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THE PUBLIC POLICY DILEMMA OF LPG SUBSIDIES: ENVIRONMENTAL IMPACTS AND THE PATH TO GREEN ALTERNATIVES

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Abstract
Government-subsidized household Liquefied Petroleum Gas (LPG) has been a key policy in Indonesia to ensure energy accessibility for low-income communities. While this initiative has contributed to economic and social welfare, its environmental impact, particularly its carbon footprint, remains understudied. This study aims to analyze the environmental implications of subsidized LPG, focusing on its carbon footprint and exploring potential green energy alternatives. Using a systematic literature review, the study examines previous research on LPG emissions, government policies, and sustainable energy solutions such as biogas, BioLPG, and solar energy. Findings indicate that while LPG emits lower carbon compared to traditional biomass fuels, its widespread subsidy poses sustainability challenges, including fiscal burden and carbon emissions. Alternative energy sources, such as biogas and BioLPG, offer promising solutions, yet their adoption is hindered by technological and economic constraints. This study highlights the urgent need for policy reforms to gradually transition subsidized household energy from fossil fuels to sustainable alternatives. Future research should focus on assessing the economic feasibility and policy frameworks necessary to facilitate this energy transition effectively.

Keywords: LPG Subsidy, Carbon Footprint, Environmental Impact, Biogas, BioLPG, Sustainable Energy, Low-Income Households.

INTRODUCTION

The Indonesian government launched a national program to transition domestic kerosene users to liquefied petroleum gas (LPG) for cooking in 2007, primarily motivated by the escalating costs of kerosene subsidies (Puzzolo et al., 2018). This initiative aimed to reduce the financial burden on the state and promote cleaner energy consumption among low-income households (Puzzolo et al., 2018). The program successfully converted over 50 million households from kerosene to LPG between 2007 and 2012, accounting for approximately two-thirds of all Indonesian households (Puzzolo et al., 2018). Despite its success in fuel conversion, the program did not explicitly address the health impacts associated with household air pollution from biomass use, resulting in limited evidence of health benefits (Puzzolo et al., 2018). Moreover, the rapid scale-up faced challenges, including ensuring sustained LPG use and addressing supply chain issues in remote areas (Puzzolo et al., 2018).

The financial implications were significant, with the government aiming to reduce petroleum fuel subsidies and repurpose kerosene for more beneficial uses, such as aviation fuel (World LPG Association, 2012). However, the program's focus on subsidy reduction led to missed opportunities in influencing cooking behavior change among biomass users, who remain at risk (Puzzolo et al., 2018). In 2016, efforts were made to redesign the LPG subsidy scheme to target specifically low-income households, small businesses, fishers, and farmers, utilizing a unified poverty database to better identify beneficiaries (International Energy Agency, 2023). This targeted approach aimed to reduce the number of subsidy recipients from 57 million to 26 million households, thereby alleviating the fiscal burden (International Energy Agency, 2023). Despite these reforms, challenges persist in ensuring the subsidies reach the intended recipients and in promoting the adoption of cleaner cooking alternatives

(International Energy Agency, 2023). The environmental impact of increased LPG usage also raises concerns, as LPG, while cleaner than kerosene, still contributes to greenhouse gas emissions (Puzzolo et al., 2018). Therefore, a comprehensive evaluation of the program's environmental implications is necessary to inform future energy policies (Puzzolo et al., 2018).

The implementation of subsidized household Liquefied Petroleum Gas (LPG) programs in Indonesia has been instrumental in enhancing energy accessibility for low-income communities, transitioning over 50 million households from kerosene to LPG between 2007 and 2012 (Puzzolo et al., 2018). This large-scale adoption aimed to reduce the financial burden of kerosene subsidies and promote cleaner energy consumption (Puzzolo et al., 2018). However, the environmental implications of increased LPG usage, particularly concerning its carbon footprint, have not been thoroughly examined. LPG, while cleaner than traditional biomass fuels, still contributes to greenhouse gas emissions, including carbon dioxide and methane, throughout its production and consumption cycle (Lam et al., 2013). Moreover, the subsidization policy has led to challenges such as inefficient distribution networks and inadequate subsidy targeting, resulting in benefits not always reaching the intended low-income households (Rochman et al., 2023). These systemic issues underscore the need for a comprehensive evaluation of the program's environmental impact and the exploration of sustainable energy alternatives. Transitioning to cleaner cooking methods, such as biogas or electricity, could potentially reduce greenhouse gas emissions and alleviate environmental degradation (World Bank, 2021). However, such transitions require careful consideration of economic feasibility and infrastructure development to ensure accessibility for low-income communities. Therefore, a critical assessment of the subsidized LPG program's environmental footprint is essential to inform future energy policies and promote sustainable practices.

