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Risk Management in Geothermal Projects Funding and Governance Issues

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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 that year. 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.

During the project life-cycle risk management and mitigation became a central activity in the DEEPEGS operations. Firstly, due to licensing problems for the French energy company project partner that encountered unexpected regulatory and public concern barriers at the regional government level in France. This caused significant delays in the project schedule and by the third project year a drastic modification of the planning was needed to avoid research funding termination by the Innovation and Networks Executive Agency (INEA). Secondly, although also a direct consequence, the French geothermal industrial partner had signed on for a research project without previous experience about this funding mechanism, and as well, being a new player in the Geothermal energy sector without the experience needed to execute such a project in the framework of a research funding programme.

The other consortium partners did their utmost to guide and advice the French energy partner about what the consequences might be if they would not comply to the EU grant agreement. After nearly a year of meetings and discussions, a period of no real activity in the French demonstration work, it was decided to opt for a mitigation strategy where the two demonstration sites facing licensing problems were abandoned as part of the DEEPEGS project and an alternative geothermal site in France, fully licensed for the partner concerned, to be brought in to replace the two not being timely licenced. The contract amendment was done in 2019 with some retroactive dating of work into 2018 for the alternative site that had in large part already been drilled for 2 deep wells to be connected with multi-drain drilling and enhanced geothermal system (EGS) protocols, like e.g. soft stimulation to avoid risk of seismicity. This alternative site in France is the first geothermal project to be carried out by the French industrial partner concerned, and the experience has taught them some very hard lessons. The project consortium also learned a lot from this situation regarding transparency and trust issues, and also that often human decision making is not clearly rational, when large amounts of money are involved. Policy actions or sometimes inaction, or slow administrative processes that clearly do not facilitate evenly the successful geothermal implementation across Europe and the European Economic Area (EEA), and market considerations are not equal across the common market zone. The lessons learned from the DEEPEGS project are addressed in this paper and cover perspectives from the project management and from the policy environment. The aim is to share the experience gained and discuss how the barriers might be addressed to truly enable geothermal developments to be deployed more widely and ensure that the knowledge and technical developments can more successfully be facilitated and transferred from publicly funded projects like DEEPEGS.

1. INTRODUCTION

The key project management lessons learned from the DEEPEGS project is 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 review from an Innovation and Demonstration H2020 project that has been concluded, and the following list of issues and key lessons learned are among those that can be presented and discussed 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,
- Amending procedures for H2020 framework contracts,
- Transparency and trust among actors,
- Public relations and outreach communications.

2. THE DEEPEGS PROJECT IMPLEMENTATION

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.

