

# GEO THERM

## WORK PACKAGE 6

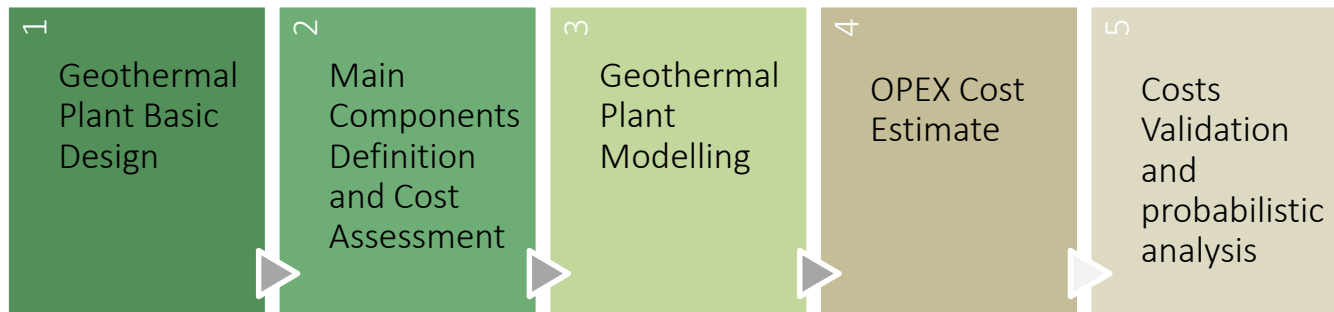
MAY 2019

# Geothermal Business Case

A geothermal project consists of three primary phases: project engineering, drilling and construction and production. This work package will look at the Business Case holistically; however, primary focus will be on assessing the cost profile (**OPEX**) of the production cycle.

Sustained productivity is pivotal to the overall project economy, and requires knowledge of the district heating system requirements (consumer) in combination with maintenance, and predictive failure of components.

Data has been empirically deduced mainly from DK facilities mainly, and modelling of the cost base has resulted in knowledge on how to set-up a fully operational facility. The work packages aimed at understanding the long-term perspective in sustained production of geothermal energy.

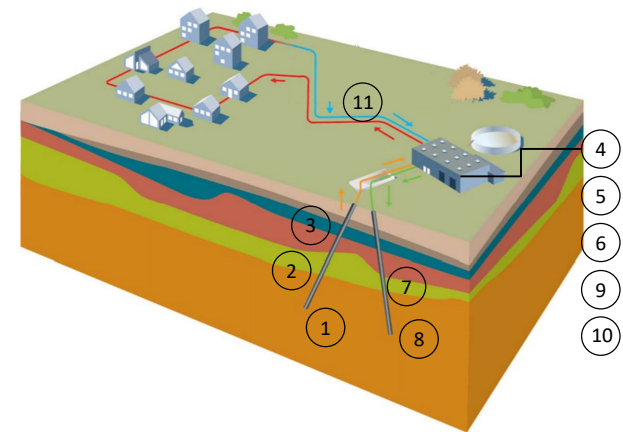


■ Completed

# Geothermal Facilities

## Main Components

1. Producer Lower Completion
2. Producer (wellbore)
3. Production Electrical Submersible Pump (pESP)
4. Filtration
5. Heat exchanger
6. Injection Pump (iP)
7. Injector (wellbore)
8. **Injector Lower Completion**
9. Heat Pump
10. **Auxiliary systems**
11. Heating Loop (distribution)



Costs related to the maintenance or enhancement of the injection rates, for example:

- Well test
- Wireline Operations
- Acid job
- Rock the Well
- Scraper run
- Re-perforation

