

## Indonesia's National Energy Supply Chain Resilience Strategy: Comparative Lessons and Policy Recommendations within the Asta Cita Framework

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### Abstract

Energy supply chain resilience constitutes the foundation of economic sovereignty explicitly mandated by the Second Asta Cita of the Prabowo-Gibran Administration 2024–2029. This article analyses the structural vulnerabilities of Indonesia's energy supply chain—80.58% LPG import dependency, significant fuel imports, 20–25 days of operational reserve, and a US\$20.4 billion oil-and-gas trade deficit in 2024—and constructs a resilience framework through comparative learning from Brazil (Proálcool), India (Production Linked Incentive scheme), Japan (254-day strategic reserve), and Germany (Energiewende sequencing failure 2022). The study employs comparative-historical analysis and systematic literature review covering 30 academic references and official policy documents. Findings demonstrate that resilience requires integration of Christopher and Peck's (2004) four pillars with APERC's (2007) 4A energy security framework, operationalised through five strategic pathways: (1) establishing a 90-day Strategic Petroleum Reserve; (2) replicating India's renewable manufacturing incentive package; (3) ensuring biofuel policy consistency across regimes; (4) institutionalising annual energy supply chain stress-tests; and (5) properly sequencing the transition by maintaining gas and geothermal baseload. The article proposes a Conceptual Framework for National Energy Supply Chain Resilience (KR-RPEN) as a context-specific theoretical synthesis.

**Key Word:** Supply Chain, Asta Cita, Energy Self-Sufficiency, Energy Transition, Policy Analysis

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### INTRODUCTION

The inauguration of President Prabowo Subianto on 20 October 2024 marks a new chapter in Indonesia's energy governance. In the government's vision and mission document, set out in the eight Asta Cita, the second point explicitly positions energy self-sufficiency as a pillar of national independence, on a par with food and water self-sufficiency (Ministry of the State Secretariat, 2024). This mandate is not merely symbolic rhetoric but a response to Indonesia's structural paradox: a country with the greatest energy resource potential in Southeast Asia, yet trapped in a cycle of import dependency that exacerbates fiscal and geopolitical vulnerabilities.

The latest data underscores the urgency of this mandate. The Directorate General of Oil and Gas at the Ministry of Energy and Mineral Resources notes that LPG imports accounted for 80.58% of national demand in 2025 and surged to 83.97% in February 2026 (Ministry of Energy and Mineral Resources, 2026a). Operational oil reserves will last only 20–25 days, far below the IEA standard of 90 days (Bloomberg Technoz, 2026). Indonesia's 2024 oil and gas balance deficit reached US\$20.4 billion (BPS, 2025), and the energy subsidy in the 2026 Draft State Budget stood at Rp381.3 trillion (Ministry of Finance, 2025), exceeding the combined education and health budgets of several developing countries.

The central question addressed in this article is both normative and operational: how can Indonesia build an energy supply chain that is resilient, antifragile and aligned with the Asta Cita, by

drawing lessons from comparative global experiences?

Previous studies on Indonesia's energy sector have generally focused on a single dimension: the renewable energy transition (Maulidia et al., 2019; Setyowati, 2020), the political economy of coal (Ordonez et al., 2021), or the contradictions of transitional justice (Kennedy, 2018; Fathoni et al., 2021). Few studies have holistically integrated supply chain resilience theory with energy security frameworks and presented operational comparative insights. This article fills this gap with three contributions: first, a theoretical synthesis between supply chain resilience (Christopher & Peck, 2004; Pettit et al., 2010) and the 4A energy security framework (APEREC, 2007; Kruyt et al., 2009); secondly, a comparative analysis of four countries with contrasting trajectories—Brazil, India, Japan and Germany; thirdly, the formulation of the Conceptual Framework for National Energy Supply Chain Resilience (KR-RPEN) along with five actionable policy recommendations within the 2025–2029 National Medium-Term Development Plan (RPJMN) timeframe.

## RESEARCH METHODS

This article employs a qualitative approach using two complementary methodological strategies: comparative historical analysis and a systematic literature review. This approach was chosen because the research questions are explanatory in nature: exploring why and how the energy policy trajectories of certain countries have succeeded or failed, in line with Yin's (2018) recommendations for 'how' and 'why' questions.

