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Introduction to Electricity Industry I

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- Basics of Electricity
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What is Electricity?

http://www.youtube.com/watch?v=8gvJzrjwjds

Electricity has many advantages:

- easy to handle
- simple transfer
- it is clean and non-polluting
- it is elegant and inexpensive

- Is electricity cheap?

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Basic Quantities and Units

- fluorescent lamp 8–25 W
- lightbulb 25–200 W
- laptop (sleep) 12 W
- laptop 20 W
- PC + LCD monitor 80 W
- colour TV 100 W
- washing machine 500-2,000 W
- iron 1,000 W
- el. pan/hot-plate 1,200 W
- toaster 1,200 W
- dishwasher 1,500 W
- vacuum-cleaner 1,000–2,000 W*
- tea-kettle 1,200–2,000 W
- electric locomotive 2 MW
- electric induction furnace 40 MW

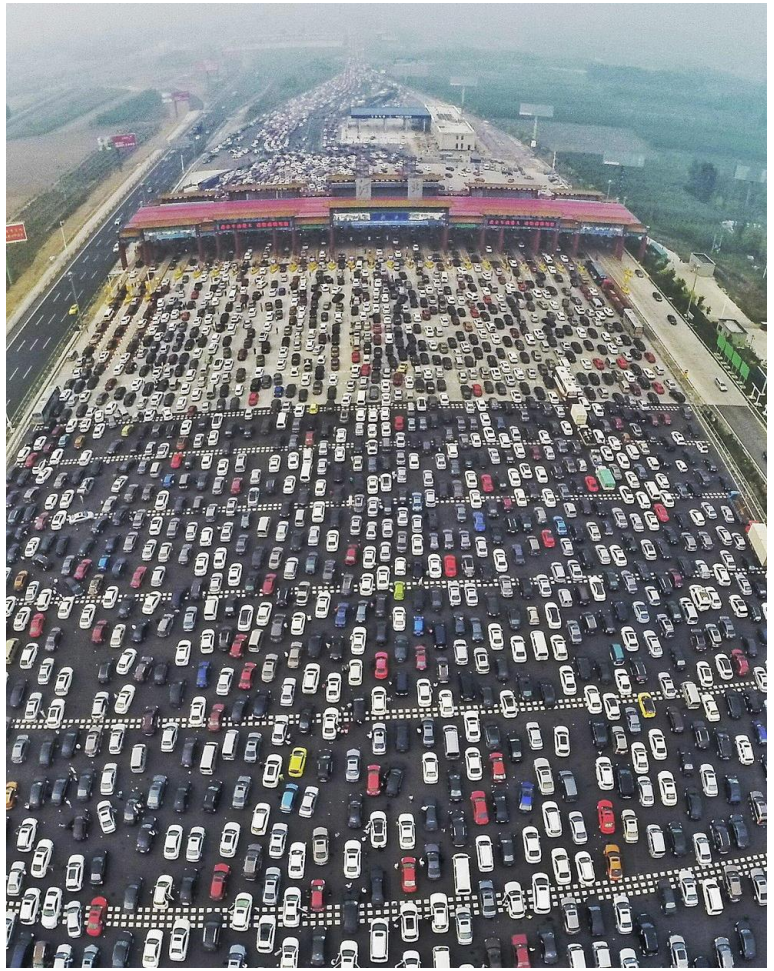
* 9/2014 1,600+ W banned in EU; 1/2017 900+ W banned in EU

Basic Quantities and Units

– Voltage	U (V)	unit 1 volt
– Current	I	unit 1 ampere
– Resistance	R	unit 1 ohm (Ω)
– Installed capacity	P	unit 1 watt
– Energy / work	E	unit 1 joul (Ws), j Wh
– Frequency	f	unit 1 hertz
– Efectivity	η	dimensionless quantity (%)

