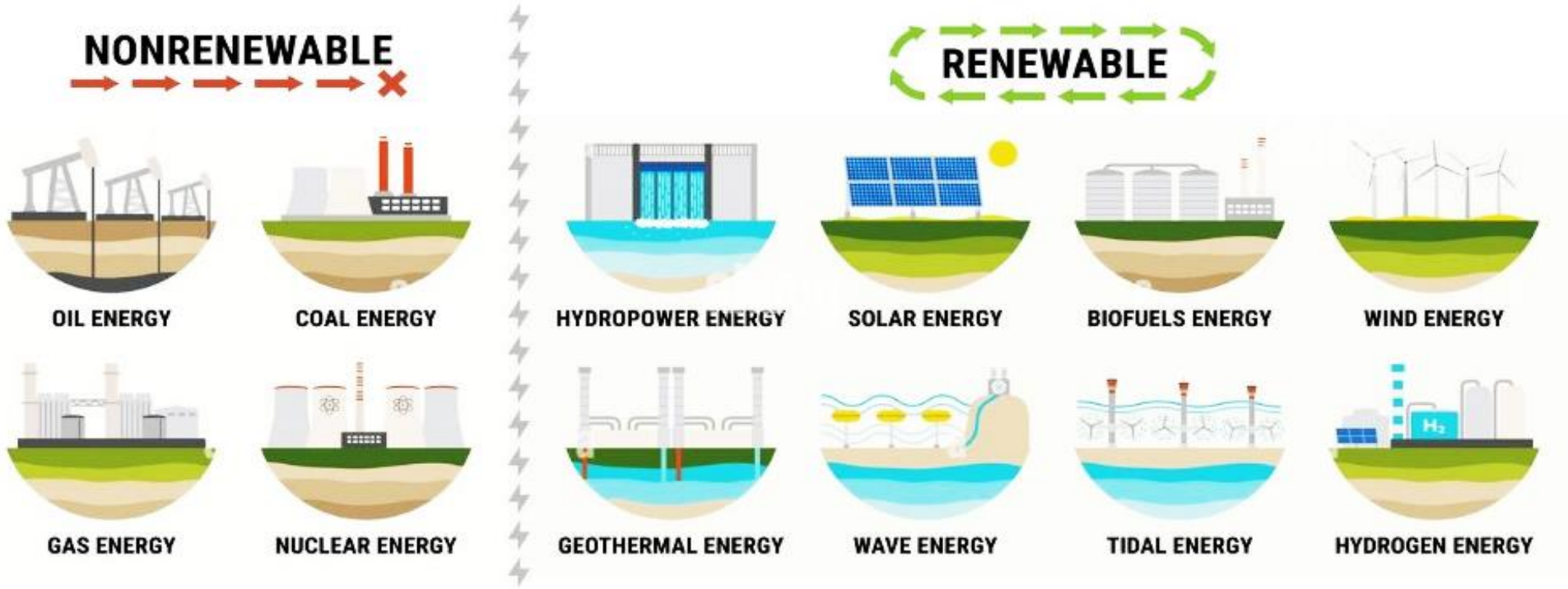
“TIIAME”
National Research University

Dilshod KODIROV
Professor, Doctor of Science

Head of the Department of Power Supply and Renewable Energy Sources

kodirov.dilshod@gmail.com
d.kodirov@tiiame.uz

GEOTHERMAL ENERGY

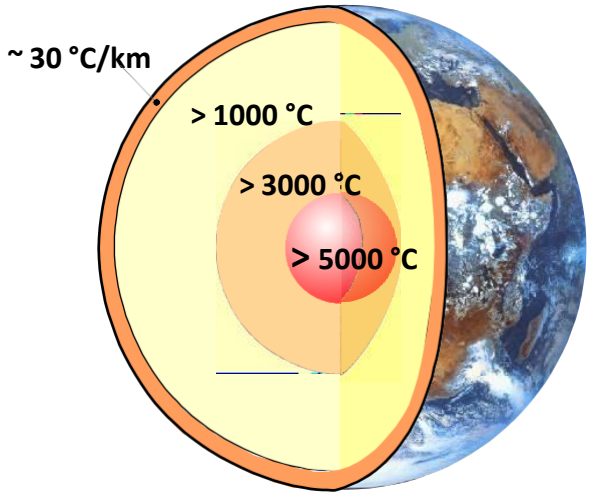


WHAT IS GEOTHERMAL ENERGY

Geothermal Energy

From Greek ***gêo*** (earth) e ***thermòs*** (heat)

Heat inside the Earth

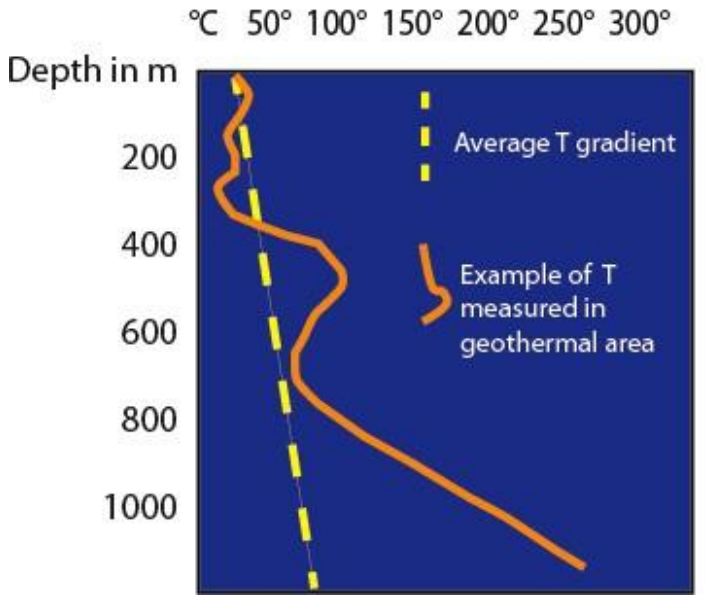


The basis of geothermal energy is the immense heat content of the earth's interior: the Earth is slowly cooling down. Since billions of years the heat in the Earth Crust is constantly supplied by the decay of natural radioactive isotopes or the cooling of hot, shallow magmatic bodies.

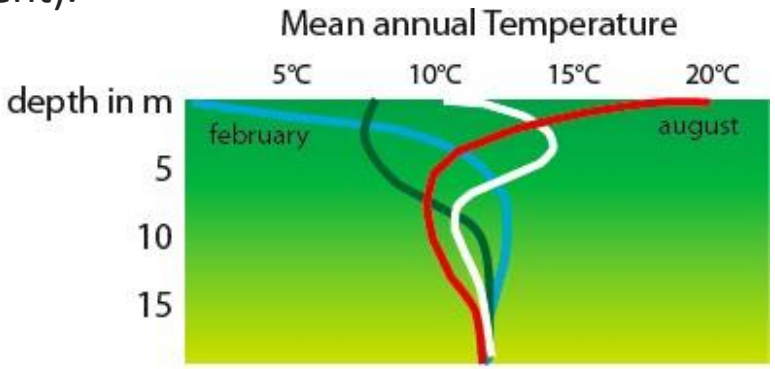
The resource is vast and ubiquitous and has a corresponding **large potential for utilization**.

WHAT IS GEOTHERMAL ENERGY

Temperature in the ground has a daily (few cm) and seasonal (few meters) fluctuations, becoming essentially constant and equal to the average air temperature at about 18-20 m depth. Below this depth, it essentially increases with depth (geothermal gradient).



