# On the Sustainability of Battery Electric Vehicles from View Point of ” Well to Wheel Model”

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* New Generation Power Electronics System Research Consortium Japan

# Global Collaboration on Power Electronics




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# Technical term abbreviation

/Well to Wheel Model:  Well to Tank and Tank to Wheel
/Carbon Dioxide Emission Coefficient (Vehicle) : g/km
/Carbon Dioxide Emission Coefficient ( Power Plant) : kg/kWh
/Energy Density : Wh/kg (Battery, Gasoline)
/Fuel Efficiency : km/kWh (BEV), kw/L (ICEV)
/ICEV: Inner Combustion Engine Vehicle
/EV: Electric Vehicle
/HEV: Hybrid Electric Vehicle
/MHEV: Mild Hybrid Electric Vehicle
/SHEV: Strong Hybrid Electric Vehicle
/PHEV: Plug-in Hybrid Electric Vehicle
/EREV: Extended-Range Electric Vehicle
/BEV: Battery Electric Vehicle
/GDP: Growth Domestic Product
/SE: Solar Energy
/RE: Renewable Energy

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1. Analysis of direct $CO_2$ Emission from ICEVs

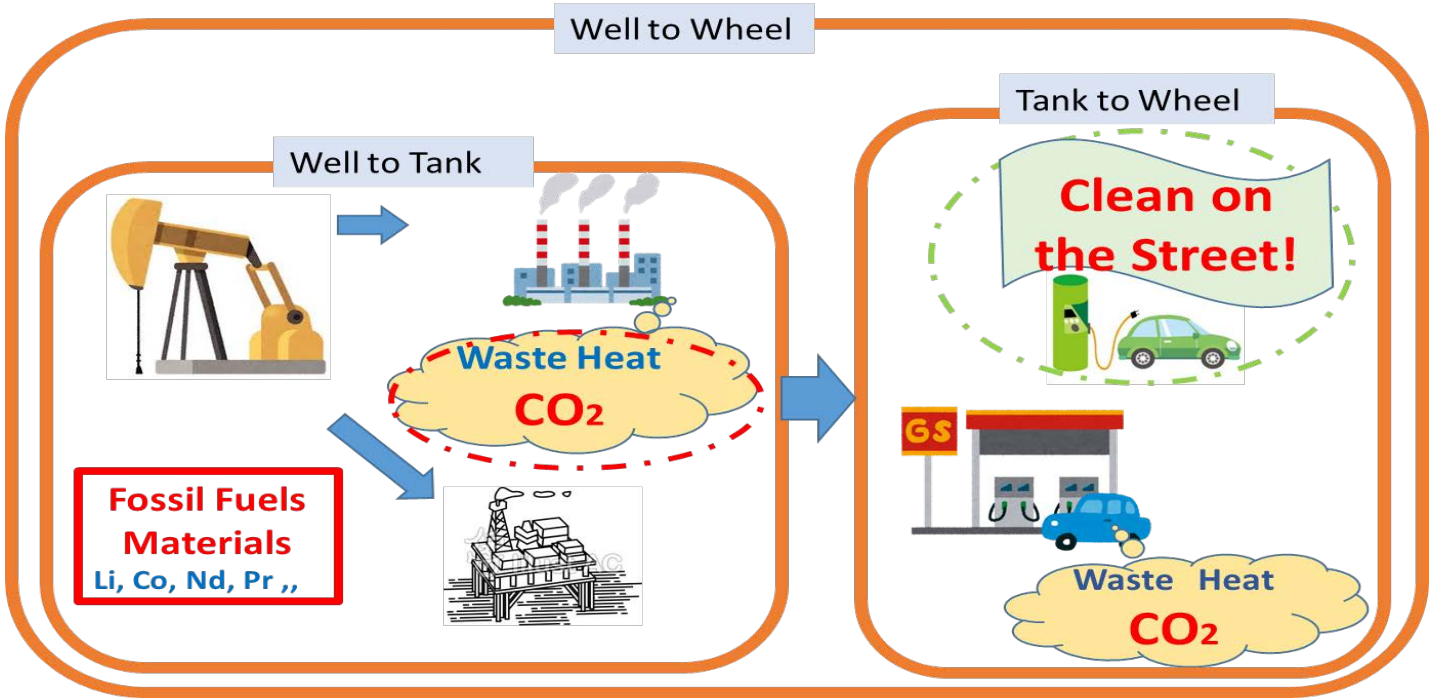
2. Analysis of indirect $CO_2$ Emission related to BEVs from view point of "Well to Wheel Model"【Fossil Fuel Power Generation】

