# Session 3: Opportunities and challenges for increasing the role of rail

Its all about mode share and occupancy rates

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Subtitle:

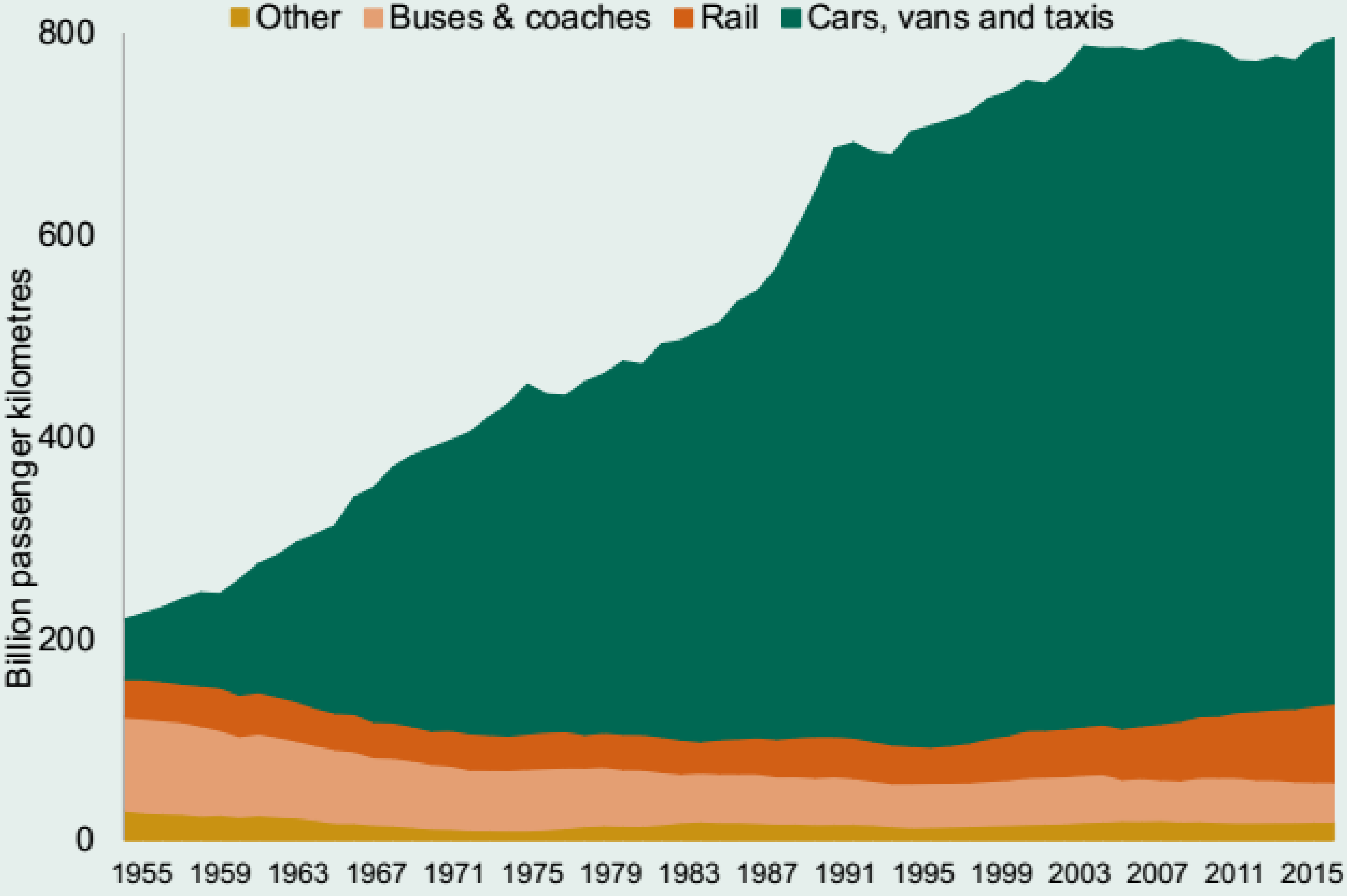
Its simple in principle

BUT

**All motion uses energy and produces pollution**
In general, as we become wealthier we travel further and faster
**And the faster we go the more energy we use**
Different fuels cause different emissions and at different places
Pollution can be both localised and global
**Sustainable transport is, in the strict sense, an oxymoron**