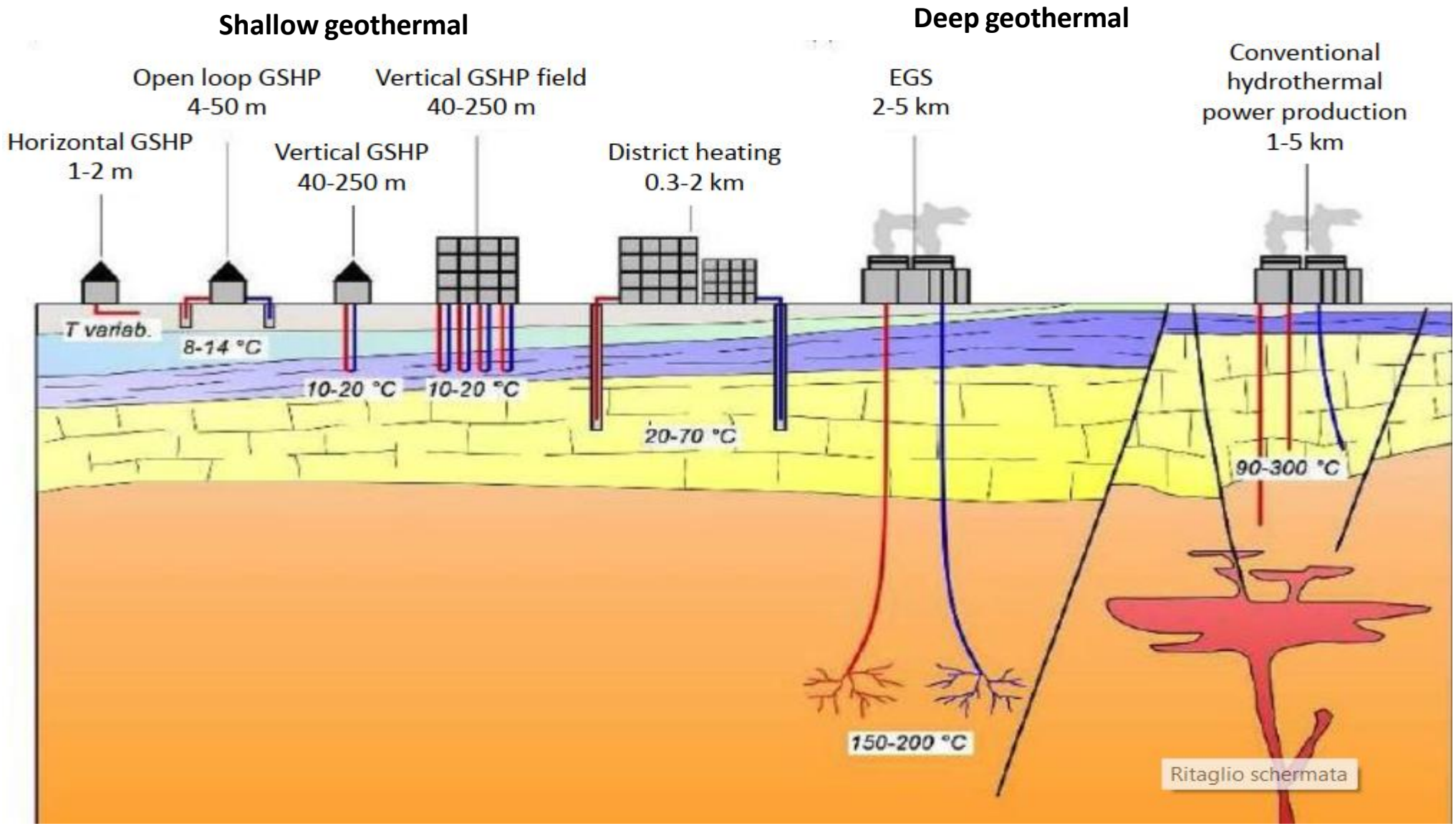
Deep geothermal: exploits the underground heat at T>> air T



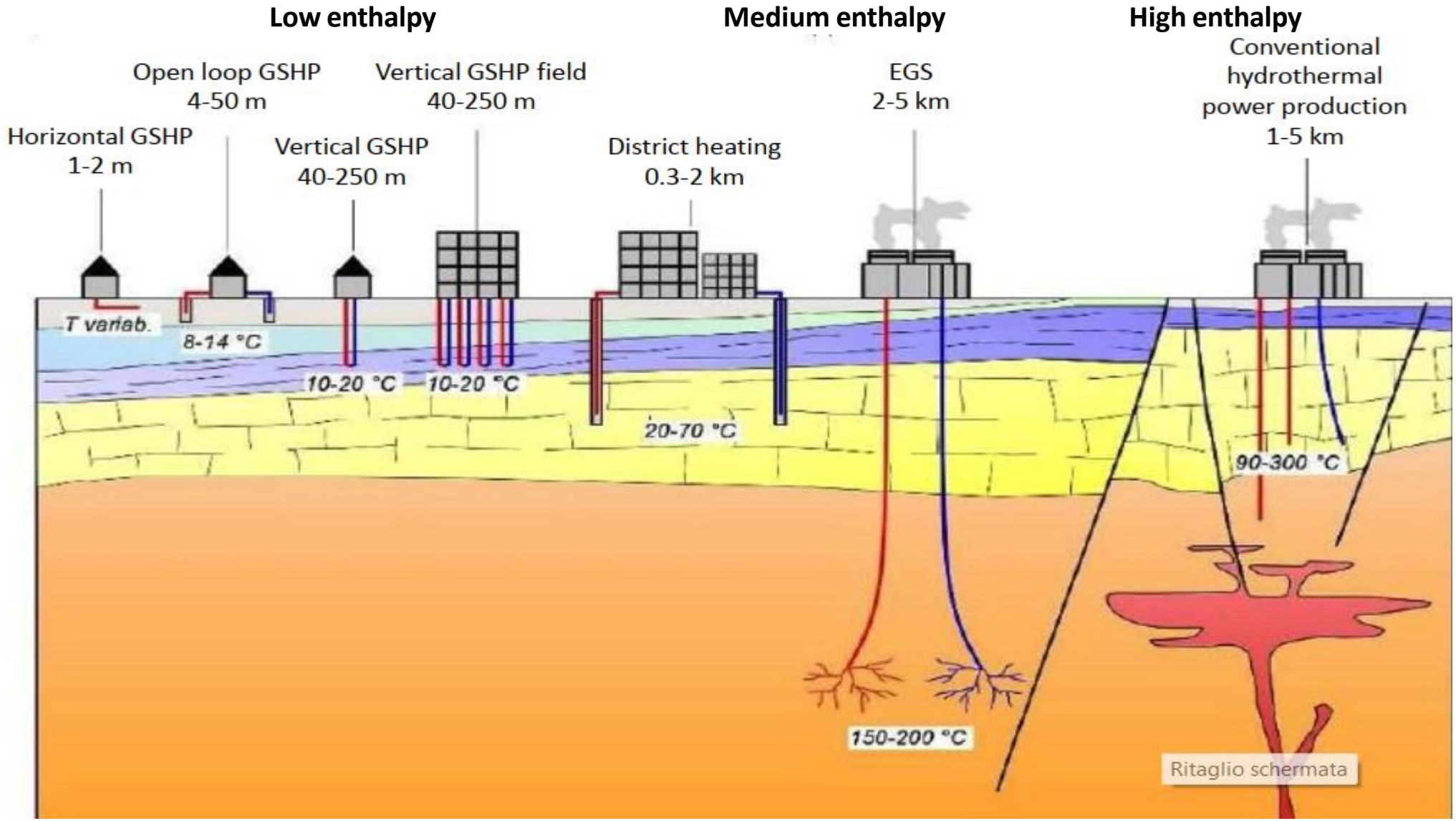
Shallow geothermal: exploits the underground constant T= average air T

The resource is vast and ubiquitous and has a corresponding large potential for utilization.

