



ETIP-DG

European Technology & Innovation
Platform on **Deep Geothermal**

GEOTHERMAL ENERGY IN THE LONG-TERM PERSPECTIVE OF A DECARBONISED EUROPEAN ECONOMY

Geothermal energy is an energy of the future for Europe. It is a renewable source that can provide a secure supply of electricity, heating and cooling when it is needed. It is a proven solution in many areas of Europe, but a large untapped potential remains. In the long term, thanks to a pragmatic use of available resources and the benefits of RD&I in the first quarter of the 21st Century, the development of geothermal energy allows this energy source to account for a significant part of the heating and cooling demand – notably for space heating and cooling – and to be a core component of the decarbonised European electricity sector.

GEOTHERMAL AT THE CENTER OF THE DECARBONISATION EFFORT

The commitments to the Paris agreement, and the objective of a carbon neutral European economy in 2050 it entails, and to remain a world leader in renewables, force Europe to seriously engage in decarbonising its energy system. As it does so, it maximises the potential of its available renewable resources, including geothermal. To meet the requirements of the energy transition, at the lowest environmental cost possible, geothermal energy indeed proves a valuable asset, with a limited environmental impact guaranteed by the application of a robust and harmonised European environmental regulatory framework.

STABILITY AND FLEXIBILITY FROM GEOTHERMAL ENABLE THE FULL DECARBONISATION OF ELECTRICITY SUPPLY

Meanwhile, geothermal energy becomes a pillar of the electricity sector, providing a stable, flexible and dispatchable renewable supply, that allows moving toward a fully decarbonised electricity sector. **Able to provide grid services, geothermal electricity has a value that goes beyond the simple value of the kWh produced.** Moreover, the development of geothermal electricity capacity makes geothermal heat available for businesses, communities or industries that are located nearby the powerplants.

DEEP GEOTHERMAL ENERGY AS AN ENABLER OF THE DECARBONISATION OF HEATING AND COOLING

The decarbonised electricity supply in the long term justifies a **smart electrification of some processes**, notably transport but also heating and cooling provided the most efficient technologies are used. Individual geothermal heating systems, and large shallow geothermal systems become a prominent solution for heating and cooling, providing the benefits of a higher efficiency than other options for electrifying space heating. Moreover, RD&I in underground thermal energy storage yields benefits for managing the seasonal shift in the energy demand, which remains significant despite the effects of climate change.

Geothermal energy, notably when used for heating and cooling, proves an asset in the eradication of energy poverty across Europe (see figure below, presenting current data, not considering potential future cost-reductions), a major policy priority which further legitimises the energy transition. The **low operational costs of geothermal energy allow its integration in a long-term planning of the heating and cooling system that supplies affordable heat to communities.** Geothermal district heating, among the most cost-effective district heating solutions, is also a solution to prevent vulnerable household to fall into energy poverty when confronted with increasing energy performance requirements, as individual renewable heating system tend to require large investments. It is a particularly **relevant solution in dense urban areas and historic city centers where the cost-efficient energy savings potential is more limited due to the historical characteristics of the building stock.**