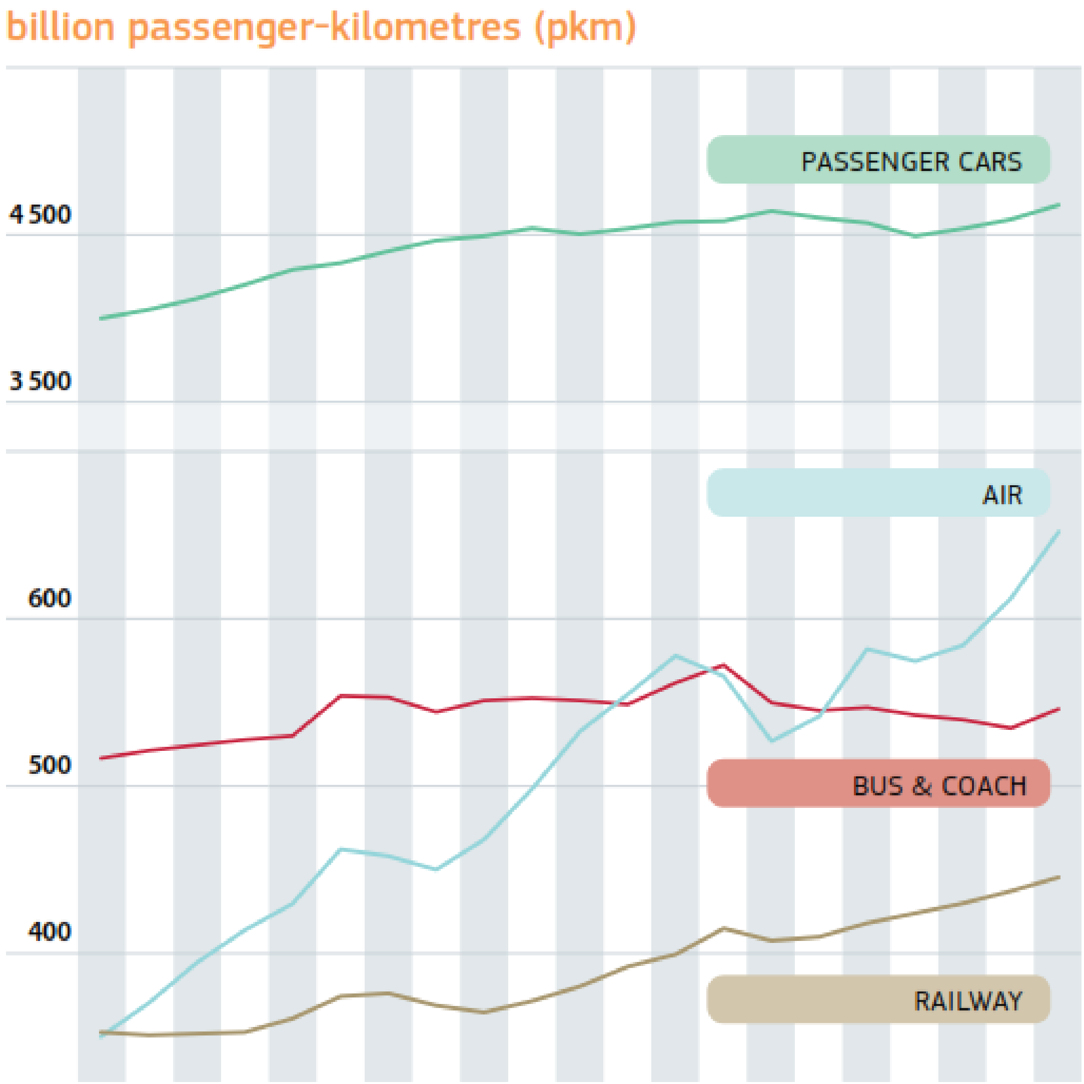
# Passenger transport [TSGB0101-0102]

Passenger kilometres by mode: Great Britain 1952 to 2015



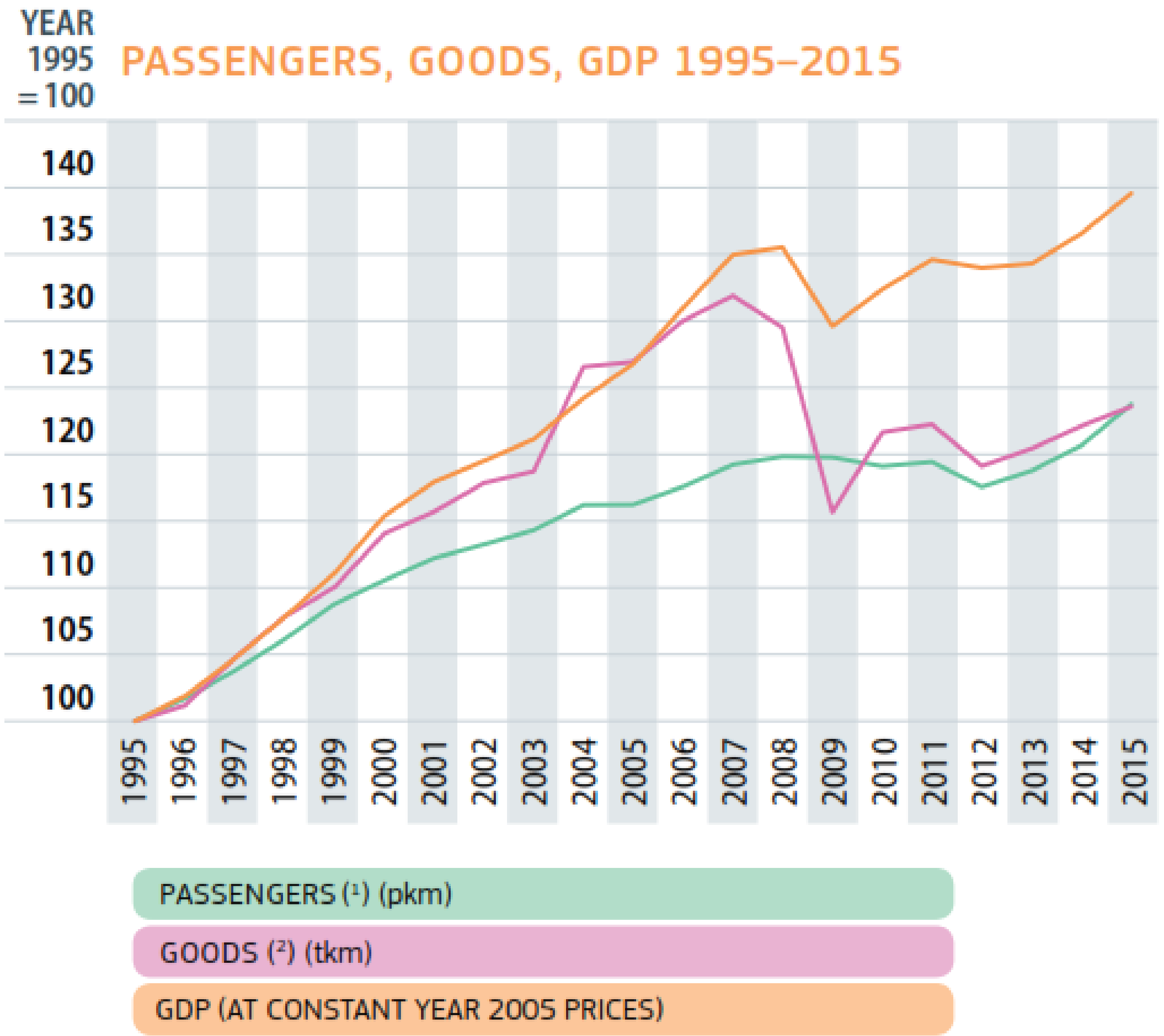
# EU-28 Performance for Passenger Transport 1995-2015 – BY MODE

