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Reducing GHG Emissions from HDVs

HDV fuel efficiency regulation background and implementation to date

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Today's Contents

1. Background
2. Test procedure
3. Target Value and Improvement
4. Integrated Approach

1. Background

2. Test procedure

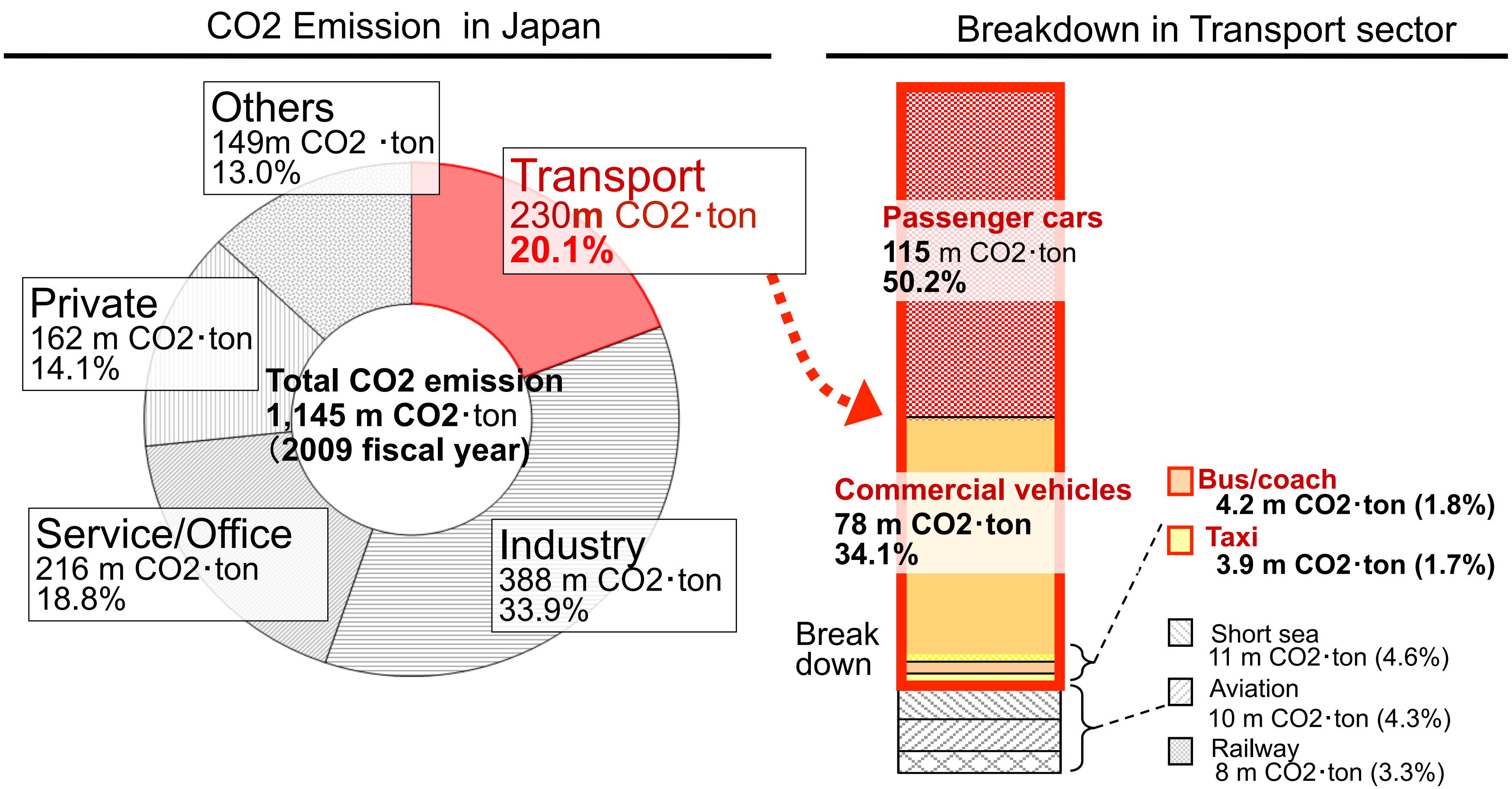
3. Target Value and Improvement

4. Integrated Approach

CO2 Emission from transport sector in Japan

CO2 Emission from transport sector is 20% of total emission in Japan.

Road transport emits 84% of transport emission.

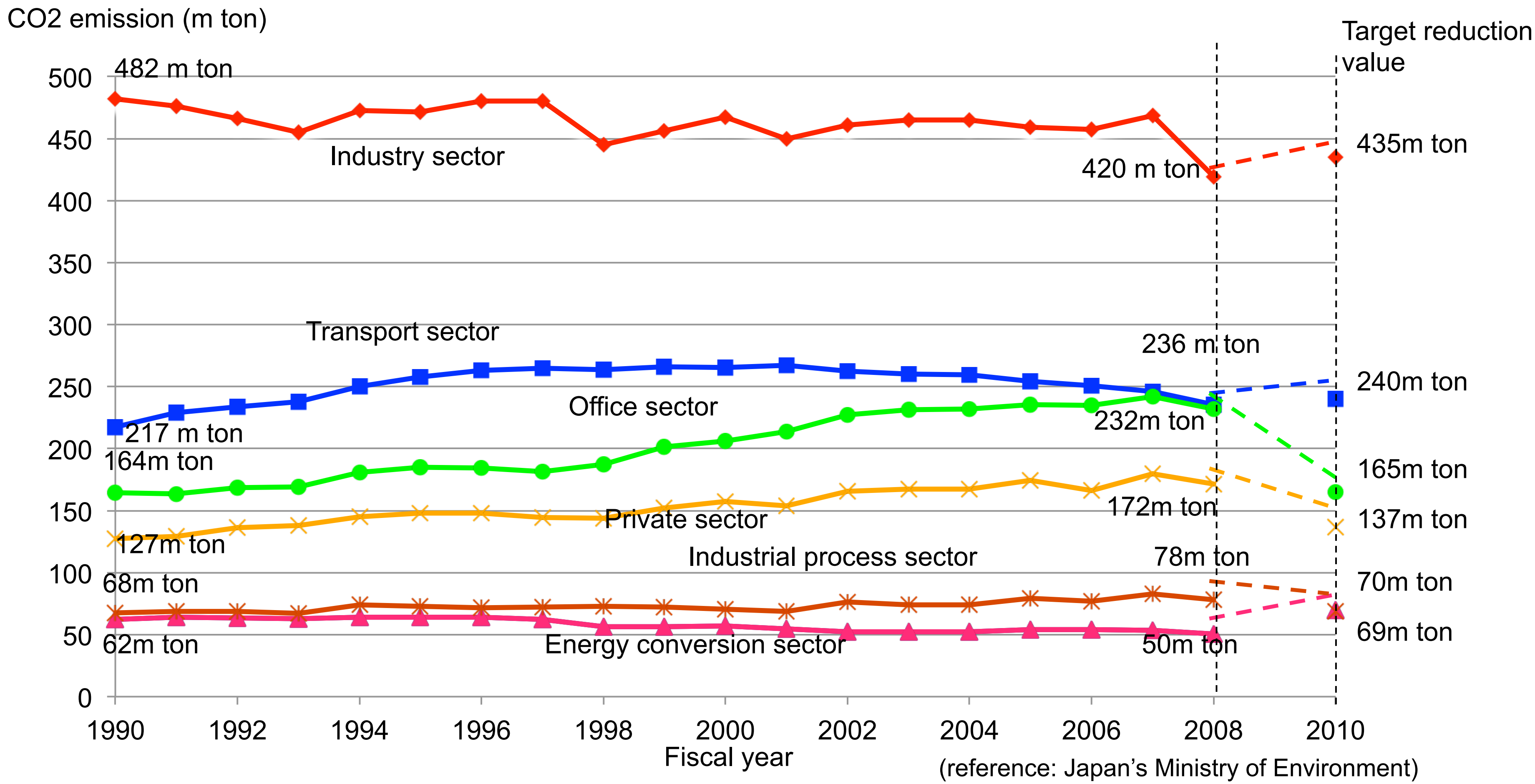


※ Emission from electric generation and thermal generation are distributed to final demand sectors according to amount of consumption of each sector.

