Geothermal feasibility study

Or how to reach a RECOMMENDATION-TO-INVEST decision

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GEOTHERM

Geothermal energy from sedimentary reservoirs
– Removing obstacles for large scale utilization

Innovation Fund Denmark: project 6154-00011B

Revision History

Author	Date	Version	Comments
JPB	31.10.2019	1	Created
HJ	04.11.2019	1.1	Corrections
WGH	05.11.2019	1.2	Corrections

The GEOTHERM project (2017-2019) is co-funded by Innovation Fund Denmark. The full title of the project is: GEOTHERM: Geothermal energy from sedimentary reservoirs – Removing obstacles for large scale utilization. Innovation Fund Denmark: project 6154-00011B.
Work Package 6 focussed on the geothermal business case. This best practice is a result of this work package. The authors would like to thank GEUS, Sønderborg Varme A/S, Hofor A/S, Thisted Varmeforsyning Amba and FORCE Technology for their input. Additionally, international partners have contributed to the project, i.e. BRGM, GFZ Potsdam and Lunds Universitet.

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1 Executive summary in Danish

Hvordan kan og bør man tilgå en vurdering af, om geotermi er relevant? Spørgsmålet er blevet stillet mange gange af forsyningselskaber, ikke bare i Danmark, men også på tværs af Europa.

Der findes ikke kun en model. Denne rapport er en faseopdelt model, hvor man efter hvert element kan tage en beslutning om at fortsætte eller stoppe analysen.

Studiet fokuserer på at skabe en spiral af viden, som kan lede frem til et beslutningsgrundlag.

	Element (English)	Element (Dansk)
	Project Clarification	Projekt målsætning
		Hård milepæl – fortsæt/afslut
	Subsurface data	Undergrundsdata
		Hård milepæl – fortsæt/afslut
	Geological target identification	Reservoir identification
		Hård milepæl – fortsæt/afslut
	Recommendation to drill	Bore anbefaling
		Blød milepæl – vurdering af viden
	Well and facility design and cost estimates	Brønd og produktionsanlæg design og omkostningsestimater
		Hård milepæl – fortsæt/afslut
	Project risk assessment	Projekt risici
	Environmental amd regulatory requirements	Miljø- og lovgivningsmæssige krav
	Geothermal feasibility study	Beslutningsgrundlag for vurdering af potentiale for geotermisk produktion
		👍 eller 👎

Table 1 - English -> Dansk strukturtræ

Processens elementer handler hver især om et emne, som afdækkes. Tilhørende hvert emne er en række sideordnede spørgsmål, som er gennemgående i hele processen og med til at granulere det endelige beslutningsgrundlag.

De sideordnede spørgsmål er:

- Organisation
- Risko
- Ansvarsmatrise
- Budget
- Tidsplan

Samlet set vil beslutningsgrundlaget belyse de tekniske, regulatoriske, miljømæssige, afsætningsmæssige og ikke mindst økonomiske aspekter ved geotermisk produktion på en given lokation.

2 Executive summary

Is geothermal energy relevant for us? And how can we conduct an assessment of its feasibility? The question has been voiced by many district heating companies, not only in Denmark, but across Europe.

It is safe to say that there is more than one model. However, we present a model with phases and decision gates. The decision gates allow an informed decision to stop or continue the process. The model focussed on creating an iterative process, with increasing levels of details leading to a final decision point of RECOMMENDATION-TO-INVEST.

	Element	Decision gate
	Project Clarification	Hard milestone – stop/continue
	Subsurface data	Hard milestone – stop/continue
	Geological target identification	Hard milestone – stop/continue
	Recommendation to drill	Soft milestone – Assessment of knowledge
	Well and facility design and cost estimates	Hard milestone – stop/continue
	Project risk assessment	👍 or 👎
	Environmental and regulatory requirements	
	Geothermal feasibility study	

Table 2 – Elements and decision gates

Each of the elements is topic-specific. With each element, there is also a series of adjacent questions which are general and repeated. These questions will substantiate the final decision gate or the RECOMMENDATION-TO-INVEST.

Some of the adjacent qustions are;

- Organisation
- Risk
- Responsibility matrix
- Budget
- Timeplan

All of the information will, collectively, highlight the geological, technical, regulatory, environmental, distribution and not least economical aspects of geothermal heating production.

3 Feasibility study of a geothermal project

There are numerous ways of defining the set-up of a geothermal project. Geoop has based its theorem of project development on a methodology adopted from the oil and gas industry.

The aim of the study is to provide an easy-to-access process. The process adds layers of information and data, and has built-in decision gates to assess the feasibility on a multi-factor scale.

Project development is ever changing and the analysis of many factors mostly within geology and technology influence the decision process. However; organisation, risk and commercialisation are engrained structural elements in the process which must be reiterated at every decision gate.