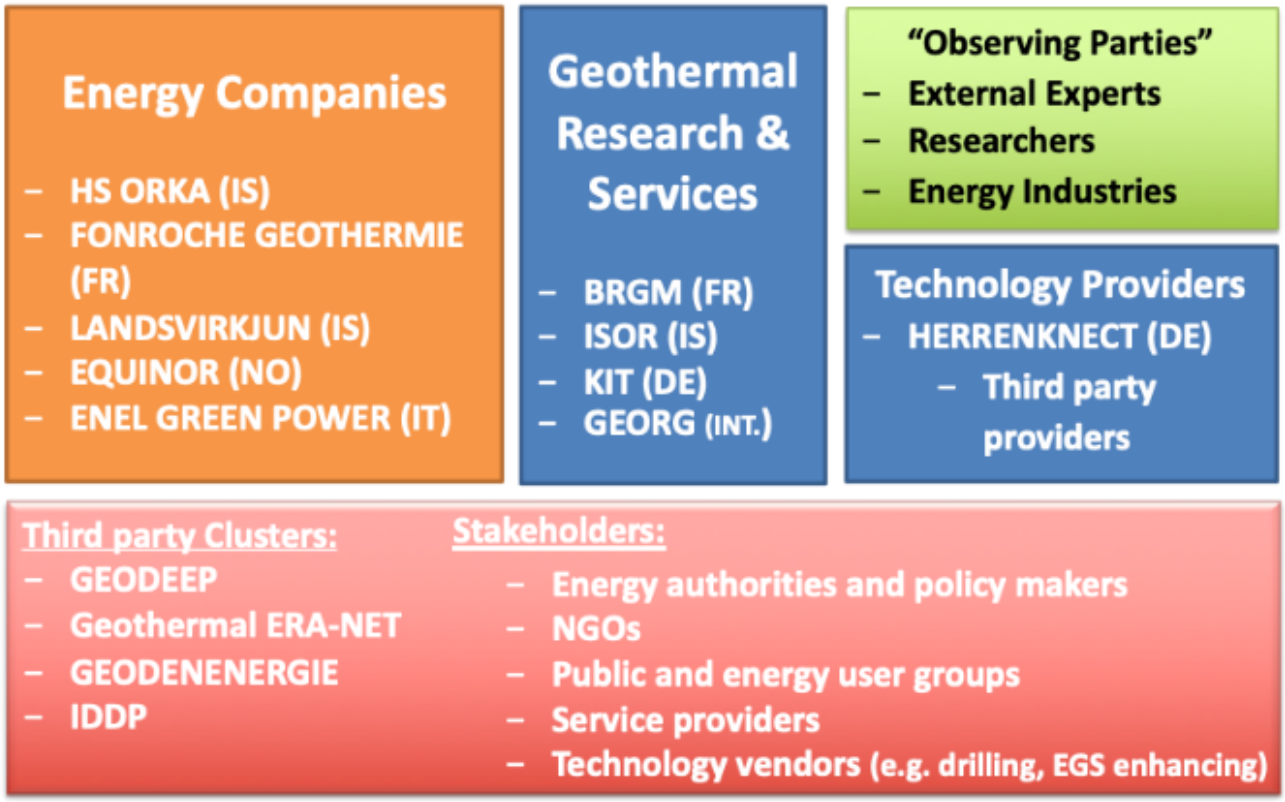

Figure 1: The figure shows categories partners in the DEEPEGS consortium, 5 energy companies (50%), 4 geothermal research organisations (40%) and one specialised drilling technology company (10%). The consortium is as well extremely well networked to other relevant actors and stakeholders of key importance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

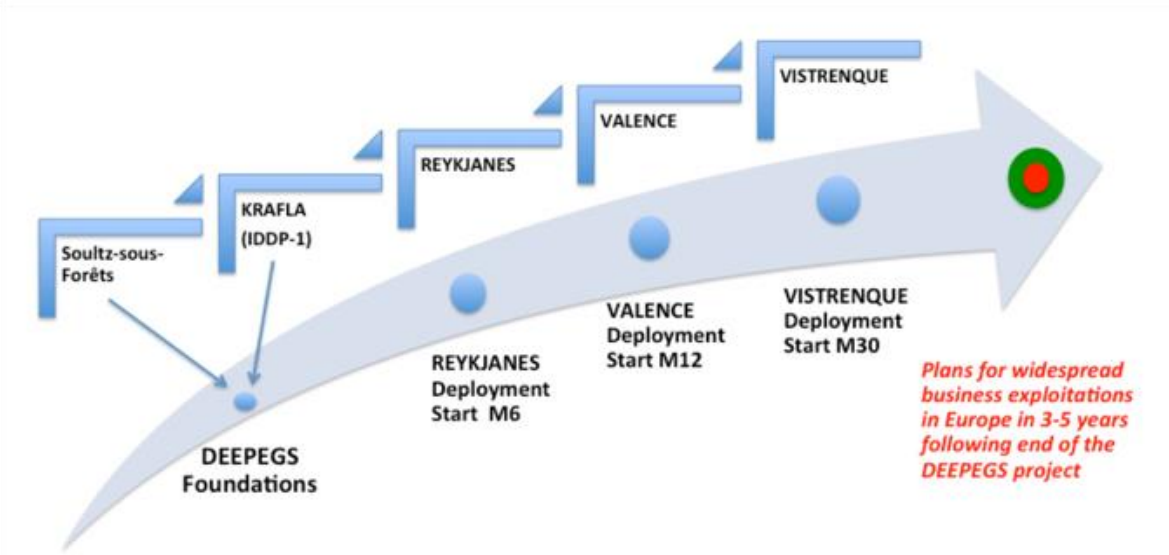

Figure 2: The original stepwise progressing of the planned demonstrators.

