

Introduction to Energy Statistics / Energy Balances

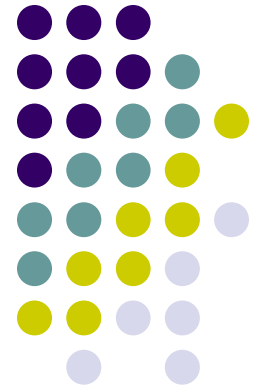
Workshop on Energy Statistics and Energy Balance

Kuala Lumpur, Malaysia

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EDMC, IEEJ



What is Energy Balance Table?

- **Energy is:**
 - **Producible** (Coal Mines, Oil/Gas wells, Hydro Plants, etc.)
 - **Tradable** (Imports / Exports)
 - **Transformable** (Oil Refinery, Power Generation, Heat Distribution, etc.)

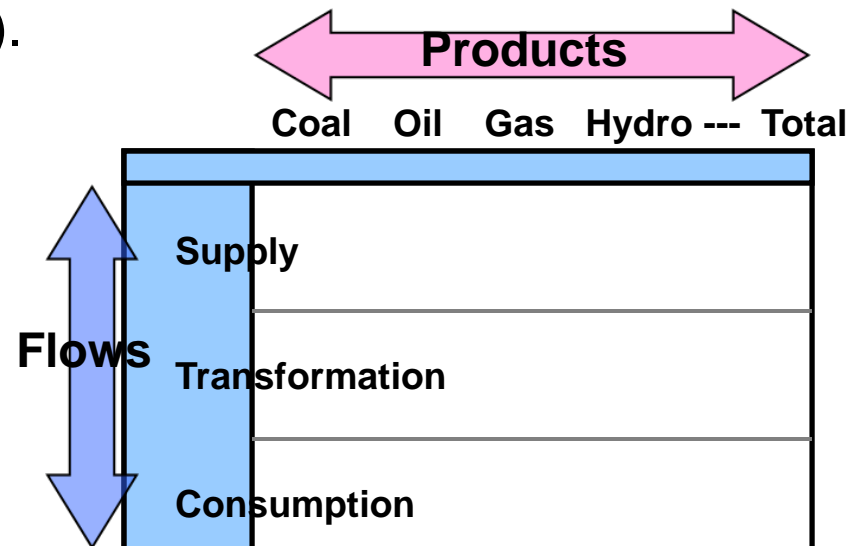


- **An Energy Balance Table:**

*Illustrates **Energy Flow** (Supply, Transformation and Demand) of each **product** (Coal, Oil, Gas, Hydro, Nuclear, Electricity, etc.) in specific area / period **in same thermal unit.***

What is an Energy Balance Table?

- An **aggregate presentation of energy flows** from primary resources (indigenous production), through each transformation sector and to final energy consumption for an economy, a region or the world.
- Expressed in **thermal unit**: Terajoules or Petajoules or tonnes of oil equivalent (toe).
- Usually on an annual basis or quarterly.
- **Energy flows in rows** and **products in columns**.
- Conventions: input (-) and output (+).



What is an Energy Balance Table?

- **Why is an Energy Balance Important?**

- It is an easy way of reporting energy data in a common unit.
- It is **easy to compare** the shares of each fuel source in each sector of an economy (or by year).

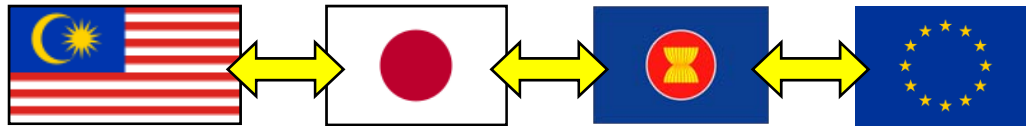


- Energy Balance shows the **flows of different sources of energy** from supply to demand (eg, double check on total supply and demand).
- A quality control before any energy publications e.g., double count fuels, inputs/outputs in the transformation sector.

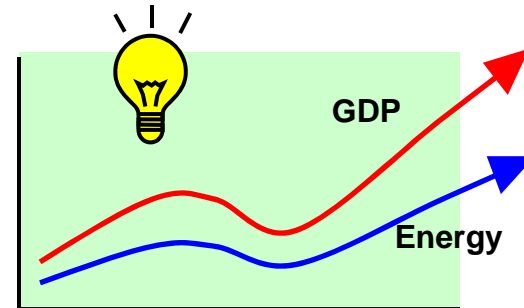
What is an Energy Balance Table?

- **Why is an Energy Balance Important?**

- A standard format facilitates comparison between countries (or regions).



- Energy Balance is a **starting point for construction of energy indicators** of energy consumption (eg, energy consumption per capita or per unit of Gross Domestic Product) and of energy efficiency.



- It shows a country's dependence on imports and exports.
- It will help to identify inconsistent time series data.

Primary Energy Data to Energy Balances

- Use of primary energy statistics.
 - Coal, Oil, Gas, Electricity & Heat, NRE
 - Sales data to end-users
 - Consumption data by sub-sectors
- Application of appropriate methodology.
 - Thermal conversion factors: NCV or GCV
 - Thermal efficiency of primary electricity
 - Hydro, Nuclear, Geothermal, etc

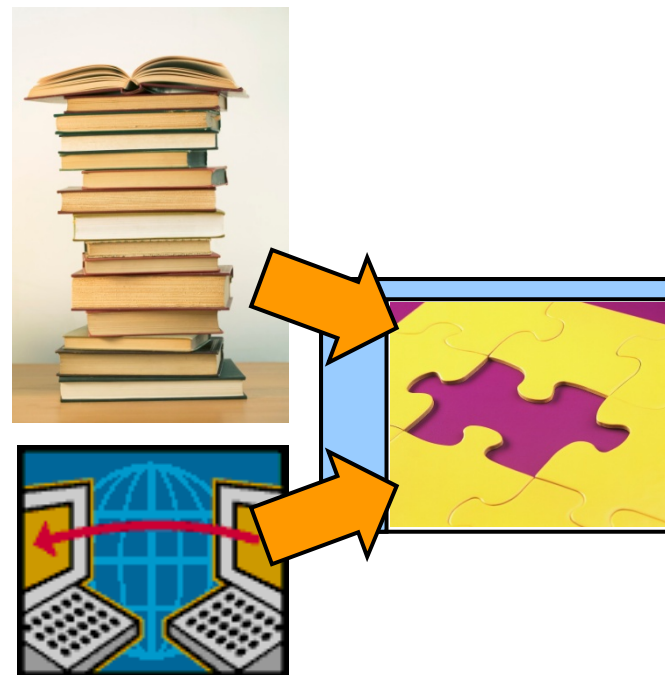
Primary Energy Statistics

- **Collection of Primary Energy Data**

- Collection of energy supply data from energy industries
- Collection of energy consumption data
 - Industry Sector
 - Transport Sector
 - Commercial Sector
 - Residential Sector
 - Agriculture, Fishery, etc.

- **Methodology of Data Collection**

- Mandatory basis
- Voluntary basis



List of Energy Statistics (Japan)

Statistics	Name	Resource	Survey	Publish	Energy	Item
	Mineral Resources and Petroleum Products Statistics	METI	Fundamental Statistics	Monthly Annually	Coal, Oil, Gas	Production, Import, Export, Stock changes etc
	Trade Statistics of Japan	MOF		Monthly Annually	All Products	Import, Export etc
	Supply and Demand of Electricity	Japan Electricity Association		Monthly	Electricity	Power generation, Input fuels, sales amount etc
	Supply and Demand of Electricity	ANRE	Administrative Statistics	Annually	Electricity	Power generation, Input fuels, sales amount etc
	Report of the Current Survey of Energy Consumption	METI	Fundamental Statistics	Monthly Annually	Coal, Oil, Gas, Electricity	Consumption by Industry etc
	Report of Gas Company	ANRE	Fundamental Statistics	Monthly	Gas	Production, sales amount etc
	Report of Gas Company	ANRE		Annually	Gas	Production, sales amount etc
	Heat Service Utilities Statistics	JHSUA		Annually	Heat residue, fuels	Consumption etc
	Input and Output Table	Ministry of Internal Affairs and Communications	Fundamental Statistics	5years	Expenditure etc	Coefficients, inverse matrix, coefficients, domestic production, producer's prices, purchaser's prices

List of Energy Statistics (Japan)

Statistics	Name	Resource	Survey	Publish	Energy	Item
<CT>	Vehicle Transport	MLIT	Fundamental Statistics	Monthly Annually	Gasoline, Diesel oil etc	Ton-km, Passenger-km, Consumption etc
<CT>	Rail Road Transport	MLIT	Fundamental Statistics	Monthly Annually	All Products	Ton-km, Passenger-km
<CT>	Coastwise Vessel Transport	MLIT	Fundamental Statistics	Monthly Annually	Fuel oil etc	Ton-km, Passenger-km, Consumption etc
<CT>	Aviation Transport	MLIT	Fundamental Statistics	Annually	Jet Fuel	Ton-km, Passenger-km, Consumption etc
<F>	Report on the Family Income and Expenditure Survey	Statistics Breau	Fundamental Statistics	Monthly Annually	Town Gas, LPG, Kerosene etc	Residential Consumption, Expenditure etc

