I 200 anni dell'utilizzo industriale del sito di Larderello: una geotermia sostenibile

Tipologie di campi geotermici nel mondo e frontiere della ricerca geotermica.

Ruggero Bertani
Head of geothermal innovation unit EGP
President of EGEC and ETIP-DG

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7/05/2018

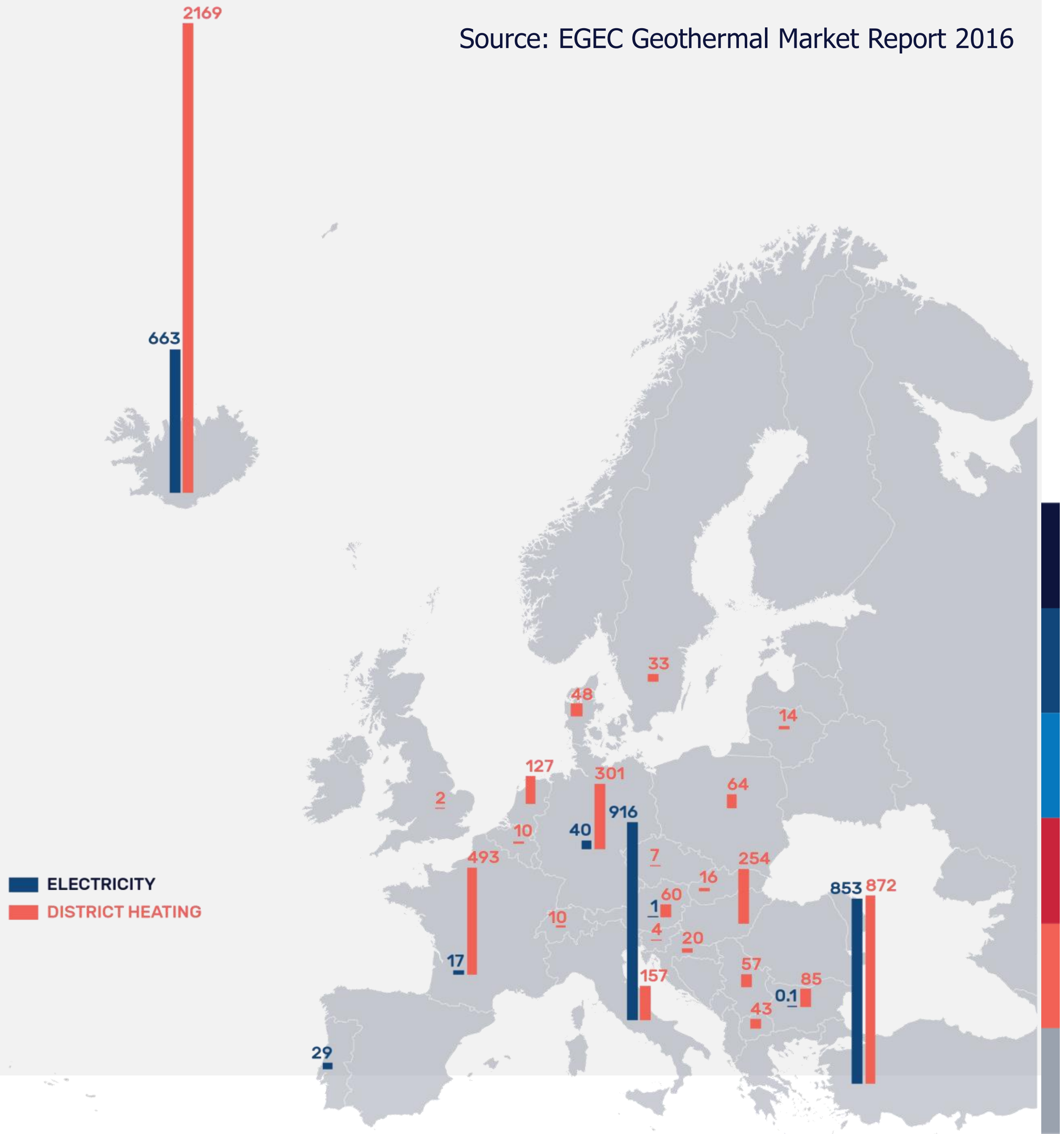
Geothermal energy in Europe

More than **1.7 million**
GEOTHERMAL HEAT PUMPS
installations

More than **100** power plants
2.5GWe Installed capacity for
GEOTHERMAL POWER

More than **280** DH plants
4.8GWe Installed capacity for
GEOTHERMAL DISTRICT HEATING

