JPEC Forum 2026

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Only a multi-pathway approach can achieve net zero mobility

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AICE (The research association of **A**utomotive **I**nternal **C**ombustion **E**ngines)

Agenda

1. Introduction of AICE
2. Future Forecast of Automobile PT Penetration and CO_2 Emissions in Japan
3. Summary

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1. **Introduction of AICE**
2. **Future Forecast of Automobile PT Penetration and CO_2 Emissions in Japan**
3. **Summary**

Establishment of AICE

*The Research Association of **A**utomotive **I**nternal **C**ombustion **E**ngines*

C.I.P Collaborative Innovation Partnership

TOYOTA

DAIHATSU

NISSAN MOTOR CORPORATION

SUBARU

HONDA

SUZUKI

AICE

mazda

ISUZU

MITSUBISHI MOTORS

AIST

JARI

10th ANNIVERSARY

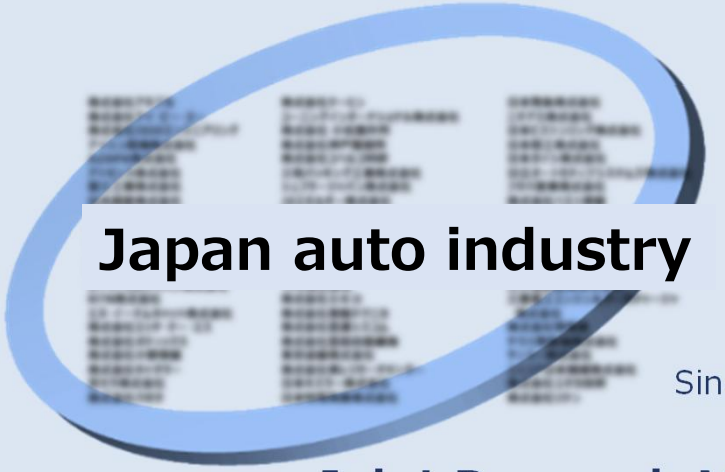
9 automobile companies and 2 institutes are association members of AICE

Today's AICE partners

- Association Member (9 OEMS＋2 Institutes), Joint Research Member around 60 companies
- Partnership with Zero Emission Mobility Power Source Research Consortium (University)

Established
Since 2014

Association Members



Since 2019

Joint Research Members

Many auto related companies has joined;
passenger car / trucks / construction machinery /
agricultural machinery / motorcycles / auto parts manufacturers /
engineering service provider

Universities
Research Institutes

ZEM

Since 2020

Zero Emission Mobility Power Source Research Consortium
The planning body of AICE's joint research
Currently, more than 100 researchers participating

AICE's future vision

- Collaborate with other industries/countries and play a central role in achieving carbon neutrality of vehicles equipped with ICE.
- Along with the close relationship with the government, fund earning maintains research collaboration with academia/science.

Government

Academia

subsidy

Scenario proposal

Research fund

Study results

TRAMI

RITE

CO_2 Recovery

Petroleum Industry
C-N fuel industry

Domestic Collaboration

TOYOTA, DAIHATSU, NISSAN MOTOR CORPORATION, SUBARU, HONDA, SUZUKI, AICE, mazda, ISUZU, MITSUBISHI MOTORS, AIST, JARI

Japan Industry (research collaboration)

International Collaboration

Stationary

Industrial Machine

HD Truck

Agricultural Machine

LCV

PV

Motorcycle

Achieving carbon neutrality of vehicles equipped with ICE

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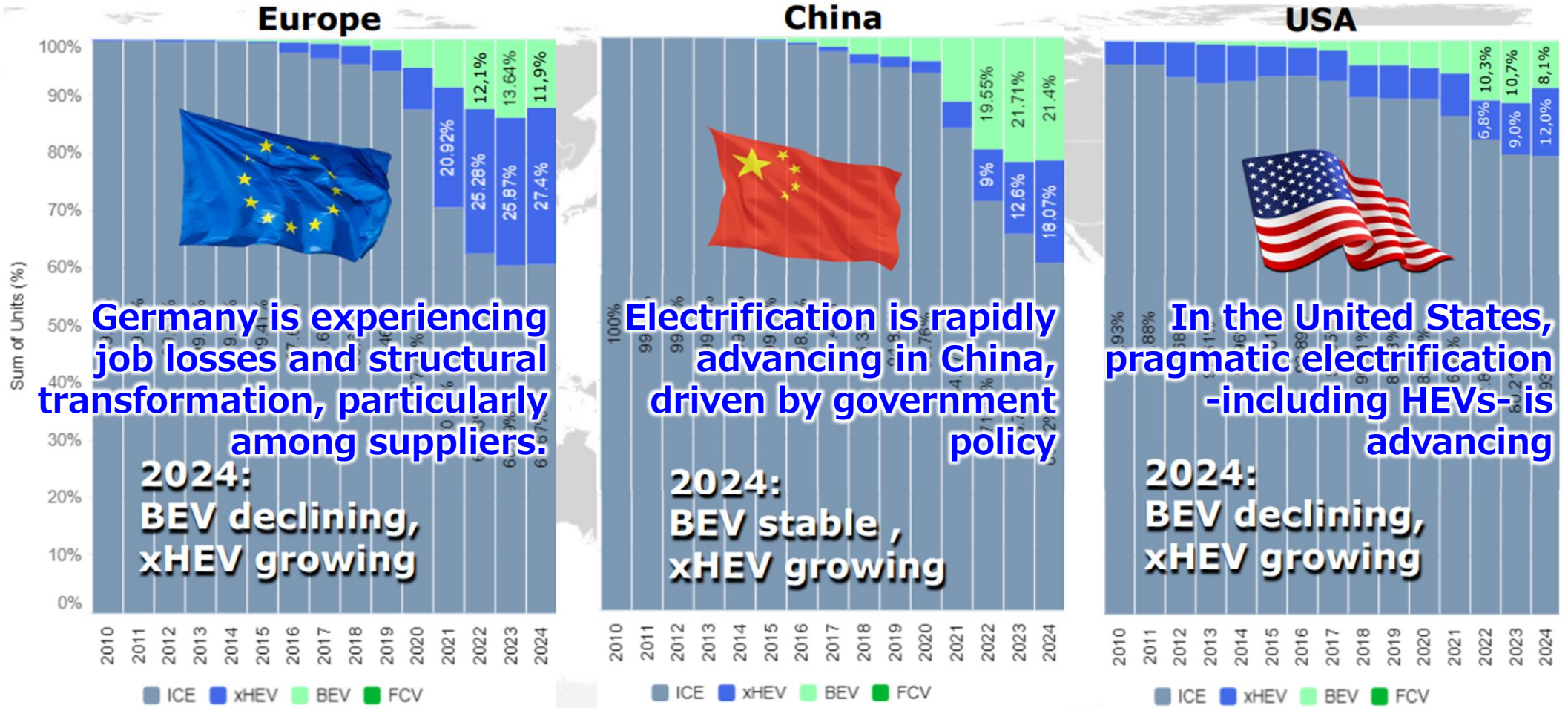
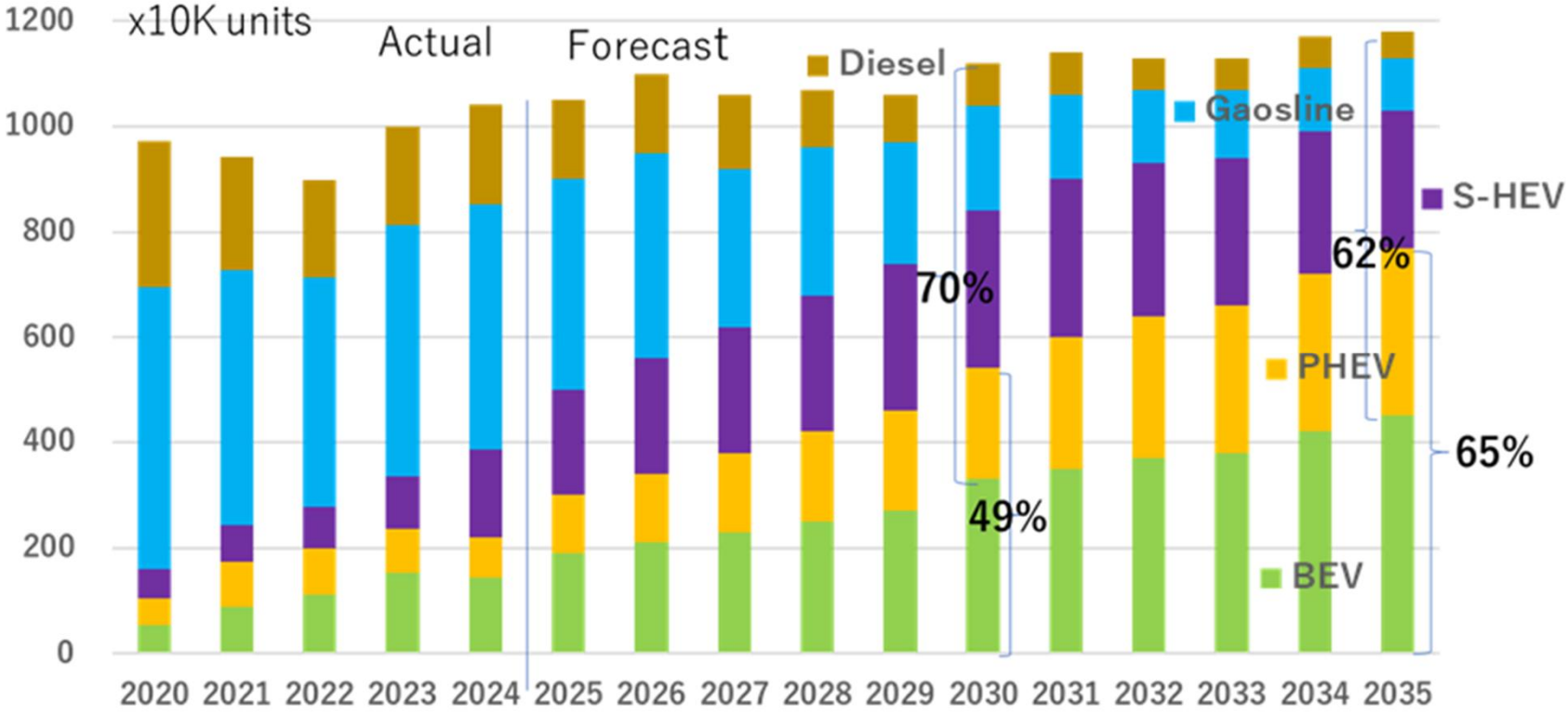
Breakdown of passenger car sales by region



