ELECTRICITY

Annual Electricity and Heat Questionnaire Overview

Joint IEA, ESCWA and RCREEE National Workshop on Energy Statistics

Cairo, Egypt

27 April – 01 May 2014

International Energy Agency

OVERVIEW

- Global trends in electricity production 1973 - 2011
- IEA Annual Electricity and Heat Questionnaire
- Data consistency checks
- Use of the data

Global Trends in Electricity Production 1973 - 2011

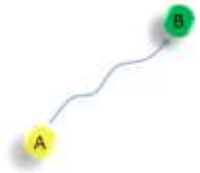
1973 **2011**












Electricity usage patterns have changed over 38 years

Global Trends in Electricity Production

1973

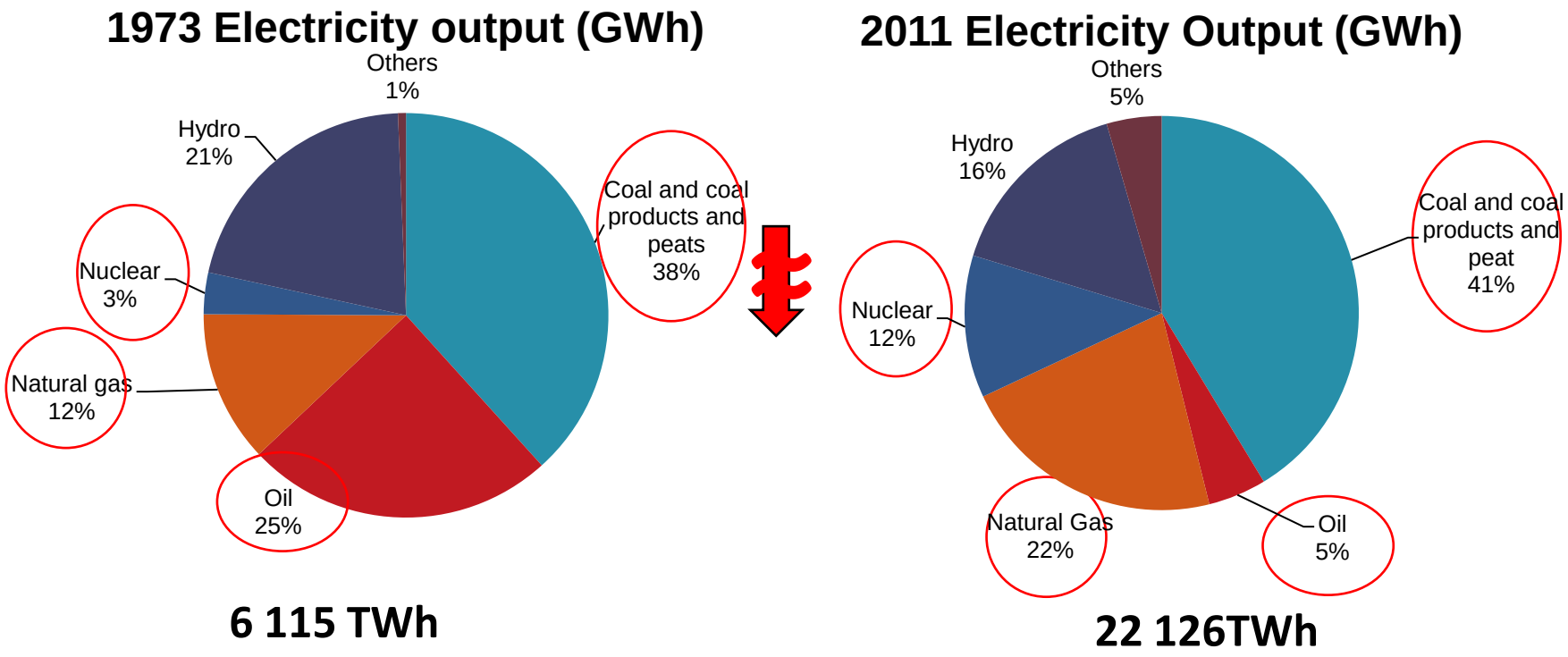
6 115 TWh

2011

22 126 TWh

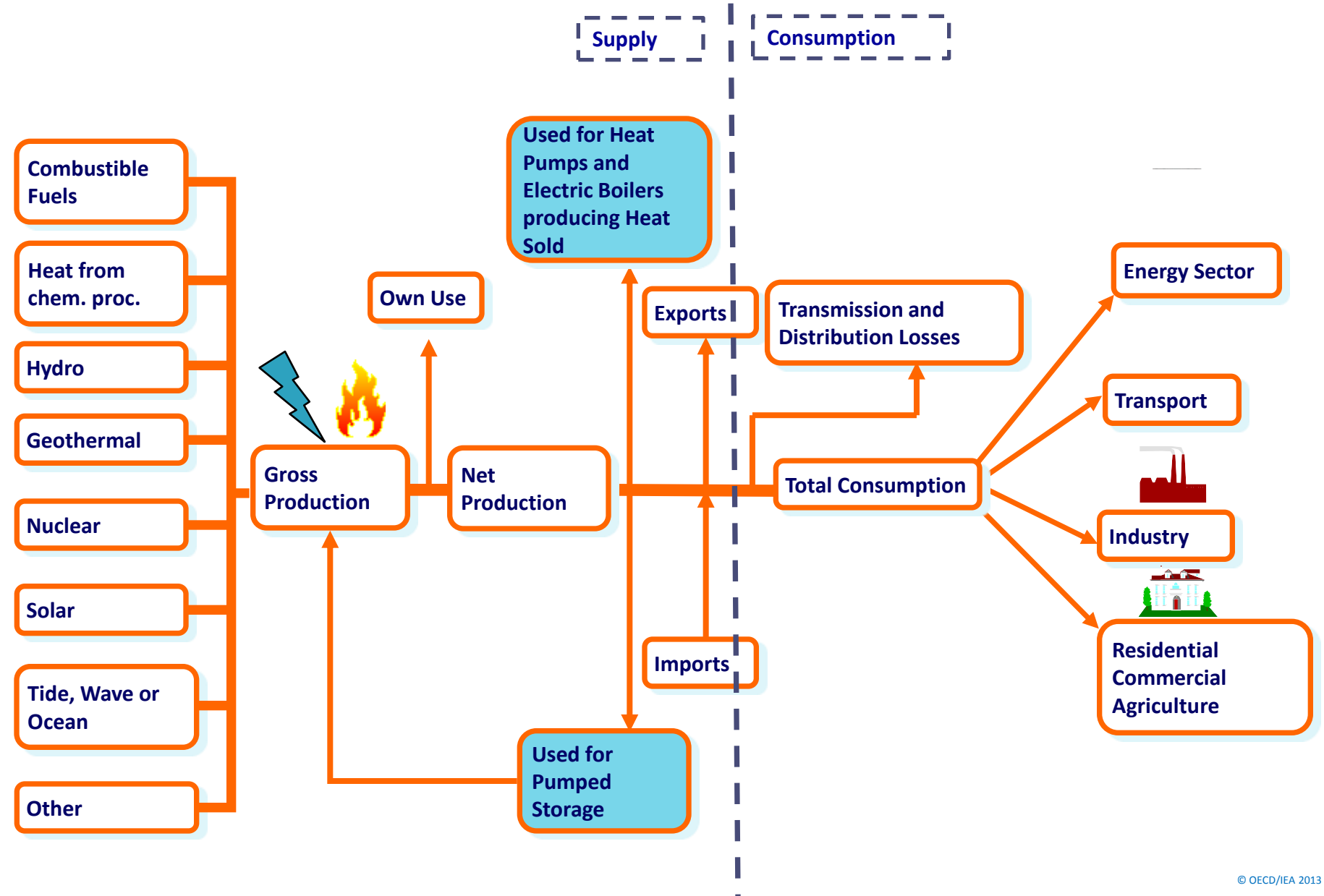
Global electricity generation more than triples in 38 years

WORLD FUEL SHARES OF ELECTRICITY

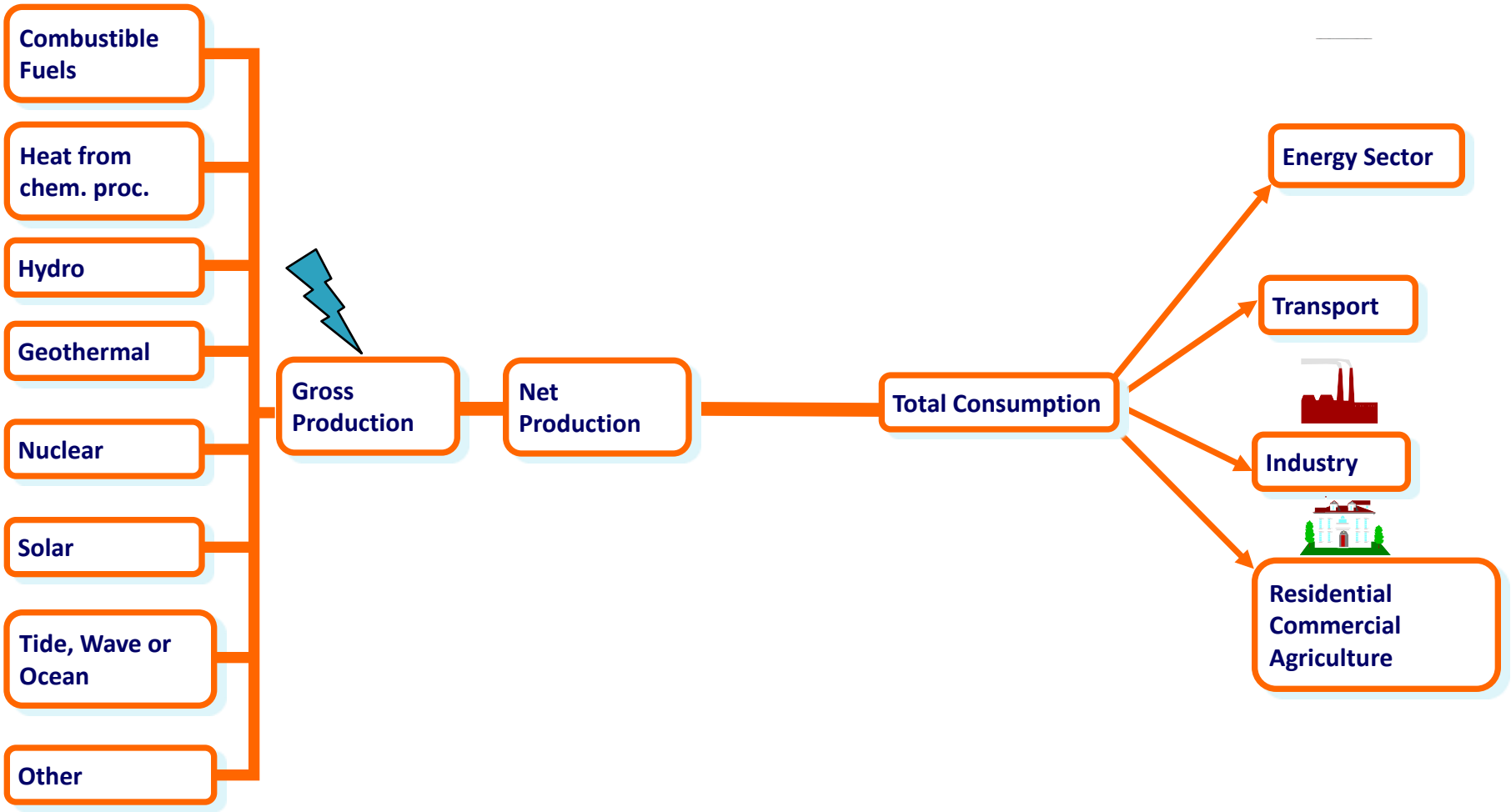


Coal remains the major fuel source for electricity despite the increased shares from other sources

