

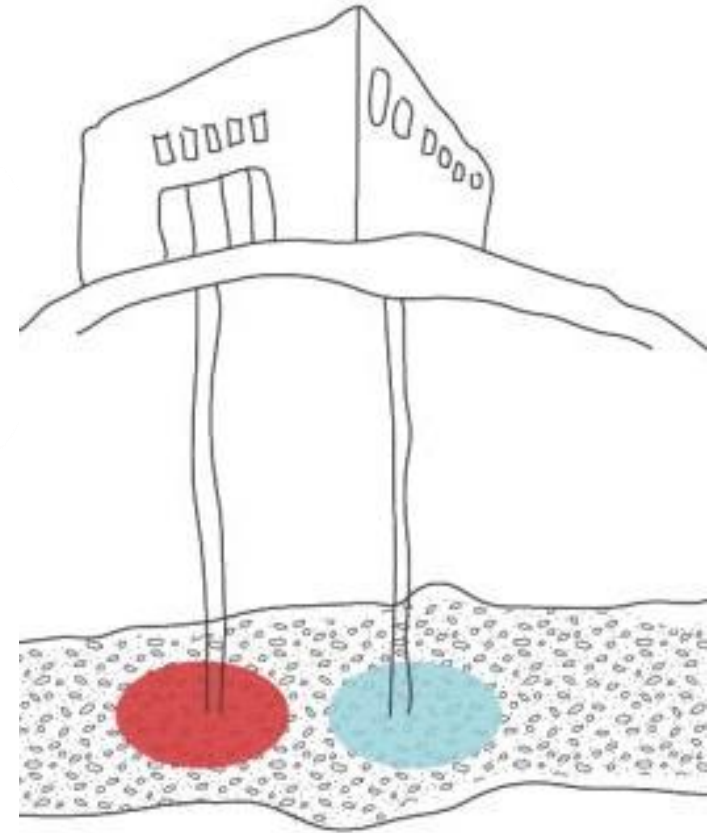


**Question today**  
*imagine tomorrow*  
**create for the future**

*John Smith, Vice President, Canada*

# Subsurface Energy Storage and Buffering (ATES and Shallow Geothermal Plants)

*David Klemetz (WSP Sweden)*





