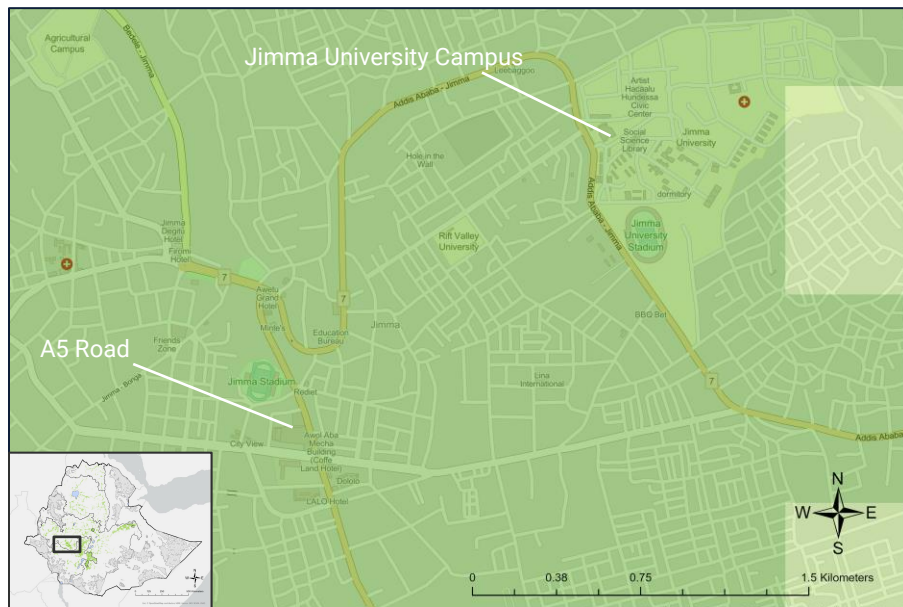
**Source:** Fraym, Ethiopia 2016 DHS

## Top LGAs with Secondary-followers

Region	Woreda	Number of Secondary-Follower Households
Addis Ababa	Addis Ababa	18,000
Oromia	Goma	11,000
Oromia	Kersa	9,000
Oromia	Dedo	9,000
Oromia	Shashemene Zuria	8,000
Oromia	Haro Maya	8,000
Amhara	Gonder Zuria	8,000
Oromia	Omo Nada	7,000
Oromia	Adama	7,000
Oromia	Seka Chekorsa	7,000

# Secondary-Followers

Secondary-follower households are common in towns in Oromia, such as Jimma. However, the highest concentration of these consumers can be found in the center of Addis Ababa.



Neighborhoods near Jimma University Campus and the A5 Road have a large concentration of secondary-followers.

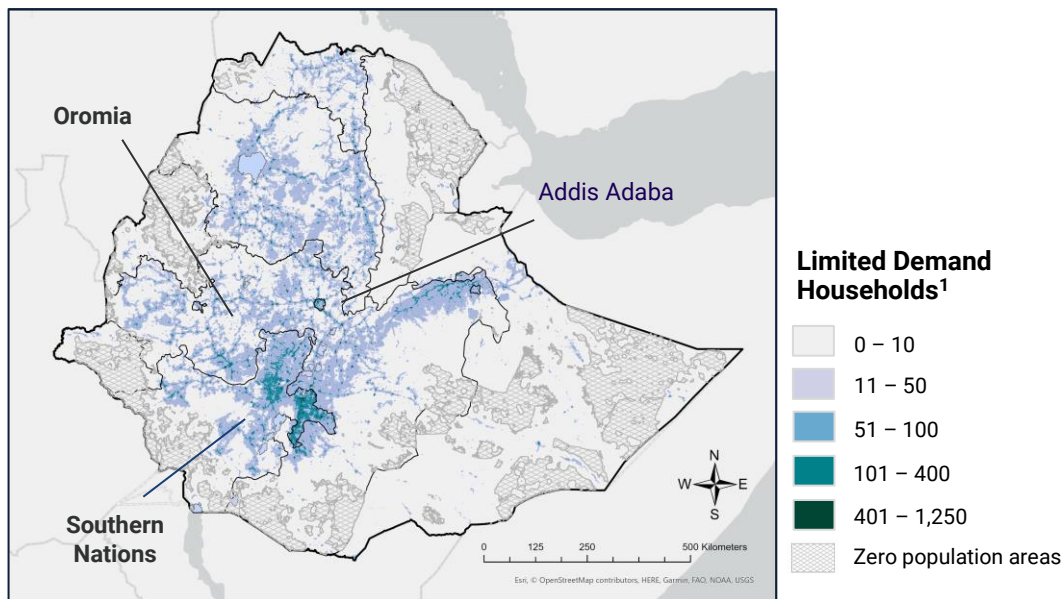
**Note 1:** This map shows the estimated number of secondary-follower households per 1km<sup>2</sup>. Secondary-follower households own at least one high-cost asset or own a radio and have housing made of at least one high-quality material.

