eCook Bangladesh:

Cooking Diary and Appliance Testing

M. Rezwan Khan
Professor, Dept. of EEE
United International University, Dhaka, Bangladesh

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Executive Summary

Cooking by electricity is still not a popular option in Bangladesh. The main reasons are – i) the general feeling that cooking by electricity will be more expensive compared to natural gas, LPG or firewood; ii) access to electricity was very limited even 5 years back; and iii) lack of reliability of power supply due to load shedding gives a negative impression about electric cooking. It is an accepted fact that the usual concept of electric cooking is an energy intensive process and a high electricity bill at the end of the month is not an unfounded assumption. Most of the household electric cooking appliances have a power rating ranging from 700W to 2500W and most of the general-purpose cooking appliances, like hotplate, induction cooker or infrared cookers, have a power rating ranging from 1500W to 2200W. However, specialized cooking appliances like rice cookers, multi-cookers, curry cookers or electric pressure cookers (EPC) have a lower power rating like 700W-1200W but has the limitation while frying food items. All these facts make the electric cooking more challenging compared to gas or firewood stoves as these are general purpose cookers. Recent research shows that efficiency of electric cooking may easily go as high as 90%, as loss reduction in electric cooking is relatively a simpler task. On the other hand, achieving an efficiency close to 40% is a real challenge for household cooking using gas, biomass or firewood. The main reason is the requirement of fresh air for renewed oxygen supply which carries away a significant part of the combustion energy in the form of hot exhaust. With increased awareness, it is being gradually understood that electric cooking is the most efficient way of cooking with almost zero emission of unwanted gas or heat in the kitchen environment. However, we must keep in mind that electric cooking is effectively not a zero-emission process as the generation of electricity at the power stations do emit greenhouse gases. As increasing percentage of renewable resources are being added to the power system, the actual greenhouse gas emission corresponding to any electricity consumption is gradually reducing.

As already mentioned, electric cooking is still not a popular option and availability of electric cooking appliances in the market are mainly limited to the urban areas. With the expansion of national grid (its present level of access is close to 95%, as claimed by the government agencies), people are getting used to electric appliances and the single most popular electric cooking appliance is the rice cooker/multi-cooker. As far the cost of the appliances is concerned, there are a number of local manufactured brands assembling the appliances from Semi Knock Down (SKD) or Complete Knock Down (CKD) spare parts. Although the prices are within affordable range, their workmanship, quality and performance are not beyond questionable doubts. The thermostat is the single most vulnerable component in these appliances. Besides the rice cooker/multi-cooker, local manufacturers are also assembling induction cooker, infrared cooker, hotplate and electric pressure cooker. Induction cooker, infrared cooker or electric pressure cooker is not yet a widely available item as very few people have the awareness on these appliances. The international brands are also available in the city areas, but they have low popularity due to their high price.

The following appliances were tested in the lab for the quality of workmanship and cooking performance:

a) Hotplate
b) Rice cooker/Multi-cooker
c) Curry cooker
d) Induction cooker
e) Infrared cooker

f) Electric pressure cooker

The water boiling and cooking performance tests show that different brand of appliances of the same category perform with similar cooking efficacy, but local brands showed more problems with premature activation of the thermostats after using for some time. None of the appliances we tested, irrespective of local or international make, provided extra insulation for heat loss reduction. Of all the appliances we studied, the induction cooker seems to have the best energy transfer performance to the cooking pan, as the pan is directly heated by eddy current from the heating element. The actual power consumption in an induction cooker is really low, when the pan is removed from the cooker. In case of an infrared cooker, the heating is done by radiation from the heating element and it heats up the body structure of the cooking appliance. Significant energy loss takes place from the radiating heating element due to scattering in the surroundings. However, induction cooker pans are sometimes over heated resulting in energy loss due to convection and radiation, which can be reduced significantly if insulated cooking pans are used. Although the rice cooker, multi-cooker, curry cooker or electric pressure cooker also have conductive heat transfer process, the cooking pans are inside their outer frame which reduces heat loss. The pressure cooker, as expected, has the best cooking performance, as the pressurized cooking pan get a water boiling temperature much higher than 100°C (125-130°C). Additionally, an electric pressure cooker can be used as a regular cooking appliance by keeping the lid open. However, such an operation, as per our experience is not a very convenient or efficient one and is likely to be not very popular.

Limited field level data obtained from Jaldhaka (a rural area situated 300km north of capital city Dhaka), when compared to the cooking energy data obtained from the lab, indicates that awareness on energy efficiency and training on the efficient and safe use of the appliances is important. In the field, energy consumed for the similar type and amount of food consumed close to 25% more energy than that in the lab. Amount of water needed, time of cooking and power setting of the cookers are also important elements in efficient cooking.

When energy efficiency is a very important issue (to reduce energy cost) to popularize electric cooking in Bangladesh, understanding science of cooking can help in a significant way. There can always be a debate regarding the temperature at which the cooking starts. Conventionally, we cook with water and it is a general notion that we need to reach 100°C (the boiling temperature of water) to cook food. But scientifically, cooking is the decay process of the biological cells due to heating and it can start from 60°C (70°C is the temperature we use for pasteurization). So, boiling temperature is not a necessary temperature for cooking. Cooking process is faster if the temperature is higher. Frying is altogether a different cooking process where high temperature cooking oil is used giving the food a very different crunchy texture. However, frying is a very energy intensive process and requires relatively higher amount of energy. In the lab, we performed experiments to see how the cooking power affects the overall consumption of cooking energy. Using the same appliance and same amount of food, it was observed that lower cooking power takes longer time but consumes less energy. The two main reasons for such a phenomenon are reduction in loss through the escaping steam from the cooking pan after food starts boiling and significant time the food gets to precook when the temperature gradually rises from 60 to 100°C. It is possible to reduce the cooking energy by more than 30% if slow cooking is adopted without any additional loss reduction mechanism. The experimental results also show that when the same appliance and same power is used, cooking of higher amount of food in a particular pan requires less energy per kg of food cooked.

Cooking with LPG gas cylinders show that cooking energy required for similar amounts of food is nearly twice as much when compared to the energy required in electric cooking. However, there is always an argument that generation of electricity from heat also incurred losses of similar order in the power stations, so such a loss figure for LPG is not really too bad. However, incorporation of renewable energy resources in the grid electricity will reduce overall carbon emission and electric cooking will prove to be emitting less GHG compared to LPG or natural gas cooking.

A financial analysis shows that the cost of electric cooking for a family of 6 persons in Bangladesh is around to BDT 600 (GBP 5.45) per month whereas the LPG and firewood-based cooking costs BDT 800 (GBP 7.27) per month. Cooking with efficient electric cooking appliances and adopting slow cooking in appropriate situations, we can reduce the electricity cost by 25%, which we find very encouraging in promoting electric cooking in a country like Bangladesh or other developing countries. Some recent research funded by MECS show that it is possible to achieve low-cost integration of the solar Photovoltaic (PV) in the households that can reduce the monthly cost to BDT 350 (GBP 3.25). This will encourage the rapid uptake of electric cooking and at the same time improve the renewable share in the power generation.

In conclusion, the transition to cooking with electricity could be accelerated if the following issues are addressed:

i) Build awareness amongst the users regarding the cost and improved kitchen hygiene benefits of electric cooking.
ii) Proper training of how to use the electric appliances safely and efficiently is also an important issue.
iii) Integration of roof top solar PV in the electric cooking for energy cost reduction that can reduce energy cost.
iv) Recent expansion of national grid and installed capacity of generation will have a negative economic impact on the power generation companies if the consumption of electricity does not increase within a short period of time. Encouraging electric cooking could be a two-way solution for increased power consumption and at the same time provide access to clean cooking for the households and move a step forward in achieving SDG 7.

A more difficult issue to address is the high rate of load shedding/power failures due to overloading of the distribution lines (particularly in summer season) that will have a negative impact on the confidence of the general population to adopt electric cooking. So, it will be important to get policy level intervention and we expect that the situation on the distribution side will improve significantly within short period of time as more new distribution lines are being installed to avoid overloading of the distribution lines.

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1. Introduction

Cooking in Bangladesh still predominantly use biomass for cooking, particularly in the rural areas. Almost 74% of the total population still rely on biomass for cooking and the cook stoves used are three stone stoves that usually have an efficiency of 12-15% [1]. Gas is mostly used in the urban or per-urban areas and nearly 24% of the population rely on gas cooking. Only 1% of the population, including rural and urban, use electric cooking [2]. So far the efficiency of the cooking stoves is concerned, we find different efficiency values in the literature. Efficiency of biomass based improved cookstoves, gas stoves and the electric cooking appliances vary within 25-35%, 30-40% [3] and 60-90% respectively [4]. Efficiency of the cookstoves is important as they give us an idea about GHG emission related to the cooking energy and also the cost. Biomass based cookstoves are the worst as far as GHG emissions and kitchen hygiene are concerned. Respiratory and vision-related ailments are quite common with the people who use biomass-based cooking stove. In case of gas burners, it is far cleaner, produces less GHG and kitchen hygiene is significantly better. But there is still some issue of carbon monoxide (toxic gas) emission inside the kitchen [5]. Electric cooking is the best energy source for cooking where kitchen hygiene and kitchen working environment is concerned. However, there is a debate on the generation of GHG at the power stations where heat energy is converted to electricity and that electricity is reconverted to heat once again while cooking in electricity. No doubt it is a very relevant question to be raised and one needs to get deeper into the energy conversion efficiencies involved in the process to get the correct picture. The large sized electrical generators usually have a high energy conversion efficiency, the lower values are close to 45% and the higher ones with combined cycle can be higher than 60% [6]. Taking a conservative figure of 45% and assuming an average electrical efficiency of the cookstoves to be 85%, we effectively get an overall efficiency of 0.45x0.85 which comes out to be 38.25%. This is quite high when compared to biomass-based cooking and is comparable to the gas-based cooking. With the development of RE technologies like solar PV or wind power, most of the power systems across the world are going to incorporate higher percentage of RE power reducing the percentage share of the conventional fossil fuels. Even if we consider a 20% renewable share in the power system, the actual GHG emission from electric cooking will reduce by 20% and that will make it much cleaner and environmentally friendly compared to gas cooking. Moreover, there is always an opportunity to use roof top solar to be incorporated with electric cooking to get more than 50% of the cooking energy from the roof top PV [7]. As PV energy is getting cheaper than the grid electricity, it will make the cooking energy cost lower and at the same time can have a positive impact on the overall GHG emission.

1.1. Barriers to uptake of electric cooking

As far as the expansion of the electric cooking in Bangladesh is concerned, the challenge comes from two different angles.

i) **Policy level where electric cooking is not encouraged**: It is the common notion at the policy maker level that electric cooking may overload the existing power lines and may require more power generation. So, significant capital investment may be required if electric cooking is encouraged at the policy level.

ii) **Cost of cooking energy**: We find that it is possible to reduce the electricity consumption if energy efficiency measures are adopted in the cooking process. In other words, awareness building and training on electric cooking can make a significant difference in the energy consumption pattern reducing the energy cost. So, in electric cooking there is

ample opportunity to improve the cooking efficiency and reduce energy consumption to a level such that electric cooking would not be a concern for the power generation and distribution systems. In the last few years, there have been rapid growth in the power generation [8] and also in the distribution line (access to electricity has reached more than 90%). Now there is a concern that there may be a surplus generation capacity which may become a threat to the economic power generation as surplus generation capacity will increase overhead cost. So, a rapid growth in the electric cooking may be beneficial for the power generation companies.

In this study, we mainly concentrated on the collection and analysis of cooking energy data for common types of Bangladeshi foods, both in the lab and in the field, and then made a comparison on how much energy reduction is possible if cooking is done more scientifically. We also made a limited market survey to understand the availability of the electric cooking appliances, their price and the product quality. Post project feedback from the field users were taken to understand their thinking on electric cooking. A financial analysis is done to estimate monthly energy cost for the users of electric cooking appliances and possible barriers that may hinder the 'frog leap' growth of electric cooking.

2. Objective

Electric cooking is not yet very popular in most of the under-developed or the developing countries. The main reasons include limited access to electricity, cost of electric cooking and lack of awareness.

Modern Energy Cooking Services (MECS) funded this project to get first-hand information about the status of electric cooking and the prospects and problems in popularizing electric cooking as a viable clean cooking solution in Bangladesh. The specific objectives of the project were:

a) Market survey on the availability of the electric cooking appliances
b) Testing the performed of gas cylinder-based cooking, hot plate, induction cooker, rice cooker and electric pressure cookers
c) Tests will include the performance evaluation regarding efficiency, safety and workmanship
d) Four or 5 popular brands of cooking appliances to be selected for cooking performance testing in the lab
e) Collection of energy data from lab testing for cooking rice, vegetable (like potato), chickpeas and a few other traditional foods commonly taken by the Bangladeshi people. In each case data on energy consumption and time of cooking will be taken. Gas consumption while cooking with gas cookers will also be estimated
f) Collection of field data on cooking from 30 different households in 6 different districts in Bangladesh
g) A comparative analysis will be made by compiling the data in the final report.

