MECS Modern Energy Cooking Services

Situational and Context Assessment: Ethiopia

Kitchen Lab Test : Ethiopia

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1 Overview

In Ethiopia, cooking with electricity in urban areas has been continuously increasing for the last ten years. The main driver for increased adoption of electric stoves is the relatively cheaper price of electricity compared to other cooking fuels. Until two years before, price of electricity remained unchanged since the last tariff revision made in 2006. In real terms, electricity was continuously getting cheaper. However, since December 2018 a four-year tariff revision plan has been introduced by the utility.

Even though increased adoption of electric cooking benefitted urban households in terms of cheaper cooking costs and access to clean cooking solutions, high power rating added to poor performance of the most widely used electric stoves, have made electric cooking contribute to the peak load demand in a significant scale.

The MECS project believes that promoting efficient and low power rating electric stoves would benefit both users and the electricity utility. The cost of cooking with efficient and low power rating e-cooking powered with off-grid solar PV systems (with mini-grids or stand-alone solar PV systems) would be competitive with cooking with charcoal in terms of Life Cycle Cost analysis. The objective of the Kitchen Lab Test is to compare the cost of cooking with different fuels and compare how low power and efficient e-cooking stands out in terms of cost saving, performance requirement and convenience.

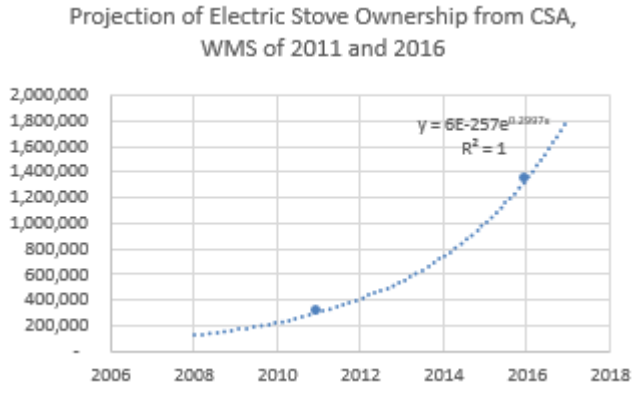
2 E-cooking in Ethiopia

Household Ownership of Electric Stoves

Estimates based on electric stove ownership growth trend from CSA and import data from ERCA indicates that in 2017 about 1.8 million households in Ethiopia own at least one electric stove (Table 1).

Table 1. Estimation of Electric Stove Ownership from CSA WMS for year 2008 to 2017

Year	Electric Stove Ownership	
	CSA/WMS	Projected
2008		122,774
2009		165,669
2010		223,551
2011	**301,656**	**301,656**
2012		407,049
2013		549,264
2014		741,167
2015		1,000,118
2016	**1,349,739**	**1,349,541**
2017		1,821,046



Following the increasing trend of electricity adoption in the last decade and the expansion of grid electricity, current ownership of electric stoves in Ethiopia could be over 2 million households (estimate).

3 Contribution of Electric Stove to the Peak Load Demand

The country context study and a rapid survey conducted in Addis Ababa in June 2020 highlight the following:

- About 1.8 million households owned electric stoves for cooking in 2017, which has risen rapidly since 2012. Similar trends are also experienced in other urban centres across Ethiopia.
- Survey result shows that 50%, 35%, and 40% of households cook at the same time each day, contributing to morning, midday, and evening peak demand respectively.
- Power ratings of most household stoves range from 1,000 to 1,500 Watt.
- Assuming an average power of 1000 Watt for electric stoves, the electricity demand from electric cooking is shown in Table 2.
- The peak load demand on the national grid in Addis Ababa alone is about 2,900 MW. This figure is quite significant given that the country's total installed capacity is around 4200 MW.

Table 2 Contribution of electric cooking by household to the peak electricity demand on the national grid

Peak Demand Hours	Morning peak (6-7AM)	Mid-day peak demand (11AM– 12PM)	Evening peak demand (6-7PM)
Peak demand on grid (MW)[1]	1800	2650	2900
Percentage of electric stoves used at peak demand[2]	50%	35%	40%
Power demand from electric cooking (MW)	900	630	720
Percentage of elec. stove contribution to peak demand	50%	24%	25%

1. *EEU, 2019*
2. *MECS Survey in Addis Ababa, 2020*

4 Kitchen Lab Test

The kitchen lab was carried out in a single location. The purpose of the kitchen lab was to

- Perform practical experiments of cooking typical Ethiopian cuisines with charcoal stoves, electric ring stoves, and Electric Pressure Cookers (EPCs). This allows a comparative study of the three stoves to prepare the most common types of food cooked in Ethiopia.
- Determine the performance of the stoves in terms of energy consumption, power requirements, and cooking time of common dishes.
- To evaluate the quality, performance, and safety of modern electric cookers to understand the potential for adoption and likely challenges in Ethiopia.