3. Analysis of indirect $CO_2$ Emission related to vehicle battery systems 【Battery Transport, Energy Density (Wh/kg)】

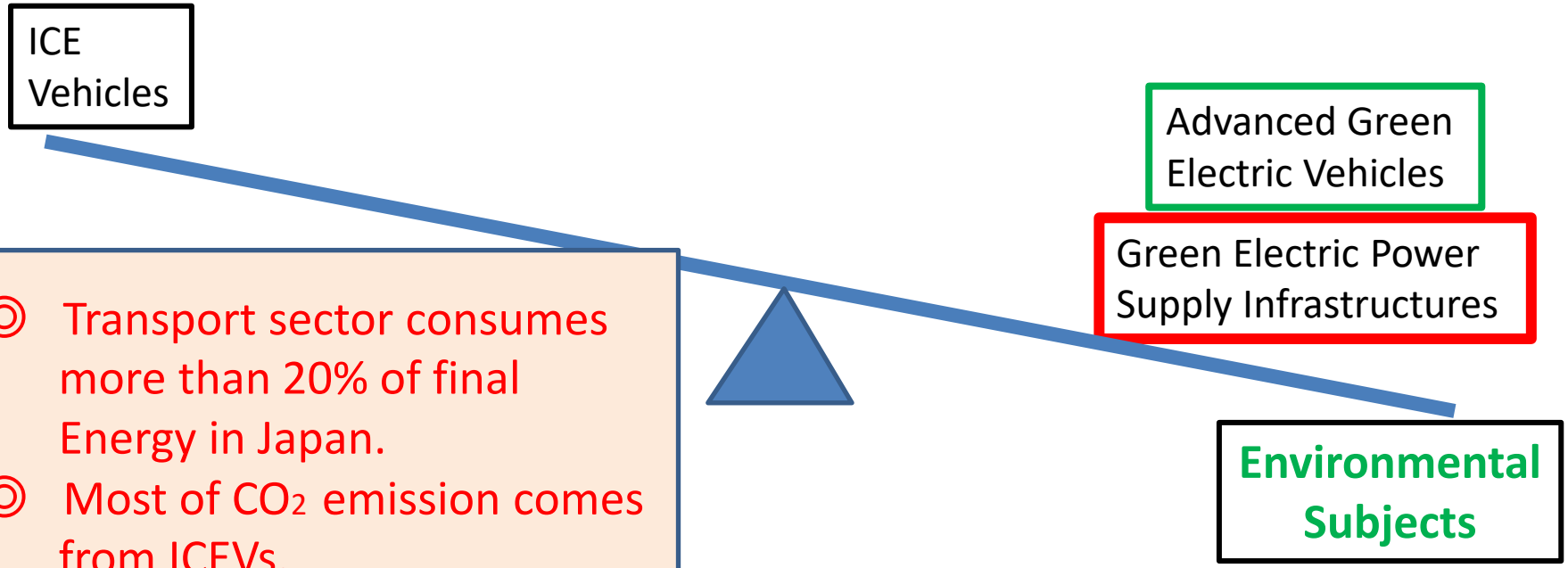
4. Analysis of indirect $CO_2$ Emission during manufacturing BEVs and Li-ion batteries based on macroeconomic model 【$CO_2$ Emission and GDP】