Source : Guenter Fraidl, Potential Impacts of Consumer Trends on Future Powertrain Technology, WASEDA-AVL Sympojium 2024.9.4. https://jin.kusaka.w.waseda.jp/w_a_sympo/2024/02_Fraidl.pdf

Future PT forecasts for PCs in EU market (new car sales)

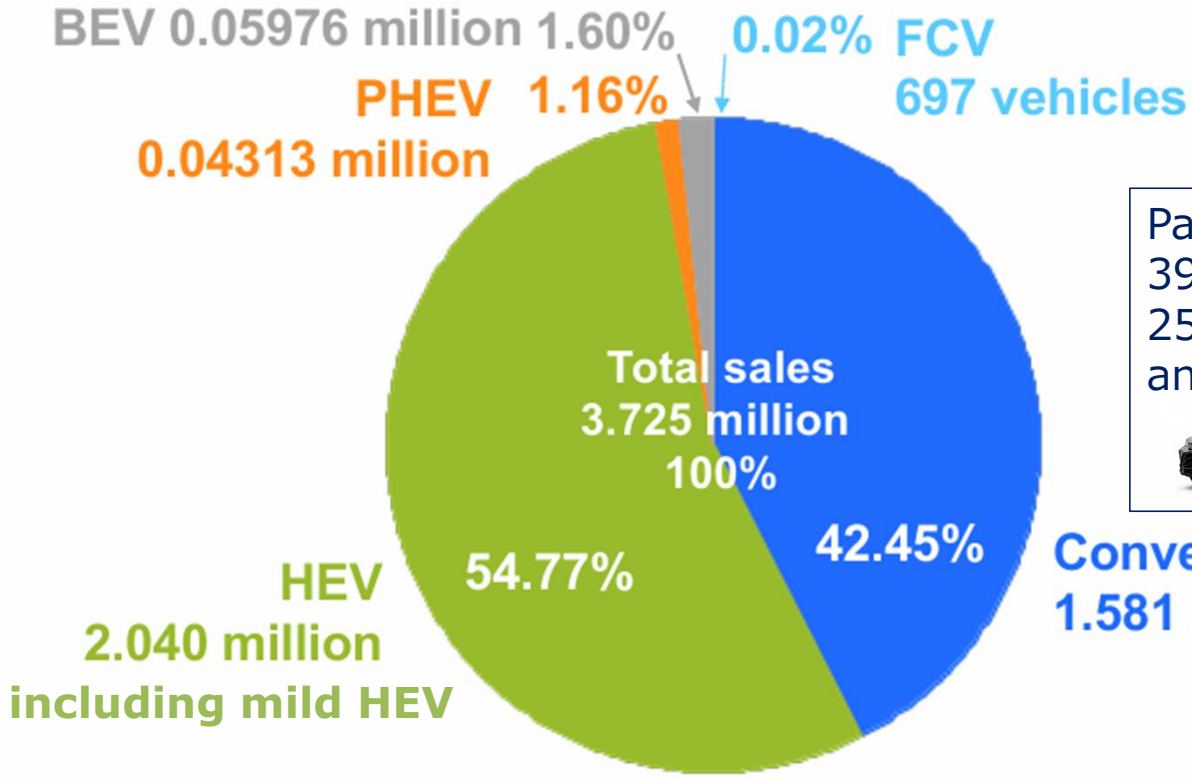


Taking into account the existing European CO_2 regulations and the available electricity supply

Source : Kazuo Takeuchi, "Future Powertrain Predictions from the Collapse of European BEVs“, FOURIN Global Automotive Technology Survey Monthly, No.131, 2025.2

Even in 2035, BEVs and PHEVs will be limited to around 65% of the market due to power and infrastructure bottlenecks.

