Power Sector Planning and Sector Governance

Experience from Indonesia

Syofvi Roekman

PNG Nasional Power Sector Forum

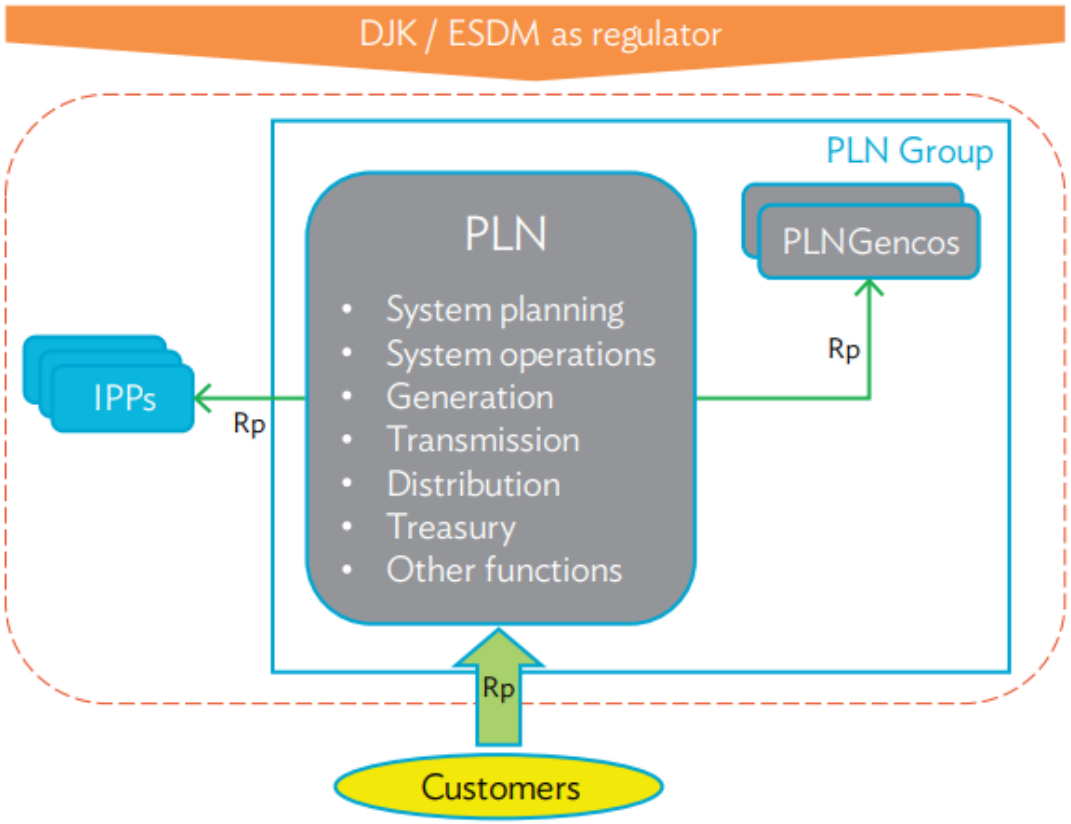
APEC Haus, 3-4 April 2025

Discussion Outline

- Current Structure of Indonesian Power Sector
- Regulation in Indonesia on Power Sector Planning
- Current Practice of Power System Planning
- Key Takeaways for PNG

Current Structure of Indonesian Power Sector

Current Structure of the Indonesian Power Sector



DJK = Direktorat Jenderal Ketenagalistrikan (Directorate General of Electricity), ESDM = Kementerian Energi dan Sumber Daya Mineral (Ministry of Energy and Mineral Resources), gencos = generation companies, IPP = independent power producer, PLN = PT Perusahaan Listrik Negara (Persero) (State Electricity Corporation), Rp = Indonesian Rupiah.

Source: Asian Development Bank.

Current conditions:

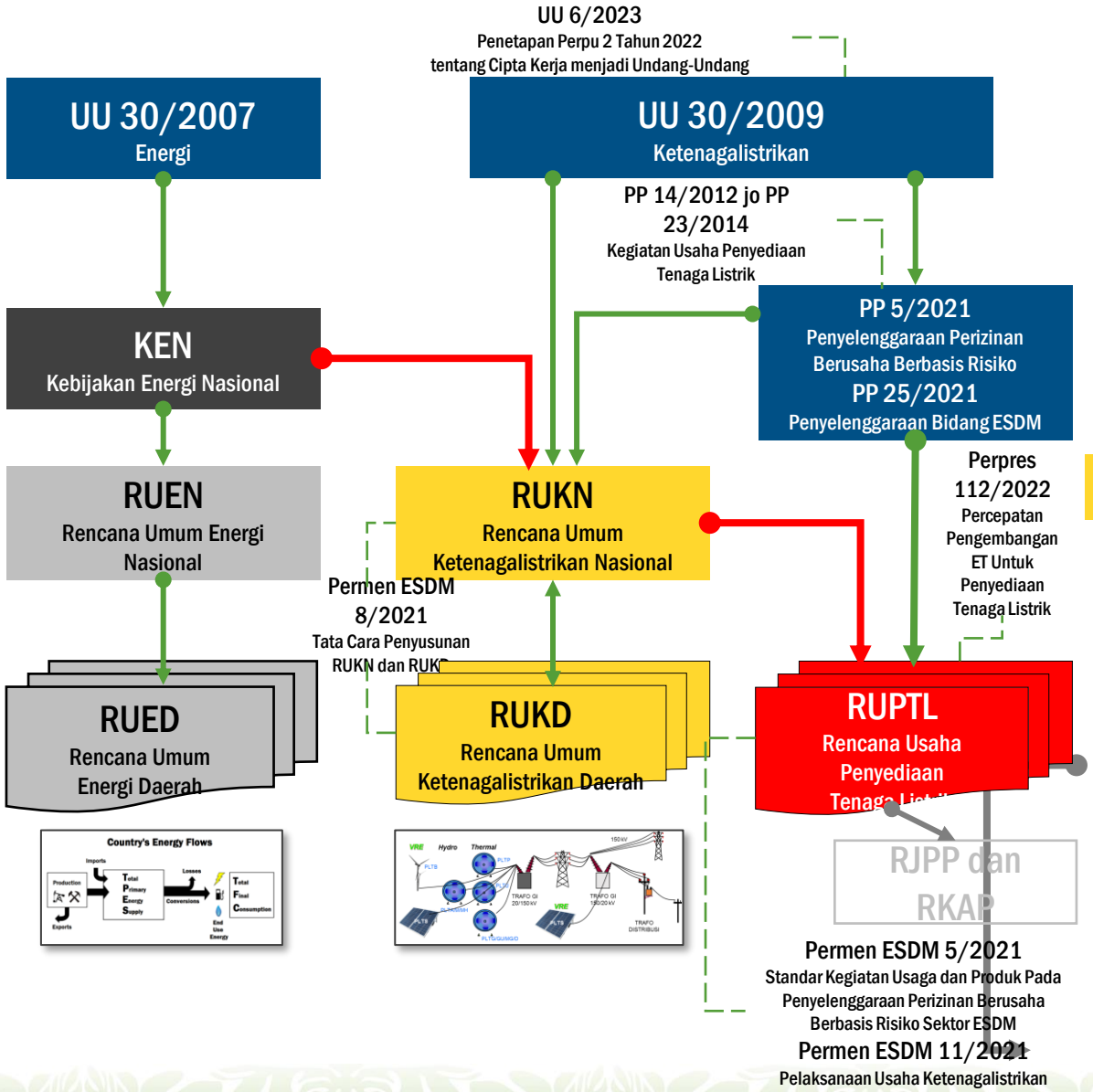
- The Ministry of Energy and Mineral Resources – Directore General of Electricity (DJK /MEMR) serve as regulator
- Electricity tariff is regulated by DJK/MEMR
- PLN as a Vertically Integrated State-owned Company (Gen, Trans, Dist & Retail)
- PLN consolidates all functions other than generation
- Planning, procurement, and system operations separated in different directorates
- Payments to IPPs on commercial basis (PPA based on Take or Pay system), payments to PLN generation at less than cost (first generation of contract).

How to Ensure PLN's Independence from PLN Generation Companies (Gencos) and IPPs

- **PLN's Business Segments**
  - ✓ PLN operates under a vertically integrated model, but its business units are **separated** into:
    - PLN as the system operator and off-taker (four big load dispatc center)
    - PLN Gencos (Sub Holding: PLN Nusantara Power, PLN Indonesia Power, etc.)
    - PLN's transmission and distribution units
  - ✓ This **functional separation** aims to prevent conflicts of interest, ensuring PLN as the buyer treats **PLN Gencos and IPPs fairly**
- **Competitive Procurement Process**
  - ✓ Renewable energy and IPP projects are **procured through competitive bidding** or selected bidding.
  - ✓ These rules require PLN to **evaluate IPP and JV (IPP & PLN Genco) projects equally**, preventing undue favoritism
- **MEMR oversight and regulation**
  - ✓ MEMR regulates PLN's procurement policies, ensuring that:
    - PPAs are **reviewed and approved** to prevent unfair deals
    - **Renewable energy auctions and ceiling price mechanisms** create a level playing field
- **BPK and KPK oversight**
  - ✓ The State Audit Board (BPK) and Anti-Corruption Commission (KPK) conduct **audits and monitoring** into PLN's procurement to prevent conflicts of interest and corruption
- **Independent market monitoring**
  - ✓ Though PLN still dominates as the sole off-taker, there are **third-party verifications** and involvement of independent consultants in evaluating IPP proposals

Regulation in Indonesia on Power Sector Planning

Regulation in Indonesia on Power Sector Planning



National Electricity Plan (RUKN)

1. Contains electricity policy, demand projections and supply optimization as well as plans for the development of electricity systems.
2. Prepared based on the National Energy Policy and involving the Provincial Governments.
3. Stipulated by the Minister Decree.
4. The latest RUKN covers from 2024-2060 period.

Province Electricity Plan (RUKD)

1. Prepared by the Provincial Governments (energy division) and approved by the Governor (8 provinces issued RUKD)

Electricity Supply Business Plan (RUPTL)

1. Contains demand projections and a list of power generation, transmission and distribution projects, covering a 10-year period.
2. Compiled based on RUKN, including its energy mix targets.
3. For RUPTL PLN, it must be **established by the Minister of Energy and Mineral Resources** after **coordinating with the Minister of State-Owned Enterprises and the Minister of Finance, according** to the mandate of Presidential Regulation 112/2022.
4. The latest draft of the RUPTL PLN, which is still under discussion, covers the period from 2025 to 2034.

