WARMINGUP
Innovatief Duurzaam Warmtecollectief

TNO

Realisatie van geothermie in stedelijk warmtenet

Booster event 27-9-2022

Agenda

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14:00 Quick intro round

14:05 Introduction Theme 4 for realisation of geothermal

14:20 Q&A ‘Can results be used and how?’

14:35 Pitch integration in heat network

14:40 Discussion

14:55 Wrap-up

Thema 4: geothermie in de gebouwde omgeving

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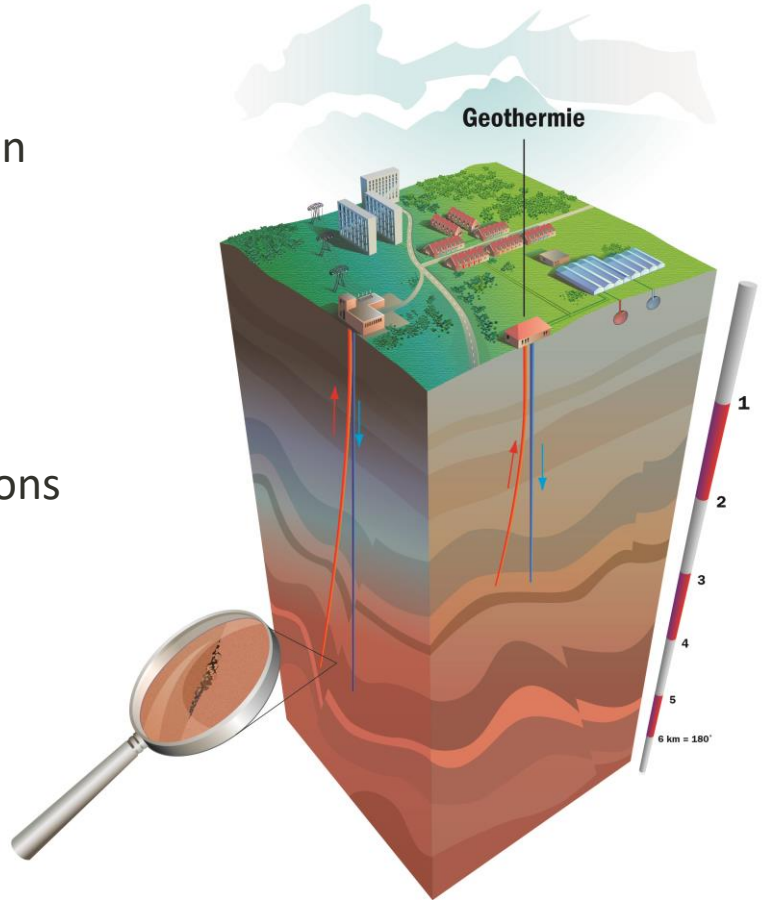
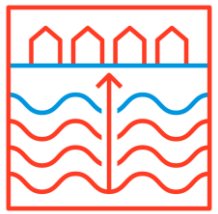
Geothermal heat as source in an urban heat networks

- Characterisation
- Realization
- Seismicity
- Optimization of design and operations



Thema 4 partners

TNO
WEP work well together
ebn
Huisman
VATTENFALL
ennatuurlijk
hvc energie en hergebruik
Aardyn Geothermie ontwikkeling & beheer
Eneco
Gemeente Breda
Provincie Noord-Brabant
ecw energy solid solutions for a sustainable future



Realization of geothermal

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- What developments/knowledge is required to enable geothermal heat as a source in an urban heat network (from the point of view of the geothermal source)?
- What is different than in ‘traditional’ geothermal?
- What role can shallow geothermal play (500-1500 m depth) and how can it be produced?

Topics

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Integration in heat network

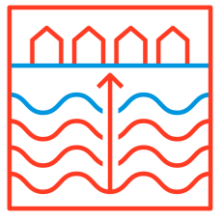
Shallow (500-1500 m)

Reduce CO_2 footprint

Well design for shallow depth

Handling variability in heat demand

Fines/sand production from unconsolidated



Optimal well placement and design

Optimal operational decisions

Cost-effective measurement technology

Generic topics

Shallow geothermal (500-1500 m)

