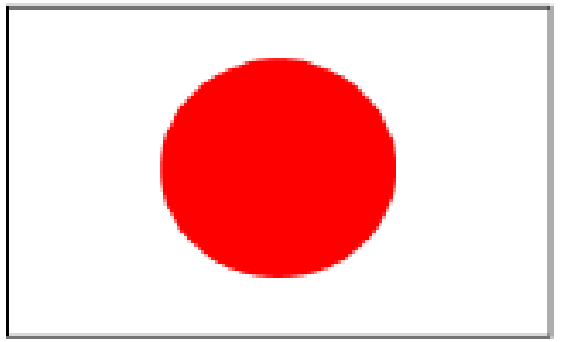
Latest Technology for Carbon Neutrality (Transportation Sector)



October 2022

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Technical Expert
The Energy Conservation Center, Japan

ACE METI ECCJ

Contents

Challenges and Solutions for Reducing Greenhouse Gas Emissions in the Transportation Sector

◆ The six main technologies needed to solve the problem are listed below.

Challenges		Solutions
Consignors, etc.	Choice of transportation method Improved transportation efficiency ・Improved load factor ・Larger transportation equipment ・Cooperation between incoming consignors and carriers ・Packing design with transportation efficiency in mind ・Development of logistics bases	Smart Logistics BET・FCT ITS→ Autonomous Driving Railroad・Ship・Aircraft BEV・FCV Cold Chain Logistics
Cargo Transport Carrier	Use of fuel-efficient transportation equipment ・railroad ・automobile ・ship ・aircraft	
Passenger Transport Carrier	Operation and management of transportation equipment Larger transportation equipment	

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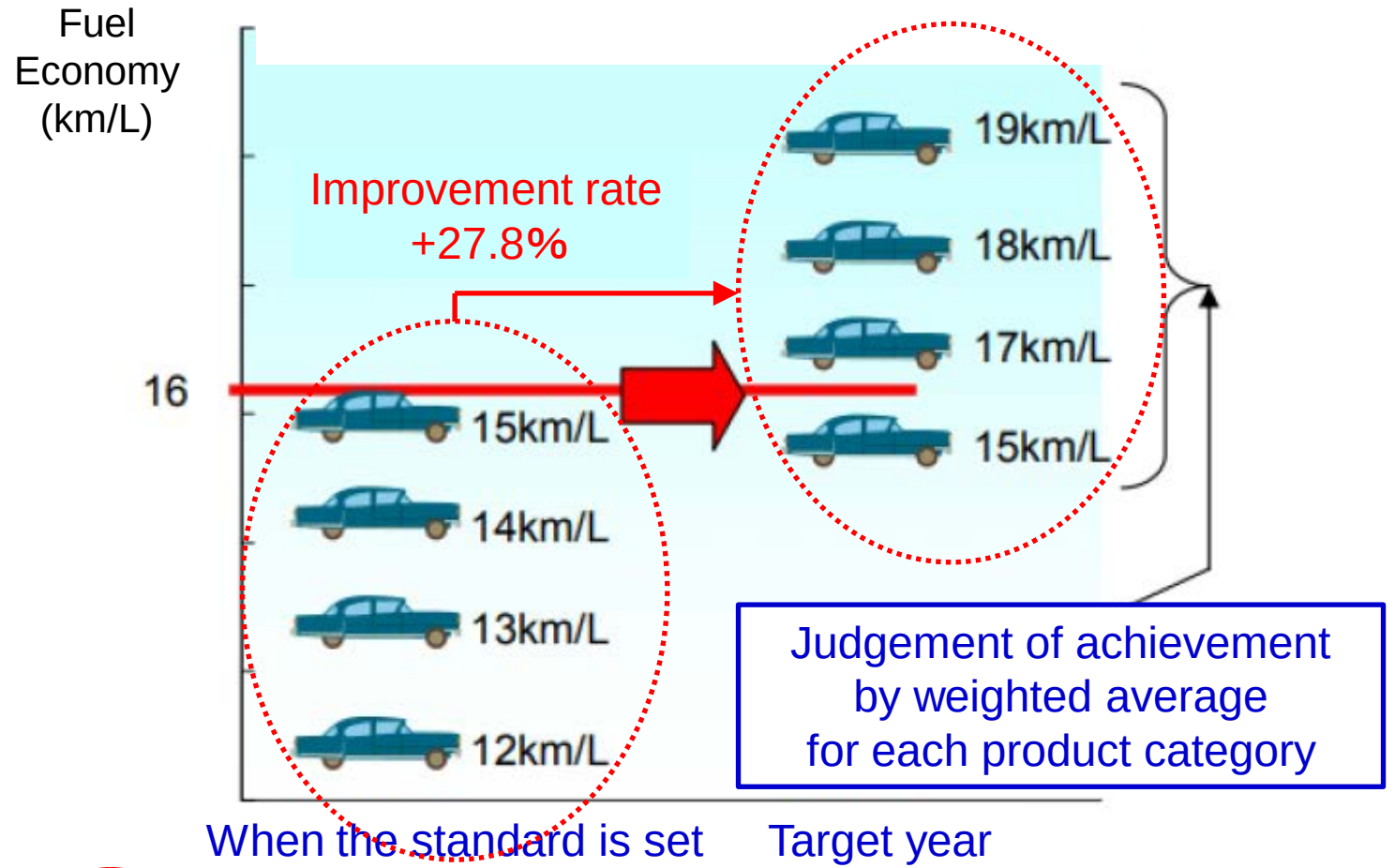
Source：MLIT Website

1. New technologies in the Transportation Sector
1-1. Next Generation Vehicles

What is the Top Runner Program ?

- The car with the best fuel economy at the moment (when the standard is set) will be the fuel economy standard for the target year.



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Source : METI Website

Results of applying the Top Runner Program to passenger cars

- Improvements are progressing steadily by applying the Top Runner Program three times.

Period	Improvement rate (Fuel economy)	Achievement time
①FY2004→FY2015	+23.5% (14.2km/L→17.5km/L)	Achieved 4 years ahead of schedule
②FY2009→FY2020	+24.1% (16.3km/L→20.3km/L)	Achieved 7 years ahead of schedule
③FY2016→FY2030	+32.4% (19.2km/L→25.2km/L)	In progress

(Note1) ① and ②are measured values in JC08 mode, and ③ are measured values in WLTC mode.
(Note2) ③ includes BEVs and PHEVs.

Source：Japan Automobile Manufacturers Association Website

Sales and Dissemination of Next Generation Vehicles

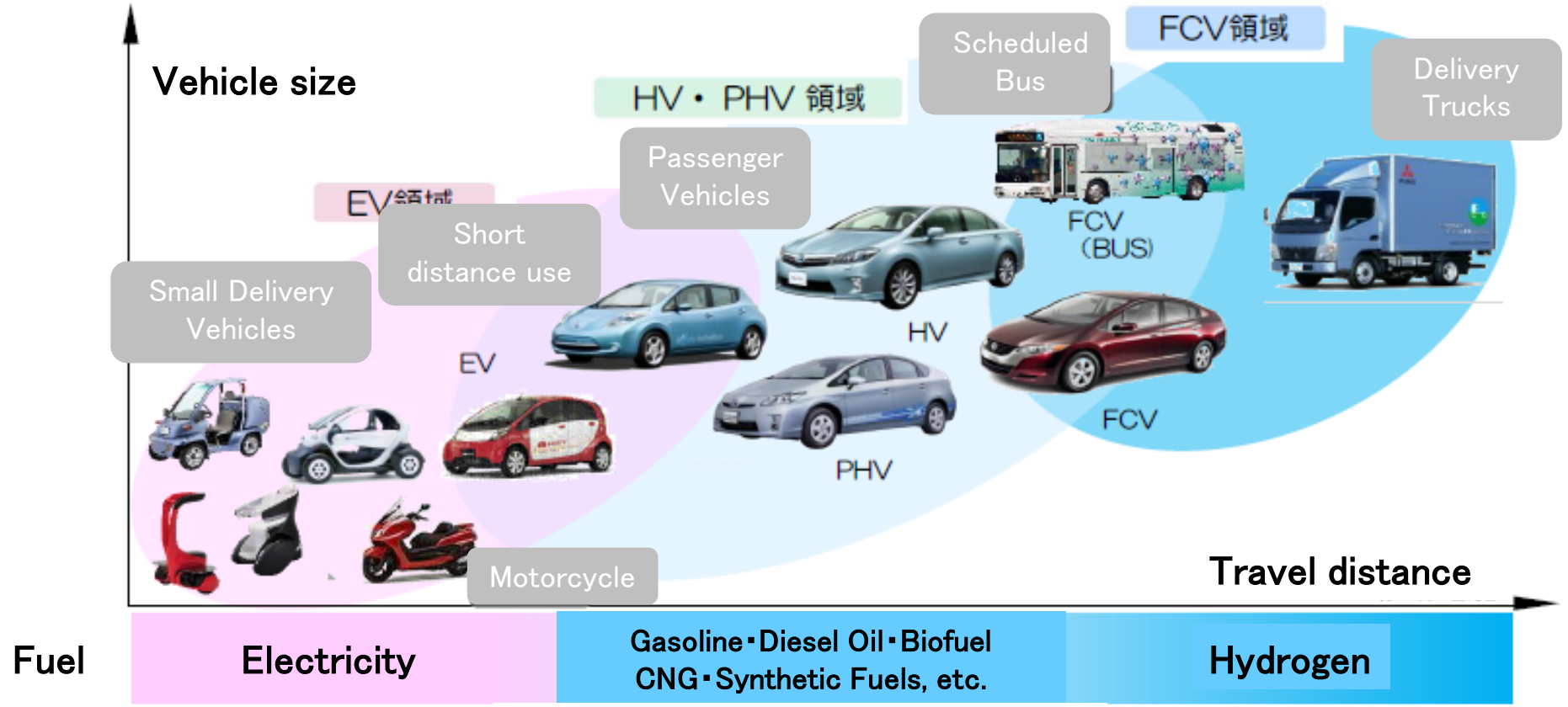
◆ HEVs have already achieved their goals at this point.
(FY2035：Next Generation Vehicle 100%)

	2021年 (Actual Results)	2030年 (Goals)
Conventional Vehicles	59.6%	30～50%
Next Generation Vehicles	40.4%	50～70%
HEVs	35.5%	30～40%
BEVs and PHEVs	0.8%	20～30%
FCEVs	0.04%	～3%
Clean Diesel Vehicles	4.0%	5～10%

Source：Japan Automobiles Manufacturers Association, Inc. Website

Role of Next Generation Vehicles

- Based on travel distance and vehicle size, electric and hybrid vehicles will become the mainstream among passenger cars, and fuel cell vehicles will become the mainstream among commercial vehicles. (Future technological innovations will expand the scope of protection.)



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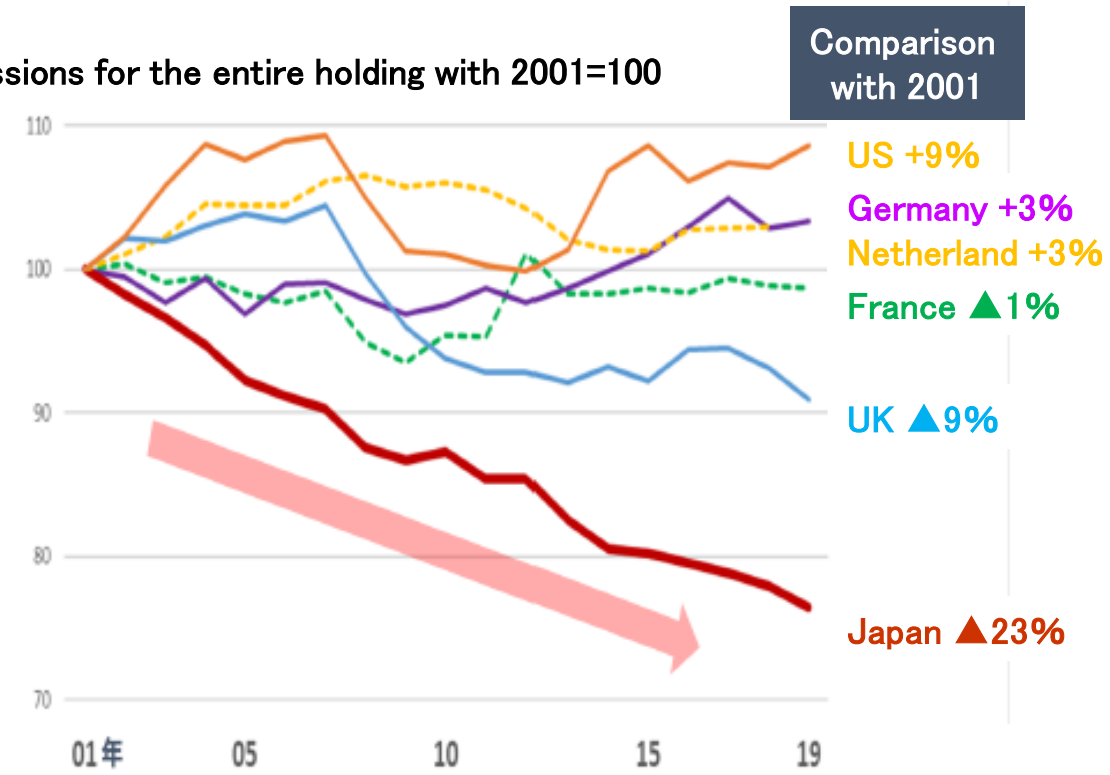
Source：Japan Automobiles Manufacturers Association, Inc. Website

CO2 emission reductions in countries around the world

◆ Japan has steadily reduced CO2 emissions by promoting the spread of HEVs.