Stoves and fuels

Three types of stoves were tested with three types of food. The source of energy for the two stoves was electricity. The third stove was a charcoal stove (Table 3).

Table 3 Description of stoves and sources of energy used

Type of Stove	Energy Source	Rated Power (W) @220V
EPC	Electricity	1000
Electric Rings stove	Electricity	1440
Improved Charcoal Stove ("*Lakech*")	Charcoal	*1800

**Fire power for the improved charcoal stove was the highest power achieved during this test period*

Types of food cooked

Three types of food were cooked for testing the stoves. Recipes are in Annex 1, images are in Figure 1.

i. Shiro – powder made from roasted beans or chickpea is cooked into stew
ii. Lentil Stew – a stew made from lentils with onion and other spices
iii. Meat Stew – stew made from minced or chopped meat, onion, and other spices

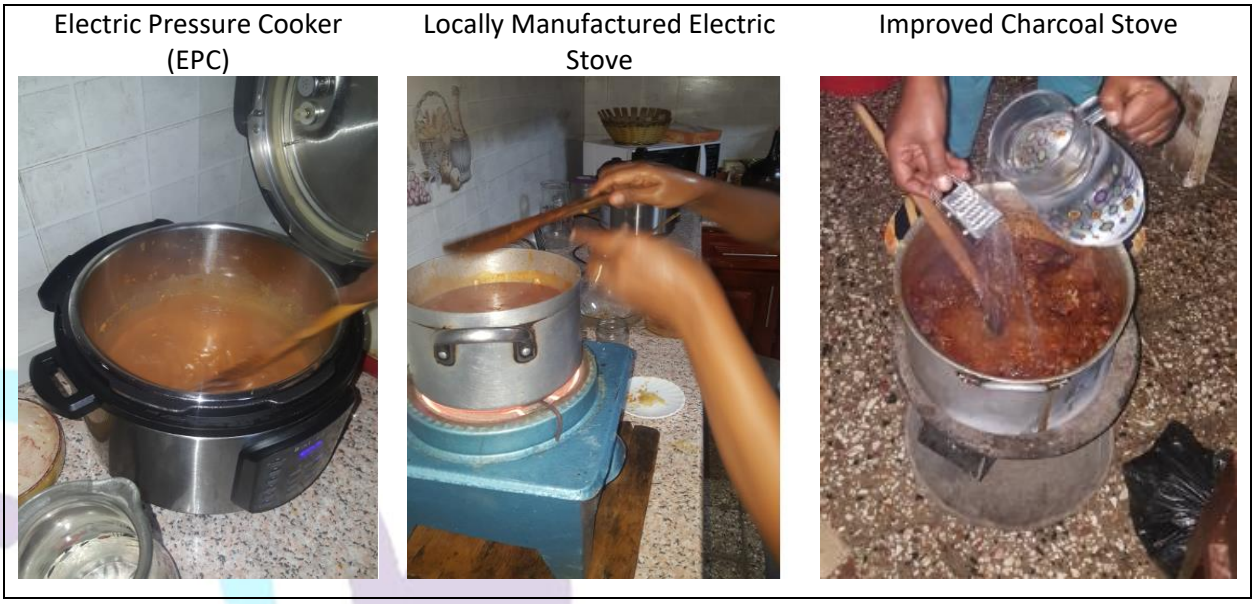


Figure 1 cooking same mean with different stoves

Note: More tests will be done with other common foods and cooking fuels.

Fuels and Prices

A rapid assessment of cooking fuel prices was conducted in June-July 2020 in Addis Ababa. The most widely used cooking fuels by urban households and their prices are listed in Table 4.

Table 4 Fuel Prices in Addis Ababa[1]

No.	Type of fuel	Purchase Unit	Price (ETB/Unit)
1	*Electricity	kWh	1.28
2	Liquid Petroleum Fuel (LPG)	kg	45.83
3	Kerosene	Litre	18.75
4	Ethanol	Litre	17.00
5	Charcoal (purchased in sack)	kg	12.07
6	Charcoal (plastic bag retail)	kg	16.40

**Electricity price considers tariff category for monthly consumption of 300kWh*

5 Findings of cooking tests

As shown in Figure 2, cooking with either locally available electricity or charcoal appliances in Ethiopia would normally require between 1,000 W to 1,500W power. This implies that if large numbers of households cook at the same time this would place significant pressure on the stability of the grid system itself.