The whole task was divided into two segments. First segment was undertaken by United International University to perform the tasks mentioned in c), d), e) and g) with limited market survey and field level data collection from 3 households in Jaldhaka situated in the north of Bangladesh. A full-scale market survey is to be conducted by Practical Action Bangladesh as described in a) and

also the tasks described in e) and f). As the project progresses, two seminars/workshops are to be organized to get feedback from the experts, the policy makers and the manufacturers or importers of the cooking appliances. The feedback from the workshops is also to be included in the final report.

3. Methodology

The methodology adopted in achieving the corresponding objective is given below.

a) Limited market survey for the electric cooking appliance

Our limited market survey was limited to 5 categories of cooking appliances namely hotplate, rice/multi-cooker, curry cooker, induction cooker, infrared cooker and electric pressure cooker. As a first step of the project, we surveyed different stores located in different areas of Dhaka city to have a first-hand idea about the availability of the electric cooking appliances and collect data on the brand, country of origin, size, power consumption and price of the appliances. We talked with the salespersons of the store to get an idea about the popularity of the appliances from their sales volume. For our project, we mostly procured more popular brand appliances and tested their performance in the lab.

b) Quality assessment of the products available in the market

The appliances selected for the lab tests were first physically observed for the sturdiness. Then the appliance connections were checked to see if proper heating insulations are provided for the connections inside the appliance. We also checked for the heat insulation layer inside the appliance, which is important for energy efficient operation. As a first step of energy efficiency test, we performed the water boiling test by putting 1kg of water at room temperature and then bring it to the boiling temperature. The time required and the amount of energy consumed was noted. We also noted the temperature at the external surfaces of the appliance to get an idea about the losses from the appliance surface and effectiveness of the insulation between the heating element and the appliance surface.

c) Energy needs for cooking of different common Bangladeshi dishes

The types of food cooked in any specific culture or geographical location may have some common elements, but the actual cooking process has its own variations depending upon the individual taste and choice. In our lab, we cooked the most common types of foods of Bangladesh in different appliances and collected the relevant cooking data. We also noted the difficulty of cooking any particular type of food in any particular appliance. It is a common understanding that cooking is an energy intensive process and the power requirement for cooking is quite high. This prompted us to see the effect of power variation on the actual energy consumption for a particular food item. We also looked into the variation of energy consumption when varying amounts of any particular food is cooked in the same appliance. Besides electric cooking, we also collected cooking data for LPG to make a comparison with electric cooking.

d) Limited field level data collection

Jaldhaka, a rural area in the northern part of Bangladesh was chosen to obtain limited field level data to compare with the lab cooking data. Three households were chosen and a person with technical background was employed to give the technical support like installing the energy meters,

training the users to read the energy data from the meter, cooking data entry process, safety issues in different electric cooking appliances etc. At the end of the project, data was collected from the users to understand their feeling about electric cooking, the difficulties faced, affordability of the energy cost, advantages and disadvantages in comparison to their existing cooking stoves etc.

e) Data analysis

The data analysis was done from two different angles – one is from the *energy consumption* point of view and the other is from *financial implication* point of view. The energy data analysis takes into account the possible variations in the energy consumption from appliance to appliance, and also possible energy saving when cooking is done more scientifically.

Based on the collected data we estimated the monthly cost of energy for electric cooking for a family of 6 members and compared it with the cost when using firewood or LPG. The financial implication for a consumer if she/he wants to switch from biomass or LPG based cooking was also analysed. Field data was collected to understand the financial capability of the rural users to judge possibility of rapid penetration of electric cooking appliances in the Bangladesh market.

f) Prospects and problems of e-cooking in the context of Bangladesh

Lesson learnt from the lab and field data, the prevailing kitchen condition in the rural areas, present power generation scenario in Bangladesh and other relevant issue were analysed to understand the prospects and problems in popularizing electric cooking in Bangladesh.

4. Limited Market Survey of the available appliances

The available electric cooking appliances in the Bangladeshi market include hotplates, induction cookers, infrared cookers, rice/multi cookers, curry cookers, electric pressure cookers, etc. Rice/Multi cooker is the more popular item as rice is the most common food item. But compared to the conventional biomass cooking, electric cooking still holds a very small share of the total number of cooking appliances. In the urban areas, people mostly use either natural gas from the national gas grid or LPG (Liquified Petroleum Gas) cylinders for cooking. It is still a prevalent idea that electric cooking will be more expensive and people either stick to gas-based cooking or biomass-based cooking. On the other hand, utilities have the notion that electric cooking may increase the electricity consumption to a level that may overload the electric distribution system.

While making a limited scale survey of the electric cooking appliances, we found that most of the appliances of their components are imported from China. Even the locally manufactured brands also import the basic components from China and assemble them locally putting a local brand name. The price of the brand products (internationally accepted brands) is much higher compared to the local or the Chinese products and have not gained popular access in the market. We found some of the imported brand products like ‘Prestige’ an ‘Sharp’ at competitive prices, but it was not possible for us to ascertain whether the products were genuinely of original quality or counterfeit. Our survey team went to different shops in different parts of the Dhaka city and interviewed the shop keepers about the sale and the usual feedback of the customers. It was a qualitative survey and no numerical data was collected. The findings of our limited market survey are given below in Table 1.

Table 1 Market data on the available cooking appliances

Appliance	Availability	Price range, GBP	
Hotplates	Available, but not widely used for cooking. These are more used in shoe making factories.	9-13	
Rice/Multi cooker	Available and has the highest penetration in the market compared to other electric cooking appliances	25-35	
Curry Cooker	Availability is limited and is not popular yet.	20-30	
Induction cooker	Available but still not very popular as they require special cooking pans.	25-40	
Infrared cooker	Available, but it is getting more popular compared to the induction cooker as no special pans are required	25-40	
Electric pressure cooker	Availability is limited and not very popular yet as there is a lack of awareness. The price range varies by a large margin as some of the electric pressure cookers have more control options on the panel.	50-80	

5. Laboratory test of the cooking appliances

In assessing the manufacturing quality of the appliances we looked into the constructional features like sturdiness of physical construction, insulation, workmanship etc. The observations are given in the Table 2.

Table 2 Preliminary observations on the appliances used in the lab.

Appliance brand, model, and rating	**Sturdiness, Electric connection quality, Insulation**	**Comments**
Walton Rice Cooker (CGA180), 1.8L, 220V, 700W Assembled/made in Bangladesh	The body is made of steel but thickness is small. Does not look very strong. The wire connections are good, they are covered with heat resistant electric insulators. There is a fuse of rating 10A. Besides, there is a thermostat to prevent overheating which operates when the cooking pan surface temperature reaches 115-120°C There is no insulation in between the inner cooking pot and the outer frame other than a small air gap.	
Vision Rice Cooker (SS-40-06), 1.8L, 220V, 700W Assembled/made in Bangladesh	The body is made of steel. Build quality is quite good. The body looks heavy and strong. The wire connections are good, they are covered with heat resistant electric insulators. There is a fuse of rating 15A. There is a thermostat to prevent overheating which operates when the cooking pan surface temperature reaches 115-120°C. There is no insulation in between the inner cooking pot and the outer frame other than a small air gap.	
Panasonic Rice Cooker (SR-JN185) 1.8L, 220V, 650W	The body is made of steel and it is strong. Build quality and physical condition is good. The wire connections are good, they are covered with heat resistant electric insulators. There is a fuse of rating 15A. There is a thermostat to prevent overheating which operates when the cooking pan surface temperature reaches 115-120°C. There is no insulation in between the inner cooking pot and the outer frame other than a small air gap.	
Miyako Hot Plate (1012B), 220V, 1500W Assembled/made in Bangladesh	The body is made of steel and the mechanical fixing of the heating element is not strong. The wire connections are covered with heat resistant electric insulators. No fuse used. There is a thermostat to prevent overheating which operates when the hotplate surface temperature reaches 120-130°C.	After a few days, the thermostat mal-functioned and started to cut the power out prematurely

	There is no insulation in between heating element and the metallic body frame.	
Osaka Hot Plate (HP-150A), 220V, 1100W Assembled/made in Bangladesh	The body is made of steel and built quality is quite good. The wire connections are covered with heat resistant electric insulators. There is no fuse available but there is a thermostat to prevent overheating which operates when the hotplate surface temperature reaches 120°-130° C. There is no insulation in between heating element and the metallic body frame.	After a few days, the thermostat mal-functioned and started to cut the power out prematurely
Future 21 Hot Plate (1010B), 220V, 1500W Assembled/made in Bangladesh	The body is made of steel but the built quality is poor. The wire connections are covered with heat resistant electric insulators. There is no fuse available but there is a thermostat to prevent overheating which operates when the hotplate surface temperature reaches 120°-130°C. There is no insulation in between heating element and the metallic body frame.	After a few days, the thermostat mal-functioned and started to cut the power out prematurely
Walton Induction Cooker (WI-F15), 220V, 1800W Assembled/made in Bangladesh	The base of the cooker is made of thick plastic and the upper part is glass. Built quality is good. The wire connections are covered with heat resistant electric insulators, and there is a fuse with a 12.5A rating. The cooker consumes ~5W when no cooking pan is placed on the cooker. There is a power setting facility that can be adjusted from the highest setting of 1800 to the lowest setting of 120 which is effectively warming mode.	
Miyako Induction Cooker (TC-R2), 220V, 2200W Assembled/made in Bangladesh	The base of the cooker is made of thick plastic and the upper part is glass. Built quality is good. The wire connections are covered with heat resistant electric insulators, and there is a fuse with a 12.5A rating. The cooker consumes ~1W when no cooking pan is placed on the cooker. There is a power setting facility that can be adjusted from the highest setting of 2200 to the lowest setting of 88 is effectively warming mode.	

Prestige Induction Cooker (PS245), 220V, 2000W	The base of the cooker is made of thick plastic and the upper part is glass. Built quality is good. The wire connections are covered with heat resistant electric insulators, and there is a fuse with a 12.5A. The cooker consumes ~1W when no cooking pan is placed on the cooker. There is a power setting facility that can be adjusted from the highest setting of 2000 to the lowest setting of 120 is effectively warming mode.	
My Choice Induction Cooker (MC-17), 220V, 2000W	The base of the cooker is made of thick plastic and the upper part is glass. Built quality is good. The wire connections are covered with heat resistant electric insulators, and there is a fuse with a 12.5A. The cooker consumes ~5W when no cooking pan is placed on the cooker. There is a power setting facility that can be adjusted from the highest setting of 2000 to the lowest setting of 120 is effectively warming mode.	
Prestige Infrared Cooker (ME-IFC 43), 220V, 2000-2200W	The cooker has a strong built with a glass at the top. The wire connections are covered with heat resistant electric insulators, and there is a fuse with a 12A. The cooker has different cooking mode options and can be chosen from the panel.	
Miyako Infrared Cooker (20-T6), 220V, 2000W Assembled/made in Bangladesh	The cooker has a strong built with a glass at the top. The wire connections are covered with heat resistant electric insulators, and there is a fuse of 12.5A. The cooker has different cooking mode options and can be chosen from the panel.	
Miyako Curry Cooker (MC-250D), 3L, 220V, 1000W Assembled/made in Bangladesh	The body is made of steel. The body looks heavy and strong but the base is plastic and does not look sturdy. The wire connections are covered with heat resistant electric insulators, and there is a fuse of 10A. The thermostat operates when the cooking pan surface temperature reaches 150°C.	

	There is no insulation provided between the heating element and the external body frame to reduce heat loss.	
Walton Electric Pressure Cooker (WEPC-K05A10), 5L, 220V, 900W Assembled/made in Bangladesh	The body is made of steel and looks heavy and strong. Pressure exhaust bulb quality is also good. There is a mechanical timer on the pressure cooker and indicative food items are mentioned along with the timer dial. The wire connections are covered with thermal insulators, and there is a fuse of 10A. There is no insulation between the heating element or the pressure container and the external body surface.	
Geepas Electric Pressure Cooker (GPC307), 6L, 220V, 1000W	The body is made of steel and looks heavy and strong. Pressure exhaust bulb quality is also good. There is a mechanical timer on the pressure cooker and indicative food items are mentioned along with the timer dial. The wire connections are covered with heat resistant electric insulators, and there is a fuse with a 10A. There is no insulation between the heating element or the pressure container and the external body surface.	
Philips Electric Pressure Cooker (HD2103/65), 5L, 220V, 900W	The body is made of steel and looks heavy and strong. Pressure exhaust bulb quality is also good. There is a mechanical timer on the pressure cooker and indicative food items are mentioned along with the timer dial. The internal wire connections are covered with heat resistant electric insulators, and there is a 10A fuse. There is no insulation between the heating element or the pressure container and the external body surface.	

In the table above (Table 2) we find that the induction cooker has the physical mechanism where heat loss is minimum when the cooking pan is removed. At the same time, heating takes place on the pan surface only (without heating the cooker surface) which makes the induction cookers highly efficient for general purpose cooking. Infrared cookers or hotplates have neither the advantage of reducing the power consumption when cooking pans are removed from cookers nor they can avoid heat loss from their external surfaces. Rice cookers, multicookers, curry cookers and electric pressure cookers have their cooking pots placed inside their outer frames which provides some degree of natural insulation, even though no physical insulation layer is used. The rice cookers, multi-cookers, curry cookers and the electric pressure cookers have a mechanical switch which operates under the weight of the cooking pan to prevent heating when the pans are empty or too

small amount of food is loaded. All these appliances also have a second line of safety, where the thermostat disconnects the heating element from the power supply when the temperature exceeds the design value. But we found that most of the thermostats in the appliances malfunctioned after using for some days.