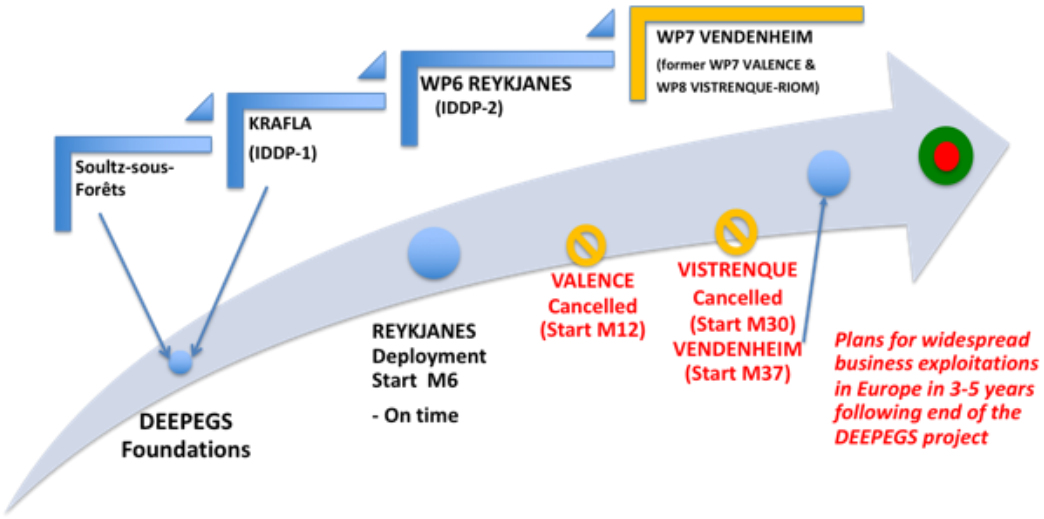

Figure 3: The modified demonstrator planning with move to Vendenheim, Alsace as the single demonstrator site in France.

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 amendment procedures for H2020 research contracts require the consortium partners to justify very well why and how the modification to the grant contract can facilitate the achievement of the overall project objectives. In the case of DEEPEGS project, the consortium needed to request two contract amendments due to the French demonstrator sites. Firstly, partner Fonroche notified that lichenising delays were affecting their progress for the site in Valence (Workpackage no. 7), and the planned Fonroche implementation at Vistrenque could not proceed according to their original plans and therefore an alternative demonstration site needed to be added into the project. This alternative site was in southern France in RIOM-Limagne region and partner Fonroche considered that this site would progress rapidly for licensing and be very relevant as their second project site (Workpackage no. 8). This first amendment procedure progressed from November 2016 up to 12 July 2017 when updated contract was signed by the Innovation and Networks Executive Agency (INEA) of the European Commission that manages the H2020 grant agreement for DEEPGS. However, during the first periodic project review by external expert (22 August 2017) Fonroche reported that the timeline might need to be further delayed for starting the drilling at Valence, and presented overview of a possible timeline for both French sites still within the four-years planned for DEEPEGS.

2.1 Mitigations Needed for the French Demonstrators

The DEEPEGS project management has in place monitoring, quality and risk management procedures and 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 initial mitigation of project implementation risks. In December 2017 the DEEPEGS project had the annual project meeting, hosted by Fonroche in Bordeaux France, and the licensing problem issues in France were discussed further, and the consortium advised that drilling should start in Valence by springtime 2018. Therefore, it came as a shock to all that Fonroche announced in February 2018 that they needed to postpone all plans for drilling in Valence and Riom-Limagne within the current 4-years project period and requested to apply for a 2-years project extension. The given justification by Fonroche was that their drill rig would be tied up at a site in Vendenheim, Alsace until summer 2018 and then be moved to another close by site in Hurtigheim, Alsace. Partner Fonroche proposed as well to offer Hurtigheim as an alternative site to replace one of

the previous demonstrators (Valence/Riom-Limagne). This was discussed by the DEEPEGS consortium, and consensus reached not to request a 2-year project extension as this could not be realistically justified. After informing the EC funding agency INEA about this situation a series of meetings were needed to motivate a reasonable way forward. In March-June 2018 four meetings with INEA were needed to inform about this and search for a justifiable mitigation solution, and Fonroche attended one such meeting in April 2018 to motivate Vendenheim/Hurtigheim. sites and explain the delays encountered for the French DEEPEGS demonstrator plans, where majority of contractual deliverables and milestones had not been achieved.

