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The Economic Impact of the Induction Stove Conversion Program in Indonesia

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Abstract

The Indonesian government has been facing problems related to LPG subsidies for households, domestic supply shortages, and electricity oversupply for nine years. Increasing LPG stoves to induction stoves is an alternative policy to overcome these problems. The research was conducted by calculating the net benefits households, the government, and companies received due to the conversion of LPG stoves to induction cookers. Then, it becomes a stimulus for the national economy, calculated through input-output analysis. Calculations are made based on two program scenarios: the conversion of households receiving electricity and gas subsidies (scenario I) and soft selling schemes (scenario II) from 2023 – 2030. The analysis shows that households participating in the program can save energy expenditure between IDR 260,011 – IDR 2,163,452, energy subsidies of IDR 22.65 trillion, and imports of 10% - 18.90% per year. The impact of the national economy in scenario I through input-output analysis creates a GDP of IDR 71.01 trillion and a labour income of IDR 21.88 trillion. Meanwhile, scenario II creates a GDP of IDR 52.85 trillion and a labour income of IDR 19.76 trillion. The soft selling scheme minimizes government costs and significantly impacts the national economy so that it can be implemented as a national program.

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INTRODUCTION

Several developing countries are developing access to clean cooking facilities. India is promoting the use of biogas stoves and solar stoves. Ethiopia is developing ethanol stoves. Meanwhile, Cameroon, Ecuador, Ghana, and Indonesia are promoting significant use of LPG (Purohit et al., 2002; Benka-Coker et al., 2018; Quinn et al., 2018)

The success of the kerosene to LPG conversion program, which began in 2007 in Indonesia, has implications for an average consumption increase of 5% per year, accompanied by an increase in LPG imports and consumption of 3kg cylinder LPG which is subsidized LPG (MEMR, 2021). Figure 1 shows that more than 70% of the national LPG supply comes from imports, resulting in a negative trade balance.

The increase in consumption of 3kg (subsidized) LPG cylinders was due to the price being fixed by the government and using an open distribution system (PKAPBN, 2020). Meanwhile, the selling price of non-subsidized LPG fluctuates according to world oil and gas market prices. As a result, the burden of LPG subsidies continues to increase yearly (P3TKEBTKE, 2020; Suharsono et al., 2021). To overcome this, the House Representatives of The Republic of Indonesia (DPR) and the government agreed to change the open distribution policy to a closed distribution in the non-cash form directly to targeted households by 2022 (Directorate General of Oil and Gas, 2021). The reformation of the LPG subsidy is expected to result in specific segments of the population, who previously benefited from subsidized LPG at a relatively low cost, incurring higher expenses to obtain LPG. Additionally, the cessation of LPG imports contributes to a diminishing supply, leading to potential shortages.

On the other hand, data for the last nine years shows that PLN's electricity oversupply is 28 thousand – 30 thousand GWH compared to the electricity sold each year (PLN, 2022). Based on the take-or-pay contract system implemented by PLN, the government must allocate approximately IDR 3 trillion for each excess gigawatt supply (Ahdiat, 2022). This has resulted in an expansion of the national budget issued by the state. Furthermore, per capita electricity consumption in Indonesia still significantly lags behind that of Southeast Asian countries. As of September 2022, per capita electricity consumption in Indonesia stood at 1,169 kWh/capita, while the ASEAN average electricity consumption was 3,672 kWh/capita (MEMR, 2022). Consumers need to increase their electricity consumption to absorb the energy reserves generated by power plants. Therefore, the Government continues to support policies and regulations to accelerate the increase in electricity consumption, including in the household sector.

Transitioning from LPG to induction stoves is an alternative government policy to address this issue. Several countries have previously promoted induction cookers as an alternative to LPG. Ecuador initiated the PEC program in 2015 to convert LPG stoves to induction cooktops for 3.5 million households (80% of total households) by 2018 (Gould C. F., et al., 2018). India is also studying the potential for using induction cookers due to their dependence on imports, price volatility, and inefficiencies in the distribution of LPG (IRAD, 2018). Meanwhile, the United States is considering banning the use of household gas stoves due to the findings of Gruenwald (2022) regarding a 35% increase in the risk of asthma in children in the United States or as many as 12% of cases of asthma in children due to household gas stoves. (Gruenwald et al, 2022).

Studies related to electricity consumption using induction cookers have been carried out in several countries. Tiandho (2020) and Irsyad (2022) found that the electricity consumption for cooking 1L of water is 0.108 kWh – 0.318 kWh. Saha (2021) in Bangladesh found that the average consumption of electricity for cooking per household of 5 – 6 people is 2.5 kWh/day. Meanwhile, Banerjee (2016) in India found that household electricity consumption for cooking was 82 kWh/month. Meanwhile, economic simulations conducted by Hakam (2020) show

that by consuming 2.34 – 3.02 kWh/day, low-income households will save cooking costs of IDR 10,344/month (300 W induction cooker) or IDR 21,344/month (induction hob 500 W). Meanwhile, middle-high income households can save IDR 43,606/month (1800 W stove) (Tiandho et al., 2020; Irsyad et al., 2022; Saha et al., 2021; Banerjee et al., 2016; Hakam et al., 2022).

Several studies have been conducted on the impact of the energy sector and the national economy through the input-output method. Input-output analysis is a method that can reveal the interrelationships between sectors at a granual level, facilitating detailed insights into growth dynamics (Nazara, 2005). Through the input-output analysis method, it was found that the global financial crisis had an impact on reducing energy consumption by 16% in Malaysia and 9.21% in China. In comparison, GDP decreased by 13% in Malaysia and 7.33% in China. The stimulus from the Malaysian government, amounting to RM67,000, is projected to boost GDP by 1.83% and energy consumption by 4.64%. Meanwhile, a stimulus package of RMB 4,000 billion in China is expected to increase GDP by 4.43% and energy consumption by 1.83% (Bekhet & Yasmin, 2014; Yuan, Liu, & Xie, 2010).

