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Supported by:
CASE for Southeast Asia
Federal Ministry for Economic Affairs and Climate Action
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IKI INTERNATIONAL CLIMATE INITIATIVE

# CASE Indonesia's Long Term Energy Scenario: Skenario Indonesia Emas (SERIES)

**11th June 2025, Jakarta**
**Energy Planning Bootcamp: Strengthening the Role of Higher Education as a Strategic Partner in Energy Transition Planning in the Region.**

on behalf of Clean, Affordable and Secure Energy (CASE) for Southeast Asia

# Background Information

**Purpose:** This initiative aims to assist the Bappenas TKKA (then KTI)'s technical assessment to support Indonesia's "Visi Indonesia Emas 2045" and the subsequent policy planning process.

**Goals:** To project energy needs aligned with Indonesia's economic aspirations and to strategise for the Net-Zero Emissions 2060 goals.

**Temporal Coverage:** 2021–2060, setting a foundation towards NZE 2060.

**Geographical & Sectoral Coverage:**

- Regions: Jawa, Bali-Nusra, Kalimantan, Sulawesi, Maluku, and Papua.
- Sectors: Household, Industry, Commercial, and Transportation.

# Model Inception, Data & Planning Integration

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**Demand Planning Exercise:** LTES develops a LEAP structure focusing on robustness and adaptability, with sector-specific analysis through national top-down interventions and bottom-up data insights where possible.

**Supply-side Optimisation:** LTES analyses supply-side optimisation with PyPSA by considering cost, technology progression, build rates, and renewable energy prospects, constrained by Indonesia's geographic diversity.

**Data sources** for the model include published documents, ongoing consultations, and policy directives from key stakeholders: *Bappenas, BPS (Statistics Indonesia), MEMR (Ministry of Energy and Mineral Resources), and DEN (National Energy Council)*.

The model's development involves the **combined expertise** of Bappenas TKKA (then KTI), GIZ, IESR, LAPI ITB, and independent energy experts, integrating a wide array of informed perspectives and data.

# Exploring Multiple Possibilities

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LTES evaluates multiple pathways, factoring in varied efficiency levels, technology adoption rates, and demand-side interventions, alongside diverse supply-side targets and constraints.

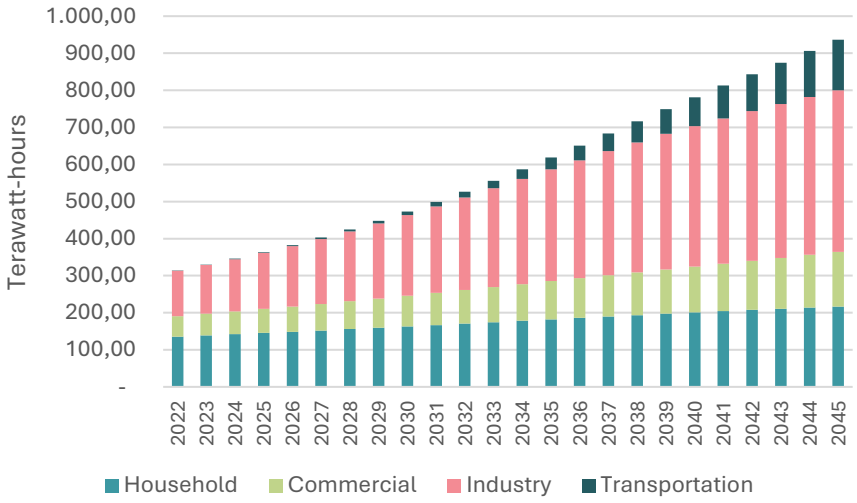
This report zeroes in on **a demand forecast** aligned with the optimal path to NZE, mindful of existing tech limits, and **a supply scenario** that includes nuclear power generation, maintaining the status quo for coal-fired plants.