The consortium was required by INEA to obtain a consensus on how this dire situation could be justifiably be mitigated through a contract amendment. Series of consortium meetings using video conference call services were carried out and an extraordinary General Assembly and Executive Board in person meeting conducted on 15 May 2018 in Leiden, The Netherlands. A consensus resolution was reached there, however, partner Fonroche did not follow through on this agreement and battled to maintain its indicative full grant amount from the original grant (8.2 million Euro). This went against the context of the Leiden Resolution, where, Fonroche would bring in the Vendenheim site as the single French demonstrator. This meant that Riom-Limagne site (WP8) would fall outside of the project, and only WP7 with Vendenheim replacing Valence could continue within the 4-years project plan. The project budget needed to be adjusted to reflect this change in project scope and this reality was not absorbed by Fonroche until several months later. In late June INEA wrote the consortium a letter, where the lack of progress on the French demonstrators was challenged, as majority of contractual deliverables and milestones were severely delayed. This letter threatened a project termination, unless a plausible mitigation solution supported by a consortium consensus would be provided. The initial given deadline was for 10 July 2018 and as the consortium could not reach agreement with Fonroche, the whole project was in jeopardy due to their unreasonable stance on the budgeting scope. A request for extension of the letters deadline was sent in on 10 July to get added time to facilitate an amicable solution, this was granted to 30 August 2018. Further correspondences were delivered to INEA by that time and follow ups until October, when updated Consortium Plan was adopted and consensus on the budget reached. Amendment procedure was launched to bring in Vendenheim as demonstrator (WP7) and cancelling of Riom-Limagne site (WP8), and modification of the grant budget, where indicative max grant to Fonroche was changed to 6.6 million Euro to reflect the change from the DEEPEGS scope of work. The overall grant budget was reduced to 42 million Euro and overall funding to 18.9 million. Some re-distribution of funds was agreed as well, and the most significant was to increase the level of testing of the Flexible Coupling prototypes that had been foreseen in the original grant aimed at increasing to TRL to 6 from a more basic TRL development achieved by the H2020 GeoWell project. The increased funding will allow testing 13 3/8 inch flexible couplings (FC) and machine up to 100 FC for insertion in a production well at Reykjanes for further prove of the concept post-DEEPEGS project. This is seen as providing a big step forward for a patented new technological solution that can significantly increase the success rate in hot wells where casing buckling failures are one the highest risk factor for the geothermal project in general due to well failures or casing buckling.

The second DEEPEGS grant amendment was put in force on 12 July 2019, where the French demonstrator will be the Vendenheim site, and it's expected that flow testing of the doublet wells that include drilled side-tracks be started autumn 2019 and demonstrator open days be held before end of the project. The consortium has requested 5-months extension to facilitate data gathering from flow testing and other relevant activities impacted by the very long time required to adopt the amendment. The final project event, communications and dissemination activities will as well benefit from the extension.

2.2. DEEPEGS project technological outputs

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.

The work has been progressing very well on deep drilling into the high-enthalpy volcanic rock formation in Reykjanes and this demonstrator work has been on time, except the flow testing has been delayed and is starting in August 2019. The consortium is hoping that the Vendenheim demonstrator as an alternative French DEEPEGS demonstrator site will be effective in providing expected results. The drilling of the two wells in Vendenheim down to about 5 KM depth was completed by Fonroche prior to the signed second contract amendment was in place, and the EGS demonstrator includes further side-tracks drilling its demonstration readiness for EGS stimulation and flow testing starting in late summer to autumn 2019 can be effectively demonstrated. Partners BRGM (FR) and KIT (DE) have already been given access to some Vendenheim site data and more stringent follow up and actions are pending to bring this French demonstrator work fully into the DEEPEGS project actions.

In Reykjanes the casing damage has once more showed the importance of new flexible couplings technology development (GEOWELL H2020 project[1]). Testing ending in GEOWELL at TRL4 (Thorbjornsson et. al. 2016, 2017), but will be continued as progressive work in DEEPEGS to advance this further to TRL 6 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. Partner Fonroche has indicated in the amended contract that possible in-field testing of the mud-hammer tool could take place in Hurtigheim should drilling be completed of their first well there in time.

