Mega Conversion from LPG to Induction Stove to achieve Indonesia's Clean Energy Transition

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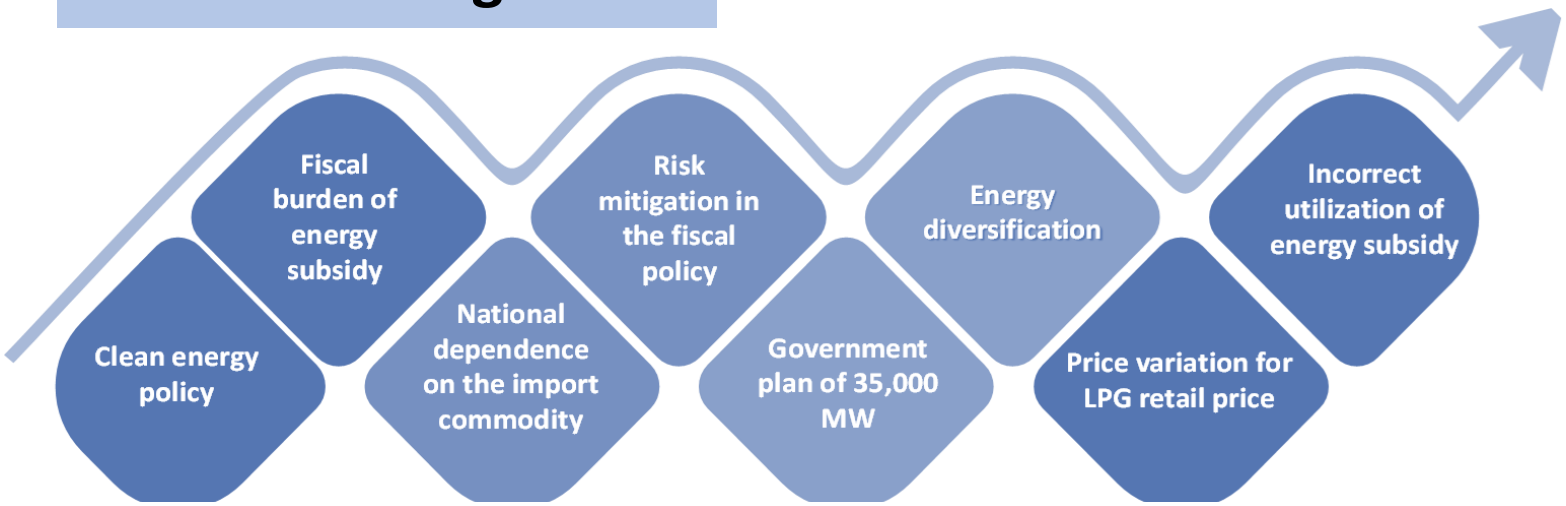
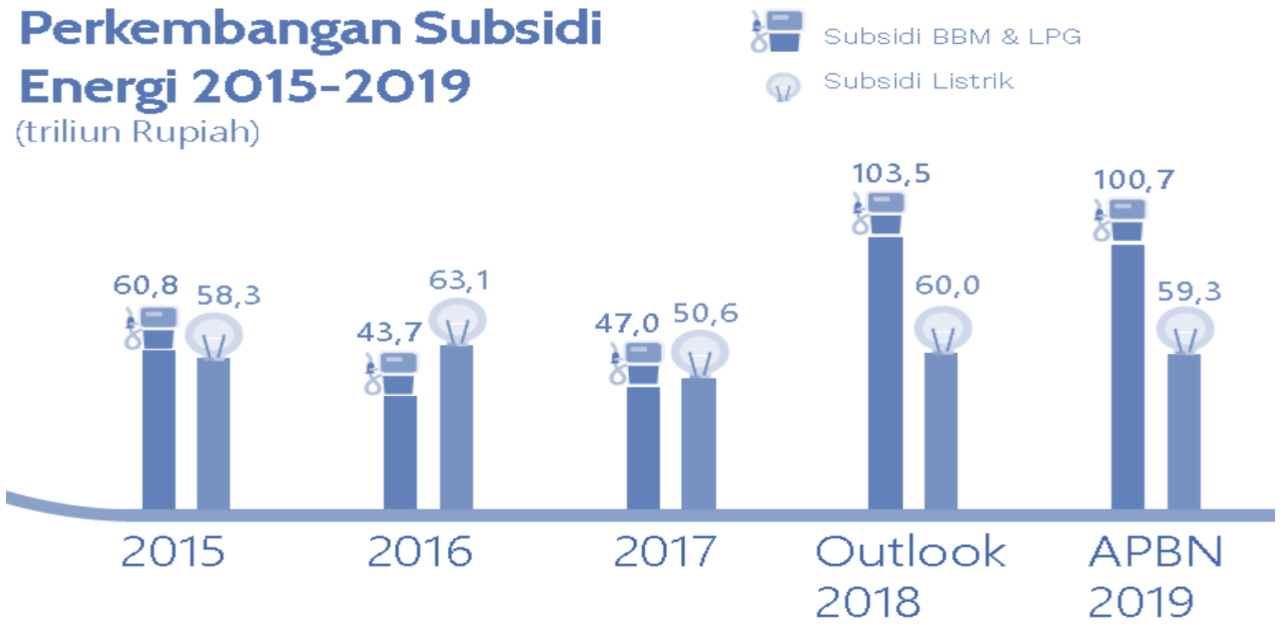
Research Background

