

Introduction to Energy Balance Table (EBT)



AIM Training Workshop
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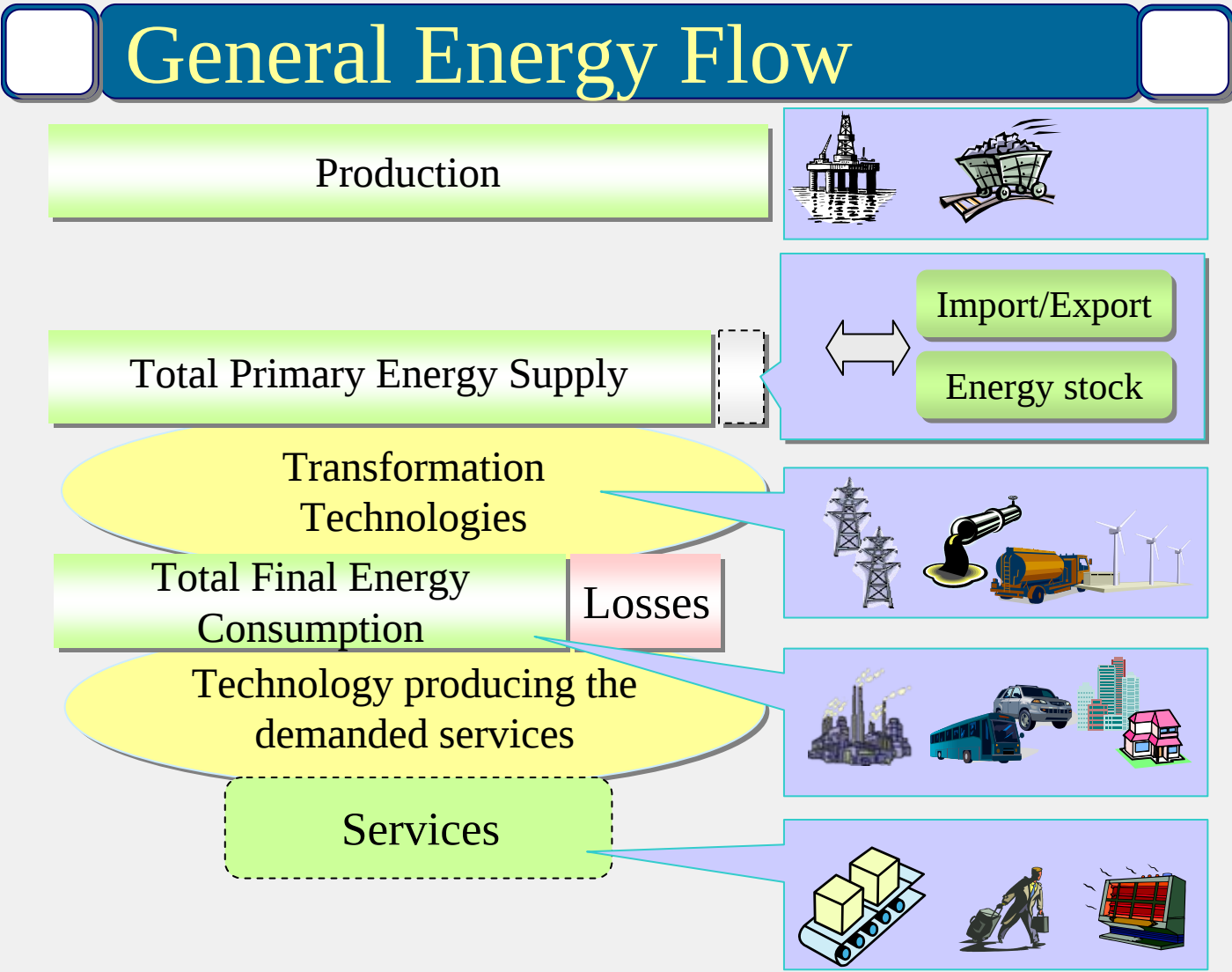
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Data preparation

Terms (Definitions)

- **Primary Energy**

Energy embodied in natural resources (e.g. coal, crude oil, sunlight, uranium) that has not undergone any anthropogenic conversions or transformations (IPCC).

