Various pathways for decarbonizing the road transport sector in the Global South

～Efforts and challenges toward BEV and biofuels deployment～

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Introduction

IEEJ Outlook 2025 :

- LCA of GHG emissions for different powertrains (ICV, HEV, PHEV and BEV) and different regions (advanced Europe, Brazil, ASEAN and India)
- Various pathways for decarbonizing the road transport sector and different optimal powertrains depending on the circumstances of countries and regions

IEEJ Outlook 2026 :

- More comprehensive analysis beyond powertrains
- Three case studies on various pathways of the Global South leaders: Indonesia (BEV), Brazil (bioethanol) and India (biogas)
- Analysis on their efforts and challenges toward BEV and biofuels deployment

Indonesia: BEV policies

- Ambitious BEV industrial policies aiming at a global hub of BEV production
  - Existing industrial base: the second largest car-production and the largest car-sales in ASEAN
  - Critical mineral for battery: 51% share of global nickel production (2023)

- Targets of BEV domestic production

Year	2024	Target for 2025	Target for 2030	Target for 2035
BEV production	**42K**	**400K**	**600K**	**1,000K**

Source: 2022 regulation of Ministry of Industry of Indonesia and GAIKINDO

- Target of BEV domestic stock

Year	2024	Target for 2030
BEV stock	**76K**	**2,000K**

Source: press release from Ministry of Energy and Mineral Resources of Indonesia (May 2024) and IEEJ's estimate based on GAIKINDO

Indonesia: Nickel refining by Chinese companies

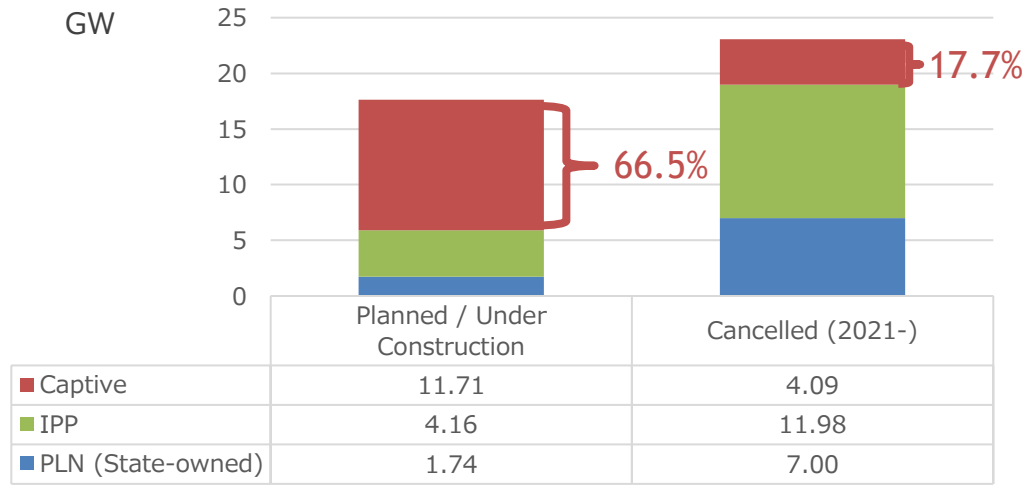
- GOI's ban on Ni ore exports since 2014: Chinese smelters account for three-quarters of Ni refining in Indonesia, building on remote islands smelters and small, low-efficiency coal-fired power plants (CFPP).

- Exception plus exception
  - Captive CFPP serving Ni smelting and industrial parks is exempt from GOI's ban on CFPP construction after 2023.
  - Captive CFPP in industrial parks related to the Belt and Road Initiative is exempt from GOC's policy of halting support of new CFPP abroad.

- In addition to CO_2 emissions increase by captive CFPP,
  - Deforestation and degraded ocean eco-system
  - Risk of SO_2 emissions

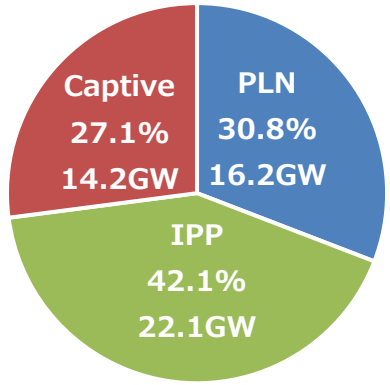
Overall environment impacts including supply chain?