Source: EGEC Geothermal Market Report 2016



Geothermal & Agri-food in Europe

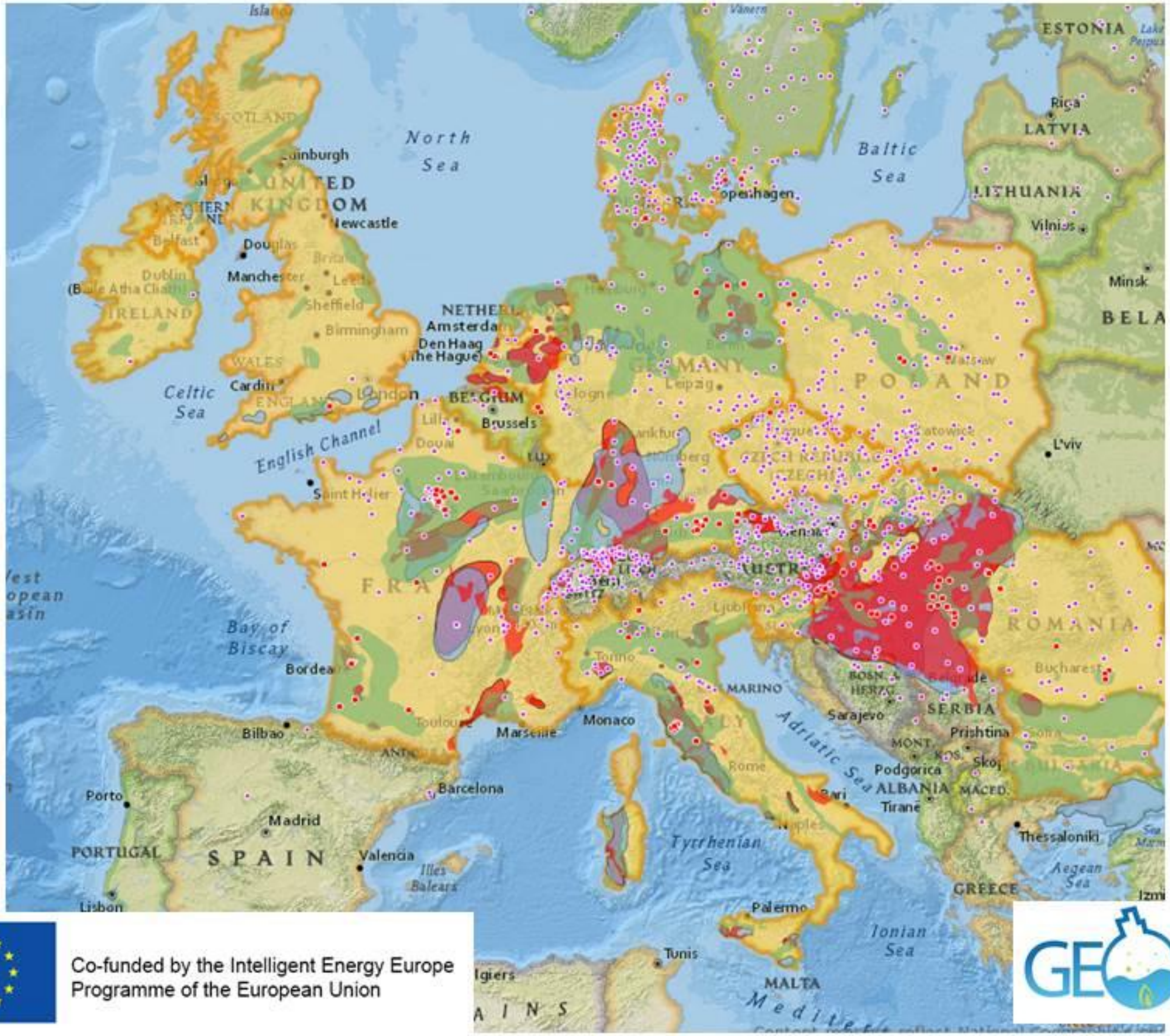
Geothermal energy is used in …

- Greenhouses
- Spirulina cultivation
- Geothermal winemaking
- Fisheries
- … and more

- More than **9,000** people directly employed, in **19** countries
- **1688 MW_{th}** capacity installed & **6145 GW_{th}/yr** production

Source: EGC 2016

More than ***25% of the EU population*** *lives in area directly suitable for geothermal district heating*



Co-funded by the Intelligent Energy Europe Programme of the European Union

GEODH

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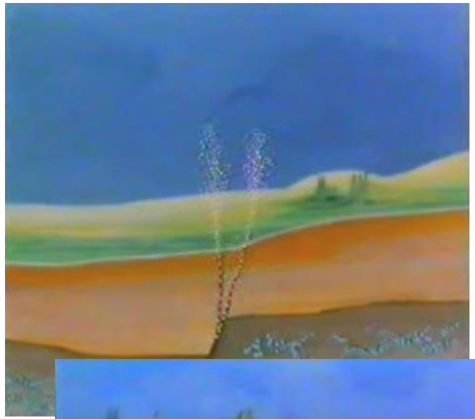
Geothermal System