Energy Balance Table in Japan

	100	150	200	250	400	450	550	600	700	800
	Coal	Coal Products	Oil	Oil Products	Natural Gas	Town Gas	Hydro	Nuclear	Electricity	Heat
1000	Primary Energy Supply									
1100			<R>		<R>		<E>	<E>		
1200	<C><T>	<R>	<R>	<R>	<R>					
1500	TP Total Primary Energy Supply									
1600	<R>	<R>		<R>						
1700		<R>	<R>	<R>	<R>					
1900	DP Domestic Primary Energy Supply									
2000	Energy Conversion & Own use									
2100	<E>	<E>	<E>	<E>	<E>	<E>	<E>	<E>	<E>	
2200	<C>	<C>	<C>	<C>	<C>	<C>	<C>		<E>	
2300	<C>	<C>	<C>	<C>	<C>	<C>				<C>
2350	<AH>			<AH>		<AH>			<AH>	<AH>
2400		<G>		<G>	<G>	<G>				
2500	<R>	<C>		<C>						
2600			<R>	<R><C>	<C>					<C>
2700	<R>			<R>		<AG>				
2800	TC Total Conversion									
2900	<C>	<C>	<C>	<C>	<C>	<G>			<C>	<C>
3000	OI Other Input/Output									
3500	<C>	<C>	<C>	<C>	<C>					
5000	Final Energy Consumption									
6000	Industry									
6100	<IO>	<IO>		<IO>	<IO>	<IO>			<E>	
6500	I Manufacturing									
6520				<C>	<C>	<C>			<E><C>	<C>
6550	<C>	<C>		<C>	<C>	<C>			<E><C>	<C>
6570	<C>	<C>		<C>	<C>	<C>			<E><C>	<C>
6580	<C>	<C>		<C>	<C>	<C>			<E><C>	<C>
6600	<IO>	<IO>		<IO>	<IO>	<IO>			<E><C>	<C>
6700	<C>			<C>	<C>	<C>			<E><C>	<C>
6900	<IO>	<IO>		<IO>		<IO>			<E><C>	<C>
7000	ResCom									
7100				<F>		<AG>			<E>	<AH>
7500		residue		residue		<AG>			<IO>	<IO>
8000	Transportation									
8000				<CT>					<E><CT>	
9500	Non-Energy									
9500		<C>		<C>	<C>					

• Energy Balance Table of Japan is “Processed Statistics” and this table is made by over 10 Statistics.

• METI estimate some missing part.

Energy Balance Table in Japan

2006FY	100	150	200	250	400	450	500	550	600	700	800	900	
	Coal	Coal Products	Oil	Oil Products	Natural Gas	Town Gas	Renewable	Hydro	Nuclear	Electricity	Heat	Total	
1000	Primary Energy Supply	114,786	1,402	217,609	49,478	85,999	0	16,553	17,933	63,447	0	567,207	
1100	Indigenous Production	0	0	781	0	3,547	0	16,553	17,933	63,447	0	102,261	
1200	Import	114,786	1,402	216,828	49,478	82,452	0	0	0	0	0	464,946	
1500	Total Primary Energy Supply	114,786	1,402	217,609	49,478	85,999	0	16,553	17,933	63,447	0	567,207	
1600	Export	-1	-1,381	0	-22,709	0	0	0	0	0	0	-24,091	
1700	Stockpile Change	0	382	-4,348	-802	2,634	0	0	0	0	0	-2,134	
1900	Domestic Primary Energy Supply	114,785	404	213,261	25,967	88,632	0	16,553	17,933	63,447	0	540,981	
2000	Energy Conversion & Own use	-102,483	33,416	-219,884	176,213	-87,339	31,297	-15,834	-17,933	-63,447	84,345	17,073	-164,578
2100	Power Generation	-49,604	-4,583	-5,755	-10,120	-50,339	-1,427	-1,748	-16,559	-63,447	82,576	0	-120,838
2200	Auto Power Generation	-5,323	-3,322	-1	-9,007	-472	-1,742	-5,979	-1,374	0	10,961	0	-16,260
2300	Industrial Steam Generation	-4,853	-832	-2	-8,229	-291	-1,479	-7,943	0	0	0	19,878	-3,750
2350	District Heat Supply	-15	0	0	-25	0	-432	-161	0	0	-99	621	-112
2400	Town Gas Production	0	0	0	-1,089	-35,184	36,211	-1	0	0	0	0	-62
2500	Coal Products	-44,664	44,015	0	-314	0	0	0	0	0	0	0	-963
2600	Oil Products	0	0	-213,437	212,700	189	0	0	0	0	0	-3,325	-3,874
2700	Other Conversions & Blending	471	0	0	-535	0	535	0	0	0	0	0	471
2800	Total Conversion	-103,988	35,277	-219,195	183,380	-86,096	31,666	-15,832	-17,933	-63,447	93,438	17,173	-145,556
2900	Own Use & Loss	-168	-2,330	-2	-7,417	-1,010	-369	0	0	0	-9,093	-100	-20,489
3000	Other Input/Output	0	0	0	377	0	0	0	0	0	0	0	377
3500	Stock Change	1,672	468	-687	-128	-233	0	-2	0	0	0	0	1,090
4000	Statistical Discrepancy	2,255	0	-6,623	-56	-328	0	0	0	0	5	0	-4,747
5000	Final Energy Consumption	10,046	33,819	0	202,235	1,621	31,297	719	0	0	84,340	17,073	381,151
6000	Industry	9,463	33,760	0	72,433	1,604	5,166	127	0	0	27,641	16,475	166,669
6100	Non-Manufacturing	4	17	0	10,271	81	603	0	0	0	252	0	11,228
6500	Manufacturing	9,459	33,743	0	62,162	1,523	4,563	127	0	0	27,389	16,475	155,441
6520	Pulp & Paper	0	0	0	442	5	29	2	0	0	3,038	5,785	9,301
6550	Chemical	193	1,112	0	45,412	770	157	0	0	0	4,153	5,891	57,687
6570	Cement & Ceramics	3,808	518	0	1,863	9	28	127	0	0	1,881	224	8,458
6580	Iron & Steel	5,921	23,664	0	1,898	583	1,518	0	0	0	6,202	2,269	42,055
6600	Machinery	0	122	0	680	92	638	0	0	0	7,475	0	9,008
6700	Duplication Adjustment	-572	0	0	-321	-15	-28	-2	0	0	-579	-1,917	-3,435
6900	Other Industries & SMEs	43	8,117	0	8,777	0	1,392	0	0	0	1,505	3,084	22,919
7000	Residential & Commercial	583	59	0	41,599	17	26,131	592	0	0	55,065	599	124,645
7100	Residential	0	0	0	15,540	0	10,245	574	0	0	24,041	32	50,431
7500	Commercial & Others	583	59	0	26,060	17	15,885	18	0	0	31,024	567	74,213
8000	Transportation	0	0	0	88,203	0	0	0	0	0	1,634	0	89,837
9500	Non-Energy	0	420	0	43,602	397	0	0	0	0	0	0	44,419

(Source) METI

Appropriate Methodology

- **Definitions of Products and Flows**
 - Following International Definitions
 - Definition on the APEC/ASEAN Joint Questionnaires.
 - Global definitions prepared by the International Energy Statistics Group (InterEnerStat).
- **Methodology to produce Energy balance Table based on the primary data**
 - Net Calorific Values vs. Gross Calorific Values
 - Coal & Oil: 0.95, Gas: 0.90
 - Thermal efficiency of primary electricity
 - Hydro: 100%, Nuclear: 33%, Geothermal: 10%
 - Average thermal efficiency of coal, oil and gas



APEC/ASEAN Joint Annual Questionnaires

- 5 Questionnaires
 - Coal, Oil, Gas, Electricity & Heat and NRE (New & Renewables)
 - Supply, Transformation, Final Consumption
 - Microsoft Excel format
- The energy data should be filled in the questionnaires.
 - Following the definitions
 - Minimize statistical difference
 - Check for inconsistent historical trend

APEC-ASEAN Joint Format for Annual Coal Data
Supply Sector (Table 1)

Update	Primary Fuel							Secondary Fuel						
	Crude Oil	Anthracite	Other bituminous coal	Sub-bituminous coal	Lignite	Low	Low Fuel	Coal	Coal Tar	EEB/EB	Gas: VLS: Gas	Coal: Oven Gas	Blow: Lignite Gas	
	(0000)	(0000)	(0000)	(0000)	(0000)	(0000)	(0000)	(0000)	(0000)	(0000)	10 ⁶ kcal (gross)	10 ⁶ kcal (gross)	10 ⁶ kcal (gross)	
	A	B	C	D	E	F	G	H	I	J	K	L	M	
Production														
of which underground														
of which surface														
From Other Source														
of which from Gas														
Export														
Import														
Stock Change														
Inventory (End of Year)														
Inventory (Start of Year)														
Inventory (End of Year)														
Inventory (Start of Year)														
Inventory (End of Year)														
Inventory (Start of Year)														
Inventory (End of Year)														
EE code														
EE code														
EE code														