Reduction of CO2 emissions from automobiles
(Past 20 years)

CO2 emissions for the entire holding with 2001=100



XEV Ratio (PV)
(CY2020)

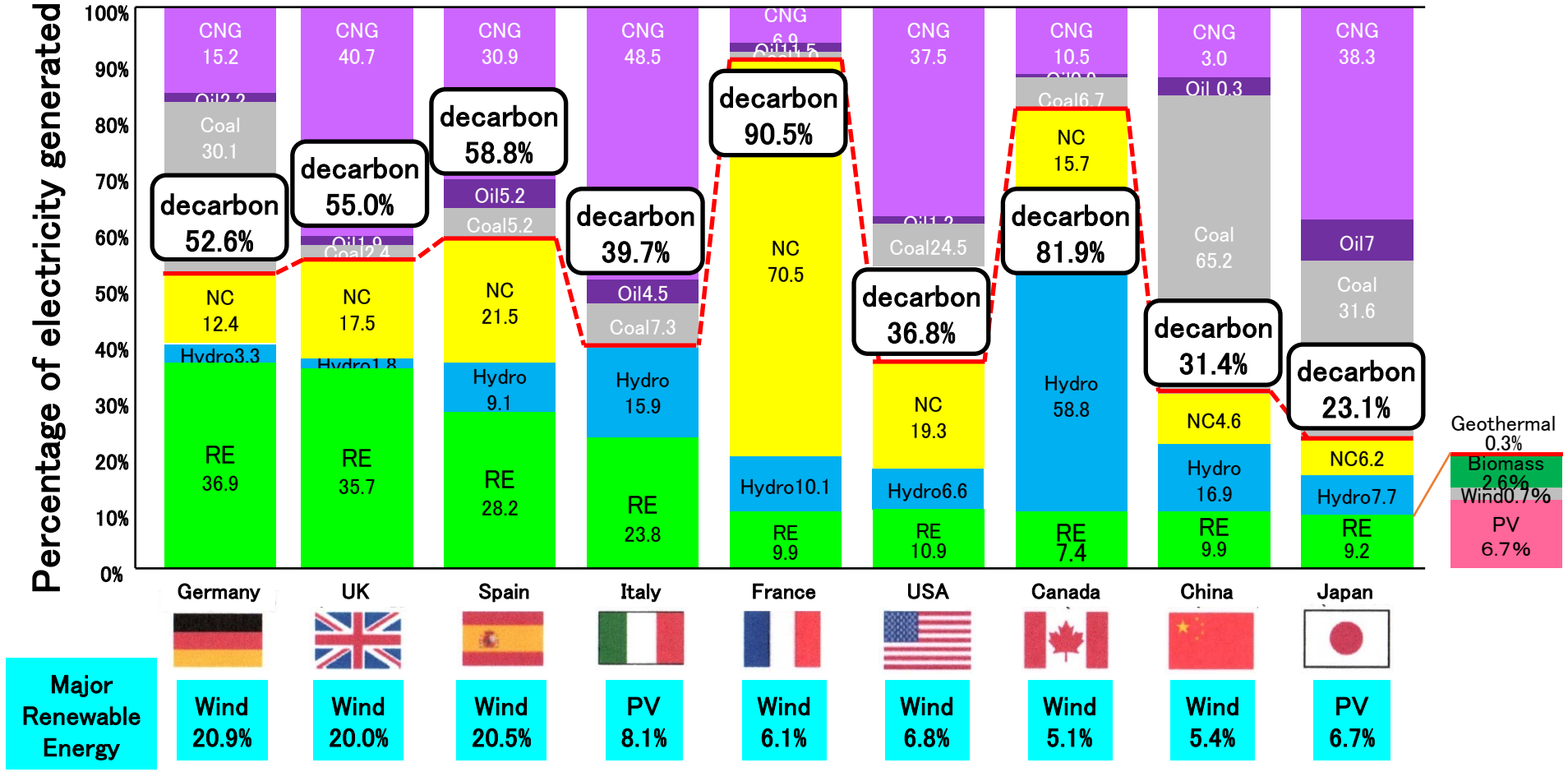
Country	XEV Ratio	No. of XEV
Norway	83%	120k
Iceland	58%	5k
Japan	36%	1,350k
Germany	25%	720k
France	22%	360k
China	7%	1,490k
US	5%	750k

※No. of XEV=Total of HEV,PHEV,BEV,FCEV

Source：Japan Automobiles Manufacturers Association, Inc. Website

International comparison of decarbonized power source ratios

- In Europe, power supply decarbonization is more advanced than in Asia. In this state, the concentional vehicles must be converted to BEVs to make progress in overall decarbonization.



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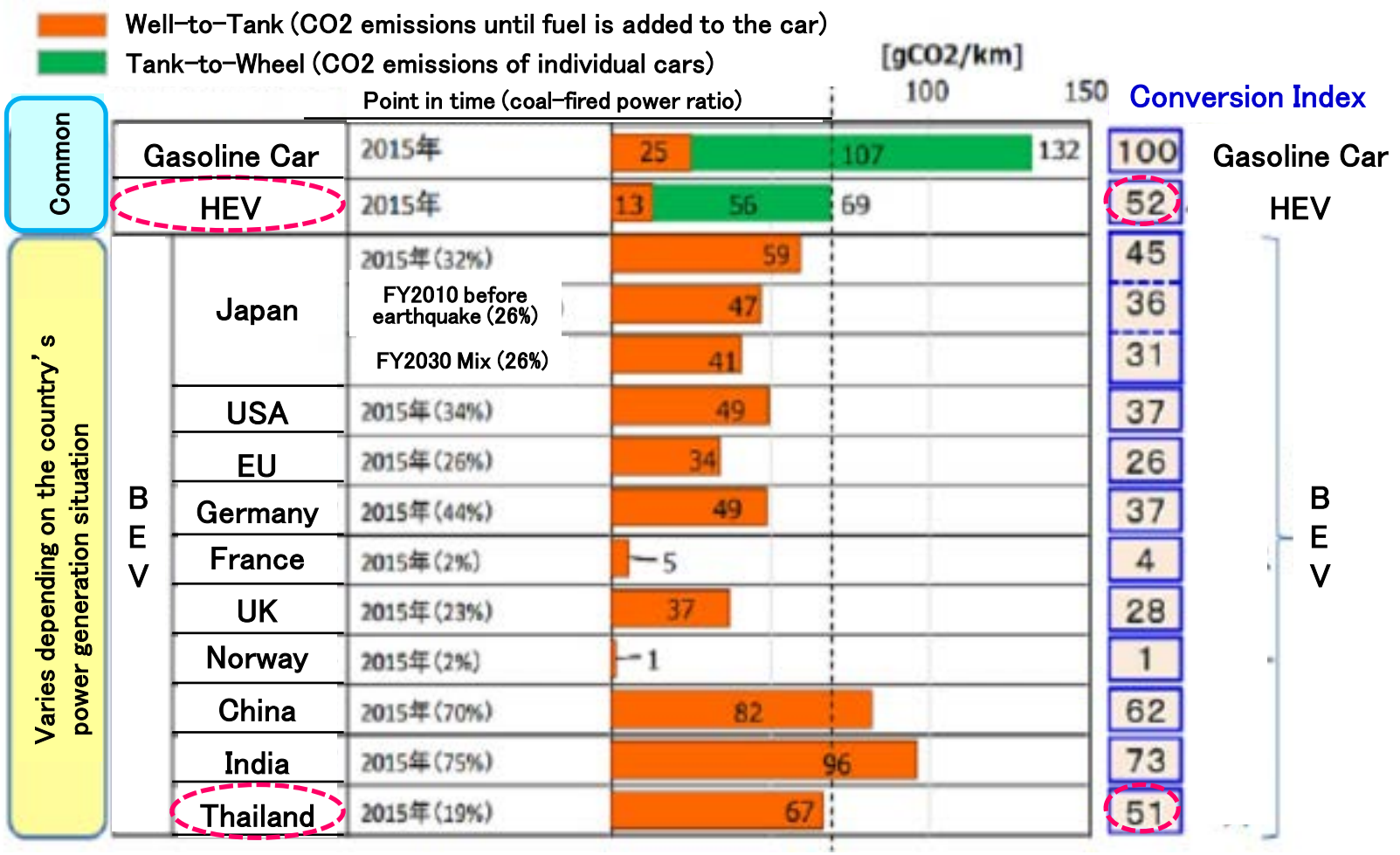
Source : METI Website

Relative Comparison of CO2 Emission Reduction Effects

- The effect of introducing EVs in Thailand is almost equivalent to that of introducing HEVs in Japan.



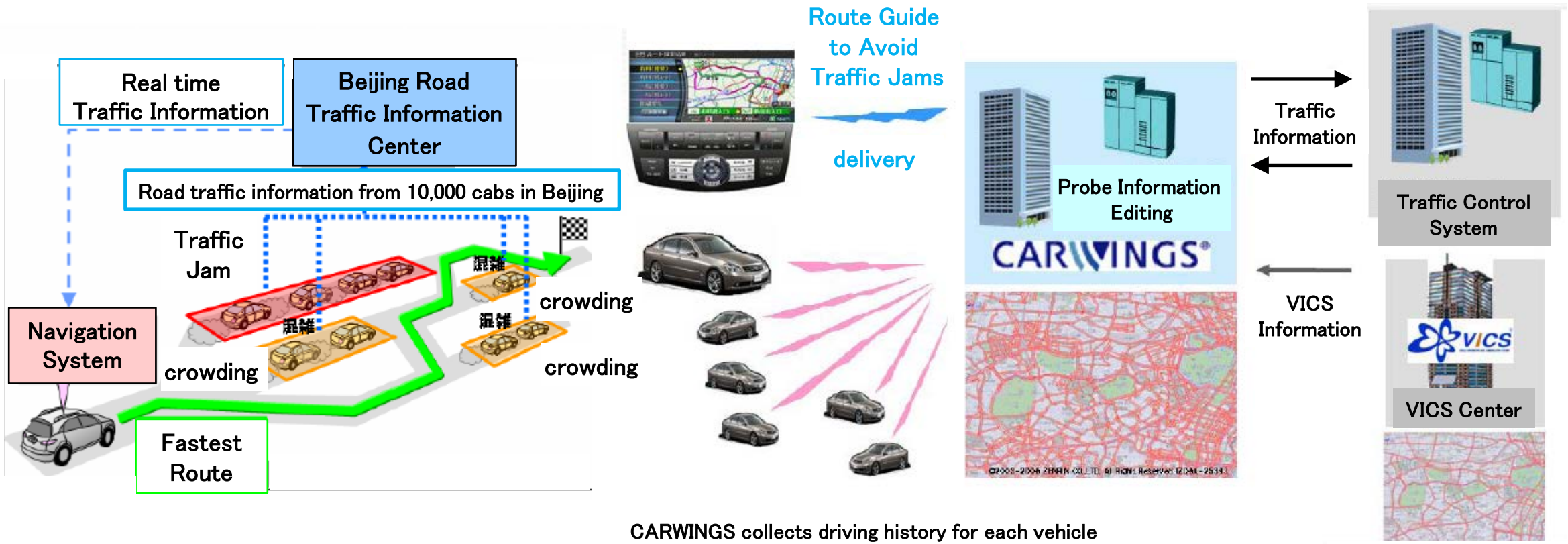
Source : Japan Automobiles Manufacturers Association, Inc. Website

1. New technologies in the Transportation Sector
1-2. ITS→Autonomous Driving

(38) 空港リムジンバス・自動運転タクシー・自動運転モビリティを活用した公道MaaS実証実験プロモーション動画 - YouTube

Traffic Jam Relief by Intelligent Transportation Systems

- Collects information on the driving history of taxies and other vehicles, and uses in-vehicle navigation to guide routes to avoid traffic jam.