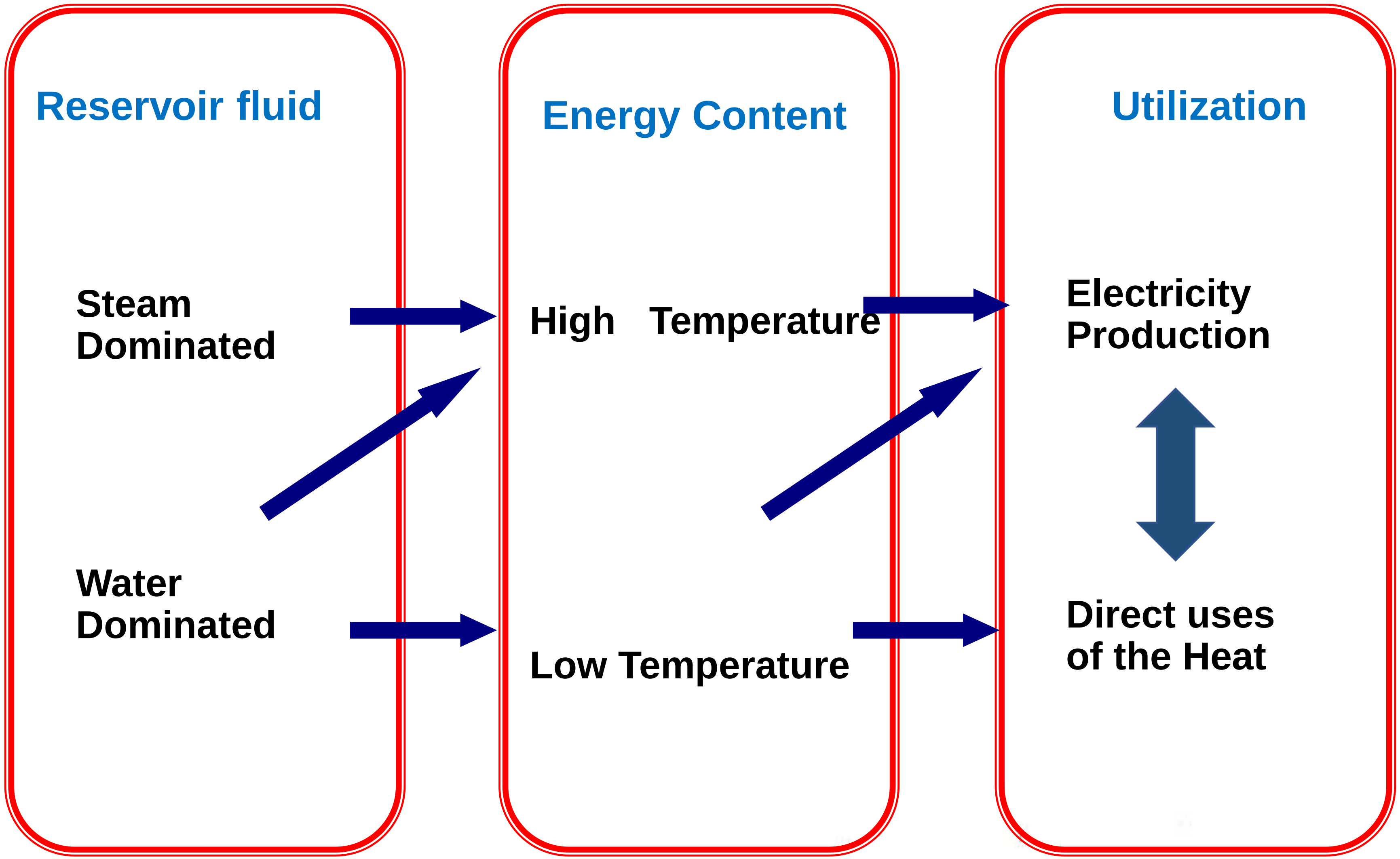


Natural discharge of hot water or steam: *geothermal manifestation*.

Hydrostatic pressure in the reservoir:
Water dominated systems.

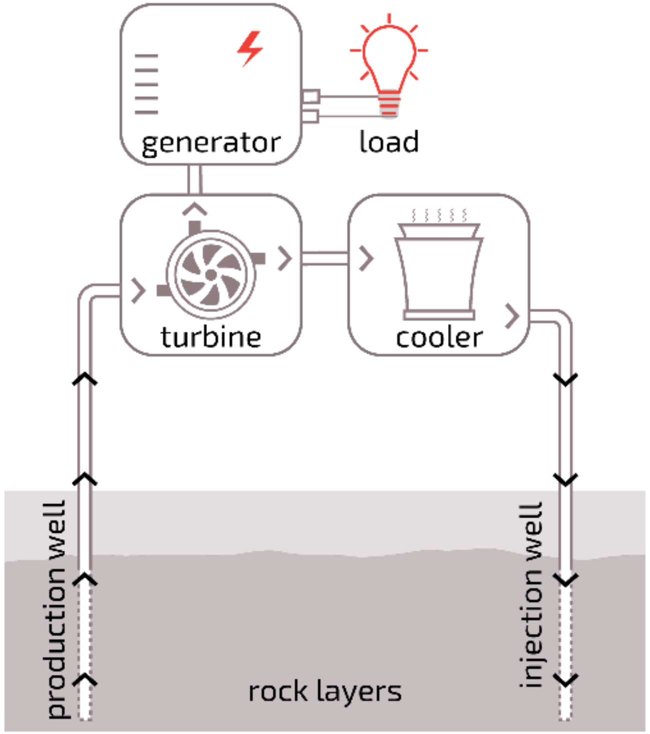
In some situations, the pressure is relatively low and t is regulated by the steam phase:
Steam dominated systems

In some situation there is an heat source without reservoir:
Hot Dry Rock
Enhanced Geothermal System


Reservoir fluid
Steam Dominated
Water Dominated
Energy Content
High Temperature
Low Temperature
Utilization
Electricity Production
Direct uses of the Heat