Relation between the Questionnaires and the for Energy Balance Table

Malaysia	Coal	Coal Products	Crude Oil	Petroleum Products	Gas	Hydro	Nuclear	Geothermal, etc.	Others	Electricity	Heat	Total
Indigenous Production	676		35513	2356	57022	642						96208
Imports	8310		8565	7370	4447					9		28701
Exports	-176		-14994	-9517	-21600					-50		-46337
International Marine Bunkers				-66								-66
International Aviation Bunkers												
Stock Changes	-695		144	-115								-666
Total Primary Energy Supply	8114		29229	28	39869	642				-41		77839
Total Transformation Sector	-6894		-26740	25917	-27982	-642				9563		-26778
Main Activity Producer	-6894			-479	-13300	-642				9103		-12211
Autoproducers				-63	-1004					460		-607
Gas Processing					-13679							-13679
Refineries			-26740	26459								-281
Coal Transformation												
Petrochemical Industry												
Loss & Own Use				-993	-1411					-772		-3175
Discrepancy	244		-2488	-519						-768		-3532
Total Final Energy Consumptions	1464			24433	10474					7983		44354
Industry Sector	1464			6092	10250					3685		21490
Transport Sector				16175	189					15		16378
Other Sector				2167	36					4283		6486

Coal Questionnaire:
 Supply
 Transformation
 Final Consumption
 Thermal Quantity
 (Unit: kilo-tonnes)

Oil Questionnaire:
 Refinery Intake
 Supply
 Transformation
 Final Consumption
 (Unit: kilo-tonnes)

Gas Questionnaire:
 Supply
 Transformation
 Final Consumption
 (Unit: million CM)

Renewables Questionnaire:
 Supply
 Transformation
 Final Consumption
 (Unit: kilo-tonnes)

Electricity & Heat Questionnaire:
 Generation
 Input
 Supply - Demand
 (Unit: GWh / PJ)

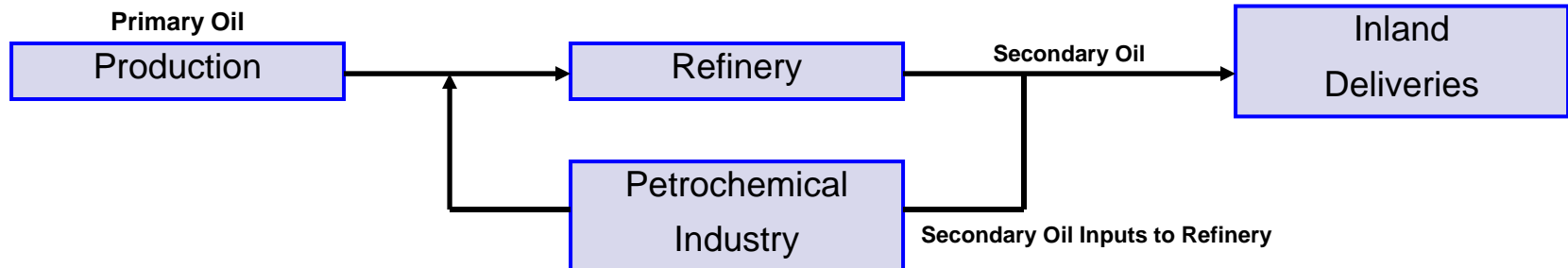
Points in Checks -Coal-

- **Classification of Coal**
 - Heat content basis
 - Bituminous Coal / Sub-bituminous coal / Lignite
 - End-use basis
 - Coking coal / Steam coal / Anthracite
- **Coke oven process**
 - Coal to Coke and Coke Oven Gas
- **Blast furnace process**
 - Coke & Coke Oven Gas to Blast Furnace Gas

Points in Check -Oil-

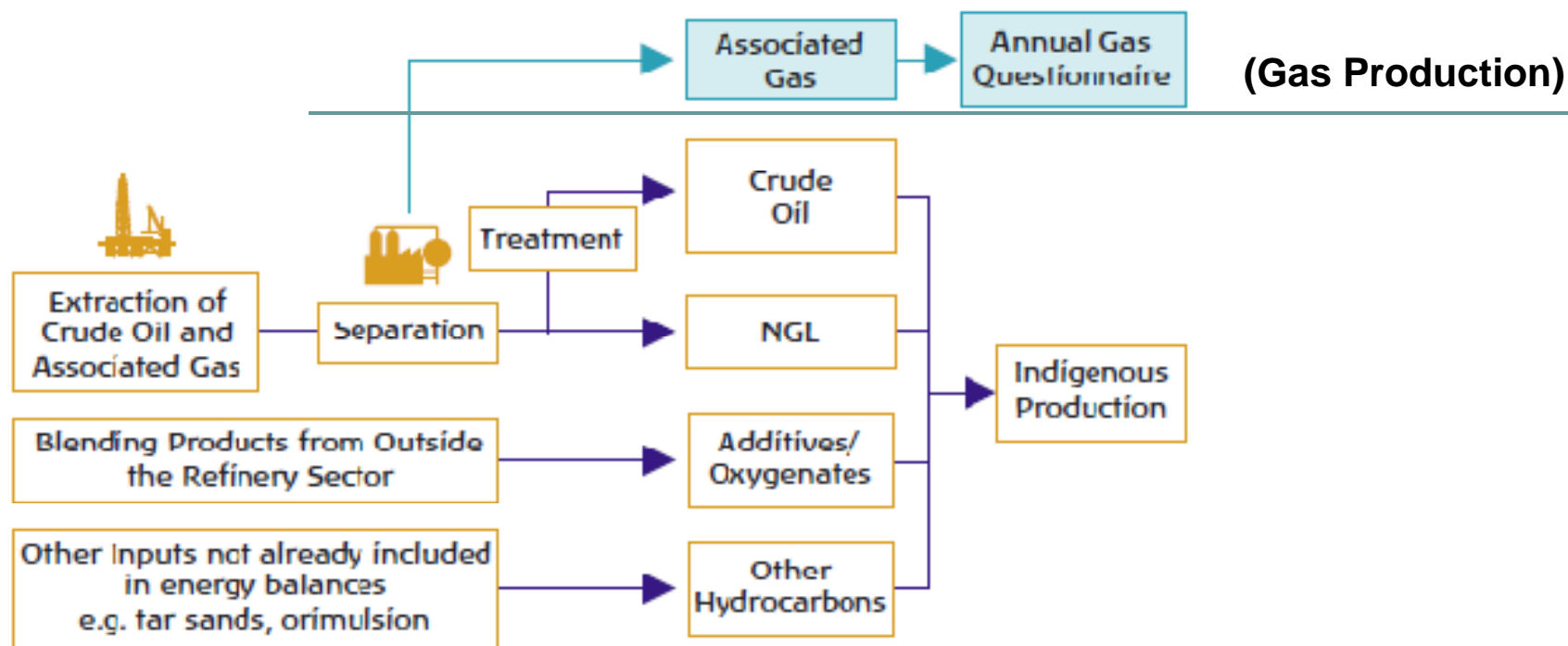
- Crude Oil is a mineral oil of natural origin comprising a mixture of hydrocarbons and associated impurities, such as sulphur.
- Petroleum Products are manufactured from mainly Crude Oil through Refinery Process.

Primary Oil Products	Crude Oil Natural Gas Liquids (NGL) Other Hydrocarbons		
Secondary Products Inputs to Refinery	Additives/Blending Components Refinery Feedstocks		
Secondary Oil Products	Refinery Gas Ethane LPG Naphtha Aviation Gasoline Motor Gasoline	Gasoline Type Jet Fuel Kerosene Type Jet Fuel Other Kerosene Gas/Diesel Oil Fuel Oil White Spirit	Lubricants Bitumen Paraffin Waxes Petroleum Coke Other Products