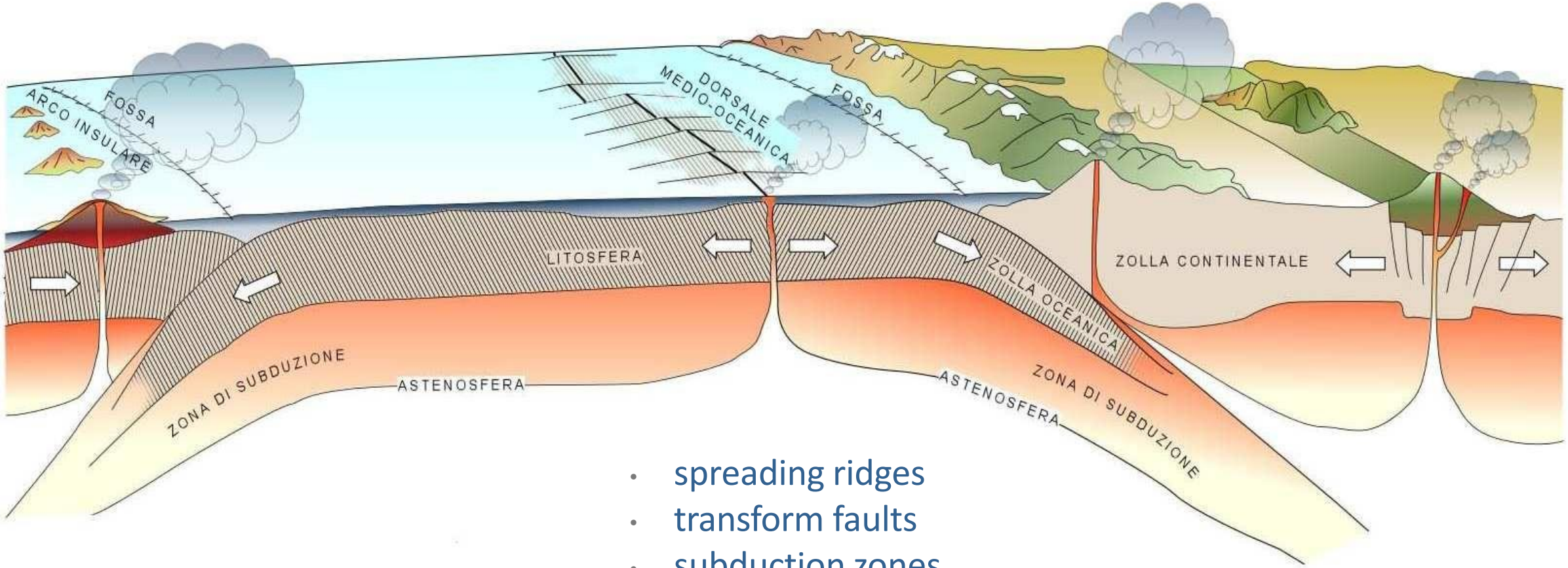
WHAT IS GEOTHERMAL ENERGY



WHAT IS GEOTHERMAL ENERGY

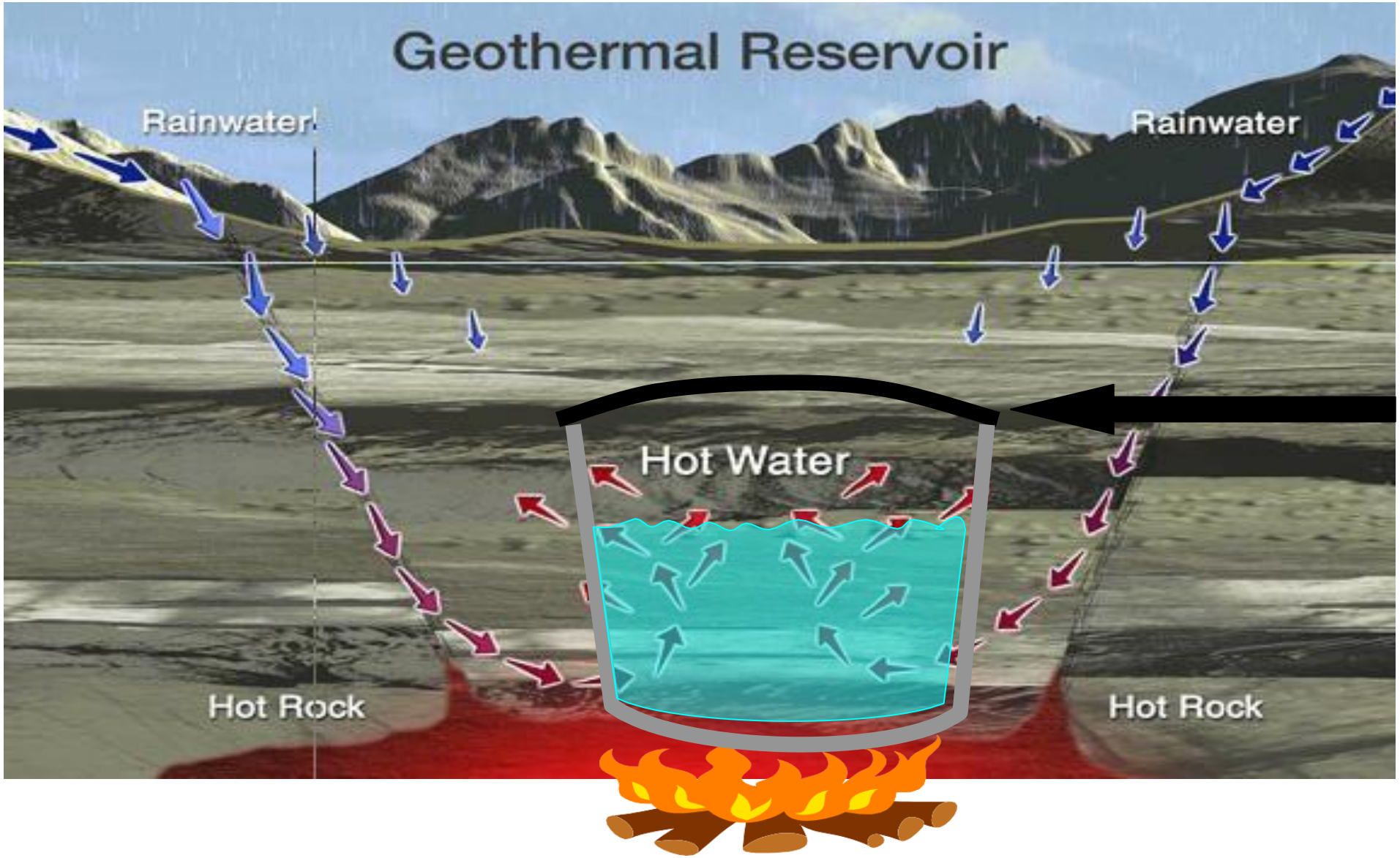


NATURE OF GEOTHERMAL RESOURCES

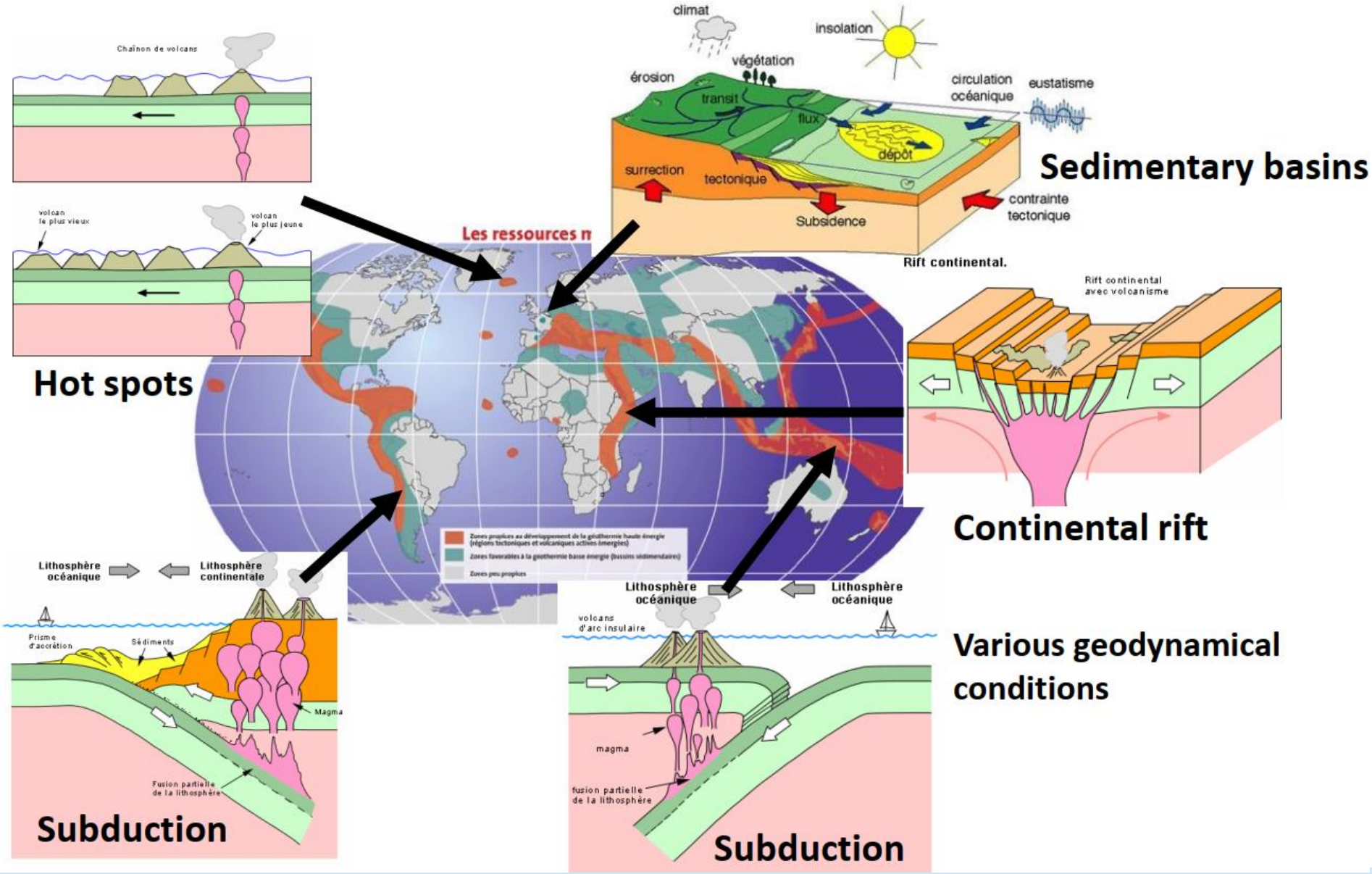


- spreading ridges
- transform faults
- subduction zones
- magmatic arcs
- plates