As a basis for making national policies, a program should be based on studies both at the household and national levels. Previous studies only considered the cost implications of energy due to using induction stoves. However, this is the first research that considers investment costs for cooking, revenues from the industrial sector, spending on the government, and its impact on the national economy. The program to convert LPG stoves to induction cookers will have an impact on changes in final demand for household consumption, especially energy consumption, the induction cooker industry and its supporting equipment, the LPG distribution business sector, as well as the efficiency value of energy subsidies by the government which will then become a stimulus for the national economy. This study aims to complement previous studies related to saving energy consumption at the household level by calculating the economic impact on households, industry, and government to the macroeconomic impact of the conversion program of LPG stoves to induction cookers through two policy scenarios, namely policies on households receiving energy subsidies and a soft selling scheme for wealthy households so that it can be taken into consideration in policy-making. The results of the study are expected to provide input and policy evaluation in preparing government programs, especially programs using induction cookers as an alternative to LPG.

RESEARCH METHODS

The analysis begins by calculating the value of the net benefits received by households and business entities in the electricity supply sector, induction cookers, induction cooker supporting equipment, the LPG distribution business sector and the government's net benefit, which then acts as a stimulus by using the multiplier model through input-output analysis. The Input-Output table used is the 2016 Indonesia Input-Output table published by the Central Statistics Agency of the Republic of Indonesia in 2021. The study assumes that there have been no significant changes in the economic structure between 2016 and 2022. For example, the manufacturing sector has been the largest contributor to GDP from 2016 to 2023, followed by the Wholesale and Retail Trade sector, based on constant prices (CSA, 2020; CSA, 2022).

The economic impact calculations are based on two program scenarios, as shown in Table 1. In the simulation of household calculations in scenario I, the government aims to distribute free induction stoves to subsidized households, starting with 300 thousand units at the beginning of the activity, increasing to 5 million units annually, reaching 8.2 million units by 2025. Subsequently, the number of induction stove users increases by 2 million units annually, reaching 18.3 million units in accordance with the National Energy Grand Strategy (Damayanti, 2022; Munir, 2021). As for non-subsidized households (above 1300 VA), the number of induction stove users is adjusted based

on the average growth rate of induction stove users by The Central Statistic Agency from 2020 to 2021, which is 10,000 units multiplied by the average household growth rate in Indonesia, which is 1.2% (CSA, 2021). In scenario II, the number of induction stove users through the soft selling scheme is 2 million units annually as stated in the National Energy Grand Strategy and increasing by 1.2% annually according to the population growth rate.

The data used is secondary data obtained from P3TKEBTKE-KESDM, BPS, Directorate General of Electricity and Directorate General of Oil and Gas, Ministry of Energy and Mineral Resources, and PT. PLN.

Table 1. Number of households based on the scenario of converting LPG stoves to induction stoves

HH Electrical Power (VA)	Number of households	Simulation of additional plans for induction cooker users (thousand households)							
		2023	2024	2025	2026	2027	2028	2029	2030
Scenario I (Conversion in subsidy recipient households)									
450	24,403,120	225	2,250	3,750	1,500	1,500	1,500	1,500	1,500
900	8,562,924	75	1,250	1,250	500	500	500	500	500
900/NS	26,089,844	0	0	0	0	0	0	0	0
1,300	12,850,691	6.774	6.856	6.939	7.023	7.108	7.194	7.281	7.369
2,200	3,905,196	2.058	2.084	2.109	2.134	2.160	2.186	2.213	2.240
3,500 - 5,500	1,876,411	0.989	1.001	1.013	1.026	1.038	1.050	1.063	1.076
> 6,600	337,163	0.179	0.180	0.182	0.184	0.187	0.190	0.191	0.193
Scenario II (Softselling of induction cookers to potential households)									
1,300	12,850,691	1,354.88	1,371.28	1,387.8	1,404.66	1,421.66	1,438.8	1,456.2	1,473.8
2,200	3,905,196	411.73	416.72	421.76	426.86	432.03	437.26	442.54	447.90
3,500 - 5,500	1,876,411	197.83	200.23	202.65	205.10	207.58	210.10	212.64	215.21
> 6,600	337,163	35.55	35.98	36.41	36.86	37.30	37.75	38.21	38.67

Source: MEMR's Primary Data, 2022, (Data Processed)

For microeconomic analysis, calculations were conducted to determine the net benefit value households received from induction stoves. The net benefit value for a household is the savings that can be made by a household as a result of converting LPG stoves to induction stoves, which are then consumed again for other household consumption. The net benefit value consists of energy costs and capital costs.

The energy net benefit is obtained from the difference in energy costs incurred between the LPG and the induction cooker. The amount of LPG consumption and the value of the equivalence factor are the results of a survey and research conducted by P3TKEBTKE (2020) on the average amount of LPG consumption in a household per household electricity power group. The research assumes that RT 450 – 900 VA uses subsidized 3kg cylinder LPG, RT 450 – 1,300 VA uses a 1000 W stove, and RT 2,200 -> 6,600 VA uses a 2000 W stove, as shown in Table 2. So that the net benefit energy value for each class of household tariffs per year is:

$$NB_{Energy} = (Cost_{LPG} - Cost_{Electricity})\ x\ 12\ month \quad \text{..... (1)}$$

Table 2. LPG Consumption Data, Induction Cooker Power, Electricity Tariff, Prices, And Equivalence Factor Values

