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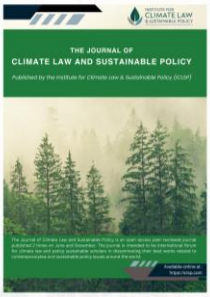

# Energy Transition: An Analysis of Legal Barriers to the Integration of Solar PV and Battery Energy Storage Systems in Indonesia

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**ABSTRACT**

*Indonesia has committed to an ambitious decarbonization target through the Enhanced Nationally Determined Contribution (NDC) 2022. However, the realization of the renewable energy mix is still stagnating due to fluctuating policy dynamics. This study aims to map the structural barriers in the adoption of Solar Photovoltaic (PV) and Battery Energy Storage Systems (BESS) in the residential sector. This research uses a qualitative method with a literature review approach and document analysis. The interesting results of the study show that there is a phenomenon of "Regulatory Chill" or freezing of investment interest due to policy inconsistencies, especially after the elimination of net-metering incentives, which were replaced by restrictive quota mechanisms. In addition, the study identified a regulatory vacuum related to BESS safety and governance standards, which creates technical and financial risks for users. The study's conclusions confirm that the current regulatory framework is counterproductive to national climate targets. The study recommends the need for policy harmonization based on legal certainty and long-term economic incentives.*

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## 1.Introduction

Indonesia has reaffirmed its position in global climate action through the Enhanced Nationally Determined Contribution (NDC) document released on September 23, 2022. In the renewed commitment, Indonesia increases the greenhouse gas emission reduction target to 31.89% independently (unconditional) and 43.20% with international support (conditional) by 2030 (Government of Indonesia, 2022). This increased ambition demands an urgent structural transformation of the energy sector, given the country's historical reliance on fossil fuel-based power generation as a major contributor to emissions. In this decarbonization effort, the integration of Solar Photovoltaic (PV) with Battery Energy Storage Systems (BESS) emerged as the most strategic technological solution. This combination is not only crucial to address the intermittent nature of solar energy but also vital to ensure the reliability of electricity supply in Indonesia's complex archipelago grid architecture (Amiruddin et al., 2024).

Solar PV is the most prospective renewable energy asset in Indonesia, both in terms of the availability of natural resources and economic feasibility (Pambudi et al., 2023). However, technological readiness alone has proven not to be a guarantee of successful adoption at the national level. The study of Mudakir, Aripriharta, and Wibawa (2024) reveals a paradox in which BESS integration is technically able to stabilize the network, but its implementation is hampered by the absence of a standard national technical standard. Furthermore, Redaputri (2024) highlights that inconsistencies in rooftop solar regulations have created "market uncertainty" that has drastically reduced consumer interest in adoption. This phenomenon indicates that the main obstacles to the energy transition in Indonesia have shifted fundamentally: from technological constraints to a regulatory governance crisis.

Handayani (2025) noted that the licensing process for clean energy projects is still burdened by bureaucratic inefficiencies, while the SSEK Law Firm report (2023) identified legal uncertainty related to tariff schemes and fiscal incentives as the main barriers to investment. Although international partnerships, such as Indonesia-Korea cooperation, offer significant technology transfer opportunities (Zubaidi, 2025), their effectiveness is highly dependent on the existence of an adaptive and supportive domestic legal framework. Despite the many technical studies on the performance of Solar PV and BESS, there is a distinct research gap related to the critical evaluation of the legal framework of energy storage in Indonesia.

The majority of previous literature has tended to focus on technical-economic aspects or macro energy policy in general, but has not comprehensively dissected how specific regulations, such as the elimination of net-metering and the absence of BESS rules, structurally limit public participation in the energy transition. Therefore, this study aims to fill the literature gap by conducting a critical evaluation of the latest energy policies. Through an in-depth literature review, this study analyzes the impact of regulatory changes on the feasibility of Solar PV and BESS adoption, and formulates policy recommendations to address regulatory regression in order to effectively achieve the Enhanced NDC 2030 target.

## 2. Research Method

This study applies a qualitative design with a juridical-normative approach enriched by a literature review. This methodology was strategically chosen to explore the construction of law in the normative order (law in books) as well as evaluate its practical implications for the dynamics of the energy transition (law in action). This approach allows for a comprehensive analysis of the gap between national policy mandates and the realities of implementation on the ground without the need for primary field data collection, but rather through an in-depth synthesis of policy documents and scientific literature. Data collection is carried out through documentary research techniques that classify data sources into two main categories. First, the primary legal materials that are the

object of analysis include the hierarchy of laws and regulations, starting from Law No. 30 of 2007 concerning Energy and Law No. 30 of 2009 concerning Electricity as a fundamental foundation. The specific analysis is focused on the dynamics of regulatory changes from Presidential Regulation No. 112 of 2022 to the latest technical regulation, namely the Minister of Energy and Mineral Resources Regulation No. 2 of 2024, in order to identify shifts in incentive schemes. Second, secondary data is used to map empirical reality (Das Sein), which is curated from government strategic documents such as the 2022 Enhanced Nationally Determined Contribution (NDC) and PLN's 2021-2030 Electricity Supply Business Plan (RUPTL).