Looking closely at the operating power of the three stoves, it is possible to observe that cooking with charcoal uses more power than electric stoves, followed by the local electric stoves. Some variations in the operating power to cook the different dishes were also observed, especially for charcoal. The EPC registered the lowest reading by a significant margin for each of the dishes, remaining in the range of 675 to 800W with shiro and meat stew at each end of these readings. One other interesting observation is that the EPC self regulates the power requirement depending on the type of food cooked.

The ability to cook with low power reduces the contribution of electric cooking on the peak power demand on the grid. For a country such as Ethiopia that has low generation capacity (4300 MW) for the size of its population (110 million), the widespread use of efficient cooking appliances can address multiple challenges.

Widely used electric stoves, imported or locally manufactured, are of low quality in terms of their durability and performance. The kitchen lab test shows that the EPC reduced energy consumption from 50% to 70% depending on the type of food cooked.

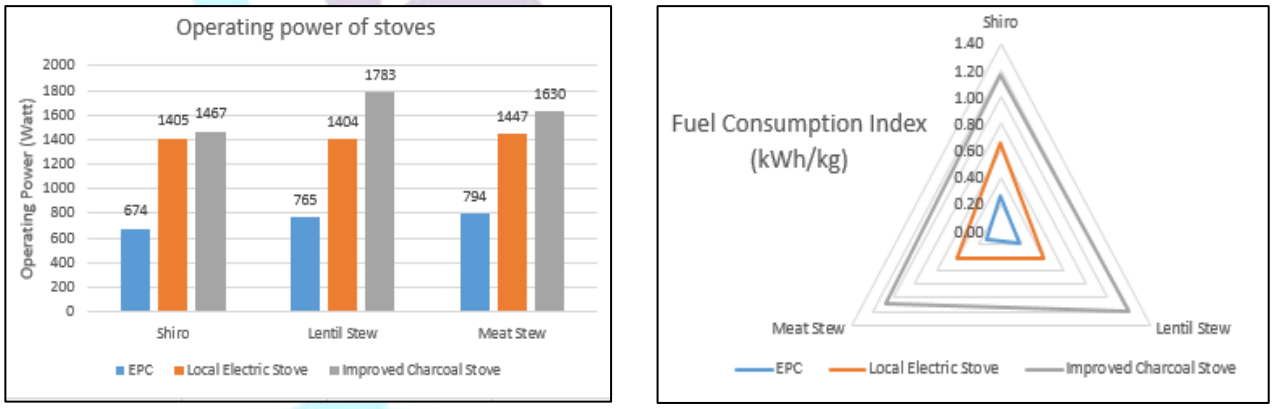


Figure 2. Operating power & fuel consumption Characteristics of stoves in Addis Ababa

[1] ERG, MECS Fuel price survey, Addis Ababa, July 2020

The reduction of energy consumption is related to the length of the cooking time. Most typical Ethiopian dishes require long periods of simmering and cooking, which also has energy implications. As illustrated in Figure 3, cooking times for shiro are lowest (32 to 58 minutes), followed by lentil stew (45 to 94 minutes) and meat stew (80 to 138 minutes). Cooking times using local electric stove were slightly lower than the EPC, with the charcoal stove needing significantly longer to cook all three dishes. The low power requirement and low energy consumption of the EPC, along with cooking times within the normal cooking time acceptable by the households, gives EPCs an edge on energy criteria over the other two options.

