Electricity Overview

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Training Workshop on Energy Statistics
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IEA

Outline

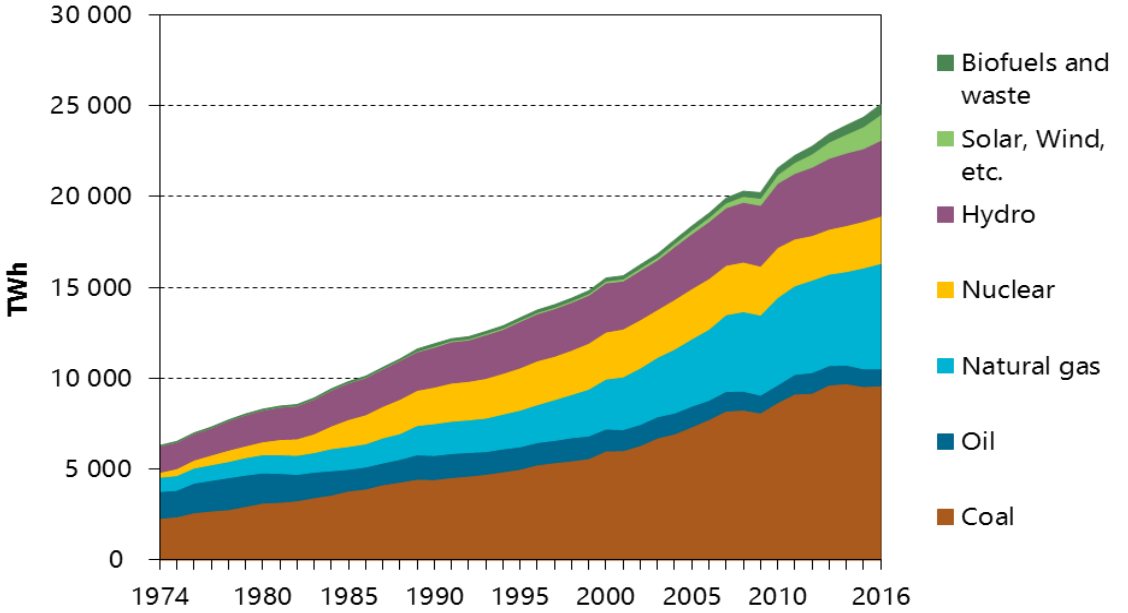
Key Electricity trends

Key concepts

Key points for exercises

Key Electricity trends

World Electricity Production by Source

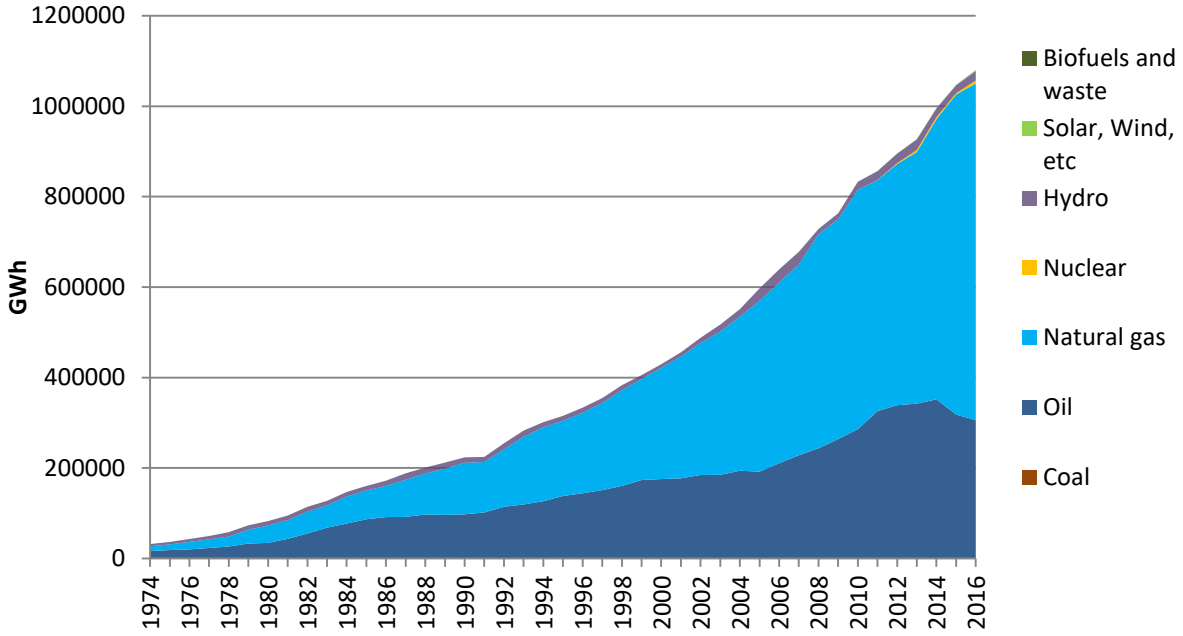


Since1974:

- 4X increase in global electricity production
- Lower share of Oil
- Lower share of Hydro
- Higher share of Natural Gas
- Higher share of Nuclear
- Higher share of Solar & Wind