The cooking performance of the cooking appliances are assessed based on water boiling test by noting the time required, energy consumed, temperature at the exterior surface etc. In water boiling test, we raised 1kg of water (tap water) at room temperature to the boiling temperature (100° C) and the lab test results are given below in Table 3.

Table 3 Water boiling test data for the cooking appliances

Appliance brand, model, and rating	**Initial water temp. °C**	**Time to boil, Min.**	**Energy consumed (kWh)**	**External surface temp. °C**
Walton Rice Cooker (CGA180), 1.8L, 220V, 700W	30.60	10.00	0.13	44.50
Vision Rice Cooker (SS-40-06), 1.8L, 220V, 700W	30.50	10.00	0.12	45.50
Panasonic Rice Cooker (SR-JN185) 1.8L, 220V, 650W	33.60	10.00	0.12	47.00
Miyako Rice Cooker (MCM-686A), 1.8L, 220V, 395W	29.70	11.00	0.13	38.30
Miyako Hot Plate (1012B), 220V, 1500W	31.70	10.00	0.18	58.60
Osaka Hot Plate (HP-150A), 220V, 1100W	28.90	12.00	0.18	56.90
Future 21 Hot Plate (1010B), 220V, 1500W	32.40	15.00	0.17	55.80
Walton Induction Cooker (WI-F15), 220V, 1800W	28.00	03.00	0.11	40.8
Miyako Induction Cooker (TC-R2), 220V, 2200W	30.30	04.00	0.10	35.9
Prestige Induction Cooker (PS245), 220V, 2000W	33.10	03.00	0.10	34.9
My Choice Induction Cooker (MC-17), 220V, 2000W	33.90	05.00	0.10	34.8
Prestige Infrared Cooker (ME-IFC 43), 220V, 2000-2200W	32.60	09.00	0.18	38.7
Miyako Infrared Cooker (20-T6), 220V, 2000W	30.40	09.00	0.19	43.00
Miyako Curry Cooker (MC-250D), 3L, 220V, 1000W	31.20	09.00	0.13	48.80
Walton Electric Pressure Cooker (WEPC-K05A10), 5L, 220V, 900W	31.40	08.00	0.14	42.10
Geepas Electric Pressure Cooker (GPC307), 6L, 220V, 1000W	30.80	07.00	0.13	40.50
Philips Electric Pressure Cooker (HD2103/65), 5L, 220V, 900W	33.30	07.00	0.14	42.2

The water boiling test gives us the preliminary idea about the thermal efficacy of the cooking appliances. Although the same amount of water is boiled, the amount of energy consumed is higher for larger appliances like rice cooker or the electric pressure cooker as self-consumption (to raise its body temperature to steady state) is higher due to their higher self-weight. As the actual time required for the water boiling test was not high, the effect of self-consumption is apparent in the data. However, for longer cooking time, the self-consumption of heat should become less significant as they reach steady state. The curry cooker and the rice/multicooker have very similar construction, but the thermostat setting is higher for the curry cookers. So, unlike rice cookers, curry cookers can be used for frying.

The low energy consumption data of the induction cookers are also based on the similar logic that induction cookers heat the cooking pan only and self-consumption due to self-weight is insignificant. The thermal efficiency of the cooking appliances depends on the insulation of the appliances and the heat transfer efficiency from the heating element to the cooking pans/food. In case of pressure cookers, the test was performed with the lid loosely placed so that high pressure does not build up inside the pressure cooker. The cooking efficacy of the electric pressure cookers cannot be estimated form the water boiling test as pressure cookers operate at a temperature much higher than the usual boiling temperature of water, but we can get some idea about the losses from its external surfaces. The induction cooker heats up the cooking pan effectively bulk of the cooker power is delivered to the cooking pan. A comparison between the induction cooker and the infrared cooker indicates that infrared cookers are less efficient than the induction cookers. This an expected outcome, as infrared cooker power is independent of the actual power transferred to the cooking pan and the glass plate at the top of the infrared cooker gets heated, which could then lose heat in the form of convection and radiation. The working principle of an infrared cooker would also allow for the infrared from the source to be scattered by the pan and the glass plate at the top of the cooker and contribute to the heat loss mechanism. However, the infrared cooker, unlike the induction cooker, need not use special cooking pans made from magnetic materials.

The water boiling tests indicate that all the appliances of similar category (like induction cooker or rice cooker) have similar water boiling performance. While using them in the lab and in the Jaldhaka site, we faced malfunction of the thermostats in some of the locally manufactured rice cookers, hotplates and pressure cookers. It seems that the quality of the thermostats should be improved to get a more reliable operation of the appliances.

6. Cooking Diary: Laboratory data

Cooking tests were performed in the lab for the typical food items taken by the general Bangladeshi population. We concentrated on the main food items like rice, chapati, vegetable, fish and meat curry, and noodles. The laboratory tests were performed scientifically keeping in mind the possible sources of energy loss. We understand that, in everyday cooking condition, people may not use the appliances scientifically. Our lab data shows how much improvement is possible if someone is aware or more careful about the cooking process. Although we performed the experiments scientifically, we tried not to deviate from the usual cooking practices to keep conformity with the traditional cooking. Although curry is the main traditional item, actual cooking practice varies from family to family. People add different amounts of gravy (water added during cooking) or vegetables (like potato) in the dishes that make a difference in cooking time and energy required. In the cooking data we mention all the components added during cooking to keep a record of the total amount loaded in the pan.

In the presented data, we have mentioned the type of cooking appliance used but not the brand of the appliances, as different brands had very similar cooking performance as indicated in the water boiling test and also in the cooking performance experiments.

6.1. Rice

Boiled rice is the most common food in Bangladesh, as Bangladesh is a major producer of rice. Some people in the rural areas eat rice 3 times a day (including the breakfast). After washing the rice, people add almost 1.25kg of water for boiling 500gm of rice. Once the rice with added water is placed on the stove, the softness of the rice is checked after the water starts boiling. Rice absorbs a significant amount of water and swells during the boiling process, so there is almost 100% increase in the volume after the rice is boiled. Although an unhealthy practice, sometimes the excess water is drained from the cooking pan after the rice is boiled (as the drained water contain significant nutrients). Rice water is sometimes used in soup but is mainly wasted. Usually, rice becomes sticky after boiled and draining excess water keeps it less sticky. Some people think that less sticky rice tastes better when eaten with other side dishes. Rice is the only exception in Bangladeshi food where no salt or spices are added for cooking.

Boiled Rice

Table 4 Cooking data for boiled rice

Appliance type, Capacity, rating	**Food cooked**	**Time required for cooking**	**Energy consumed (kWh)**
Rice Cooker	Rice = 500 gm Water = 1200 gm	31	0.33
Hot Plate	Rice = 500 gm Water = 1300 gm	38	0.41
Induction Cooker	Rice = 500 gm Water = 1300 gm	25	0.35
Infrared Cooker	Rice = 500 gm Water = 1300 gm	33	0.38
Electric Pressure Cooker	Rice = 500 gm Water = 1000 gm	21	0.19

While cooking rice, amount of water added varied slightly as the rate of evaporation was not same for all the appliances. As for example, in an electric pressure cooker steam cannot escape and the amount of water required is less. This is an additional advantage of boiling rice in pressure cooker as lower amount of water reduces the energy requirement.

6.2. Dal

Lentil soup commonly known as 'Dal' is a very popular item in Bangladesh. The lentils are boiled in water till it becomes soft and can easily be made like a paste. Spices like onion, turmeric, red chili etc. are fried in small amount of oil till the onion becomes brownish, and then the lentil paste and water is added. Usually 1200-1500gm of water is added to 100gm of lentils to make the soup.

Dal (Lentil soup)

In the following table, the cooking data for lentil soup is presented.

Table 5. Cooking data for Lentil soup (dal)

Appliance type, Capacity, rating	Food cooked (lentil soup)	Time required for cooking (min)	Energy consumed (kWh)
Rice Cooker	Lentils = 80 gm Others = 100 gm Water = 1200 gm	49	0.55
Hot Plate	Lentils = 80 gm Others = 100 gm Water = 1300 gm	52	0.62
Induction Cooker	Lentils = 80 gm Others = 100 gm Water = 1300 gm	32	0.59
Infrared Cooker	Lentils = 80 gm Others = 100 gm Water = 1300 gm	38	0.62
Curry Cooker	Lentils = 80 gm Others = 100 gm Water = 1300 gm	40	0.44
Electric Pressure	Lentils = 80 gm Others = 100 gm Water = 1000 gm	34	0.31

The item 'others' in the table gives the combined amount of oil, onion and spices added while cooking.

Amount of water added varied with the appliances as the evaporation rate for the appliances were not same. In case of pressure cooker, there was no scope of evaporation, so the added water was much less compared to the other appliances. The lid of the rice cooker and curry cooker (made of glass) was heavy and had good insulation property, which effectively reduced evaporation of water and showed better efficacy. Lentil is a very common and popular food item and requires significant boiling time to make the lentils soft enough to be mashed. This makes the use of electric pressure cooker save significant amount of time and energy in cooking lentil soup.

Chickpea dal

Chickpea dal is another popular dal item which is usually consumed with chapati during the breakfast time. Similar to lentils, chickpeas usually take a long time to boil and is an energy intensive food item. The cooking data for the chickpea dal is given below.

Table 6 Cooking data for chickpea dal

Appliance type, Capacity, rating	**Food cooked**	**Cooking time, (min)**	**Energy consumed (kWh)**
Rice Cooker	Chickpeas = 250 gm Others = 120 gm Water = 1200 gm	65	0.58
Hot Plate	Chickpeas = 250 gm Others = 110 gm Water = 1200 gm	67	0.72
Induction Cooker	Chickpeas = 250 gm Others = 120 gm Water = 1300 gm	39	0.64
Infrared Cooker	Chickpeas = 250 gm Others = 120 gm Water = 1300 gm	43	0.71
Curry Cooker	Chickpeas = 250 gm Others = 130 gm Water = 1200 gm	53	0.51
Electric Pressure Cooker	Chickpeas = 250 gm Others = 110 gm Water = 1000 gm	32	0.28

*'Others' mean oil, onion, salt and spices.

In preparing chickpea dal, the onion and spices are lightly fried in a small amount of oil and then the chickpeas and water is added. While cooking in the pressure cooker, the frying part is done without the lid, so a part of the cooking process did not use cooking under higher pressure. As expected, the energy consumed is much lower for the electric pressure cooker.

6.3. Vegetable

Vegetable cooking has two very specific processes, one is fried vegetable and the other is boiled or vegetable curry. In preparing fried vegetable, onion and spices are first fried in a small amount of oil till they turn brown in colour and then washed vegetable pieces are added to it. The item is cooked till the vegetable becomes soft enough for consumption. However, the fried vegetable is not really a deep-fried dish and it is effectively boiled with very limited amount or no added water (water content of the vegetable is usually good enough) leaving no gravy after cooking. One vegetable dish is usually consumed during lunch or dinner. Bangladesh produces different types of vegetables and people eat seasonal vegetable throughout the year.

Mixed vegetable curry

There is another type of vegetable dish prepared from 'greens'. These are usually the green leaves of different vegetable plants called 'Shuk' and cooked or fried to serve during the lunch or dinner. The cooking process is very similar to other vegetable items as described above.

Potato is a major vegetable item in Bangladesh. People add potato to meat, fish curry or mixed vegetable. Sometimes potato fry or potato curry are cooked as a vegetable item. In most of the cases, the potatoes are not pre-boiled and are just added along with the main cooking item like meat/fish or other vegetable and are cooked together.

Table 7 Cooking energy data for mixed vegetable.

Appliance type, Capacity, rating	Food cooked (mixed vegetable)	Time required for cooking (min)	Energy consumed (kWh)
Rice Cooker	Vegetable = 1010 gm Others = 153gm Water = 700 gm	63	0.52
Hot Plate	Vegetable = 1020 gm Others = 145 gm Water = 700 gm	60	0.68
Induction Cooker	Vegetable = 1027 gm Others = 153 gm Water = 800 gm	35	0.62
Infrared Cooker	Vegetable = 1055 gm Others = 145 gm Water = 800 gm	42	0.67
Curry Cooker	Vegetable = 1020 gm Others = 140 gm Water = 700 gm	45	0.43
Electric Pressure Cooker	Vegetable = 1055 gm Others = 140 gm Water = 500 gm	33	0.35

The item 'others' in the table gives the combined amount of oil, onion, salt and spices added while cooking.

In this experiment, like the previous one, the amount of water varied to compensate for the loss of water due to evaporation. The cooking time for vegetable also indicates that EPC is a good candidate for cooking vegetable in the Bangladeshi style.

6.4. Fish and Meat Curry

Fish curry

Bangladesh is a major producer of sweet water fish and fish cultivation is quite widespread throughout the country. Fish is the most popular protein-based food. Fish is usually cooked in two different ways – one is fried fish and the other is fish curry. While cooking fried fish, the fish pieces are covered with ground spices like turmeric powder, chili powder etc. and then fried in oil till they turn brown outside and well-cooked inside. These are then usually served with fried onions on the top of the dish. The other most popular dish is the fish curry (with gravy). In preparing fish curry people adopt two different approaches. In one approach, the fish pieces are first pre-fried to their taste and then cook them with turmeric, chili powder and other spices by adding small amount of oil and appropriate amount of water. Vegetable like potato, cauliflower, cabbage or beans are sometimes added to make the fish curry. In the second approach, the pre-frying is not done but the rest of the cooking process remains the same as described above.