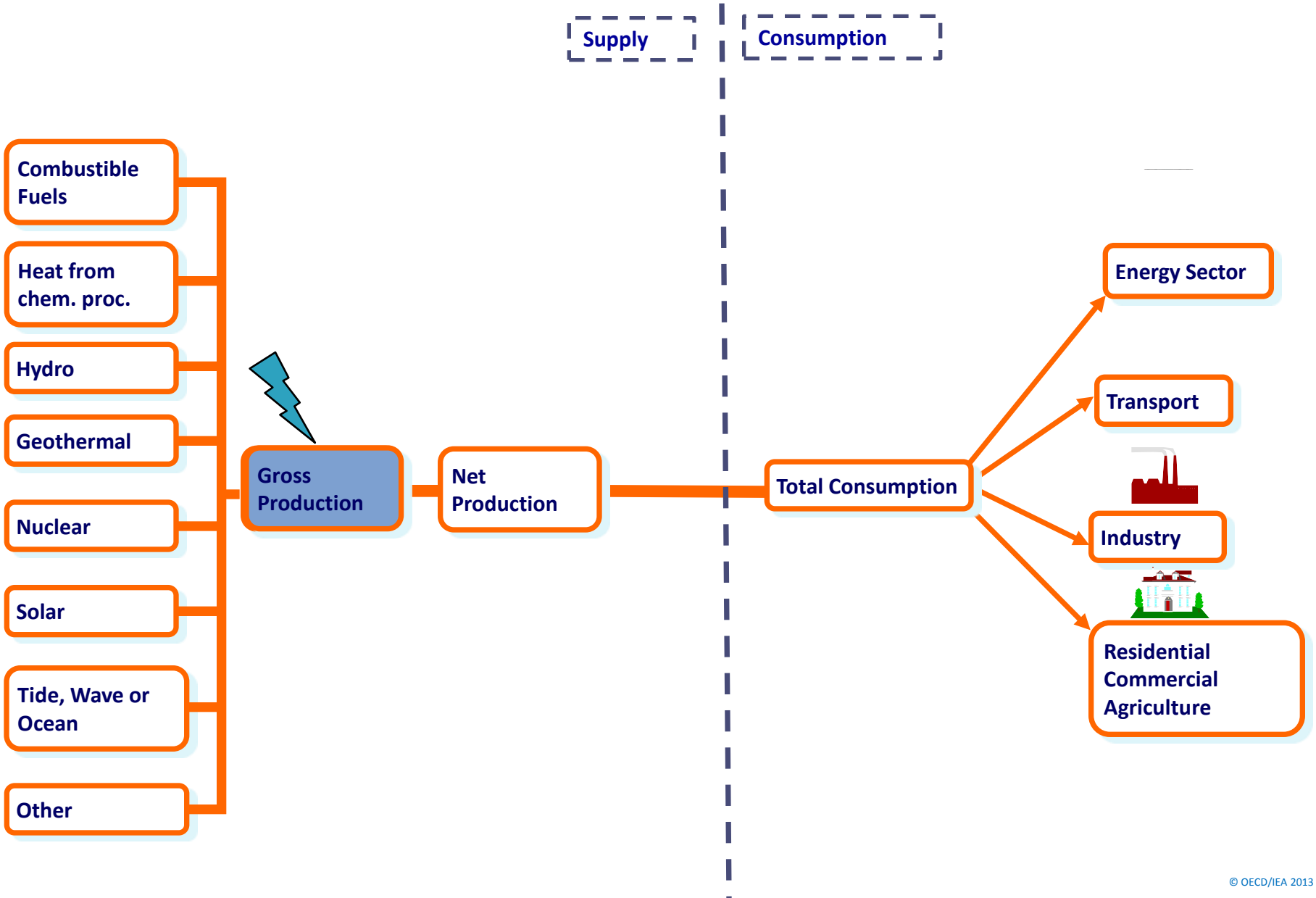
ELECTRICITY AND HEAT SUPPLY & DEMAND CHAIN



ELECTRICITY AND HEAT SUPPLY & DEMAND CHAIN



ELECTRICITY AND HEAT SUPPLY & DEMAND CHAIN



Electricity and Heat Production

Gross Electricity - the sum of the electrical energy produced by all of the generating sets (including pumped storage) measured at the output terminals of the main generators.

Gross Heat - is the heat produced by the installation, including the heat used by the installation's auxiliaries which use a hot fluid (for activities such as space heating) and losses in the installation/network heat exchanges, as well as heat from chemical processes used as a primary energy form.

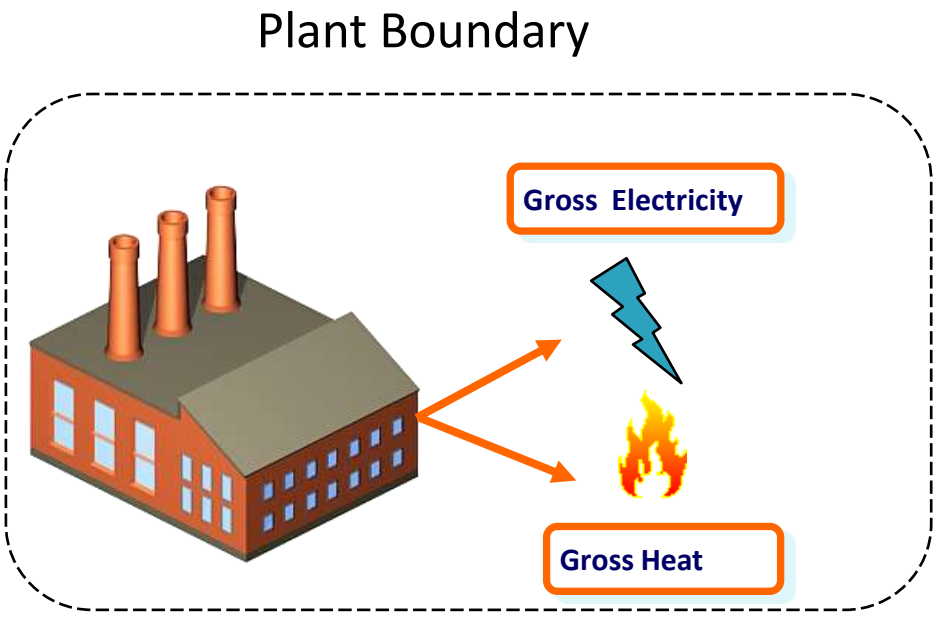


TABLE 1. GROSS ELECTRICITY AND HEAT PRODUCTION

Menu		MAIN ACTIVITY PRODUCER PLANTS			AUTOPRODUCER PLANTS			TOTAL	
		ELECTRICITY (ONLY)	CHP	HEAT (ONLY)	ELECTRICITY (ONLY)	CHP	HEAT (ONLY)	MAIN ACTIVITY PRODUCER	AUTOPRODUCER
ELECTRICITY UNIT: GWh (10^6 kWh)		A	B	C	D	E	F	G(=A+B+C)	H(=D+E+F)
Electricity	1	55 394	226		1 227	2 857		55 620	4 084
Nuclear	2							0	0
Hydro	3	23 772			421			23 772	421
Pumped Hydro	4							0	0
Geothermal	5							0	0
Solar	6							0	0
Tide, Wave and Ocean	7							0	0
Wind	8	38						38	0
Combustible Fuels	9	31 584	226		806	2 857		31 810	3 663
Heat from Chemical Sources	10								0
Other Sources	11								0
HEAT Unit: TJ									
Heat	12		0	0					0
Nuclear	13							0	0
Geothermal	14							0	0
Solar	15							0	0
Combustible Fuels	16							0	0
Heat Pumps	17							0	0
Electric Boilers	18							0	0
Heat from Chemical Sources	19								0
Other Sources	20							0	0

Type of Plant

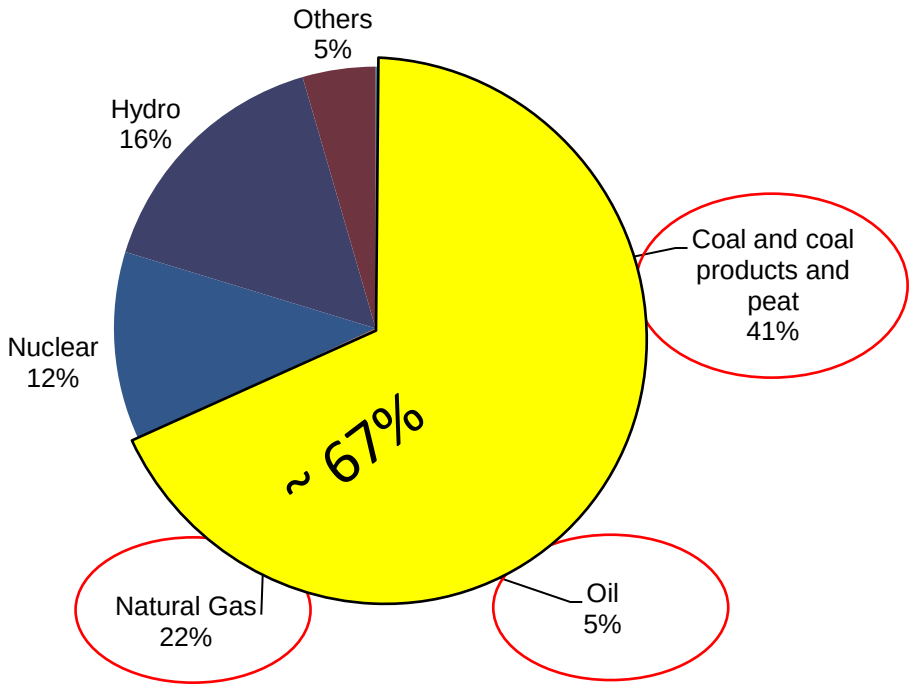
Type of Producer

Details on the type of combustible fuel are also collected.

Sources of electricity and heat

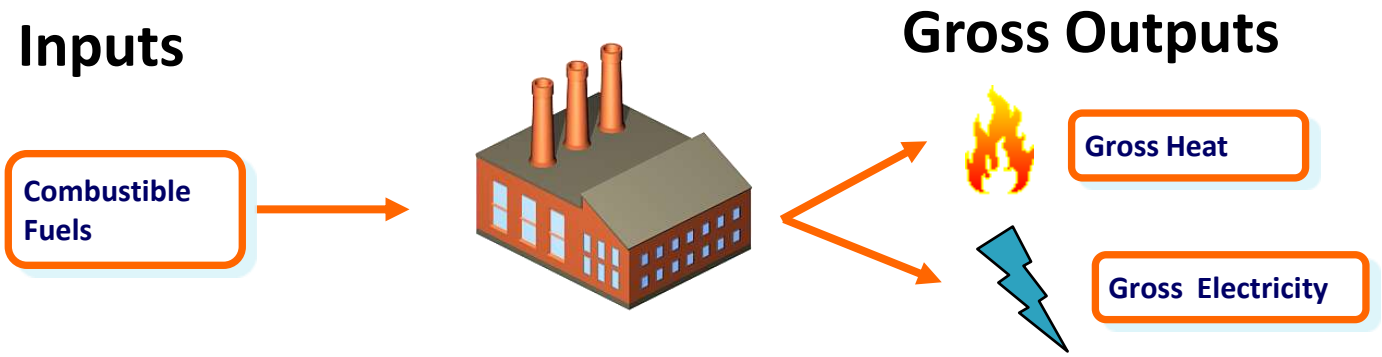
WORLD FUEL SHARES OF ELECTRICITY

2011



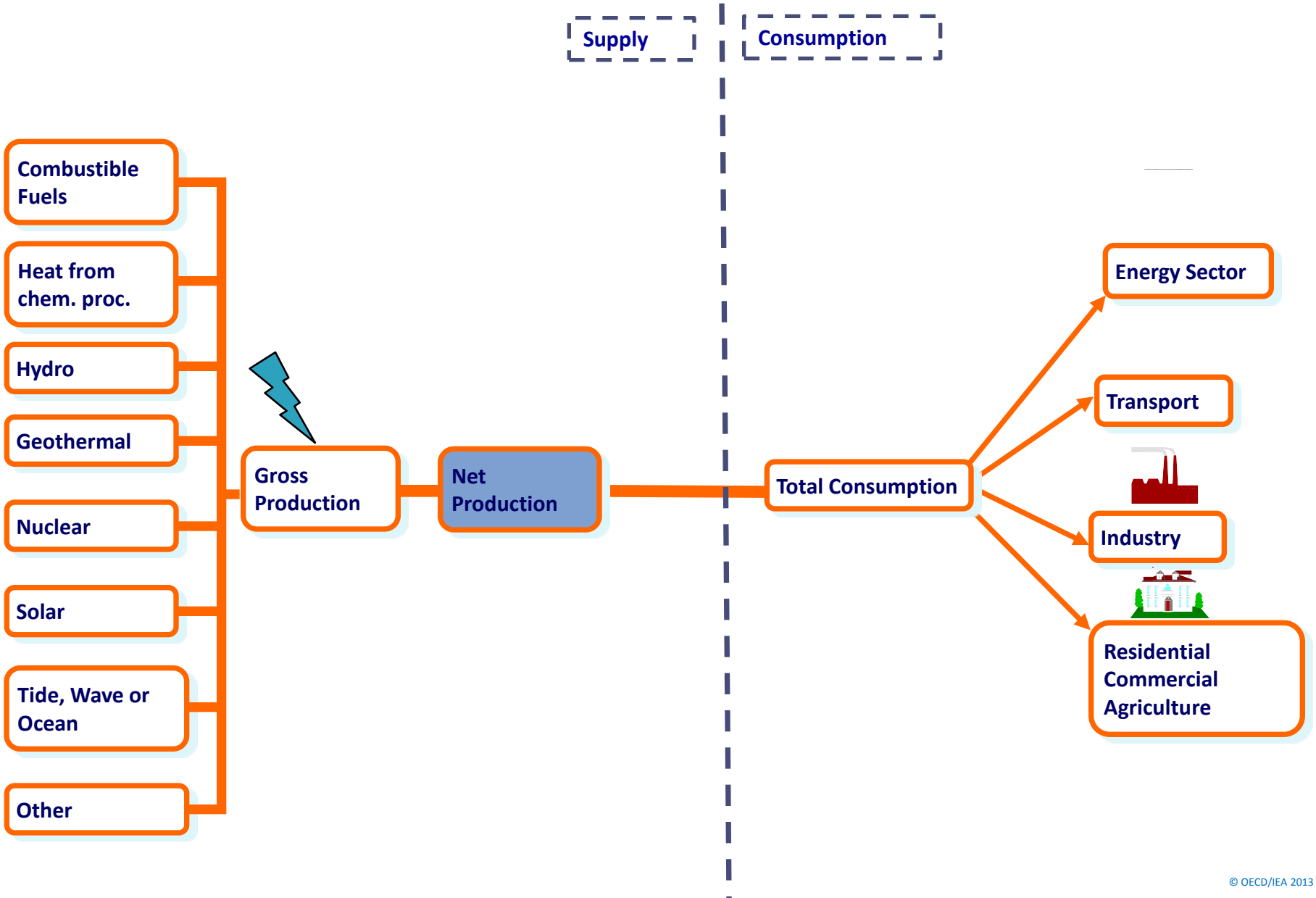
22 126 TWh

TABLE 6. GROSS ELECTRICITY AND HEAT PRODUCTION FROM COMBUSTIBLE FUELS



- Table 6A – Coal and coal products
- Table 6B – Oil
- Table 6C – Natural gas
- Table 6D – Biofuels and wastes

ELECTRICITY AND HEAT SUPPLY & DEMAND CHAIN



Electricity and Heat Production

Gross Electricity - the sum of the electrical energy produced by all of the generating sets (including pumped storage) measured at the output terminals of the main generators.

