



A new energy culture

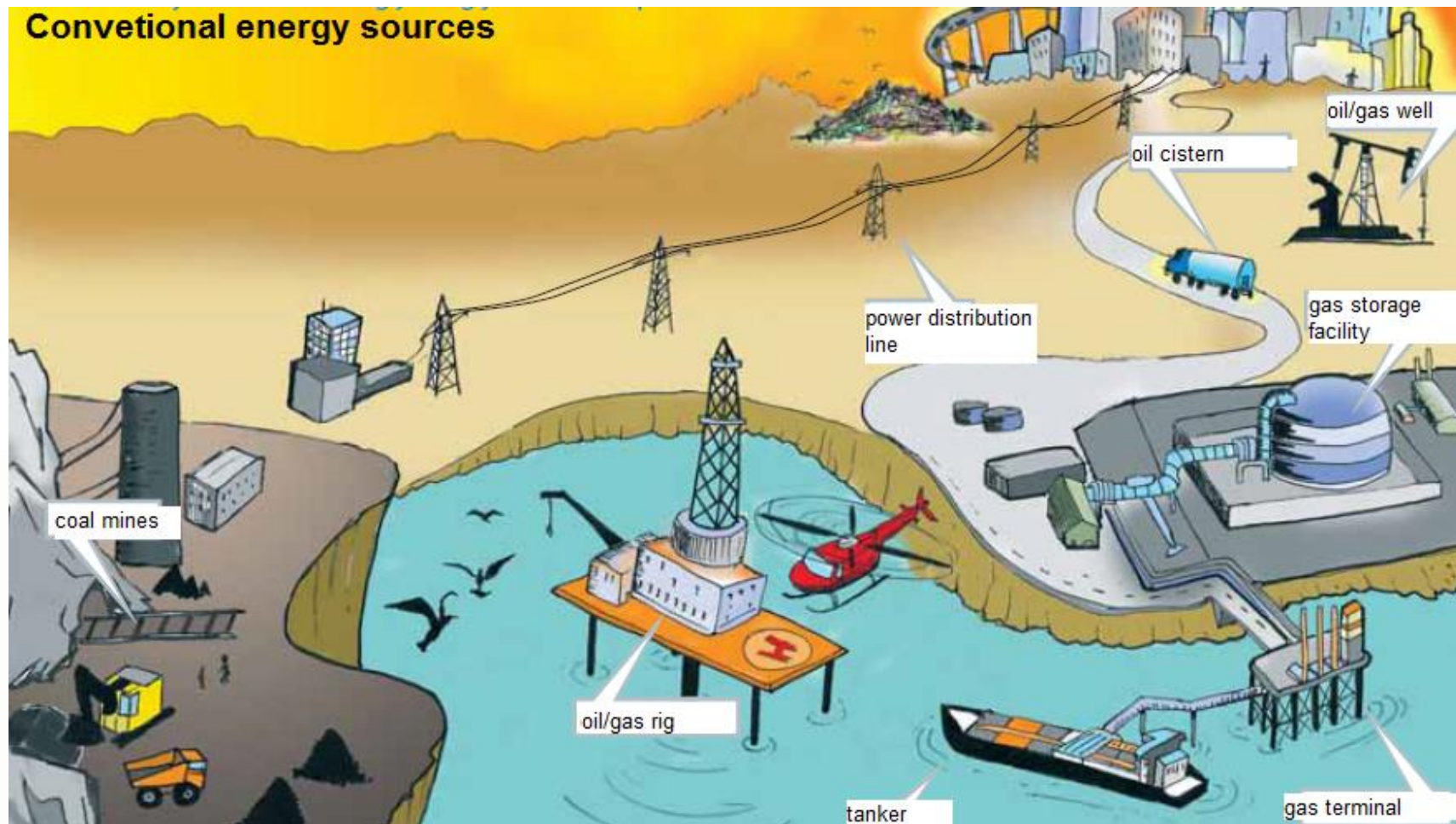
sustainability and territories



Renewable sources of energy

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Conventional energy sources



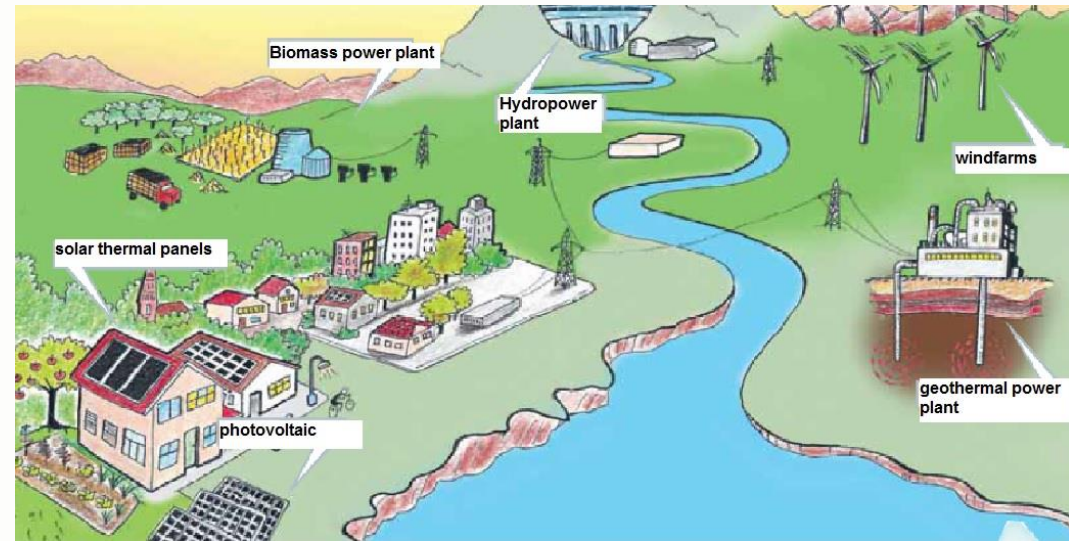
- Kyoto protocol
- First period: from 2008 till 2012 – carbon dioxide (CO₂) emission reduction by 5%
- Croatia fulfilled this demand
- Second period: from 2013 till 2020 – carbon dioxide emission reduction by 20%
- Use of renewable energy sources increase by 20%

Types of renewable energy sources

- Definition: it is naturally occurring and inexhaustible source of energy
- ***Solar energy***
- Most cleanest and abundant source available

- Photovoltaic

- Solar thermal



Pros	Cons
Once the panels are bought , using of solar energy is free	No Sun during the night
Solar panels do not emit greenhouse gases are there is almost no noise while operating	It can be used during cloudy days, but their efficiency is much smaller
Energy is produced at the designated spot – very little expenses concerning cables and wires	Solar panels are still expensive, even though the price is slowly, but steadily decreasing

- ***Wind energy***
- Wind turbines
- wind – form of solar energy – uneven heating of the atmosphere by the Sun, the irregularities of the Earth’s surface and the rotation of the Earth
- Wind flow patterns and speed vary greatly around world
- Wind turbines convert kinetic energy in the wind into mechanical power, which is transformed into electricity