Basic Quantities and Units

Basic Quantities – Analogy with Highway



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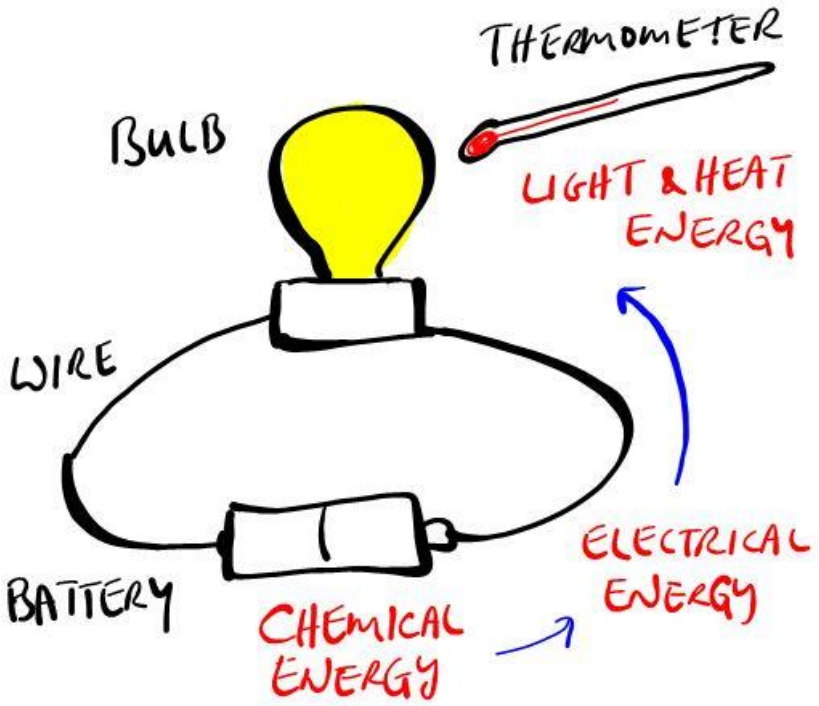
Basics of Electricity

- Installed Capacity
- Electricity Production (work)
- Capacity Factor
- Efficiency and Energy Transformation



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Basics of Electricity – Installed Capacity

Installed Capacity in the Czech Electricity Grid on December 31, 2018		
Type of Power Station	**Installed Capacity (MWe)**	**Percentage (%)**
Thermal	11,075.4	49.7
Gas Combined Cycle	1,363.5	6.1
Gas Fired	909.7	4.1
Hydropower	1,088.7	4.9
Pumped-storage Hydropower	1,171.5	5.3
Nuclear	4,290.0	19.3
Wind	316.2	1.4
Solar	2,048.9	9.2
Geothermal Power	0	0
Total	22,263.9	100
Source: Energetický regulační úřad		

Basics of Electricity – Electricity Production

Gross Electricity Production in the Czech Republic in 2018		
Type of Power Station	**Electricity Production (GWh)**	**Percentage (%)**
Thermal	45,070.8	51.2
Gas-fired and Gas Combined Cycle	7,378.7	8.4
Nuclear	29,921.3	34.0
Hydropower (incl. Pumped-storage Hydroelectricity)	2,677.8	3.0
Wind	609.3	0.7
Solar	2,338.6	2.7
Total gross production	87,996.4	100
Total net production	81,896.4	93.1% of gross production
Source: Energetický regulační úřad		

Basics of Electricity – Capacity Factor

Capacity Factor in the Czech Republic in 2018			
Type of Power Station	**Potential Eletricity Production (GWh)**	**Electricity Production (GWh)**	**Capacity Factor (%)**
Thermal Power Station	97 020.5	45 070.8	46.5
Gas-fired and Gas Combined Cycle Power Station	19 913.2	7 378.7	37.0
Nuclear Power Station	37 580.4	29 921.3	79.6
Hydroelectricity (incl. Pumped-storage Hydroelectricity)	19 799.4	2 677.8	13.5
Wind Power	2 769.9	609.3	21.2
Solar Power	17 948.4	2 338.6	13.0
Source: Energetický regulační úřad			

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Basics of Electricity – Capacity Factor

Basics of Electricity

Boiler variants of Coal-fired power plants			
Type	**Pressure (MPa)**	**Temperature (° C)**	**Efficiency (%)**
Sub-critical	12 – 20	510 – 560	35 on average
Critical	23 – 25	510 – 560	35 – 47
Super-critical	25 – 36	580 – 600	up to 47
Ultra-super-critical	25 – 36	600 – 700	up to 54
Source: Kolat, Roubíček, & Kozaczka, 2008, s. 20.			

