THE UNIVERSITY OF TOKYO

Global Environmental Policy Making on Technology
環境・エネルギー技術政策

http://sunshine.naoe.t.u-tokyo.ac.jp/jun/kougi/gep/gep.html

8th and 15th, November, 2010
Jun TAKAHASHI

- ✓ **Global energy balance**
- ✓ **How to read statistics data ?**
  - ✓ **Long-term viewpoint**
  - ✓ **Suspect an interpretation and the data itself !**
- ✓ **How to make a policy ?**
- ✓ **Quiz**

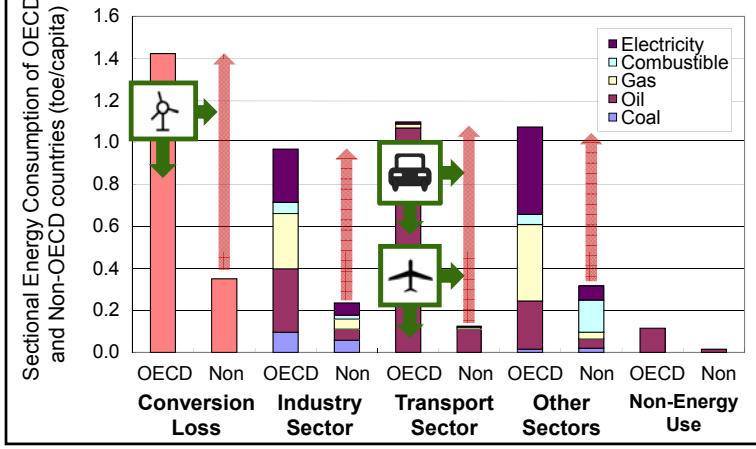
Student's Presentation at 15th November

◆ Theme
- ◆ Consider effective policy to reduce world's fossil fuel consumption by using statistics shown in today's lecture or following website first.
  - ◆http://www.iea.org/
- ◆ Then, show your assumption about technological development, i.e. electric vehicle, and introducing schedule of the technologies to our society.
- ◆ Evaluate the long term effect of the technologies on the reduction of fossil fuel consumption till 2050 quantitatively based on your assumption.

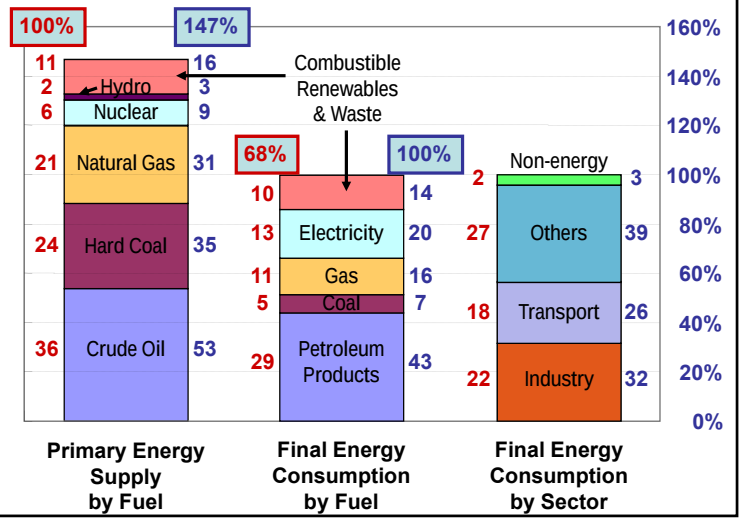
◆ Presentation and Submission at 15th November
- ◆ You have to make a group which consists of 2 to 5 students.
- ◆ Discuss well about your presentation in your group.
- ◆ Every group have to make a 15 to 20 minutes presentation by using Microsoft powerpoint. After the class, the slide which includes names of the group member have to submit by e-mail to jun@sys.t.u-tokyo.ac.jp.
- ◆ If you can't contribute any presentation, you should submit more than 10 pages PPT file by e-mail to jun@sys.t.u-tokyo.ac.jp by 15th November.

Sectional Energy Consumption of OECD and Non-OECD countries (2003)

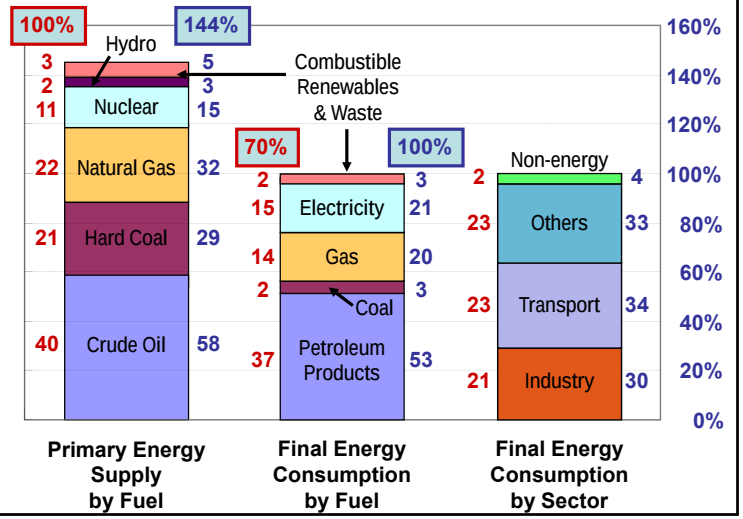
	Population	Total Primary Energy Supply	Total Final Energy Consumption
OECD	1154 million	4.67 toe/capita	3.25 toe/capita
Non-OECD	5114 million	1.04 toe/capita	0.69 toe/capita



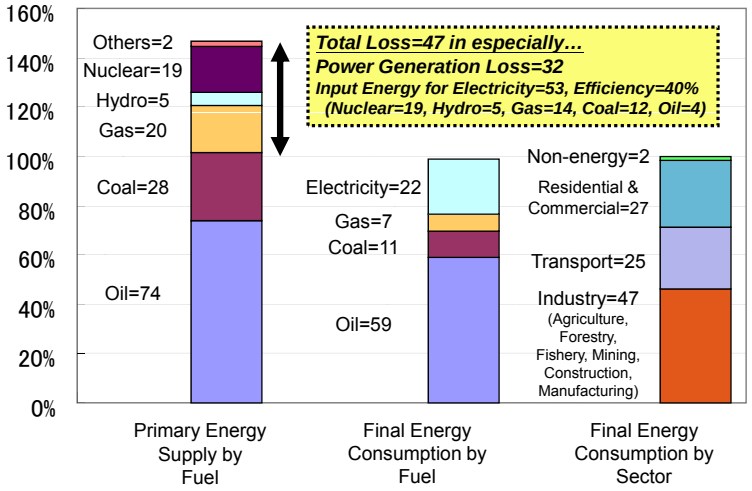
World Energy Balance on 2003 (Source IEA statistics)



OECD Energy Balance on 2003 (Source IEA statistics)

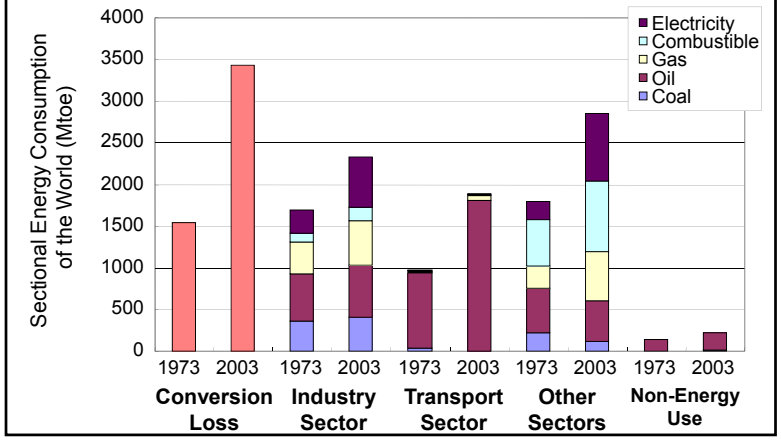


Japanese Energy Balance on 2001 (Source EDMC2003)