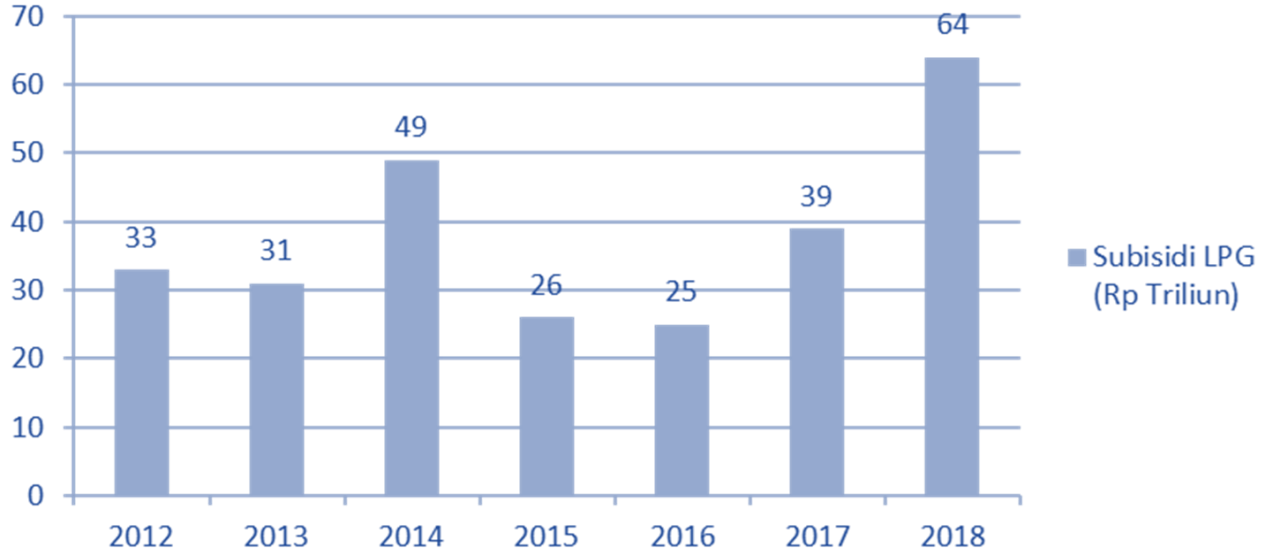


- **Clean energy policy:** Induction stove program increases household access to clean energy resources, improve public health, adverse effect of climate change caused by household LPG emission, increasing energy efficiency and energy security (Quinn *et. al*, 2018)
- **Fiscal burden of energy subsidy**: Indonesia's government deals with the increasing of energy subsidy each year in the form of LPG 3 kg subsidy (RAPBN, 2019)
- **National dependence on the import commodity**: Indonesia import the refinery product of *crude oil* for LPG. Therefore, reducing LPG utilization for household will lead to reducing national dependence on the LPG import
- **Risk mitigation in the fiscal policy**: LPG price dominantly influenced by the global crude oil price. A sudden shock in the crude oil price will resulted in fiscal burden for Indonesia's government.
- **Government plan of 35,000 MW**: The new installed power plant capacity from 35,000 MW creates additional *reserve margin* that need to be absorbed by the consumer (RUPTL, 2019)
- **Energy diversification**: Shifting from LPG to induction stove has a meaning of energy diversification and dependence reduction from fossil energy
- **Price variation for LPG retail price**: Implementation of one price program for LPG 3 kg is intricate to solved due to the price dependence on the point of delivery, the conformity of HET *(Harga Eceran Tertinggi)* from the retail seller, and the scarcity of the LPG 3 kg in the region
- **Incorrect utilization of energy subsidy**: Finding in the field shows that LPG 3 kg also consumed and utilized by the wealthy citizen