PLN Long Term Plan (**RJPP**, covers a 5-year period. The latest RJPP is for 2024-2028.
PLN Work Plan and Budget (**RKAP**, is updated annually)

Source: DJK / MEMR (2024)

Key Provisions of RUKN 2024-2060

- The RUKN is designed to support Indonesia's economic growth target of **8% per annum**.
- The RUKN projects a total power generation capacity of **443 GW by 2060**, with **79% derived from renewable sources**. This expansion is intended to meet the anticipated rise in electricity demand and support the nation's energy transition objectives.
- It includes strategies for **phasing out coal-fired power plants** by 2040. Proposed methods involve co-firing with biomass and retrofitting existing coal infrastructure with carbon capture and storage (CCS) technology.
- It also emphasizes the **development of generation systems, transmission networks, and smart grids** to enhance the efficiency and reliability of electricity distribution across the archipelago.
- **Expand rural electrification**, aiming to achieve near-universal access to electricity by 2025.

RUKN vs RUPTL PLN

Aspect	RUKN	RUPTL PLN
Regulating Authority	Government (MEMR)	PT PLN (Persero), aligned with MEMR policies
Scope	National-level electricity planning	PLN's specific business plan for electricity supply
Timeframe	36 years (**long-term**)	10 years (**medium-term**)
Objective	Defines national electricity policies, targets, and projections	Provides detailed planning for electricity supply, including generation, transmission, and distribution
Legal Basis	Based on Electricity Law No. 30/2009 and MEMR regulations	Guided by RUKN and approved by MEMR after coordinating with MSOE and MOF
Focus	National electricity demand growth, electrification ratio, energy mix targets	PLN's power plant projects, procurement plans, grid expansion, and investment needs
Update Frequency	Updated periodically (typically every 5 years)	Updated annually or biennially
Renewable Energy Policy	Sets **national RE targets** and mandates PLN's role in achieving them	Details **specific RE projects** that PLN will develop or procure
Implementation	Guides **all stakeholders** (PLN, IPPs, industries, regulators)	Serves as **PLN**'s operational blueprint for expansion and investment

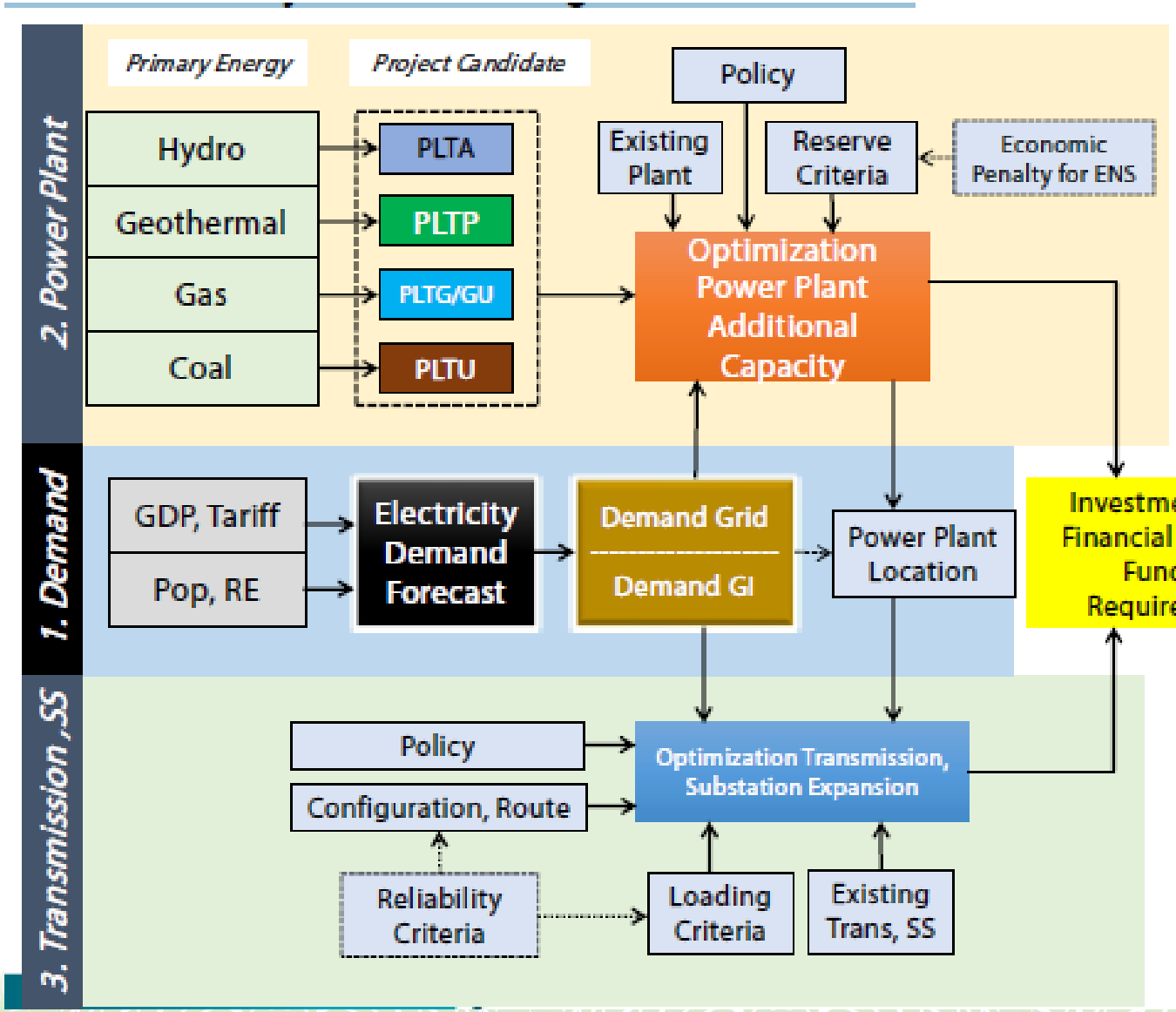
- **RUKN is a high-level national policy document**, setting broad electricity goals for Indonesia.
- **RUPTL is PLN's specific business roadmap**, detailing projects and implementation strategies to meet national targets.
- **RUPTL aligns with RUKN**, ensuring PLN's plans contribute to Indonesia's overall energy strategy.