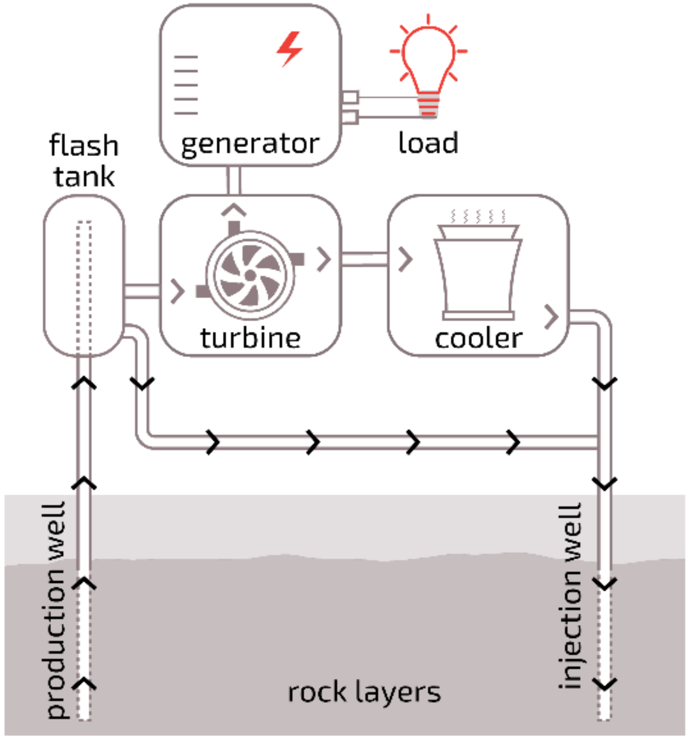
Technologies for electricity production

Dry steam power plants



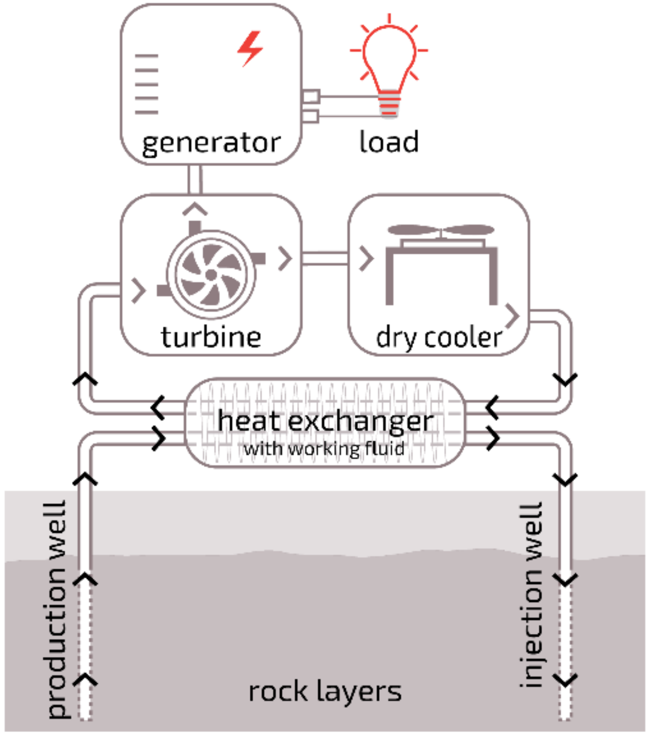
Highly cost competitive but geographically limited

Flash steam power plants



Most dominant in terms of global capacity

Binary cycle power plants



Useful alongside geothermal heating, hot spring, etc

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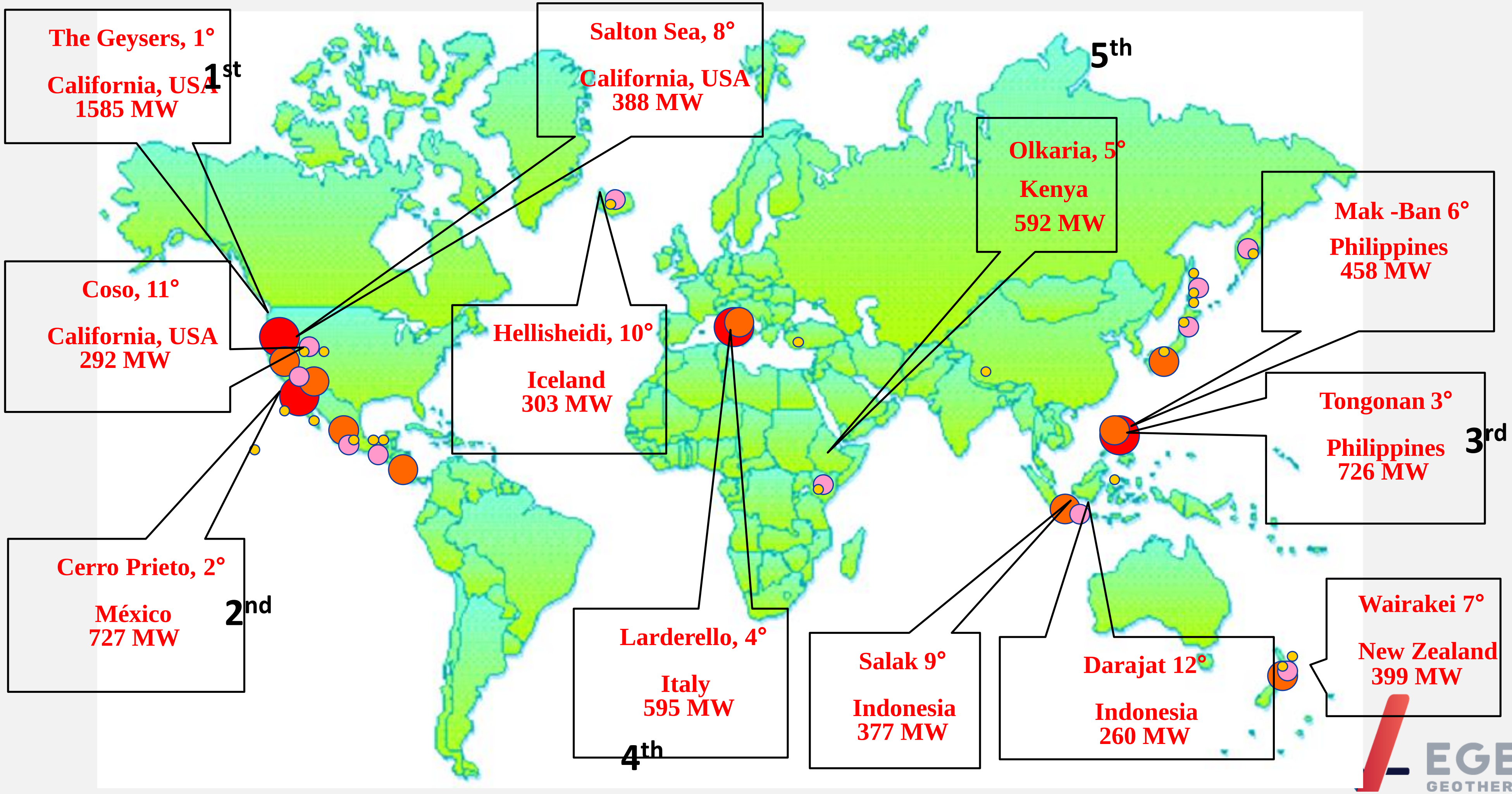
2015 Top Dozen of Geothermal Fields

