

GRMF DIRECT USE – TECHNICAL ASPECTS

MARKET SOUNDING WEBINAR

Kristin Steinunnardottir

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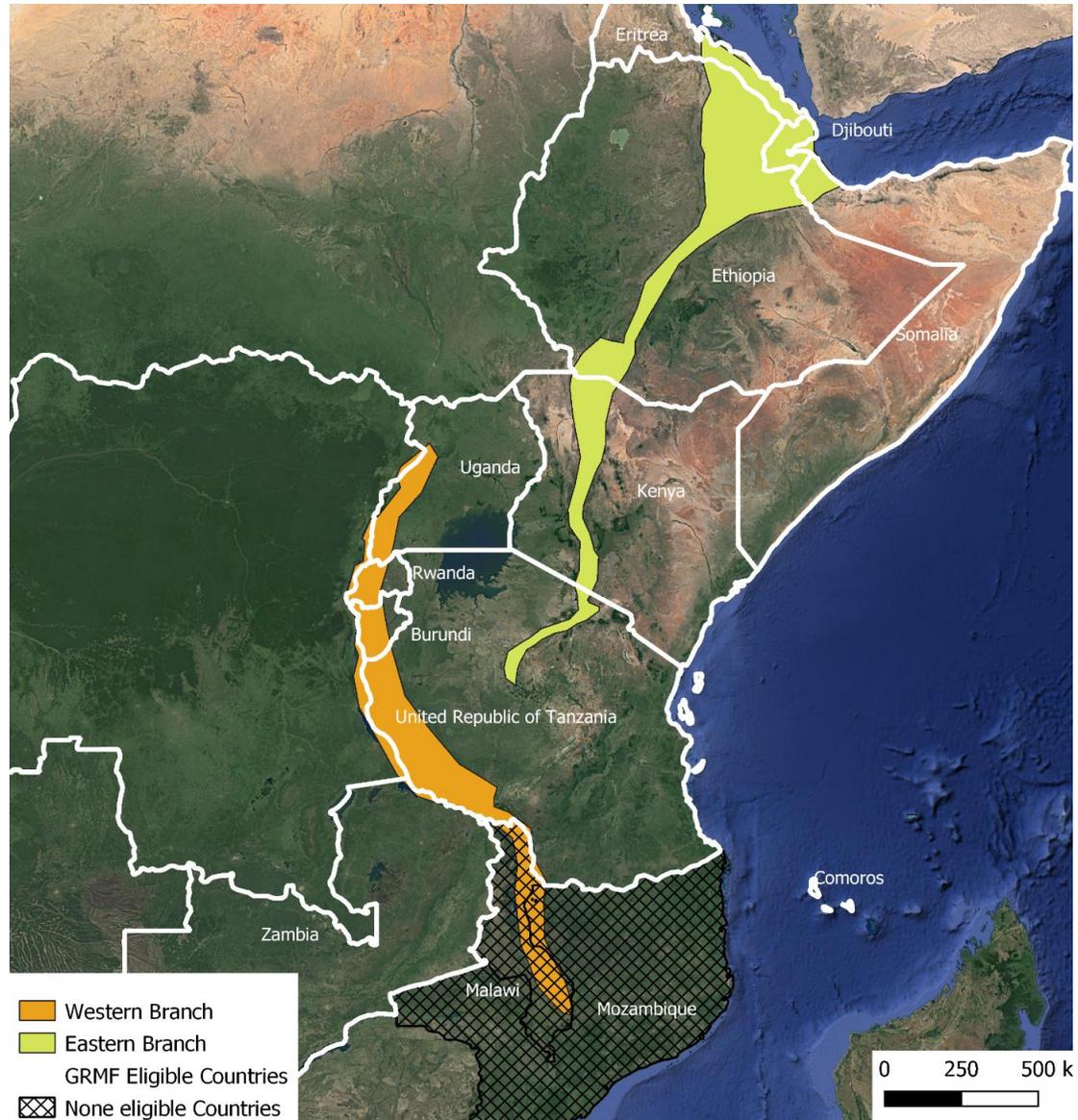


GRMF - DIRECT USE WEBINAR

1	Geothermal potential in East Africa
2	What to consider when planning a geothermal direct use project?
3	Surface studies
4	Geothermal direct use wells
5	Types of direct use configurations



1. GEOTHERMAL POTENTIAL IN EAST AFRICA



1. WHAT TO CONSIDER WHEN PLANNING A GEOTHERMAL DIRECT USE PROJECT?

Each geothermal system is unique.