2.3.1

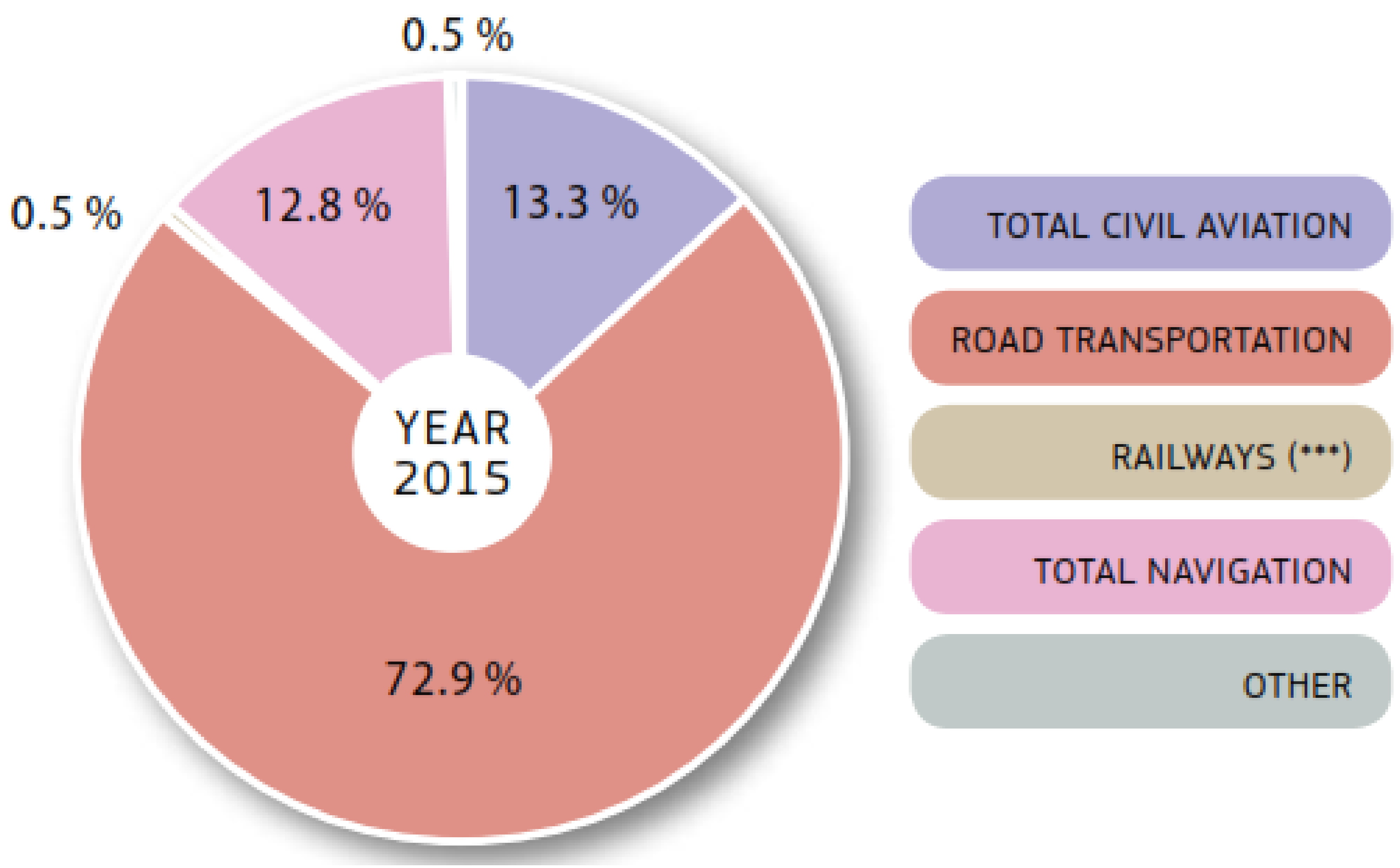


# Transport Growth EU-28





# $CO_2$ Emissions from Transport
## EU-28 – BY MODE (SHARES %)



# Typical values enegy required kWh per 100 passenger-km

| Car 1 occupant | 80 |
|---|---|
| Car 4 occupants | 20 |
| Ryan Air 2000 | 73 |
| Ryan Air 2007 | 37 |
| 747 full | 42 |
| 747 80% | 53 |
| Inter City train | 3-9 if full |
| Bus | 32 |

Challenges:

Travel less (probably impossible except work shift for commuting)

Use less energy

Driving style, constant speed, lighter vehicles etc,

Use different traction energy

Electricity (depends on how produced), store energy, regen. etc

Reduce pollution (particulates, $NO_X$ and $CO_2$ )

