



Energy Transfer & Conversion

Renewable Energy Integration in the Energy System

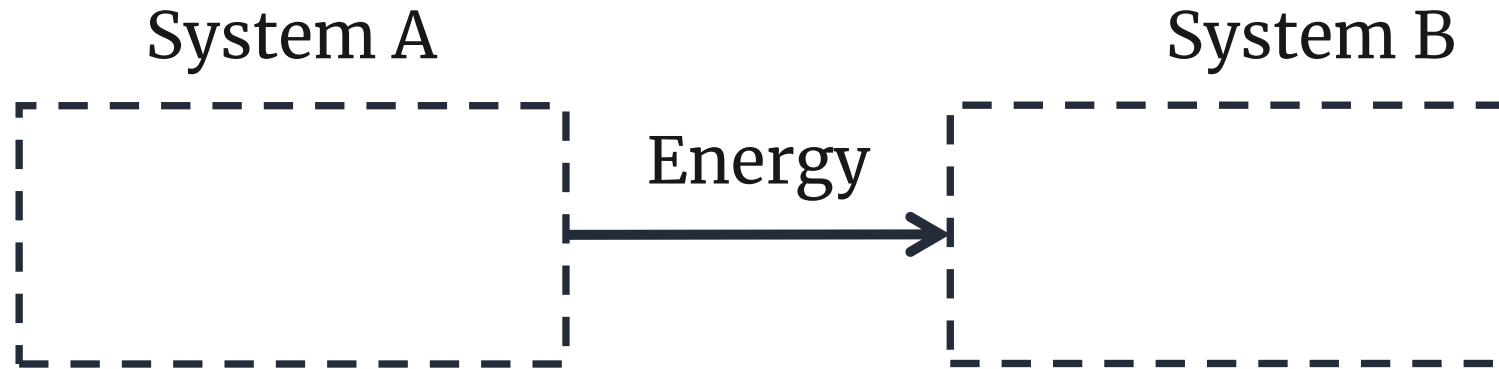
Tadeo-Baldiri Salcedo-Rahola & Ruben van Duren

Research Group Energy in Transition

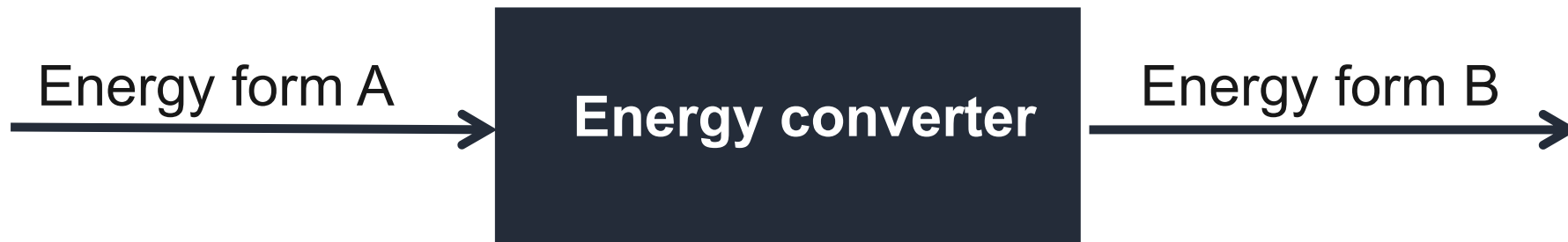
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UNIVERSITY OF
APPLIED SCIENCES