CARWINGS collects driving history for each vehicle

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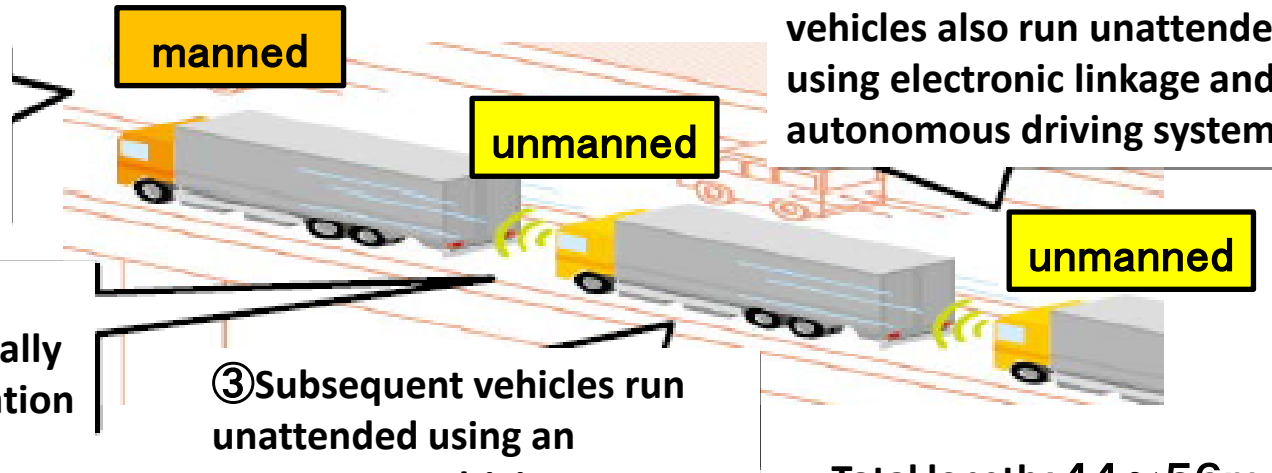
Source : METI Website

Demonstration for Social Implementation of Large Trucks Driving in Formation by Autonomous Driving

- The project aims to develop the necessary technology and study its social acceptability in order to implement the following-vehicle unmanned convoy driving, which is expected to solve the driver shortage and significantly reduce CO2 emissions.
- Progress: In February 2021, the team achieved formation driving on the New Tomei Expressway.
  Technical issues: Preventing ordinary vehicles from interrupting the formation, merging at ICs and SA/PAs, etc.
  Legal issues: Classification of vehicles traveling in formation, handling of total length, required driver's license, etc.

Image of driving in formation



①The lead vehicle is manned by a driver who drives the truck.

②Leading and trailing vehicles are electronically linked to form a formation

③Subsequent vehicles run unattended using an autonomous driving system

④Third and subsequent vehicles also run unattended using electronic linkage and autonomous driving systems

Vehicle Image

（日野自動車提供）

Large 25-ton cargo type truck

Total length：44～56m、
Distance between two vehicles：4～10m

Source：Japan Automobiles Manufacturers Association, Inc. Website

Manpower saving and automation of warehouse operations by automated robots

- Combining automated guided vehicles, forklifts, and tractors that can be operated automatically, warehouses can be manned and automated.
  These robots can also be used in refrigerated warehouses.

【Automatic Guided Vehicles】

carriRO FD

【Forklift】

【Tractor】

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Source：ZMP Website

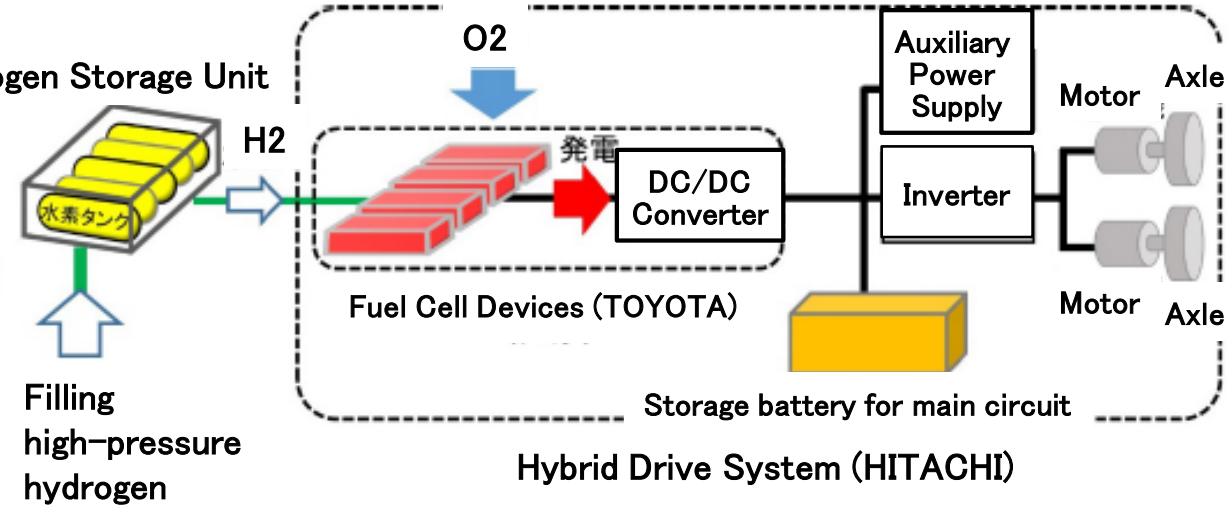
1. New technologies in the Transportation Sector
1-3. Other than Automobiles
(Railroad・Ship・Aircraft)

Carbon Neutralization of Railroads (Diesel to Hydrogen Fuel Cell)

- Diesel trains are used in non-electrified sections of Japan. The power source will be replaced by fuel cells using hydrogen as the power source. Demonstration tests are currently underway.
- Hitachi, Ltd., which specializes in the development of railroad vehicles, and Toyota Motor Corporation, which specializes in fuel cells, worked together to develop the vehicles and delivered a prototype to East Japan Railway Company.

【Prototype Vehicles (HIBARI)】

【System Configuration】



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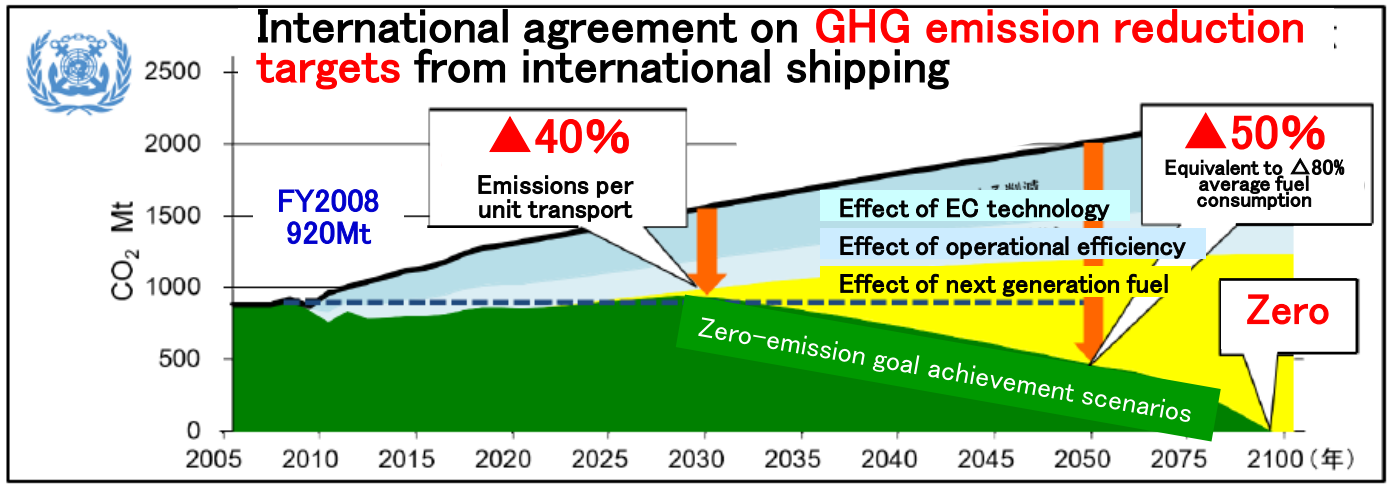
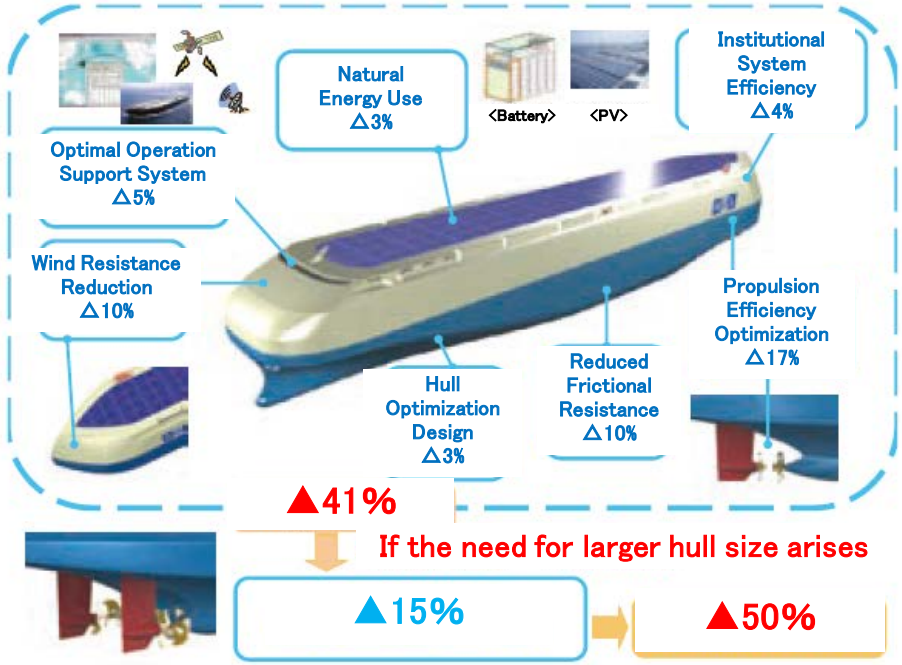
Source : METI Website

Carbon Neutralization of Ships (Super Eco Ship)

- International Maritime Organization targets for 2030：▲40%, 2050：▲50%, 2100：zero.
- Electricity generated by solar power is stored in lithium-ion batteries and used for navigation in ports and loading/unloading will be reduced to zero.
  Also, CO2 emissions during ocean navigation will be reduced by up to 50%.