Ref: Kementerian Keuangan. 2019; Quinn et.al, 2018, RUPTL PLN 2019,

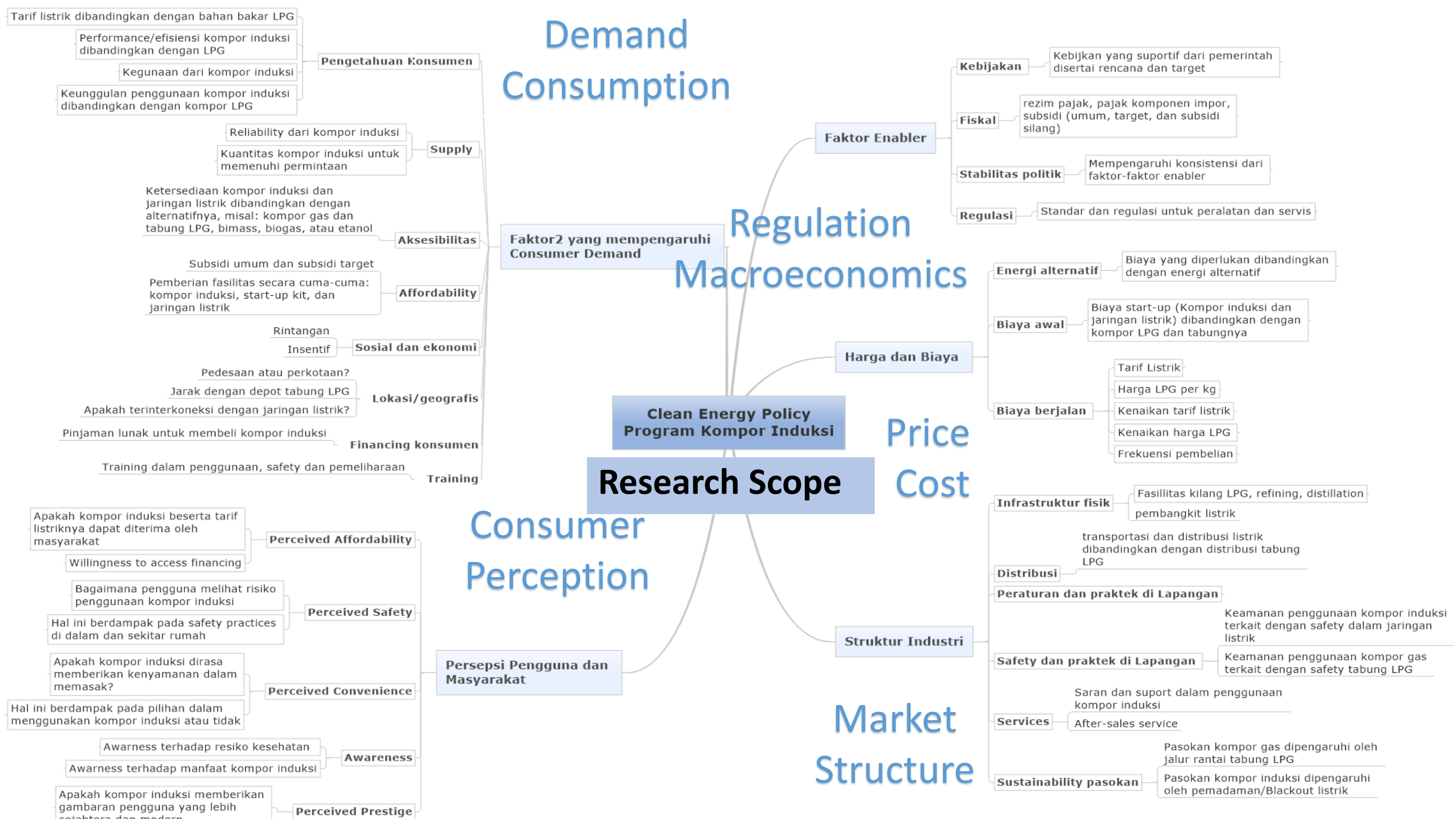
Research Contribution and Novelty



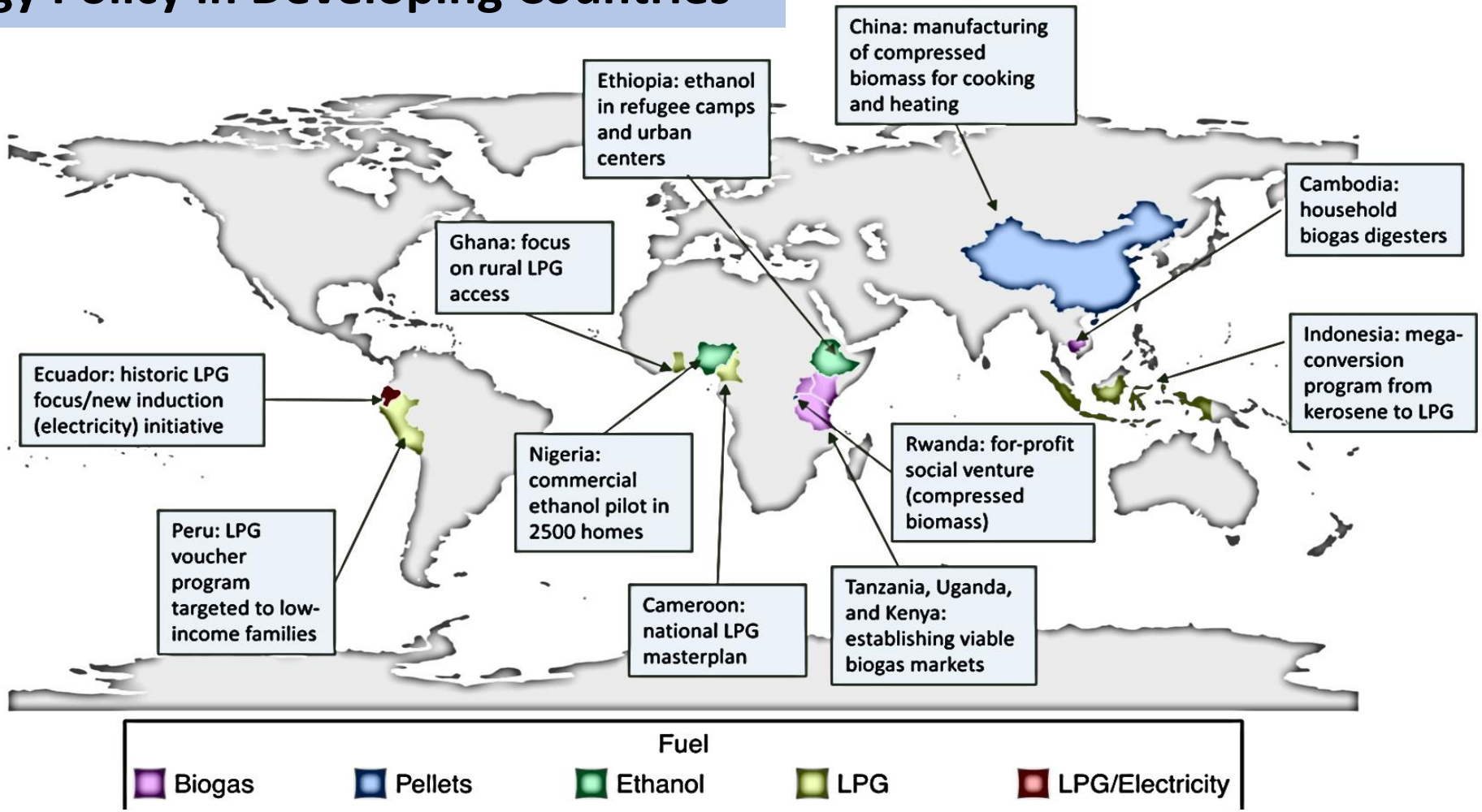


Reference: RAPBN 2019, ESDM Statistic Handbook 2019

- The literature review regarding the economics and policy of the development of induction stove in Indonesia's electricity market is still limited.
- This study is the first research that comprehensively analyze the policy and economics of cooking technology conversion from LPG to induction stove in Indonesia electricity market.
- This study determines the economics of induction stove compared to LPG stove for each electricity and LPG tariff, i.e., subsidy and non-subsidy tariff.
- This research could serve as an academic reference for energy sector stakeholders in Indonesia in objective to implementing the clean energy policy to shift cooking technology from LPG stove to induction stove.
- Therefore, this research contributes to the academic literature review of clean energy policy in Indonesia.


Demand
Consumption
Tarif listrik dibandingkan dengan bahan bakar LPG
Performance/efisiensi kompor induksi dibandingkan dengan LPG
Kegunaan dari kompor induksi
Keunggulan penggunaan kompor induksi dibandingkan dengan kompor LPG
Pengetahuan Konsumen
Reliability dari kompor induksi
Kuantitas kompor induksi untuk memenuhi permintaan
Supply
Ketersediaan kompor induksi dan jaringan listrik dibandingkan dengan alternatifnya, misal: kompor gas dan tabung LPG, bimass, biogas, atau etanol
Aksesibilitas
Subsidi umum dan subsidi target
Pemberian fasilitas secara cuma-cuma: kompor induksi, start-up kit, dan jaringan listrik
Affordability
Rintangan
Insentif
Sosial dan ekonomi
Pedesaan atau perkotaan?
Jarak dengan depot tabung LPG
Apakah terinterkoneksi dengan jaringan listrik?
Lokasi/geografis
Pinjaman lunak untuk membeli kompor induksi
Financing konsumen
Training dalam penggunaan, safety dan pemeliharaan
Training
Faktor2 yang mempengaruhi Consumer Demand
Regulation
Macroeconomics
Faktor Enabler
Kebijakan
Kebijkan yang suportif dari pemerintah disertai rencana dan target
Fiskal
rezim pajak, pajak komponen impor, subsidi (umum, target, dan subsidi silang)
Stabilitas politik
Mempengaruhi konsistensi dari faktor-faktor enabler
Regulasi
Standar dan regulasi untuk peralatan dan servis
Clean Energy Policy Program Kompor Induksi
Research Scope
Price
Cost
Harga dan Biaya
Energi alternatif
Biaya yang diperlukan dibandingkan dengan energi alternatif
Biaya awal
Biaya start-up (Kompor induksi dan jaringan listrik) dibandingkan dengan kompor LPG dan tabungnya
Biaya berjalan
Tarif Listrik
Harga LPG per kg
Kenaikan tarif listrik
Kenaikan harga LPG
Frekuensi pembelian
Consumer
Perception
Persepsi Pengguna dan Masyarakat
Apakah kompor induksi beserta tarif listriknya dapat diterima oleh masyarakat
Perceived Affordability
Willingness to access financing
Bagaimana pengguna melihat risiko penggunaan kompor induksi
Perceived Safety
Hal ini berdampak pada safety practices di dalam dan sekitar rumah
Apakah kompor induksi dirasa memberikan kenyamanan dalam memasak?
Perceived Convenience
Hal ini berdampak pada pilihan dalam menggunakan kompor induksi atau tidak
Awarness terhadap resiko kesehatan
Awareness
Awarness terhadap manfaat kompor induksi
Apakah kompor induksi memberikan gambaran pengguna yang lebih
Perceived Prestige
Market
Structure
Struktur Industri
Infrastruktur fisik
Fasillitas kilang LPG, refining, distillation
pembangkit listrik
transportasi dan distribusi listrik dibandingkan dengan distribusi tabung LPG
Distribusi
Peraturan dan praktek di Lapangan
Keamanan penggunaan kompor induksi terkait dengan safety dalam jaringan listrik
Safety dan praktek di Lapangan
Keamanan penggunaan kompor gas terkait dengan safety tabung LPG
Saran dan suport dalam penggunaan kompor induksi
Services
After-sales service
Pasokan kompor gas dipengaruhi oleh jalur rantai tabung LPG
Sustainability pasokan
Pasokan kompor induksi dipengaruhi oleh pemadaman/Blackout listrik

Clean Energy Policy in Developing Countries



Ecuador (LPG; induction)	Government policy, clean fuel access, and persistent fuel stacking in Ecuador	***Target***: LPG: never specified. Induction: 3.5 million homes. ***Reach***: LPG: 91% of Ecuadorian homes. Induction: 670,000 homes ***Time frame***: LPG: 1970s – present; Induction: 2014-present.	LPG: agency for Regulation and Control of Hydrocarbons; Induction: Ministry of Electricity and Renewable Energy; Agency for Regulation and Control of Electricity; electricity utilities	LPG: part of broad social welfare efforts; Induction: utilize new hydroelectric power generation and reduce fiscal burden of LPG subsidy	The Government of Ecuador is responsible for all funding associated with the LPG subsidy (approx. US$681 million per year) and the induction cookstoves program (expansion of electricity networks; 220 V wiring; electricity subsidy). Cost of stoves borne by households.