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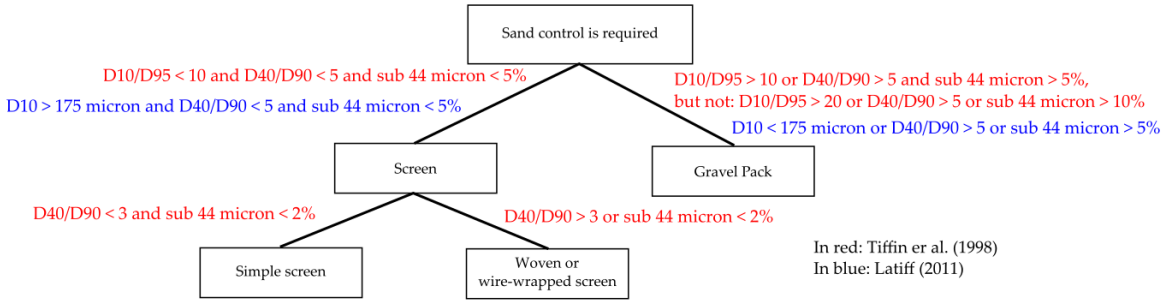
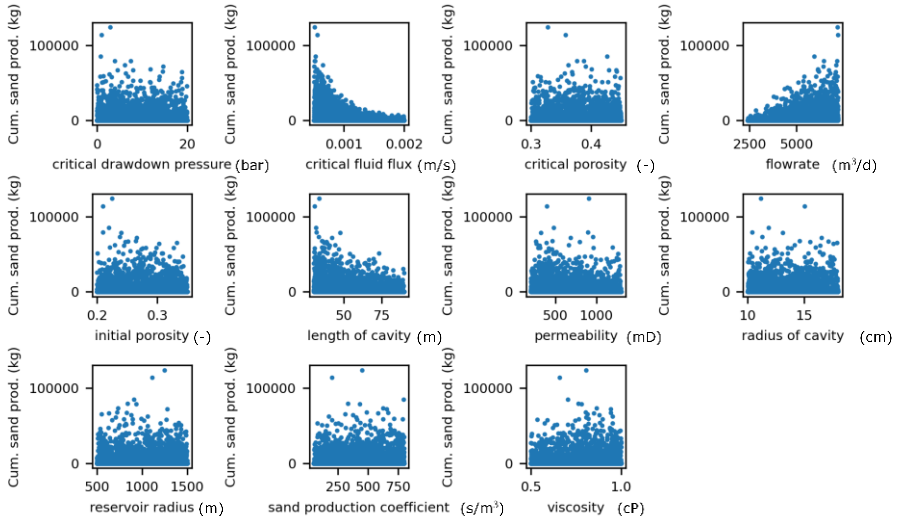
- Sand/fines can be produced at too high rates from poorly consolidated formations
- Limiting rate is not generally feasible
- Literature study into other solutions



In red: Tiffin er al. (1998)
In blue: Latiff (2011)