Breakdown of passenger car sales in Japan in 2024

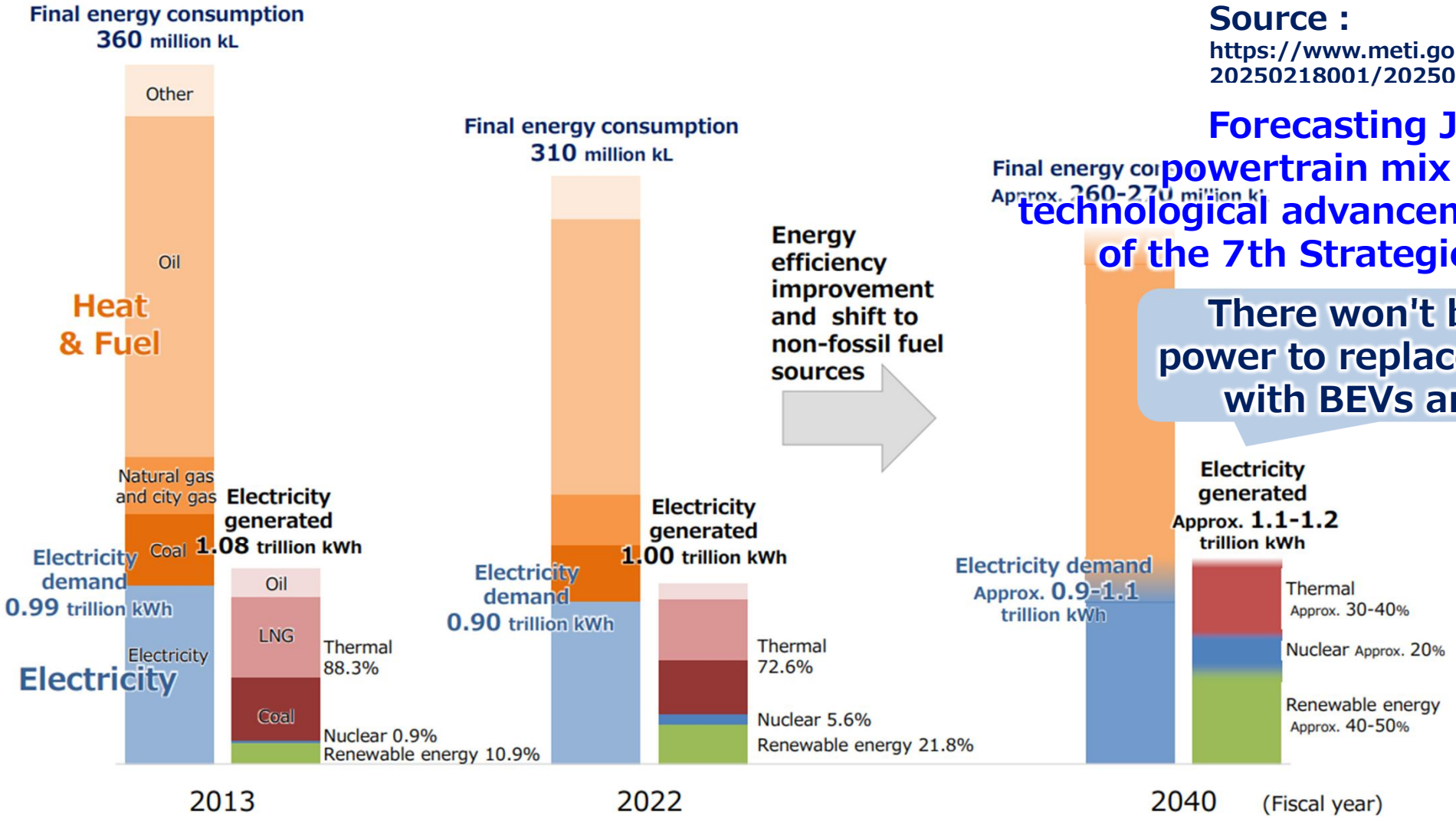


Passenger cars consist of 39% standard-sized PCs, 25% compact PCs, and 36% Kei-cars.

Source : Jin Kusaka, The Challenges with Three-way Catalysts in Strong Hybrid Systems for Passenger Cars, KIT, MODEGATⅧ, 9.22, 2025

In Japan, the adoption of BEVs is constrained by insufficient charging infrastructure, high costs, a market centered on Kei-cars, and the presence of strong alternative technologies such as HEVs.

Japan's Seventh Strategic Energy Plan



Source :
https://www.meti.go.jp/press/2024/02/20250218001/20250218001.html

Forecasting Japan's future powertrain mix based on the technological advancement scenario of the 7th Strategic Energy Plan

There won't be enough power to replace all vehicles with BEVs and PHEVs

Predicted penetration of BEVs and PHEVs in Japan

※Using JARI's CAMPATH tool

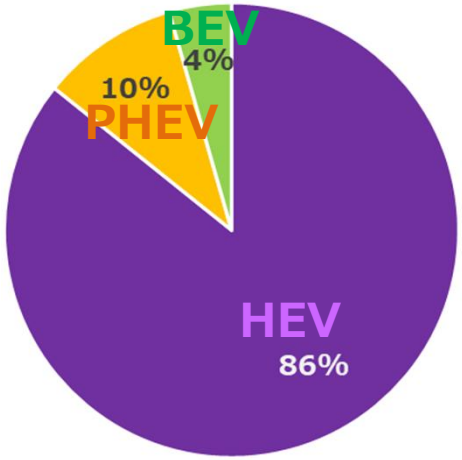
Automobiles (PCs and CVs) in Japan	2035	2040	2045	2050
# of BEVs owned (10,000 units)	184	261	629	1,196
# of PHEVs owned (10,000 units)	290	358	963	1,686
Power consumption in road sector (TWh)	13	**17**	34	**54**
# of ICEVs owned (10,000 units)	6,341	5,980	5,282	4,407
Bioethanol demand (billion liters)	8.2	8.7	6.2	3.8
Biodiesel demand (billion liters)	1.4	1.5	1.6	1.7
e-fuel demand for achieving CN (billion liters)	47.0	37.3	27.0	17.6
Total power generation (TWh)		1,080		1,200
Electricity available for road sector (TWh)		**16**		**53**

Japan's Strategic Energy Plan (Technological advancement scenario)

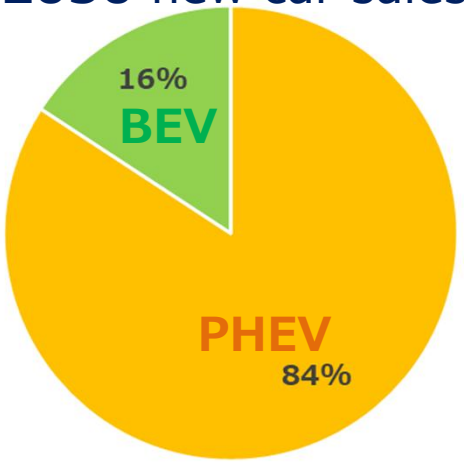
Because of the limited amount of available electricity in the road sector, there will still be many ICE-equipped vehicles in 2050. This makes e-fuels/biofuels essential to achieving carbon neutrality.

