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The Prosumer's Role as a Driver of Energy Transition: A Study of Individual Power Producers in Jakarta, Indonesia

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Abstract— *The transition to a sustainable energy system is a global and national imperative, especially in line with Indonesia's Net Zero Emissions (NZE) target by 2060. In this context, the emergence of the "prosumer"—individuals who both consume and produce energy, particularly via Rooftop Solar Power Plants (PLTS Atap)—is reshaping the dynamics of urban energy systems. This study investigates the strategic role of prosumers in Jakarta using a techno-social framework that integrates technical, economic, policy, and behavioral dimensions. A key focus is the shift in regulatory policy from MEMR Regulation No. 26/2021, which supported net-metering, to MEMR No. 2/2024, which eliminates compensation for exported energy. This change transforms the prosumer's role from a grid contributor to a self-consumption optimizer. Consequently, technologies such as Battery Energy Storage Systems (BESS) and Home Energy Management Systems (HEMS) become essential for maintaining economic viability. The findings suggest that the success of prosumers as energy transition agents hinges on stable, supportive policy environments. Without consistent regulatory backing, the transformative potential of prosumer-driven decentralization may remain underutilized.*

Keywords: *Prosumer, Energy Transition, Rooftop Solar PV, Techno-Social, Energy Policy.*

I. INTRODUCTION

1.1 Indonesia's Energy Transition in a Global and National Context

The shift from fossil fuels to environmentally sustainable energy sources has become a central global agenda in the 21st century. This transformation is driven not only by growing awareness of the climate crisis but also by international pressure to establish ambitious decarbonization targets. As a major economy in Southeast Asia, Indonesia has pledged its commitment through its Nationally Determined Contribution (NDC), aligned with the Paris Agreement, targeting Net Zero Emissions (NZE) by 2060 or earlier.

For a developing country like Indonesia, however, energy transition poses complex challenges. It involves not only technological innovation but also profound economic and social transformations. The government must simultaneously pursue decarbonization, economic growth, universal electrification, and poverty alleviation [18]. These efforts are further complicated by structural barriers, such as fiscal reliance on fossil fuel revenues, limited electricity infrastructure, and the high cost of renewable energy investments.

Jakarta home to over 10 million people—is at the heart of this transition. As the country's political and economic center, the city is also a major energy consumer with a substantial carbon footprint. This positions Jakarta as a strategic testing ground for more decentralized and sustainable energy solutions. A successful transition in Jakarta could serve as a model for replication across Indonesia.

1.2 The Rise of Prosumer in a Decentralized Energy Landscape

Traditionally, Indonesia's power system has been centralized, with large-scale power plants delivering electricity in a one-way flow to passive consumers. However, declining costs of rooftop solar technology and increasing environmental awareness have paved the way for a new actor: the prosumer.

A prosumer—short for producer-consumer—is an individual or entity that both consumes and generates electricity, often via rooftop PV systems. This shift enables a more democratic, bidirectional energy model where citizens contribute to clean energy production and grid stability. Prosumers are no longer passive recipients of energy; they are active participants in the energy transition.

1.3 Problem Formulation

Despite its conceptual appeal, the implementation of prosumerism in Jakarta remains limited. A complex web of technical, economic, policy, and social factors influences adoption. Key issues include rooftop PV feasibility, cost competitiveness, regulatory clarity, and public perception.

This study seeks to explore a central question: **How do techno-social factors in Jakarta shape the emergence and sustainability of individual prosumers as energy transition agents?** The study places special emphasis on recent regulatory shifts and their implications for household-level energy participation.

II. RESEARCH METHODS

This study adopts a literature-based methodology with a techno-social analysis lens [38]. Rather than relying solely on technological determinism—which sees innovation as the primary driver of change—this approach emphasizes the mutual shaping of technology and society.

The techno-social framework enables the analysis to move beyond technical efficiency or economic viability, incorporating socio-political contexts and distributional impacts. It critically examines how public policy, institutional structures, and user behavior interact to support or hinder the adoption of rooftop PV systems.

