



Enablers and Barriers in Indonesia's Household Energy Transition to Induction Cookstove: A Sustainability Perspective

Hasna Wahidaturrasyidah Anshori¹, Retno Wulan Damayanti², Eko Pujiyanto³, Muhammad Hisjam⁴

^{1,2,3,4} Department of Industrial Engineering, Faculty of Engineering, Sebelas Maret University, Surakarta, Indonesia

ABSTRACT: The transition from LPG stoves to induction cookstove is an important part of efforts to decarbonize the household sector and achieve sustainable development in Indonesia. Although induction cookers offer potential environmental, social, and economic benefits, their adoption rate is still relatively limited. This study aims to identify and analyze the enablers and barriers to transitioning to induction cookers from a sustainability perspective, considering environmental, social, and economic dimensions. This study is based on a structured synthesis of empirical and conceptual findings from previous studies discussing the transition to electric cooking technology and clean cooking, with a focus on countries that have implemented this technology. The analysis was conducted to group and interpret the main enablers and barriers within the sustainability framework. The results of the study show that the main enablers of transition include energy efficiency and technological performance, perceived benefits of use, awareness of health and environmental risks, reliability of electrical infrastructure, and government policy and program support. Conversely, the dominant barriers include the high initial cost of the devices, the perceived high cost of electricity, limited household electricity capacity and reliability, cultural cooking habits and preferences, and strong dependence on LPG subsidies. This study concludes that the transition to induction cookers in Indonesia is still at a partial readiness stage and requires an integrated, inclusive, and sustainability-oriented policy approach to ensure fair and sustainable transition.

KEYWORDS: Induction cookstoves, Clean cooking transition, Enablers and barriers, Sustainability perspective, Household energy transition.

INTRODUCTION

Indonesia is currently in a crucial phase of its energy transition towards sustainable development, with reducing dependence on fossil fuels as one of its top priorities. In the household sector, cooking activities are still dominated by the use of LPG, particularly subsidized LPG, which not only contributes to greenhouse gas emissions and indoor air pollution but also poses a significant fiscal burden due to high energy imports and subsidies [1], [2]. The continued reliance on subsidized LPG also creates structural vulnerabilities for national energy security, as fluctuations in global energy prices directly affect domestic supply stability and government expenditure [2]. This situation underscores the urgency of developing cleaner, more efficient, and sustainable cooking technology alternatives.

One of the strategic initiatives currently being developed is the adoption of electric induction cookers as an alternative to LPG cookers. Various studies show that induction cookers are more energy efficient than fossil-fuel and biomass cookers and do not produce direct combustion emissions in households. These characteristics have the potential to improve indoor air quality and reduce health risks, while supporting climate change mitigation efforts, especially in electricity systems with increasingly low-carbon energy mixes [3], [4], [5]. In the Indonesian context, the introduction of induction cookers was piloted by PT PLN (Persero) in 2022 [6]. The pilot project results showed potential benefits in terms of energy efficiency and cooking convenience. However, field implementation also revealed various challenges, including limited access to information, concerns about initial investment costs, limited power and household electrical infrastructure, and the incompatibility of the technology with the community's cooking habits and culture.

International literature shows that the success of induction cooker adoption is not solely determined by technological superiority, but by the complex interaction among various enabling and inhibiting factors. Awareness of health and environmental benefits, energy efficiency, government policy support and incentives, and increased energy literacy are often identified as key enablers. At the same time, relatively high initial costs, perceptions of high electricity costs, limited electrical infrastructure, and resistance to changes in cooking practices are significant barriers [1], [7], [8], [9].



From a sustainability perspective, the transition to induction cookers has interrelated implications across environmental, social, and economic dimensions. The national electricity mix heavily influences environmental benefits. At the same time, social impacts are closely linked to household health, cooking safety, and the role of women as the primary users of cooking technology. On the other hand, although induction cookers have the potential to deliver long-term cost savings and reduce the burden of state energy subsidies, affordability for low-income households remains a major challenge [10], [11], [12].

In a broader global context, the transition to induction cookers is strongly aligned with the Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) [13]. Promoting clean and efficient cooking technologies supports universal access to modern energy services while reducing exposure to harmful indoor air pollution that disproportionately affects women and children. Moreover, the adoption of electric cooking technologies contributes to more efficient household energy use and emissions reduction, especially when integrated with low-carbon electricity systems [14]. For developing countries such as Indonesia, aligning cooking technology transition strategies with the SDGs provides a coherent framework to balance environmental sustainability, social inclusion, and economic affordability, ensuring that household energy transition initiatives contribute to broader sustainable development objectives.

