Risk Control as a key to keep geothermal developments fundable

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ABSTRACT

Financing deep geothermal projects is deemed a high risk infrastructural investment. In addition, the probability for economic loss during the execution of developing the wells is high, which together with the financial risks, constitutes a large threshold for insurers and financial institutions to participate in projects. The Risk Control approach responds to the requirements that arise from project challenges, and contributes by providing an efficient risk mitigation policy to further ensure the fundability of geothermal developments.

1. INTRODUCTION

In order to combat climate change the Dutch government endeavors a 49% reduction in CO_2 emissions by 2030. Additionally, severe infrastructural damages related to gas extraction in Groningen compel the Netherlands to gradually terminate their own gas production. These constraints create a fresh impetus to the development and utilization of renewable energy. Deep geothermal energy is considered one industry that will essentially contribute to the future energy demand.

Geothermal energy has been used worldwide for more than 100 years, however, the application of deep geothermal energy is a rather young industry in the Netherlands, which started about 10 years ago. This limited experience combined with potential problematic developments, makes insurers and financial institutions feel uncomfortable about geothermal projects; severe technical and financial risks underpin that feeling.

For a successful realization of geothermal projects, effective risk identification and mitigation is crucial. In order to reduce operational risks involving failure probability and construction activities respectively, operators developed a high standard risk management system to ensure long term well integrity (Ikenwilo 2016, Heijnen 2015). However, insurers and financial institutions require a more tailored risk assessment, which serves the objective of an efficient loss prevention. The Risk Control approach provides that assessment and, in addition, safeguards the interests of insurers, financial institutions and (future) owners.

2. THE RISK CONTROL CONCEPT

Risk Control has successfully been implemented for transportation projects, such as urban tunnelling, for many decades, but it has not been applied previously to geothermal projects in the Netherlands.

In deviation to the classic risk management strategy, Risk Control aims to apply an efficient risk mitigation approach to “control” identified risks. Decisions to avoid, accept, share or transfer potential risks, as commonly applied to traditional risk management practice, are replaced by the implementation of mitigation measures. These measures apply various technical adaptions over operational procedures to create an adjusted financial policy. In this respect, the ultimate objective of Risk Control regards loss prevention (or at least loss reduction to an acceptable amount) and budget control on behalf of insurers and financiers.

The mitigation of risks by technical means is very common in all project-based risk management strategies and hence, provides the basis of Risk Control. A typical example of a procedural mitigation measure in the context of Risk Control is the introduction of a smoking policy for miners on a tunnel boring machine (Schipper et al., 2011). Regarding budget control for geothermal activities, the financial reinforcement of the contingency reserve is an adequate measure for a comprehensive cover of project uncertainties.

3. THE RISK CONTROL APPROACH FOR GEOTHERMAL PROJECTS

In the Netherlands, the resource risk of geothermal developments (insufficient geothermal potential of the aquifer) is covered by a state guarantee fund (RNES Aardwarmte). Operators could apply for this insurance when a geological feasibility study substantiates a 90% probability of success (POS). Therefore, the resource risk is not a key topic for Risk Control.

In 2013, initiated by a consultancy request from insurer Delta Lloyd, Sweco, together with Geoteam, transformed the Risk Control concept into a tailored approach for geothermal projects. Starting as a service for CAR insurers (Construction All Risk), Risk Control initially focussed on loss prevention during the drilling process. Gradually this approach was adopted to the entire life span of a project, from the feasibility study over the execution, to operation and maintenance of a plant. Nowadays, Risk Control has also developed into a main part of Lenders Technical Advisor (LTA) services for various financial institutions.

With respect to the character of a geothermal development, it is known that the most intensive level of risk and capital investment occurs during the initial project stages, up until the completion of the wells. In these stages up to 55% percent of the total project budget is required upfront (Gehringer and Loksha, 2012). As a primary objective, Risk Control is developed to respond to the needs that arise from this high uncertainty.

During the acceptance procedure of insurers and financial institutions, an initial risk assessment is carried out. The initial risk profile used for the assessment of a geothermal development is established based on the provided design documents (POS, global well program, etc.), the basic investment needs and the proposed organization of a project. Key aspects of this assessment are aquifer depth, aquifer properties, geological setting, well design (with due regard to integrity and sustainability), drilling program, contractual policy, record and specific experience of the contractor, budget estimate, financial contingency reserve and timeline. The initial risk profile of a project is based on a comparison with State-of-the-Art practice of the industry. Given experience from adjacent off-set wells (preferable executed in the same geothermal field) along with the Risk Controller's loss database, additionally serve as basis for the evaluation. This initial risk profile determines whether or not a project is accepted and becomes the baseline for further risk monitoring.