This evidence base is strengthened by technical data on installed capacity and BESS performance synthesized from the Institute for Essential Services Reform (IESR) report, as well as the latest Scopus-indexed journal articles (e.g., Pambudi et al., 2023; Mudakir et al., 2024; Zubaidi, 2025). All data collected were analyzed descriptive-analytically using the gap analysis method. This technique contrasts the idealism of legal norms (*Das Sollen*) with the challenge of actual implementation to identify the points of regulatory dysfunction. The analysis is framed within an energy governance framework that evaluates four crucial indicators: regulatory clarity, policy consistency, economic incentives, and institutional capacity. The final synthesis of this analysis is used to formulate adaptive policy recommendations to address the identified structural barriers.

## 3. Result and Discussion

### 3.1. The Paradox of Abundance: The Technical Potential vs. the Reality of Emission Reduction

Indonesia's climate targets set out in the 2022 Enhanced Nationally Determined Contribution (NDC) reflect a significant increase in mitigation ambitions. With emission reduction commitments of 31.89% (unconditional) and 43.20% (conditional) by 2030, the government places the largest burden of decarbonization on the energy sector, which has historically been a major contributor to emissions (Government of Indonesia, 2022). Theoretically, this target is supported by the abundance of natural resources.

The study by Pambudi et al. (2023) confirms that Indonesia has an average daily solar irradiation of 3.7–4.7 kWh/m², with a cumulative technical potential exceeding 200 GWp. In fact, the latest estimates from the Ministry of Energy and Mineral Resources (2024) and IESR, which take into account marginal land, project that the technical potential of solar reaches a massive figure of 3,294 GW. However, empirical data reveal a very contradictory reality. Until the end of 2023, the installed capacity of solar power plants in Indonesia will remain stagnant in the range of 0.57 GW (574 MW). This figure represents less than 0.02% of the total national technical potential. Furthermore, the 2021-2030 RUPTL target, which only sets an additional 4.7 GW of solar PV, is considered too conservative and not in line with the Net Zero Emission trajectory. This extreme gap between potential, targets, and realization is illustrated in **Table 1.**

**Table 1:** *Implementation Gap*

| ***Category*** | ***Capacity (GW)*** | ***Description*** |
|---|---|---|
| *Technical Potential* | *3,294* | *Latest estimate by the Ministry of ESDM (2024) and IESR, including marginal land.* |

| | | |
|---|---|---|
| *Policy Target* | *4.7* | *Target addition for 2021–2030 based on RUPTL.* |
| *Actual Realization* | *0.57* | *Total installed capacity as of the end of 2023.* |

The striking disparity seen in Table 1 emphasizes the existence of the "Implementation Gap". Although the political ambition in the NDC document is increasing, policy instruments on the ground have failed to mobilize this potential. This phenomenon indicates that the main obstacle to the energy transition in Indonesia is not technical or resource availability, but structural-regulatory.

The low adoption of rooftop solar is directly correlated with regulatory uncertainty and changes in incentive schemes—such as the elimination of net-metering—that drastically reduce the economic viability of projects for prosumers. Indonesia's climate commitment in the 2022 Enhanced Nationally Determined Contribution (NDC) indicates the urgency of transforming the energy sector. However, there is a fundamental discrepancy between the availability of natural resources and the realization of policies at the implementation level. This sub-chapter analyzes these structural barriers, focusing on the rigidity of fossil generation contracts and the market distortions that hinder the penetration of renewable energy.

### 3.1.1. Implications of Oversupply and Contractual Rigidity

Although Indonesia has significant technical potential for solar energy reaching 3,294 GW based on data from the Ministry of Energy and Mineral Resources and IESR (2024), the realization of installed capacity until the end of 2023 was recorded at 0.57 GW, or less than 0.02% of the total potential. This stagnation is strongly correlated with the phenomenon of electricity supply surplus (oversupply) on the Java-Bali network. The Trend Asia report (2024) identified allocative inefficiencies in the national electricity system, where the Java-Bali reserve margin as of June 2023 reached 44%, exceeding the operational ideal limit. In the national aggregate, this surplus is estimated to reach 6 GW. This condition creates a fiscal burden for state utilities (PLN) due to the electricity purchase and sale agreement (PPA) scheme with private Steam Power Plants (PLTU) (IPP) that implements a Take-or-Pay clause.