Although studies on the adoption of clean cooking technologies continue to evolve, most research still discusses enablers and barriers separately and partially. Studies that explicitly integrate these factors into a sustainability framework that simultaneously considers environmental, social, and economic dimensions, particularly in developing countries such as Indonesia, remain relatively limited. Therefore, this study aims to identify and analyze the enablers and barriers to transitioning to induction cookers from a sustainability perspective. This study is expected to enrich the literature on household energy transition and provide a conceptual basis for formulating more effective, inclusive, and sustainable policies and strategies to encourage the adoption of induction cookers in Indonesia.

METHODOLOGY

This study uses the Systematic Literature Review (SLR) method to identify and synthesize various enabler and barrier factors in the transition to induction cookers from a sustainability perspective. The SLR approach was chosen because it allows for structured, transparent, and replicable literature searches. The article selection and screening process in this study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines as recommended in the latest SLR study [15]. The article selection flow is presented in the PRISMA flow diagram in Figure 1.

Phase 1: Defining search keywords. The first phase involved formulating search keywords relevant to the research focus: the transition from cooking technology to induction cookers and the factors driving and inhibiting its adoption. The keywords used include induction cookstove, electric cookstove, electric cooking, cookstove technology, technology adoption, technology transition, energy transition, enabler, driver, facilitator, barrier, challenge, and sustainability. The "OR" operator connects terms with similar meanings within a group, while the "AND" operator links groups of keywords so that search results remain relevant to the research objectives.

Phase 2: Defining the search database and running the search. The second phase involved identifying the scientific databases used in the literature search. The selected databases are reputable and widely used in research, namely Scopus, ScienceDirect, IEEE Xplore, Wiley Online Library, MDPI, and SpringerLink. The article search was limited to publications from 2011 to 2025 in order to capture relevant and current research developments. Based on initial searches across all these databases, 215 articles were retrieved.

Phase 3: Removing duplicates. At this stage, all articles retrieved from the selected databases were systematically examined to identify and remove duplicate records. Duplicate articles commonly arise due to overlapping coverage among major scientific databases, particularly for widely cited journals and conference proceedings. The duplicate removal process was conducted by comparing article titles, authors, publication years, and digital object identifiers (DOIs) where available. This step was essential to avoid double counting of the same study and to ensure the integrity and reliability of the subsequent screening process. By eliminating redundant records, the dataset was refined to include only unique publications, thereby improving the accuracy and efficiency of the screening and selection stages that followed.

Phase 4: Screening and final selection of articles. The remaining articles were screened based on predefined inclusion and exclusion criteria. Inclusion criteria covered peer-reviewed journal articles, conference proceedings, and book chapters written in English, available in full text, and discussing induction cookers or electric cooking technologies with a focus on enablers and/or barriers in the context of sustainability. Exclusion criteria included articles that were not related to household cooking technologies, conceptual papers without contextual discussion, duplicate publications, and non-scientific sources such as reports, editorials, or opinion papers. Screening was conducted by reviewing abstracts and conclusions, resulting in 35 eligible articles. A full-text review was then performed, leading to the final selection of 25 articles used as the basis for analysis in this study.

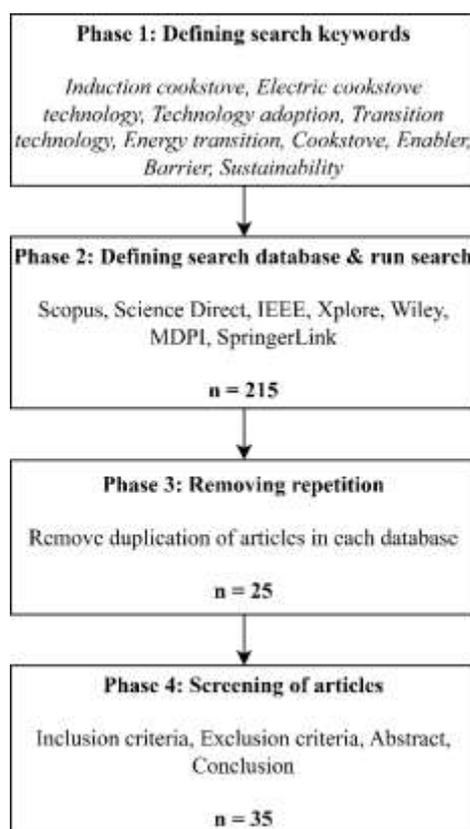


Figure 1. Research Flowchart

RESULTS AND DISCUSSION

Based on literature searches across various scientific databases for the period 2011–2024, the number of studies on induction cookers shows an upward trend. This aligns with the growing number of countries that have begun implementing and encouraging the use of clean cooking technologies, particularly induction cookers, as part of their energy transition and sustainability strategies. From the entire selection process, 25 articles were identified that met the previously established inclusion criteria and were relevant to the objectives of this study. Of the 25 selected articles, 20 used a qualitative approach, including a literature review. These findings indicate that studies on enablers and barriers to induction cooker adoption are more often conducted using a qualitative approach, with an emphasis on synthesizing prior studies' results.

