

# **World energy scenarios and green growths**

**April 21, 2014**

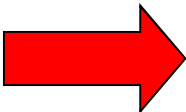
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# Analysis using Kaya identity

- We analyze the relationships between economic growths, energy consumption and CO<sub>2</sub> emission using Kaya identity as follows.

$$CO_2 = GDP \times \frac{E}{GDP} \times \frac{CO_2}{E}$$

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$$\frac{\Delta CO_2}{CO_2} \approx \frac{\Delta X}{X} + \frac{\Delta Y}{Y}$$

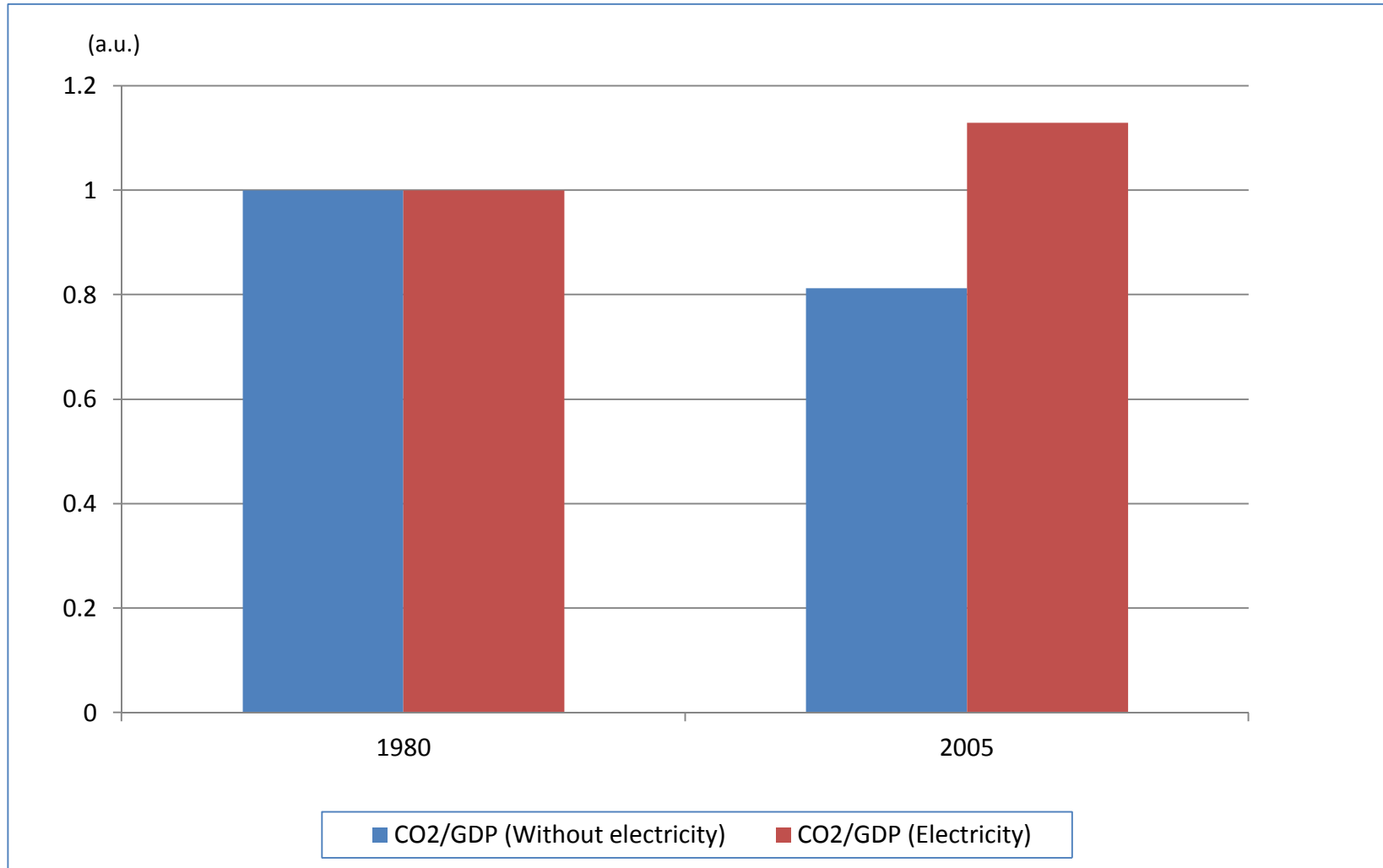
X: GDP, Y: CO<sub>2</sub>/GDP

# Green growths

Here the green growth is defined to decrease  $\frac{CO_2}{GDP}$ , while economic growth is sustained.