**Source:** Fraym, Ethiopia 2016 DHS



# Limited Demand

Limited demand consumers are the most common out of all segments. There are around 12 million limited demand households, representing more than 60 percent of all households in Ethiopia.



**Note 1:** This map shows the estimated number of limited demand households per 1km<sup>2</sup>. Limited demand households do not fit any of the four core consumer profiles due to their limited consumption ability.

**Source:** Fraym, Ethiopia 2016 DHS

**12M** Limited Demand households

**27%** of households are headed by a woman

**4.7** Average household size

**1%** of household heads have completed secondary education

**86%** use wood as their primary cooking fuel

**3%** use charcoal as their primary cooking fuel

# 04

---

## Data Sources and Methodology



# Asset-Based Consumer Segmentation

---

**Improving upon previous studies of African consumers, Fraym fills two critical gaps by offering reliable market estimates and sub-national specificity. Consumer segments provide a useful framework for thinking about different markets for clean cooking technologies. The goal of this effort is to understand different levels of consumption power within each group of potential clean cooking fuel consumers.**

To understand the potential market for different types of clean cooking technologies, Fraym segmented households that primarily use solid cooking fuels into four groups. Instead of basing the profiles on consumers' income and spending, which can be susceptible to seasonal fluctuations, Fraym used a composite measure that classifies households based upon key characteristics such as asset ownership, household building material, and access to services. Each consumer segment only includes households not currently using clean cooking fuel, and each of these groups are mutually exclusive, with each household being classified into the highest tier for which it is eligible.

**Early-Adopter households** are those with high consumption power, as evidenced by their ownership of high-cost assets, access to electricity, and homes made from high-quality materials.<sup>1</sup> Early-Adopter households were segmented into two groups: *Urban Early-Adopter* and *Peri-urban and Rural Early-Adopter* households.

**Follower households** have moderate consumption power as evidenced by asset ownership, home construction material, and financial inclusion. Follower households were segmented into two groups: *Fast-Followers* are households with bank accounts suggesting some access to financial tools to facilitate larger purchases, and *Secondary-Followers* are households that own a radio, suggesting some discretionary spending power. Both groups can be found in both urban, peri-urban, and rural areas.

The remaining solid fuel cooking limited demand households were categorized into a limited demand profile, with very low consumption ability.

