DEEPEGS project management - Lessons learned

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ABSTRACT

The DEEPEGS Horizon 2020 Innovation action project *"Deployment of deep enhanced geothermal systems for sustainable energy business"* was selected for funding in 2015, and its official launch was in December 2015. The project's total budget of 44 million Euro received an EU grant of about 20 million Euro for its four years duration, making this one of the larger publicly funded H2020 projects. The consortium of 10 partner organisations is from the geothermal industry, technical and oil- and gas sectors, and research organisations coming from five European countries. The main objective was to test and demonstrate Enhanced Geothermal System (EGS) technology in three different geothermal systems and geological settings with the goal of facilitating the transferability of the expected results to other deep geothermal sites throughout Europe and worldwide.

The project has over its life cycle encountered several hurdles that have needed to be addressed by the consortium management. Number of these directly link to policy actions or sometimes inaction or slow administrative processes that clearly do not facilitate evenly the successful implementation across the European Economic Area (EEA), and market considerations are not equal across the common EEA market zone.

1. INTRODUCTION

The project management lessons learned from the DEEPEGS project will be addressed in this paper. Project management perspective from within a complex collaborative international publicly funded research and innovation action will be shared, as well as insights gained from the policy environment. The aim is to share the experience gained and discuss how the barriers encountered might be addressed to enable geothermal developments to be deployed more widely. The knowledge and technical developments from DEEPEGS need to be more actively facilitated and transferred to the geothermal sector across Europe and around the world. The public research funding for this and other geothermal projects makes it an obligation to exploit the innovations developed, and share lessons learned in the project.

The successful drilling in Reykjanes for the deep well is thoroughly described by G. Ó. Fridleifsson *et. al* (2017, 2018), and the background geology and structure of the volcanic Reykjanes system in Iceland by K. Sæmundsson, *et al.* (2018). The drilling of the well began in August 2016 and the well was completed at a depth of 4659 m MD (Measured Depth, 4.5 km vertical depth) in January 2017. Supercritical conditions were encountered at the bottom (measured temperature: 426 °C and estimated to be around 500–530 °C at 340 bar pressure (Fridleifsson et al., 2017; Stefanson et al., 2017). The high-enthalpy well in DEEPEGS, is commonly referred to as RN-15/IDDP-2, and a recent paper from Peter-Borie et al. (2018) describes the borehole damaging under thermo-mechanical loading. The research work at Reykjanes well site provided the project consortium with opportunities to deploy monitoring tools at the geothermal field and improve the knowledge base for future work and other projects (Darnet et al., 2018). Fridleifsson et al (2019) discusses the impacts generated from the deep IDDP-2 (DEEPEGS) well in Reykjanes and how this work provides improved understanding of the geothermal reservoir and connectivity to the other production wells in the geothermal field.

This paper presents a current overview from an ongoing active project, and the following list of issues and lessons learned are among those that can be presented and discussed now by this paper:

- Licensing of geothermal projects under different policy regimes,
- Project management and disruptive decision-making barriers,
- Funding mechanism, partner commitments and lessons learned,
- Transparency and trust among actors,
- Public relations and outreach communications.

2. DEEPEGS PROJECT

The H2020 call Topic: *LCE-3: Demonstration of renewable electricity and heating/cooling technologies* for this project had specifically requested the following geothermal coverage:

***Deep geothermal energy**: Testing of enhanced geothermal systems in different geological environments – Widespread deployment of enhanced geothermal systems (EGS) needs new and improved models and innovative solutions are needed to routinely create EGS reservoirs with sufficient permeability, fracture orientation and spacing. Cross-fertilisation with hydrothermal fields and cross-fertilisation with tight oil and gas fields can be explored.*

The DEEPEGS project consortium, coordinated by the Icelandic energy company HS Orka, brings together geothermal research organisation, companies from both the geothermal and oil and gas energy industry sectors. The 10 partner organisations (Fig. 1) jointly mobilise the required expertise and cross-fertilisation required to demonstrate the feasibility of creating EGS reservoirs for wider future deployment in Europe and elsewhere.

