Analysis of Technical Aspects and Economic Aspects of Electrical Energy Consumption in the Induction Stove Program

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Abstract: Stove is a cooking utensil for households to provide food to meet daily needs. LPG gas stoves are very commonly used by various groups because they're easy to buy and in terms of prices are very affordable because of subsidies from government which makes gas prices very affordable because government still provides subsidies for LPG for 3-kilogram. The government is now encouraging the Import-Based Energy Transfer Program into Domestic-Based Energy through the Conversion of LPG Stoves to Induction Stoves to support National Energy Security, and the conversion of LPG stoves to Induction cookers as one of the strategies to reduce LPG imports. In previous studies, the performance of gas stoves and induction cookers was tested, comparing energy consumption and economic aspects by testing them in boiling 1 liter of water. From the results of research on technical aspects, it states that an induction stove can replace a 3-kilogram LPG stove, the use of an induction cooker with a 2-burner design (1,000 Watt and 1,800 Watt), cooking costs are more efficient Rp. 45,770/month for the power group of 450VA and Rp. 30,190/month for 900VA power group households. The economic aspect has an impact on reducing LPG imports to meet national energy needs.

1 INTRODUCTION

Stoves are daily necessities that are used by the community as a tool to provide various foods to meet basic needs. The use of gas stoves is very commonly used by various groups because they are easy to buy and in terms of cost are very affordable due to subsidies from the government which causes gas prices to be very affordable (Pawenary, 2020).

In Indonesia's efforts towards the transition of Net Zero Emmision and supporting environmentally friendly campaigns, the Government is now encouraging the Transfer of Import-Based Energy to Domestic-Based Energy through the Conversion of LPG Stoves to Induction Stoves to support National Energy Security, and the conversion of LPG stoves to Induction stoves is one of the strategies to reduce LPG lmpor tubes of 3 kg, which began with through the movement of 1 million induction stove users in 2021 and starting in 2022, it will increase by 2 million / year so that it reaches 18.2 million induction stove users in 2030. The Government's strategy in the LPG stove conversion program to Induction stoves in addition to aiming to save lpg import costs is also to save significant LPG subsidies, because LPG consumption in the household sector (LPG stoves) has a portion of almost 96% of the total national LPG consumption.

Based on the description above, it is necessary for researchers to answer the problems mentioned above through the analysis of technical aspects and economic aspects of electrical energy consumption in the induction stove program so that the public can know the differences and advantages of using these stoves.

This research will be conducted to compare and the benefits of induction stoves and gas stoves such as the amount of energy consumption and the costs required in their use.

2 METHODOLOGY

The testing methods that will be carried out in this study are as follows:

a. Heating water from temperature ± 20 °C to ± 90 °C;
b. Water mass weighing ± 2500 grams;

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c. Using the same time/utensil tool (for testing induction and LPG stoves);
d. Efficiency is calculated the ratio of the displacement of the kalor (Q = m x cp x ΔT) with the use of real heat; and
e. KPM 450 VA, on the kWh Meter was replaced the original power limit (MCB) of 2 A was changed to 10 A. Installation of a Split Connect Panel box (PHB) where two MCBs with a capacity of 10 A for cooking with Induction Stoves and 2 A for non-cooking according to contract power.

The stages of testing that will be carried out in this study are as follows:

a. Induction stove measurement data collection includes maximum power setting, maximum rated power, time, energy consumption, conversion, efficiency during the discharging of the induction stove;
b. Taking gas stove measurement data includes the mass of gas (before and after use) to determine the magnitude of the amount of heat used and data on time changes; and
c. Comparative Measurement of Energy Use and Cost Results on Induction Stoves and Gas Stoves on customers of 450 VA power and 900 VA power.

2.1 Equations Used in the Study

2.1.1 Effort or Electrical Energy

Effort or electrical energy can also be expressed in the following, equation:

$$W = V.I.t \quad (1)$$

Where:
I = Strong electric current (amperes)
V = Potential difference (volts)
t = time (second)
W = Electrical effort or energy (Watt.second or Joule)

2.1.2 Thermal Energy (Heat)

If a substance or object undergoes a change in shape or form at a fixed temperature, a certain amount of heat is needed in the process. The magnitude of the required amount of heat can be expressed in the following equation:

$$Q = m.L \quad (2)$$

Where:
Q = Amount of heat released or absorbed (Joule)
m = Mass of an object or substance (kg)
L = The amount of heat released/absorbed any change in the shape or form of a substance per unit mass or can also be referred to as Heating Value (Joule/Kg).