The project model will initially focus on geology and district heating infrastructure. As the study develops it changes focus and looks at drilling and production.

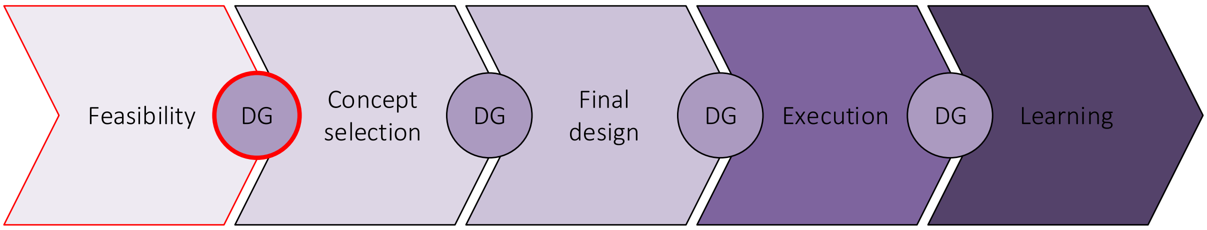


Figure 1 – Project model

The feasibility will result in stage gate desion to proceed or stop. The process leading to the production of geothermal energy will require several iterations and decision gates.

3.1 Heating or power

The report has been written with heat production facilities in mind, utilising thermal energy from reservoirs occurring at depths of approximately 1 to 3 kilometers, where the thermal power is brought to the surface using the naturally occurring saline fluids in the reservoir as the carrier fluid.

3.2 Principals to conduct study

It can be hard to define which resources are principal to conduct a geothermal study, however, the following functions are deemed necessary to cover the width of the study:

- Geologist
- Heat production specialist/engineer
- Drilling / Well engineer
- Economist
- Project & Risk manager (can be one of the above function)

It is advisable to have ad-hoc resources which cover:

- Production chemistry
- Reservoir engineering
- Legal and regulatory issues

- Financing

3.3 Objective of the study

The objectives of the feasibility study are to Identify, evaluate and quantify the opportunities for the production and commercial use of geothermal power for district heating. It provides a comprehensive and realistic, technical and economic assessment of the asset. An asset in this context is the site where the geothermal production facility is conceptualised and the subsurface in a radius of 3km surrounding the site. This will allow for an informed decision on the project's viability.

The results of the feasibility study are used to support an informed decision to on whether or not to proceed with the project. Safety and environment

The study has to address several concerns with regards to safety and the environment. The objective of any project is to emphasis that it is completed with no harm to individuals or the environment.

3.4 Phases in the study

A feasibility study must be broken down into manageable elements. Each element has its own scope and delivery, which acts as a link in a chain leading to the final study and recommendation to proceed.

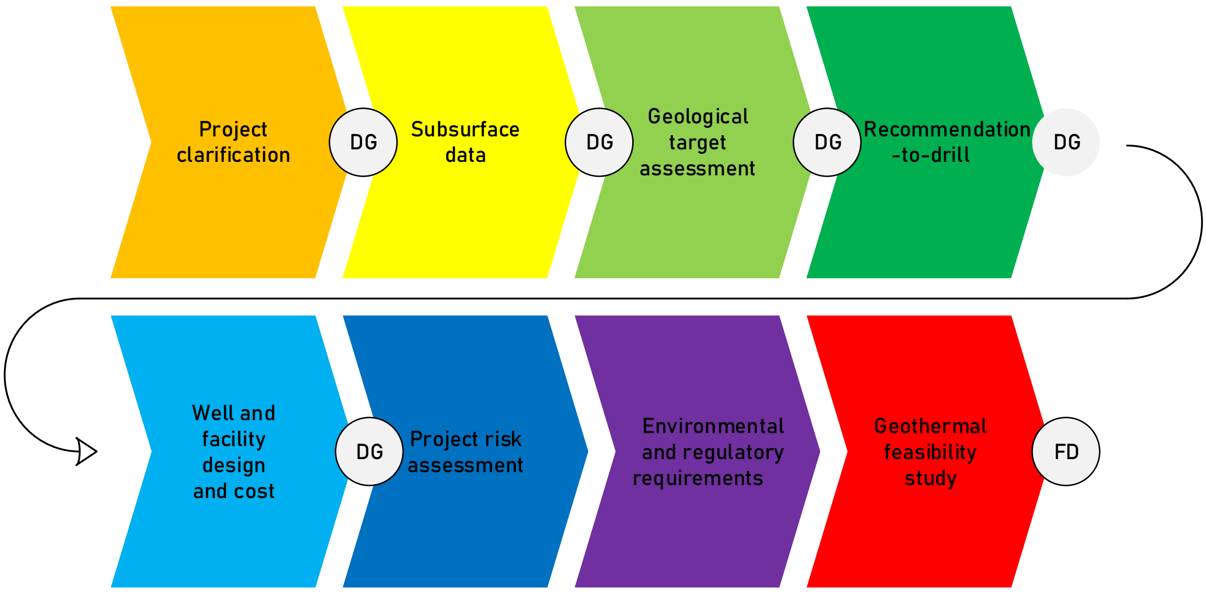


Figure 2 – Phase in process

At the end of (almost) each element of the study there is a stage gate.