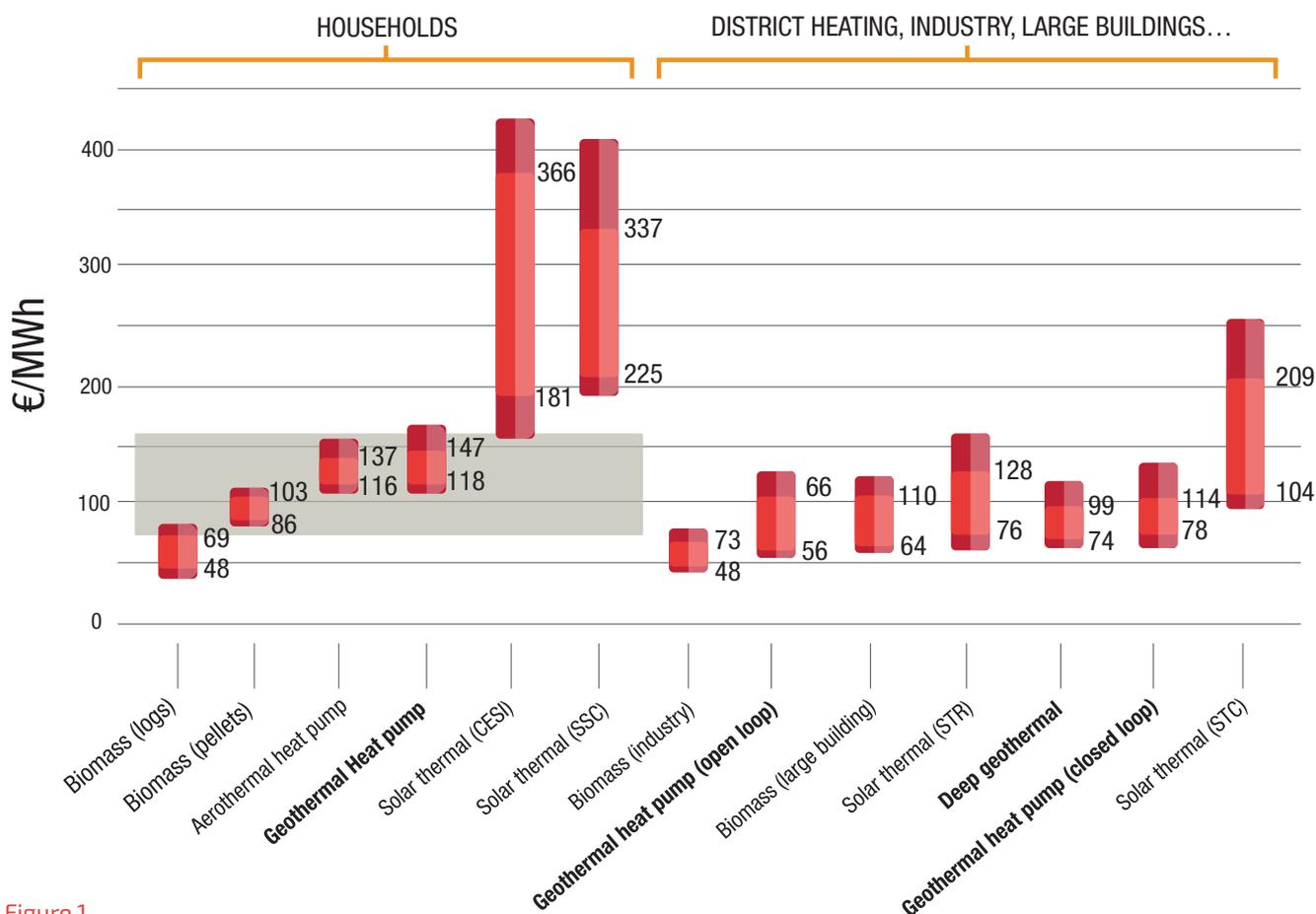


Figure 1.
Heat full cost in France
The grey zone corresponds to the range of
"conventional" heating – direct electric, gas, fuel oil
(source: ADEME 2016)

GEOHERMAL: A FACTOR OF SECURITY AND DEVELOPMENT IN THE ENERGY TRANSITION

Geothermal energy is crucial, should the EU remain a world leader on renewable energy. Innovation in the European geothermal sector opens new possibilities for energy production, and allows the European geothermal industry to be a global leader, providing know how and technologies beyond the boundaries of Europe. **The benefits of innovation on geothermal energy also contribute to the creation of jobs and value for the European economy, notably with innovations such as brine mining, and the use of geothermal heat in industry and the agrifood cluster.**

In an interconnected world, faced with many disruptive forces, from geopolitical risk, supply chain disruption or increasingly harsh climate impacts, geothermal energy provides resiliency to the European communities that benefit from it. Geothermal facilities' resistance to disasters allow to maintain or rapidly restore the supply of heat to communities after a storm for instance. The use of geothermal systems reduces the urban heat island effect that is otherwise reinforced by conventional AC technology during heatwaves – thereof reducing health issues and mortality. As a zero-emission technology, **the use of geothermal for heating also avoids air emissions, improving the air quality in urban environments.**

THE VISION FOR THE CITY OF THE FUTURE

By 2030, almost 60% of the world's population will live in urban areas. The way in which cities are organized will play an always bigger role in terms of social, environmental, and economic sustainability of human societies.