The identification of the initial risk profile of a geothermal development follows the "traffic light system", green for an acceptable risk profile, yellow for a provisional acceptance with recommendations of additional mitigation measures and red for an unacceptable high risk profile. The workflow of the decision-making process for a project-acceptance by insurers and financial institutions is displayed in Figure 1.

During the execution of wells, Risk Control provides daily monitoring of the drilling progress and periodic site inspections. These services aim at a proactive detection of threats and their proper mitigation.

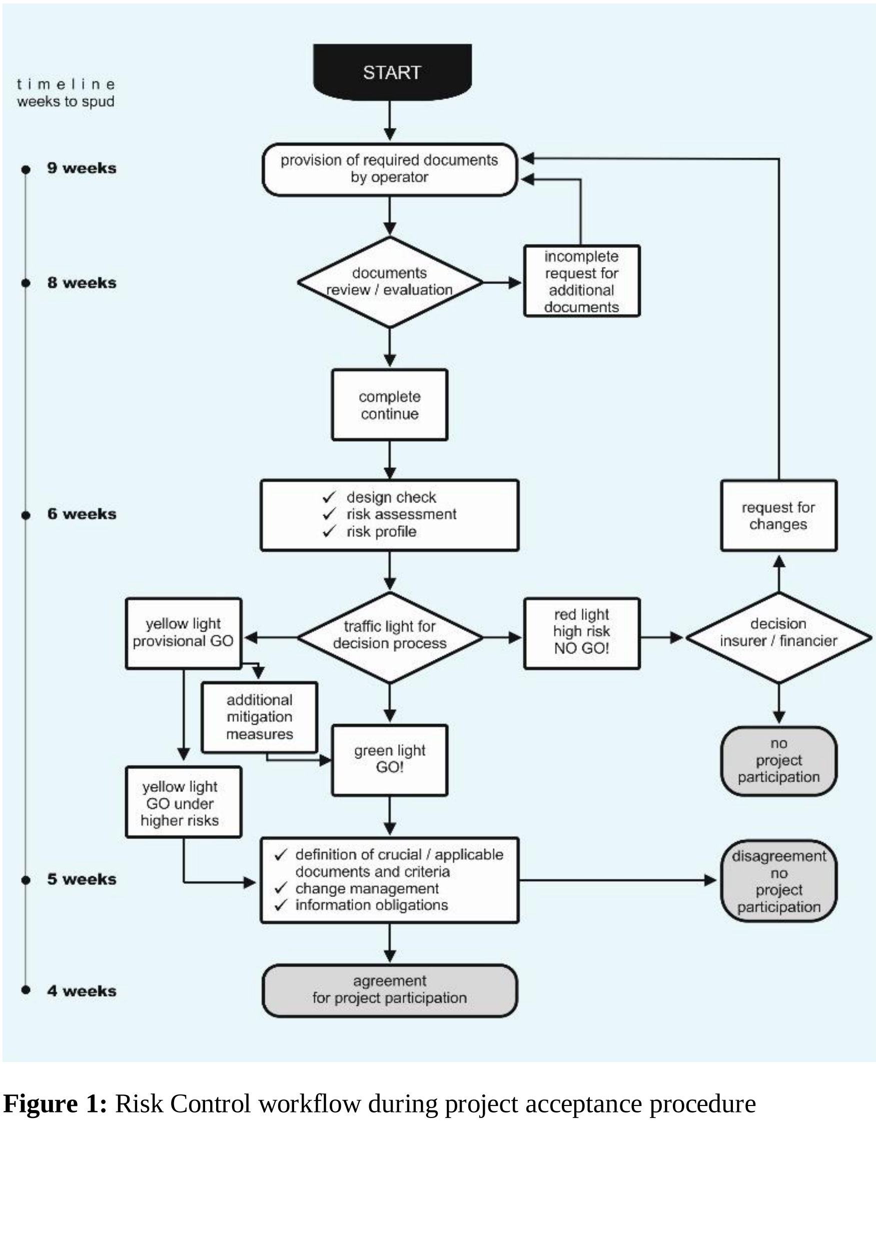

Figure 1: Risk Control workflow during project acceptance procedure

Within the scope of the daily monitoring, the Risk Controller screens the drilling reports and mirrors the actual operations on the accepted program. Whenever the received information is not sufficient for a personal assessment, the Risk Controller clarifies information with the operator. Conducting site inspections enables the Risk Controller to verify the provided information from his own observations and put the Risk Control policy in the position to randomly check design requirements (for instance the steel quality of the casing). A non-hindering policy of ongoing operations is a key principle of these inspections.