This clause requires PLN to absorb or pay a minimum of power availability (80% on average), regardless of fluctuations in real demand. Estimates show that every 1 GW of unabsorbed capacity has the potential to harm PLN up to Rp 3 trillion. With a surplus of 6 GW, the potential for budget inefficiency can reach Rp 18 trillion per year. Long-term projections indicate that without policy intervention, this surplus could increase to 41 GW by 2030. This financial rigidity creates a structural disincentive for PLN to accommodate the integration of rooftop solar PV, because the additional supply from prosumers (producer consumers) will reduce the absorption of coal electricity that has been contracted, thereby escalating the take-or-pay liability.

### 3.1.2. Regulatory Regression: Utility Protectionism vs. Market Incentives

The imbalance in the utility financial balance due to the burden of oversupply has distorted the direction of national energy regulation. Sectoral policies tend to shift to utility asset protection (defensive) instruments instead of decarbonization drivers. This indication can be seen in the issuance of the Minister of Energy and Mineral Resources Regulation No. 2 of 2024, which abolishes the net-metering scheme. The elimination of this electricity export-import mechanism fundamentally changes the economics of the residential rooftop solar project. This policy forces consumers to bear losses due to wasted energy (curtailment) during peak production hours or requires additional investment in battery storage systems (BESS) that are not yet economical.

These restrictive regulations reflect short-term priorities to mitigate grid oversupply, but counterproductively hinder public participation in the energy transition. This is in contrast to global best practices, where energy decentralization is encouraged through fiscal incentives and ease of interconnection.

### 3.1.3. Regional Comparative Analysis: Policy Divergence of Indonesia and Vietnam

The lagging adoption of solar energy in Indonesia is an anomaly when compared to Vietnam, a neighboring country with similar geographical characteristics and tropical climate. Data from the International Renewable Energy Agency (IRENA) and the ASEAN Centre for Energy show a sharp disparity in achievements. Vietnam has successfully implemented the acceleration of solar capacity from 8 MW (2015) to 16.5 GW (2020). In 2020 alone, Vietnam recorded an increase in rooftop solar capacity of 9 GW. In contrast, Indonesia in the same period until 2023 only reached 0.57 GW.

This significant difference (16.5 GW versus 0.57 GW) confirms that the main determinant of the success of the energy transition is not technical-geographical variables, but policy frameworks (political will). Vietnam's success is driven by the implementation of a Feed-in Tariff (FiT) mechanism that provides certainty of return on investment and open market access. On the contrary, Indonesia applies a restrictive quota approach due to the limited fiscal space of PLN, which is held hostage to coal contracts. This case study validates the argument that the main obstacle in Indonesia is structural-political economy, where the dominance of fossil energy contracts inhibits the penetration of renewable energy, which is actually cost-competitive.

## 3.2. Regulatory Analysis: Regression of Economic Incentives and the Emergence of Structural Barriers

Although Indonesia has an abundance of solar resources that are able to support the national energy transition, the realization of installed capacity for rooftop solar PV has experienced persistent stagnation. This chapter argues that the gap is a direct product of counterproductive regulatory design. Analysis of the dynamics of energy law in the last three years reveals a "Regulatory Regression". The shift in the legal framework from the Minister of Energy and Mineral Resources Regulation No. 26 of 2021 to the Minister of Energy and Mineral Resources Regulation No. 2 of 2024 has fundamentally deconstructed the economic feasibility of rooftop solar projects and eroded market confidence.

Furthermore, this latest regulation indicates that the current national energy governance is more oriented towards protecting state utility assets (PLN) than achieving decarbonization targets. More deeply, this phenomenon can be explained through the theory of "Regulatory Capture" or regulatory hostage-taking. This latest regulation indicates that the current national energy governance is more oriented towards protecting state utility assets (PLN) that are experiencing oversupply, rather than achieving decarbonization targets. Law as a tool of social engineering no longer functions as an instrument of social engineering to encourage clean energy, but rather as an instrument of protection for state corporations from market competition.