- **Secondary Energy**

Form of energy generated by conversion of primary energies, e.g. electricity from gas, nuclear energy, coal, and gasoline from mineral oil, coke and coke oven gas from coal (European nuclear society).

- **Total primary energy supply (TPES)**

Total primary energy supply (TPES) is made up of production + imports - exports - international marine bunkers stock changes (IEA)

- **Total final energy consumption (TFC)**

Total final consumption (TFC) is the sum of consumption by the different end-use sectors (IEA).

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Terms (Definitions)

- **Energy intensity**

Ratio between the consumption of energy to a given quantity of output.

- **Carbon intensity**

The relative amount of carbon emitted per unit of energy or fuels consumed.

- **Energy Service**

Useful energy output of any final technical energy consumption system. Examples of energy services would include

- mechanical work, transportation, force
- pumping, venting and vacuum applications
- thermal uses (specific heating and cooling)
- lighting / illumination / magnification

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General Descriptions of EBT

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What is Energy Balance Table?

- Simple Table Format
- Illustrate general energy flow (production to end-use) of a region in question
- Flow (in row), Product (in column)
- Input (-), Output (+)
- Available at;
 - *IEA, Energy Balances and Statistics (170 countries)*
 - *APEC, APEC Energy Handbook etc.*
 - *National statistics (each country)*



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Why is EBT so important?

- Easy comparison (by country, by year)
- Easy interpretation
- “Double count” avoided
- Same format data available (Internationally)
- But...a little differences in “definitions” (Be careful!!)

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How is it look like?

	Crude oil	Petro. Products	Hydro/ Nuclear	Elec.	Coal/ Gas etc.	Total
Production	0.7	0.0	81.6	0.0	10.5	92.8
Imports	220.3	54.6	0.0	0.0	175.8	450.7
Exports & Stock Change	0.2	-15.2	0.0	0.0	-1.7	-16.7
TPES	221.2	39.4	81.6	0.0	184.6	526.8
Electricity Plants	-6.2	-24.1	-81.6	93.2	-111.8	-130.5
Petro. Refineries	-214.4	212.7	0.0	0.0	0.0	-1.7
Other Transformation	-1.2	-2.1	0.0	-0.1	0.1	-3.3
Own Use / Trans. losses	0.0	-12.3	0.0	-9.3	-4.0	-25.6
Statistical Differences	0.6	6.3	0.0	0.0	0.6	7.5
TFC	0.0	219.9	0.0	83.8	69.5	373.2
Industry	0.0	93.3	0.0	35.9	50.9	180.1
Domestic. & Commercial	0.0	37.6	0.0	46.1	18.7	102.4
Transportation	0.0	89.2	0.0	1.9	0.0	91.1

TPES: Total Primary Energy Supply*TFC: Total Final Consumption*

Total Primary Energy Supply 23,060

Transformation/Losses –6,871

Total Final Energy Cons. 16,024

Nuclear

Hyd/Ren/Geo

NG

OIL

COAL

Pub. Power Plant

Autoproducer

City Gas

Oil Refinery

Crude oil
(Before refinery)