Source: *Electricity Information*, OECD/IEA, 2018

Middle East Electricity Production by Source

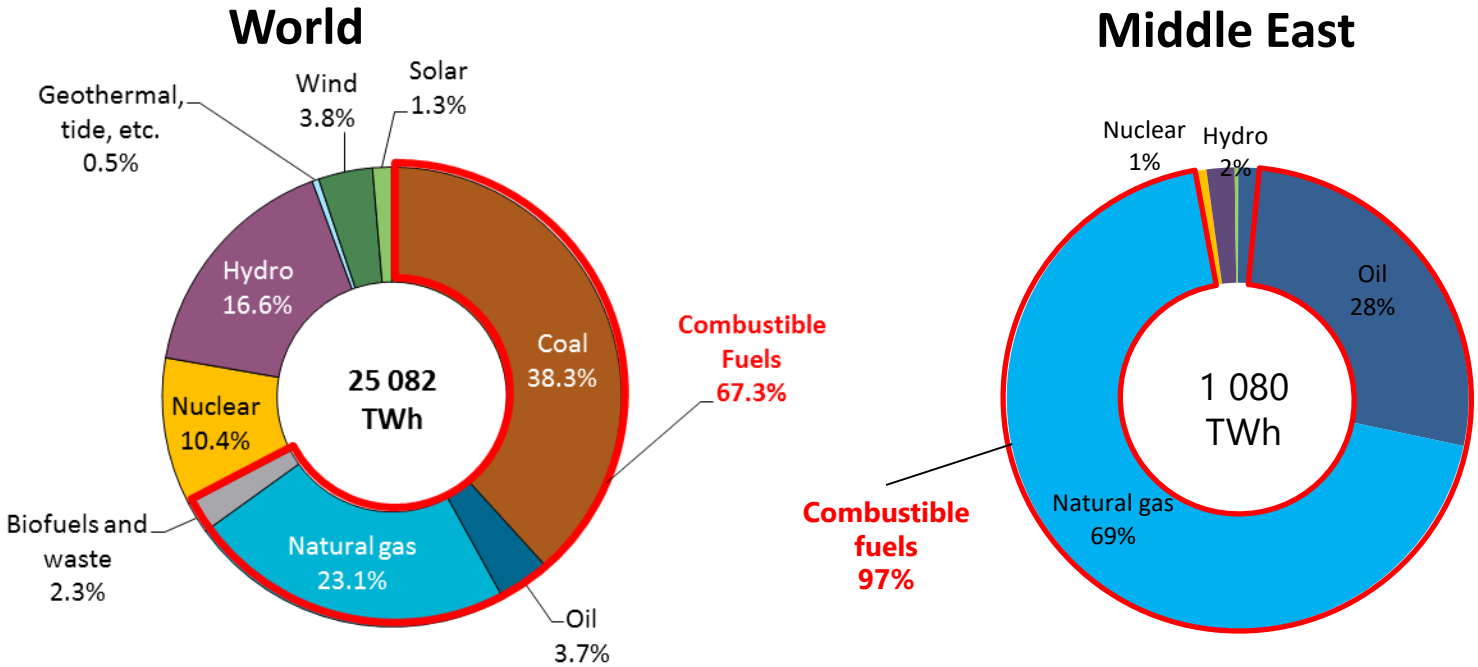


Since1974:

- More than 30X increase in electricity production.
- 70X increase in electricity production from gas.
- Hydro and other renewables account for 2% of electricity production.

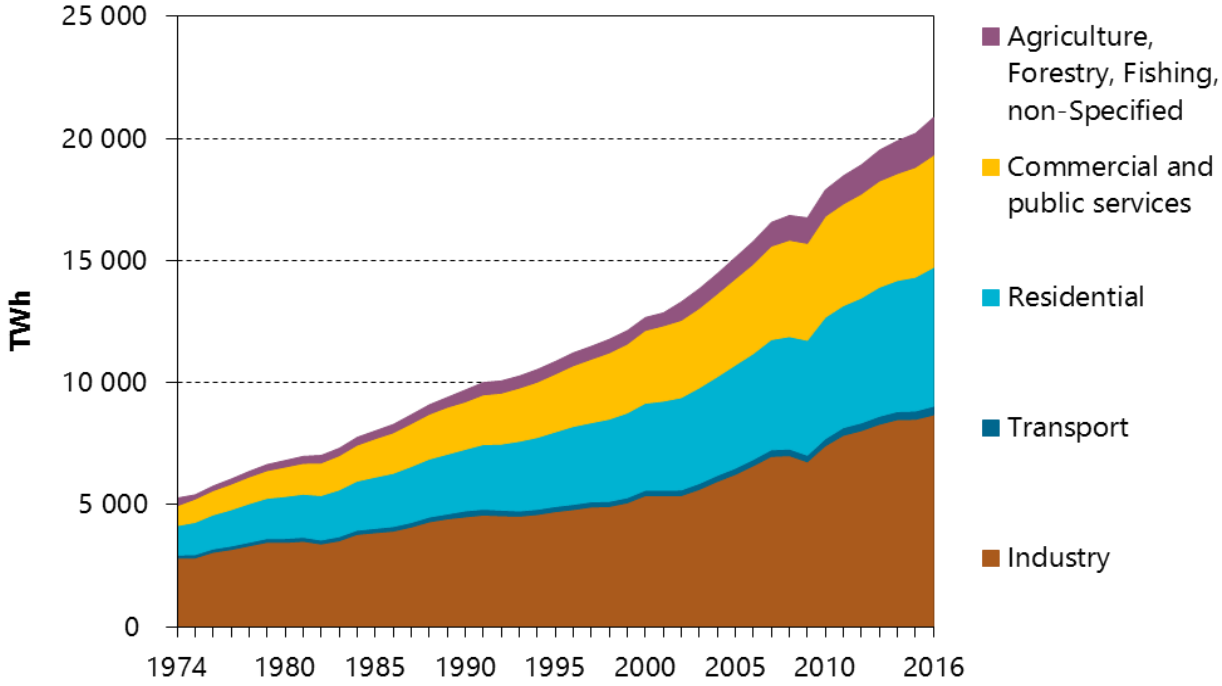
Source: *Electricity Information*, OECD/IEA, 2018

Electricity Production by Source: World and Middle East (2016)