- Is the project sound – technically and financially?
    - Are risks understood, managed and communicated to the stakeholders?
    - Is the organisation well defined and is there stakeholder commitment?
    - Is there a clear understanding of the goals and milestones of the next phase?

4 Repeated data points

With the development of each element there are a series of repetitive points which must be continuously updated to reflect status and knowledge, these are:

- Organisation
- Risk
- Responsibility matrix
- Budget/financing
- Timing

4.1 Organisation

Know your organisation! A geothermal project has to have management attention and involvement. Decision shall when needed be taken without delay and this is only possible with the involvement and buy-in of the sufficient level of management.

It imperative to have and update an organogram. The organogram will visually supply all project stakeholders with information about the decision hierarchy and where to address questions that arise in the development of the project.

The organogram will start simple, and as elements are addressed will include more functions, names and lines of responsibility.

A suggestion to reduce visual complexity is to subdivide the organograms into subcategories

- Project
- Construction & Commissioning
- Drilling & Testing
- Production

4.2 Risk

What is risk?

Risk is a central element in every project. The risk for at geothermal project can be defined in the following categories;

- Project risks
  The overlaying factors that form the core of the work scope. These risks can make or break the project, and they must be readily identified for their significance for the project process looking ahead
- Design/engineering risks
  The risks pertain to not only functionality / technology, but also to HSE matters. It is not the intent to say 'yea' or 'nay' to matters of functionality / technology / installation / implementation, however, the usage of said function from a risk perspective and its fit to HSE procedures is to be noted and considered.

- Drilling/construction risks
  With the project entering into the drilling and construction phase, it shifts from desk to work floor; this also entrails that the risks become very real. The project organisation has to be very aware of this and will focus on safe conduct of operations as well as organizational implementation of management systems.
- Production risks
  The risks in production fall into maintenance of the facilities and management of the reservoir. The risks are associated with safe conduct, but also adherence to guidelines.

4.2.1 Methodology

Working with risks is akin to working with explosives, which is why a methodology adopted from the navy can be adopted.

4.2.1.1 Detection

Implement an approach that permeates through at all levels the organization. Use processes and procedures that are likely to identiry risks and discrepancies covering all project stages. Implementation of an effective risk strategy includes:

1. Education of the project team members
2. Theme-auditing the project organization (and 3rd party vendors and service contractors), to highlight systematic implementation, reporting and its use

4.2.1.2 Identification

Address all issues and assess the origins. This will often focus on problematic issues and discussion of these alone may be enough to rectify and mitigate these, however, should the underlying cause be more fundamental this is detected by looking at the underlying decision processes.

4.2.1.3 Classification

The project teams will determine the severity and consequence of the detected risks within the project risk matrix (see below).

4.2.1.4 Disposal

Take mitigating measures

For the broader application of risk detection, this is done by working actively with risk reducing measures.

4.3 Cost of risks

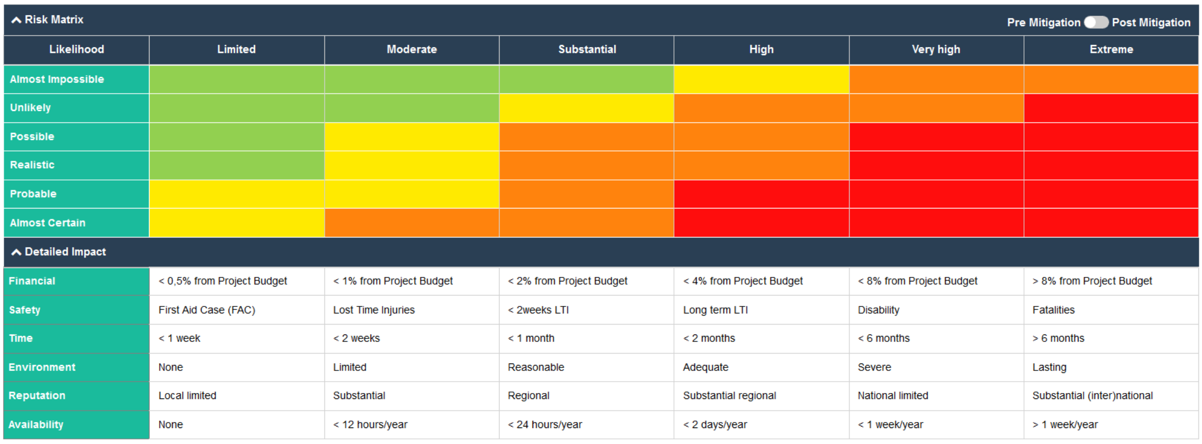
While a risk can be very real when an incident occurs, it can be very hard to monetize effects of likelihood, severity and consequences.

