Presentation

Pusat Riset Sistem Produksi Berkelanjutan dan Penilaian Daur Hidup

Research Center for Sustainable Production System and Life Cycle Assessment

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Research Organization of Energy and Manufacture

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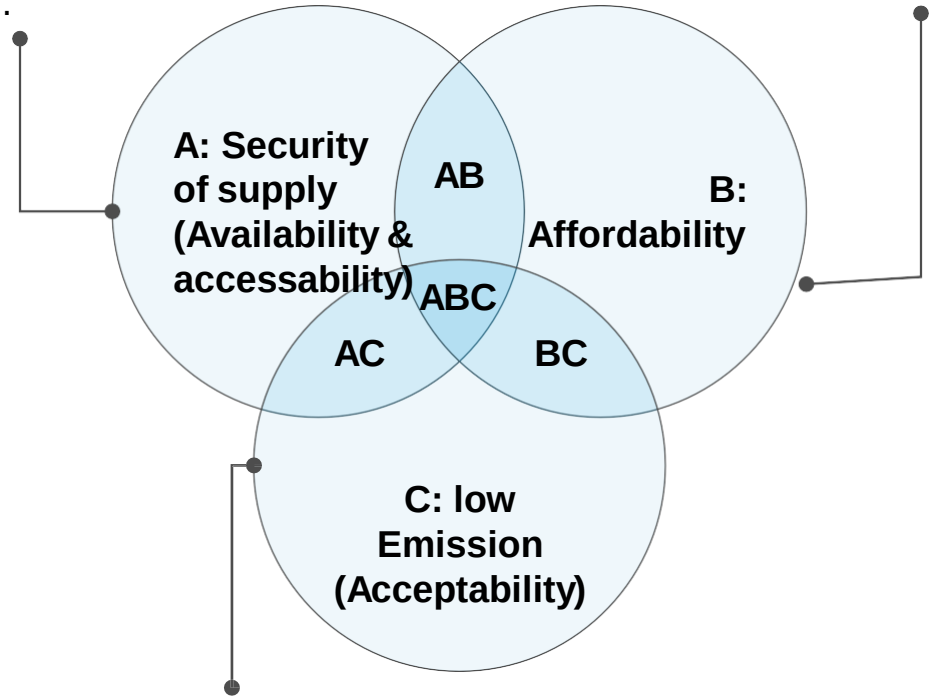
The Concept of Electricity Infrastructure Development in the Energy Transition

Availability of local resources: the main determinant of supply security and is directly related to the progress of the national economy.

Characteristic: Primary energy potentials **GJ/area** are very high.

Electricity is an industrial enabler so the economy of electricity tariffs determines the progress of the national economy.

Power plant characteristic: **LCOE cent/kWh** is low.



Indonesia's per capita emission level is low. Emission reduction is Indonesia's contribution to the global community, but it is not directly related to today's national interest.

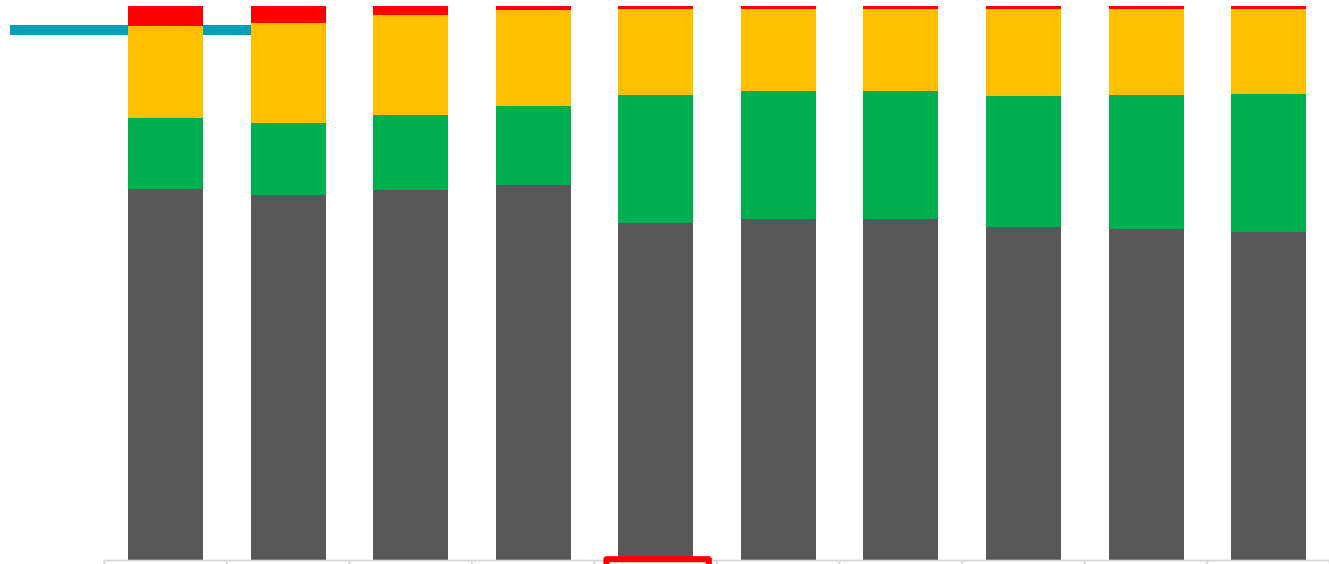
Power plant characteristics: production / emission **CO_2/kWh** low.

Intersection area on diagram:

Area	Condition	Implementation in Indonesia	Complementary Technology
AB	The primary energy supply is safe & controlled, at affordable prices, but does not meet emission criteria	Coal Fired Power Plant	CCS (carbon capture & storage), IGCC (integrated gasification combine cycle)
BC	Affordable price and low emission, but supply security is not guaranteed	NRE Intermittent: solar PV	Battery (energy storage)
AC	Guaranteed and controlled supply and low emission, but expensive	Geothermal	
ABC	Desired ideal conditions: electricity supply is guaranteed, cheap, and low emissions.	?	

Coal plays a very important role in the current national energy security.