Coal Product

Generation &
Transmission
losses

Own use

Electricity

Transportation
Fuel

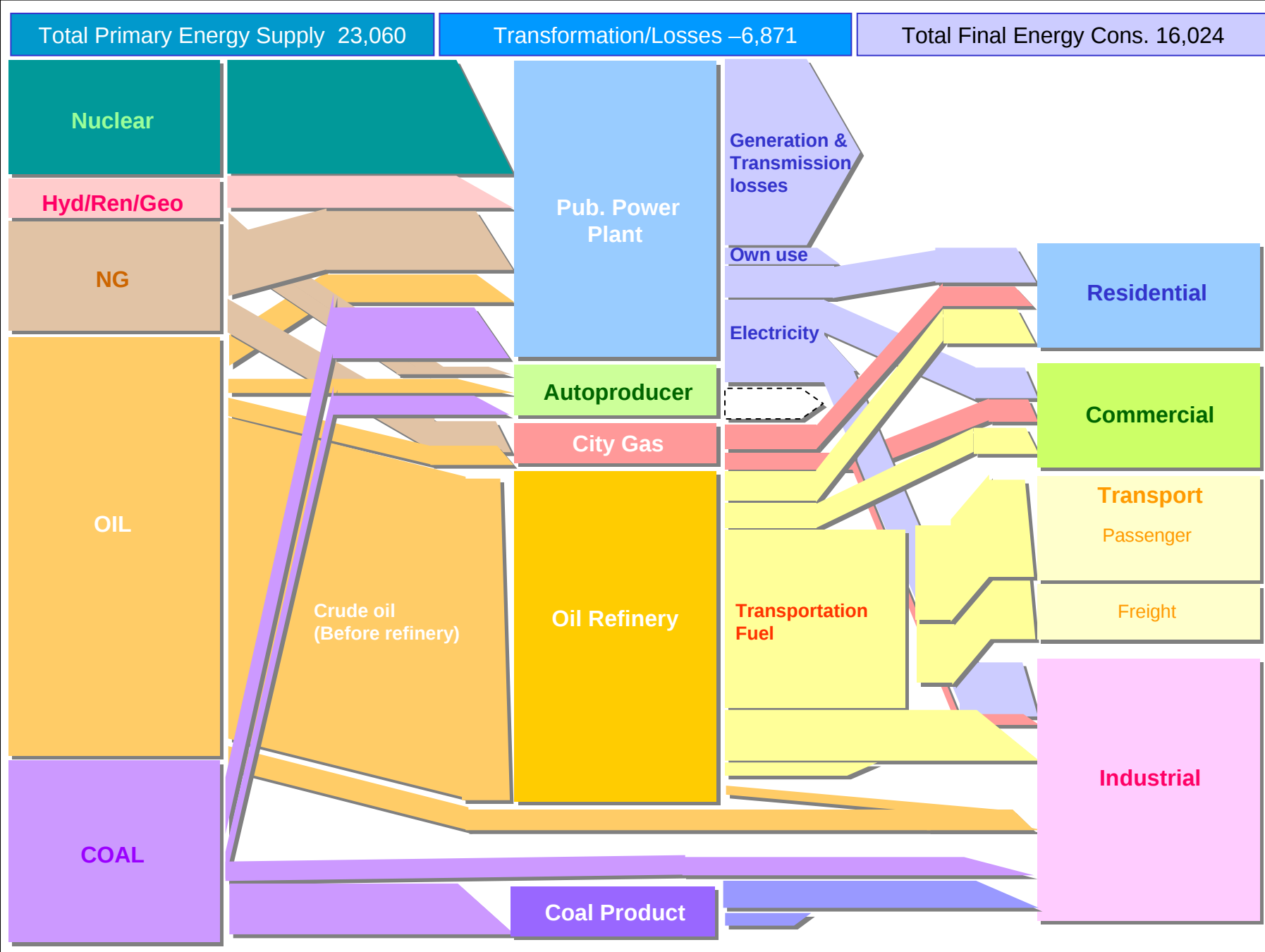
Residential

Commercial

Transport
Passenger

Freight

Industrial



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How to interpret EBT ?

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*TPES: Total Primary Energy Supply

*TFC: Total Final Consumption

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Interpretation (Production etc.)