Source: *Electricity Information*, OECD/IEA, 2018

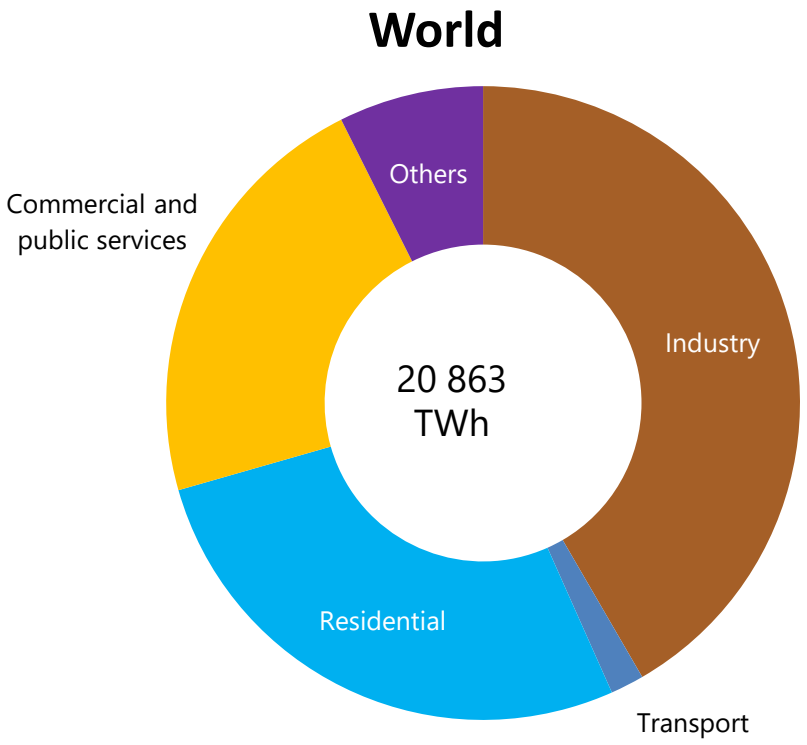
World Electricity Consumption by Sector (2016)

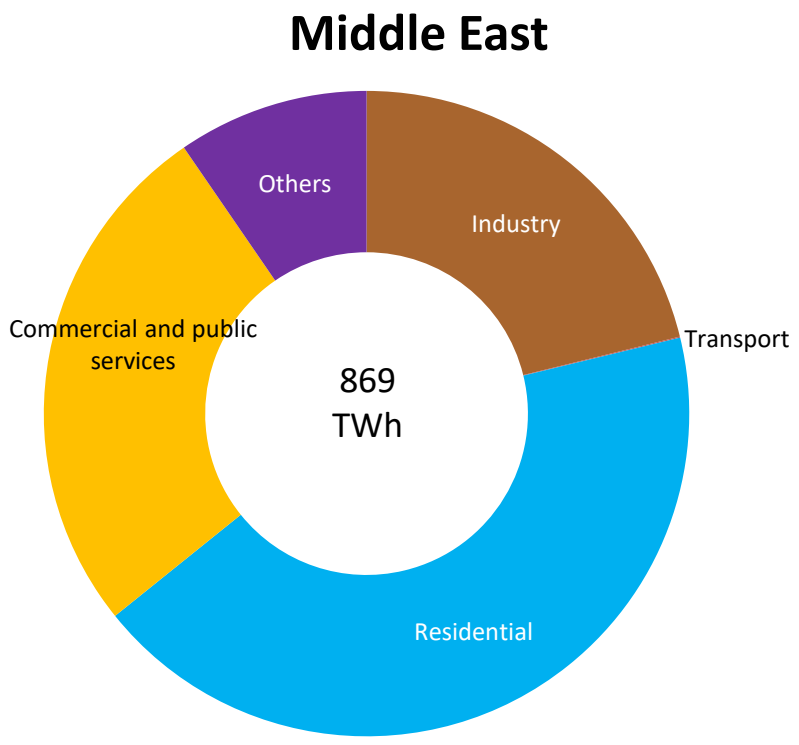


- Electricity consumption has increased 4x since 1974
- Industry remains the largest consuming sector
- However, the Residential and Commercial sectors are increasing their share of consumption

Source: *Electricity Information*, OECD/IEA, 2018

Electricity Consumption by Sector: World and Middle East (2016)





Source: *Electricity Information*, OECD/IEA, 2018

Key concepts

Electricity: Primary vs. Secondary

Electricity is produced as both primary and secondary energy

Primary

Hydro

Solar PV

Wind

Tide/Wave

Secondary

Combustible Fuels

Nuclear

Geothermal

Solar Thermal
(Concentrated solar power)

Production: Two Producer Types

Main Activity Producer

Generate electricity / heat for third parties as a primary activity.

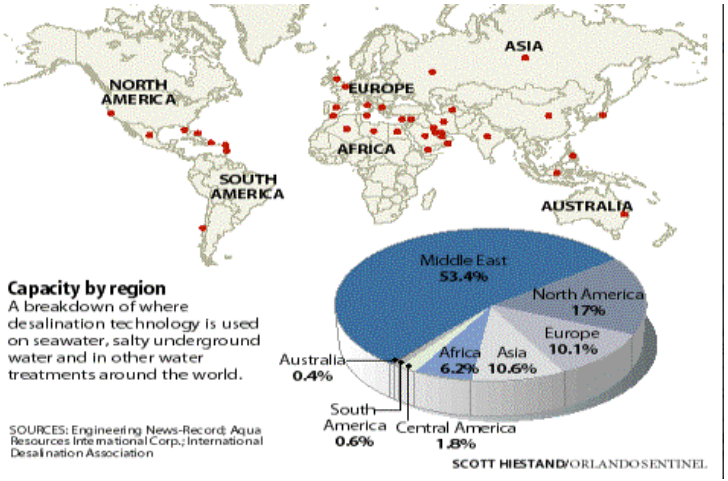
Autoproducer

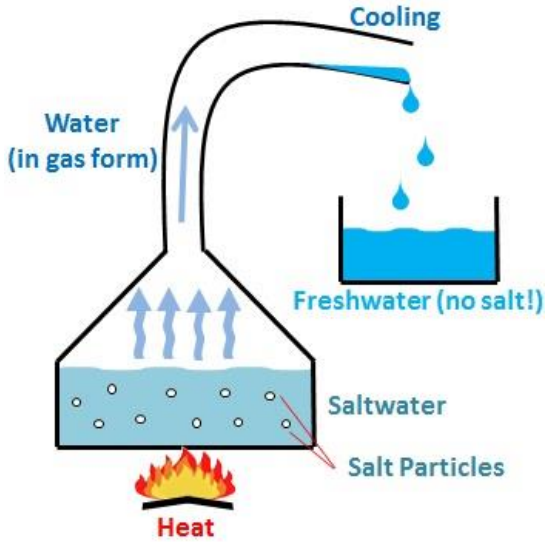
Generate electricity / heat wholly or partly for their own use as an activity which supports their primary activity.