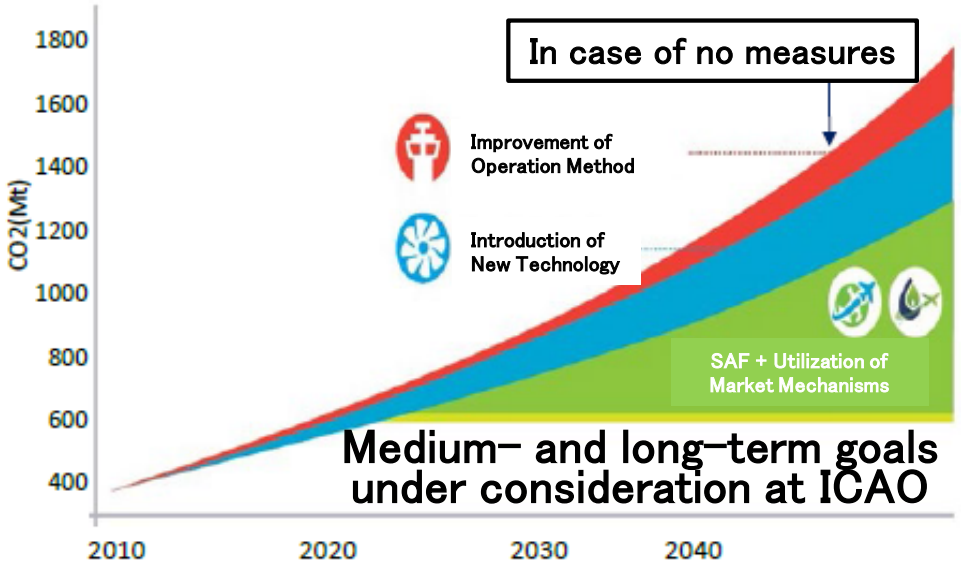


Source：METI and Mitsui O.S.K. Lines Website

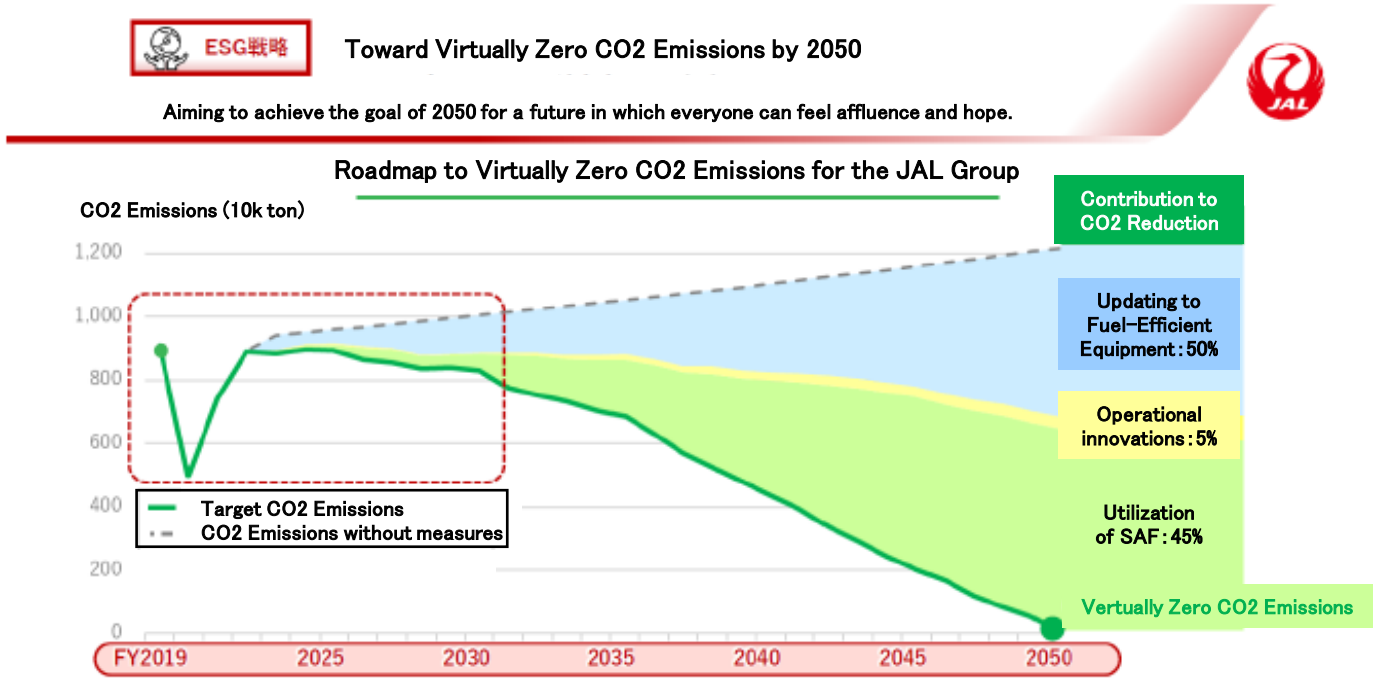
Carbon Neutralization of Aircraft (Use of SAF)

- ICAO's goal is to keep CO2 emissions in 2021 and beyond at the same level as in 2019. To achieve this goal, SAF (Sustainable Aviation Fuel) will be utilized.

【CO2 emission regulation by ICAO)】



【Japan Airlines' Efforts to Reduce CO2 Emissions】



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Source : METI Website

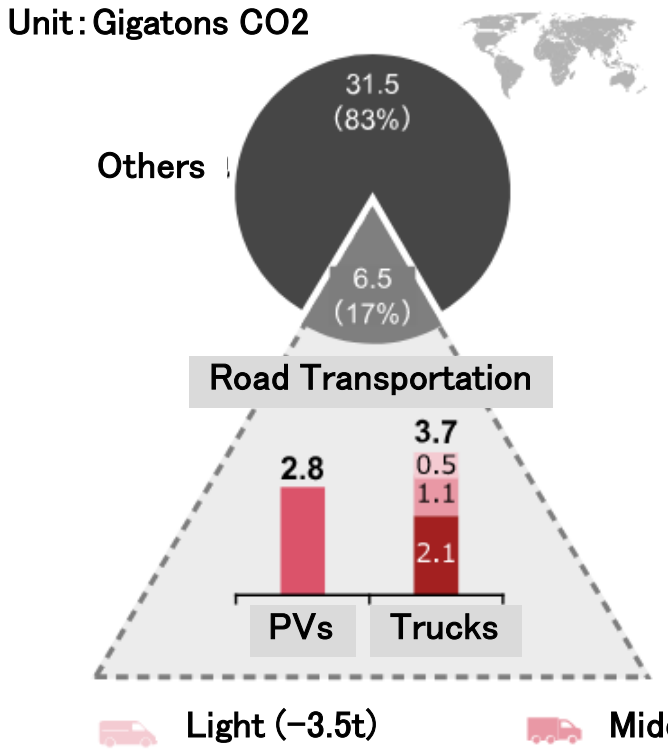
1. New technologies in the Transportation Sector
1-4. Next Generation Trucks

CO2 Emissions from Trucks for Transportation

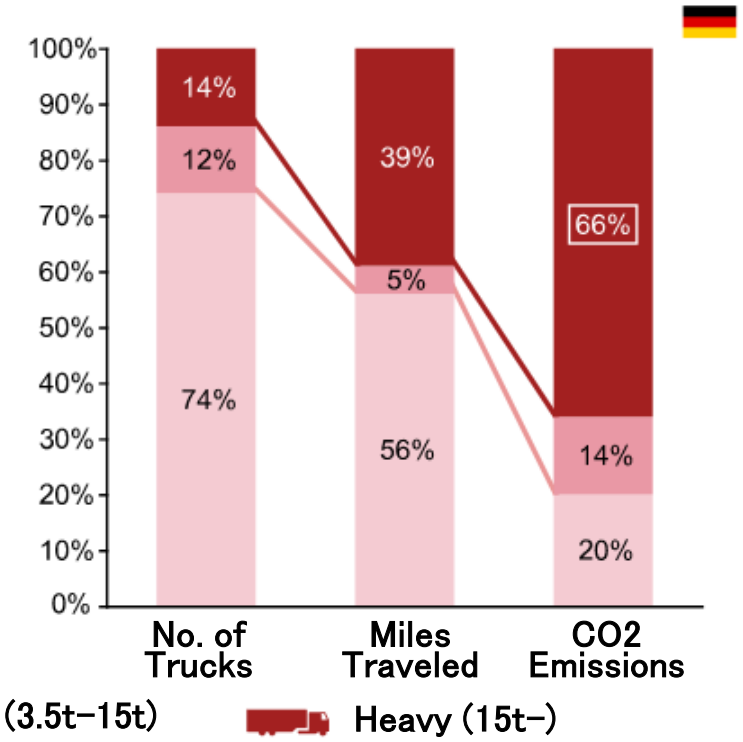
- Trucks are a major contributor to global CO2 emissions, with heavy trucks accounting for 66% of CO2 emissions from road transport in Germany.

Global CO2 Emissions and Major Market Trends

Global anthropogenic CO2 emissions



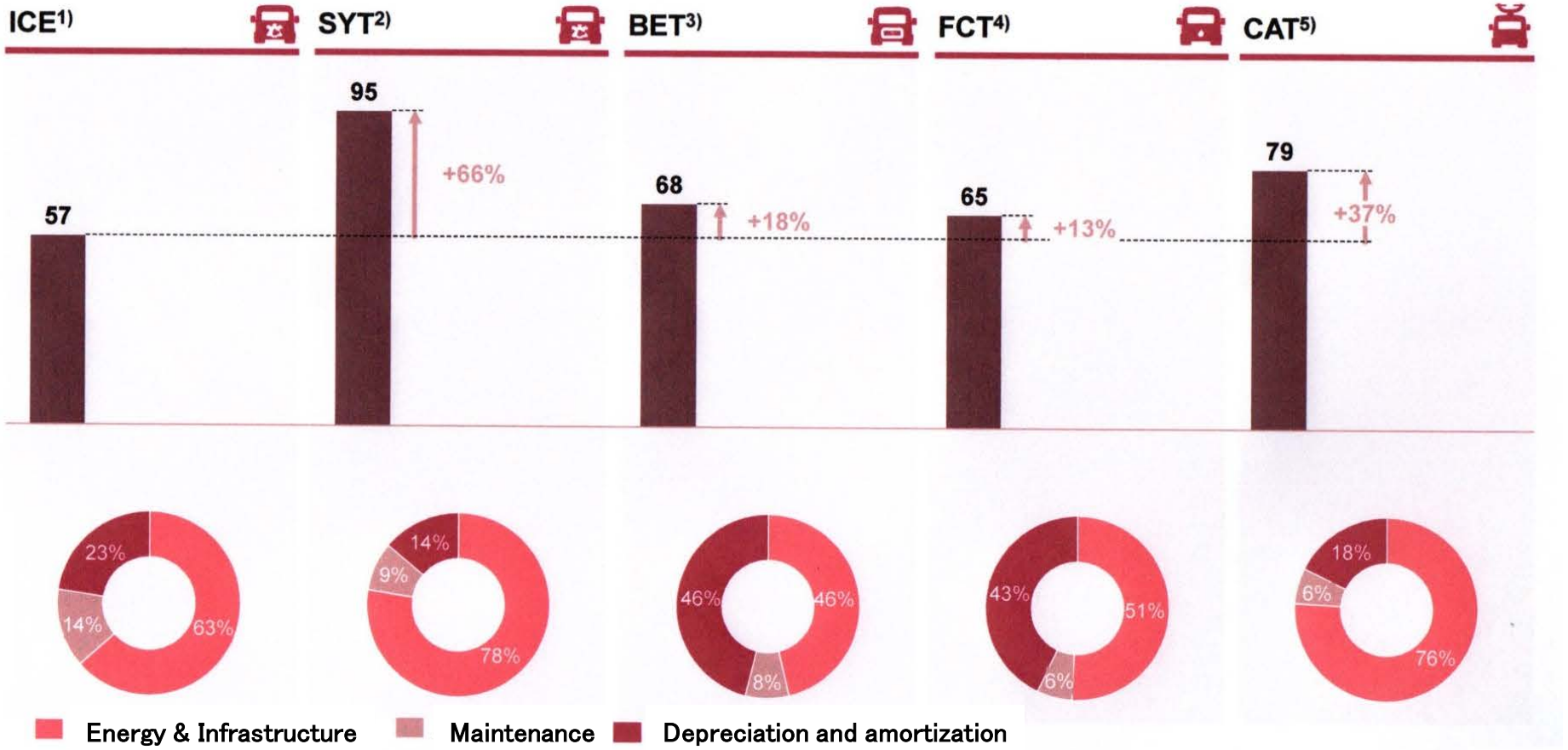
Number of Trucks, Miles Traveled, and CO2 Emissions in Germany



Source : Strategy& Website

Total cost of ownership of Next Generation Transportation Trucks as of 2030

◆ Total cost of ownership of BET and FCT goes closer to ICE (current diesel vehicles).