Points in Check -Oil-

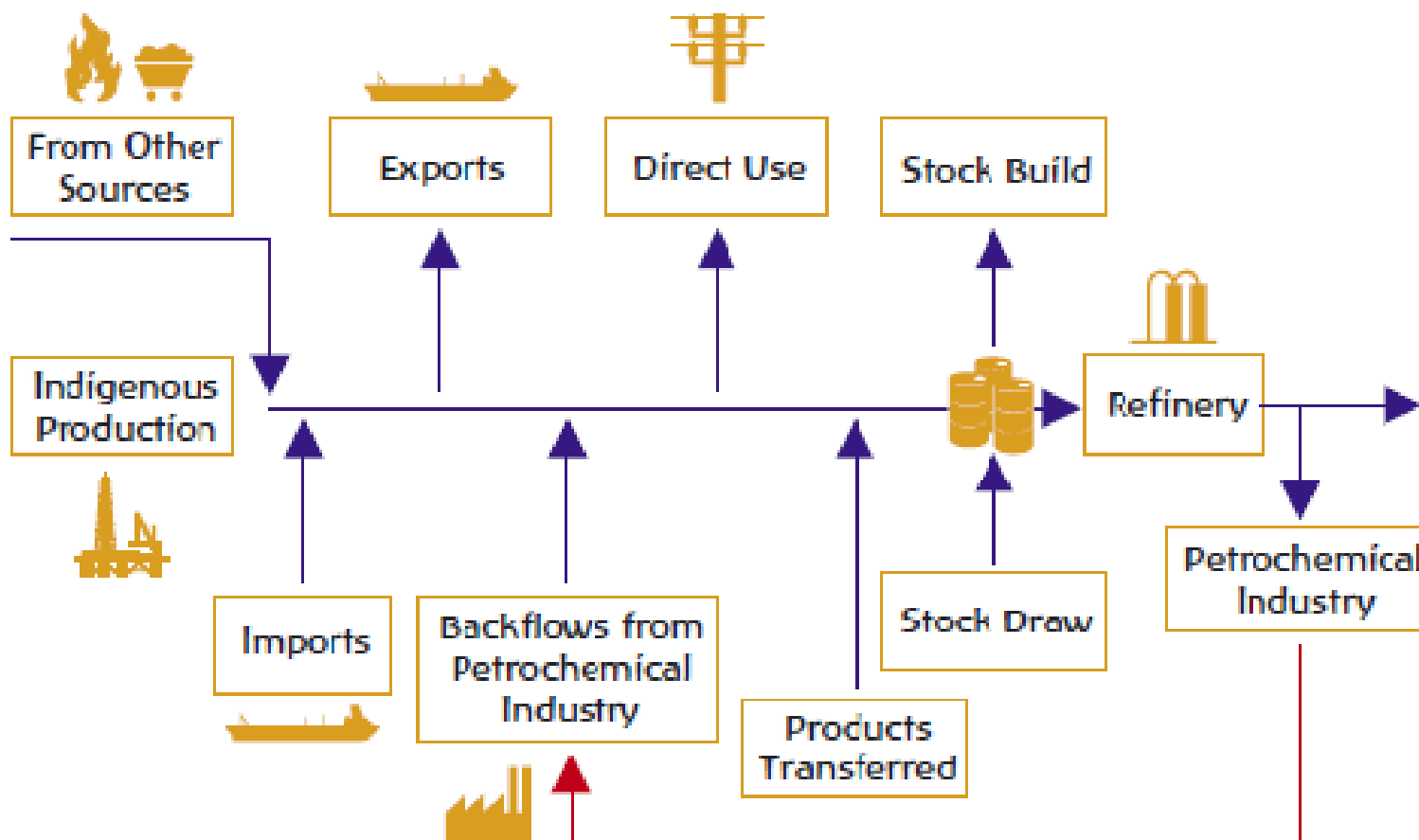
Indigenous Production of Oil



Energy Statistics Manual (IEA)

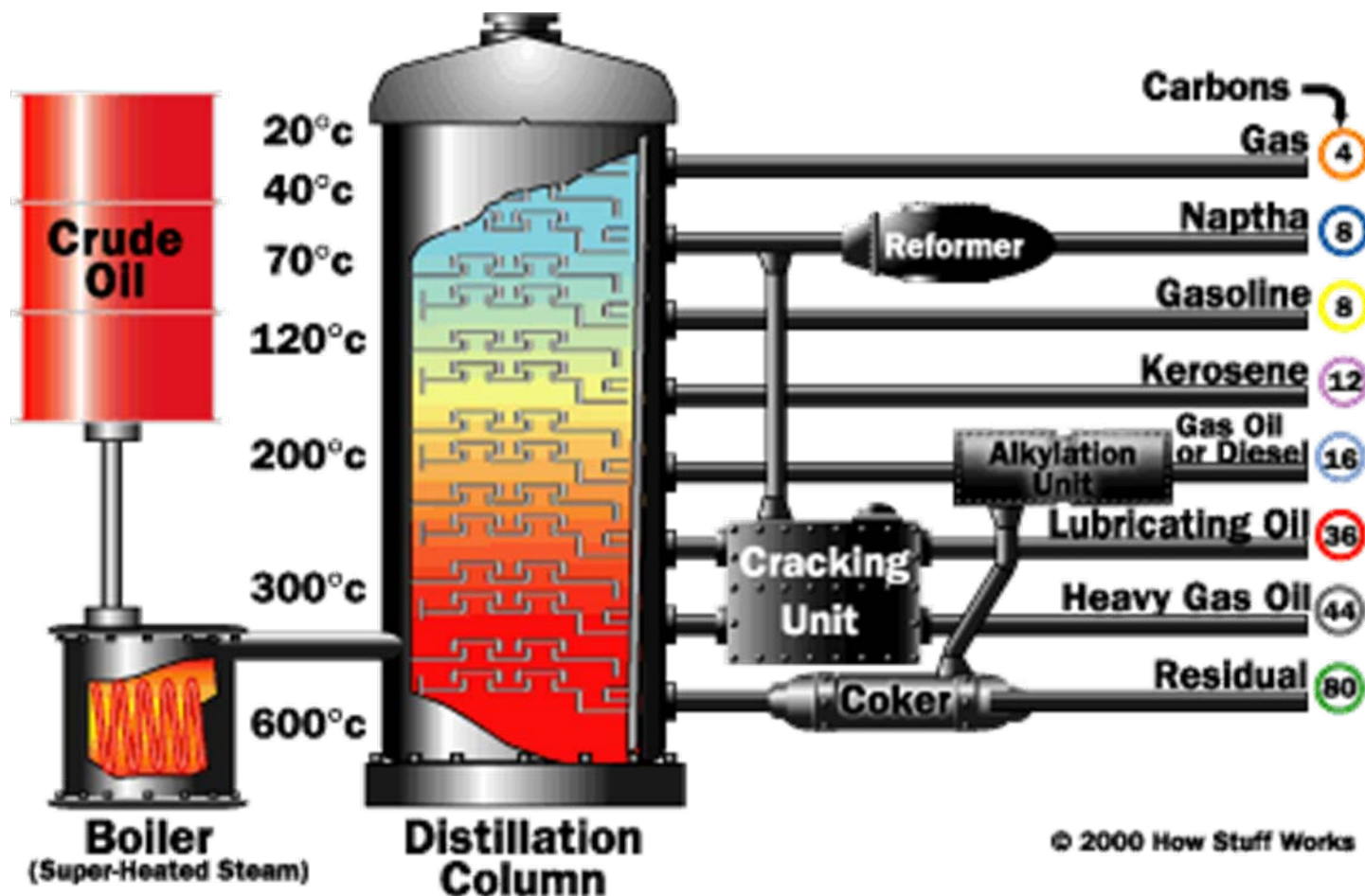
Points in Check -Oil-

Primary Supply of Crude Oil



Energy Statistics Manual (IEA)

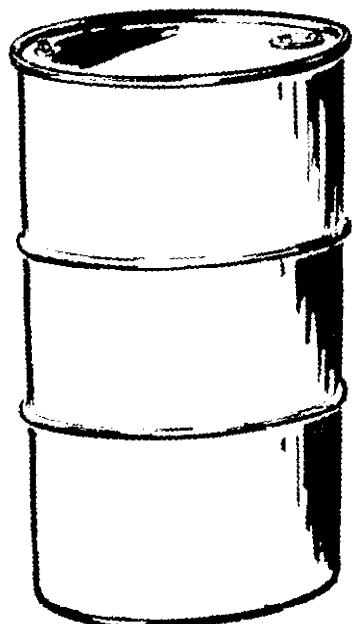
Points in Check -Oil-



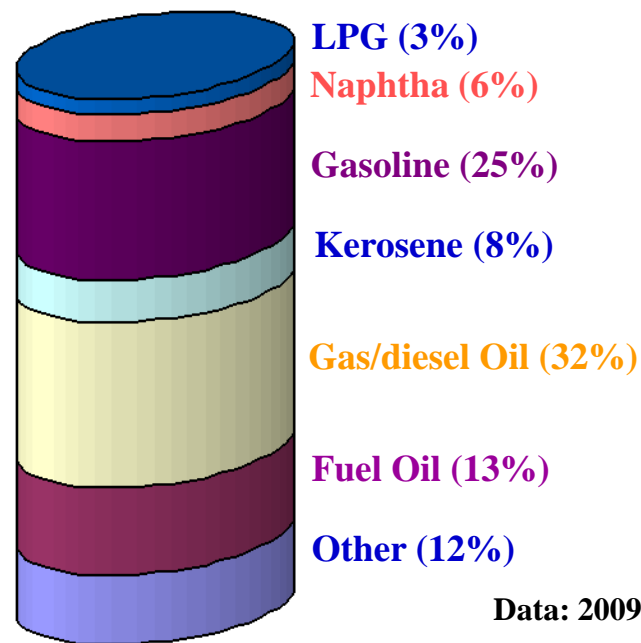
Source: How Stuff Works:<http://science.howstuffworks.com/oil-refining4.htm>