Horizontal axis; three blades

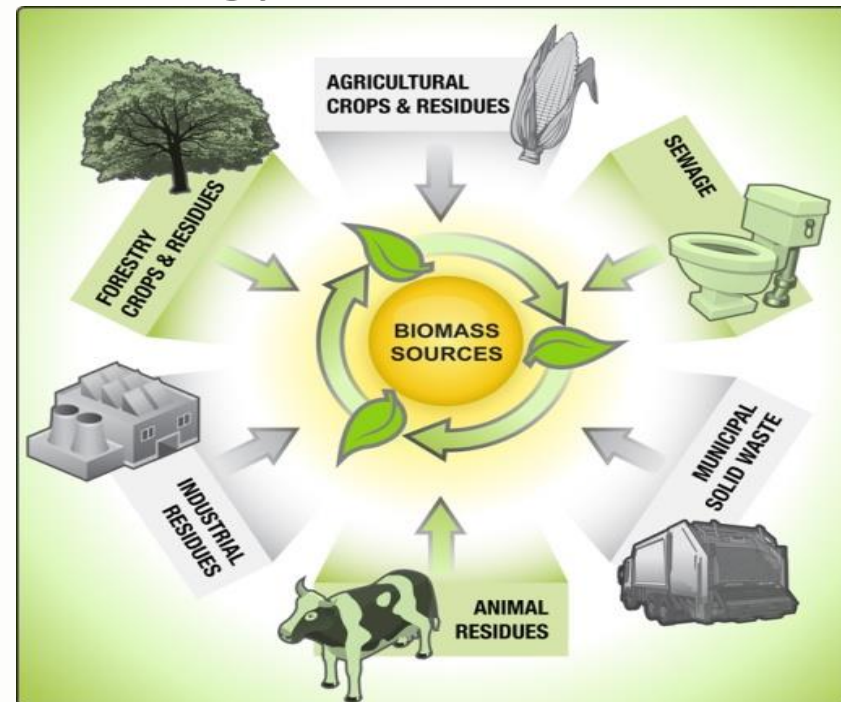


Vertical axes; the eggbeater (Darrieus model)



Offshore windfarm; London Array

- ***Biomass energy***
- The oldest source of renewable energy
- Biomass - organic matter that has stored energy through photosynthesis
- Biopower (heat) and biofuels