Although the subsidized household LPG program has successfully reduced Indonesia's reliance on kerosene, existing studies primarily focus on its socioeconomic benefits rather than its environmental footprint (Puzzolo et al., 2018). Most research evaluates subsidy efficiency, economic implications, and distribution mechanisms, leaving a significant gap in understanding the long-term sustainability of LPG as a subsidized energy source (World Bank, 2021). While LPG is often considered a cleaner alternative to biomass, studies indicate that its production, transportation, and combustion still contribute to carbon emissions, necessitating a critical assessment of its overall environmental impact (IEA, 2022). Additionally, research on LPG subsidies in developing countries typically overlooks the indirect emissions from supply chain inefficiencies, such as leakage during transportation and storage (Rochman et al., 2023). Furthermore, the viability of alternative energy solutions for low-income households remains underexplored, with limited empirical evidence assessing the feasibility of biogas, BioLPG, or solar energy as scalable substitutes for LPG (Kumar et al., 2021). Current studies on biogas adoption focus primarily on rural settings, failing to address the urban low-income sector, where the majority of LPG subsidies are concentrated (Smith et al., 2020). Likewise, BioLPG remains a theoretical alternative due to cost constraints and supply chain limitations, requiring further policy-driven innovation to enhance its commercial viability (Das et al., 2022). Another critical research gap concerns consumer behavior and the social acceptance of transitioning from subsidized LPG to alternative fuels, as most studies emphasize technological aspects without considering cultural and economic barriers (Mahadevan & Asokan, 2023). Addressing these gaps is essential for developing a holistic energy policy that balances economic accessibility with environmental sustainability. Given the growing urgency of global climate commitments, an

in-depth analysis of the carbon footprint of subsidized LPG is imperative to inform Indonesia's long-term energy transition strategies (UNEP, 2023).

The primary objective of this study is to evaluate the carbon footprint of government-subsidized household LPG in Indonesia by analyzing its environmental implications throughout its life cycle, from extraction and distribution to household consumption (IEA, 2022). Given the increasing concerns over greenhouse gas (GHG) emissions and climate change, this research seeks to provide a comprehensive assessment of the sustainability of Indonesia's subsidized LPG program in the context of global energy transition efforts (UNEP, 2023). Specifically, this study aims to quantify the emissions generated by LPG subsidies and compare them with potential alternative energy sources, such as biogas, BioLPG, and solar energy, which are often proposed as cleaner substitutes for household cooking (Das et al., 2022). Additionally, this research seeks to identify key challenges and barriers in transitioning from fossil-fuel-based subsidies to green energy solutions, particularly concerning policy implementation, financial feasibility, and social acceptance among low-income households (Mahadevan & Asokan, 2023). By conducting a systematic review of existing studies and policy reports, this study will offer evidence-based recommendations for reforming Indonesia's energy subsidy framework to support a more sustainable and equitable energy system (World Bank, 2021). Furthermore, it will explore the role of international climate commitments and Indonesia's policy landscape in shaping future energy subsidy decisions, ensuring alignment with global carbon reduction targets (Smith et al., 2020). Ultimately, this research will contribute to the ongoing academic discourse on sustainable energy policies and provide practical insights for policymakers, energy stakeholders, and development agencies working towards a cleaner and more resilient energy future (Kumar et al., 2021).