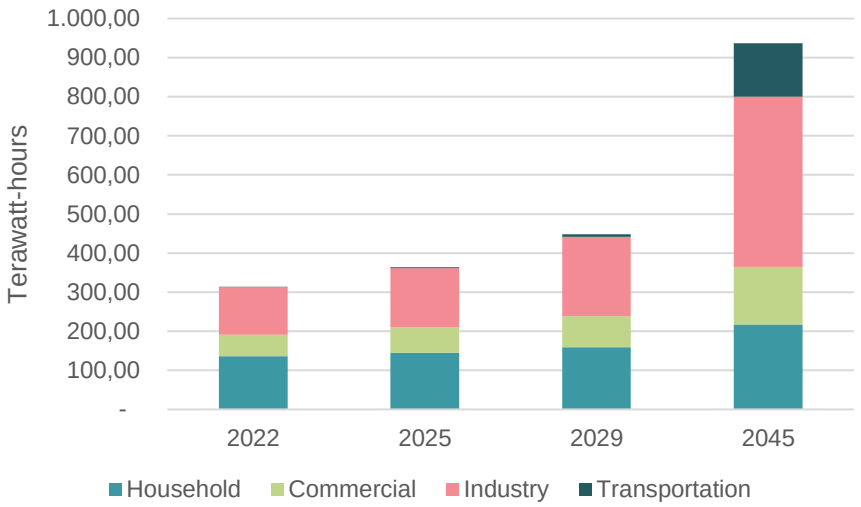
***The following result* is based on the selected pathways deemed to be the most aligned with Visi Indonesia Emas 2045 & NZE 2060.***

*The following result is based on our modelling by 2023.