Energy Mix 2021 – 2030
General Plan of Electric Power Development



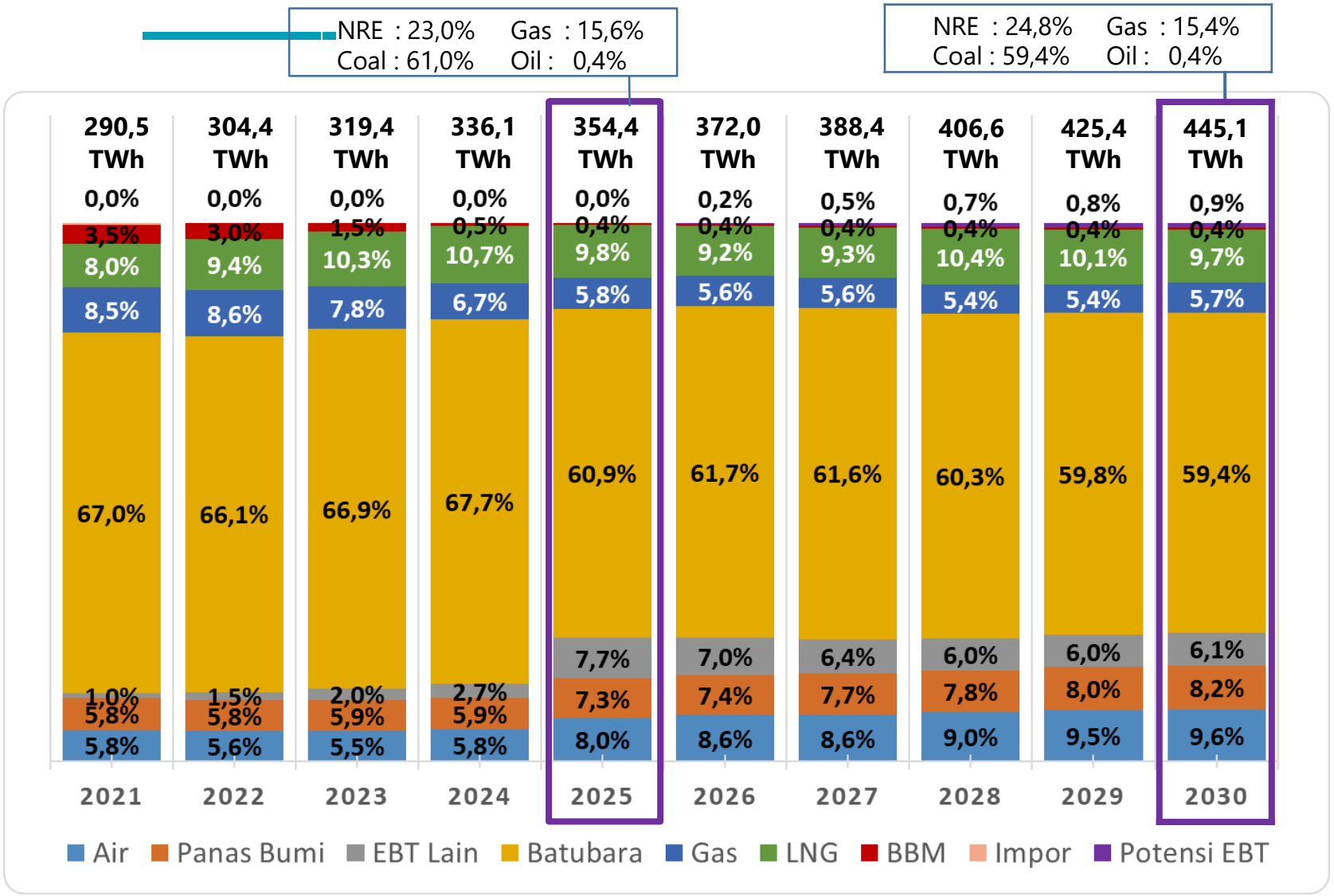
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BBM	3,5%	3,0%	1,5%	0,5%	0,4%	0,4%	0,4%	0,4%	0,4%	0,4%
Gas	16,6%	18,0%	18,1%	17,4%	15,6%	14,8%	14,9%	15,7%	15,5%	15,4%
EBT	12,9%	12,8%	13,4%	14,4%	23,0%	23,1%	23,1%	23,5%	24,2%	24,8%
Batubara	67,0%	66,1%	66,9%	67,7%	60,9%	61,7%	61,6%	60,3%	59,8%	59,4%

After 2025 the NRE mix is maintained at more than 23%. By the end of 2030, the NRE mix will reach more than 24%. The coal mix will decline after 2026, the fuel mix should be kept to a minimum after 2025 and only for a 3T regional supply, and the gas mix will be varied because of load followers and peaker.

Efforts to achieve the target of 23% NRE mix starting in 2025 and prevent the increase in The Production Costs :

1. Prioritizing NRE plants that do not increase Production Cost much
2. More Solar PV system is encouraged because the price tends to fall and utilizes reservoirs
3. Cofiring PLTU is encouraged by maintaining environmental sustainability
4. De-dieselization program with NRE generators

Projection of Energy Mix (Indonesia)