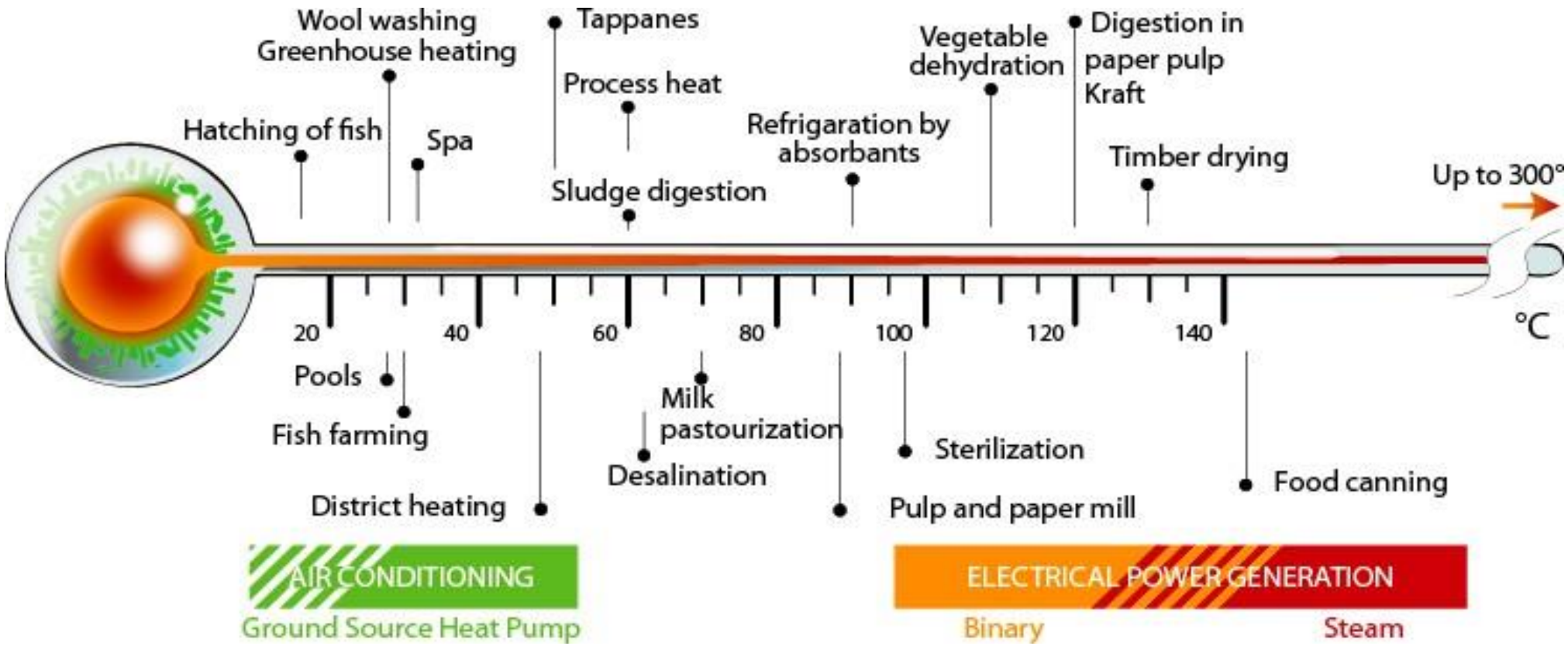
WHAT IS GEOTHERMAL ENERGY



WHAT IS GEOTHERMAL ENERGY



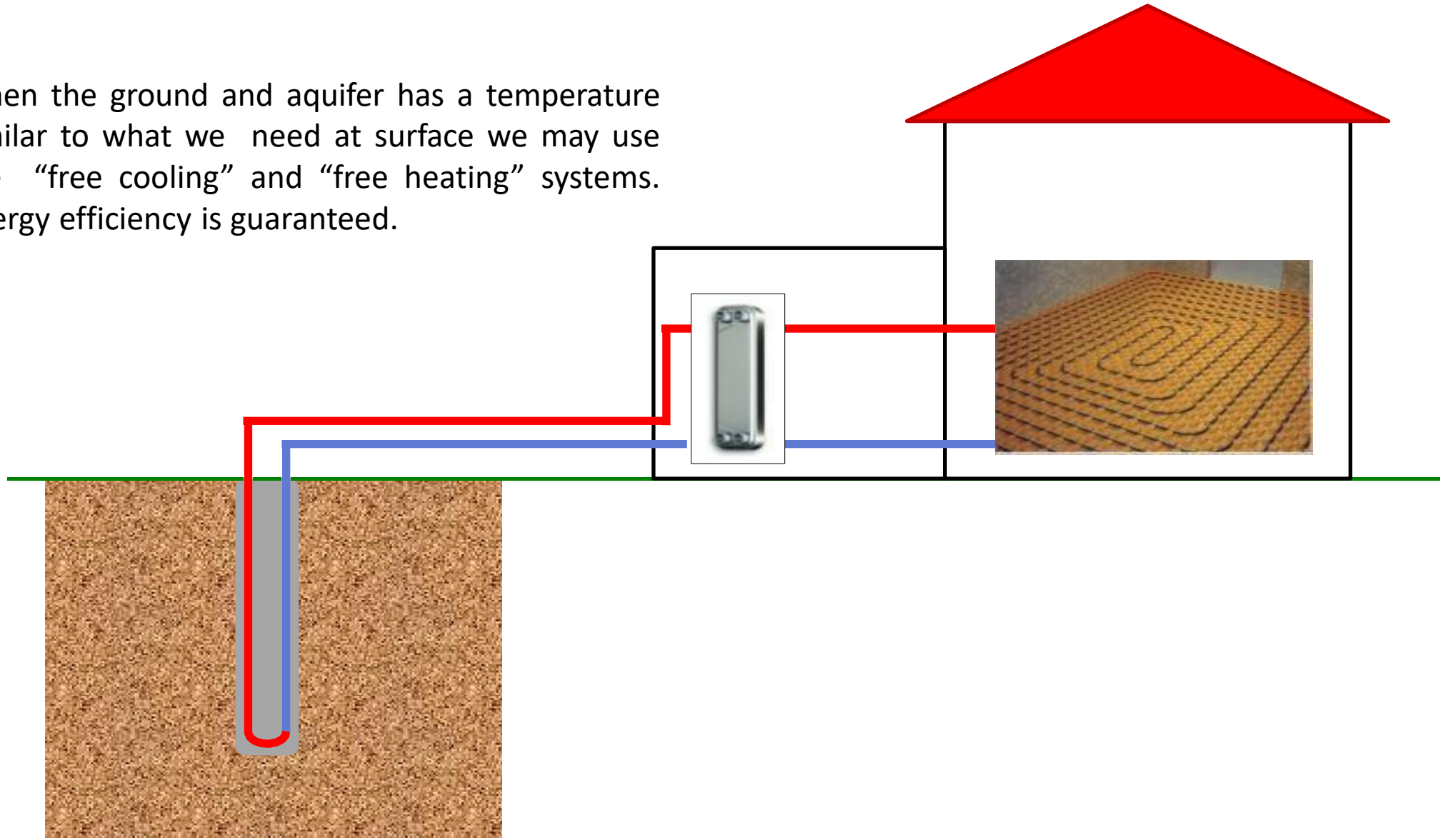
HOW GEOTHERMAL ENERGY IS USED



Warm and hot fluids can be extracted from the underground in a wide range of temperature and discharge rate, and used **directly for their heat content or to produce electric power**. Even the modest temperatures found at shallower depths can be used to extract or store heat by means of ground source heat pumps, that are nowadays a widespread application for geothermal energy.

HOW GEOTHERMAL ENERGY IS USED

When the ground and aquifer has a temperature similar to what we need at surface we may use the "free cooling" and "free heating" systems. Energy efficiency is guaranteed.