Technical aspects of electricity production in different power stations		
Type of Power Station	**Capacity factor (%)**	**Conversion efficiency (%)**
Thermal	50 – 80	32 – 47
Nuclear	80 – 95	27 – 33
Gas Combined Cycle Power Station	11 – 60	38 – 60
Solar	5 – 20	12 – 14 (25, 34)
Wind Turbines	15 – 28	20 – 45
Pumped-storage Water	10 – 15	85 – 95
Water-flow	45 – 70	85 – 95
Source: author		

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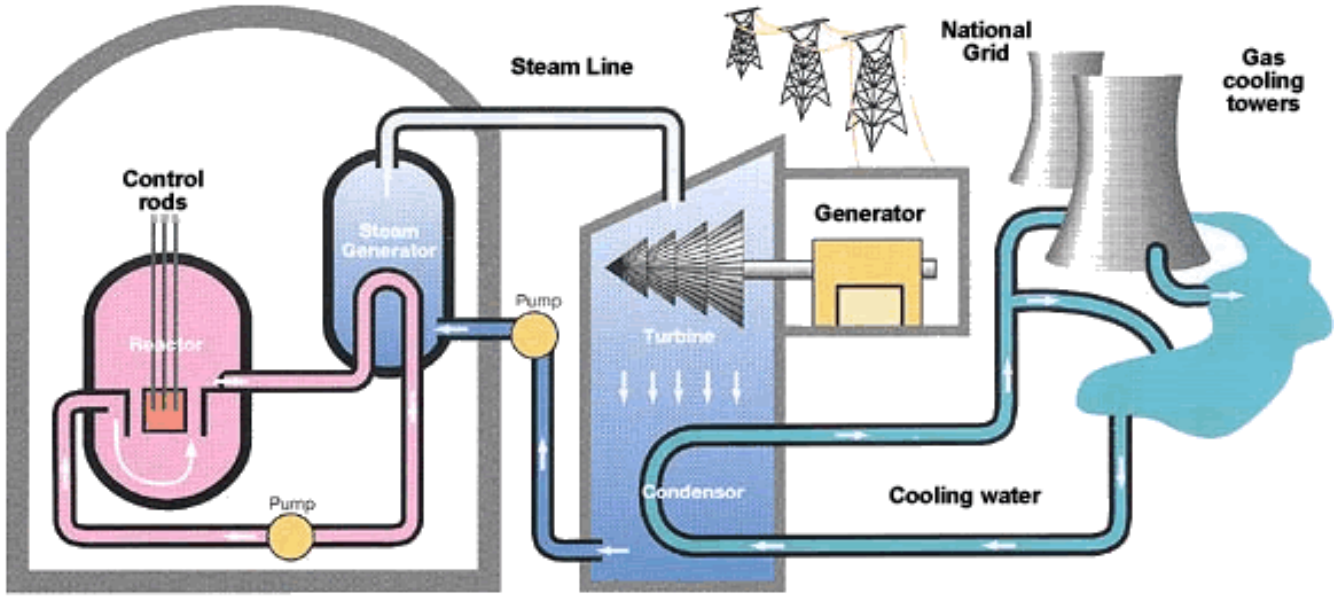
Energy Transformation and Efficiency

Energy Transformation and Efficiency



Nuclear Energy

stored in the nucleus of an atom and released as nuclei are split

→

Heat Energy

produced from the fission as kinetic energy of the fragments of the fission and the KE of free neutrons

→ used to heat water and produce steam that under pressure causes turbine blades to turn

Kinetic Energy

The turning of the turbine makes the coil of wire turn in a magnetic field

→

Electrical Energy

Produced by electromagnetic induction and then tranmitted to the National Grid to be transported around the country.