※Developed by MLIT referring to “Japanese GHG Inventory report “

CO2 Emission from each sectors in Japan

Total CO2 emission increases by 13.3% compared to 1990 level.
Transport sector has turned into decrease.



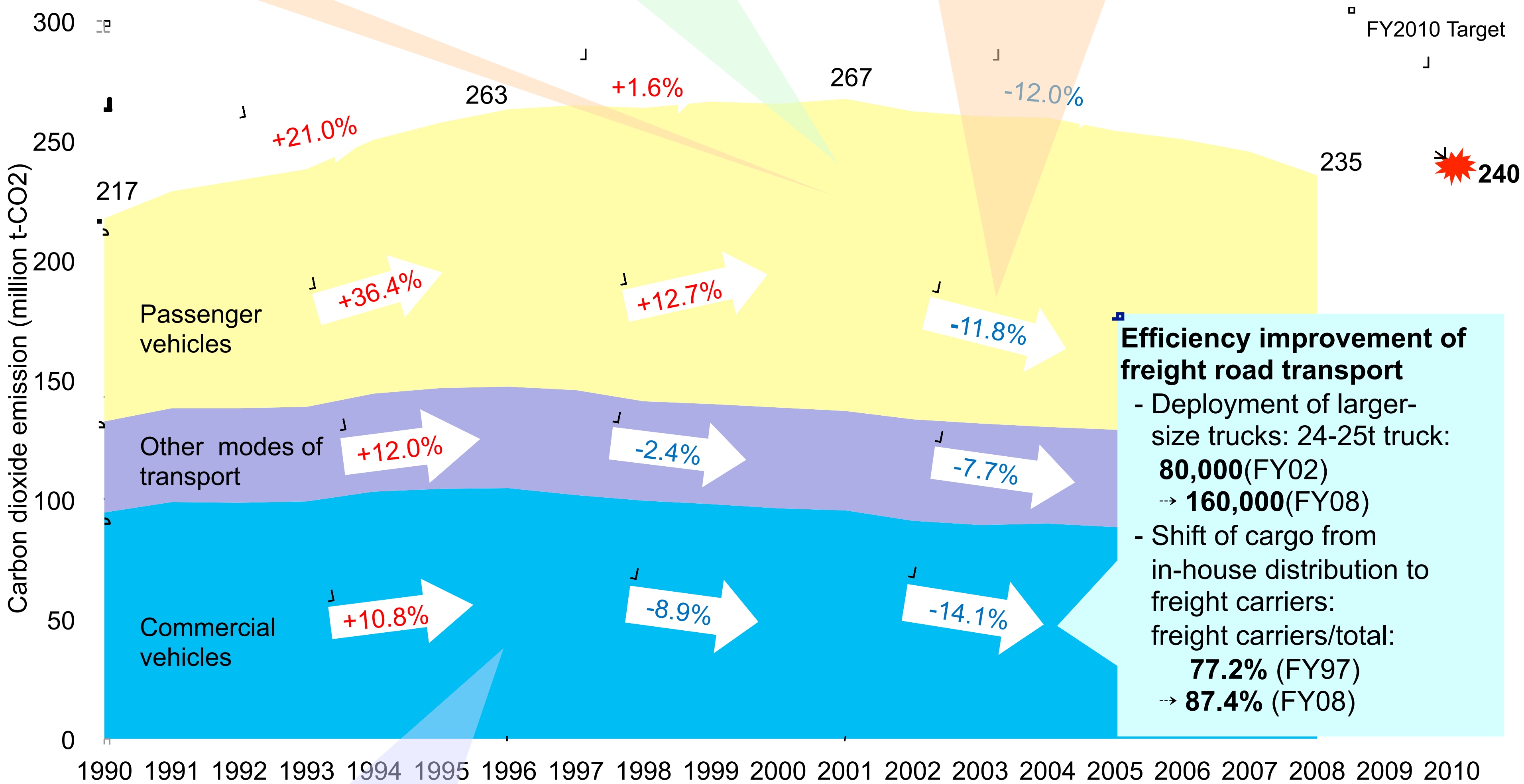
(reference: Japan's Ministry of Environment)

CO2 emission in Transport sector

Emissions from passenger transport on road peaked in FY2001.

Since FY2001, emissions from the transportation sector have been on a downward trend.

Improvement of mileage of passenger vehicles
- Fuel Efficiency regulation
- Green Tax (Since FY2001)
  18.2mil./57.7mil. registered vehicles are GREEN



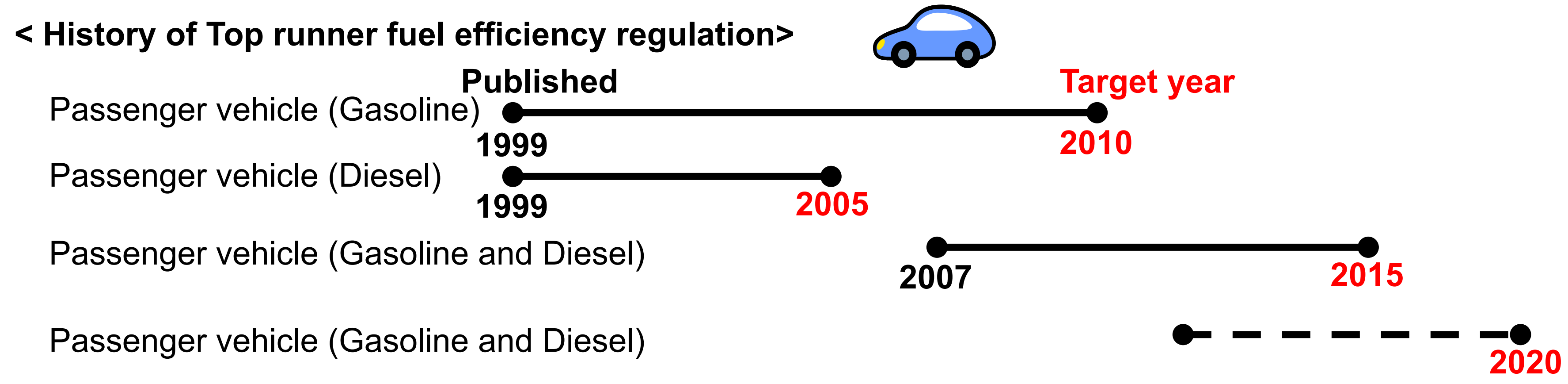
Efficiency improvement of freight road transport
- Deployment of larger-size trucks: 24-25t truck: **80,000**(FY02) → **160,000**(FY08)
- Shift of cargo from in-house distribution to freight carriers: freight carriers/total: **77.2%** (FY97) → **87.4%** (FY08)