The study proceeds through six sections. Following the introduction and methods, Section III presents the conceptual framework of prosumerism. Section IV examines technical aspects of rooftop PV implementation in Jakarta. Section V explores socio-economic and regulatory factors, followed by a synthesis in Section VI, and policy recommendations and conclusions in Section VII.

III. CONCEPTUAL FRAMEWORK: PROSUMERISM THROUGH A TECHNO-SOCIAL LENS

3.1 Defining the Energy Prosumer: A Spectrum of Roles

The concept of the "prosumer" was initially introduced by Alvin Toffler in 1980 to describe the blurring of lines between producers and consumers across various sectors. In the context of energy, the term has evolved to denote individuals or entities that not only consume energy but also produce their own, typically through small-scale renewable energy systems like rooftop PV. A prosumer generally utilizes the energy produced for personal needs, and any surplus can be stored or exported to the grid. The primary characteristics of a prosumer are energy management autonomy and active involvement in the energy market ecosystem.

However, the role of a prosumer is not uniform; it exists on a diverse spectrum of engagement. At one end are passive prosumers—those who indirectly become energy producers, for instance, by purchasing a home with a pre-installed PV system. At the other end are active prosumers—those who consciously decide to invest in an energy generation system, motivated by economic, environmental, or energy independence aspirations. Beyond individuals, prosumers can also be collective, such as energy communities, local cooperatives, or peer-to-peer (P2P) models that enable energy exchange among community members via a microgrid. With the support of technologies like batteries, smart meters, and electric vehicles, prosumers can evolve into a vital part of providing ancillary services such as load balancing and power storage. However, this transformation is not automatic; it is highly dependent on the surrounding ecosystem—especially government regulations and incentives. Without adequate policy and infrastructure support, the role of the prosumer risks stagnation and suboptimal development.

3.2 A Techno-Social Lens for the Energy Transition

To comprehensively understand the dynamics of prosumerism, an approach that balances technological and social aspects is required. The techno-social approach—originating from the discipline of Science and Technology Studies (STS)—provides a suitable framework for exploring the interplay between technology, institutions, policies, and society. This approach posits that technology does not operate in a vacuum but is influenced by and, in turn, influences social values, political policies, and individual behaviors. Conversely, society is not neutral towards technology but plays a role in its formation and developmental trajectory.

In the context of the energy transition, this approach proposes three main principles:

1. **A holistic view of the energy system:** Any technological intervention must be analyzed in relation to its social, economic, and institutional impacts. For example, a change in PV regulations will affect consumer behavior, market dynamics, and grid cost structures.
2. **Comprehensive system mapping:** It is necessary to identify all actors involved—such as potential prosumers, the state utility (PLN), technology providers, government, financial institutions, and communities—and the reciprocal relationships among them.
3. **Dynamic and participatory adaptation:** As the energy system is constantly evolving, its governance must also be flexible. This approach encourages iterative policy models that are open to input from various stakeholders.

By applying a techno-social lens, regulations like MEMR 2/2024 can be viewed not merely as technical policies but as interventions that trigger layered consequences—on user behavior, technological competitiveness, and the overall direction of the energy transition.

3.3 The Developing Country Context: A Just and Sustainable Transition

The energy transition in developing countries, including Indonesia, has its own unique dynamics that differ from those in developed nations. On one hand, these countries need to pursue industrialization and economic growth. On the other, they face global demands to reduce carbon emissions from the outset of their development. Some prominent challenges in the developing country context include:

- Limited grid infrastructure capacity, which complicates the integration of intermittent renewables like solar PV.
- A young demographic, which presents opportunities for new technology adoption but also requires policies that are adaptive to the needs of the productive generation.
- Financial constraints, which hinder public access to clean energy technologies, especially given their high initial investment costs.

In this context, the concept of a Just Transition becomes highly relevant. This principle ensures that the benefits and burdens of the energy transition are not borne inequitably. It encompasses three main principles:

1. **Distributive Justice:** Ensuring that the gains and costs of the transition are shared fairly among different societal groups.
2. **Procedural Justice:** Guaranteeing public involvement in decision-making processes through inclusive and transparent mechanisms.
3. **Restorative Justice:** Acknowledging and correcting historical inequalities caused by the fossil fuel-based energy system.