Points in Check -Oil-

Crude Oil



World - Oil product consumption

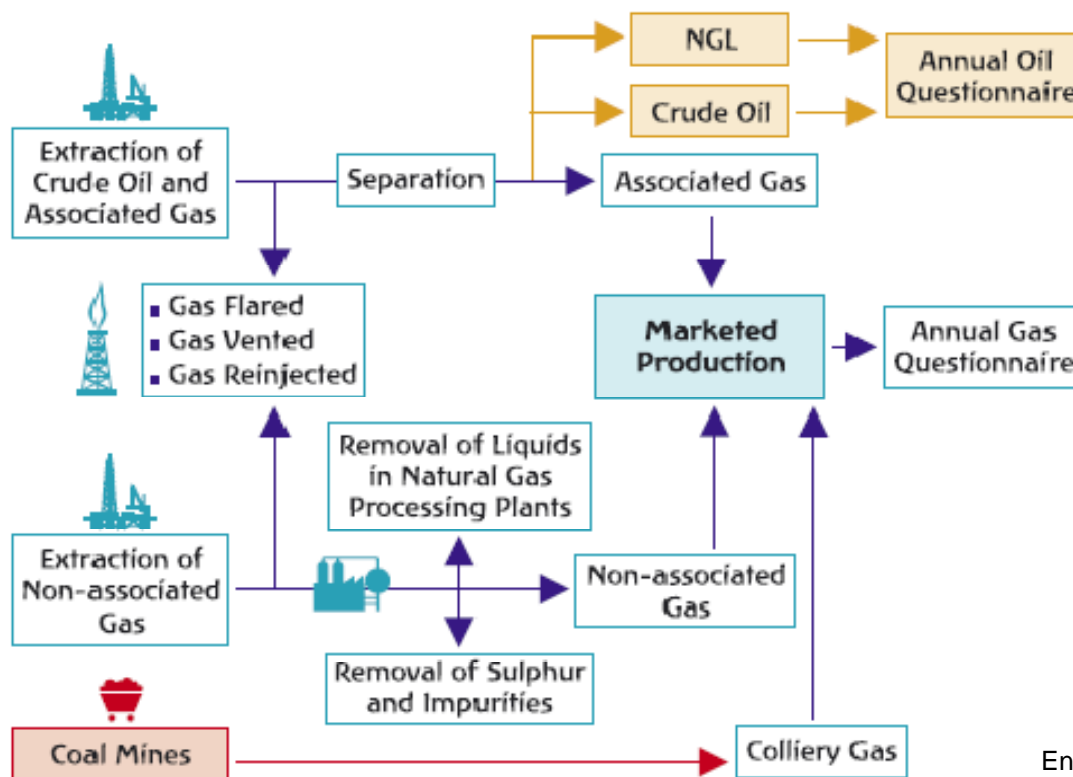


Data: 2009

Source: IEA

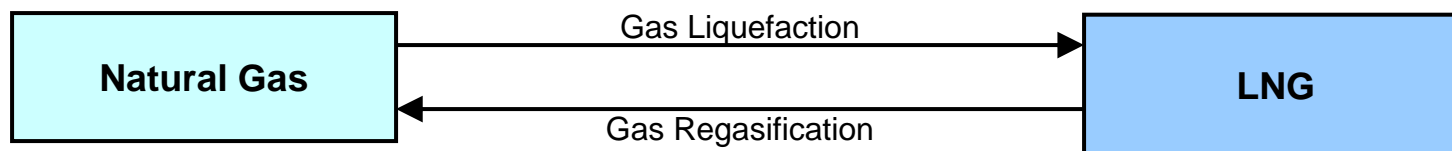
Points in Checks -Gas-

Natural Gas Production



Energy Statistics Manual (IEA)

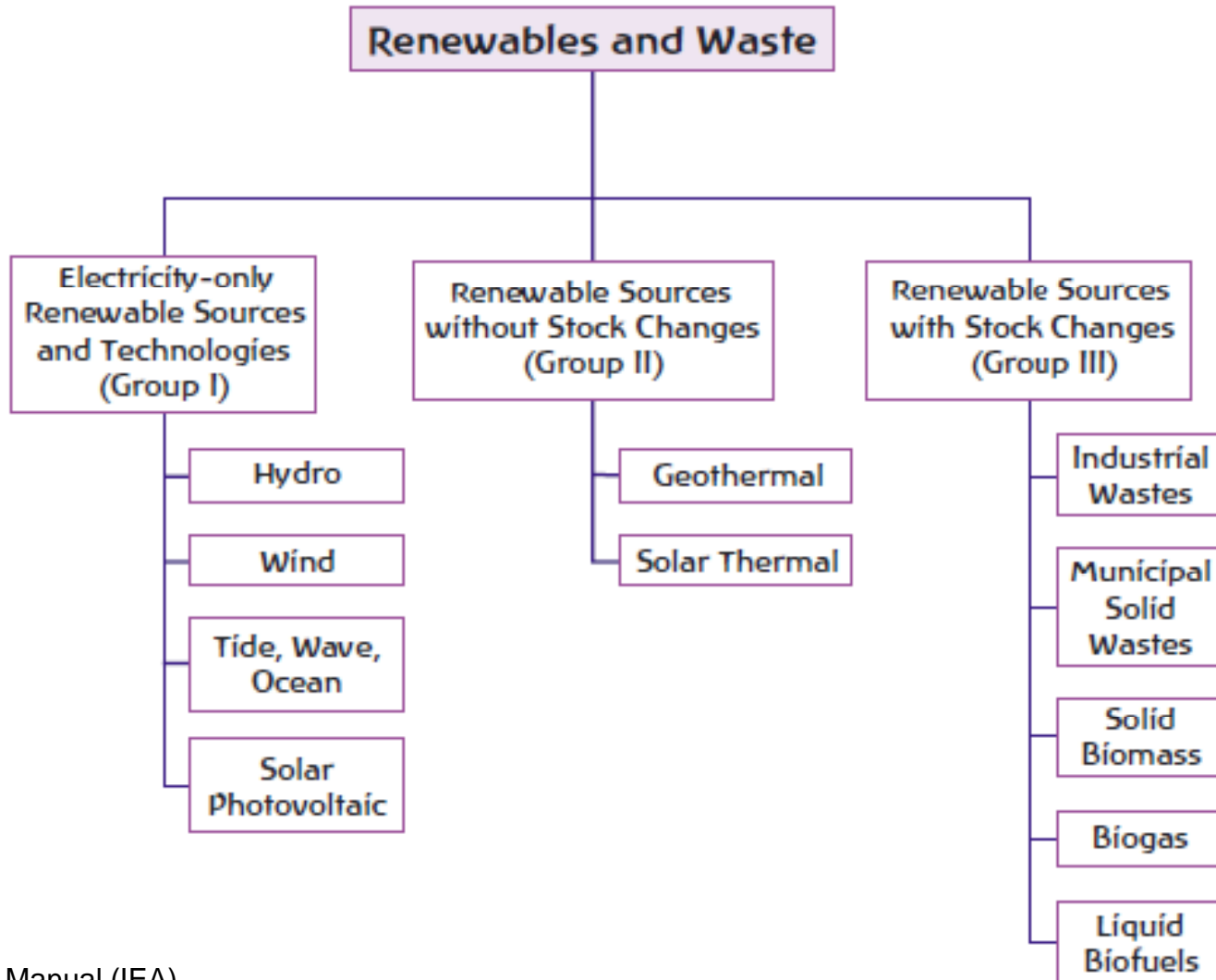
LNG Transformation



Points in Check -Electricity-

- **Thermal power generation should be separated by fuel input:**
 - Coal & coal products
 - Petroleum products
 - Natural gas
- **Auto-Producers**
 - Fuel input & power generation amounts by players
 - Data collection is very hard.
- **Generation from Solar Photovoltaic (PV)**
 - Estimation: Accumulated solar panel (GW) *24 *365 * Lf
 - Lf: Load factor
- **Generation from Biomass**
 - Power generation amount and fuel input

Points in Checks -New & Renewables-



Energy Statistics Manual (IEA)

Analysis of Energy Supply / Demand in Malaysia / Japan

Primary Energy Supply

Malaysia	Coal	Coal Products	Crude Oil	Petroleum Products	Gas	Hydro	Nuclear	Geothermal, etc.	Others	Electricity	Heat	Total
Indigenous Production	876		35513	2358	57022	842						98208
Imports	8310		8565	7370	4447					9		28701
Exports	-176		-14994	-9517	-21600					-50		-46337
International Marine Bunkers				-86								-86
International Aviation Bunkers												
Stock Changes	-695		144	-115								-666
Total Primary Energy Supply	8114		29229	28	39869	842				-41		77839

Japan	Coal	Coal Products	Crude Oil	Petroleum Products	Gas	Hydro	Nuclear	Geothermal, etc.	Others	Electricity	Heat	Total
Indigenous Production	827		855		3482	7017	65805	3302	8251			89139
Imports	117013	1106	210089	44300	81307							453815
Exports		-650		-19440								-20090
International Marine Bunkers				-5272								-5272
International Aviation Bunkers				-8081								-8081
Stock Changes	-1103		-1863	-208	-10							-3184
Total Primary Energy Supply	116537	456	209081	13299	84779	7017	65805	3302	8251			508327

Primary Energy Supply

Malaysia: 77 839 ktoe

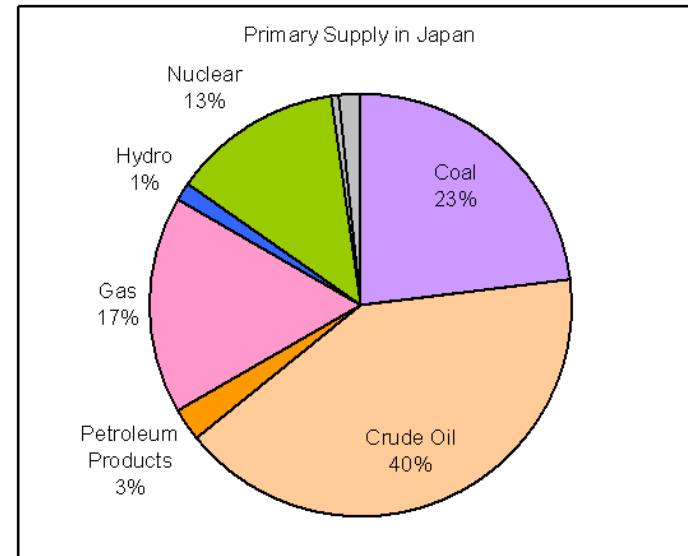
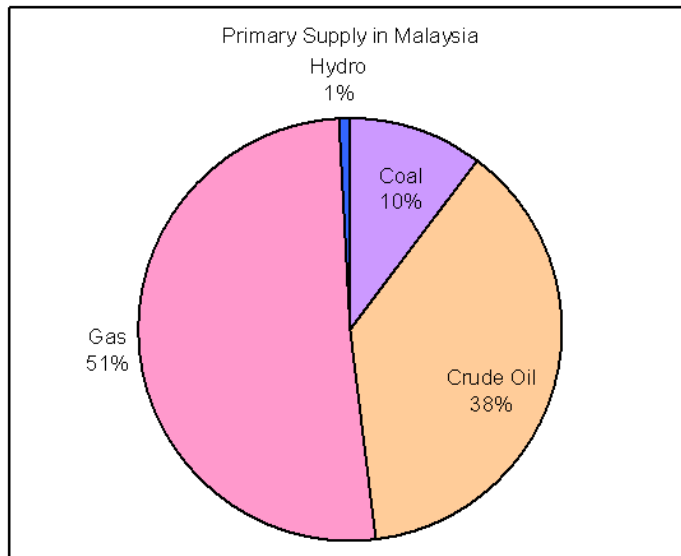
Japan: 508 327 ktoe