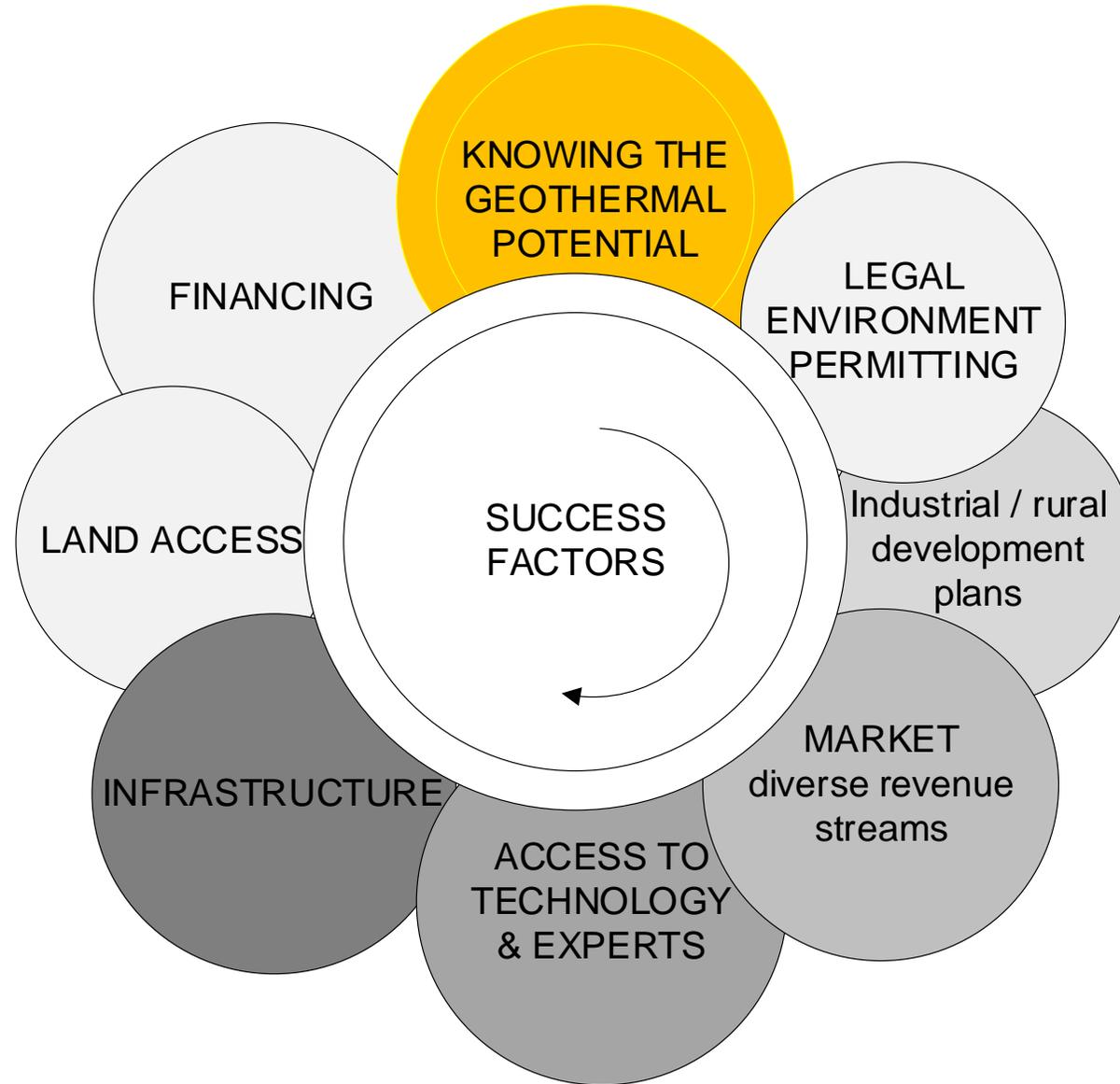
The production capacity of geothermal systems is highly variable:

- Temperature
- Reservoir volume
- Geology and tectonics
- Fluid chemistry
- Dynamics and physics