Coordination Mechanism in Indonesia's Electricity Sector

- DJK – MEMR **leads coordination meetings** with PLN and private sector representatives. Topics include grid development, procurement policies, tariff structures, and investment incentives. These meetings **align RUKN and RUPTL**.
- MEMR and PLN **coordinate with provincial governments** to ensure electricity supply planning meets local economic growth needs.
- MEMR and PLN host **industry dialogues** (e.g., the Indonesia Electricity Investment Forum).
- PLN **engages in regular working groups with IPP associations** (APLSI, *Masyarakat Energi Terbarukan Indonesia*, etc.). These focus on improving procurement, financing, and grid integration for renewable energy projects.
- **Industrial and commercial consumers** (e.g., mining companies, smelters, data centers) **negotiate directly with PLN and MEMR** for direct power supply agreements or captive power solutions.

Current Practice of Power System Planning

Outline of the System Planning Process at PLN



Questions must be answered by the Planner:

- How will electricity demand grow?
- How much capacity for power generation and transmission will be constructed?
- Where should new power generation and transmission be built?
- How is the financial ratio (covenant) to implement the capex planning?
- How is the target of emission reduction (NZE) that wants to be achieved in the future power system?
- **Iteration among technical, financial and emission target**

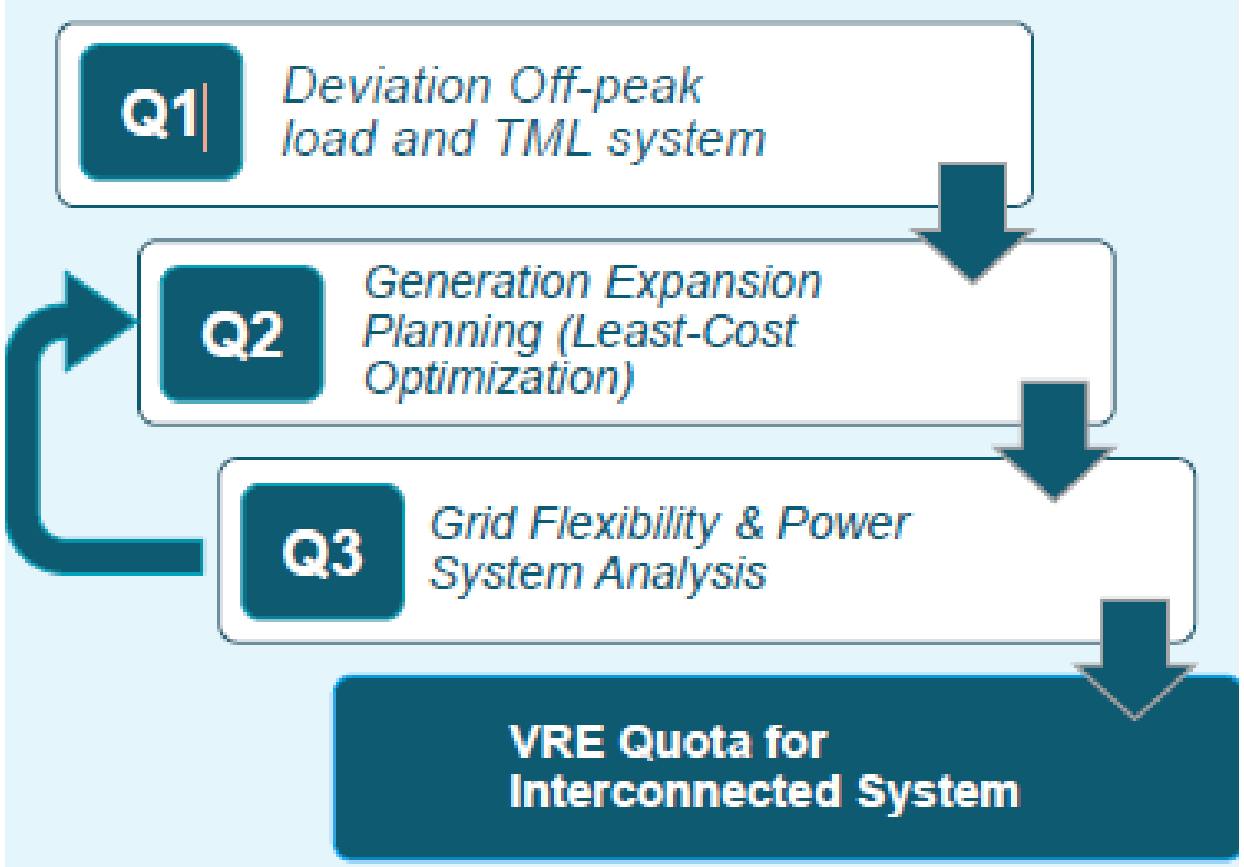
Source: PLN (2023)

VRE Development Plan Methodology

To achieve optimal VRE penetration acceptable to the system, both from a technical perspective (without disrupting power plant operation) and an economic perspective, PLN conducts a study in three stages.