The literature review approach uses a structured, systematic methodology that includes clear stages ranging from literature search, study selection, and quality assessment to data synthesis. This approach enables the collection and analysis of information to be carried out consistently and transparently, thereby making the findings more reliable and credible. The results of the literature synthesis related to enabler and barrier factors in the transition to induction cookers are summarized in Table 1.



Table I. Enablers and Barriers in Indonesia’s Transition to Induction Cooking Across Sustainability Dimensions

Research/ Country	Object	Enabler	Barrier	Sustainability Perspective		
				Environmental Aspect	Social Aspect	Economic Aspect
(Bajracharya & Adhikari, 2022) in Nepal [8]	Induction stove	Technology awareness; Clean energy intention	High initial costs; Unstable electricity; Cookware compatibility; Cooking time/taste concerns	Household emission reduction; indoor air quality improvement	Women as primary users; cooking practice shift	Reduced LPG imports; energy ladder advancement
(Damayanti et al., 2023) in Indonesia [16]	Induction stove	Positive technology perception; Community support; Government regulation	Technology change resistance; Entrenched cooking habits; Knowledge limitations	LPG consumption reduction; long-term emission reduction	Cooking safety and comfort; community empowerment	Reduced LPG subsidies; import cost reduction
(Energy, 2021) in Chicago, US [17]	Electric stove	Health awareness; Policy initiatives; Incentives/rebates	Renter choice limitations; Limited incentives; Performance concerns	Emission reduction; elimination of indoor gas pollution	Public health improvement ; protection of vulnerable groups; energy justice	Upfront cost vs long-term benefit; role of incentives and rebates
(Romero-Arismendi et al., 2024) in Mexico [5]	Induction stove	Higher energy efficiency; Gas emission reduction; Lower long-term costs	High initial costs; Electricity access limitations; Lack of public policy	Kitchen pollution reduction (electricity mix dependent)	Health improvement ; cultural acceptance challenges	Potential LPG subsidy reduction; tariff reform needs
(Tiandho et al., 2021) in Indonesia [18]	Induction stove	High energy efficiency; Government support; Price subsidy programs	High power demand; High initial costs; Electricity infrastructure limitations	Household CO ₂ and CO emission reduction	Improved cooking safety and health	Lower operating costs; price intervention required
(Tornel-vázquez, 2024) in Asia, Africa, America latin [19]	Biogas/LPG/ICS	Household income; Information access; Women's involvement; Social capital	High initial costs; Economic limitations; Cultural patriarchy; Low literacy	Reduced deforestation; indoor air pollution reduction	Reduced women’s workload; gender equality	Long-term cost efficiency; stable energy expenditure
(Kc & Lohani, 2024) in Nepal [20]	Induction stove	High technology efficiency; Long lifespan; Electricity access; Clean energy policy	High initial/operational costs; Unstable supply; Distribution limitations; Tariff increase fears	Carbon and biomass pollutant reduction	Health improvement ; reduced domestic burden	Long-term efficiency; household energy resilience
(Kar & Zerriffi,	Clean cooking	Technology benefit perception;	Previous cooking habits; Cost/risk perception;	Household air pollution	Behavioral change;	Cost perception;



2018) in India [21]	solutions	Social/policy support; Infrastructure availability	Energy supply instability	reduction	improved household health	importance of post-adoption support
(Sambodo et al., 2025) in Indonesia [22]	LPG to Induction	Energy efficiency; Ease/safety; Clean kitchen perception; Government programs	Strong LPG subsidies; Household power limits; Initial costs; Service ecosystem	Long-term emission reduction potential	Health benefits; strong gender dimension	Lower national cost; higher household cost
(Paudel, Sharifi, & Khan, 2023) in Nepal [12]	Induction stove	Low monthly cooking costs; Reliable supply; Time efficiency; Environmental perception	High perceived electricity costs; Old practices dependency; Supply reliability concerns	Household air pollution reduction; climate mitigation	Health improvement ; women's time savings	Long-term savings; willingness to pay (~4% income)
(Liu et al., 2025) in NSW, Australia [23]	Household electric technologies	Established energy infrastructure; Efficiency policies; Modern technology access	Income inequality; Uneven infrastructure; High initial costs; Remote area limitations	Emission reduction potential; carbon lock-in risk	Unequal technology access; health risk disparity	Higher energy cost burden for low-income households
(Ocen et al., 2024) in Asia and Africa [9]	LPG/biogas/electric /ICS	Income/assets; Credit/subsidy access; Energy literacy; Women's empowerment	High initial costs; Cheap fuel dependency; Fuel stacking; Market access limitations	Household air pollution and GHG reduction	Health improvement ; gender equity	Long-term cost efficiency; subsidy dependence
(Dipesh et al., 2025) in Nepal [24]	Induction stove	National policy support; Electricity access growth; Efficiency/safety	Inadequate wiring/metering; Outages; High costs; No special tariffs	Household air pollution reduction potential	Health impacts; gendered decision-making	High upfront and electricity costs
(Boudewijns et al., 2022) in Asia, Africa, America latin [25]	Clean fuels (electricity included)	Technology benefit perception; User knowledge; Policy/subsidies	High initial/sustained costs; Cultural mismatch; Low energy literacy	Deforestation and GHG reduction	Reduced time burden; lower health risks for women	Long-term efficiency; affordability challenges
(Kumar et al., 2025) in India, Nepal, Kenya, Ethiopia, Nigeria [26]	Electric cooking	Electricity reliability; Education level; Cooking speed/comfort	Unreliable electricity; Poor household wiring; High initial costs	Household air pollution reduction (clean electricity dependent)	Health benefits; energy access equity	Long-term efficiency; subsidy requirement
(Guayanlema et al., 2024) in Ecuador [2]	Induction stove	Superior efficiency; LPG subsidy reduction policy	Large LPG subsidies; Grid capacity needs; Social resistance	GHG and household pollution reduction	Cooking health and safety improvement	LPG subsidy reduction; high infrastructure investment