4.4 Working with risks

4.2.1 Risk register and matrix

Working with risks must be implemented as an integral part of the project process. Risks and their mitigation are pivotal for the execution of a successful project.

The risk matrix figure below is a 'blank' from the system OilfieldOS developed by Apriside. For a geothermal project a risk matrix should be elaborated with the primary stakeholders in the project orgainsation.



Likelihood	Limited	Moderate	Substantial	High	Very high	Extreme
Almost Impossible						
Unlikely						
Possible						
Realistic						
Probable						
Almost Certain						

Detailed Impact

Financial	< 0,5% from Project Budget	< 1% from Project Budget	< 2% from Project Budget	< 4% from Project Budget	< 8% from Project Budget	> 8% from Project Budget
Safety	First Aid Case (FAC)	Lost Time Injuries	< 2weeks LTI	Long term LTI	Disability	Fatalities
Time	< 1 week	< 2 weeks	< 1 month	< 2 months	< 6 months	> 6 months
Environment	None	Limited	Reasonable	Adequate	Severe	Lasting
Reputation	Local limited	Substantial	Regional	Substantial regional	National limited	Substantial (inter)national
Availability	None	< 12 hours/year	< 24 hours/year	< 2 days/year	< 1 week/year	> 1 week/year

Figure 3 – Risk Matrix

Risk Profile

By elaborating the risk matrix the project organisation will get to know the risk profile of the project. The risk profile can be defined as the 'willingness to risk exposure' which can be summarised as the project robustness – without jeopardising the principle of ALARP.

4.4.1.1 ALARP (As Low As Reasonably Possible)

Risks must follow the ALARP principle. Risks must be mitigated until the risks are considered 'as low as reasonably practical'. However, with risks, which are of a financial or reputational nature only, the project organisation can select freely to take a high risk exposure and not necessarily follow the ALARP principle.

Risks related to Q&HSE, must be mitigated following ALARP. The consequence of this is that the project organisation cannot make an equipment selection / installation method, if there are better / safer possibilities.

The project management must review all risks and their mitigation, and must fully be aware of their consequences at every stage gate.

4.2.1.3 Risk register

A risk register is the record of the risks. All risks are entered into the risk register, and given a likelihood and consequence. The risks are assessed with regards to the risk involved green, yellow, orange and red. For all risks registering orange or red, mitigating action must be taken. Upon the completion of the mitigation action (and it associated risks) a new evaluation of likelihood and consequence is made. The process is iterated until all risks have been mitigated to ALARP (yellow/red for financial only risks).

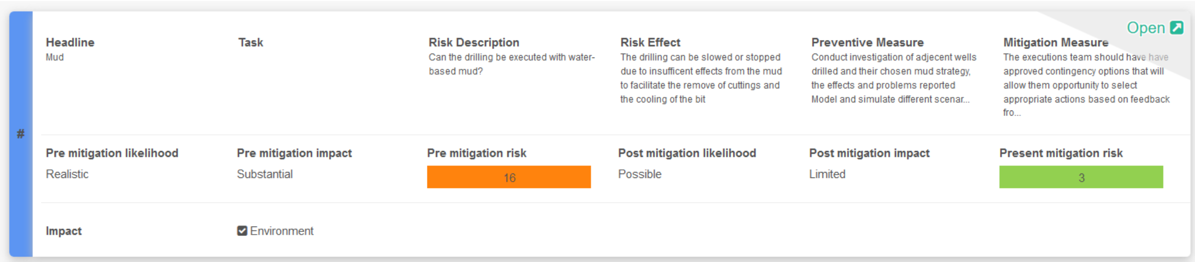


Figure 4 – Risk register entry

4.4.2 Risk work flow & Assessment

The model below illustrates the work flow when working with risks.