Electricity and Cogeneration: desalination

- Desalination is electricity and heat intensive.
- Commonly, electricity and water desalination are considered in the same industry.
- Statistics can be readily available through cogeneration authority.

Major desalination plants worldwide





Production: Three Plant Types

Electricity Only	**Generate electricity only**
Heat Only	**Generate heat only**
Combined Heat and Power (CHP)	**Generate both electricity and heat simultaneously**

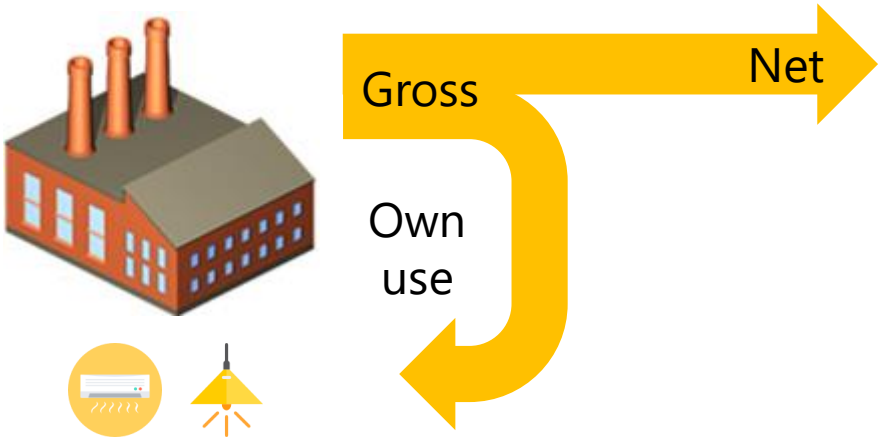
Reporting Conventions: Electricity & Heat

	 **Main Activity Producer**	 **Autoproducer**
 **Electricity Only**	**Report all production**	**Report all production**
 **Heat Only**	**Report all production**	**Report heat SOLD only***
 **CHP**	**Report all production**	**Report all electricity production** **Report heat SOLD only***

*Only report fuel inputs related to heat sold

Production: Gross vs. Net

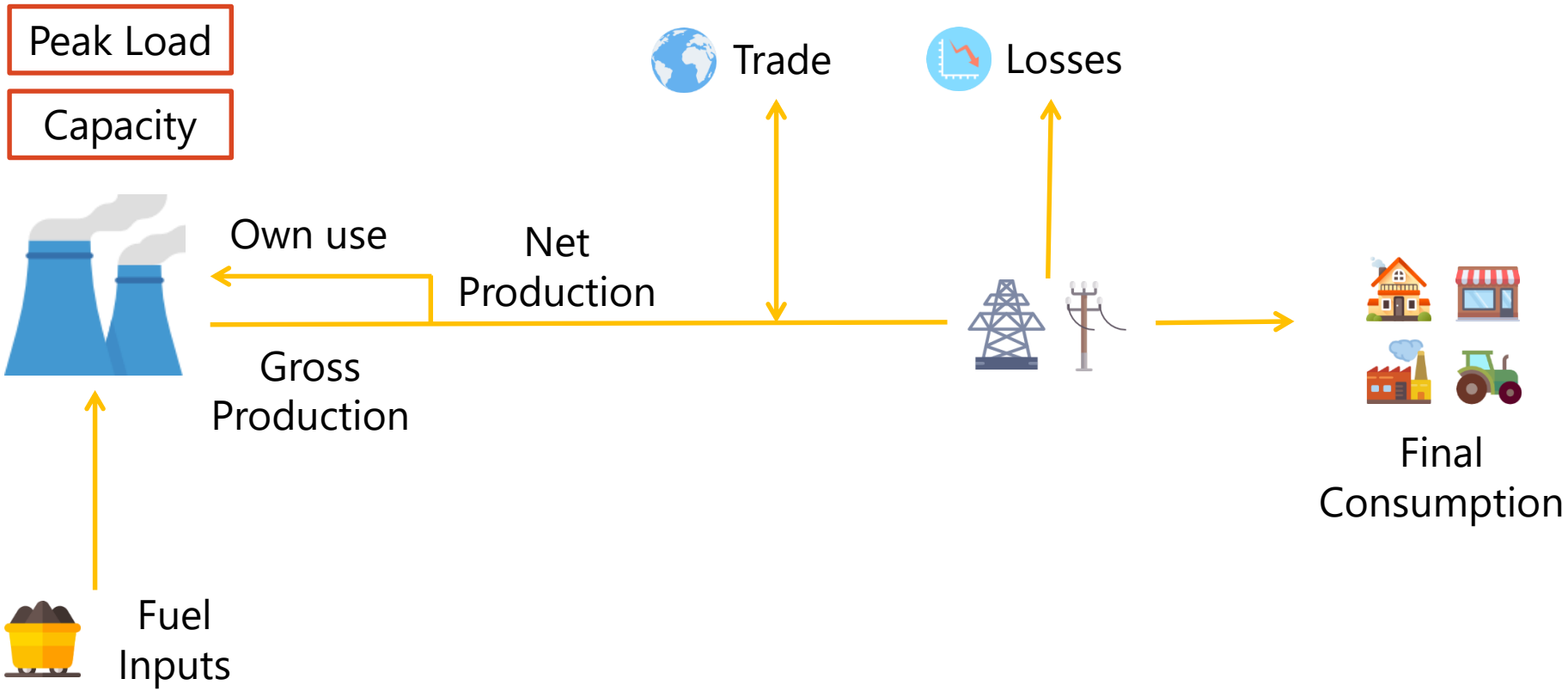
- **Gross Production:** All electricity / heat produced
- **Own Use:** Amount consumed to support plant operations
- **Net Production:** Electricity / heat distributed