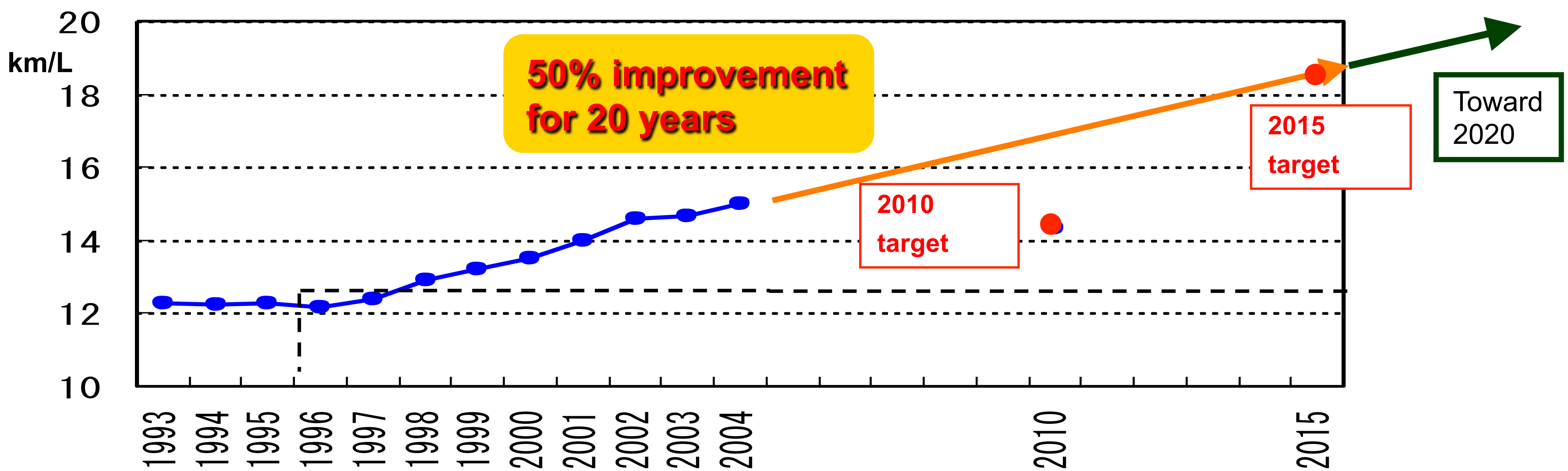
Emissions from freight transport on road peaked out in FY1996

History of Fuel efficiency standard

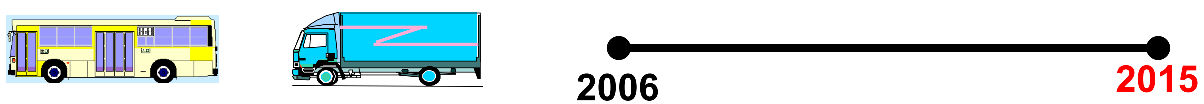
Japan has long history to execute FE regulation.
Through this regulation, Japan’s average FE of automobile has been improving steadily.