Sensitivity analysis sand production



→ *Continuation in proposal WarmingUP GOO*

Well designs for shallow reservoirs

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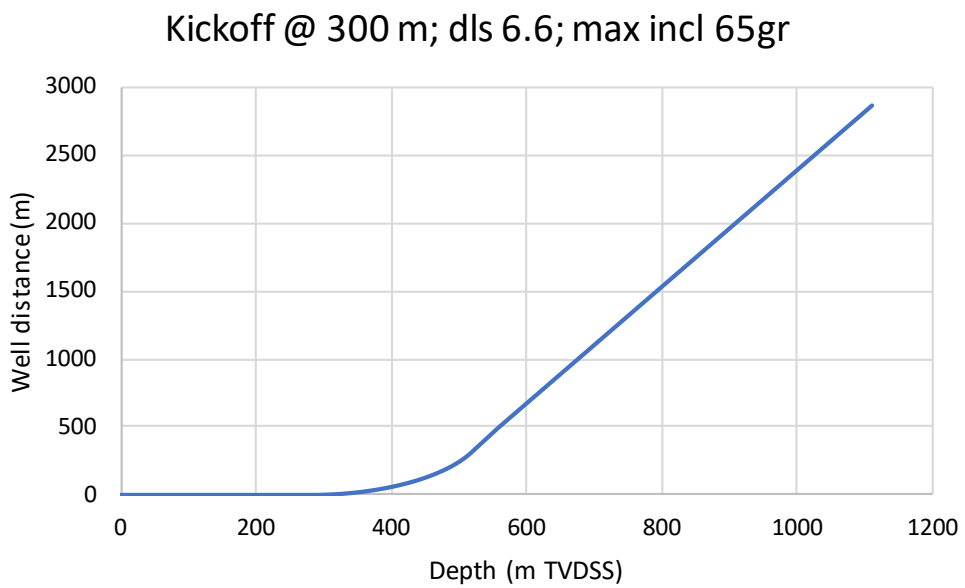
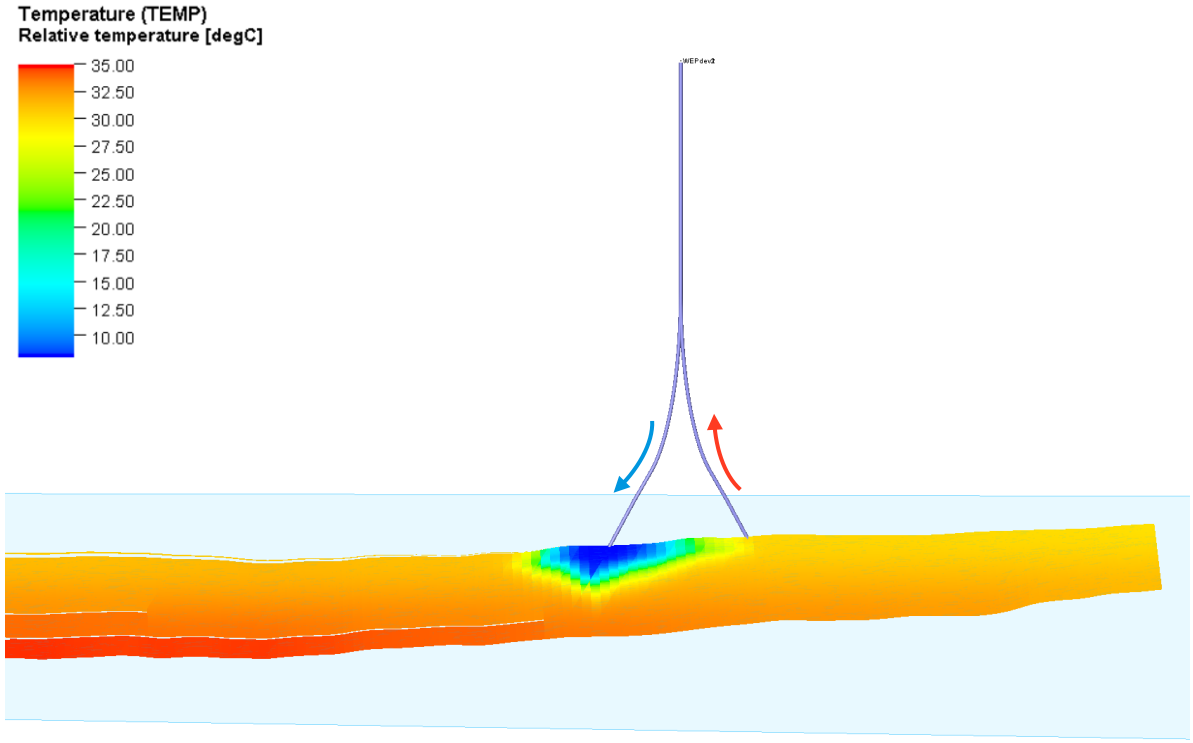
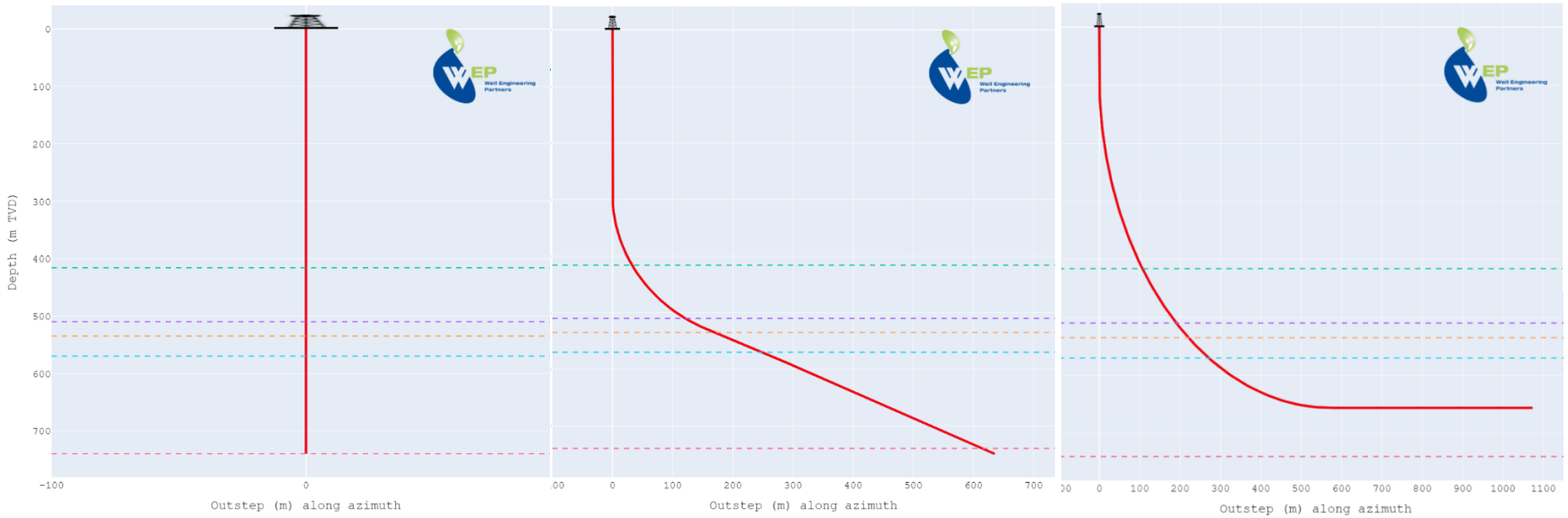
Add shallow depth (< ~800 m), the distance between ‘traditional’ deviated wells is insufficient.