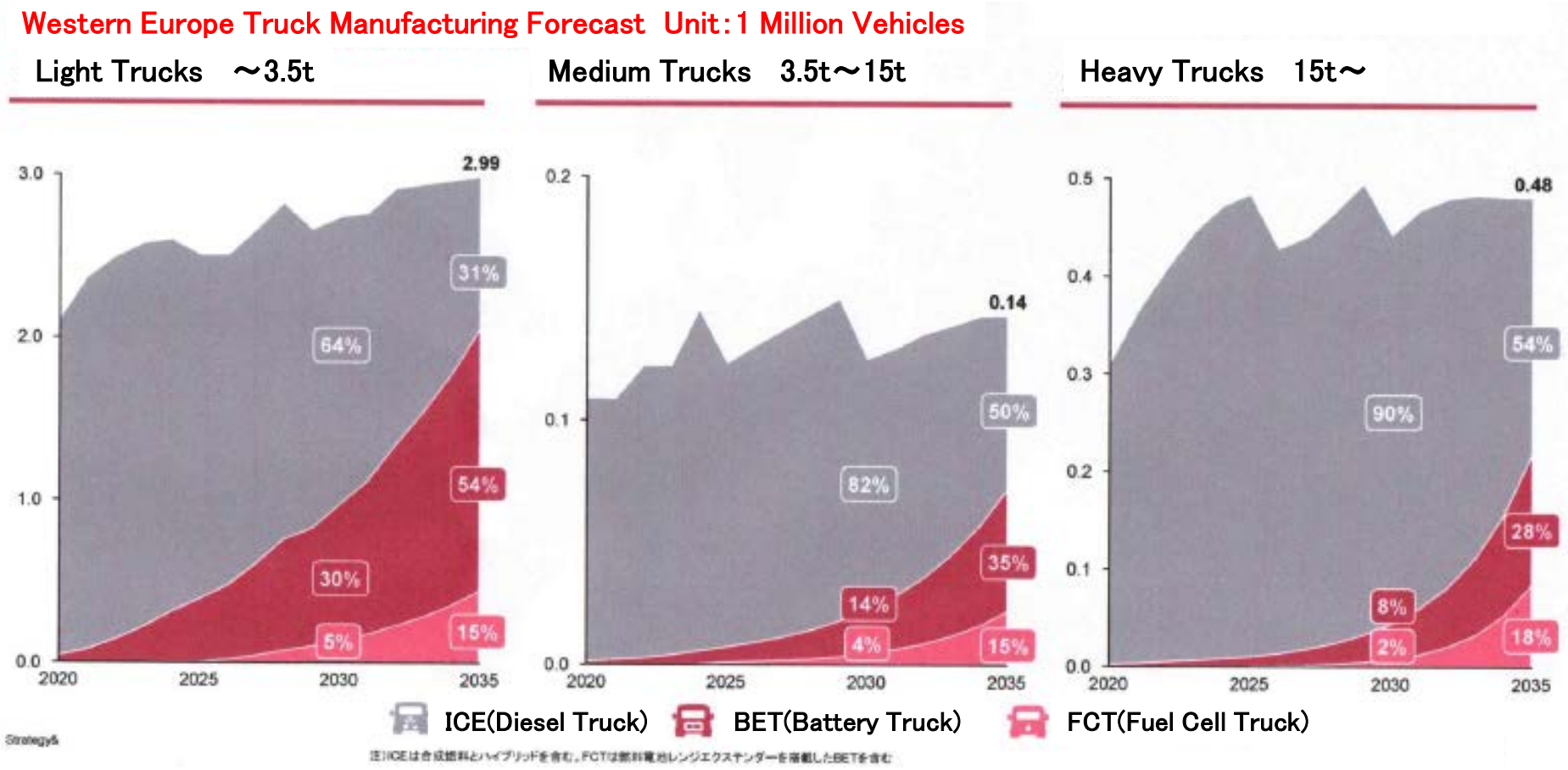


(note) Overall Parameters：Annual mileage 100,000km、All periods 4 years、Tolls, insurance, vehicle taxes, and interest rates are not included.
All energy prices are net prices excluding VAT.

Source：Strategy& Website

Forecasting the Diffusion of Next Generation Transportation Trucks

- The electrification rate is highest for light-duty trucks, and a certain level of sales is expected for heavy-duty trucks.



ACE METI ECCJ

Source：Strategy& Website

1. New technologies in the Transportation Sector
1-5. Smart Logistics

Logistics Challenges Facing Japan

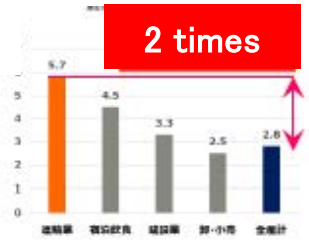
◆ Although each company is making efforts to help itself, it's in an area that can't be resolved by the company alone.

1. Insufficient people out

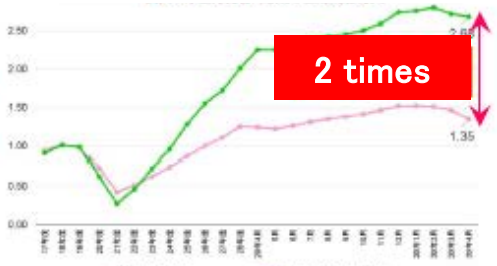
【Future Projections of Truck Driver Supply and Demand】

	2017年	2020年	2028年
Demand	1,090,701人	1,127,246人	1,174,508人
Supply	987,458人	983,188人	896,436人
Shortage	▲103,243人	▲144,058人	▲278,072人

【Vacancy Rate by Industry】



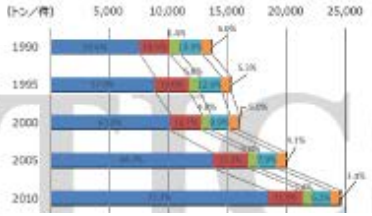
【Changes in the ratio of effective job offers to job seekers】



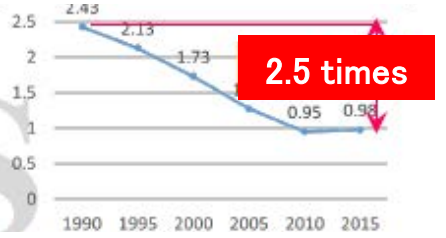
2. Diversification of needs

【Changes in Truck Loading Efficiency】

【Cargo volume per cargo】

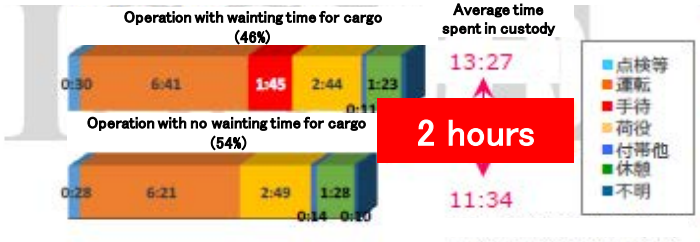


【Number of logistics cases】

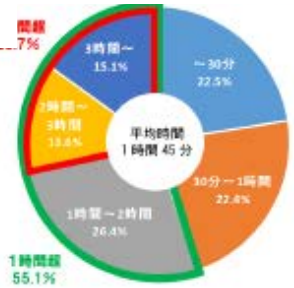


3. Unique business practices

【Average time and breakdown of captivity per operation】



【Distribution of cargo waiting time per operation】



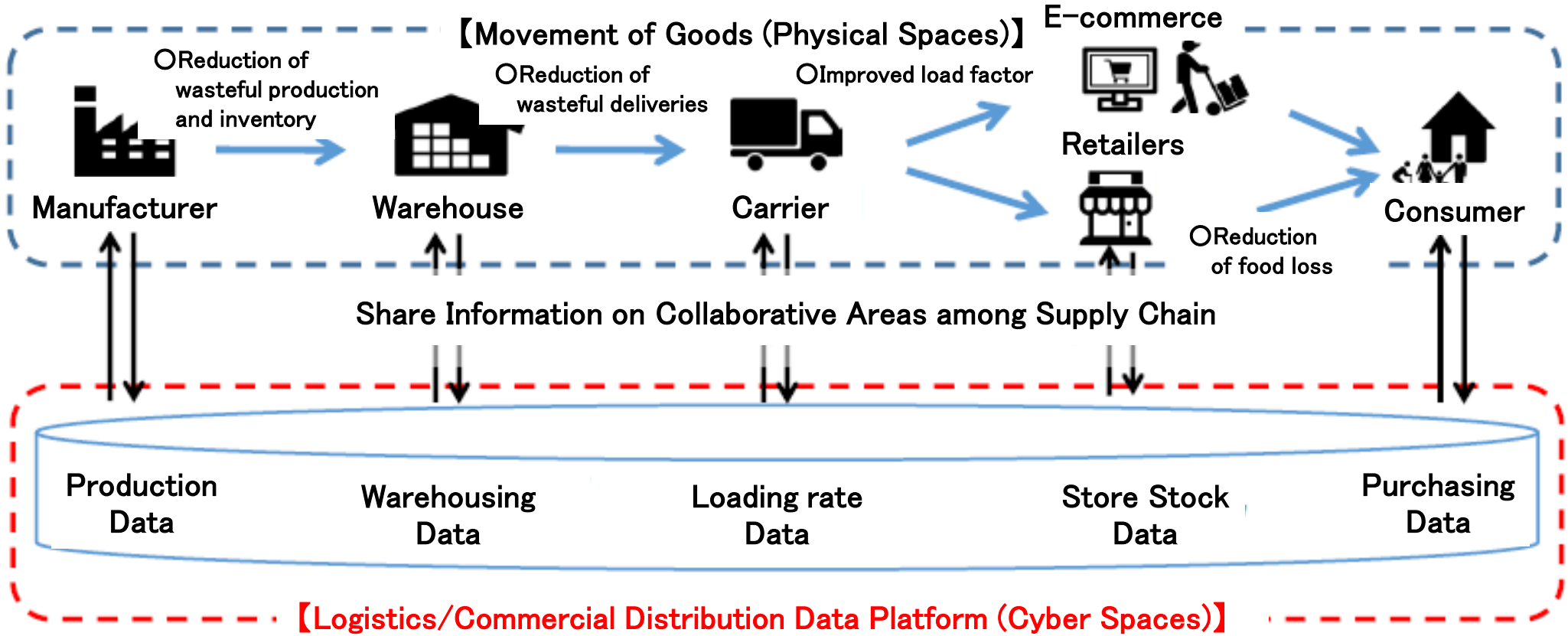
【Annual Working Hours】

ACE METI ECCJ

Source：METI Website

Smart Logistics Service Concept

- Visualize "movement of goods (logistics)" and "product information (commercial distribution)" and build a "logistics/commercial distribution data platform" to accumulate, analyze, and share data beyond the boundaries of individual companies and industries.