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

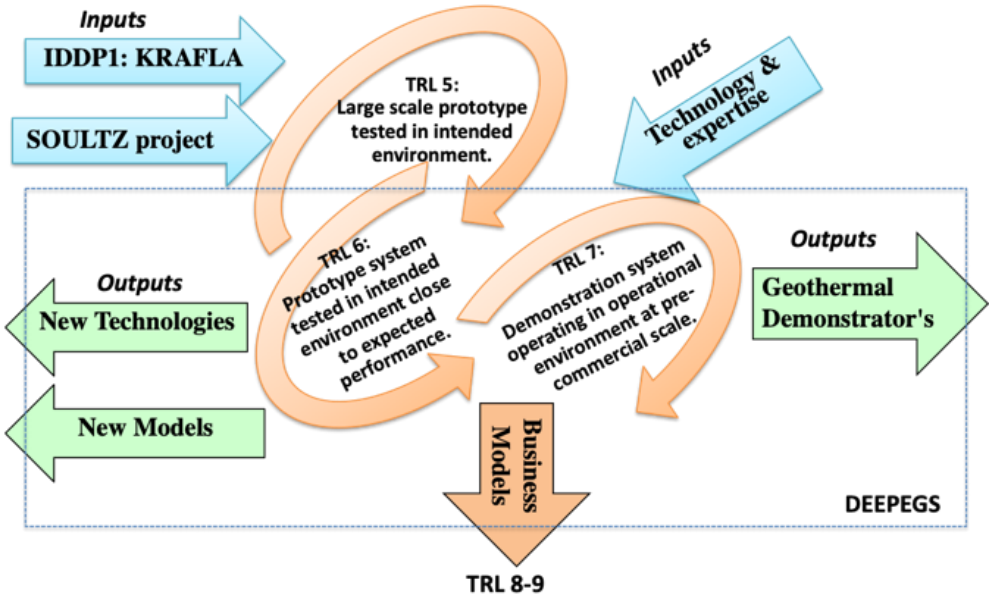

Figure 4: The DEEPEGS ambition is to progress know-how inputs starting at TRL 4-5 at DEEPEGS start, and anticipated progress to TRL 6 and TRL 7 stages during the project.

3. 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 now brought into the project, replacing the original two planned demonstrators. The drilling work in Vendenheim started by Fonroche in 2018 and in first half of 2019 two deep wells have been drilled and this will be 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 and results to be presented at the WGC 2020 event.

3.1 Lessons Learned

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, complains have arisen in France that too few staff are available with required expertise on geothermal,

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

- 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,
- 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 key lesson learned by the DEEPEGS consortium was that the general inexperience of the French energy partner in the geothermal sector and as well lack of understanding of the contractual responsibilities in H2020 research contracts proved the main project risk encountered. This presented critical hurdles in meeting the project objectives and for a time placed the whole project into jeopardy. This will hopefully be fully mitigated with an alternative French demonstration site onboard.

A second critical lesson learned is that industrial partners need to understand that collaborative projects require the partners to share more-timely and transparently critical information that may affect the project implementation. In this context, the high-risk industrially driven projects need to take better informed decisions founded on the H2020 framework programme grant regulations noted in the contract, and with full respect and trust to the collaborative consortium.

A third crucial lesson learned is that with changes of scope of work will affect the grant budget and funding share, and more flexibility in realigning the budget to maximise obtainable results could be vested in the consortium. Currently in H2020 rules this amount of flexibility is not accepted without contract amendments, and they take very long time for processing with the funding agency.

A fourth lesson learned is that wider deployment and demonstration of the potential of enhanced geothermal systems (EGS) has been successful in DEEPEGS at several fronts;

1) The benefit of cross-fertilisation and know-how transfers from the oil and gas sector has been significant in this project,
2) New understanding and models for business deployment will result from this project,
3) Risk management, risk communications and public acceptance issues have benefitted from the project work,
4) Innovative solutions have significantly progressed state of art for the flexible couplings that could in near future solve a critical barrier for successful wider deployments.

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.

4. 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.

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