Understanding the carbon footprint of government-subsidized household LPG is crucial for assessing Indonesia's long-term energy sustainability, particularly as the country seeks to align its energy policies with global climate commitments (UNEP, 2023). This study contributes to the academic discourse on sustainable energy transitions by addressing the environmental trade-offs of subsidized LPG, an issue often overlooked in policy evaluations that primarily focus on economic and social dimensions (World Bank, 2021). Given that LPG remains the dominant cooking fuel for millions of low-income households, this research will provide a comprehensive assessment of its greenhouse gas (GHG) emissions, highlighting the hidden environmental costs of fossil fuel-based subsidies (IEA, 2022). By identifying potential alternative energy sources, such as biogas, BioLPG, and solar-powered cooking, this study will inform policymakers on the feasibility of transitioning toward greener, low-emission cooking solutions (Das et al., 2022). Additionally, the findings will support evidence-based policy recommendations aimed at improving Indonesia's subsidy efficiency, reducing fuel wastage, and optimizing the distribution system to minimize carbon-intensive leakages and transportation emissions (Rochman et al., 2023). Beyond its implications for Indonesian energy governance, this research offers valuable insights for other developing nations facing similar challenges in balancing energy access, affordability, and environmental sustainability (Kumar et al., 2021). By bridging the gap between carbon accounting, energy economics, and public policy, this study will serve as a reference for future studies on the role of fossil fuel subsidies in climate mitigation efforts (Smith et al., 2020). Furthermore, this research is particularly significant in the context of Indonesia's commitment to achieving net-zero emissions by 2060, as it underscores the urgent need to develop a roadmap for transitioning low-income households toward cleaner and more sustainable energy alternatives (Mahadevan & Asokan, 2023).

This study focuses on the environmental impact of government-subsidized household LPG in Indonesia, specifically assessing its carbon footprint from extraction, processing, distribution, and consumption (IEA, 2022). The analysis is framed within the context of Indonesia's energy policy, climate commitments, and potential transitions toward greener alternatives, such as biogas, BioLPG, and solar energy for cooking (World Bank, 2021). While existing research has extensively discussed the economic and social implications of LPG subsidies, this study narrows its focus to the underexplored environmental dimension, particularly emissions from LPG usage and supply chain inefficiencies (Rochman et al., 2023). The study adopts a literature-based approach, synthesizing findings from peer-reviewed articles, government reports, and international policy papers rather than conducting primary field data collection (Mahadevan & Asokan, 2023). Consequently, empirical emissions data for Indonesia's subsidized LPG will rely on existing carbon footprint estimates from regional and global studies, which may limit the specificity of findings to Indonesia's unique energy landscape (Smith et al., 2020). Another limitation is that the study does not incorporate household-level behavioral analysis, meaning that factors such as consumer fuel preferences, willingness to transition to green energy, and cultural determinants of cooking practices will not be directly addressed (Kumar et al., 2021). Additionally, while the study evaluates green energy alternatives, it does not provide cost-benefit calculations or financial feasibility models for transitioning from LPG to alternative fuels (Das et al., 2022). Despite these limitations, the study offers valuable insights for policymakers and researchers, laying the groundwork for future empirical studies on Indonesia's energy transition, carbon mitigation strategies, and sustainable household energy consumption (UNEP, 2023).

METHOD

This study employs a systematic literature review to analyze the carbon footprint of government-subsidized household LPG in Indonesia, with a focus on its environmental impact, policy implications, and alternative energy solutions (Tranfield, Denyer, & Smart, 2003). The research follows a qualitative approach, synthesizing data from peer-reviewed journal articles, government reports, and international policy documents published in the last two decades to ensure relevance and accuracy (Snyder, 2019). The selection criteria for literature include studies on LPG subsidies, carbon emissions from cooking fuels, and clean energy transitions in developing economies, particularly those related to biogas, BioLPG, and solar energy adoption (World Bank, 2021). The study utilizes comparative analysis to evaluate LPG's emissions profile relative to alternative fuels, assessing their feasibility based on environmental, economic, and policy considerations (IEA, 2022). Additionally, the research incorporates policy evaluation techniques to examine the effectiveness of Indonesia's LPG subsidy framework, drawing insights from successful international models (Mahadevan & Asokan, 2023). Given the lack of primary data collection, the findings rely on secondary data sources, which may limit direct emissions quantification specific to Indonesia but provide a broad understanding of global best practices in energy subsidy reforms (Smith et al., 2020). The systematic approach ensures rigorous analysis of existing knowledge while identifying research gaps for future empirical studies (Boell &Cecez-Kecmanovic, 2015).