# Sustainable BEVs

## -Well to Wheel Model- (Energy, $CO_2$, Raw Materials)

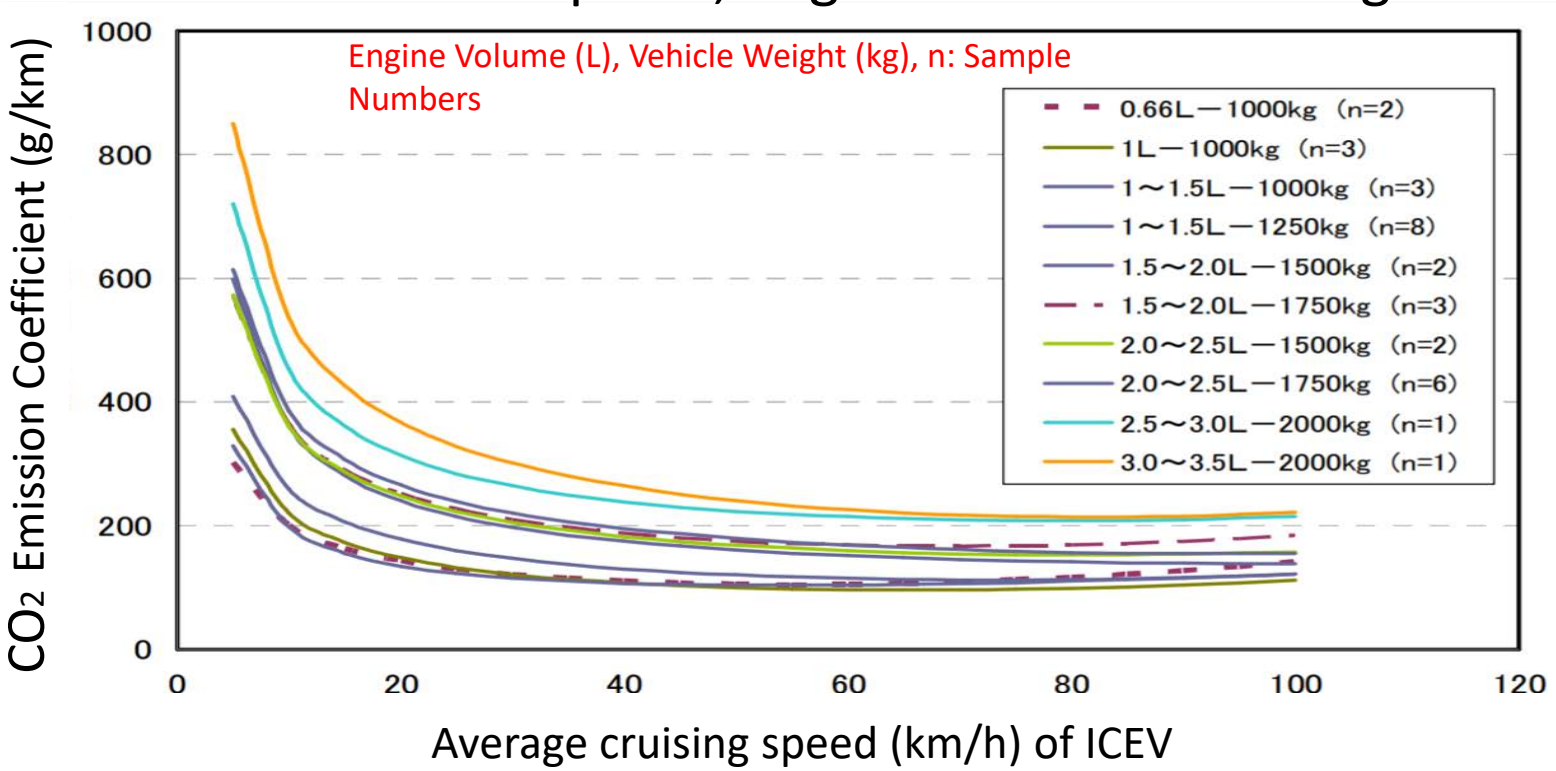


# Dissemination of green BEVs requires Green Logistic Support in Energy



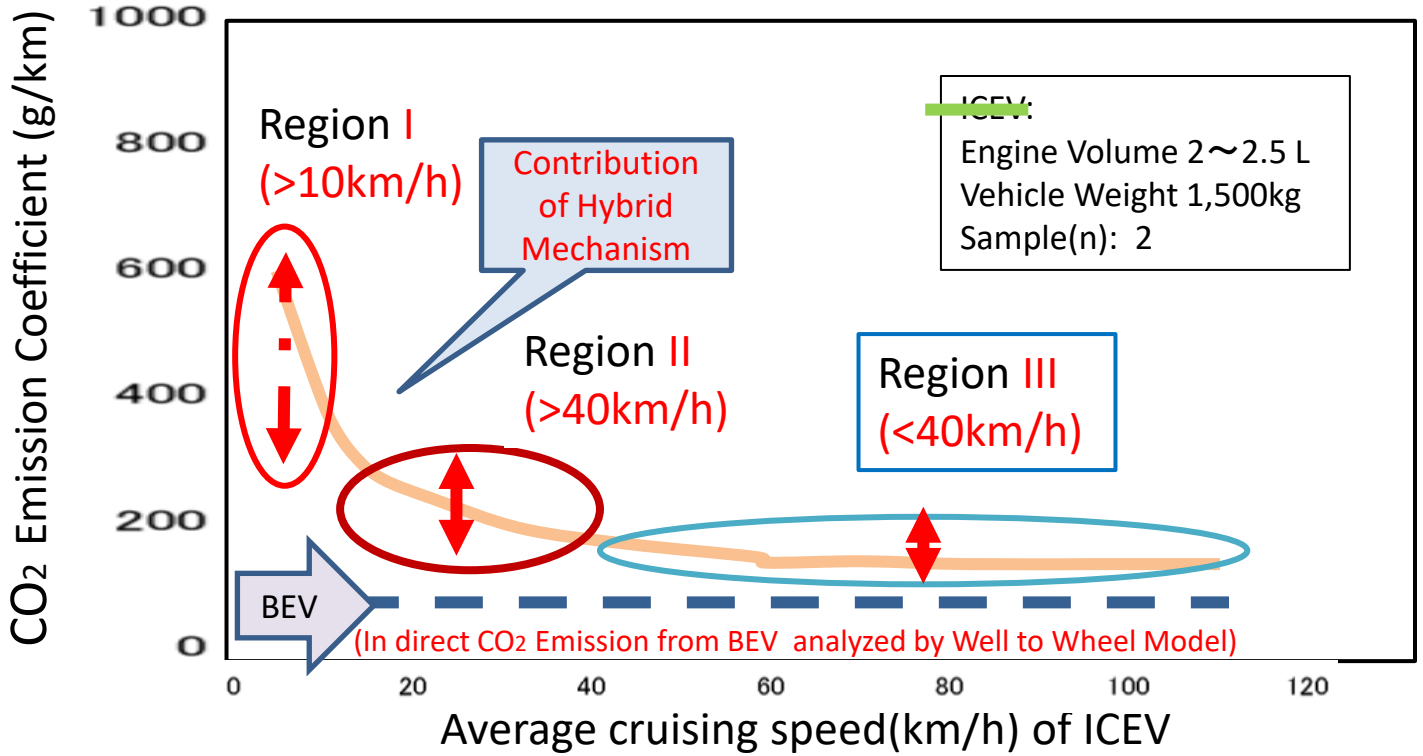

- ◎ Transport sector consumes more than 20% of final Energy in Japan.
- ◎ Most of $CO_2$ emission comes from ICEVs.