< History of Top runner fuel efficiency regulation>



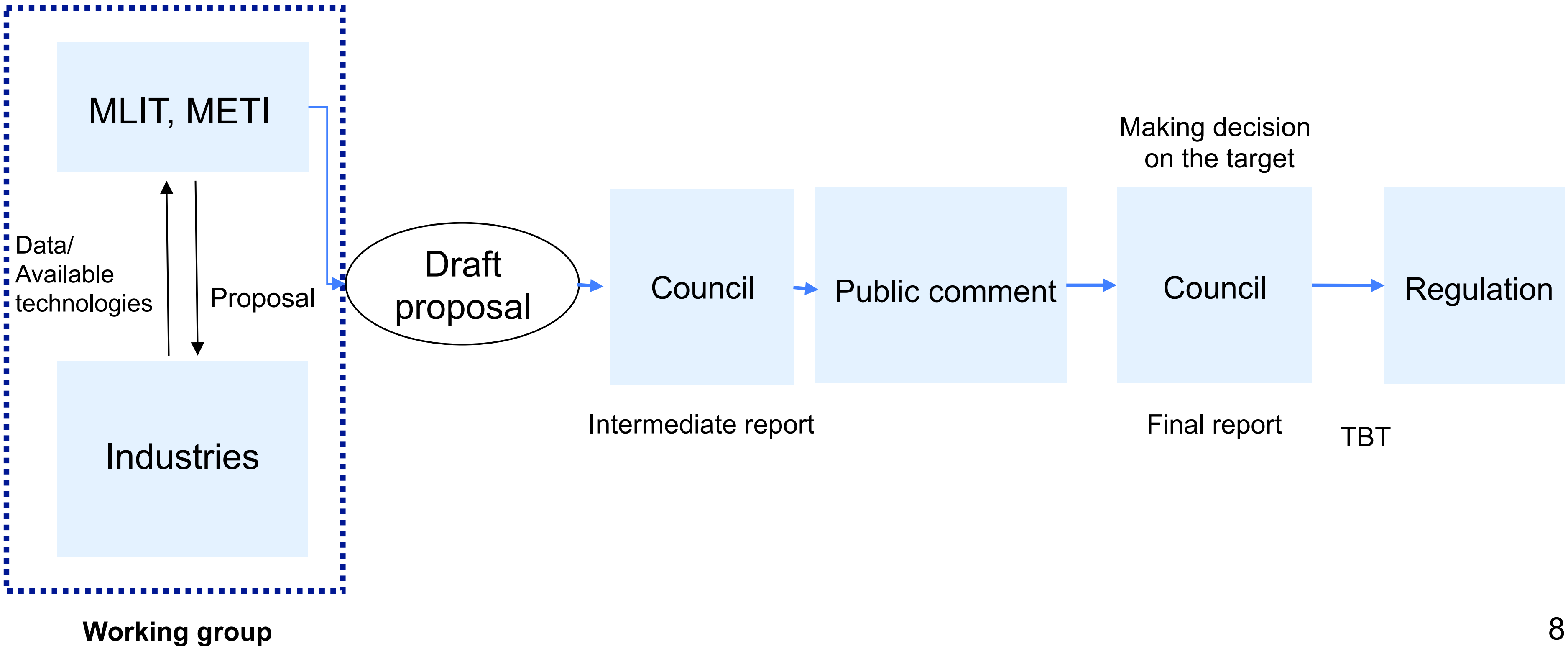


FE regulation for HDV



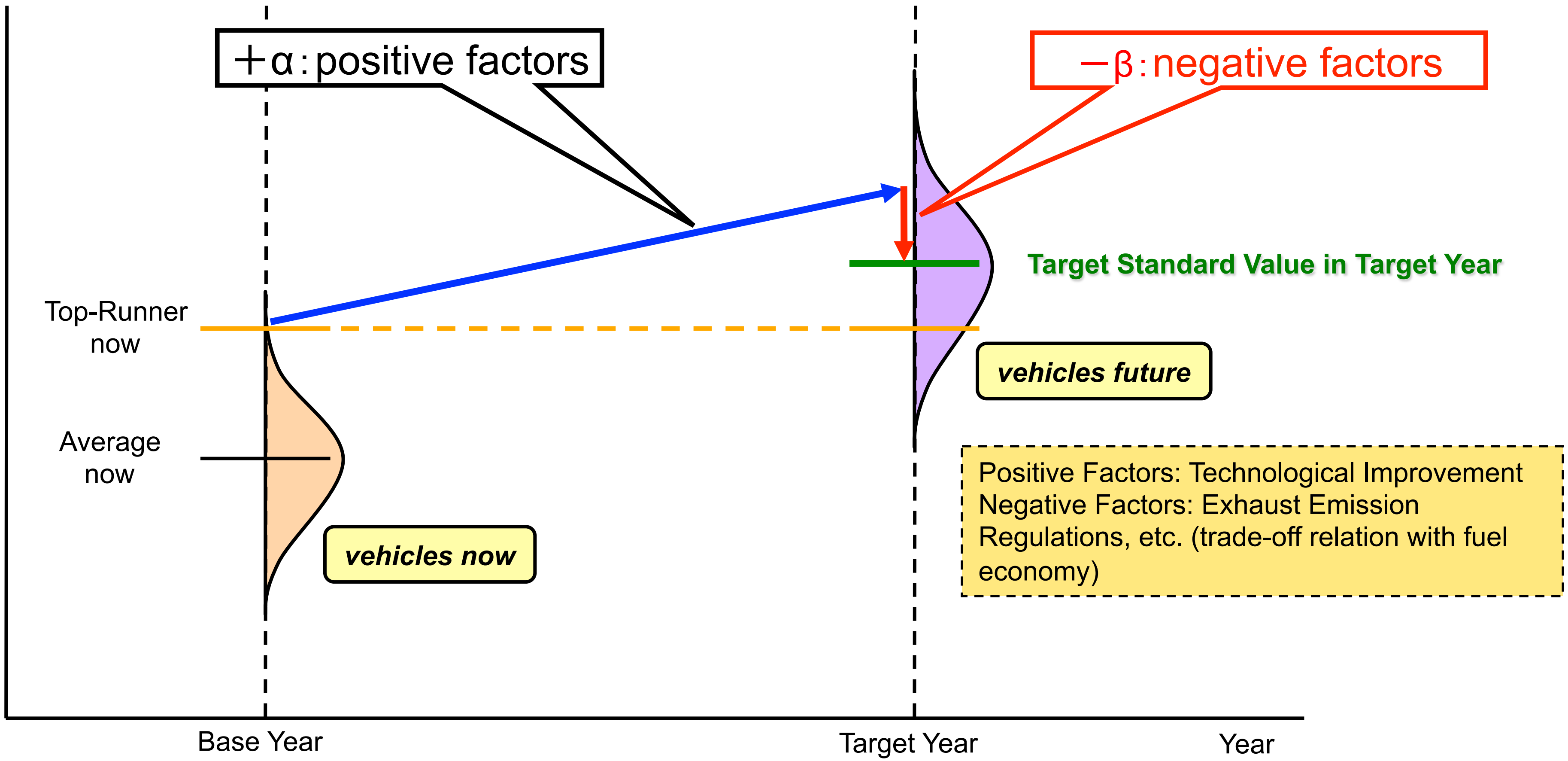
Drafting Process

1. First, we establish a expert working group to start discussing a new regulation. Vehicle manufacturers provide fuel efficiency performance data with all the types of HDVs in the market, as well as their expectations on positive and negative factors.
2. We develop a draft proposal and submit it to the council body of our government.
3. The council consists of academics and stakeholders. It intensively discuss the submitted draft proposal. The Intermediate report of the council goes through public comments procedure and the result must be taken into consideration when it publish the final report.
4. The final draft should be completed by MLIT and METI based on report by the council.
5. The final regulation and test procedures are published after WTO/TBT notification procedure.



Top Runner Approach

- By target year, average fuel consumption must be higher than the best fuel efficiency in the base year.
- Standard should be high but reachable because target values are already achieved by actual vehicles in the base year.
- Particular types of cars such as HEVs and MT mounted cars are excluded from top runner



1. Background

2. Test procedure

3. Target Value and Improvement

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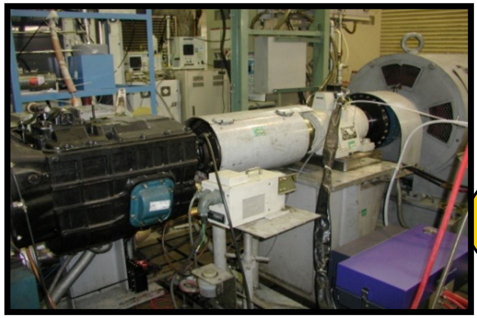
Overview of Test procedure

○ FE of HDVs is measured by engine dynamometer, not using whole vehicle. FE map of an engine is measured by this instrument.

○ By using computer simulation with FE map and vehicle specification data, FE of HDV is calculated.

○ With computer simulation, we can save cost and time, because FE map data of a engine can be used for various vehicle with that engine.



Driving mode
(time and speed)

combine with JE05 mode and Interurban driving mode

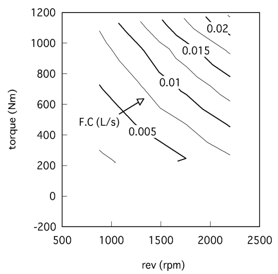
Conversion program
・determine gear-shift positions
・calculate engine speed and torque

Vehicle specifications
（vehicle weight, tire resistance, transmission etc.）

Engine operating mode

computing

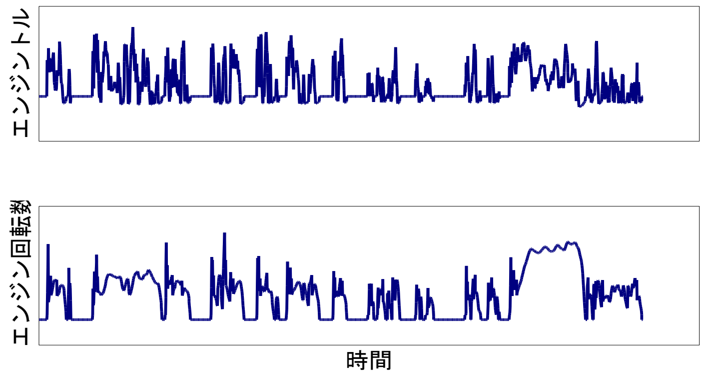
Fuel efficiency map



Fuel consumption

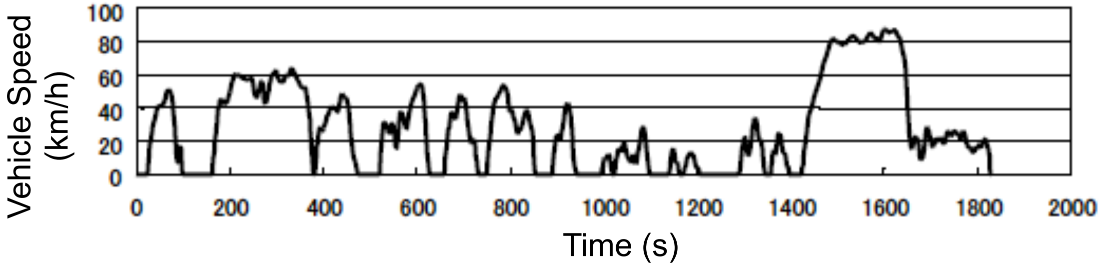
$$燃料量 = \sum_{i=start}^{end} F.C(i)$$

Fuel efficiency



"Heavy-duty Vehicle Mode"

- ▶ **Urban Driving Mode = JE05 Mode**



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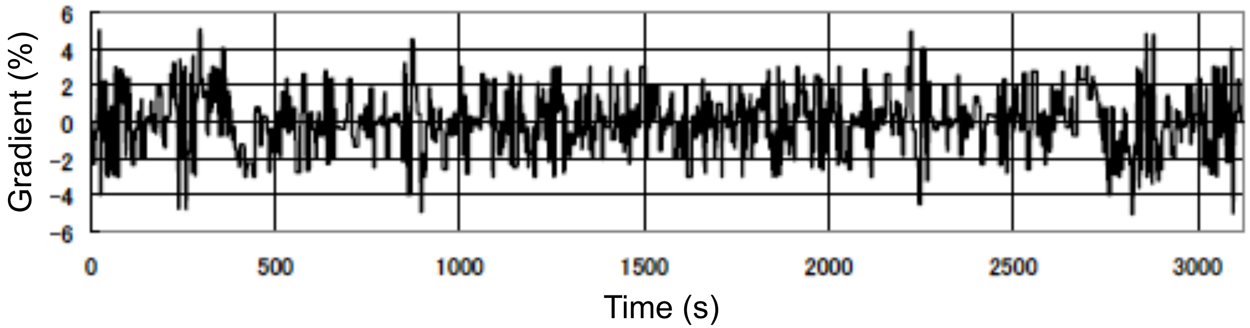
- ▶ **Interurban Driving Mode**
  = 80km/h Constant Speed Mode with Road Gradient



➡ **Evaluation of Fuel Efficiency by *Simulation Method***

Simulation Method Overview

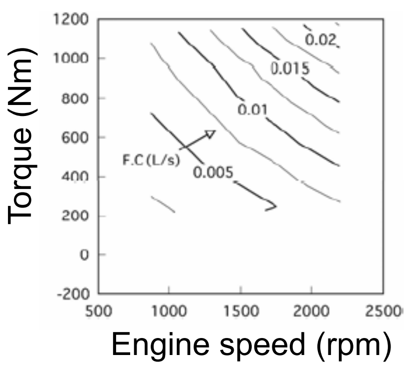
Driving mode = { **Urban driving mode** / **Interurban driving mode** }