Improve design

Streamlining, better motors, yet again lighter

Improve passenger density, extend ETRMS

Trains are better:
BUT
Other modes improving (particularly autos)
Electric cars are rapidly improving
Energy storage difficult, but improving, flywheels, hydrogen?
Contactless charging

AND
**Trains need very expensive infrastructure, expensive in € and $CO_2$ to both build and to maintain.**

The elephant in the room:

**Occupancy rate** of trains comparatively low
**Growth** of the transport market wil swamp rails efforts

Take growth over 20 years, proportional to exp (growth rate X time)

With 2, 4, 6 % annual growth rate, market becomes
1.5, 2.23 and 3.32 times bigger

And emissions would increase by the same ratios, if there were no other
Interventions and the capacity would also need to increase to retain
the same mode share


go
easyJet

Optimum distance for HS rail km

300 1000

500 700


Electric
re-charging
lane

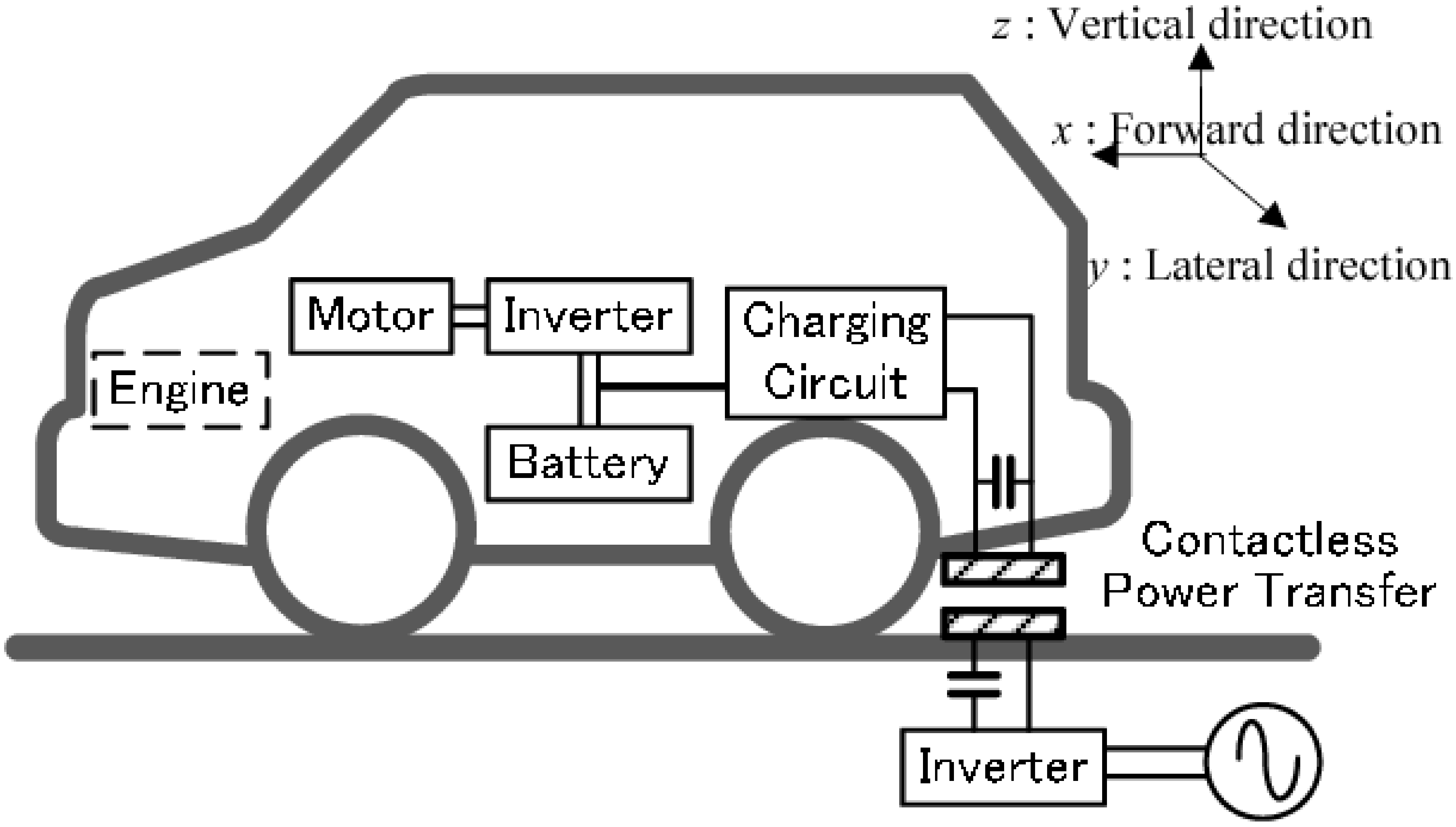
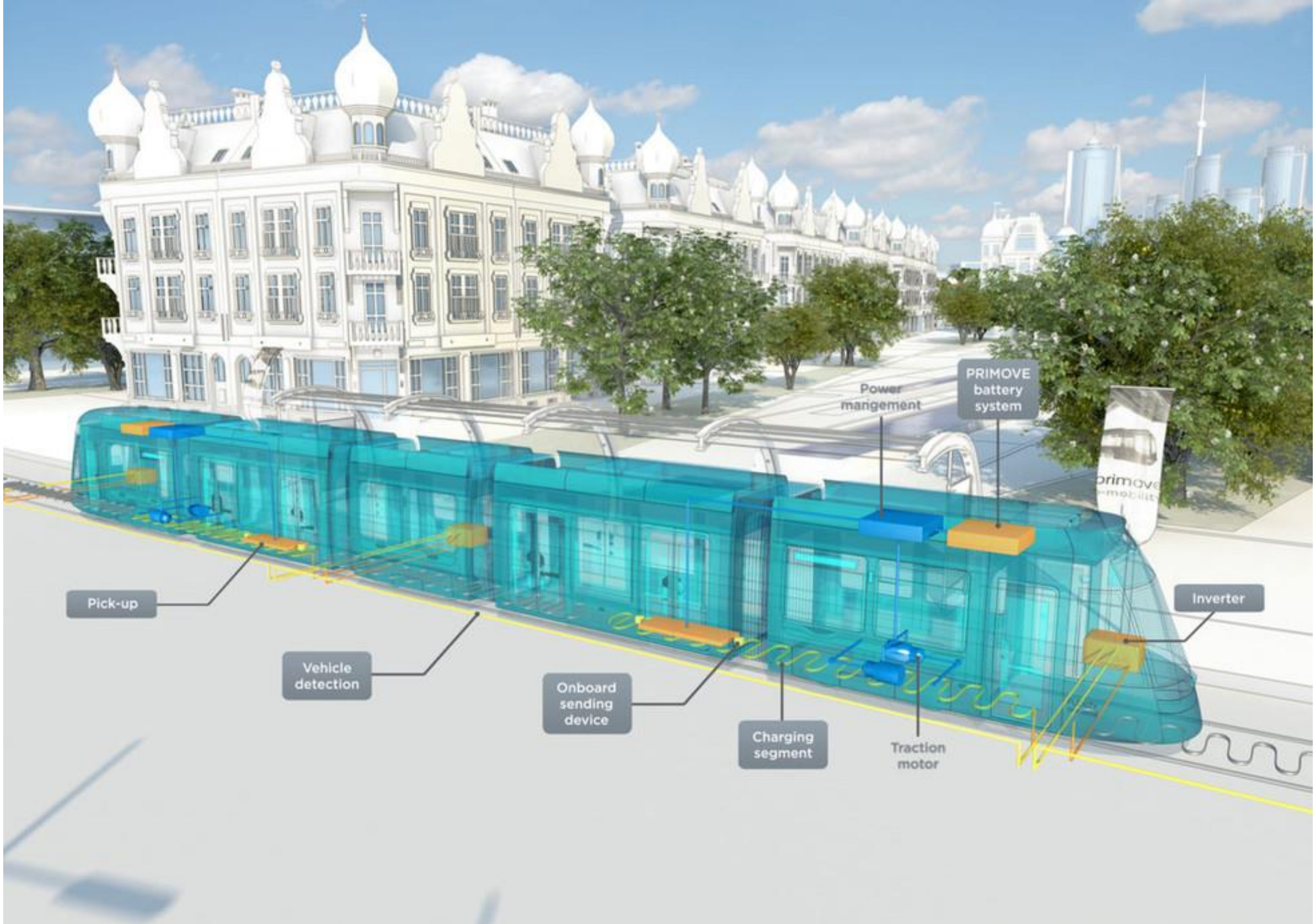