Ref: Quinn et al, 2018; Beaton and Lontoh; 2010

Research Methodology

Economic Modelling Assumptions

Methodology

Method	Delivery Point of Subsidized LPG (3 kg)	Electricity Tariff	LPG Prices	Daily LPG Consumption
Descriptive analysis	LPG Agent Rp 4,250/kg Rp 12,750/tube	Subsidy 450 VA and 900 VA Rp 605/kWh	Subsidized LPG Rp 6,666/kg	3 kg /7 days
Economic Simulation	Highest Retail Price (HET) Rp 17,900/kg	Non-Subsidy 900 VA Rp 1,352/kWh	Non-Subsidized LPG Rp 12,083/kg	3 kg /10 days
	Household Rp 22,000/kg	Non-Subsidy 1,300 VA and 2,200 VA Rp 1,467/kWh		

The economic simulation in this study applies three types of subsidized LPG (3 kg) prices based on the delivery point, namely:

- 1. The delivery point at LPG agent with LPG price Rp 4,250 / kg or Rp 12,750/tube
- 2. The retail delivery point is based on the Highest Retail Price (HET) of Rp. 17,900/tube
- 3. The retail delivery point for households is IDR 22,000 / kg

There are three types of electricity tariff applied in (PLN Research Institute 2017):

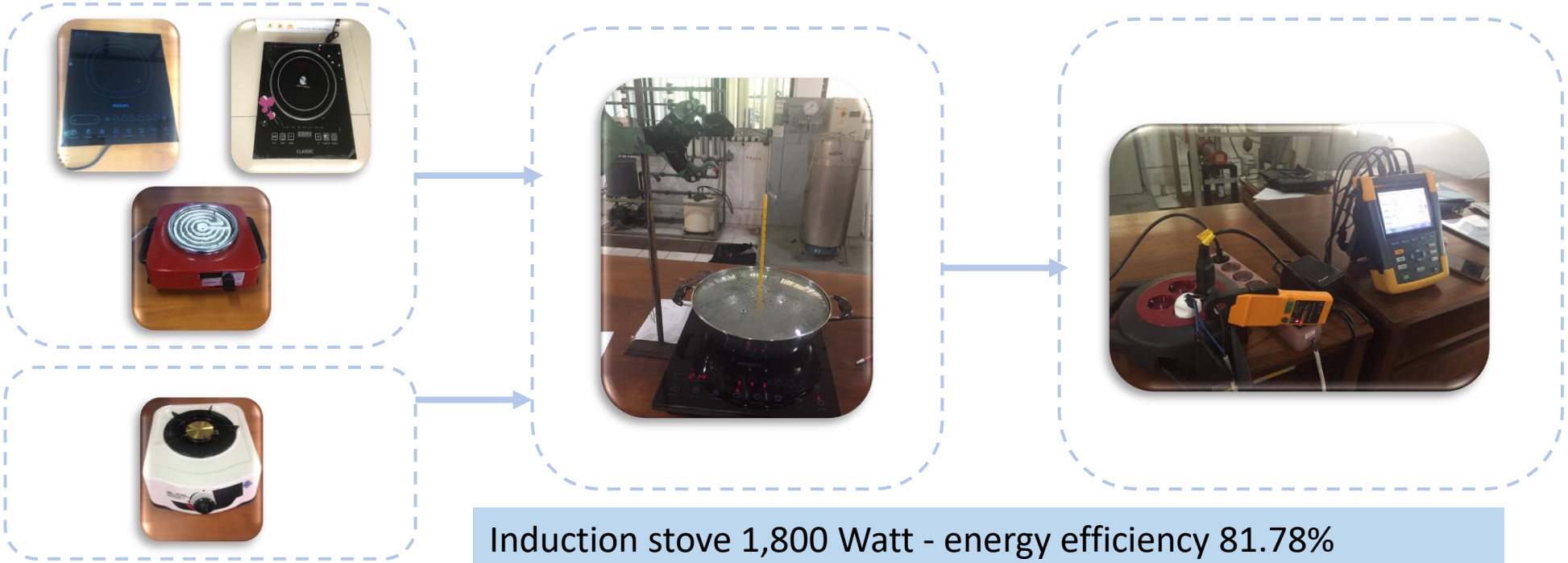
- 1. Electricity tariff with subsidy of 605 Rp/kWh for 450 VA and 900 VA household
- 2. Electricity tariff non-subsidy of 1,352 Rp/kWh for 900 VA household
- 3. Electricity tariff non-subsidy of 1,467 Rp/kWh for 1,300 VA and 2,200 VA

Type of Stove	Nominal	Cost	Volume		Equivalency	
Induction stove	300 Watt	210.3	0.14333	kwh	10.696	kwh
	500 Watt	180.51	0.12302	kwh	9.181	kwh
	1000 Watt	165.75	0.11296	kwh	8.430	kwh
	1400 Watt	159.11	0.10844	kwh	8.093	kwh
	1800 Watt	152.3	0.1038	kwh	7.746	kwh
LPG Stove	LPG 3 kg	89.33	0.0134	kg	1	kg
	LPG 12 kg	161.92	0.0134	kg	1	kg

Ref: PLN Research Institute, PLN. 2017, ESDM 2019, PLN Statistics 2019, PLN Research Institute, PLN. 2017, ESDM 2007

Research Methodology

Technical Assumption



Induction stove 1,800 Watt - energy efficiency 81.78%

Type of stove	Efficiency energy (%)	Cooking time (minute)	Cost (Rp) per type of stove per Electricity Tariff division			Cost (Rp) per type of stove per gas tariff	
			1,300/2,200 VA	900 VA-non subsidy	900 VA-subsidy	Subsidy	Non subsidy
			1,467 Rp/kwh	1,352 Rp/kwh	605 Rp/kwh	6,666 Rp/kg	12,083 Rp/kg
Induction stove 300 W	59.23	23.57	210.3	193.78	159.74		
Induction stove 500 W	69	14.92	180.51	166.33	74.43		
Induction stove 1,000 W	75.15	7.16	165.75				
Induction stove 1,400 W	78.28	4.71	159.11				
Induction stove 1,800 W	81.78	3.66	152.3				
Electricity stove 300 W	32.15	55.9	387.42	356.98	159.74		
Electricity stove 600 W	41.87	21.71	297.47	274.1	122.66		
LPG stove	45.06	3.85				89.33	161.92