Conversion program
- **Determine gear-shift positions.**
- **Calculate engine speed and torque.**

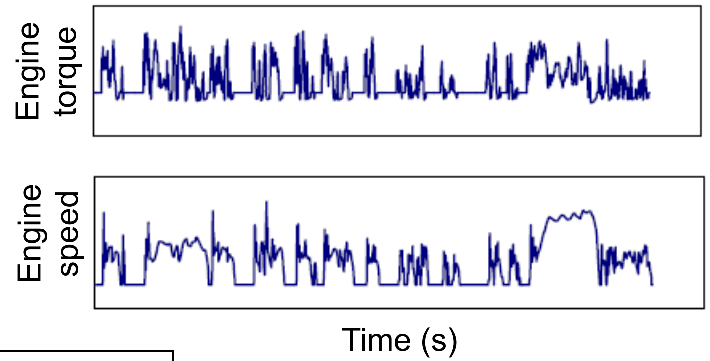
Vehicle specifications

Fuel efficiency map

Engine Operating Mode



Computing



Fuel consumption $= \sum_{i=start}^{end} F.C.(i)$

Fuel efficiency

***Before simulation, perform operation tests to create a fuel efficiency map**

Phase of conversion

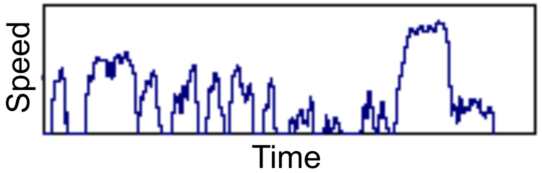
Speed vs. time

Engine speed / torque vs. time

Phase of calculation of fuel efficiency

Source: Japan Automobile Research Institute: Survey Report on Evaluation Methods for Heavy Vehicles, March 2003

Conversion Program Overview



Driving mode

The vehicle specifications (technical data)

Engine related parameters
- Full load engine torque
- Idling engine speed
- Maximum output engine speed
- Maximum engine speed with load

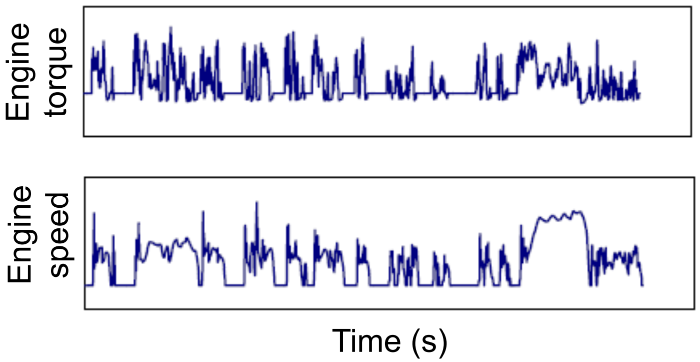
Drivetrain related parameters
- Number of transmission gears
- Transmission gear ratios
- Final reduction gear ratio
- Tire dynamic load radius

Driving resistance parameters
- Rolling resistance coefficient
- Air resistance coefficient

Vehicle weight related parameters
- Complete vehicle kerb weight
- Maximum load
- Riding capacity

Conversion program
Determine the shift lever position

Engine operating mode
- Engine speed
- Engine torque



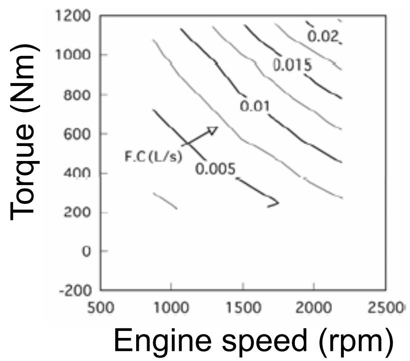
Characteristic of Simulation Method

“Simulation Method”

≠ Actual Engine Measurement Test by Driving Mode

✓ **The method is based on real vehicle and engine specifications.**

Fuel consumption map



Engine related parameters

- Full load engine torque
- Idling engine speed
- Maximum output engine speed
- Maximum engine speed with load

Drivetrain related parameters

- Number of transmission gears
- Transmission gear ratios
- Final reduction gear ratio
- Tire dynamic load radius

✓ **The method is an extension way of the emission test**

- Low cost and high test efficiency
- Reproducibility of driving resistance

Simulation Method Flowchart and Equation

Urban Driving Mode
JE05 mode
▶ **Engine Operating Mode** ▶ **E_u: Fuel Efficiency**

Combined ▶ **E: Fuel Efficiency**

Interurban Driving Mode
80km/h constant speed mode with gradient
▶ **Engine Operating Mode** ▶ **E_h: Fuel Efficiency**

$$E = 1 / (\alpha_u / E_u + \alpha_h / E_h)$$

E: **Heavy vehicle mode fuel efficiency (km/L)**
E_u: **Urban driving mode fuel efficiency (km/L)**
E_h: **Interurban driving mode fuel efficiency (km/L)**
α_u: **Proportion of urban driving mode**
α_h: **Proportion of interurban driving mode**

Driving Distance Proportion by Driving Mode

$$E = 1 / (\alpha_u / E_u + \alpha_h / E_h)$$

::

	Passenger vehicles (riding capacity : 11 persons or more)			Freight vehicles			
Vehicle Type	Ordinary bus		Route bus	Other than tractor		Tractor	
GVW	14 t or less	Over 14 t		20 t or less	Over 20 t	20 t or less	Over 20 t
Drive proportion							
Upper: α_u	0.9	0.65	1.0	0.9	0.7	0.8	0.9
Lower: α_h	0.1	0.35	0.0	0.1	0.3	0.2	0.1

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Target Standard Values: Passenger Vehicles

Ordinary Bus

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Vehicle Category	Gross Vehicle Weight Range (t)	Target Standard Values (km/L)
B1	3.5 < & ≤ 6	9.04
B2	6 < & ≤ 8	6.52
B3	8 < & ≤ 10	6.37
B4	10 < & ≤ 12	5.70
B5	12 < & ≤ 14	5.21
B6	14 < & ≤ 16	4.06
B7	16 <	3.57

Route Bus

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Vehicle Category	Gross Vehicle Weight Range (t)	Target Standard Values (km/L)
BR1	6 < & ≤ 8	6.97
BR2	8 < & ≤ 10	6.30
BR3	10 < & ≤ 12	5.77
BR4	12 < & ≤ 14	5.14
BR5	14 <	4.23