Fish curry

Table 8 Cooking data for fish curry without pre-frying

Appliance type, Capacity, rating	Food cooked	Time required for cooking	Energy consumed
Rice Cooker	Fish = 303 gm Others = 367 gm Water = 617 gm	42.33	0.42
Hot Plate	Fish = 295 gm Others = 330 gm Water = 675 gm	47	0.53
Induction Cooker	Fish = 300 gm Others = 375 gm Water = 717 gm	26.67	0.46
Infrared Cooker	Fish = 310 gm Others = 353 gm Water = 700 gm	30.5	0.52
Curry Cooker	Fish = 300 gm Others = 350 gm Water = 600 gm	33	0.41
Electric Pressure Cooker	Fish = 300 gm Others = 350 gm Water = 500 gm	25	0.23

The item 'others' in the table gives the combined amount of oil, onion, salt, potato and spices added while cooking.

In the above table, water and vegetable (potato) was added at first to get the vegetable pre-cooked and then the fish was added 10-12 minutes later. In case of electric pressure cooker, initial part of the cooking was done with the lid open.

Meat curry

Consumption of meat was quite limited in Bangladesh even 20-25 years back. With the development of cattle and poultry farming, the availability of the meat supply has increased and so has consumption of meat. However, consumption of meat is still much lower compared to that of fish. Chicken is the most popular meat, as it is less expensive and are mainly consumed in the urban and peri-urban areas. Meat curry is the most common dish and is sometimes cooked with potato. Fried meat is usually cooked on special occasions. While cooking meat curry, the meat is mixed with onion and spices and then put in the cooking pan with small amount of oil. In the table below, the cooking data for chicken is presented.

Chicken curry

Table 9 Cooking data for chicken curry

Appliance type, Capacity, rating	**Food cooked**	**Time required for cooking**	**Energy consumed**
Rice Cooker	Chicken = 385 gm Others = 375 gm Water = 500 gm	69	0.60
Hot Plate	Chicken = 370 gm Others = 395 gm Water = 750 gm	72	0.67
Induction Cooker	Chicken = 380 gm Others = 390 gm Water = 800 gm	40	0.66
Infrared Cooker	Chicken = 390 gm Others = 380 gm Water = 800 gm	43	0.68
Curry Cooker	Chicken = 390 gm Others = 390 gm Water = 700 gm	50	0.48
Electric Pressure Cooker	Chicken = 395 gm Others = 400 gm Water = 500 gm	34	0.33

The item 'others' in the table gives the combined amount of oil, onion, salt, potato and spices added while cooking.

Beef is also a common food item, but is less popular than chicken, as the price of beef is much higher compared to that of chicken. Beef usually requires higher cooking time as beef fibres are tougher and takes longer time to soften. However, the cooking process is similar to that of chicken. Potato is a common additive to the beef curry.

Beef curry

Table 10 Cooking data for beef curry

Appliance type, Capacity, rating	Food cooked	Time required for cooking	Energy consumed
Rice Cooker	Beef = 500 gm Others = 360 gm Water = 500 gm	76	0.66
Hot Plate	Beef = 500 gm Others = 370 gm Water = 600 gm	82	0.95
Induction Cooker	Beef = 500 gm Others = 385 gm Water = 800 gm	56	0.86
Infrared Cooker	Beef = 500 gm Others = 395 gm Water = 800 gm	60	0.93
Curry Cooker	Beef = 500 gm Others = 360 gm Water = 600 gm	68	0.63
Electric Pressure Cooker	Beef = 500 gm Others = 360 gm Water = 500 gm	41	0.39

The item 'others' in the table gives the combined amount of oil, onion, salt, potato and spices added while cooking.

6.5. Chapati

Chapati is a common breakfast item in Bangladesh. Dough is made from wheat flour by adding required amount of water. Round thin wafer-like breads are rolled out from the dough and are then baked in hot pans. Baking chapati is usually an energy intensive process and usually have a light brownish colour after baking. Production of wheat requires much less water in the farmlands that has encouraged farmers to switch from rice to wheat cultivation during the dry seasons. With the development of dairy and poultry farming, consumption of wheat has increased significantly. At the same time, less sugar content of wheat, compared to rice, has prompted health-conscious people to increase the wheat-based food items in their daily diets.

Baking chapati

Table 11 Cooking data for Chapati

Appliance type, Capacity, rating	Food cooked	Time required for cooking (min)	Energy consumed (kWh)
Hot Plate	Chapati = 6 Pieces Flour= 350 gm Water = 180 gm	41	0.37
Induction Cooker	Chapati = 6 Pieces Flour= 350 gm Water = 180 gm	14	0.22
Infrared Cooker	Chapati = 6 Pieces Flour= 350 gm Water = 180 gm	22	0.32
Curry Cooker	Chapati = 6 Pieces Flour= 350 gm Water = 180 gm	26	0.24

Making chapati requires quite high temperature of the cooking pan and is not suitable for rice/pressure cooker. However, curry cooker has a thermostat setting much higher than rice cooker or pressure cooker that allows the users to bake chapati.

6.6. Noodles

Although noodles as a food item migrated from China, it has become quite a popular food in Bangladesh. However, the cooking process is different compared to the Chinese way of cooking noodles. The Bangladeshi style of cooking noodles involves light frying of onion, spices and vegetable (like potato, carrot etc.) in small amount of oil before the noodle and water is added to it. Scrambled eggs are added at the final stage of the cooking when the noodles are close to complete boiling. Cooking noodles requires open lid cooking and so it was not tried with pressure cooker.

Noodles with vegetable

Table 12 Cooking data for noodles

Appliance type, Capacity, rating	Food cooked	Time required for cooking (min)	Energy consumed (kWh)
Rice Cooker	Noodles = 70gm Vegetable= 140 gm Others = 50 gm Water = 300 gm 2 eggs = 96gm	24	0.28

Hot Plate	Noodles = 70gm Vegetable= 130 gm Others = 50 gm Water = 350 gm 2 eggs = 102gm	24	0.34
Induction Cooker	Noodles = 70gm Vegetable= 130 gm Others = 50 gm Water = 350 gm 2 eggs = 105gm	15	0.30
Infrared Cooker	Noodles = 70gm Vegetable= 140 gm Others = 50 gm Water = 350 gm 2 eggs = 104gm	17	0.32
Curry Cooker	Noodles = 70gm Vegetable= 130 gm Others = 97gm Water = 350 gm 2 eggs = 106gm	22	0.26

The item 'others' in the table gives the combined amount of oil, salt, onion and spices added while cooking.

6.7. Fried Potatoes

Fried potato is a popular vegetable item. It is sometimes taken at breakfast, but mostly it is a side dish during lunch or dinner. Potatoes are peeled and cut to small pieces. Small amount of oil is poured in the cooking pan and heated close to frying temperature. Onion and spice are added to fry them for a short while and potato is added after the onions turn light brown. Salt is added to the taste of the individuals. The potatoes are then cooked till they become soft enough for consumption. Sometimes, geen chilies are added at the end of the cooking for added chili favour.

Fried potato

Table 13 Cooking data for fried potato.

Appliance type, Capacity, rating	**Food cooked**	**Time required for cooking (min)**	**Energy consumed (kWh)**
Hot Plate	Potato = 360 gm Others = 130 gm	29	0.26
Induction Cooker	Potato = 370 gm Others = 130 gm	16	0.23
Infrared Cooker	Potato = 360 gm Others = 140 gm	17	0.25
Curry Cooker	Potato = 370 gm Others = 130 gm	28	0.23

'Others' mean onion, salt, oil and spices.

6.8. General discussion on electric cooking

Tables 4 to 13 provide the cooking data for a number of popular food items of Bangladesh. If we compare the cooking performance of the cooking appliances we can see that Electric Pressure Cooker, as expected, is the most efficient appliance when boiling of the foods are concerned. However, all types of foods cannot be cooked in pressure cookers (i.e. under higher pressure) specially when frying is involved. It is possible to achieve light frying in pressure cookers, but the operation is not under high pressure as the lid has to be kept open. In case of the rice cooker, frying is effectively not possible as the usual thermostat setting of a rice cooker is low. Interestingly, curry cooker shows quite good energy efficiency, which was not really expected. In Table 3, we can see that the surface temperature of the side walls were higher in case of the curry cooker which indicates higher loss from the side walls. However, the design of the curry cooker is such that it has a larger diameter but the vertical height of the curry cooker is smaller than the rice cooker which may result in less losses from smaller area of the side walls. Bottom of the curry cooker is made from plastic whereas the bottom surface of the rice cooker is made of metal. So, loss from the curry cooker through the bottom surface should also be lower. Top surface is a glass lid in both the cases and glass is a very good insulator that should not have much contribution to the loses.

Cooking with the appliances like hotplate, induction cooker or infrared cooker has the similarity that the cooking pans are not an integral part of the appliance itself and can be chosen as per requirement of the user. But the actual heating process is quite different for all three types of appliances. In a hotplate, the heating element heats up the top surface of the hotplate by heat conduction and then the heat is transferred from the hotplate to the cooking pan. Here, two stages of heat conduction is required – first one is from the heating element to the top of the hotplate and the second one is from the top of the hotplate to the cooking pan. Any weakness in the design or workmanship can have reduced heat conduction from the heating element to the cooking pan and adversely affect the energy efficiency. Usually, body of the hotplates are made from steel and there is significant conduction from the heating element to the metal body that causes additional energy loss by convection or radiation. If we compare the cooking data presented in the tables, we see that hot plate has the lowest energy efficiency compared to the other appliances used in the lab. In case of infrared cookers, the heating element effectively radiates infrared that is supposed to pass through the glass plate at the top of the cooker and heat up the cooking pan. But in reality, the glass plate absorbs and scatters part of the infrared which is apparent from the heating up of the glass plate at the top and feeling of heat that the user experiences while cooking. Additionally, any radiation from the heating element that is not incident on the cooking pan is lost to the environment. Our experimental data shows that infrared cookers consume higher power compared to induction cookers. When performance of a rice cooker is compared with the induction cooker, rice cookers show better energy efficiency. This is due to the fact that the outer surface of the rice cooker body effectively gives a partial heat insulation. However, if we consider the heat transfer from the heating element to the cooking pan, induction cooker is the best one as it heats the surface of the cooking pan only leaving little option of energy loss when compared to a heat conduction process in other types of cooking appliances. It would be interesting to see the improvement in energy efficiency if the manufacturers of rice cookers or the pressure cookers use induction type of heating mechanism instead of conduction of heat directly from the heating element.

6.9. LPG

Liquified Petroleum Gas (LPG) is one of the major sources of cooking fuel, specially in the urban areas, where the gas from the national grid is not connected. The LPG cylinders come in different sizes, the most popular one is the 12kg cylinder. In the laboratory a single burner gas cooker was installed and the consumption of the gas was measured from the loss in weight of the gas cylinder. The calorific value of the LPG is 55kJ/gm was then used to calculate the energy consumption for a particular food item. The pans and the frying pans used were the same ones used in hotplate, induction cooker or the infrared cooker. Some basic food items were cooked and their energy consumption is given in Table 14 below.

Table 14 Energy consumption for some basic food items of Bangladesh when using LPG

Food cooked	Time required for cooking (min)	LPG used (gm)	Eq. energy in kWh	Cost in GBP
Rice = 500 gm Water = 1300 gm	25	50	0.76	0.038
Fish = 310 gm Others = 380 gm Water = 700 gm	28	80	1.22	0.061
Chicken = 410 gm Others = 420 gm Water = 700 gm	45	120	1.83	0.091
Beef = 480 gm Others = 440 gm Water = 900 gm	58	160	2.44	0.121
Lentils = 80 gm Others = 100 gm Water = 1300 gm	42	100	1.53	0.076
Vegetable = 1010 gm Others = 140 gm Water = 800 gm	34	60	0.92	0.046
Chapati = 6 Pieces Flour= 350 gm Water = 180 gm	14	30	0.46	0.023

Calorific value of LPG – 55kJ/gm; cost of LPG in Bangladesh - ~BDT 1000 for a 12kg cylinder, 1GBP = BDT 110

When we look at the energy values they look high compared to the electric cookers. The main reason lies in the fact that gas cookers are never as efficient as the electric cookers. The typical efficiency of the gas cooker ranges from 30-40%, whereas the efficiency of an electric cooker can be as high as 90%. However, the actual energy consumed in electric cooking is not that low as power stations, when converting the heat energy to electricity, has typical thermal efficiency of 40-45% and can go up to 60% when combined cycle is used. If we consider overall fuel efficiency corresponding to the electrical energy in electric cooking, the efficiency figure will be better than LPG in most of the cases, but not by a big margin.