Energy cost saving potential per household per month
Tariff 450-watt Subsidy

	LPG						Induction stove			
Consumption (per Household)	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	32.09	kwh / 7 days	32.09	kwh / 10 days
Consumption (per household per month)	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	128.36	kwh / month	96.27	kwh / month
Delivery point	Agen		Retail (HET)		Household retail		Lov voltage network			
Price	12,750	Rp/tube	17,900	Rp/tube	22,000	Rp/tube	605	Rp/kwh	605	Rp/kwh
Cost per household per month	51,000	38,250	71,600	53,700	88,000	66,000	77,655.87	Rp	58,241.90	Rp
Energy saving per household per month							10,344.13	Rp	7,758.10	Rp
Energy saving per household per month on scarcity							82,344.13	Rp	61,758.10	Rp

Economic Simulation scenario 1 (Induction stove 300 Watt and electricity tariff 605 Rp/kWh)

- Low Income Household (Cooking Expenditure) Sensitive to the Scarcity of LPG 3 KG
- Availability of Low Efficiency Induction Stove

Induction Stove-Subsidy	LPG Stove-Subsidy	Energy Cost Saving / month	Energy Cost saving / month (Scarcity)
Rp 605/kwh	12 kg LPG/ month	Rp 10,344	Rp 82,344
450 VA	Household retail price		

Energy cost saving potential per household per month
Tariff 900-Watt subsidy

	LPG						Induction stove			
Consumption (per Household)	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	27.54	kwh / 7 days	27.54	kwh / 10 days
Consumption (per household per month)	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	110.17	kwh / month	82.63	kwh / month
Delivery point	Agen		Retail (HET)		Household retail		Lov voltage network			
Price	12,750	Rp/tube	17,900	Rp/tube	22,000	Rp/tube	605	Rp/kwh	605	Rp/kwh
Cost per household per month	51,000	38,250	71,600	53,700	88,000	66,000	66,655.55	Rp	49,991.66	Rp
Energy saving per household per month							21,344.45	Rp	16,008.34	Rp
Energy saving per household per month on scarcity							93,344.45	Rp	70,008.34	Rp

Economic Simulation scenario 2 (Induction stove 500 Watt and electricity tariff 605 Rp/kWh)

- Low Income Household (Cooking Expenditure) Sensitive to the Scarcity of LPG 3 KG
- Availability of Low Efficiency Induction Stove

Induction Stove-Subsidy	**LPG Stove-Subsidy**	**Energy Cost Saving / month**	**Energy Cost saving / month (Scarcity)**
Rp 605/kwh	12 kg LPG/ month	Rp 21,344	Rp 93,344
900 VA	Household retail price		

Energy cost saving potential per household per month
Subsidized electricity tariff with 1,800-Watt Induction stove

Consumption (per Household)	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	23.24	kwh / 7 days	23.24	kwh / 10 days
Consumption (per household per month)	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	92.96	kwh / month	69.72	kwh / month
Delivery point	Agen		Retail (HET)		Household retail		Lov voltage network			
Price	12,750	Rp/tube	17,900	Rp/tube	22,000	Rp/tube	605	Rp/kwh	605	Rp/kwh
Cost per household per month	51,000	38,250	71,600	53,700	88,000	66,000	56,238.66	Rp	42,178.99	Rp
Energy saving per household per month							31,761.34	Rp	23,821.01	Rp
Energy saving per household per month on scarcity							103,761.34	Rp	77,821.01	Rp

Economic simulation scenario 3 (Induction stove 1,800 Watt and electricity tariff 605 Rp/kWh)

- Economic Savings three times greater than Case 1
- Installation Upgrade for Low Income Household

Induction Stove-Subsidy	**LPG Stove-Subsidy**	**Energy Cost Saving / month**	**Energy Cost saving / month (Scarcity)**
Rp 605/kwh	12 kg LPG/ month	Rp 31,761	Rp 103,761
> 2200 VA	Household retail price		

Energy cost saving potential per household per month
Non-Subsidized electricity tariff with 1,800-Watt Induction stove

	LPG				Induction stove			
Consumption (per Household)	1 gas tube/ 7 days	1 gas tube/ 10 days	1 gas tube/ 7 days	1 gas tube/ 10 days	23.24	kwh / 7 days	23.24	kwh / 10 days
Consumption (per household per month)	4 gas tube = 12 kg	3 gas tube = 9 kg	4 gas tube = 12 kg	3 gas tube = 9 kg	92.96	kwh / month	69.72	kwh / month
Delivery point	Agent		Household retail		Lov voltage network			
Price	39,000	Rp/gas tube	45,000	Rp/gas tube	1,467	Rp/kwh	1467	Rp/kwh
Cost per household per month	156,000	117,000	180,000	135,000	136,393	Rp	102,295	Rp
Energy saving per household per month					43,606.85	Rp	32,705.14	Rp

Economic simulation scenario 4 (Induction stove 1,800 Watt and electricity tariff 1,467 Rp/kWh)

- Highest Energy Cost Saving compare to other cases
- Migration of cooking behavior of mid and high-income household

Induction Stove-Subsidy	LPG Stove-Subsidy	Energy Cost Saving / month	Energy Cost saving / month (No Scarcity)
Rp 1,467/kwh	12 kg LPG/ month	Rp 43,606	Rp 43,606
> 2200 VA	Household retail price		

Research Simulation

Low Income Household - Existing

- 300 W : Monthly cooking savings per household of Rp 10,344
- 500 W : Monthly cooking savings per household of Rp Rp. 21,344