The study is conducted using proven engineering methods and software (Plexos and Digsilent/ PSSE).

The calculation study for VRE quota is conducted in three stages, to assess grid impact and system economic optimization:



Source: PLN (2023)

Key Takeaways for PNG

The Benefits of an Integrated Power Sector Plan – Key Takeaways for PNG

Overcoming Fragmented Decision-Making

Improving Resource Efficiency

Enhancing Investment Security

Strengthening Energy Security

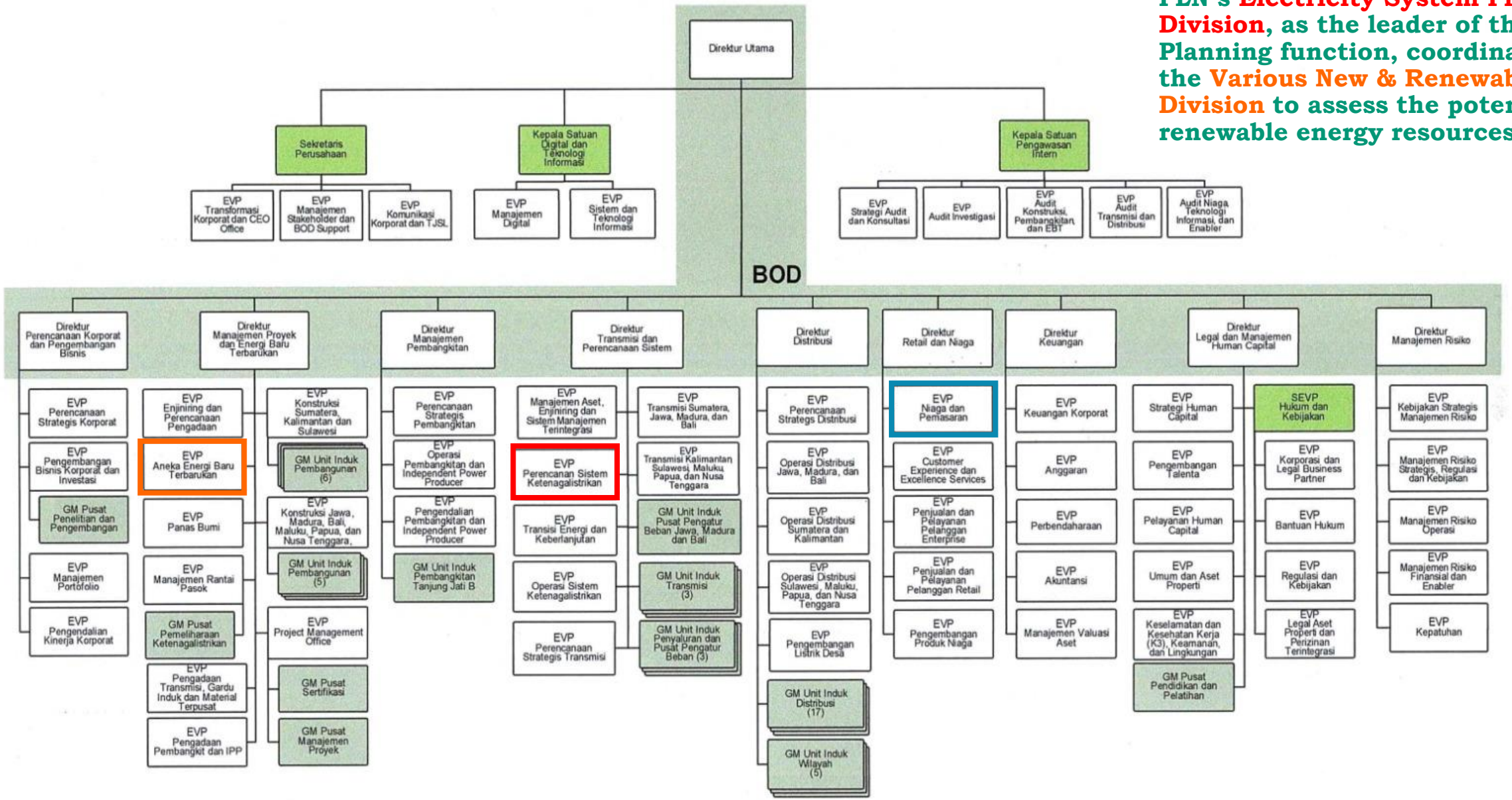
Positioning PNG for Long-Term Growth

Thank You

Terima Kasih

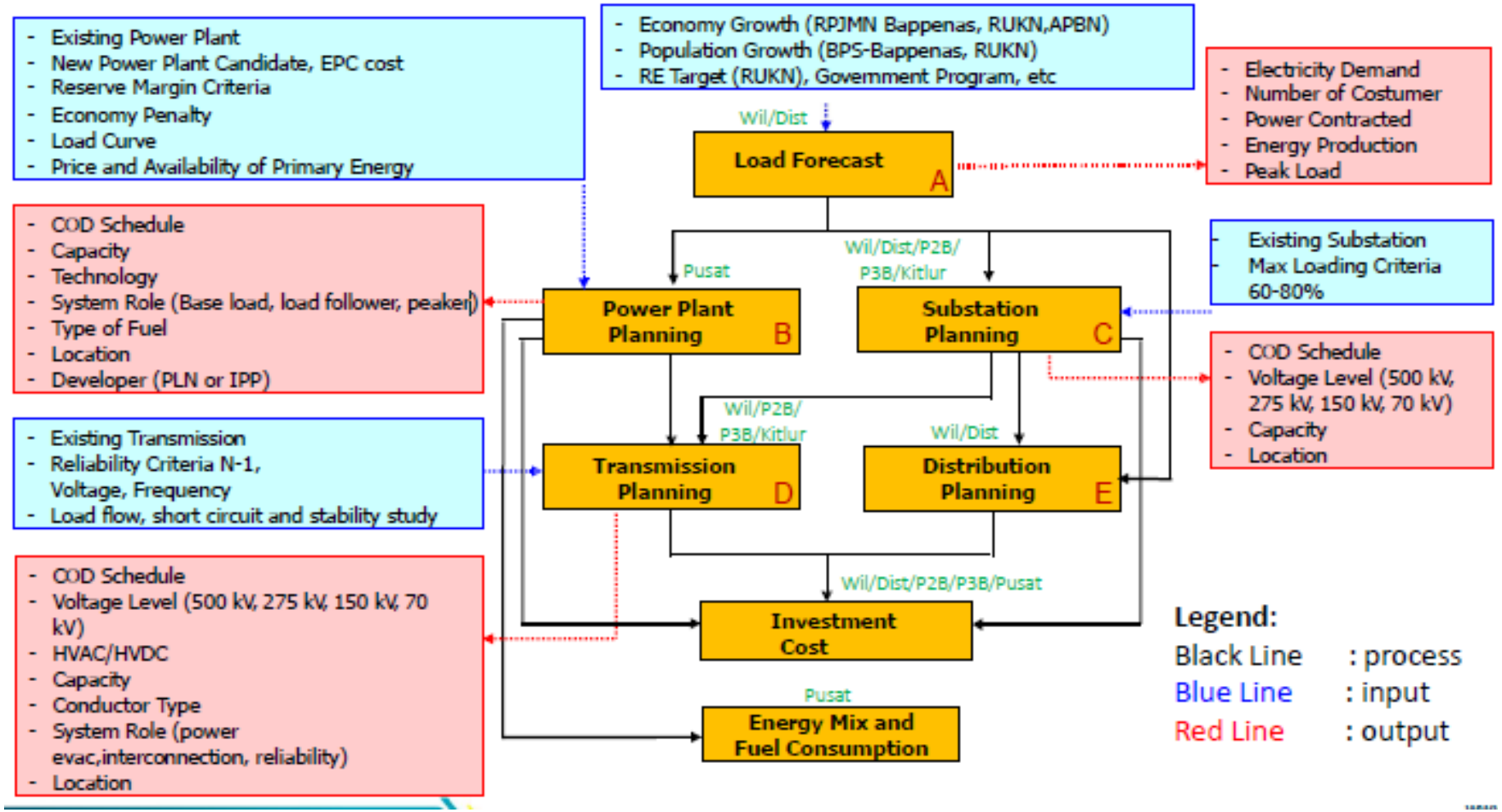
syofviroekman@gmail.com

D. Struktur Jabatan PT PLN (Persero)



PLN's Electricity System Planning Division, as the leader of the System Planning function, coordinates with the Various New & Renewable Energy Division to assess the potential of renewable energy resources

System Planning Process and Criteria for RUPTL Preparation in PLN



Source: PLN (2023)

Development Planning for the Power Generation System (1/2)

Characteristics of system planning:

- Long-term planning, which should span a minimum of 10 years, is essential due to the extensive time needed for the preparation and construction of a new power plant.
- This planning confronts notable uncertainties, including load forecasts and future fuel prices, so it is important to update the plan at least once a year (ideally).