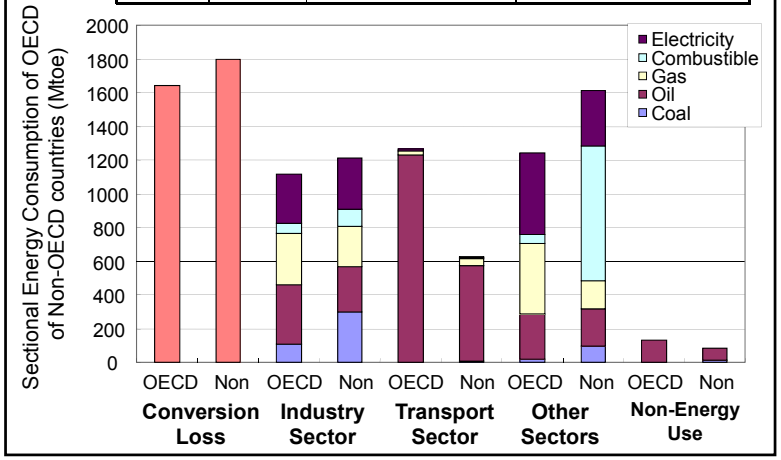
Sectional Energy Consumption of the World

World	Population	Total Primary Energy Supply	Total Final Energy Consumption
1973	3890 million	6152 Mtoe	4606 Mtoe
2003	6268 million	10723 Mtoe	7287 Mtoe



Sectional Energy Consumption of OECD and Non-OECD countries (2003)

	Population	Total Primary Energy Supply	Total Final Energy Consumption
OECD	1154 million	5395 Mtoe	3754 Mtoe
Non-OECD	5114 million	5328 Mtoe	3534 Mtoe



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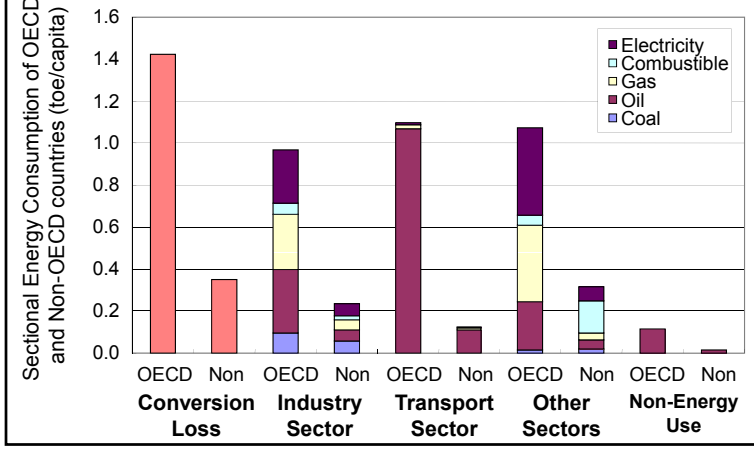

Note: "Advanced" countries must first reconsider the size of their own share.

Sectional Energy Consumption of OECD and Non-OECD countries (2003)

	Population	Total Primary Energy Supply	Total Final Energy Consumption
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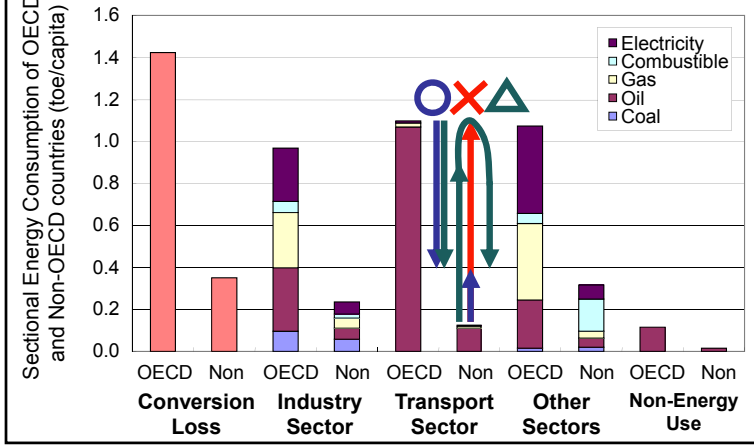
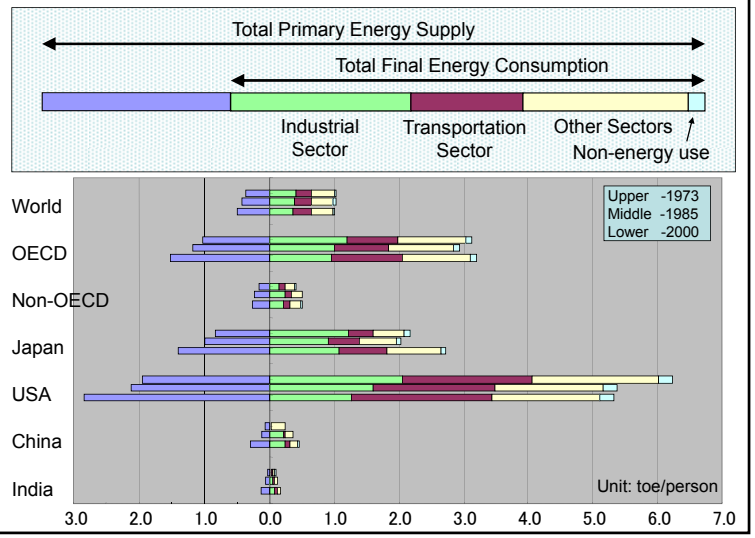
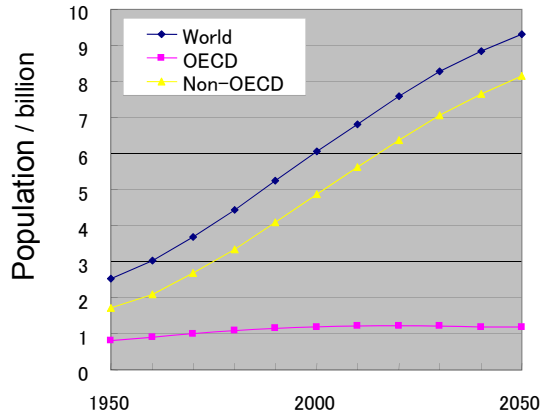


Total final energy consumption per capita (toe/person)



Transition of the population in the world
Source: UN



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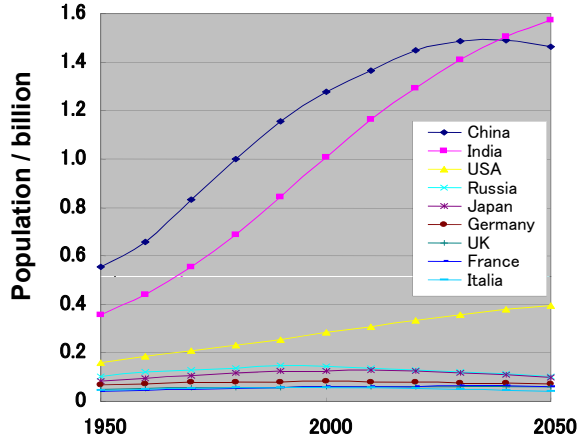
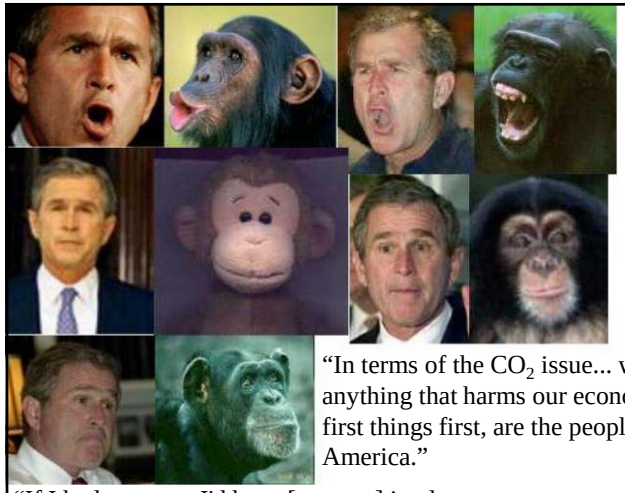
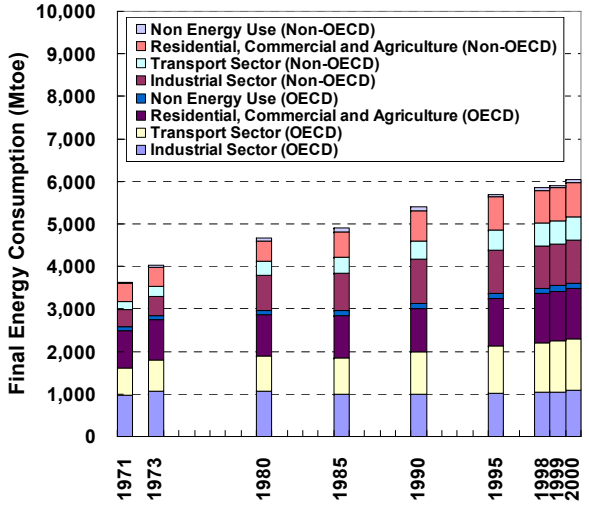