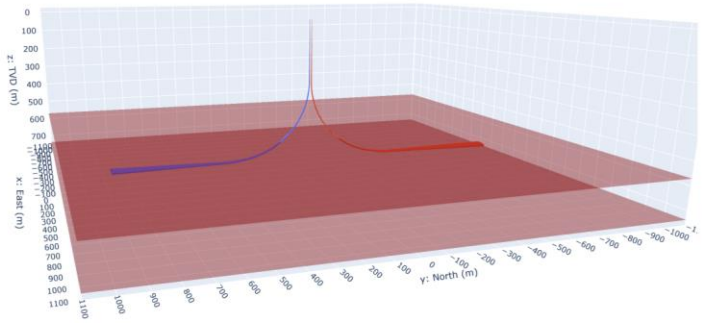


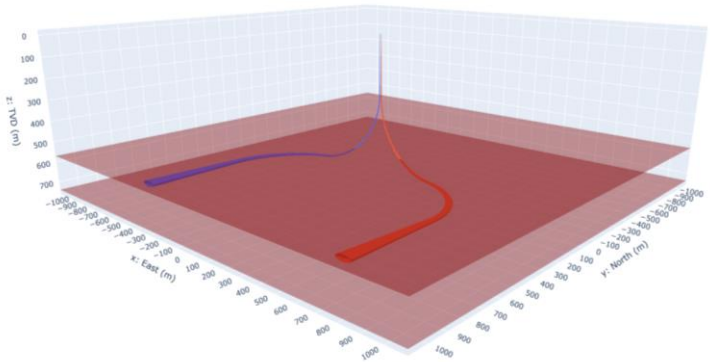


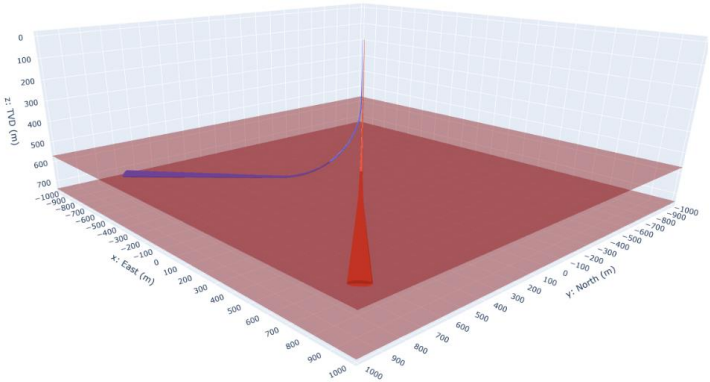
Cold water reaching the production well early

Well designs for shallow reservoirs









65 m net reservoir
PI =9.6 m³/hr/bar

140 m
PI=11.6 m³/hr/bar

750 m
PI=16.3 m³/hr/bar

	Net present value [€]	Internal rate of return [%]
Design 1: Vertical well	-2,104	-7%
Design 2: Inclined well	-159	7%
Design 3: Horizontal well - 850m	-552	5%
Design 4: Horizontal well - 1250m	-196	7%
Design 5: Horizontal well - perpendicular	834	12%