DRY STEAM: The Geyser, Larderello, Darajat, Kamojang



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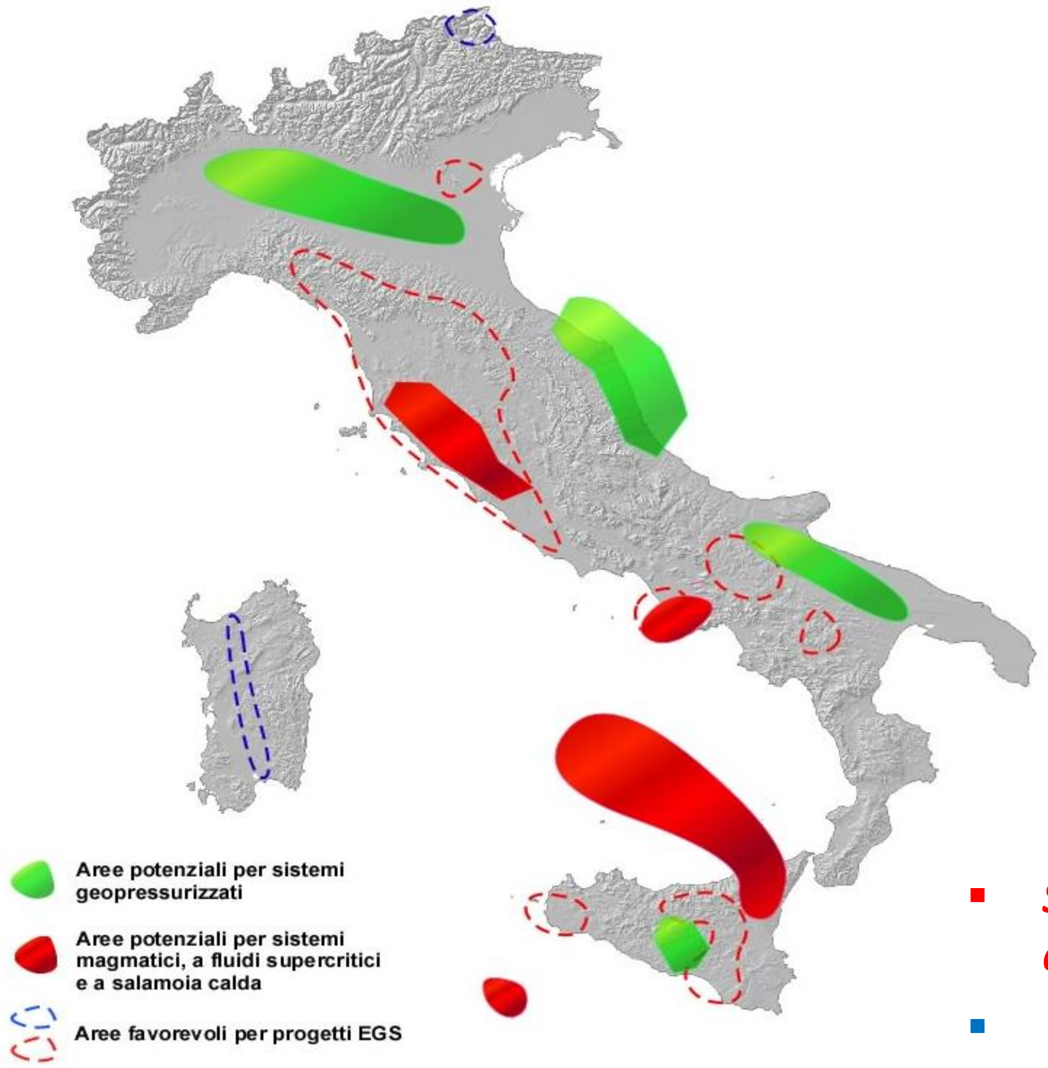
Non Conventional Resource in Italy