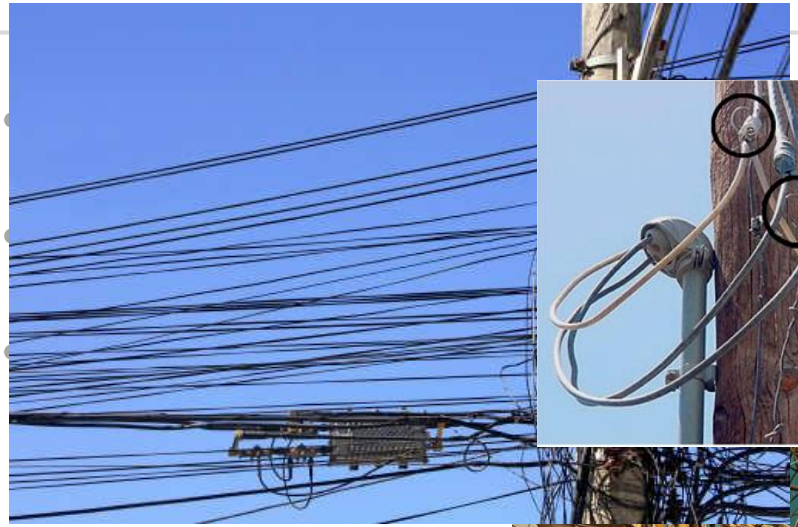
Reporting Conventions: Own Use

	Main Activity Producer	Autoproducer
Electricity Only	Gross – Own Use = Net	Gross – Own Use = Net
Heat Only	Gross – Own Use = Net	Assume Gross = Net
CHP	Gross – Own Use = Net	Electricity: Gross – Own Use = Net Heat: Assume Gross = Net

Supply & Demand



Transmission and Distribution Losses



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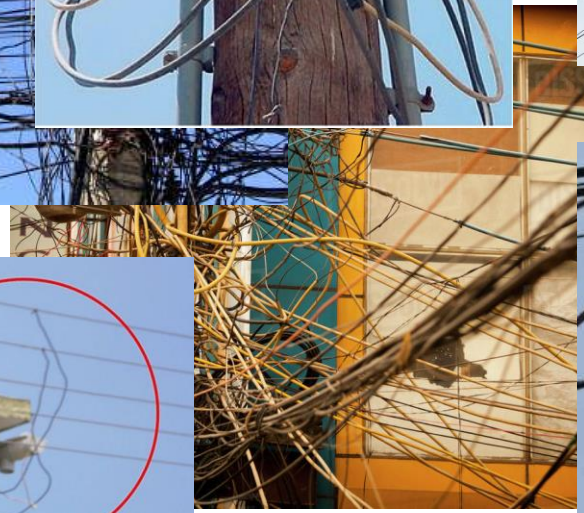

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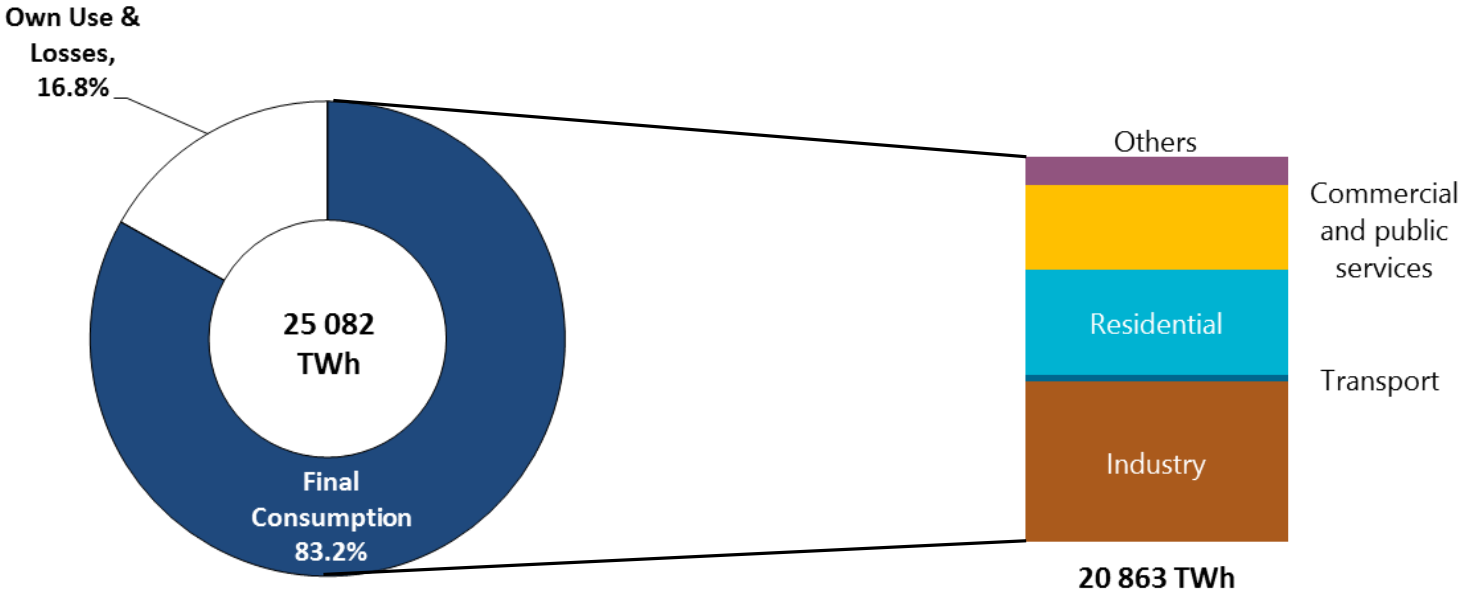
Gross production vs Final consumption (2016)