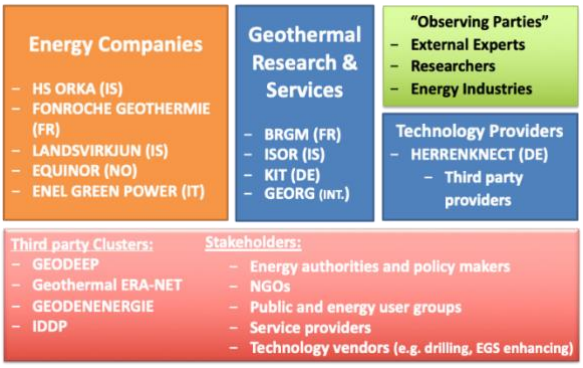

Figure 1 - The figure shows categories partners in the DEEPEGS consortium, 5 energy companies (50%), 4 geothermal research organisations (40%) and one specialised drilling technology company (10%). The consortium is as well extremely well networked to other relevant actors and stakeholders of key importance for successful uptake of the results and future exploitation of the demonstrated results

The project planning streamlines as well inputs from previous geothermal projects through earlier work by some of the partners (Fig. 2). The vision presented had an original ambition of two demonstrator countries, two sites in France, and one in Iceland.

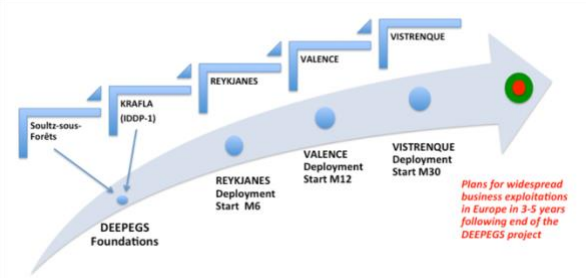

Figure 2 The original stepwise progressing of the planned demonstrators

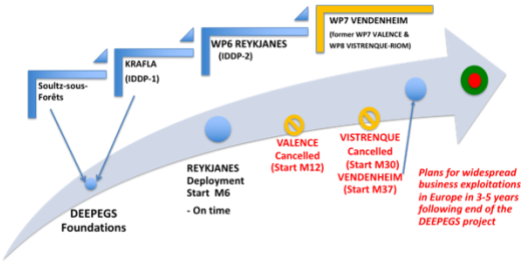

Figure 3 - The modified demonstrator planning with move to Vendenheim, Alsace as the single demonstrator site in France.

Fig. 3 above shows the modified approach required for the demonstrator site planning in France that mitigated the risks and delayed licensing processes in France.

The DEEPEGS project brings together existing technologies and new development inputs at lower Technology Readiness Levels (TRL) that are being taken forward to a higher TRL and to be demonstrated in the field. Figure 4 shows how the project consortium aims to deliver some technologies at levels up to TRL6-7, and improved business models that could be close to being market ready at the end of the project.

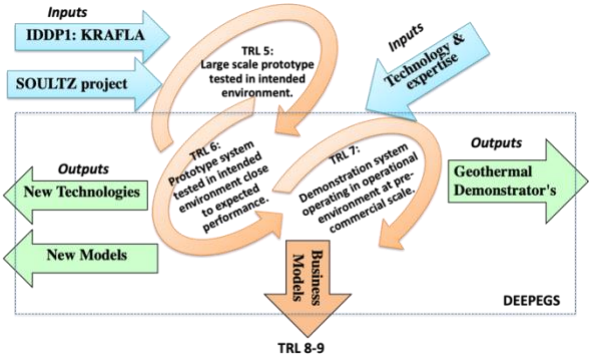

Figure 4 - The DEEPEGS ambition is to progress know-how inputs starting at TRL4-5 at DEEPEGS start, and anticipated progress to TRL 6 and TRL 7 stages during the project.

The work has been progressing very well on deep drilling into the high-enthalpy volcanic rock formation in Reykjanes, but only recently in the Vendenheim demonstrator that currently is pending a grant amendment by the Innovation and Networks Executive Agency (INEA) of the European Commission that

manages the H2020 grant agreement for DEEPGS. The drilling of two wells in Vendenheim down to about 5 KM depth is completed, and currently the EGS demonstrator is undergoing multi drain drilling and later stimulation which will be followed by flow testing later this year, 2019.

In Reykjanes the casing damage (Peter-Borie et al, 2018) has once more showed the importance of new flexible couplings technology development (GEOWELL H2020 project[1]). Testing ending in GEOWELL at TRL4 (Ingolfsson et. al. 2016, 2017), but will be continued as progressive work in DEEPEGS to advance this further to TRL6 level.

Another technological development in the project is a drilling tool technology manged by partner Herrenknect Vertical GmbH, and field testing. at TRL5-6 could take place during latter half of 2019.

The DEEPEGS project management has in place monitoring, quality and risk management procedures. Also, project management bodies like the Executive Board, a Project Office and a qualified and experienced coordination team. This proved to be crucial in moving the project forward and enabled the mitigation of risks. The consortium worked jointly to seek solutions and during 2018 a number of extraordinary management meetings were required to progress the consortium plans. Several meetings with INEA were also organised to provide the funding agency with up to date information on the situation.