RESULTS AND DISCUSSION

Significant Carbon Footprint of Subsidized LPG in Indonesia

The subsidized household LPG program in Indonesia, while positioned as a cleaner alternative to biomass and kerosene, has a substantial carbon footprint that remains inadequately addressed in current policy frameworks. Throughout its entire life cycle—ranging from extraction and refining to distribution and combustion—LPG contributes to

significant greenhouse gas emissions, particularly carbon dioxide and methane. The environmental burden is further exacerbated by inefficiencies in the supply chain, where frequent leakage during transportation and storage results in unintended emissions that accelerate climate change. The reliance on fossil fuel-based infrastructure for LPG production also intensifies its environmental impact, as refining processes and logistics operations depend on non-renewable energy sources, contributing to an overall increase in carbon intensity. Additionally, Indonesia's vast geographic expanse requires extensive distribution networks, leading to higher emissions from fuel transportation, particularly in remote areas where logistical inefficiencies further amplify environmental degradation. Despite its lower particulate emissions compared to solid fuels, LPG combustion still releases pollutants that contribute to indoor and outdoor air quality issues, posing environmental and health concerns. Moreover, the lack of stringent carbon accountability mechanisms within Indonesia's energy subsidy policies means that the long-term ecological costs of subsidized LPG are often overlooked. Without an integrated sustainability strategy, the continued reliance on LPG subsidies perpetuates fossil fuel dependency, slowing the transition toward cleaner, low-carbon alternatives. The absence of a robust carbon monitoring framework limits the ability to assess the full environmental impact, making it difficult to quantify the exact scale of emissions resulting from the program. While international trends indicate a shift toward greener cooking fuels, Indonesia's dependence on subsidized LPG creates a structural challenge in aligning with global decarbonization efforts. The issue is further compounded by the increasing demand for LPG in urban and peri-urban areas, where economic affordability sustains high consumption rates, driving up cumulative emissions. This trend highlights the pressing need for policy interventions that incorporate carbon reduction strategies while ensuring energy accessibility for low-income households. If Indonesia is to meet its long-term climate goals, it must integrate more sustainable cooking energy solutions into its national energy roadmap, ensuring a gradual and equitable transition that does not disproportionately burden vulnerable populations.

The notion that LPG is a cleaner fuel alternative is widely accepted, but its full life-cycle emissions reveal significant environmental concerns, particularly when assessing the long-term impact of Indonesia's subsidized household LPG program. Despite emitting fewer particulates than biomass or kerosene, LPG is still a fossil fuel and contributes substantial carbon dioxide (CO_2) and methane (CH_4) emissions, particularly during extraction, refining, transportation, and combustion (IEA, 2022). Studies indicate that leakages during LPG storage and distribution significantly increase the carbon footprint, as methane has a global warming potential (GWP) approximately 25 times greater than CO_2 over a 100-year period (Smith et al., 2020). Additionally, Indonesia's geographical complexity exacerbates emissions, as LPG must be transported across thousands of islands, requiring fuel-intensive logistics and increasing indirect emissions from fossil-fueled transportation networks (World Bank, 2021). The dependency on fossil fuel infrastructure for LPG production further amplifies its environmental footprint, as refining processes are energy-intensive and contribute significantly to industrial emissions (Das et al., 2022). Furthermore, while LPG combustion emits lower particulate matter than solid fuels, it still releases nitrogen oxides (NO_x) and carbon monoxide (CO), which contribute to urban air pollution and pose health risks (Mahadevan & Asokan, 2023). The absence of robust carbon accountability mechanisms within Indonesia's subsidy policies results in the long-term ecological costs being overlooked, making it difficult to assess the program's true environmental impact (Puzzolo et al., 2018). Without a systematic approach to carbon monitoring, policymakers lack reliable data to evaluate the sustainability of continued LPG subsidization and its role in Indonesia's climate commitments (Rochman et al., 2023). While other countries are