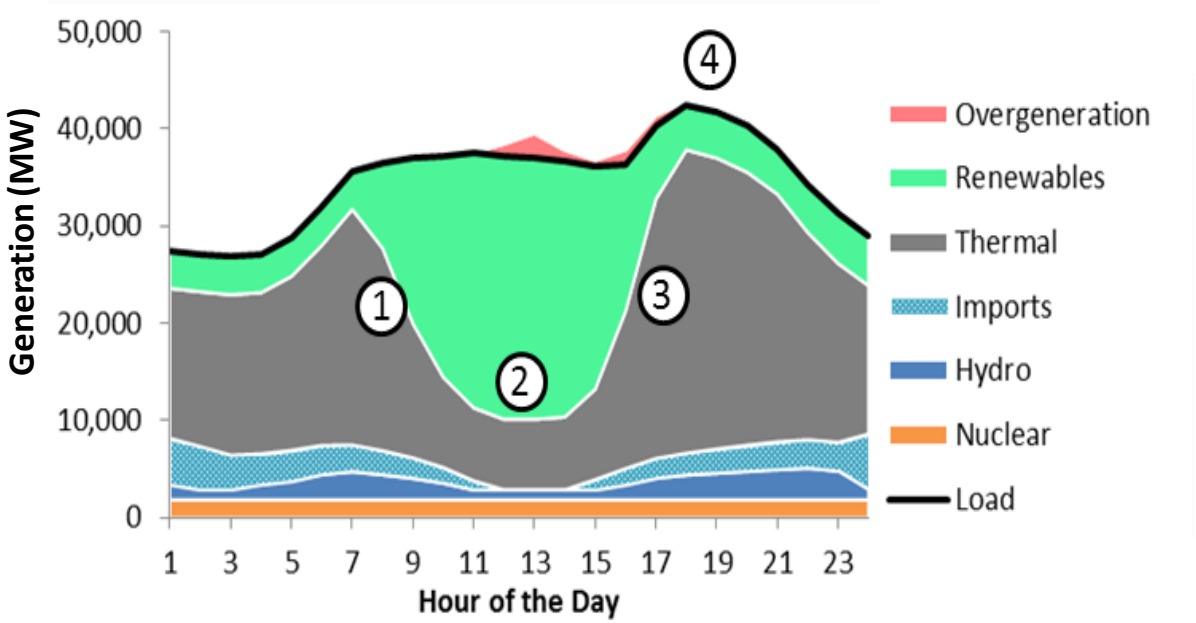
The strategies undertaken to achieve a 23% NRE mix starting in 2025 are as follows:

1. Increase the success of PLTP COD (1.4 GW) and PLTA / PLTM (4.2 GW) by accelerating permits, exploration and land acquisition
2. De-dieselization Program spread 588 MW converted into Solar PV System 1,2 GWp and Batteries.
3. Development 4,7 GW Solar PV System and 0,6 GW Wind Power to achieve NRE mix 23% in 2025.
4. Implementation Biomass Co-Firing at Coal Fired PP in PLN by average 10% Jawa-Bali, and 20% Outside Jawa-Bali by CF 70% from total capacity equivalent 2,7 GW (up to 13,7 million ton/year biomass, energy mix 6%.
5. Base-load PP after 2025, 1 GW minimum by NRE
6. Retirement 1,1 GW Coal-fired PP Sub-Critical in Muarakarang, Priok, Tambaklorok and Gresik by 2030.

Issues in Efforts to Accelerate Energy Transition

Development VRE *massive* (Solar PV) Impacting the System- Phenomenon *Duck Curve*

Solar PV System Typical Production in Load Curve - *Duck Curve*

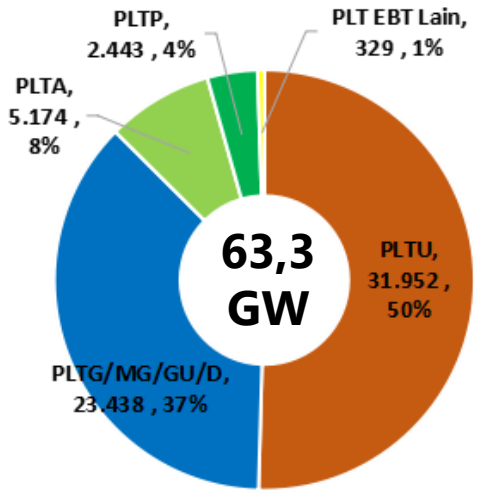


Ramping Capability

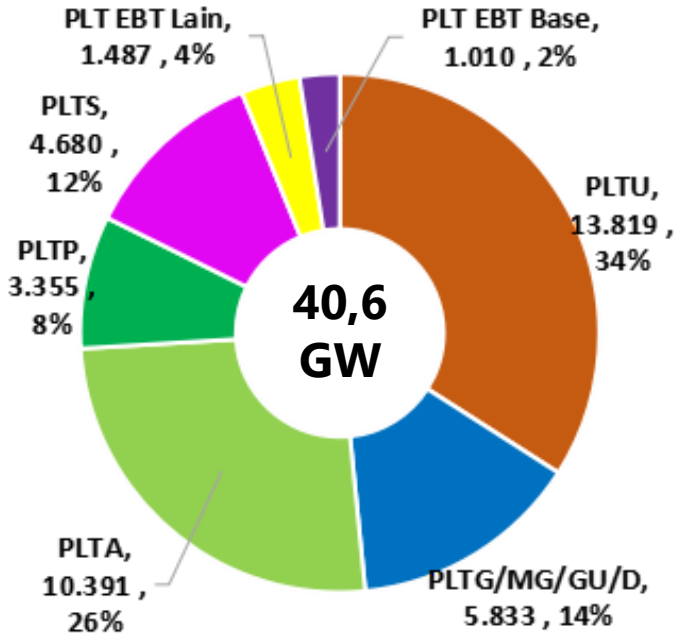
1. *Downward Ramping Capability*
2. *Technical Minimum Loading*
3. *Upward Ramping Capability*
4. *Peaking Capability*

When Solar PV System / PLTS starts production (1), other generators must reduce their production and must not trip (TML limit) (2) because when PLTS production decreases in the afternoon, there is an increase in load, and other generators must meet the power demand in a short time (3), so that peaking ability is needed (4).

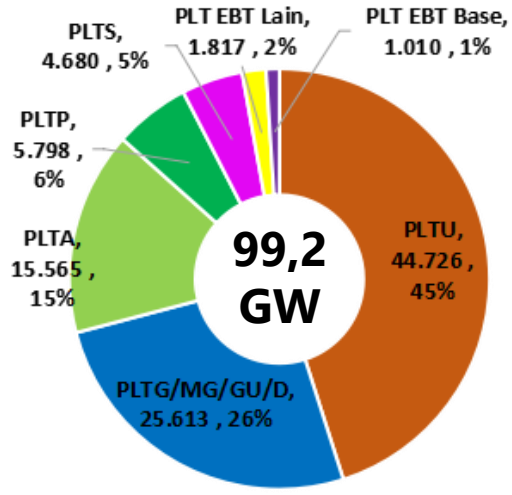
Plan to Add Power Plants to RUPTL 2021-2030
Greener RUPTL as a Foundation for Achieving Zero Carbon 2060



Installed Capacity 2020



New Installation RUPTL 2021-2030



Installed Capacity 2030

The installed capacity of PLN's power plants in 2020 is 63.3 GW. The plan to add new power plants is 40.6 GW for 10 years with the NRE portion reaching 20.9 GW or 51.6%. It is planned that the PLTU retirement of 1.1 GW and the replacement of old PLTD/PLTMG/PLTG spread around 3.6 GW so that PLN's generating capacity in 2030 will be 99.2 GW.