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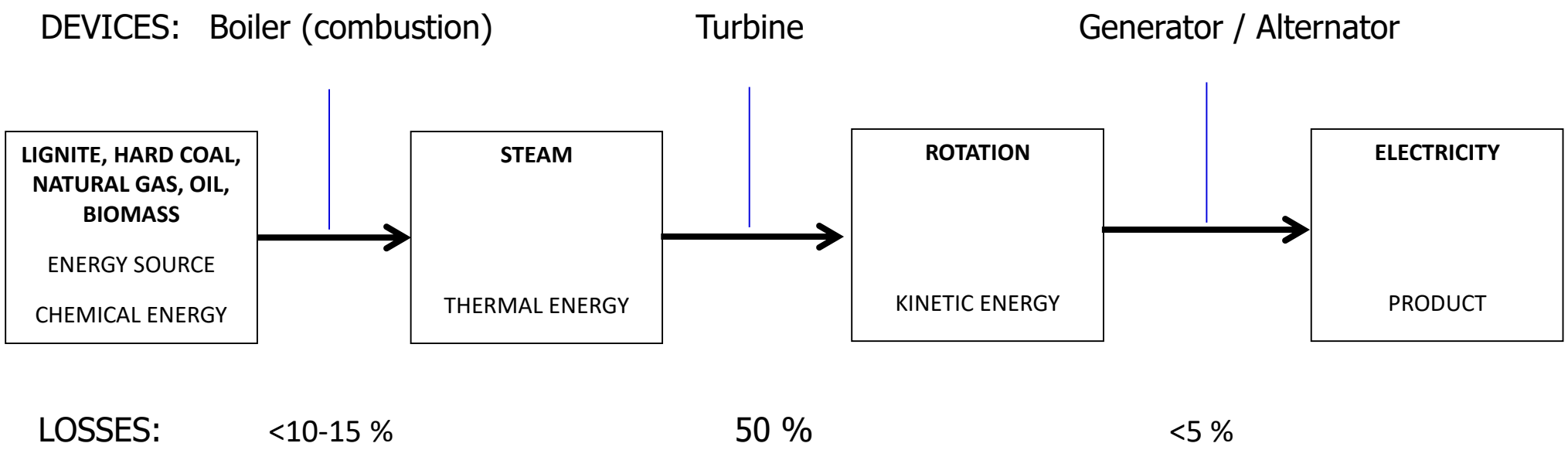
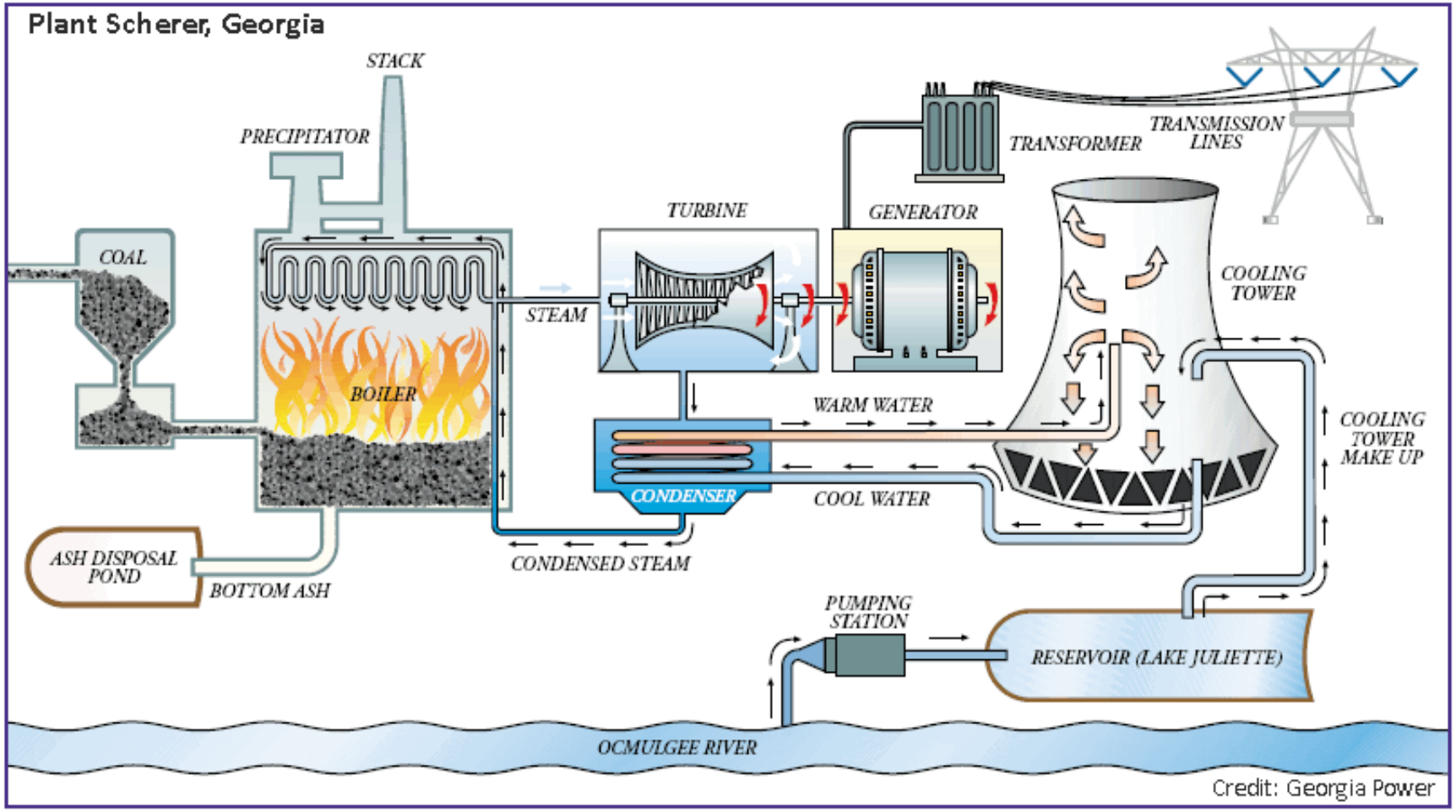
Energy Transformation and Efficiency