Optimal operational decisions

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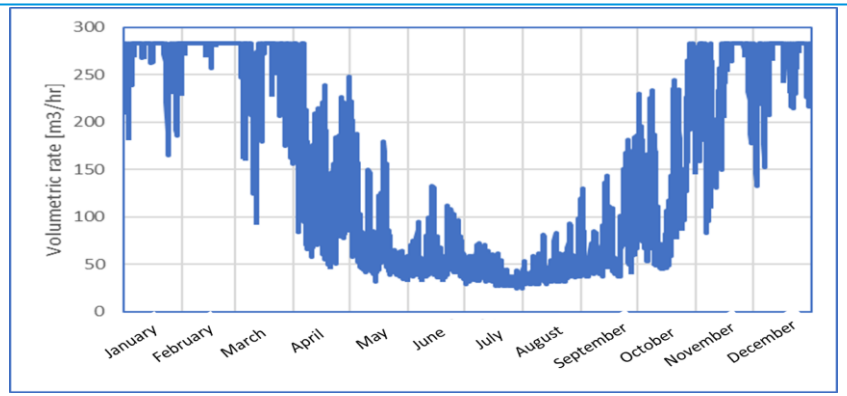
Driven by variable heat demand



Several operational challenges, planned/unplanned maintenance

Support operators with operational decisions

Optimal operational decisions

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Optimal operational decisions
What was developed?

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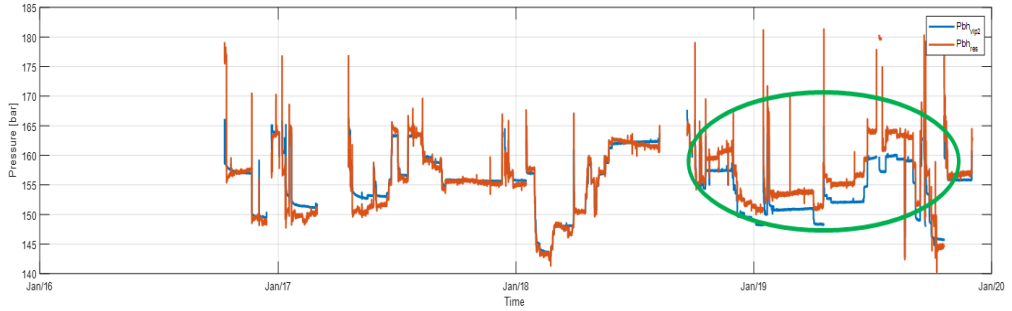
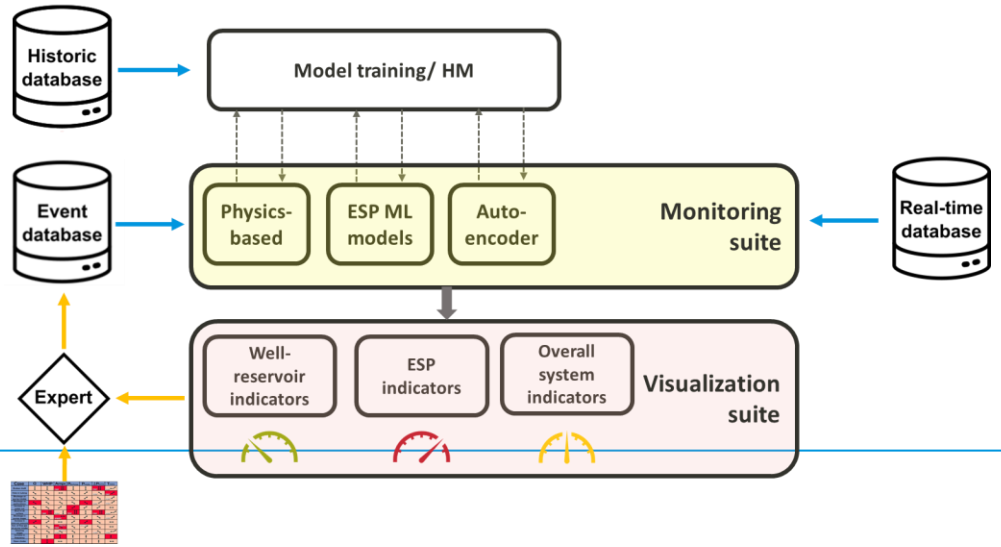
Real-time monitoring of geothermal/HTO systems