The historical-comparative analysis strategy follows the framework set out by Mahoney and Rueschemeyer (2003) and George and Bennett (2005). Four countries were selected using purposive sampling based on three criteria: (1) has concrete experience in building energy supply chain resilience; (2) is relevant to Indonesia's structural conditions; and (3) presents a range of outcomes (successful, developing, failed) to meet the 'most-similar/most-different' systems design principle. Brazil represents a long-term success story in biofuels; India, a case of a latecomer to renewable energy manufacturing; Japan, the gold standard for strategic reserves; and Germany, a cautionary tale of sequencing failure.

This systematic literature review adopted the three-stage protocol of Tranfield et al. (2003) and was classified as an integrative review (Snyder, 2019). The search was conducted on Scopus, Web of Science, ScienceDirect and Google Scholar using a combination of keywords ('supply chain resilience' OR 'energy security') AND ('Indonesia' OR 'Brazil' OR 'India' OR 'Japan' OR 'Germany'), covering the period 2004–2026. A total of 30 verified references formed the basis of the synthesis. Data triangulation was carried out by comparing at least three sources for each key numerical claim.

## RESULTS AND DISCUSSION

### Structural Vulnerabilities in Indonesia's Energy Supply Chain

The analysis reveals three interlinked layers of issues. The first layer—upstream vulnerabilities—is most critical in the case of LPG and petroleum products. LPG imports stand at 80.58% (2025) and are projected to rise to 83.97% by February 2026 (Ministry of Energy and Mineral Resources, 2026). Fuel consumption of 1.5–1.6 million barrels per day is met solely by domestic production of approximately 600,000 bpd. The absence of a Strategic Petroleum Reserve (SPR), as highlighted by Rahman et al. (2021), means that current reserves are purely operational (20–25 days) rather than strategic.

The second layer, midstream vulnerability, is reflected in the lag in transmission infrastructure. The 2025–2034 RUPTL targets 47,758 km of new transmission circuits with a total investment of Rp2,133.7 trillion (Ministry of Energy and Mineral Resources, 2025a)—a figure that illustrates the scale of the current infrastructure deficit. In the terminology of Pettit et al. (2010), Indonesia lies outside the 'zone of resilience': capacity is out of balance with vulnerability.

The third layer, emergent vulnerabilities, concerns the supply chains for transition technologies. More than 75% of nickel smelter capacity is controlled by Chinese companies (C4ADS, 2025), whilst the IEA (2022b) documents global concentration: China controls 85% of solar modules, 92% of cells and 98% of wafers. Indonesia risks replacing its dependence on fossil fuel imports with a new dependence on renewable energy components—a trap that Cherp and Jewell (2014) refer to as 'shifting vulnerabilities'. Only US\$3.1 billion of the US\$21.4 billion

commitment—14%—has been disbursed under the JETP, confirming Setyowati's (2020) argument that a non-bankable policy framework hinders implementation.

### **International Comparative Learning**

#### ***Brazil: Five Decades of Consistent Leadership***

Brazil's Proálcool programme, in place since 1975, offers the most compelling lesson in policy consistency across different administrations. Brazil's ethanol production in 2024 reached a record 36.83 billion litres (UNICA, 2025). The blending mandate increased to E30, effective August 2025, through the Future Fuel Law No. 14,993/2024 (Government of Brazil, 2024). Flex-fuel vehicles accounted for 79.1% of new vehicle sales in 2024, with a cumulative stock exceeding 40 million units (ANFAVEA, 2024). Total emissions avoided between 1975 and 2022 exceeded 828 Mt CO<sub>2</sub>eq (Aguiar et al., 2024).

The five key elements of Proálcool's success that can be replicated: (1) a statutory mandatory blending mandate; (2) demand pull through a flex-fuel mandate; (3) capital subsidies via the BNDES; (4) parallel distribution infrastructure; and (5) a transition from subsidies to carbon market instruments (RenovaBio, 2017). Indonesia's B40 programme, which is projected to save Rp130.21 trillion in foreign exchange by 2025 (Ministry of Energy and Mineral Resources, 2026b), is on the right track, but requires a legal framework at the level of a law to ensure its sustainability.