Recap

Energy Transfer



Energy Conversion



Energy sources

Geothermal
Energy

Tidal
Energy

Nuclear
energy

Solar
Energy

Biomass

Fossil fuels

Rain

Wind

Sun light

Air & earth
surface heat

Energy transfer and/or conversion

Energy delivery

Heat

Electricity

Electricity

Electricity

Motion

Heat

Electricity

Motion

Electricity

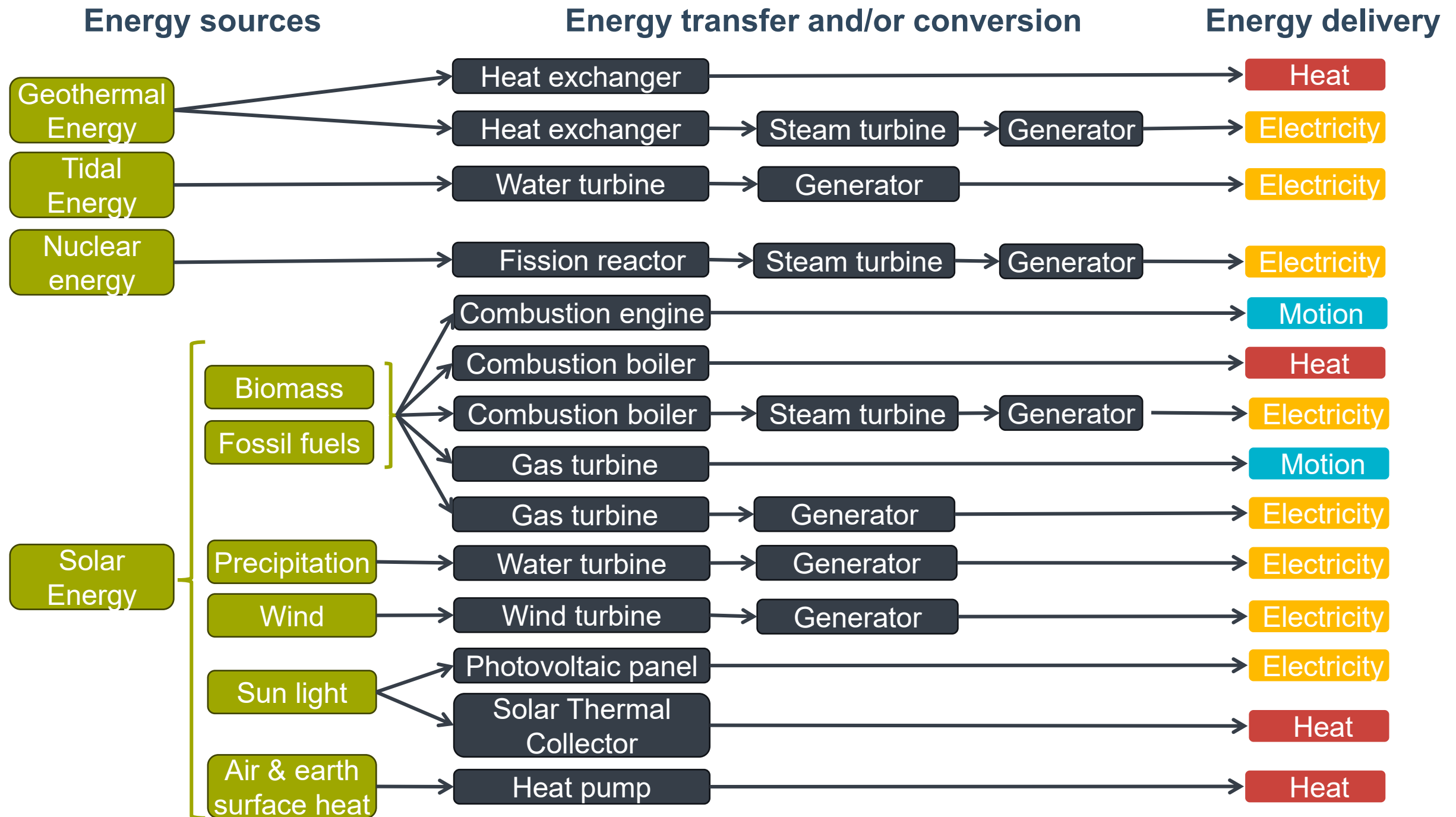
Electricity

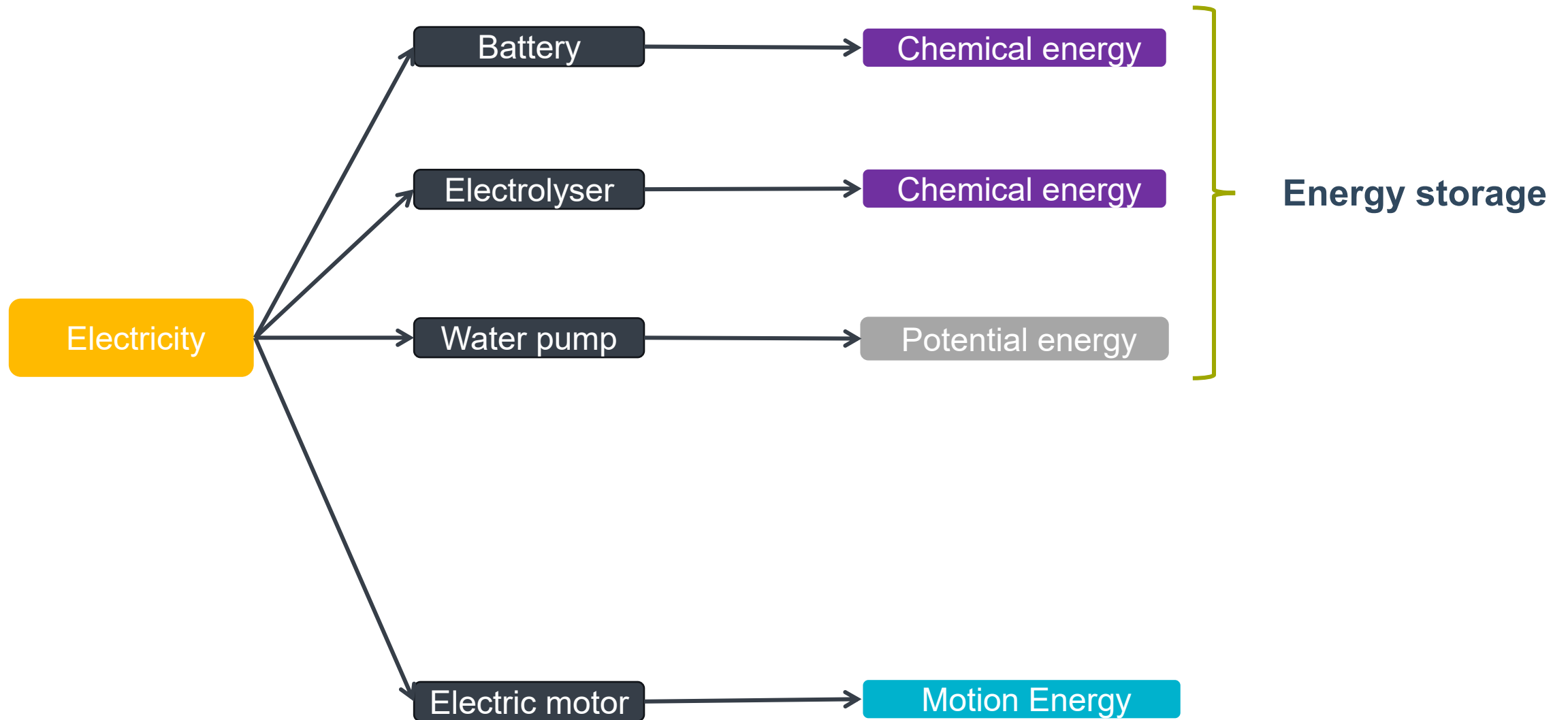
Electricity

Electricity

Heat

Heat



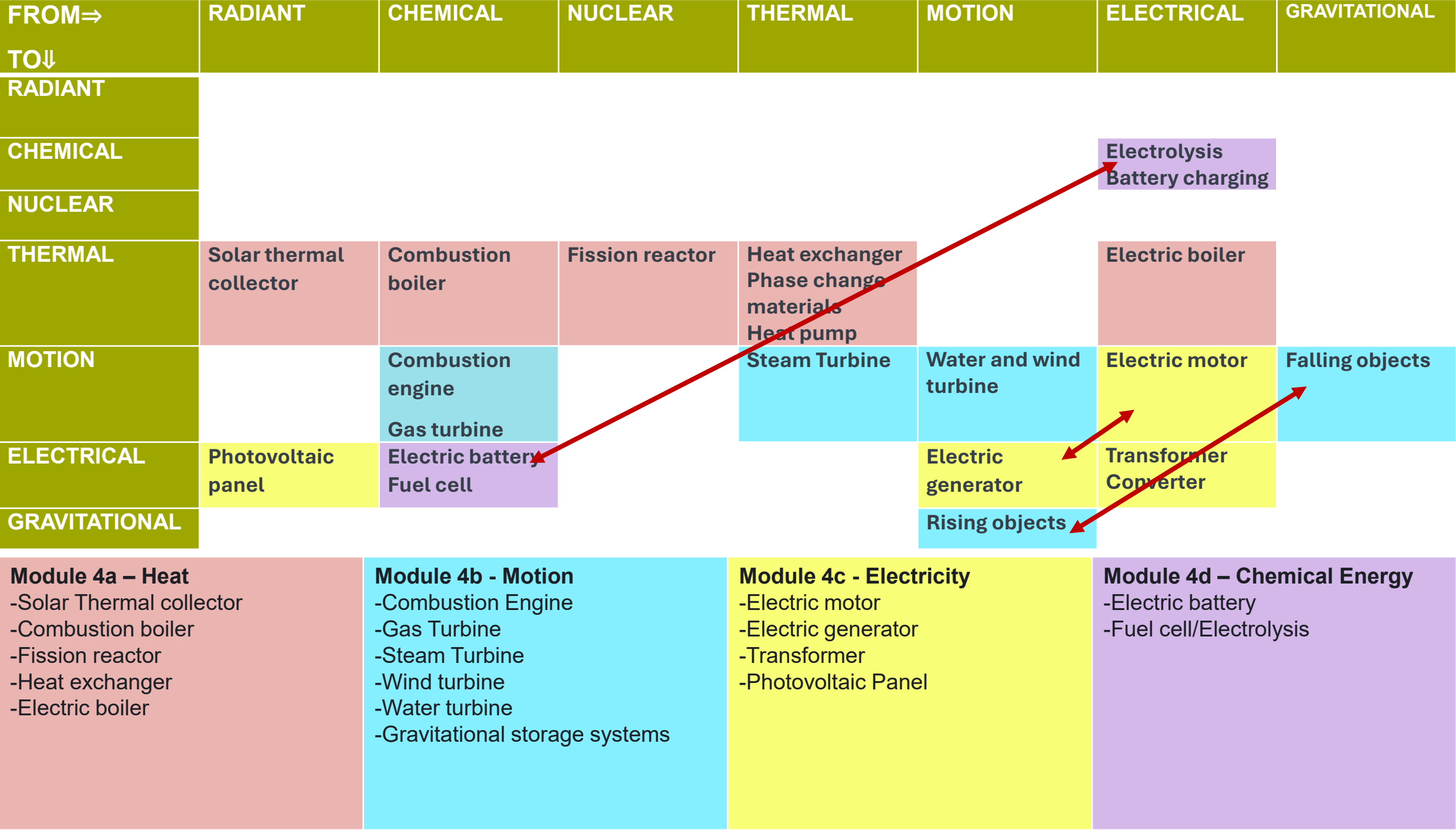


Energy transfer or conversion

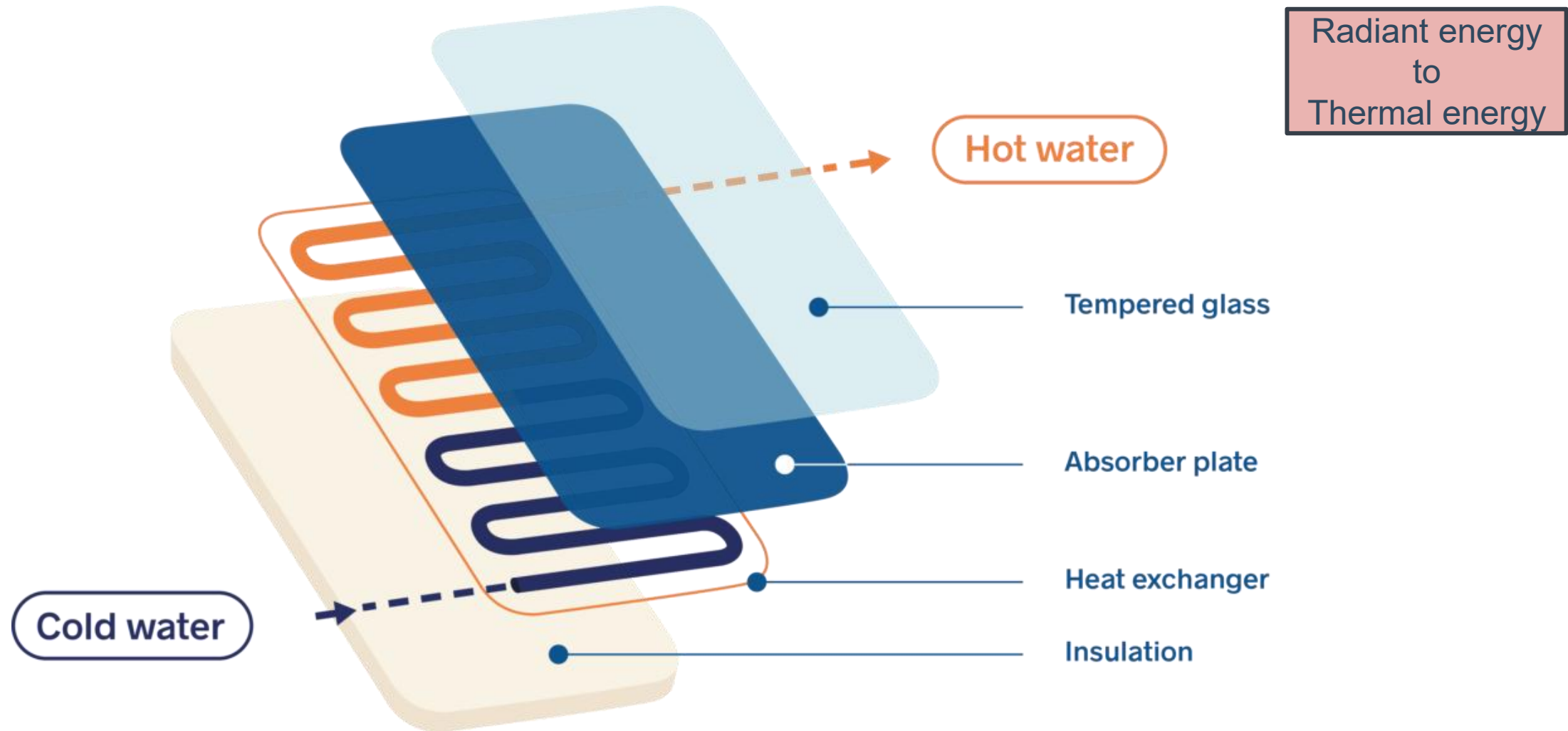
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RADIANT							
CHEMICAL						Electrolysis Battery charging	
NUCLEAR							
THERMAL	Solar thermal collector	Combustion boiler	Fission reactor	Heat exchanger Phase change materials Heat pump		Electric boiler	
MOTION		Combustion engine Gas turbine		Steam Turbine	Water and wind turbine	Electric motor	Falling objects
ELECTRICAL	Photovoltaic panel	Electric battery Fuel cell			Electric generator	Transformer Converter	
GRAVITATIONAL					Rising objects		