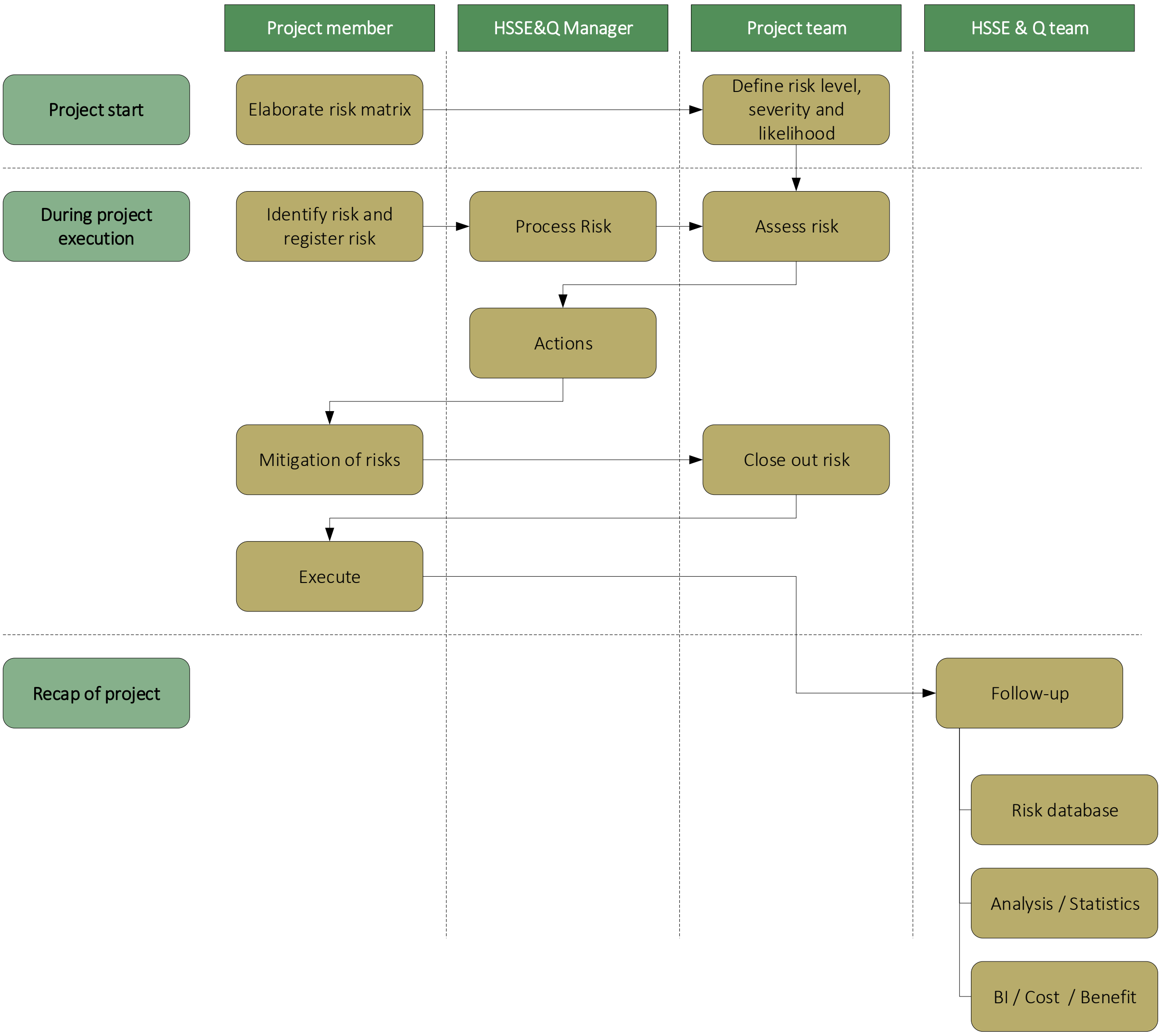


Figure 5 – Work flow for risk analysis

4.4.2.1 During risk execution

Identification of the risk must be simplistic; follow simple rules of identification and registering the risk (Hazard, Cause and Effect). Subsequently, all identified risks should be dealt with by the project team on a continuous basis, whereas the initial risk assessment is evaluated and mitigating measures are implemented. Once the mitigation of the risk has been completed, the effect is evaluated in a close-out session.

4.5 Responsibility matrix

The RACI matrix is a responsiblity assignment chart that maps out every task involved in completing a geothermal project and assigns which roles are *Responsible* for each action item, which role is *Accountable*, and, where appropriate, who needs to be *Consulted* or *Informed*.

A RACI matrix is one of the simplest tools for defining and documenting project roles and responsibilities. The total organisation's project elements will create synergies across stakeholders that enhance project deliveries, and provide a baseline for dialogue and communication in the project.

The risk of not having a shared understanding of participant roles and responsibilities or documentation to support it is a project break-down. Employing the RACI model can get an 'immobilised' project moving again, and it provides the project stakeholders with a defined path for moving forward in the project processes.

Figure 6 – RACI chart

The Operator Asset Manager is always overall accountable and liable for all processes and decisions in the geothermal project.

The RACI chart shows the delegated accountability within the project that the Operator Asset Manager can choose to delegate to the project team members. The member that is assigned accountability is the member that will make the final decision on the specific topic, and the ensures that the Operator Asset Manager is informed of and understands the decision.