# Dependence of $CO_2$ Emission from ICEVs on Speed , Engine Volume and Weight *1




*1 https://www.tokyokankyo.jp/kankyoken_contents/report-news/2008/hokoku204.pdf

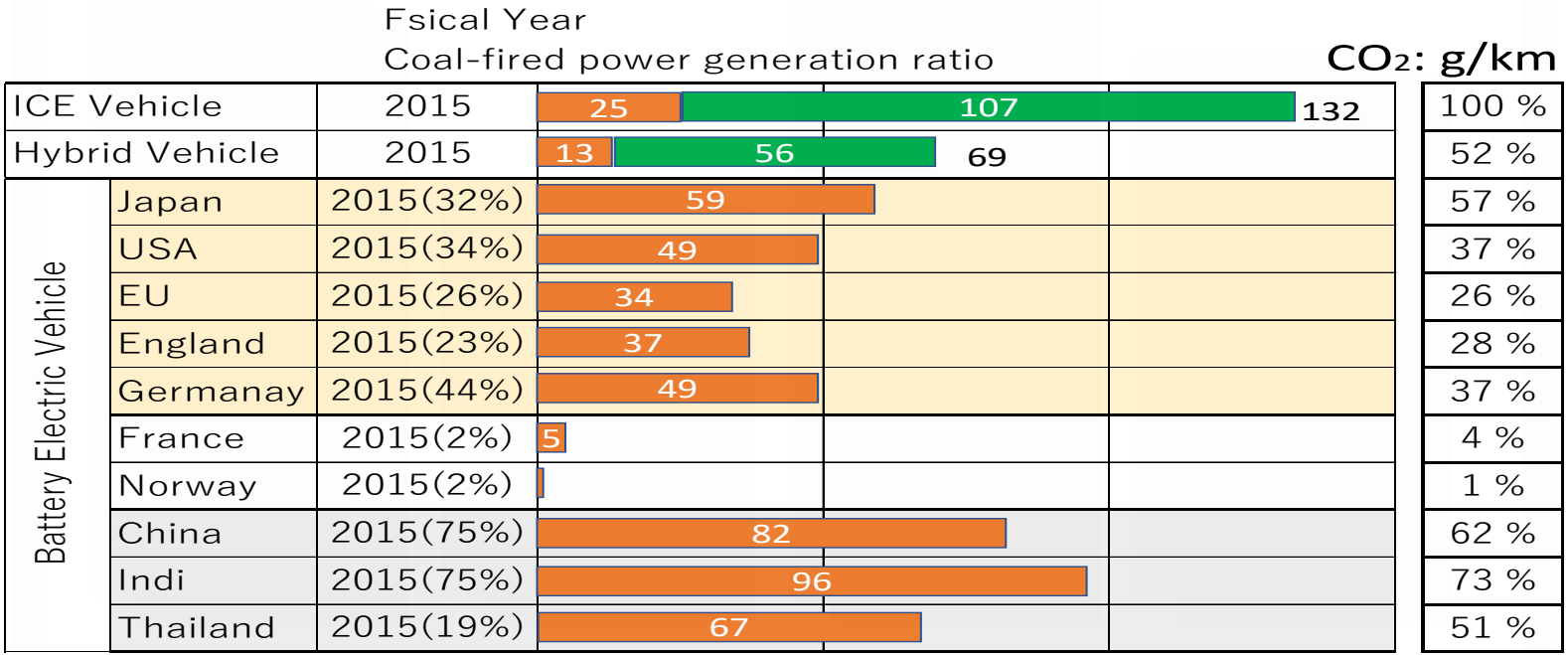
# Dependence $CO_2$ Emission Characteristics from a model ICEV on cruising Speed