CFPP by Supplier and Status (Planned & UC / Cancelled)



	Planned / Under Construction	Cancelled (2021-)
Captive	11.71	4.09
IPP	4.16	11.98
PLN (State-owned)	1.74	7.00

Operating CFPP by Supplier



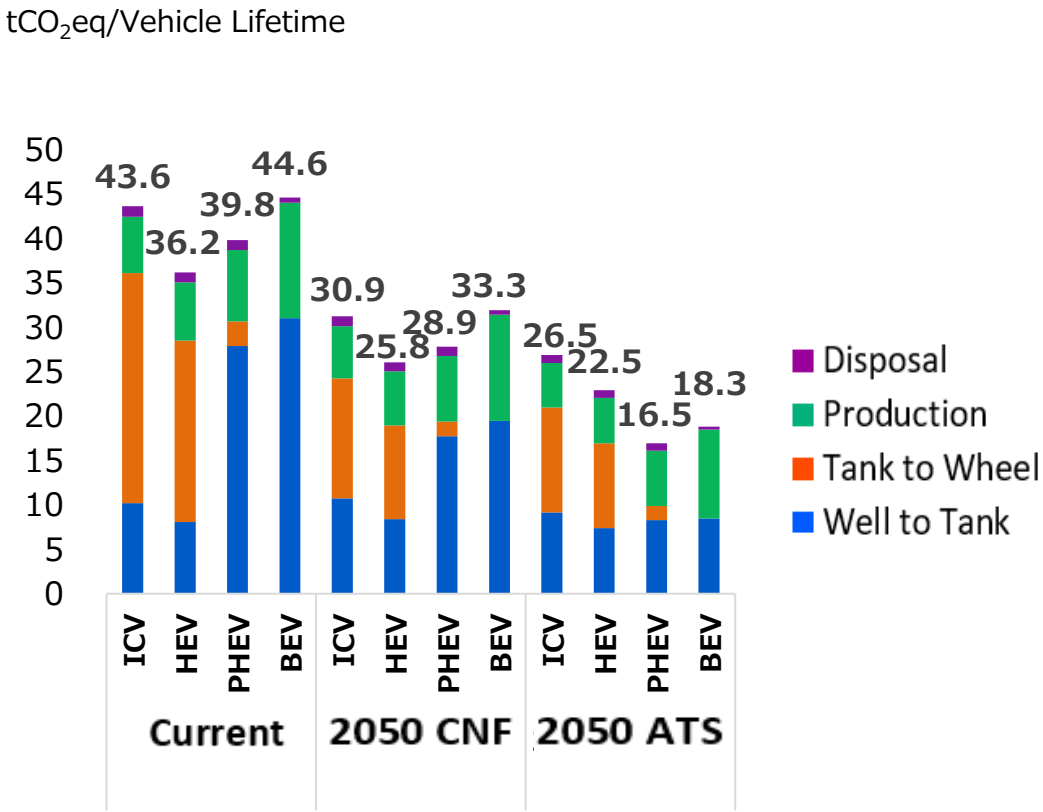
Source: Global Coal Plant Tracker; compiled by IEEJ. As of July 2025.

Indonesia: Is BEV low carbon?

- Two thirds of power generation are from CFPP: its emissions factor, 829gCO_2/kW, is 1.4 times higher than global average, 575gCO_2/kWh.
  - Current: BEV's LCA GHG emissions are higher than ICV
  - Future: the same without sufficient decarbonization of power sector (2050 CN Fuel case)

- The above is based on all-day/all-source emissions factor, but:
  - Current: excessive CFPP could be used for charging BEV, leading to more CO_2 emissions.
  - Future: if BEV charging concentrates in the evening, cheaper CFPP could be used as marginal power source.

BEV's Well to Tank emissions could increase by 1.3 times currently and 1.6～3.8 times in 2050.



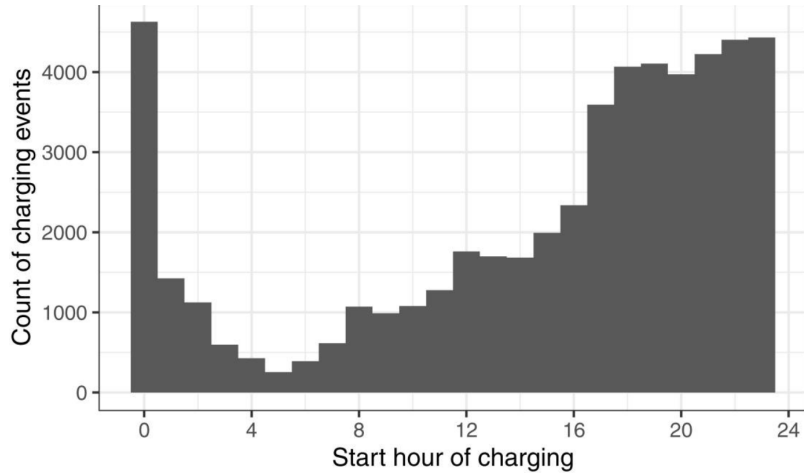
Decarbonization of electricity and peak-shift are essential.