# Demand: Some Key Factors

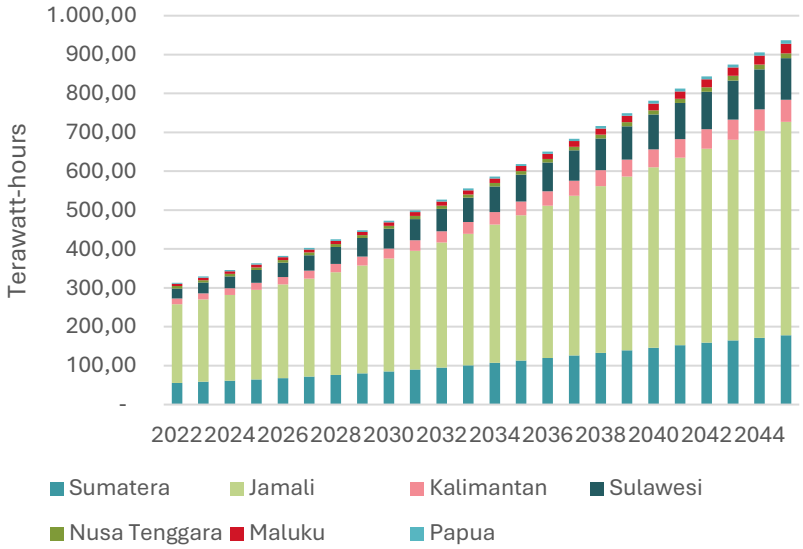
# Final Energy Demand per Sectors

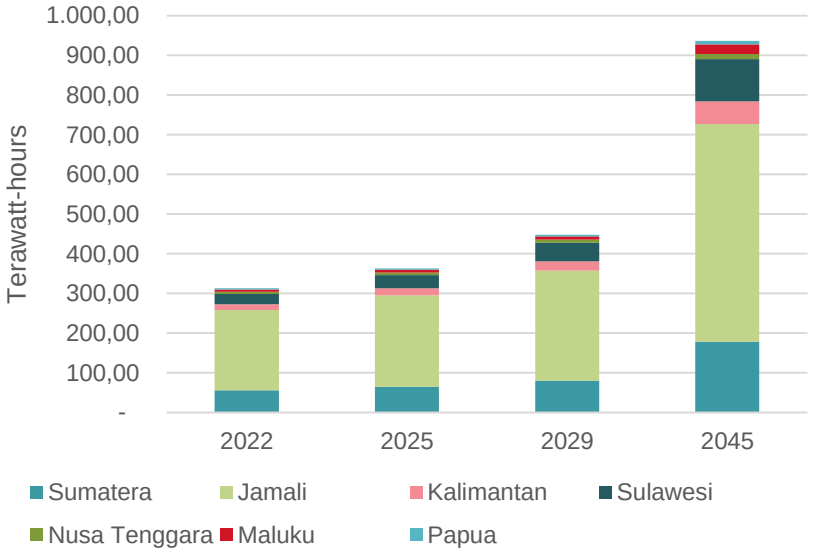



- The total electricity demand in Indonesia is projected to reach 313 TWh in 2022, 363 TWh in 2025, 448 TWh in 2029, and 937 TWh in 2045.
- The highest demand for electricity comes from the industrial sector, followed by households, and then the commercial sector.
- Electricity demand from the transportation sector is expected to increase by up to 100 times, from 0.2% in 2022 to 14.6% of the total electricity demand in 2045.

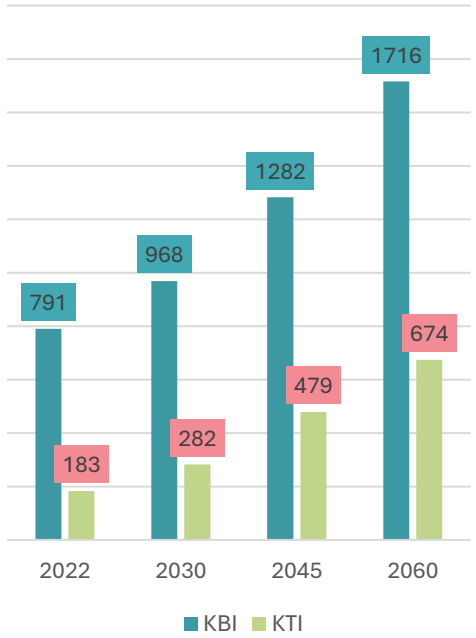
# Final Energy Demand per Region



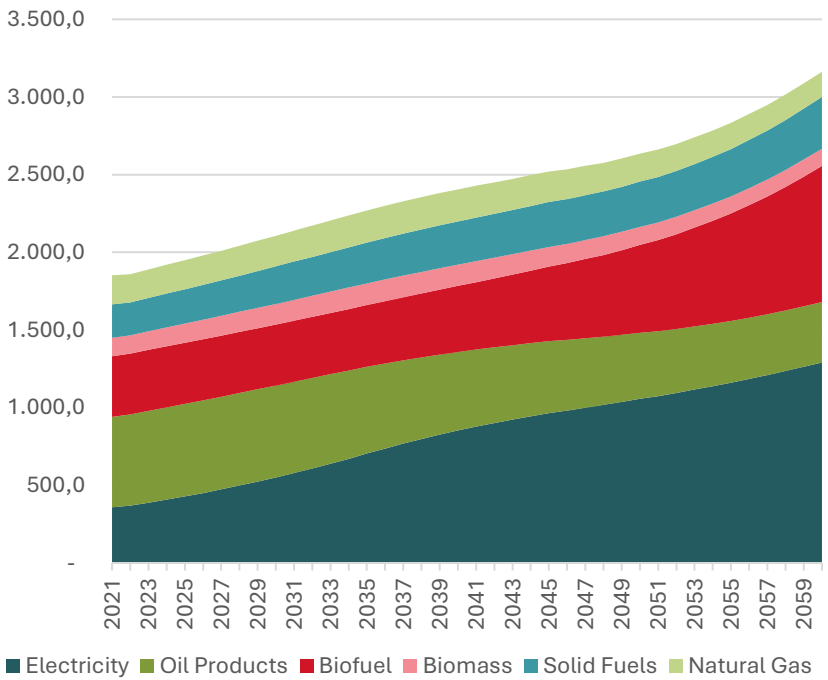




- The largest electricity consumption occurs in the Jamali region, followed by Sumatra, Sulawesi, and Kalimantan.
- Regarding electricity demand growth, Maluku experiences a higher growth rate of around 6.32% compared to other regions, while the lowest electricity demand growth is in Nusa Tenggara at around 3.06%.
- Similar to energy demand, electricity demand in the Eastern Indonesian Region (KBI) is expected to be significantly higher than in the Western Indonesian Region (KTI).