In the context of Jakarta, the drastic change in rooftop PV regulations without public consultation and the reduction of economic incentives for prosumers raise concerns about procedural and distributive justice. This study seeks to highlight this issue as part of a critique of an overly technocratic approach to the energy transition that neglects the accompanying socio-political dynamics.

IV. TECHNOLOGICAL DIMENSION: FEASIBILITY OF ROOFTOP PV IN JAKARTA

4.1 System Architecture and Components

Rooftop PV systems provide an accessible technological pathway for individual participation in renewable energy. Despite their compact form, these systems consist of integrated components:

- **Solar Panels (PV Modules):** Convert sunlight into direct current (DC) electricity. Performance varies based on module type (e.g., monocrystalline, polycrystalline).
- **Inverter:** Converts DC into alternating current (AC) synchronized with the PLN grid. Most modern inverters include protection and monitoring features [93].
- **Mounting System:** Supports panel stability, optimizing tilt angle and ensuring structural resilience to wind and weather.
- **Monitoring and Metering:** Enables real-time tracking of energy production and consumption, especially with smart meters in grid-interactive systems.

In Jakarta, two main configurations are prevalent:

- **On-Grid Systems:** Directly connected to the PLN grid, with energy consumed internally and any excess exported (now without compensation under MEMR 2/2024).
- **Hybrid Systems with BESS:** Combine grid connection with battery storage, allowing energy use at night or during outages.

4.2 Technical Potential for Energy Production

Jakarta's equatorial location offers consistent solar irradiation, making it well-suited for rooftop PV deployment. A tilt angle of 10°–15° is optimal for year-round performance. Local studies reinforce this potential:

- A 2.1 kWp system in Serpong demonstrated sufficient capacity to meet daytime office loads.
- A larger installation in Lampung produced approximately 110 MWh annually.

These cases highlight the strong feasibility of rooftop PV for both residential and commercial buildings in Jakarta's urban environment.

4.3 Grid Integration Challenges

While rooftop PV technology is mature, integrating it into Jakarta's distribution grid presents technical hurdles. Designed for one-way power flow, PLN's low-voltage networks face new stresses from bidirectional flows:

- **Voltage Rise:** Excess power injection can lead to overvoltage at the point of interconnection, risking equipment damage and power quality issues.
- **Intermittency:** Solar output varies with time and weather, complicating supply-demand balancing for grid operators.

To address this, MEMR Regulation No. 2/2024 shifts the policy focus toward self-consumption. While this reduces grid burden, long-term integration still requires modernization—such as smart grids, real-time voltage control, and intelligent distribution systems. These investments are essential to ensure decentralization does not compromise system reliability.

V. SOCIO-ECONOMIC DIMENSION: FEASIBILITY, REGULATION, AND PROSUMER ACCEPTANCE

4.3 Economic Feasibility Analysis: A Changing Calculation

Financial considerations are a primary factor for many individuals when deciding to adopt rooftop PV. Typically, the investment decision rests on the projection of electricity bill savings sufficient to cover the initial cost within a reasonable timeframe. Various feasibility studies conducted under the previous regulation—MEMR No. 26/2021—indicated that rooftop PV systems were economically viable. Indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) were widely used to assess this viability. Several studies, such as those in Lampung and Serpong, reported positive NPVs and payback periods of under 11 years—an attractive figure given the technical lifespan of a PV system can reach 20–25 years.

However, with the drastic rule change brought by MEMR No. 2/2024, the validity of these studies is now questionable. Under the new rule, the net-metering scheme is abolished, and surplus energy exported to the grid is no longer financially valued. Consequently, all previous economic calculations have become less relevant. The payback period is now significantly longer, and in many cases, the NPV could turn negative unless the energy is almost entirely self-consumed.

In addition to the loss of export incentives, the initial investment cost remains a major barrier. The price of PV systems and batteries is still quite high for lower- to middle-class households. Without innovative financing mechanisms or new incentives, access to PV risks becoming exclusive, enjoyed only by certain segments of society.