Private Participation in Power Plant Development Plan

Power Plant	MW	Portion
NRE	20.923	**51,6%**
Non NRE	19.652	**48,4%**
Total	**40.575**	

Developer	MW	Porsi
PLN	**14.269**	
EBT	9.14	
Non EBT		
Private		
To		

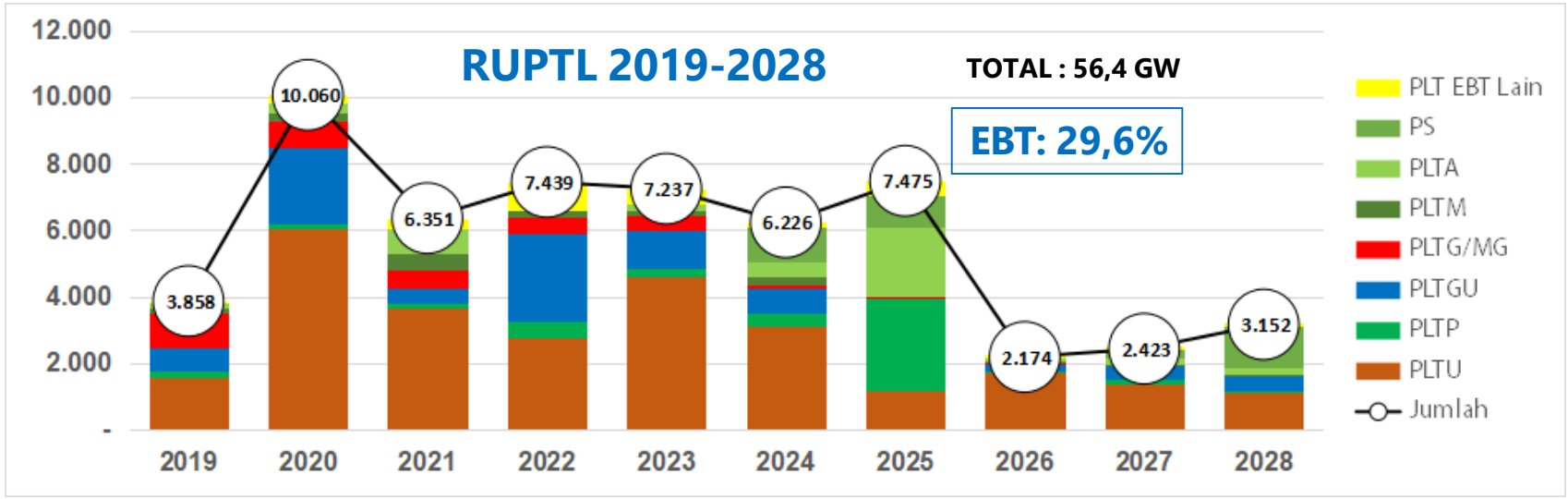
NRE	MWp	Porsi
PLN	9.144	**43,7%**
Private	11.779	**56,3%**
Total	20.923	

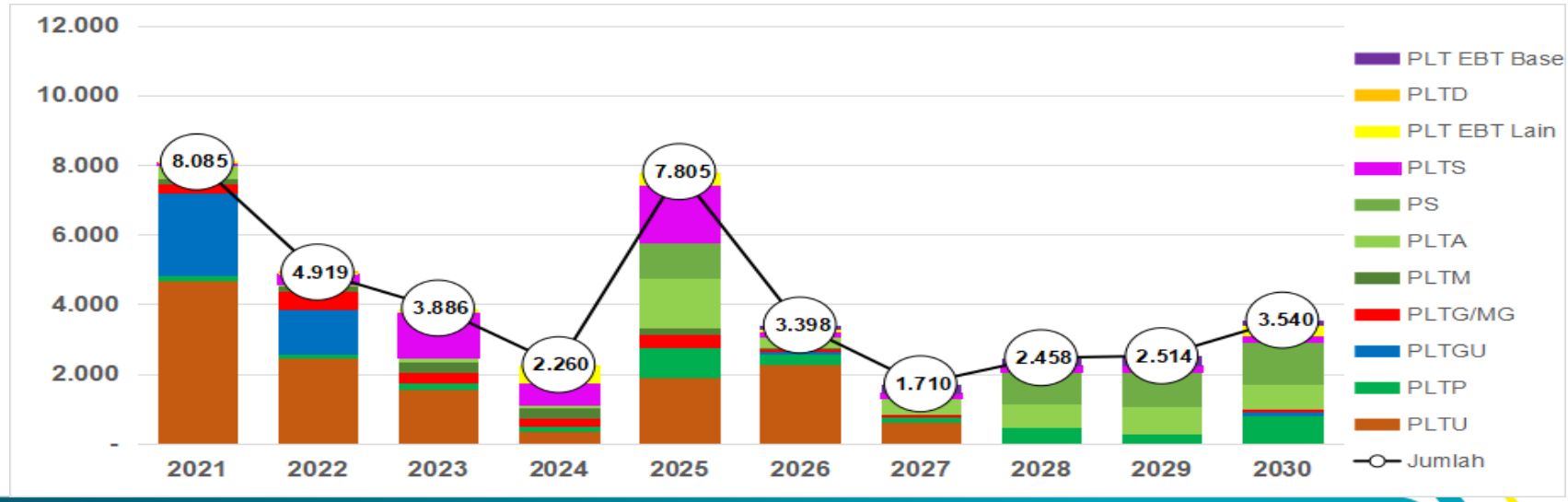
PLTS / Solar PV	MWp	Porsi
PLN	**1.701**	**36,3%**
Private	**2.979**	**63,7%**
Total	4.680	