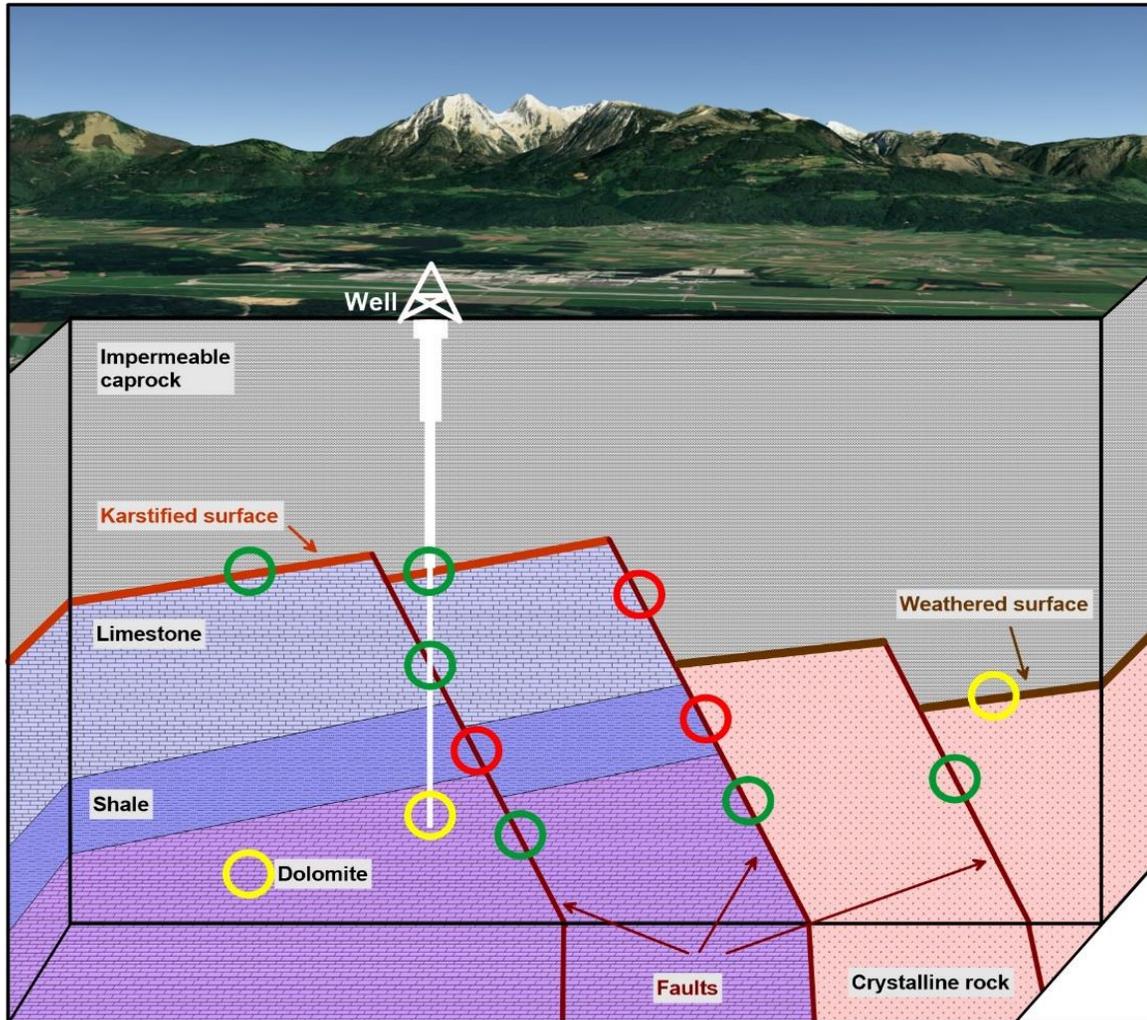
Detailed studies and exploration of the geothermal resource are the foundation of successful geothermal development.



1. WHAT TO CONSIDER WHEN PLANNING A GEOTHERMAL DIRECT USE PROJECT?



3. SURFACE STUDIES



Compared to high temperature systems the medium to low temperature systems are sometimes in greater depth of basin areas.