2.1.3 Efficiency

Efficiency is calculated by comparing the heat transfer with the use of real heat.

$$Q = m \times cp \times T \quad (3)$$

Where:
Q = Heat needed or released
M = mass
Cp = calorific type of substance
ΔT = the difference between the initial temperature and the final temperature.

2.2 Equipment Specification on Induction Stove Testing

1. Type/Brand of Induction Stove: Induction Stove 1 Furnace (@ 1,000 Watt).
   a. Maximum Power: 1200 Watt -2000 Watt
   b. Customer Electrical Power: 450 VA and 900 VA
   c. Basic Electricity Tariff: Rp. 160/kWh and 1,352/kWh.

Figure 1: Induction stove 1 furnace.

2. Type/Brand of Induction Stove: Induction Stove 2 Furnace (@ 1,800 Watt + 1,000 Watt).
   a. Maximum Power: 1200 Watt - 2000 Watt.
   b. Customer Electrical Power: 450 VA and 900 VA.
   c. Basic Electricity Tariff: Rp. 160/kWh and 1,352/kWh.

Figure 2: Induction stove 2 furnace.

3. Replacement Power limit: KPM 450 VA, on kWh Meter is done replacement of the power limit (MCB).
   a. MCB I: 10 A for cooking with Induction Stove;
   b. MCB II: 2 A for non-cooking according to contract power.

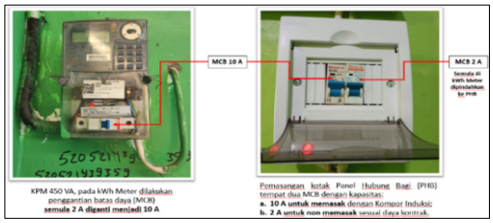

Figure 3: Replacement of the KPM Power Meter to KPM Power Limit 450 VA (ESDM, 2022).

4. The IoT module for reading induction cooker electricity consumption provides information on kWh usage data by bluetooth or Scan QRcode on each induction cooker that can be monitored.

Figure 4: The IoT feature of reading electricity consumption on an induction cooker (ESDM, 2022).

2.3 Equipment Specifications on Gas Stove Testing

1. Type/Brand of Gas Stove: Gas Stove 1 Furnace.
2. Gas Cylinder Mass Before use: 8 Kg.
3. Gas Content/Composition: 30% Propane and 70% Butane.
4. Price of 3 kg LPG gas: Rp.21.000 (subsidized).

3 RESULTS AND DISCUSSION

3.1 Induction Cooker Testing

Testing on induction stoves was carried out as many as 13 times measurements with different stove power (ESDM, 2022). Measurements are carried out with measurement parameters as described in the table below.

Table 1: Testing data of 1 furnace induction stove with a power of 1,200-2,000 watts.

Brand	Max Power setting	Max Power rated	Time T20-T90		Energy Consumption	Conversion	Efficiency
Stove 1 Furnace	Watt				kWh	Kcal	
Stove A	1200	1200	14 minutes	10 seconds	0,279	242	72%
Stove B	1300	1230	13 minutes	53 seconds	0,273	235	75%
Stove C	1300	1294	13 minutes	15 seconds	0,275	237	74%
Stove D	1500	1292	13 minutes	42 seconds	0,289	249	71%
Stove D1	1500	1621	9 minutes	24 seconds	0,252	216	81%
Stove E1	1600	1548	10 minutes	26 seconds	0,265	228	77%
Stove D2	1800	1828	8 minutes	23 seconds	0,254	218	80%
Stove E2	1800	1759	8 minutes	58 seconds	0,256	221	79%
Stove E	2000	1918	8 minutes	12 seconds	0,250	215	81%
Stove F	2000	1879	8 minutes	40 seconds	0,270	228	77%
Stove G	2000	1916	8 minutes	38 seconds	0,268	231	76%
Stove H	2000	2025	7 minutes	56 seconds	0,261	225	78%
Stove I	2000	1903	8 minutes	16 seconds	0,257	221	79%
LPG			10 minutes	58 seconds	0,0347 kg	391	45%

Table 2: Testing data for 2 furnaces induction stoves with 2 x 2000 watts of power.