Self Sufficiency Rate

(Production / TPES)

Malaysia: 17.5 %

Japan: 123.6 %

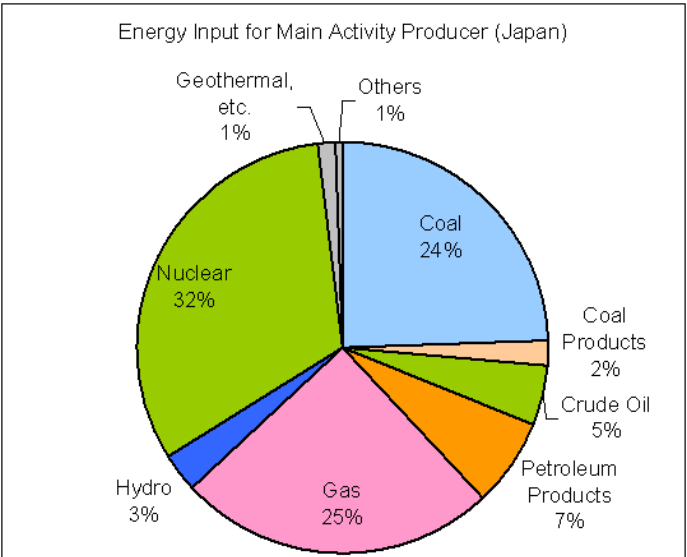
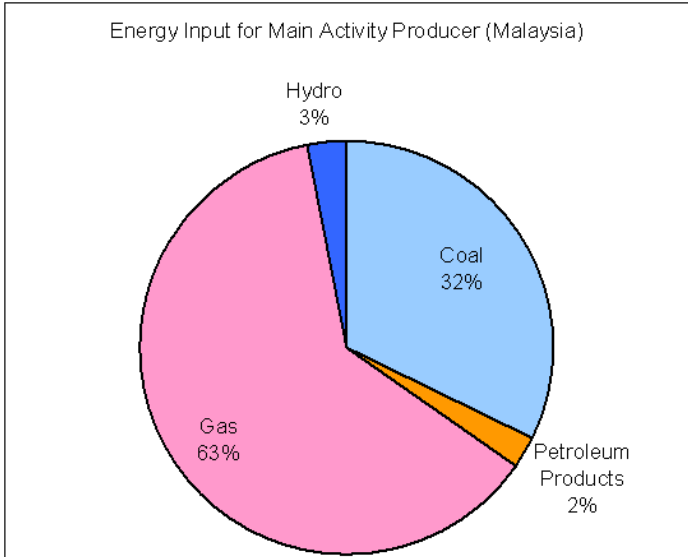


Analysis of Energy Supply / Demand in Malaysia / Japan

Transformation Sector: Power Generation

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Petrochemical Industry												
Loss & Own Use				-993	-1411					-772		-3175

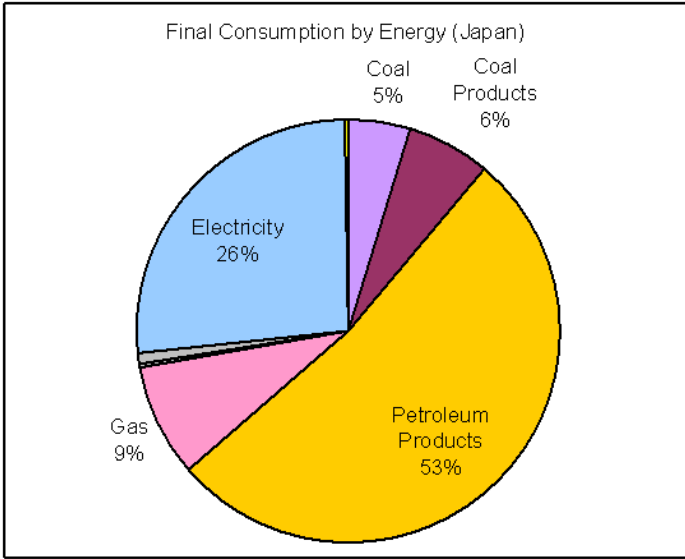
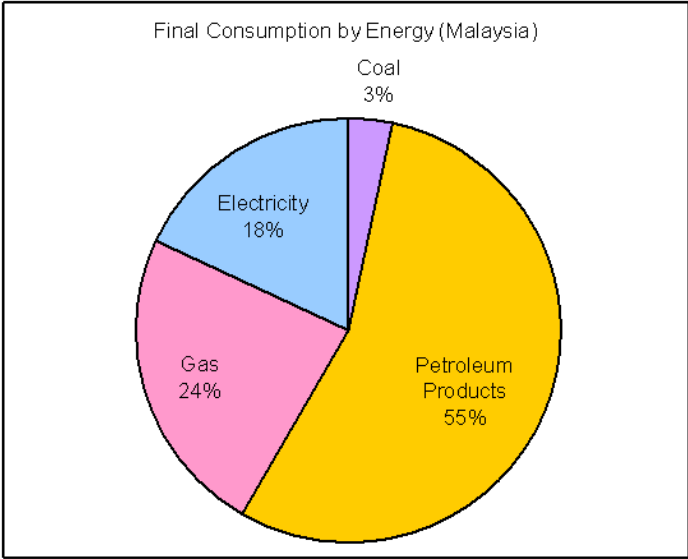


Analysis of Energy Supply / Demand in Malaysia / Japan

Final Consumption by Energy

Malaysia	Coal	Coal Products	Crude Oil	Petroleum Products	Gas	Hydro	Nuclear	Geothermal, etc.	Others	Electricity	Heat	Total
Total Final Energy Consumptions	1464			24433	10474					7983		44354
Industry Sector	1464			6092	10250					3685		21490
Transport Sector				16175	189					15		16378
Other Sector				2167	36					4283		6486

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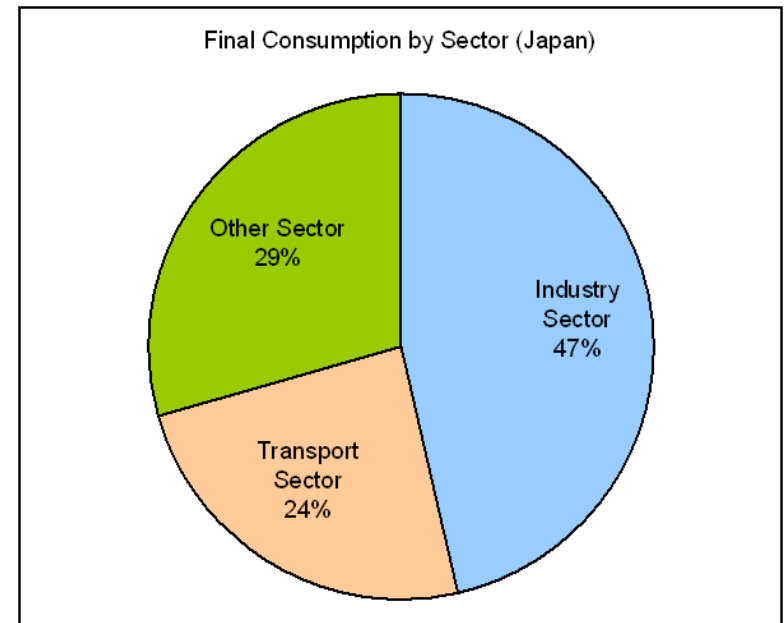
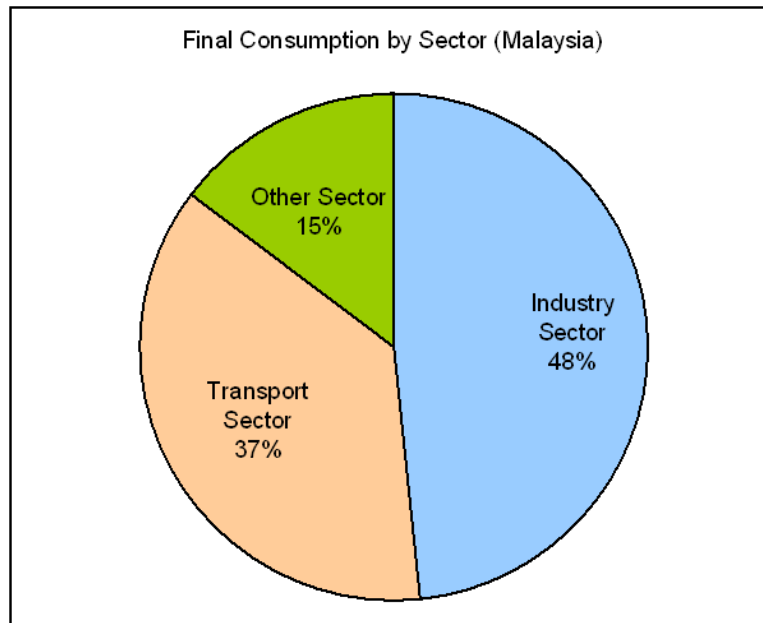