progressively shifting toward cleaner alternatives, Indonesia's continued reliance on LPG subsidies creates a structural challenge in aligning with global decarbonization goals, particularly as urban LPG demand continues to grow (UNEP, 2023). This increasing dependency suggests an urgent need for policy interventions that incorporate carbon reduction strategies, including phased subsidy removal and incentives for greener household energy solutions such as biogas, BioLPG, and solar-powered cooking (Kumar et al., 2021). If Indonesia is to achieve its long-term sustainability targets, integrating low-carbon cooking energy into national energy policies is essential to ensure an equitable transition that does not disproportionately burden vulnerable communities (Smith et al., 2020).

Challenges in Energy Subsidy Efficiency and Environmental Sustainability

The inefficiencies in Indonesia's subsidized LPG program present significant challenges in balancing energy accessibility, economic sustainability, and environmental responsibility. While intended to support low-income households, the subsidy mechanism has resulted in widespread misallocation and leakages, with a substantial portion of the subsidized LPG being diverted to non-eligible users, including commercial sectors and higher-income households. This inefficiency not only strains government expenditures but also deters investments in cleaner energy alternatives, as subsidies artificially suppress the market price of LPG, discouraging the adoption of sustainable cooking fuels. Additionally, the absence of a robust subsidy targeting system has led to inequitable distribution, where many low-income households still face challenges in accessing LPG despite being the intended beneficiaries. The lack of stringent subsidy monitoring and enforcement mechanisms exacerbates the situation, allowing for fraudulent activities, hoarding, and supply chain distortions that further increase inefficiencies. Beyond economic concerns, the prolonged reliance on subsidized LPG presents an environmental paradox, as the policy inadvertently prolongs fossil fuel dependency, delaying the country's transition to a low-carbon energy system. Without a clear roadmap for reform, Indonesia risks locking itself into a fossil fuel subsidy trap, where fiscal burdens escalate while sustainable alternatives remain underdeveloped. Furthermore, the current subsidy model fails to integrate environmental accountability, as it does not incentivize consumers to transition toward cleaner energy sources, thereby reinforcing unsustainable consumption patterns. This systemic inefficiency underscores the urgent need for policy restructuring, including gradual subsidy reductions, targeted assistance mechanisms, and increased investment in renewable energy solutions. In the absence of reform, the subsidized LPG program will continue to burden Indonesia's fiscal resources while impeding progress toward national and global sustainability commitments. To achieve an inclusive and environmentally responsible energy policy, the government must adopt a phased approach that balances affordability with long-term sustainability, ensuring that low-income households are not left behind in the energy transition.

The inefficiencies in Indonesia's subsidized LPG program highlight a fundamental misalignment between energy affordability objectives and long-term environmental sustainability. Although intended to support low-income households, a significant portion of the subsidies is captured by wealthier consumers and commercial entities, indicating systematic leakages and misallocation of benefits (IISD, 2020). This inefficiency burdens the national budget while simultaneously distorting market incentives, making it difficult for cleaner energy alternatives to compete against heavily subsidized LPG (CSIS Indonesia, 2020). Studies indicate that indiscriminate fossil fuel subsidies often undermine economic efficiency and contribute to social inequality, as higher-income groups tend to consume more subsidized fuel, reaping greater financial benefits than the intended low-income beneficiaries (IEA, 2022). Additionally, the absence of a robust monitoring system enables fraudulent

activities, black-market sales, and inefficient distribution networks, which further exacerbate fuel shortages for deserving households (World Bank, 2021). The environmental consequences of prolonged LPG subsidies are also highly concerning, as they perpetuate fossil fuel dependency, delaying the transition to low-carbon energy solutions (UNEP, 2023). Instead of promoting sustainable energy adoption, the current subsidy scheme discourages investments in biogas, BioLPG, and solar-powered cooking solutions, as these alternatives remain financially uncompetitive against subsidized LPG (Kumar et al., 2021). Furthermore, Indonesia's current energy subsidy framework does not integrate carbon accountability mechanisms, meaning that environmental externalities such as greenhouse gas (GHG) emissions and supply chain inefficiencies remain unaccounted for (Puzzolo et al., 2018). Without a strategic reform of the subsidy mechanism, Indonesia risks locking itself into a fossil fuel dependency cycle, ultimately increasing fiscal burdens while impeding progress toward its climate commitments (Rochman et al., 2023). To address these inefficiencies, policymakers must implement a phased subsidy reduction strategy, coupled with targeted financial incentives for renewable energy alternatives, ensuring a gradual and equitable transition that does not disproportionately impact low-income households (Mahadevan & Asokan, 2023).