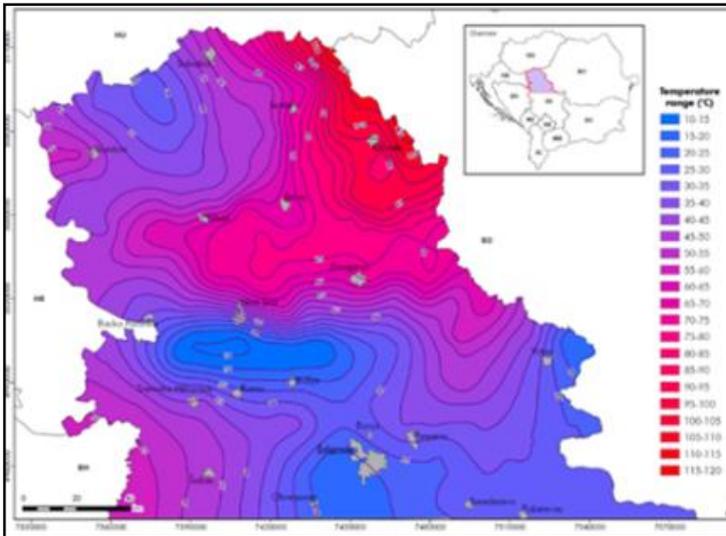
- Use of magneto-telluric method has less importance.
- Seismic measurement is quite useful and frequent method to identify the internal structure of the sedimentary layers for locating faults or the depth position of the targeted aquifer.
- Target temperature depends on planned application.

3. SURFACE STUDIES



Typical surface surveys for locating the site and target for the first wells in low to medium temperature direct use project development are e.g.:

- Data gathering
- Evaluation of existing borehole data
- Interpretation of existing seismic and gravity measurements
- Evaluation of geological maps
- Analysis of tectonics, stress field and fault kinematics
- Geochemical analysis of chemistry data
- Creation of 3D conceptual model of the resource
- Sampling and analysis of wells and thermal springs
- Performing seismic measurements
- Planning and drilling temperature gradient wells