## A crazy world #1



## A crazy world #2

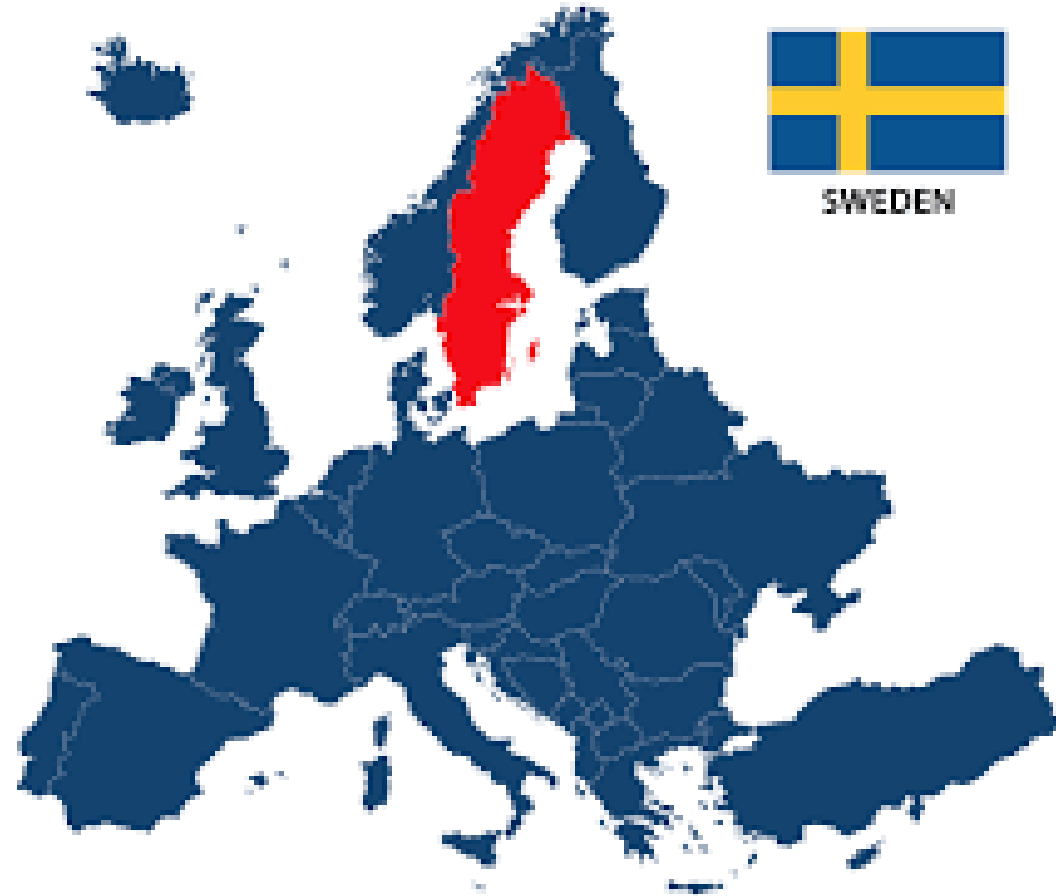




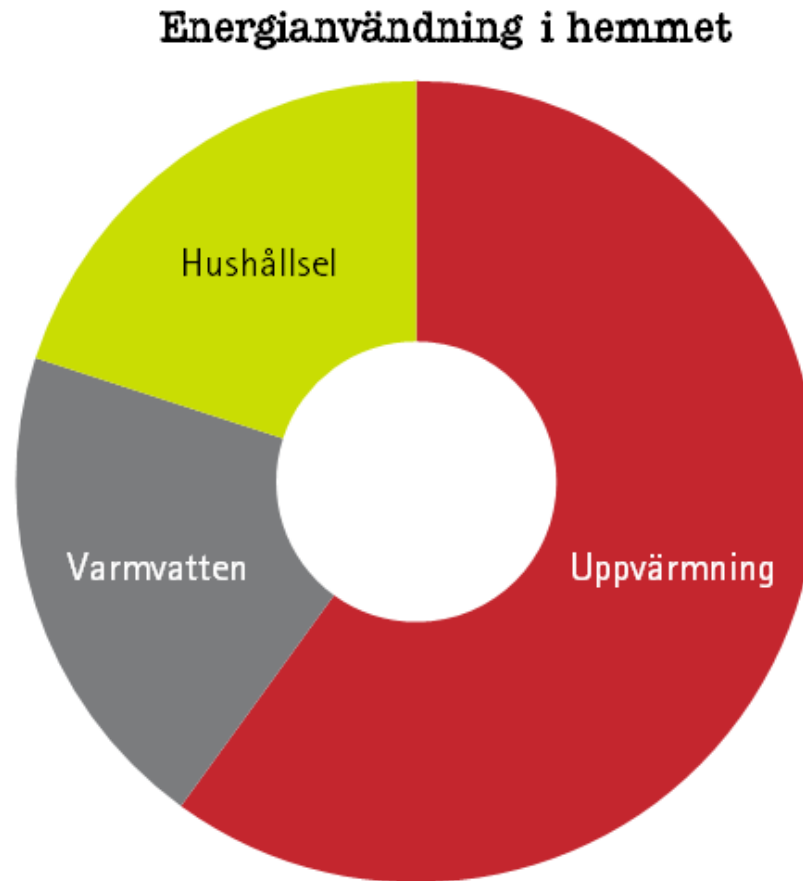
## A crazy world #3



# SWEDEN

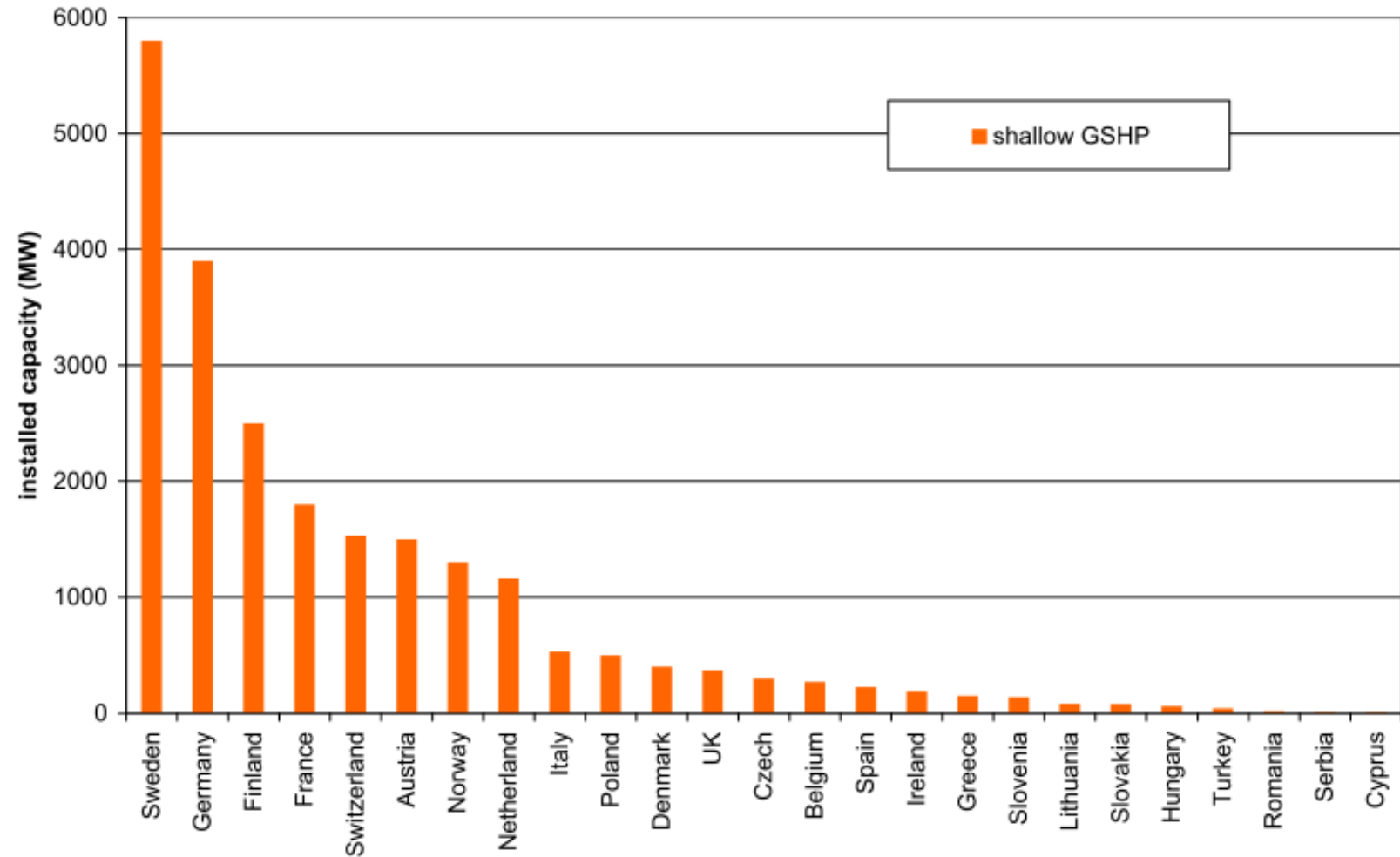


