Annual Monitoring Report

YEAR 1 – June 2020

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Deep GEOTHERMAL IWG
SUPPORT UNIT

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Introduction

This report presents the first Annual monitoring in June 2020 of the key performance indicators established by the IWG. It will be updated every year.
EGEC oversees the monitoring of the key performance indicators (KPIs) established in the report D6.5.
The SU-DG-IWG partners together with the members of the IWG evaluate and monitor the learning curve of the different geothermal technologies through reference assets and plants.

This first report is then listing the reference plants and assets and referring to a starting point in terms of costs.

The main objective is to establish mechanisms to monitor the RD&I activities set by the Deep Geothermal Implementation Plan and to start the monitoring process. The impacts of RD&I projects are defined by quantified smart performance indicators referred as reference plants and assets. Results of this reporting aims at facilitating the work of the IWG by understanding the current trends in R&I in order to adopt corrective implementation measures if needed.

MONITORING BASELINE

The DG-IWG decided to have as baseline the date of endorsement of the Implementation Plan by the SET Plan Steering Committee i.e. 24/01/2018.
The costs data correspond to the year 2019. They are reported mid-2020, following the adoption of the reference plants and assests in D6.5.

Key Performance Indicators

The reference assets are used to assess progress against the targets of the implementation plan of the SET-Plan's action on deep geothermal energy, which is one of a number of technologies that have been identified in two actions whose purpose it is to position Europe as "No. 1 in Renewables". Those actions are (1) to sustain technological leadership by developing highly performant renewable technologies and their integration in the EU's energy system and (2) to reduce the cost of key technologies. The Deep Geothermal Implementation Plan has 8 research and innovation activities as well as 2 activities on non-technical barriers and enablers that serve to address the targets of the declaration of intent.

The indicators refer both to geothermal power and/or heat plants and key assets.

Six plants are considered: three for power production including one on EGS, and three plants for heat supply including one combined heat & power system:

- 20 MW_e high temperature plant (Flash turbine)
- 10 MW_e medium temperature plant (Binary turbine)
- 5 MW_e electric EGS plant (or thermal EGS plant with a capacity of 25 MW_{th})
- 10 MW_{th} heating plant
- 10 MW_{th} heating plant assisted with large heat pumps
- 5 MW_e and 20 MW_{th} CHP plant

A series of assets are presented in this first report. Following reports will not only update costs data but also add new assets made relevant by technological development.

REFERENCE PLANTS

The choice of reference plants was defined to specifically address the challenges defined in the Implementation Plan's target to "Reduce production costs of geothermal energy (including from unconventional resources, EGS, and/or from hybrid solutions which couple geothermal with other renewable energy sources) to below 10 €ct/kWhe for electricity and 5 €ct/kWh_{th} for heat by 2025".

For each plant category, the reference plant has been taken from the costs of plants in operation. The source is often from a basket of plants in a developed area, for example:

- 20 MW_e high temperature plant (Flash turbine): Tuscany, Italy
- 10 MW_e medium temperature plant (Binary turbine): Bavaria, Germany
- 5 MW_e electric EGS plant (or thermal EGS plant): Alsace, France
- 10 MW_{th} heating plant: Paris region Ile-de-france, France
- 10 MW_{th} heating plant assisted with large heat pumps: France, Netherlands
- 5 MW_e and 20 MW_{th} CHP plant: Bavaria, Germany

The costs of geothermal plants depend notably upon economies of scale. The levelized cost of electricity decreases with an increase in installed plant capacity. In general, economies of scale allow both, unit capital cost (in euros per kW installed) and unit operating and maintenance cost (in euros per kWh produced) to decline with increased installed capacity.

2019			
Plants	Capital Costs	Production Costs	Comments
20 MW_e high temperature plant (Flash turbine)	€33-62 million in total	38/52 €/MWh_e[1]	€1.65-3.1 million/ MW_e
10 MW_e medium temperature plant (Binary turbine)	€22-37 million in total	140-180 €/ MWh_e	€2.2-3.7 million/ MW_e
5 MW electric EGS plant (or thermal 25 MW_{th})	€35-50 million in total	Not available	€7-10 million/ MW_e
10 MW_{th} heating plant	€13-20 million in total	15 to 55 €/MWh[2]	€1.3-2 million/ MW_{th}
10 MW_{th} heating plant assisted with heat pumps	€16.5-24 million in total	15 to 55 €/MWh	€1.65-2.4 million/ MW_{th}
5 MW_e and 20 MW_{th} CHP plant	€18-25 million in total		Combined heat & power costs

[1] International Renewable Energy Agency (2017) « Geothermal Power Technology Brief ».
[2] ADEME (2020) “Costs of RES in France”

REFERENCE ASSETS

For the purposes of the development of key performance indicators for the Deep Geothermal Implementation Plan (the 8 research and innovation activities) “assets” were defined as any activity that has the potential to help deliver the targets of the Deep Geothermal Declaration of Intent and specifically the cost targets. The activities have economic and commercial value and hence are characterized as “assets”.