### 3.2.1. The Legal Shift: Transformation from Incentives to Restrictions

A comparative analysis of the last two legal regimes shows a drastic paradigm shift. Minister of Energy and Mineral Resources Regulation No. 26 of 2021 had become a benchmark for progressive policies that placed public participation as a pillar of the energy transition. This regulation offers legal certainty through three vital instruments: a 1:1 net-metering scheme that allows electricity exports to the PLN network as a bill reduction, the absence of capacity quota limits, and measurable connection procedures. However, the issuance of the Minister of Energy and Mineral Resources Regulation No. 2 of 2024 marks a policy reversal. A detailed comparison between these two regimes is presented in Table 2.

**Table 2.** *Regulatory Comparison: Incentives in ministerial regulation 2021 vs. Restrictions in ministerial regulation 2024.*

| ***Policy Indicator*** | ***ministerial regulation ESDM No. 26/2021 (Incentive Regime)*** | ***ministerial regulation ESDM No. 2/2024 (Restriction Regime)*** | ***Structural Impact*** |
|---|---|---|---|
| *Net-Metering Mechanism* | *Allowed (1:1 Ratio). Prosumers can export surplus energy to the grid to offset 100% of their electricity bill.* | *Abolished. No export credit allowed. Surplus energy sent to the grid is not counted (zero export value).* | *Economic Loss. Creates "stranded energy" and extends the Return on Investment (ROI) period significantly.* |
| *Capacity Limit* | *Technical-Based. The limiting factor is the inverter capacity (up to 100% of connected power).* | *Quota-Based. The "Development Quota" is set unilaterally by the Utility (PLN) every 5 years.* | *Market Uncertainty. Limits market access based on utility discretion rather than technical feasibility.* |
| *Licensing Procedure* | *Time-Bound. Applications must be approved/rejected within a strict timeline (e.g., 5 days).* | *Bureaucratic. Subject to quota availability and a tiered approval process ("clustering").* | *High Barrier to Entry. Increases administrative complexity and waiting times for applicants.* |

The most fundamental and damaging change was the total abolition of the net-metering scheme. Under the new legal regime, electrical energy produced by prosumers can no longer be transacted or sent to the PLN network. The juridical and technical consequences of this rule are the creation of stranded energy on a massive scale; All surplus energy produced during the day is wasted because it cannot be utilized or monetized. The elimination of export rights also harms the rights of consumers guaranteed in Law No. 30 of 2009 on Electricity, especially related to the right to get efficient electricity services. By forcing consumers to waste their energy (curtailment) without compensation, the state indirectly creates systemic inefficiencies.

In fact, in global practices such as those in Australia or California, excess power from citizens' roofs is valued as an asset that helps stabilize the peak load of daylight, rather than being treated as worthless waste. In addition, the 2024 regulation introduces a new control mechanism in the form of a "Rooftop Solar Power Development Quota". Unlike the previous regime, which was based on the technical capacity of customers, this new regime gives full authority to PLN to limit the number of installations based on network availability quotas. This mechanism not only eliminates transparency but also creates legal uncertainty for potential investors. As noted by a legal analysis from SSEK Law Firm (2023), this kind of policy inconsistency is a major determinant of green investment. Thus, the legal character of Ministerial Regulation 2/2024 has shifted from facilitative regulation to "defensive regulation" designed to brake the pace of technology adoption.

### 3.2.2. The Economic Blow: The Destruction of Household Financial Feasibility

From an economic perspective, the elimination of the electricity export-import mechanism is a fatal blow to the financial viability of small-scale rooftop solar PV. IESR study reports consistently show

that net-metering is a key variable in the economic calculation of solar power plants in the residential sector. The most obvious impact is the surge in the return on investment (ROI) period. Under the legal umbrella of Ministerial Regulation 26/2021, ROI is in the attractive range of 6-8 years.

However, after the enactment of Ministerial Regulation 2/2024, economic simulations show that this period extends to 12 to 17 years. This condition creates a double disincentive. On the one hand, solar energy investment is not feasible without batteries because 30-60% of energy is wasted. On the other hand, the investment in the addition of a battery system (Battery Energy Storage System - BESS) is also economically justified because of the high initial cost (CAPEX), which is not compensated by attractive electricity tariffs.

This economic problem is exacerbated by the high price of battery units in the domestic market. Although the global price of Lithium-ion batteries has fallen, the cost of BESS installation in Indonesia still ranges from Rp 7-10 million per kWh. Without fiscal incentives such as VAT exemptions or direct subsidies, the addition of batteries would double the upfront cost, making the technology exclusive only to the upper economic class and unaffordable for the majority of the middle class. In fact, the study by Pambudi et al. (2023) confirms that the adoption of renewable technology is very sensitive to fiscal incentives. By removing the element of saving electricity bills, the government has effectively shut down the organic rooftop solar market in Indonesia.