#### ***India: Manufacturing Incentive Package as a Fast Track***

India has demonstrated that a major developing country can establish a renewable energy manufacturing supply chain in less than five years. The PLI scheme, with a total outlay of 24,000 crore rupees (~US\$2.9 billion), has successfully boosted solar module capacity from ~8 GW (March 2021) to ~120 GW (June 2025) (JMK Research & IEEFA, 2025). Module imports plummeted by 50.6% from FY2024 to FY2025. India's multi-instrument strategy—PLI (output-based), 40% BCD, ALMM, and DCR—created a cohesive manufacturing ecosystem (Shiradkar et al., 2022).

India's limitations are also instructive: domestic polysilicon production stands at just 3.3 GW, or less than 5% of module capacity, indicating a persistent reliance on China for upstream supplies. Indonesia must chart a course towards upstream capacity from the outset, to avoid falling into the same trap.

#### ***Jepang: Arsitektur Cadangan Strategis Tiga-Pilar***

Japan maintains total oil reserves equivalent to 254 days' supply as of December 2025: 146 days' worth of state reserves, 101 days' worth of private sector obligations, and 7 days' worth of joint stockpiling (METI/ANRE, in Nippon.com, 2026). Three relevant Japanese institutional innovations: (1) joint stockpiling with Saudi Aramco, ADNOC, and Kuwait Petroleum—Japan leases tanks as commercial reserves for producers, with priority supply rights during crises; (2) geographical diversification of storage from Hokkaido to Kagoshima; and (3) the S+3E doctrine (Safety + Energy security + Economic efficiency + Environment) as a bipartisan consensus since 1973 (Vivoda, 2019).

#### ***Germany: A Cautionary Tale of Sequencing Failure***

Germany provides the most significant case study of what Indonesia should avoid. The Energiewende pursued an aggressive phase-out of nuclear power before sufficient dispatchable renewable energy capacity and storage were in place, resulting in a reliance on Russian gas for baseload power (~55% of imports prior to 2022). Following the 2022 invasion, wholesale electricity prices surged to €397/MWh—more than ten times the 2019–2020 level (DIW Dieter, in Banque de France, 2024). The Bundesrechnungshof (2024) states that the Energiewende is 'not on track': the onshore wind target has been met by only 50%; grid costs have soared to over €460 billion.

Five lessons from Germany: (1) do not phase out baseload power before there is sufficient dispatchable renewable energy; (2) avoid over-reliance on a single supplier; (3) institutionalise annual stress tests by an independent audit body; (4) integrate geopolitical considerations from the outset into the transition discourse; and (5) ensure transparency regarding total system costs—transmission, storage, and system services.

**Table 1.** Comparative Matrix of Energy Supply Chain Resilience Policies in Four Countries

Dimensions	Brazil (Proálcool)	India (PLI Solar)	Japan (SPR)	German (Energy Transition)	Implications for Indonesia
Key instruments	E27→E30 blending mandate; flex-fuel; BNDES loan	PLI: Rp24,000 crore; BCD; ALMM; DCR	Petroleum Stockpiling Act; JOGMEC tiga-pilar	EEG feed-in tariff; nuclear phase-out agresif	A combination of push (manufacturing incentives) and pull (blending mandates)
The regime's consistency	50 years across different governments; the 2024 Future Fuels Act	Atmanirbhar Bharat since 2020; a cross-ministerial commitment	The S+3E consensus since 1973; bipartisan	A sudden shift in discourse following the 2022 crisis	The BBN Act and the SPR Presidential Regulation need to be binding across administrations
Strategic reserves	(irrelevant—biofuel)	Under construction; 14 days' supply of oil	254 days (public sector 146 + private sector 101 + joint 7)	There is no equivalent SPR; dependent on Russian gas	Build a multi-tier SPR: 60 days (2029), 90 days (2034)
Supplier diversification	Fully domestically sourced (sugar cane + maize); no imported raw materials	The upstream polysilicon sector is still 95% Chinese	Low HHI; joint stockpiling with the UAE, Saudi Arabia and Kuwait	High HHI prior to 2022 (Russia: 55% gas); now an urgent need for diversification	Avoid >40% in any single country; invite investors from Korea, Japan and Europe
Transition sequencing	In stages: 1975 (mandate) → 2003 (flex-fuel) → 2017 (carbon market)	Phased: BCD (2018) → PLI (2021) → ALMM (2024)	S+3E: retain nuclear power and LNG as baseload	Phasing out nuclear power before renewable energy is sufficient → the 2022 crisis	Maintain geothermal and gas power until there is sufficient dispatchable renewable energy
Independent audit	Not particularly noticeable	Limited; a few MNRE reviews	Laporan tahunan METI; Tinjauan sejawat IEA	Bundesrechnungshof of 2024: Energiewende 'not on-track'	Annual LTKRPE by BPK-DEN; access to PLN and Pertamina data
Measurable results	36.8 billion litres of ethanol; 79% FFV; 828 Mt of CO <sub>2</sub> avoided	120 GW of module capacity; module imports down by 50%	254 days' supply; IEA release of 15 million barrels (2022)	Peak price €397/MWh; grid costs >€460 billion	Targets for 2029: 60-day strategic petroleum reserve; 40% local content for diesel; B50; geothermal capacity increased by 5 GW
Weakness	The collapse of the 1990s as oil prices fell; the food-energy competition	Polysilicon <5% of capacity; China's upstream bottleneck persists	High reserve costs; reliance on imported LNG	The EU's most expensive energy; reactivation of coal-fired power stations; the contradictions of decarbonisation	Avoid all the pitfalls listed above; learn from every failure