(Gould et al., 2020b) in Ecuador [27]	LPG/biomass/induction	Electricity access; Fast/clean perception; Government promotion	Cultural preferences; High initial costs; Infrastructure gaps	Pollution reduction if biomass displaced	Women's role; social resistance	LPG subsidy burden; high household costs
(Banerjee et al., 2016b) in India [28]	Induction stove	High electrification; Efficiency/ease; Entrepreneur distribution	Fuel stacking; Cooking incompatibility; Bill increase fears	Limited firewood and LPG reduction	Reduced smoke exposure; unequal social benefits	Unaffordable without policy support
(Lane et al., 2024) in New York City, US [29]	Electric stove	Health awareness; City gas bans; Clean energy interest	Gas cooking preference; Bill increase fears; Upgrade complexity	Indoor air pollution reduction	Health awareness; gas-cooking preference persistence	Cost concerns; transition complexity
(Leary et al., 2021) in Tanzania, Zambia, Bangladesh, Myanmar. [11]	Electric cooking	Convenience/time savings; Clean/safe perception; Demonstrations	High perceived electricity costs; Supply reliability; After-sales service	Household air pollution reduction	Health benefits; cooking practice change	Context-specific operating cost savings
(H. Qi. Karima et al., 2023) in Indonesia[30]	Induction stove	Family/neighbor support; Ease of use; Heating speed	High investment perception; Electricity cost fears; Limited experience	Reduced LPG dependency	Social support; user experience	Household energy economic risk mitigation
(Kim et al., 2017) in Korea Selatan [3]	Induction stove	Usage comfort; Safety perception; No emissions; Easy maintenance	Energy price disparity; Low-income sensitivity; Established gas infrastructure	Elimination of gas combustion pollution	Household safety and health improvement	High willingness to pay; electricity demand impact
(Davi-arderius et al., 2023) in Ecuador [31]	Induction stove	High household income; Policy support (subsidies/credit)	Poverty; Poor housing conditions; LPG dependency	National CO ₂ emission reduction potential	Social inequality risk	LPG subsidy reduction; affordability concern
(Yandri et al., 2021) in Indonesia [32]	Hi-Tech Cook Stove (HTCS)	Efficient stove design; Environmental awareness	High initial costs; User knowledge/skills limitations; Infrastructure gaps	Environmental cleanliness	Skills; Awareness	Cost; incentives
(Cordes, 2011) in India [33]	LPG/Biomass/Electric/Solar	Awareness/education; Policy support; Stakeholder engagement	Low clean energy awareness; High initial costs; User preferences	Clean energy awareness	Habits; Perception	Initial cost