HOW GEOTHERMAL ENERGY IS USED

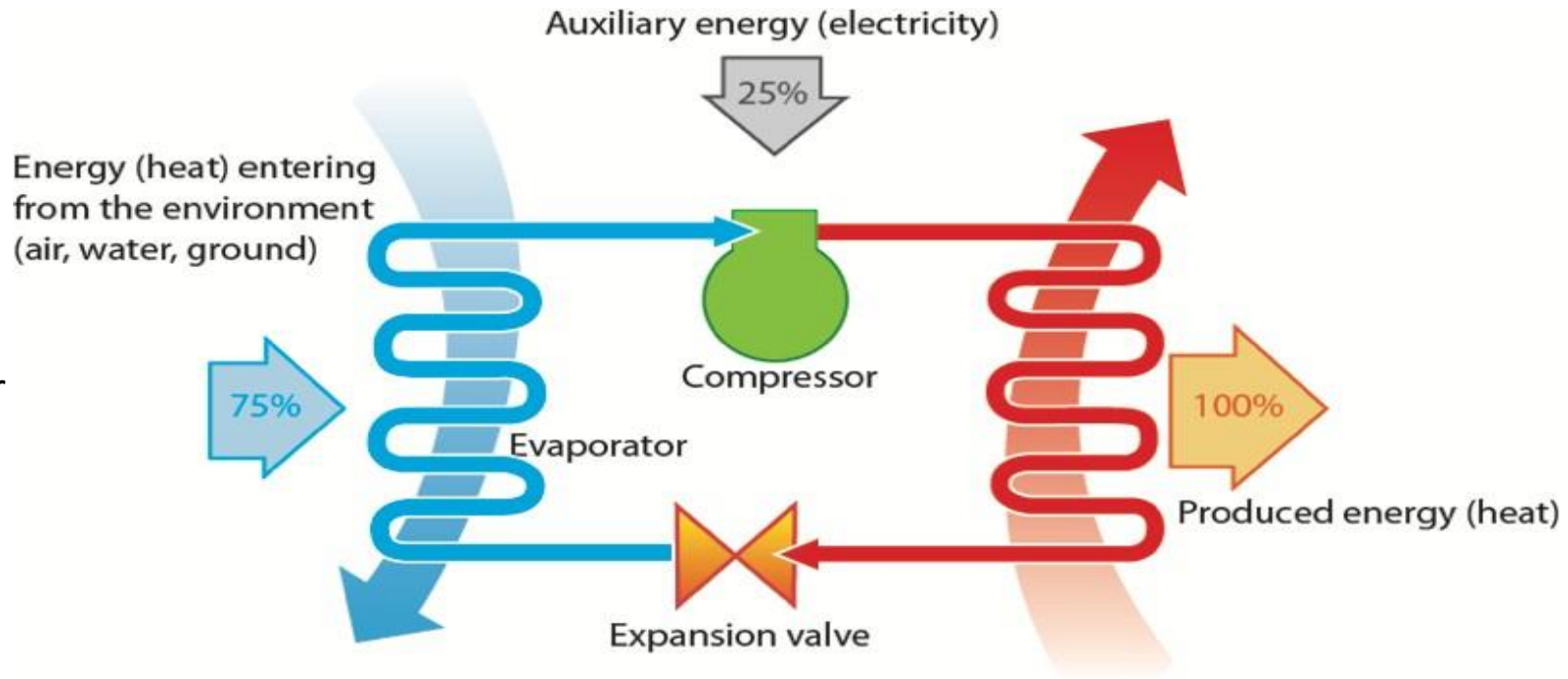
Geothermal heat pump (GHP) or Ground Source Heat Pump (GSHP)

The heat pump systems exploit the physical property of fluids to absorb and release heat when they vaporize or condense, respectively, and move heat from a space (to keep it cool) discharging heat at higher temperature (heating mode).

compressor (power consumption) to compress the vapour

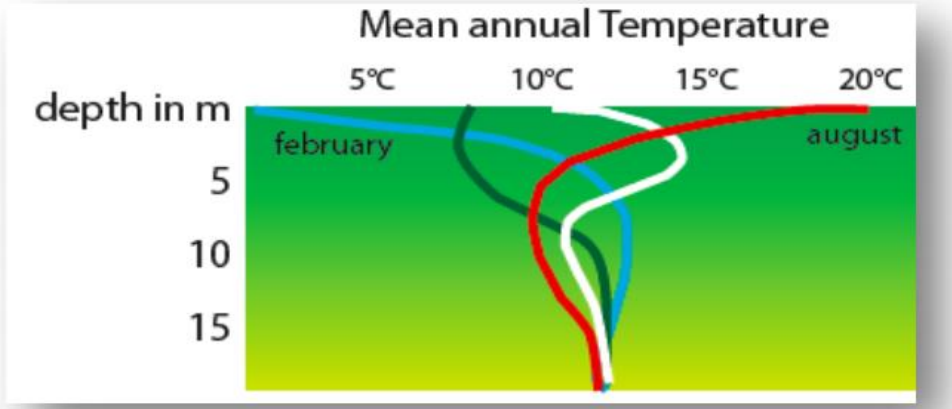
cold source (ground)

In the evaporator the fluid absorbs heat and evaporates

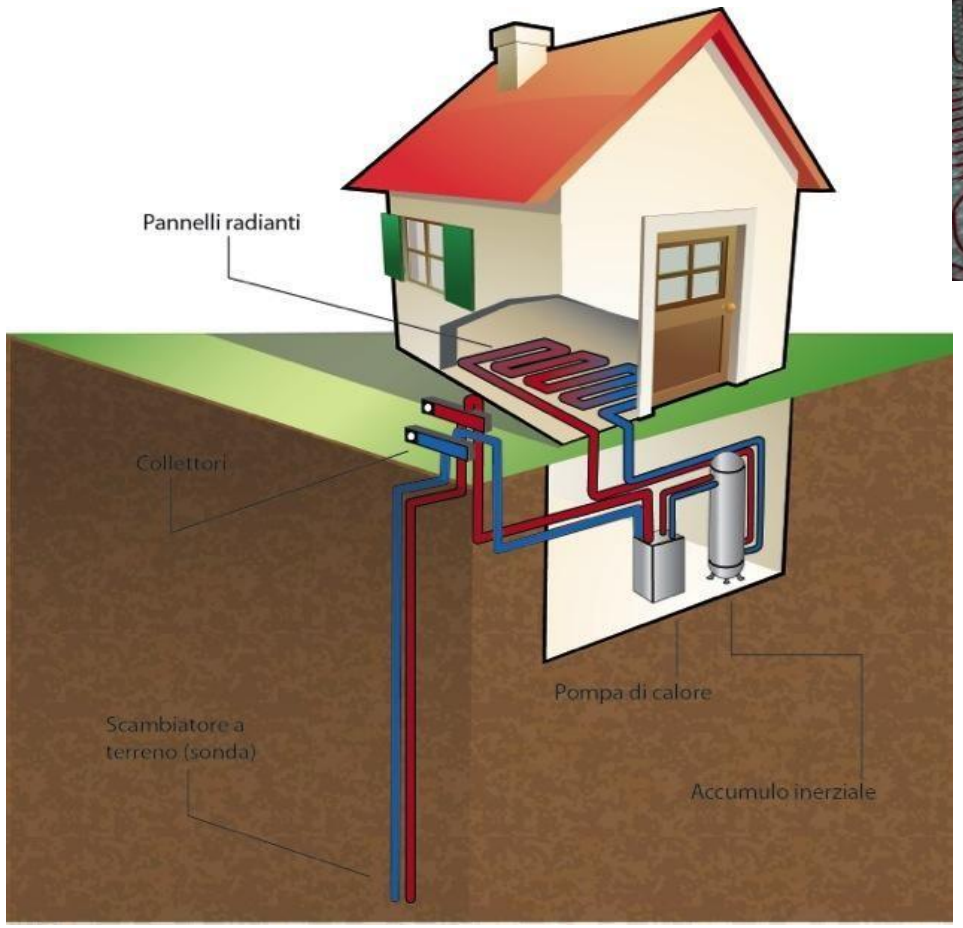


condenser where the warm vapour releases heat and becomes liquid while heating

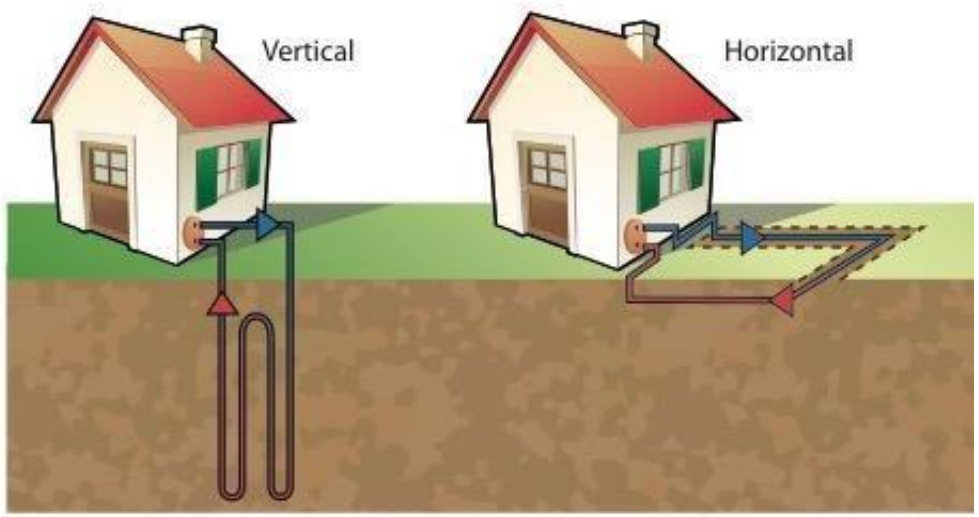
HOW GEOTHERMAL ENERGY IS USED



HOW GEOTHERMAL ENERGY IS USED



HOW GEOTHERMAL ENERGY IS USED



Closed loop systems

A ground-coupled systems where a plastic pipe is placed in the ground, either horizontally at 1-2 m depth or vertically in a borehole down to 50-250 m depth. A water-antifreeze solution is circulated through the pipe collecting heat from the ground in the winter and optionally rejecting heat to the ground in the summer.