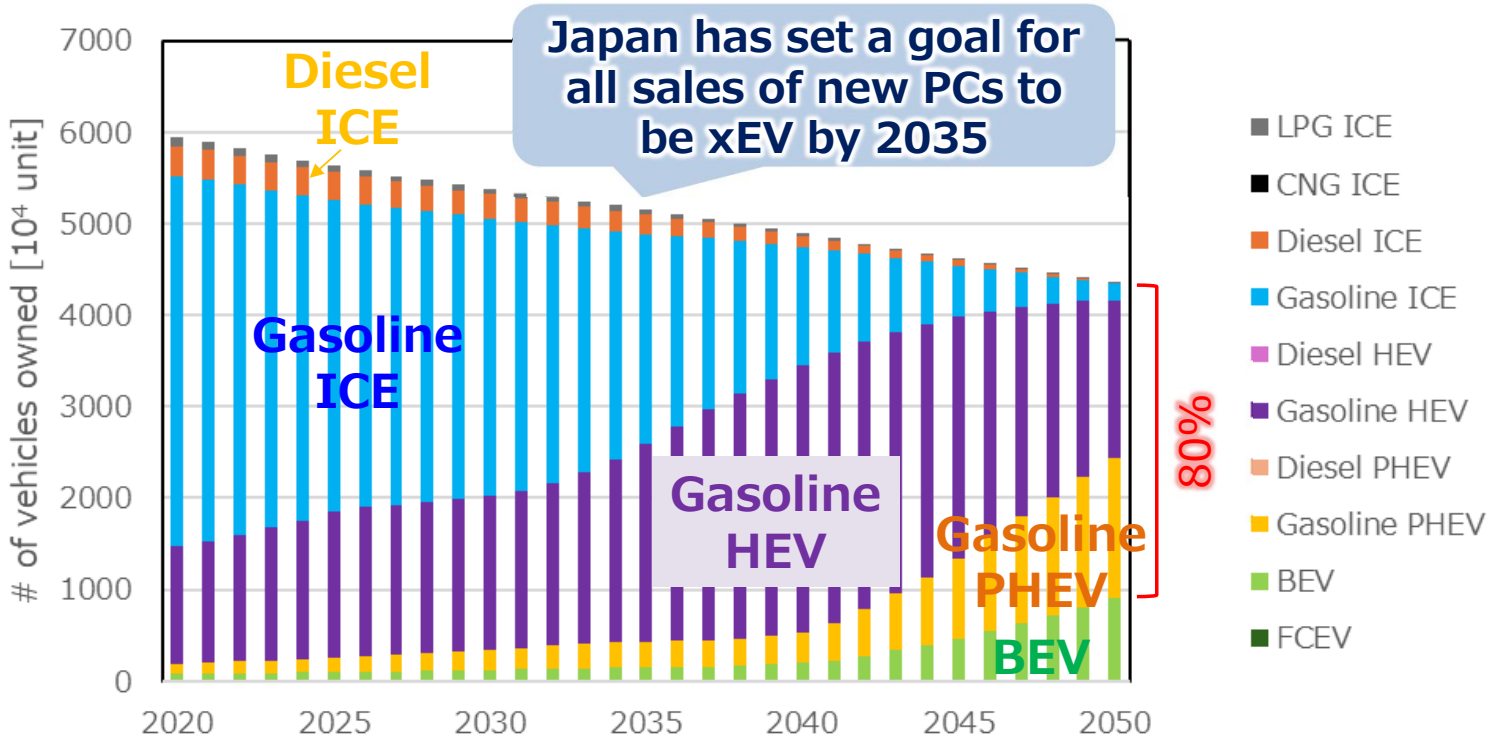
Future PT forecasts for PCs in Japanese market

Standard-sized PC
2035 new car sales



2050 new car sales



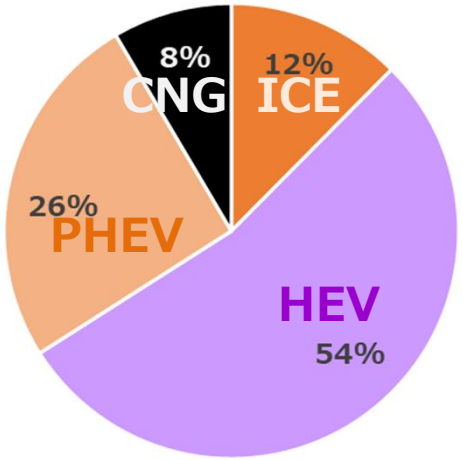


Until 2040, power shortages will limit the expansion of BEV & PHEV. **ICE-equipped vehicles (ICE/HEV/PHEV) will still account for around 80% of vehicle ownership by 2050.**

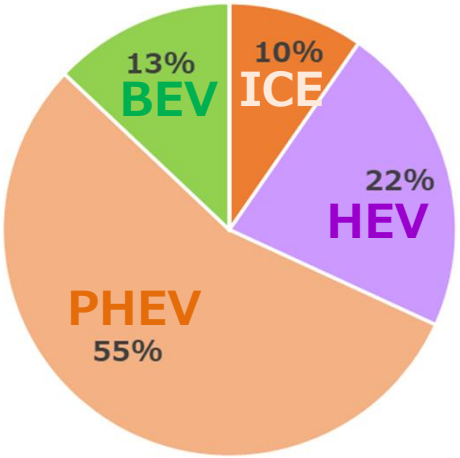
Future PT forecasts for HDVs in Japanese market