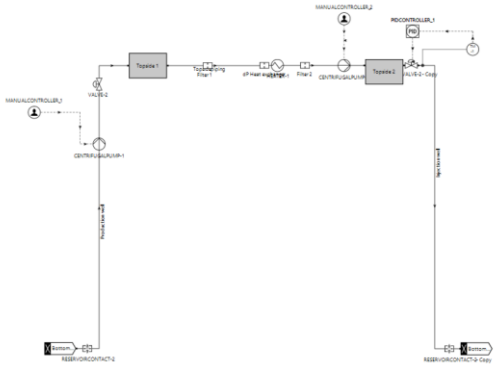
Case study, electrical submersible pumps

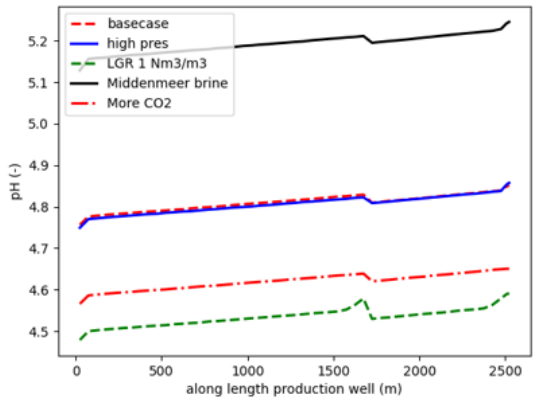
Detect events up to 6 months prior to failure

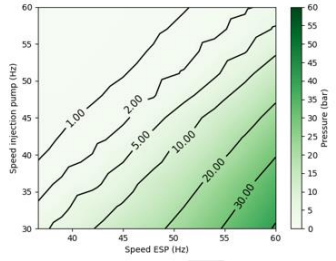


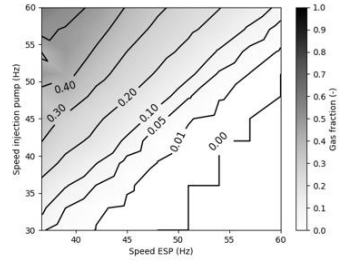


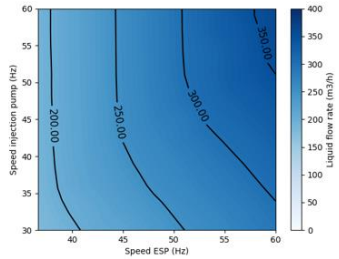
Engineering of technologies/methods to handle GHG in geothermal systems