1. Enablers factor for the transition to the induction stove

- Perception of the benefits of using technology
Perceptions of technology's benefits are an important enabler of induction cooker adoption, as households tend to accept technology when its benefits can be directly felt in everyday cooking practices. The literature shows that cleaner kitchens without smoke, higher safety levels due to the absence of open flames, faster heating times, and ease of use and maintenance form positive perceptions of the performance and practicality of induction cookers [8], [16], [22]. These tangible benefits increase households' interest and readiness to switch from fossil fuel stoves, especially among primary stove users, particularly women who prioritize comfort, safety, and time efficiency [1], [34]. Several studies also show that the perception of induction cookers as fast, clean, and easy-to-operate technology continues to drive adoption intentions despite concerns about electricity costs or energy infrastructure limitations [3], [4], [11]. Thus, the perception of technological benefits serves as an experience-based enabler, reinforcing positive evaluations of induction cookers relative to conventional cooking technologies [25].
- Health and environmental risk awareness
Awareness of health and environmental risks has emerged as an important cognitive enabler in the adoption of induction cookers and clean cooking technologies. The literature shows that concerns about indoor air pollution and exposure to harmful emissions from combustion-based cooking practices have prompted households to question the use of fossil fuel stoves and consider electric alternatives [17]. A study in Nepal shows that greater understanding of the health impacts of kitchen smoke contributes to more positive attitudes toward induction cookers, though this awareness does not always lead to immediate adoption [8]. These findings confirm that health and environmental awareness play a greater role in shaping psychological readiness than in triggering final adoption. Furthermore, energy literacy, including understanding of technological efficiency, electricity consumption, and the difference between direct and indirect emissions, strengthens acceptance of induction cookers and reduces perceptions of the risks of using electricity [9], [25]. Education programs, demonstrations, and the provision of accurate information have proven effective in strengthening the intention to adopt clean cooking technologies by correcting misconceptions about costs and environmental impacts [11], [19]. Thus, health and environmental awareness supported by energy literacy serve as a cognitive enabler that strengthens the acceptance of induction cookers at the household level.
- Energy efficiency and technological performance are the basis for initial acceptance
Energy efficiency and technological performance are the most fundamental enablers of initial acceptance of induction cookers, as they form the basis for households' practical evaluation of the technology's suitability. Technically, induction cookers have a thermal efficiency of over 80-90%, which is much higher than LPG cookers, which range from 40-55%, resulting in shorter cooking times, responsive heating, and lower energy loss [35]. However, the literature shows that households do not assess this efficiency through technical indicators, but rather through direct experiences such as heating speed, heat stability, and ease of temperature control, which shape positive perceptions of the technology's performance [8]. Perceptions of more consistent cooking performance have been shown to increase adoption interest even before users consider cost or environmental impact aspects [18]. Furthermore, energy efficiency is often perceived as a symbol of more modern and practical technology, thereby reinforcing the quality image of induction cookers and reducing resistance to changes in cooking practices [5]. Thus, energy efficiency not only serves as a technical advantage but also as a signal of quality, reducing resistance to changes in cooking practices.
- Public policy support and government programs
Public policy support and government programs are important enablers of the transition to induction cookers, as household adoption is strongly influenced by the direction and consistency of national energy policy [36]. Regulations, incentives, and government programs help build public trust and reduce perceptions of risk associated with this relatively new technology [16]. In Indonesia, a pilot program for the transition from LPG to induction cookers has been shown to reduce households' financial and technical concerns by positioning the government as a social guarantor in the adoption process [22]. A similar experience was found in Ecuador, where LPG subsidy reforms accompanied by support for induction cookers strengthened the legitimacy and acceptance of electric technology in the household sector [2]. However, the literature emphasizes that



policy effectiveness is highly dependent on the design of fair financing mechanisms, as non-inclusive subsidy reforms can have regressive impacts on low-income households [37].

- Availability and reliability of electrical infrastructure

The availability and reliability of electrical infrastructure are key prerequisites for the transition to induction cookers, as this technology relies entirely on a stable, high-quality electricity supply [20]. Studies show that households with reliable electricity access, adequate power capacity, and good network quality have a higher adoption rate than households in areas with unstable electricity supply [4]. Although Indonesia's electrification rate has reached 99,45%, disparities in supply quality and power limitations outside Java remain structural barriers to the adoption of induction cookers [38]. Electricity reliability also includes the readiness of household systems such as installations, meters, and installed power, which are often inadequate to support the load of induction cookers safely [24]. When supply quality is low, the risk of blackouts and voltage fluctuations increases perceptions of uncertainty and encourages fuel stacking practices with LPG or biomass [7]. Beyond technical aspects, energy service factors such as tariff affordability, ease of capacity upgrades, and cost transparency also influence user confidence, where concerns about electricity bill spikes can hinder adoption even when electricity is physically available [11], [39]. Thus, reliable and quality access to electricity serves not only as supporting infrastructure but as an enabler of trust in the transition to sustainable cooking practices [22].

- Social and community support

Social and community support play an important role in encouraging the adoption of induction cookers, as the decision to switch cooking methods is often influenced by the immediate environment, including family, neighbors, and the local community [30]. Studies show that recommendations from other users who have had positive experiences with induction cookers increase trust and reduce perceptions of risk associated with new technologies [40]. The existence of user communities, discussion forums, and cooking experience-sharing activities also accelerates technology diffusion through social learning and peer influence mechanisms [11]. This social support strengthens the acceptance of technology not only from a functional perspective, but also from a social and cultural perspective, making the transition to induction cookers more easily accepted in everyday household life [9].