- ① **Type 1 Green Growth** : Combining product innovations as energy saving electric appliances, photovoltaics and so on with market innovations to disseminate them, the Type 1 green growth decreases  $\frac{CO_2}{GDP}$  in the residential sector, while contributing to economic growth.
- ② **Type 2 Green Growth** : Combining process innovations in energy intensive industries with innovations in institutions, the Type 2 green growth decrease  $\frac{CO_2}{GDP}$ , in industrial sectors while contributing to economic growth.
- ③ **Type 3 Green Growth** : Combining various kinds of innovations, sectors on ICT, service, medical and social welfare, education, culture and sports with low CO2 per value added production increase their shares, so that  $\frac{CO_2}{GDP}$  is decreased in industrial sectors while contributing to economic growth in the Type 3 green growth. Namely, it is change in economic structure.

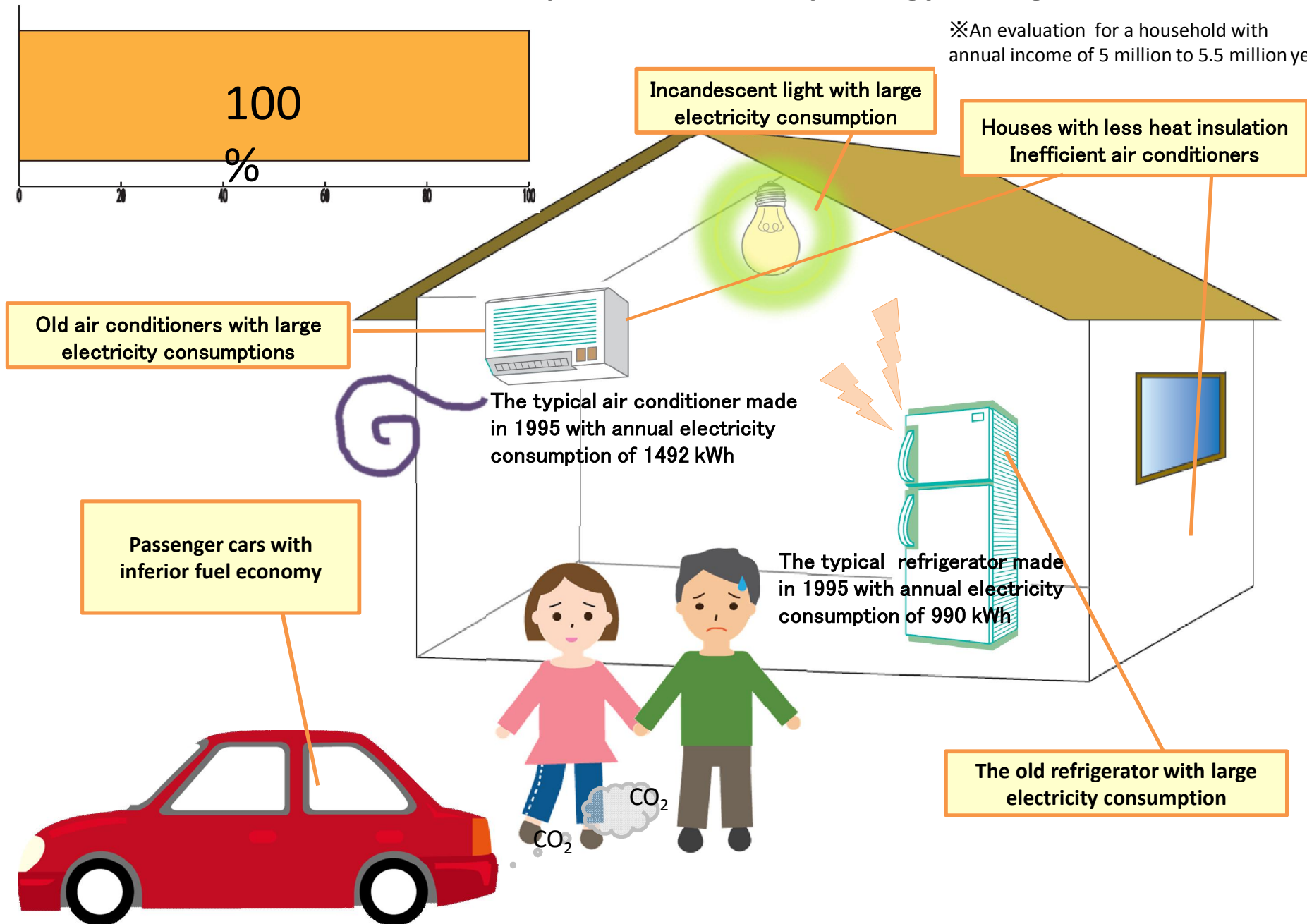
# Type 1 green growth in Japan



CO<sub>2</sub>/GDP in the household sector

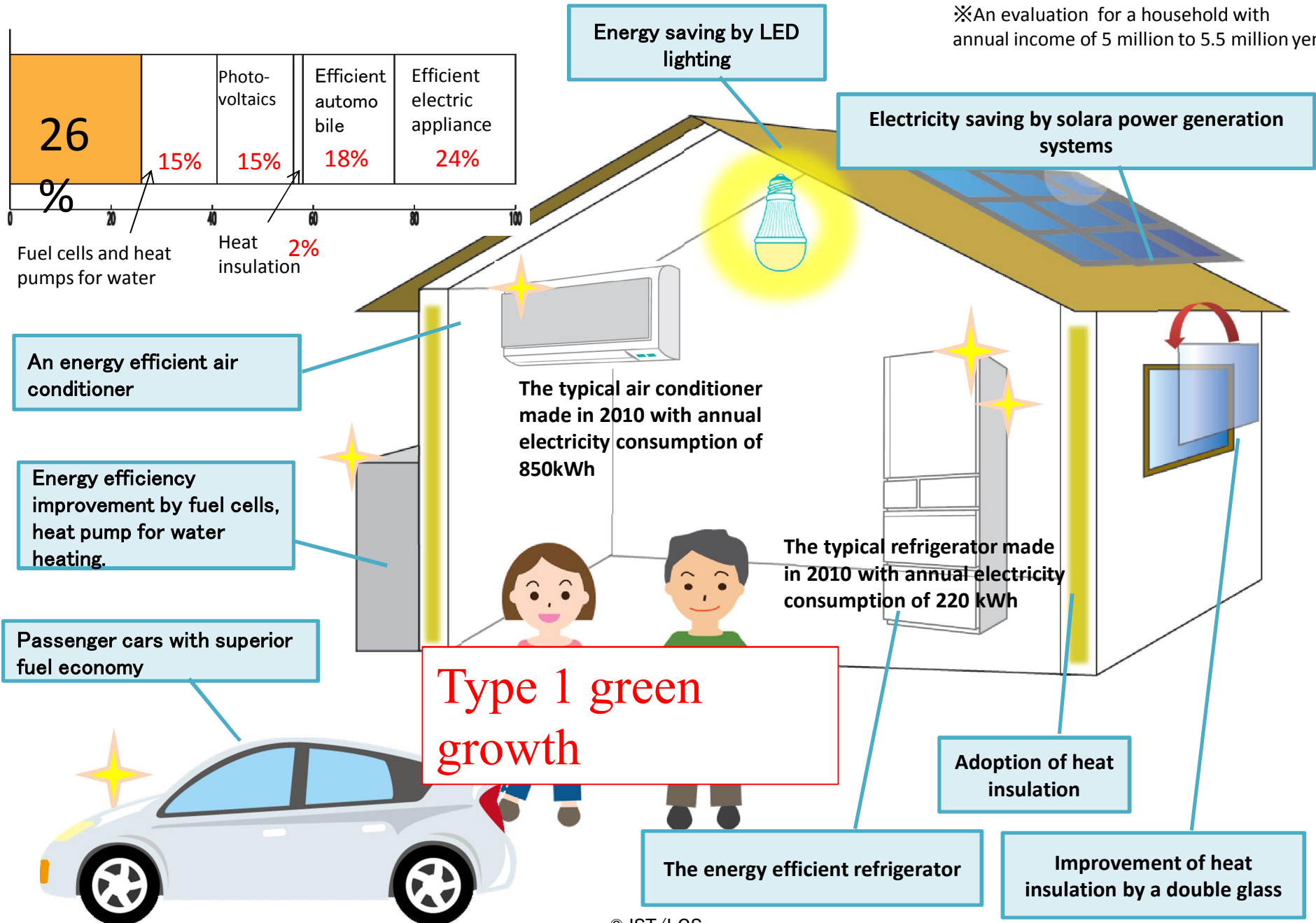
# If we estimate energy consumption without any energy saving as 100% . . .