Energy transfer or conversion

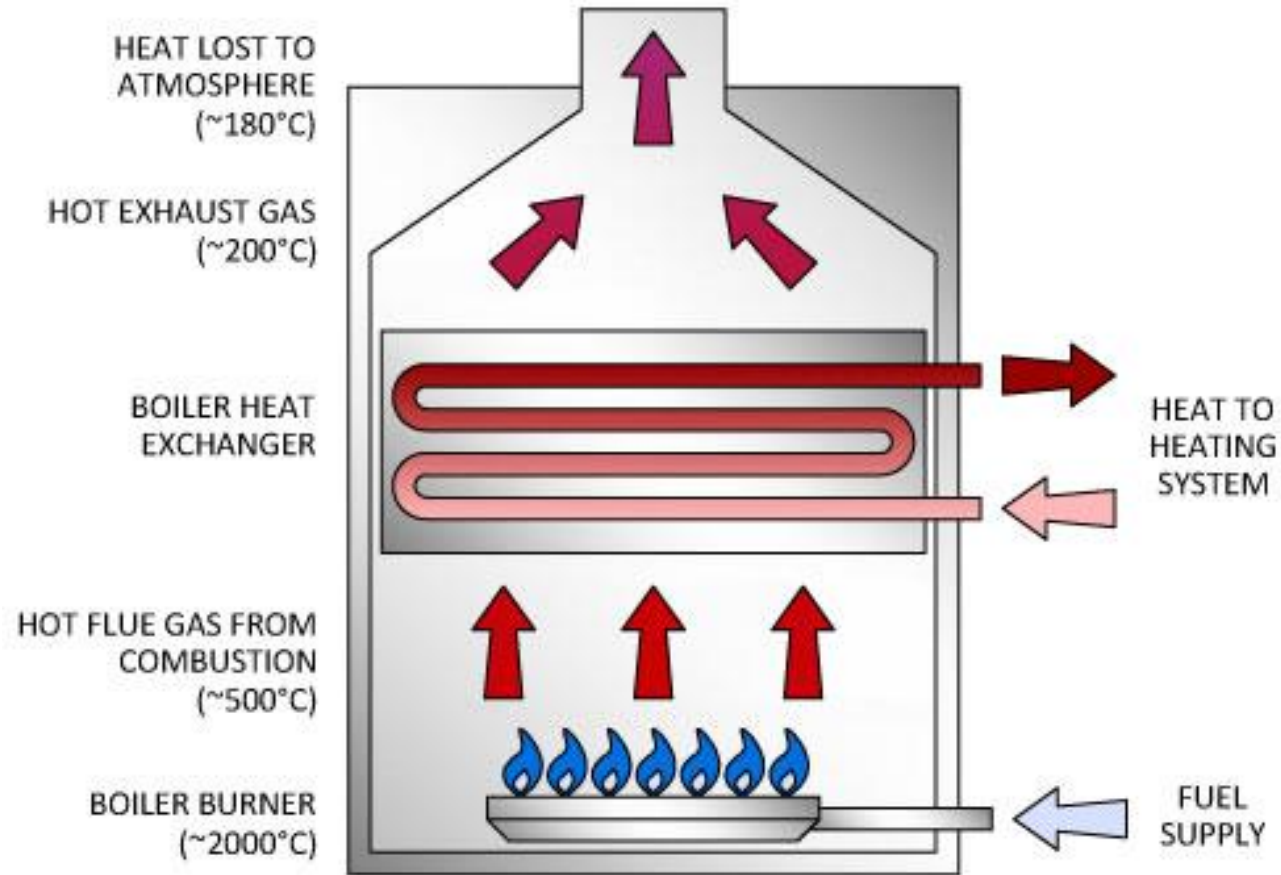
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GRAVITATIONAL					Rising objects		