Table 1. Summary of Economic Feasibility Studies for Rooftop PV in Indonesia (Based on Pre-2024 Regulations)

Study / Location (Capacity)	Investment Cost (IDR)	Paubacк Period (Years)	NPV (IDR)	Key Assumption	Critical Commentary on Post-2024 Viability
Rectorate Building Poltekkes, Lampung	Not specified	10	128,912,672	Net-metering mechanism, export value credited	This payback period is no longer valid. Without value for exports, the payback period would be much longer, and the NPV could become negative without a BESS
Building 65 PUSPIPTEK, Serpong (2.1 kWp)	40,603,000	10.4 - 11.2	48,687,928	Net-metering mechanism, 100% credit for exports	This calculation is entirely dependent on the net-metering scheme. Under the new rules, the project's value will drop drastically unless all energy can be self-consumed
Boarding House, Surabaya (Off-Grid)	15,100,000	~8-9	Positive	Off-grid system, unafected by export-import regulations	This model is unaffected by PLN's regulatory changes but requires a significant initial battery investment, leading to a higher cost per kWh

5.2 Evolution of the Regulatory Framework: From Net-Metering to Zero-Export Credit

Public policy plays a critical role in shaping the trajectory of prosumerism. In Indonesia, the policy regarding rooftop PV has undergone a drastic change in just three years, shifting from a highly supportive regulation (MEMR 26/2021) to a much stricter policy that offers no compensation for energy exports (MEMR 2/2024).

Under the old policy, every kWh of electricity exported by a prosumer was recorded and compensated at a 100% rate against the following month's bill. This scheme provided a strong incentive for users to install relatively large systems. Furthermore, the maximum capacity of the rooftop PV system was set at 100% of the customer's connected power. In contrast, the new policy completely eliminates export incentives and introduces a quota system controlled by PLN. This quota limits the capacity of new rooftop PV installations based on the condition of the power system in each area. Additionally, the application for installation now depends on quota availability, making the process more uncertain.

A comparison of these two policies highlights how regulatory changes directly impact the prosumer business model. The new policy forces a shift from a maximum production strategy to a self-consumption optimization strategy. Meanwhile, the uncertainty in the permitting process and the absence of financial value for exported power create significant barriers to the growth of the rooftop PV market—particularly from the perspective of investment risk perception.

Table 2. Comparison of Key Rooftop PV Regulation (MEMR 26/2021 VS. 2/2024)

Provision	MEMR No. 26 of 2021	MEMR No. 2 of 2024	Implication for Prosumer
System Capacity	Limited to a maximum of 100% of the customer's connected power	Capacity is adjusted to needs and follows a development quota from PLN (no percentage limit on connected power)	Provides design flexibility but is limited by an uncertain quota.
Export-Import Mechanism	Excess energy is exported and calculated as a reduction in the bill (100% credit)	Excess energy exported to the grid is not recorded and has no economic value	Eliminates the primary economic incentive for exporting. Shifts focus from maximum production to optimizing self-consumption
Capacity Charge	Imposed on industrial customers	Abolished for all tariff classes	Benefits large industrial customers by removing an additional cost
Application Process	Can be submitted at any time	Dependent on the availability of quotas published by PLN	Creates uncertainty for potential customers and installation service providers
Metering	Uses a kWh export-import meter	Uses an advanced meter, with the cost borne by PLN	Potential for better data, but its primary function (recording exports) loses its economic value

5.3 Social Acceptance and Adoption Motivations

Beyond technical and economic aspects, the social dimension greatly influences the successful adoption of renewable energy technology. Public acceptance of rooftop PV is generally high, as solar energy is associated with a clean, modern, and energy-efficient image. However, this positive perception does not always align with the public's technical readiness or understanding of the system's details.

Factors driving PV adoption include:

- **Environmental Awareness:** Growing concern about climate change motivates some citizens to participate in local solutions.
- **Economic Incentives:** The expectation of electricity bill savings has been a major attraction, though this is now diminished by policy changes.
- **Social Influence:** Recommendations or examples from neighbors and communities can accelerate the intention to adopt.
- **Access to Information:** Clear information about the technical and regulatory aspects of rooftop PV increases the trust and interest of potential prosumers.