The difference between Gross production and final consumption is due to **Own Use** and **Transmission and Distribution losses**

Source: IEA/OECD *Electricity Information*, 2018

Generation efficiency

Efficiency = Output / Input (NCV)

- It is always < 100 %
- It differs by fuel / technology
- It must be calculated in energy units

Example:

Efficiency = (20+45)/100
= 65%

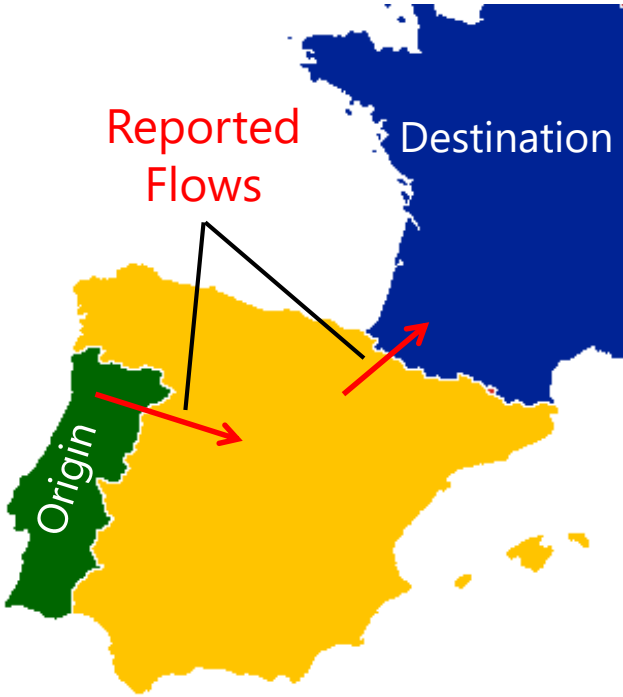
Trade

Unlike other fuels, trade of electricity and heat:

- Is reported on the basis of borders crossed, NOT origin and destination.
- Includes all trade, including transit.

Example:
Exports of electricity from Portugal to France transiting through Spain, would be reported as:

- Portugal: Exports to Spain
- Spain: Imports from Portugal and Exports to France
- France: Imports from Spain



Energy vs. Power

Power = **Energy** / **Time**

1 Watt = 1 Joule / second

In 1 hour: 1 Watt of Power consumes 3 600 Joules of energy
For convenience, this amount is known as a watt hour (Wh)

i.e. 1 Watt hour = 3600 Joules

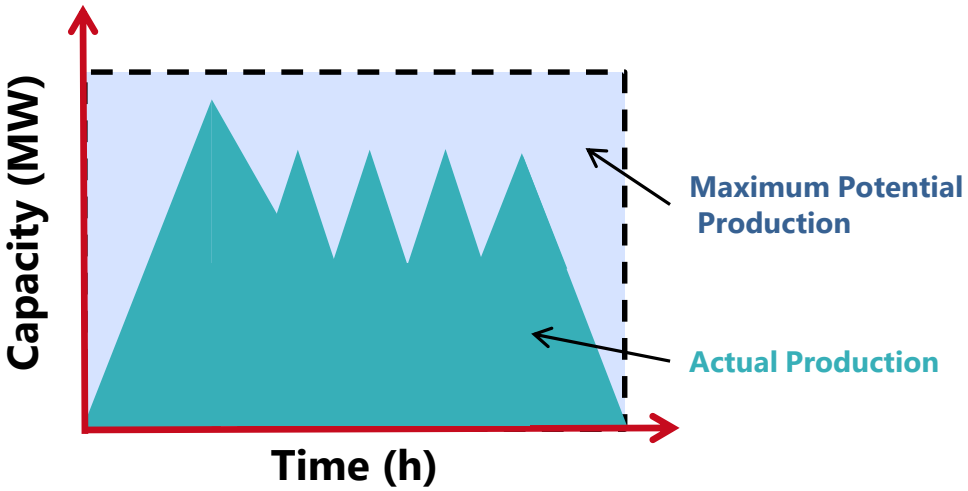
Key point: Watts are units of power

Watt hours are units of energy

Net maximum Capacity

Net maximum capacity is the maximum potential power that can be supplied with at the point of outlet, with all plant running, on 31 December.

$$\textbf{Capacity Factor} = \frac{\text{Actual Production}}{\text{Maximum } \textit{Potential} \text{ Production}} = \frac{\text{Actual Production}}{\text{Capacity} \times \text{Time}}$$



Capacity Factor:

- Is a useful check
- Should be ≤ 100%
- Has different expected values depending on the technology e.g. Solar PV vs. Nuclear