Open loop systems

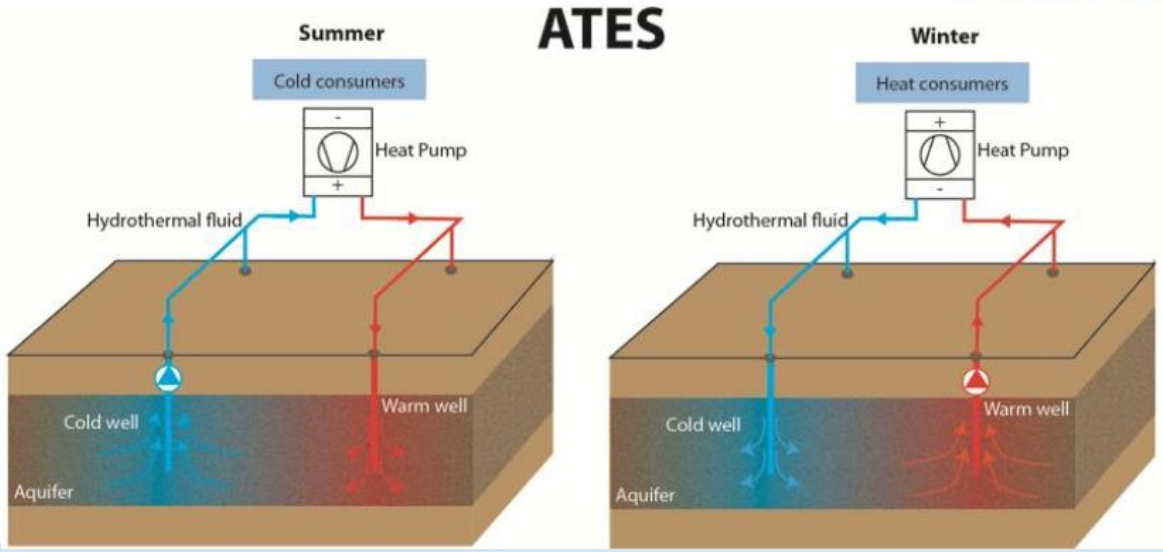
It uses groundwater or lake water as a heat source in a heat exchanger and then discharges it into another well, a stream or lake or even on the ground.

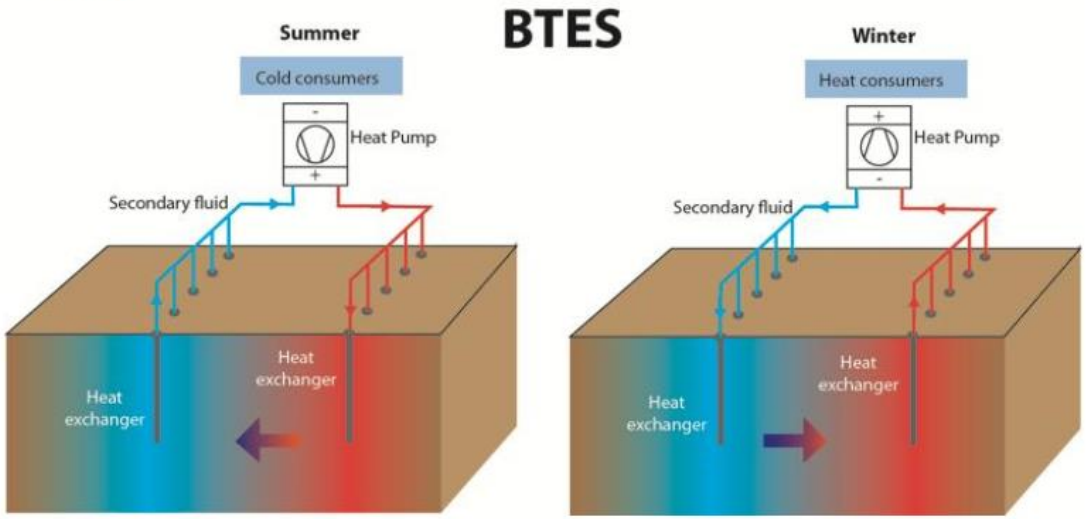
HOW GEOTHERMAL ENERGY IS USED

UTES (*Underground Thermal Energy Storage*) is an increasing research field for storing heat/cold and use it when necessary