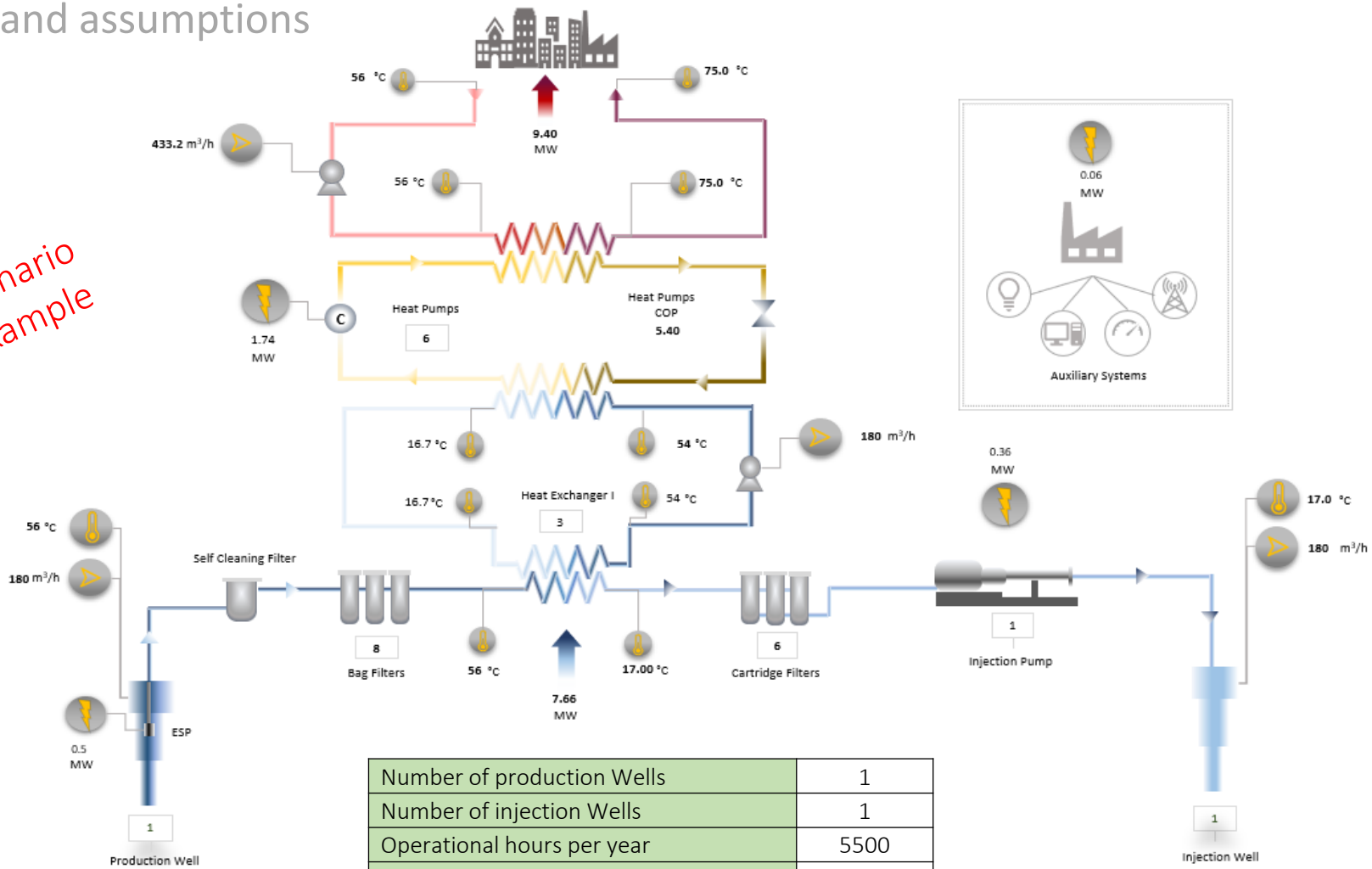
Costs related to maintenance of the production facilities and personnel, for example:

- Auxiliary Systems power consumption
- Personnel
- Building and land maintenance
- IT costs for control and regulation
- Valves, meters and piping maintenance