Fig. 1. Contactless power transfer system for an EV



Power
mangement
PRIMOVE
battery
system
Pick-up
Inverter
Vehicle
detection
Onboard
sending
device
Charging
segment
Traction
motor

# Advance of vehicle structure of Tokaido Shinkansen

| |  0 |  100 |  300 |  700 |  N700 |  N700A |  N700S |
|---|---|---|---|---|---|---|---|
| Max. Speed | 210km/h | 220km/h | 270km/h | 270km/h Sanyo/285km/h | 270km/h Sanyo/300km/h | 285km/h Sanyo/300km/h | 285km/h Sanyo/300km/h |
| Mass | 970t | 925t | 711t | 708t | 715t | 713t | 700t |
| Body | Steel | | Aluminum  (single-skin) | aluminum alloy  (double-skin) | | | |
| Bogie | Bolster | | Bolster-less | | | | lighter |
| Motor | DC 11840kw/train | DC 11040kw/train | Induction 12000kw/train | Induction 13200kw/train | Induction 17080kw/train | Induction 17080kw/train | smaller lighter |
| Acc. | 1.0km/h/s | 1.6km/h/s | | 2.0km/h/s | 2.6km/h/s | | higher |
| Brake | rheostatic | | regenerative | | | | |
| panto graph | cross-arm 8/train | cross-arm 3/train | single arm 2/train | | | | smaller lighter |