- Achieving regional parity in energy consumption—a goal even more ambitious when considering development parity—is a complex issue.
- A surge in energy use can result from changes in transportation use, urban migration, and the rising affluence associated with population growth, indicating that a combination of economic growth and industrial development targets alone is insufficient for creating an even energy landscape, let alone ensuring overall development parity.
- This reveals a gap in our approach to achieving better distributed regional development: energy use reflects a deeper socio-economic discussion. This yields a valuable insight, showing that drawing a pathway towards development parity cannot be achieved through a rather simplistic long-term target without holistic measures.



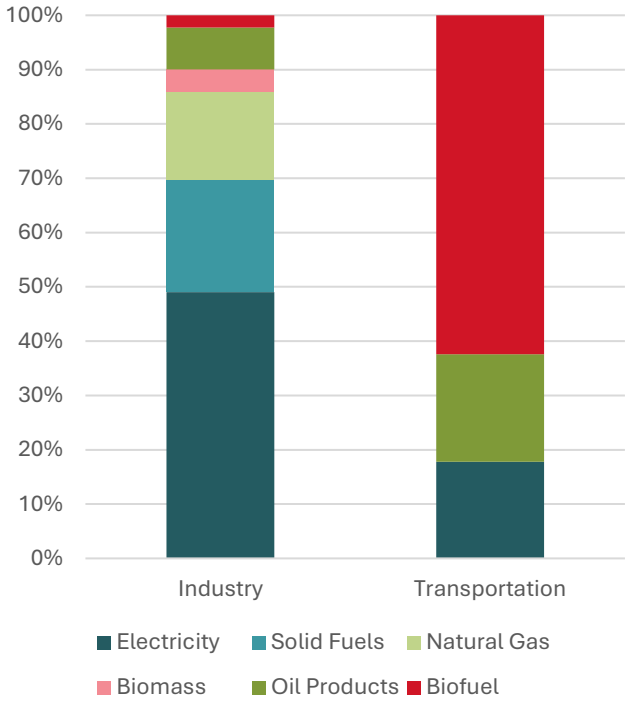
# An Attempt to Reduce Emission




- Upon viewing the demand projection from fuel consumption, a notable insight is revealed: electricity usage will rise over the coming decades as Indonesia aims to shift towards energy sources with a higher potential for zero emissions. However, despite its apparent growth, these projections also underscore a critical reality**: not all energy demand can feasibly be met by electric power.**

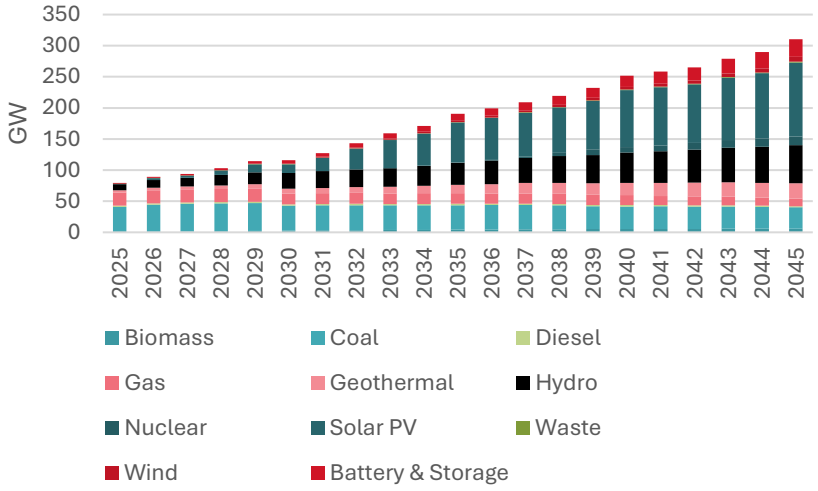
- On top of that, be mindful that LTES, along with many other long-term projections, generously assumes sweeping electrification in some sectors, extending to daily activities such as cooking and personal transport. Compounding this challenge is the fact that current infrastructure and technology are not yet capable of supporting a fully electrified global economy, nor are they likely to develop at the needed pace.