Brand	Max Power setting	Max Power rated	Time T20- T90		Energy Consumption	Conversion	Efficiency
Stove 2 Furnace	Watt				kWh	Kcal	
Stove AB (@1000 W)	2 x 1000 Watt	1988	21 minutes	35 seconds	0,680	585	60%
LPG			10 minutes	58 seconds	0,0347 kg	391	45%

3.2 Comparison of Test Data for a 1 Furnace Induction Cooker with a Power of 1,200 – 2,000 Watt

Comparison of test data for a 1 furnace induction stove with a power of 1,200 - 2,000 Watts (ESDM, 2022) as described in the table below.

Table 3: Comparison of 1 furnace induction stove test data with power 1,200-2,000 Watts.

No.	Parameters	Stove LPG 3 kg	Induction Cooker	Information
1.	Time required to cook	10 minutes	8 minutes (Power 1,800 Watts)	Induction Stove faster cooking boiling water 90 °C compared to 3 kg LPG Tube stove
2.	Energy Consumption	391 Kcal.	218-221 Kcal	
3.	Monthly energy consumption	11.4 Kg	82 kWh (equivalent to 11.4 Kg)	The cost of cooking with an induction stove is more efficient than a 3 Kg LPG stove
4.	Cooking Costs Power 450 VA	Rp. 79.800/ month	Rp.34.030/ month	
5.	Cooking Costs Power 450 VA	Rp. 79.800/ month	Rp.49.610/ month	
6.	450 VA cook cost-effective	-	Rp45.770/ month	
7	900 VA cook cost-effective	-	Rp30.190/ month (Gol 900 VA)	

3.3 Average User of Subsidized Household Induction Stove

Data on the average household cooking per day 2-furnace induction stove is 2 hours on per day (ESDM, 2022).

So the data on the average monthly use of an induction cooker for cooking are: (2 JN x 1,8 kw x 30 days x 0,76) = 82 kWh. Where: 1.8 kw is the optimal power capacity of induction cooker discharging 2 furnaces.

3.4 Comparison of Energy Use Results and Costs on Induction Stoves and Gas Stoves on Customers of 450 VA Power and 900 VA Power

The comparison results of the calculation of energy consumption and costs on induction stoves and gas stoves on customers of 450 VA power and 900 VA power are shown in the following table.

Table 4: Data on the results of the comparison of energy consumption and costs on induction stoves and gas stoves on customers of 450 VA power and 900 VA power from the consumer side.

Consumer Side	Induction cooker			LPG 3 kg	
	Group 450 VA	Group 900 VA	Unit	Massive	Unit
Energy consumption/month (equivalent)	82	82	Kwh	11.4	Kg
Energy prices in consumers	415	605	Rp/kWh	7.000	Rp/kg
Cooking cost per month	34,030	49,610	Rp/month	79,800	Rp/month
Save on cooking costs	45,770	30,190	Rp/month		
Break Even Point (BEP)	2,7	4,1	Year		

Table 5: Data on the comparison of energy use and costs on induction stoves and gas stoves for customers with 450 VA power and 900 VA power from the APBN side.

State Budget Side	Induction cooker			LPG 3 kg	
	Group 450 VA	Group 900 VA	Unit	Massive	Unit
Economic pricing	1,640	1,640	*Rp/kWh*	17,208	*Rp/kg* *)
Subsidized Energy Prices	415	605	*Rp/kWh*	4,250	*Rp/kg*
Subsidies per volume	1,225	1,035	*Rp/kWh*	2,958	*Rp/kg*
Subsidies per month	**100,411**	**84,831**	***Rp/month***	**147,721**	***Rp/month***
Save on subsidies compared to 3kg LPG	**7,310**	**62,890**	***Rp/month***		

4 CONCLUSIONS AND SUGGESTIONS

Based on the research that has been carried out, it can be concluded that:

The use of induction stoves with a design of 2 furnaces (1,000 Watts and 1,800 Watts) (ESDM, 2022), then:

a. The cost of cooking with an induction cooker is IDR 45,770/month for a household with a 450 VA power group compared to using a 3 kilogram tubes gas stove with liquefied petroleum gas; and
b. The cost of cooking with an induction cooker is IDR 30,190/month for a household with a power of 900 VA power group compared to using a 3 kilogram liquefied gas fuel stove;

The use of energy on induction stoves can replace 3 kilogram tubes LPG gas stoves, this is from the

results of research to save subsidies compared to 3 kilogram LPG, then:

a. The cost of cooking with an Induction Cooker can save more in subsidies of IDR. 47,310/month for 450 VA power group households; and
b. The cost of cooking with an Induction Cooker can save more in subsidies of IDR. 62,890/month for 900VA power group households.

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