Gross Heat - is the heat produced by the installation, including the heat used by the installation's auxiliaries which use a hot fluid (for activities such as space heating) and losses in the installation/network heat exchanges, as well as heat from chemical processes used as a primary energy form.

Gross production - Own Use = Net production

Net Electricity

- the gross electricity production less the electrical energy absorbed by the generating auxiliaries and the losses in the main generator transformers.

Net Heat

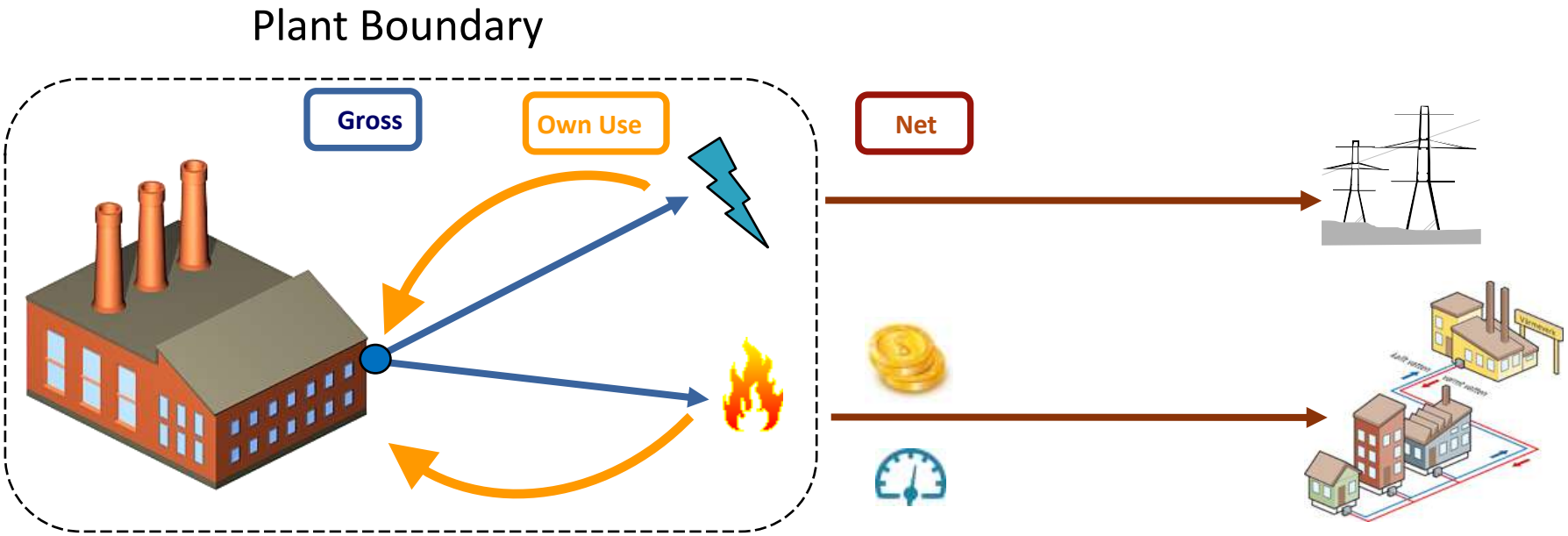
- Is the heat supplied to the distribution system as determined from measurements of the outgoing and return flows

Electricity and Heat Production

Gross Electricity – all the electricity produced
Gross Heat – all the heat produced

Own Use – amount consumed to support the operations of the plant

Net Electricity - is the electricity sent to the grid
Net Heat – refers to **heat sold** to third parties



Electricity and Heat Production

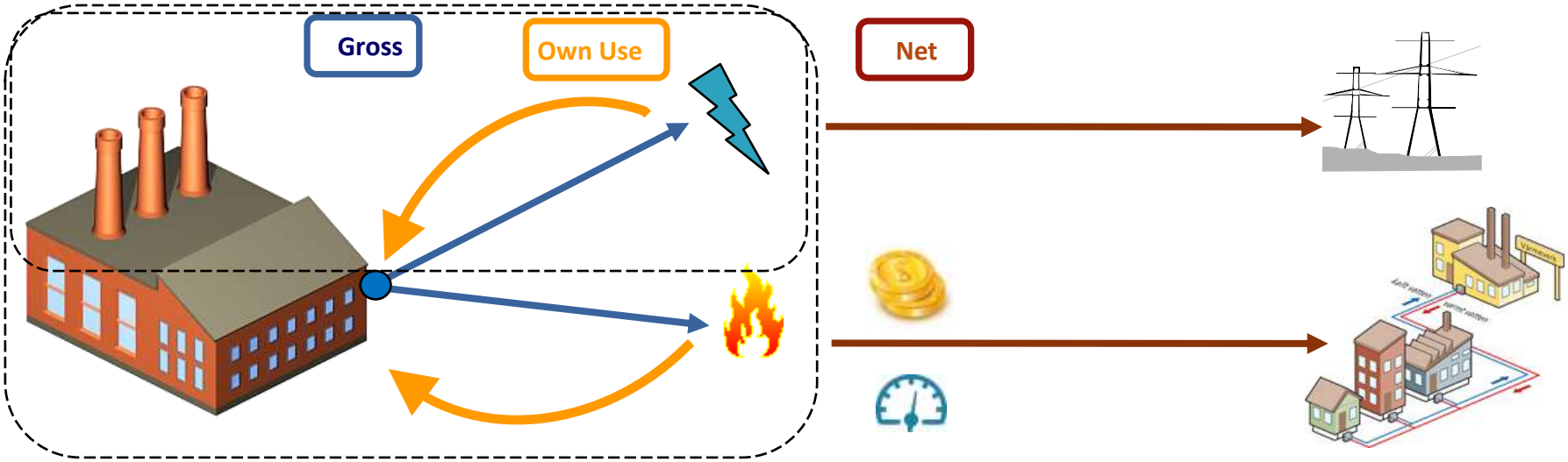
Gross production - ~~**Own Use**~~ = **Net production**

Autoproducers HEAT:

- Own use of heat used by the autoproducer plant is not collected
- Only heat sold to third parties is reported → Gross Heat = Net Heat

Gross Heat production = **Net Heat production**

Autoproducer CHP and Heat Plants



DIFFERENCE BETWEEN TABLE 1 AND TABLE 2

	Electricity Only	CHP	Heat Only
Main Activity Producer	Report all production and all fuel used	Report **all** electricity and heat produced and all fuel used	Report **all** heat produced and all fuel used
Autoproducer		Report all electricity produced and heat **sold** with corresponding fuel used	Report heat **sold** and corresponding fuel used

	Electricity Only	CHP	Heat Only
Main Activity Producer	**Gross Electricity production - Own Use = Net Electricity production** **Gross Heat production - Own Use = Net Heat production**		
Autoproducer	**Gross Electricity production - Own Use = Net Electricity production** **Gross Heat production = Net Heat production**		

ELECTRICITY AND HEAT SUPPLY & DEMAND CHAIN

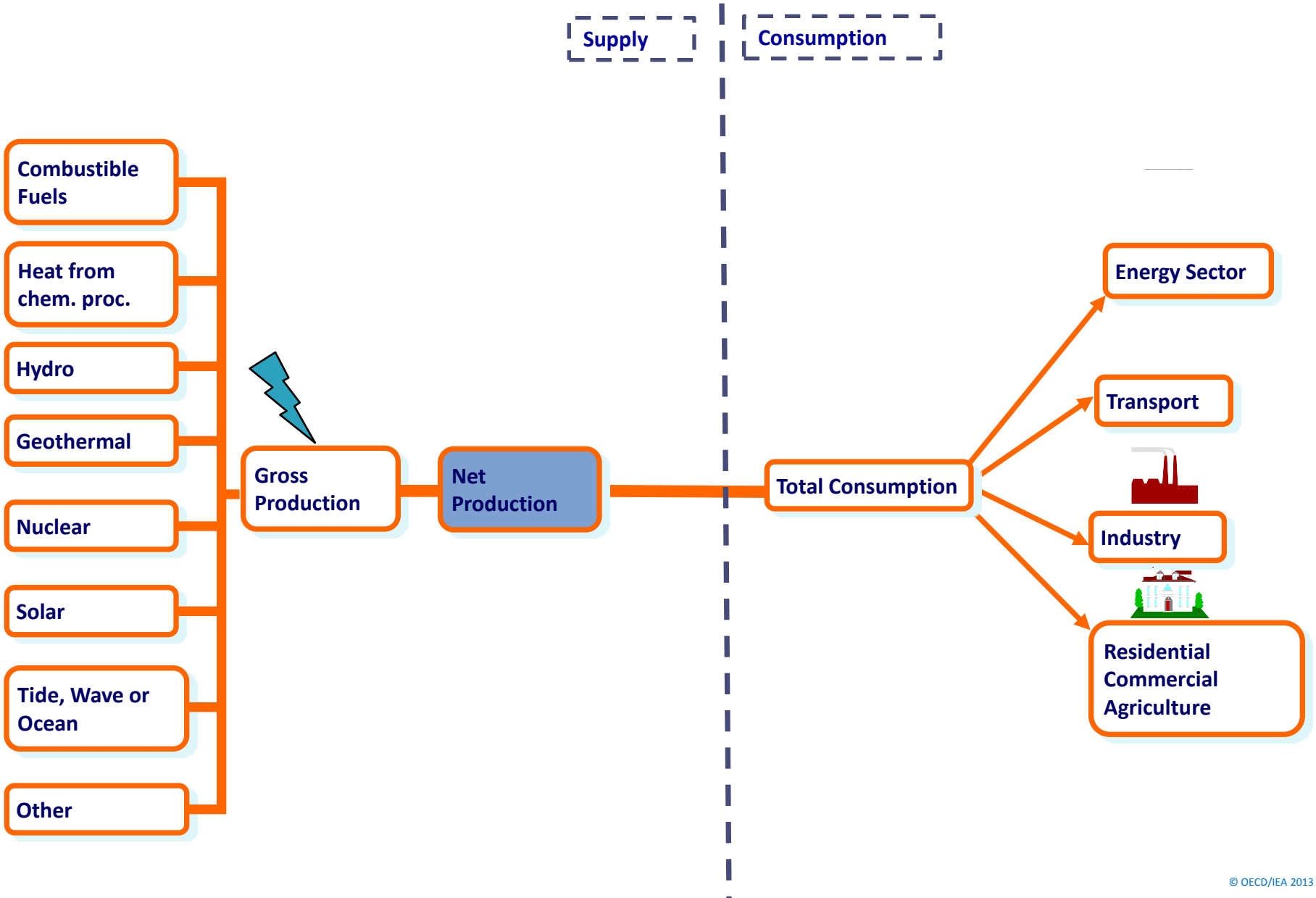


TABLE 2. NET ELECTRICITY AND HEAT PRODUCTION

Men		MAIN ACTIVITY PRODUCER PLANTS			AUTOPRODUCER PLANTS			TOTAL	
		ELECTRICITY (OMLT)	CHP	HEAT (OMLT)	ELECTRICITY (OMLT)	CHP	HEAT (OMLT)	MAIN ACTIVITY PRODUCER	AUTOPRODUCER
ELECTRICITY UNIT: GWh (10^6 kWh)		A	B	C	D	E	F	G(=A+B+C)	H(=D+E+F)
Electricity	1	**53 900**	**171**		**1 217**	**2 793**		**54 071**	**4 010**
Nuclear	2							**0**	**0**
Hydro	3	23 259			421			**23 259**	**421**
Pumped Hydro	4							**0**	**0**
Geothermal	5							**0**	**0**
Solar	6							**0**	**0**
Tide, Wave and Ocean	7							**0**	**0**
Wind	8	38						**38**	**0**
Combustible Fuels	9	30 603	171		796	2 793		**30 774**	**3 589**
Heat from Chemical Sources	10								**0**
Other Sources	11							**0**	**0**
HEAT Unit: TJ									
Heat	12		**0**					**0**	**0**
Nuclear	13							**0**	**0**
Geothermal	14							**0**	**0**
Solar	15							**0**	**0**
Combustible Fuels	16							**0**	**0**
Heat Pumps	17							**0**	**0**
Electric Boilers	18							**0**	**0**
Heat from Chemical Sources	19								**0**
Other Sources	20							**0**	**0**