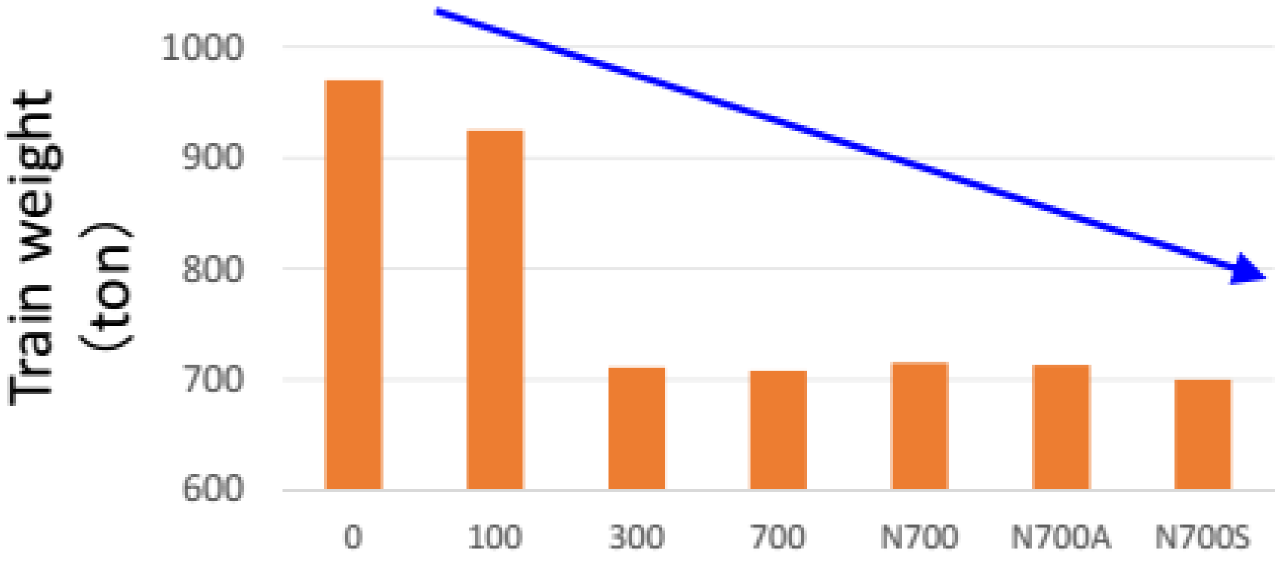
# Weight Reduction

**Weight Reduction of Vehicle**

car body, bogies, traction equipment, reduction of pantographs

Reduce axle loads

Reduce maintenance costs

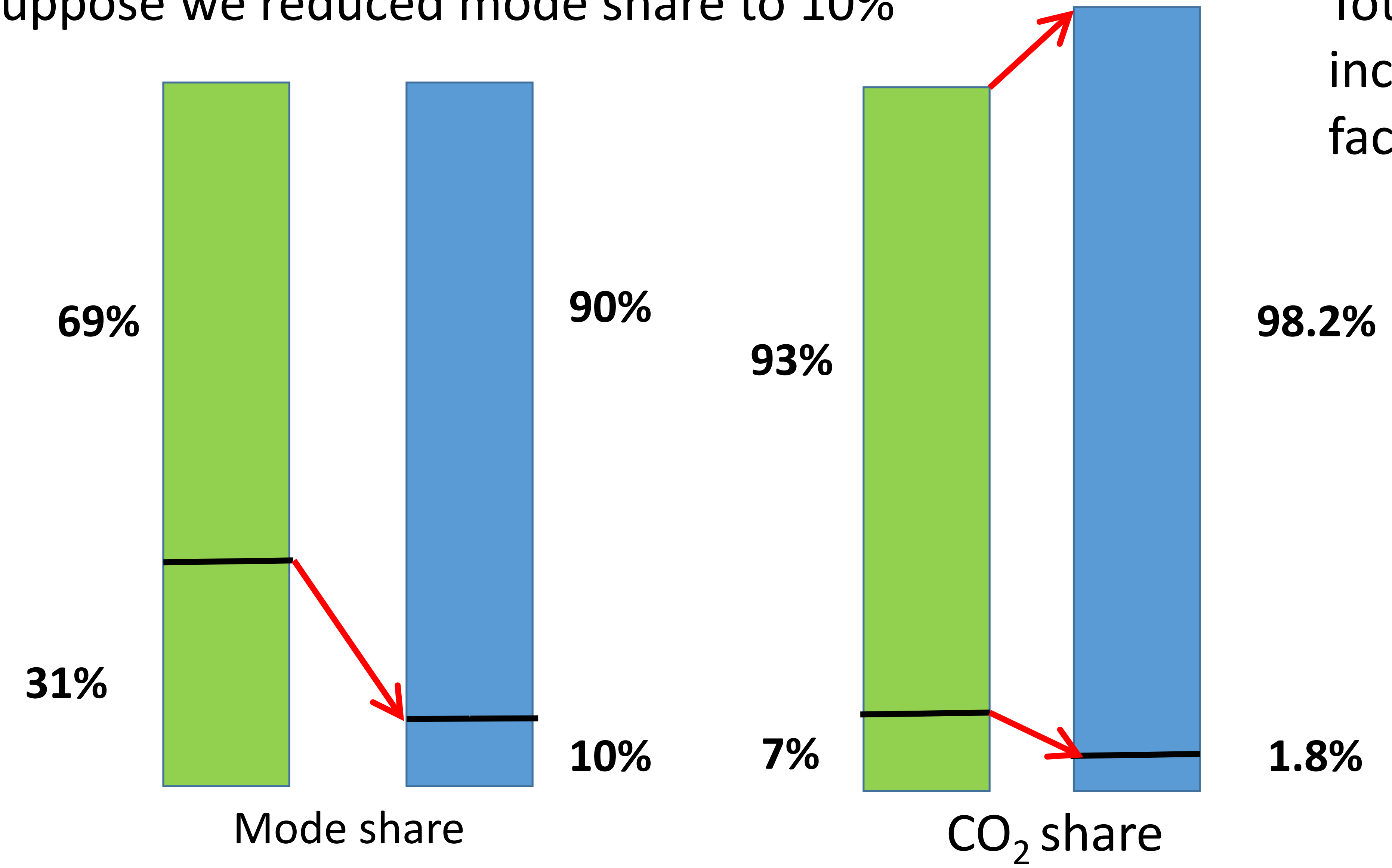



**Weight reduction can produce not only speed-up, but also reduction of energy consumption!**

Japan's rail mode share for passengers is 31%, worlds highest

Suppose we reduced mode share to 10%

Total emissions increased by factor of 1.24



# Rolling Stock of the Tokaido Shinkansen

## *Transition of Tokaido Shinkansen Rolling Stock

| 1964 | 1985 | 1992 | 1999 | 2007 | 2012 |
|---|---|---|---|---|---|

**1st generation rolling stock**

- Steel carbody
- Conventional bogie
- DC motor drive

**2nd generation rolling stock**

- Aluminum alloy carbody
- Bolsterless bogie
- Asynchronous motor drive (VVVF control)
- Regenerative brake