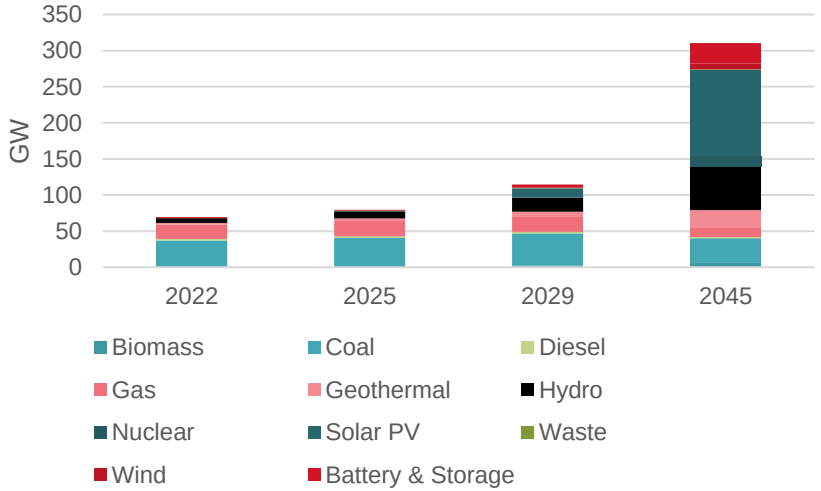
- This also presents a sobering view of emission reduction challenges within developing economies. **Sectors such as cement and steel are notoriously difficult to decarbonise and yet are fundamental to economic expansion**, creating a tension between growth and sustainability. Their processes require high-energy inputs and produce significant emissions, making a shift away from fossil fuels arduous with current technologies.
- In transportation, **no sustainable alternatives currently match fossil fuels' energy density and performance for long-haul, heavy-duty, and aviation needs.** This sector's transition to clean energy is hindered by the lack of viable commercial fuels and the immense infrastructure tailored to conventional fuels.
- Technological hurdles are a significant barrier; however, systemic change is equally critical. This situation is exacerbated by the potential impacts of climate change and resource depletion, pressing the need for innovation and a strategic shift toward sustainable practices.
- Lastly, it is critical to emphasize that emission reductions assumed here are contingent upon this electricity being generated entirely from renewable energy sources. Despite aligning with ambitious national targets and global trends, LTES projection shows that it might be too optimistic for Indonesia to hope for such a situation.



# Supply: Some Key Factors

# National Power Generation Capacity

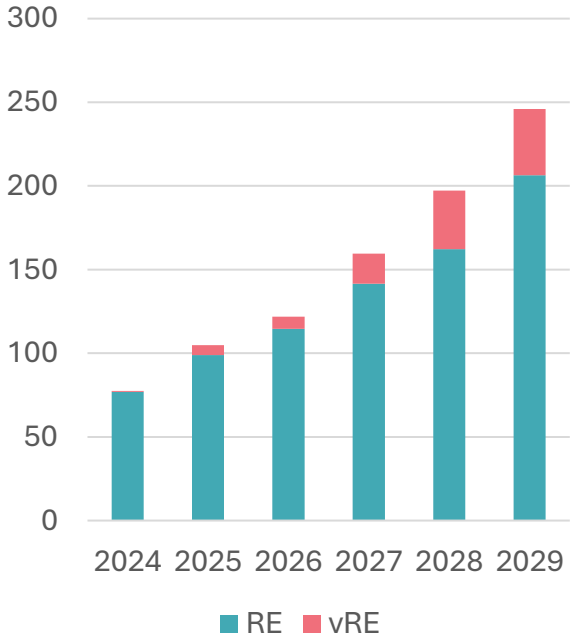



- The national power generation capacity reached 69.2 GW in 2022, 79.6 GW in 2025, 114.4 GW in 2029, and 310.5 GW in 2045.
- The power generation capacity up to 2045 is projected to increase at an average annual rate of approximately 27.16%.

# Expansion of Renewable Energy Capacity

- KESDM is tasked with ensuring the mitigation of risks and barriers related to the addition of Renewable Energy (RE) to the grid.
- KLHK is responsible for ensuring the achievement of emission reduction targets and avoiding resource competition between energy, water, and food.
- Kemenkeu is responsible for ensuring the economic viability of RE development.
- BRIN are responsible for ensuring the maturity of technology, research, development, and the elimination of risks such as the availability of renewable energy sources and the reliability of energy storage.