**3.2.3. The Bureaucratic Barrier: Conflict of Interest in Quota Governance**

In addition to financial barriers, Ministerial Regulation 2/2024 institutionalizes bureaucratic barriers through a quota system. Giving a mandate to PLN to set development quotas creates an inherent conflict of interest. PLN is placed in a dual position: as a monopoly network operator, as well as a generation business entity that is grappling with the condition of oversupply. In the monopoly market structure, giving discretion to PLN to determine "how many competitors (prosumers) are allowed to enter" is a regulatory flaw that risks triggering moral hazards. This governance defect is exacerbated by the existence of information asymmetry.

The public does not have access to real data on grid hosting capacity in their area. Without this data transparency, PLN can set zero or very minimal quotas in an area on the grounds of "technical limitations, without any mechanism for the public or independent regulators to verify the validity of these reasons. This creates a non-technical barrier that takes refuge behind technical arguments. The implications are far-reaching, not only for individual households but also for community-based initiatives. Energy cooperatives and green housing developers now face the risk of business planning failure due to quota uncertainty. This is diametrically opposed to the global trend that actually encourages energy decentralization (distributed generation) as a climate resilience strategy.

**3.2.4. International Insights: Comparison of Residential Solar Power Plant Incentives**

The stagnation of policies in Indonesia is even more contrasting when compared to the success of neighboring countries in encouraging the adoption of solar energy. Vietnam, for example, implemented an aggressive Feed-in Tariff (FiT) scheme of ±USD 0.09/kWh in the 2017–2020 period. This consistent incentive policy triggered a surge in solar rooftop capacity of up to 9.3 GW in just one year (2020). As of 2022, Vietnam's total solar capacity has reached 16.6 GW, far exceeding Indonesia's, which has similar solar potential. In addition to Vietnam, Indonesia is also lagging behind the global smart grid management practices.

The state of South Australia, for example, is facing a very high penetration of rooftop solar that exceeds the demand load; however, instead of banning exports like Indonesia, regulators there

implemented "Dynamic Operating Envelopes. This technology allows residents' solar inverters to continue to export electricity flexibly according to real-time grid conditions, instead of blocking total market access. This suggests that the technical challenges of oversupply should be answered with technological innovation, not with regulatory bans. This comparison confirms the thesis that the difference in results between Indonesia and Vietnam is not caused by geographical or technical factors, but purely by political policy factors (political will). When Vietnam uses fiscal instruments to accelerate the market, Indonesia uses regulatory instruments to brake the market in order to protect the status quo of state utilities.

### 3.3. Regulatory Gap in the Governance of Battery Energy Storage System (BESS)

#### 3.3.1. Post-Net Metering Policy and BESS Structural Urgency

The regulatory transformation after the issuance of the Minister of Energy and Mineral Resources Regulation No. 2 of 2024 is a decisive policy turning point for the residential solar sector in Indonesia. The abolition of the net-metering mechanism—which was previously regulated in the Minister of Energy and Mineral Resources Regulation No. 26 of 2021—has changed the operational logic of residential solar PV from a grid-interactive system to a self-consumption system. This policy shift eliminates the ability of consumers to export excess power to PLN's network, which leads to systematic energy curtailment during peak daytime production. Empirical modelling by IESR (2023) shows that under a no-export regime, households could potentially lose 30–60% of their total solar energy production.

This condition makes residential solar PV investment not financially attractive unless it is paired with a Battery Energy Storage System (BESS). As a result, BESS has transformed from an optional accessory to a structural necessity. This phenomenon creates what is referred to in political economy as "Forced Market Creation. Consumers are being pushed to a corner where they "must" buy storage technology so that their solar assets do not lose money. But ironically, the state requires this condition without preparing a regulatory safety net.

This is in contrast to the battery market in Germany or Japan, which is growing organically because it is supported by mature safety standards and clear fiscal incentives. In Indonesia, the BESS market is growing on a fragile regulatory foundation. However, the acceleration of BESS adoption, which is "required" by market conditions, has not been accompanied by the development of adequate legal infrastructure. This condition creates a regulatory vacuum that weakens public safety, consumer protection, and environmental governance. Therefore, this sub-chapter conducts a critical evaluation of the BESS regulatory gap by combining juridical-normative review and comparative analysis.