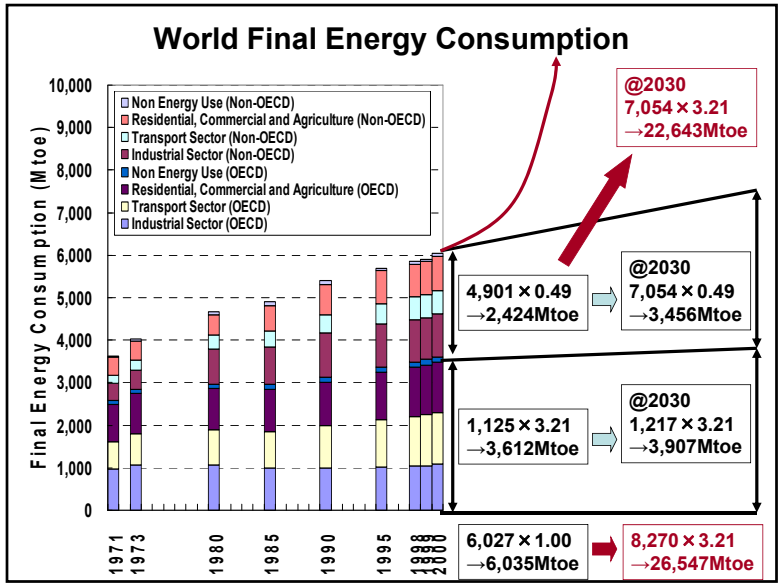


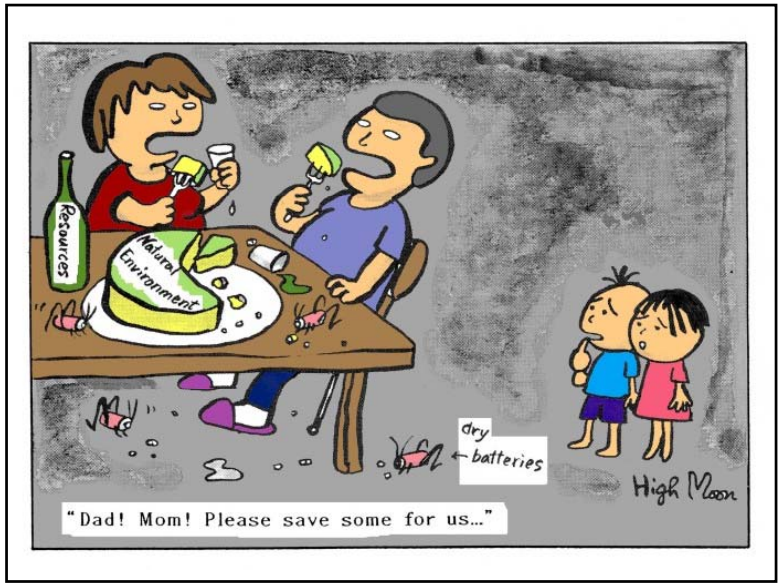
"In terms of the CO_2 issue... we will not do anything that harms our economy. Because, first things first, are the people who live in America."

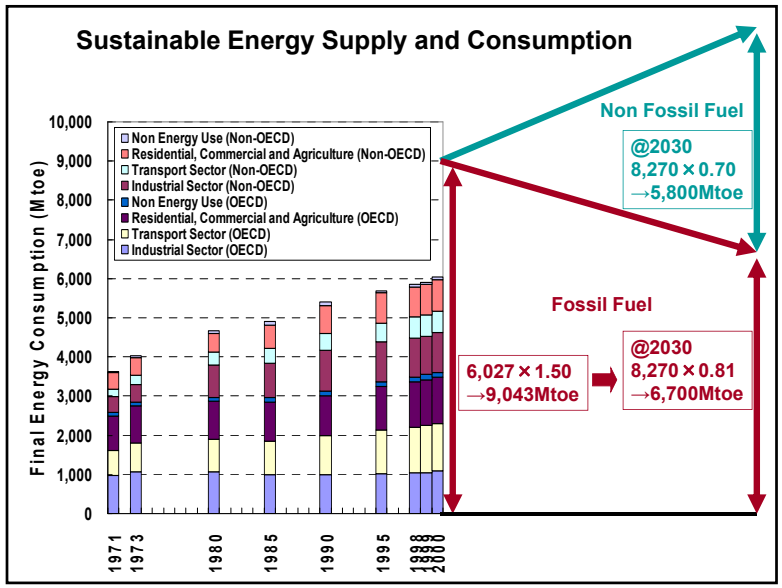
"If I had my way, I'd have [tax cuts] in place tomorrow, so that people would have money in their pockets to deal with high energy prices."

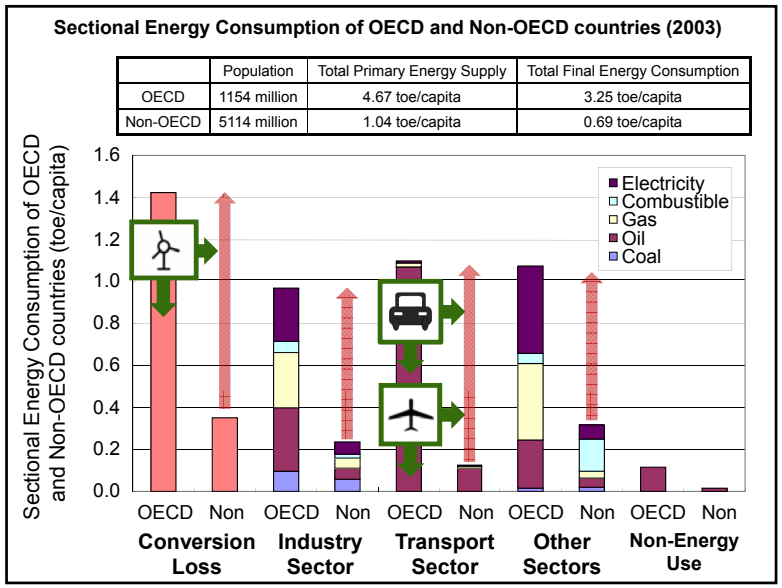
World Final Energy Consumption




World Final Energy Consumption
Final Energy Consumption (Mtoe)
Non Energy Use (Non-OECD)
Residential, Commercial and Agriculture (Non-OECD)
Transport Sector (Non-OECD)
Industrial Sector (Non-OECD)
Non Energy Use (OECD)
Residential, Commercial and Agriculture (OECD)
Transport Sector (OECD)
Industrial Sector (OECD)
@2030
7,054×3.21
→22,643Mtoe
4,901×0.49
→2,424Mtoe
@2030
7,054×0.49
→3,456Mtoe
1,125×3.21
→3,612Mtoe
@2030
1,217×3.21
→3,907Mtoe
6,027×1.00
→6,035Mtoe
8,270×3.21
→26,547Mtoe