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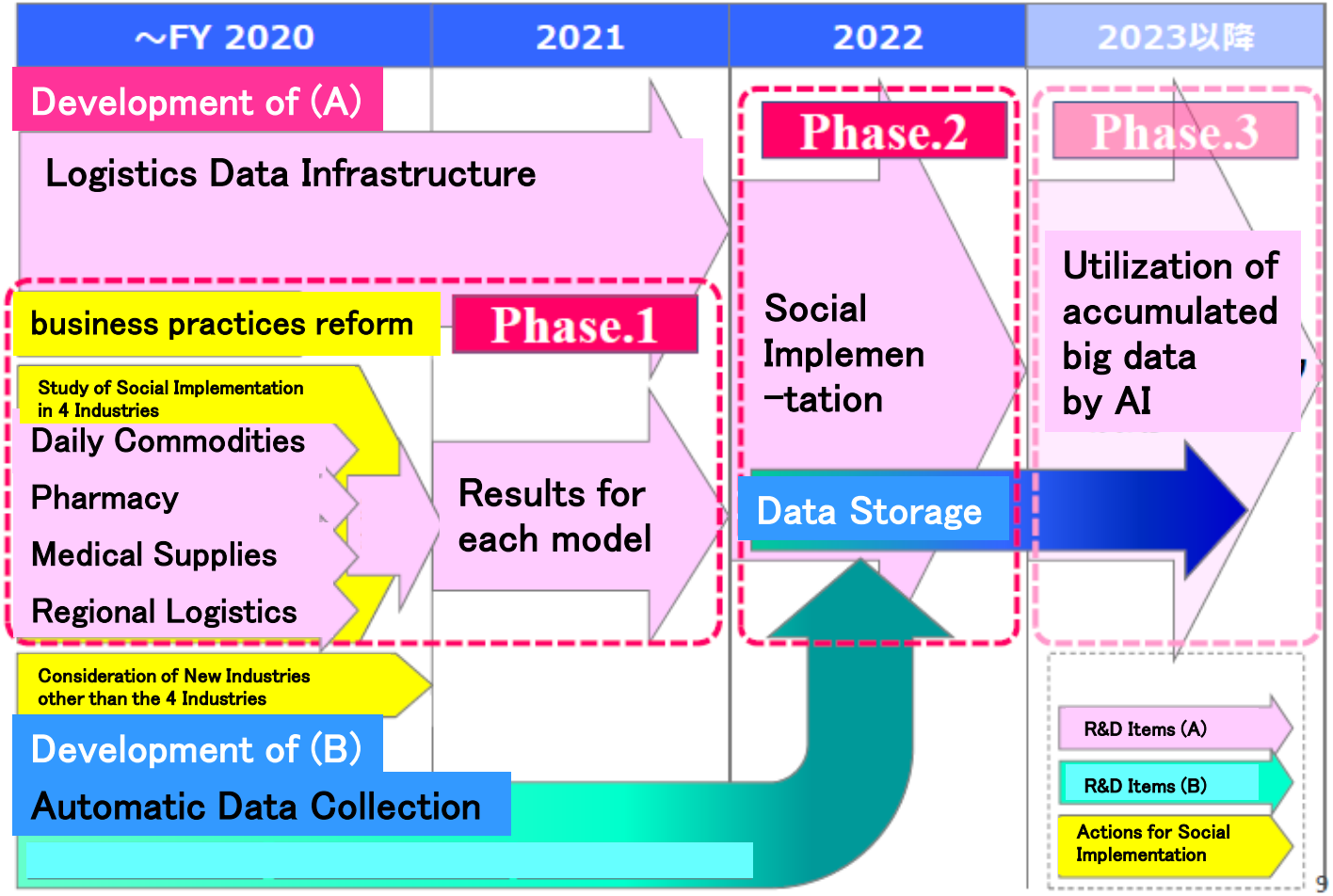
Source : MLIT Website

Research and Development Process

- Simultaneous development of (A) logistics data infrastructure and (B) automatic data collection technology.



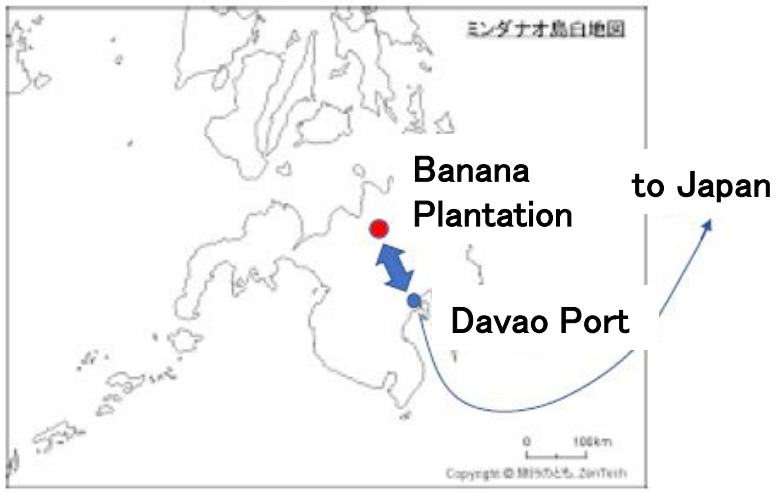
1. New technologies in the Transportation Sector
1-6. Cold Chain Logistics

A Case Study of Cold Chain Logistics in the Philippines

- **Foods (bananas) are stored in containers and transported from truck to ship to Japan.**

【Current business development (banana transportation)】

Mindanao Island Map



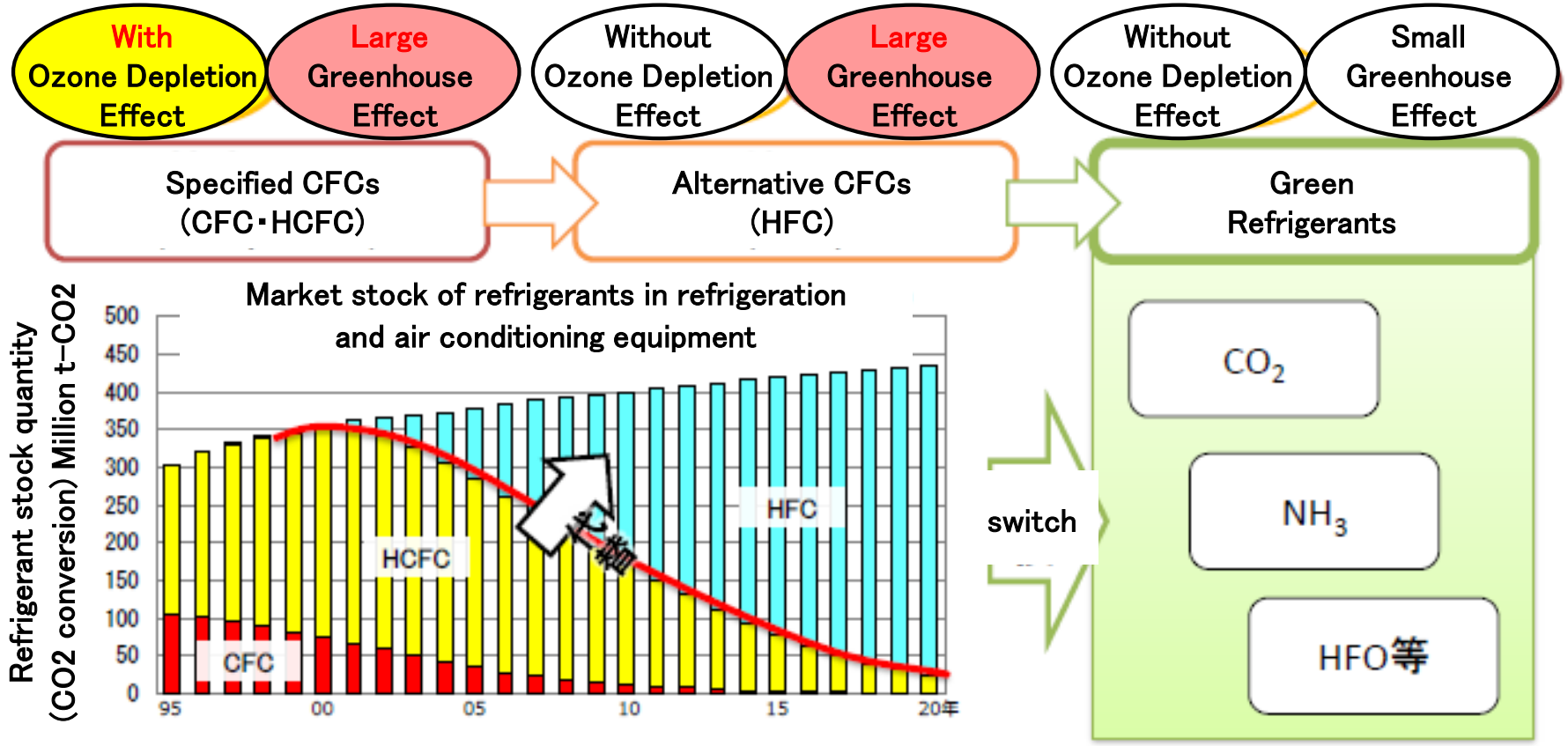
Banana Carrier (Davao→Japan)

【Demonstration test (avocado)】

Source：Daikin Industries Websire

Refrigerant Conversions for Freezing and Refrigerated Warehouses

- At present, natural refrigerants with a small greenhouse effect are being developed for CN.



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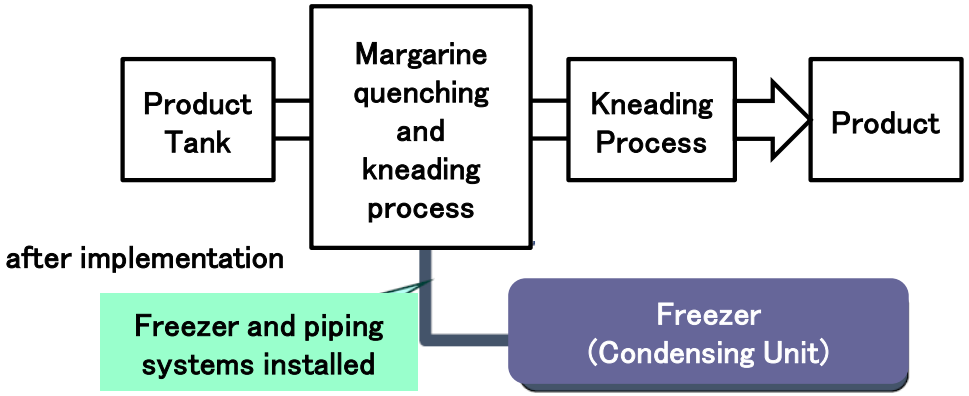
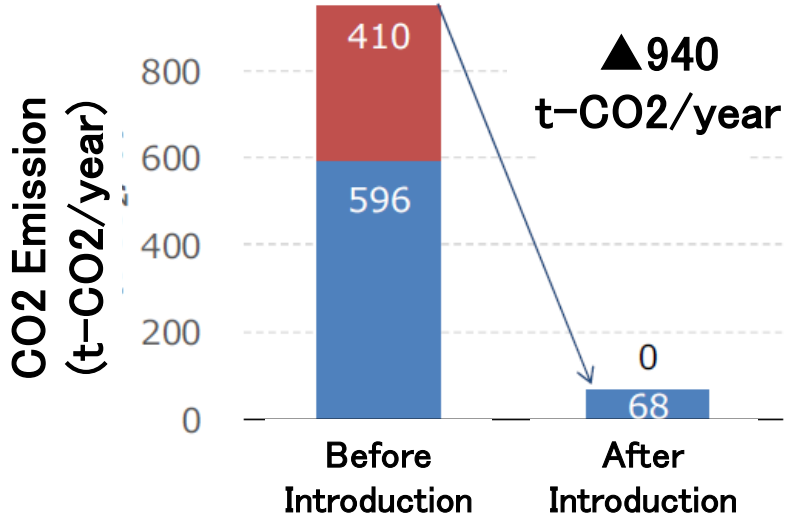
Source : METI Website

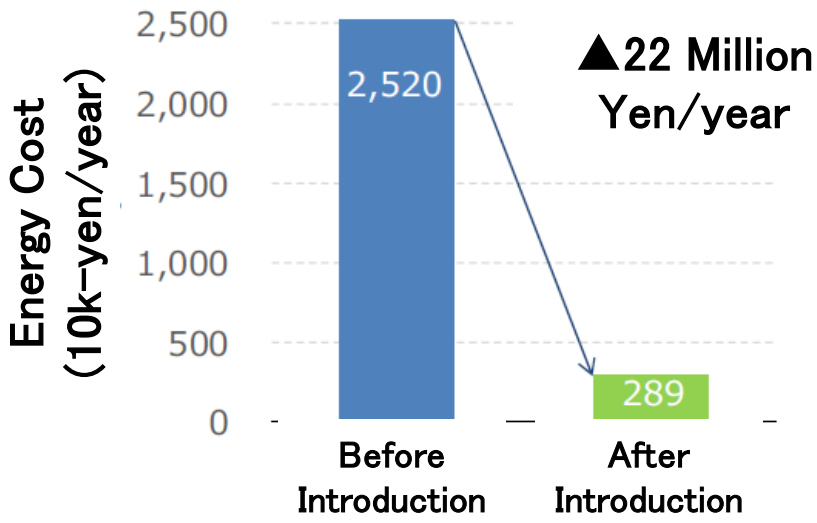
Reduction of CO2 emissions by conversion to natural refrigerant (CO2)

- CO2 emissions were reduced by ▲94% by converting refrigeration equipment to natural refrigerants.