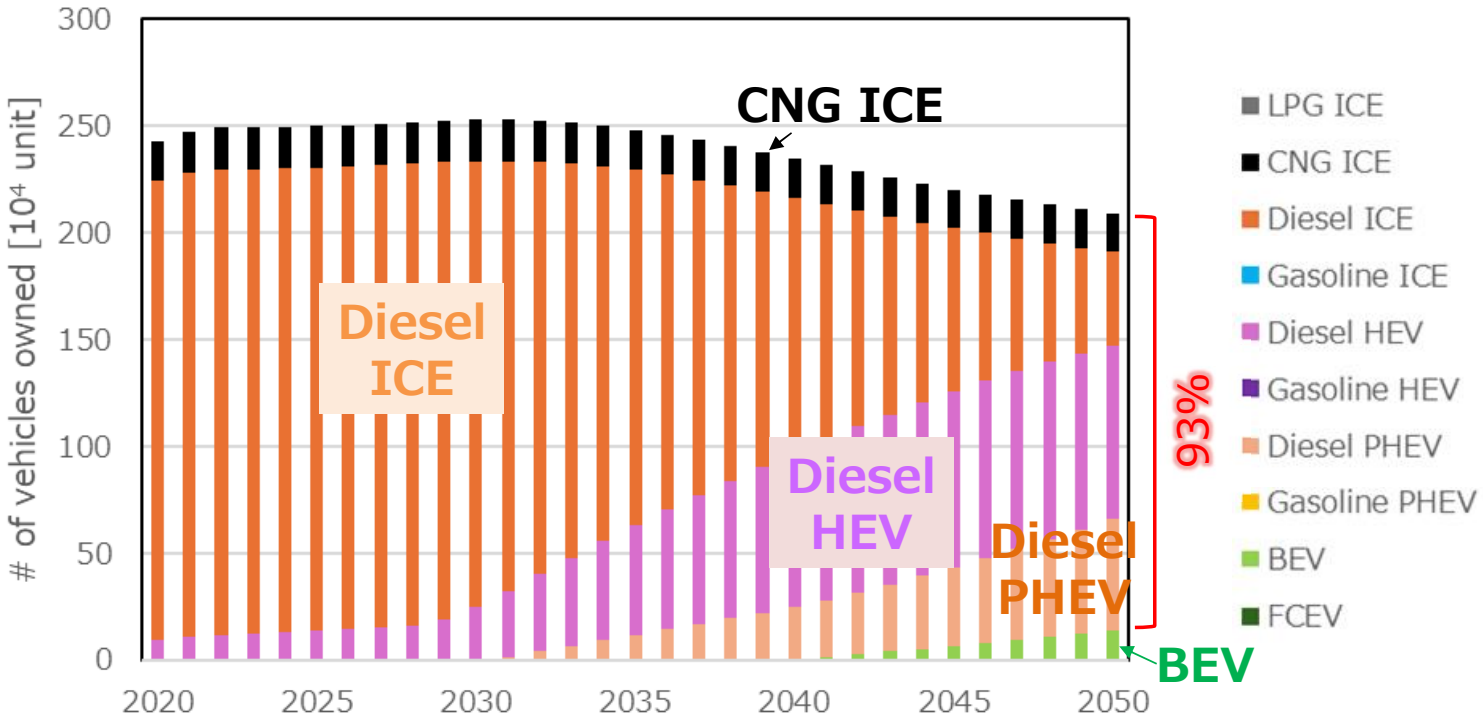
HDV

2035 new car sales



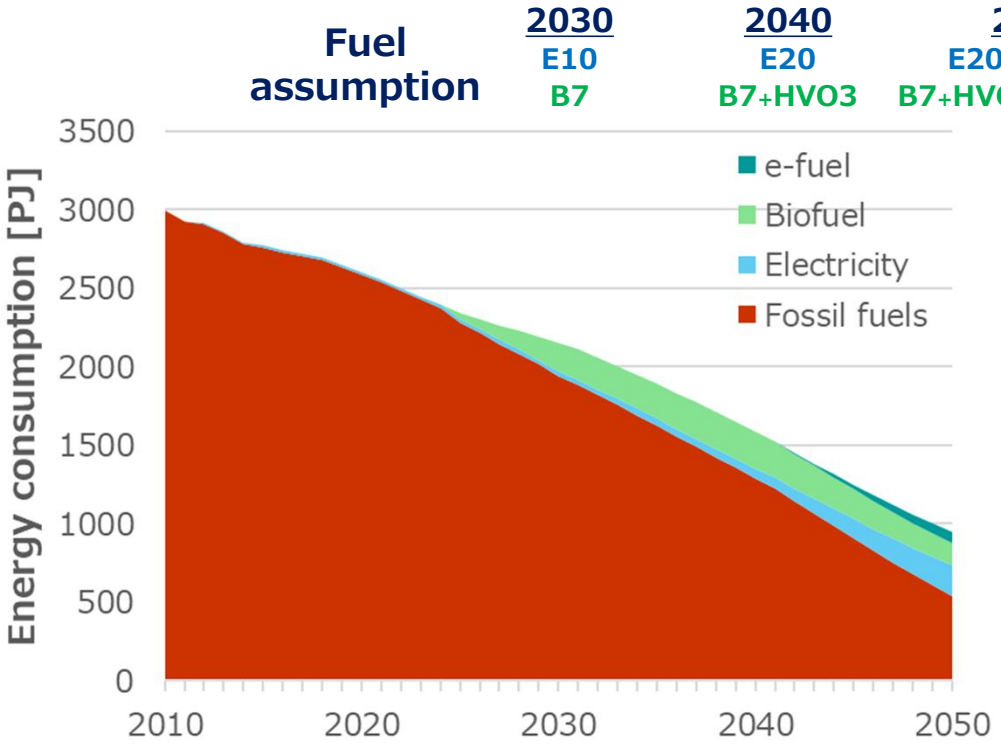
2050 new car sales

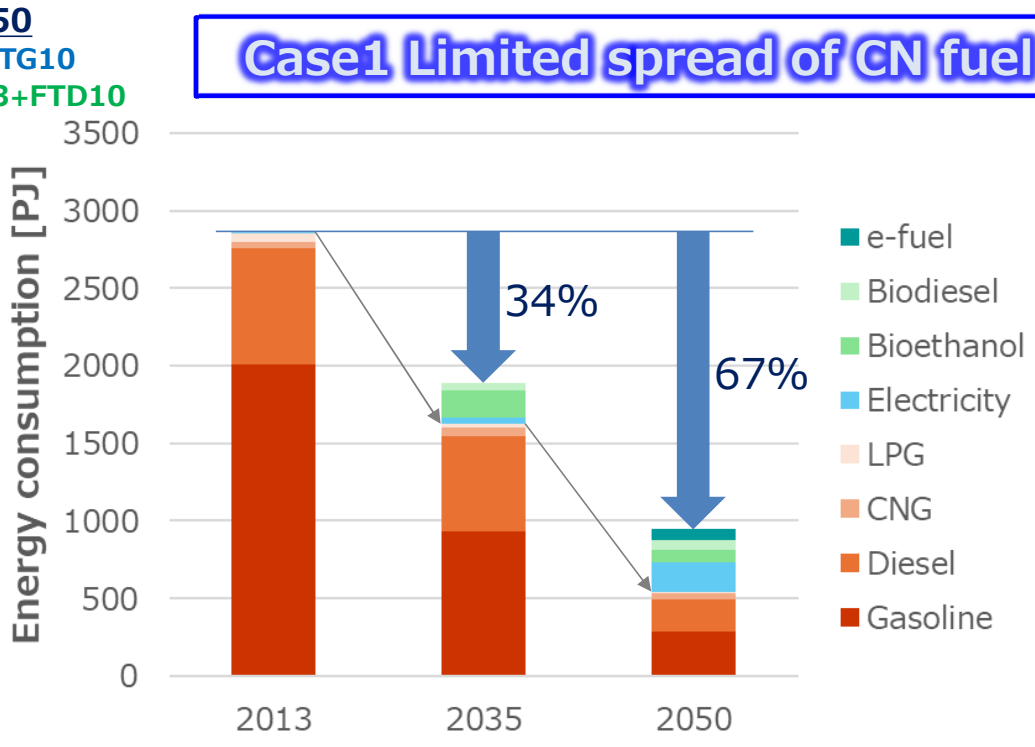




The electrification of HDVs is progressing more slowly than that of PCs. **Even in 2050, approximately 93% will be ICE-equipped vehicles .**

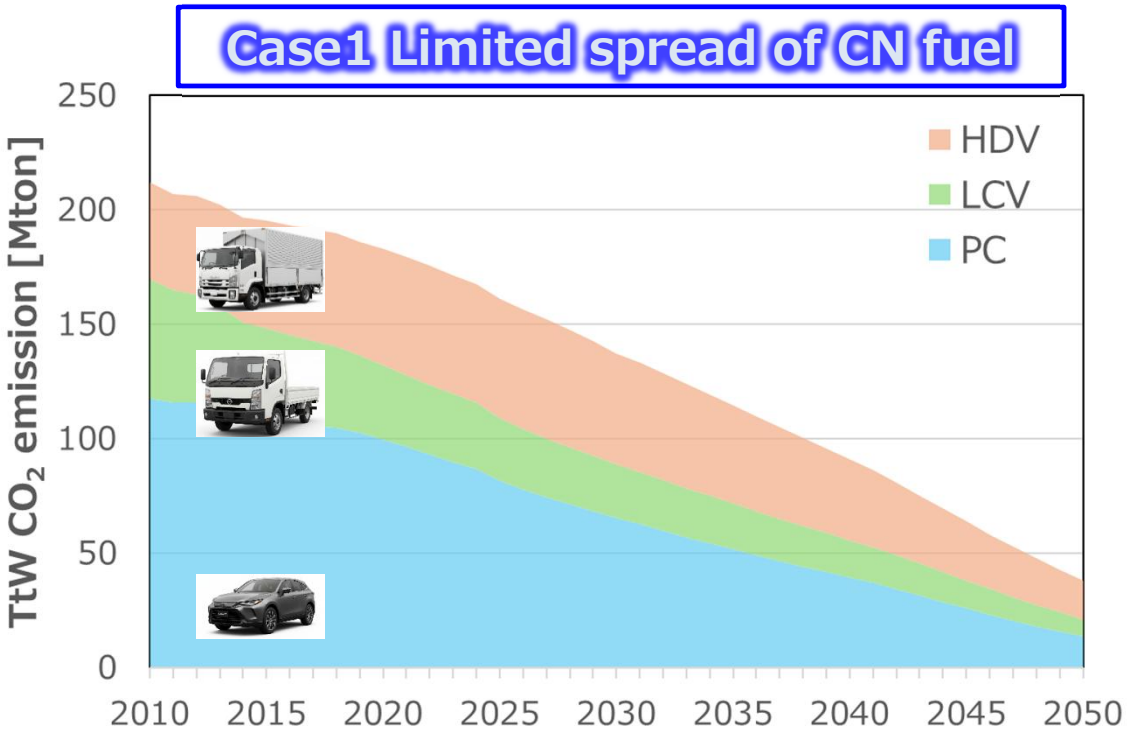
Energy consumption from on-road vehicles in Japan