#### 3.3.2. Absence of Technical Standards: Unmitigated Public Safety Risks

Although the urgency of using BESS is increasing, Indonesia does not yet have a fundamental regulatory instrument that is a prerequisite for energy storage safety standards. Specifically, the national regulatory framework does not yet regulate: 1. Safety Installation Standard: Equivalent to NFPA 855 or AS/NZS 5139. 2. Product Quality Certification: Equivalent to IEC 62933 series. 3. Fire Risk Mitigation: Special requirements for thermal runaway and fire protection in residential areas. 4. Installer Competence: Special certification mechanism for energy storage technicians. 5. Technical Interoperability: Standard interface between the hybrid inverter and the battery.

The absence of these standards makes the installation of BESS in Indonesia take place unsupervised. This exposes households to fatal risks related to lithium-based battery technology, such as thermal runaway, internal short circuits, and arc-faults (NFPA, 2020). This risk is not just a hypothesis. Learning from the case in South Korea, there were 23 fire incidents at energy storage facilities (ESS) between 2017 and 2019, which forced the local government to temporarily halt all

ESS operations for safety investigations. The investigation found that the main cause was poor installation management and the absence of specific protection standards. In the absence of a mandatory Indonesian National Standard (SNI) for residential battery installations, Indonesia has the potential to import similar risks into the midst of densely populated settlements.

**3.3.3. Comparative Regulatory Analysis: International Norms vs. Indonesian Vacancies**

To visualize the significance of this gap, Table 3 presents a comparative analysis of international safety standards with the current regulatory conditions in Indonesia.

**Table 3.** *International ESS Regulation Comparison Matrix*

| Regulation Dimensions | NFPA 855 (Amerika Serikat) | IEC 62933 (UE/Global) | AS/NZS 5139 (Australia) | Indonesia (2024–2025) |
|---|---|---|---|---|
| **Installation Security** | **Mandatory.** Set safe distances and detailed room specifications. | General safety principles. | Mandatory & Strict. Technical specifications of the storage room. | **Absent** |
| **Mitigasi *Thermal Runaway*** | Explicit mitigation, mandatory ventilation, and fire separators. | Included in the guide but not binding. | Mandatory flame retardant & heat detection sensor. | **Absent** |
| **Installation Location** | Prohibited in habitable rooms. | Location restrictions are recommended. | It is strictly prohibited in residential areas. | **Unregulated** |
| **Installer Certification** | Required (Certified Installer). | Required | Required (CEC Accreditation). | **Not Available Yet** |
| **Enforcement Mechanism** | Powered by the Fire Code. | Supported by industry standards. | Required as a condition for connection to the network (Grid). | **No Mechanism** |

***Source:*** *Author's analysis based on NFPA, IEC, and AS/NZS standards.*

Indonesia's position of structurally forcing the market to adopt batteries without preparing a regulatory basis is an anomaly in the global norm. The absence of this basic standard fails to meet the precautionary principle mandated in global energy governance (Sovacool et al., 2020).

**3.3.4. Environmental Governance Gap: Absence of BESS Waste Regulation**

Lithium-based storage units are classified internationally as hazardous waste (B3) because they contain flammable electrolytes, transition metals (Ni, Mn, Co), and the potential for toxic gas emissions in the event of failure. Although Government Regulation (PP) No. 22 of 2021 has regulated B3 waste, this regulation is still oriented on an industrial scale and fails to address the context of household-scale B3 waste (household hazardous waste). Specifically, the current regulations do not regulate, for example, 1) Specific classification of household-scale lithium BESS waste, 2) Collection points mechanism for post-use batteries, 3) Extended Producer Responsibility (EPR) scheme for battery importers/manufacturers, 4) Logistics for reverse supply chain management. This legal vacuum plants an ecological "time bomb".

With the projected increase in battery usage as the energy transition progresses, the volume of lithium battery waste is expected to jump dramatically in the next 10-15 years (end of battery life). Without EPR rules that require importers/manufacturers to take back post-use products, the burden of the cost of destroying B3 waste will fall on consumers or local governments, which often ends up in illegal dumping in public landfills, contaminating groundwater with heavy metals. This negligence projects a future environmental crisis. An empirical study on battery waste streams (Sudibyo & Adyana, 2022) highlights that Indonesia currently lacks operational national-scale lithium recycling facilities, so illegal dumping is a real environmental risk.

**3.3.5. Economic Inequality: Absence of Fiscal Instruments**

The post-net metering policy framework forces households to bear the high cost of BESS investment, but the state does not provide economic incentives to support this capital-intensive technology. This fiscal gap is characterized by: 1) The absence of VAT (Value Added Tax) incentives for the BESS component, 2) The absence of a special residential green financing scheme, and 3) The absence of a subsidy mechanism for battery purchases. The economic impact is very significant. IESR data shows that the Levelized Cost of Storage (LCOS) in Indonesia is still relatively high compared to the global average due to an immature supply chain. The addition of batteries can increase the total cost of the solar PV system by 80-100%.