7. Science of Cooking: Analysis of the experimental data

Cooking is the scientific process where we heat the food to a level such the biological tissues are softened to our taste. The level of softening required depends on the type of food and the type of dish to be prepared. We can look at the cooking process from two different angles – one is the art of cooking and the other is the science of cooking. In art of cooking the cooks determine the cooking process so that the cooked food has a specific taste, flavour and texture. In science of cooking, we mainly look at the energy and the hygiene of the cooked food. Although the rate of applying heat or the process of applying heat to a food during cooking is determined by the art of cooking, there is ample scope of saving energy if we cook the food scientifically, keeping the taste and texture of the food unaffected.

Although art and science of cooking look like very different aspects of cooking, there is a significant overlap area. Art of cooking cannot be implemented unless the science of cooking is properly taken into account. Cooking is an art, as already mentioned, that makes the difference in taste, texture and flavour of a cooked food. Precooking process like marinating or fermenting has a lot of contribution in the art of cooking that makes a difference in the taste and texture of the food. However, the cooking of any dish usually undergoes 3 different processes – frying, boiling and baking. Frying is a very energy intensive process that gives the outer surface of the food a crunchy texture. In many fried foods, the process of frying makes the outer surface crunchy but at the same time makes the inner portion of the food softened to an appropriate level as decided by the cook. Boiling is also a very common cooking process, where the food is heated in presence of water to raise the temperature usually close to 100°C. In pressure cookers the temperature can be much higher like 130-135°C. The boiling process makes the biological tissues softer suitable for our consumption and the level of softening is determine by the cook. Baking is usually done in a closed heated chamber where hot air cooks the food from all the directions and baking gives a very different texture to the food that cannot be achieved by frying or boiling. All these cooking processes have their own energy implications and we discuss here some of the interesting aspects.

The basic of cooking deals with the temperature, but not with the heat directly. As already mentioned, cooking is the process of making the biological tissues softer to make them suitable for human consumption and at the same time to keep the hygiene. So far as hygiene of the cooking is concerned, a temperature close to 70°C is sufficient to kill most of the germs or harmful organisms that exist in the raw food. However, edible protein or vegetable sells starts decaying (get cooked) when the temperature goes higher than 60°C. However, softening of the food is a temperature dependent process and the softening process is faster when the temperature is higher. This is the reason why cooking food in pressure cookers require much lower time. If we keep the temperature near to 70°C, it will be possible to cook the food, but it will take a much longer time. However, there is a limit to the temperature that we should raise while cooking a food. In dip fried process, the temperature of the oil could be as high as 160-180°C. A higher temperature will burn the outer surface but the inner part will remain uncooked. In an oven temperature may go as high as 200°C.

Now let us try to see what the energy consumption processes for cooking at different temperatures are. While boiling food with water, the actual energy consumption is quite critical with the cooking process. It is not an unusual observation that people, while boiling foods, think that increasing the power of the stove/cooker will make the food to cook faster. But this is a wrong notion, as the temperature of water does not increase, rather remains close to 100°C, even if the power of the stove is increased. The increased energy will cause the water to boil more vigorously and the heat

that is given as the input is carried away by the steam that escapes the cooking pan. The optimum cooking energy at such a temperature would correspond to the value that will keep the water temperature close to boiling without producing much steam. At this stage, we may raise two relevant issues related to the energy efficiency of any cooking process. Let us consider two possible situations – (a) the cooking is performed with higher power and (b) if we apply low power so that the whole cooking process is done slowly. So, in process (a), the power is higher but the cooking time is shorter and in (b) power is lower but the time is longer. So, it may appear that both the processes will consume similar amount of energy. Experiments were performed in the lab to see the variations in cooking energy for high and low powered cooking. Figure 1 shows a graph for rice cooking where three different energy levels were used.

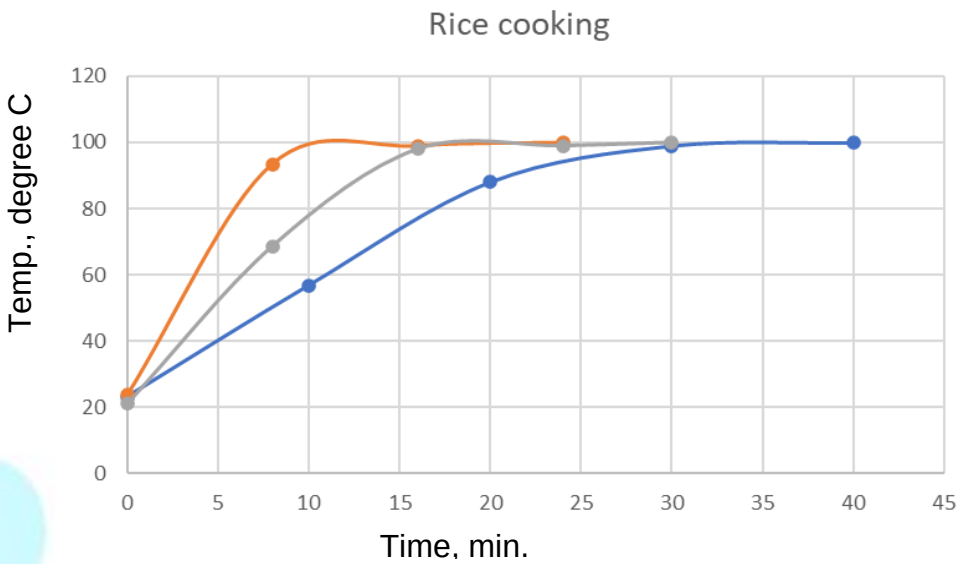

Figure 1 Rice cooking with different power level in an induction cooker. The induction cooker had the power setting option from 80 to 2000. Set value of 2000 would mean full power and lower settings indicate lower power levels. The brown, ash and blue graphs are for power settings of 1200, 800 and 300 respectively. Amount of rice cooked is 500gm.

The graphs in the figure shows that the orange-brown graph, having the higher power setting (1200) with an average power of 1300W, came to boiling temperature within less than 10 minutes. It took another 15 minutes for the rice to become soft enough for consumption. The ash-coloured graph has a power setting of 800 and an average power consumption of 800W and comes to the boiling point at around 16 minutes and then the power was kept ON for another 14 minutes to complete rice cooking. In the blue graph, the power setting was 300 and the average power, as measured, was 400W and the water took around 30 minutes to boil. After reaching the boiling temperature, it took another 10 minutes for the rice to be cooked properly. Table 15 below shows the energy required for cooking at different power levels.

Table 15 A comparative data for different power level, cooking time and cooking energy.

Food	Power setting in the induction cooker	Cooking Time, min	Energy required, kWh
Rice 500gm Water added 1300gm	1200	24	0.35
	800	30	0.33
	300	40	0.27

The results presented in Table 15 are very important in the sense that cooking the same food requires lower amount of energy if the cooking process is made slower. This is a very interesting consideration from an environmental and energy cost point of view. As already discussed, the cooking starts when the temperature gets higher than 60°C. In Fig.1, the orange-brown graph, which has the highest power, gets only 6 minutes to reach a temperature of 100°C from 60°C. On the other hand, the ash and the blue coloured graphs get around 10 and 15 minutes respectively by the time the temperature reaches 100°C from 60°C. So, the slowest cooking gets the highest cooking time by the time the water starts boiling. After the water starts boiling, the higher power generates more steam and loses higher amount of energy by the escaping steam. This loss is minimum for the minimum power setting. So, the results, as presented in Table 15 is quite logical, which can be exploited for efficient cooking.

We next tried to cook beef with two different power levels and the cooking time variations are shown in Figure 2. The orange-brown graph is for an induction cooker power setting of 1000 and the blue graph is for 300. At 1000 power setting (900W), the water reaches boiling temperature within 20 minutes and then the temperature remains at the water boiling point. The total cooking time needed was 55 minutes. While the power setting was kept to 300 (consuming 400W), it took almost 40 minutes to boil and the final cooking time was 86 minutes. The energy consumption data is presented in Table 16.

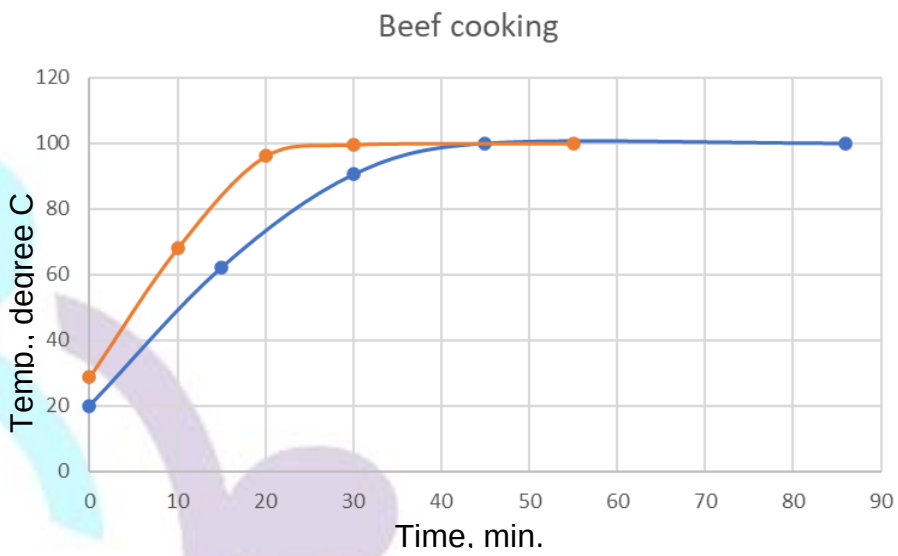

Figure 2 Cooking time data for beef curry for two different power levels. The orange-brown graph is for 900W and the blue graph if for 300W.

Table 16 Comparative power consumption data for beef curry for different power levels.

Food (Beef Curry)	Power setting in the induction cooker	Time, minutes	Energy required, kWh
Beef 500gm Potato, water, salt, oil and spices 1300gm	1000 (900W)	55	0.86
	300 (400W)	86	0.59

The energy consumption data show the similar trend as the energy data presented in Table 15 (rice cooking). In both the tables we can see a reduction in cooking energy by more than 25% compared to the higher power data. However, we must keep in mind that this energy saving is achieved at the cost of longer cooking time. In the circumstances, where length of cooking time is unimportant, cooking energy cost can be reduced significantly by adopting slow cooking. It opens up an opportunity for programmable cooking option for working class people, where they can leave their cooking appliances ON while leaving for work and then come back after 8 or 9 hours to get the food ready and warm for their immediate consumption.

Next we investigated the variation in energy requirement when the amount of food cooked is varied. In the same cooking pan/appliance we cooked different quantities of rice and measured the energy required for cooking. The results are presented in the Figure 3 below.

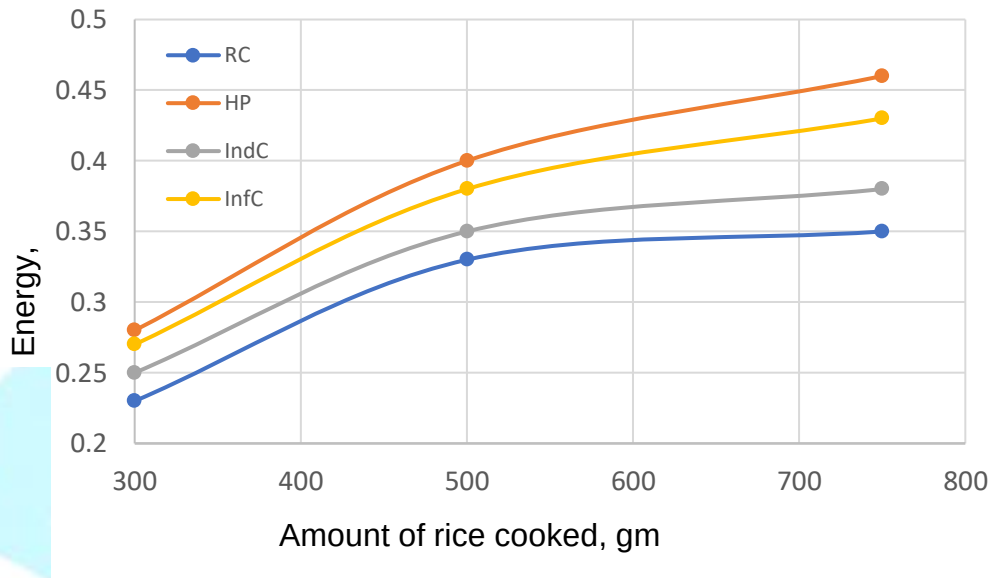

Figure 3 Variation of cooking energy for varying amount of food in different appliances (HP-Hotplate, RC- Rice cooker, IndC- Induction cooker, InfC- Infrared cooker and EPC- Electric pressure cooker).

It is interesting to see that the amount of energy needed does not increase in the same proportion as the amount of food cooked. If we consider the actual cooking process, the amount of heat that is delivered by the cooking appliance is used up in 3 different ways – first, is the heat delivered to the food, second is the heat consumed by the cooking appliance itself (as its body temperature goes up while cooking) and third is the losses. The amount of heat consumed by the appliance is approximately independent of the amount of food as the body temperature reaches the steady state if the amount of food is not too small or the food is cooked for a very short time. The losses are functions of the external temperature of the cooking appliance and the amount of steam that can escape while the cooking is in progress. When the amount of food in a particular cooking appliance is higher, the temperature of the food rises slowly and we get the benefit of slower cooking. So, the result presented in Figure 3 is quite an expected one, but is often not taken into consideration properly.

