EUA-EPUE
European Platform of Universities in Energy Research & Education

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EUA-EPUE Response to SET-Plan Consultation

Key Action No. 1 and 2: "Deep Geothermal Energy"

BACKGROUND

This response provides the perspective of the European Platform of Universities in Energy Research & Education (EUA-EPUE) to the consultative process on the European Strategic Energy Technology Plan (SET Plan) - Key Action No. 1 and 2 “Deep geothermal energy”.

EUA-EPUE responds to the consultation from the perspective of the universities’ role in society. Universities constitute a significant part of the research capacity in Europe. At the same time, they educate the highly skilled work force of our societies. We consider therefore that setting up the SET-Plan projects with ensured integration of innovative research with education, including industrial partners, will provide a high pay-off towards achieving the energy system transition, which is a major objective of the SET Plan and the European Union.

RESPONSE

For the main expected outcome: To make specific recommendations on the priorities/targets proposed in the issues paper(s)

- Do you agree with the targets set in the issue paper?
- Do you think that the level of ambition is correct?
- Are there any standing issue(s) in the way to reaching the proposed targets/priorities?

It may be useful to understand the broader context in which these targets/priorities need to be achieved. If possible, we suggest that the following is addressed as well:

- *What are your specific recommendations on prioritising R&I activities on these issues (and building where appropriate on relevant existing initiatives)?*
- *Who are the best placed actors to implement the targets/priorities (Industry, EU, Member States, regions, groups of countries/organisations/etc.)?*

Comments on Introduction:

- The distinction between deep and shallow geothermal systems is described. However the distinction between low and high temperature (or enthalpy) systems should be made (i.e. low<150°C and high>150°C) as this indicates whether systems are capable of producing heat and electricity or heat alone. Also, it should be noted that the lowest temperature from which power is currently generated is 72°C[1] . Success of such system is the large difference between ambient air temperature and resource temperature, i.e. in cooler climates more heat can be recovered[2].

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[1] Holdmann, G. (2006) The Chena Hot Springs 400kW geothermal power plant: experience gained during the first year of operation, in: Chena Geothermal Power Plant Report. Chena Power Plant, Alaska, 2007 pp. 1-9

[2] Adams, C.A., Auld, A.M., Gluyas, J.G. and Hogg, S. (2015) Geothermal energy–The global opportunity. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, *229*(7), pp.747-754.

- The total gross production of derived heat in the EU in 2013 was 2.45 million TJ, the highest share of this (40.2%) was produced using natural gas.[3] Geothermal heat therefore has important future roles in offsetting the use of gas for heat production and is compatible with district heat networks.
- The impact and benefits of heat utilisation in terms of energy security and reduction of emissions should be discussed. Geothermal heat cannot be transported far without substantial losses so its use essentially needs to be indigenous to the country of origin. This contrasts strongly with gas much of which needs to be imported to the EU. Utilisation of geothermal heat would improve national energy security and at the same time help nations hit their carbon emissions targets.

Comments on Targets:

General comment 1: The targets are mainly focused on a technical perspective. Some attention should be given to social and environmental issues. These include for instance public acceptance for developing geothermal projects in the vicinity of populated areas, as well as the advantages of using warm water for space heating. Some attention should also be given to downstream use of the waste streams from geothermal plants that might increase the benefits and social acceptance; this might also include the development of Geothermal Resource Parks.

General comment 2: The paper does not currently address in any detail the direct use of heat which has a great potential in many locations in the member states. This might be addressed in relation to deep geothermal as a downstream use of the waste streams that are produced during electricity generation.

Target related to cost reduction

1. Reduce the exploration costs by at least 25% in 2020, and by 50% in 2050, expressed as reduced number of abandoned projects

- On the one hand, the enlargement of the geothermal market may help to lower the prices of field acquisition by a mass effect. Nevertheless limited impact is expected in a near future. On the other hand, the efficiency of the exploration to avoid abandoned projects is a real way of progress.
- The use of 3D seismic should be encouraged: most of the targeted geothermal reservoirs are along faulted zones, with mostly 3D geometries, and sub-vertical dip faults, leading to the need of large offsets. The 3D seismic is about to provide sufficient resolution and geometric control at depth to position the drilling boreholes. The technology is mature, widely used in oil and gas exploration. The major issue is the cost per survey. In addition, most of the exploration area for geothermal energy are on-shore. Nevertheless, gain in 3D resolution for the specificity of the imaged structures, should improve significantly the predictability of the reservoir properties when using 3D vs 2D seismics.
- The use of 3D vertical seismic profile, offset or 3D Vertical Seismic Profiling (VSP), should also be promoted. Examples include the design and positioning of the next boreholes after a first

[3] Eurostat (2014) Energy, transport and environment indicators. Luxembourg ISSN 2363-2372

exploration borehole has been drilled. This mature technology also comes from the oil and gas industry. It may provide an economically efficient solution to obtain 3D information, down to great depth with higher resolution than surface seismics. The limitation is the need of a priori exploration borehole and the covered volume close to the borehole. The improvement in imaging specific targeted geological features for geothermal energy should be demonstrated. Specific processing and attributes may be developed.