As technical difficulties emerge, the Risk Controller first gathers additional information on the foreseen mitigation and then assesses the proposed measures. If these measures are deemed sufficient for an efficient loss prevention, no further action is required. During a regular drilling process, insurers and financial institutions are kept informed on the ongoing operations by means of a periodic status report and, if requested, additional oral explanations are provided.

In case of major difficulties, such as stuck pipes or a lost-in-hole incident, insurers are alerted immediately by phone, the situation is discussed and further actions are agreed. The involvement of Risk Control during an incident management procedure is proactive but no binding conditions are imposed to the operations. For the workflow of this procedure see Figure 2.

The results of the well tests are a key condition to the success of each geothermal project. They lay the foundation for the detailed design of the production and reinjection pumps, the above ground installations and the corresponding distribution grid. An independent review on the results of the well tests is often a basic demand of financial institutions for the continuation of their investment. A second opinion of the well tests is an important part of the Risks Control approach for financial institutions.

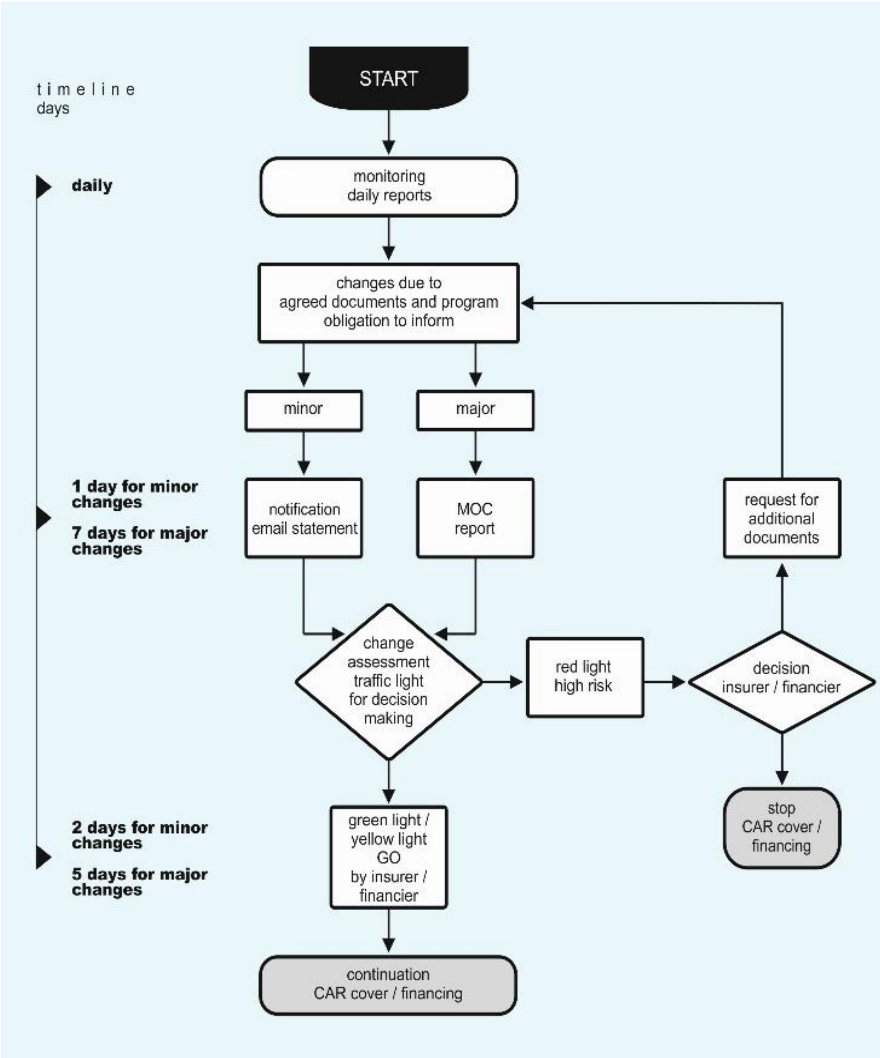

Figure 2: Risk Control workflow during drilling process

During the exploitation of a geothermal project Risk Control periodically reviews the operations and monitors the maintenance risks, such as a decrease of the flow rate due to changes in the wells or the aquifer. The primary objective of Risk Control during this stage is to ensure a constant cash return from the project.