8.Limited field data from Jaldhaka

8.1. Location of the site

Jaldhaka is situated in the north of Bangladesh, almost 300km from the capital city Dhaka. It is a rural area where people do not have modern cooking facilities. So, the cooking is mainly done using firewood. In recent years, the grid connection has expanded rapidly and presently Bangladesh has more than 90% coverage of the national grid only excepting the 'char' areas (islands) and the remote areas of the hill tracts situated at the south-east of the country. With the improvement of the access to electricity some families have started using rice cookers.

Figure 4 Location of Jaldhaka in the northern part of Bangladesh.

8.2. Selection of the users

As per the MECS proposal, 3 households were chosen to collect cooking diary data from at the field level.

Initially, it was planned that we will conduct a preliminary survey in Jaldhaka to get some idea about their existing cooking facilities, disadvantages/difficulties they face with their existing stoves, number of members in the family, their interest in electric cooking etc. before selecting three households. We were to select three households based on the survey data considering their income level (keep some degree of diversity in the family income level), their interest in electric cooking and their educational level (as entry of data requires a minimum level of education) etc. Due to the outbreak of the COVID-19 pandemic, we could not perform the general survey in the selected area. We employed Mr. Jahid Akter, a staff member from Jaldhaka Polytechnic institute to monitor the project. Mr. Akter has a technical background and has the knowledge and understanding of electrical

appliances. As per our directives, he selected three households from lower middleclass, middleclass and upper middleclass background. The names of the selected users (pseudonyms are used), who cook in their kitchens, are given below. Their background and other relevant data are included in the appendix.

Table 17 Name and background of the selected users. (We have used pseudonyms for the sake of anonymity.)

Name	No. of family members	Monthly family income, BDT	Education level	Social status
Anisa and her daughter in law Faria	6	30,000	Grade 8 Faria: Master's degree	Upper middle class
Raisa	6	20,000	Grade 9	Middle class
Sheuli	5	12,000	Grade 8	Lower middle class

All three selected families used firewood as the main cooking fuel, with some experience on rice cookers. After the households were selected, Mr. Akter took the initiative to connect a separate electric energy meter to keep an account of the energy consumed by the electric cooking appliances. Before the households started the collection of cooking data, an online meeting was conducted to explain the users the aim of the project, importance of reliable data in such a project. At the same time the individual users were given a brief on the appliance they were going to use.

Figure 5 Selected users from left to right, Anisa, Raisa, Sheuli.

8.3. Prevailing kitchen environment in Jaldhaka

Jaldhaka has a typical Bangladeshi rural background, where families predominantly use firewood for cooking. Bangladesh is a country under monsoon climatic condition and the weather is very wet and humid from the months of June to October. The typical day and night temperatures vary within 35°C to 27°C respectively with humidity remaining more than 80% for most of the days. The average rainfall is more than 50 inch per year and it is a challenge for the families to keep their firewood dry. Usually, they require a small shed to save their firewood from rainwater. However, due to high humidity, the firewood contains large percentage of moisture even if they are not exposed to rain. Such high percentage of moisture causes significant smoke and fume when firewood is used in the conventional three stone cookstoves. Fumes cause respiratory and eyesight problems for the kitchen users and at the same pose a challenge to keep the kitchen clean as back carbon soot is deposited in the kitchen ceiling and walls. At the same time, the cooking pans are also blackened and it is an extra work to keep them clean. For these reasons, most of the families have their kitchen outside their main housing structure with just a minimum shed for the cooking area. This makes the life of the housewives (the persons who generally cook for the family) even more difficult during the rainy season to go to the kitchen from the main housing structure and then bring in the food to the dining space.

Fig.6. Location of a typical kitchen (left) outside the house (middle) and the firewood storage area.

8.4. The Collection of cooking data

We provided the selected households with four different types of cooking appliances, one at a time. They were requested to stick to the cooking appliance as much as they could and collect the weight of the food, time of cooking and the energy consumed. In case they felt that the food item they intend to cook was not suitable for the electric cooking appliance or when there is a power failure, they cooked on their conventional firewood stoves. We also requested to keep an idea on the percentage of food items they cooked in the electric cookers. It was not an easy task for the households as they are not habituated to such data collection process during their cooking time. However, they had been very cooperative and despite some inconsistencies in the data, they gave sincere efforts in collecting reliable data. The appliances given to them were

1. Hotplate
2. Rice Cooker
3. Induction Cooker
4. Electric Pressure Cooker.

They were given one appliance at a time and they were requested to cook for 2/3 weeks. Then we provided them with another appliance and the old one was taken back. By this way, we wanted to make sure that we could get an idea about the conveniences/inconveniences while cooking, variation in energy requirement and the opinion of the users on the individual appliance.

It is a well understood reality that the actual cooking time and energy is dependent on the way of cooking. While cooking rice, amount of water added varies and in most of the cases the extra water is drained after the rice is properly boiled. In some cases, only right amount of water is added while boiling and no extra water is left after the rice is cooked. So, depending on the amount of water added, the cooking time and energy varied. As curry is the most common dish, amount of water and time of boiling also varied from household to household for the same type of food (like vegetable, fish, meat etc.). The collected data clearly shows such variations – it varied from user to user and also from one day to another for the same user. In Table 18 below, we present a summary of representative data

Table 18 Energy for different food items, as obtained from the field data

Appliance	Item	Amount (with water and others), gm	Time, min	Energy, kWh
Hotplate	Rice	1200-2000	50-60	0.48-0.65
	Dal	600-2200	30-50	0.50-0.70
	Vegetable	1000-1300	40-50	0.50-0.85
	Beef	900-1000	40-65	0.98-1.53
	Fish	1500-1800	30-48	0.45-0.90
Rice cooker	Rice	1000-1800	40-60	0.32-1.01
	Dal	800-1300	30-65	0.40-0.96
	Vegetable	600-1200	45-55	0.63-0.85
	Fish	800-1500	32-70	0.67-0.90
Induction cooker	Rice	1400-2000	30-60	0.60-0.9
	Dal	-	-	-
	Vegetable	1200-1400,	40-60	0.90-1.05
	Fish	1000-1500	60-70	0.74-0.90
EPC	Rice	1000-2000	34-42	0.35-0.43
	Dal	700-1000	45-60	0.25-0.48
	Vegetable	1200-2200	30-49	0.38-0.89
	Fish	1000-1300	25-30	0.3-0.35

The individual cooking data shows variations in energy consumption for the same type of food of similar quantity. On investigation we realized that as they did not have any previous experience of electric cooking, they learnt it through trial and error and the time and energy for cooking varied. After a few days, a new appliance was given to them and they had very similar experiences with the new appliance once again. So, we ignored some of the data that looked too much away from the expected value. At the same time, the taste of the families varied and the actual cooking process did make a significant variation in energy consumption in the cooking similar foods. As for example, it is a common practice that fish is first fried for a while before water and vegetable is added to it to make fish curry. It is our understanding that the degree of frying varied form one family to the other

and so too the energy for cooking. In the case of rice cooking, the amount of water used for boiling and the time of boiling varied from family to family. However, the data obtained looked realistic when compared to the data we obtained in our lab. It is an interesting observation that none of the families cooked 'dal', a very common item, while using the induction cookers. Induction cookers require cooking pots made from steel and commonly used cooking pots are made from aluminium. The users had one or two cooking pots made from iron and they preferred rice and another dish like vegetable or fish to be cooked in the induction cooker. They preferred dal cooking in their firewood stove as dal cooking is straight forward and does not require much attention.

In Table 19, we have compiled the appliance wise cooking data for the individual families. The 3rd column in the table indicates the % of food cooked in that particular appliance. This column was intended to give an idea that they did not or could not cook some of the food in the appliance due to power failure or limitation of the cooking appliances (like frying is not convenient in rice cooker and pressure cooker) or they had to cook larger amount of food to entertain guest and had to use their biomass-based stove. The last column 'KWh/day' is the calculated value of energy consumption (corresponding to 100% cooking in that particular appliance) per day based on the energy data in column 5, number of days in column 4 and the %cooking data in column 3. The summary of the appliance usage and corresponding energy data is given in the table below.

Table 19 Compiled energy consumption data for the families

Name of the user	Appliance used	% cooking done with the appliance	No. of days	Energy consumed, kWh	kWh/day (scaled to 100% cooking)
Raisa 6-member family	Rice cooker	90	43	119.08	3.08
	Hotplate	90	31	75.25	2.70
	Induction cooker	70	24	47.33	2.82
	EPC	80	15	33.15	2.76
		Total	**113**	**-**	**2.86**
Anisa 6-member family	Rice cooker	80	44	86.21	2.45
	Hotplate	90	30	97.80	3.62
	Induction cooker	60	24	33.72	2.34
	EPC	70	14	29.85	3.05
		Total	**112**	**-**	**2.82**
Sheuli 5-member family	Rice cooker	90	30	58.30	2.16
	Hotplate	90	41	112.62	3.05
	Induction cooker	65	23	42.51	2.84
	EPC	80	25	64.09	2.82
		Total	**119**	**-**	**2.72**

The EPC energy data shows higher energy consumption values than expected. This is due to the fact that we requested them to use only one appliance for cooking food for a particular period of time. So, they used the EPC for pre-frying of the food items with the lid open before putting the food

with water to boil. The table shows that the daily energy consumption is very similar for all three families, as the number of members in the family ranges between 5 and 6. This is quite a reasonable value of energy consumption that will cost them less than firewood or gas cylinder (detailed cost analysis is presented in section 9). It may be mentioned here that all the families buy firewood for their cooking that costs them close to Tk. 800 per month. It is our feeling that with proper training and understanding the actual energy consumption will reduce close to 2.5kWh/day which can have a further positive impact on electric cooking.

8.5. User feedback after completion of data collection

After the data collection cycles were complete (almost 120 days), the users were asked about their feelings on the electric cooking appliances. All the users appreciated the convenience of electric cooking. Earlier, they had to face problems in cooking during wet seasons as the firewood used to generate lots of fumes and cooking in the kitchen. Despite some power failure, they are very happy to cook inside their house with much less effort and physical stress.

The hotplate was the most unpopular appliance, although it was closer to the conventional cookers. The main complaint about the hotplates was their erratic performance. As the users do not have technical background, they could not identify the malfunction of the hotplate thermostats, but complained that they were taking much longer time in cooking after using for a few days. Some of the hotplates had electrical leakage and gave mild electric shocks to the users. All the users had previous experience with rice cookers and they feel that rice cooker is a very good appliance for cooking rice, but is not a very convenient one for foods where initial frying is needed. Regarding the induction cooker, they showed high interest as it can cook all types of foods if the right type of cooking pan (steel-based cooking pan) is used. Frying was never an issue with induction cookers. Although the electric pressure cookers have similar limitations like the rice cooker where frying is difficult, all of the users gave the highest priority to the EPCs. The users felt that the cooking time was quite low and the timer setting option in the EPCs allowed them to have a carefree cooking with no extra attention needed while cooking. All of them have the same opinion that a combination of induction cooker and an EPC would be the best possible option for cooking Bangladeshi foods.

When the users were asked about the cost of electricity in electric cooking appliances, they found out that electric cooking was almost 25% less expensive compared to the cost of firewood (at the tariff level of their electricity consumption). Additionally, one participant had severe respiratory problems and used to buy inhalers and other medicines costing about BDT 1200 per month. After adopting electric cooking, her inhaler cost was reduced by BDT 250. Other users also had respiratory and visual ailments from the firewood fumes but not as severe. All the users were of the opinion that they have a better comfort level and a cleaner cooking environment that has reduced their physical stress and the extra burden of cleaning the blackened cooking pans. The users have shifted their cooking inhouse avoiding the kitchen outside. All of them have a very clear opinion that they would like to continue with electric cooking even if the cost of electricity is slightly higher than the cost of firewood-based cooking.

It is the feeling of all the users that electric cooking gave them more spare time as less attention is needed while cooking. When asked how they would like to use their spare time, they responded that they have almost non-stop activities in the house even when they used to cook in the conventional cooking stoves. They feel more relaxed, can give more time for household activities. Sheuli has to do the house cleaning and feeding the cattle in the backyard. Raisa now gets more time to look after

the grandchildren, praying and reciting the Quran (holy book of the Muslim community). Anisa and her daughter in law Faria cooks in the kitchen. Although Anisa has completed grade 8, her daughter in law is highly educated with a Master degree. Anisa finds cooking more relaxed and Faria gets more time for her 11month old baby and for her preparation for a job. The detailed background and response of the users are given in appendix.

9. Financial Analysis: Cost of electric cooking

The cost implication of electric cooking has two aspects, the upfront cost of the appliances and the recurring cost (energy cost and maintenance). Analysing the data that we have obtained, the cost of electric cooking will vary by about 15-20% if we consider the lab data and the field level data. It indicates that awareness about energy losses and training on how to cook efficiently can make a difference. The field data indicates that an average household in rural Bangladesh will usually have rice, one dal or vegetable dish and a fish or meat curry (fish is the more popular one) as their main meal in the lunch and dinner. During breakfast, they usually take rice, dal or vegetable and tea. As already mentioned, the field level energy data for similar dishes and amounts varied by a significant margin. Although, EPC reduces the energy consumption by a large margin, EPCs are more expensive and not too many people may be interested to buy EPCs. So, in our energy estimation, we used our experience and judgment without going for a straightforward averaging of the obtained data. It may be mentioned here that our results presented in Tables 15 and 16 show that the energy consumption does not increase linearly with the amount of food. So, an educated judgment in estimating the energy consumption would be more realistic rather than going for a linear extrapolation of the energy data. Our assumed energy values for a family of 6 are summarized in the table below.