Nevertheless, adoption also faces several barriers:

- **High Upfront Costs:** For many families, the initial investment cost is prohibitive without financing support.
- **Limited Knowledge:** Many people lack an adequate understanding of the installation, permitting, and management of a PV system.
- **Regulatory Uncertainty:** Rapid and unpredictable policy changes erode consumer confidence in the system's stability.

For the residents of Jakarta, where environmental awareness is relatively high but the economic burden is also heavy, the interplay between motivations and barriers is complex. Without informational support, fiscal incentives, and legal certainty, the decision to become a prosumer may only be feasible for those with capital and a strong commitment to sustainability.

VI. SYNTHESIS AND DISCUSSION: RE-EXAMINING THE ROLE OF THE PROSUMER IN POST-2024 JAKARTA

6.1 The Evolving Role of the Prosumer: From Grid Contributor to Self-Optimizer

A synthesis of the technological, economic, regulatory, and social dimensions reveals that the role of the prosumer in Jakarta has undergone a significant shift since the implementation of the new regulation in 2024. Whereas prosumers were previously seen as active actors contributing clean energy to the national grid, their role has now pivoted toward the internal optimization of consumption.

With the elimination of compensation for energy exported to the grid, the prosumer's economic strategy has changed from a market-participatory approach to one of personal cost-avoidance. The primary goal is no longer to sell surplus energy but to ensure that all electricity generated by the rooftop PV system is optimally self-consumed. Consequently, the size of the installed PV system is no longer determined by the limit of PLN's connected power but by the user's energy consumption patterns. Prosumers must now align their production curve with their daily energy needs to avoid uncompensated power export. In this framework, the prosumer evolves into an entity more focused on internal efficiency and household energy management rather than a provider of power for the collective good. This phenomenon demonstrates that policy direction and regulatory design have a direct impact on reshaping the public's role in the energy system.

6.2 Techno-Social Interaction in Practice: The Urgency of Batteries and Smart Energy Management

The shift in the prosumer's position from "grid contributor" to "self-consumption optimizer" also triggers new dynamics in the need for supporting technologies. One of the greatest challenges is the temporal mismatch between energy production and consumption times. Rooftop PV systems generate the most energy during the day, while the largest household consumption often occurs in the morning and evening. Under the net-metering scheme, this time gap could be bridged by using the PLN grid as a "virtual battery". However, with the loss of this function under the new regulation, technical solutions become increasingly urgent:

- **Battery Energy Storage Systems (BESS)** become a crucial element. With batteries, prosumers can store surplus daytime energy for use at night, thus still obtaining economic benefits from their PV system without relying on grid exports.
- **Home Energy Management Systems (HEMS)** enable the automatic adjustment of electrical loads based on solar energy availability. This technology helps prosumers shift the use of large appliances to peak production times—for example, running a water pump or charging an electric vehicle when solar irradiation is high (load shifting).

Interestingly, a policy initially perceived as a hindrance could become a catalyst accelerating the transformation toward smart, renewable-energy-based homes. This is a tangible example of techno-social interaction, where socio-political changes drive the accelerated adoption of more adaptive and efficient technologies.

6.3 Future Policy and Research Directions

Regulations based on zero-export credit, such as MEMR 2/2024, have proven to have wide-ranging consequences. Although intended to maintain grid stability, this policy risks extinguishing the economic incentive for the middle-to-lower market segment, which was previously quite enthusiastic about adopting rooftop PV. To create an energy ecosystem that balances public interest with technical feasibility, the government should consider alternative incentive models, such as:

- **Time-of-Use (ToU) Pricing:** Offering different electricity prices at different times. This would incentivize power export when the grid needs it most.
- **Feed-in Tariff (FiT):** Providing a fixed price for every kWh of clean electricity supplied to the grid, a model successfully implemented in many countries.
- **Net-Billing:** A scheme where exported energy is valued at a rate lower than the retail tariff but still provides a rational partial incentive.

From an academic perspective, further research is needed, including:

- Longitudinal studies to evaluate the long-term impact of the new regulation on PV adoption in Indonesia's urban areas.
- Economic analyses of PV + BESS systems, considering variations in customer load profiles and changes in equipment prices.
- Studies on prosumer behavior to understand how policy changes alter household perceptions, attitudes, and energy investment strategies.
- Exploration of collective prosumer models, such as community-based energy systems, particularly for apartments, commercial blocks, and industrial estates.