## Energy demand in household



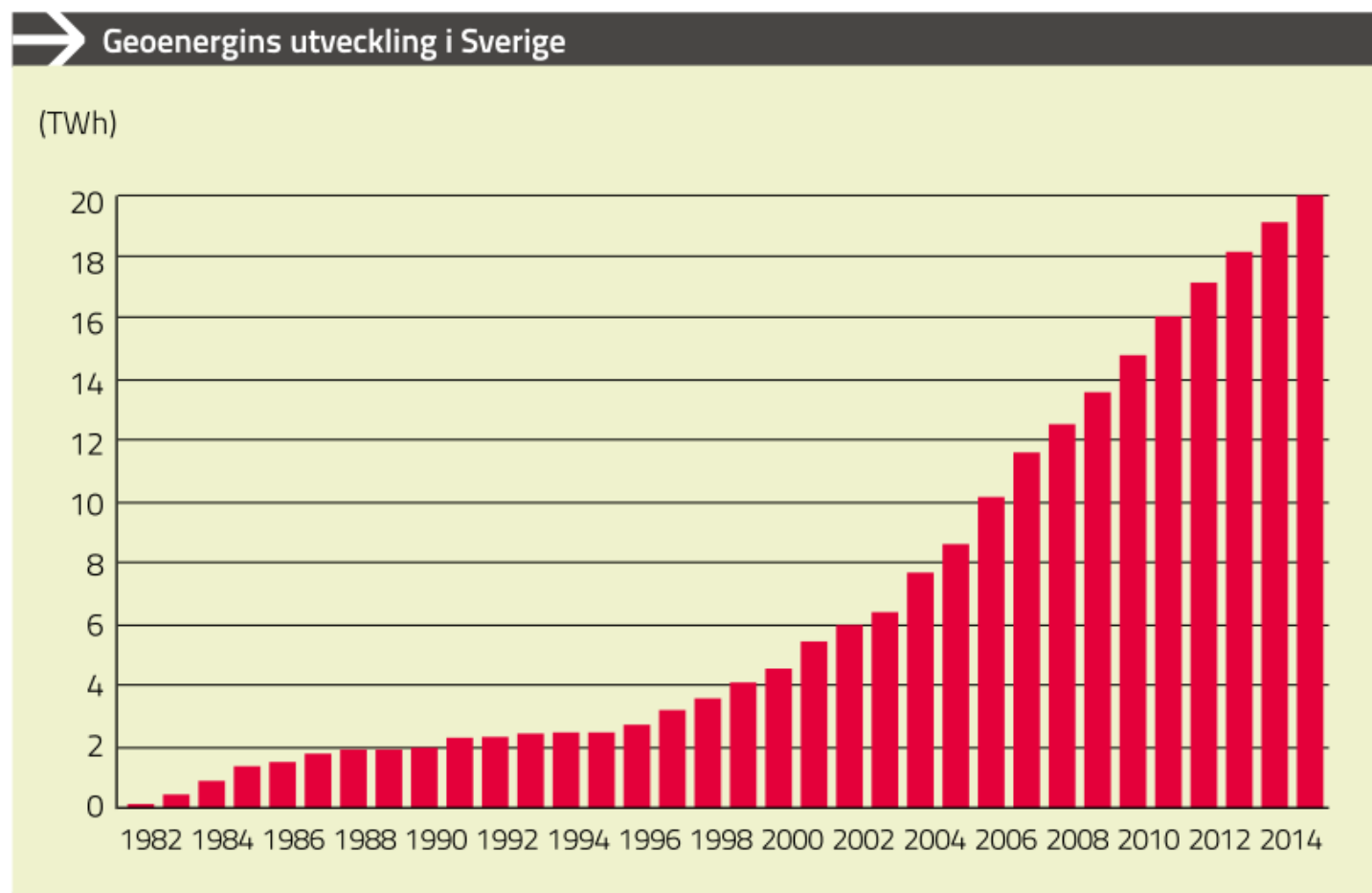
Nearly 80% of the energy consumption in household is related to heating or upheated tappwater

# SWEDEN





# Geoenergy in Sweden

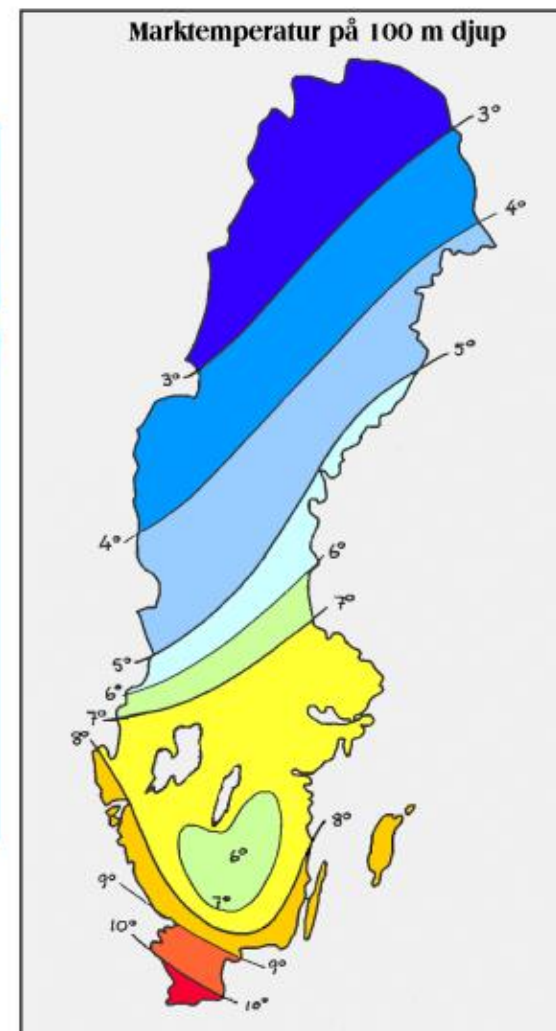
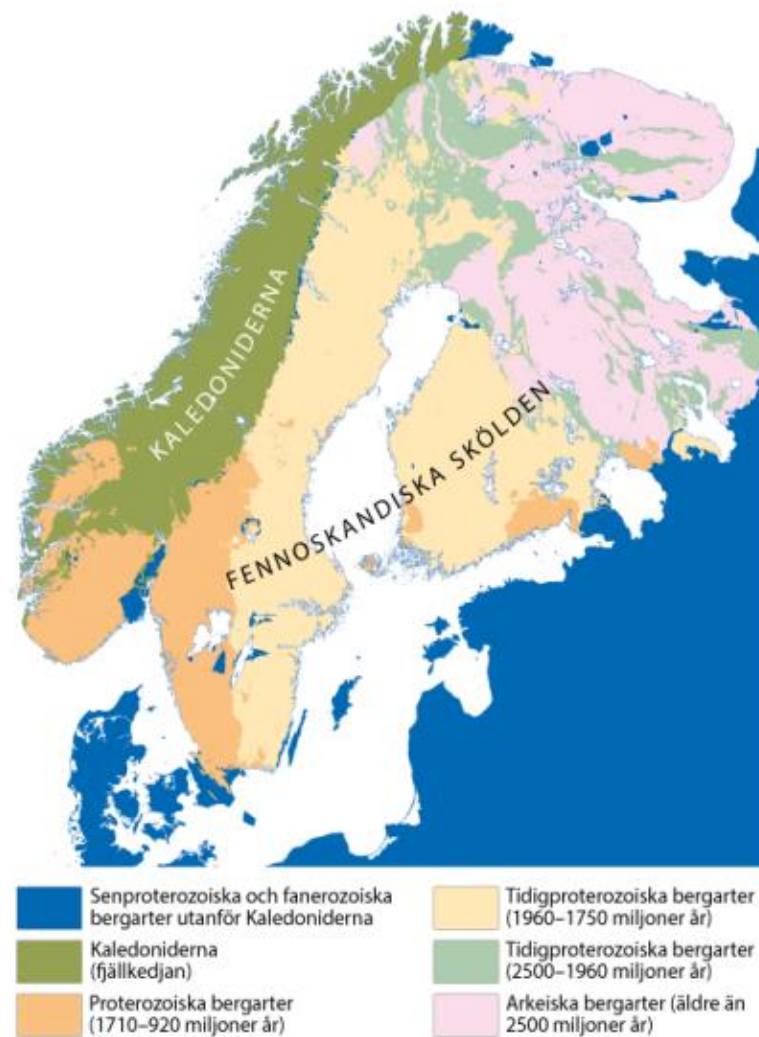