HH Electrical Power (VA)	450	900	900/NS	1,300	2,200	3,500 - 5,500	> 6,600
Avg. LPG Consumption (kg/month)[1]	8.6	10.5	10.0	11.0	12.7	16.1	32.7
Induction cooker power (W)	1,000	1,000	1,000	1,000	2,000	2,000	2,000
LPG Equivalence Factor (kWh/kg)[1]	9.19	9.19	9.19	9.19	7.20	7.20	7.20
Electricity consumption for induction cooker (KWh/month)	79.03	96.50	91.90	101.09	91.44	115.92	235.44
Electricity tariff (IDR/kWh)[3]	415.0	605.0	1,352.0	1,444.7	1,444.7	1,699.53	1,699.53
LPG Price (IDR/kg)[2]	6,333	6,333	17,750	17,750	17,750	17,750	17,750

Source: P3TKEBTKE,2020; MEMR's Primary Data, 2022; PLN, 2022 (Processed)

The net capital benefit is obtained from the difference in costs incurred by households to obtain an induction cooker with the value of the benefits households receive from the LPG stove they currently own. The research assumes that households (450 VA – 900 VA) benefit from the cost of upgrading power and the assistance of induction cookers and woks from the government. The price of equipment (capital) and the cost of adding electric power can be seen in Table 3. So that the net capital benefit can be summarized by the following model:

$$\mathrm{NB}_{\mathrm{capital}} = (\mathrm{Capital}_{\mathrm{LPG}} - \mathrm{Capital}_{\mathrm{induction}}) \;..\; (2)$$

Table 3. Prices for capital goods for induction cookers and LPG stoves

Capital Goods	Induction cooker (IDR)	LPG Cooker (IDR)
Cooker	1,812,000	300,000
Gas cylinders	-	150,000
Gas regulator	-	50,000
Frying pan	300,000	50,000
Boiling pan	120,000	50,000
Other pans	120,000	50,000
Spatula	20,000	20,000
Total	**2,372,000**	**670,000**
Electricity power up	**Tariff**	
450 to 2.200 VA	1,749,750	
900 to 2.200 VA	1,328,100	

Source: Christian & Suryadi (2021); PLN (2022) (Processed)

The NB Energy value is multiplied yearly by the number of households participating in the program. Meanwhile, the NB Capital value is issued only once in the study period and multiplied yearly by the number of program participants. The sum of the NB Energy and NB Capital, every year of all conversion program participants based on the household scenario, is divided proportionally to 185 business sectors in the final demand column for household consumption in the Indonesian input-output table; domestic transactions are based on the 2016 base price as an economic stimulus for the final demand for household consumption each year.

After considering the net benefit received by households, calculations were made regarding the impact on the sales of induction stoves and cooking equipment supporting induction cookers (cookware). The demand for induction cookers is obtained by multiplying the number of households in the implementation scenario each year by the price of induction cookers, as shown in Table 3. Then, it becomes the final demand shock in the household electrical appliance sector (row 127). However, the demand for cooking equipment supporting induction cookers (cookware) is obtained by multiplying the cost of supporting equipment (table 3) by the number of households in the implementation scenario each year. Then, the shock is in the metal kitchenware, carpentry, household, and office furniture sectors (row 119).

The use of induction stoves will increase household electricity consumption. The electricity demand is obtained by multiplying the electricity used due to induction cookers per year for each household power group by the basic household electricity tariff per power group and the accumulated number of conversion program participants per household group each year (table 1). Then, the electricity demand every year shocks the national economy in the electricity sector (row 145).

Meanwhile, the adoption of induction stoves will inevitably impact the demand for LPG. The average trade margin between agents, distributors, and LPG bases is approximately IDR 1000.00/kg (Peraturan Gubernur Sulsel No. 11, 2021; Peraturan Bupati Majalengka No. 39, 2021). The value of reduced profits for LPG agents/distributors involves multiplying the amount of unsold gas each year per household power group by the accumulated number of

households per power group (referenced in Table 1) and the average trade margin value. The value of the loss becomes a negative shock in the trading sector other than cars and motorbikes (row 156).

In the implementation of scenario I, the conversion of LPG stoves to induction stoves in households receiving electricity subsidies cannot be separated from government assistance in the form of capital. It is assumed that households that enrolled in the 450 VA–900 VA electricity program will retain their eligibility for electricity subsidies, thus entailing both capital costs and ongoing electricity subsidies from the government. The primary benefit of the program is the reduced value of LPG subsidies.

The value of capital costs per year consisting of induction cookers, woks, and increased power (Referenced in Table 3) is then multiplied by the number of households with 450 VA and 900 VA electricity each year. Meanwhile, the cost of electricity subsidies is calculated from the amount of electricity consumption due to induction cookers (Referenced in Table 2) in a year multiplied by the accumulated number of each 450 VA and 900 VA households and the number of electricity subsidies per kWh, which is IDR 918/kWh for 450 VA and IDR 728/kWh for 900 VA.

The benefit value in the form of a reduction in LPG subsidies every year is obtained from the total consumption of 450 VA and 900 VA households in a year multiplied by the accumulated number of households participating in the program each year and the value of the LPG subsidy, which is IDR 10,425/kg. Meanwhile, households with electric power of 900 VA (M) until 6,600 VA are not counted in the calculation because it is assumed that a closed distribution of 3kg LPG has been carried out so that the decrease in LPG consumption in these households is not due to the conversion program of LPG stoves to induction stoves.

Furthermore, the government's net benefit value is obtained from the difference between the benefits received by the government and the costs incurred by the government. The government must reallocate costs from other sectors if the net benefit is negative. In this case, it is assumed that the government is reallocating infrastructure funds so that its net benefit value becomes a negative stimulus in the residential and non-residential building sectors (row 149).

The decrease in LPG consumption directly affects LPG imports. The decrease in LPG consumption is calculated by multiplying the average amount consumed per household power group each year by the accumulated number of program participants per power group. It is assumed that all household LPG needs come from imports, so the total decrease in the level of LPG consumption is the efficiency of LPG imports.