Total Autoproducer net production is also collected by sector (Table 5)

Net electricity and heat production by Autoproducer (Table 5)

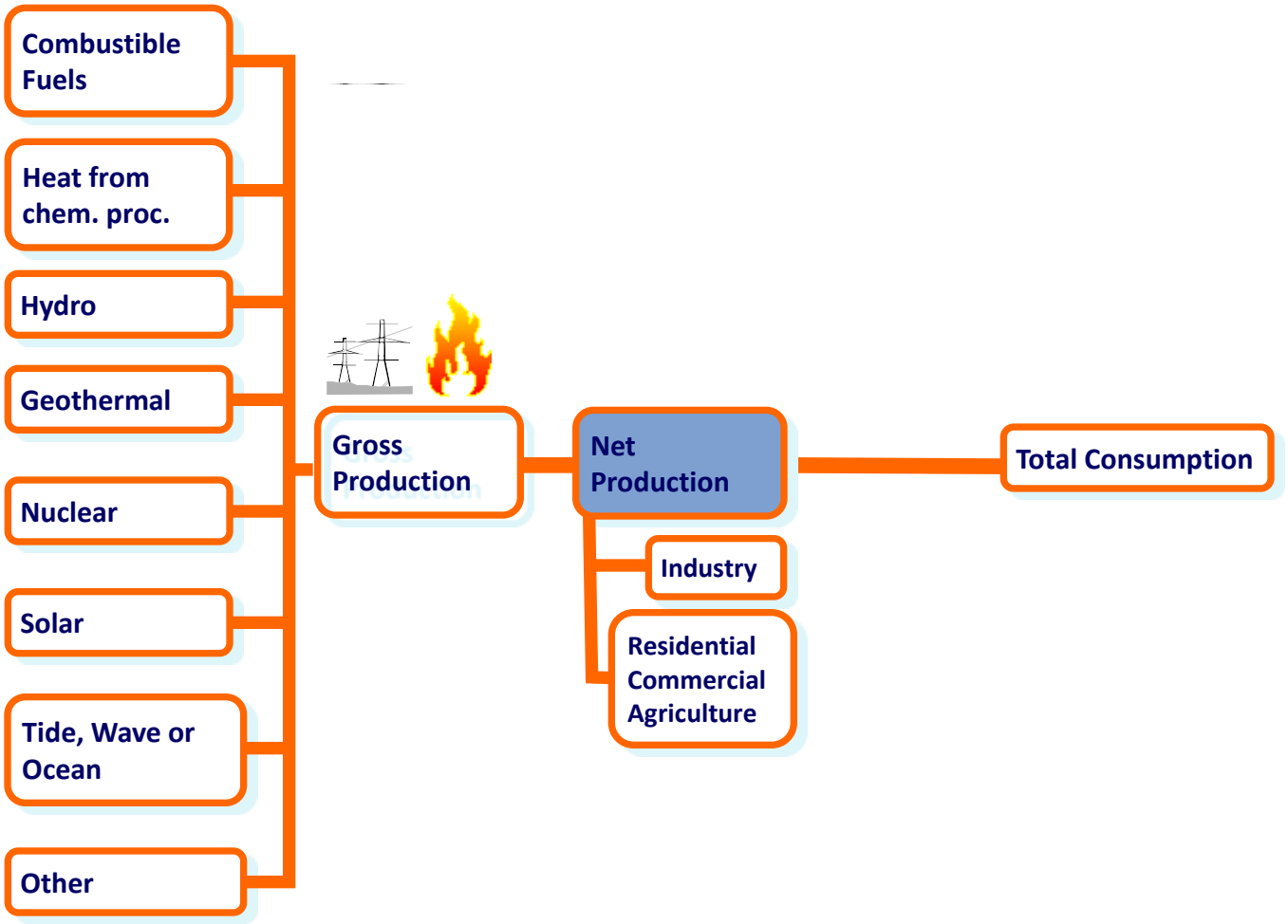


TABLE 5. NET ELECTRICITY PRODUCTION BY AUTOPRODUCERS

		ELECTRICITY (ONLY) PLANTS	CHP PLANTS	TOTAL
		A	B	C
Total Net Production	1	1 217	2 793	4 010
Industry Sector	17	0	2 793	2 793
Iron and Steel	18			0
Chemical (including Petrochemical)	19			0
Non-Ferrous Metals	20			0
Non-Metallic Minerals	21			0
Transport Equipment	22			0
Machinery	23			0
Mining and Quarrying	24			0
Food, Beverages and Tobacco	25			0
Paper, Pulp and Printing	26		2 793	2 793
Wood and Wood Products	27			0
Construction	28			0
Textiles and Leather	29			0
Non-specified (Industry)	30			0
Transport Sector	31	0	0	0
Rail	32			0
Pipeline Transport	33			0
Non-specified (Transport)	34			0
Other Sectors	35	1 217	0	1 217
Residential	36			0
Commercial and Public Services	37			0
Agriculture/Forestry	38			0
Fishing	39			0
Non-specified (Other)	40	1 217		1 217

Trade (Table 8)

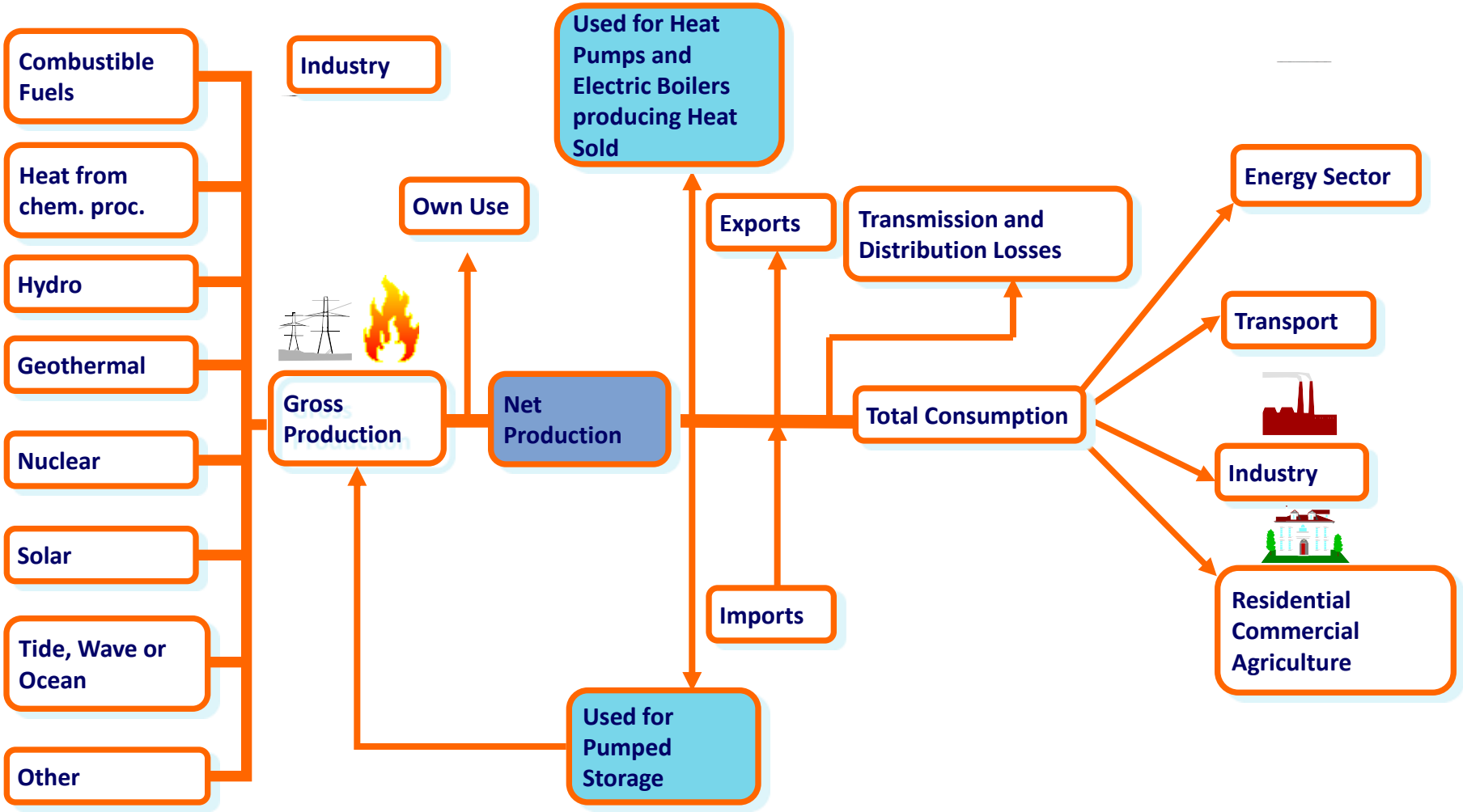


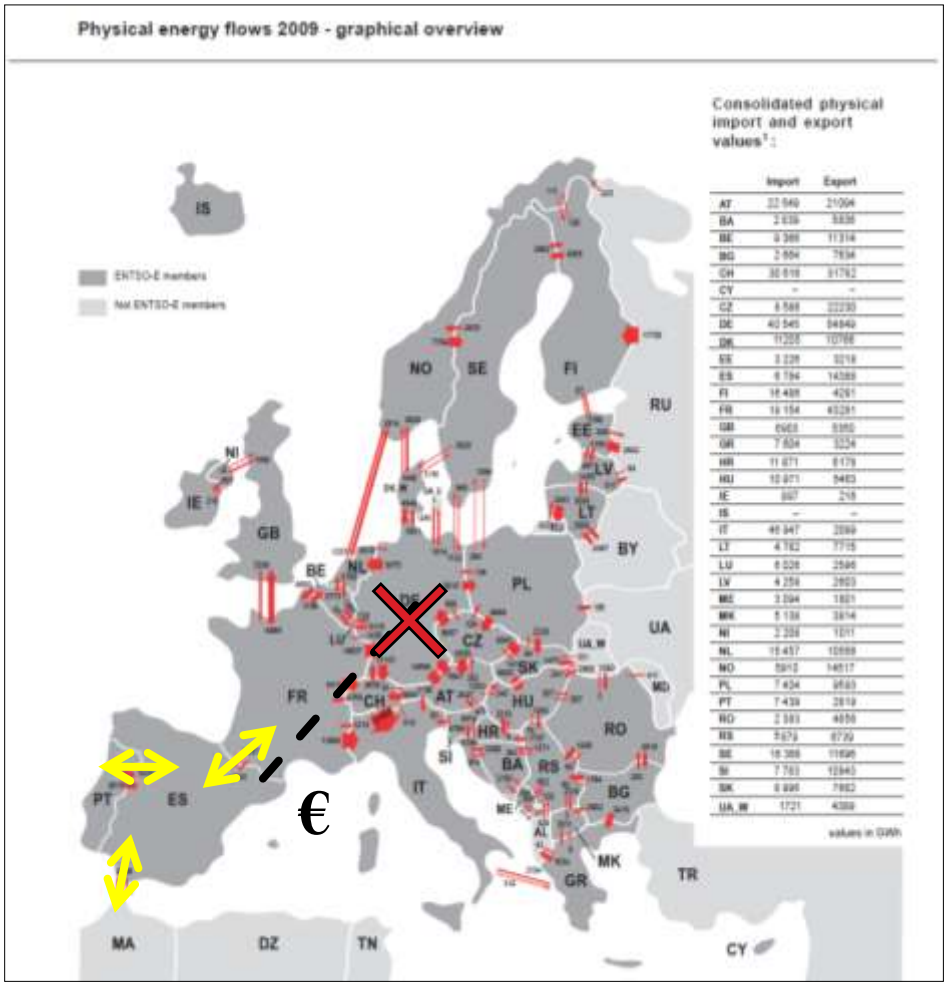
TABLE 8 – IMPORTS AND EXPORTS

- Non-specified/Other – for countries not listed, specify in Remarks page
- Reported differently from trade of most other fuels:
  - **Physical amounts crossing borders (not final destination)**

Menu		Report Electricity in Columns A and B (Unit = GWh)		Report Heat in Columns C and D (Unit = TJ)	
		IMPORTS A	EXPORTS B	IMPORTS C	EXPORTS D
Syria	55				
Tajikistan	56				
Turkey	57				
Turkmenistan	58				
Ukraine	59				
United Kingdom	60				
United States	61				
Uzbekistan	62				
Non-specified/Other	63	**1 154**			
TOTAL	64	**1 154**	**0**	**0**	**0**