2019			
Assets	Capital Costs	Comments	
average cost of identifying a resource	€350,000 and €1,000,000	costs of exploratory drilling is excluded	While many of the assets that constitute value of exploration techniques are low cost, the costs for 2D & 3D seismic surveys and sophisticated modelling tools may be substantial.
Cost estimates for resource exploration	€1-10 million	for the full exploration phase	
Drilling costs to a depth of 1800 m and rate of penetration (hole-making) of 5-10 m per hour	€4 million per well	For a typical heat plant	
Downhole pumps: ESP	€180,000 - €300,000	Investment cost for selecting and installing an ESP	
Yearly operational costs	€60,000 - €100,000	without including the electricity costs for driving the pump.	

Piping and controls for steam gathering	€80,000 - 200,000	steam gathering system of a high temperature flash system can exceed €300/kWe once installed	
heat exchanger	€130,000 – 150,000	most expensive positions are manufacturing (welding, machining, assembling…) and the acquisition of tubes and sheet plates	
Large Heat Pumps of 4 MW_{th}	€3.5 - 4 million		
Transfer station of a 1 MW_e power plant	€80,000 - €85,000		
Routing and cable installation	€100-150 per meter		
District heating grid	€1 million/km	On average	

Perspectives

Inputs will be collected in 2020 to report a broader perspective in 2021. The aim is to update the six reference plants in a report with a European average and costs ranges coming from plants from all over Europe.

The deployment of geothermal electricity production in Europe has continued in 2019 following the positive dynamic of the previous year. The new developments happened in the highly dynamic market of Turkey, in a 'low-temperature country' as Germany through a new project commissioned and with a retrofit of an old installation in Iceland. These new developments brought the European geothermal electricity generation capacity to 3.3 GWe for a total of 130 geothermal power plants across Europe, a 5% growth from the previous year. At the end of 2019, there were 130 operating installations in Europe, 36 projects under development, and 124 projects in the planning phase. This predicts that the number of operating plants could double in the next 5-8 years. Moreover, while the European geothermal electricity market remains heavily dominated by 3 countries – Turkey, Italy, Iceland – and exists in only a few more, recent milestones and an ongoing trend draw a different picture for the future.

Europe is a leading global market for geothermal district heating and cooling for buildings, industry, services and agriculture. In 2019, there were 5.5 GW_{th} of installed geothermal district heating and cooling capacity in 25 European countries, corresponding to 327 systems. The status of geothermal district heating and cooling in Europe reflects a strong interest for this renewable resource and the possibility to implement it almost everywhere in Europe. The trend of ongoing projects anticipates a rapid acceleration and diversification in leading markets. The number of annual installations has also stabilised in the past three years, thanks to the steady deployment of new capacity in the Netherlands. This country continues to be the driving European market for deep geothermal heating and cooling, with 6 newly commissioned systems in 2019 (representing 100 MW_{th}).

Regarding reference assets, current defined assets will be updated with new data and new assets may be integrated.
Thanks to continuous technological developments, geothermal resources that previously were out of reach will be explored and developed. The new technological assets will make it technically and economically feasible. These new assets like storage will be assessed in the upcoming years.

Data will notably be updated with inputs from Netherlands: SDE+ reference plants OPEX/O&M cost described in the yearly SDE+ advice report by PBL on behalf of Dutch Ministry[3].

In the upcoming versions of the KPI report, new aggregated data will be checked against real-life data.
For example, the first real-life cost benefit data for Underground Thermal Energy Storage will come from the Dutch UGTES Pilot at ECW that is being realised within the framework of GEOTHERMICA's HEATSTORE project.

[3] PBL 2020 report, that is used as a basis for the SDE+ feed-in premium system for renewables (electricity and heat) : https://www.pbl.nl/sites/default/files/downloads/pbl-2020-eindadvies-basisbedragen-sde-plus-plus-2020_3526_27-02-2020.pdf . Geothermal reference plants are described in chapter 7, page 60-71.