Solar thermal collector

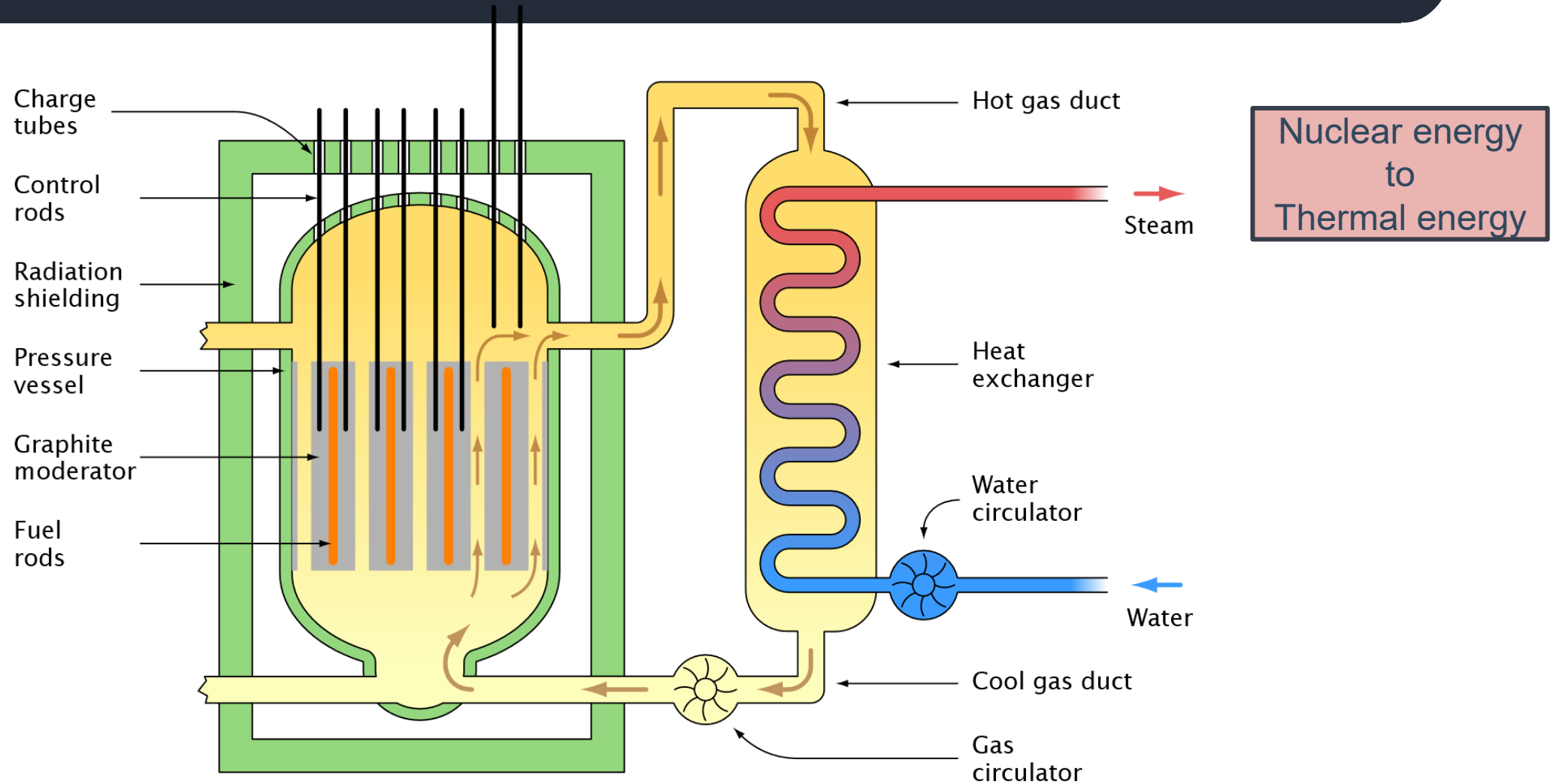


Combustion boiler

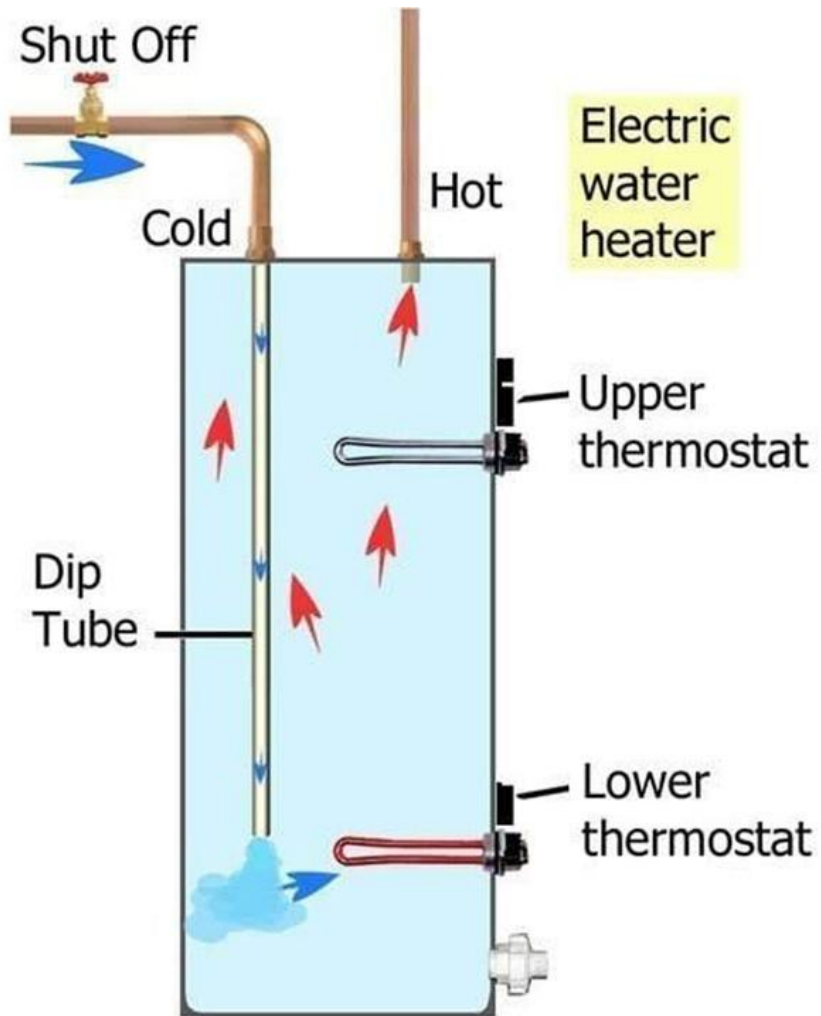


Chemical energy
to
Thermal energy

Fission reactor



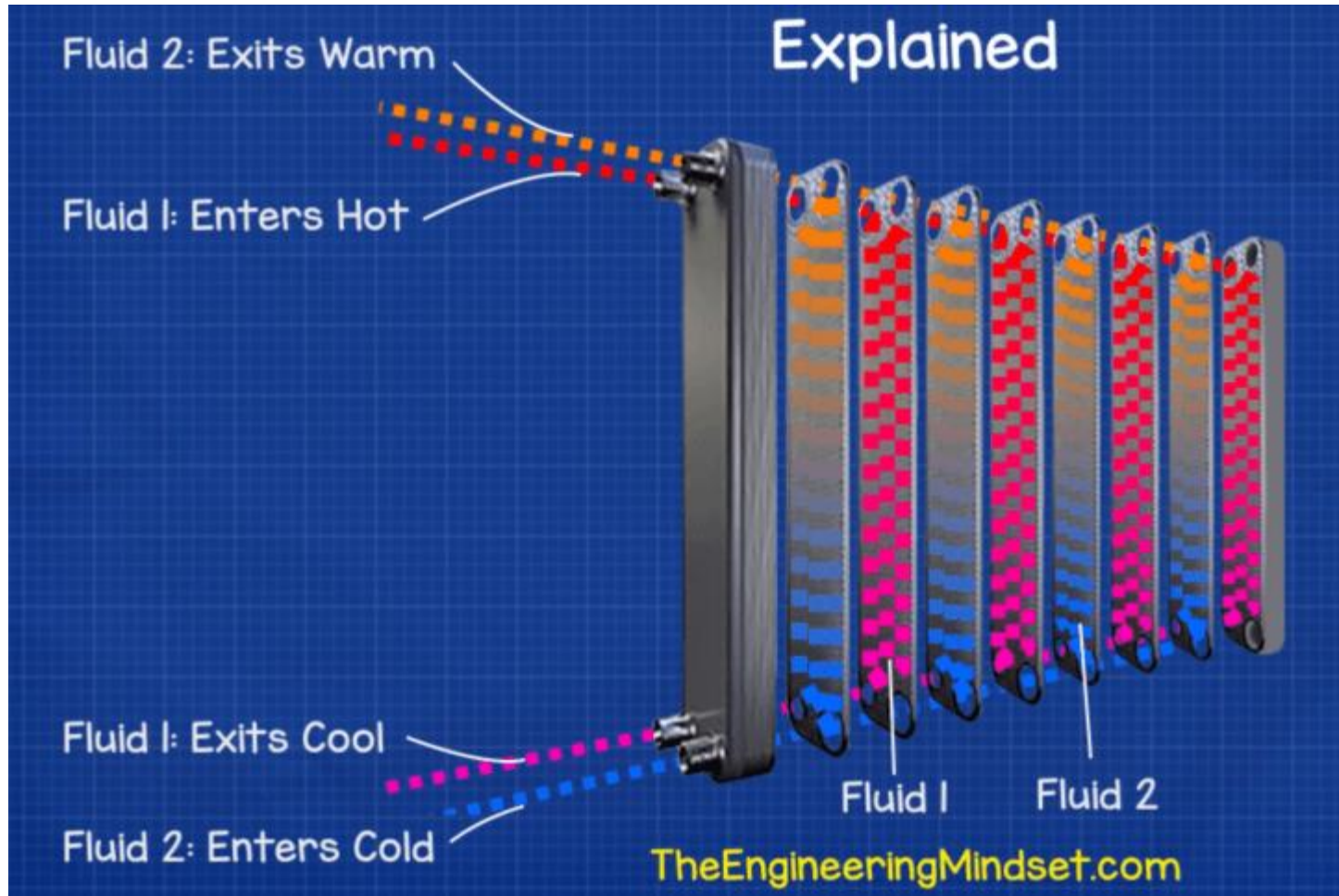
Electric boiler



Electrical energy
to
Thermal energy



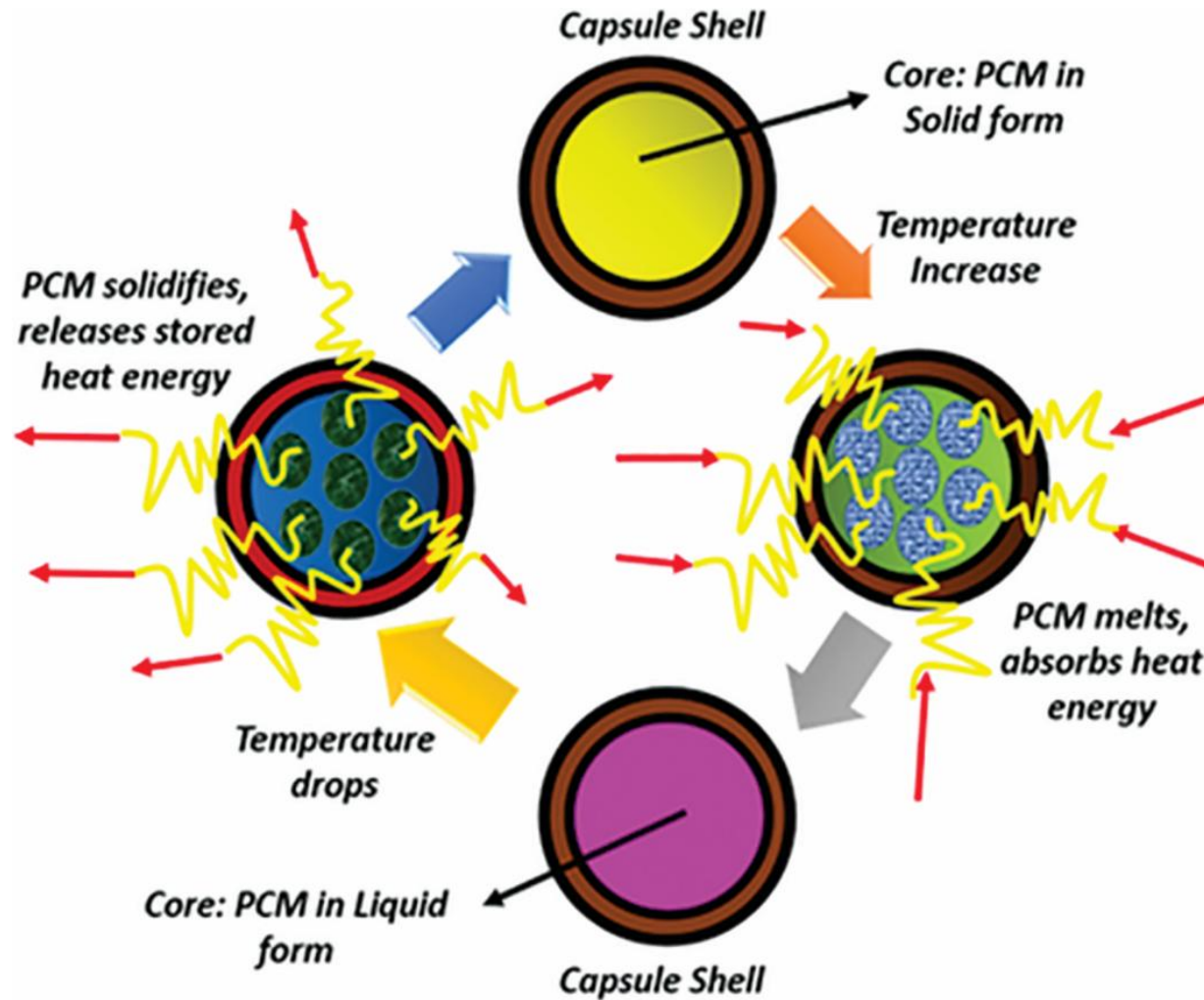
Heat exchanger



Thermal energy transfer



Phase change materials

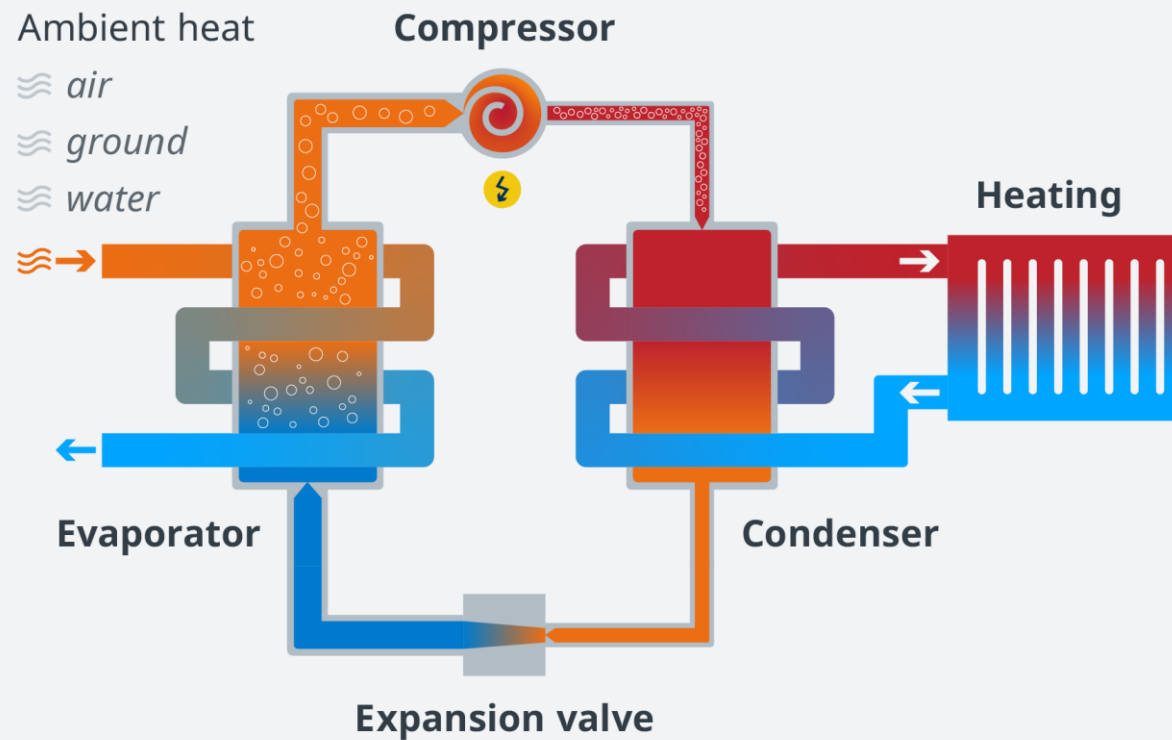