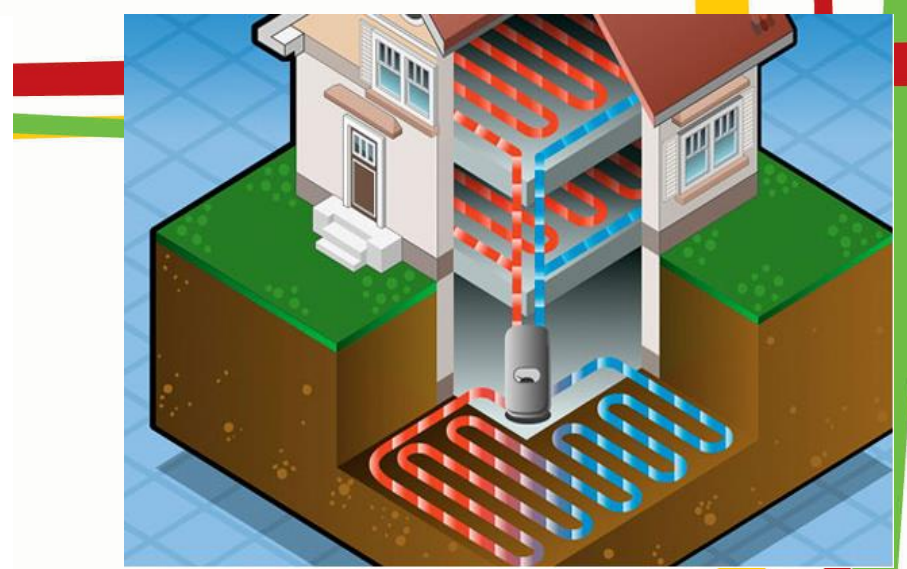
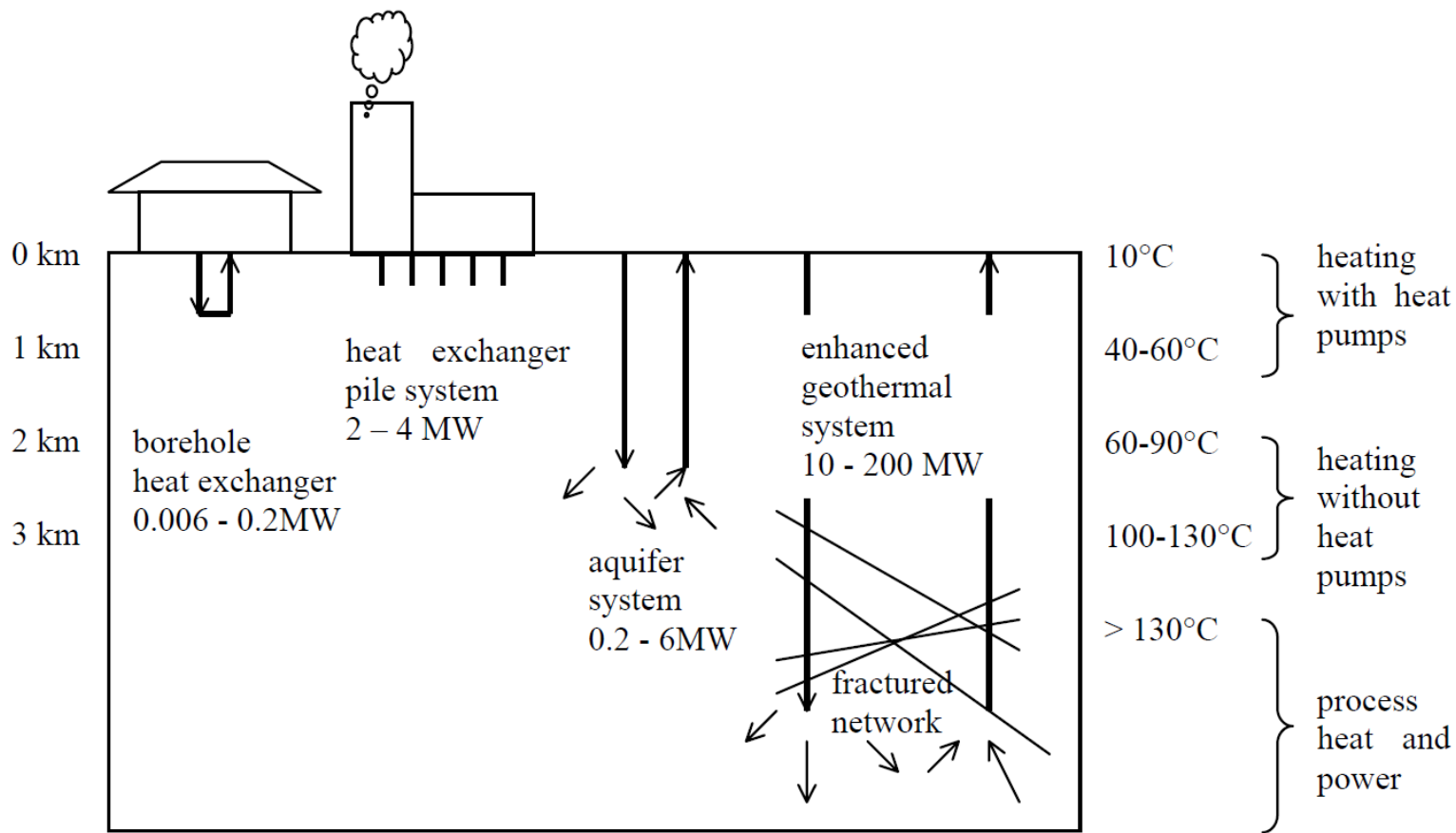


- Problems:
- biomass can be harvested at unsustainable rates
- damage the ecosystems
- produce harmful air pollution
- consume large amounts of water
- produce greenhouse gas emissions