# Geothermal Plant Model

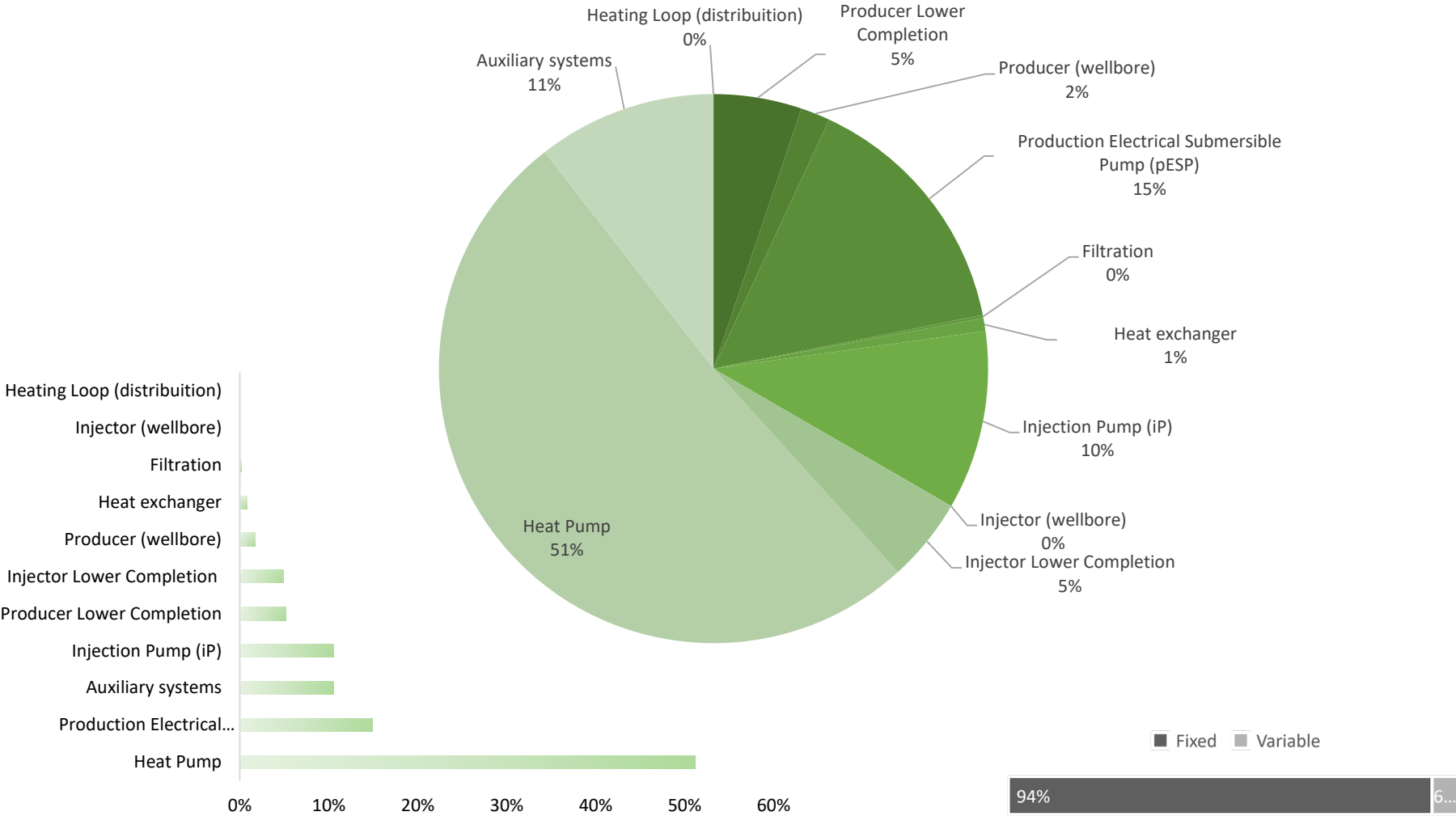
## Process and assumptions

Scenario example



Number of production Wells	1
Number of injection Wells	1
Operational hours per year	5500
Number of Years	30
Electricity Cost (DKK/KWh)	0.4
District heating low temperature ( $^\circ\text{C}$ )	56
Desired heating high temperature ( $^\circ\text{C}$ )	75

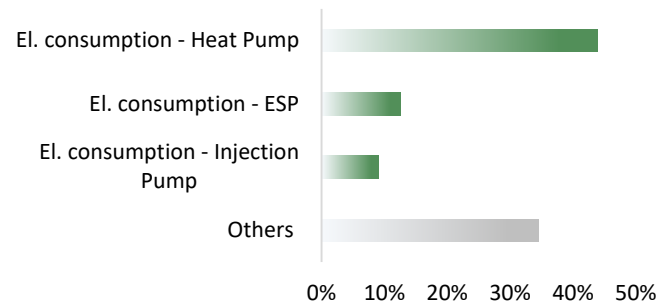
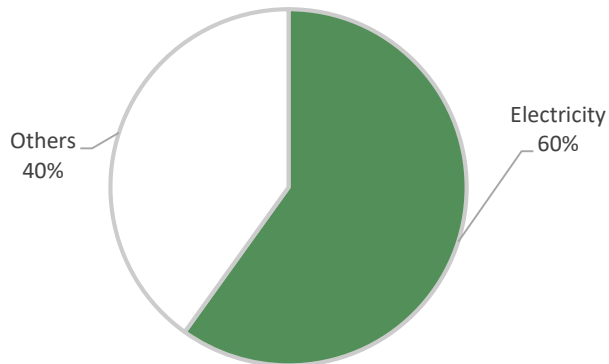
# OPEX Distribution



# OPEX Distribution

## Electricity Consumption

	Annual OPEX (MDKK)	
Producer Lower Completion	0.44	5%
Producer (wellbore)	0.15	2%
Production Electrical Submersible Pump (pESP)	1.27	15%
Filtration	0.02	0%
Heat exchanger	0.07	1%
Injection Pump (iP)	0.89	11%
Injector (wellbore)	0.00	0%
Injector Lower Completion	0.42	5%
Heat Pump	4.34	51%
Auxiliary systems	0.89	11%
Heating Loop (distribution)	0.00	0%
<b>OPEX cost/year (MDKK)</b>	<b>8.49</b>	<b>100%</b>



# OPEX costs

## Probabilistic analysis

Due to the uncertainty of occurrence of different events with high impact on the final cost (e.g. well interventions, equipment failures etc.), a probabilistic analysis is being conducted and will demonstrate the range and variation of the OPEX and identify the main cost drivers of the project.