- The role of women as primary users and decision makers

Women play a central role in the transition to induction cookers because they are generally the primary users and decision makers in household cooking activities [19]. Research shows that when women are actively involved in the process of introducing and selecting cooking technologies, the adoption rate of clean cooking tends to be higher and more sustainable [9]. Induction cookers are considered to provide direct benefits to women, such as increased safety, reduced exposure to indoor air pollution, and shorter cooking times [4]. Furthermore, empowering women through increased energy literacy and access to information strengthens their position in decision-making, thereby encouraging changes in cooking practices toward cleaner, more sustainable technologies [25].

- Hands-on experience, demonstrations, and trials

Firsthand experience through demonstrations and trials of induction cookers has proven to be an effective way to reduce uncertainty and resistance to new technologies [11]. Several studies show that households participating in demonstration or trial programs have a better understanding of the efficiency, safety, and convenience of induction cookers than those who receive information passively [28]. Trials allow users to directly evaluate the suitability of the technology for their cooking habits, kitchen equipment, and household electricity consumption [4]. Thus, this empirical experience serves as a bridge between initial perceptions and actual adoption, while increasing user confidence in the long-term benefits of induction cookers [22].

2. Barriers factor for the transition to the induction stove

- High initial costs

The initial cost of purchasing induction cookers and supporting equipment, such as compatible cookware, remains a major barrier to the transition to electric cooking, especially for low- and middle-income households [41]. Several studies show that although the operational costs of induction cookers are relatively lower in the long term, the decision to adopt them is often hampered by household liquidity constraints in the early stages [5]. Studies in Indonesia show that perceptions of high initial



investment often have a greater influence than evaluations of long-term operating costs, leading households to delay adoption decisions [22]. These barriers are structural in nature because they cannot be overcome simply by increasing information or awareness. This condition is exacerbated when no financing schemes, initial subsidies, or affordable installments are available, so that the long-term economic benefits are insufficient to offset the initial investment burden borne by users [2]. Thus, the initial investment cost acts as a social filter, determining who can access modern cooking technology.

- Perception of high electricity operating costs

The perception that monthly electricity costs will increase significantly after switching to induction cookers is a strong psychological barrier, even though it is not always supported by actual cost calculations [12]. Research in Indonesia shows that concerns about electricity bill spikes are the main reason for rejection of adoption, even though actual calculations show more balanced results [30]. The lack of clarity in the electricity tariff structure often influences this perception of cost. Unclear information on electricity tariffs, concerns about bill spikes, and the negative experiences of other users reinforce this perception and reduce interest in adoption [29]. Cross-country studies show that uncertainty about monthly costs is more concerning to households than the actual costs themselves [26]. This explains why tariff transparency and real-world experience are important factors in overcoming this barrier.

- Limitations of household electrical infrastructure

Limitations in household electricity capacity and reliability are significant structural barriers to the adoption of induction cookers, particularly in areas with low installed power or unstable electricity supply [18]. Several studies have noted that power outages, voltage fluctuations, and inadequate household electrical installations reduce user confidence in the reliability of electric cooking technology [20]. These conditions lead households to retain LPG as a backup or to adopt fuel stacking, thereby hindering a full transition to induction cookers [11]. Cross-country research in Asia and Africa shows that inadequate electrical installations increase the risk of operational disruptions and equipment damage, thereby reducing interest in adoption [26]. These barriers are not only technical in nature but also raise concerns about the additional costs of upgrading installations. Research [22] shows that limited household electricity is the main reason for the inconsistent use of induction cookers, even though they have received the devices from a government program. This shows that household infrastructure readiness is an important prerequisite that is often overlooked.

- Deep-rooted cultural preferences and cooking habits

Cooking habits deeply rooted in social and cultural traditions pose a significant non-technical barrier to the adoption of induction cookers [1]. Studies in India show that certain cooking practices, such as high-heat cooking and large portions, make induction cookers appear less suitable [21]. Taste preferences, specific cooking techniques, and the flexibility of gas or biomass stoves are often considered not fully replaceable by induction technology [28]. This resistance is reinforced by the perception that induction cookers are less suitable for cooking large quantities or certain traditional dishes, making users reluctant to change long-standing cooking practices [40]. Cross-regional studies confirm that cultural resistance tends to persist even when economic barriers have been reduced, underscoring the need for a more contextually grounded socio-cultural approach [25]. This shows that the adoption of cooking technology cannot be separated from everyday social practices.

- Low Energy Literacy and Lack of Direct Experience

Low energy literacy and lack of direct experience using induction cookers are significant barriers to information. Studies in Indonesia show that a lack of understanding of how induction cookers work and their technical requirements reinforces perceptions of technological risk [16]. Cross-country research shows that written information or one-way campaigns are less effective than hands-on demonstrations in changing households' attitudes toward new cooking technologies [11]. Without real-world experience, households tend to stick with familiar technologies. Studies in India show that low energy literacy also limits households' ability to critically evaluate claims of efficiency and cost [33]. Thus, information barriers contribute to the preservation of the status quo in cooking practices.