**DIAGRAM 1** ▪ Geoenergins utveckling i Sverige 1980–2015 (inklusive el till värmepumpar).

Källa: Gehlin och Andersson, 2016, *European Geothermal Congress*.

# SWEDEN

12



# District heating



In Sweden more than 50% of all houses are connected to district heating

Sweden is a front-runner even in this case



## SWEDEN – Summery

- Sweden is a world leading country using, shallow geothermal energy (GSHP and BTES).
- More than 600.000 GSHP and BTES installations → 25% of Swedish buildings.
- The market for larger shallow geothermal energy systems (ATES/BTES) has been expanding over the last years.

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- On the other hand, Sweden is a also “world leading” using distict heating...

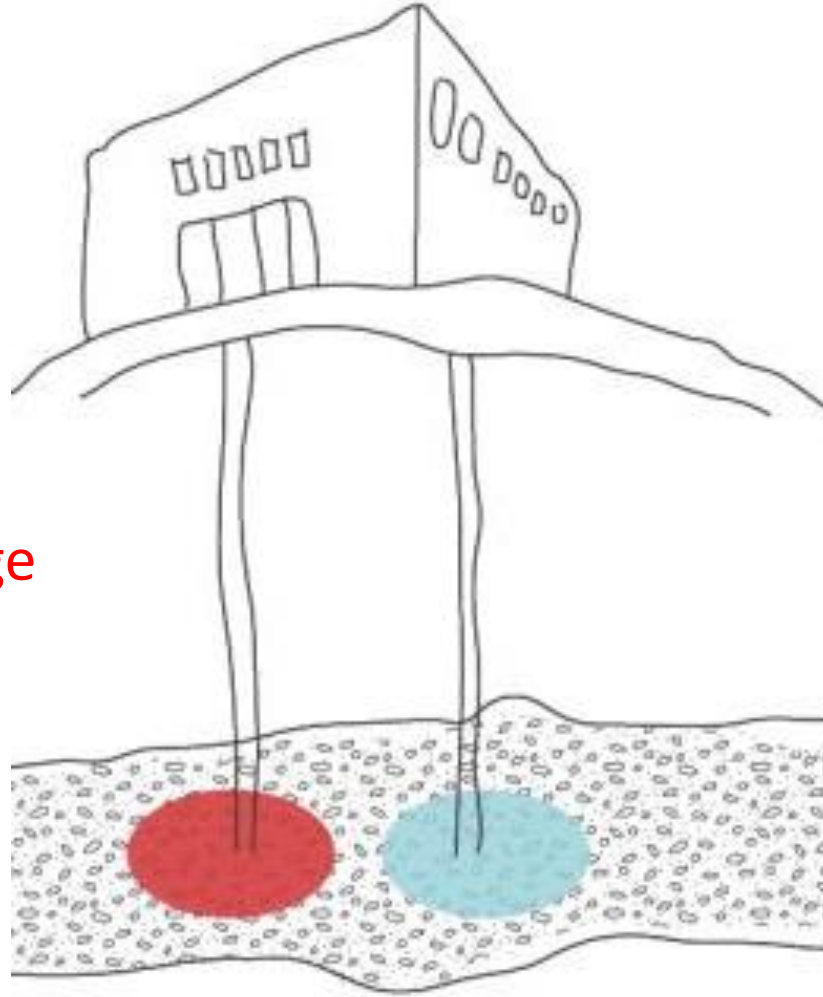
## SWEDEN

—There is an **on going “fight”** between district heating and geothermal energy in Sweden – it is almost impossible to implement geothermal plants inside district heating zones...