TABLE 8 – IMPORTS AND EXPORTS

- Reported differently from trade of most other fuels:
  - **Physical amounts (not final destination)**
  - Equals amounts crossing borders either on land or underwater
- Example:
  - Physical electricity trade data for Spain is accounted for only with:
    - France
    - Portugal
    - Morocco (underwater cable)
    - X not Germany
- Exercise



Energy and Industry Sector Consumption (Table 4)

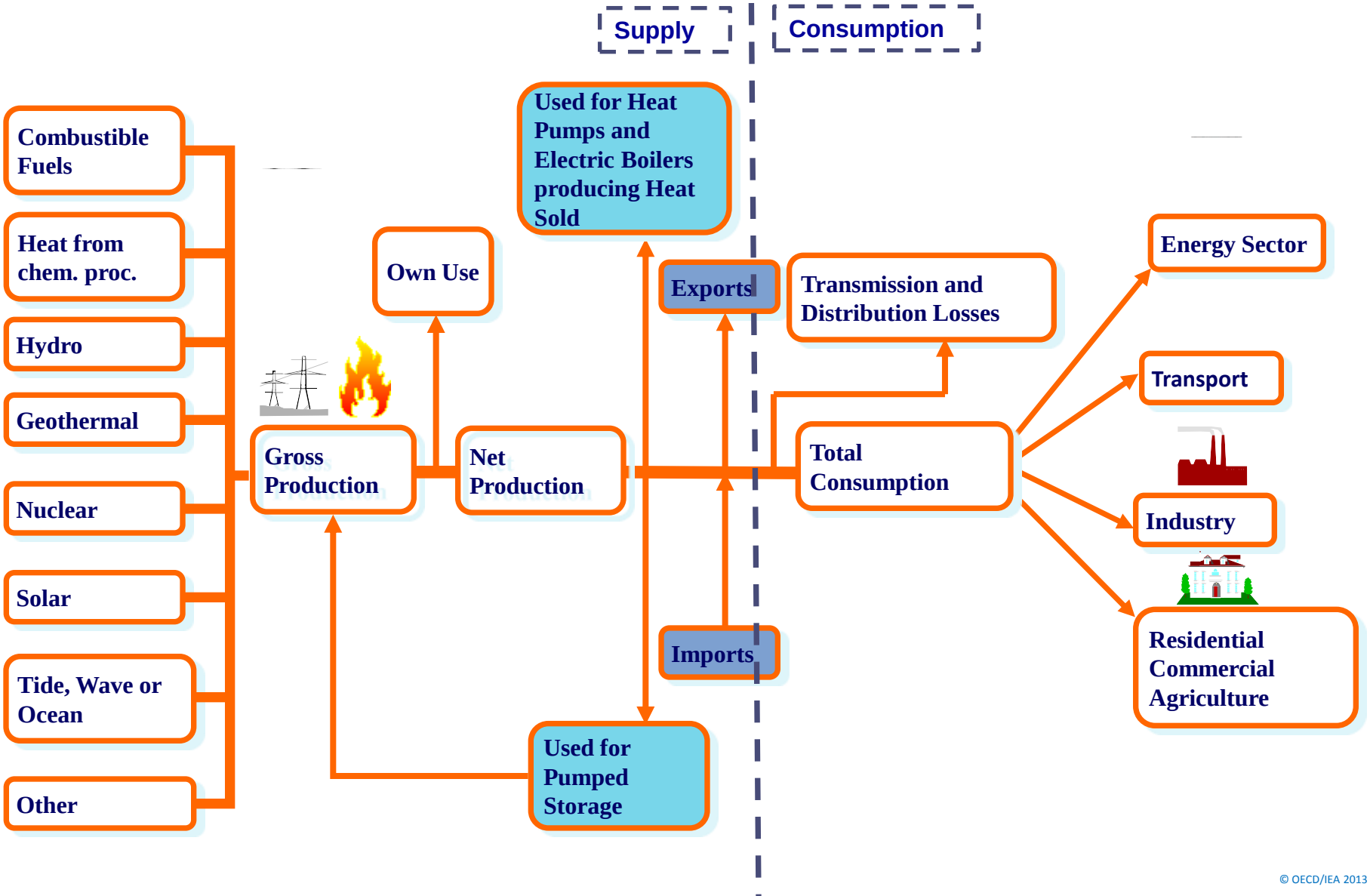


TABLE 4. ELECTRICITY AND HEAT CONSUMPTION IN INDUSTRY AND ENERGY SECTORS

Menu		ELECTRICITY (GWh)	HEAT (TJ)
		A	B
Energy sector	1	**645**	**0**
Coal mines	2		
Oil and gas extraction	3		
Patent fuel plants (Energy)	4		
Coke ovens (Energy)	5		
BKB / PB plants (Energy)	6		
Gas works (Energy)	7		
Blast furnaces (Energy)	8		
Oil refineries	9		
Nuclear industry	10		
Coal liquefaction plants (Energy)	11		
Liquefaction (LNG) / Regasification plants	12		
Gasification plants for biogas	13		
Gas-to-liquids (GTL) plants (Energy)	14		
Charcoal production plants (Energy)	15		
Not elsewhere specified (Energy)	16		
Industry sector	17	**36 509**	**0**
Iron and steel	18	605	
Chemical and petrochemical	19	601	
Non-ferrous metals	20		
Non-metallic minerals	21	607	
Transport equipment	22		
Machinery	23		
Mining and quarrying	24		
Food, beverages and tobacco	25		
Paper, pulp and printing	26	5 345	
Wood and wood products	27		
Construction	28		
Textiles and leather	29		
Not elsewhere specified (Industry)	30		

645

20 279

9 072

ELECTRICITY AND HEAT STATISTICS

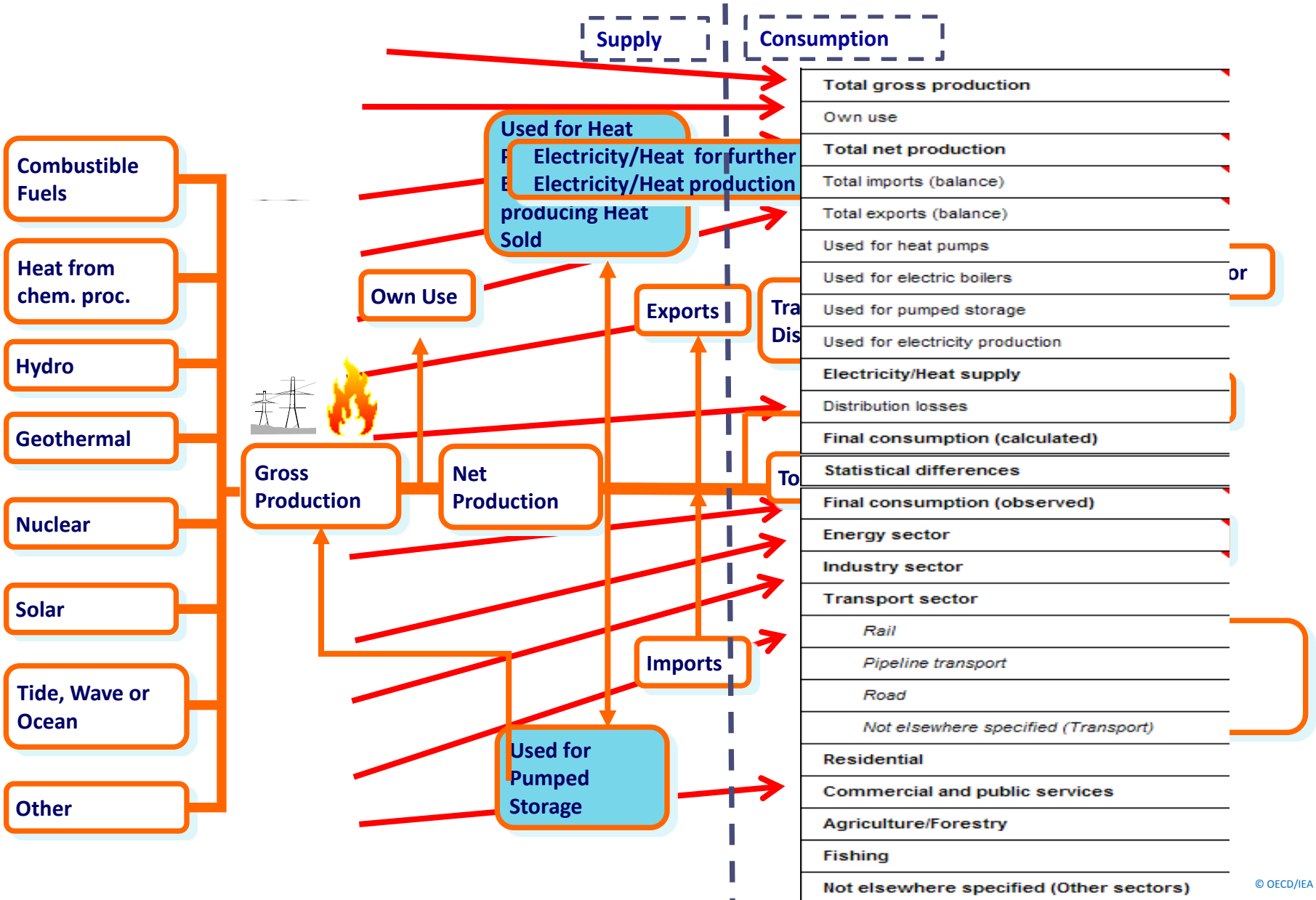


TABLE 3. ELECTRICITY AND HEAT SUPPLY AND CONSUMPTION

			ELECTRICITY (GWh)	HEAT (TJ)
Menu			A	B
Total gross production	1	(=)	**59 704**	
Own use	2	(-)	**1 623**	0
Total net production	3	(=)	**58 081**	
Total imports (balance)	4	(+)	**1 154**	
Total exports (balance)	5	(-)		
Used for heat pumps	6	(-)		
Used for electric boilers	7	(-)		
Used for pumped storage	8	(-)		
Used for electricity production	9	(-)		
Electricity/Heat supply	10	(=)	59 235	0
Distribution losses	11	(-)	5 081	
Final consumption (calculated)	12	(=)	54 154	0
Statistical differences	13		1	0
Final consumption (observed)	14		54 153	0
Energy sector	15		**645**	0
Industry sector	16		**36 509**	0
Transport sector	17		426	
Rail	18		426	
Pipeline transport	19			
Road	20			
Not elsewhere specified (Transport)	21			
Residential	22		8 749	
Commercial and public services	23		7 636	
Agriculture/Forestry	24			
Fishing	25		188	
Not elsewhere specified (Other sectors)	26			

= Total in Table 1

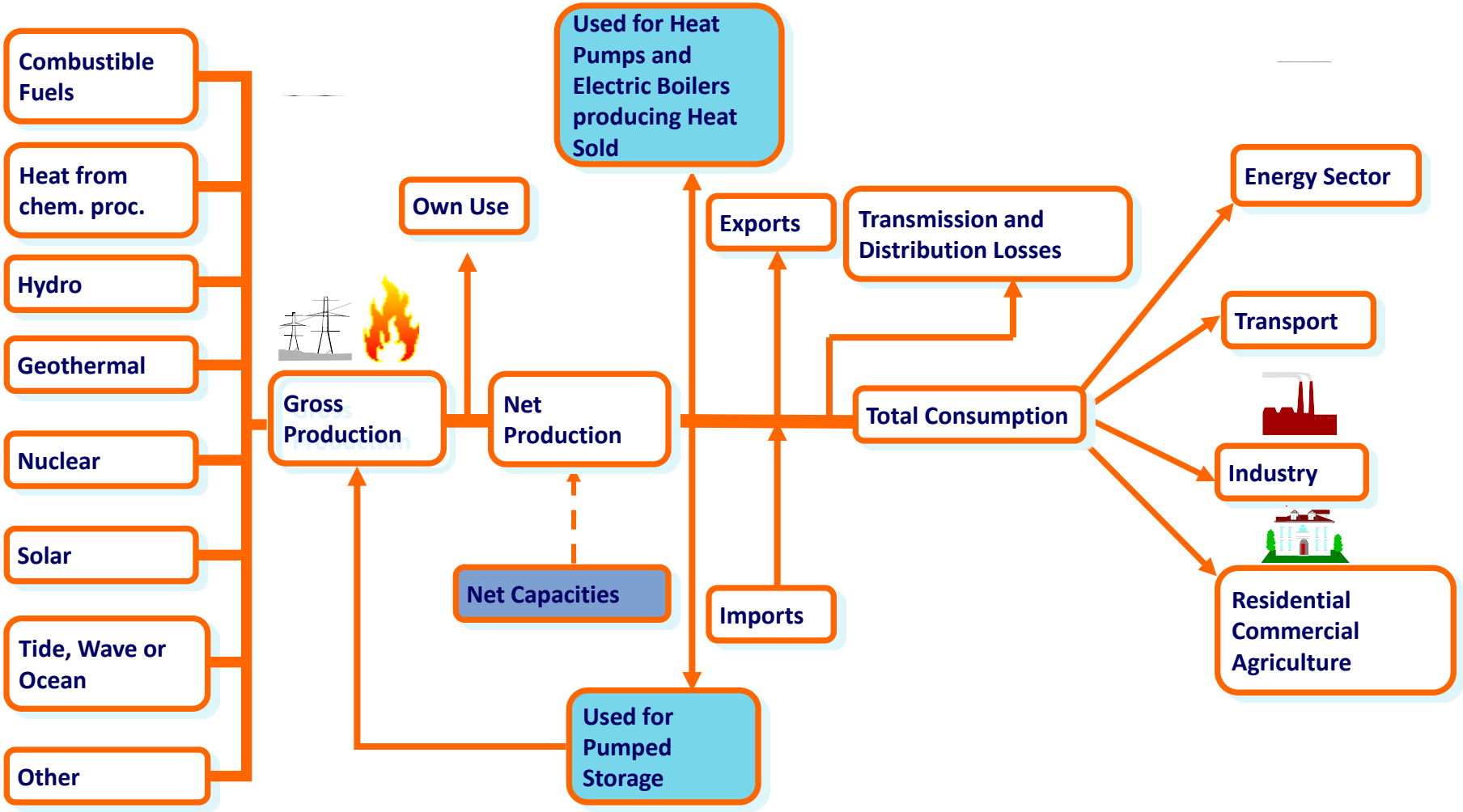
Own use = gross - net

= Total in Table 2

= Trade totals in Table 8

= Totals in Table 4

Technical Characteristics (Table 7)