Low Income Household – Installation Upgraded

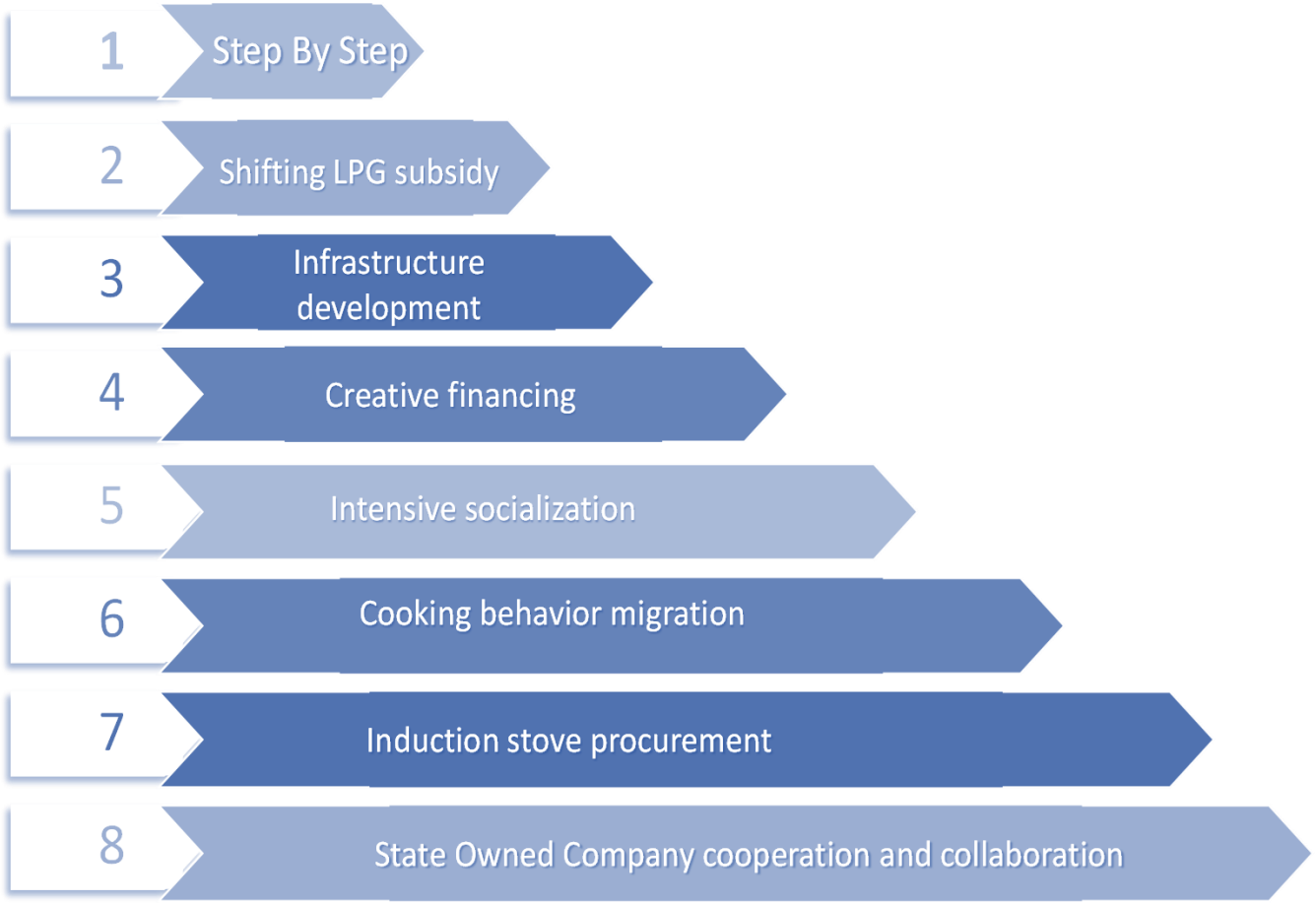
- 1,800 W : Monthly cooking savings per household of Rp 31,761

Middle- and High-Income Household

- 1,800 W : Monthly cooking savings per household of Rp 43,606

Induction stoves for cooking are more economical when compared to LPG stoves.

Research Analysis: Mega Conversion Strategy



Ref: Beaton, C., & Lontoh, L. (2010). ESDM-Bappenas. (2007); Budya and Arofat 2011

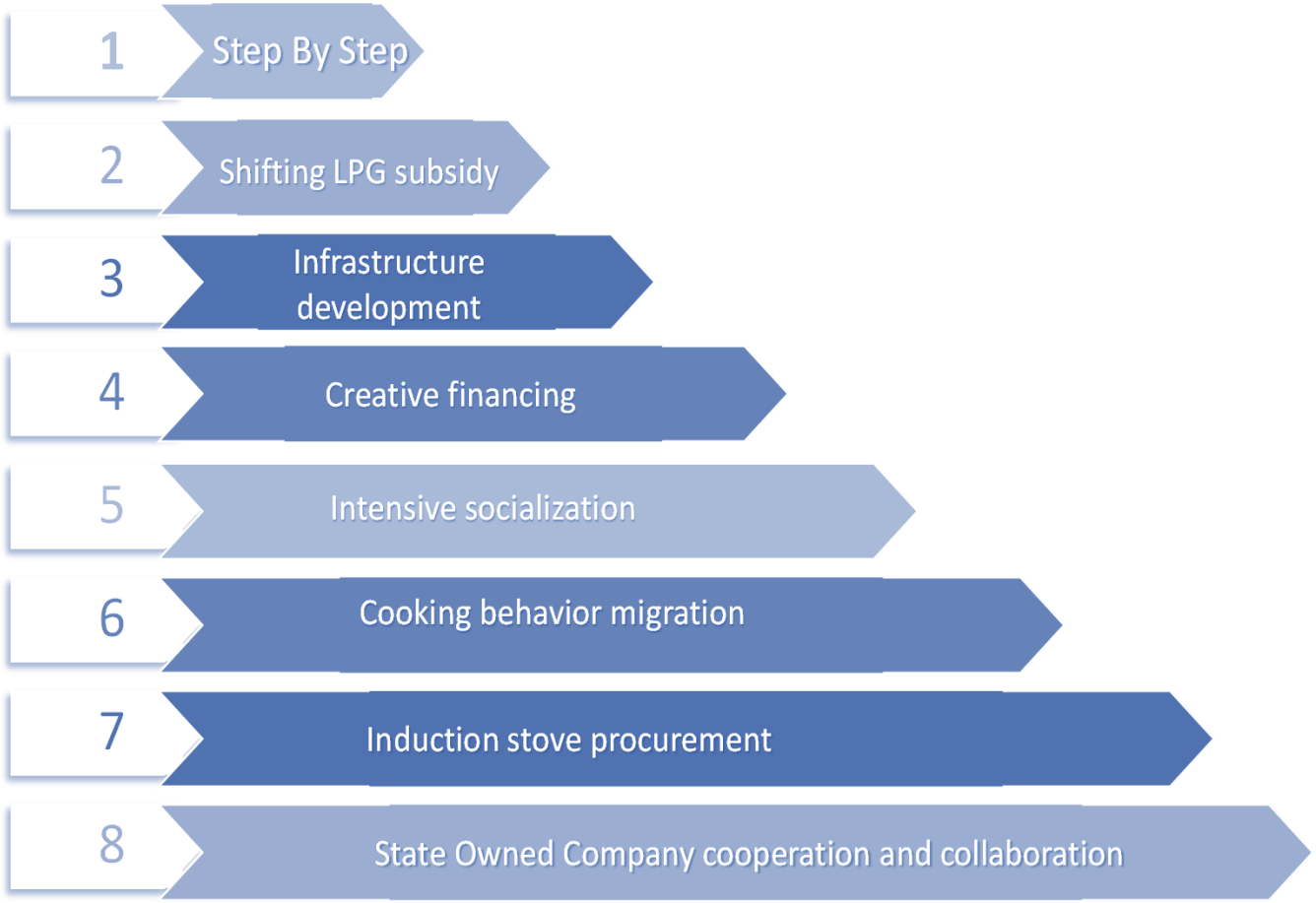
Step by Step

The conversion program of LPG stove to induction stove is carried out in stages starting from Java and Bali, Sumatra, and then other regions. It is important to note that the conversion program with phases has its own advantages and disadvantages. With the regional phases starting from Java, especially DKI Jakarta, the government can focus on executing conversion programs in areas with the largest number of LPG stove users in Indonesia. In addition, the implementation of conversion programs in Java can be used as a lesson learned for the implementation of conversion programs on other islands. However, the gradual implementation of the conversion program can also cause agent seeking rent problems where there are parties who can take advantage of the price disparity and scarcity of LPG for personal gain. Agent seeking rent problems arise when the Indonesian government conducted a mega conversion program of kerosene to LPG stoves.

Shifting LPG Subsidy

The phasing out of the 3 kg LPG subsidy, starting from the pilot area, DKI Jakarta. If the 3 kg LPG subsidy continues to be rolled out to the community, the low-income household is incentivized to use LPG stove for cooking. It is important to note that fuel stacking is very likely to be done by households if another cooking option is available, i.e., LPG stove, especially with the existence of LPG subsidy. If the fuel stacking occurs where the induction stove is only a secondary cooking technology, the conversion program will not run optimally.