4. GIVEN EXPERIENCE TO DATE

In the period 2013 to 2018 Sweco/Geoteam applied the Risk Control approach for 21 deep drillings in the Netherlands and Belgium, including deep and explorational boreholes such as MOL-GT-01 (3.6 km deep) and NLW-GT-01 with an along-hole depth of approximately 4.5 km (part of the Trias Westland doublet). The majority of the monitored boreholes (20 drillings) were located in the Netherlands. This number represents more than 80% of the total amount of executed wells in that period in the Netherlands.

The monitored drillings were part of 12 various low enthalpy projects with direct heat production for greenhouse warming. With only one exception, all geothermal projects were executed by different operators (no portfolio approach).

With respect to the geological setting eight projects out of 12 were based in the West Netherlands Basin. The others were located within the structures of the Texel-IJsselmeer High, the Oosterhout Platform, the Roer Valley Graben and the Campine Basin. Ten projects, or 17 drillings, targeted sandstones in a depth of approximately 2.5 km as aquifer. The remaining four wells were drilled into highly jointed carbonate rocks. Figure 3 displays an overview of all monitored projects and indicates their geological position.

In all cases, the design of the monitored geothermal projects met the State-of-the-Art practice of the industry. Therefore, none of the projects had to be rejected during the acceptance procedure. In various cases, recommendations were made in order to improve risk mitigation.

About 50% of the drillings encountered severe difficulties during execution due to geological conditions, technical failures, and human factors, with geological reasons being by far the most predominate cause. Bitballing, overpulls and stuck pipe events turned out as most common threats to drilling success. Most of the events occurred in formations dominated by marl and claystone, where swelling clays and caving led to severe borehole instabilities. On the other hand, unexpected and total mud losses due to depleted reservoirs and severely jointed rocks caused differential sticking. Furthermore, gas horizons and chert layers in the various geological settings represented a minor hazard.