Furthermore, the impacts on household, industry, and government levels serve as stimuli for the economy, which can be analyzed through input-output multiplier analysis. The multiplier coefficient measures the response to an economic change stimulus expressed in a cause-and-effect relationship. The multiplier coefficient also becomes a parameter economists use in decision-making to understand the economic effects of an increase in money flow. Based on the processing of data from the 2016 Input-Output Table released by the Central Statistics Agency (BPS), the ranking of output multipliers, gross value added (GVA), and income for sectors among the 185 sectors include:

Table 4. The ranking of output multiplier, gross value added, and income in the sector related to the conversion from LPG stoves to induction stoves

Sector	Multiplier Ranking		
	Output creation	**GVA creation**	**income creation**
Electricity (145)	1	145	161
residential and non-residential building sectors (149)	32	149	47

Sector	Multiplier Ranking		
	Output creation	GVA creation	income creation
household electrical appliance sector (row 127	79	127	86
metal kitchenware, carpentry, household, and office furniture sectors (119)	105	119	72
trading sector other than cars and motorbikes (156)	131	156	51

Source: Data Processed, 2023

The economic impact (macroeconomic analysis) is calculated using three variables: the impact of creating output, the impact of creating gross added value (GVA), and the impact on household income creation.

The impact of creating output calculated by the equation:

$$dX = (I - A)^{-1} dF \quad \text{.....(3)}$$

Where, dX is Change in output; (I – A)-1 is Leontief inverse matrix; and dF is the change in stimulus. The impact of creating Gross Added Value (GVA), or GDP approach, is calculated by the equation:

$$VA = \hat{V}(I - A)^{-1}F \quad \text{.....(4)}$$

Where, VA is impact of gross added value; $\hat{V}(I - A)^{-1}$ added value multiplier; and F = economic stimulus.The equations calculate the impact on household income creation:

$$V_{201} = \widehat{V_{201}}(I - A)^{-1}F \quad \text{.....(5)}$$

Where V_{201} is impact on workers' income; $\widehat{V_{201}}(I - A)^{-1}$ is worker's income multiplier; and F = economic stimulus.

RESULTS AND DISCUSSION

The results of calculating the value of the household net benefit each year are shown in Table 5. The results show that households with electricity above 6,600 VA have the highest monthly energy expenditure savings, IDR 2,163,452. Meanwhile, households with 450 – 900 VA have a positive net benefit value of cookware because they receive assistance from the government in the form of two induction cooker units and accessories that add value to the benefits. A positive net benefit value will be obtained if non-electricity subsidized households entirely use non-subsidized LPG. Based on economic theory, households will maximize their utility by consuming lower prices of goods to get more goods. Therefore, the government needs to ensure that closed subsidies for 3 kg LPG cylinders are implemented.

Table 5. Net benefit per household electricity power by type of expenditure (in IDR)

HH Electrical Power	450	900	1.300	2.200	3.500 – 5.500	> 6.600
NB_{Energy} (per year)	260,011	97,446	590,463	1,119,860	1,065,186	2,163,452
$NB_{Cookware}$	280,000	280,000	-1,652,000	-1,652,000	-1,652,000	-1,652,000
$NB_{power\ up}$	1,749,750	1,328,100	0	0	0	0
PV NB (r=8%)	3,373,586	2,048,970	1,863,550	4,905,799	4,591,609	10,902,947

Source: Data Processed, 2023

For households receiving subsidies, additional net benefits are obtained from subsidized electricity, assistance from induction cookers and their supporting equipment, and additional support for free electricity. Induction cookers require high electric power, so if subsidized households increase their electricity power, the household will lose the right to the subsidy. Therefore, unique integration is needed so that households gain access to higher electricity power without losing their right to

electricity subsidies so that the net benefit value is positive.

The results of calculating the total net benefit received by all program-participating households based on scenarios I and II are in Table 6. Households with electric power of 1300 VA–3500 VA in scenarios I and II cumulatively have a negative net benefit value in the first year of program implementation because the net benefit value of energy is smaller than the initial investment cost in the form of purchasing an induction cooker unit and its supporting equipment. In the second year, the net benefit value received by participating program households is positive except for households with 1,300 VA electricity. In scenario II, the net benefit value is negative in the two years of implementation because the number of empowered 1300 households is worth more than 67% of all households.

The value of the net benefit or savings received by households is assumed to be additional income and re-consumed by households with a proportional consumption pattern in the IO Table so that it becomes a stimulus to the national economy. This pattern is based on research by Reimers et al. (2021), where the increase in consumption due to energy efficiency shows wide variations in other sectors. Household consumption patterns will differ depending on the average household income and changes in consumption patterns from time to time. This pattern aligns with dynamic economic effects and influences the emerging impacts.

Table 6. Number of household net benefits (in billions of rupiah)

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I									
450	30,570.25	515.20	5,210.46	9,230.13	5,053.21	5,443.22	5,833.24	6,223.26	6,613.27
900 S	6,606.53	127.92	1,286.47	2,212.33	1,054.97	1,103.70	1,152.42	1,201.14	1,249.87
1300	29.96	-7.19	-3.28	0.68	4.69	8.75	12.85	17.01	21.21
2200	35.46	-1.10	1.20	3.52	5.86	8.24	10.65	13.08	15.54
3500	15.73	-0.58	0.47	1.53	2.60	3.68	4.78	5.89	7.02
6600	7.57	0.09	0.48	0.87	1.26	1.66	2.07	2.48	2.90
NB	37,265.49	634.34	6,495.80	11,449.0	6,122.60	6,569.25	7,016.01	7,462.86	7,909.81
Scenario II									
1300	5,991.73	-1,438.2	-655.65	136.42	938.08	1,749.44	2,570.62	3,401.73	4,242.90
2200	7,092.29	-219.10	239.33	703.31	1,172.91	1,648.19	2,129.21	2,616.06	3,108.80
3500	3,146.19	-116.09	93.23	305.09	519.51	736.53	956.17	1,178.47	1,403.46
6600	1,509.55	18.18	95.31	173.37	252.38	332.34	413.27	495.18	578.08
NB	17,739.75	-1,755.2	-227.77	1,318.20	2,882.88	4,466.50	6,069.27	7,691.45	9,333.25

Source: Data Processed, 2023

The economic stimulus value for induction cooker sales is shown in Table 7. In scenario I, the biggest shock will occur in 2025, with a target number of 5 million households. In scenario II, 1300 W households are the target for most program participants. This study assumes that the induction cookers produced use components from within the country entirely and that all households use the same type and brand (both those with a power of 1000 and 2000 W).