2. LICENSING POLICY OBSERVATIONS

In Iceland the regulatory and policy framework for geothermal projects is linked to similar policy processes and licencing processes as found in some EU countries. Environmental assessments and planning licences are required for new fields prior to their development. Orkustofnun (2019) is responsible for the licensing process. The ownership of resources inside the ground is attached to a private land, while on public land resources inside the ground are the property of the State of Iceland, unless others can prove their right of ownership. Even though the ownership of resources is based on the ownership of land, research and utilisation is subject to licensing according to the Act on Survey and Utilisation of Ground Resources, No. 57/1998 and the Electricity Act, No. 65/2003. Survey, utilisation and other development pursuant to these Acts are also subject to the Nature Conservation Act, Planning and Building Act and other acts relating to the survey and utilisation of land and land benefits.

In France the regulatory framework and licensing process has been recently described by Dumas et al, and Fraser (2013), and that the French mining law distinguishes two steps in every mining project, including geothermal: the first one is exploration and the second one production. Therefore, the rules of licensing consist in two permits: the exploration license or the production license. Boissavy (2015) confirms that the main barrier in France remains administrative constraints and delays to get the permission for drilling.

In the DEEPEGS project two geothermal demonstration sites were planned in France and the company Fonroche Geothermie[2] had secured the exploratory licenses for the two planned geothermal sites. However, the drilling licences are managed under the French mining code and regional approval process was required separately for both the sites. This licensing process was very time consuming and several hurdles had to be overcome step by step. Repeatedly, the company needed to delay planned drillings due to the slow progress at the regional level. The timeline in the French sites slipped continually, and finally in 2018 an alternative solution was needed within the DEEPEGS project. An alternative demonstrator site in Alsace, France that Fonroche had obtained all licences for is through a pending grant amendment being brought into the project, replacing the original two planned demonstrators in the H2020 project. The drilling work in Vendenheim started by Fonroche in 2018 and in first half of 2019 two deep wells have been drilled and becomes the DEEPEGS project's alternative French demonstration site.

Currently the work in Iceland and France demonstrators is focused on the EGS part and flow testing of the wells is to be carried out in 2019 and continuing into 2020. Data on geothermal fluids and energy potential will be available for reporting during 2019 and presented at the WGC 2020 event.

The lesson learned regarding policy environment and geothermal project licensing was a truly difficult and uphill journey for the French industrial energy partner. This delayed significantly the planned work in DEEPEGS and put the project at a significant risk for achieving the main objective of demonstrating successful EGS outcomes.

- Regional governance and regulatory barriers,
- Slow processing of licensing issues, in part due to lack of experienced government officials in France,
- As the mining code regulates the process for geothermal, few staff available with required expertise on geothermal,
- In France, some regions have very limited background on geothermal, exception being Alsace and Aquitaine region
- Geothermal is possibly the "GREAT-Unknown, or a know-how mystery, therefore, caution takes charge and slow actions become the current norm.
- All licenses for the geothermal site need to be confirmed prior to launching the project,

[1] The GEOWELL H2020 Project, http://geowell-h2020.eu. Visted by Internet, 6 March 2019.

[2] Visted by Internet 6 March 2019, https://www.fonroche-geothermie.com/

- For risk mitigation, an alternative site needs to be identified should any unforeseen issues arise for the site,
- More flexible arrangement for realigning H2020 funding within a project, should mitigation actions be required,
- Strong internal communications among partners,
- High-level of collaborative trust between partners is crucial and willingness to share timely information,

The DEEPEGS project consortium is currently working on the preparation of numerous scientific papers and reports. These are being prepared for publication in open access formats to communicate the significant scientific know-how generated and the crucial lessons learned at the DEEPEGS Reykjanes geothermal demonstrator site. Many of these are targeting the World Geothermal Congress in Reykjavík in April 2020 as at this time the core outcomes from DEEPEGS will be available, following the end of the project. The delayed work in the French demonstrator is now coming much later through in the project, but expectations are for wider dissemination and communications regarding outcomes from the Vendenheim demonstrator site as well.

3. CONCLUSIONS

The DEEPEGS project has provided significant new knowledge for deep wells in volcanic regions like Iceland that will be applicable in other regions, like e.g. Italy and internationally. The complex and slow acting licensing processes in France have presented significant barriers for progress in DEEPEGS project. This has impacted the French industrial partner and the whole consortium that needed to devote significant unforeseen effort on project risk mitigation actions. The key lesson learned is that all licenses for the geothermal sites need to be confirmed prior to launching a H2020 funded project. At project management level the core lesson learned is on the core importance of trust among actors and transparency of timely information sharing.