Drilling Planning and Operations requires team members proactively assume responsibility for their respective tasks.

4.5.1 Creating a RACI chart

1. Identify all the tasks, milestones and stage gates involved in delivering the project and list them in the chart
2. Identify all the project stakeholders and list them along the top of the chart
3. Complete the cells of the model identifying who has *responsibility*, *accountability* and who will be *consulted* and *informed* for each task
4. Ensure that every task has at least one person *Responsible* for it
5. No tasks should have more than one person who is *Accountable*. Resolve any conflicts.
6. Share, debate and agree on the RACI model with the project stakeholders at the start of the project. This includes resolving any conflicts or ambiguities.
7. Reiterate the process as new tasks, milestones and stage gates are identified

4.5.2 Working with a RACI chart

Analysis for each stakeholder (vertical analysis):

- Are there too many R's: Does one stakeholder have too much of the project assigned to them?
- No empty cells: Does the stakeholder need to be involved in so many of the activities? Can Responsible be changed to Consulted, or Consulted changed to Informed? I.e., are there too many "cooks in this kitchen" to keep things moving? (And if so, what does that say about the culture within which this project is being managed?)
- Buy-in: Does each stakeholder agree with the role and tasks they are assigned?

Analysis for each task (horizontal analysis):

- No R: Who is executing the task? Who is lead?
- Too many R's: Too many "cooks in this kitchen"?
- No A's: Who is Accountable? There must be one 'A' for every task
- More than one A: Who has final say?
- Every box filled in: Do all the stakeholders have to be involved?
- A lot of C's: Do all the stakeholders need to be Consulted, or can they be Informed

4.6 Budget/Financing

A geothermal project should be sufficiently financed to be successful. Budgetting is always complex, and for the first elements of the feasibility study the budget will reflect the general economic frame for the project.

This report will not further detail the layout of a project budget. We recommend using approved standards from industry.

4.7 Timing

When is the project expected to be finalised? what is the critical path?

This report will not further detail timing and planning. We recommend using approved standards from industry.

5 Project Clarification

5.1 Status

The project clarification phase contains a hard stage gate.

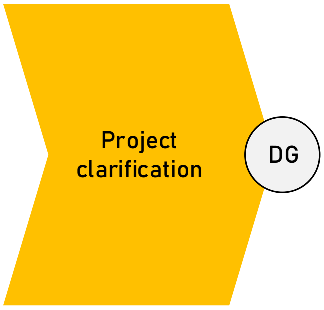


Figure 7 – Project clarification

5.2 Context

The purpose of this element is to understand the environment surrounding the project, and the interests from a regulatory, regional and local level that influences the decision processes. The information requested will allow understanding of the predicted heat demand:

- What are the principle drivers for the project (resilience of supply, change of fuel type, carbon reduction)?
- What are the principal social considerations?
- What is the current size of the heat network in terms of dwellings and demand?
- What is the current expectation for expansion of the network?
- What are the network heat demand growth forecasts?
- How are plans for the heat supply to the network (multiple sources and which)?
- How will the network be funded, is there an outline business model?
- Has consideration been given to the surface plant?
- What are the timing considerations to achieve a carbon-free heating system?
- Will upscaling make economic sense?

This information will be used to model the baseline economics of the project and provide a recommendation for the heat source options. Within the envelop of the GEOTHERM project, it is our interest to promote the use of geothermal energy, however, this may not be the optimum solution, particularly in the case of smaller heating networks with no plans to expand.

5.3 .. not to forget

Create organograms, start the risk matrix and register and develop the RACI chart.

5.4 Decision gate

The project team should assess the general feasibility of the project at this stage. Can geothermal energy be phased into the existing systems, or is the system adaptable to accommodate this type of energy?

6 Subsurface data

6.1 Status

The project clarification phase contains a hard decision gate.

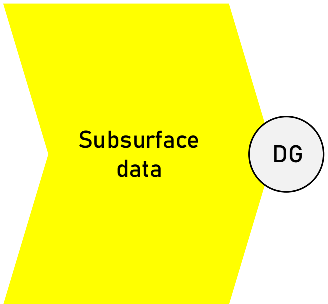


Figure 8 – Subsurface data

6.2 Context

When assessing the potential of a geothermal project and the underlying drilling operations, the availability of good quality subsurface data is crucial, consideration will be given to the following:

- What is the quality of the available seismic data sets? We refer to the guidelines developed in the GEOTHERM project on obtaining and record seismic data.
- Are there substitute data which can supplement seismic data e.g. magnetic, atomic dielectric resonance etc
- Have any offset wells been drilled in the area? And what is the quality of the data that can be derived from these – are the pre- or post-digitalisation? Ideally the analysis material should contain;
  - Lithological description
  - Borehole logs
  - Sidewall cores from reservoir section
- Can data be derived for analysis from well tests which will indicate properties to sustain developing geophysical and -chemical model?
- What information can be concluded from local and regional geology studies?
- It's possible that some of this information may not be publicly available and it may be necessary to purchase this information at additional cost.