EFFICIENCY is the sum of effectivity of all energy transformation processes, in the picture above it is calculated as 100 x 0.85 x 0.5 x 0.95 = 40.375%

ELECTRICITY is an intermediate form of energy (carrier), we do not use electricity, but heat, light, mechanical energy = effectivity (losses) of downstream appliances also comes in play

Energy Transformation and Efficiency



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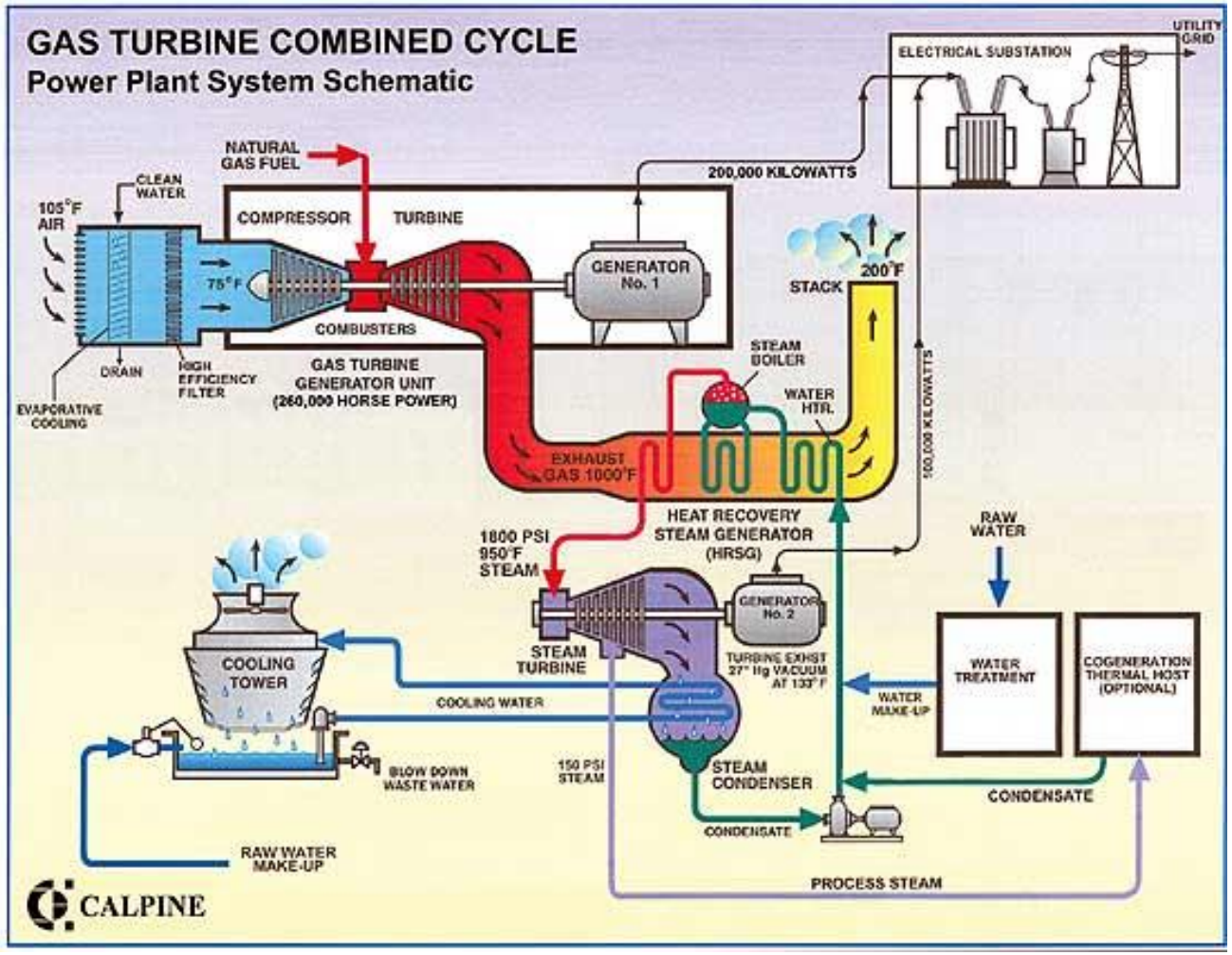
Energy Transformation and Efficiency