Table 7. Total final demand for induction cookers (in billion rupiahs)

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I									
450	17.881,77	407,70	4.077,00	6.795,00	2.718,00	2.718,00	2.718,00	2.718,00	2.718,00
900 S	5.960,59	135,90	1.359,00	2.265,00	906,00	906,00	906,00	906,00	906,00
1300	73,24	12,27	12,42	12,57	12,73	12,88	13,04	13,19	13,35
2200	22,26	3,73	3,78	3,82	3,87	3,91	3,96	4,01	4,06
3500	10,69	1,79	1,81	1,84	1,86	1,88	1,90	1,93	1,95
6600	1,92	0,32	0,33	0,33	0,33	0,34	0,34	0,35	0,35

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Total	23.950,49	561,72	5.454,34	9.078,56	3.642,79	3.643,01	3.643,24	3.643,48	3.643,71
Scenario II									
1300	14.649,42	2.455,05	2.484,75	2.514,82	2.545,25	2.576,04	2.607,21	2.638,76	2.670,69
2200	4.451,81	746,06	755,09	764,23	773,47	782,83	792,31	801,89	811,59
3500	2.139,05	358,48	362,81	367,20	371,65	376,14	380,70	385,30	389,96
6600	384,37	64,41	65,19	65,98	66,78	67,59	68,41	69,24	70,07
Total	21.624,65	3.624,00	3.667,85	3.712,23	3.757,15	3.802,61	3.848,62	3.895,19	3.942,32

Source: Data Processed, 2023

The economic stimulus for the demand for cooking equipment supporting induction cookers (cookware) is in Table 8. In scenario I, the most significant shock will occur in 2025, with a target number of 5 million households. The price of cooking equipment, such as pans that are compatible with induction cookers, is relatively higher than pans made from aluminium, which are commonly used by households in Indonesia. This study also assumes that supporting cooking equipment is produced using components from within the country and that all households use the same type and brand of supporting cooking equipment.

Table 8. Final demand for supporting the cooking equipment industry (in billion rupiahs)

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I									
450	5,526.38	126.00	1,260.00	2,100.00	840.00	840.00	840.00	840.00	840.00
900 S	1,842.13	42.00	420.00	700.00	280.00	280.00	280.00	280.00	280.00
1300	22.64	3.79	3.84	3.89	3.93	3.98	4.03	4.08	4.13
2200	6.88	1.15	1.17	1.18	1.20	1.21	1.22	1.24	1.25
3500	3.31	0.55	0.56	0.57	0.57	0.58	0.59	0.60	0.60
6600	0.60	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11
Total	7,401.92	173.60	1,685.67	2,805.74	1,125.81	1,125.88	1,125.95	1,126.02	1,126.09
Scenario II									
1300	4,527.42	758.73	767.91	777.21	786.61	796.13	805.76	815.51	825.38
2200	1,375.84	230.57	233.36	236.19	239.04	241.94	244.86	247.83	250.82
3500	661.08	110.79	112.13	113.48	114.86	116.25	117.65	119.08	120.52
6600	118.79	19.91	20.15	20.39	20.64	20.89	21.14	21.40	21.66
Total	6,683.11	1,120.00	1,133.55	1,147.27	1,161.15	1,175.20	1,189.42	1,203.81	1,218.38

Source: Data Processed, 2023

The results of calculations on household electricity demand are shown in Table 9. Scenario II shows a relatively higher final demand stimulus value yearly than Scenario I because households using electricity from 1300 VA to more than 6600 VA are customers who pay non-subsidized electricity rates and consume relatively more electricity.

Table 9. Final demand for electricity (in billion rupiahs)

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I									
450	15,954.25	88.56	974.13	2,450.09	3,040.48	3,630.86	4,221.25	4,811.63	5,402.01
900 S	9,465.71	52.54	577.96	1,453.65	1,803.93	2,154.20	2,504.48	2,854.76	3,205.03
1300	287.11	11.87	23.89	36.05	48.36	60.81	73.42	86.18	99.10
2200	78.92	3.26	6.57	9.91	13.29	16.72	20.18	23.69	27.24

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
3500	56.55	2.34	4.70	7.10	9.53	11.98	14.46	16.97	19.52
6600	20.69	0.86	1.72	2.60	3.48	4.38	5.29	6.21	7.14
Total	25,863.23	159.43	1,588.97	3,959.40	4,919.06	5,878.95	6,839.08	7,799.44	8,760.04
Scenario II									
1300	57,425.04	2,374.48	4,777.69	7,209.98	9,671.70	12,163.2	14,684.8	17,237.0	19,820.0
2200	15,785.03	652.70	1,313.30	1,981.89	2,658.56	3,343.43	4,036.58	4,738.13	5,448.15
3500	11,311.05	467.70	941.06	1,420.15	1,905.04	2,395.80	2,892.49	3,395.19	3,903.98
6600	4,128.11	170.69	343.45	518.30	695.27	874.38	1,055.65	1,239.12	1,424.81
Total	88,649.23	3,665.58	7,375.50	11,130.3	14,930.5	18,776.8	22,669.5	26,609.4	30,597.0

Source: Data Processed, 2023

Table 10 shows the effect on the LPG trading sector. The conversion program will directly impact entrepreneurs engaged in the distribution of LPG. The calculation results show that the negative stimulus value in the national economy will peak in 2030. The reduction in gas consumption in the natural gas and geothermal sector (sector 039) is not considered because it is assumed that imports meet the LPG sector and do not affect national output.