※An evaluation for a household with annual income of 5 million to 5.5 million yen

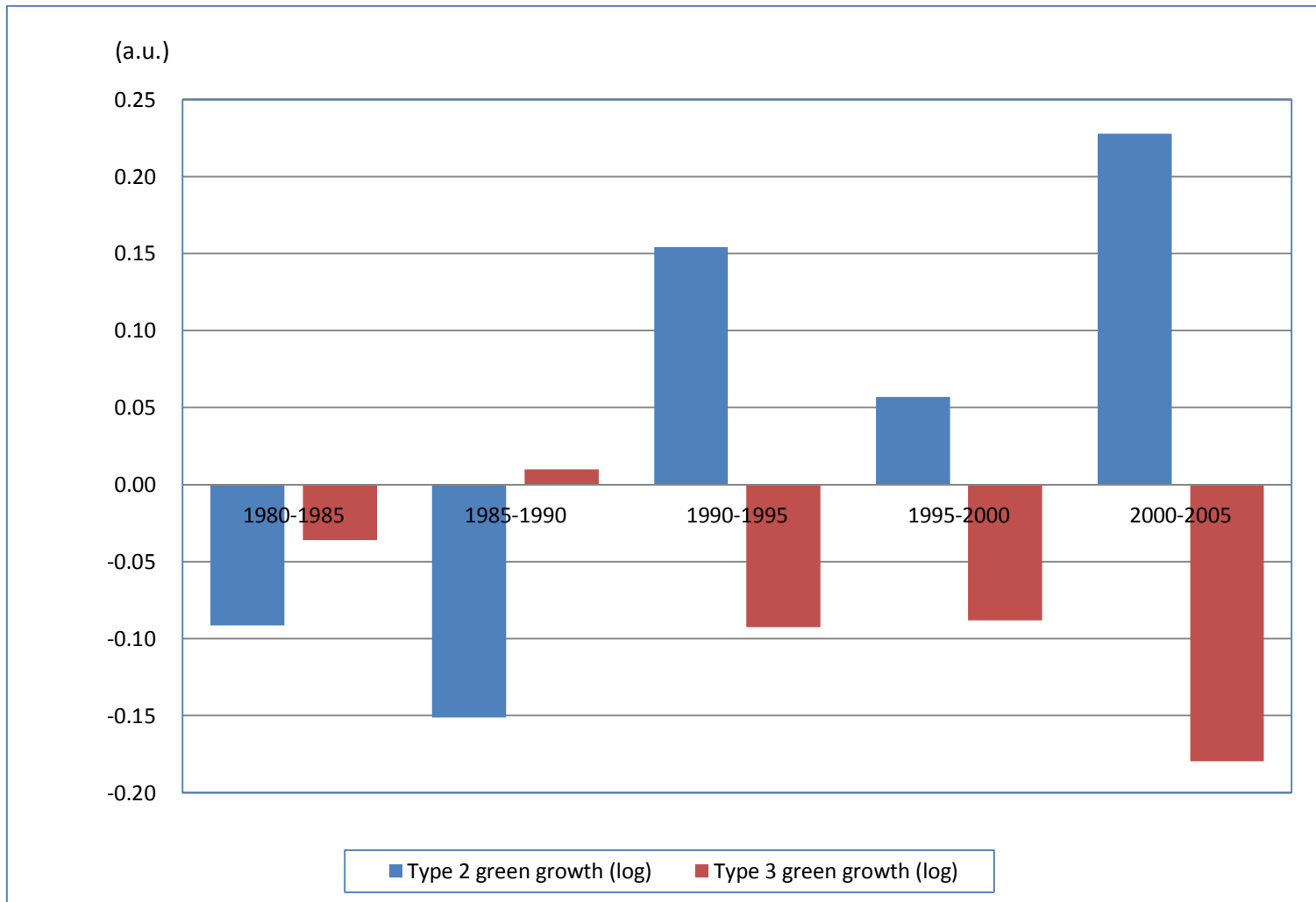


# Energy consumption of the house could be reduced by 74% as the figure below.

※An evaluation for a household with annual income of 5 million to 5.5 million yen