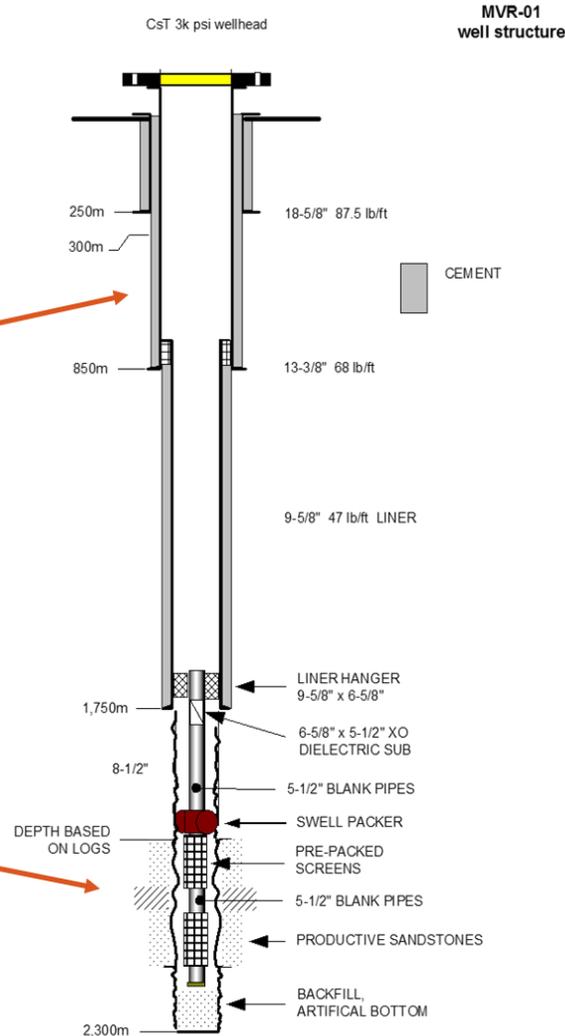


4. GEOTHERMAL DIRECT USE WELLS

Well Design Example - Lower temperature hydrothermal reservoir with Sand Control

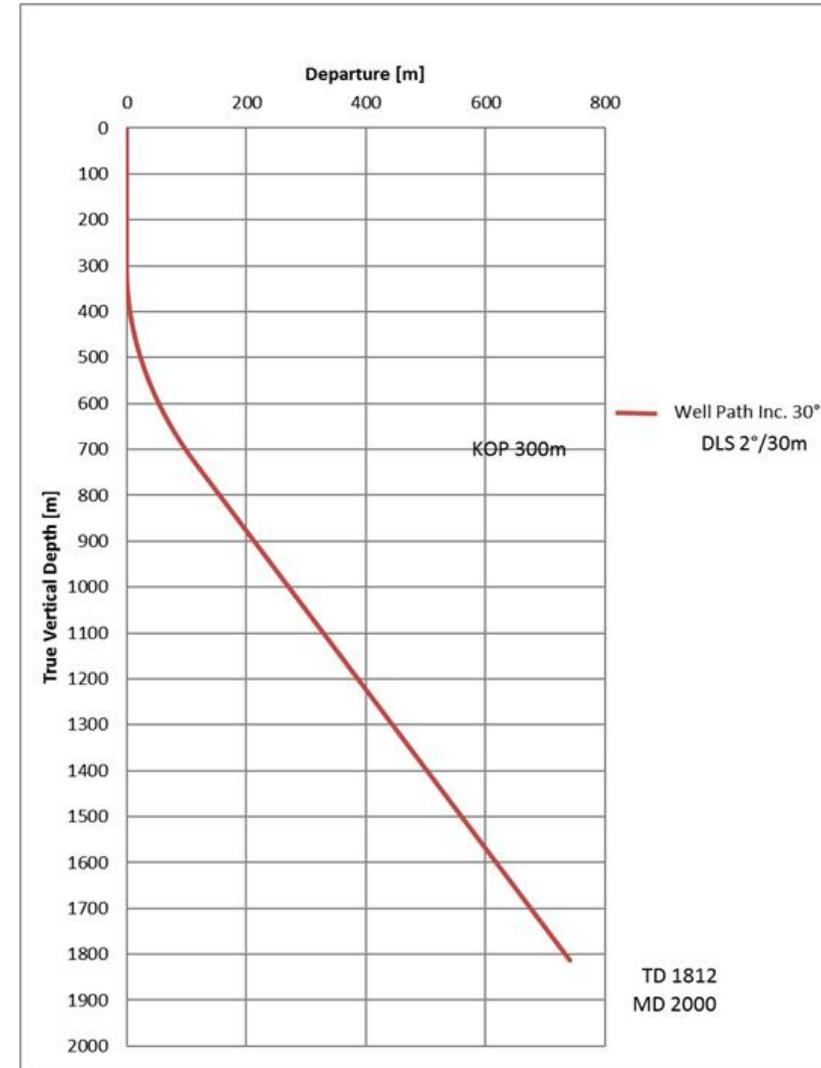
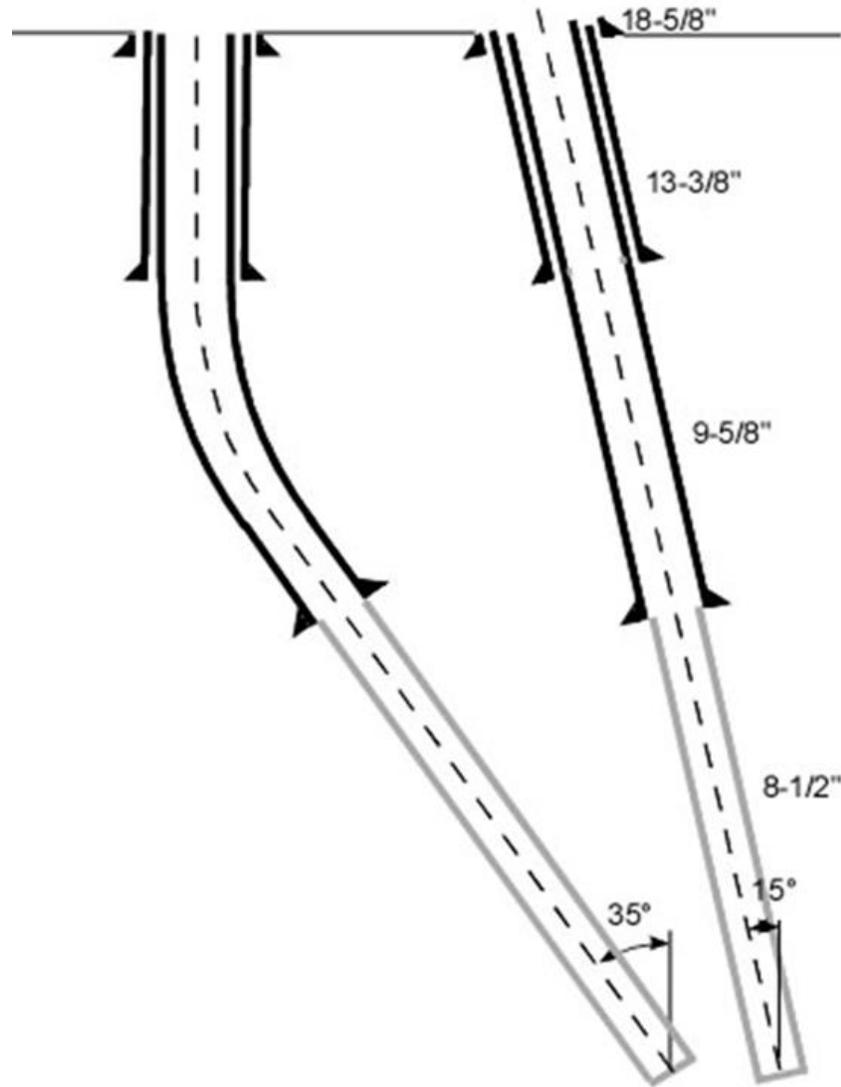
Pump Chamber