Resources
Natural Environment
dry batteries
"Dad! Mom! Please save some for us…"
High Moon


Sustainable Energy Supply and Consumption
Final Energy Consumption (Mtoe)
Non Energy Use (Non-OECD)
Residential, Commercial and Agriculture (Non-OECD)
Transport Sector (Non-OECD)
Industrial Sector (Non-OECD)
Non Energy Use (OECD)
Residential, Commercial and Agriculture (OECD)
Transport Sector (OECD)
Industrial Sector (OECD)
Non Fossil Fuel
@2030
8,270×0.70
→5,800Mtoe
Fossil Fuel
6,027×1.50
→9,043Mtoe
@2030
8,270×0.81
→6,700Mtoe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Population
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OECD
1154 million
4.67 toe/capita
3.25 toe/capita
Non-OECD
5114 million
1.04 toe/capita
0.69 toe/capita
Sectional Energy Consumption of OECD and Non-OECD countries (toe/capita)
Electricity
Combustible
Gas
Oil
Coal
OECD Non
Conversion Loss
Industry Sector
Transport Sector
Other Sectors
Non-Energy Use

Calculation of the amount of solar energy

Reference

- World primary energy supply is about 1.5 toe/ year par capita
  - 1.5 [toe/ year par capita] ＝ 40000 [kcal/day par capita]
- Human need energy of 2000 [kcal/day par capita] to live.

Solar energy flowing into the earth

$0.7 \times \pi R^2\,[m^2] \times 1367\,[J/m^2s]$

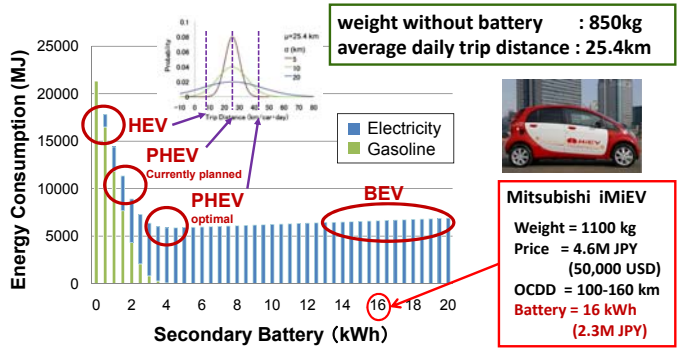
$= 0.7 \times 1.286 \times 10^{14}[m^2] \times 1367\,[J/m^2s]$

$= 1.23 \times 10^{17}[J/s]$

$= 2.94 \times 10^{13}[kcal/s]$ （$=40000 \times 10^4$[kcal/day par capita]）

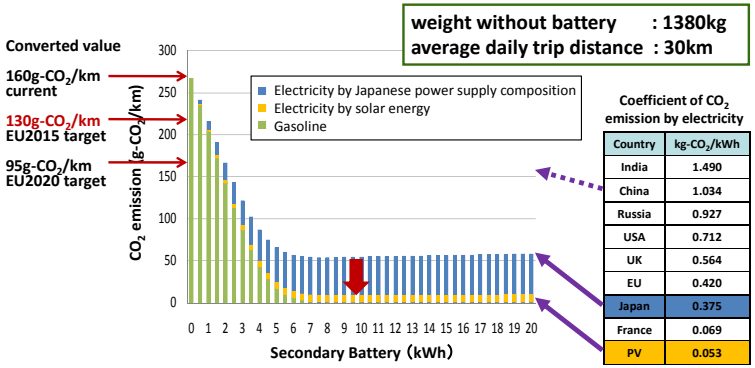
$= 2.94$[Mtoe/s] （$=1.5 \times 10^4$ [toe/year par capita]）

Energy Consumption Structure of mini-PHEV



- There is an optimal amount of secondary battery depends on the weight of vehicle and average daily trip distance.
- Hence, the spread of such an optimal PHEV must be difficult in case of heavier cars and countryside.

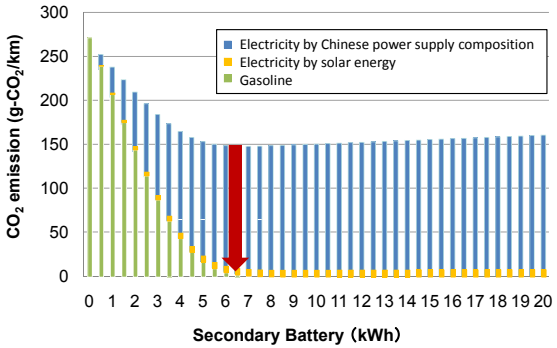
CO_2 Emission Structure of Japanese PHEV



- Combination of solar and PHEV shows a significant effect !!!
  - $3m^2$ of PV generates 2kWh daily, hence PV-PHEV is possible.
  - The amount of secondary battery is more important from a viewpoint of CO_2 emission.

CO_2 Emission Structure of PHEV in China

weight without battery : 1380kg
average daily trip distance : 30km



The Items of Final Energy Consumption

Industrial Sector

- Manufacturing
  - Material
    - Steel
    - Chemicals
    - Cement
    - Paper and Pulp
  - Processing/assembly
    - Foods
    - Textile
    - Nonferrous metal
    - Machines
    - Others
- Non-manufacturing
  - Agriculture, Forestry & Fishery
  - Mining
  - Construction

Residential Sector

- Heating
- Cooling
- Hot Water Supply
- Cooking
- Power & etc.

Commercial Sector

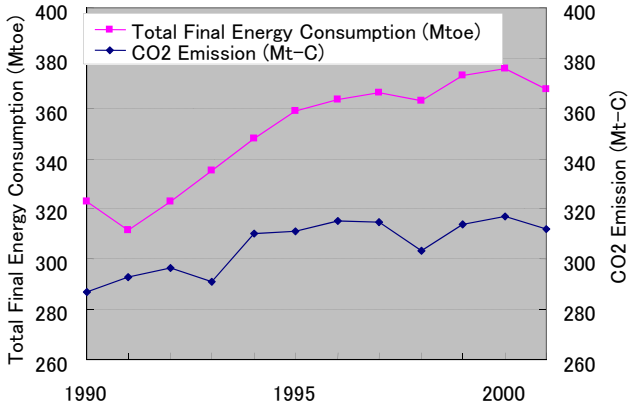
Transport Sector

- Passenger
  - Car (Private)
  - Car (Commercial)
  - Bus
  - Airplane
  - Ship
  - Railway
- Freight
  - Truck
  - Airplane
  - Ship
  - Railway

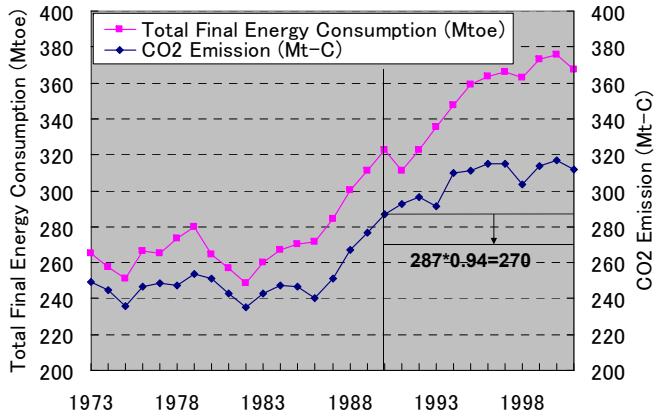
Non Energy Use

- Asphalt, grease, paraffin, lubricating oil, etc.