- Weak after-sales support ecosystem and technical services

The lack of after-sales service, limited access to repair services, and low energy literacy are significant barriers to the adoption of induction cookers beyond the initial adoption phase [11]. Several studies show that negative post-purchase experiences, such as breakdowns without adequate technical support, reduce user satisfaction and increase the risk of



discontinuing use [25]. The lack of education on optimal use and energy efficiency also prevents households from fully realizing the technology's benefits [21]. Studies in Africa and Asia show that the absence of spare parts and local technicians increases the perception of technological failure risk [26]. The success of the clean cooking transition depends heavily on a supporting ecosystem that includes distribution, service, and user education [25]. Without this support, the technology tends to fail in the long term.

- **Social resistance and policy uncertainty**

Social resistance to technological change is reinforced by uncertainty over the direction of energy policy and inconsistent government programs [22]. When policy support is temporary or not accompanied by long-term commitments, households tend to delay adoption decisions due to concerns over changes in incentives and electricity tariffs [17]. This situation undermines public confidence and weakens the energy transition signals that should encourage widespread adoption of induction cookers [29].

- **Strong dependence on LPG subsidies**

Long-standing LPG subsidies have created energy price distortions and become a major barrier to the transition to induction cookers [22]. The relatively low price of LPG reduces the economic appeal of induction cookers, even though they are superior for the environment and health [2]. This dependence also shapes people's preferences and expectations for cheap cooking energy, so that the transition to electric technology is perceived as an additional burden rather than an improvement in welfare [1]. Cross-country studies show that as long as fossil fuel subsidies remain dominant, households tend to delay adopting electric technologies due to perceived short-term cost differences [31]. This confirms that subsidy reform is a sensitive but crucial policy prerequisite.

3. Sustainability Implications of Induction Cookstove Transition

- **Environmental Sustainability**

From an environmental perspective, the transition to induction cookers has significant potential to reduce household emissions and indoor air pollution, especially when compared to LPG and biomass [8]. The elimination of direct combustion in cooking reduces CO₂, CO, and other harmful pollutants that affect health and domestic environmental quality [5]. However, these environmental benefits are context-dependent and highly influenced by the national electricity mix, in which electricity systems still dominated by fossil fuels can limit the magnitude of aggregate emission reductions [2]. Furthermore, dependence on LPG subsidies and fuel stacking practices prevents optimal reductions in emissions because induction cookers often serve only as a complementary technology rather than a primary replacement [22]. Thus, the environmental sustainability of induction cooker adoption is determined not only by its technological characteristics, but also by the consistency of energy policies and the acceleration of the transition to a cleaner electricity system.

- **Social Sustainability**

Socially, the adoption of induction cookers contributes to improved household health by reducing exposure to indoor air pollution, which has a significant impact on women and vulnerable groups who are the primary users of the kitchen [11]. This technology also has the potential to encourage safer, more convenient cooking practices and to reduce the time burden and risks of domestic work for women [9]. However, resistance to changes in cooking habits and deep rooted cultural preferences are major challenges in realizing these social benefits on a broad scale [1]. Inequalities in access to electricity, technology, and information also create the risk of social exclusion, where only certain groups can enjoy the benefits of induction cookers [23]. Therefore, the social sustainability of this transition depends heavily on an inclusive approach that considers energy literacy, community empowerment, and the role of women in household energy decision-making [42].

- **Economic Sustainability**

From an economic perspective, induction cookers offer long-term cost efficiency through reduced LPG consumption and potential stability in household energy expenditure [4]. At the macro level, this transition has the potential to reduce the fiscal burden of LPG subsidies and energy imports, thereby strengthening national energy security [22]. However, these economic benefits have not been fully realized at the household level due to the high initial cost of the devices, the perception that electricity is expensive, and limited access to affordable financing [8]. Without appropriate policy intervention, this transition risks regressive impacts, with low-income households bearing a greater cost burden than the benefits they receive [31].



Therefore, the economic sustainability of induction cooker adoption requires integrating electricity tariff policies, initial investment incentives, and fair financing schemes to ensure economic benefits are felt evenly and sustainably.

4. Policy Implications for Indonesia's Transition to Induction Cookstove

Findings regarding enablers and barriers to induction cooker adoption from a sustainability perspective indicate that the success of the transition in Indonesia cannot rely solely on a technological approach; it requires integrated policy design across the energy, social, and fiscal sectors. From an environmental perspective, the potential to reduce household emissions through the use of induction cookers will be optimally realized only if accompanied by a strategy to decarbonize the national electricity system. Therefore, the induction cooker transition policy should be positioned within the national energy transition agenda rather than as a stand-alone LPG substitution program. Integration with renewable energy development, increased power plant efficiency, and strengthening of the electricity grid are key prerequisites to ensure that environmental benefits are not partial or long-term only.