Once the data gather is complete and assessed, a recommendation will be made at this point to continue or not based on the information in hand.

6.3 .. not to forget

Update the organograms, risk register, RACI chart, budget and timing.

6.4 Decision gate

The project team should assess the subsurface feasibility of the project at this stage.

Is it anticipated that the subsurface conditions are favourable for the production of geothermal power?

7 Geological target identification

7.1 Status

The project clarification phase contains a hard decision gate.

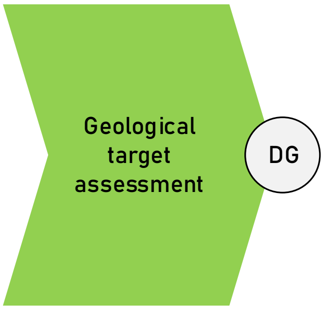


Figure 9 – Geological target assessment

7.2 Context

At this element the project starts to have a more narrow scope with the aim of providing evidence of the commerciality of producing geothermal energy at a specific location.

The questions to be asked are multiple and the analysis required will outline the economic potential for further developing a geothermal heating solution.

- Is there a target reservoir?
- If several targets are present, can they be ranked?
- What are the anticipated parameters of the reservoirs (porosity, permeability, thickness and distribution)?
- Characterisation of the geothermal reservoir
  - Geology (from the previous element)
  - Petrophysics
  - Flow properties
  - Temperatures
  - Brine composition
- Quantify the geothermal resource
  - Reservoir and well productivity
  - Reservoir temperature
  - Thermal energy production
- Are there anticipated challenges to the drilling process?

7.3 .. not to forget

Update the organograms, revisit the risk matrix (for changes to risk perception), risk register, RACI chart, budget and timing.

7.4 Decision gate

The project team should assess the specific feasibility of the project at this stage; Can geothermal power be produced at the project location at commercial rates?

8 Recommendation to drill

8.1 Status

The project clarification phase contains a soft decision gate.

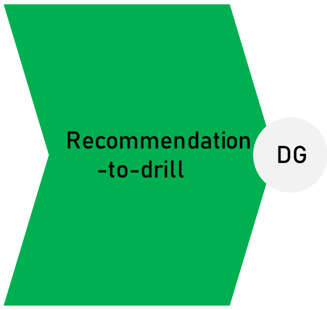


Figure 10 – Recommendation-to-drill

8.2 Context

This element presents the technical specifications for the well based upon the outputs from previous subsurface work. This includes a provisional well design, drilling fluid design and pore pressure and fracture gradient analysis.

This document resolves and locks the project design criteria, allowing the engineers to proceed with well concept selection and planning. The criteria are:

- Well surface locations, among the parameters to be assessed are
    - Access to site (for heavy transport)
    - Power, water and sewage
    - Zoning
    - Geotechnical knowledge
    - Environmental assessment
    - Synergies
    - Expansion to accommodate future demand
- Well Target locations subsurface
- Formation tops anticipated
- The subsurface pressure regime
- The subsurface geomechanical regime will be assessed on offset and regional data
- Geohazards
- Exploration or production well

8.3 .. not to forget

Update the organograms, risk register, RACI chart, budget and timing.

8.4 Decision gate

The project team should assess the specific feasibility of the project at this stage; Is the site drillable? Are the factors that exclude the site or subsurface from inclusion in a geothermal project?

There is a soft decision gate at this stage as it would often be necessary to conduct the next element 'Well design and cost estimates' to have a full understanding of the impact of project economy and timing.

9 Well and facility design and cost estimates

9.1 Status

The project clarification phase contains a hard decision gate.

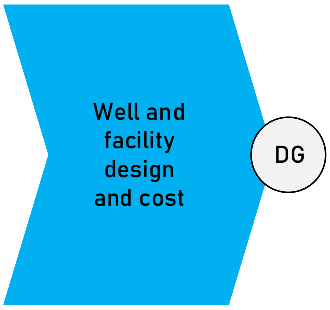


Figure 11 – Well and facility design and cost

9.2 Context

The purpose of this section is to deliver cost estimates for engineering above and below ground. It is anticipoated that the budget will fall within ±30% of the final cost. The well design will be based on the Recommendation-to-drill, and will focus on designing well design alternatives, and through a selection process find the best suited for the location. It should be emphasised that at this early stage the design work carried will focus on cost data. The intention is to minimise costs in a pre-recommendation-to-invest phase.

The final output will be a provisional well design with a focus on well integrity and environmental safety. Based on this design probabilistic time and cost estimates will be generated.