The Vision dreams about the “City of the Future”: a combination of renewable energy sources, for local electricity and heating/cooling supply at house level, with or without storage facilities, and electrical cars integrated into the system. It envisions large heating networks fed by geothermal heat, with intelligent exchanges of energies between houses and the major supply pole. It will be a city that has 100% renewable sources in terms of electricity, heating/cooling and mobility, with zero impact on the environment (no pollution, no GHG emission, no long-distance transportation of fossil fuels), where citizens will act as “prosumers” in a smart, clean, renewable and sustainable system.

Figure 2.
Vision of the city of the future
(Source: ETIP DG,
vision for deep geothermal, 2018)



DEEP GEOTHERMAL IN EUROPE TODAY

With its long tradition of electrical power production, first developed in Italy at the dawn of the 20th century, and of district heating, almost one century old in Iceland, geothermal is one of the first pillars of the renewable energy system in Europe. Today, geothermal energy is being developed quickly across Europe, from the Netherlands to Switzerland, as a solution for decarbonised domestic energy supply.

In areas of historical development, the Levelised Cost of Electricity (LCoE) from geothermal is very competitive with renewable and conventional capacity, not including the supply of heat for various applications which largely contribute to energy efficiency improvements in addition to the penetration of renewable energy sources. By the 1970s, only a few geothermal power plants had been installed in Europe (mainly in Italy and Iceland), but with the development of binary cycle technologies, which can produce electricity from lower temperatures, geothermal plants were then set up in other countries as well. Today, there are 102 geothermal power plants in seven European countries, with a total installed capacity of 2,5 GWe. Electricity generation from geothermal resources has a huge potential in Europe. Especially when the new generation technologies for enhancing heat extraction become competitive, electricity could be generated in most European countries. In Europe, where the heating and cooling sector represents nearly 50% of the energy demand, the 280 geothermal district heating plants already in operation in 24 countries use just a minimal part of the enormous geothermal potential. With 163 plants under construction or investigation in 2016, the heating capacity from deep geothermal sources in Europe is expected to grow significantly and the same goes for industrial applications (i.e. food industry or bio-refinery, etc.).

A VISION FOR THE FUTURE

Alongside its already numerous and diversified applications, the geothermal sector has many more possibilities for further development. The Vision aim is to use deep geothermal to cover a large part of domestic heat and electrical power in Europe. It goes beyond the urban areas, by exploring the numerous applications already in operation producing heat for industrial and agricultural processes, for balneology and health spas. As the scientific knowledge and the technological developments are moving forward, augmenting the efficiency and the accuracy of plants, the geothermal community is also expanding. Thanks to continuous innovation, geothermal resources that previously were out of reach will be explored and developed. The new technologies will make it technically and economically feasible to deliver hot fluids even in low temperature areas. The increase in the number of wells also means increased knowledge of the underground, which will in turn improve forecasting of underground conditions and the performance of applications, enhancing the resilience of the system.

CHALLENGES AHEAD

Of course, these ambitions cannot be realized without a collective commitment. As we have learned in the last decades, energy transition is not only a matter of techno-scientific innovation, but also of cultural habits, social issues and political choices, which are strongly interconnected. ***To redesign the European energy systems towards a more sustainable future, it is fundamental to put in place an interdisciplinary, open, 360 degrees approach, which cannot exclude the inexhaustible, renewable, and indigenous heat flow running under our feet.***