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Example

How much will I pay for 2 liters of tea, if I have a 1 l electric teapot (P = 1,500 We)? It takes 5 minutes to boil the water in the teapot and the electricity costs 4 CZK /1 kWh.

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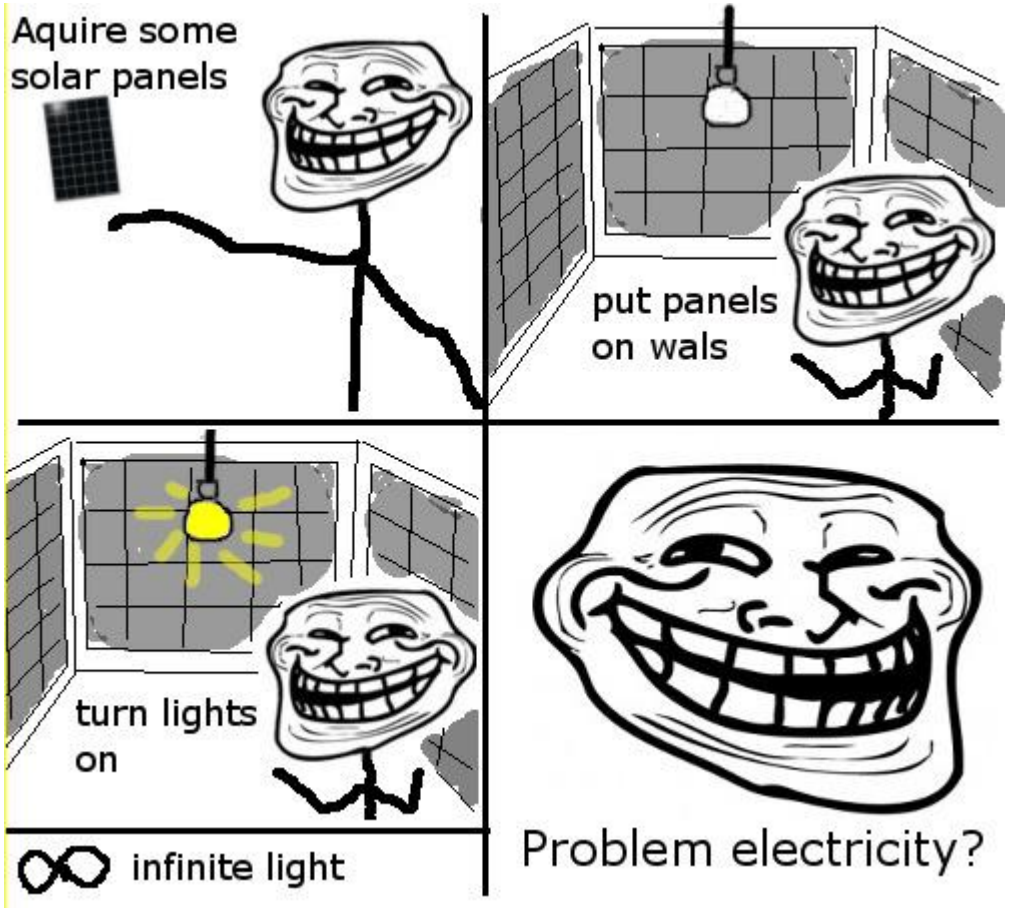
Example

How much will I pay for 2 liters of tea, if I have a 1 l electric teapot (P = 1,500 We)? It takes 5 minutes to boil the water in the teapot and the electricity costs 4 CZK /1 kWh.

The teapot is used twice for 5 minutes = 10 minutes =

= 1/6 * 1,500 We = 250 Wh = 0.25 kWh * 4 CZK = 1 CZK

Thank you for your attention.



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