TABLES 7A – NET MAXIMUM ELECTRICAL CAPACITY AND PEAK LOAD

CLASSIFICATION BY SOURCE		MAIN ACTIVITY PRODUCERS	AUTOPRODUCERS
		A	B
	1 - Total capacity	**13 136**	**0**
	2 - Nuclear		
	3 - Hydro	4 943	
	4a - Mixed plants		
	4b - Pure pumped storage		
	5 - Geothermal		
	6 - Solar photovoltaic		
	7 - Solar thermal		
	8 - Tide, wave and ocean		
	9 - Wind	20	
	10 - Combustible fuels	**8 173**	
	11 - Other sources		
Combustible fuels: TYPE OF GENERATION	**12 - Total conventional thermal**	**0**	**0**
	13 - Steam		
	14 - Internal combustion		
	15 - Gas turbine		
	16 - Combined cycle		
	17 - Other type of generation		

Total should = combustible fuels on row 9

?

PEAK LOAD INFORMATION		MAIN ACTIVITY PRODUCERS	AUTOPRODUCERS
PEAK LOAD	18 - Peak load		
	19 - Capacity at peak		
	20 - Date of peak load occurence		
	21 - Time of peak load occurence		

TABLE 7B. NET MAXIMUM ELECTRICAL CAPACITY OF COMBUSTIBLE FUELS

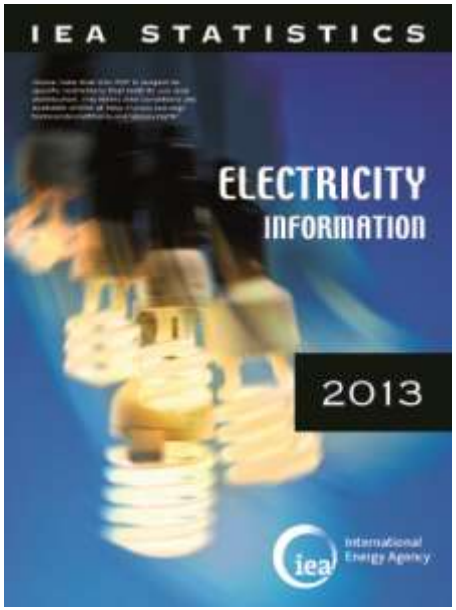
					MAIN ACTIVITY PRODUCER PLANTS	AUTOPRODUCERS
COMBUSTIBLE FUELS: of which:		Primary Fuel (please list where not on Form)	Alternate Fuel (please list)	Second Alternate Fuel (please list)	A	B
SINGLE FUEL FIRED	1	- Coal + coal products			2 043	
	2	- Liquids fuels			1 220	
	3	- Natural gas			4 743	
	4	- Peat				
	5	- Biofuels and wastes			166	
MULTI-FIRED SOLIDS AND LIQUIDS	6					
	7					
	8					
TOTAL	9					
MULTI-FIRED SOLIDS AND NATURAL GAS	10					
	11					
	12					
TOTAL	13					
MULTI-FIRED LIQUIDS AND NATURAL GAS	14					
	15					
	16					
TOTAL	17					
MULTI-FIRED SOLIDS LIQUIDS AND NATURAL GAS	18					
	19					
	20					
TOTAL	21					

DATA VERIFICATION

- Internal Consistency – (checks between tables internally)
- External Consistency (comparison with other questionnaires)
- Data Relationship Analysis
  - Ratio of gross to net generation
  - Ranges of calorific values
  - Capacity factors
  - Distribution losses vs. energy supplied
  - Own use vs. total production
  - Efficiencies
- Fluctuations in time series data → rationale?

USES OF THE DATA

- Electricity Information book
- Electronic online files
- Energy balances
- CO_2 emissions
- Energy efficiency indicators
- Data support for other IEA divisions/other organizations
- Country reviews
- Analysis
  - Assessing security of supply
  - Evolution of efficiencies
  - Environmental impacts
- Making policy and business decisions

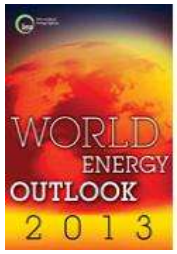


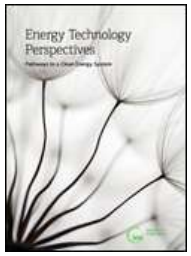
Published data is used by many:

IEA

- Oil & Gas Medium Term -
  - Electricity demand for peaking – indicator of the gas demand

- World Energy Outlook
- Energy Technology Perspectives





Public

- Purchasers of Electronic Data:

McKinsey&Company

TOTAL

- Media uses IEA figures:
  - Ad hoc requests from:

The Economist

NATIONAL GEOGRAPHIC

  - Japan – nuclear
    - Analysts, reports pulled Electricity Information data out to assess % of power and installed capacity of Nuclear
  - In response to Germany's call for shutting down reactors – capacity information was asked for avoided/new emissions

ENERGY EFFICIENCY INDICATORS

- Main activity power plant efficiency
- CHP power plant efficiency
- Share of generation from renewable fuels
- Share of generation from fossil fuels
- Electricity/GDP ratio
- Electricity per capita