Growth by nearly 5 times requires cross-sector interventions.

# Further Question and Challenge

# A look at Efficiency Improvement

- The LTES and similar models often presuppose that enhancing efficiency will naturally curtail energy use; however, as Huang et al. (2023)[5] indicate, efficiency improvements frequently lead to increased energy consumption—a fact well-documented in recent research.
- This rebound effect, where better efficiency paradoxically results in more energy use, heightened resource extraction, and greater material demand, poses a substantial challenge. To counteract this effect, a comprehensive strategy is imperative.

- Policy interventions such as progressive energy tariffs could be implemented to discourage excessive energy use while simultaneously promoting energy efficiency and expanding renewable energy to promote sustainable consumption patterns.
- This would effectively limit the total energy supply, thereby naturally reducing consumption.
- Presently, there is a regional knowledge gap in understanding the rebound effect, particularly in developing economies. Indonesia has the opportunity to pioneer research in this area, potentially leapfrogging this global challenge and enhancing its approach to energy management.

[5]Huang, W., Miao, J. & Wei, T. Rebound effects of energy efficiency improvement based on computable general equilibrium models: a systematic review. Energy Efficiency 16, 65 (2023).

# A Deeper Assessment on Tech Adoption

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- The quest towards NZE is modelled in LTES with a heavy emphasis on significant tech adoption that leads to a less-intensive energy system either through a fuel shift towards electricity or a simple efficiency improvement.

- Technology adoption in energy modelling must carefully consider socio-cultural and technical barriers that could impede implementation. For instance, transitioning Indonesia's cookstoves to electricity is not just a matter of providing reliable, round-the-clock power; it also involves cultural shifts away from cooking traditions linked to specific methods.
- Additionally, the widespread adoption of EVs presents its own set of challenges. To manage the increased demand on the electricity grid from EV charging, particularly overnight, a suite of measures is required. These could include promoting public charging infrastructure, pioneering battery-swapping stations for lighter vehicles, and enhancing public transportation to reduce the reliance on private vehicle ownership.

- Furthermore, the volatility of global markets, such as unexpected drops in technology prices, can disrupt national plans, leaving governments scrambling to mitigate adverse impacts from delayed response to rapid tech adoption. It is essential for policymakers to anticipate these shifts and develop adaptive strategies that can absorb shocks and maintain progress toward energy transition goals.

# A Focus on Timely Development

- Timing is a critical yet often overlooked component in the energy transition, and Indonesia's situation exemplifies the delicate balancing act required. Currently, the country grapples with an overcapacity in power generation, which has resulted in significant financial losses. Conversely, there is a looming concern that, in the future, the Java-Bali region may face a shortfall in RE potential and possible RE electricity build rate. This could force a choice between contravening policy directions by building new coal power plants or facing an electricity deficit.

- To avoid these pitfalls, Indonesia needs to prioritize the development of inter-island electrical connections from Java to Sumatra or Kalimantan and invest heavily in renewable energy sources. Additionally, initiating the development of nuclear power as an alternative source is another avenue that requires immediate attention, as with today's level of development, a massive deployment of nuclear may not happen in the next decades. According to LTES and other projections, Java might need to start importing electricity as early as the 2030s, making swift action essential.

- Learning from cases where the rapid deployment of energy solutions without systemic foresight led to economic and resource allocation issues, Indonesia's approach must therefore be both agile and comprehensive, anticipating future energy needs while considering the intricate web of dependencies that characterize the transition to a sustainable energy landscape.