Indonesia: Infrastructure for BEV deployment

- Power supply and grid expansion
  - 15GW or more additional power demand in 2040 if BEV deployment is accelerated as targeted and if half of BEV charging concentrate in the evening as in California.
  - GOI plans to increase power capacity from 106GW in 2025 to 242GW in 2040; 15GW is significant.

BEVs play a pivotal role in demand-supply adjustment if peak can be shifted, avoiding infrastructure costs.

Start hour of BEV charging in California



- Charging infrastructure
  - The targets require 23 trillion IDR for the next 6 years.

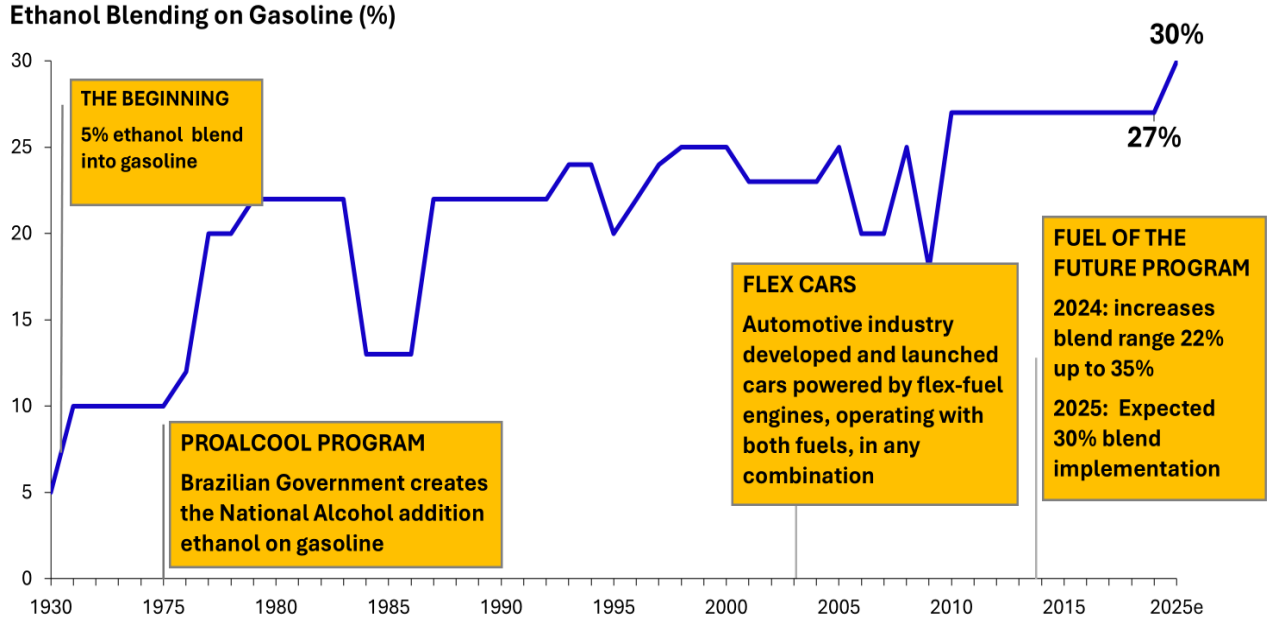
Charging speed	2024	Target for 2030
Middle High Ultra-high	3,202 units	30,796 units 19,538 units 12,584 units
Total	3,202 units	62,918 units

- Support measures for BEV
  - 5 to 6 trillion IDR are needed annually for purchase incentives (VAT and luxury tax reduction) and discount of electricity tariff for BEV night-charging.
- Decrease of local tax revenues (5～10% of gasoline price)