## Analyses of $CO_2$ Emission from Well to Wheel by METI

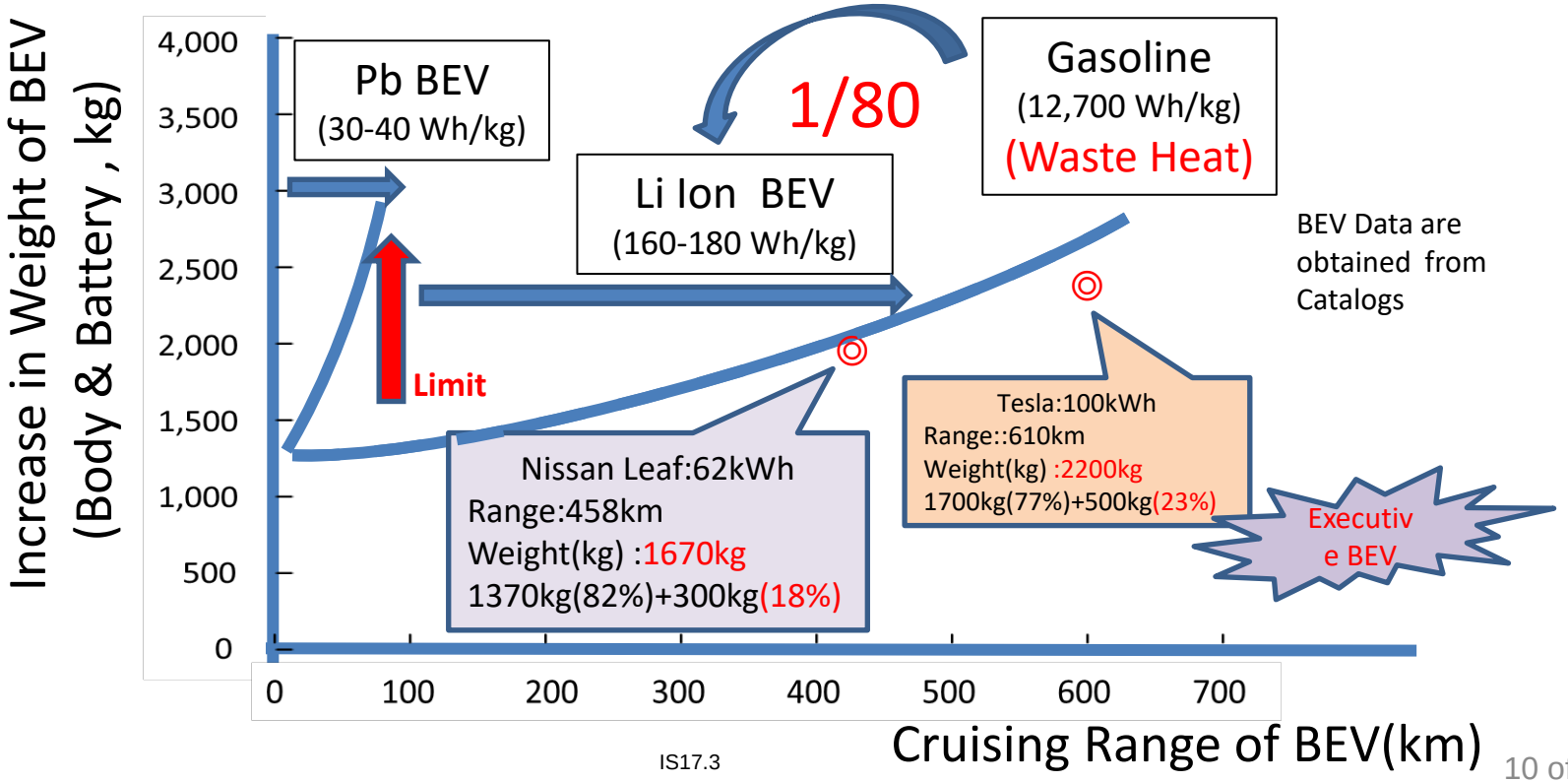
Estimated from Well-to -Tank

Estimated from Tank-to-Wheel

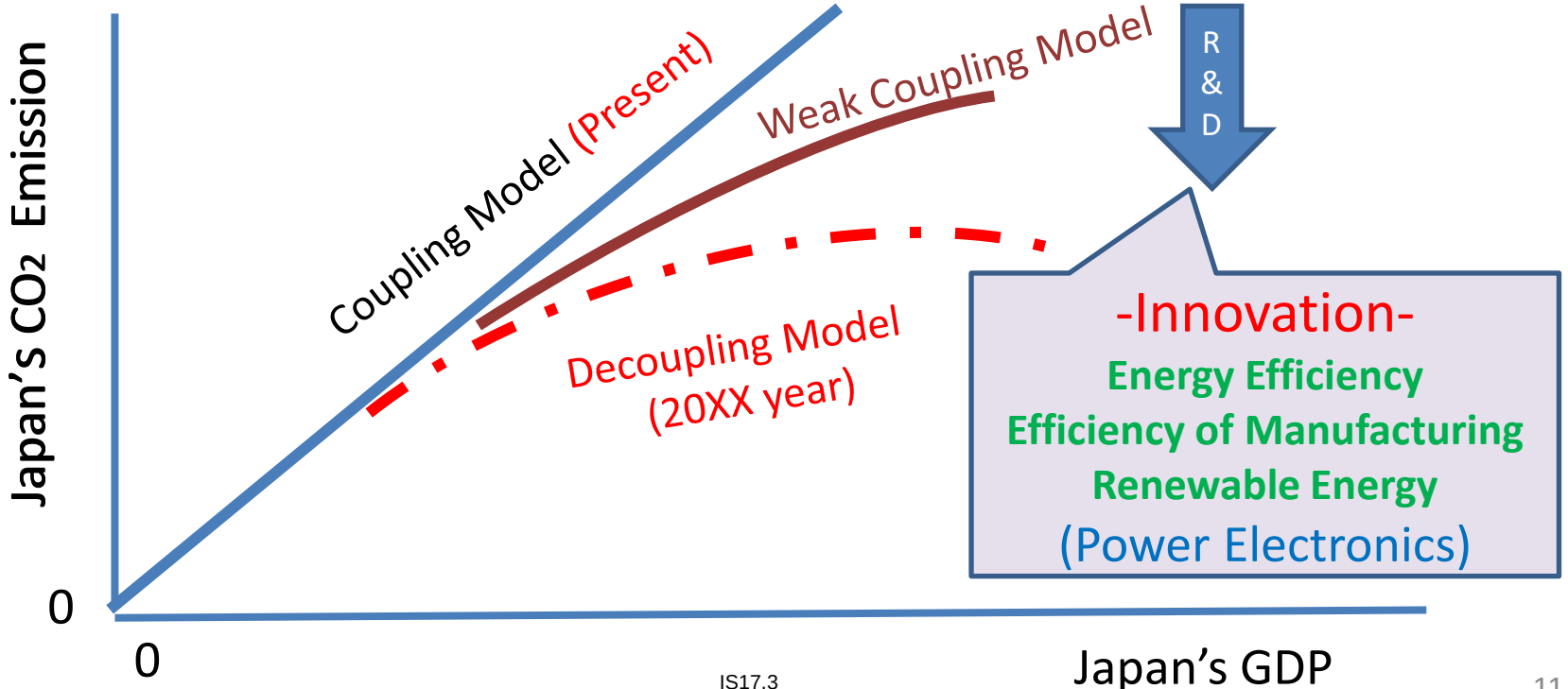



METI (2018): https://www.meti.go.jp/shingikai/mono_info_service/jidosha_shinjidai/pdf/20180831_01.pdf

# Increase in Weight of BEV for Cruising Range Demand
## -Schematic Figure of Energy Density Effects-



# Estimation of $CO_2$ Emission from manufacturing Processes based on