## My Mission #1

Geothermal Storage  
(ATES)

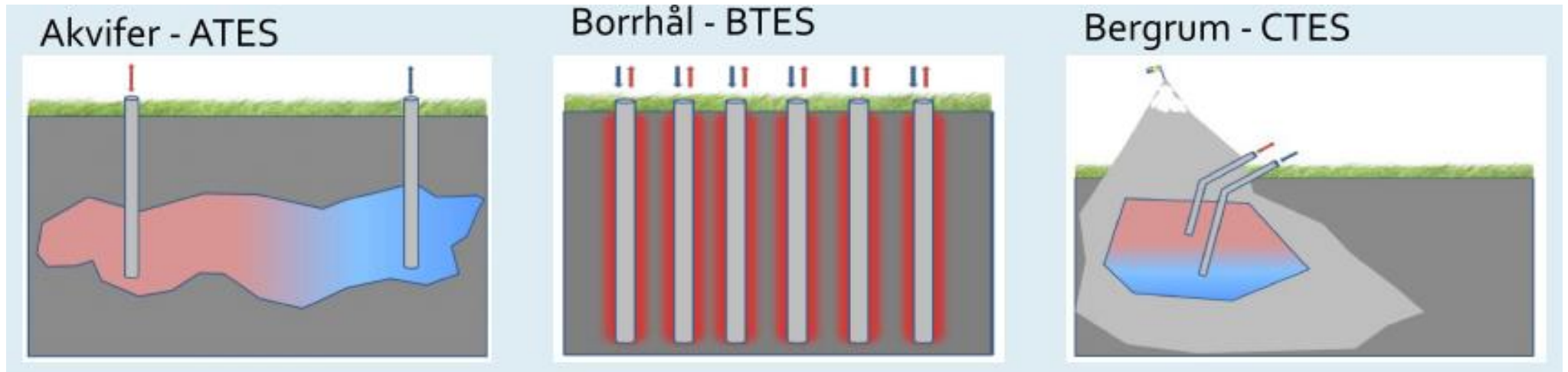




# Geoenergy – a quick overview

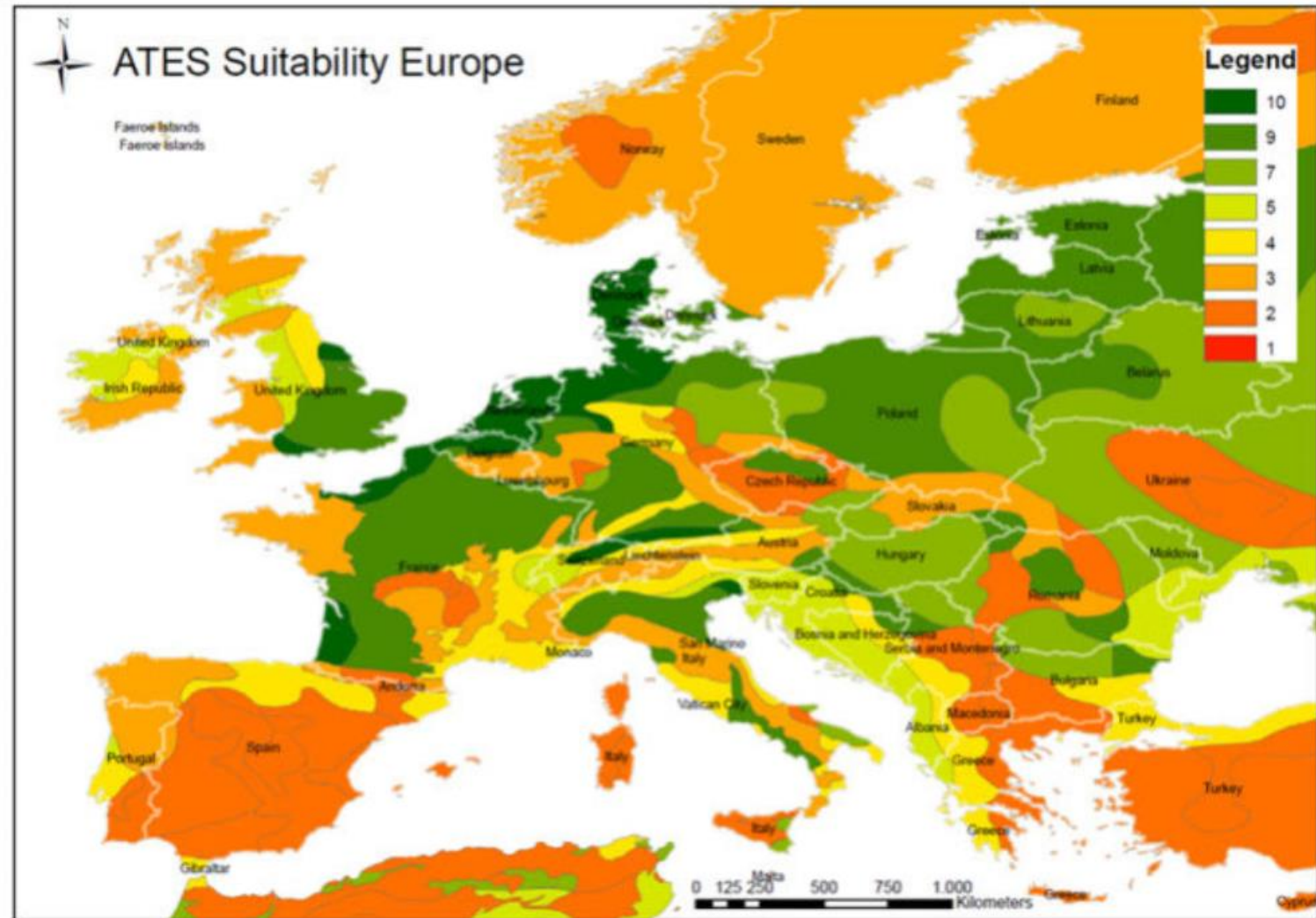
Open loop - system

Closed loop -system



HT-BTES!!!