Source: Compiled from various sources (2024–2026)

### Conceptual Framework for the Resilience of the National Energy Supply Chain (KR-RPEN)

Based on theoretical synthesis and comparative analysis, this article proposes the Conceptual

Framework for National Energy Supply Chain Resilience (KR-RPEN) as a three-tiered integration:

The foundational layer—4A APERC (2007)—sets out the ultimate objectives: Availability (90-day strategic reserves + reactivation of idle wells); Accessibility (diversification of suppliers beyond Singapore/China); Affordability (gradual rationalisation of the Rp381.3 trillion subsidy); and Acceptability (a fair transition in line with the 8th Asta Cita priority programme). Cherp and Jewell (2014) emphasise that these four dimensions should be viewed as ‘low vulnerability of vital energy systems’—not as four separate indicators.

The operational layer—Christopher & Peck’s (2004) four pillars—defines execution as: (1) re-engineering through the geographical restructuring of storage facilities and the diversification of transshipment hubs; (2) collaboration through strengthened coordination between the Ministry of Energy and Mineral Resources – Pertamina – PLN – BPH Migas – Ministry of Finance; (3) agility through a real-time energy supply chain information system; and (4) a risk management culture through annual stress tests.

The aspirational layer—Taleb’s (2012) concept of antifragility—promotes an energy system that grows stronger in the face of shocks. The barbell strategy is implemented in two forms: an energy portfolio combining highly secure sources (geothermal, hydro, B40/B50) with limited exposure to frontier technologies (green hydrogen, SMR nuclear); and a policy portfolio that maintains conservative instruments whilst experimenting with market-based instruments.

### **Strategic Policy Recommendations**

#### ***Construction of the 90-Day Strategic Petroleum Reserve***

Indonesia must establish a 90-day multi-tier strategic petroleum reserve (SPR) within the 2025–2029 National Medium-Term Development Plan (RPJMN) timeframe: a 50-day state reserve, a 30-day private commercial reserve obligation, and a 10-day joint stockpiling arrangement with producers—adopting the Japanese model. The national reserves are managed by a new entity on a par with JOGMEC (the restructured BPH Migas or National Energy Reserves Agency). Strategic storage sites are spread across: Kalimantan (Balikpapan), Sulawesi (Bitung), Sumatra (Dumai, Plaju), and Java (Cilacap, Tuban). Joint stockpiling has begun with the UAE, Saudi Arabia and Brunei. The estimated investment is between Rp80 trillion and Rp120 trillion over four years, equivalent to 30% of the annual energy subsidy.

#### ***Replication of the Indian Model for Renewable Energy Manufacturing Incentive Packages***

Indonesia has adopted a three-pronged incentive package: (1) the Indonesia-PLI for solar modules and batteries, with an initial outlay of Rp30 trillion over five years, targeting 20 GW of module capacity by 2029; (2) TKDN-EBT is mandatory for all IPPs—40% (2026), phased up to 60% (2029); and (3) the Approved Module Manufacturers List (DPMT) with BMTP on imported modules once domestic capacity reaches the threshold. Supplier diversification is a non-negotiable principle—inviting investors from Korea, Japan, India and Europe to avoid concentration exceeding 75%, as seen in the nickel smelter sector.