Key points for reporting electricity & heat data

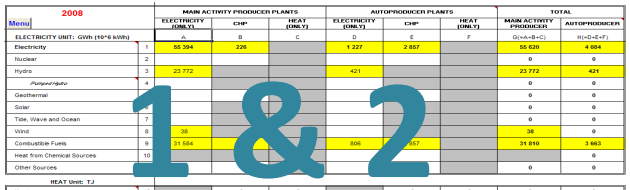
Looking at IEA Joint Questionnaire

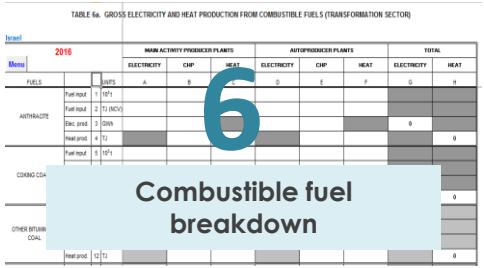
Tables and products

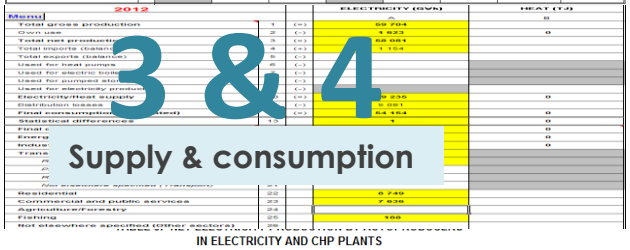
8 Tables

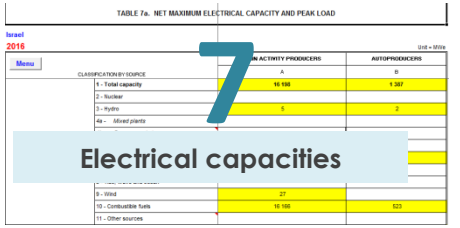
covering

- **Electricity and heat data** generation by:
  - **47** individual fuels
  - type of producer
  - type of plant/unit
- **Consumption data** by sector
- **Technical information** on electrical systems









IN ELECTRICITY AND CHP PLANTS

Israel

Unit = GWh

2016

		ELECTRICITY PLANTS	CHP PLANTS	TOTAL
		A	B	C
Total net production	1	4	0	4 305
Energy sector	2	1	0	1 074
Coal mines	3			0
Oil and gas extraction	4			0
Patent fuel plants (Energy)	5			0
Coke ovens (Energy)	6			0
BKB / PB plants (Energy)	7			0
Gas works (Energ				0
Blast furnaces (Er				0
Oil refineries				1 074
Coal liquefaction plants (Energy)	11			0
Liquefaction (LNG) / Regasification plants	12			0
Gasification plants for biogas	13			0
Gas-to-liquids (GTL) plants (Energy)	14			0

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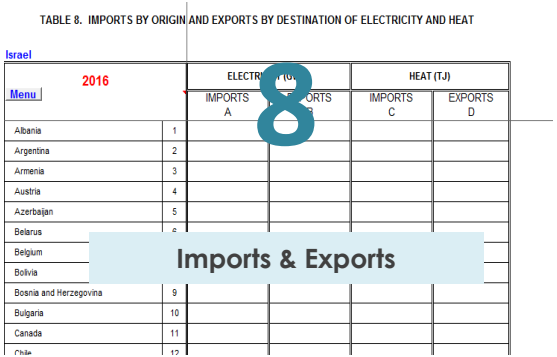
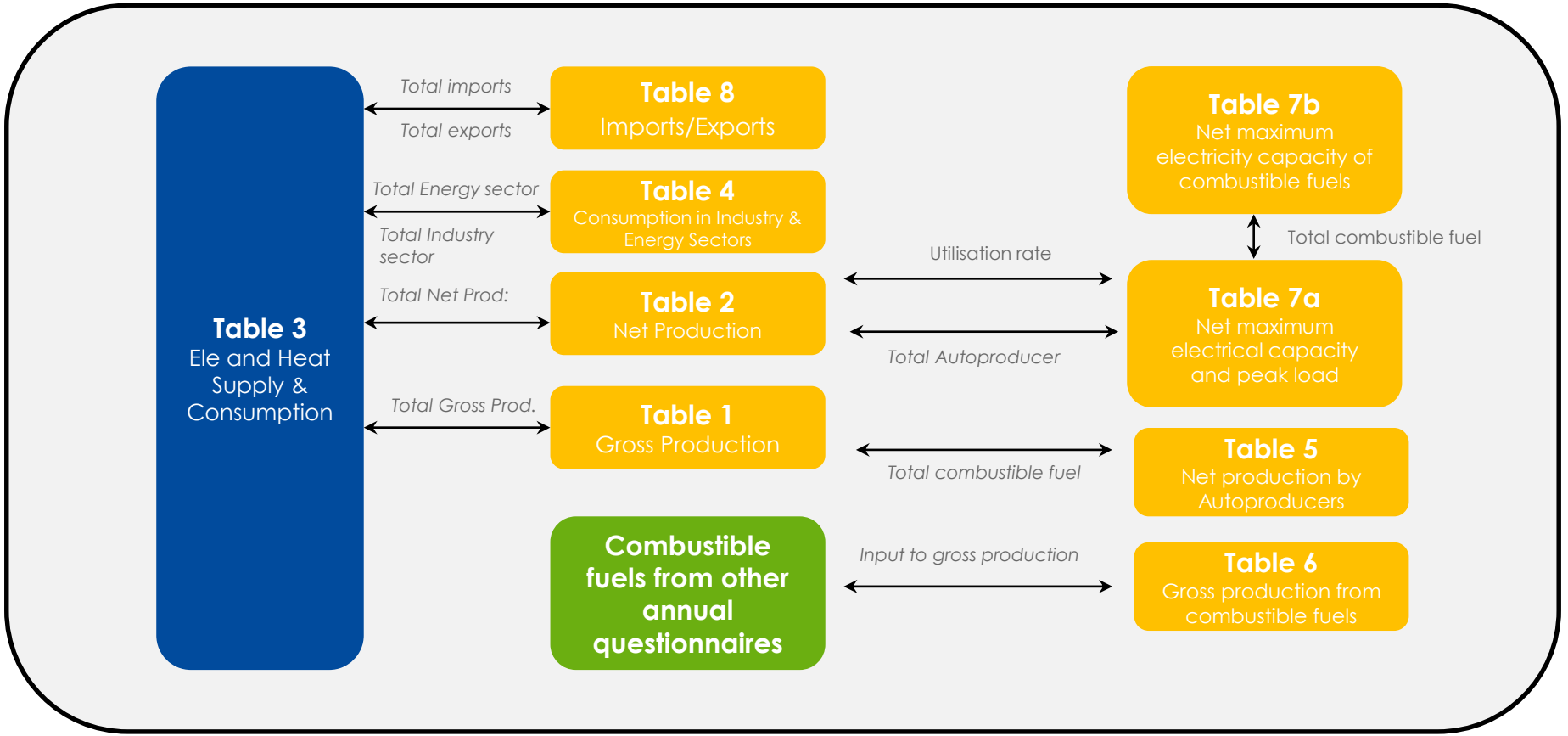
Autoproducers