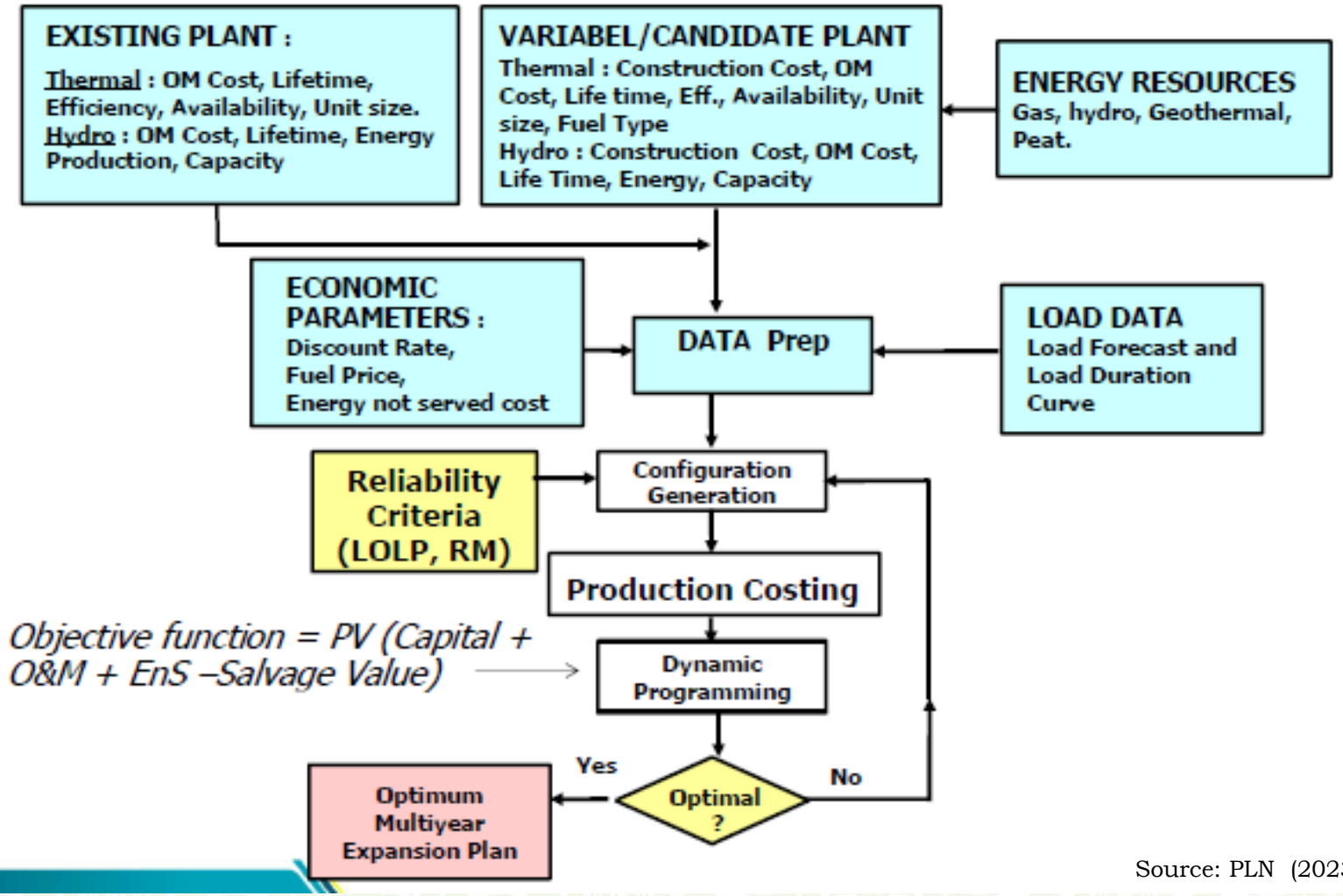
The development planning for the power generation:

- How much capacity needs to be added for generating units?
- What types of technology and fuels will be used for these units (Hydro, Geothermal, Gas, Wind, PV, etc.)?
- When should these generating units be operational?

The selection of power plant locations typically depends on several factors:

- Sources, based load such as hydropower and geothermal.
- Load centers or load balancing, and power generation capacity, such as natural gas/LNG power plants and gas turbine power plants.

Development Planning for the Power Generation System (2/2)



Source: PLN (2023)