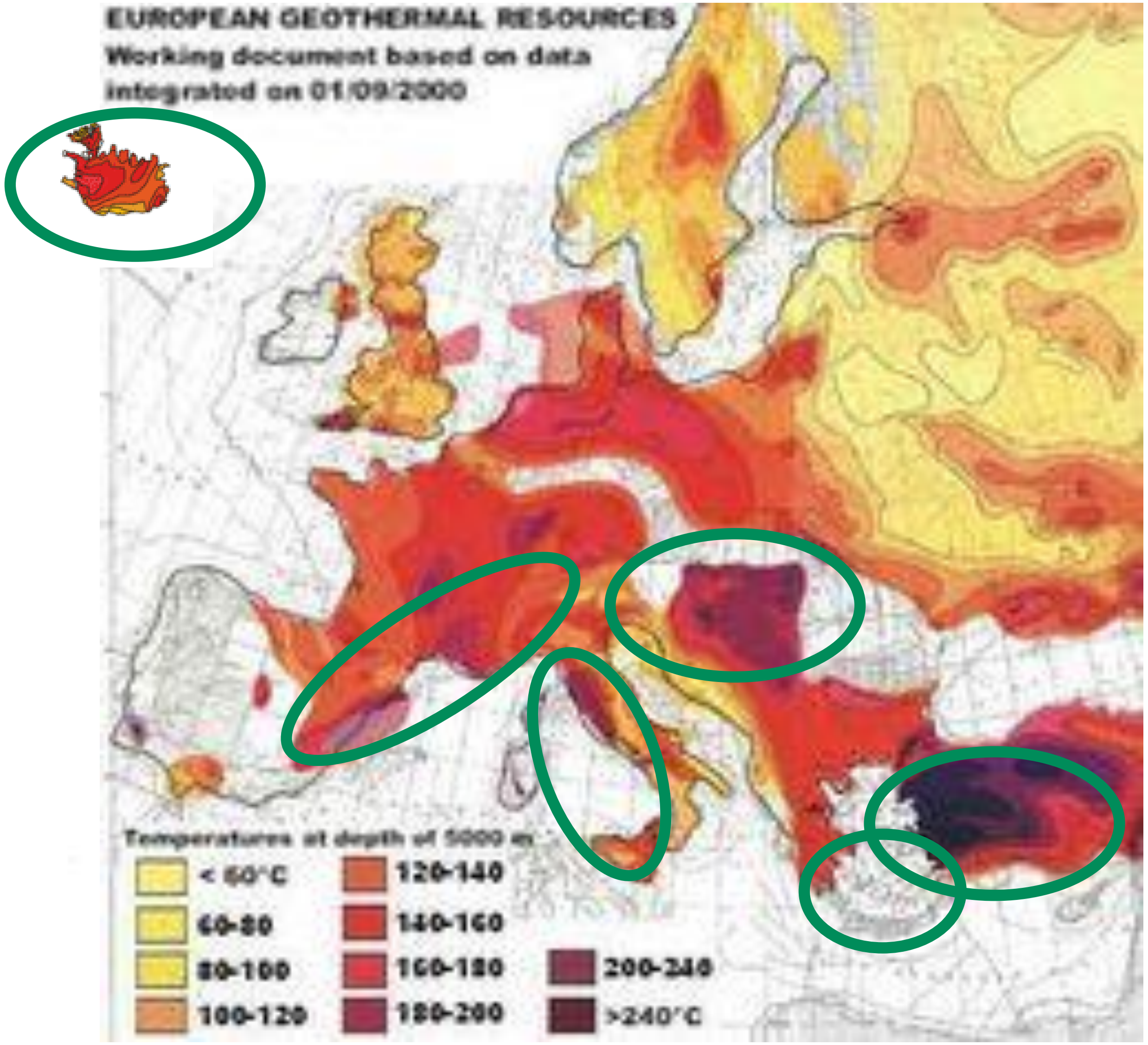
Potential



- *Hot Dry Rocks - Enhanced Geothermal Systems (high temperature and low-to-very low permeability)*
- *Pressurized systems in clastic complexes*
- *Hot brines, Mainly in volcanic systems. High temperature fluids at very high salinity (>> 10 g/l).*
- *Supercritical fluids, high temperature and depth in supercritical conditions*
- *Magma systems, heat capture in active volcanic areas*

Unconventional Geothermal Systems (UGS), can exist in Italy at depths 2 – 5 km

A Supercritical Resource in Europe
Potential



Map of the expected temperature distribution at depth of 5 km in Europe.

Iceland

Tyrrenic coast of Italy

Greek islands

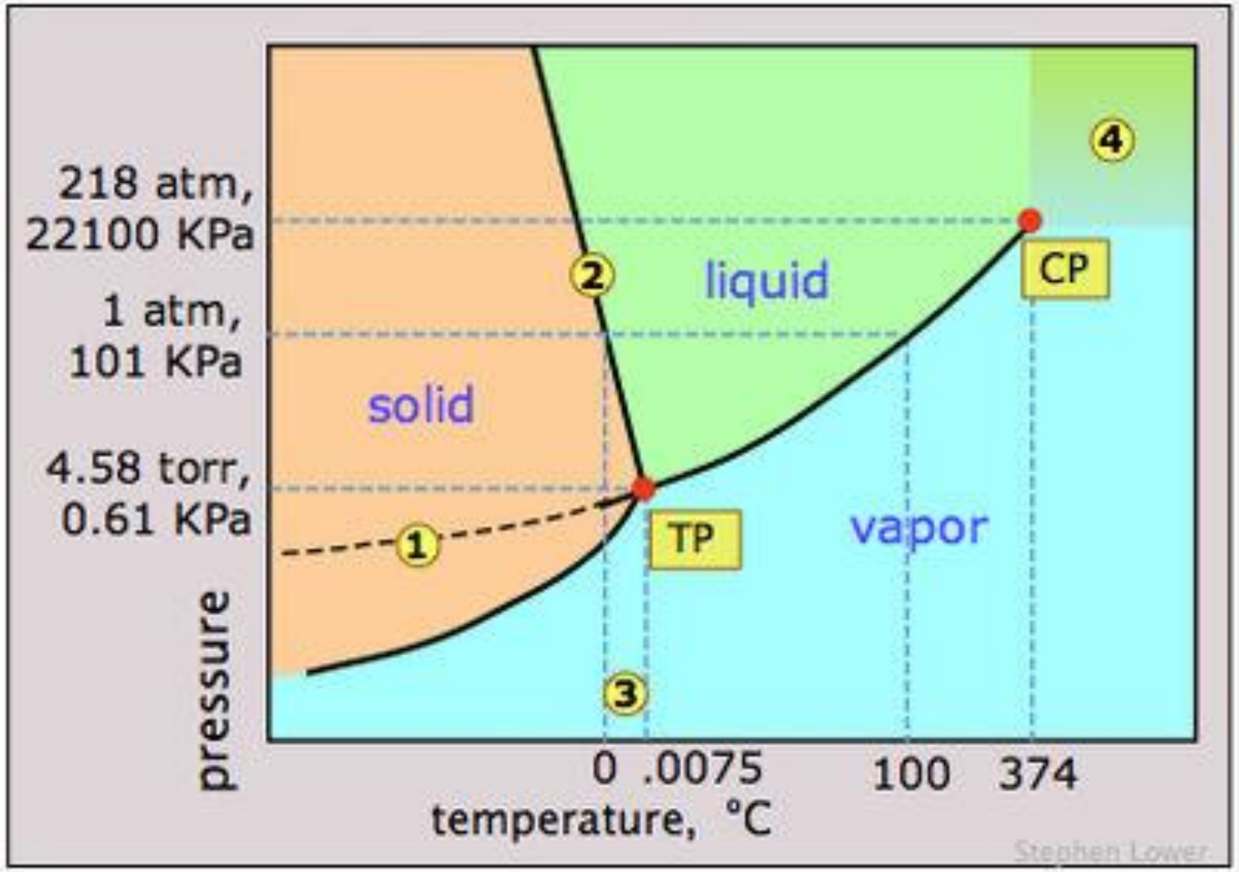
Western part of Turkey

Pannonia basin

Southern regions in Spain and France

What is a “Supercritical Resource”?