ATES

Aquifer Thermal Energy Storage





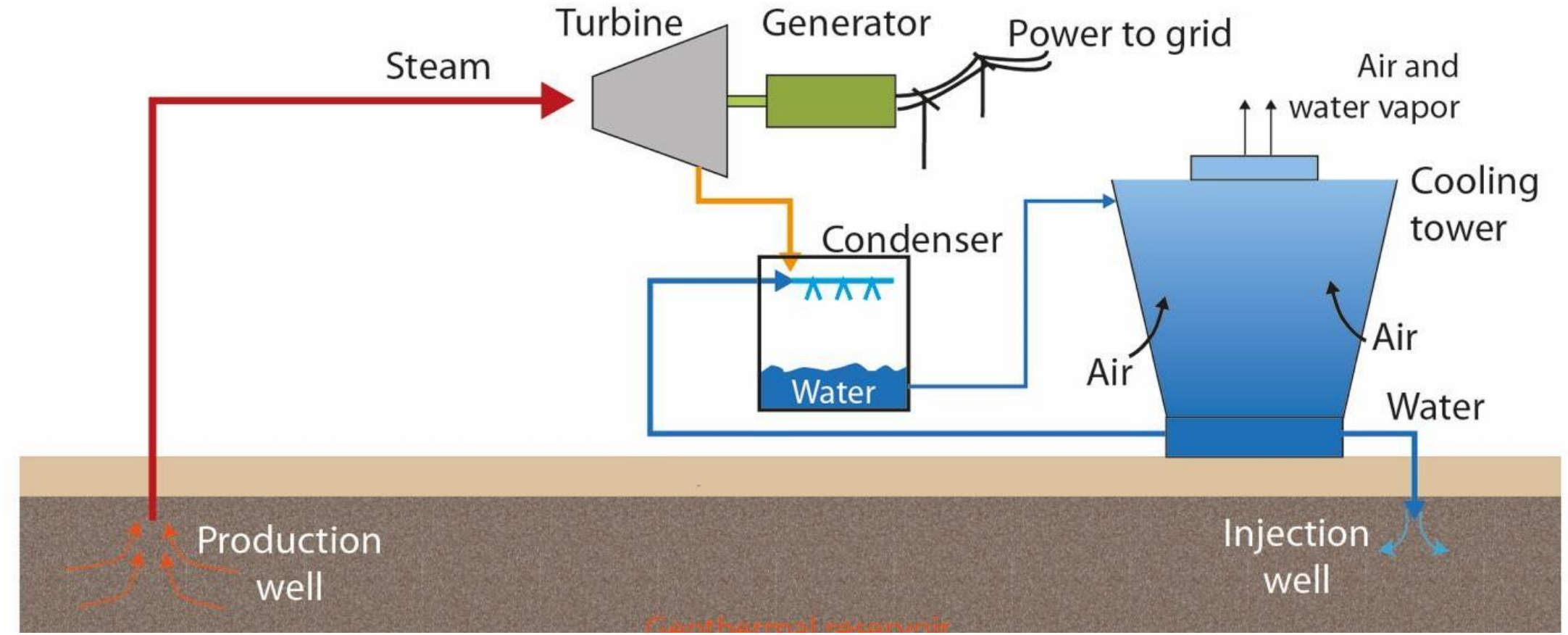
BTES

Borehole Thermal Energy System

HOW GEOTHERMAL ENERGY IS USED

Dry steam plants

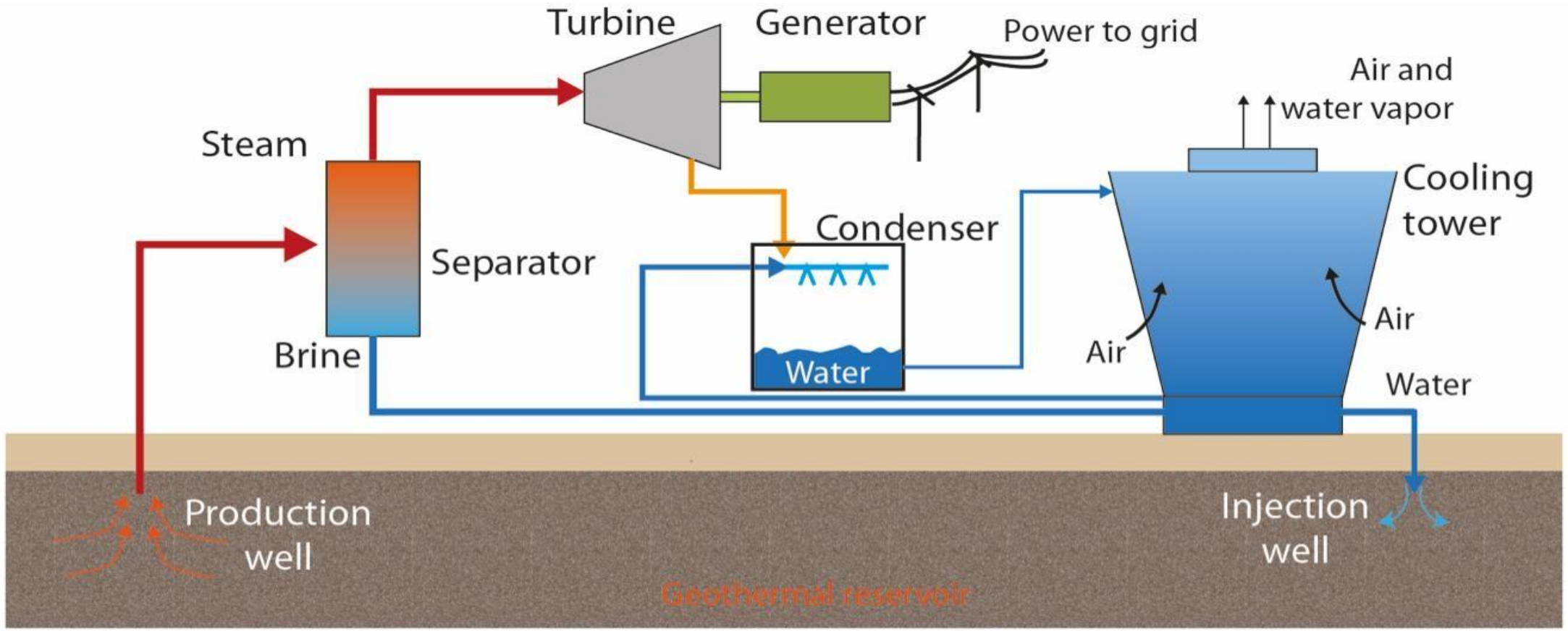
use hydrothermal fluids that are primarily steam. The steam goes directly to a turbine, which drives a generator that produces electricity.



HOW GEOTHERMAL ENERGY IS USED

Flash steam power plants

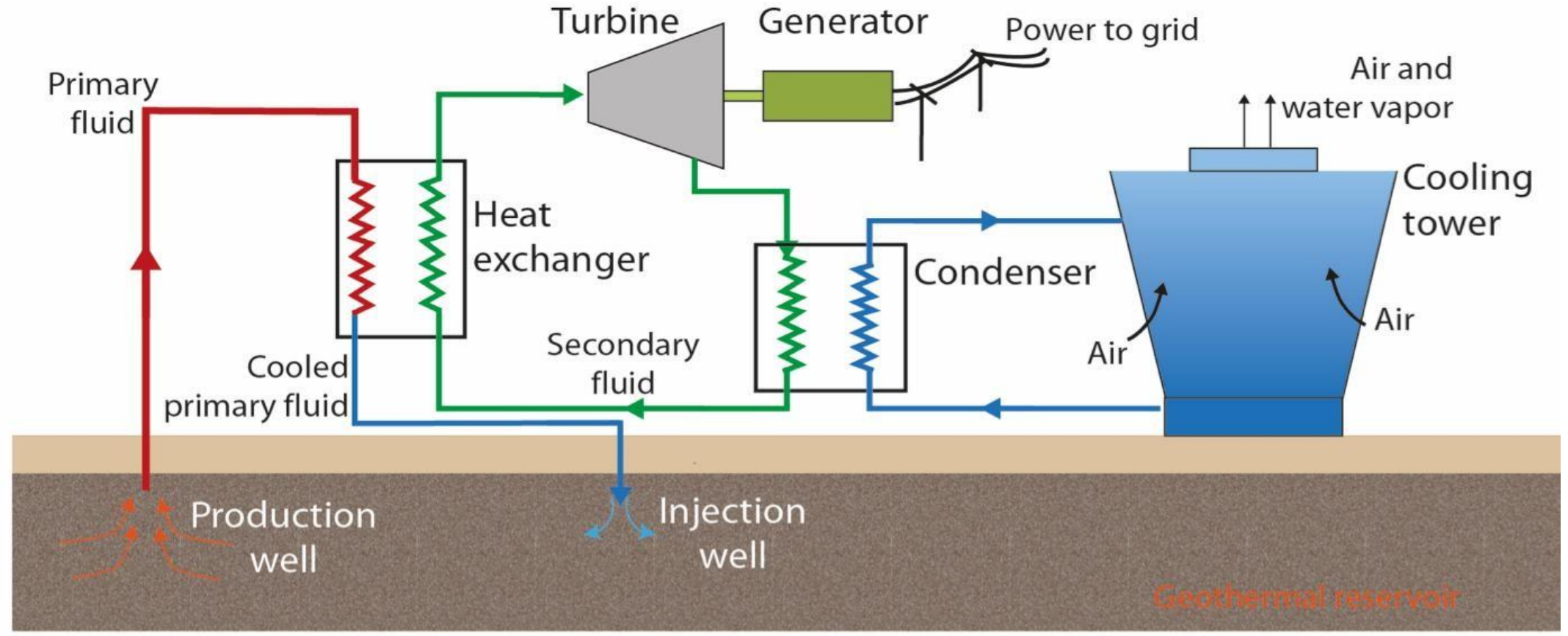
tap into reservoirs of water with temperatures higher than **180° C**. As it flows, the fluid pressure decreases and some of the hot water boils or "flashes" into steam. The steam is then separated at the surface and is used to power a turbine/generator unit



HOW GEOTHERMAL ENERGY IS USED

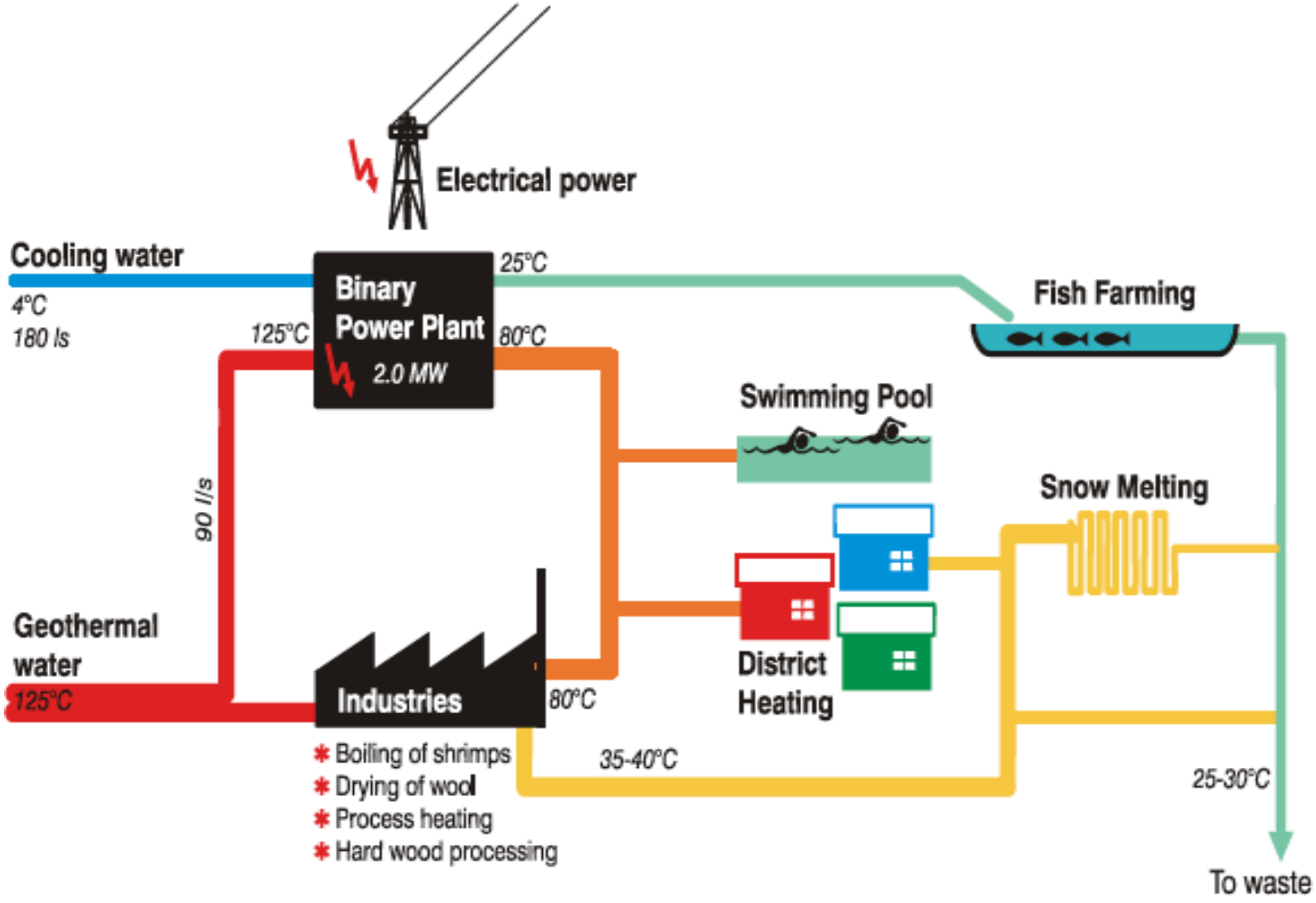
Binary cycle power plants

operate on water at lower temperatures of about **105-180° C**. These plants use the heat from the geothermal water to boil a working fluid, usually an organic compound with a low boiling point.