#### ***Consistency in Biofuel Policy Across Regimes***

The government must ensure the B40 transition through a cross-government Biofuels Act, modelled on Brazil’s Lei do Combustível do Futuro. This law stipulates: (1) a mandatory schedule for B40→B50→B60 with a fixed timeline; (2) a minimum E10 mandate for RON 90/92 petrol; (3) a flex-fuel mandate for new vehicles from 2030; and (4) sustainable palm oil governance (a moratorium on expansion on peatlands, mandatory ISPO certification). Bioethanol development must be accompanied by off-take guarantees from Pertamina, BPDPKS credits, and tax differentials.

#### ***Institutionalisation of the Annual Energy Supply Chain Stress Test***

The BPK, together with the DEN, submits the Annual Report on Energy Supply Chain Resilience (LTKRPE) to the House of Representatives, following a standard structure: (1) the status of target achievement for the RUPTL, RUEN and RUKN; (2) a vulnerability-capability analysis based on Pettit et al. (2010); (3) stress-test scenarios for disruption in the Malacca Strait, a Chinese embargo, and a price surge >US\$120/barrel, with quantification of Time-to-Recover (TTR) and Time-to-Survive (TTS) (Simchi-Levi et al., 2014); and (4) administratively binding corrective recommendations. Access to PLN and Pertamina data, as well as whistleblower protection, must be guaranteed.

**The Right Sequence of Transitions—Maintain the Baseload**

Germany’s hardest lesson must be taken to heart: do not phase out baseload power before a replacement is ready. The failure of Germany’s Energiewende transition provides strong empirical justification for Indonesia not to proceed with the early retirement of coal-fired power stations in a reactive manner without having a replacement baseload in place; otherwise, the risks for Indonesia, as an archipelago with an isolated electricity grid, would be far more devastating. Therefore, maintaining natural gas as a bridge fuel and accelerating the development of geothermal energy as a truly dispatchable renewable energy source is not merely a transition strategy, but a crucial measure to mitigate the energy security crisis. Indonesia has two structural advantages: (1) geothermal potential of 23.7 GW (40% of global potential) with only ~11% currently utilised (Ministry of Energy and Mineral Resources, 2025b)—a true baseload renewable energy source capable of replacing coal on a dispatchable basis; and (2) gas reserves of 101.54 TCF that could serve as a bridge fuel for 1–2 decades.

Three-phase sequencing strategy: Phase I (2025–2029)—accelerating geothermal capacity by +5 GW through government-led drilling, a reduction in reference tariffs, and KEN reform; Phase II (2030–2040)—massive expansion of solar PV with GWh-scale BESS from the Karawang IBIP; Phase III (2040–2060)—full decarbonisation through green hydrogen, SMR nuclear power, and CCS.

**Table 2.** Five Strategic Pathways for National Energy Supply Chain Resilience

Strategic Route	Target 2029	Target 2034	Investment Estimate	Core Instruments
90-Day SPR	60 days’ operational and strategic reserves	90 days (IEA standard)	Rp80–120 trillion; saving ~Rp50 trillion per year during the crisis	Energy Reserves Act; National Energy Reserves Agency; UAE–Saudi Arabia–Brunei joint stockpiling
Renewable Energy Manufacturing	10 GW modules; 25 GWh domestic batteries	20 GW modules; 60 GWh batteries	Rp30 trillion (PLI); component imports down by around 40%	Indonesia-PLI; Local Content Requirement (TKDN) – Renewable Energy (EBT) 60%; List of Approved Module Manufacturers (DPMT); Imported Module Tariff (BMTP)
Consistent Biofuel	National B50; E10 (RON 90/92 petrol)	B60; E20; flex-fuel mandate for new vehicles	Foreign exchange savings of over Rp200 trillion per year	Biofuel Law; Pertamina’s off-take guarantee; BPDPKS loans; sustainable palm oil governance
Annual Stress Test	The first LTKRPE will be published in 2027	Standard specifications; real-time data from PLN–Pertamina	Operating costs <Rp100 million per year	BPK–DEN has published the LTKRPE; scenarios involving disruption in the Malacca Strait, an embargo and price surges; quantification of TTR–TTS
Baseload Sequencing	Geothermal +5 GW; bridging gas retained	10 GW of geothermal power; phased retirement of coal-fired power stations; start of SMR nuclear projects	Avoid losses on the German model >Rp500 T	Accelerating geothermal exploration; government-led drilling; SMR nuclear options; delaying the phase-out of coal-fired power stations until large-scale battery energy storage systems (BESS) are in place