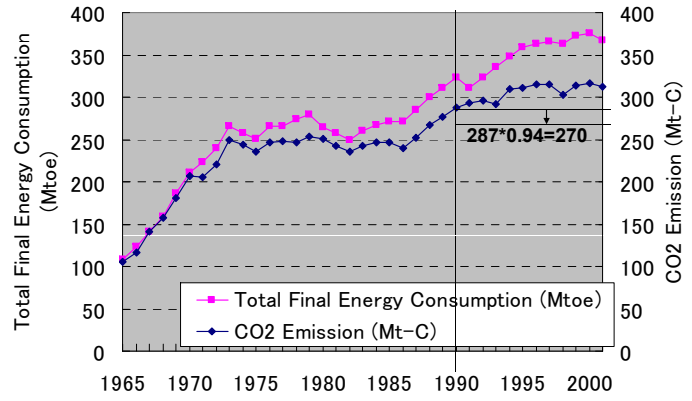
Japanese TFC and CO2 Emission (1990-2001)



Japanese TFC and CO2 Emission (1973-2001)

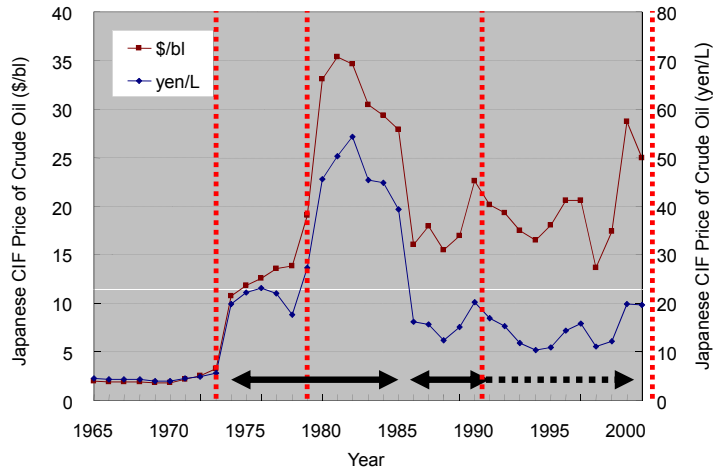


Japanese TFC and CO2 Emission (1965-2001)

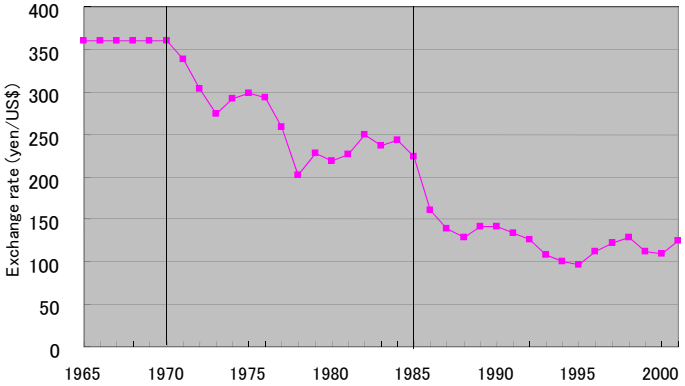


Japanese CIF Price of Crude Oil

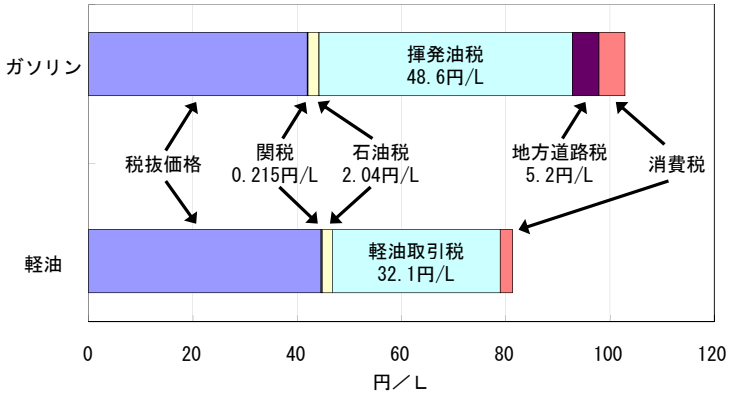
CIF: Cost + Insurance + Freight

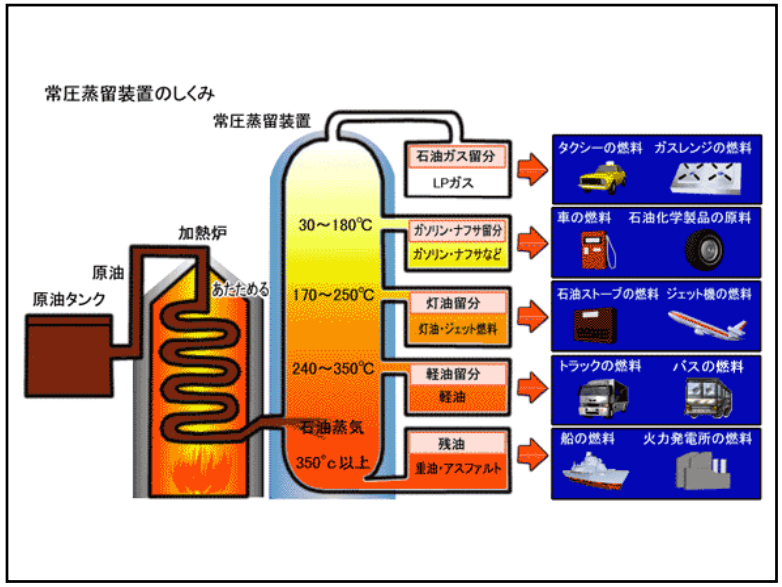


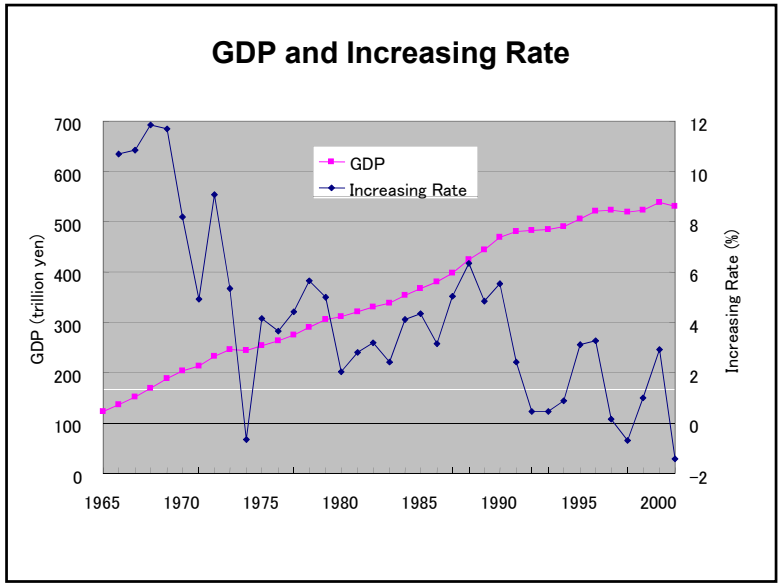
Exchange Rate (yen/US$)