THANK YOU

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ELECTRICITY & HEAT

Questionnaire Key Points

Joint IEA, ESCWA and GCC Training for trainers on Energy Statistics

Muscat, Oman

9 – 13 March 2014

Vladimir Kubecek

IEA Energy Data Center

International Energy Agency

Tables 1&2: Plants by energy source

Combustible fuels

Nuclear

Wind

Hydro

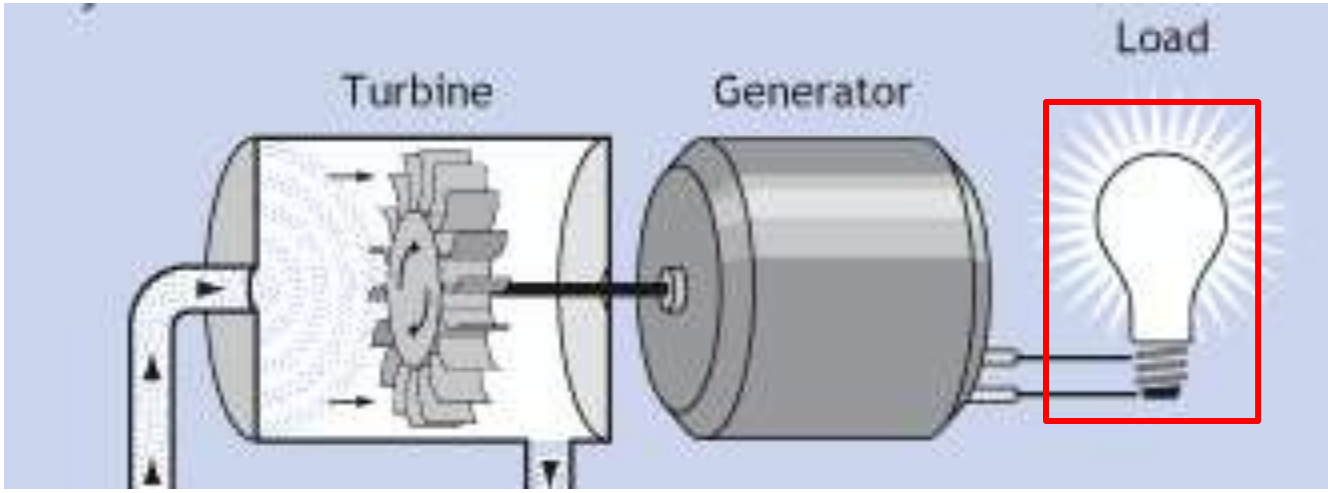
Geothermal

Waves, Tides

Solar

Tables 1&2: Electricity only power plant

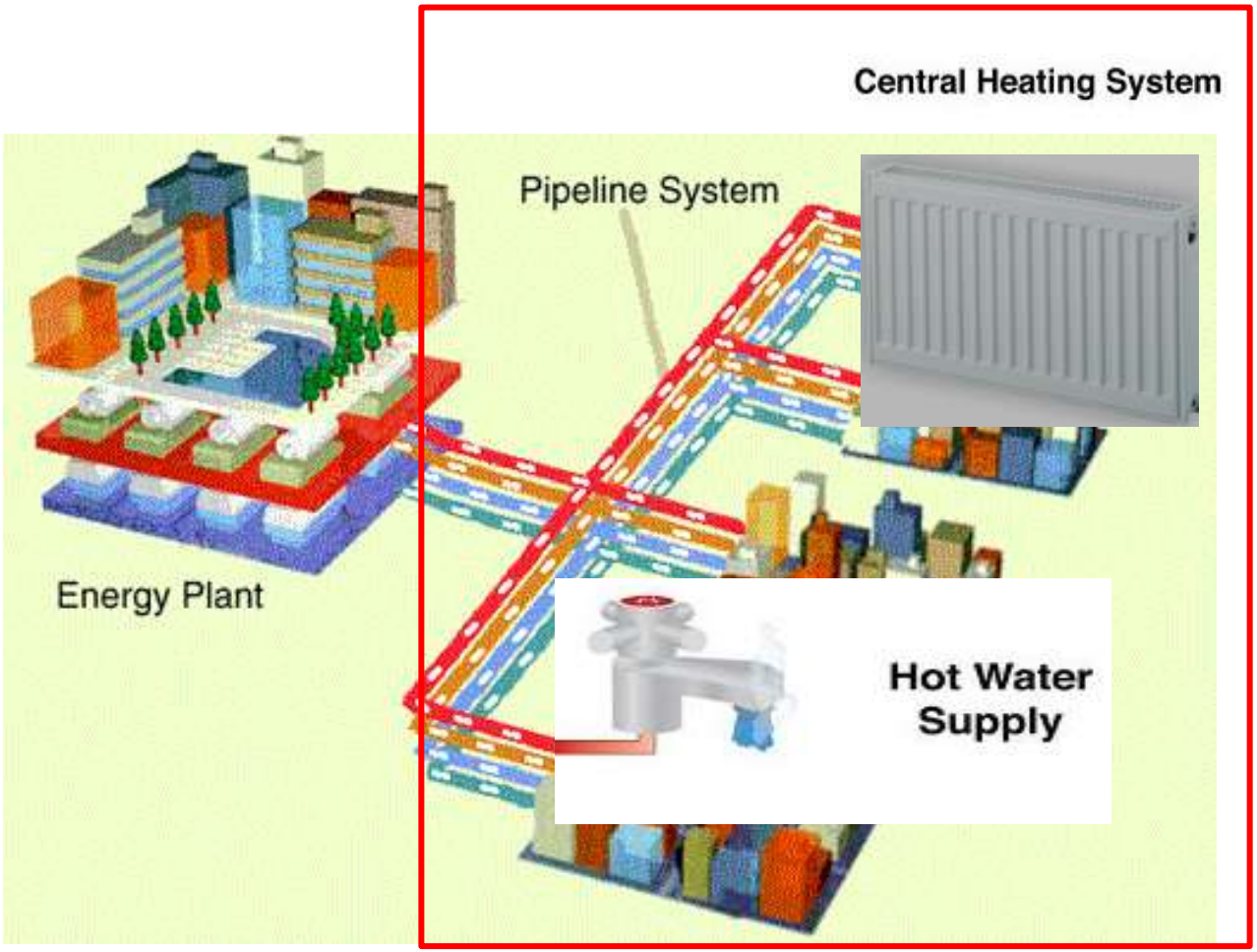
ELECTRICITY



Power Plant Block

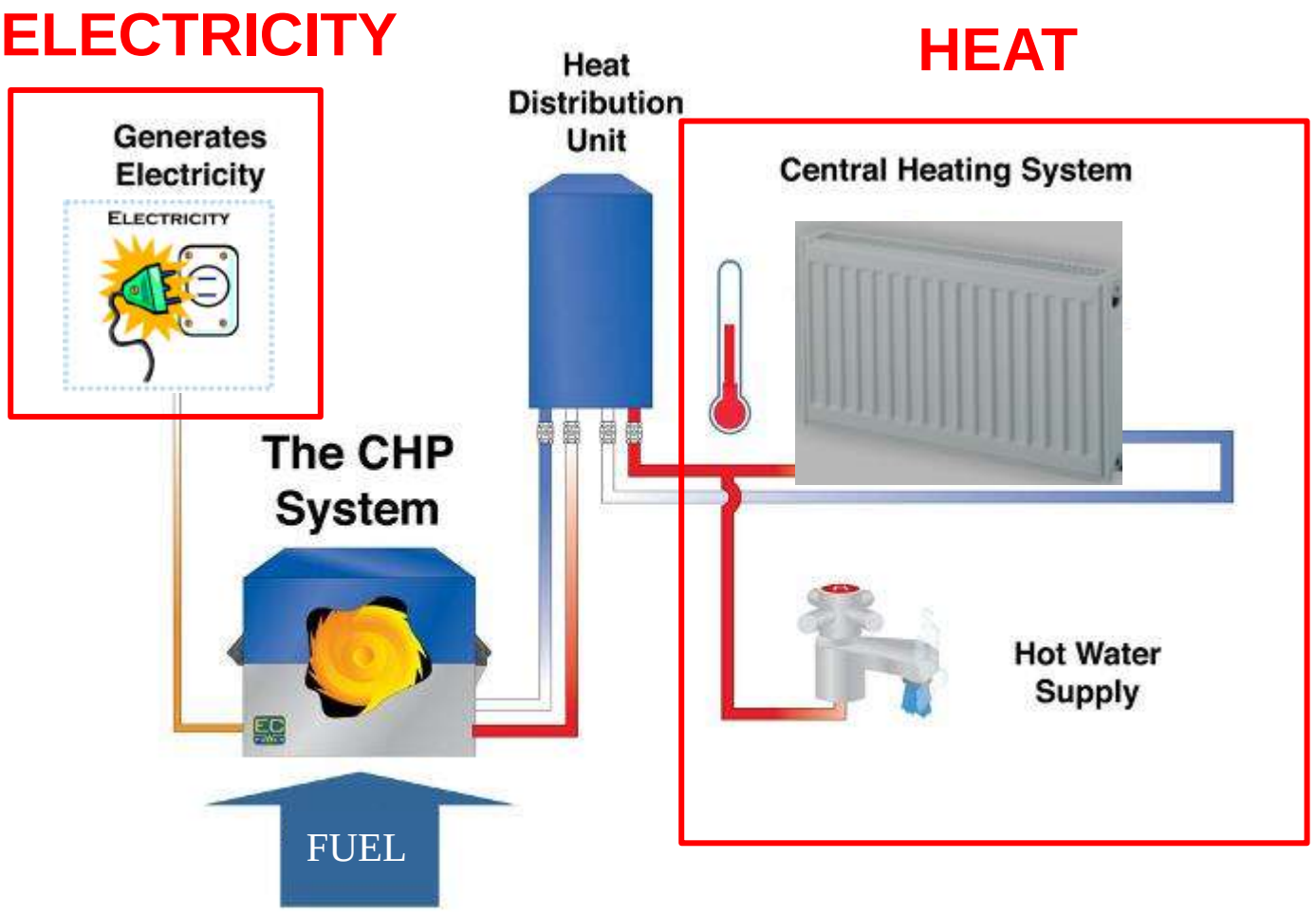
SOURCE: http://www1.eere.energy.gov

Tables 1&2: Heat only power plant



SOURCE: http://www.jdhc.or.jp

Tables 1&2: CHP



SOURCE: http://www.proenviro.com

Tables 1&2: Plants by function

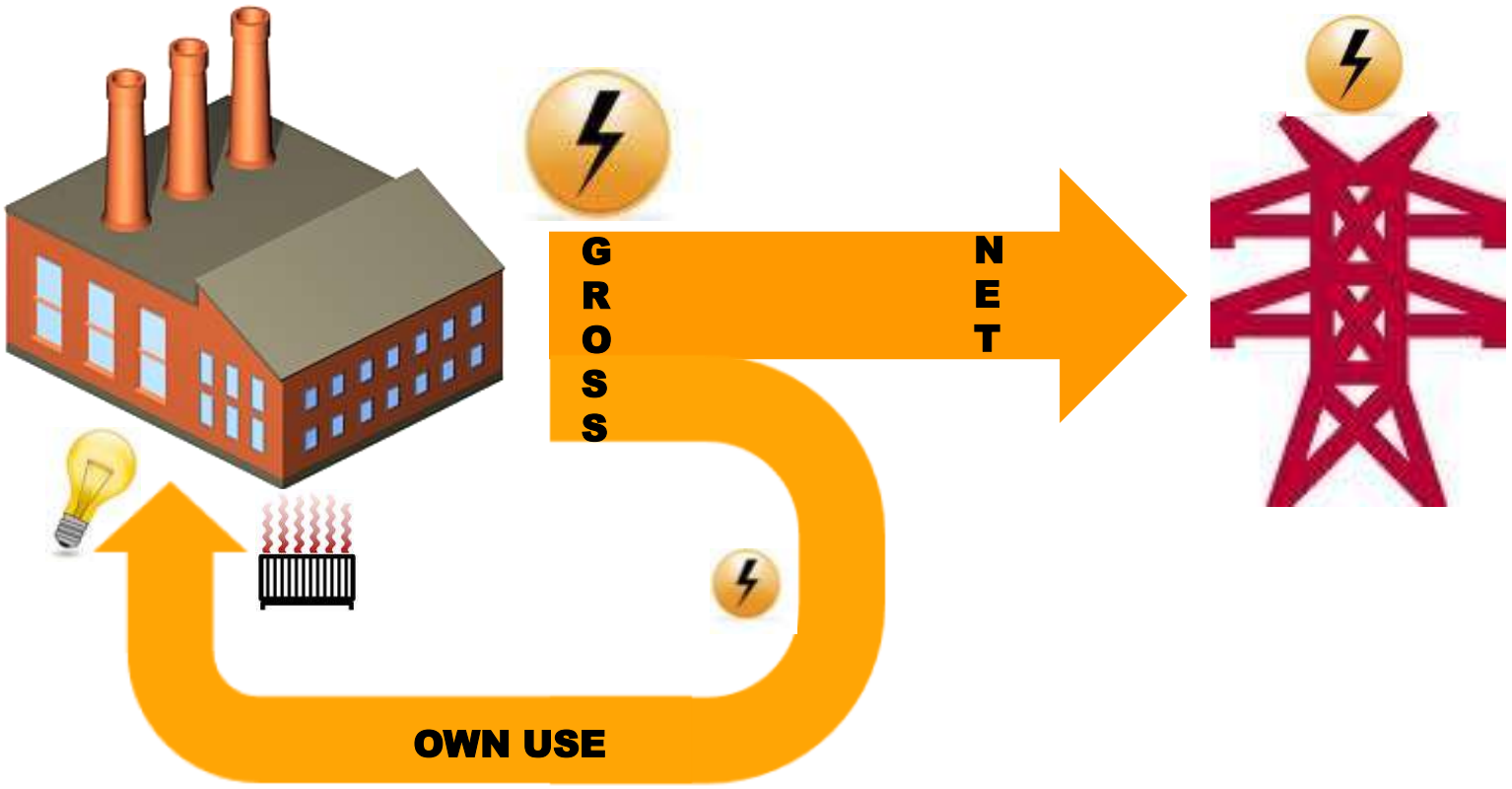
"Main activity" producer plants

- Undertakings generating electricity and/or heat for sale to third parties *as their primary activity*
- Regardless whether they are state or privately owned

Autoproducers

- Undertakings generating electricity and/or heat wholly or partly for their own use *as support to their primary activity*
- Again, regardless whether they are state or privately owned

Tables 1 vs. 2: *Gross* and *net* electricity production



- GROSS: electricity produced measured at output terminal of the main generator
- OWN USE: electricity absorbed by the generating auxiliaries + electricity lost in the final transformer
- NET = GROSS – OWN USE

Table 6: Fuel Input

Menu				MAIN ACTIVITY PRODUCER PLANTS		
				ELECTRICITY (ONLY)	CHP	HE. (ON
FUELS			UNITS	A	B	C
ANTHRACITE	Fuel input	1	10^3 t			
	Fuel input	2	TJ (NCV)			
	Elec. prod.	3	GWh			
	Heat prod.	4	TJ			

For each combustible fuel:

INPUT shall:

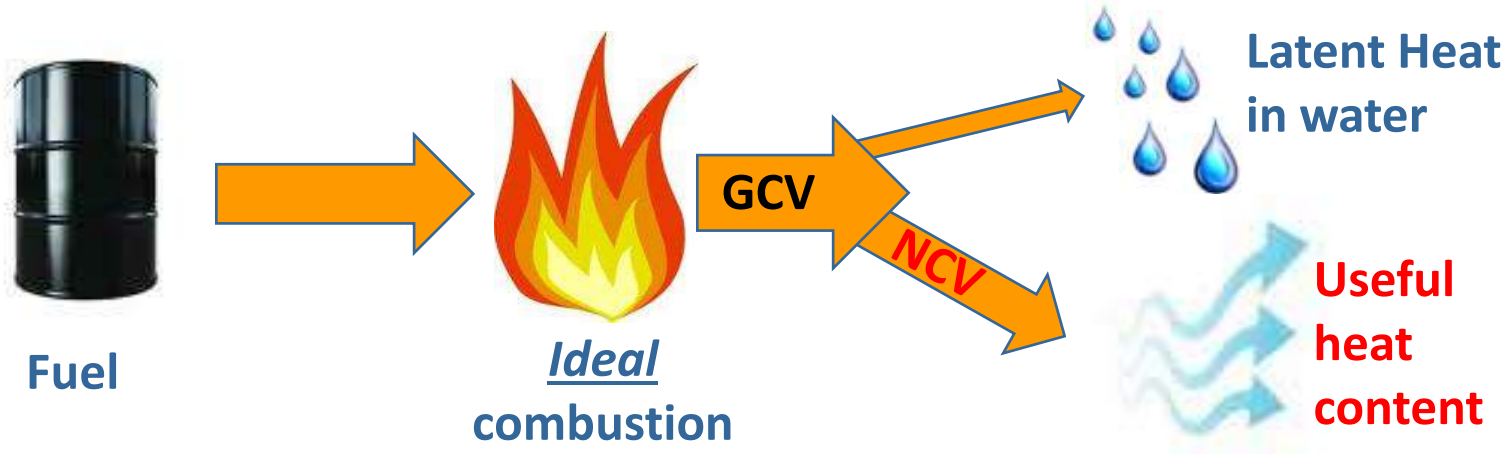
- be reported <u>both in natural (e.g. Ktons) and energy units (e.g. TJ)</u>
- match INPUT given in the other AQs. Check it!

INPUT (TJ) = INPUT (ktons) x NCV (TJ/ktons)

NCV shall:

- be in reference ranges for a given fuel (realibility)
- match NCVs given in the other AQs

Gross vs. Net calorific value



GCV/NCV approximately:

- **10% natural gas**
- **5% oil**
- **5% coal**

Table 6: Electricity/Heat production

2008 Menu				MAIN ACTIVITY PRODUCER PLANTS		
				ELECTRICITY (ONLY)	CHP	HE. (ON
FUELS			UNITS	A	B	C
ANTHRACITE	Fuel input	1	10^3 t			
	Fuel input	2	TJ (NCV)			
	Elec. prod.	3	GWh			
	Heat prod.	4	TJ			

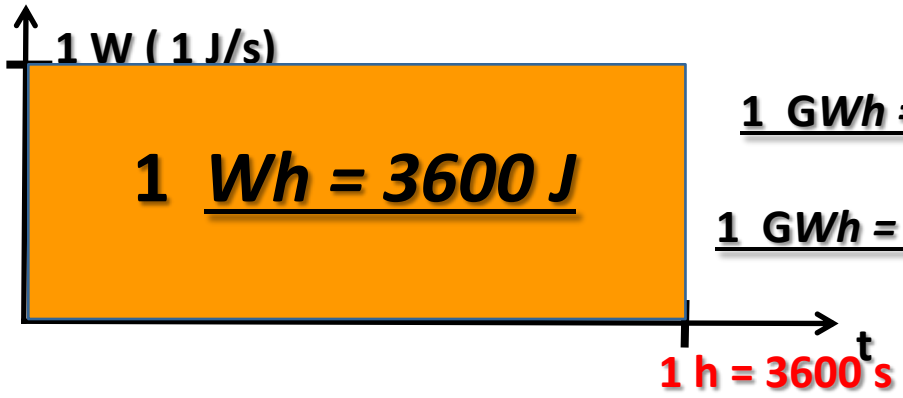
Production (gross): electricity in GWh, heat in TJ