Table 20 Food and estimated energy consumption for a family of 6 members

Food item	Amount with water and others, gm	Energy data from field data, kWh	Energy data from lab data, kWh
Rice	2500	0.5	0.5
Dal	800	0.55	0.5
Vegetable	1000	0.7	0.55
Fish	1200	0.80	0.5
Chapati	500	-	0.35

If we consider that 50% of the people take chapati in the morning, then we assume the energy consumption due to chapati will be 0.35kWh. Our field level data does not show any chapati cooking by the users as they take rice in the morning. We do not claim that these are the only food items that people take and addition of new food item or having a different menu of food items may have some change in the energy consumption value, but it is expected to be of similar order. Considering the table above, the daily average energy consumption is close to 2.9 kWh if the field data is used. This calculation is consistent with the field data presented in Table 19. On the other hand, the estimate from lab data gives a value of 2.4 kWh/day. So, we assume that the energy consumption for a family of 6 members will vary from 2.4 kWh on the lower side to 2.9kWh on the higher side depending on their level of education, awareness and process of cooking. However, it may be mentioned here that if EPCs are used, we expect a reduction in the energy consumption by more than 25%; but users may not like to cook all types of foods in EPCs. If we ignore EPCs, we estimate

that the average monthly energy consumption will vary within 87 and 72 kWh. In Bangladesh, cost of electricity varies with higher consumption and the electricity tariff is given below.

Table 21 Electricity tariff in Bangladesh for different energy consumption slabs.

Units, kWh	0-50	0-75	76-200	201-300	301-400	401-600	>600
Tariff, BDT	3.75	4.19	5.72	6.00	6.34	9.94	11.46

There is a 15% VAT. (downloaded from Power Cell website on Jan.28, 2021); 1GBP= BDT 110

If we consider an average tariff of BDT 7.00/kWh, this will correspond to a cooking electricity bill ranging from BDT 504 and 609 per month. It may be mentioned here that adopting slower cooking process can reduce the energy consumption by around 25%, as already discussed in Section 7.

Proceeding in the same way, we make an estimate of the energy consumption for the same types of foods cooked in an LPG gas cooker in the lab. Our estimated energy values are presented in Table 22 below.

Table 22 Cooking energy data for LPG for a family of 6 members.

Food item	Amount with water and others, gm	LPG consumed, gm
Rice	2500	65
Dal	800	85
Vegetable	1000	40
Fish	1200	90
Chapati	500	35

From the table we see that the daily consumption of LPG comes out to be 315gm. The LPG price in Bangladesh is BDT 1000 (GBP 1.0= BDT 110) for a 12kg cylinder which corresponds to BDT 0.083/gm (BDT 4.96/kWh). So, the monthly cooking cost with LPG comes out to be BDT 784 per month. However, it is to be considered that the LPG data is based on the lab experiment and the actual consumption outside the lab environment can be higher by 10-15%. Table 23 summarizes the cooking energy cost for a family of six members for different fuel options.

Table 23 Compiled cooking energy cost for different energy sources.

	Firewood	LPG	Electricity
Monthly Cooking energy cost for a family of 6 members, BDT	800	784	552 (average)

As far as the initial cost of purchasing the cooking appliances are concerned, the price of the appliances (Table 1), other than the electric pressure cooker, is within the purchasing capability of the lower middle class. For families, financially not very strong, a single appliance like induction cooker (costing GBP 25-35) will be the best possible option. Although the curry cooker is slightly less expensive than the induction cooker (GBP 20-30), the user will have to transfer the food from

the curry cooker to another pan to cook more items. Rice cookers are quite convenient for cooking rice and are well within the affordability range (GBP 25-35), but many of the Bangladeshi foods (other than rice) will be difficult to cook in rice cookers. The situation is also very similar with electric pressure cookers. However, it has been observed that most of the less expensive appliances are made or assembled in Bangladesh and we face regular problem of thermostat operations within few weeks of usage. This issue needs to be addressed by taking up the issue with the local manufacturers, otherwise popularizing the appliances will be seriously hampered.

Our field data indicated that the users are prepared to buy the electric appliances if there is an opportunity for monthly instalment. The users are prepared to pay an additional amount of BDT 300-600 for the appliances, which is quite an acceptable range to get back the full payment within a year. This is a very positive outlook which indicates that with proper awareness campaign, electric cooking can be made popular very fast if a proper business model is developed.

10. Prospects and problems of e-cooking in the context of Bangladesh

The Bangladesh economy has been growing at a rate close to 6% for last 20 years, with the exception of 2020 (the growth rate was close to 4.5%) due to COVID-19 pandemic. We expect that the economy will start growing again at a rate close to 7% once the pandemic is over. This steady rate of economic growth has significantly increased the purchasing power of the people and at the same time enhanced the economic activities. With this backdrop, we need to judge the prospect of popularizing electric cooking in Bangladesh. From the analysis presented in section 9, we can see that the cost of electric cooking is competitive with that of LPG and firewood. So, the country's economic trend looks positive for the adoption of electric cooking. There is no doubt that economic feasibility is the main concern for such a development, but we must not ignore some other issues that may have significant impact on adopting electric cooking. These issues are:

a) **Lack of awareness**: Our field study shows that people have some idea about rice cookers, but they have not heard of appliances like induction cooker and electric pressure cookers. So, awareness building program is of utmost importance in popularizing electric cooking.
b) **Appropriate business model**: As most of the rural population are using the conventional cooking stoves, switching to electric cooking will require them to buy the appropriate appliances which may be economically burdensome for a significant percentage of rural population. Our studies indicate that they have the capability to pay the price in instalments ranging from BDT 300 to BDT 600 per month. This range of monthly instalment looks quite attractive for a viable business model as the price of appliances like rice cooker, induction cooker or curry cooker can be paid back within 12 to 18 months. So, there needs to be a business model that will encourage them to buy new appliances to switch to electric cooking.
c) **Quality**: Quality of the locally assembled or manufactured products showed serious compromise in the quality control of the products as their performance starts deteriorating within a few weeks of operation. The thermostat is the main element that shows frequent malfunction. As the cost of the local products are at least 25-30% lower than the foreign products, it is expected that they will dominate the market. If people start getting problems from these appliances within weeks of their purchase, it will have a very strong negative influence on the 'frog leap' promotion of the electric cooking. There should be a policy level imposition to grade the appliances (like 3, 4 or 5 star) based on their performance.
d) **Training on cooking**: The lab experiments and the field data indicate that the actual energy consumption in cooking depends on the scientific adoption of the cooking process. We feel that

proper training on the economic usage of the appliances can save the users 20-25% of their cooking energy cost.

e) **Policy Advocacy**: In the stake holders' seminars organized under this program, we felt that there is still significant misunderstanding even in the policy level that wide adoption of electric cooking will over burden our transmission and distribution lines. Advocacy at the policy maker level is important to have the right policy in place to promote electric cooking.

f) **Training of the technicians**: Training of the rural technicians to trouble shoot common problems of electric cooking appliances will be necessary to provide backup support once the appliances get penetration in the market.

g) **Grid power quality**: Power generation scenario has improved significantly over last 5/6 years and presently we have more than 90% population having access to electricity. However, power quality is still an issue as power failure frequency is still at an unacceptable level in some places.

h) **Integration with roof top solar**: In Bangladesh, unlike many of the developing countries, cooking is predominantly done during the daytime that makes it attractive to integrate rooftop solar PV to electric cooking system to reduce power burden on the national grid. At the same time, the cost of energy will also reduce as solar electricity is cheaper than the grid power.

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Appendix A1 *(highlights indicate responses)*

INTERVIEW QUESTIONNAIRE FOR COOKING DIARY PROJECT

Interview before providing electric cooking appliance

Name : Raisa	Address: South Koranipara	
Village/police station: South Koranipara	Upazilla/District: Sadar/ Nilphamari	
General law and order of the locality: Satisfactory	Lat/Long:	
Type of installation	A. DOMESTIC [____]	
Assessment of the owner's Interests	A. Positive B. Negative C. Not sure	

A. BACKGROUND OF THE RESPONDENTS

1. Name: Raisa			
2. Gender: A. Male B. Female	3. Age: A. Young Adult B. Middle Adult (45) C. Late Adult		
4. Category: A. Main bread earner	B. Main Cook	C. Both	D. None
5. Total Family Member: 6	6. School Going Children: A. Yes (My youngest son is doing honours in Management) B. No		
7. Education (Last Degree): Class 9	8. Occupation of the earning member: My husband does business and my elder son owns a computer shop (print, photocopy)		
9. Total Monthly income (Approx.): BDT 20,000	10. Total Monthly Electricity Bill (Approx.): BDT 500		
11. Approx. Fuel-cost/month: BDT 1000			

B. PRESENT COOKING CONDTION (for Domestic user)

13. Who cooks	A. Family Member	B. Others
15. Energy source for cooking	A. Gas (i) Cylinder (Secondary) (II) Other B. Wood (Primary) C. Coal D. Electricity (Rice cooker for rice only)	
16 Usage of Electric Rice Cooker: A Yes B. No	Usage of Pressure Cooker: A Yes B. No	
17. Knowledge of Induction cooker	A. Yes	if yes than : Level of Usage: A. Regular B. sometimes C. never
18. If not using Induction cooker	WHY: A. Billing B. Fear C. Dissatisfied Taste D. Others: (Could not afford to buy an induction cooker)	
19. Number of burners for cooking	1	
20. Time spend for cooking	3 hours	

21. Cooking for how many people	6

C. Level of Interest in Fireless & Heat-less (Clean) Cooking without offering low-cost solution

(This part must be filled in in consultation with the person who physically cooks in the kitchen)

What difficulties are faced with cookers?	Heat( )	smoke( )	carbon particles( )	pot cleaning ( )	Others (During winter biomass don't catch fire easily and during monsoon biomass gets wet and it is also difficult to commute to the outside kitchen due to rain)
Do you have any health problem related to kitchen usage?	Respiratory ( )		Visibility( )	Others(Smoke causes headache and running eyes/Epiphora)	
How much spent for medicine every month? (Approx.)	BDT 400				
Are you interested in electric clean cooking?	Very interested/ Interested		Not interested/extremely disinterested		
	Why: To explore the relative advantages/disadvantages		Why not:		
How much can you afford/month for the appliances?	Full payment( )		Down payment( )	Monthly Instalment (BDT 500)	
Do you know about rice/multi cooker/ Induction cooker/Pressure cooker?	Yes (List) Rice Cooker		No(List)		

To be filled up after using electric cooking appliances

Did you like electric cooking in comparison to your earlier cooking appliance?	Yes/No	
If yes, what are the advantages? (you may choose more than one)	○ Clean ○ No smoke ○ No excessive heat ○ Easy cleaning of cooking pan ○ No health issue ○ Not to worry for stocking dry wood ○ Cooking can be done inside the house ○ Spare time for other household activities ○ Requires less attention while cooking ○ Other: Previously I had to wake up very early in the morning and start cooking food. Now as electric cooking requires less time and attention, I am a bit more relaxed	
What are the disadvantages (you may choose more than one)	○ Takes longer time to cook ○ Cooking all types of food is difficult (Potato fries, Fish fries and chapatti in pressure cooker) ○ Electricity bill may be high ○ Power failure is a problem ○ Other:	
Which type of appliances you liked most (write the order of preference on the right side of the appliance); highest preference is 1 and lowest is 4	4. Hotplate: Why: over-heating and electric shock 3. Rice Cooker: Why: All types of foods cannot be cooked 2. Induction cooker: Why: Needs monitoring otherwise food may burn 1. Electric Pressure cooker: Why: Auto cooking, takes less time	
Did the appliance change the way you cook? If so, how?	Takes less time, better taste, and improved kitchen hygiene	
Have the responsibilities for preparing food changed at all with the new appliances? For example, do other members of the family now cook more often?	Daughter in law helps in cooking more often than before	
Have you learned any new tips/techniques to help you cook with these appliances? If so, how did you learn them?	Initially for cooking any particular dish, I used same amount of water in case of pressure cooker like I used in case of induction cooker which used to overcook the food and took more time. Now I use less amount of water and cooking seems to be perfect now	
Were there foods/dishes you found easy (or enjoyable) to cook in the appliance?	Meat (Beef) (pressure cooker) and Khichuri (pressure cooker)	

Were there foods/dishes you struggled to, or could not, cook using the appliance? If so, which?	Shuk vaji (vegetable fry), Alu vaji (potato fry), Fish fry (Pressure cooker)
Do you think you will use electricity for cooking after the project is over?	Partial/full, Why: Less time, less expensive, more hygienic, indoor cooking can be done
Would you recommend any of the appliances? Which ones? Why?	Pressure cooker (Less time and auto cooking)
Have your neighbors/friends/family shown interest in acquiring these appliances?	Yes
Do you feel that electric cooking requires less attention and you get some spare time?	Yes/No If yes how do you plan to use that time: I do other household chores, give time to grandchild, take my prayer)
Who is responsible for paying the electricity bill?	My husband
Who is responsible for decisions around cooking fuel?	Myself
Who is responsible for decisions around cooking appliances?	Myself
Do you experience power outages at all? - If so, how often? And how long do the outages last?	Power outages took place rarely. Power outage vary from 30 mins to 1 hour. In case of maintenance, prior notice is given to us and we cook during the morning time .
Do outages affect cooking with electrical appliances? yes If yes, how do you cook?	Gas burner / Firewood