Chemical energy
to
Thermal energy

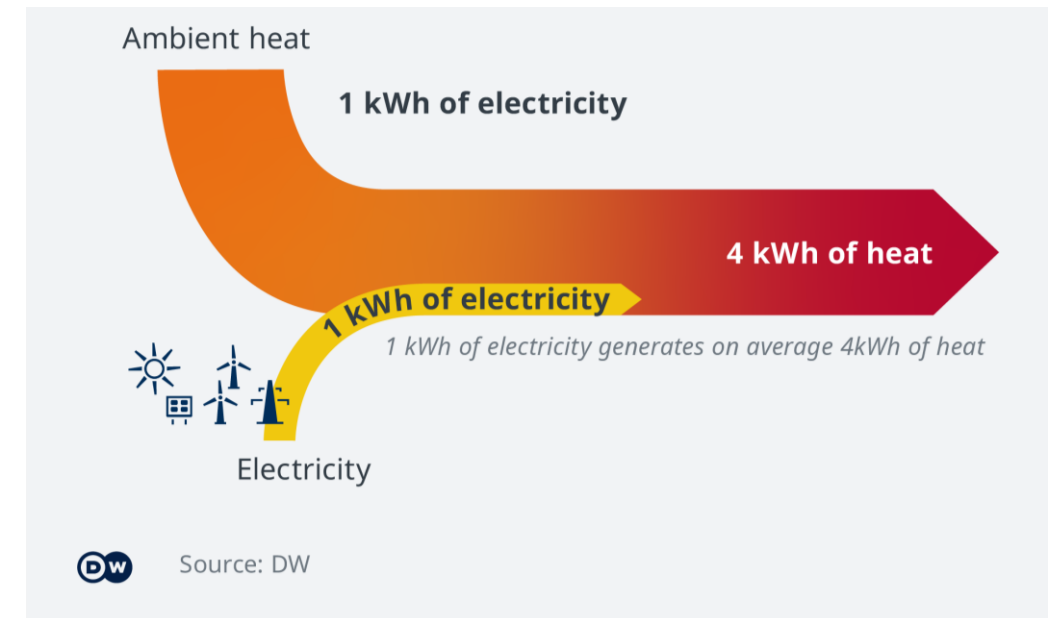
Thermal energy
to
Chemical energy

Heat pump

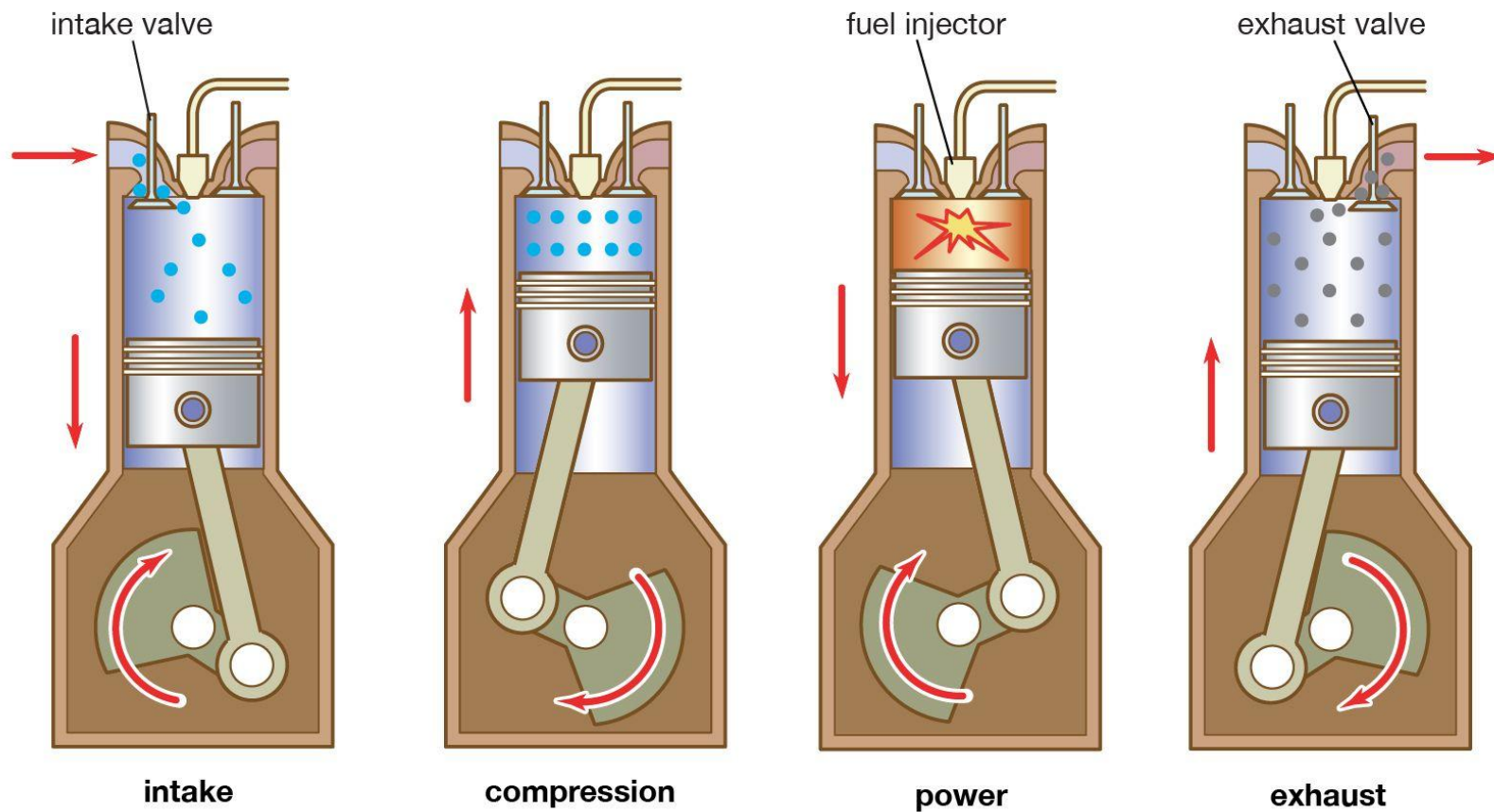
How do heat pumps work?



Thermal energy transfer



Combustion engine

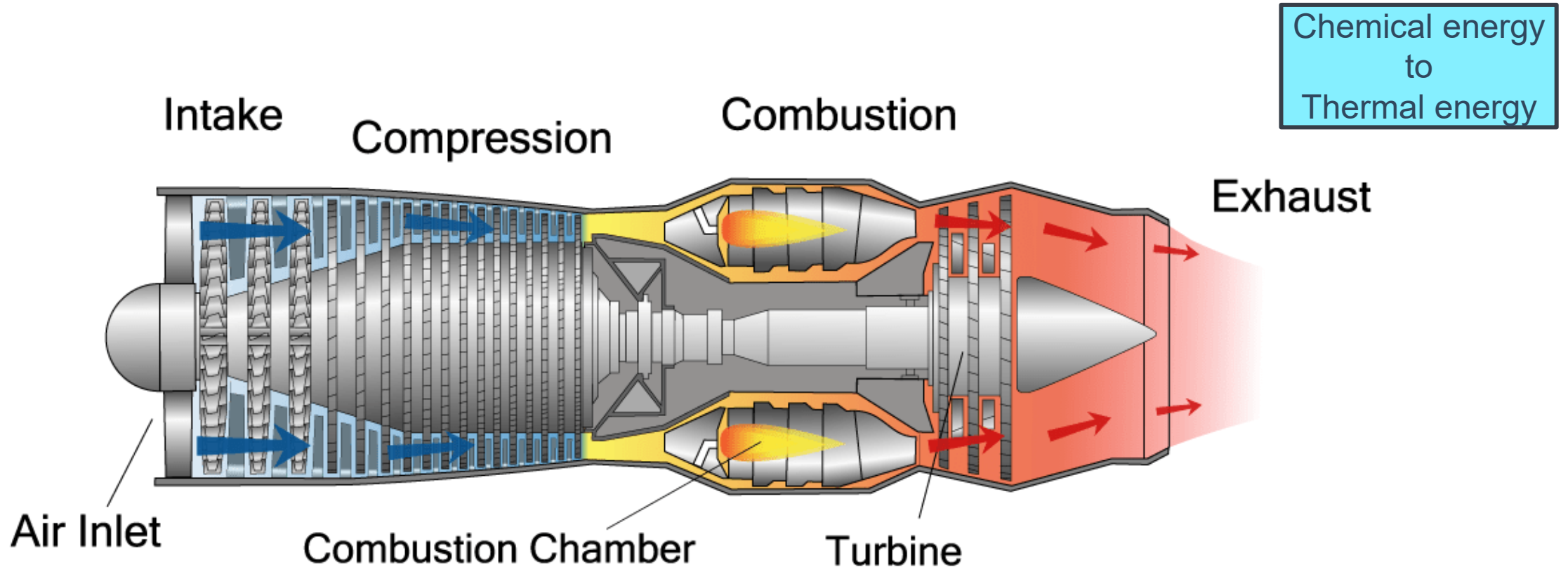


Chemical energy
to
Thermal energy

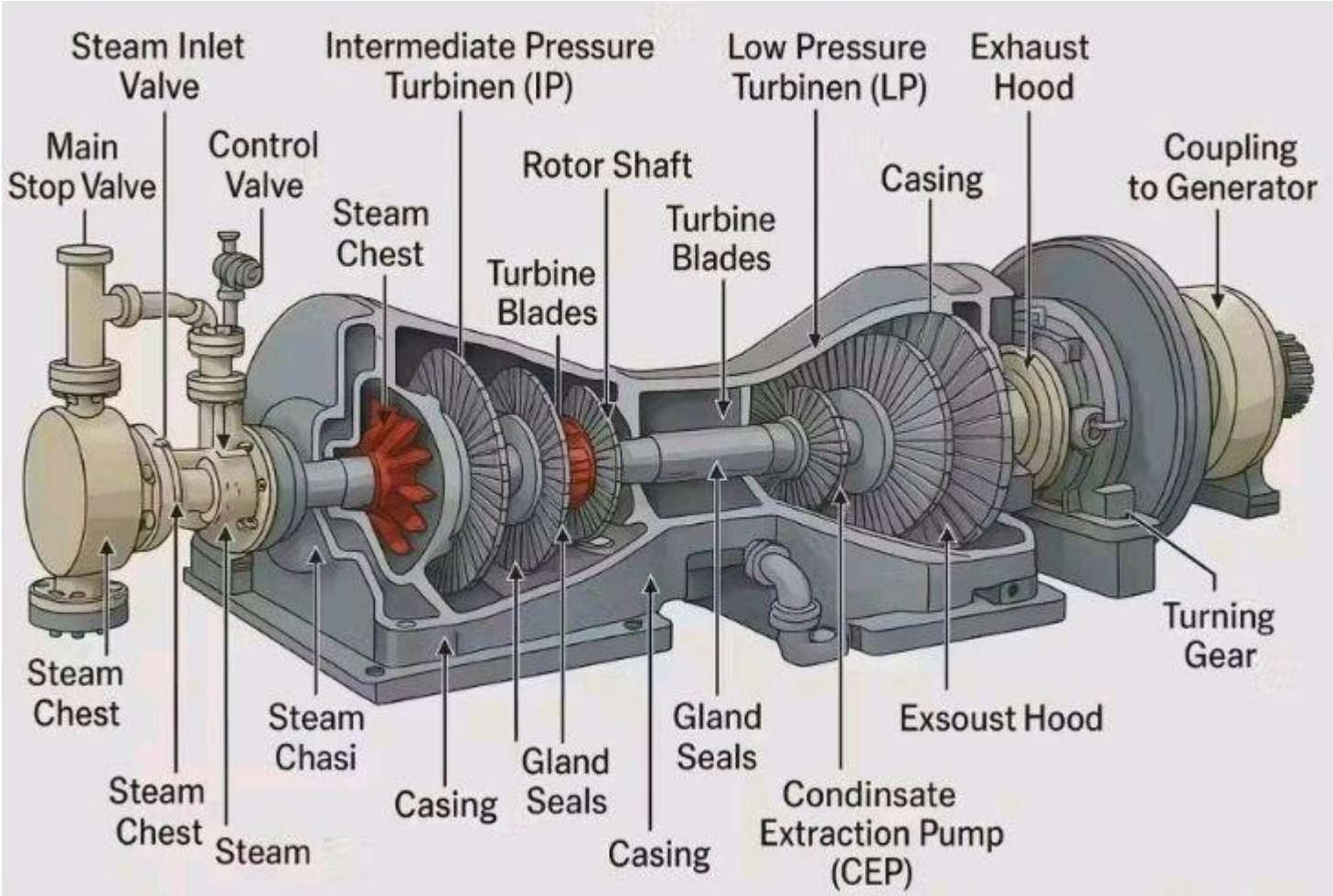
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Gas turbine