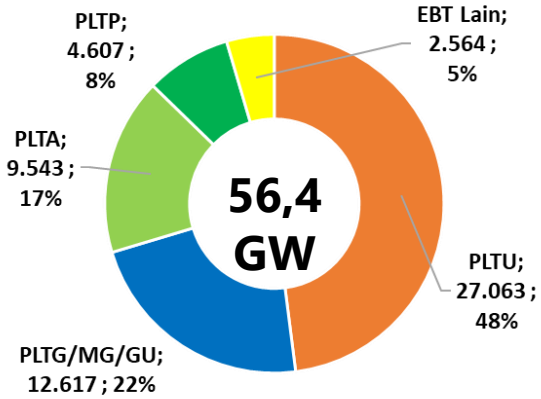
PLTS On-Grid	MWp	Porsi
PLN	**1.476**	**45,6%**
Private	**1.760**	**54,4%**
Total	**3.236**	

1. PLN plans that 51.6% of the power plants will be NRE power plants
2. PLN supports private sector participation in the development of electricity infrastructure where 64.8% of the power plant portion is planned to be developed by the private sector.
3. 56.3% of NRE power plants planned to be developed by the private sector
4. For PLTS, 63.7% will be developed private.
5. Specifically for on-grid PLTS, 54.4% will be developed by the private sector.

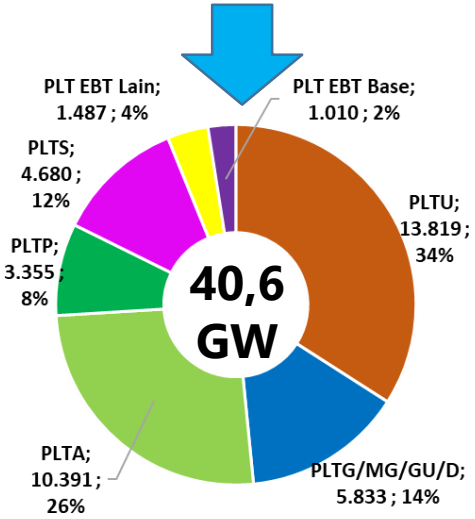
Comparison of Planned Addition of Power Plants







RUPTL 2019-2028



RUPTL 2021-2030

Roadmap NRE Power Plants Development 2021-2030

Per Year (MW)

No	NRE Power Plants	Capacity	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
1	PLTP (Geothermal)	MW	136	108	190	141	870	290	123	450	240	808	3.355
2	PLTA (Large Hydropower)	MW	400	53	132	87	2.478	327	456	1.611	1.778	1.950	9.272
3	PLTM (Microhydro)	MW	144	154	277	289	189	43	-	2	13	6	1.118
4	PLT Surya (Solar PV)	MWp	60	287	1.306	624	1.633	127	148	165	172	157	4.680
5	PLT Bayu (Wind Power)	MW	-	2	33	337	155	70	-	-	-	-	597
6	PLT Biomass / Waste	MW	12	43	88	191	221	20	-	15	-	-	590
7	PLT EBT *Base (NRE)*	MW	-	-	-	-	-	100	265	215	280	150	1.010
8	PLT EBT Peaker (NRE)	MW	-	-	-	-	-	-	-	-	-	300	300
Total		**MW**	**752**	**648**	**2.026**	**1.670**	**5.546**	**978**	**991**	**2.458**	**2.484**	**3.370**	**20.923**

Per Regional (MW)

No	NRE Power Plants	Capacity	Jamali	Sumatera	Kalimantan	Sulawesi	MPNT	Total
1	PLTP	MW	1.915	1.180	-	75	185	3.355
2	PLTA	MW	3.903	2.682	1.153	1.444	90	9.272
3	PLTM	MW	418	426	28	156	91	1.118
4	PLT Surya	MWp	2.906	193	304	176	1.101	4.680
5	PLT Bayu	MW	260	110	70	130	27	597
6	PLT Biomasa/ Sampah	MW	232	117	86	50	106	590
7	PLT EBT *Base*	MW	-	230	100	230	450	1.010
8	PLT EBT *Peaker*	MW		300				300
Total		**MW**	**9.634**	**5.237**	**1.741**	**2.261**	**2.050**	**20.923**

1. The addition of NRE power plants until 2025 is 10.6 GW.
1. PLT EBT Base is a Coal-fired PP plan that has not been committed and can be replaced with NRE generators to meet the needs of base/peak load generators
2. (the type of generator will be determined through a more comprehensive study).

Development Strategy of NRE Power Plants

1. The development of NRE power plants continues to pay attention to the supply-demand balance, system readiness and economy.
2. PLN will utilize renewable energy sources from water energy, geothermal energy (including small/modular scale), biofuel, wind, sunlight, biomass and waste, etc. as well as support RE-BID (Renewable Energy Based on Industrial Development) efforts.
3. Development of centralized PV to electrify many remote communities far from the grid in underdeveloped areas, frontier islands bordering neighboring countries and other outermost islands.
4. Convert PLTD (Diesel Engine) to EBT (NRE) using batteries. This strategy is prioritized for areas that are low flame (below 12 hours/day), generally in Eastern Indonesia.
5. Micro-grid development for isolated areas. Areas that in the next 2-3 years have not planned to build distribution or small thermal generators, are proposed to use PV mini-grid.
5. The use of co-firing uses pelleted biomass (garbage, wood, etc.) in coal power plants.
6. Utilization of PLTS: ex-mining land, reservoirs and PLTS to reduce the use of own power plants.
7. Using NRE generators as a power supply for the new National Capital City (IKN) plan.