Target Standard Values: Freight Vehicles

Other Than Tractor

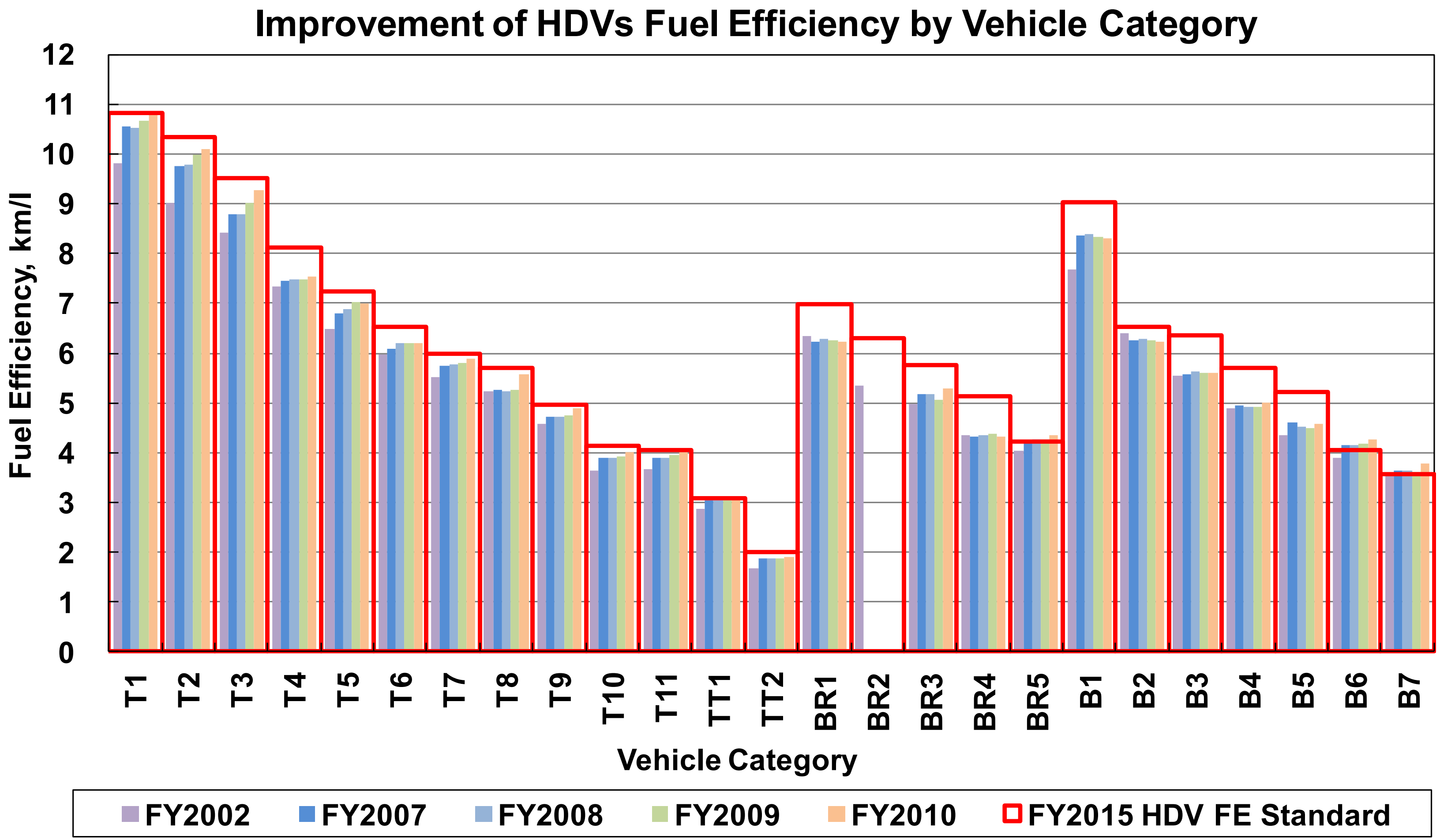
Vehicle Category	Gross Vehicle Weight Range (t)	Maximum Load Range (t)	Target Standard Values (km/L)
T1	3.5 < & ≤ 7.5	≤ 1.5	10.83
T2		1.5 < & ≤ 2	10.35
T3		2 < & ≤ 3	9.51
T4		3 <	8.12
T5	7.5 < & ≤ 8		7.24
T6	8 < & ≤ 10		6.52
T7	10 < & ≤ 12		6.00
T8	12 < & ≤ 14		5.69
T9	14 < & ≤ 16		4.97
T10	16 < & ≤ 20		4.15
T11	20 <		4.04

Tractor

Vehicle Category	Gross Vehicle Weight Range (t)	Target Standard Values (km/L)
1	≤ 20	3.09
2	20 <	2.01

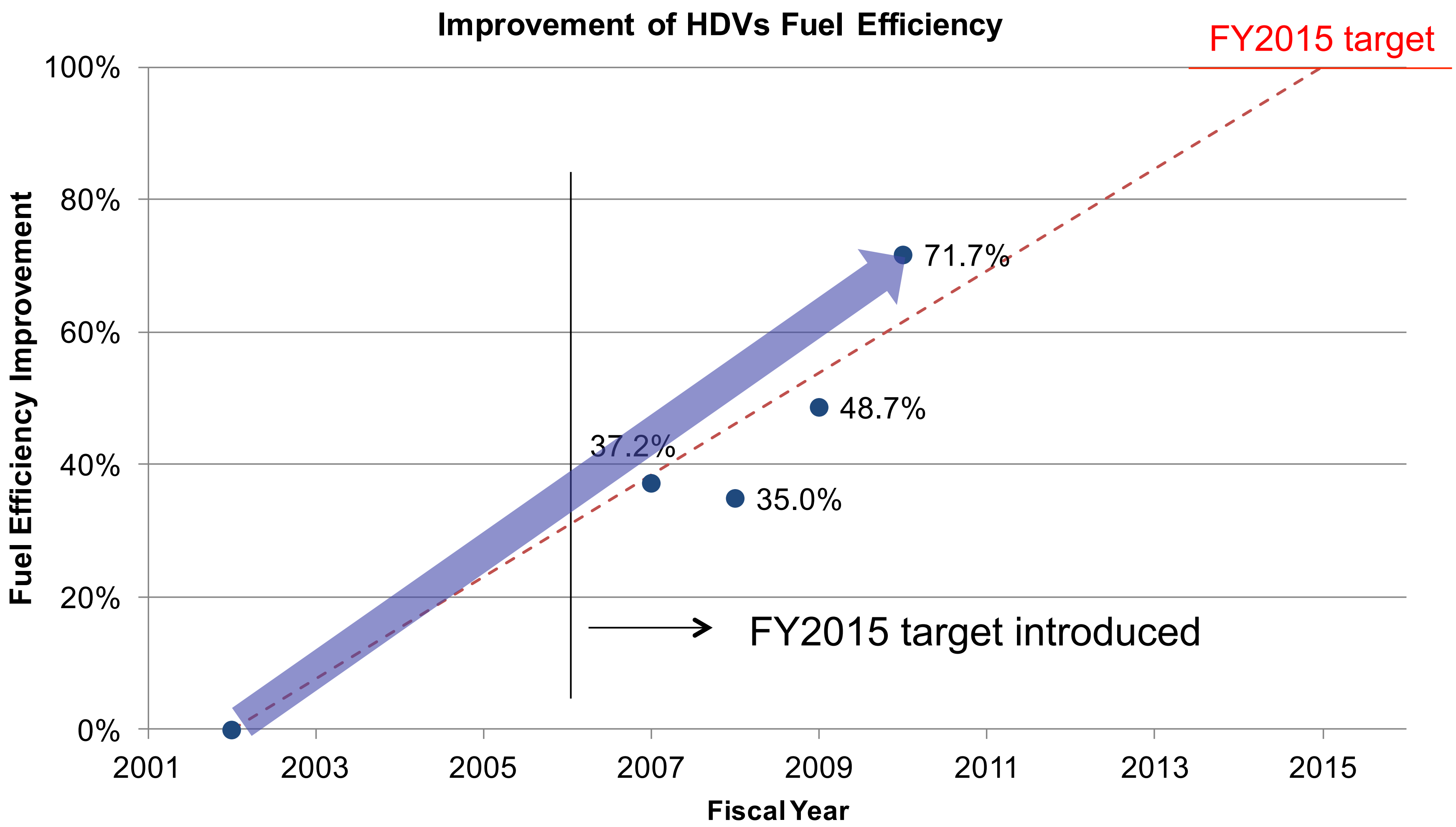
Improvement of HDVs Fuel Efficiency (1)

- Through the HDV FE standards, average fuel efficiency has been increasing to the target values.
- However, in some categories, especially in buses, average fuel efficiency has not been improved well.



Improvement of HDVs Fuel Efficiency (2)

- Through the HDV FE standards, average fuel efficiency has been increasing steadily to the target values.
- However, in some categories, average fuel efficiency has not been improved well.