Brazil: Bioethanol policies

- 100-year history of blending
  - Both regulation (e-30) and actual use (45%) are the highest in the world.
- Industrial promotion and job creation
  - Started in 1931 as support for sugarcane industry, doubling the percentage of sugarcane employees in agriculture from 4% to 8% in the 2000s.
  - High domestic production ratio of automotives: 80% of new car-sales are FFV

copersucar

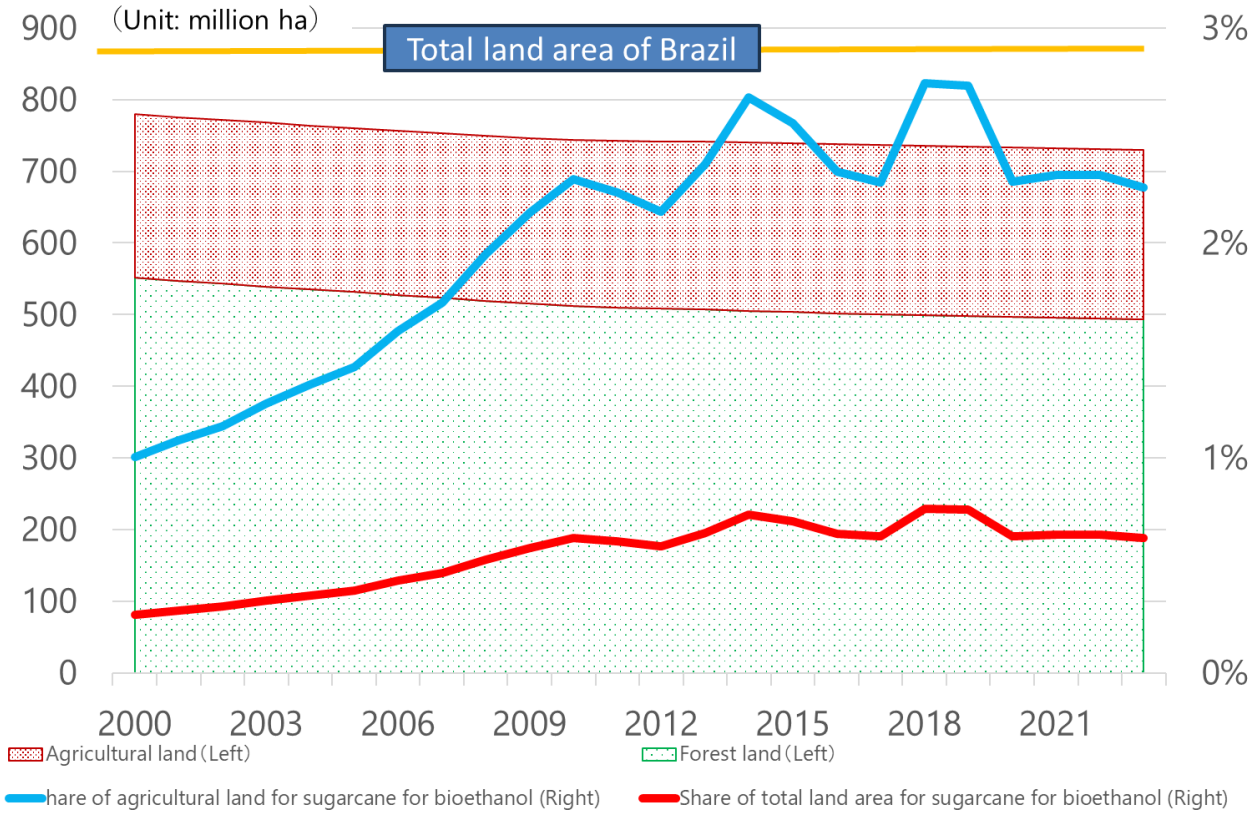


Source：Copersucar

- Energy security
  - Blending ratio was raised in WW2 and Oil Shock to conserve oil; energy self-sufficiency reached 116% in 2023, with biofuels contributing 33% of primary energy supply.
  - Crude oil exports quadrupled in this decade; in 2023, 70% of increase of domestic energy demand was covered by biofuels, leading to more crude oil exports and foreign currency earnings.

Brazil: Challenges for bioethanol

- Deforestation due to land-use change is the biggest concern in Brazil.
- Ratio of sugarcane fields for bioethanol to total national land remains stable historically.
- Efforts to reduce CFP of bioethanol:
  - Utilization of byproducts for truck fuels as biogas and fertilizer
  - two-term cultivation with corn
  - Utilization of bagasse, sugarcane residues, for power generation and second-generation bioethanol
  - Possible introduction of BECCS