From a social perspective, the study results emphasize the importance of a household and community-based approach, with women as key actors in domestic energy decision-making. The policy implications for Indonesia include shifting from a top-down to a participatory approach through education programs, demonstrations, and support for the use of induction cookers at the local level. Programs such as the PLN pilot project need to be expanded with an emphasis on trial use, as this has been proven to reduce social resistance, correct negative perceptions of cost and performance, and encourage changes in cooking practices. In addition, the transition policy must uphold the principle of energy justice, ensuring that low-income households are not left behind due to limited access to electricity, information, and technology.

Economically, the most crucial policy implications lie in reforming energy financing and subsidy mechanisms. Strong dependence on LPG subsidies has proven to be a structural barrier to the competitiveness of induction cookers at the household level, even though, at the macro level, it has the potential to reduce the country's fiscal burden. Therefore, a sustainable transition in Indonesia requires a gradual, targeted subsidy adjustment strategy, such as shifting part of the LPG subsidy into incentives for purchasing induction cookers, low-interest installment schemes, or special cooking tariffs. Without a policy design that protects vulnerable groups, this transition risks being regressive and causing wider social resistance.

Overall, the policy implications of this study confirm that the transition to induction cookers in Indonesia must be understood as a multidimensional transformation of the household energy system. Environmental, social, and economic sustainability can be achieved only through synergy among energy policy, social protection, and subsidy reform. With this approach, induction cookers serve not only as an alternative cooking technology but also as a strategic instrument to support energy security, public health, and the achievement of sustainable development goals in Indonesia.

This study contributes by presenting an integrated analysis of enablers and barriers to the transition to induction cookers within the framework of environmental, social, and economic sustainability, thereby expanding the fragmented literature on household energy transition. However, because this study is based on a literature review, the findings are not supported by primary empirical data and therefore may not capture local contextual variations in Indonesia. In addition, the sustainability analysis remains qualitative and does not quantify the impact of adopting an induction cooker. In the future, empirical research, such as surveys or longitudinal studies, is needed to validate these findings and explore the implications of energy policy, electricity tariffs, and subsidy reforms for supporting a sustainable cooking transition.

CONCLUSION

This study confirms that the transition from LPG stoves to induction cookers in Indonesia is a complex socio-technical process that cannot be understood solely as a change in cooking technology, but rather as a change in the household energy system influenced by technical, economic, social, and institutional factors. Through literature synthesis and enabler-barrier analysis, this study shows that transition readiness is largely determined by the dynamic interaction among electricity access and reliability, cost perceptions, cooking habits, and support from the policy and market ecosystem.

From an enabler perspective, induction cookers have strong sustainability potential, particularly for the environment, through reduced direct household emissions and improved indoor air quality. In addition, energy efficiency, safety, and ease of operation provide added social value, especially in terms of health, comfort, and reduced domestic risks for users. Government policy support, energy conversion programs, and appropriate financing mechanisms also play an important role in lowering adoption



barriers and increasing acceptance of this technology. However, this potential has not been fully internalized by the community due to limited energy literacy, limited direct experience with use, and the perception that electricity operating costs are higher than LPG.

On the contrary, the analysis shows that structural barriers still dominate the transition process. The relatively high initial cost of the appliances, limited capacity and reliability of household electricity, and strong dependence on LPG subsidies create a lock-in effect that hinders the shift to electric cooking technology [43]. These barriers are reinforced by socio-cultural factors, such as a preference for fire-based cooking and the need for large cooking capacities for household consumption and social activities, which make induction cookers not yet fully perceived as a solution that fits with everyday cooking practices in Indonesia. The weak post adoption support ecosystem, including after-sales services and energy literacy, further strengthens resistance to transition.

Sustainability analysis shows that there are short-term trade-offs and long-term benefits. Economically, although the transition to induction cookers has the potential to reduce the state's fiscal burden by reducing fossil fuel subsidies and LPG imports, at the household level, this technology is still perceived as expensive and risky. Socially, the transition has the potential to create new inequalities if it is not accompanied by policies that are sensitive to low-income groups and areas with limited access to electricity. Thus, the success of the transition depends not only on technological readiness but also on the equitable distribution of benefits and risks.

Overall, the findings of this study indicate that the transition to induction cookers in Indonesia is still at a stage of partial readiness, where the potential environmental, social, and economic benefits have been identified but have not yet been fully translated into household adoption practices. The lack of synchronization among technological readiness, social acceptance, and economic affordability indicates that the transition's sustainability cannot be achieved through a technological approach alone. Without stronger integration between energy policy, economic incentive structures, and inclusive social strategies, the adoption of induction cookers risks producing limited environmental benefits, social inequality, and new economic pressures for vulnerable groups. Therefore, the transition to induction cookers in Indonesia should be understood as a systemic sustainability process that requires alignment across environmental, social, and economic dimensions to develop fairly and sustainably in the long term.

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