[9]Hagens, N., & White, D. J. (2021). Reality blind: Integrating the systems science underpinning our collective futures (Vol. 1)

# A Focus on Timely Development (2)

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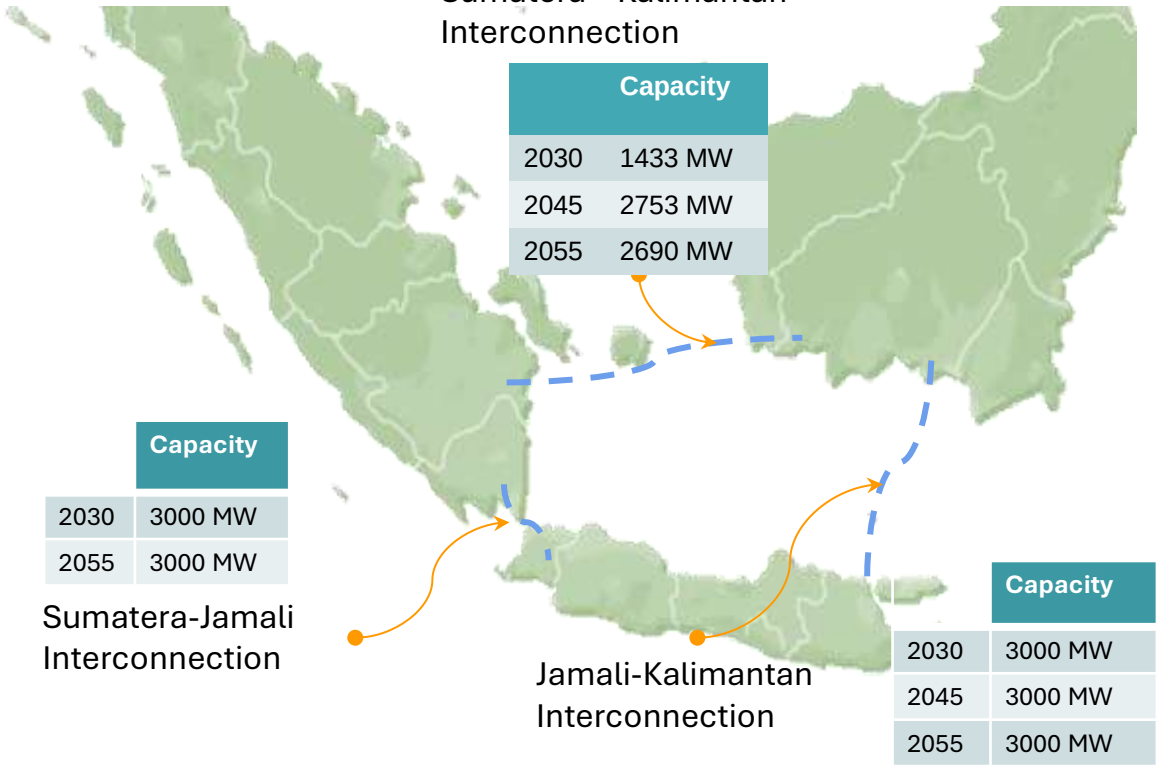


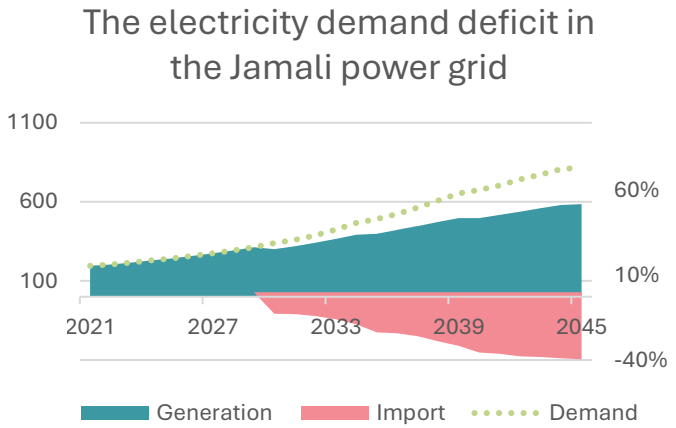


- LTES projects a potential deficit of electricity generation versus demand in Jamali (Java-Madura-Bali grid) in the early 2030s.
- The period of 2024–2029 is crucial in preparing the inter-island grid.
- Without the grid, Jamali might succumb further to dirty electricity or be left with a deficit of 40% from the annual electricity demand in 2045.

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**Thank you for your attention**

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