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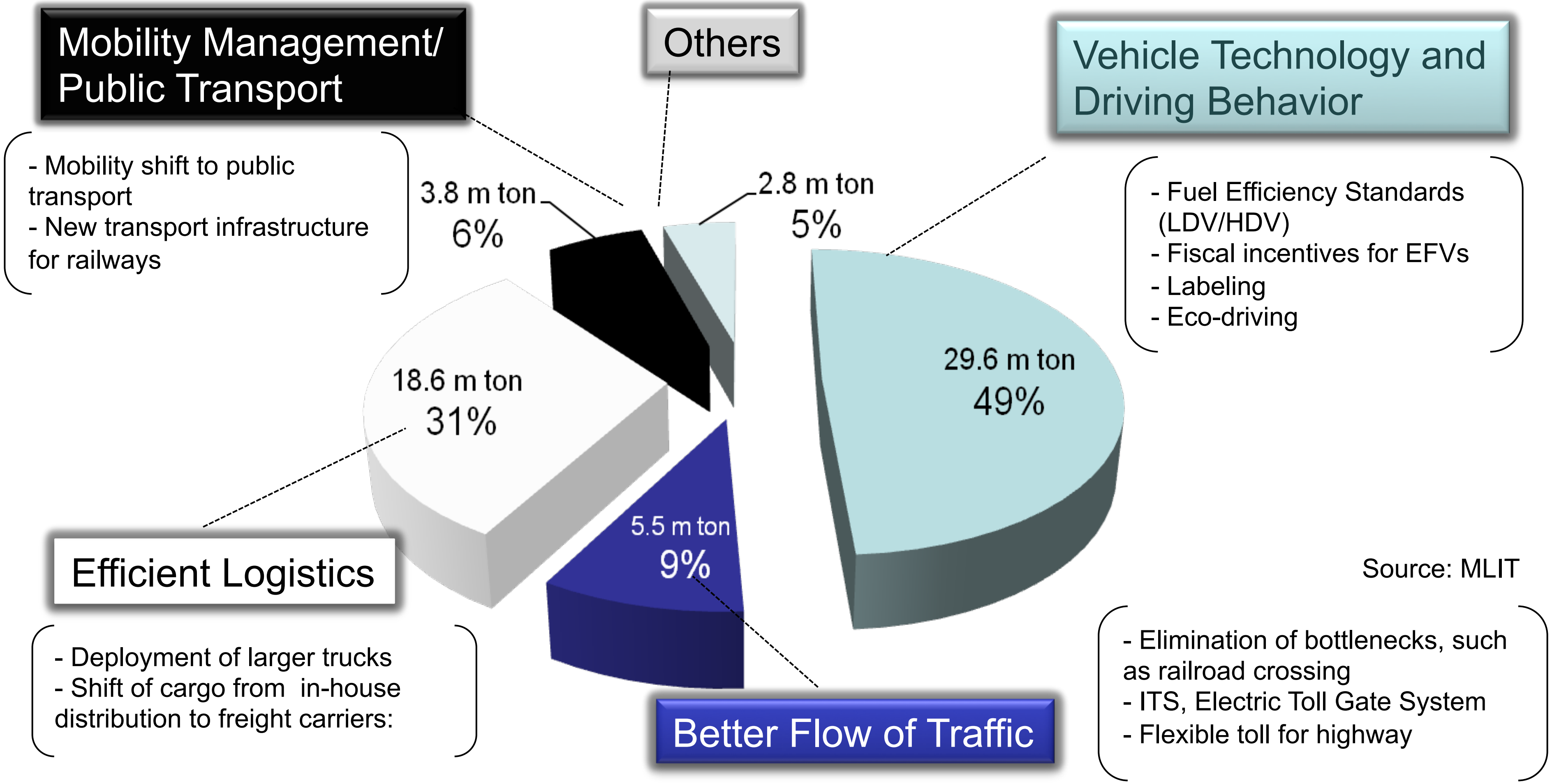
Key for success; Integrated Approach

- ○ The key for success is the policy approach that integrates all the relevant measures.
- ○ This approach designed and coordinated all the measures so that both maximized CO2 reduction and minimized social and economic cost can be achieved.

Breakdown of reduction potential In transport sector



Source: MLIT

Japanese Integrated Approach

How to reduce CO2 emission?

Various factors are related to amount of CO2 emission from vehicles.
(energy efficiency, traffic congestion, ・・・)

It is not reasonable to focus only on improvement of vehicle performance.

Integrated approach has been introduced in Japan.

- Approaches from 3 viewpoints
  - ・vehicle performance
  - ・usage
  - ・infrastructure

Vehicle performance improvement (Tax Incentive)

Term Apr. 2008 - Mar. 2011	Initial tax (Acquisition tax)	Annual tax (Auto tax/ Weight tax)
Next generation vehicles EV, PHEV, HV, CNG, Clean Diesels	**Exempted**	**Exempted (weight tax)/** **-50% (Auto tax)**
Normal ICEs (passenger cars) 平成22年度 燃費基準+25%達成車 and ★★★★ 低排出ガス車 平成17年排出ガス基準75%低減 国土交通大臣認定車 +25% 2010 FE reg, +75% JP05	**-75%**	**-75%(weight tax)/** **-50% (Auto tax)**
平成22年度 燃費基準+15%達成車 and ★★★★ 低排出ガス車 平成17年排出ガス基準75%低減 国土交通大臣認定車 +15% 2010 FE reg, +75% JP05	**-50%**	**-50%(weight tax)/** **-25% (Auto tax)**
Normal ICEs (Heavy duty vehicles) 平成27年度 燃費基準達成車 and JP09 level 2015 FE reg	**-75%**	**-75%(weight tax)**
平成27年度 燃費基準達成車 and ★ 低排出ガス重量車 平成17年基準NOx&PM10%低減 国土交通大臣認定車 2015 FE reg, +10% JP05	**-50%**	**-50%(weight tax)**

High tax incentives are accelerating dissemination of fuel-efficient cars significantly.

Subsidies for introduction of low-pollution vehicles, etc.

○ By subsidies for bus and truck companies, the use of low-pollution vehicles is promoted and the air environment is improved.

Government → Subsidies → Truck, bus, and taxi companies ← Subsidies ← Local public agencies, etc.

Subsidiary		Subsidiary rate
New vehicles	CNG truck and bus 	1/3 of difference with normal vehicle price or 1/4 of vehicle main body price
	Hybrid truck, bus and taxi 	
	Electric vehicle (including PHV)  	1/2 of difference with normal vehicle price or 1/4 of vehicle main body price
Remodeling of in-use vehicles to CNG vehicles or Electric vehicles		1/3 of remodeling cost

Usage improvement (Eco-driving)

○ Eco-driving contributes to fuel efficiency and CO2 reduction by 10% in average.
○ Campaigns, education, monitoring programs should play an important role, as well as in-car equipment to assist eco-driving.

Eco-driving assist system/ Fuel consumption meter

Education and monitoring program

National campaign "10 tips for Eco-Driving"

Next generation EFV project

○ A national project" Next generation EFV(HDV) project" has been implemented to develop next-generation low-pollution trucks and buses in cooperation with research institute, academics, manufactures. Verification running tests for improving their practicability are being conducted.