Historical note



In the phase diagram of water, as the temperature and pressure increases, water starts to travel across the solidus line, and reaches the **triple point (TP)**. Triple point denotes a temperature and pressure when all the three phases are present in the water. From that point, as the water follows through the liquid line, it reaches the **critical point (CP)** where water has only one phase. Beyond critical point **(the area is marked as 4 in the phase diagram)**, water molecules are not held by hydrogen bond; therefore, they can float around as free radicals. This is one reason why supercritical water or fluid has such a high solubility because of its high reactivity. Supercritical water cannot be liquefied by increasing pressure.

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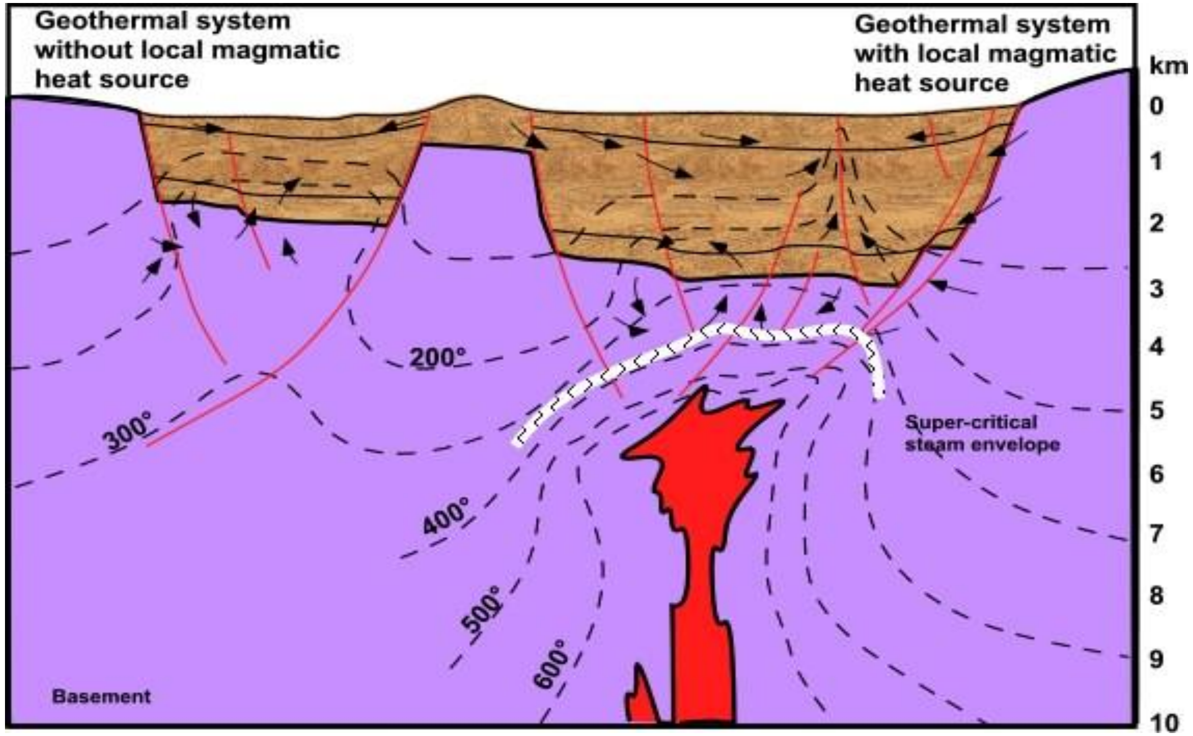
What is a "Supercritical Resource"?
Historical note

High heat flow conditions ➡ rift zones, subduction zones and mantle plumes.

Thick blankets of thermally insulating sediment covering a basement rock that has a relatively normal heat flow ➡ lower grade

Other sources of thermal anomaly:

- Large granitic rocks rich in radioisotopes
- Very rapid uplift of meteoric water heated by normal gradient



Supercritical threshold
T > 374 C, P > 221 bar for pure water,
T > 406 C, P > 298 bar for seawater

SUPERCRITICAL RESOURCES

- **IDDP-1 Iceland; 2009, depth 2,1, magma at 900°C**
- **Kakkonda – Japan; 1994-1995, depth 3,7 km, inferred T 500°C**
- **IDDP2 – Iceland; 2016, depth 4,6 km, T 427°C and P 340 bar**
- **DESCRAMBLE – Italy; 2017, depth 2,9 km, T 510°C and P 250-300 bar**
- **JSP – Japan; planned after 2020**