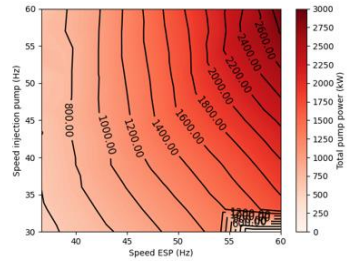












Optimal operational decisions - Vision

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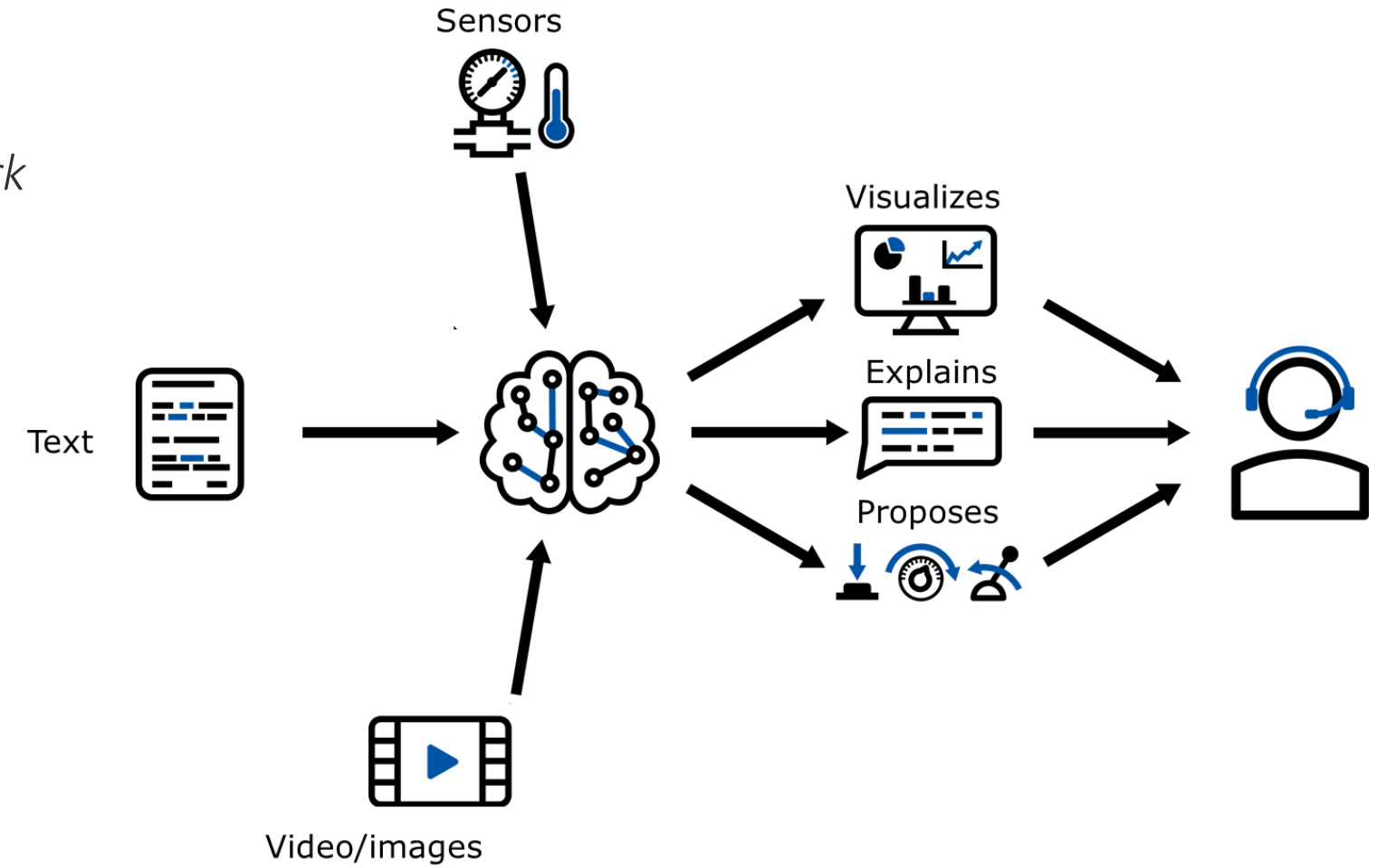
- *Towards an intelligent decision support framework*
- *Design and operation*
- *Automating workflows*



How can the results be applied?

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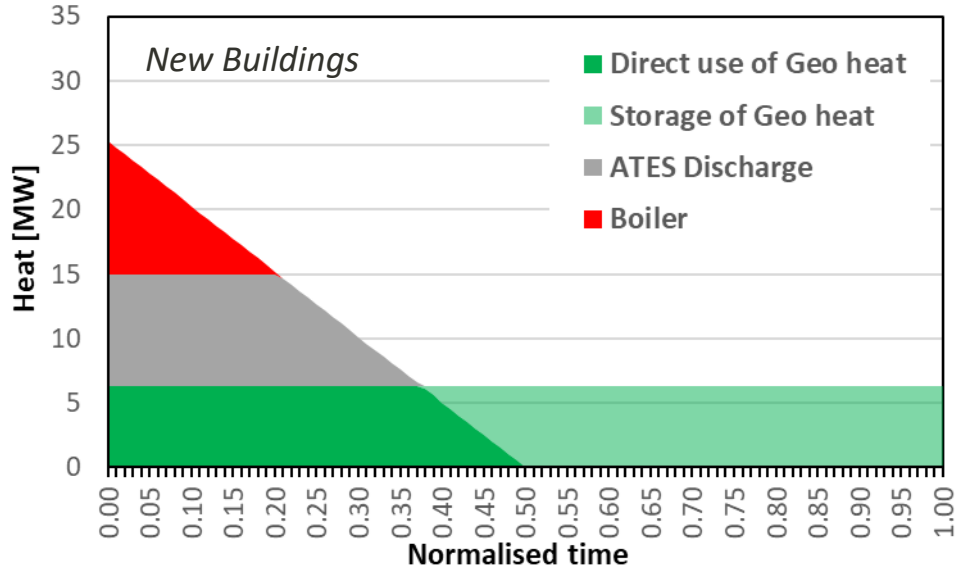
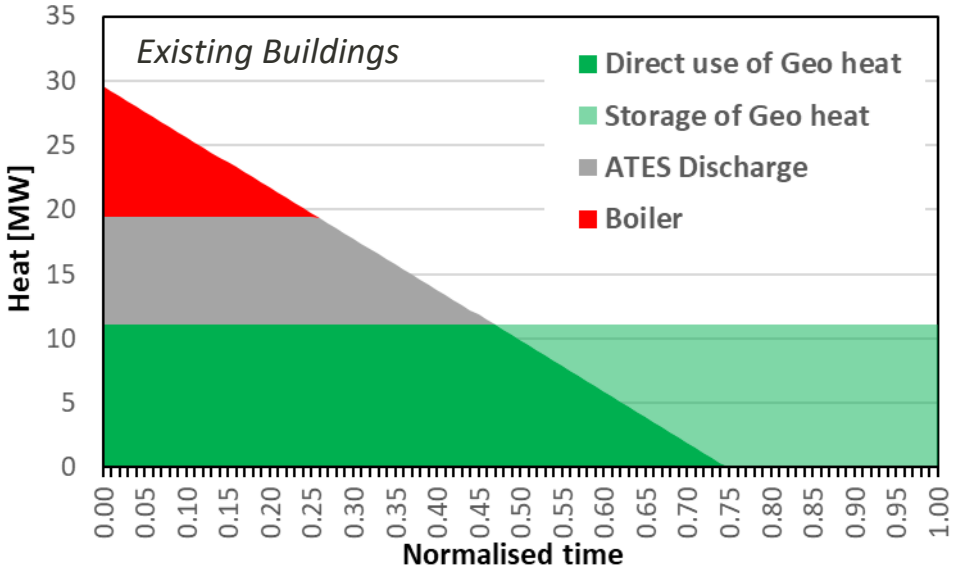
Integration in heat networks