*Source: Compiled by the author (2026)*

As a concise overview of the three phases outlined above, the Roadmap for energy transition sequencing and supply chain resilience is summarised in Table 3.

**Table 3.** Roadmap for Transition Sequencing and Supply Chain Resilience

Transition Phase	Time Horizon	Key Strategies & Infrastructure Targets	Focus on Supply Chains & Resilience
Phase I: Foundations & Early Transition	2025–2029	Accelerating geothermal baseload capacity (+5 GW); maintaining natural gas as a bridge fuel.	60-day SPR construction; 60% TKDN-EBT requirement; National B50 mandate.
Phase II: Massive Expansion of Renewable Energy	2030–2040	A massive expansion of solar PV backed by GWh-scale Battery Energy Storage Systems (BESS); coal-fired power stations are being phased out gradually.	The 90-day SPR target (IEA standard) has been met; the domestic solar cell and battery manufacturing ecosystem is now mature.
Phase III: Full Decarbonisation	2040–2060	The adoption of cutting-edge technologies such as Green Hydrogen, Small Modular Reactors (SMRs) and Carbon Capture and Storage (CCS).	Full self-sufficiency (antifragility); An energy system resilient to geopolitical shocks and global price fluctuations.

**CONCLUSIONS AND RECOMMENDATIONS**

**CONCLUSIONS**

This article finds that Indonesia’s energy supply chain vulnerabilities are structural, multi-layered and interlinked—ranging from an 80.58% reliance on LPG imports and a US\$20.4 billion oil and gas deficit to the concentration of 75% of nickel smelters and the global diesel supply chain in China. These vulnerabilities cannot be resolved by the Rp381.3 trillion in subsidies alone, nor by the US\$21.4 billion JETP commitment, of which only 14% has been realised. What is needed is a transformation of the policy framework that integrates supply chain resilience theory with the energy security framework. Four comparative countries offer contrasting lessons. Brazil demonstrates that a consistent mandate over five decades has led to structural transformation (36.8 billion litres of ethanol per year). India shows that the right package of manufacturing incentives can double capacity within four years (8 GW → 120 GW of solar modules). Japan has the most well-developed backup infrastructure (254 days). Germany, to its cost, serves as a stark reminder of the dangers of mis-sequencing—the 2022 crisis was the logical consequence of phasing out baseload power before a replacement was ready. The Prabowo-Gibran administration has a window of opportunity within the 2025–2029 National Medium-Term Development Plan (RPJMN). The second of the Asta Cita will serve as a true political litmus test if the five recommendations are enacted, budgeted for, and consistently audited. Energy independence does not arise from ambition; it arises from choices made in the absence of a crisis—exactly as Sheffi (2005) reminds us.

**RECOMMENDATIONS**

The proposed KR-RPEN framework integrates three layers: the APERC 4A objectives as the foundation, the four Christopher-Peck pillars as the operational framework, and Taleb’s concept of antifragility as the aspiration. Five strategic pathways—the 90-day Strategic Petroleum Reserve (SPR), the renewable energy manufacturing package, the Biofuels Act, annual stress tests, and a transition sequencing that maintains baseload capacity—constitute concrete operational measures expected to save over Rp200 trillion in foreign exchange annually and strengthen energy sovereignty as a pillar of Indonesia Emas 2045. The agenda for further research includes: (1) quantitative modelling of TTR-TTS for Indonesia’s petroleum supply chain; (2) an economic-political feasibility study of the Energy Reserve Act; (3) a comparative analysis with Vietnam and Thailand; and (4) an evaluation of the impact of B50 on deforestation and the national carbon balance.

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