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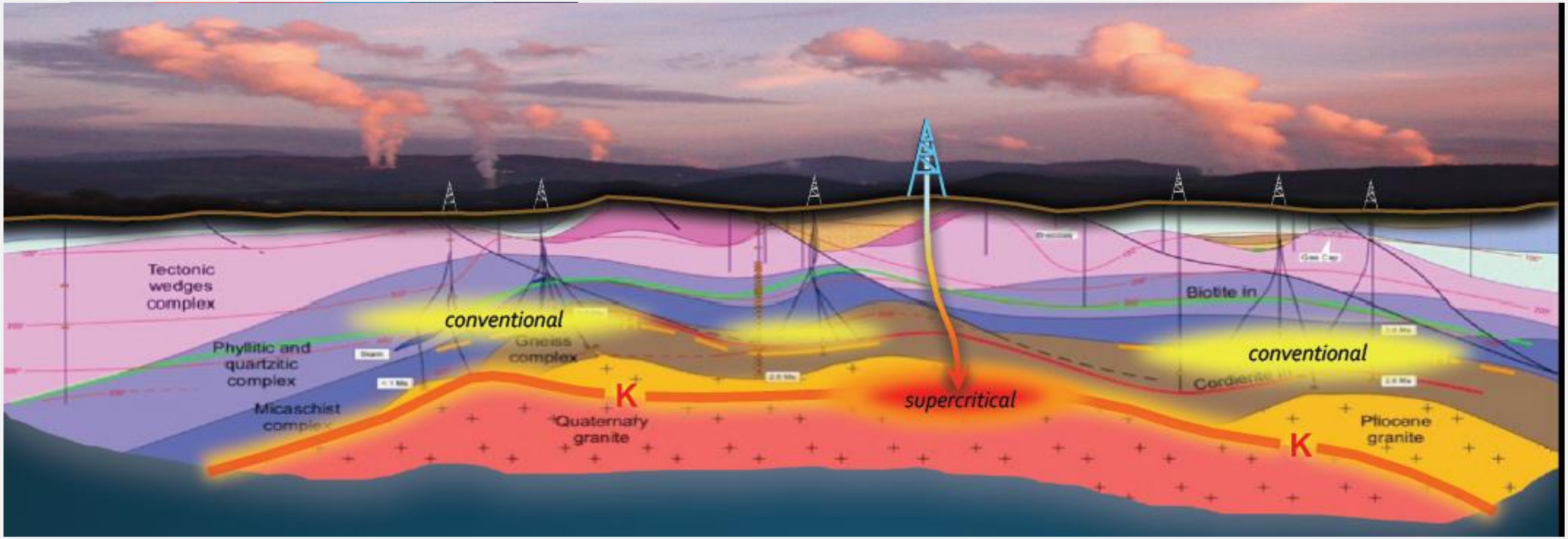
DESCRAMBLE



Drilling down to a new frontier of the geothermal development:

the deep supercritical conditions

DESCRAMBLE

HIGHLIGTH ON THE MOST INNOVATIVE ASPECTS

Applied research/demonstrations of industrial component in an unconventional application:

- **Materials**: Bottom hole assembly components, Cementing process, Drilling fluids, Well materials (casing, well head, and cement
- **Well design and control**: the research will optimize new procedures, explicitly utilizing synergies with oil and gas industry.
- **Predicting and controlling super-critical conditions**: the research will optimize new procedures, explicitly using synergies with oil and gas industry. Existing simulators will be extended to the super-critical regime.
- **Development of a new logging tool**: suitable for measurement of pressure and temperature at supercritical conditions.
- **Scientific research aspects**: Seismic characterization of the super critical region, Petrophysics and log interpretation, Geochemical monitoring and Petrology

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DESCRAMBLE

HIGHLIGTH ON THE MOST IMPORTANT BENEFITS

- Increased power output per well (5-10 fold)
- Production of a higher value steam (higher P-T)
- Extending the resource base and lifetime of existing fields
- Knowledge of reservoir characteristics at greater depths
- Advancing techniques of UGR (Unconventional Geothermal Resources)
- Development of an environmentally benign resource
- Development of high-temp. instruments and drilling technology
- Application to high-temp. geothermal systems world wide
- Educational, industrial and economic spin offs

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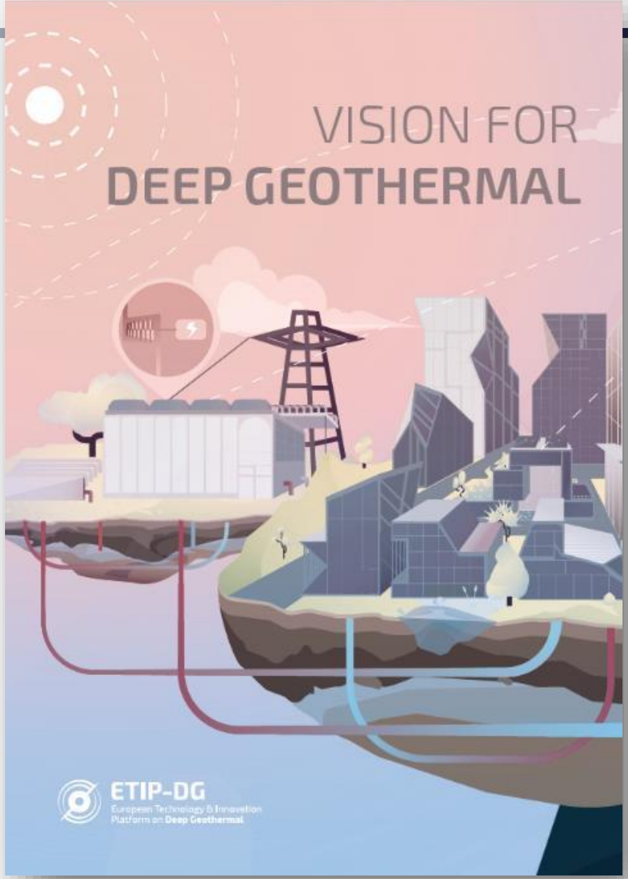
About the Vision



This VISION looks toward **the future of Deep Geothermal energy development** by 2030, 2040, 2050 and beyond, and highlights the great potential of untapped geothermal resources across Europe. After an **Introduction & Overview** the document briefly describes the **Actual Status of geothermal development** and the VISION's aim for

> Unlocking geothermal energy

> Increasing the Social welfare in Europe

> Novel technologies for full and responsible deployment of geothermal potential

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The City of the Future

Just announced on 25.4.2018:

EGC2019

European Geothermal Congress

11-14 JUNE 2019

THE HAGUE, THE NETHERLANDS

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