- How to handle the high **variability** (*daily,* seasonal) in urban heat demand, ….

  …. considering:
  - Security of heat-supply
  - Cost (constant production)
  - Emissions

- Possible systems
  - Only geothermal, following demand?
  - Geothermal + gas heater
  - Geothermal + HTO
  - Geothermal + HTO + gas heater





10k households, space heating only
Geo power = average heat demand

Integration in heat networks

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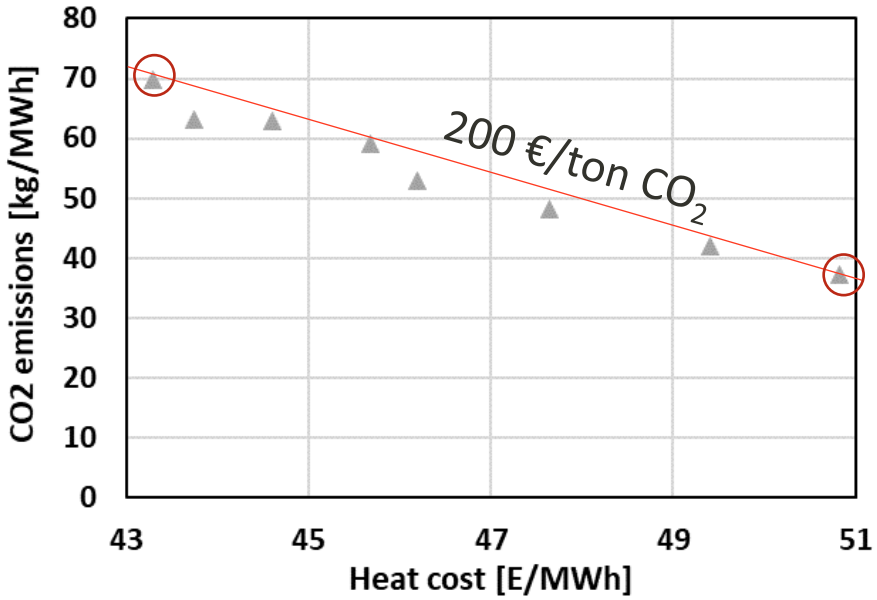
- Geothermal (constant) + HTO + gas heater
  - Small Geo & HTO: ~43 €/MWh 70 kg CO_2/MWh
  - Large Geo & HTO: ~51 €/MWh 35 kg CO_2/MWh

→ CO_2 emission reduction: ~200 €/ton CO_2

- New: ~43 €/MWh 70 kg CO_2/MWh
- Existing: ~43 €/MWh 46 kg CO_2/MWh



Beneficial to make geothermal more flexible?

Impact of fluctuations of energy price?

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Thank you for your contribution

Bedankt voor jullie bijdrage

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