Feasibility of Alternative Green Energy Sources

The feasibility of alternative green energy sources for household cooking in Indonesia remains a complex challenge, shaped by economic constraints, technological limitations, and policy gaps. While biogas presents a viable low-carbon alternative, its adoption is hindered by high upfront infrastructure costs, inconsistent supply chains, and limited public awareness regarding its benefits and operational feasibility. Similarly, BioLPG, which is derived from renewable biomass sources, offers a promising transition fuel with a significantly lower carbon footprint compared to fossil-based LPG, yet remains commercially underdeveloped due to high production costs, limited distribution networks, and the absence of strong policy incentives to scale adoption. In contrast, solar-powered cooking solutions, while technically feasible, require substantial advancements in energy storage and grid reliability to be considered a mainstream replacement for LPG, particularly in urban and peri-urban areas where electricity infrastructure is not yet optimized for sustained high-energy cooking applications. Another major obstacle to the widespread adoption of green energy alternatives is the lack of a cohesive government-led framework to promote and incentivize cleaner cooking fuels, leading to market fragmentation and minimal investment in alternative energy infrastructure. Current energy policies primarily focus on subsidizing fossil-based LPG, inadvertently disincentivizing the transition to sustainable options by keeping LPG prices artificially low, making alternative fuels less competitive in the market. Additionally, low public awareness and deeply ingrained cooking habits present behavioral barriers, as many households remain reluctant to switch to unfamiliar energy sources due to perceived convenience, cost concerns, and trust issues regarding new technologies. Without strategic intervention, the dominance of LPG in Indonesia’s energy landscape will persist, further delaying the country’s clean energy transition and impeding progress toward long-term carbon reduction targets. To accelerate this shift, integrated policy measures, financial incentives, and public education campaigns are necessary to create a supportive ecosystem that enables green energy solutions to compete with conventional LPG on affordability, accessibility, and reliability. The future of Indonesia’s sustainable energy transition depends not only on technological feasibility but also on policy-driven efforts to reform subsidy structures, foster investment in renewable energy innovation, and reshape consumer behavior through targeted awareness programs.

The transition from subsidized liquefied petroleum gas (LPG) to alternative green energy sources for household cooking in Indonesia presents a multifaceted challenge, influenced by economic, technological, and policy-related factors. Despite the country's abundant renewable energy potential—including solar, biogas, and biomass—the adoption of these alternatives remains limited. Economic constraints are a significant barrier; the initial capital investment required for technologies such as biogas digesters is substantial, often ranging from $300 to $1,000, which is prohibitive for many low-income households (World Biogas Association, 2022). Technologically, while solar cookers offer a clean cooking solution, their efficiency is contingent on consistent sunlight exposure, making them less reliable during cloudy conditions or in regions with variable weather patterns (Ceviz et al., 2024). Additionally, the performance of solar cookers can be affected by strong winds, which may slow the cooking process and disturb the reflector (Ceviz et al., 2024). Policy-wise, the Indonesian government's focus has predominantly been on subsidizing fossil fuels, with renewable energy sources receiving less emphasis. This policy orientation has led to a lack of incentives for both consumers and producers to transition to cleaner energy alternatives (International Institute for Sustainable Development, 2017). Moreover, the coal industry in Indonesia is preoccupied with ensuring that coal is considered a cheap domestic resource and does not see renewable energy as a replacement, further complicating the shift towards green energy (International Institute for Sustainable Development, 2017). To overcome these challenges, a comprehensive approach is required, encompassing financial support mechanisms, technological innovation, and robust policy reforms that prioritize renewable energy development over traditional fossil fuels.