Development Planning for the Transmission and Sub-station

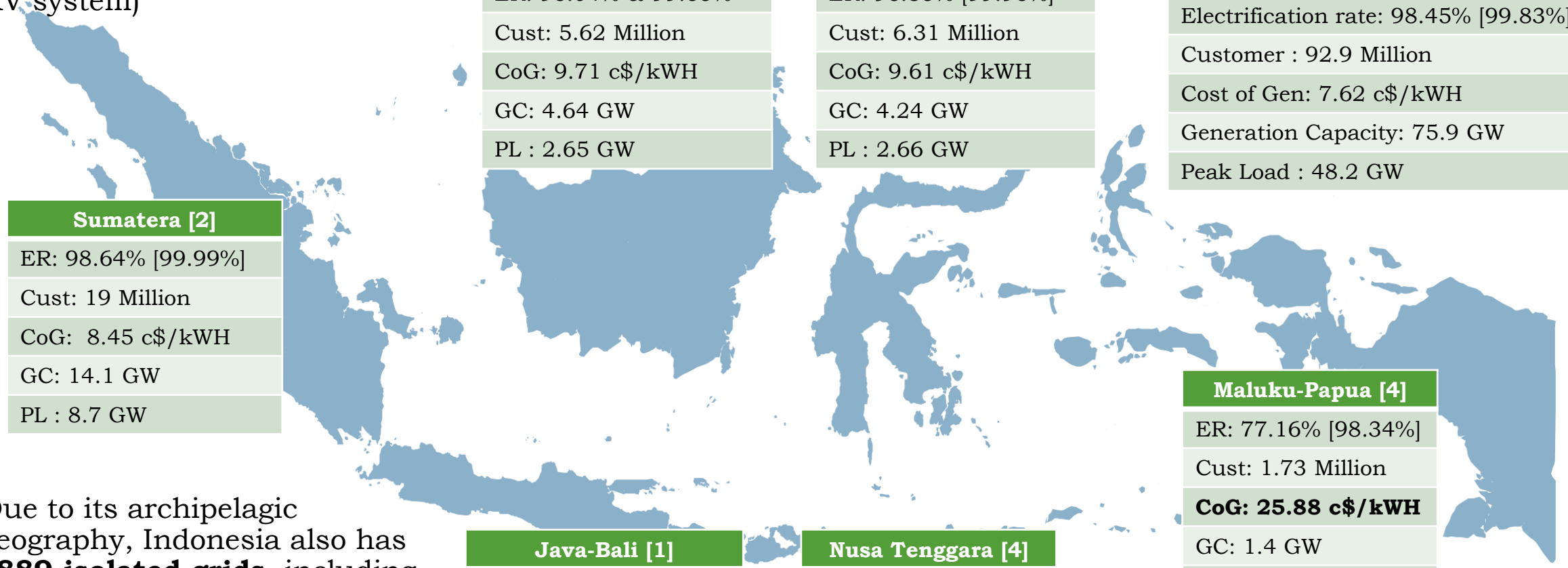
- Transmission planning use contingency criteria N-1, either static or dynamic
- For electricity distribution outside of Java-Bali, at least one substation should be built in each district/city.
- Power transformers (TT/TM) are generally planned to have a capacity of up to 60 MVA.
- Major cities in Java and provincial capitals outside Java with dense populations are prioritized for using Gas-Insulated Switchgear (GIS).
- The number of transformer units in a substation is limited by available land, transmission capacity, and the number of outgoing feeders. A new substation is required if it cannot accommodate further load growth due to these limitations.
- New substation developments should provide good voltage at the end of the network.
- EHV IBT Transformer limitation Up to 4 units of transformers (500/150 kV and 275/150 kV) per EHV Sub- station
- Spare IBT transformers could be provide for per location for EHV GIS and 1 phase per type per province for conventional EHV Substation.
- Substations with minimalist design for electrifying communities with slow growing electricity demand.
- Criteria for adding transformer/IBT capacity when the transformer load reaches 70%-90%.
- The planned connection points from IPP power plants to PLN's Substation points are not limited to just one substation point but allow for nearby substation.
- Additional transformer should consider reliability aspect, especially province capital

Various Technical Tools and Modeling Techniques to Develop RUPTL PLN

- **Demand projection models**
  - ✓ Uses **Simple-E + injection** to predict electricity demand based on industrial, commercial, and household trends
  - ✓ **Bottom-up vs. Top-down Approaches** – PLN **integrates provincial-level demand data into national forecasts** (RUPTL)
- **Generation Expansion (emission) Planning including,** PLN uses generation planning software to determine optimal power plant additions
  - ✓ **Plexos (by Energy Exemplar):** A power system optimization tool used by PLN to model long-term generation expansion scenarios (fossil vs. renewables)
  - ✓ **Renewable Energy Zones (REZ) Mapping:** GIS-based tools to identify optimal locations for solar, wind, and hydro projects
  - ✓ **HOMER (Hybrid Optimization Model for Electric Renewables):** Simulates hybrid power systems (solar + batteries + diesel) **for isolated grids**
- **Grid and Transmission Planning**
  - ✓ **PSS/E or DIgSILENT PowerFactory:** Used for load flow analysis, contingency analysis, and stability assessments as well as model the integration of renewable energy plants into the grid and analyzes grid reliability
  - ✓ **Geospatial Planning Tools (ArcGIS, QGIS):** Used for mapping new transmission corridors
  - ✓ **Grid and Transmission Planning**
- **Financial Analysis: Home-tool for financial projection**

Overview of Power Systems in Indonesia as Dec 2024

- Indonesia / PLN has **16 large power systems** that function through transmission lines (> 70 kV system)



Sumatera [2]
ER: 98.64% [99.99%]
Cust: 19 Million
CoG: 8.45 c$/kWH
GC: 14.1 GW
PL : 8.7 GW

Kalimantan [2]
ER: 96.04% & 99.65%
Cust: 5.62 Million
CoG: 9.71 c$/kWH
GC: 4.64 GW
PL : 2.65 GW

Sulawesi [3]
ER: 96.85% [99.96%]
Cust: 6.31 Million
CoG: 9.61 c$/kWH
GC: 4.24 GW
PL : 2.66 GW

Indonesia
Electrification rate: 98.45% [99.83%]
Customer : 92.9 Million
Cost of Gen: 7.62 c$/kWH
Generation Capacity: 75.9 GW
Peak Load : 48.2 GW

Maluku-Papua [4]
ER: 77.16% [98.34%]
Cust: 1.73 Million
CoG: 25.88 c$/kWH
GC: 1.4 GW
PL : 0.6 GW

Java-Bali [1]
ER: 99.87% [99.91%]
Cust: 56.9 Million
CoG: 6.67 c$/kWH
GC: 50.1 GW
PL : 32.8 GW

Nusa Tenggara [4]
ER: 95.31% [98.48%]
Cust: 3.29 Million
CoG: 16.56 c$/kWH
GC: 1.38 GW
PL : 0.82 GW

PLN as Dec 2024)

- USD 34.3 billion of revenue
- Fuel Mix 4% including bio-diesel B30, [CFPP 66%, GFPP 18% & RE 12%]

- Due to its archipelagic geography, Indonesia also has **±889 isolated grids**, including both low voltage and medium voltage systems.

Source: PLN (2025)

Source of Funding for the Implementation of Power Sector Planning