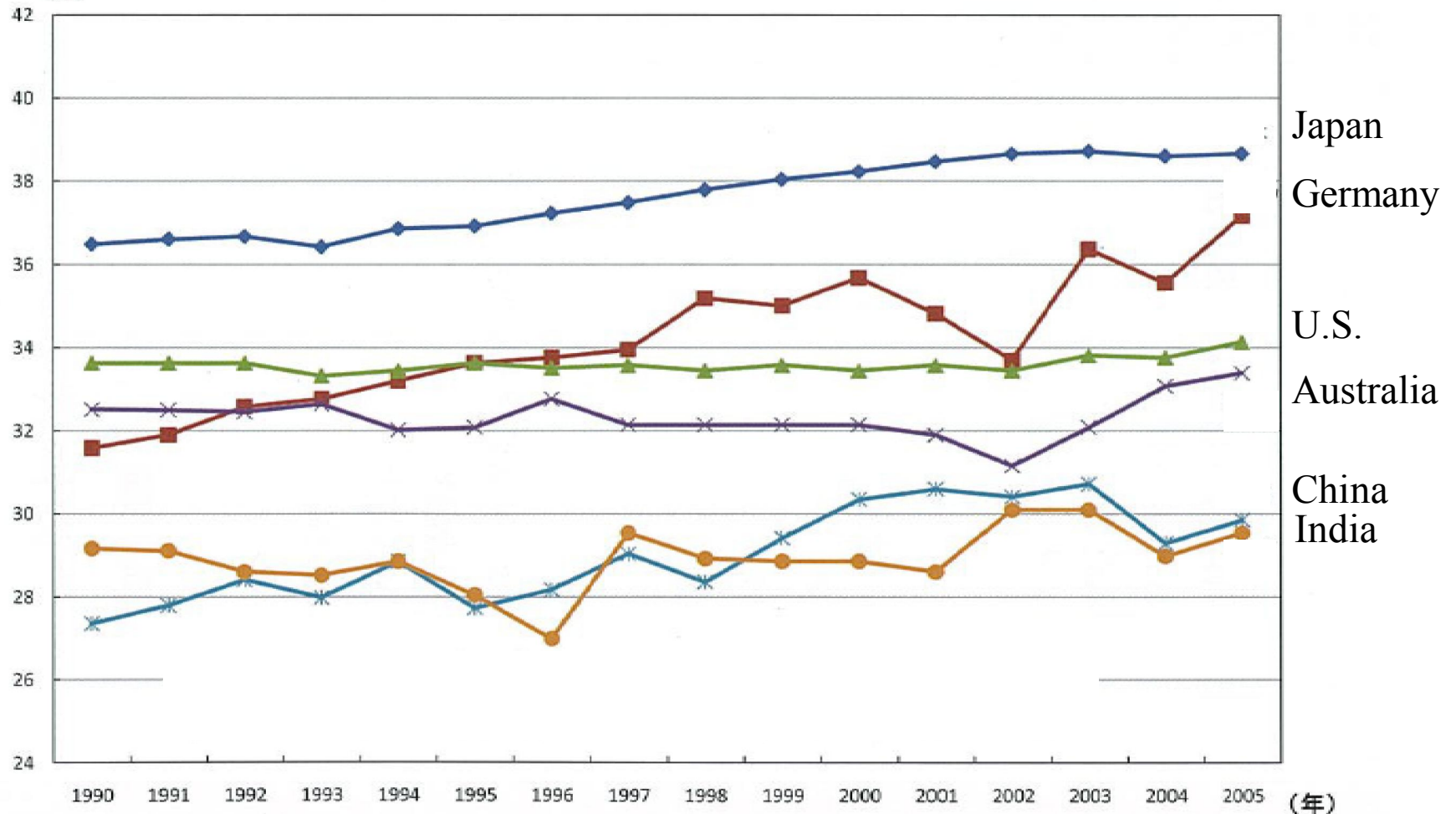
# Type 2 & 3 green growth in Japan



CO<sub>2</sub>/GDP in the industrial sector

# Capacity of Type 2 green growth (1)

Efficiency % (HHV)