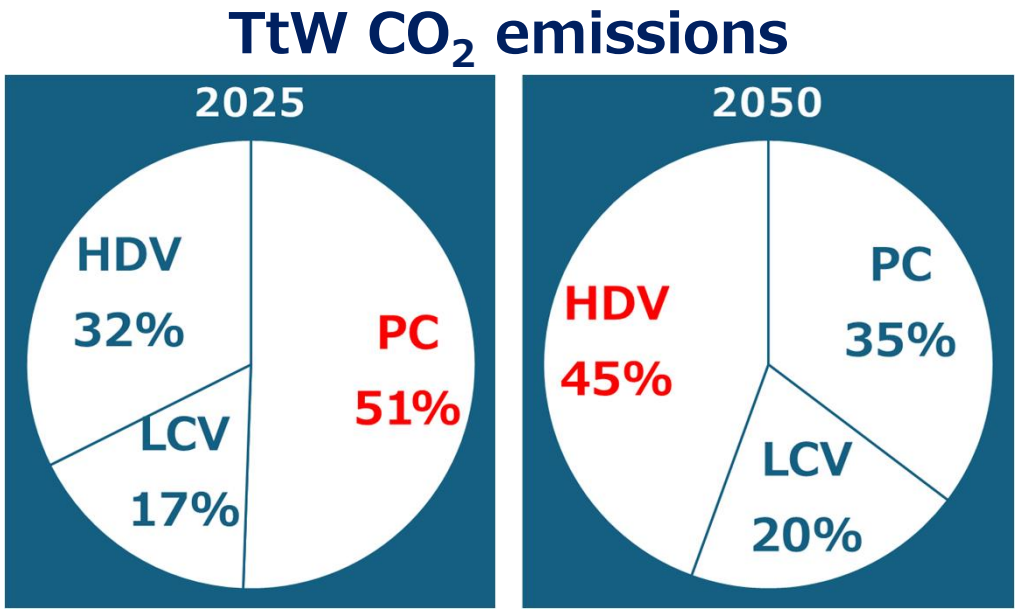




Due to electrification (xEV), improved engine thermal efficiency, improved vehicle efficiency, and fewer vehicles, total energy consumption is expected to decrease. **Even in 2050, however, 500 PJ of energy will still come from fossil fuels.**

TtW CO_2 emissions from ICE-equipped vehicles in Japan

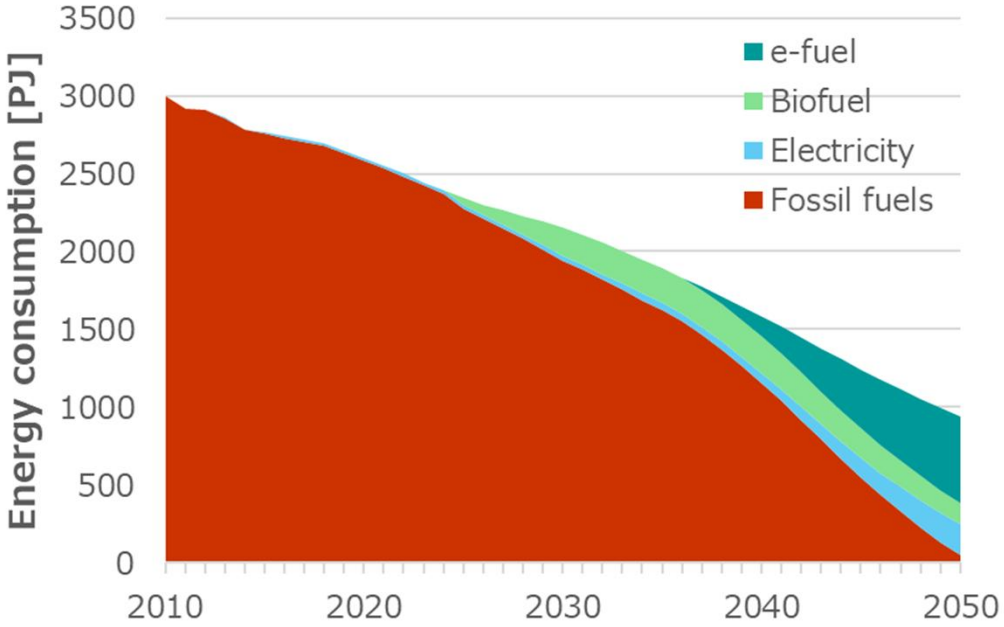




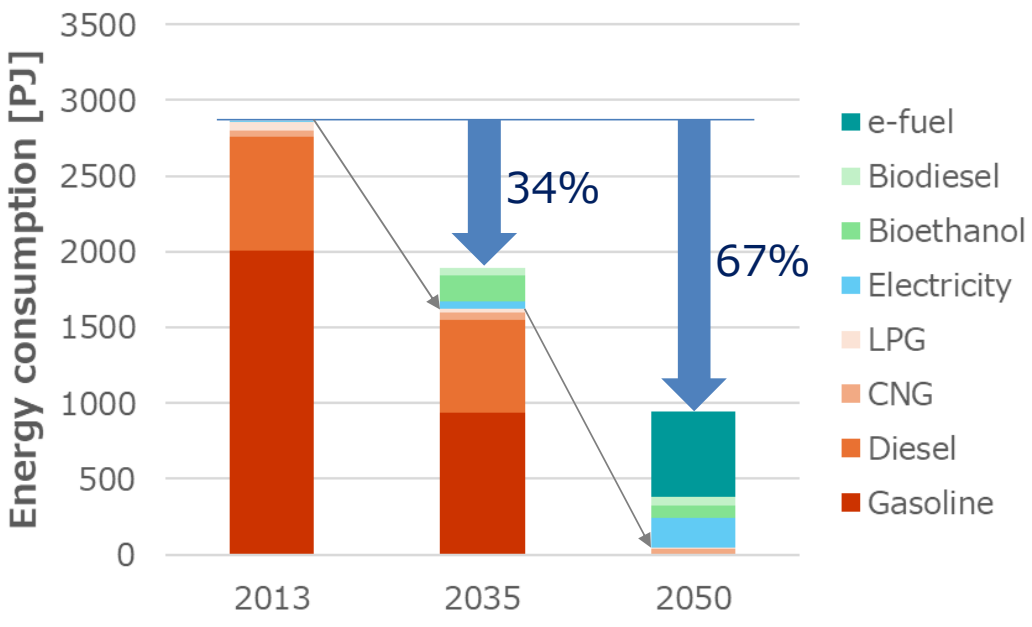
In Case 1, TtW CO_2 emissions in 2050 will be about 80% lower than in 2013. HDVs will account for the largest proportion of these emissions.

Energy consumption from on-road vehicles in Japan

Fuel assumption	2030	2040	2050
	E10 B7	E20+MTG9 B7+HVO3+FTD9	E20+MTG80 B7+HVO13+FTD80