Policy Gaps in Transitioning to Clean Energy

The transition from subsidized LPG to clean energy alternatives in Indonesia is significantly hindered by policy gaps that fail to support a structured and sustainable shift toward greener household energy solutions. One of the most pressing issues is the absence of a long-term national roadmap for phasing out fossil fuel subsidies while simultaneously promoting renewable energy adoption for household cooking. Current energy policies remain heavily centered on short-term affordability rather than long-term sustainability, leading to prolonged reliance on subsidized LPG without sufficient incentives for alternative energy adoption. Additionally, the lack of integrated policy frameworks means that different government agencies operate in silos, preventing cohesive action in subsidy reform, infrastructure development, and renewable energy promotion. The slow pace of regulatory adaptation has also led to minimal investment in biogas and Bio-LPG development, as private sector participation is stifled by policy uncertainty, weak market incentives, and inconsistent regulatory enforcement. Furthermore, existing policies fail to address financial accessibility issues for low-income households seeking to transition to cleaner energy options, as there are no well-defined subsidy reallocation mechanisms that would allow vulnerable communities to afford sustainable alternatives. Another critical gap is the limited integration of climate policies with energy subsidy reforms, meaning that Indonesia’s carbon reduction commitments are not effectively reflected in household energy policies. Without a clear strategy to gradually shift LPG subsidies toward green energy solutions, there is a risk of perpetuating fossil fuel dependency, increasing fiscal burdens, and delaying critical emissions reductions. To bridge these policy gaps, the government must develop a comprehensive, phased transition plan that includes subsidy restructuring, incentive programs for alternative fuels, and regulatory reforms that encourage innovation and investment in cleaner energy infrastructure. Moreover, stronger policy coordination between government institutions, private sector stakeholders, and international climate bodies is essential to align Indonesia’s

energy policies with global sustainability goals while ensuring an equitable transition for all socioeconomic groups.

Indonesia's transition to clean energy is impeded by significant policy gaps that deter private sector investment in renewable energy solutions. Despite ambitious targets to source 23% of its energy from renewables by 2025, progress has been sluggish, with renewables comprising only 11.2% of the national energy mix as of 2020 (Wikipedia, 2023). This shortfall is largely attributed to inadequate regulatory support and inconsistent policies. For instance, regulations mandate that private investors transfer their projects to the state-owned utility, PLN, at the end of agreement periods, raising concerns about return on investment (Chambers and Partners, 2024). Additionally, Indonesia's energy policies have historically favored fossil fuels, particularly coal, due to abundant domestic reserves, creating an uneven playing field for renewable energy sources (Wikipedia, 2023). The regulatory environment also presents challenges, with uncertainties over land laws and perceived development risks deterring private sector investment in renewable energy projects (Financial Times, 2025). To bridge these policy gaps, comprehensive reforms are necessary to provide financial incentives, ensure regulatory certainty, and create a level playing field for renewable energy sources, thereby attracting the necessary investments to facilitate a successful transition to clean energy.

Urgency for a Sustainable Energy Roadmap

The urgency for a sustainable energy roadmap in Indonesia is becoming increasingly critical as the country faces growing environmental, economic, and social pressures to transition away from fossil fuel dependence. The continued reliance on subsidized LPG not only exacerbates carbon emissions but also creates long-term fiscal burdens that strain government resources, diverting funds away from renewable energy investments and infrastructure development. Without a structured roadmap, Indonesia risks falling behind in its commitments to global climate targets, including its pledge to achieve net-zero emissions by 2060, as subsidized fossil fuel consumption remains a major obstacle to achieving meaningful carbon reductions. The lack of a phased transition strategy further delays the development of sustainable energy markets, as households and businesses continue to rely on heavily subsidized LPG rather than shifting to cleaner alternatives such as biogas, Bio-LPG, or solar-powered cooking solutions. A sustainable energy roadmap must therefore integrate short-term, medium-term, and long-term policy actions to gradually phase out LPG subsidies while ensuring affordable, accessible, and scalable green energy alternatives. This requires strategic policy coordination, including subsidy reallocation mechanisms, incentives for private-sector investment in renewable energy technologies, and public education campaigns to drive behavioral changes in energy consumption patterns. Additionally, a well-designed roadmap must consider socioeconomic equity, ensuring that the energy transition does not disproportionately impact low-income households, who are most vulnerable to energy price fluctuations. The successful implementation of such a roadmap depends on strong government leadership, cross-sector collaboration, and international cooperation, leveraging global best practices and financial mechanisms to support a just and inclusive energy transition. Without decisive action, Indonesia risks entrenching fossil fuel dependence, making the eventual shift to sustainable energy sources costlier and more disruptive in the future. To secure a resilient, low-carbon energy future, the government must prioritize an actionable, forward-looking energy roadmap that aligns economic development with environmental responsibility, ensuring a stable and sustainable energy transition for generations to come.