<Developed Vehicle types>

<DME Vehicle>

<Inductive power transferred hybrid vehicles>

<Large CNG Vehicles >

<LNG Vehicles>

<FTD Vehicles>

<Super Clean Diesel Engine>

<Hydrogen Engine>

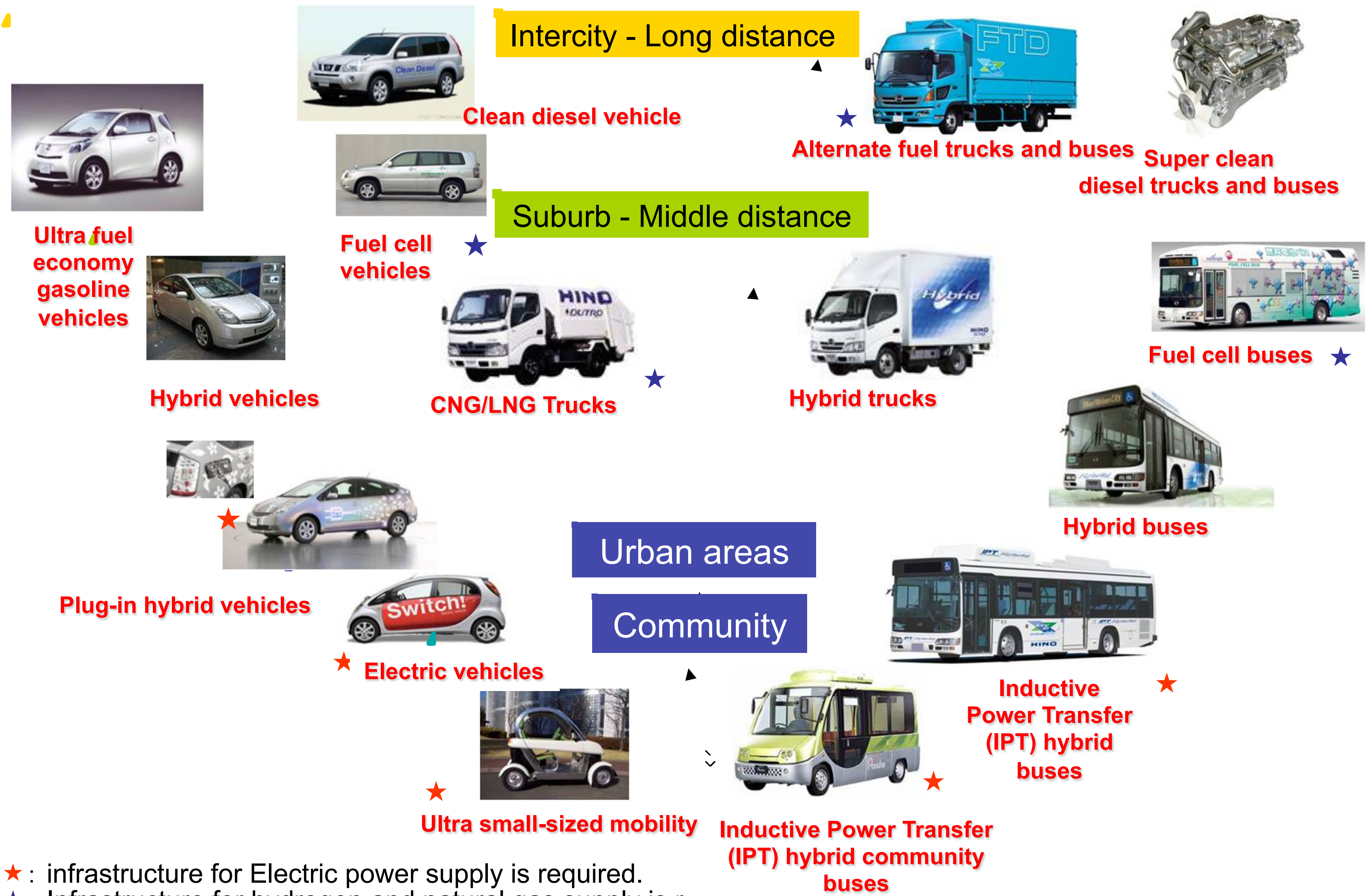
<Vehicle types under development>

<Electric/ Plug-in hybrid Trucks>

<Next-Gen Biodiesel engines>

<High performance electric route buses>

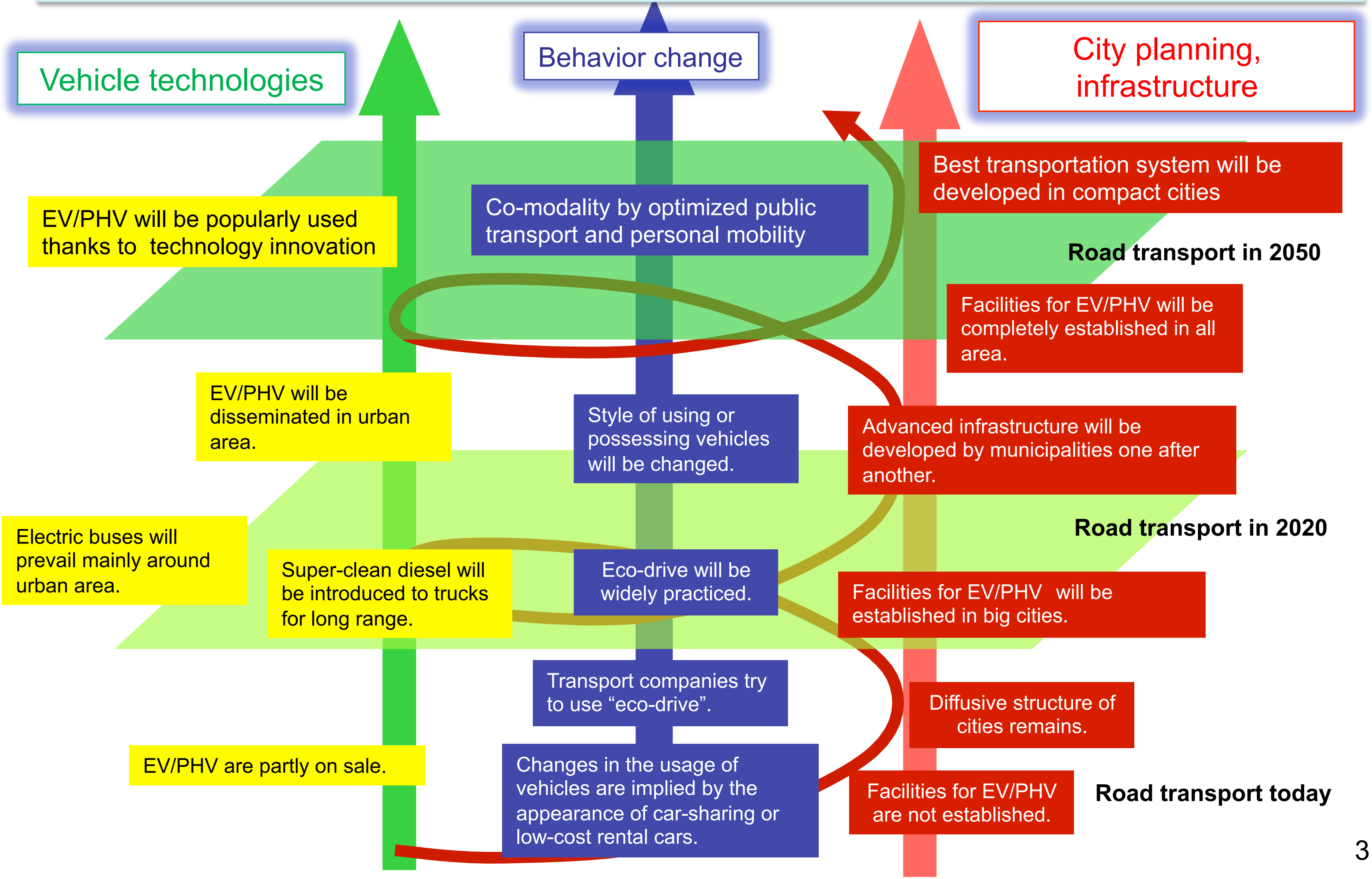
Best use of new propulsion system and conventional vehicles



★ : infrastructure for Electric power supply is required.
★ : Infrastructure for hydrogen and natural gas supply is required.

Future transport

Future of road transport should be realized through harmonized and simultaneous evolution of “vehicle technologies”, “people’s behavior” and “city planning/Infrastructure”.



Summary

1. Fuel efficiency target standard values for heavy duty vehicles were set in JAPAN in 2006 for the first time in the world.

2. Average fuel efficiency has been improving from 2006 by introducing the target standard values.

3. In the test procedure, Japan has been using simulation method, because stand-alone engine test requires large resources (time, labor and money).

4. Japan has been taking Integrated approach to mitigate the Global Warming, not only the improvement of the vehicles, but also the usage of them and city planning.

Thank you for your attention