Analysis of Energy Supply / Demand in Malaysia / Japan

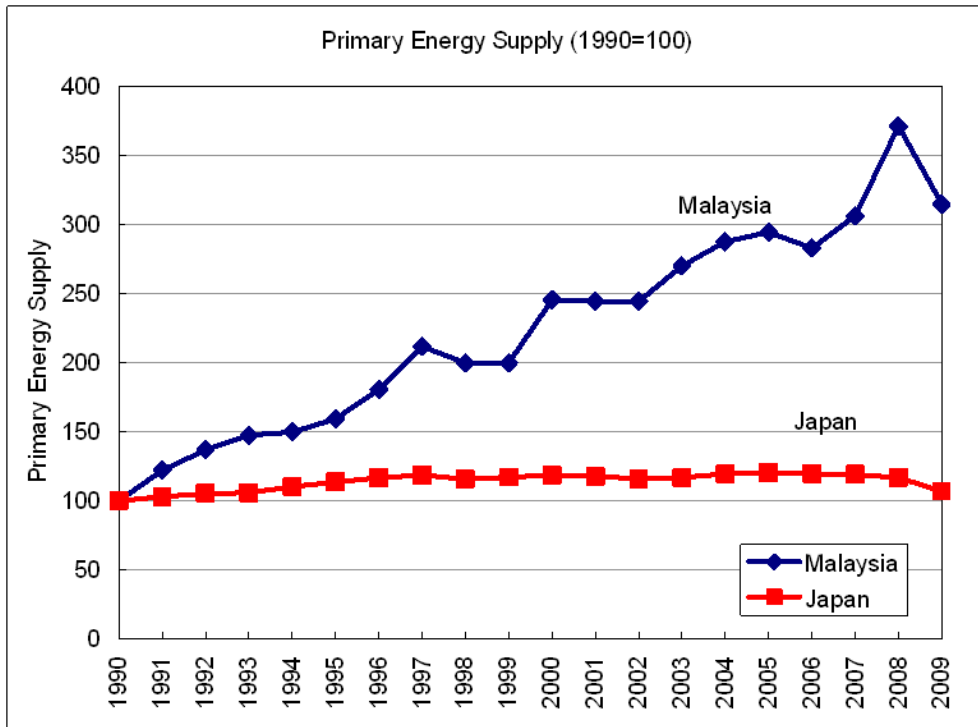
Final Consumption by Sector

Malaysia	Coal	Coal Products	Crude Oil	Petroleum Products	Gas	Hydro	Nuclear	Geothermal, etc.	Others	Electricity	Heat	Total
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Industry Sector	1464			6092	10250					3685		21490
Transport Sector				16175	189					15		16378
Other Sector				2167	36					4283		6486

Japan	Coal	Coal Products	Crude Oil	Petroleum Products	Gas	Hydro	Nuclear	Geothermal, etc.	Others	Electricity	Heat	Total
Total Final Energy Consumptions	15935	21437		176063	29250			512	3031	88916	580	335724
Industry Sector	15935	20748		63583	14707				3009	38119		156102
Transport Sector				79389						1842		81232
Other Sector		689		33090	14543			512	22	48954	580	98390

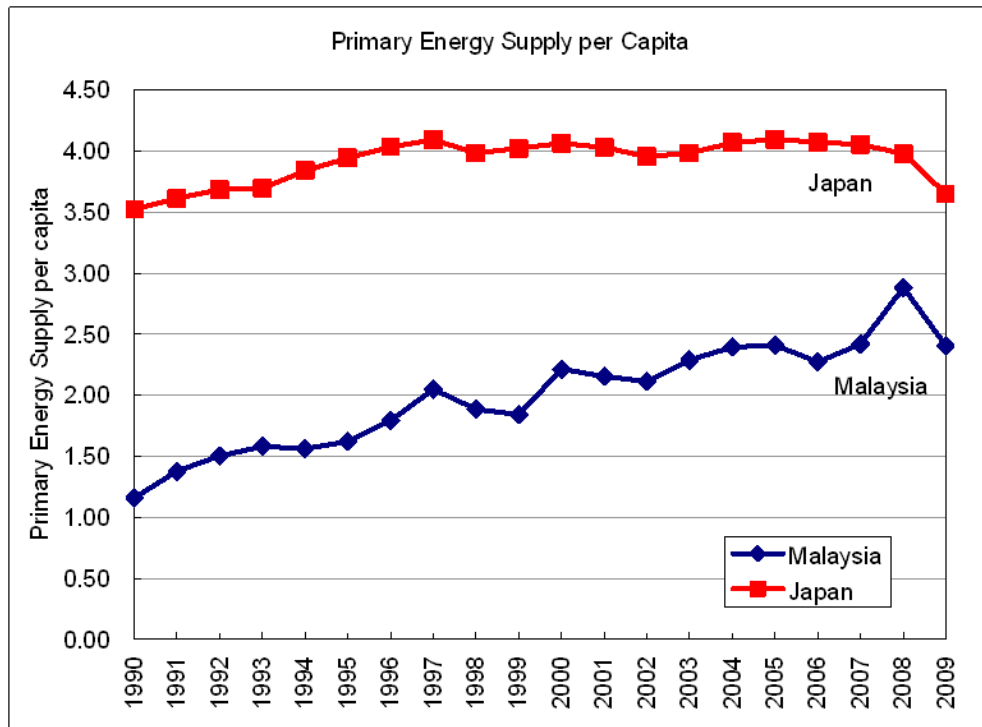


Historical Trend of Energy Supply in Malaysia / Japan



From 1990 to 2009, Primary Energy Supply in Malaysia increased by 214% (from 21.0 mtoe to 66.0 mtoe), while that of Japan increased by 7.0%.

Primary Energy Supply per Capita in Malaysia / Japan

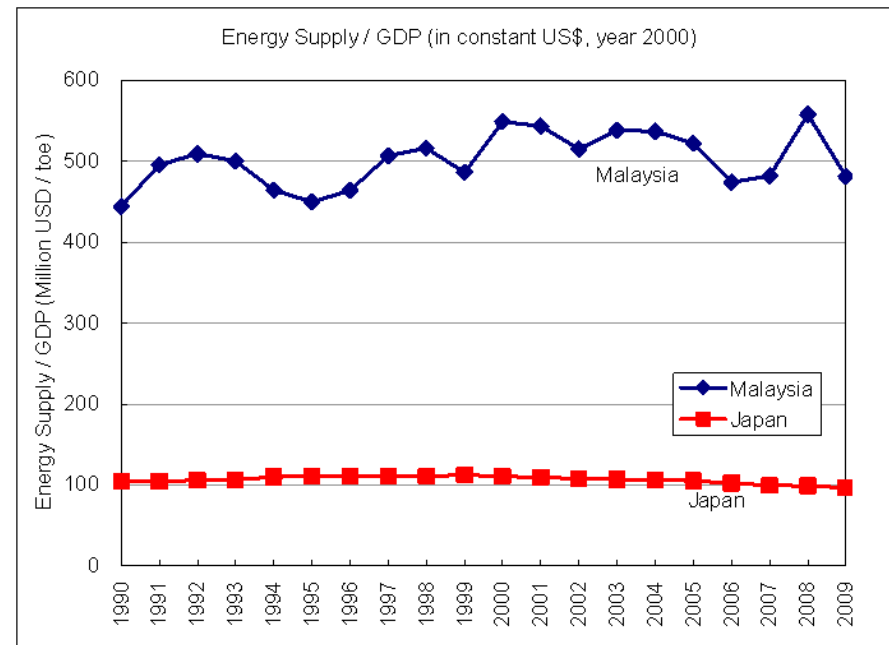
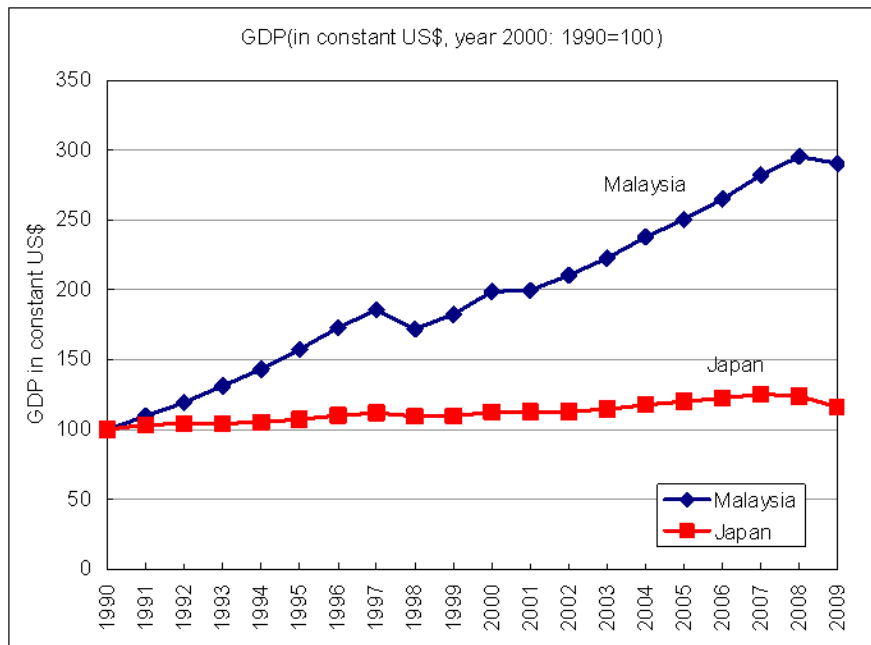


Primary Energy Supply per Capita in Malaysia was 2.40 (toe/capita) in 2009, 3.65 (toe/capita) in Japan.