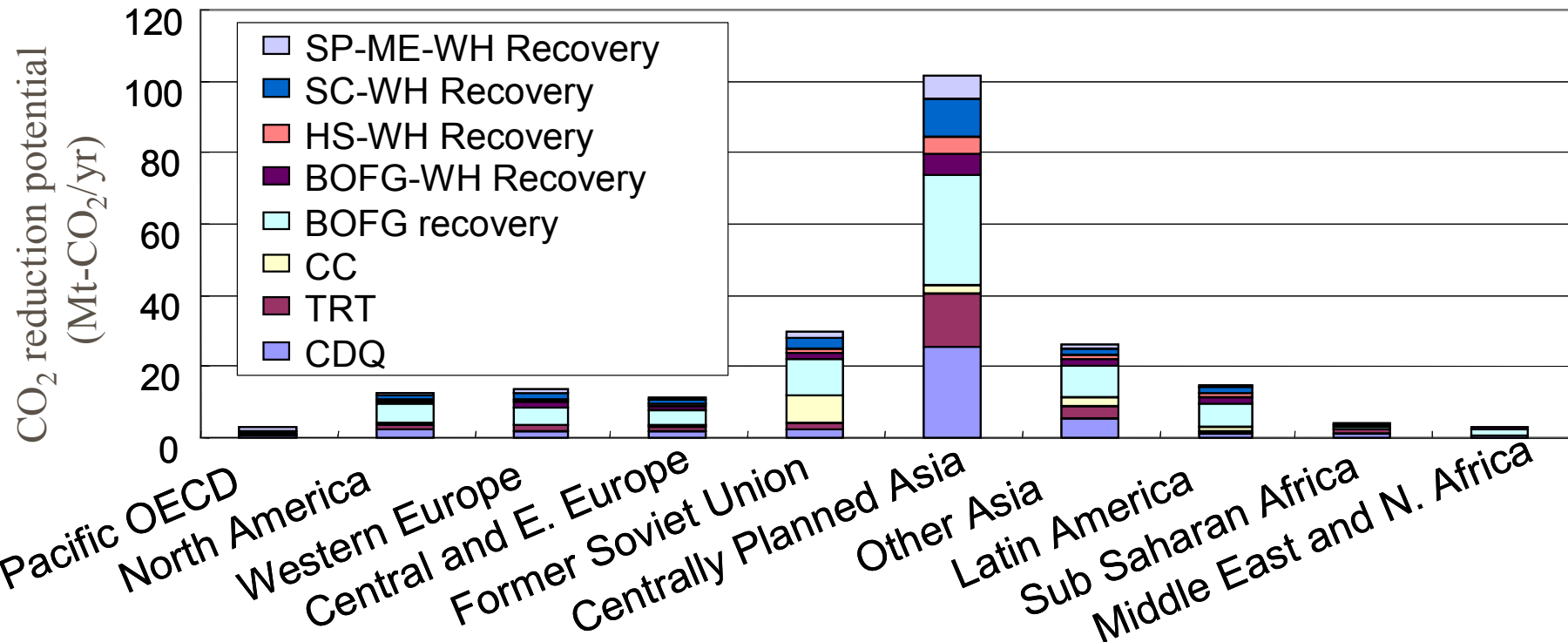


## Thermal efficiency of coal fired power plants

東京大学大学院工学系研究科編, 震災後の工学は何をめざすのか, 内田老鶴圃, 2012.7 より引用(松橋が翻訳)