Freezer (Condensing Unit)





CO2 emissions from energy Refrigerant leakage CO2 emissions

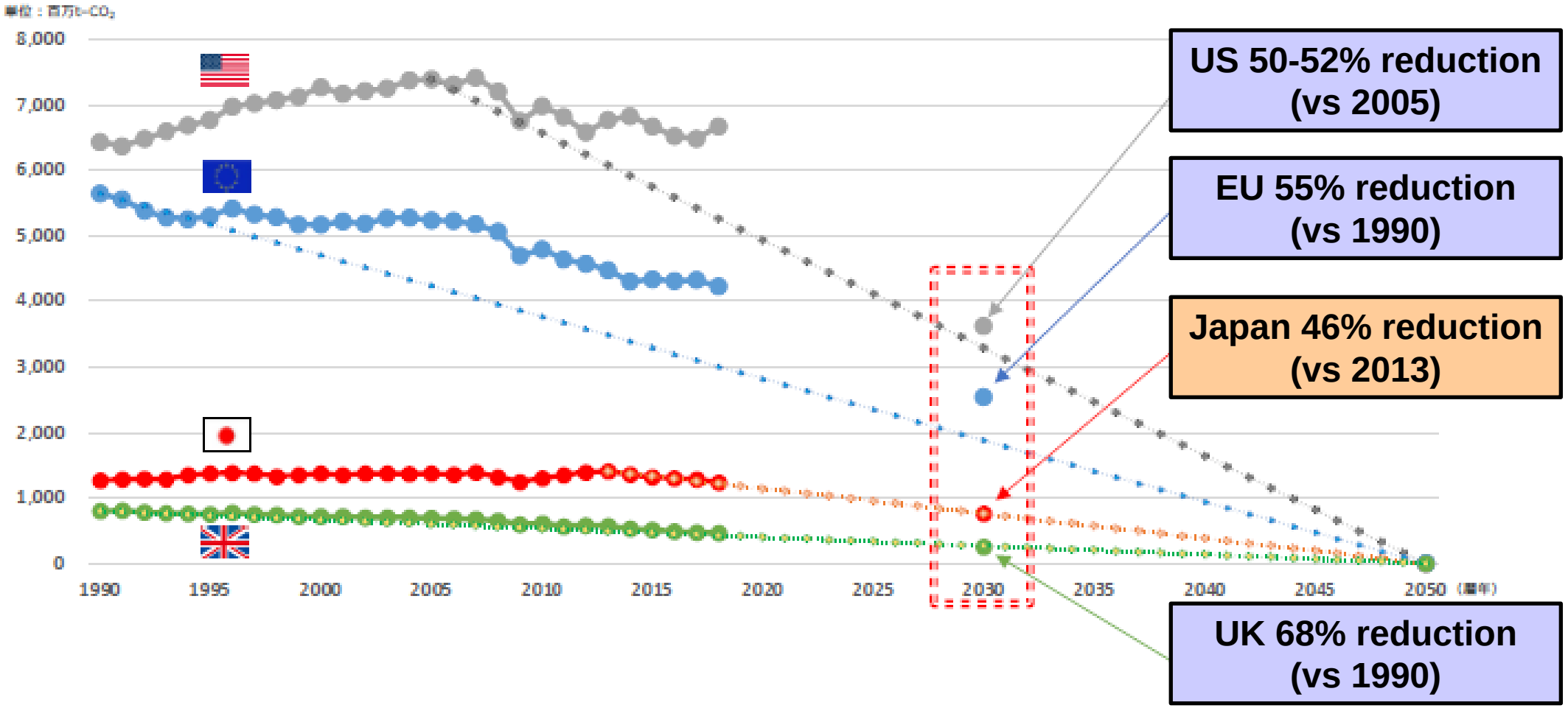
ACE METI ECCJ

Source : METI Website

2. Summary

CO2 emission reductions in countries around the world

◆ Japan has steadily reduced CO2 emissions by promoting the spread of HEVs.



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Source：Japan Automobiles Manufacturers Association, Inc. Website

Summary

- Japan's policy on carbon neutrality in the transportation sector is focused on automobiles and logistics. The main areas of improvement are the electrification of passenger and commercial vehicles, the spread of autonomous driving, and the introduction of railways and ships.
  The main areas of improvement include the electrification of passenger and commercial vehicles, the spread of automated driving, the decarbonization of railroads, ships and aircraft decarbonization, smart logistics and cold chain logistics, etc.

- In Japan, HEVs have largely met their penetration targets, resulting in significant reductions in CO2 emissions. In Europe, the overall effect of EV diffusion is significant because of the prevalence of decarbonized power sources. In ASEAN, the spread of EVs in countries with a high ratio of thermal power generation will have an effect comparable to that of HEVs in Japan.
  On the other hand, in countries with a high ratio of hydroelectric power generation, as in Norway, the overall effect of EV diffusion is significant.

- This year's report is a general overview, with emphasis on the main points and a bird's-eye view of the overall picture. From next presentation onward, we hope to introduce detailed information as needed and contribute to the development of ASEAN's transportation sector.

Thank you for your attention.

Symbol of energy conservation

SMART CLOVER

ASEAN's EV Conversion Plan

(1) Singapore and Thailand's targets are the highest in the world, surpassing those of the USA and EU.
(2) Laos has set a highly effective target by taking advantage of its high ratio of hydroelectric power generation.
(3) Brunei's target is higher than that of China, while the Philippines' target is modest.

	ASEAN				Asia		EU		USA	
	Sales	Country	Sales	Country	Sales	Area	Sales	Area	Sales	Area
2021					16%	China	17%	EU	4.5%	USA
2022					2.0%(note2)	Japan				
2030	100%	S	30%	L					50%	USA
			50%(note1)							
				Ma						
			100,000							
2035	100%	T	60%	B	50%(note3)	China	100%	EU		
2040			10%	P						
2050	100%	I	40%	C						

(note1) Government-owned vehicle、(note2) Japan's sales ratio is the instantaneous value as of June 、
(note3) China aims for 50% EV and 50% HEV in 2035.

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Source：Inception Meeting

Comparison of gains and losses for next generation vehicle

◆ Sales of BEVs are declining in both Europe and China, while sales of PHEVs are increasing.

Charging congestion needs to be resolved. The introduction of BEVs with all solid battery is desirable.

	Source of Power	Energy Source	Infrastructure	Evaluation	Driving Country Driving Company
ICE (Gasoline)	Engine	Gasoline	Gasoline stand	× (large CO2 emissions)	---
Synthetic Fuel Engine	↑	Synthetic Methane (CO2+H2→CH3)	Gas Station	(Under Development)	VW
H2 Engine	↑	Hydrogen	H2 station	↑	Toyota
PHEV	Engine/Motor	Gasoline/Electricity	Charging stand (Stationary charging)	◎ for long driving (No need to charge)	All makers
BEV with Li-ion battery	Motor	Electricity	Charging stand (Quick charging)	△ for long driving (Long period of time)	All makers
BEV with all solid battery	↑	↑	↑	◎ for long driving (Short period of time)	Japanese-affiliated lead the way
FCEV	↑	Hydrogen	H2 station	(Under Development)	Japan・Korea (Germany)

ACE METI ECCJ

Source：Made by ECCJ

EV vehicle sales price (in Japan)

- Due to high subsidies, they may be cheaper than gasoline-powered cars. (The same is true in Germany.)

	ICEV		EV	
	Suzuki Wagon R	Daihatsu Tanto	Nissan Sakura	Honda e
Photo				
FE/CD Length × Width Vehicle Weight	FE : 25.2km/l 3,395mm × 1,475mm 790kg	FE : 20.0km/l ← 930kg	CD : 180km ← 1,080kg	CD : 259km 3,895mm × 1,750mm 1,540kg
Sales Price Subsidy(METI) Subsidy(Tokyo) Purchasing Price	¥1,421,200 --- --- ¥1,421,200(注1)	¥1,875,500 --- --- ¥1,875,500(注2)	¥2,399,100 ▲¥550,000 ▲¥450,000(注3) ¥1,399,100(Lowest)	¥4,510,000 ▲¥662,000 ▲¥450,000(注3) ¥3,398,000

(注1) HEV、(注2) Gasoline-powered with turbo 、(注3) Kanagawa Prefecture subsidy is ¥200,000.

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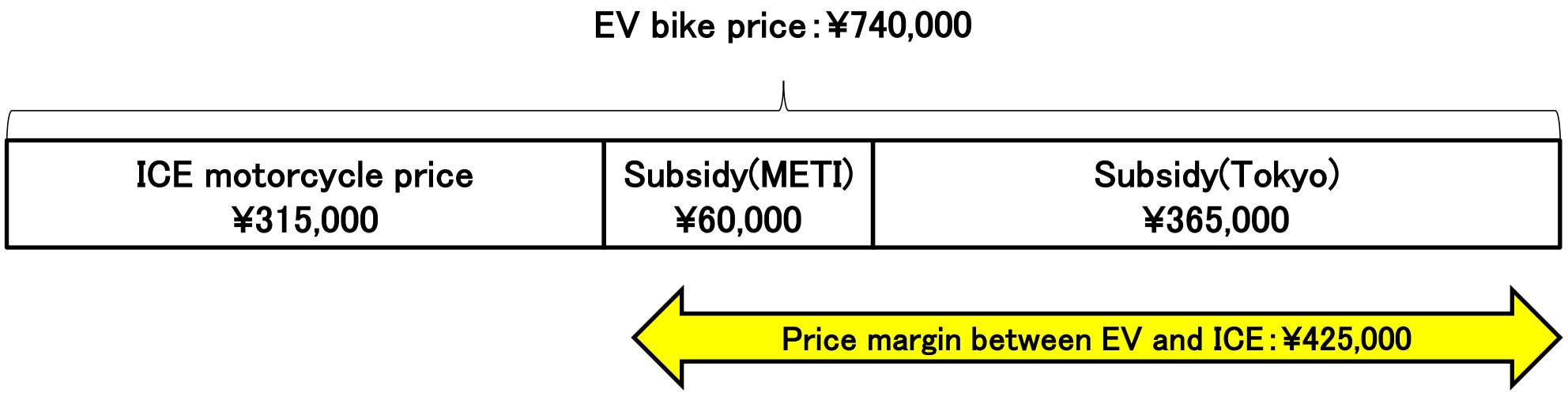
Source : All about Nissan Sakura

Subsidies for EV Motorcycles (in Japan)