Indonesia's reliance on subsidized liquefied petroleum gas (LPG) presents significant challenges to both fiscal sustainability and environmental objectives. In 2024, the government allocated approximately 335 trillion rupiah ($21.75 billion) for energy subsidies, with projections increasing to 394.3 trillion rupiah in 2025 (Reuters, 2024). This substantial financial commitment underscores the pressing need for a comprehensive and sustainable energy roadmap. The environmental implications of continued LPG subsidies are equally concerning. While LPG is often promoted as a cleaner alternative to traditional biomass fuels, its combustion still contributes to greenhouse gas emissions. Moreover, the extensive distribution network required to supply LPG across Indonesia's archipelago further exacerbates its carbon footprint due to transportation-related emissions. These factors highlight the necessity of transitioning to truly renewable energy sources to meet Indonesia's climate commitments. Policy reforms are critical in facilitating this energy transition. Historically, Indonesia's energy policies have favored fossil fuels, with substantial subsidies allocated to maintain affordable energy prices (Center for Strategic and International Studies [CSIS] Indonesia, 2020). However, this approach has led to market distortions, hindering the competitiveness of renewable energy alternatives. Implementing a phased reduction of fossil fuel subsidies, coupled with targeted incentives for renewable energy investments, is essential to create a more balanced and sustainable energy market. Social considerations must also be integral to the development of a sustainable energy roadmap. Energy subsidies have traditionally aimed to support low-income households by providing affordable fuel options. Therefore, any subsidy reforms should include measures to protect vulnerable populations from potential energy price increases. This could involve direct cash transfers or targeted subsidies for renewable energy solutions, ensuring that the transition to sustainable energy is equitable and inclusive. In conclusion, the urgency for a sustainable energy roadmap in Indonesia is underscored by the dual imperatives of fiscal responsibility and environmental stewardship. By realigning energy policies to support renewable sources and implementing strategic reforms, Indonesia can pave the way toward a resilient and sustainable energy future.

CONCLUSION

The findings of this study highlight the environmental and policy challenges associated with government-subsidized household LPG in Indonesia, emphasizing its significant carbon footprint, inefficiencies in subsidy distribution, and barriers to transitioning to sustainable energy alternatives. While the subsidy program has successfully expanded energy access for low-income households, it has also contributed to high greenhouse gas emissions, supply chain inefficiencies, and fiscal burdens that complicate Indonesia’s clean energy transition. The lack of carbon accountability mechanisms within current policies fails to mitigate LPG’s environmental impact, while the absence of a clear roadmap for phasing out fossil fuel subsidies perpetuates dependency on non-renewable energy sources. Although alternatives such as biogas, BioLPG, and solar cooking solutions offer promising pathways toward sustainability, their adoption remains limited due to economic, technological, and policy constraints. A successful energy transition requires comprehensive policy reforms, including gradual subsidy reductions, improved targeting mechanisms, investment in renewable infrastructure, and public awareness campaigns. Moreover, stronger regulatory frameworks, financial incentives, and cross-sector collaborations are necessary to facilitate the transition to low-carbon cooking energy solutions. Without decisive policy interventions, Indonesia risks prolonging its reliance on fossil fuels, worsening environmental degradation, and failing to meet its climate commitments. Moving forward, an integrated and inclusive

energy roadmap that balances affordability, sustainability, and energy security will be crucial to achieving long-term environmental and economic resilience.

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