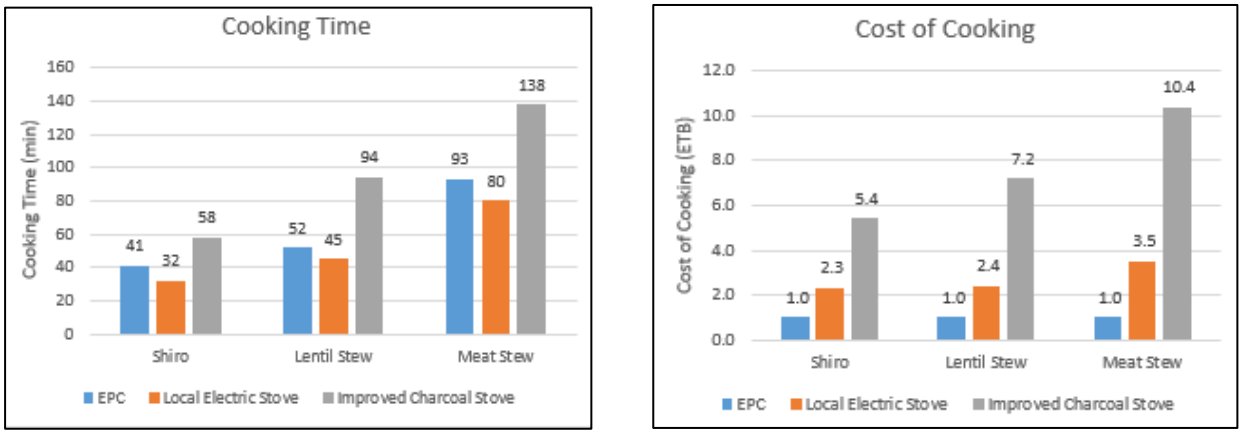


Figure 3 Cooking time and cost using different appliances

Figure 3 also shows the cost of cooking the three dishes, using the three cooking appliances. The EPC performed significantly better on the cost of cooking across the variety of dishes. Using the locally manufactured electric stoves and improved charcoal stoves, the cost of cooking was between 2.3 and 10.4 times more costly than using the EPC, with foods that take longer to cook consuming more energy and thus costing more money. The kitchen lab study shows that using an EPC on a regular basis in an average sized household could save ETB 1,000 a year with a payback time of less than 3 years.

6 Conclusions and recommendations

Cooking Tests were conducted with three different types of stoves and two types of cooking energy sources, electricity and charcoal. Preliminary results indicate that EPCs are not only energy efficient but are also able to cook with only half the power required by most widely used electric stoves in the households in Ethiopia. EPCs benefit both the households and the electricity utility by reducing the cost of cooking and the peak load demand. More tests will be carried out with additional fuels such as kerosene, LPG, and ethanol, cooking different types of widely cooked foods in Ethiopia to identify affordable and acceptable clean cooking options.

As the initial cost of acquiring an EPC is slightly higher than the widely used electric stoves, fiscal measures would be required to encourage wide scale adoption of the EPC. The EPC pays back in 3 years through the savings in reduced electricity consumption. With effective promotion, financing, and fiscal policy measures, it could be possible to make EPCs penetrate up to 50% of electric user households. This is equivalent to a reduction of up to 400MW from the peak load demand.

Annex 1: Recipe for Three Main Ethiopian Dishes

(i) Shiro

Dish 1: Shiro Wot with Injera / Injera is a flat, soft, and spongy bread made out of Teff. Wot is a sauce having different ingredients.

Ingredients	***Instructions***
No. / Ingredient / Weight (g) 1 Weight of water 1052 2 Shiro powder (chickpea or beans) 141 3 Onion 135 4 Oil 95 5 Chilly paper (powder) 21 6 Garlic Cloves 11 7 Salt 8 8 Ginger (Optional) --	1. In a standard pot, cook onions on medium heat for a few minutes until they begin to soften. 2. Add the oil and fry for few minutes. 3. Add tomatoes and salt and cook for 3-4 minutes. Add water continue to simmer. 4. Add red chili (red paper powder - *berbere*), garlic and small amount of water. Cook for 4-6 minutes 5. Start adding Shiro flour at a time while continuously stirring. (Shiro gets to be thicker). 6. Let it simmer for 15- 20 minutes. 7. Add small amount of water until desired thickness is reached while stirring for 1-2 minutes. 8. Add the garlic, stir well for additional 2 minutes until bubbles appear. 9. Finally, ready to be served with injera on the side. •
***Cooking Time**: 25-30 Minutes / **Serving:** 4-6 people*	

(ii) Lentil Stew

Dish 2: Misir Wot with Injera / Injera is a flat, soft, and spongy bread made from Teff. Wot is a sauce having different ingredients.

Ingredients

No.	Ingredient	Weight (g)
1	Weight of water	1512
2	Lentil (pealed and crashed)	372
3	Onion	162
4	Oil	150
5	Chilly paper (powder)	76
6	Garlic Cloves	8
7	Salt	11
8	Ginger (Optional)	34

Instructions

1. In a standard pot, cook onions on medium heat for several minutes until they begin to soften.
2. Add the oil or Butter and cook for few minutes.
3. Add tomatoes and salt and cook for 3-4 minutes
4. Add red chili (red paper powder - *berbere*), garlic and small amount of water. Cook for 4-6 minutes.
5. Add Misir, let it cook for 20- 25 minutes.
6. Add small amount of water until desired thickness is reached while stirring and let it cook for additional 8-12 minutes.
7. Finally, ready to be served with injera on the side.