# Capacity of Type 2 green growth (2)

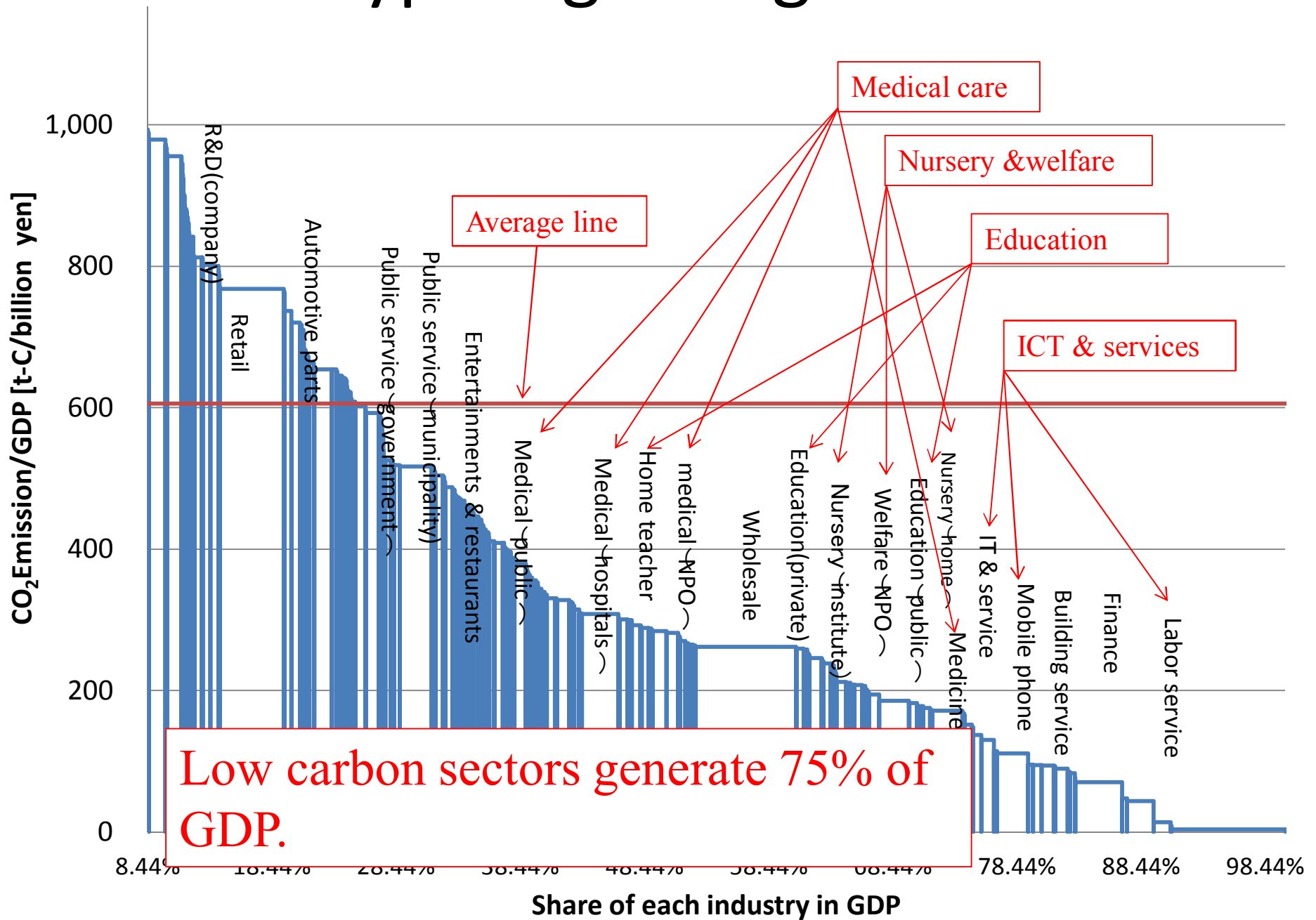


CD= Coke Dry Quenching, HS = Hot Stove, TRT = Top Pressure Recovery Turbine  
 SC = Sinter Cooling, CC= Continuous Casting, SP= Sinter Plant  
 BOFG= Basic Oxygen Furnace Gas, ME = Main Exhaust, WH = Waste Heat

## *CO<sub>2</sub> Reduction Potential of Eight Energy Saving Technologies*

Bernstein, L., J. Roy, K.C. Delhotal, J. Harnisch, R. Matsuhashi, L.Price, K. Tanaka, E. Worrel, F. Yamba, Z. Fengqi, "Industry. In Climate Change 2007," the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, pp447-496, (2007)

# Type 3 green growth



# Conclusions

- (1) According to the WEO, long-term solutions to global challenges remain scarce. **We here propose to maximize our effort to promote the three kinds of green growths.**
- (2) Type 1 green growth is effective to improve CO<sub>2</sub>/GDP in the households sector **in developed and developing countries.**
- (3) Type 2 green growth is effective, **if the energy saving technologies could be diffused to developing countries.**
- (4) Type 3 green growth is expected to **magnify especially in developed countries.**