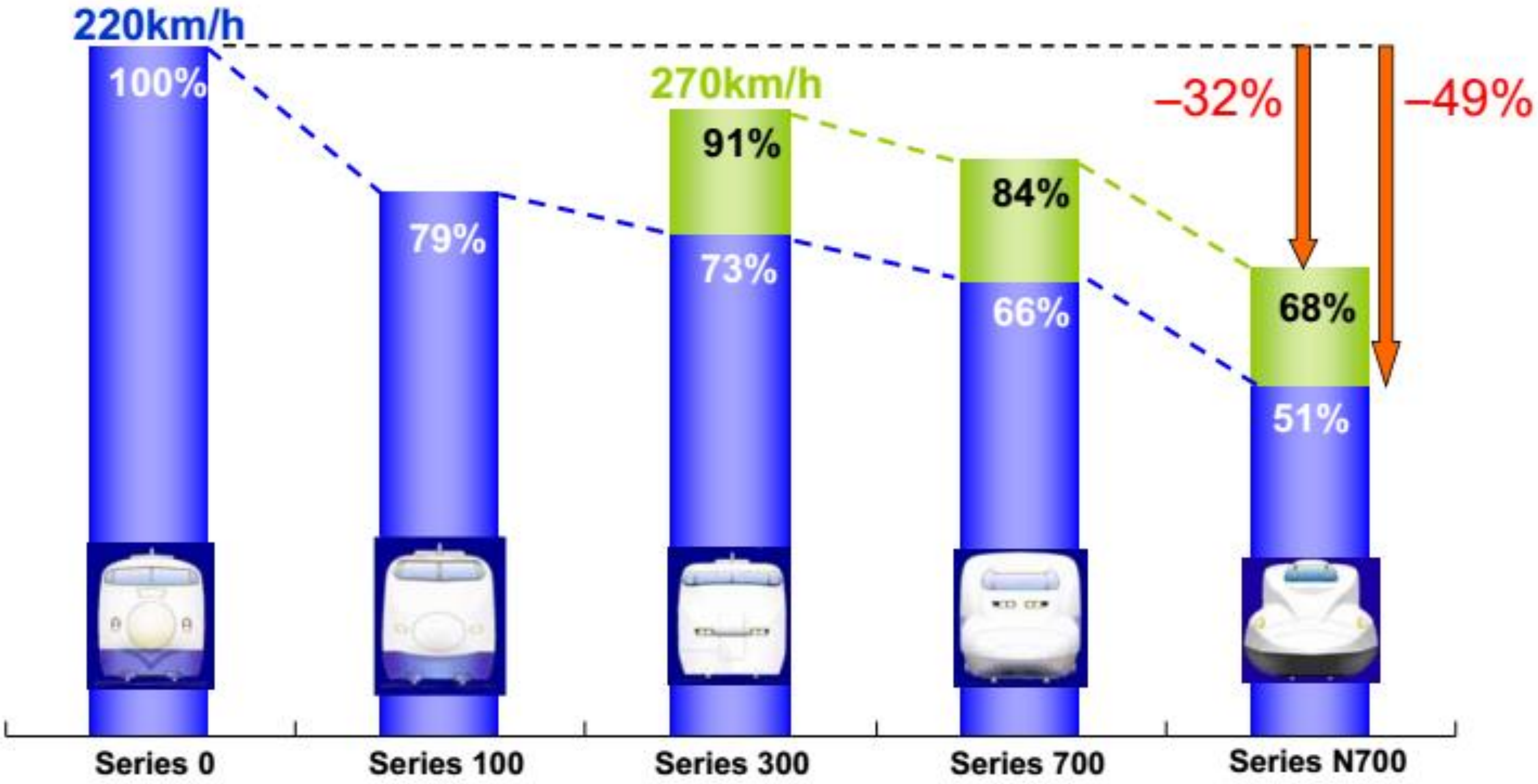
| Series 0 | Serires100 | Series 300 | Series 700 | Series N700 | Series N700A |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| 210km/h | 220km/h | 270km/h | 270km/h (285km/h) | 285km/h (300km/h) | 285km/h (300km/h) |
| 972t | 925t | 711t | 708t | 715t | |