## ATES in Sweden

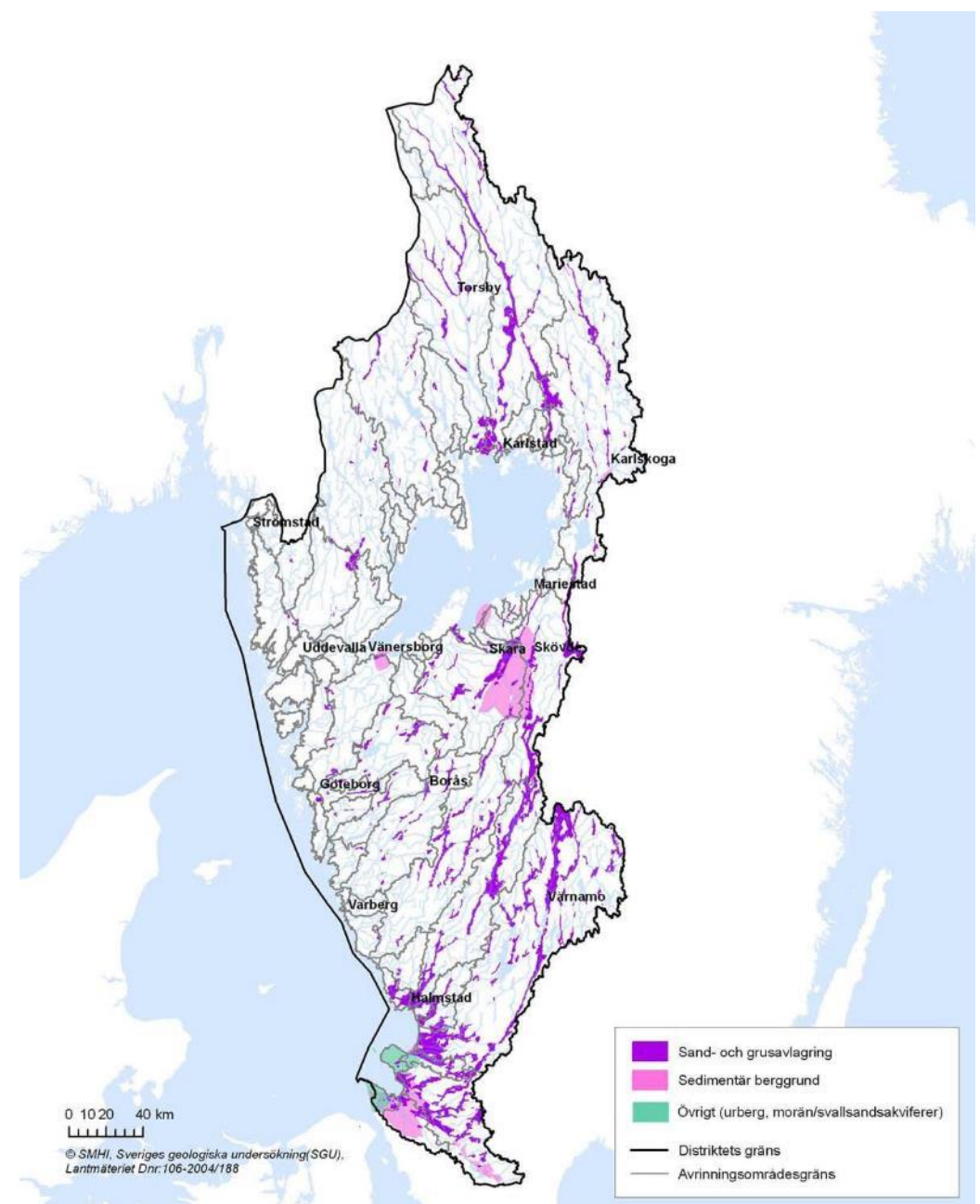


# ATES in Sweden

Where is ATES feasible?

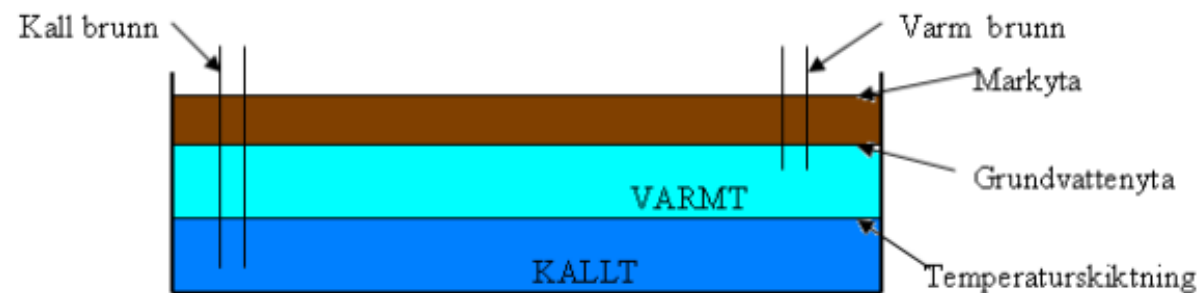
At 10-15 % of the area!

(where 25-30% of population lives)