Macroeconomic Model



# Increase in GDP through Dissemination of BEVs and Li ion Batteries

(I) Estimated CO2 Emission from GDP (In Japan ,2017)

◎ GDP: $ 4.67 Trillion

◎ CO2 Emission: 1,330 million tons

◎ CO2 Emission Coefficient: 0.284kg/$

(II) Estimate CO2 Emission from Vehicle Cost

◎ Cost Difference between a BEV and an ICEV

⇒ around $14,000 (in the case of Leaf)

⇒ 4t CO2 Emission

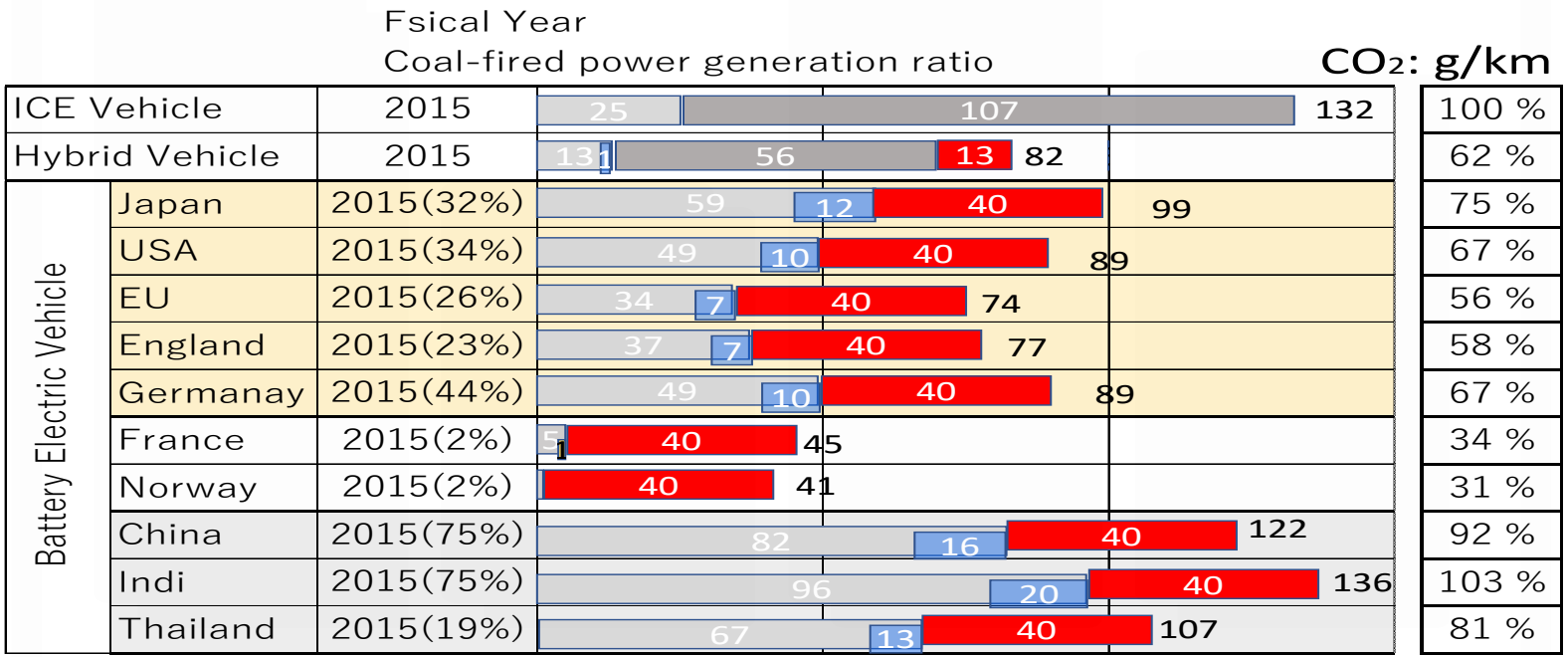
◎ Drive 100,000km (Life Cycle) by the BEV