Steam turbine



Thermal energy
to
Motion energy

Water and wind turbine

Motion energy transfer



Francis Turbine



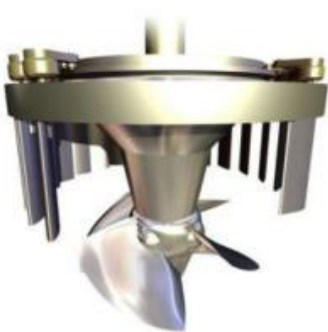
Fixed Pitch Propeller



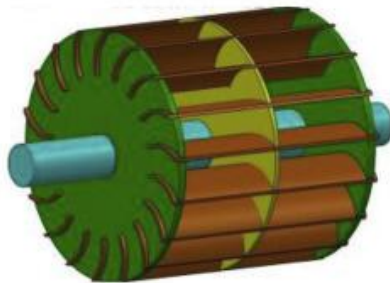
Turgo



Pelton



Kaplan

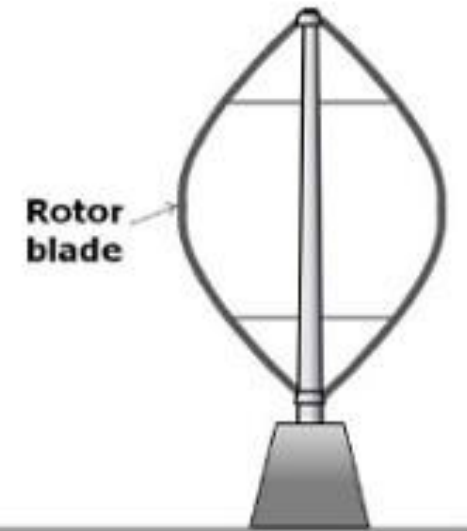


Crossflow

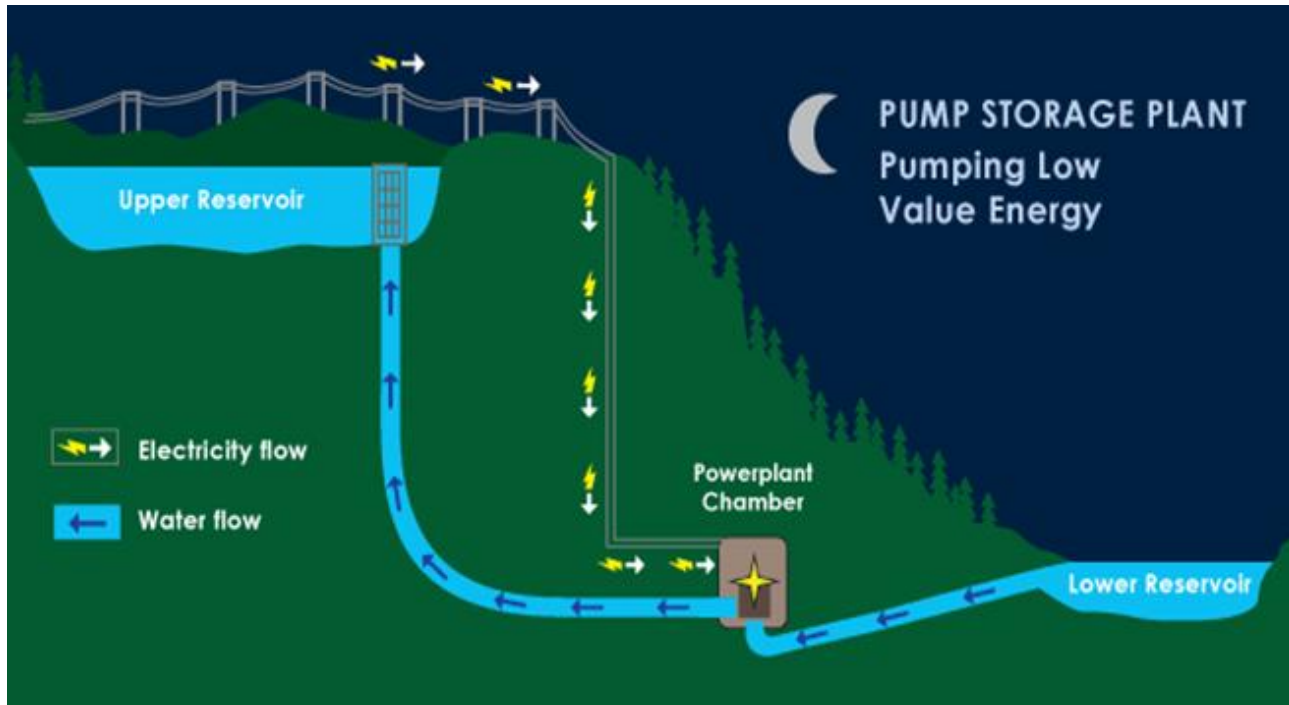
Horizontal Axis Wind Turbine (HAWT)