Table 10. Decrease in final demand on LPG distributor revenue (in billion rupiahs)

HH Electrical Power (VA)	NPV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Scenario I									
450	-4.183,2	-23,22	-255,42	-642,42	-797,22	-952,02	-1.106,8	-1.261,6	-1.416,4
900 S	-1.702,5	-9,45	-103,95	-261,45	-324,45	-387,45	-450,45	-513,45	-576,45
1300	-21,6	-0,89	-1,80	-2,72	-3,64	-4,58	-5,53	-6,49	-7,46
2200	-7,6	-0,31	-0,63	-0,95	-1,28	-1,61	-1,94	-2,28	-2,62
3500	-4,6	-0,19	-0,38	-0,58	-0,78	-0,98	-1,18	-1,39	-1,60
6600	-1,7	-0,07	-0,14	-0,21	-0,28	-0,36	-0,43	-0,51	-0,58
Total	-5.921,2	-34,14	-362,33	-908,33	-1.127,6	-1.346,9	-1.566,3	-1.785,7	-2.005,1
Scenario II									
1300	-4.325,2	-178,84	-359,85	-543,05	-728,47	-916,13	-1.106,0	-1.298,2	-1.492,8
2200	-1.517,5	-62,75	-126,26	-190,53	-255,59	-321,43	-388,06	-455,51	-523,77
3500	-924,4	-38,22	-76,91	-116,06	-155,68	-195,79	-236,38	-277,46	-319,04
6600	-337,4	-13,95	-28,07	-42,36	-56,82	-71,46	-86,27	-101,26	-116,44
Total	-7.104,5	-293,76	-591,08	-892,00	-1.196,5	-1.504,8	-1.816,7	-2.132,5	-2.452,1

Source: Data Processed, 2023

Implementing the conversion program is expected to reduce the burden of subsidies issued by the government, especially in the energy sector. However, implementing the conversion program for subsidized households also raises investment costs, such as capital costs and support for increasing household electricity power from the government budget. Table 11 shows the results of calculating the government's net benefit each year.

The calculation results are that by the implementation of scenario I, the government can save energy subsidies of IDR 81,467,553,660 in 2023 if as many as 300 thousand households with 450 – 900 VA electric power have switched from using LPG 3 stoves to using induction stoves and increasing to IDR 2 253,935,649,600

in 2025 with 8.2 million users and IDR 4,969,520,769,600 in 2030 with 18.2 million users. However, on the other hand, during 2023 – 2030, at least the government requires an investment cost of Rp—65.45 trillion for induction cookers and equipment.

The value of the government's net benefit shows a negative result every year, which means that the government requires costs higher than the benefits obtained, namely reducing LPG subsidies. The costs that need to be incurred by the government are assumed to originate from reallocating the government's investment value to other sectors. In this study, the authors assume that the value of spending reallocations comes from the infrastructure sector, which has the highest government investment value in the 2016 IO table.

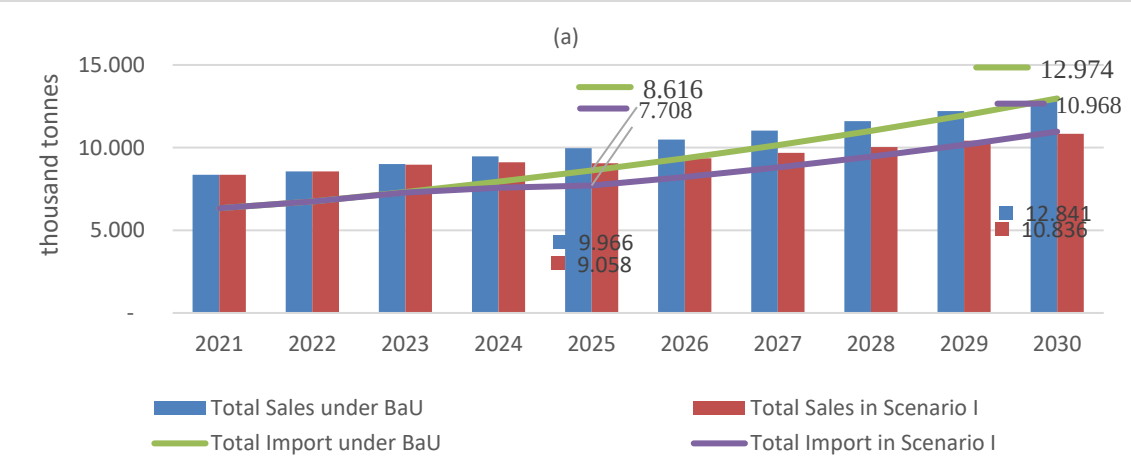
Table 11. Government's net benefit (in billion rupiahs)

Expenditure	PV (r=8%)	2023	2024	2025	2026	2027	2028	2029	2030
Benefit (in billion rupiahs)									
LPG Subsidy	61,359	341	3,746	9,423	11,693	13,964	16,235	18,505	20,776
Total Benefit (TB)	61,359	341	3,746	9,423	11,693	13,964	16,235	18,505	20,776
Cost (in billion rupiahs)									
Capital Cost	25,421	580	5,796	9,660	3,864	3,864	3,864	3,864	3,864
Electricity power up	21,636	493	4,933	8,222	3,289	3,289	3,289	3,289	3,289
Electricity Subsidy	46,682	259	2,850	7,169	8,896	10,624	12,351	14,079	15,806
Total Cost (TC)	93,739	1,332	13,579	25,050	16,049	17,776	19,504	21,231	22,959
NB (TB-TC)	-32,380	-991	-9,833	-15,628	-4,356	-3,812	-3,269	-2,726	-2,183

Source: Data Processed, 2023

Furthermore, an analysis is conducted to calculate savings in LPG import value. Figure 1 shows the projection of import needs according to the business as usual (BaU) scheme and the conversion program for LPG stoves to induction cookers.