Development Plant of PLTD / Diesel Conversion 2021-2025

Operation Areas	PLTD Eksisting		Program 1		
			PLTS	Baterai	EBT Lain
	(unit)	(MW)	(kWp)	(kWh)	(kW)
Nasional	**1.601**	**499**	**1.219.230**	**2.286.544**	**131.310**
Sumatera Kalimantan	**669**	**233**	**216.201**	**575.952**	**97.545**
Sumatera	393	181	84.750	185.130	97.545
Kalimantan	276	53	131.451	390.822	-
Jawa, Madura dan Bali	**32**	**19**	**41.200**	**151.629**	**-**
Sulmapana	**900**	**247**	**961.829**	**1.558.963**	**33.765**
Sulawesi	286	70	143.713	490.244	365
Maluku	203	42	570.502	315.071	-
Papua	168	38	163.850	490.288	10.300
Nusra	243	98	83.764	263.360	23.100

Notes:
- Program 1 Conversion to EBT / NRE
- Program 2 Gasification
- Program 3 Grid Connection

Operation Areas	PLTD Eksisting		Program 2 PLTG/MG
	(unit)	(MW)	(kW)
Nasional	**307**	**304**	**598.000**
Sumatera Kalimantan	**32**	**30**	**84.000**
Sumatera	26	26	66.000
Kalimantan	6	3	18.000
Jawa, Madura dan Bali			
Sulmapana	**275**	**275**	**514.000**
Sulawesi	23	22	40.000
Maluku	145	125	211.000
Papua	107	127	263.000
Nusra	-	-	-

Operation Areas	Program 3 PLTD Eksisting	
	(unit)	(MW)
Nasional	**1646**	**1070**
Sumatera Kalimantan	**1102**	**687**
Sumatera	526	396
Kalimantan	576	292
Jawa, Madura dan Bali		
Sulmapana	**544**	**382**
Sulawesi	376	326
Maluku	72	40
Papua	49	7
Nusra	47	10

Operation Areas	Non Program PLTD Eksist
	(unit)
Nasional	**161**
Sumatera Kalimantan	
Sumatera	
Kalimantan	
Jawa, Madura dan	
Sulmapana	
Sulawesi	
Maluku	
Papua	
N	

Notes :
PLTD which is included in Non-Program is still possible for further review

Conversion Program Diesel (PLTD) to NRE(EBT)

± 5200 unit PLTD, spread in 2130 location

Phase 1 : 265 MW in scattered location

1. Phase 1 will be implemented on isolated systems where the production cost is higher than PV + battery storage. A total of 200 MW PLTD will be converted into PV + battery storage of around 660 MWp.
2. Phase 2 of around 2,000 MW of PLTD will be converted in stages using NRE, gas or interconnection with larger systems until 2025/2026. Phase 2 is around about 560 MWp.

Notes :
Size and lokation PLTD convert to NRE in RUPTL 2021 – 2030 still as early initiation and will be assessed further in term of technical and financial feasibility to obtain firmed *size* and location.

Biomass Co-firing on Coal-fired pp / PLTU Batubara

- PLN has implemented a co-firing pilot project with a 5% portion of biomass in 32 existing PLTUs, and will be expanded to 52 locations.
- To achieve the target of 23% NRE mix by 2025, co-firing of biomass with a portion of 10-20% is required.
- To achieve the target of NRE, a very large amount of biomass is required approx 8-14 million tons per year.
- The new PLTU must be designed to be able to co-firing at least 30% of the biomass.
- Biomass co-firing challenges:

[redacted]

Implementation of *Pilot Project Biomass Co-firing*

SUMATERA
- 13 Location PLTU – 2315 MW
- **Biomass requirement HTE 2,82 Jt Ton/thn**
- **Requirement pellet & waste 0,122 m Ton/year**

JAWA
- 16 Location PLTU - 14.845 MW
- **Requirement HTE Biomass 2,73 m Ton/yr,**
- **Requirement pellet waste 0,693 m Ton/year**

KALIMANTAN
- 10 Location – 979,07 MW
- **Requirement HTE Biomass 1,16 m Ton/year,**
- **Requirement pellet waste 0,053 m Ton/year**