Indirect CO2 Emission from a BEV ⇒ 40g/km

Indirect carbon dioxide emissions resulting from the manufacturing processes vary widely depending on the models. In addition, green power usage has great significance. This is a key issue for innovation.

## Analyses of estimated indirect $CO_2$ Emissions

Estimated from Well-to -Tank
Estimated from GDP
Estimated from Tank-to-Wheel
Estimated from Battery (Wh/kg)




METI (2018): https://www.meti.go.jp/shingikai/mono_info_service/jidosha_jisedai/pdf/20180831_01.pdf

IS17.3

# Expectation for lower Price by Electrification of ICEVs: Dissemination

**BEV Manufacturing Industry**

- Reduction of mechanical parts and moving parts
- Improvement of Productivity for BEVs

**Li ion Battery**

- Cost, Capacity(kWh), Productivity, Dissemination

**Social Infrastructure for Dissemination**

- Fast Charging Station : Grid , Solar Energy, Battery

Future

ICEV

=

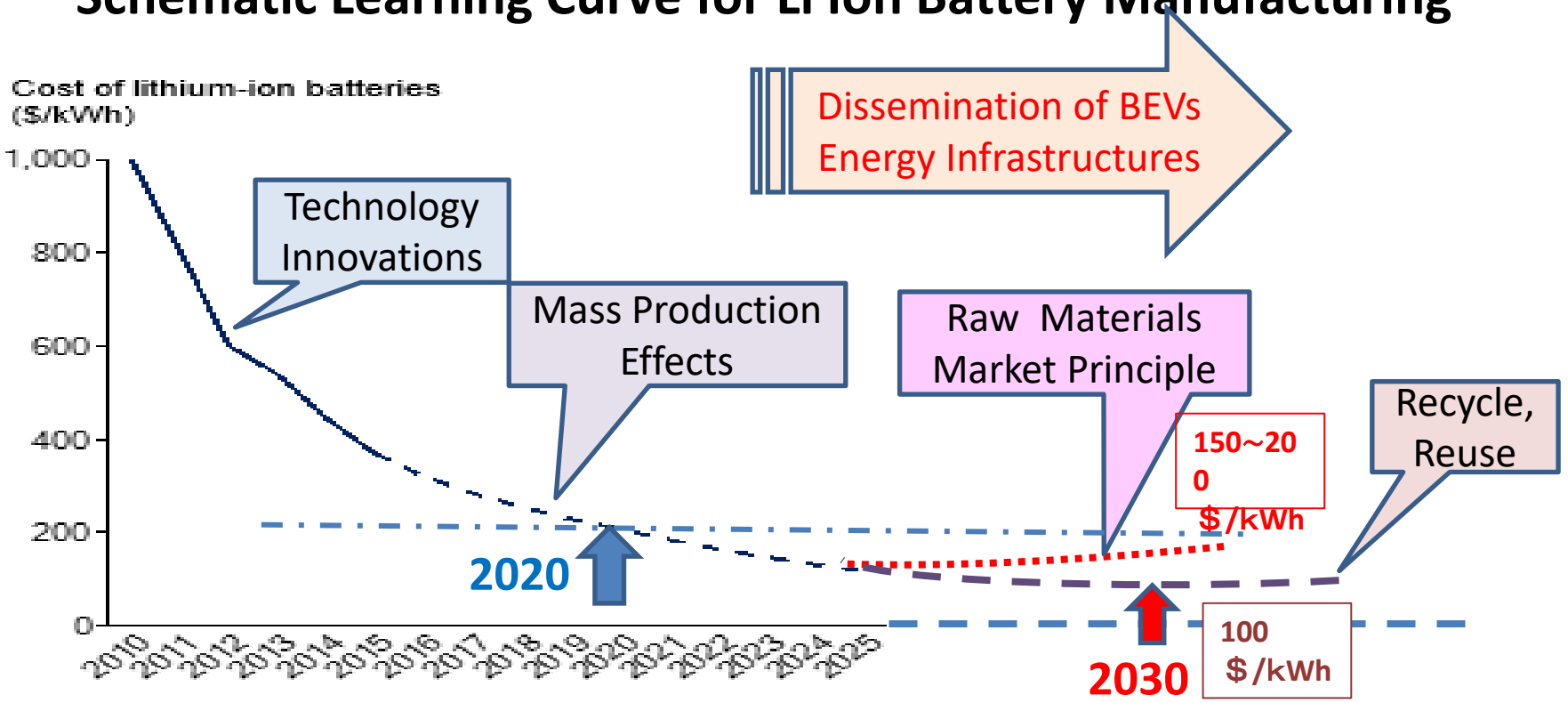
**Sales Price**

HEV, PHEV,BEV

Power Electronics &

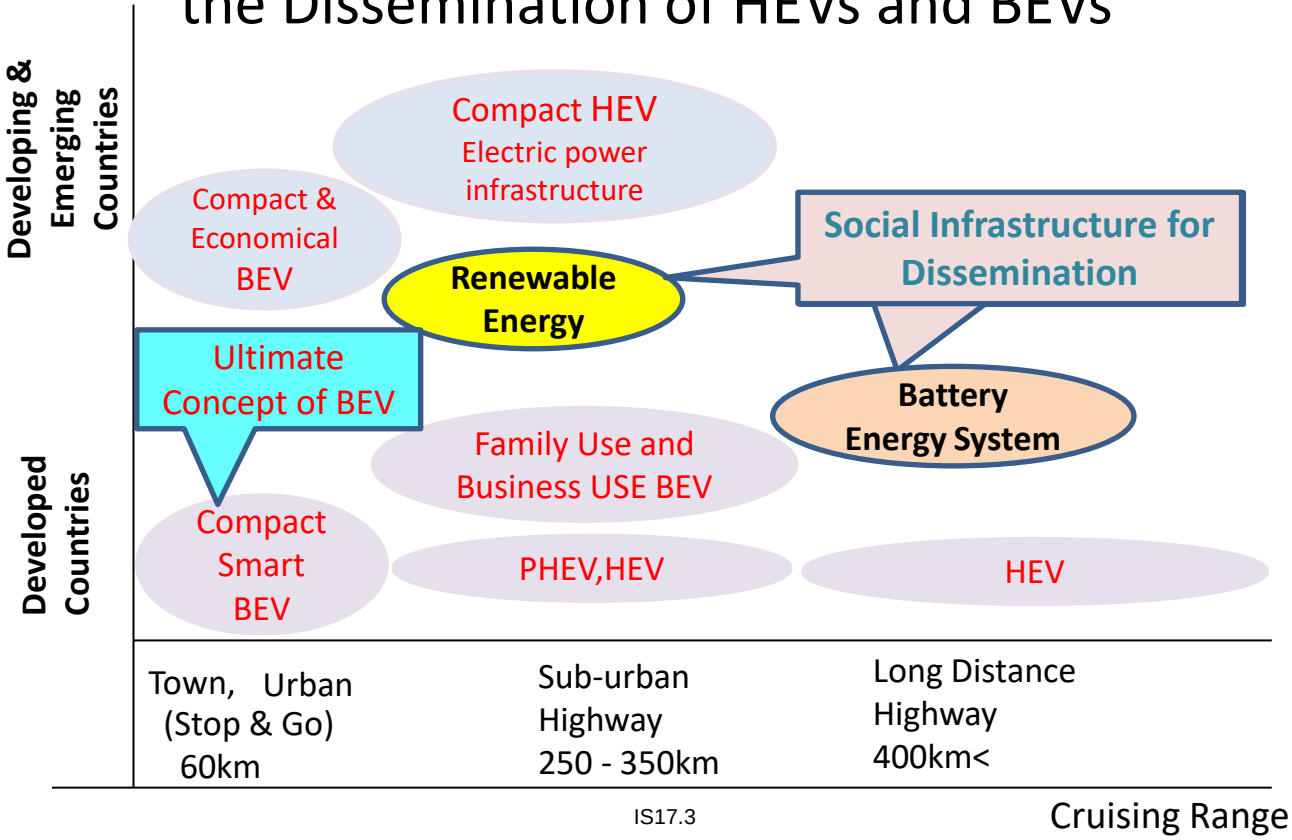
Manufacturing Innovations !!

# Schematic Learning Curve for Li Ion Battery Manufacturing




http://www3.weforum.org/docs/WEF_Future_of_Electricity_2017.pdf
Original Source :Bloom Berg, Shimizu Modified.

# Various ecological Perspectives necessary for the Dissemination of HEVs and BEVs



# Concluding Remarks

◎ Dissemination of BEVs is essential for Low Carbon Society.
◎ Logistic support for green & economic energy infrastructure is required.

(I) BEVs accompany indirect carbon dioxide emissions.
1. Well to Wheel(Energy), 2. Li ion battery (Wh/kg) , 3. Fabrication of vehicles

(II) Green energy infrastructures
1. Fluctuate renewable energy.
2. Quick Charging : Environmentally friendly battery systems、Protection of grid instability.
3. Recycle and reuse of battery systems including raw materials.

(III) Until green electric energy infrastructure is established
1. Users can purchase state-of-the-art BEVs anytime, anywhere.
2. Bridging role of HEVs to BEVs is important : Long distance cruising , Charging, Low carbon energy infrastructure.
3. This perspective is important not only in developed countries but also in developing and emerging countries for the dissemination of various EVs.

# Thank you for your attention

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