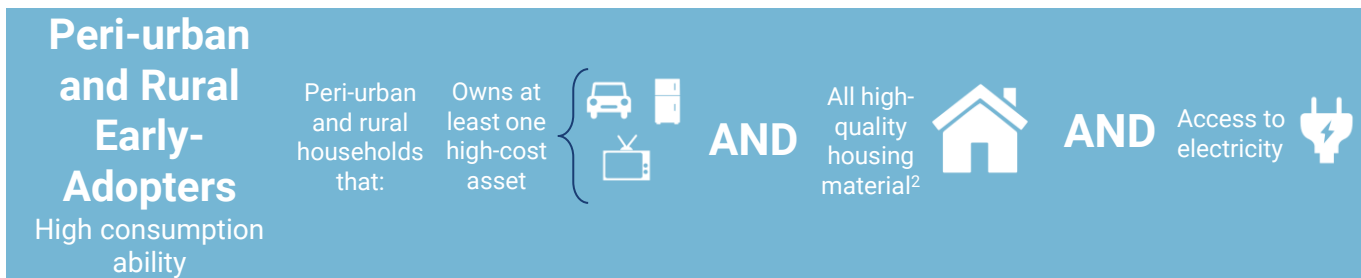
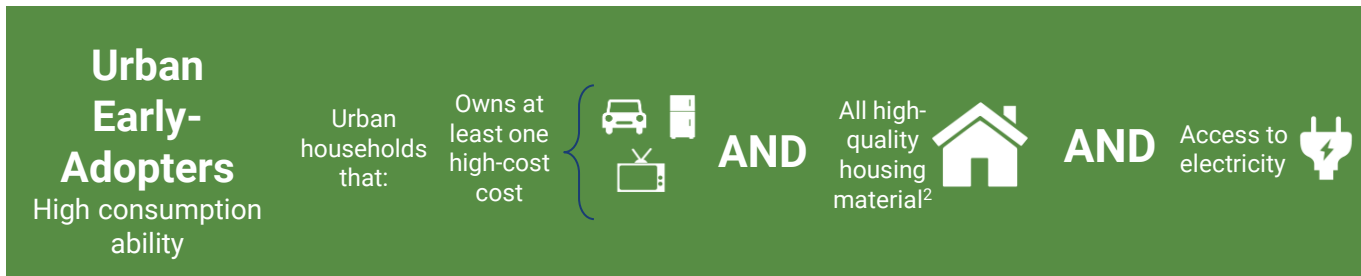
**Note 1:** High quality housing materials are defined as durable materials like concrete, metal, brick, or finished wood. All housing refers to the roof, wall, and floor.

**Source:** Fraym



# Identifying Early-Adopters

Fraym segmented solid cooking fuel households into early-adopter groups based on high-cost asset ownership, housing quality, and electricity access, which are all indicative of wealth. These households were then further segmented based on urbanicity into Urban and Peri-urban and Rural Early-Adopter households.<sup>1</sup>



**Note 1:** Urban areas were defined using the EU Global Human Settlement Layer (GHSL). Urban centers, dense urban clusters, and semi-dense urban clusters are classified as urban. Suburban or peri-urban and all rural areas are classified as peri-urban and rural.

**Note 2:** High quality housing materials are defined as durable materials like concrete, metal, brick, or finished wood. All housing refers to the roof, wall, and floor.

Source: Fraym

# Identifying Followers

**Fraym identified follower consumers from the remaining solid cooking fuel households as households with medium to moderate consumption ability, as suggested by some high-cost asset ownership and some high-quality housing materials. While predominantly rural, there are significant numbers of follow consumers in urban areas, especially among fast-follower households.**

## Fast-Followers

Medium-high  
consumption ability

Owens at least  
one high-cost  
asset

O  
R

Bank Account 

AND

Housing made of at least one high  
quality material<sup>1</sup>

## Secondary-Followers

Medium-low  
consumption ability

Owens at least  
one high-cost  
asset

O  
R

Owens a radio 

AND

Housing made of at least one high  
quality material<sup>1</sup>

**Note 1:** Urban areas were defined using the EU Global Human Settlement Layer (GHSL). Urban centers, dense urban clusters, and semi-dense urban clusters are classified as urban. Suburban or peri-urban and all rural areas are classified as peri-urban and rural.

**Note 2:** High quality housing materials are defined as durable materials like concrete, metal, brick, or finished wood. All housing refers to the roof, wall, and floor.

**Source:** Fraym

# Fraym Data

---

**The Fraym database combines satellite imagery and existing household surveys that are harmonized and re-weighted based on population data from third-party sources like multilateral and bilateral development actors, ensuring that indicators are comparable across countries and over time.**

For this study, indicators at the individual and household levels were sourced from the 2016 Ethiopia Demographic and Health Survey (DHS), the 2017 Financial Inclusion (Findex), and the 2016 Ethiopia Socioeconomic Survey (ESS). These surveys are designed to be nationally representative and use a stratified two-stage sample design. The 2016 DHS data were enumerated between January 2016 and June 2016, with a total sample size of 16,650 households. The Findex data were enumerated between May 2017 to June 2017, with a total sample size of 1,000 Individuals. ESS data were enumerated between September 2015 to May 2016, with a total sample size of 4,954. Energy usage data was also sourced from the Ethiopia - Multi-Tier Framework (MTF) Survey. The MTF data were enumerated between January 2017 to April 2017, with a total sample size of 4,317 households.