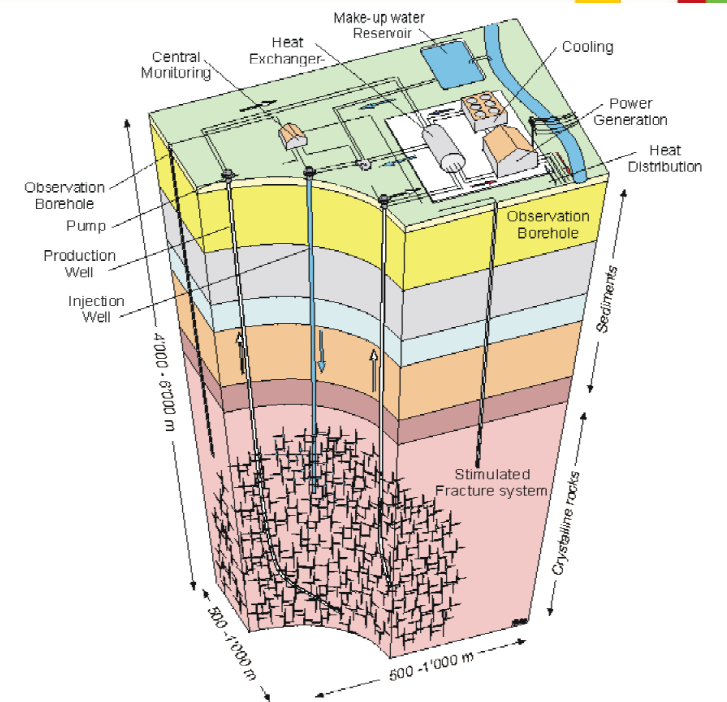


- ***Geothermal energy***

- Thermal energy contained in the rock and fluid that fills fractures and pores of Earth's crust
- Radioactive decay of materials within the Earth
- safe for the environment
- it does not emit greenhouse gases, no radioactive waste
- reduces use of fossil fuels
- compared to hydro plants, they use very small space visible on the surface
- do not depend on weather changes, unlike wind farms
- they can operate 24/7, unlike solar energy
- Problems: not available all over the world (thin Earth's crust, hot spots, near boundaries of tectonic plates)