Without fiscal incentives such as VAT exemptions (implemented in Germany) or tax credits (as in the US), these technologies become an effective economic barrier, limiting participation in the energy transition to only the economic elite. In contrast, jurisdictions that have successfully encouraged the adoption of self-sustaining solar energy implement comprehensive incentives, such as the Self-Generation Incentive Program (SGIP) in California or the KfW 275 battery subsidy scheme in Germany. The absence of fiscal alignment in Indonesia results in a contradiction between the climate commitments (NDC 2022) and actual policy instruments.

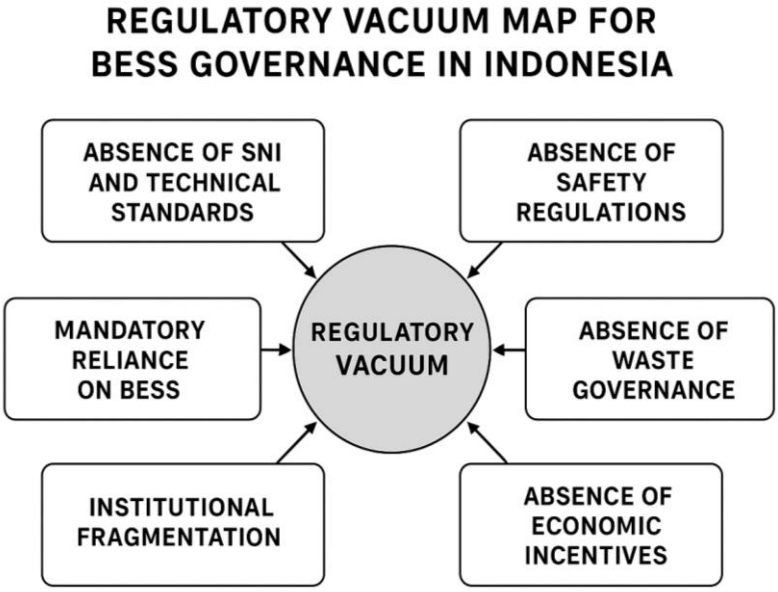
**3.3.6. Institutional Fragmentation**

BESS governance is at the intersection of the authority of several ministries: Energy and Mineral Resources (energy), Ministry of Industry (industrial standards), Ministry of Environment and Forestry (waste), BSN (technical standards), and PLN (interconnection). Currently, there is no single lead agency that leads the governance of energy storage. This fragmentation results in regulatory ambiguity, delays in standard-setting, and the absence of a coordinated national roadmap. In governance theory, this kind of fragmentation is a major predictor of ineffective policy implementation (Peters, 2018). The most obvious manifestation of this fragmentation is the clash between industrial policy and energy policy.

The Ministry of Industry (Kemenperin) implements strict Domestic Component Level (TKDN) rules for battery modules to encourage nickel downstreaming. However, on the other hand, the domestic battery cell manufacturing industry ecosystem for stationary applications (ESS) has not yet reached economies of scale. As a result, this protectionist policy of the industry has actually become a "stumbling block" for the energy transition agenda of the Ministry of Energy and Mineral Resources, because it causes the price of battery units in the local market to remain artificially high compared to the global market price, hindering mass adoption by consumers.

### 3.3.7. Regulatory Vacuum Map

To visualize the structure of this problem, Figure 1 maps the six main dimensions of the BESS governance gap in Indonesia.




Remarks: The figure above shows six dimensions of the regulatory vacuum: (1) Absence of SNI/technical standards, (2) Absence of safety regulations, (3) Absence of waste governance, (4) Absence of economic incentives, (5) Institutional fragmentation, and (6) Mandatory reliance on BESS due to the elimination of net-metering. This vacuum map shows that the BESS problem is not just a partial technical issue, but a systemic failure. This vicious circle can only be broken through integrated regulatory interventions, not fragmented sectoral approaches.

### 3.3.8. Synthesis: Juridical and Structural Implications

From a juridical-normative perspective, this regulatory vacuum gives rise to three forms of structural uncertainty:

1. Safety Uncertainty: Citizens are forced by market conditions to adopt high-risk technologies without the protection of minimum safety standards.
2. Economic Injustice: Policies require expensive investments without providing fiscal facilities, which disproportionately burden households.
3. Environmental Risk: The absence of waste regulations has the potential to shift the ecological burden of toxic waste to society and the environment in the future.