By redesigning policy more holistically and based on evidence, Indonesia has the opportunity to create an energy transition that is not only fast and efficient but also just and sustainable.

VII. CONCLUSION

This study highlights that prosumers have significant potential to accelerate Indonesia's energy transition, particularly in urban contexts like Jakarta. The findings emphasize the critical interplay between technology, policy, and social behavior, illustrating how supportive and stable regulations can unlock prosumer potential. The shift from net-metering to zero-export policies has reshaped user incentives and behavior, driving a transition from grid contribution to self-consumption optimization.

The discussion offers valuable insights for future policy design, suggesting the importance of adaptive regulatory frameworks that balance innovation, equity, and system reliability. By positioning prosumers as central agents in the decentralization of energy, this study underscores the need for participatory and inclusive energy governance.

Future research should focus on long-term behavioral studies, techno-economic modeling of PV+BESS systems, and institutional analysis of decentralized energy governance. should focus on long-term behavioral studies, techno-economic modeling of PV+BESS systems, and institutional analysis of decentralized energy governance.

REFERENCES

[1] N. Ford, J. Stephenson, and V. Brown, "Energy prosumers: A review of the New Zealand and international literature," *Centre for Sustainability, University of Otago*, 2016.

[2] N. Ford, J. Stephenson, V. Brown, B. Frame, and R. Lawson, "Prosumer collectives: A review," *University of Otago*, 2016.

[3] J. B. Jacobs, "The Energy Prosumer," *Ecology Law Quarterly*, vol. 43, no. 3, pp. 519–580, 2016.

[4] A. Toffler, A. B. M. S. Islam, and F. S. Butt, "Prosumers: A Catalyst for Sustainability, Innovation, and Market Transformation," *World*, vol. 4, no. 3, pp. 499–510, 2023.

[5] T. S. H. Schuit, "The Prosumer in the Energy Union," *Sjørettsfondet*, no. 502, 2018.

[6] G. G. Parra, A., "The Energy Prosumer," *ResearchGate*, 2017.

[7] M. Swilling et al., "Linking the energy transition and economic development: A framework for analysis of energy transitions in the global South," *Energy Research & Social Science*, vol. 81, p. 102273, 2021.

[8] A. S. Oyewo, A. A. E. Aghahosseini, P. D. Lund, and C. Breyer, "Affordable Clean Energy Transition in Developing Countries: Pathways and Technologies," *Energies*, vol. 15, no. 8, p. 2786, 2022.

[9] International Network of Energy Transition Think Tanks (INETTT), "Just energy transitions in developing countries," 2024.

[10] O. O. O. Ige, "Equitable Energy Transition: A Global Legal Framework for Developing Economies," *International Journal of Arts, Languages, and Social Science*, vol. 4, no. 2, pp. 1–15, 2024.

[11] UNCTAD, "Investing in the energy transition: Countries need more balanced policies," *United Nations Conference on Trade and Development (UNCTAD)*, 2023.

[12] University of Twente, "Research - Climate Centre," 2024.

[13] PRISM, "Systems-Based Governance," *Sustainability-Directory.com*, 2024.

[14] University of Twente, "Education - Climate Centre," 2024.

[15] A. A. Senin, N. A. M. Senin, and S. N. S. Salim, "Techno-social entrepreneurship: a systematic literature review and future research agenda," *Society and Business Review*, vol. 19, no. 2, pp. 240–262, 2024.

[16] F. A. Afifi, A. Halimatussadiah, R. Kurniawan, and D. Nainggolan, "Household preferences for rooftop solar photovoltaic systems: Evidence from a survey-based study in five Indonesian cities," *Energy for Sustainable Development*, vol. 88, pp. 101771, 2025.

[17] F. A. Pramadya and K. N. Kim, "Promoting residential rooftop solar photovoltaics in Indonesia: Net-metering or installation incentives?" *Renewable Energy*, vol. 222, pp. 119901, 2024.