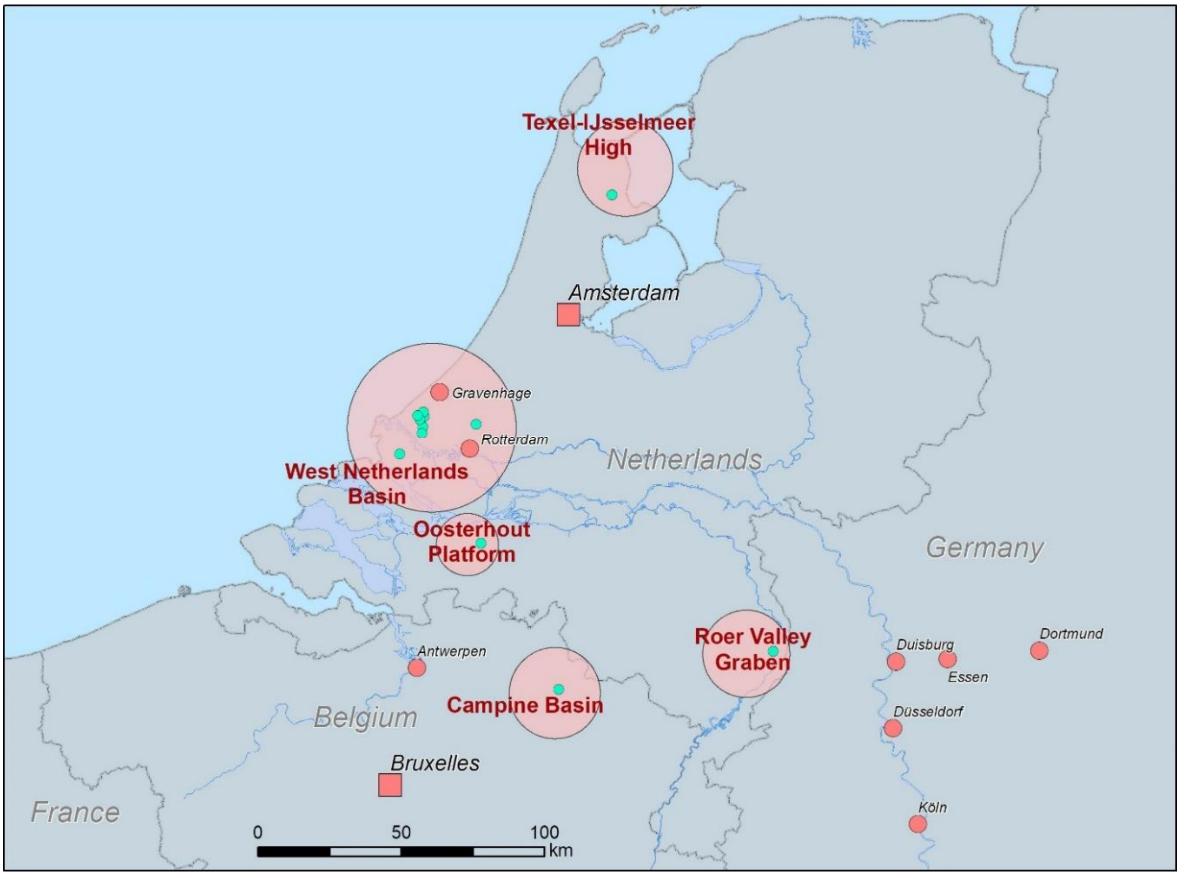

Figure 3: Overview of geothermal drillings monitored by Risk Control (period 2013 to 2018)

Beside geological based difficulties technical problems with screen setting tools, liner hanger packers or under-reaming assemblies caused hazards to a regular drilling process. In two cases, repair operations due to aquifer contamination had to be carried out.

The encountered difficulties led to the execution of six additional side tracks in five boreholes. In other words, approximately 25% of all monitored drillings required a recovery operation after a lost-of-hole event. In a few cases, lost-in-hole incidents required fishing operations, which caused consequences for the time schedule and the project budget. However, fishing operations could be carried out successfully within a few days, which limited their impact of the overall loss statistic.

Referring solely to the wells of the West Netherlands Basin, which are executed in a geothermal field with a comparable geological setting, the percentage of drillings that required a side track does not change (approximately 25% derived from three out of 13). This fact reveals that the benefits of lessons learned and their implementation to subsequently executed wells in the same field are likely compensated by difficult, local geological settings or geometrical constraints to the well design (caused in adjacent wells in operation).

Public data on drilling losses in the geothermal industry are not available and therefore the benefit of Risk Control is not verifiable by numbers. However, the authors are convinced that Risk Control as an overarching project risk mitigation strategy enhanced the risk awareness of all involved parties, and therefore, contributed positively to economic loss prevention.

5. A KEY TO KEEP GEOTHERMAL DEVELOPMENTS FUNDABLE

The majority of the monitored 21 drillings were carried out within the estimated project costs and schedule boundaries but, as indicated above, unfortunately, not in all cases were without significant losses. Nevertheless, clients communicated that the applied Risk Control approach positively contributes to their decision to further participate in geothermal energy. Also, clients considered the Risk Control approach the "missing link" to their business case for a first-time participation in geothermal energy developments.

The added value of Risk Control comprises:

- Risk Control provides specific expertise and experience that bridges the gap between technique and requirements of insurers and financial institutions.
- Risk Control safeguards the interests of insurers, financial institutions and (future) owners during the whole life span of a geothermal development and lowers the threshold for a project participation.
- Insurers and financial institutions have a representative on the job, who acts proactively on their behalf.
- The initial risk profile, established during the acceptance procedure of a project, puts insurers and financial institutions in the position to make well-informed decisions on their project participation. A standardized protocol makes projects comparable and, as far as possible, establishes an objective basis for this decision.
- Whether a decision for participation is made, the accepted risk profile of a project provides a distinct baseline for the further Risk Control monitoring. During project realization this baseline ensures an unambiguous and easy detection of deviations and changes.
- The Risk Control approach enables an imposed learning curve on the projects, which is based on experiences of losses in prior projects and their huge diversity of causes. On a mid-term perspective this learning curve undoubtably will result in a significant loss reduction.

In the current practice, the Risk Controller is commonly seen as another "expensive consultant on the project". This attitude will gradually transform towards an added value in efficient risk mitigation. Particularly because a Risk Controller, as an independent party, does not operate as a supervisor to the operations but aims to challenge the project engineers on a collaborative basis. The benefits of enlarging the risk awareness to all those involved in any geothermal development are pivotal for a successful result. Only a significant decrease in a risk profile will sustainably provide affordable insurances and financing to geothermal projects. In that respect the Risk Control approach is considered a key in keeping geothermal developments fundable.

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