Assuming sales growth of 5.2% and imports of 8.5%, the conversion of induction cookers in the scenario I can reduce the need for imports by 2,005.13 tons in 2030 or around 10% – 15% annually. In scenario II, the need for imports will decrease to 10,521 thousand tons in 2030 or decrease by 10.35% - 18.90% per year. Indonesia is committed to completely stopping LPG imports by 2030. Based on the analysis above, LPG imports cannot be stopped entirely if only relying on the conversion program of LPG stoves to induction cookers. A much more massive target market is needed, as well as implementing other programs, such as using dimethyl ether (DME) as a substitute for LPG to meet the 2030 LPG import-free target.



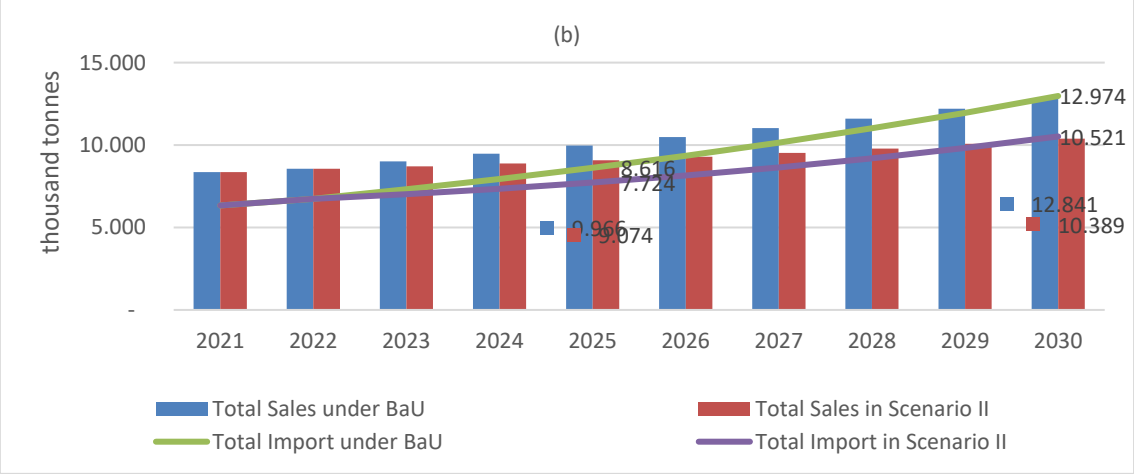


Figure 1. LPG sales and import projection based on scenario I (a) and scenario II (b)
Source: Data Processed, 2023

The results of calculating the impact of creating output, gross added value (GDP), and labour income in the 2023 – 2030 period due to the conversion program can be seen in Figure 2.

The calculation results show that for 2023 – 2030, scenario II will generate an output impact of IDR 469.68 trillion- greater than scenario I, which is IDR 177.70 trillion due to the much greater demand for the electricity sector compared to scenario I and the electricity supply sector (145) is the most significant output multiplier among the 185 other sectors.

The results of sectoral output calculations show that an increase in final demand, especially in the electricity sector, also significantly impacts increases in sectors such as coal and lignite, natural gas and geothermal, and goods produced by oil and gas refineries. It shows that the electricity sector in Indonesia is still dominated by non-renewable power plants that require input from coal, oil, and gas.

GVA is one of the closest approaches to Gross Domestic Product (GDP). GDP creation is generated through increases in primary inputs such as compensation for labour, surpluses on business, and taxes minus other subsidies on production. The results of an analysis of the creation of GDP show that scenario II has a more significant impact than scenario I, which is IDR 168.45 trillion. Meanwhile, scenario I will increase GDP by IDR 71.01 trillion from 2023 – 2030.

In general, an increase in GDP or GRDP is not an accurate indicator of the construction or implementation of a project. Hence, calculating an increase in household income or wages is the most appropriate measure in calculating the economic impact of a project. The existence of a demand for goods due to project implementation will encourage an increase in labour wages in all sectors of the economy. The results show that scenario II impacts increasing labour income by IDR 50.72 trillion, higher than scenario I, IDR 21.88 trillion.