- Production: Coal, Gas and Oil mine
- Stock change: Stock building (-), Stock using (+)

	Crude oil	Petro. Products	Hydro/ Nuclear	Elec.	Coal/ Gas etc.	Total
Production	0.7	0.0	81.6	0.0	10.5	<u>92.8</u>
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TPES	<u>221.2</u>	<u>39.4</u>	81.6	0.0	184.6	<u>526.8</u>

Oil dependence (%)

$$= \frac{221.2 + 39.4}{526.9} \times 100 = 49.5\%$$

Import dependence (%)

$$= \frac{450.7}{450.7 + 92.8} \times 100 = 82.9\%$$

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Interpretation (Transformations)

- Primary Energy $\Rightarrow$ Secondary Energy
- Input(-), Output(+)

	Crude oil	Petro. Products	Hydro/ Nuclear	Elec.	Coal/ Gas etc.	Total
TPES	221.2	39.4	81.6	0.0	184.6	526.8
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Interpretation (Energy end-use)

- Energy consumption by sector (by energy)
- Detailed Analysis possible
 - *Compare among countries*
 - *Historical change of energy consumption in certain sectors*

	Crude oil	Petro. Products	Hydro/ Nuclear	Elec.	Coal/ Gas etc.	Total
TFC	0.0	219.9	0.0	83.8	69.5	373.2
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Primary Energy Equivalent

- Conventions for primary energy (Renewables, Nuclear, Hydro, and Geothermal)
 - *The partial substitution method:*
 - The amount of energy that would be necessary to generate an identical amount of electricity in conventional thermal power plants
 - *The physical energy content method (IEA)*
 - Renewables, Hydro: 100%
 - Geothermal (electricity): 10%
 - Geothermal (Heat): 50%
 - Nuclear: 33%

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Unit of energy used in EBT

- Different unit used for each energy sources (*“tonnes” for coal, “kl” for oil “m³” for gas etc*)
 - Same unit should be used for easy analysis
 - “toe” (tonnes of oil equivalent)
 - “cal” (calories)
 - “J” (joules)
- *Energy unit in IEA: ktoe = 10^{10} kcal
- Unit prefix is commonly used

Unit Prefix	
K	Kilo (10^3)
M	Mega (10^6)
G	Giga (10^9)
T	Tera (10^{12})
P	Peta (10^{15})
E	Exa (10^{18})

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Conversion factors (Energy)

•Conversion factors for Energy

To	TJ	Gcal	Mtoe	MBtu	GWh
From:	multiply by:				
TJ	1	238.8	2.388×10^{-5}	947.8	0.2778
Gcal	4.2868×10^{-3}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe	4.1868×10^4	107	1	3.968×10^7	11630
MBtu	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
GWh	3.6	860	8.6×10^{-5}	3412	1

TPES in Japan (2004) : $562,777 \times 10^4$ (Gcal)

$=562,777 \times 10^4 \text{ (Gcal)} \times 4.29 \times 10^{-3} \text{ (TJ/Gcal)} = 2.41 \times 10^7 \text{ (TJ)}$

$=562,777 \times 10^4 \text{ (Gcal)} \times 10^{-7} \text{ (Mtoe/Gcal)} = 563 \text{ (Mtoe)}$

$=562,777 \times 10^4 \text{ (Gcal)} \times 3.97 \text{ (MBtu/Gcal)} = 2.23 \times 10^{10} \text{ (MBtu)}$

$=562,777 \times 10^4 \text{ (Gcal)} \times 1.16 \times 10^{-3} \text{ (GWh/Gcal)} = 6.53 \times 10^6 \text{ (GWh)}$

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Conversion factors (Mass/Vol.)

•Conversion factors for Mass

To	kg	t	lt	st	lb
From:	multiply by:				
Kilogramme (kg)	1	0.001	9.84×10^{-4}	1.102×10^{-3}	2.2046
tonne (t)	1000	1	0.984	1.1023	2204.6
Long ton (lt)	1016	1.016	1	1.120	2240.0
Short ton (st)	907.2	0.9072	0.893	1	2000.0
pound (lb)	0.454	4.54×10^{-4}	4.46×10^{-4}	5.0×10^{-4}	1