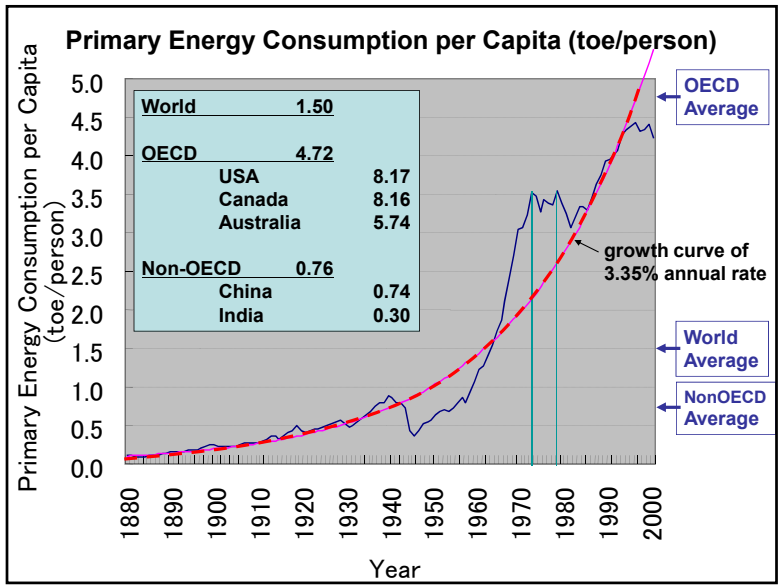


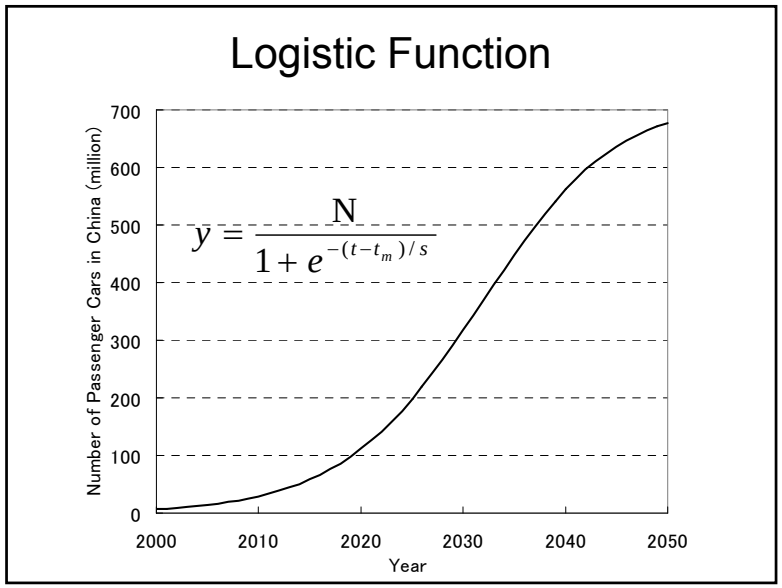
石油製品にかかる税金



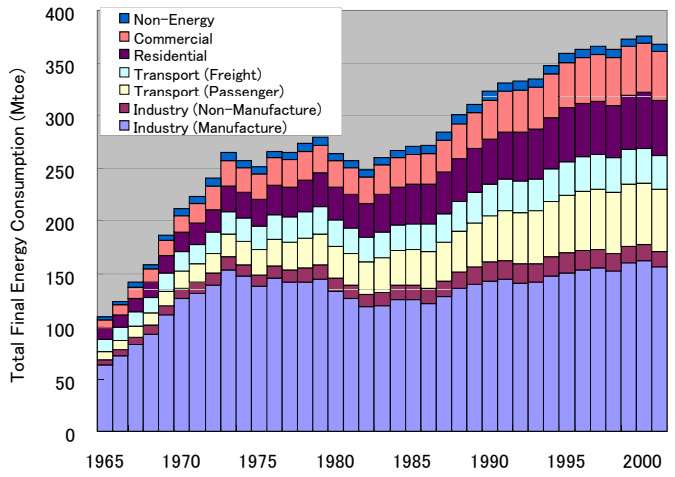

常圧蒸留装置のしくみ
常圧蒸留装置
加熱炉
原油
原油タンク
あたためる
30～180℃
170～250℃
240～350℃
石油蒸気
350℃以上
石油ガス留分
LPガス
ガソリン・ナフサ留分
ガソリン・ナフサなど
灯油留分
灯油・ジェット燃料
軽油留分
軽油
残油
重油・アスファルト
タクシーの燃料
ガスレンジの燃料
車の燃料
石油化学製品の原料
石油ストーブの燃料
ジェット機の燃料
トラックの燃料
バスの燃料
船の燃料
火力発電所の燃料


GDP and Increasing Rate
GDP (trillion yen)
Increasing Rate (%)
GDP
Increasing Rate
700
600
500
400
300
200
100
0
12
10
8
6
4
2
0
−2
1965
1970
1975
1980
1985
1990
1995
2000

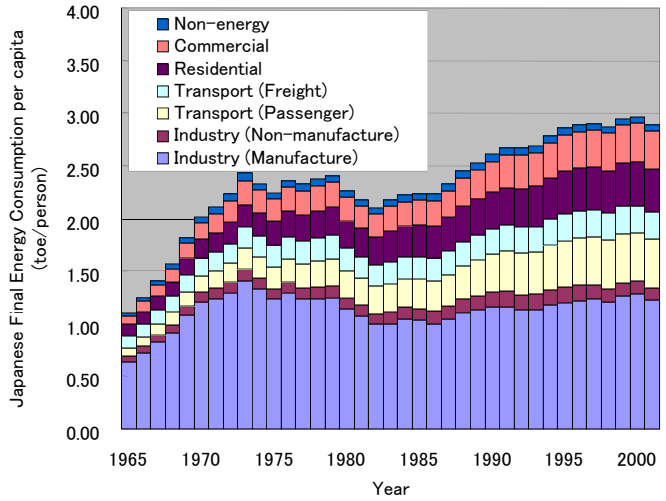

Primary Energy Consumption per Capita (toe/person)
Primary Energy Consumption per Capita (toe/person)
World 1.50
OECD 4.72
USA 8.17
Canada 8.16
Australia 5.74
Non-OECD 0.76
China 0.74
India 0.30
OECD Average
growth curve of 3.35% annual rate
World Average
NonOECD Average
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Year


Logistic Function
$y = \frac{N}{1 + e^{-(t-t_m)/s}}$
Number of Passenger Cars in China (million)
700
600
500
400
300
200
100
0
2000
2010
2020
2030
2040
2050
Year

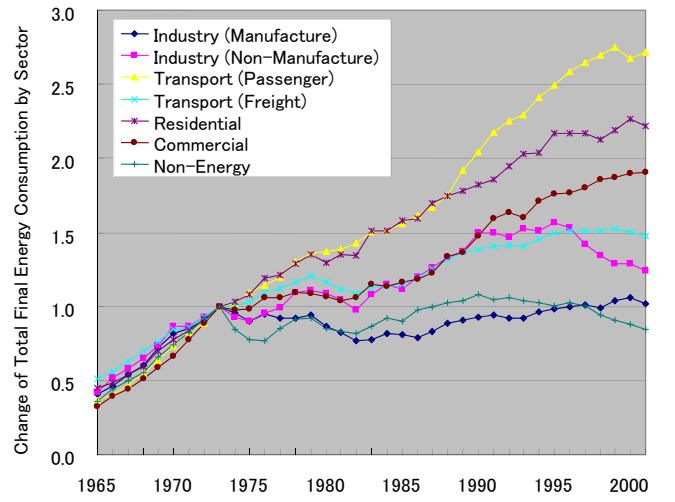
Japanese TFC by Sector (Mtoe)



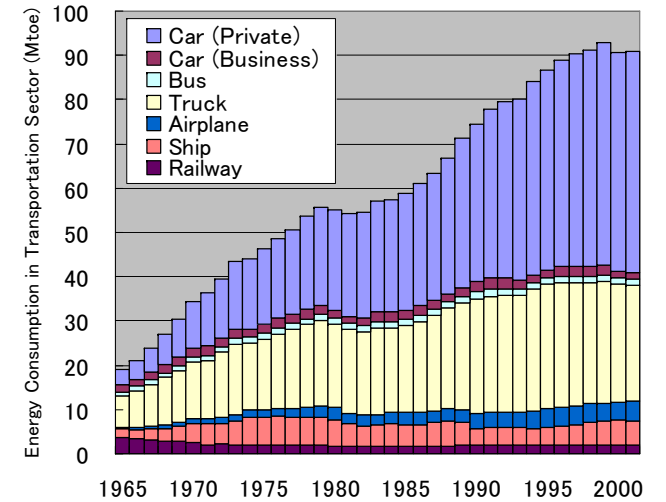
Japanese Final Energy Consumption per capita (1)