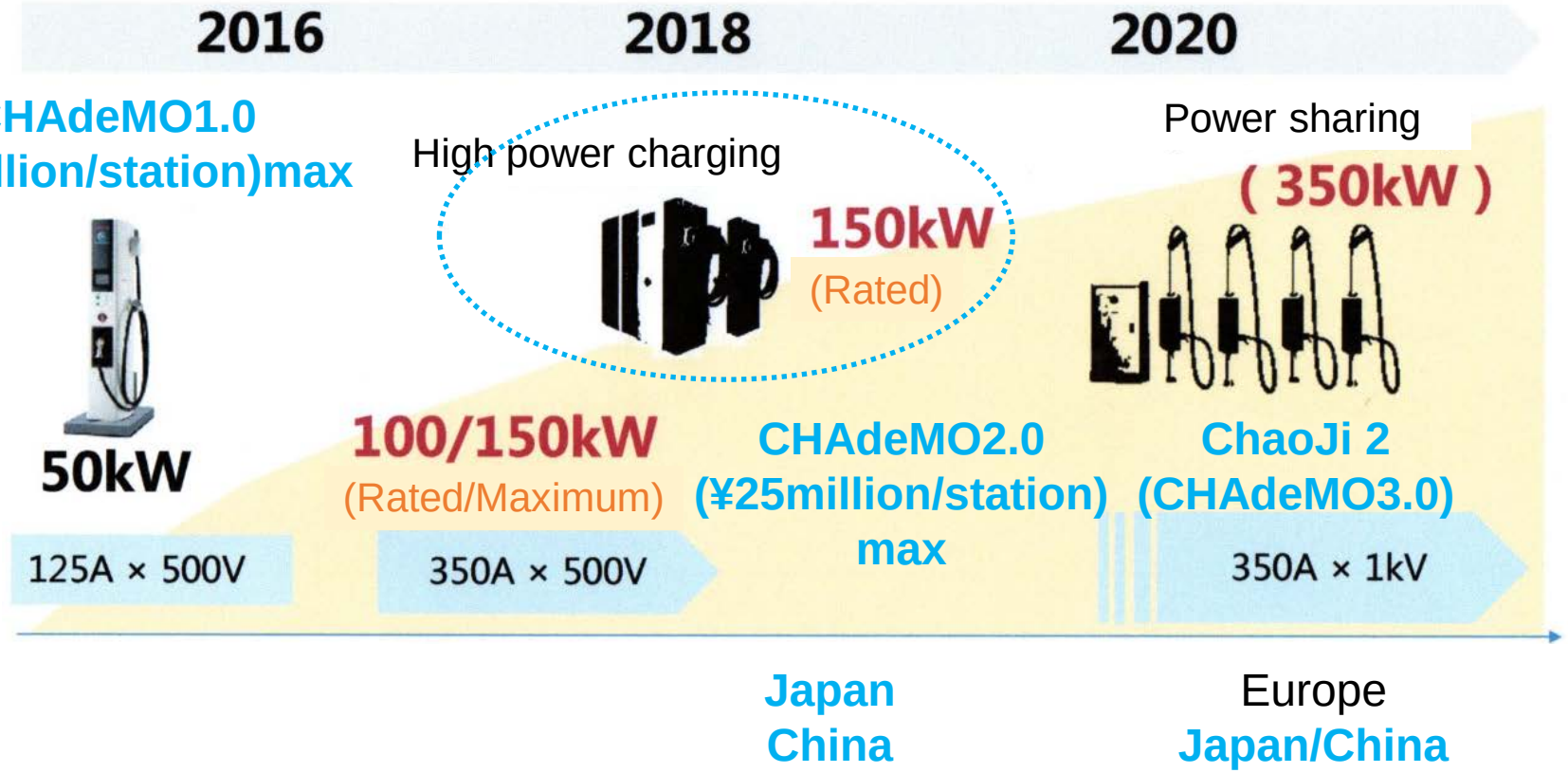
- Set the amount of the subsidy so that EV bike can be purchased at the same price as ICE motorcycle.



Source：Tokyo Metropolitan Government Website

Task：Integration of charging standards

- Due to the extended cruising distance, the battery capacity has been increased, and the charging time has increased accordingly.
  Quick charging equipment is increasing to shorten the charging time.



Source：Nikkei Electronics Website

Progress in Development of Quick Charging Standards

- The development of CHAdeMO→ChaoJi (super-class), a common standard between Japan and China, is progressing smoothly.

	Rated	Maximum	2018	2019	2020	2021	2022
CHAdeMO2.0	350A × 500V (150kW)	400A × 1kV (400kW)	☆ Start of installation (Japan)				
ChaoJi 2 (CHAdeMO3.0) with Liquid Cooling	350A × 1kV (350kW)	600A × 1.5kV (900kW)	☆ Commence -ment of study	☆ International Conference	☆ Demonst -ration	☆ Specifica -tions Publication	☆ Start of installation (China)
Ultra-ChaoJi	TBD	TBD					☆ Commence -ment of study

(note) Compatible with CHAdeMO and ChaoJi by using an adapter. Introduced to ASEAN countries (I, Ma, S, T, V) in 2019.

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Source：CHAdeMO Council Website

Subsidies for charging infrastructure (in Japan)

- **The goal is 30,000 units of quick charging for public use and 150,000 units including regular charging by 2030.**

  Subsidies for high-voltage power receiving equipment and installation costs associated with the installation of recharging facilities will also be expanded this time.

Quick Charging	Highway・government-designated rest area・Public roads, etc.		Commercial/lodging facilities, condominiums Business parking lots, etc.	
	Subsidy rate	Maximum subsidy amount	Subsidy rate	Maximum subsidy amount
Equipment cost	100%	Up to 2 units: ¥1,200K～¥5,000K 3 or more units: ¥2,500K × Number of ports	50%	Up to 2 units : ¥600K～¥2,500K 3 or more units : ¥1,250K × Number of ports
Construction cost	100%	¥2,160,000～¥2,800,000(note)	100%	¥1,080,000～¥1,400,000

(note) Highway :35,000,000

Stationary Charging	Subsidy rate	Maximum subsidy amount
Equipment cost	50%	¥70,000～¥350,000
Construction cost	100%	¥950,000～¥1,350,000

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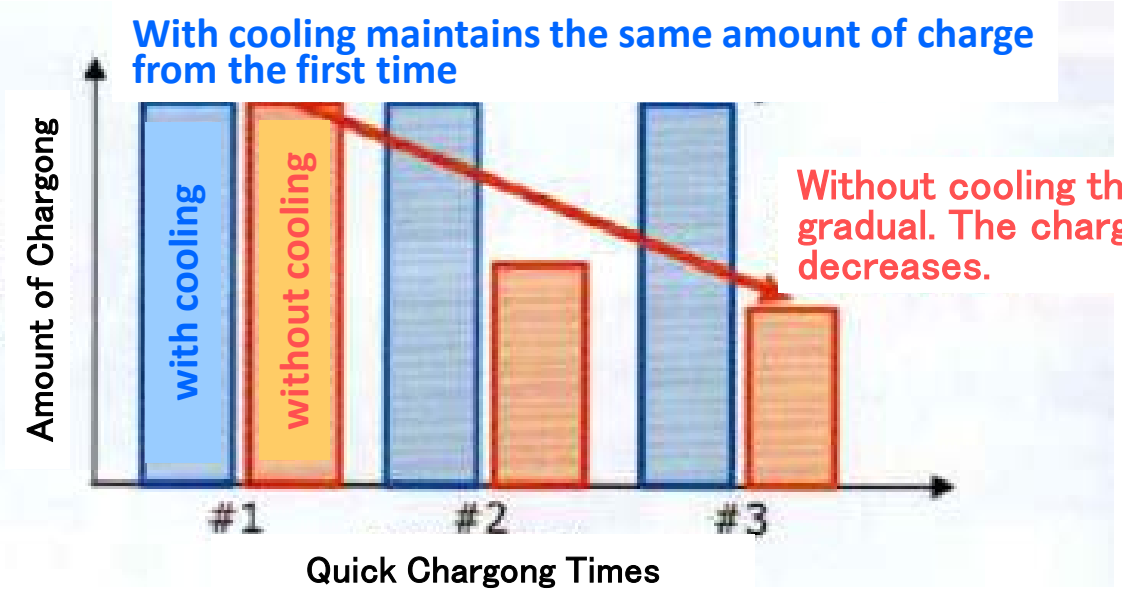
Source:Next Generation Vehicle Promotion Center Website

Improved charging capacity through battery cooling

- **Battery cooling function to allow for more charging in a shorter time during fast charging.This enables 80% charging to be performed in 30 minutes. This allows 80% charging to be performed in 30 minutes.**

【Nissan Sakura】

The temperature is controlled by cooling the battery directly with air conditioner refrigerant.



Lithium-ion batteries deteriorate faster when temperatures rise, so charge current must be limited at high temperatures.
If the cooling capacity is low, limiting must be applied from lower temperatures in anticipation of a safety factor.
However, Sakura does not limit the charging current even after three consecutive quick recharges.

Source：All about Nissan Sakura

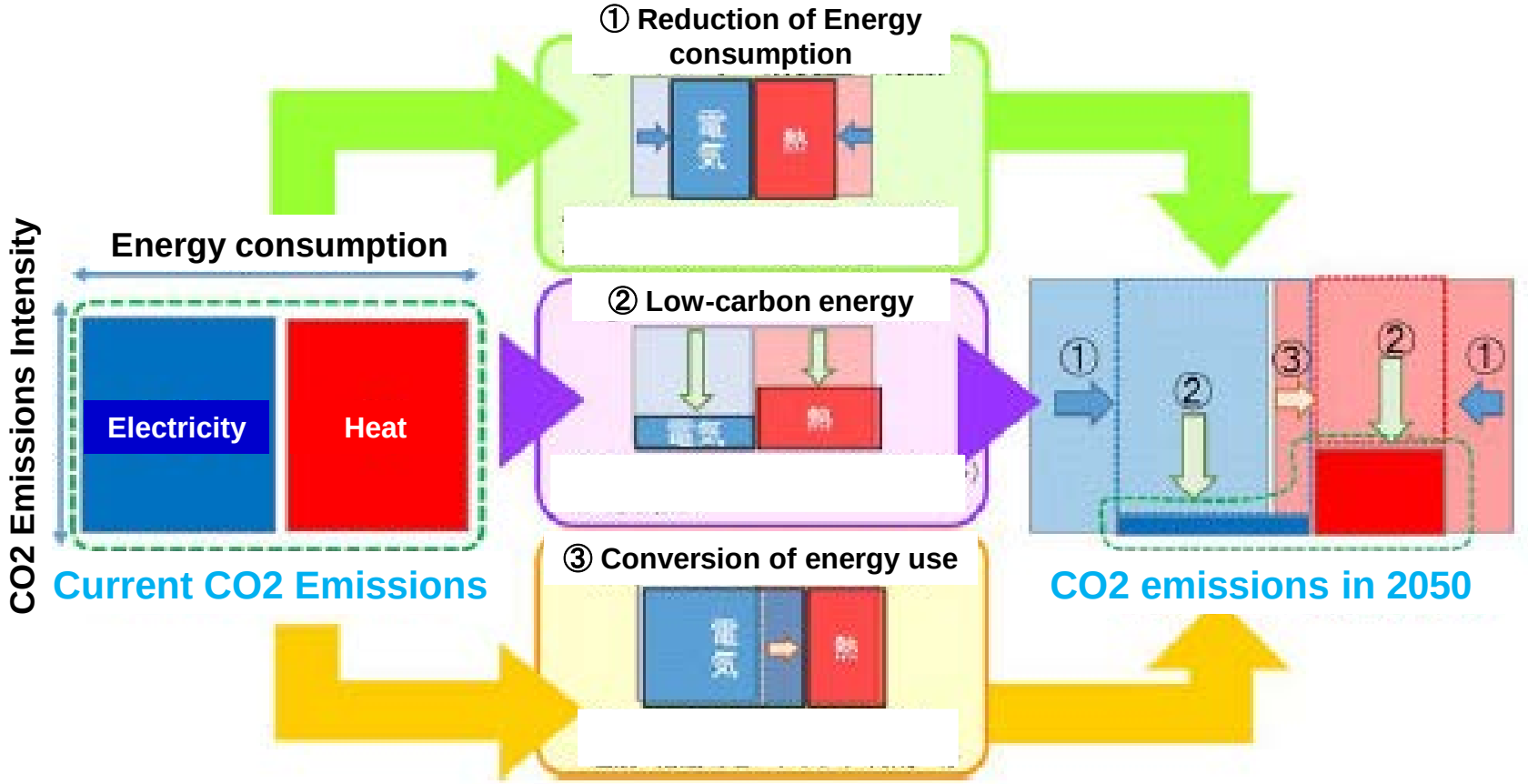
How to promote Carbon Neutrality (General Consideration)

◆ Direction of significant reduction of GHG emissions

① Reduction of energy consumption : Use of high-efficiency equipment, etc. (energy saving)

② Low-carbon energy : renewable energy, nuclear power, hydrogen (decarbonization)

③ Conversion of energy use : EVs and use of heat pumps (electrification)



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Source : MOE Website

Results of applying the direction of significant GHG reductions

◆ **Many measures are based on the conversion of energy sources.**

→Which of the main measures will be determined in the future depending on the economic feasibility.

	Automobiles	Railroads	Ship	Aircraft
Energy saving	・Fuel Economy Improvement ・HEV ・Smart Logistics ・Autonomous Driving			
Decarbon-ization	・FCEV ・Hydrogen Engine ・Synthetic fuels (e-fuel)	・FC Railcar	・H2 Turbin Ship	・Bio-Jet Fuel (SAF)
Electrifi-cation	・BEV ・Quick Charging ・All Solid-State Battery ・Wireless power transfer		・Super EcoShip (Solar Power)	

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Source：Made by ECCJ