Fraym data scientists closely examine representativeness, sampling frames, questionnaire coverage, periodicity, and a range of other factors. Fraym obtains microdata, e.g. individual rows of responses of survey data, in order to avoid any manipulation that could potentially occur during the analysis phase. After data collection, Fraym creates post-hoc sampling weights to account for any oversampling and ensure survey representativeness. The weights and resulting population proportions were triangulated with independent, third-party sources, such as the UN Population Division and the World Bank's World Development Indicators.

Additionally, granular population distribution data comes from WorldPop, a publicly available and detailed population distribution and composition data source that leverages existing census data to produce 100m x 100m resolution estimates of population density. In order to build its datasets, WorldPop relies on census data as the main primary data input, and large geotagged household surveys when they are not available. In order to project into the future from the latest census of a given country, WorldPop uses subnational and urban rural growth rates that are reconciled with UN estimates. For this report, population estimates from 2020 were used.

# Fraym's Interpolation Process

---

**Fraym has built an artificial intelligence / machine learning (AI/ML) software that weaves together high-quality household survey data with satellite imagery to create localized population information (1 km<sup>2</sup>).**

The primary data input is data from existing high-quality, geo-tagged household surveys. Key indications of a high-quality household survey include implementing organization(s), sample design, sample size, and response rates. Fraym has collected, cleansed, and harmonized more than 1,000 of these surveys from around the world. Sample sizes are normally 10,000+ households with information for 50,000+ respondents. Response rates are very high, normally higher than 95 percent.

The second major data input is satellite imagery and related derived data products, including earth observation (EO) data, gridded population information i.e. human settlement mapping, and biophysical surfaces like soil characteristics. As with the survey data, Fraym data scientists ensure that the software only uses high-quality imagery inputs. Derived products are carefully assessed for model metrics, contextual checking, and pedigree within the geospatial data science community.

To create spatial layers from household survey data, Fraym leverages machine learning to predict an indicator of interest at a 1 square kilometer resolution. This methodology builds upon existing, tested methodologies for interpolation of spatial data. The resulting model is used to predict the survey data for all non-enumerated areas. A similar approach was pioneered by USAID's Demographic and Health Surveys program in 2015 and since improved upon by Fraym and others.<sup>1</sup>

Once the spatial layer is produced, Fraym performs a series of quality checks including the comparison of the spatial layer's output to the survey at its level of representativeness (national and/or first level administrative division). This survey mean is compared against the implied mean of the surface when all grids are appropriately aggregated through population weighted zonal statistics.

**Note 1:** Gething, Peter, Andy Tatem, Tom Bird, and Clara R. Burgert-Brucker. 2015. Creating Spatial Interpolation Surfaces with DHS Data DHS Spatial Analysis Reports No. 11. Rockville, Maryland, USA: ICF International. Other notable, relevant work includes: Weiss DJ, Lucas TCD, Nguyen M, et al. Mapping the global prevalence, incidence, and mortality of Plasmodium falciparum, 2000–17: a spatial and temporal modelling study. *Lancet* 2019; published online June 19. DOI: [10.1016/S0140-6736\(19\)31097-9](https://doi.org/10.1016/S0140-6736(19)31097-9) and Tatem A, Gething P, Pezzulo C, Weiss D, and Bhatt S. 2014. Final Report: Development of High-Resolution Gridded Poverty Surfaces. University of Southampton. <https://www.worldpop.org/resources/docs/pdf/Poverty-mapping-report.pdf>

**Source:** Fraym



---

**Marina Tolchinsky**  
**[m.tolchinsky@fraym.io](mailto:m.tolchinsky@fraym.io)**

Lead Analysts: Carlos Chua, Sean Walsh