Have you had any of electric cooking appliances breakdown or fail?	No
If so, what was the problem?	Wiring/Human error/Electrical /Poor quality/durability/Wear and tear
How did you attempt to solve the problem?	No
If something went wrong, is there someone in the area that you know who fixes electrical appliances?	Yes
Has this experience affected your mindset with regards to buying future electric cooking appliances? If so, how?	Yes. I will utilize my experience during cooking.
Are there any other observations you would like to make?	I am a bit concerned about the availability of the appliances
Would you be interested in being involved in another cooking diary study?	Yes

Appendix A2 *(highlights indicate responses)*

INTERVIEW QUESTIONNAIRE FOR COOKING DIARY PROJECT

Interview before providing electric cooking appliance

Name: Anisa	Address: Madrashapara	
Village/police station: West Khutamara/Jaldhaka	Upazilla/District: Jaldhaka/ Nilphamarai	
General law and order of the locality: Satisfactory	Lat/Long:	
Type of installation	A. DOMESTIC [____]	
Assessment of the owner's Interests	A. Positive B. Negative C. Not sure	

A. BACKGROUND OF THE RESPONDENTS

1. Name: Anisa and Faria (daughter in law of Anisa)			
2. Gender: A. Male B. Female	3. Age: A. Young Adult (26) B. Middle Adult (55) C. Late Adult		
4. Category: A. Main bread earner	B. Main Cook	C. Both	D. None
5. Total Family Member: 6	6. School Going Children: A. Yes (My daughter is in Honours 3rd year in English) B. No		
7. Education (Last Degree): grade 8	8. Occupation of the earning member: Husband : Farmer Son: Job at Palli Biddut Samity		
6. Total Monthly income (Approx.): BDT 30, 000	10. Total Monthly Electricity Bill (Approx.): BDT 600		
11. Approx. Fuel-cost/month: BDT 800			

B. PRESENT COOKING CONDTION (for Domestic user)

13. Who cooks	A. Family Member	B. Others
15. Energy source for cooking	A. Gas (i) Cylinder (II) Other B. Wood C. Coal D. Electricity (Rice cooker)	
16 Usage of Electric Rice Cooker: A Yes B. No	Usage of Pressure Cooker: A Yes B. No	
17. Knowledge of Induction cooker	A. Yes	if yes than : Level of Usage: A. Regular B. sometimes C. never
18. If not using Induction cooker	WHY: A. Billing B. Fear C. Dissatisfied Taste D. Others (Lack of knowledge and awareness)	
19. Number of burners for cooking	1	

20. Time spend for cooking (hrs)	3
21. Cooking for how many people	6

C. Level of Interest in Fireless & Heat-less (Clean) Cooking without offering low-cost solution

(This part must be filled in in consultation with the person who physically cooks in the kitchen)

What difficulties are faced with cookers?	Heat( )	smoke( )	carbon particles( )	pot cleaning ( )	others(Kitchen and firewood gets wet during rain)
Do you have any health problem related to kitchen usage?	Respiratory ( )		Visibility( )	Others( )	
How much spent for medicine every month? (Approx.)	: BDT 400				
Are you interested in electric clean cooking?	Very interested/ Interested		Not interested/extremely disinterested		
	Why: I heard that electric cooking does not produce smoke and kitchen can be set inside my house		Why not:		
How much can you afford/month for the appliances?	Full payment( )		Down payment( )	Monthly Instalment(BDT 600)	
Do you know about rice/multi cooker/ Induction cooker/Pressure cooker?	Yes (List) Rice cooker Water heater		No(List)		

To be filled up after using electric cooking appliances

Did you like electric cooking in comparison to your earlier cooking appliance?	Yes/No	
If yes, what are the advantages? (you may choose more than one)	○ Clean ○ No smoke ○ No excessive heat ○ Easy cleaning of cooking pan ○ No health issue ○ Not to worry for stocking dry wood ○ Cooking can be done inside the house ○ Spare time for other household activities ○ Requires less attention while cooking	

	○ Other:
What are the disadvantages (you may choose more than one)	○ Takes longer time to cook ○ Cooking all types of food is difficult () ○ Electricity bill may be high ○ Power failure is a problem ○ Other:
Which type of appliances you liked most (write the order of preference on the right side of the appliance); highest preference is 1 and lowest is 4	4. Hotplate: Why: food used to get burnt 3. Rice Cooker: Why: All types of foods cannot be cooked 2. Induction cooker: Why: No auto cooking mode and needs monitoring 1. Electric Pressure cooker: Why: Auto cooking, takes less time
Did the appliance change the way you cook? If so, how?	Takes less time, no tension of keeping firewood dry
Have the responsibilities for preparing food changed at all with the new appliances? For example, do other members of the family now cook more often?	No
Have you learned any new tips/techniques to help you cook with these appliances? If so, how did you learn them?	No
Were there foods/dishes you found easy (or enjoyable) to cook in the appliance?	Khichuri, Payesh, Vegetables (pressure cooker)
Were there foods/dishes you struggled to, or could not, cook using the appliance? If so, which?	No
Do you think you will use electricity for cooking after the project is over?	Partial/full, Why: Less time, less expensive, more hygienic, indoor cooking can be done.
Would you recommend any of the appliances? Which ones? Why?	Pressure cooker (It takes less time to cook food, food is cooked automatically and food taste is also enhanced)
Have your neighbors/friends/family	Yes

shown interest in acquiring these appliances?	
Do you feel that electric cooking requires less attention and you get some spare time?	Yes/No If yes how do you plan to use that time: (Daughter in law) I study for job preparation and take care of my baby who is 11 months old
Who is responsible for paying the electricity bill?	My husband
Who is responsible for decisions around cooking fuel?	Myself
Who is responsible for decisions around cooking appliances?	Myself
Do you experience power outages at all? - If so, how often? And how long do the outages last?	Very rarely. Usually outage lasts 30 mins to 1 hour
Do outages affect cooking with electrical appliances? - If yes, how do you cook?	Not so often, I use wood burner.
Have you had any of electric cooking appliances breakdown or fail?	No
If so, what was the problem?	Wiring Human error Electrical Poor quality/durability Wear and tear
How did you attempt to solve the problem?	
If something went wrong, is there someone in the area that you know who fixes electrical appliances?	Yes

Has this experience affected your mindset with regards to buying future electric cooking appliances? If so, how?	Yes. I will utilize my experience so far
Are there any other observations you would like to make?	It would be very convenient if induction cooker can be made compatible for all utensils. Otherwise many of us won't be interested to buy induction cooker as most of the utensils we have is not supported by induction cooker and hence we have to buy new utensils.
Would you be interested in being involved in another cooking diary study?	Yes

Appendix A3 *(highlights indicate responses)*

INTERVIEW QUESTIONNAIRE FOR COOKING DIARY PROJECT

Interview before providing electric cooking appliance

Name: Sheuli	Address: Kamarpara	
Village/police station: Kamarpara/ Joldhaka	Upazilla/District: Joldhaka/Nilphamari	
General law and order of the locality: Satisfactory	Lat/Long:	
Type of installation:	A. DOMESTIC [____]	
Assessment of the owner's Interests	A. Positive B. Negative C. Not sure	

A. BACKGROUND OF THE RESPONDENTS

1. Name: Sheuli			
2. Gender: A. Male B. Female	3. Age: A. Young Adult B. Middle Adult (35) C. Late Adult		
4. Category: A. Main bread earner	B. Main Cook	C. Both	D. None
5. Total Family Member: 5	6. School Going Children: A. Yes (3 college going child) B. No		
7. Education (Last Degree): Class 8	8. Occupation of the earning member: Barber		
9. Total Monthly income (Approx.): BDT 12000	10. Total Monthly Electricity Bill (Approx.): BDT 500		
11. Approx. cooking fuel-cost/month: BDT 650			

B. PRESENT COOKING CONDTION (for Domestic user)

13. Who cooks	A. Family Member	B. Others
15. Energy source for cooking	A. Gas (i) Cylinder (II) Other B. Wood C. Coal D. Electricity(Rice cooker)	
16 Usage of Electric Rice Cooker: A Yes B. No	Usage of Pressure Cooker: A Yes B. No	
17. Knowledge of Induction cooker	A. Yes	if yes than : Level of Usage: A. Regular B. sometimes C. never
18. If not using Induction cooker	WHY: A. Billing B. Fear C. Dissatisfied Taste D. Others: Village people mostly use wood	
19. Number of burners for cooking	1	
20. Time spend for cooking	2 hours	

21. Cooking for how many people	5

C. Level of Interest in Fireless & Heat-less (Clean) Cooking without offering low-cost solution

(This part must be filled in in consultation with the person who physically cooks in the kitchen)

What difficulties are faced with cookers?	Heat( )	smoke( )	carbon particles( )	pot cleaning ( )	others(Rain, Wind, Contamination of food , Wet wood needs to be dried, resized and stored in a place where it will remain dry)
Do you have any health problem related to kitchen usage?	Respiratory ( )		Visibility( )	Others (No roof over the kitchen hence during rain I can't cook)	
How much spent for medicine every month? (Approx.)	: BDT 1200 (Pulmonary medicines)				
Are you interested in electric clean cooking?	Very interested/ Interested		Not interested/extremely disinterested		
	Why: To explore the advantages/disadvantages		Why not:		
How much can you afford/month for the appliances?	Full payment( )		Down payment( )	Monthly Instalment( ) BDT 300	
Do you know about rice/multi cooker/ Induction cooker/Pressure cooker?	Yes (List) Rice cooker		No(List)		

To be filled up after using electric cooking appliances

Did you like electric cooking in comparison to your earlier cooking appliance?	Yes/No	
If yes, what are the advantages?	○ Clean ○ No smoke ○ No excessive heat	

(you may choose more than one)	○ Easy cleaning of cooking pan ○ No health issue ○ Not to worry for stocking dry wood ○ Cooking can be done inside the house ○ Spare time for other household activities ○ Requires less attention while cooking ○ Other: Less time required
What are the disadvantages (you may choose more than one)	○ Takes longer time to cook (hot plate) ○ Cooking all types of food is difficult (Fish fry and all types of fry items, Chapati) ○ Electricity bill may be high ○ Power failure is a problem ○ Other: Specific type of utensil for Induction cooker
Which type of appliances you liked most (write the order of preference on the right side of the appliance); highest preference is 1 and lowest is 4	4. Hotplate: Why: Takes longer time 3. Rice Cooker: Why: Fried items can't be cooked 2. Induction cooker: Why: All types of food can be cooked 1. Electric Pressure cooker: Why: Takes less time & energy
Did the appliance change the way you cook? If so, how?	Takes less time, Improved food taste (Polaw, Payesh)
Have the responsibilities for preparing food changed at all with the new appliances? For example, do other members of the family now cook more often?	My son and Daughter show more interest to cook now which was not the case with wood based cooking.
Have you learned any new tips/techniques to help you cook with these appliances? If so, how did you learn them?	Initially the rice cooked using pressure cooker was a bit hard which my husband did not used to like. Then I increased the amount of water. Now the rice is soft enough.
Were there foods/dishes you found easy (or enjoyable) to cook in the appliance?	Meat, Polaw, Payesh
Were there foods/dishes you struggled to, or could not, cook using the appliance? If so, which?	Roti /Chapati (Rice cooker & Pressure cooker), Fish fry (Rice cooker, pressure cooker)
Do you think you will use electricity for cooking after the project is over?	Partial/full, Why: Heat, smoke, carbon particles, health, open kitchen.

Would you recommend any of the appliances? Which ones? Why?	Pressure cooker & induction cooker
Have your neighbors/friends/family shown interest in acquiring these appliances?	Yes
Do you feel that electric cooking requires less attention and you get some spare time?	Yes/No If yes how do you plan to use that time: Household chores, provides care to cattle and children.
Who is responsible for paying the electricity bill?	Husband
Who is responsible for decisions around cooking fuel?	Myself
Who is responsible for decisions around cooking appliances?	Myself
Do you experience power outages at all? - If so, how often? And how long do the outages last?	During the project time, power outrages occurred few times. The outrage duration usually varies from 15 mins to 60 mins.
Do outages affect cooking with electrical appliances? - If yes, how do you cook?	Yes. Sometimes. Wood based burner is used.
Have you had any of electric cooking appliances breakdown or fail?	The hot plate had insulation failure issues sometimes (electric shock)
If so, what was the problem?	Wiring Human error Electrical Poor quality/durability Wear and tear
How did you attempt to solve the problem?	Appliance was changed from the project
If something went wrong, is there someone in the area that	Yes

you know who fixes electrical appliances?	
Has this experience affected your mindset with regards to buying future electric cooking appliances? If so, how?	Yes. I will utilize my experience during cooking. I have already helped my niece to buy an induction cooker.
Are there any other observations you would like to make?	My expenses for medicine has been reduced by 30%.
Would you be interested in being involved in another cooking diary study?	Yes of course.