REFERENCES

Boissavy, C., Rocher, P., Laplaige, P., Brange, C.. Geothermal Energy Use, Country Update for France. European Geothermal Congress 2016 Strasbourg, France, 19-24 Sept 2016 .

Dumas, P., Kutschick, S., Kutschick, R., Fraser, S., Reith, S., Koelbel, T. REPORT ON GEOTHERMAL REGULATIONS, GEOELEC deliverable report D4.1 Report presenting proposals for improving the regulatory framework for geothermal electricity, by internernet on 8 March 2019; http://www.geoelec.eu/wp-content/uploads/2015/10/D-4.1-GEOELEC-Report-on-Geothermal-Regulations.pdf and by Appendix-1; S. Fraser (Editor) http://www.geoelec.eu/wp-content/uploads/2011/09/D4.1-A.1-Overview-of-National-Rules-of-Licencing.pdf

Friðleifsson, G.Ó., Elders, W.A., Zierenberg, R.A.,, Ari Stefánsson, A., Fowler, A.P.F., Weisenberger, T.B., Harðarson, B.S, and Mesfin, K.G. , The Iceland Deep Drilling Project 4.5 km deep well, IDDP-2, in the seawater-recharged Reykjanes geothermal field in SW Iceland has successfully reached its supercritical target. Sci. Dril., 23, 1–12, 2017 https://doi.org/10.5194/sd-23-1-2017.

Friðleifsson, G.Ó., Elders, W.A., Zierenberg, R.A., Fowler, A.P.G., Weisenberger, T.B., Mesfin, K.G., Sigurðsson, Ó., Níelsson, S., Einarsson, G., Óskarsson, F., Guðnaso,n E.G., Tulinius, H., Hokstad, K., Benoit, G., Nono, F., Loggia, D., Parat, F., Cichy, S.B., Escobedo, D., and Mainprice, D., The Iceland Deep Drilling Project at Reykjanes: Drilling into the root zone of a black smoker analog. Journ.Volc. and Geoth. Research (2018). (https://doi.org/10.1016/j.jvolgeores.2018.08.013)

Fridleifsson G.Ó., Albertsson, A., Stefánsson, A., Þórólfsson, G., Mesfin, K.G., Sigurdsson, K., Sigurdsson, Ó., Gislason, Þ., The Reykjanes DEEPEGS Demonstration Well – IDDP-2. European Geothermal Congress (EGC-2019), Den Haag, The Netherlands, 11-14 June (2019).

Gislason, S.A., Sigurðsson, D., Fridleifsson, G.Ó., 2017. The drilling of RN-15/IDDP-2 research well at Reykjanes in SW Iceland. Geotherm. Resour. Counc. Trans. 512–522.

Darnet, M., Wawrzyniaka, P., Coppo, N., Nielsson, S, Schill, E., Fridleifsson, G.Ó.. Monitoring geothermal reservoir developments with the Controlled-Source Electro-Magnetic..., Journal of Volcanology and Geothermal Research (2018), https://doi.org/10.1016/j.jvolgeores.2018.08.015

Sæmundsson, K., M.Á. Sigurgeirsson and G.Ó. Friðleifsson. Geology and structure of the Reykjanes volcanic system, Iceland. Journal of Volcanology and Geothermal Research (2018) https://doi.org/10.1016/j.jvolgeores.2018.11.022

Orkustofnun (The National Energy Authority) Legal Framework in Iceland, visited by Internet on 6 March 2019, https://nea.is/geothermal/legal-and-regulatory-framework/

Parks, M., Sigmundsson, F., Sigurðsson, Ó., Andrew Hooper, A., Hreinsdóttir S., Ófeigsson, B., Michalczewska, K., Deformation due to geothermal exploitation at Reykjanes, Iceland, J. Volcanol. Geotherm. Res. (2018), https://doi.org/10.1016/j.jvolgeores.2018.08.016

Peter-Borie, M., Loschetter, M.A., Merciu, I.A., Kampfer G., Sigurdsson, O.. Borehole damaging under thermo-mechanical loading in the RN-15/IDDP-2 deep well: towards validation of numerical modeling using logging images. Geotherm Energy (2018) 6:17 https://doi.org/10.1186/s40517-018-0102-7

Thorbjornsson, I.O., Gunnar Skúlason Kaldal (2016). Thermal expansion of casings in geothermal wells and possible mitigation of resultant axial strain. European Geothermal Congress 2016 Strasbourg, France, 19-24 Sept 2016

Thorbjornsson, G.S. Kaldal, B.S. Gunnarsson, Á. Ragnarsson. A New Approach to Mitigate Casing failures in High-Temperature Geothermal Wells. GRC Transactions, Vol. 41, 2017.

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