1 J = 1 W*secs (Watt multiplied by the seconds)

1 Wh = 3600 J (W*sec)

TIP:
3600 is the number of seconds in one hour

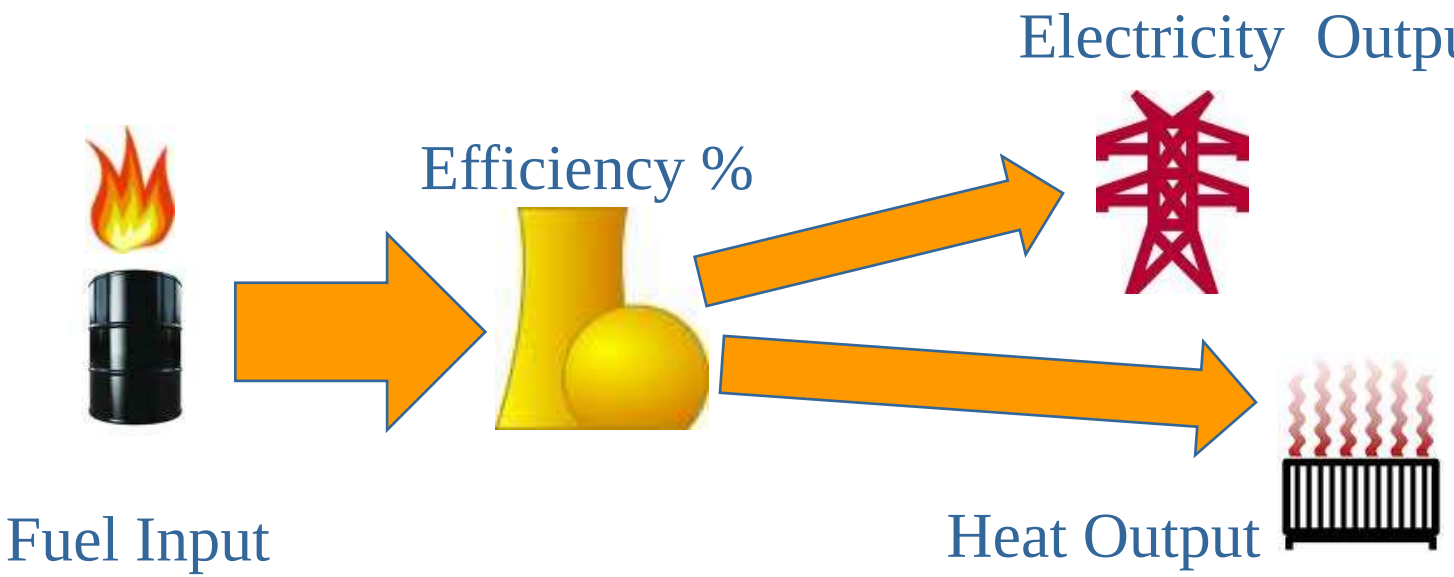
A *Wh* is the energy produced by operating at a power of 1 Watt for an hour



1 GWh = 3600 GJ

1 GWh = 3.6*1000 GJ = 3.6 TJ

Generation Efficiency

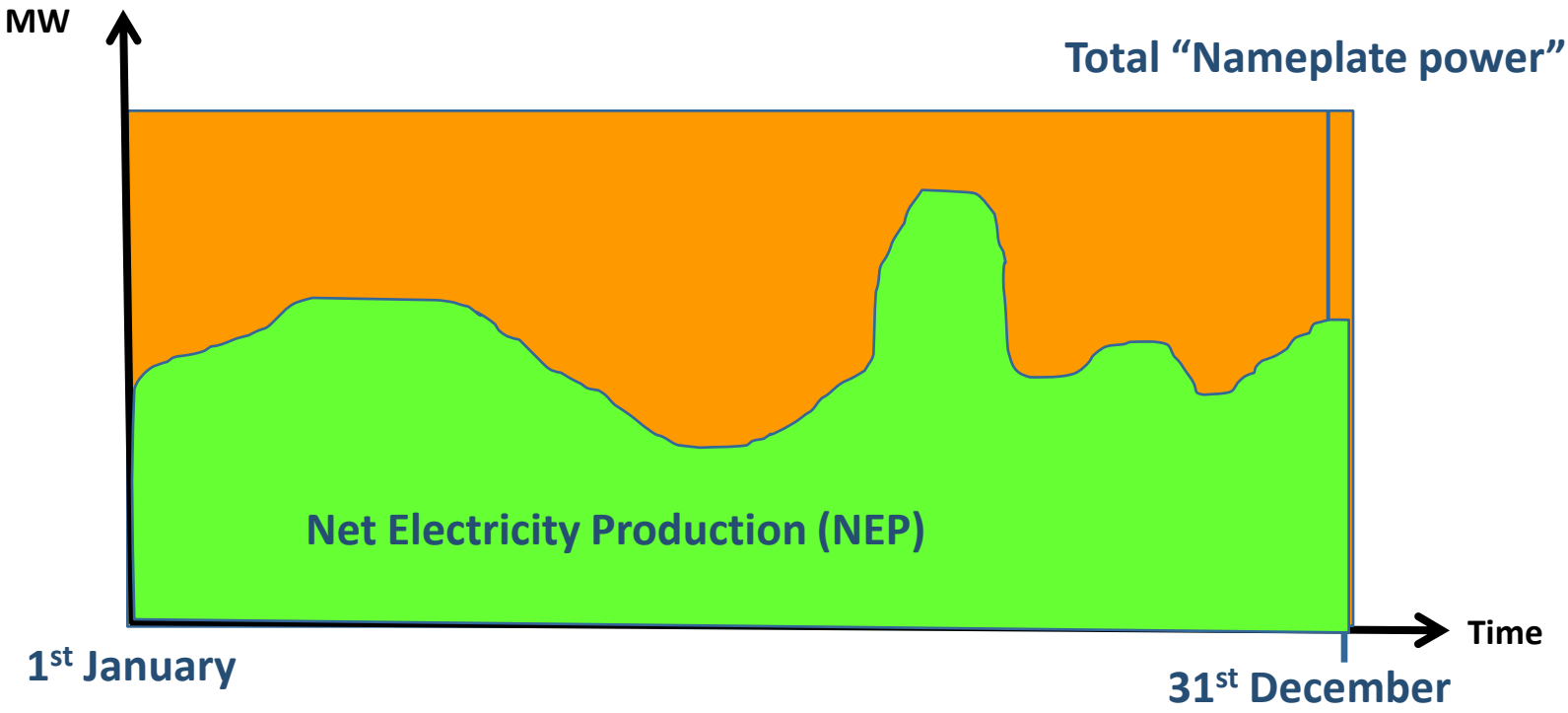


EFFICIENCY = OUTPUT / INPUT (NCV) (in energy units)

Efficiency shall:

- **be in reference ranges for each type of plant**
- **be anyway < 100%**

Table 7a: Net Maximum Electrical Capacity



Capacity factor % = actual production / maximum potential production

Capacity factor shall:

- be in reference ranges
- be anyway < 100%

Table 8: Electricity and Heat Trade

Differently from the trade rule for all other energy commodities, <u>ALL the quantities of electricity and heat crossing national borders</u> must be accounted, <u>*including transit*</u>

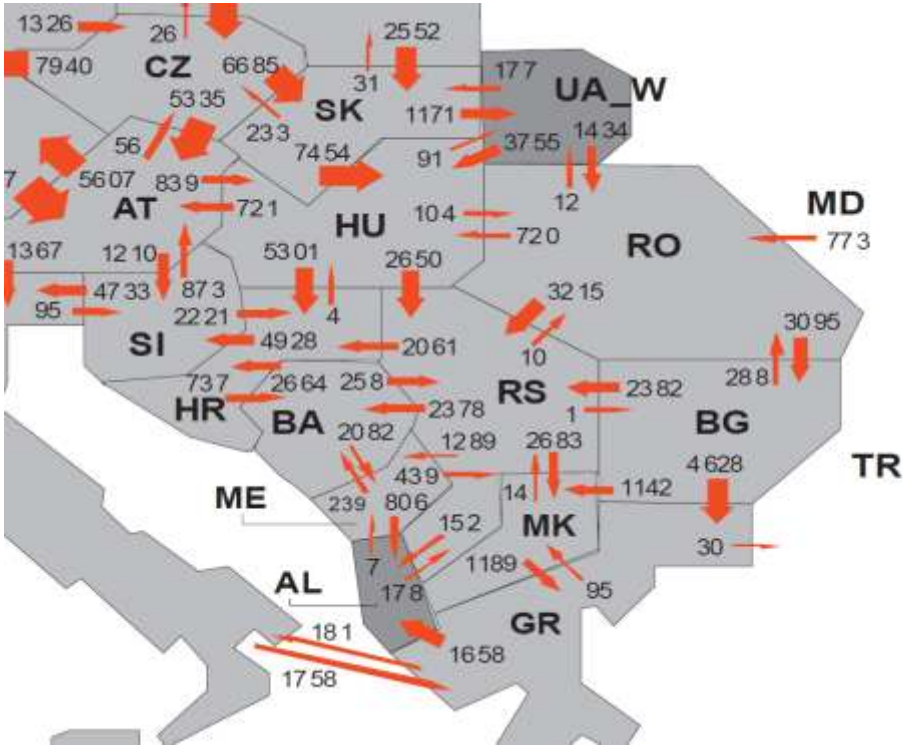
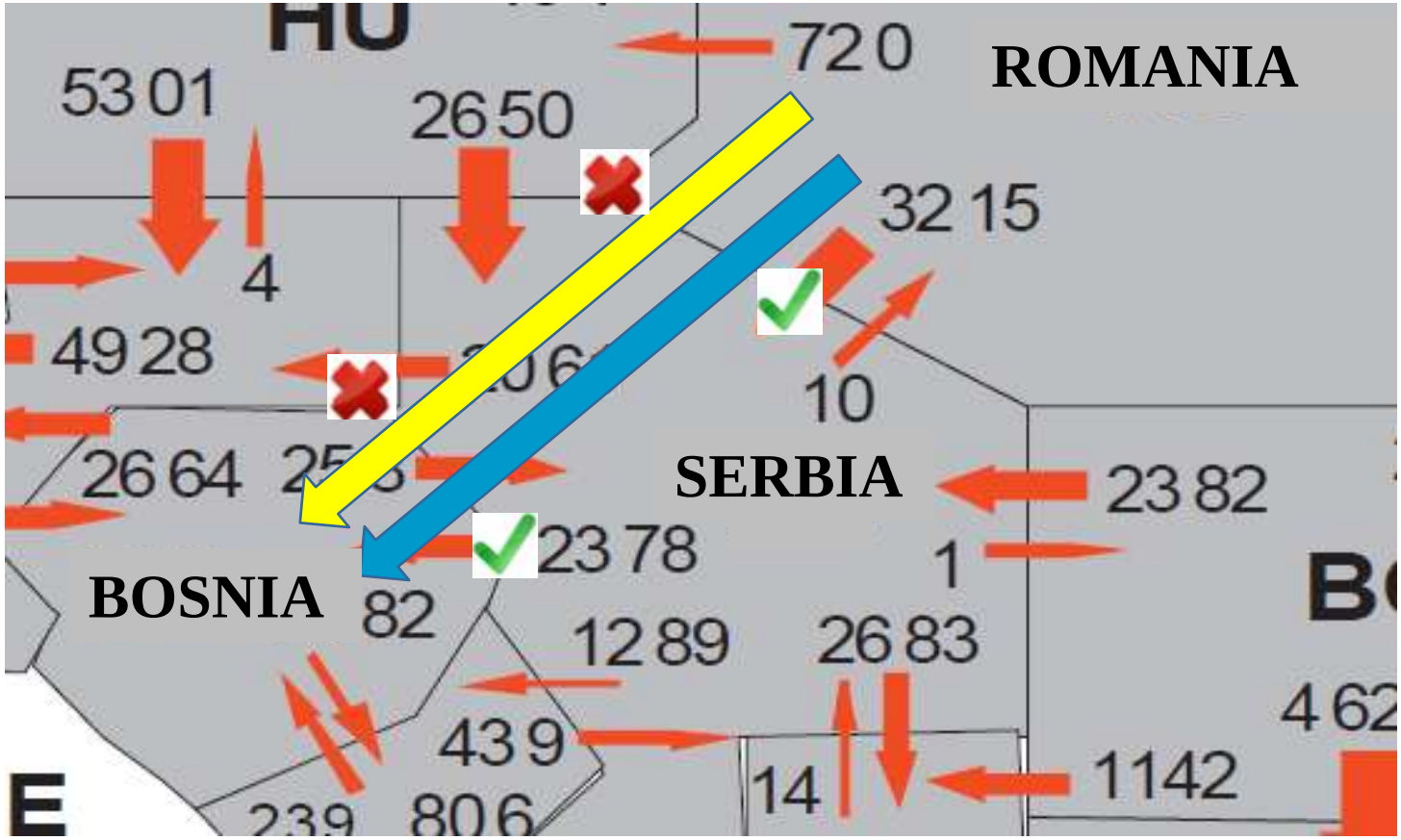


Table 8: Electricity and Heat Trade cont'd

- Example GAS: ***transit should not*** be accounted under import/export
- Example ELECTRICITY: ***transit should*** be accounted under import/export



THANK YOU

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