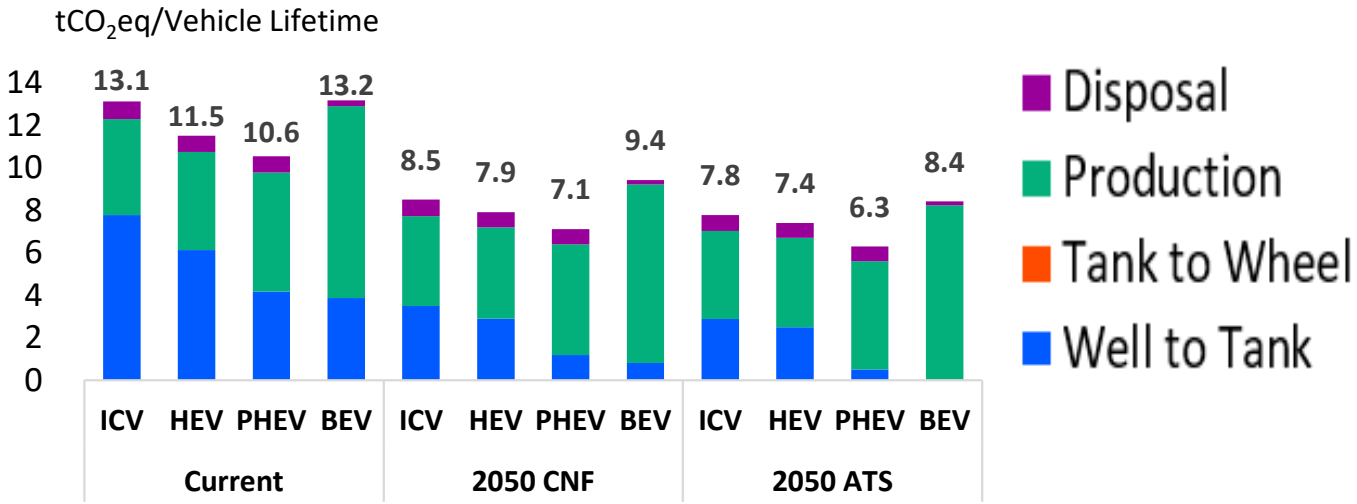


Source: IEEJ, based on World Bank Database

Higher accountability and further R&D are needed.

Brazil: Bioethanol's potential

- LCA of GHG emissions for different powertrains in Brazil
  - With e-100, BEV's CFP is the highest currently, and this remains the case in the future.
- Combination of bioethanol and HEV/PHEV well exemplifies various pathways.



- ISFM or Initiative for Sustainable Fuels and Mobility:
  - Launched in April 2024 by the two leaders of Japan and Brazil as an initiative of combining sustainable fuels such as biofuels and high-performance transport equipment such as HEV.
  - Both countries hosted the first Ministerial Meeting on Sustainable Fuels in Osaka in Sept. 2025. Expected that the bilateral cooperation would evolve to multi-lateral.

India: Biogas policies

- India is the only country in the world that mandated blending biogas into CNG (compressed natural gas) in the transport sector.
  - Wide-spread CNG vehicles due to air-pollution and cheaper fuel: as high as 28%, 19% and 7% of three-wheelers, taxis and passenger cars respectively.
  - Abundant domestic bioresources such as agricultural residues, livestock manure and wastes: as rich as Brazil for biogas potential.
  - Contribution to agriculture and livestock promotion, lower LNG import with conserved foreign currencies, and circular economy.

Sustainable Alternative toward Affordable Transportation (SATAT) scheme

	Bioethanol	Biodiesel	Biogas					SAF
Blending ratio	20%	5%	Optinal	1%	3%	4%	5%	2%
Target year / period	2025	2030	Until 2024	From 2025	From 2026	From 2027	From 2028	2028

- In India, only 5% of its huge biogas potential has been utilized; significant future production growth is expected (16 times increase by 2030 relative to 2024)

India: Challenges for biogas

- Challenges include:
  - Seasonal fluctuation of agricultural residues: concentrate in harvest
  - Undeveloped logistics infrastructure to collect feedstock from rural villages
  - Difficult investment decision and financing due to unpredictable prices
  - Insufficient human resources and certification scheme

- SATAT' target: 5,000 biogas production plants by 2024
  - Just 90 plants as of Sept. 2024
  - Lacking business incentives as opposed to Indonesia's Ni refining and Brazil's bioethanol

- Not only stick (blending mandate) but also carrot (support measures) are needed.
  - International cooperation for such grass-rooted various pathways
  - JCM for cooperation with Japan

Conclusions

- The Global South leaders, Indonesia, Brazil and India, are all making efforts to decarbonize the road transport sector;
  - Through taking advantage of strengths in regional resources and industries, and
  - From broader perspectives such as industrial policies and energy security beyond climate change.

- BEV's domestic production and deployment require 1) first and foremost, decarbonizing the power sector, 2) reducing environmental impacts including production stage, 3) peak-shift of electricity demand, and 4) infrastructure development.

- Biofuels could contribute to agricultural promotion. Drop-in biofuels could lower the cost for infrastructure development.

- Electrification is not a panacea. Various pathways should be pursued.