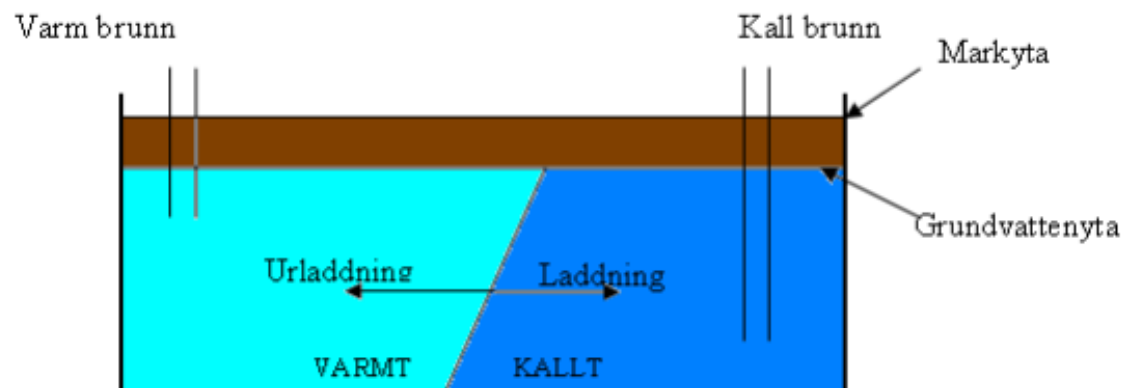




# ATES

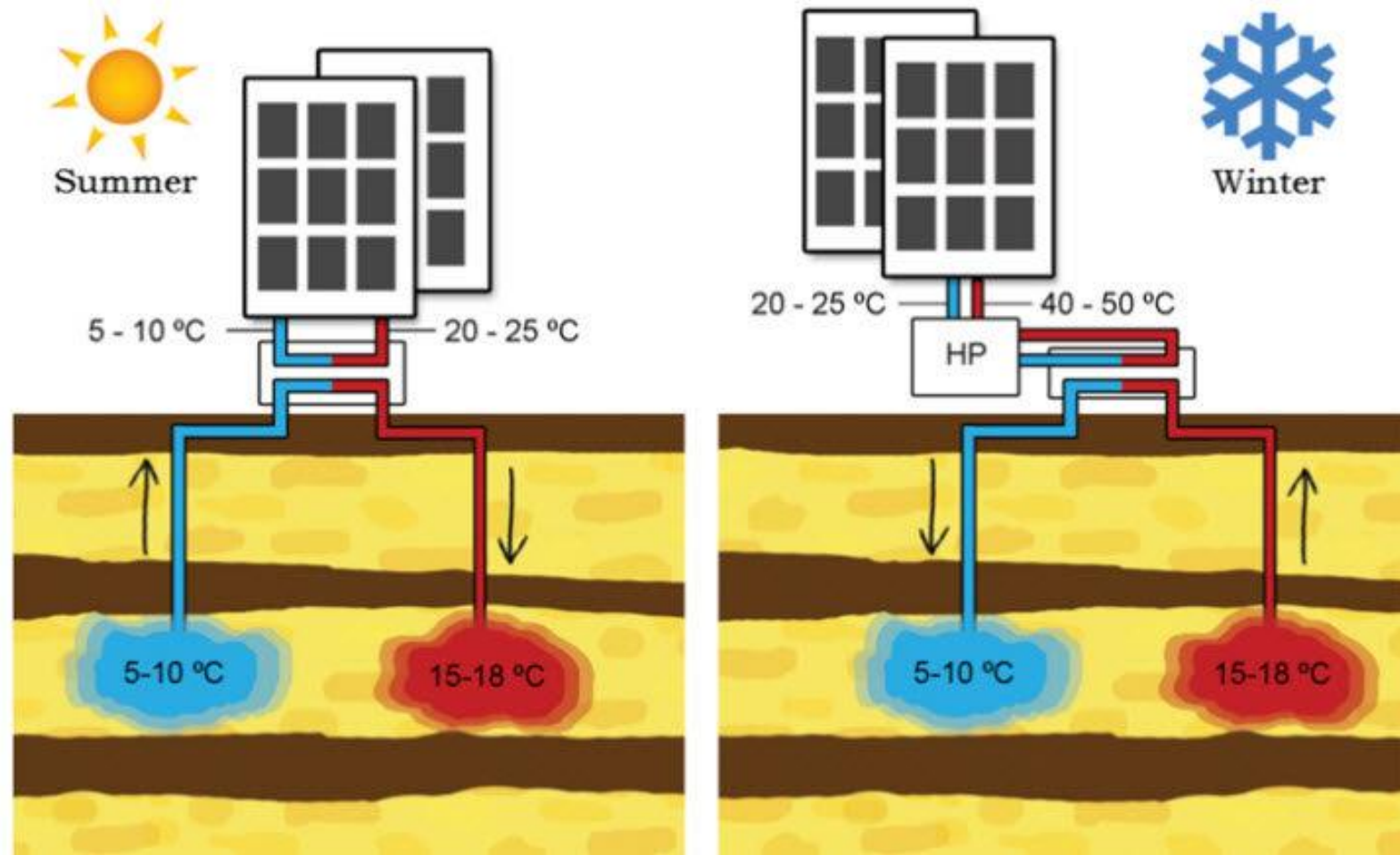


Figur 1. Horisontell skiktning i akvifärlager.



Figur 2. Vertikal skiktning i akvifärlager.