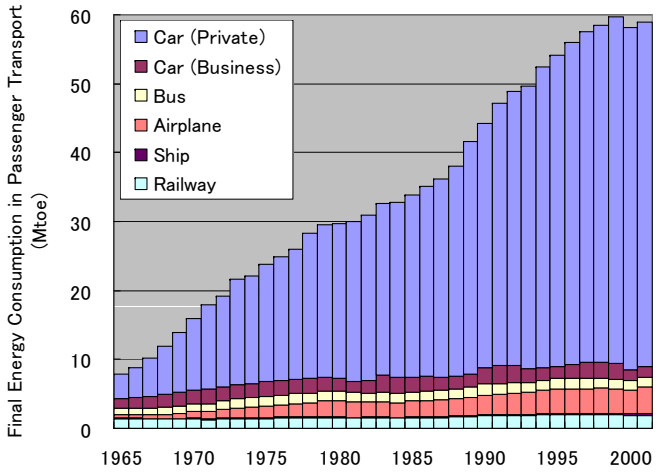
Change of TFC by Sector (in comparison with 1973)



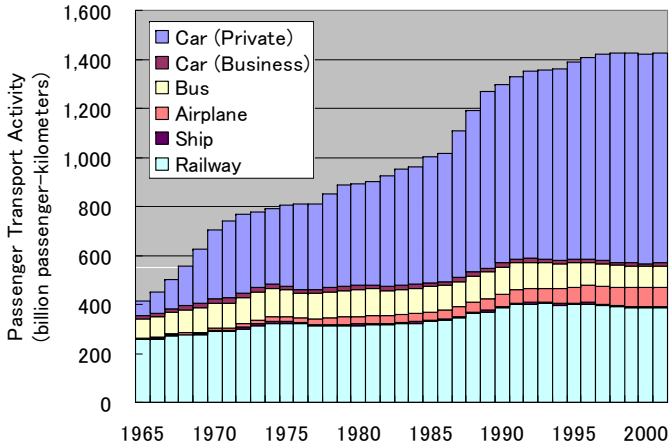
Energy Consumption in Transportation Sector (Mtoe)



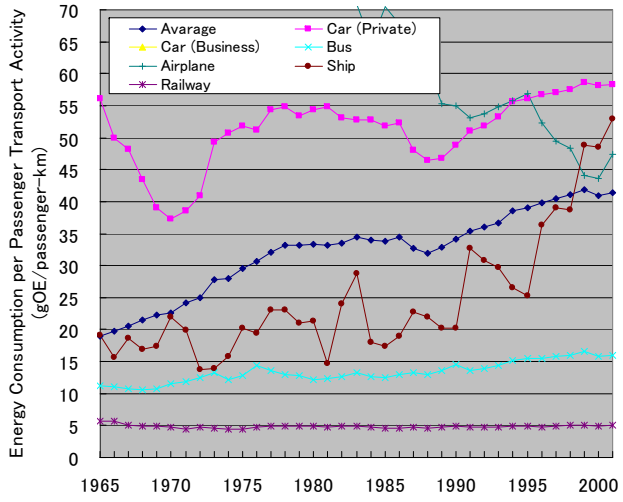
Energy Consumption in Passenger Transport (Mtoe)



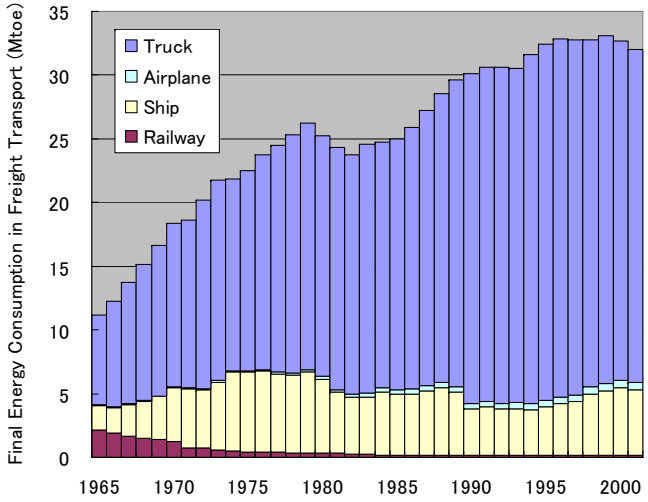
Passenger Transport Activity (billion passenger-kilometers)



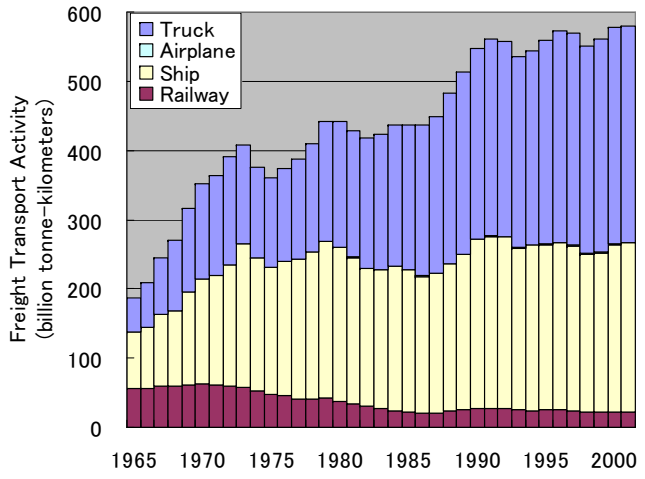
Energy Consumption per Passenger Transport Activity



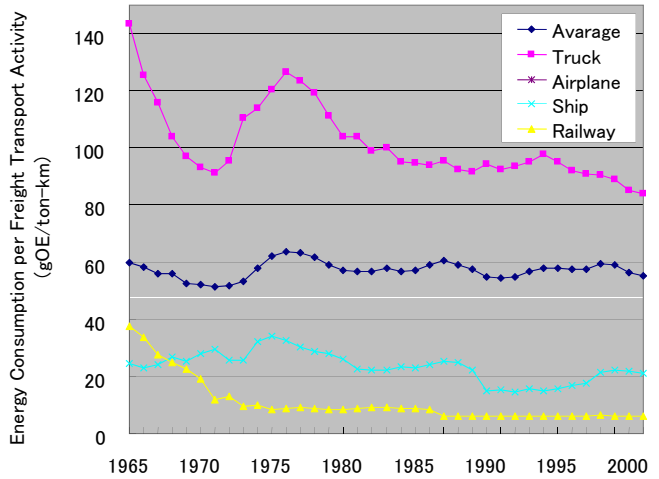
Energy Consumption in Freight Transport (Mtoe)



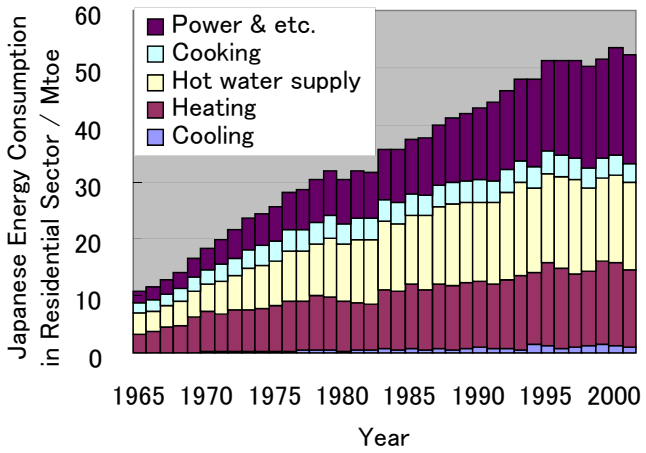
Freight Transport Activity (billion tones-kilometers)



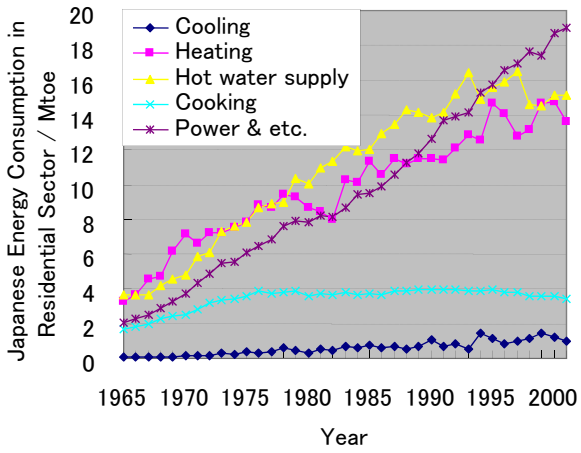
Energy Consumption per Freight Transport Activity (2)