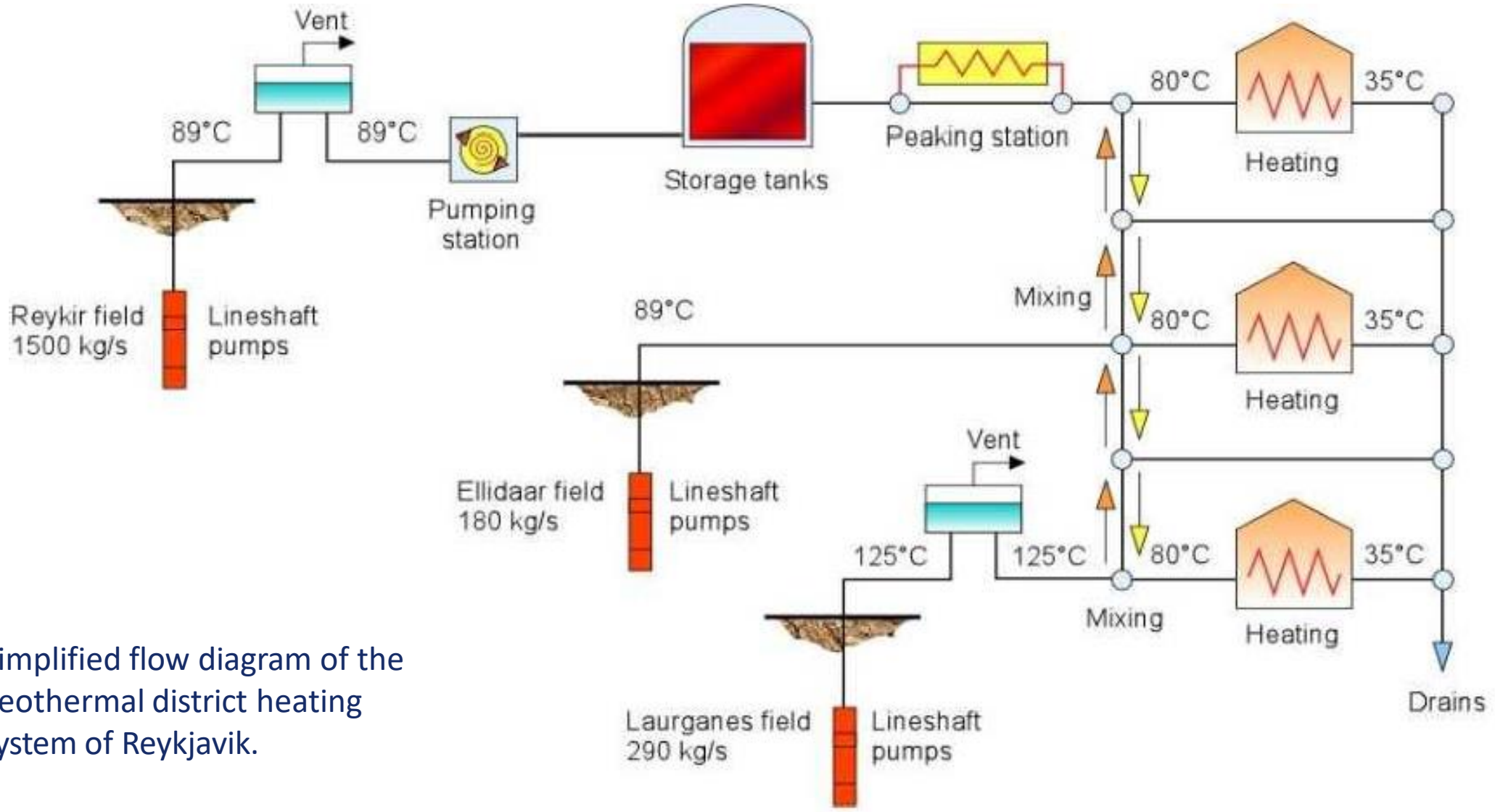


HOW GEOTHERMAL ENERGY IS USED

The efficiency of geothermal utilisation is enhanced considerably by cogeneration plants (combined heat and power plants), compared with conventional geothermal plants. A cogeneration plant produces both electricity and hot water which can be used for district heating as well as other direct uses. A necessary condition for the operation of a cogeneration power plant is that a relatively large market for hot water exists at a distance not too far from the plant.



UTILIZATION OF GEOTHERMAL RESOURCES
DIRECT HEAT USES



Simplified flow diagram of the geothermal district heating system of Reykjavik.

RESEARCH IN GEOTHERMAL ENERGY

Exploration and investigation technology: Improvement of the probability of finding an unknown geothermal reservoir and better characterize known reservoir, optimizing exploration and modeling of the underground prior to drill. Require also clear terminology, methodology and guidelines for the assessment of geothermal potential. It will result in an ***increased success rate***.

Drilling technology: improvements on conventional approaches to drilling such as more robust drill bits, innovative casing methods, better cementing techniques for high temperature, improved sensors, electronic capable of operating at higher temperature in downhole tools, revolutionary improvements utilizing new methods of rock penetration. It will result in ***reducing the drilling cost*** and it will allow to ***access deep and hot regions***.

Power conversion technology: improving heat-transfer performance for low temperature fluid, developing plant design with high efficiency and low parasitic losses. It will ***increase the available resource basis*** to the huge low-temperature regions, not only those having favorable geological conditions.

RESEARCH IN GEOTHERMAL ENERGY

Operation technology: increasing production flow rate by targeting specific zones for stimulation, improving heat-removal efficiency in fractured rock system. Refine stimulation methods (permeability enhancement) for Engineered Geothermal Systems (EGS) and reduce the risk associated with induced seismicity. It will lead to an immediate ***cost reduction increasing the output per well and extending reservoir operating life***.

Management technology: retrieve, simulate and monitor geothermally relevant reservoir parameters that influence the potential performance and long-term behavior. It includes the development of a **Zero-emission technology**, by mean of the total reinjection of fluid (and gases) within the reservoir without cooling and secondary effects.
It will secure the ***sustainable production*** achieved by using the correct production rates, taking into account the local resource characteristics (field size, natural recharge rate, etc.), extending the reservoir operating life and producing a benefit for the environment.

Unconventional Geothermal Systems (UGR) technology: emerging activities to harness energy from nowadays non-economic reservoir would make significant progress with qualified input from research. In particular, ***EGS***, reservoirs with ***supercritical fluids*** (fluids in the thermodynamic area above the critical temperature and pressure) and ***geopressurized reservoirs*** (deep sedimentary basins where fluids show high pressure and are rich of chemical elements or gases). This includes, beside peculiar power conversion and reservoir technology, also Operation & Maintenance techniques in aggressive geothermal environments, since they require specific solutions for corrosion and scaling problems. It will lead to an ***overall increase in power production***

HOW DOES IT WORK?

CONCLUSIONS

Geothermal is a “cheap”, sustainable, clean, flexible and base load energy

… when we are lucky enough to produce it economically (T and fluid). Co- production of power, heat and materials will help

Geothermal is an energy known and used since the dawn of civilization

… but very few are aware of it

Geothermal energy still requires a lot of efforts in research, to optimize technology, to use new materials and to reduce the investment risk

Geothermal energy may provide an important contribution to energy efficiency in many processes (most of our energy consumption is for heating!)

Geothermal energy is very suitable for co-production, co-generation, hybrid systems. We need to test and prove it!

Thank you very much for your attention!

Dilshod KODIROV
Professor, Doctor of Science

Head of the Department of
Power Supply and Renewable Energy Sources
“TIIAME” National Research University

kodirov.dilshod@gmail.com
d.kodirov@tiiame.uz