Primary Energy Supply per Capita in Malaysia increased 107% from 1990 (1.16 toe/capita).

Energy Intensity in Malaysia / Japan (GDP in constant US\$ basis)

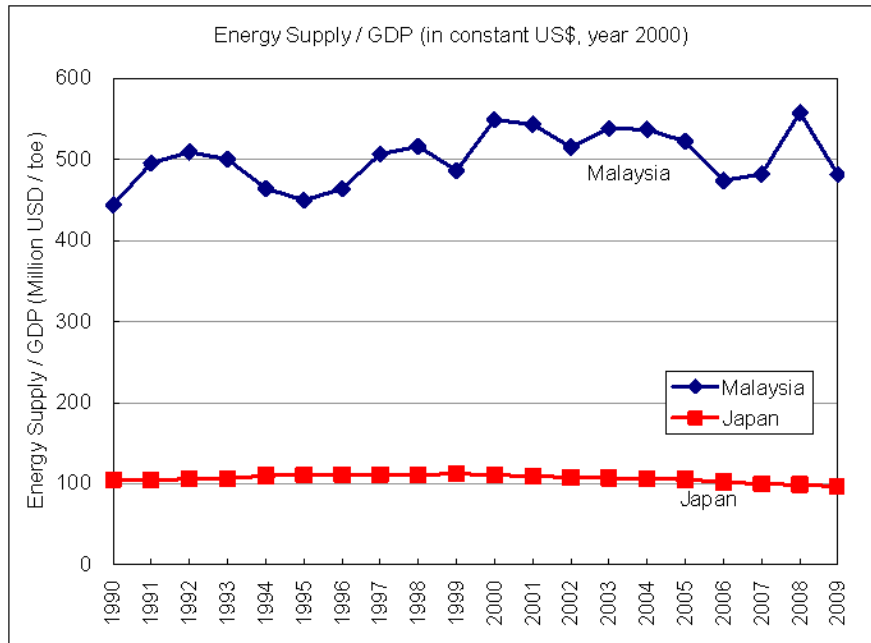
- From 1990 to 2009, GDP in Malaysia (in constant US\$ in 2000 prices) grew 190% (from 47.2 billion US\$ to 137.1 billion US\$), while Japan increased by 16.1%.
- Energy Intensity (= TPES / GDP) in Malaysia was 481.3 (Million US\$ / toe) in 2009, 96.6 (million US\$ / toe) in Japan.



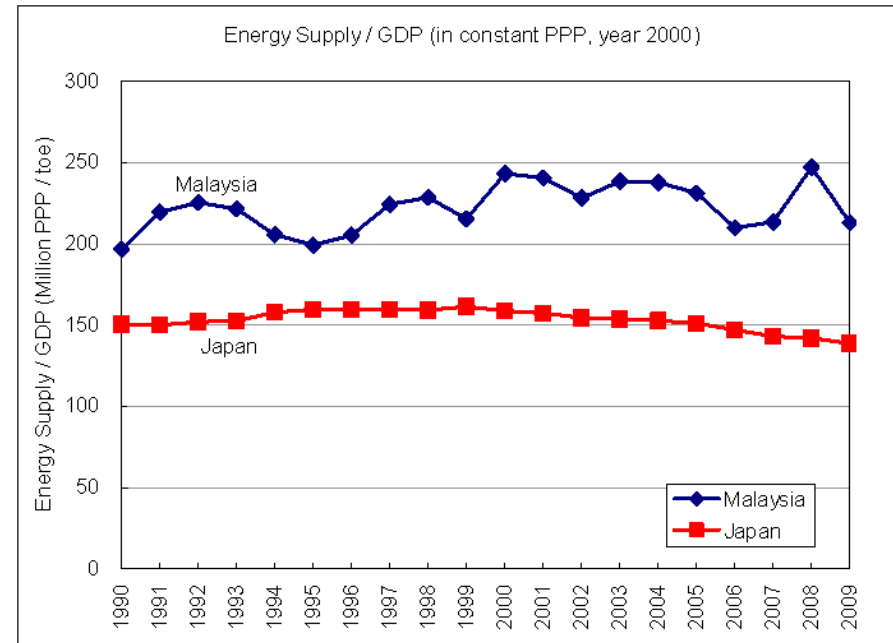
Energy Intensity in Malaysia / Japan (GDP in constant PPP basis)

- Energy Intensity in Malaysia in constant PPP (Purchasing Power Parity) was 213.0 (toe/Million \$ at PPP) in 2009, 138.7 (toe/million \$ at PPP) in Japan.

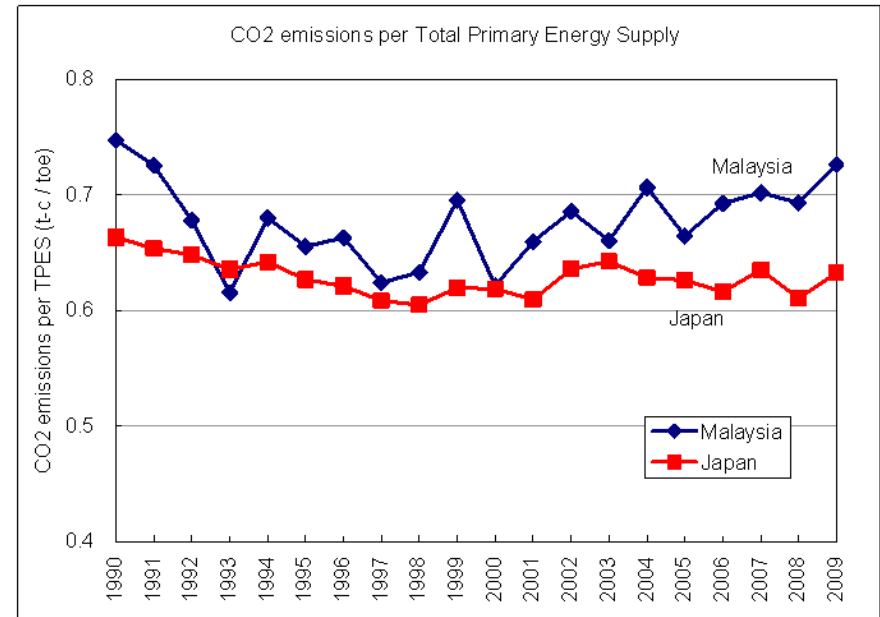
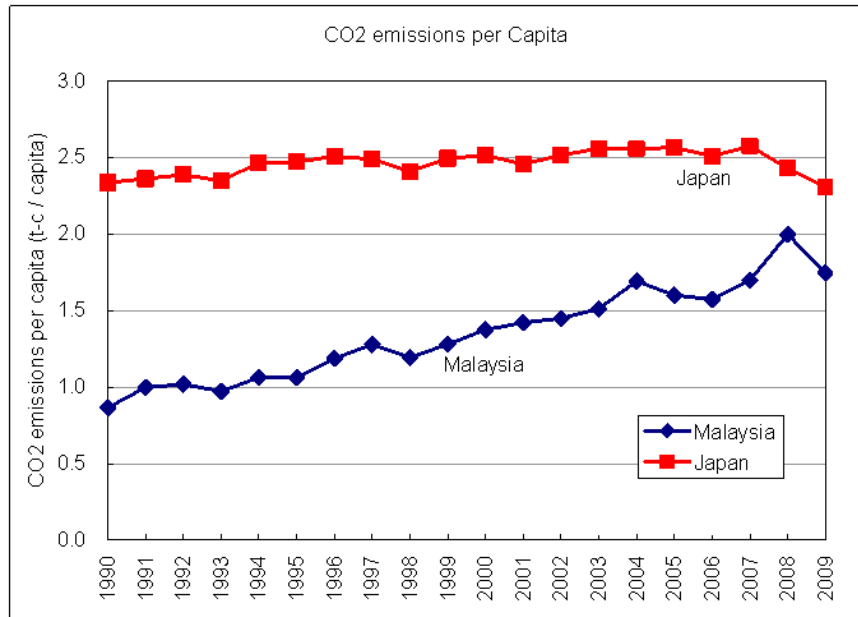
Energy Intensity: GDP in 2000 US\$



Energy Intensity: GDP in 2000 PPP



CO2 emission from Fossil Fuels in Malaysia / Japan



Conclusion

Key items to make the Energy Balance Table

- To collect data from **reliable primary data source**
- Produce in **correct / logical method**

- Consider to follow the global definition (InterEnerStat)
 - >>classification of energy products, unit, etc.
- Effective utilization of statistic database
 - >>increase the efficiency of work
 - >>avoid typographical errors (typos)

- *Accurate analysis with high precision data*
- *Application to political decision making*

Thank You