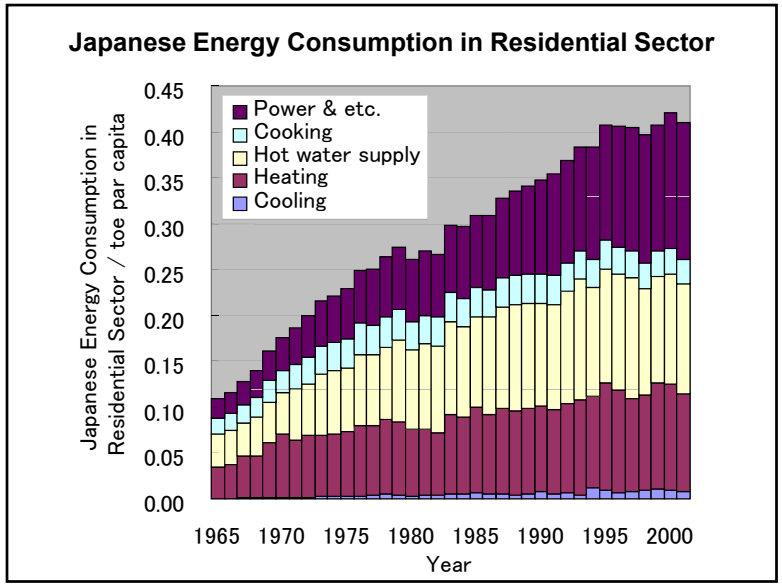


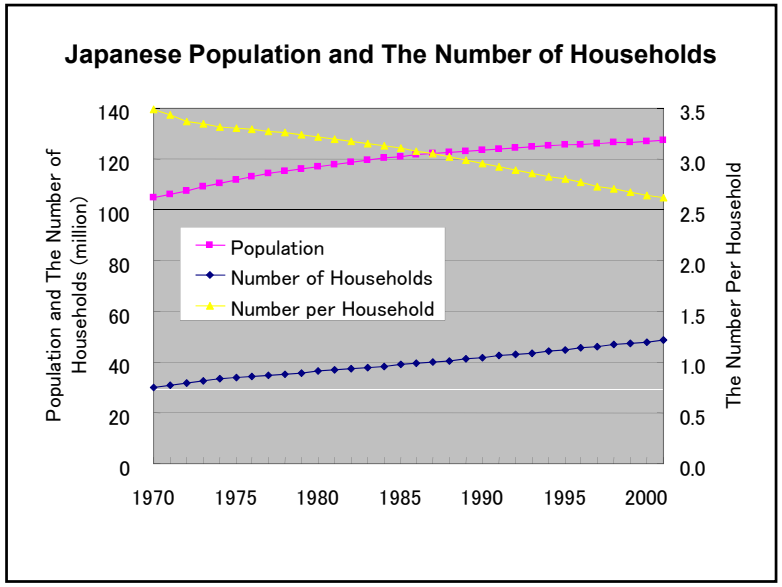
Japanese Energy Consumption in Residential Sector

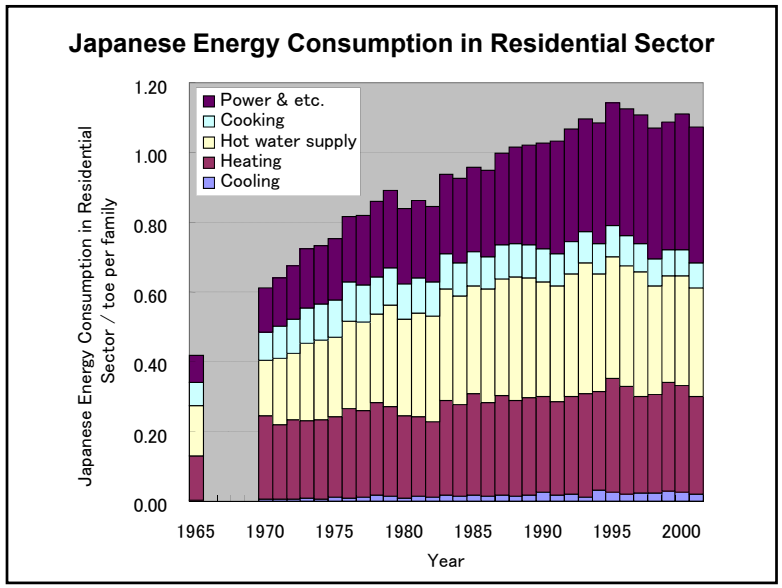


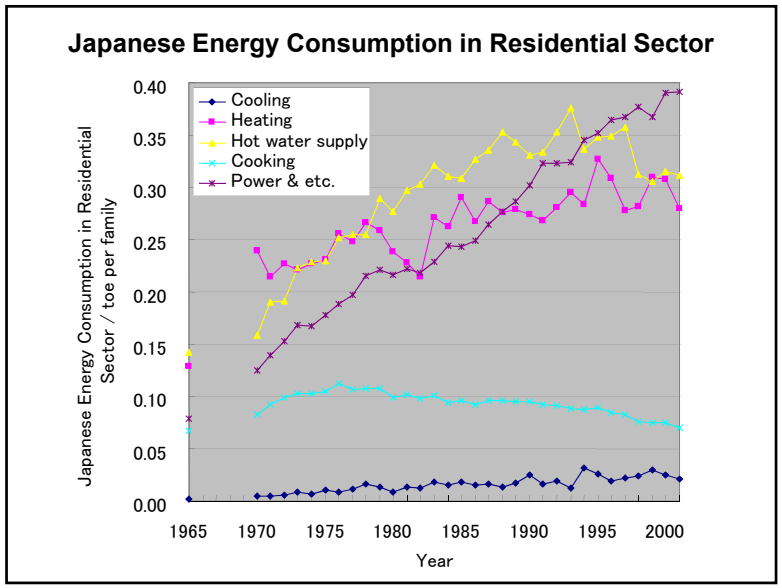
Japanese Energy Consumption in Residential Sector



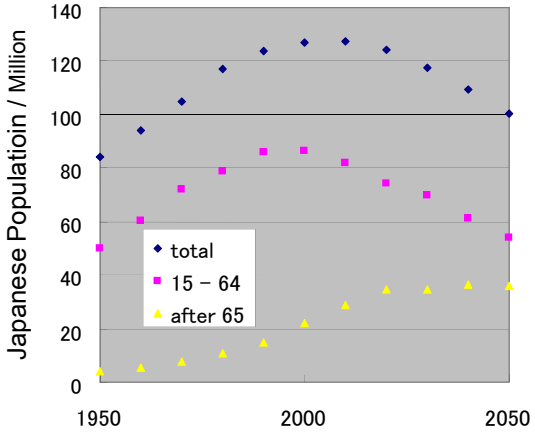

Japanese Energy Consumption in Residential Sector
Japanese Energy Consumption in Residential Sector / toe par capita
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Power & etc.
Cooking
Hot water supply
Heating
Cooling
1965 1970 1975 1980 1985 1990 1995 2000
Year


Japanese Population and The Number of Households
Population and The Number of Households (million)
140
120
100
80
60
40
20
0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
The Number Per Household
Population
Number of Households
Number per Household
1970 1975 1980 1985 1990 1995 2000


Japanese Energy Consumption in Residential Sector
Japanese Energy Consumption in Residential Sector / toe per family
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Power & etc.
Cooking
Hot water supply
Heating
Cooling
1965 1970 1975 1980 1985 1990 1995 2000
Year


Japanese Energy Consumption in Residential Sector
Japanese Energy Consumption in Residential Sector / toe per family
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Cooling
Heating
Hot water supply
Cooking
Power & etc.
1965 1970 1975 1980 1985 1990 1995 2000
Year

Transition of population composition of Japan



% of after 65

year	%
1970	7
1980	9
1990	12
2000	17
2010	23
2020	28
2030	30
2040	33
2050	36

Japanese Energy Consumption in Industry Sector