***Cooking Time**: 45-50 Minutes / **Serving:** 4-6 people*

(iii) Meat Stew

Dish 2: Misir Wot with Injera / Injera is a flat, soft, and spongy bread made from Teff. Wot is a sauce having different ingredients. **/**

Ingredients

No.	Ingredient	Weight (g)
1	Weight of water	1507
2	Chopped meet or minced meat	1141
3	Onion	1391
4	Oil	315
5	Chilly paper (powder)	203
6	Garlic Cloves	11
7	Salt	40
8	Ginger (Optional)	34

Instructions

1. In a standard pot, cook onions on medium heat for several minutes until they begin to soften.
2. Add the oil or Butter and cook for few minutes.
3. Add tomatoes and salt and cook for 3-4 minutes
4. Add red chili (red paper powder - *berbere*), garlic and small amount of water. Cook for 4- 6 minutes.
5. Add Misir, let it cook for 20- 25 minutes.
6. Add small amount of water until desired thickness is reached while stirring and let it cook for additional 8-12 minutes.
7. Finally, ready to be served with injera on the side.

***Cooking Time**: 45-50 Minutes / **Serving:** 4-6 people*

Annex 2- Summary of Kitchen Lab Test Result

i. Performances of stoves

i) Cooking Shiro

Parameters	Type of stove		
	EPC	Electric Ring Stove	Improved Charcoal
Fuel Consumption (kWh, kg)	0.308	0.717	0.176
Ethiopian Birr (ETB)	0.39	0.91	2.12
Time (min)	41	32	58
Maximum Power (W)	674	1405	1467
Power reduction	52%		
Annual Saving (ETB)	571.02		

ii) Cooking Lentil Stew

Parameters	Type of stove		
	EPC	Electric Ring Stove	Improved Charcoal
Fuel Consumption (kWh, kg)	0.417	1.001	0.317
Ethiopian Birr (ETB)	0.53	1.28	3.83
Time (min)	52	45	94
Power (W)	793.5	1,447	1630
Power reduction	46%		
Annual Saving (ETB)	1625.09		

iii) Cooking Meat Stew

Parameters	Type of stove		
	EPC	Electric Ring Stove	Improved Charcoal
Fuel Consumption (kWh, kg)	0.464	1.628	0.509
Ethiopian Birr (ETB)	0.59	2.08	6.14
Time (min)	93	80	138
Power (W)	765.1	1404	1783
Power reduction	45%		
Annual Saving (ETB)	815.34		

iv) Cost of Cooking

Type of Stove	Energy Source	Type of Food		
		Shiro	Lentil Stew	Meat Stew
EPC	Electricity	0.393	0.532	0.592
Electric Rings stove	Electricity	0.91	1.28	2.08
Improved Charcoal Stove	Charcoal	2.12	3.83	6.14

v) Cost Saving

Type of Stove	Energy Source	Type of Food		
		Shiro	Lentil Stew	Meat Stew
EPC	Electricity	0%	0%	0%
Electric Rings stove	Electricity	133%	140%	251%
Improved Charcoal Stove	Charcoal	441%	620%	938%

a) Cooking Shiro

Parameters	Type of stove		
	EPC	Electric Ring Stove	Improved Charcoal
Fuel Consumption (kWh)	0.308	0.717	1.418
Ethiopian Birr (ETB)	0.39	0.91	2.12
Time (min)	41	32	58
Maximum Power (W)	674	1405	1467
Power reduction	52%		
Annual Saving (ETB)	571.02		

b) Cooking Meat Stew

Parameters	Type of stove		
	EPC	Electric Ring Stove	Improved Charcoal
Fuel Consumption (kWh)	0.464	1.628	4.100
Ethiopian Birr (ETB)	0.59	2.08	6.14
Time (min)	93	80	138
Power (W)	765.1	1404	1783
Power reduction	46%		
Annual Saving (ETB)	1625.09		

c) Cooking Lentil Stew

Parameters	Type of stove		
	EPC	Local Electric Stove	Improved Charcoal
Fuel Consumption (kWh)	0.417	1.001	2.554
Ethiopian Birr (ETB)	0.53	1.28	3.83
Time (min)	52	45	94
Power (W)	793.5	1,447	1630
Power reduction	45%		
Annual Saving (ETB)	815.34		