9.2.1 Energy production facility

The production plant consist of the following key modules;

- Filtration
- Heat exchanger
- Heat pump
  - Electrical
  - Arbsorption
- Pumps (production and injection)[1]
- Auxilary systems
  - Building
  - Piping and cabling
  - SCADA systems
- Distribution to heating grid

[1] These can be include as a well or facility component

9.3 .. not to forget

Update the organograms, risk register, RACI chart, budget and timing.

9.4 Decision gate

The project team should assess the specific feasibility of the project at this stage. Can geothermal power be produced at commercially attractive rates?

10 Project risk assessment

10.1 Status

The project clarification element does not contain a decision gate.

Figure 12 – Project risk assessment

10.2 Context

This will require stakeholder input. A workshop is suggested using an offset in the project risk register to consider the principle project risks from a technical, economical, supply, environmental and HSE perspective. This will determine high level project risks and consider their consequences, probability and how they may be mitigated. The output will be formalised into the project risk register.

10.3 .. not to forget

Update the organograms, revisit the risk matrix (for changes to risk perception), risk register, RACI chart, budget and timing.

10.4 Decision gate or stage gate

The project team should assess the outcome of the risk session. Have issues been identificed which clearly and without ambiguity creates a stop to the development of the project? Has the future demand requirement been assessed – is their sufficient knowledge about the population development in the area, and what is required for infrasturctual development.

11 Environmental and regulatory requirements

11.1 Status

The project clarification element does not contain decision gate.

Figure 13 – Environmental and regulatory requirements

11.2 Context

This element ensures that all stakeholders are aware of the regulatory requirements in the project locations. Regulatory guidance for the geothermal industry varies from country to country. However in general terms the well construction requirements for geothermal wells borrow heavily from the relevant offshore installation and wells regulations. The main regulatory considerations are:

- What are the regulatory requirements of both the planning and well construction processes?
- What permissions are required to construct the wells?
- How shall the well examination process be conducted?
- What are the requirements of the Environmental Impact Assessment?
- How shall the relevant government Geological Survey organisation be involved?
- Who owns the geothermal asset?
- Are there any regulatory or legislative show-stoppers?

Once again the licensing requirements of geothermal wells and plants differ from country to country, and at times the question of who owns the produced heat can remain ambiguous.

11.3 .. not to forget

Update the organograms, revisit the risk matrix (for changes to risk perception), risk register, RACI chart, budget and timing.

11.4 Decision gate

The project team should assess the specific feasibility of the project at this stage; Can geothermal project obtain an exploration and production license and under which conditions? And that documentation is required to be delivered by the project to the municipality, region or country?

12 Geothermal feasibility study

12.1 Status

The element will conclude with a 'Final Decision' and a recommendation-to-invest in a geothermal energy project at a specific location.

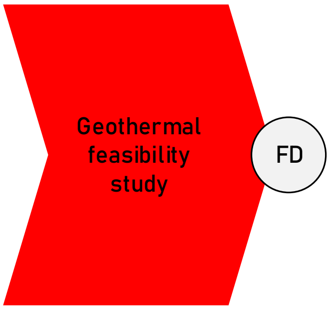


Figure 14 – Geothermal feasibility study

12.2 Context

The information from the previous documents will be combined into a project feasibility summary. This document will the stakeholders with the appropriate information for use in making an informed decision to proceed, or not;

- The social and HSE requirements will be clear
- The key technical challenges will be clear and explicit
- The costs will be clear with likely errors quantifiable
- The key risks to the project will be understood
- The revenues can be modelled
- The predicted heat output of the system will be estimated

12.3 .. not to forget

Finalise the organograms, risk register, RACI chart, budget and timing.

12.4 Decision gate

The project team should assess the specific feasibility of the project at this stage; Can geothermal power be produced as the project location at commercial rates?p

13 Timing of the geothermal feasibility study

It can be very hard to discern if an element requires more or less hours to be completed. However, the hours anticipated for each element is based on experience. The third colonm is what the total duration of the process takes – there is a lot of idle time in the project which is waiting on feedback from stakeholders in technology, planning and permitting, etc.

	Element	Anticipated hours	Weeks to complete
	Project Clarification	50	4
	Subsurface data	100	8
	Geological target identification	150	10
	Recommendation to drill	150	16
	Well design and cost estimates	100	8
	Project risk assessment	25	2
	Environmental amd regulatory requirements	75	5
	Geothermal feasibility study	75	4
		725	57

Table 3 – Timing of feasibility process

14 References

1. Seismic – best practice guide from GEOTHERM project
2. New geothermal plant design – best practice guideline from GEOTHERM project
3. Scenarios – Modelling, Assessement and Uncertainty – Project report from GEOTHERM project