- The use of dense passive seismic networks should be encouraged. On a temporary basis it may provide higher resolution than seismologic images and provide a very low threshold microseismic monitoring during development phases. It provides 3D velocity model to complete 2D seismics and allow to detect and locate very low amplitude microseismic events. Practically, it results to be difficult to use such techniques close to urban areas. The specificity of the characteristics of the seismic noise may not be optimal (anisotropy, frequency content, etc…) which may suggest specific improvement in processing and methodology.
- An integrated exploration programme should be promoted for deep geology, especially below the sedimentary cover: most sedimentary basins have been at least partially explored for oil and gas, or mining exploration. Nevertheless, the exploration depth of these previous studies rarely provides information on the basement itself whereas the transition zone or deeper is expected to provide the necessary permeability or a sufficient temperature. Integrated exploration means all domains of geosciences, in particular geophysics (seismics, gravimetry, aeromagnetism, deep electrical resistivity), geology, geomechanics, etc.

Target related to cost reduction

2. Reduce the drilling costs by 15% in 2020, 30% in 2030 and by 50% in 2050.

- Drilling costs are related to other market forces, e.g. shale gas industry and the petroleum price as these industries use the same equipment. Changes in the oil price will be reflected in drilling costs. As the recent history of petroleum exploration and development costs shows, the annual variations are larger than the forecast geothermal cost reduction trends and targets. Hence, absolute cost reduction forecasts need to be calculated very carefully. It is therefore more appropriate to compare geothermal with fossil fuel costs.
- A non-technical intervention would be to promote risk insurance schemes in order to make it more attractive for investors with limited knowledge of the field to invest in projects. The risk in geothermal projects is perceived to be high and/or ill-defined, similarly to what was the case for offshore wind in the beginning.
- **On action points**: No substantive comments are made on the role of the petroleum industry or petroleum industry technology on future developments of geothermal. Some of the actions already being called for are in place already in the petroleum industry. The geothermal industry could easily short-cut development times by doing so. Similarly, end of life (oilfields at least) in the

petroleum industry could provide old, used, holes in the ground at minimum costs for geothermal development[4,5].

Target related to performance improvements

3. Improve the overall efficiency of geothermal installations, increase reservoir management and ensure sustainable yield predicted for a given period +/- 20 years by 2030.

- It is necessary to improve investors` confidence to facilitate widespread development of deep geothermal energy in the EU. Several options exist, including the reuse of infrastructure associated with mining, oil and gas or shale gas wells. The use of single well systems that only require one borehole offers less heat per well. They are however more independent of potential geological constraints.
- Most nations can access geothermal heat though not all can develop heat and electricity projects. Therefore there is some disparity in countries using geothermal energy. Developing heat and electricity plans could be foreseen for each member state.
- Reservoir engineering in fractured reservoirs (natural or induced), and maintaining the heat exchange efficiency with time, is a complex operation. The petroleum industry has extensive experience in managing multiphase flow in oil and gas fields which typically occur in sedimentary basins, fractured or not. There is less experience in both petroleum and geothermal systems in granite and other plutonic rocks which will form the bulk of high enthalpy shallow geothermal systems. Even there, the question of hydraulic and temperature interferences between doublets is an issue which will impact the overall efficiency in future densely exploited zones. Improvements are needed in terms of data input and models refinement. In a broader sense, the hydro-chemical behaviour of the reservoir with time is a complex issue, with few case studies in the literature. This may have both and economic and environmental impact.
- New techniques based on permanent monitoring, surface based (Global Monitoring System (GPS), Interferometric synthetic aperture radar (InSAR), seismic noise interferometry, tomography) or in the boreholes, in particular optic fiber (permanent temperature and acoustic log, deformation, etc.) will provide new data to ensure the durability of boreholes. Despite rapid improvement during the last decade, further effort is needed in field application in order to test and demonstrate the gain in a better reservoir management.
- Unconventional resources, such as fields and wells with supercritical conditions, very high heat and pressures, should be considered. To this regard, significant opportunities for high yields exist.

[4] Auld, A., Hogg, S, Berson, A. and Gluyas, J.G. (2014) Power Production via North Sea Hot Brines *Energy* **78,** 674-684

[5] Hirst, C.M., Gluyas, J.G. and Mathias, S.M. (2015) Late field life of the Midlands Petroleum Province – A new geothermal prospect? Quarterly Journal of Engineering Geology and Hydrology (doi:10.1144/qjegh2014-072)

Target related to cost reduction and to performance improvements

Reduce EGS production costs below 12 €ct/kWh by 2020; establish 5 EGS plants in different geological situations, of which at least one plant of capacity 20 MWe or 40 MWth, for the technology to reach commercial-scale stage.

- The target, rather than aiming to reduce Enhanced Geothermal System (EGS) costs below a fixed price, should aim to achieve EGS cost parity with established alternatives for electricity generation.
- This section should include a target specifically aimed at the development of direct heat systems. The EU gross inland gas consumption in 2012 was 16 million TJ, 66 % of it covered by imports[3] with an increasing trend towards imports. Using geothermal energy (or waste process heat) with heat networks could displace the use of natural gas thereby reducing CO_2 emissions and making a proportional impact upon energy security.
- Nowadays, aside from the volcanic areas where geothermal industry is well implanted (which could be made even more efficient), a set of successful demonstration projects can strengthen the deep geothermal industry in continental Europe. Other suitable geological and tectonic contexts, outside of volcanic areas, could also be used. The communication concerning these projects should involve, on the one side, the public for the environmental impact, and on the other side, the stakeholders in order to demonstrate the range of applicability of deep geothermal. In order to achieve the target in 2020, more effort is needed by the member states, especially with respect of establishing 5 EGS plants.

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