Research Analysis: Mega Conversion Strategy



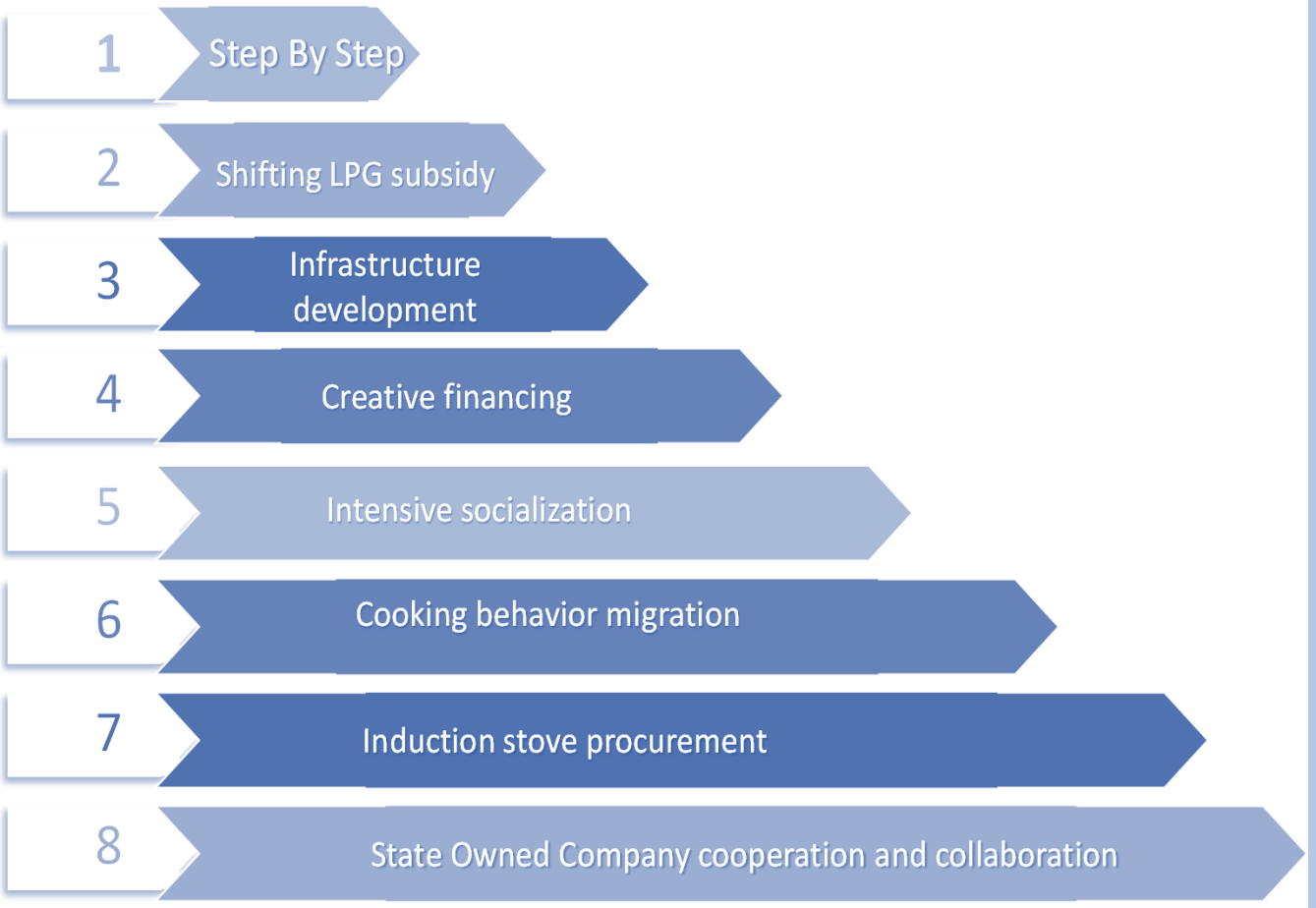
Infrastructure Development

Infrastructure development for the utilization of induction stove, starting from household electricity networks to the infrastructure of manufacturing and distribution of induction stoves. Based on the studies by PLN Puslitbang (2017) and PLN Puslitbang (2018) as well as from the results of this economic study, we can conclude that the induction stove is said to be efficient and economical for power rating above 1,800 Watts. Low-income household consist of two electricity tariff groups, i.e., 450-Watt tariff groups and 900-Watt. Therefore, it is prerequisite to prepare the 220 Volt electrical installation upgrade in low-income household that utilize the induction stove, i.e., electrical installation upgrade from 450 Watt and 900 Watt to 5,500 Watt. In addition, although household with electricity tariff of 1,300 Watt and 2,200 Watt considered as middle-income household, these household groups also need to have its household electrical installation upgraded to be ready to utilize high-power electrical equipment, in this case especially induction stove.

Creative financing

Conducting creative financing for the public to purchase an induction stove, for example charging the monthly credit of electric stove to the electric bill. Creative financing patterns like this have also been applied by other countries (for example Ecuador) that carry out induction stove program.

Research Analysis: Mega Conversion Strategy



Economic Incentive-Cooking behavior migration

Economic incentive by giving away free induction stove including accessories to the households who make the cooking patterns transition from 3 kg LPG stove to induction stove, based on priority scale, prioritized for the low-income households. Without significant economic incentives from the government for the 3 kg LPG consumers to buy induction stove and its accessories, the household will be trapped in a technology lock-in situation where consumers are reluctant to replace the technology they have bought previously (LPG stove and tube) and will consider replacing them with the new technology if the old technology has been damaged or worn out