•Conversion factors for Volume

To	gal U.S.	gal U.K.	bbl	ft3	l	m3
From:	multiply by:					
U.S. gallon (gal)	1	0.8327	0.02381	0.1337	3.785	0.0038
U.K. gallon (gal)	1.201	1	0.02859	0.1605	4.546	0.0045
Barrel (bbl)	42.0	34.97	1	5.615	159.0	0.159
Cubic foot (ft3)	7.48	6.229	0.1781	1	28.3	0.0283
Litre (l)	0.2642	0.220	0.0063	0.0353	1	0.001
Cubic metre (m3)	264.2	220.0	6.289	35.3147	1000.0	1

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CO2 Emissions (Energy related)

CO2 Emissions derived from energy use (tCO2)
=Energy Cons. (tJ)*CO2 emission factors (tCO2/tJ)
=Energy Cons. (tJ)*C emission factors (tC/tJ)*44 /12

– “tC” or “tCO2”?

TABLE 1-2 CARBON EMISSION FACTORS (CEF)	
Fuel	Carbon Emission Factor (t C/TJ)
LIQUID FOSSIL	
Primary fuels	
Crude oil	20.0
Orimulsion	22.0
Natural Gas Liquids	17.2
Secondary fuels/products	
Gasoline	18.9

Ref. Revised 1996 IPCC Guidelines