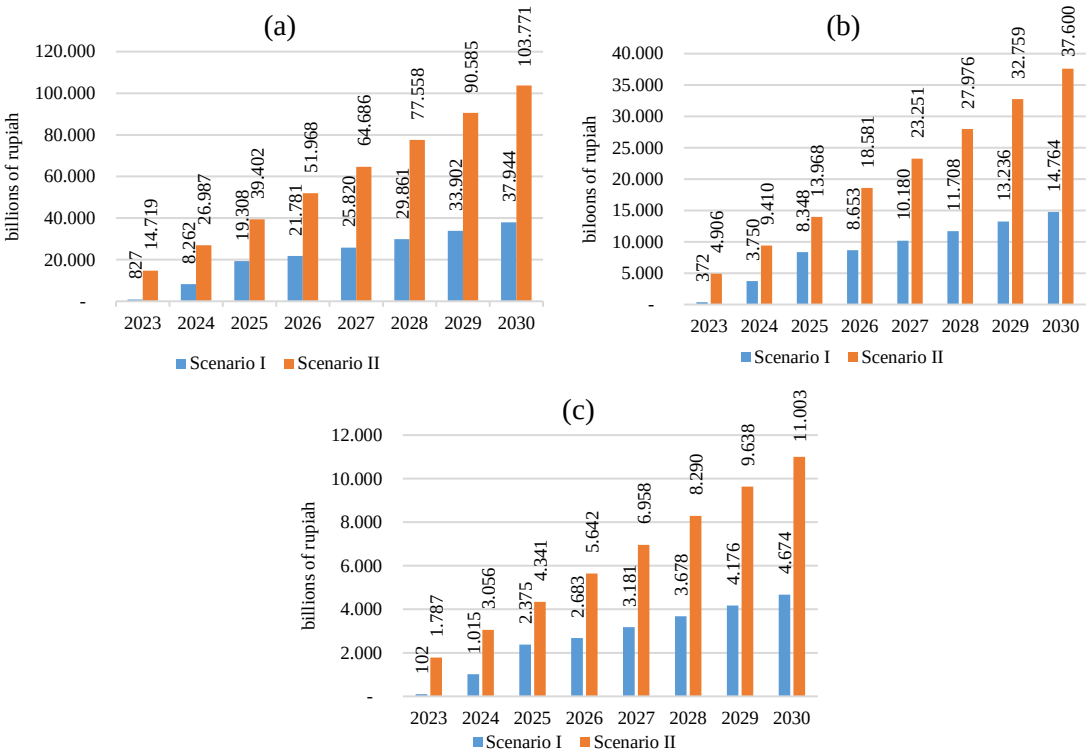


Figure 1. The impact of creating (a) output, (b) gross domestic product and (c) labour income through input-output analysis
Source: Data Processed, 2023

In general, scenario II significantly impacts output, GDP, and labour income more than Scenario I. Non-subsidized households consume more energy than subsidized households. This aligns with Hartono et al. (2020), which states that modern energy access, income, and the education level of the head of the household were the significant determinants of energy spending. The electricity supply sector has the highest output multiplier among 185 other sectors, greatly influencing the impact of creating other outputs. This aligns with Fadhilah's research (2019) regarding the electricity sector and Nguyen et al. (2020) concerning the significant relationship between energy consumption and economic growth in Indonesia.

Implementing the Scenario II scheme can also minimize government spending from investment costs for induction cooker packages and household electricity infrastructure. Therefore, scenario II can be implemented as the initial stage of the program, primarily related to the recovery of the national economy after the COVID-19 pandemic. This is further supported by Irsyad (2022), which states that non-subsidized households are more inclined to use induction stoves than energy-subsidized households. The soft selling scheme can also be implemented in regions or provinces with sufficient electricity infrastructure or lower electricity prices at generators compared to the national average.

Even so, the results of the study may have an overestimated impact. The reduction in LPG consumption due to the conversion program will not only impact distributors/agents/gas bases. However, it will also impact reduced revenues in the oil and gas refinery or processing sector, the gas transportation sector, the warehousing sector, and the gas tube industry sector due to a reduction in taxes received by the government from the oil and gas sector.

In conclusion, through input-output analysis for output creation, GDP, and household income, the implementation of Scenario II or the soft-selling scheme of induction

stoves to non-subsidized households produces a better macroeconomic impact compared to the implementation of the induction stove assistance scheme for subsidized households. However, this study can be used as material for the government's consideration of policy scenarios.

CONCLUSION

Converting LPG stoves to induction cooktops provides positive net benefits in terms of energy use. The highest net benefit occurs for households with electrical power above 6600 VA, which consumes more LPG. In contrast, households with 900 VA electricity have the lowest net benefit of energy use. It will be realized if the government has ensured the implementation of a closed distribution program for 3 kg LPG cylinders so that the presence of an induction cooker can provide the intended benefits and attract public interest.

The amount of net benefit that comes from saving energy use, purchasing cooking equipment, as well as benefits from accessible added power facilities (for subsidized households) received by all households that convert LPG stoves to induction stoves will be an additional household expenditure so that it becomes a stimulus positive for the national economy. On the other hand, there was a negative stimulus in the form of a decrease in the income of LPG distributors and a decrease in investment in the infrastructure sector by the government due to the implementation of this program. Through multiplier analysis, positive and negative stimulus values will contribute to national economic growth by creating production outputs, GDP, and labour or household income.

Currently, the induction stove distribution policy implemented in several regions, such as Bali and Solo, targets small households with micro-enterprises. However, based on the study results, implementing the conversion program through a soft selling scheme has significantly impacted production output, GDP, and labour income more than the conversion program for households receiving subsidies. Non-electricity subsidized households generally also have sufficient electrical infrastructure to implement the conversion of LPG stoves to induction stoves to minimize government spending. Therefore, the conversion program at an early stage can be started through a soft selling scheme accompanied by massive outreach, approaches to real estate and apartment entrepreneurs, bundling programs, or other promotions for middle to upper-class households. Most recently, the National Energy Council has supported the induction stove conversion policy for non-subsidized households (Mubarok, 2024). After becoming a trend, the conversion program can be continued in the middle to lower households as the final stage.

The program to convert LPG stoves to induction cooktops also positively impacted the trade balance, particularly in reducing LPG imports. Converting LPG stoves to induction cooktops reduces import values by 10% - 19% annually. However, to end LPG imports by 2030, the LPG stove conversion program to induction stove cannot be the only program the government must carry out. A massive target market and other policy alternatives, such as dimethyl ether (DME) as an LPG substitute, are needed.

This study has limitations related to the calculated national economic impact. For future research, an analysis will be carried out on workforce creation and tax revenue, considering that the demand for induction cookers will create skilled workers or new technicians in the electricity sector and potential tax revenues from related sectors. The Input-Output table analysis only considers the monetary impact of implementing the LPG stove conversion program to an induction stove. For the study to be complete, another analysis is needed, especially from social aspects and environmental impacts.

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