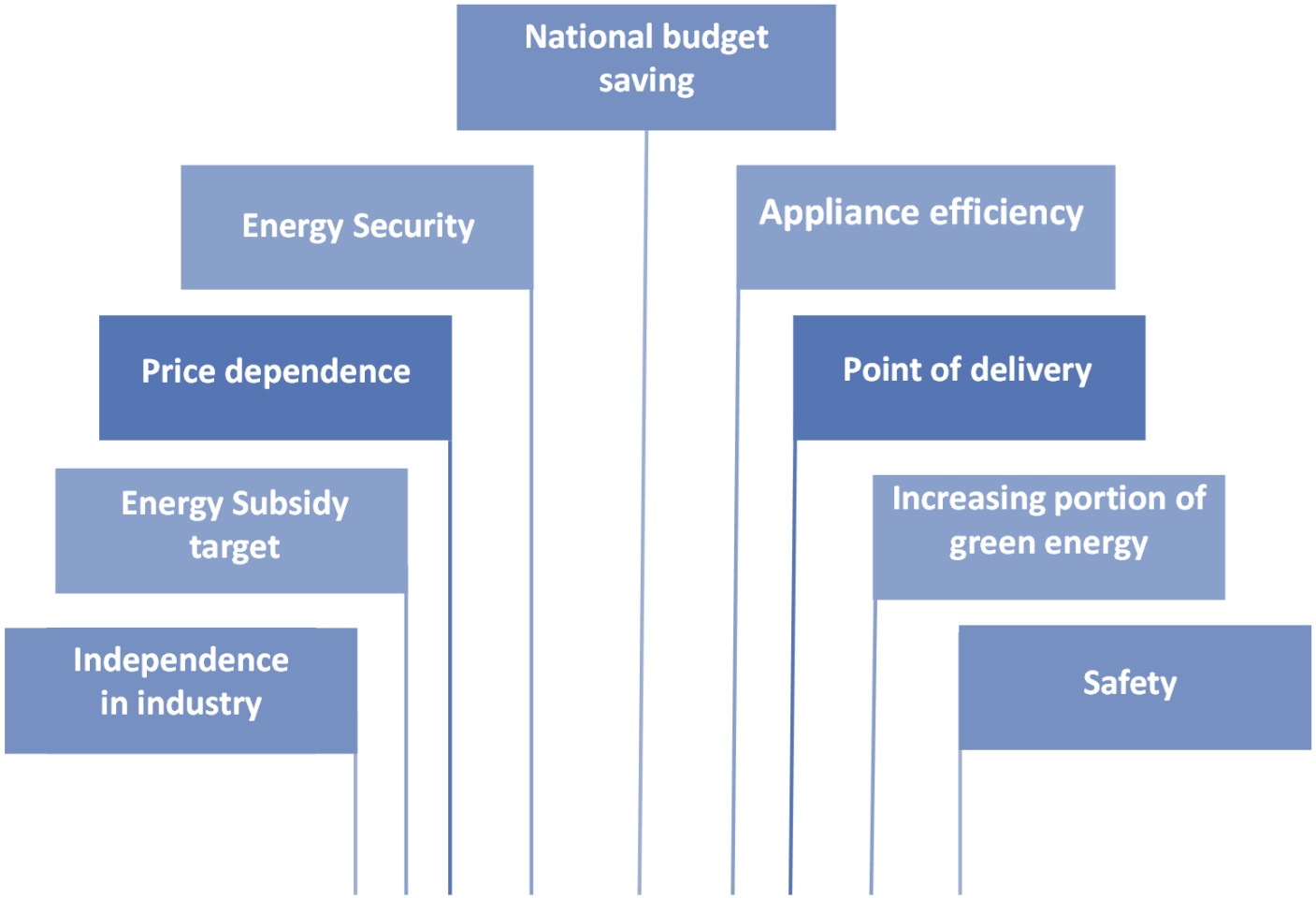
Intensive Socialization

Intensive socialization to the prospective users of induction stove, especially related to the techniques of utilization and the advantages of using induction stove. This socialization is needed to change the negative perception in the community related to induction stove. The task of socialization can be coordinated centrally by certain government ministries, but still requires synergy from various ministries and related state-owned company.

State Owned Company collaboration

Participation of state-owned company and private business entity in the mega conversion program, especially related to the electricity network upgrade and the national manufacturing of induction stove

Research Conclusion



- For various possible economic scenarios conducted in this study, the application of induction stoves for cooking are more economical when compared to LPG stoves.
- In the existing condition (without electrical installation uprating) for low-income households, the transition of cooking behavior from LPG (subsidized) stove to 300-Watt induction stove provides monthly cooking savings per household of Rp 10,344. The application of 500-Watt induction stove provides savings in cooking costs of Rp 21,344 per month per household. These scenarios need to consider the availability of low power induction stoves, in this case the induction stove with the scale of 300 Watt and 500 Watt.
- In the existing conditions for the middle- and high-income household group, the cooking cost savings obtained will be even greater of Rp 43,606 per month per household. This economic scenario is carried out by considering the use of an 1,800 Watt high-efficiency induction stove.
- If the electrical installation rating for a low-income household is upgraded so that the household can apply a high-efficiency induction cooker (1,800 Watt), the cooking cost saving gained will increase significantly of Rp. 31,761 per month per household.
- The economic saving for low-income households will increase significantly if there are a scarcity of 3 kg LPG tubes in the field.

Selected Reference

Adria, Oliver, and Jan Bethge. 2013. “What Users Can Save with Cooking What Users Can Save with Stoves and Ovens Cooking Stoves and Ovens What Users Can Save with Energy-Efficient Cooking Stoves and Ovens.”

Banerjee, Manjushree, Rakesh Prasad, Ibrahim H. Rehman, and Bigsna Gill. 2016. “Induction Stoves as an Option for Clean Cooking in Rural India.” *Energy Policy* 88 (July): 159–67. https://doi.org/10.1016/j.enpol.2015.10.021.

Beaton, Christopher, and Lucky Lontoh. 2010. “Lessons Learned from Indonesia’s Attempts to Reform Fossil-Fuel Subsidies.” *International Institute for Sustainable Development*, no. October.

BPS. 2017. “Percentage of Households by Province and Type of Cooking Fuel, 2001, 2007-2015.” *Badan Pusat Statistik*. Jakarta, Indonesia: Badan Pusat Statistik. https://www.bps.go.id/linkTabelStatis/view/id/1364.

Brown, Ed, Jon Leary, Gillian Davies, Simon Batchelor, and Nigel Scott. 2017. “ECook: What Behavioural Challenges Await This Potentially Transformative Concept?” *Sustainable Energy Technologies and Assessments* 22 (2017): 106–15. https://doi.org/10.1016/j.seta.2017.02.021.

Budya, Hanung, and Muhammad Yasir Arofat. 2011. “Providing Cleaner Energy Access in Indonesia through the Megaproject of Kerosene Conversion to LPG.” *Energy Policy* 39 (12): 7575–86. https://doi.org/10.1016/j.enpol.2011.02.061.

ESDM. 2019. “Handbook of Energy and Economic Statistics of Indonesia.” *Ministry of Energy and Mineral Resources Republic of Indonesia*. Jakarta, Indonesia.

Gould, Carlos F., Samuel Schlesinger, Andres Ochoa Toasa, Mark Thurber, William F. Waters, Jay P. Graham, and Darby W. Jack. 2018. “Government Policy, Clean Fuel Access, and Persistent Fuel Stacking in Ecuador.” *Energy for Sustainable Development* 46: 111–22. https://doi.org/10.1016/j.esd.2018.05.009.

IEA. 2018. “2018 World Energy Outlook.” *OECD/IEA*.

Kementerian Keuangan. 2019. “Informasi APBN 2019.” *Kementerian Keuangan Republik Indonesia*. Jakarta, Indonesia.

PLN Research Institute, PLN. 2017. “Kajian Teknis Dan Ekonomis Pemakaian Peralatan Listrik Rumah Tangga.” Jakarta, Indonesia.

PT PLN (Persero). 2019. “PLN Statistics 2018.”

Quinn, Ashlinn K., Nigel Bruce, Elisa Puzzolo, Katherine Dickinson, Rachel Sturke, Darby W. Jack, Sumi Mehta, Anita Shankar, Kenneth Sherr, and Joshua P. Rosenthal. 2018. “An Analysis of Efforts to Scale up Clean Household Energy for Cooking around the World.” *Energy for Sustainable Development* 46: 1–10. https://doi.org/10.1016/j.esd.2018.06.011.

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Thank You
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