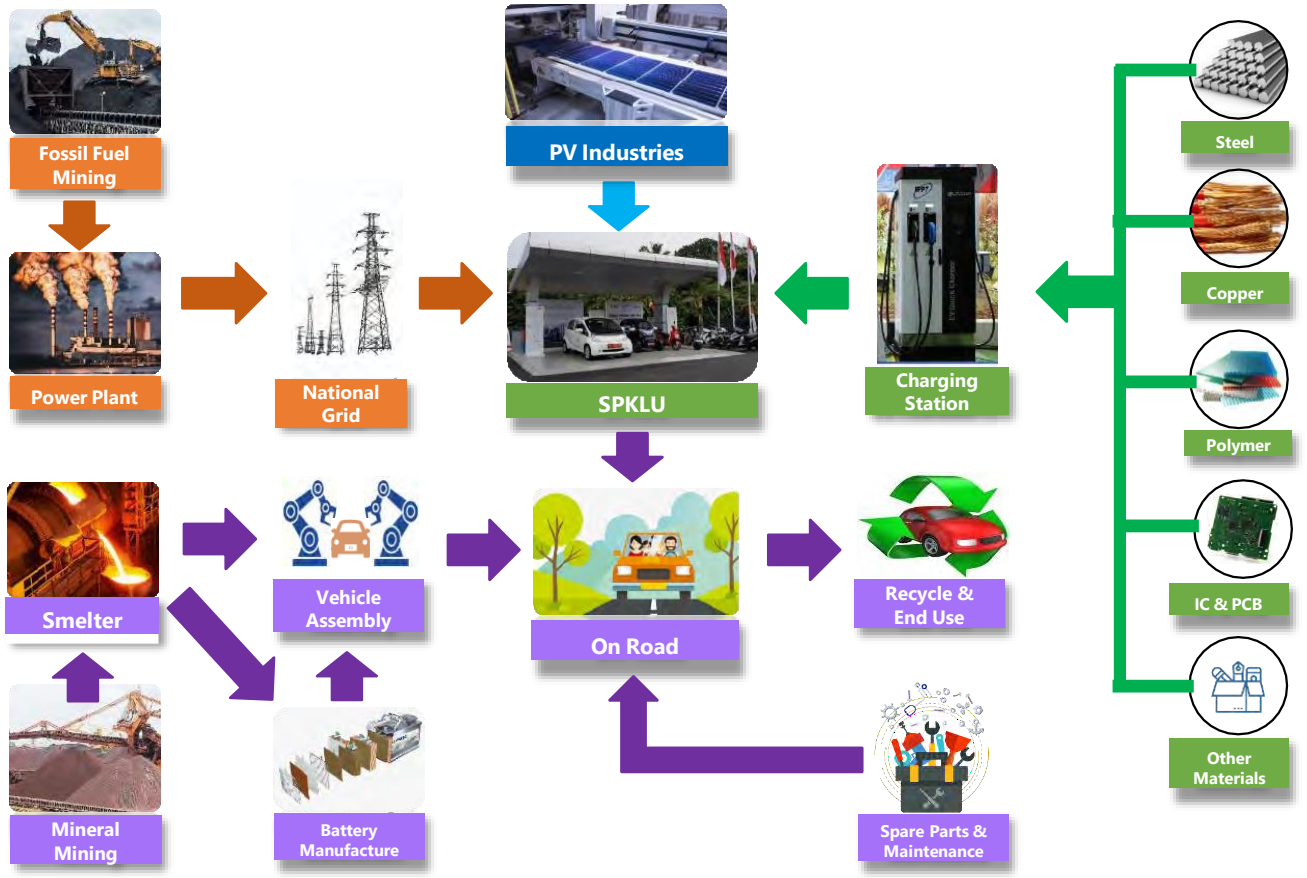
Location Coal-fired PP /PLTU Batubara

NUSA TENGGARA
- 4 Loc - 237 MW
- **Req Biomass 0,4 m Ton /year**
- **Require pellet waste 0,0136 m Ton/year**

PAPUA & MALUKU
- 3 Location – 41 MW
- **Requirement HTE Biomassa 0,17 m Ton/year,**
- **Requirement pellet waste 0,002 m Ton/year**

SULAWESI
- 6 Location – 478 MW
- **Requirement HTE Biomass 0,77 m Ton/yr,**
- **Requirement pellet waste 0,026 m Ton/year**

LCA Solar Power Supply for Electric Cars



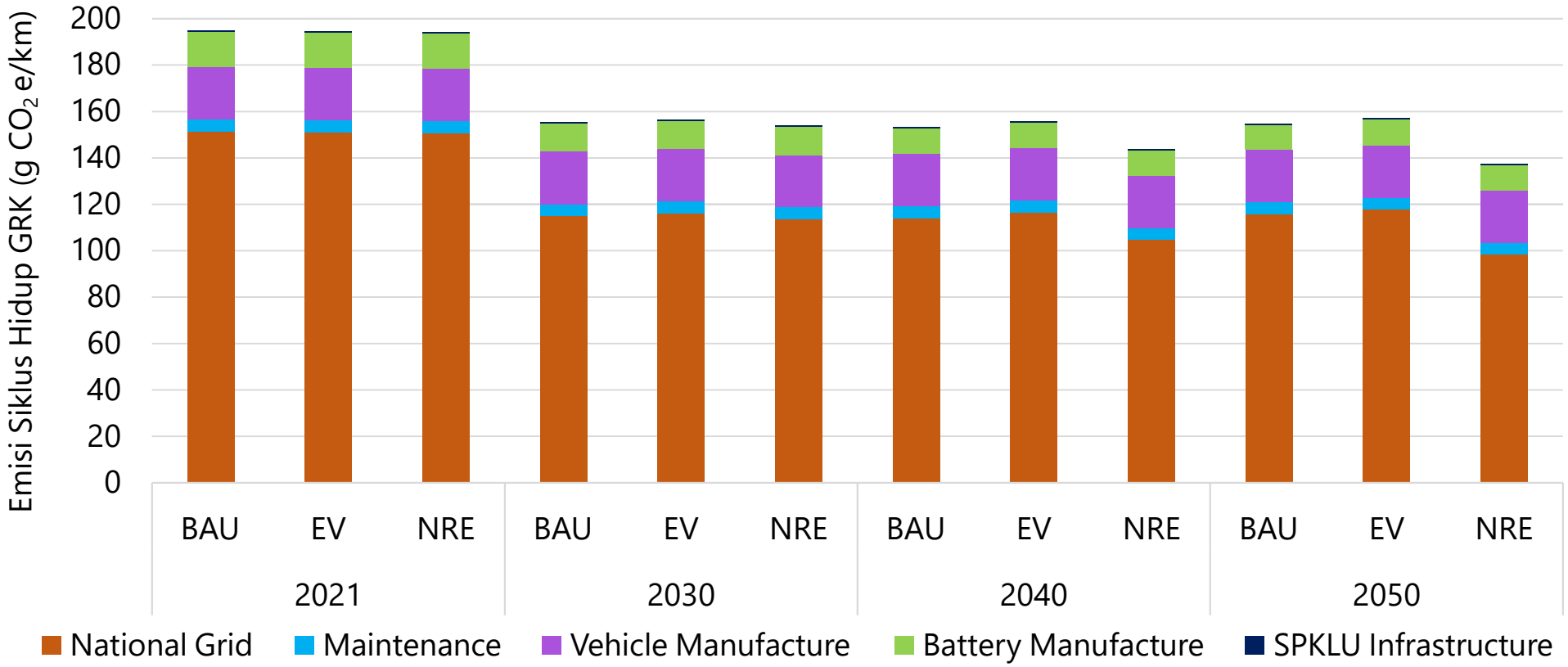
System Boundary: Cradle to Grave

The analysis starts from mining to the end use of electric cars and batteries. The life cycle assessment (LCA) simulation is divided into 4 system boundaries:

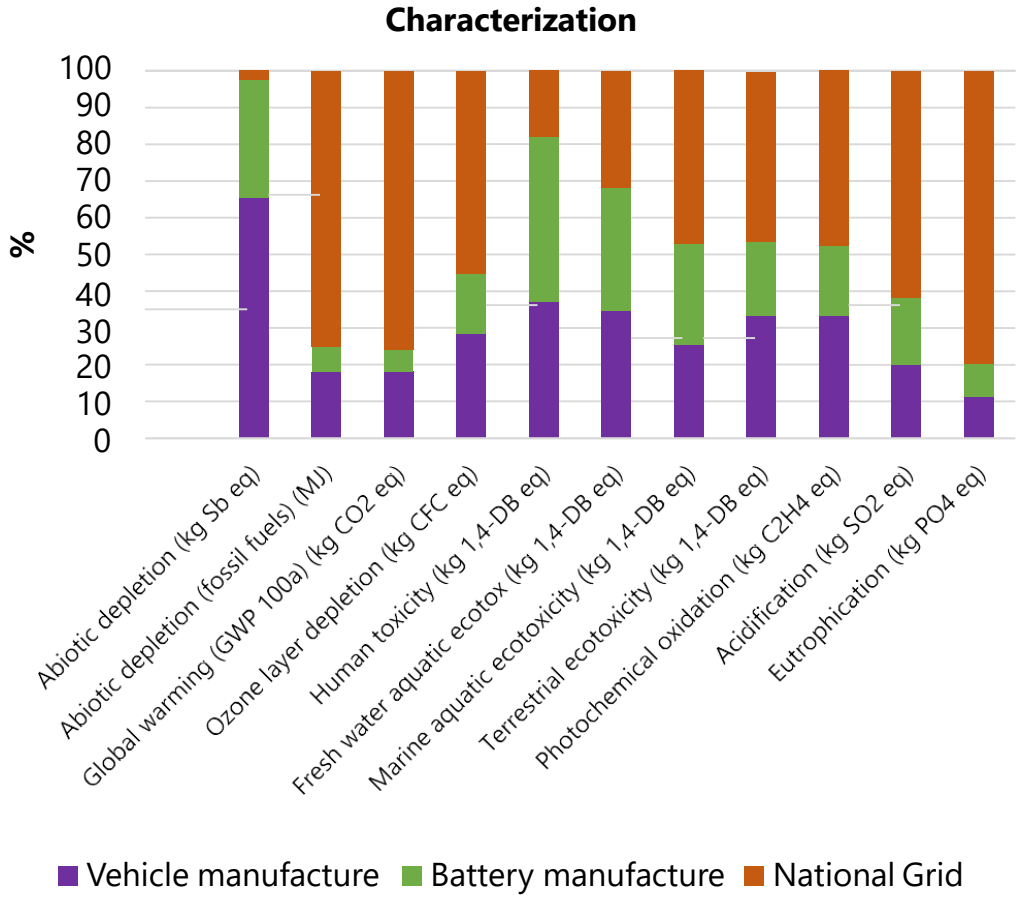
- PV panel production system
- BPPT's existing charging station system including its supporting infrastructure
- Electric power supply system Electric car and battery production system.
- Electric power supply system Electric car and battery production system.

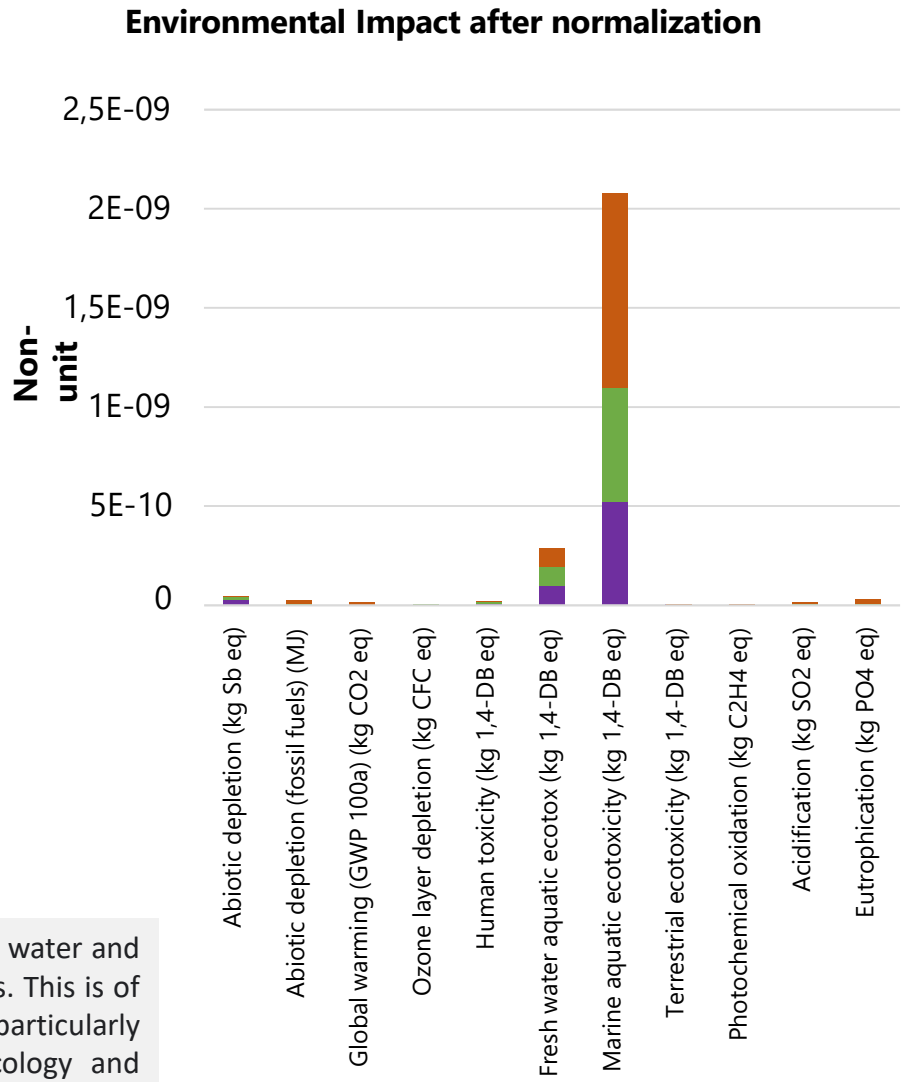
PV cells are assumed to be imported 100% from China. The power source uses BAU, EV and NRE scenarios as well as nickel-based batteries manufactured in Indonesia.

LCA Results: Life Cycle Assessment Data, GRK



Characterization and Normalization of Environmental Impact





Environmental impact analysis after normalization shows that toxicity (human, fresh water and marine aquatic) has the highest value relative to other environmental impact factors. This is of particular concern considering that new technologies for the transportation sector, particularly battery-based electric motorized vehicles (KLBB) have potential impacts on ecology and communities originating from mining, manufacturing, end-use disposal and recycling activities.

BRIN
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DAN INOVASI NASIONAL

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