Vertical Axis Wind Turbine (VAWT)
Darrieus Type



Rising/falling objects

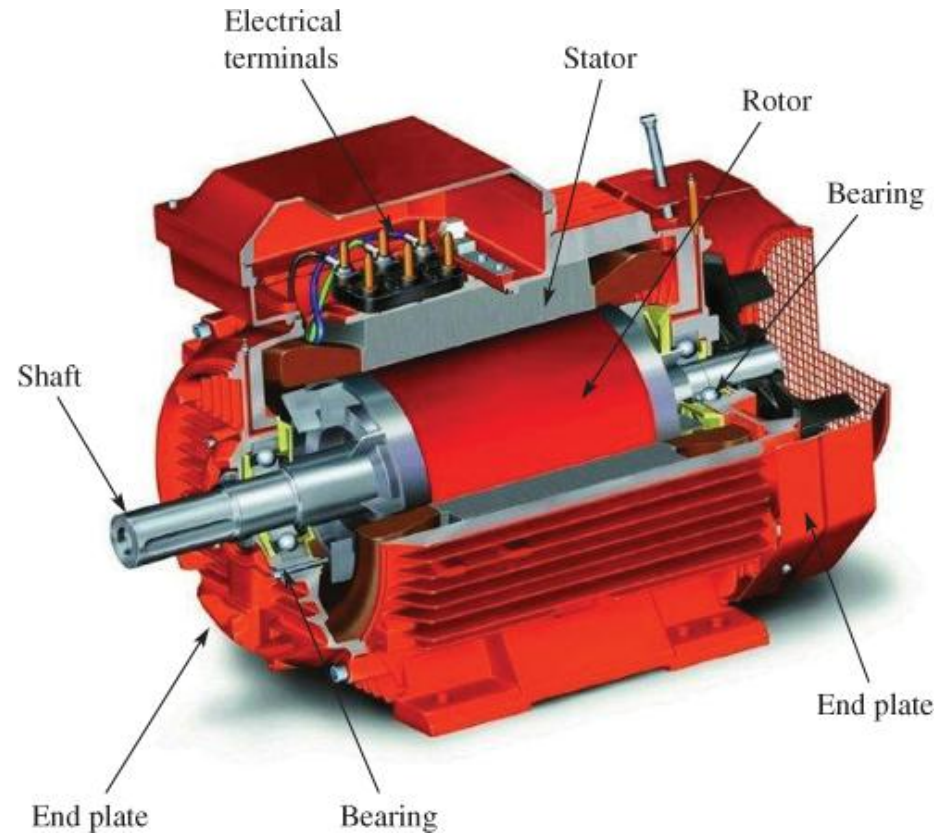


Motion energy
to
Potential energy

Gravitational energy
to
Motion energy



Electric motor/generator



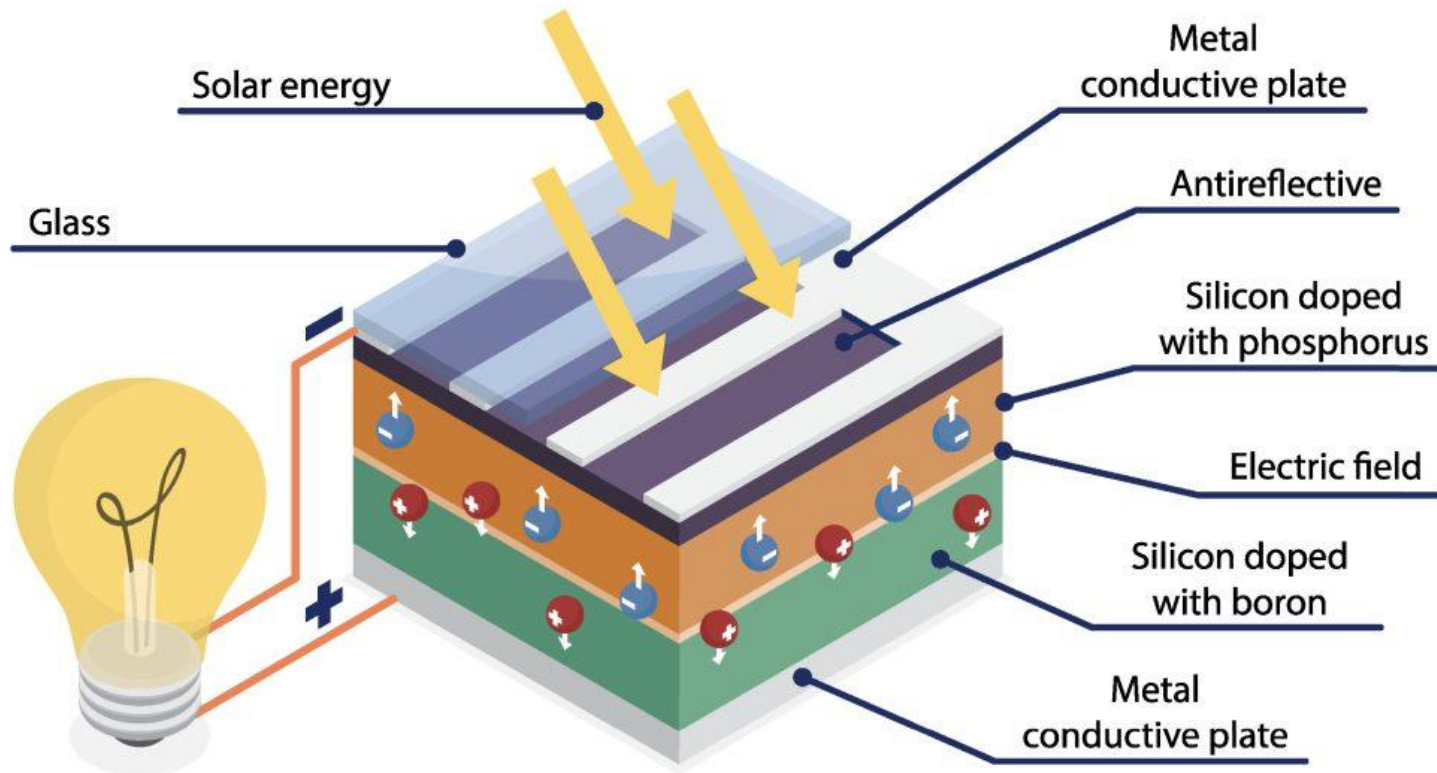
Motion energy
to
Electrical energy

Electrical energy
to
Motion energy

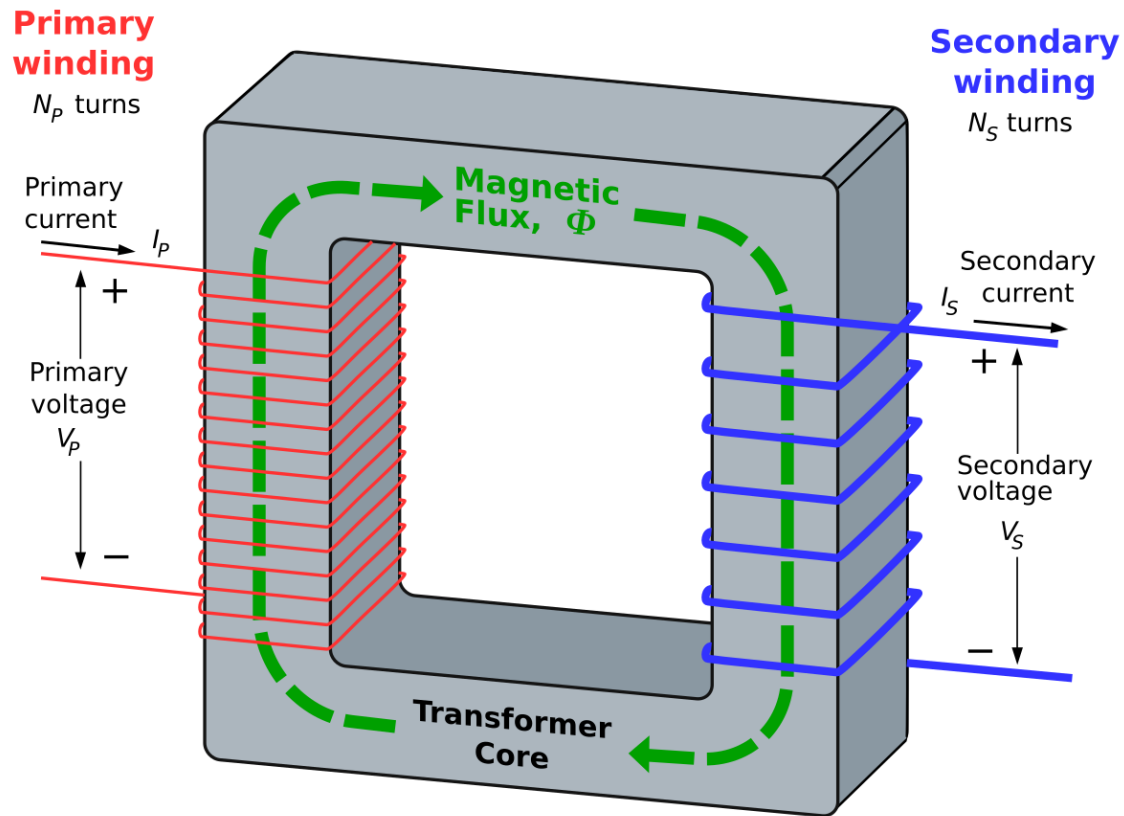
Photovoltaic panel

PHOTOVOLTAIC EFFECT

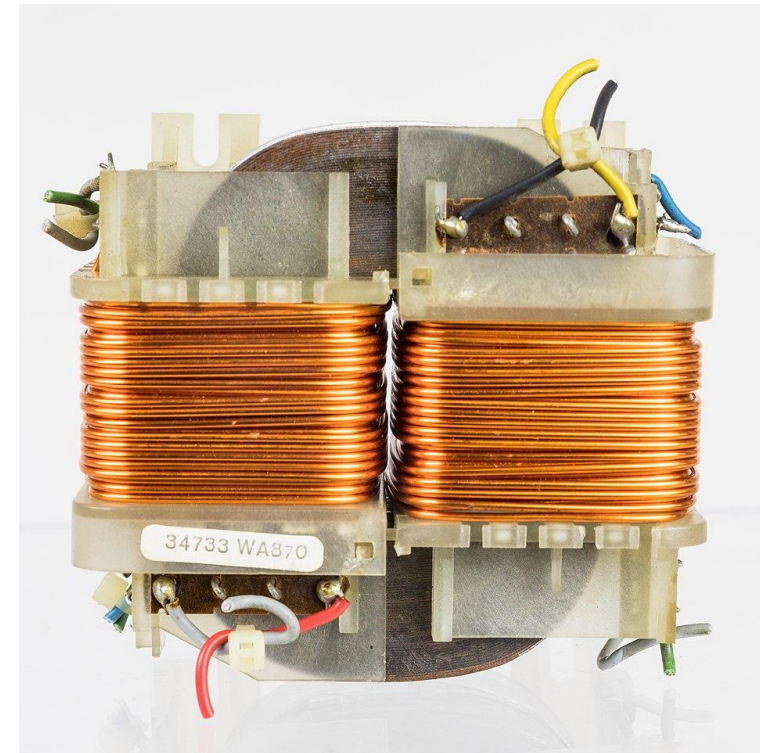
Radiant energy
to
Electrical energy



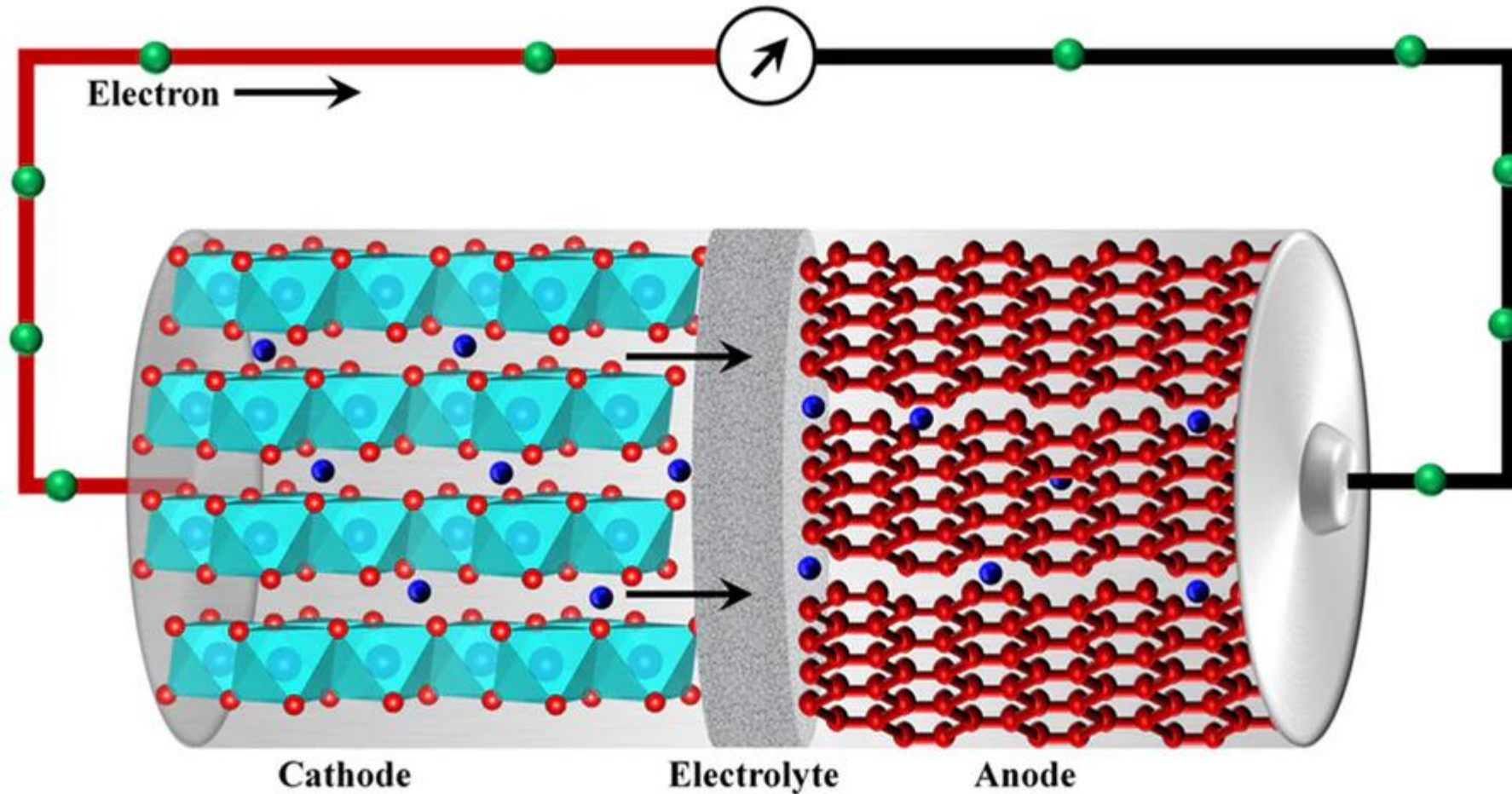
Electricity transformer



Electrical energy transfer



Electric battery

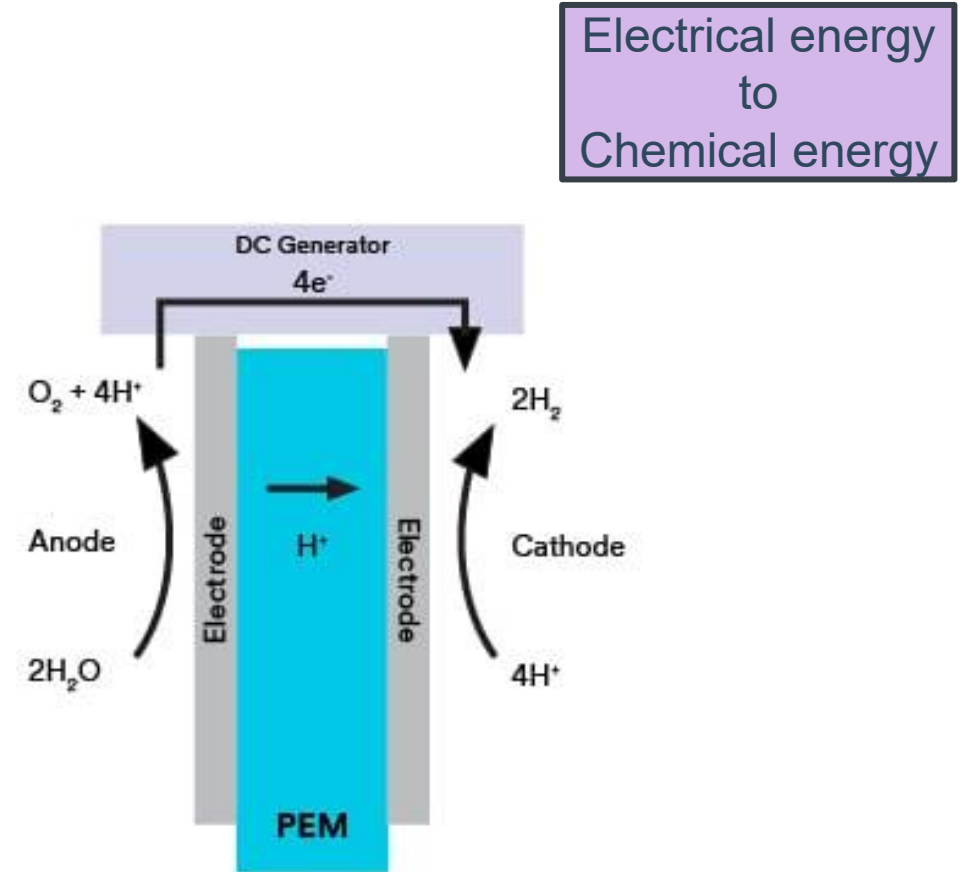
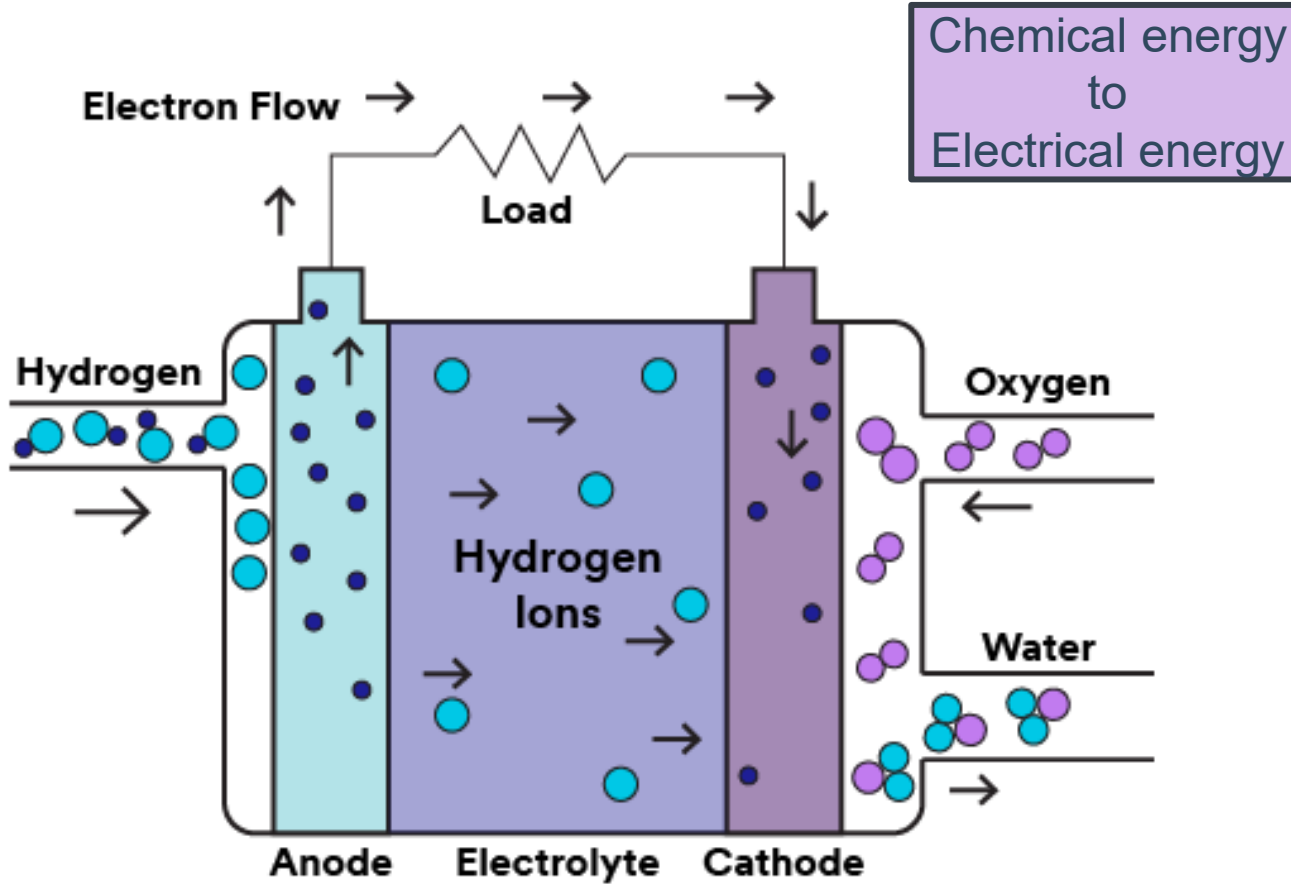


Chemical energy
to
Electrical energy

In case it is
rechargeable also

Electrical energy
to
Chemical energy

Fuel cell / Electrolyser



Content references

[What is energy?](#) BBC bitsize

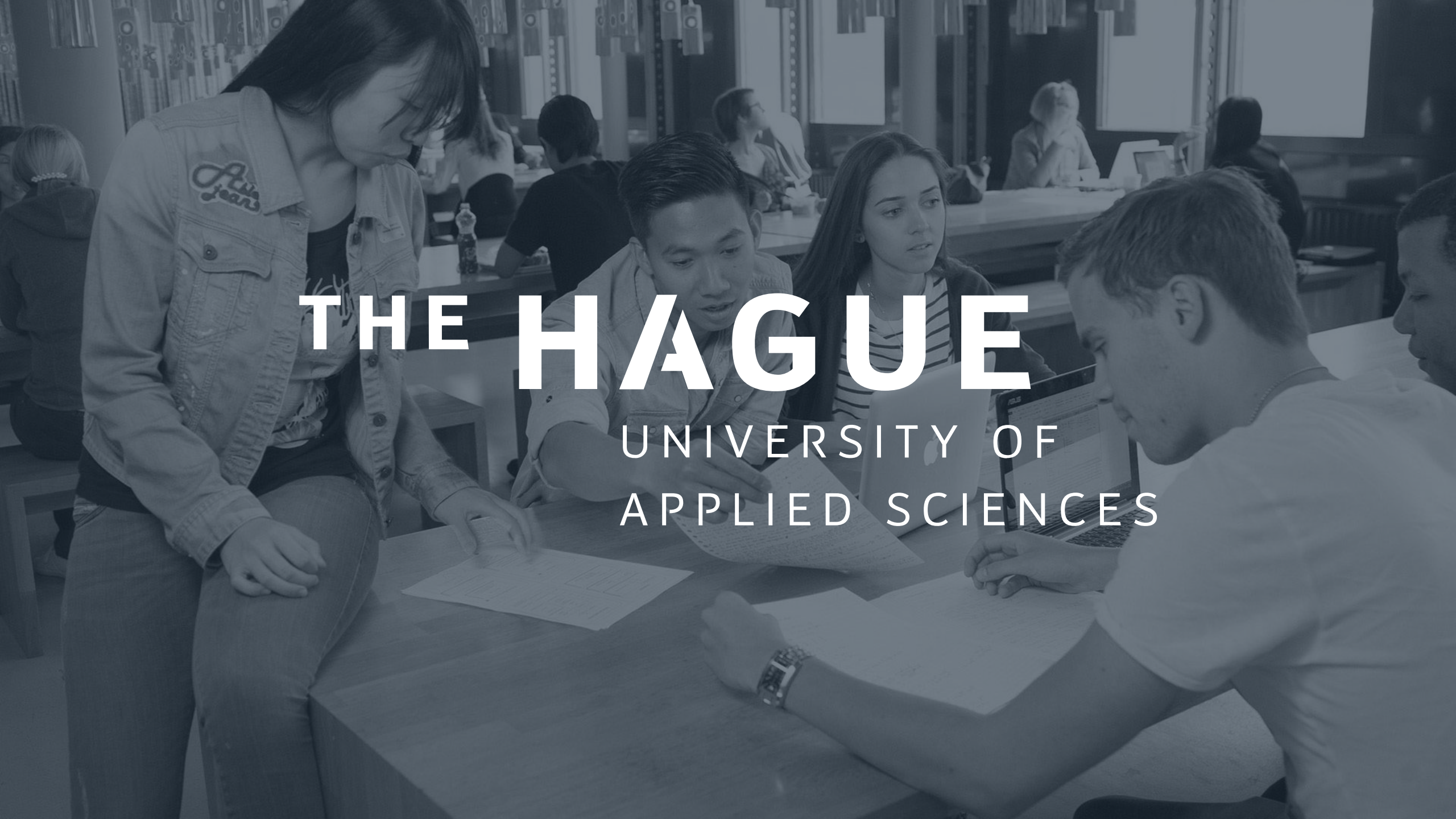
Books

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Ouwehand, J., Trynke, P., Post, E., Taal, A. (2012) Toegespaste Energietechniek, Sdu, Den Haag.

Ouwehand, J., Trynke, P., Gilijamse, W., Geus, J. de (2017) Duurzame energietechniek, Boom, Amsterdam.

A grayscale photograph of a modern classroom or study hall. In the foreground, a group of four students are gathered around a table, looking at papers and a laptop. A young woman on the left is leaning over the table, pointing at a document. Next to her, a young man is also looking at the papers. Behind him, another young woman is looking towards the right. In the foreground on the right, a young man is sitting at the table, looking at a laptop. The background shows other students sitting at long tables, some working on laptops. The room has large windows and a bright, airy feel.

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