※( ):Sanyo area

Note: Distriubuted traction from 1964

# Improvement of the Energy Efficiency

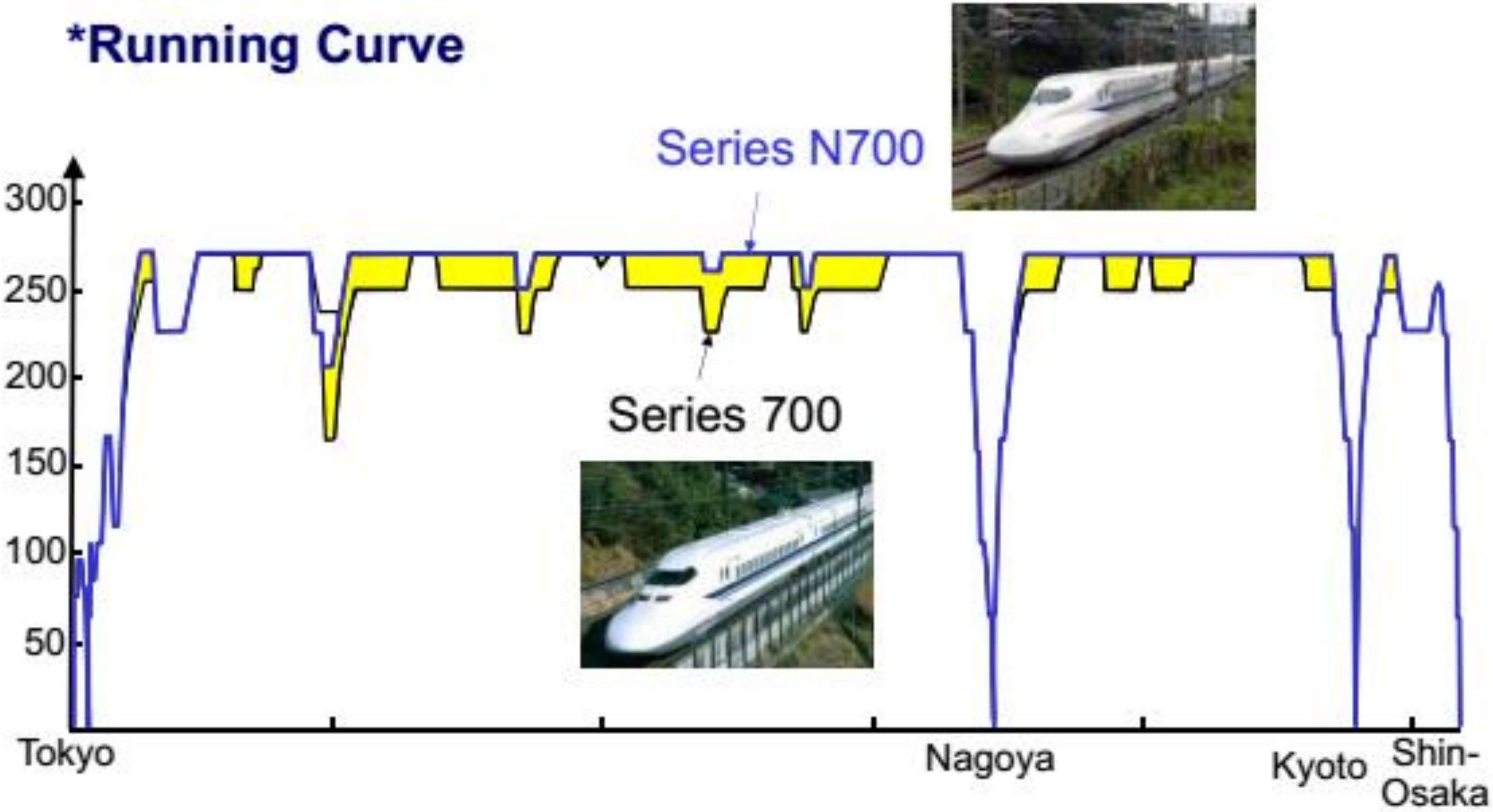
## *Improvement of the Energy Efficiency of Rolling Stocks




***Note***: Simulated run on Tokyo to Shin-Osaka route.

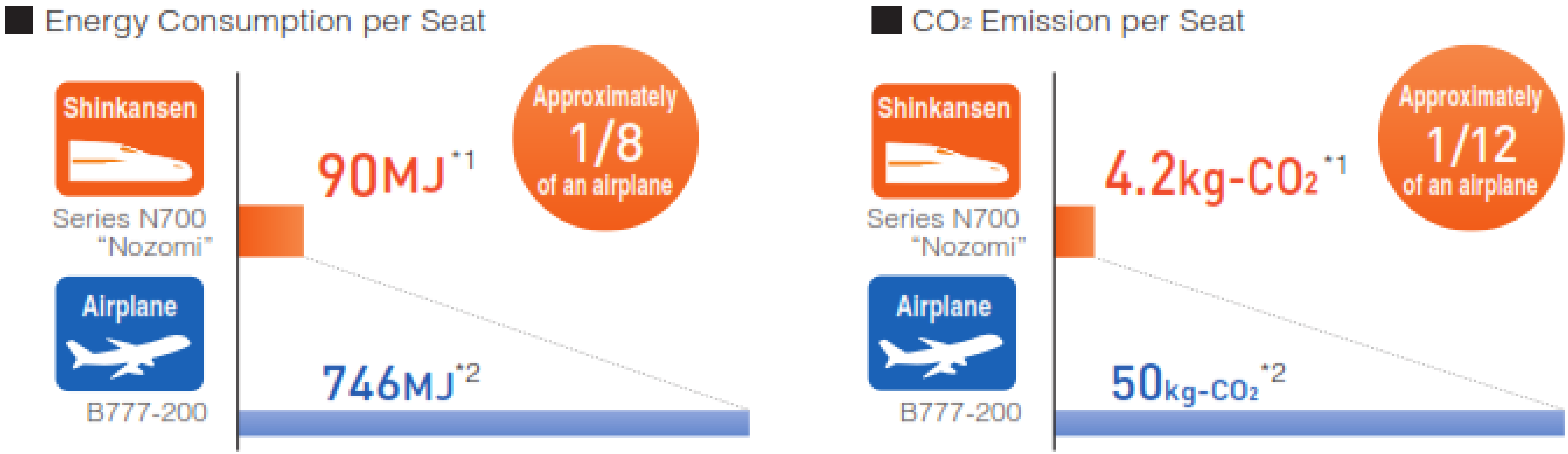
# “Body Inclining” cuts time and energy

## *Running Curve




Travel time is 5 minutes shorter (vs Series 700)

## Diagram 2 Comparison of the Tokaido Shinkansen and Airplanes (between Tokyo and Osaka)




*1 Calculation based on running performance of Series N700 Nozomi (Tokyo - Shin-Osaka) conducted by JR Central.
*2 Calculated by JR Central using ANA's "Annual Report 2011" B777-200 (Haneda - Itami/Kansai Airport) for reference.