for National Greenhouse Gas
Inventories

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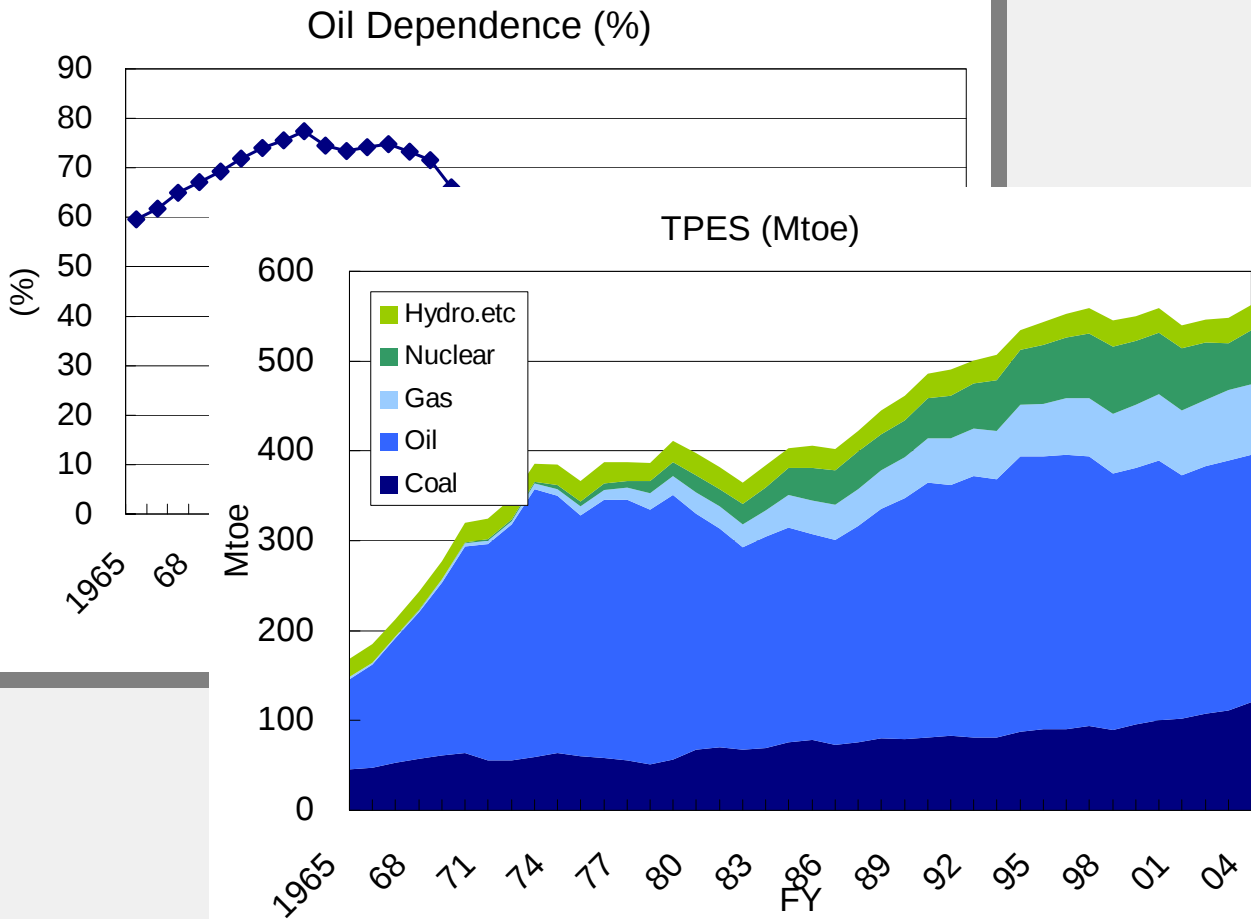
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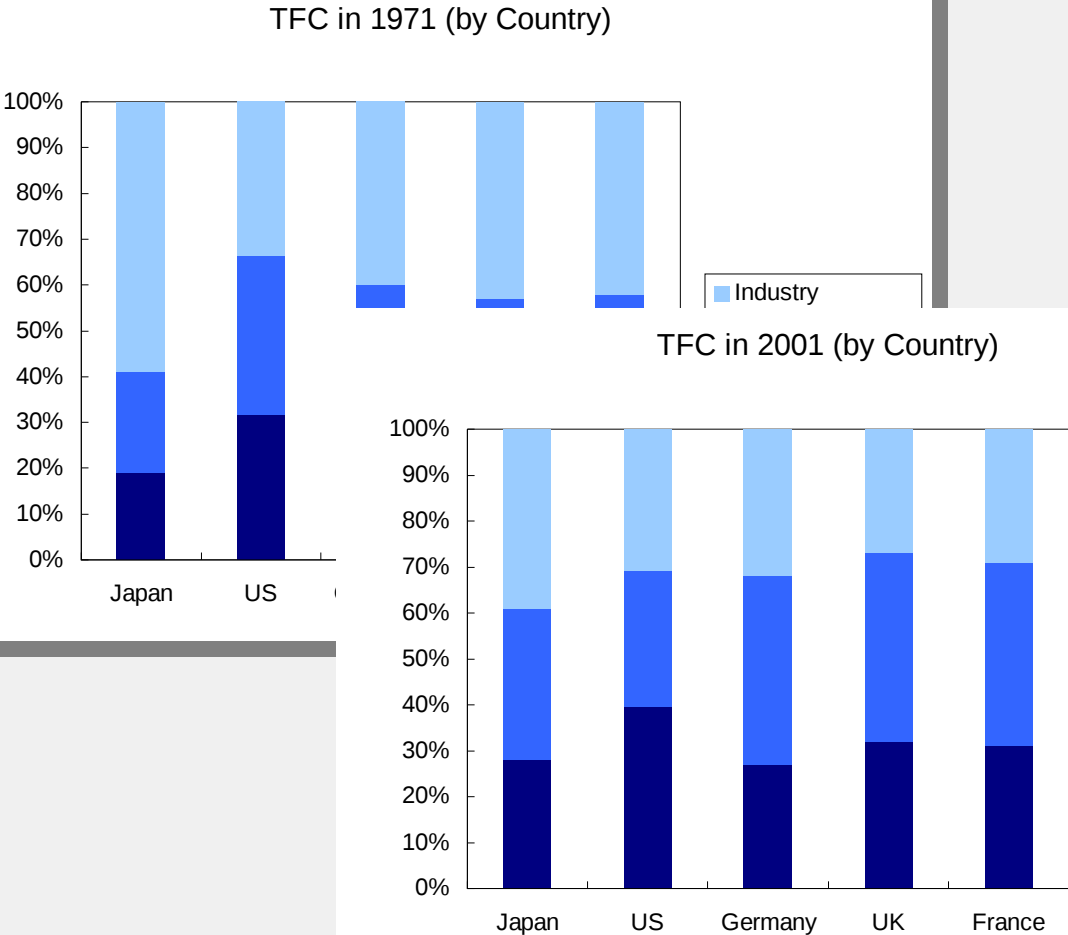
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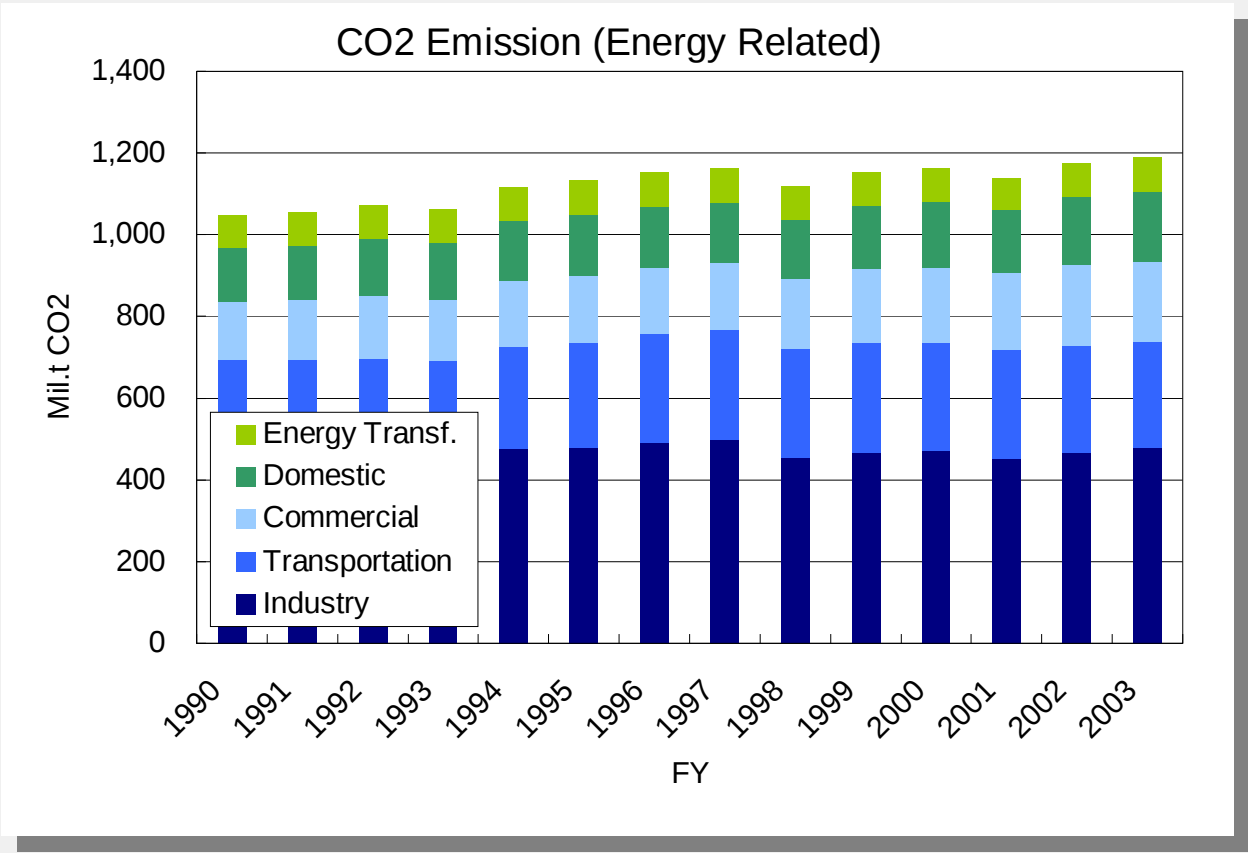
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Any Questions?



Thank you for your attention!!