Pre-packed screens
used to produce from
sandstone



- Low to medium temperature wells usually have less demanding design conditions.
- Casing diameter may need to account for downhole pump.
- Gaseous reservoirs may require design with respect to possible gas kicks.
- Well in reservoir containing sand may require sand control.
- Depths of wells can vary from a few hundred meters up to around 3 km depths.

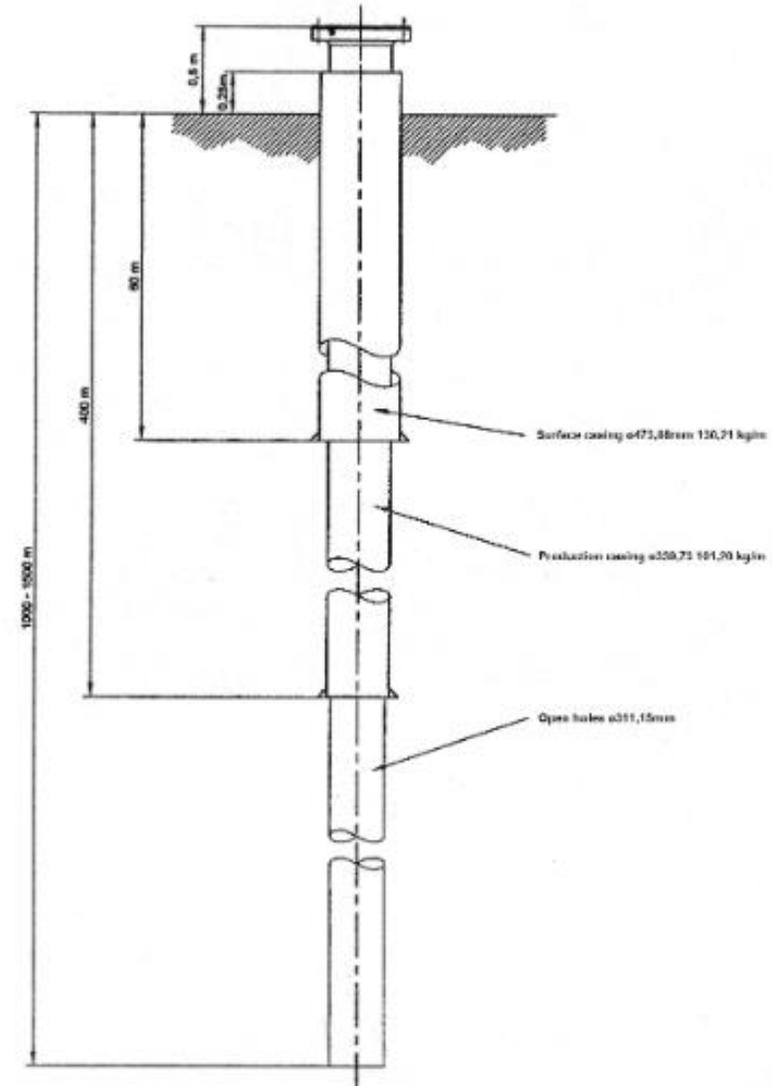
4. GEOTHERMAL DIRECT USE WELLS



4. GEOTHERMAL DIRECT USE WELLS - REINJECTION

Difference of reinjection well design parameters in comparison to production wells are often:

- Shallower depths
- No downhole pump and therefore no pump chamber, in case of known geothermal field
- Lower temperature and pressure of the fluid
- Sometimes left as an open hole
- In case of sandstone aquifer, the sections within the aquifer should be under-reamed and filled with gravel pack to avoid the migration of particles from the rockframe



5. TYPES OF DIRECT USE CONFIGURATION

Geothermal production loop system designs

Self-flowing artesian resource

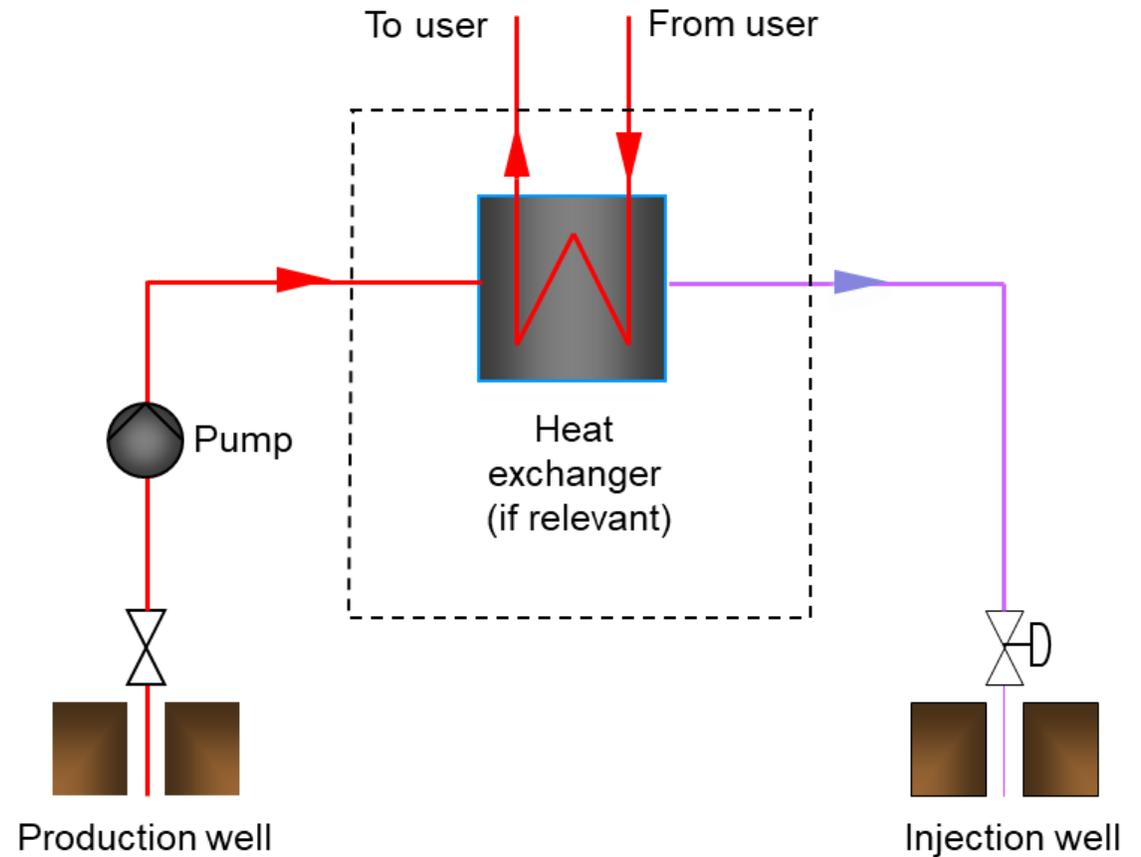
Self-flowing drilled wells

Pumped production wells

Pumped production wells with reinjection

Hybrid production, producing both electricity and direct heat

Cascaded and integrated use, where multiple heat sales are sustained by same wells often utilizing different, cascading, temperature ranges



5. TYPES OF DIRECT USE CONFIGURATION



Thank you for your attention!



Kai Imolauer
General Project Manager



Maria Ueltzen
Deputy Project Manager



Johannes Stollenwerk
Local Fund Manager



Kristín Steinunnardóttir
Technical Project Manager