Tables/Questionnaire relations in Electricity and Heat Questionnaire



Exercise 1: Net 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
Tide, Wave and Ocean	7								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

Exercise 1: Net electricity and heat production

Example:

- A power plant is using natural gas and is producing 5000 GWh of electricity
- A hydro power plant is producing 20 GWh of electricity
- A waste recycling facility uses waste to produce 45 GWh of electricity

TABLE 2. NET ELECTRICITY AND HEAT PRODUCTION : (TRANSFORMATION SECTOR)

2015		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	a	5 020	0		45	0		5 020	45
Nuclear	b							0	0
Hydro	c	20						20	0
Pumped Hydro	d							0	0
Geothermal	e							0	0
Solar	f							0	0
Tide, Wave and Ocean	g							0	0
Wind	h							0	0
Combustible Fuels	i	5 000			45			5 000	45
Heat from Chemical Sources	l								0
Other Sources	m							0	0

Exercise 2: Gross electricity and heat production from combustible fuels 1/2

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			

For each combustible fuel:

INPUT shall:

- be reported both in natural (e.g. ktons) and energy units (e.g. TJ)
- 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 (reliability)
- match NCVs given in the other AQs

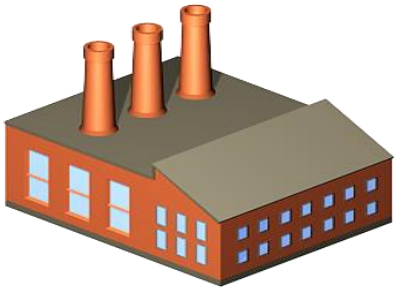
Note: See more on CVs in "Fundamentals of Energy Statistics"-presentation, pages 9-11

Exercise 2: Gross electricity and heat production from combustible fuels 2/2

2008 Menu				MAIN ACTIVITY PRODUCER PLANTS		
				ELECTRICITY (ONLY)	CHP	HE (ONI
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			

Input:
Anthracite

100 kt, 22 TJ/kt



Output:
Gross Electricity

124 GWh

$$Efficiency = \frac{\textbf{124 GWh *3.6 (TJ/GWh)}}{\textbf{100kt *22(TJ/kt)}} = \textbf{20.3\%}$$

Exercise 3: Electricity trade

Example: Exports of 1000 GWh electricity from Portugal to France transiting through Spain, would be reported as:

- Portugal: Exports 1000GWh to Spain
- Spain: Imports 1000GWh from Portugal and Exports 1000GWh to France
- France: Imports 1000GWh from Spain

IMPORTS BY ORIGIN AND EXPORTS BY DESTINATION

Portugal

2015		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
Albania	1				
Armenia	2				
Austria	3				
Finland	16				
France	17	1 000			
Slovak Republic	44				
Slovenia	45				
Spain	46				
Sweden	47				

IMPORTS BY ORIGIN AND EXPORTS BY DESTINATION

Spain

2015		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
Denmark	14				
Estonia	15				
Finland	16				
France	17		1 000		
Norway	38				
Poland	39				
Portugal	40	1 000			
Romania	41				
Russian Federation	42				

IMPORTS BY ORIGIN AND EXPORTS BY DESTINATION

France

2015		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
Poland	39				
Portugal	40				
Romania	41				
Russian Federation	42				
Serbia	43				
Slovak Republic	44				
Slovenia	45				
Spain	46	1 000			
Sweden	47				

Exercise 4. Net maximum electrical capacity

$$\textbf{Capacity Factor} = \frac{\text{Actual Production}}{\text{Maximum } \textit{Potential} \text{ Production}} = \frac{\text{Actual Production}}{\text{Capacity} \times \text{Time}}$$

Example: A power plant using natural gas has nameplate electricity **capacity 1300MW** and **produces 4500GWh** of net electricity.

- We calculate first the maximum potential electricity production as: **Capacity x Time = 1300 MW *365*24/1000= 11388 GWh**
- We divide the net electricity that is produced by the plant with the maximum potential electricity production as: **4500 GWh/11388 GWh=39.5%**
- Capacity factor **39.5%**

Final Check list

- **Main activity producers** generate electricity/heat as **primary activity** **vs** **Autoproducers** generate electricity/heat as an **additional activity** (partly or wholly for their own use.

- For electricity: **Net production = Gross production - Own use**

- For Heat:
  - Main activity: **Net production = Gross production - Own use**
  - Autoproducers: **Net production = Gross production**

- **Generation efficiency = Output / Input (NCV)** and should always be **<100**

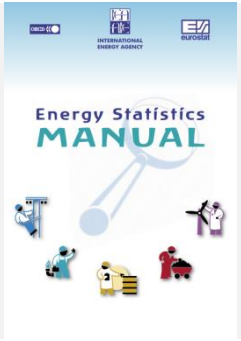
- **Capacity factor = Actual production / Maximum potential production**
  - **Maximum potential production = Capacity * 24 (hours) * 365 (days)**

Learn more about Energy Statistics

The IEA produced a comprehensive Energy Statistics Manual covering most of our data collection methodologies, consistently with the IRES framework.

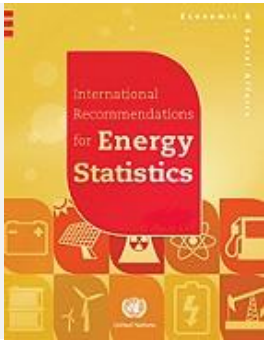
A comprehensive Energy Statistics Manual available in 10 languages.

Click to download it free of charge!



*Visit the **IEA's Statistics website** to access additional resources, including our **webinars**, questionnaires, glossary and documentation related to our data collection methodologies.*

To learn more about the international framework for energy statistics, please refer to the United Nations' International Recommendations for Energy Statistics (IRES).



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