In the construction of the State Administration Law, this neglect of regulatory vacuums has the potential to qualify as an act of maladministration in the form of neglect of legal obligations (negligence). The state holds the principle of absolute responsibility to ensure the safety of technology products that are widely circulated in society.

In the event of a fatal incident, such as a battery fire that spreads to settlements due to the absence of mandatory SNI standards, the state has the potential to face a public lawsuit (Citizen Lawsuit) on the basis of failure to provide public safety protection as mandated by the constitution. This condition is contrary to the basic principles of national energy law, including the principle of safety (Law No. 30/2009, Article 44), the principle of consumer protection (Law No. 8/1999), and the principle of environmental sustainability (Government Regulation No. 22/2021).

## 4. Conclusion

This study concludes that the energy transition in Indonesia's residential sector faces structural stagnation due to the dissonance between national climate ambitions and the reality of sectoral regulations. The juridical-normative analysis and literature review confirm two fundamental findings: First, there is a real phenomenon of Regulatory Regression through the transition from the Minister of Energy and Mineral Resources Regulation No. 26/2021 to the Minister of Energy and Mineral Resources Regulation No. 2/2024. The abolition of the net-metering scheme and the implementation of a quota system without compensation for electricity exports have destroyed the economics of the rooftop solar project for prosumers.

This policy not only violates the principle of legal certainty for existing investments, but also puts Indonesia in a divergent position compared to regional trends in ASEAN—such as Vietnam and the Philippines—which instead expand Feed-in-Tariff (FiT) or Net Energy Metering (NEM) incentives to accelerate the adoption of renewable energy. Without export incentives, the burden of prosumer investment shifts forcibly to the adoption of storage technology (Battery Energy Storage System - BESS), which currently still has a high Levelized Cost of Storage (LCOS), creating significant financial barriers for society. Second, the integration of storage technology is hampered by the critical Legal Vacuum (Rechtsvacuum).

The current national legal framework fails to provide adequate technical safety standards, interconnection protocols, and battery waste management. The absence of mandatory Indonesian National Standards (SNI) that refer to global standards (such as NFPA 855 or IEC 62933) creates consumer safety risks and legal liability uncertainty. In aggregate, this condition shows that technical regulations at the ministerial level are counterproductive to the 2022 Enhanced Nationally Determined Contribution (NDC) commitment and the 2060 Net Zero Emission (NZE) target. Instead of facilitating public participation, the current legal framework creates barriers to entry that slow down energy decentralization, ignores the Energy Law's mandate on ease of access, and fails to apply the precautionary principle in managing the risks of new technologies.

## 6. Recommendations

To overcome these legal and technical barriers, as well as to realign energy governance with sustainable development goals, this study recommends the following strategic steps: 1. Reform of the Incentive Mechanism (Regulation & Economic Intervention) The Government, through the Ministry of Energy and Mineral Resources, needs to revise the Minister of Energy and Mineral Resources Regulation No. 2 of 2024 to restore economic justice for prosumers. In view of the elimination of net-metering, it is recommended that the adoption of a Time-of-Use (ToU Tariff) mechanism be considered that provides lower electricity prices during peak daytime loads or price incentives for prosumers who have BESS and can stabilize the grid during peak hours.

Another alternative is the implementation of a long-term contract-based Micro Feed-in Tariff (FiT) scheme to provide certainty of return on investment (ROI), similar to the successful policies in Germany and Australia. 2. BESS Standardization and Safety (Technical & Legal Intervention) The National Standardization Agency (BSN), together with the Directorate General of Electricity, should immediately fill the legal vacuum by issuing technical regulations requiring SNI certification for residential BESS installations, adopting the international standards NFPA 855 (for fire protection) and IEC 62619 (for lithium battery safety).

This regulation must include installation, operation, and decommissioning protocols to ensure consumer protection in accordance with the Consumer Protection Law. 3. Sustainable Environmental Governance (Environmental Intervention) The Ministry of Environment and Forestry (MoEF) needs to strengthen specific B3 waste management regulations for post-use lithium-ion batteries within the framework of Government Regulation No. 22 of 2021.

The application of the principle of Extended Producer Responsibility (EPR) should be mandatory for battery importers and manufacturers to prevent long-term environmental impacts at the end of the battery's life. 4. Harmonization of Cross-Sector Policies. It is necessary to establish an "Energy Transition Task Force" under the coordination of the Coordinating Ministry for Maritime Affairs and Investment to remove sectoral egos between PLN (as a grid operator worried about oversupply) and national climate targets. The Electricity Supply Business Plan (RUPTL) should be revised to explicitly accommodate the target capacity of rooftop solar power plants and decentralized energy.

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