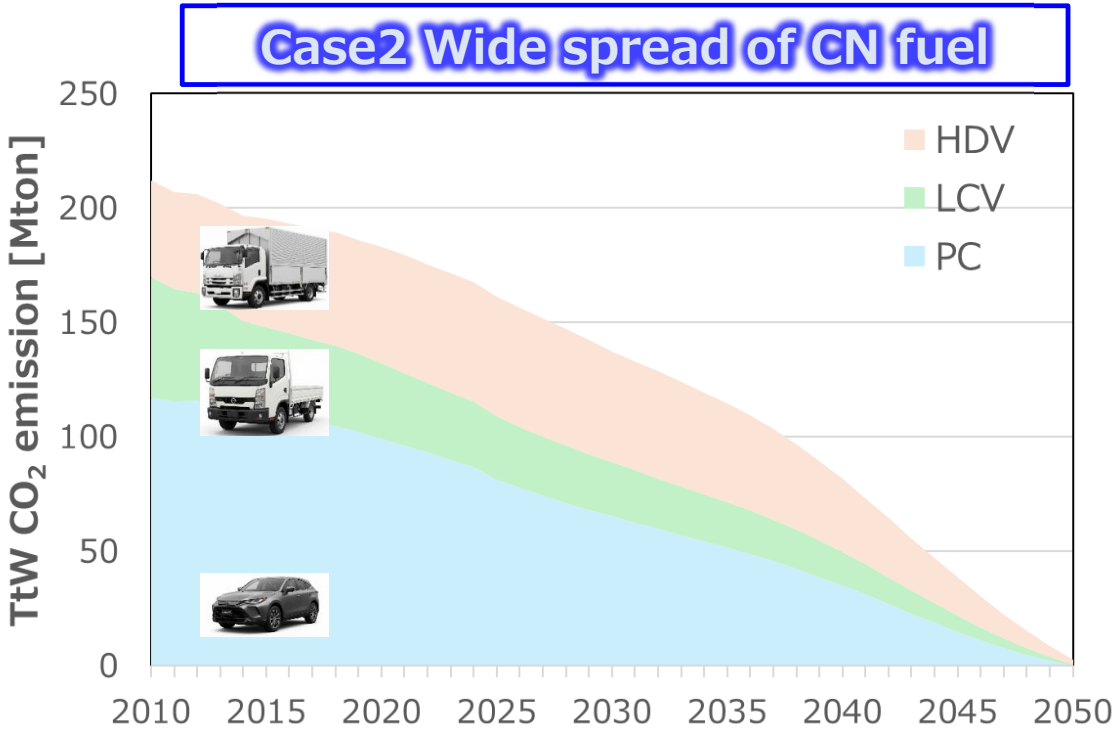


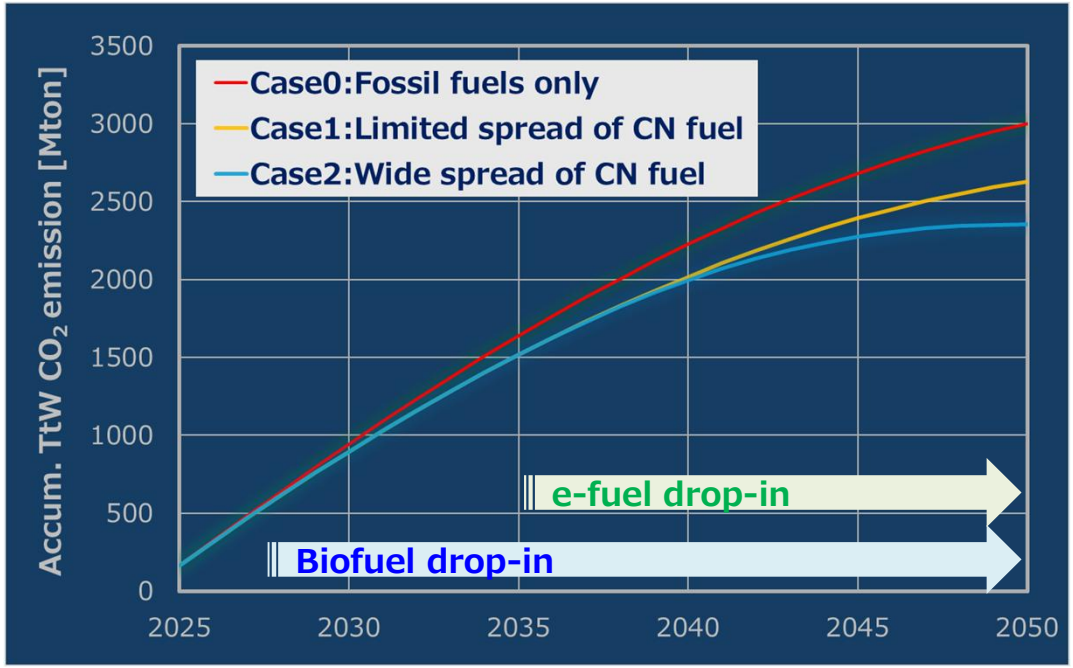
Case2 Wide spread of CN fuel



Advancements in electrification (xEVs), improvements in engine thermal efficiency and vehicle efficiency, as well as a reduction in the total number of vehicles, **will reduce energy consumption by 67% by 2050 compared to 2013 levels.**

TtW CO_2 emissions from ICE-equipped vehicles in Japan





In the fuel mix of Case 2, TtW CO_2 emissions in 2050 will be approximately 99% lower than in 2013, requiring 17.6 billion liters of automotive e-fuel annually. The difference in cumulative CO_2 emissions between Case0 and Case2 from 2025 to 2050 is 648 million tons.

E-fuel plant scale required for achieving CN

Key stats

Wind turbine capacity	3.4 MW
Electrolyzer capacity	1.2 MW
eMethanol production	350 t/a
eGasoline production	130,000 l/a
eLG production	7 t/a

⇨ 2.2BPD

Automobiles (PCs and CVs) in Japan	2050
# of BEVs owned (10,000 units)	1,196
# of PHEVs owned (10,000 units)	1,686
Power consumption in road sector (TWh)	**54**
# of ICEVs owned (10,000 units)	4,407
Bioethanol demand (billion liters)	3.8
Biodiesel demand (billion liters)	1.7
e-fuel demand for achieving CN (billion liters)	17.6
Total power generation (TWh)	1,200
Electricity available for road sector (TWh)	**53**