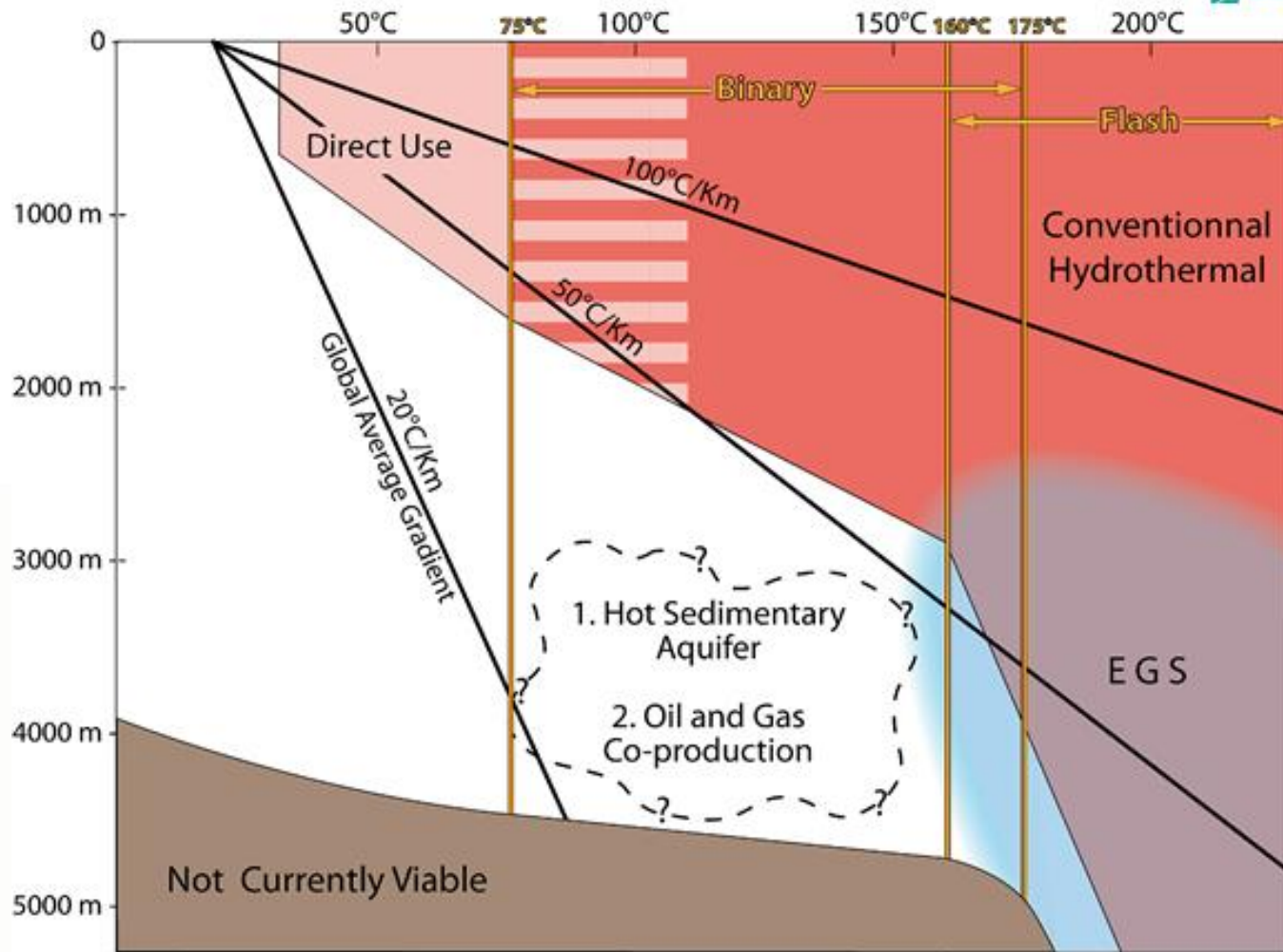


Heat pump system



Enhanced geothermal system

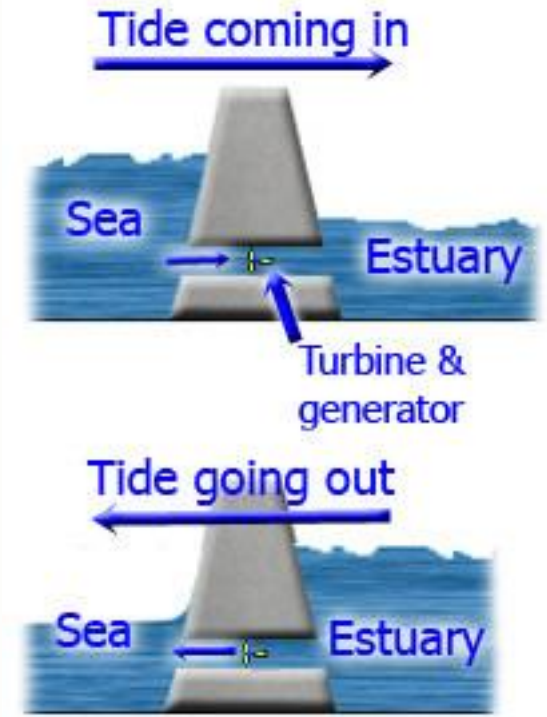
Schematic Depth-Temperature Plot for Geothermal Resources



- ***Oceans and sea energy***

- Energy which can be obtained from oceans and seas are tidal wave energy and energy of waves
- Facilities with 400kW to 240 MW can be found from China to France

The cost of building tidal wave power plant along with the fact that it can not supply power at steady rate, is making this form of renewable still in phase of research



- Wave energy – energy released from crashing of the waves
- like tidal energy, it is always available
- Very large costs of construction and transmission of this kind of energy
- Fixed or moveable, floating or submerged, onshore or offshore systems



Renewable sources in Croatia

Type of energy	Subtype	MWel	MWth
Solar	Photovoltaic	15	
	Solar panels		13,3
Wind		254,3	
Biomass			23,6
Geothermal	Heat pumps		121,80
	No heat pumps		45,3
Ocean & Sea		/	/