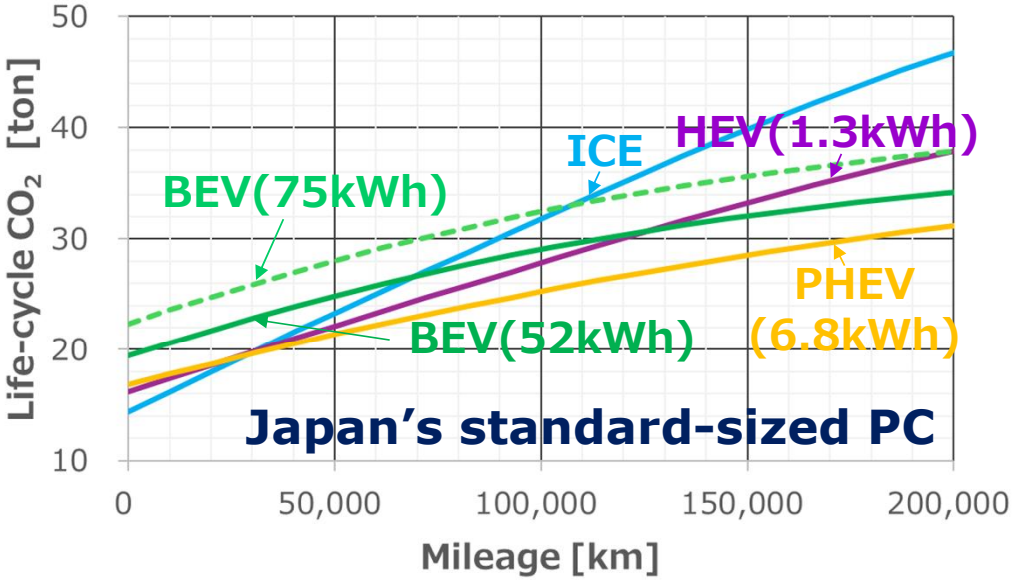
⇨ Approx.303,000BPD

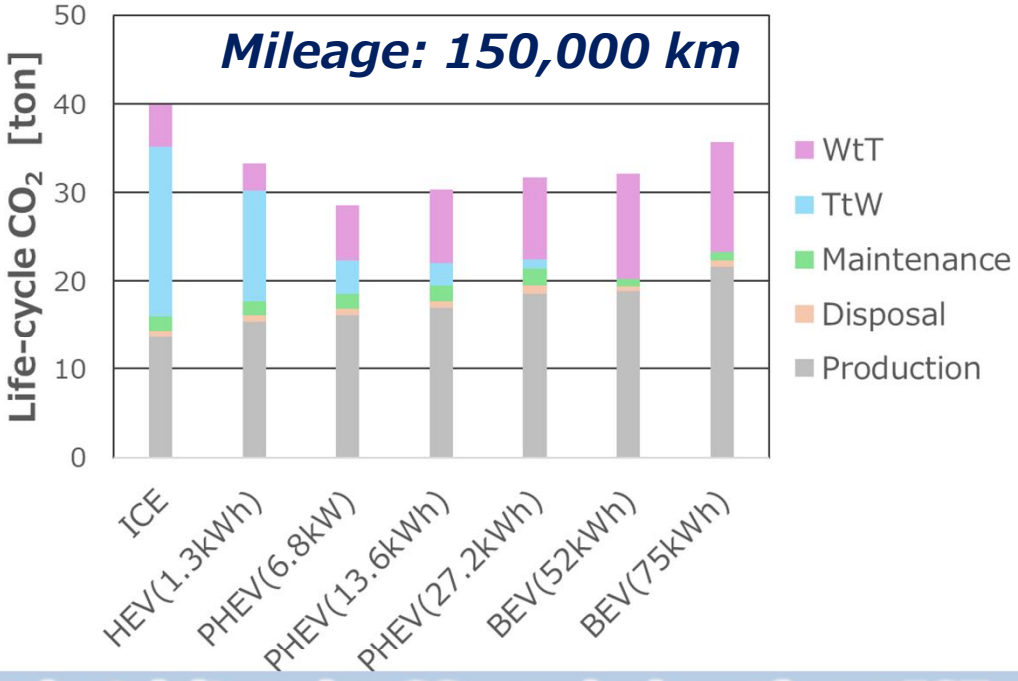
Achieving CN mobility in 2050 requires a plant for producing automotive e-fuel that is 135,000 times larger than the Haru Oni plant.

Further improvements in fuel efficiency of ICE vehicles (ex, PHEVs with small batteries) are crucial.

Life Cycle CO_2 Emissions Comparison by Powertrain

Calculation assumptions:
- **Electricity mix as defined in Japan's Seventh Strategic Energy Plan**
- **Annual driving distance of approximately 10,000 km starting in 2025**
- **Fuel mix: Case 2 (2030: E10; 2040: E20 + MTG9)**

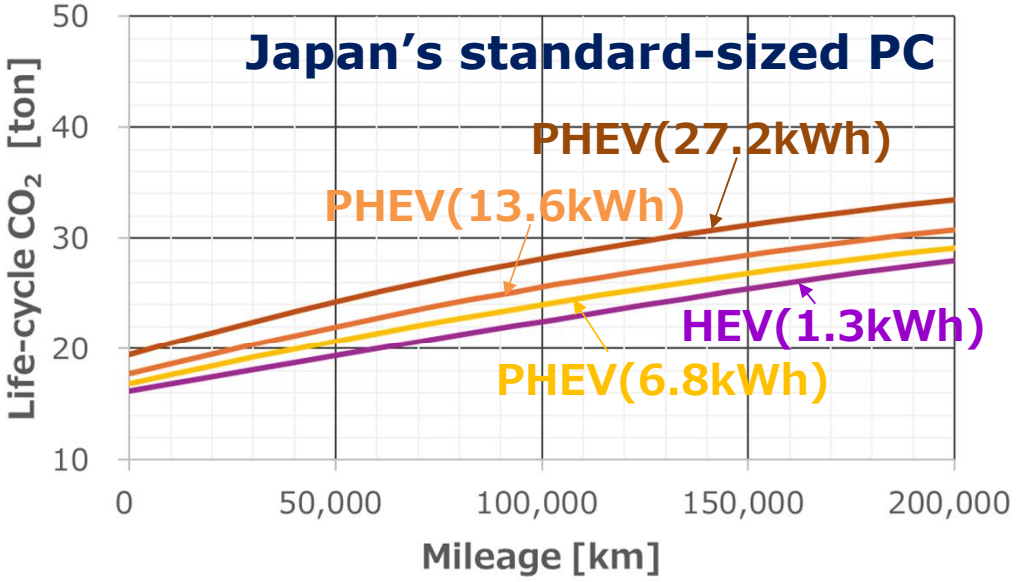


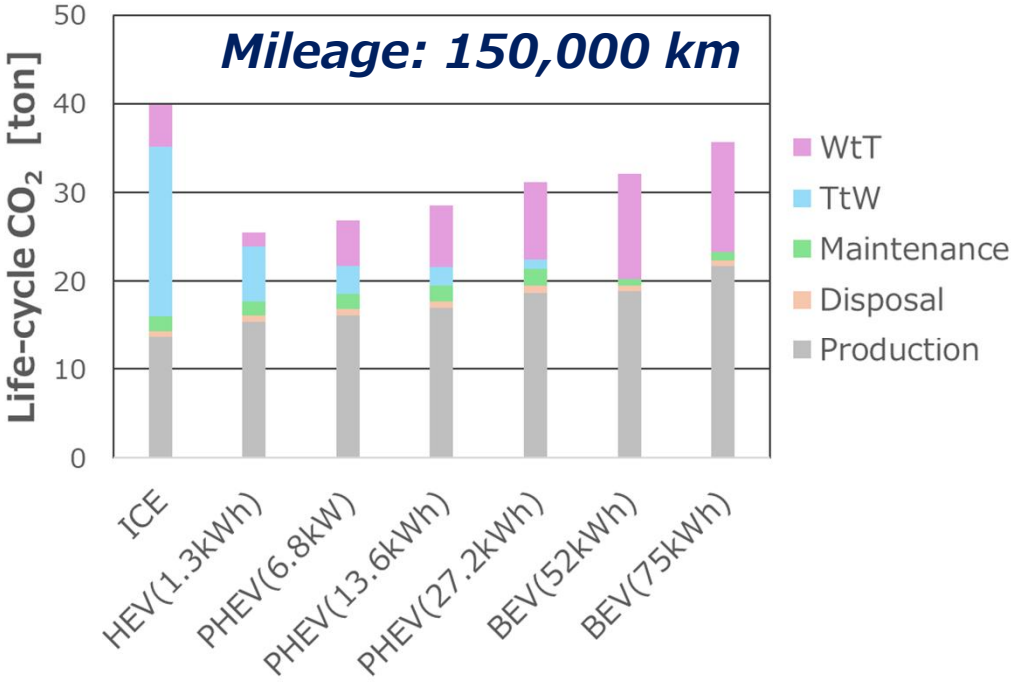


From an LCA perspective, under Japan's electricity mix, CO_2 emissions from ICE-equipped vehicles, such as HEVs and PHEVs, are comparable to or even lower than those from BEVs, making small-battery PHEVs the optimal solution.

If GI technology (50% CO_2 Reduction in HEVs) is commercialized

Calculation assumptions:
- **Electricity mix as defined in Japan's Seventh Strategic Energy Plan**
- **Annual driving distance of approximately 10,000 km starting in 2025**
- **Fuel mix: Case 2 (2030: E10; 2040: E20 + MTG9)**





Furthermore, if GI technology is widely implemented in society, HEVs and small-battery PHEVs equipped with GI technology will become the optimal solution.

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3. **Summary**

Summary

- Based on the technological advancement scenarios in Japan's Seventh Strategic Energy Plan, an analysis of the future Japanese automotive market indicates that constraints on available electricity in the road transport sector will limit the penetration of BEVs. Consequently, many vehicles are expected to remain equipped with internal combustion engines even in 2050.
- From a life cycle assessment (LCA) perspective, under Japan's electricity mix, xHEVs (HEVs and PHEVs) achieve life cycle CO_2 emissions comparable to or lower than those of BEVs even after 150,000 km of driving. Therefore, xHEVs represent an effective option for CO_2 reduction during the transition period until renewable energy is more fully deployed.
- To accelerate CO_2 emission reductions in Japan's road transport sector, it is essential to promote electrification through high-efficiency HEVs and small-battery PHEVs, while simultaneously deploying biofuels and e-fuels at an early stage to reduce emissions across the entire vehicle fleet, including existing vehicles.

Thank you for your attention

https://www.aice.or.jp/