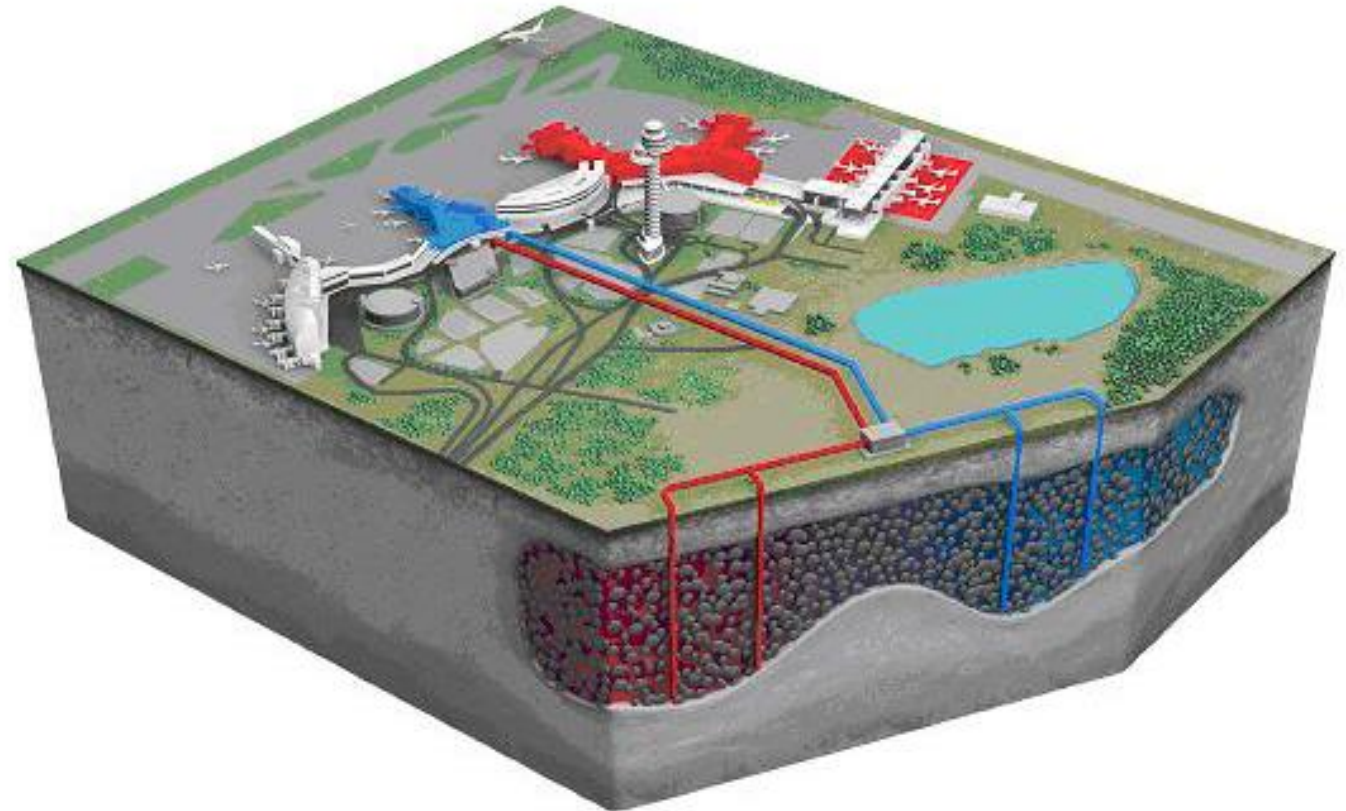
## ATES – how it works



How ATES works. Credits: Martin Bloemendal, KWR/Technical University Delft

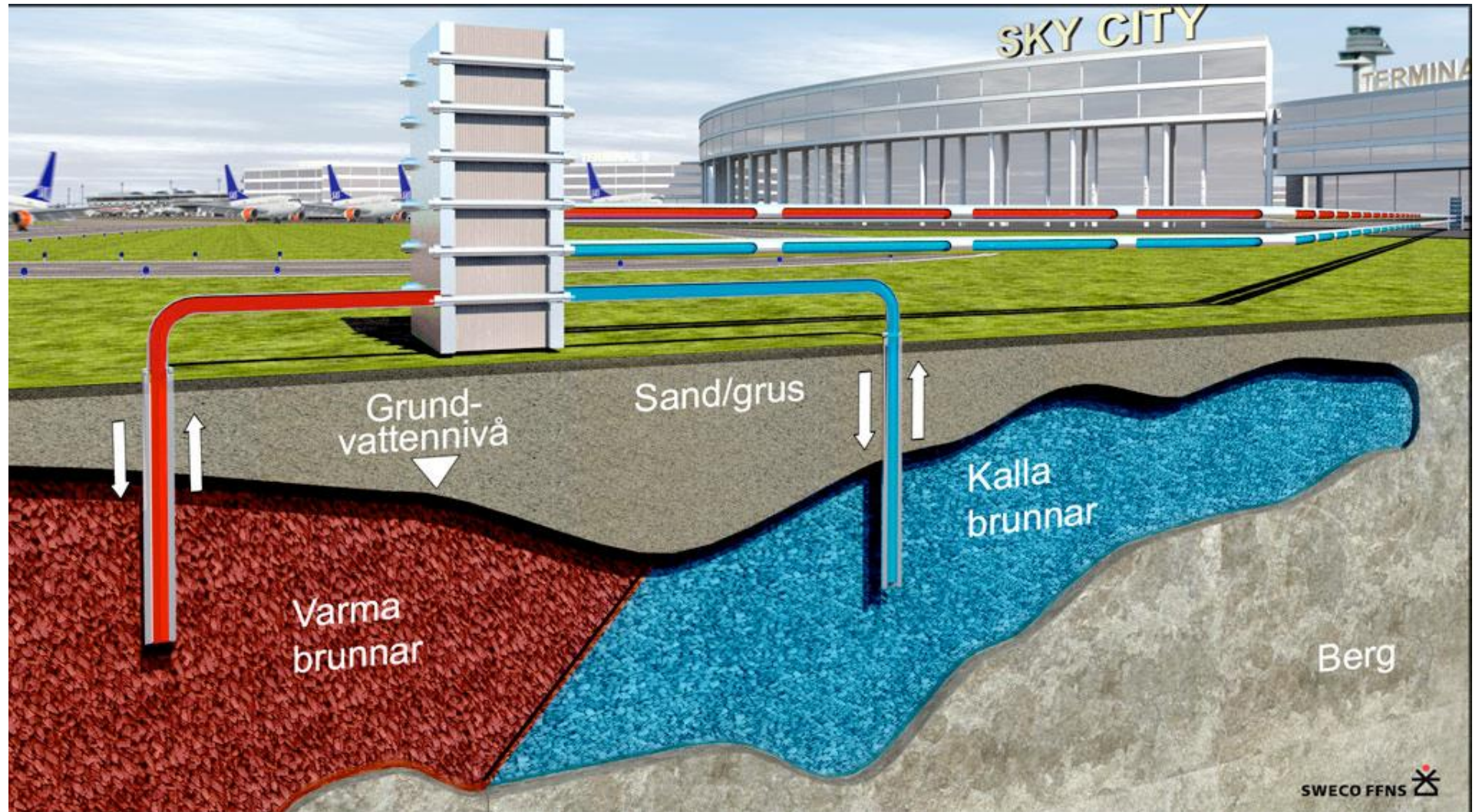
## ATES Arlanda Airport, Sweden

- Heating and cooling buildings
- Heating the ground around the aircraft-parkingslots
- No heatpumps





## ATES Arlanda Airport, Sweden



## Geoenergy - economy

### ATES

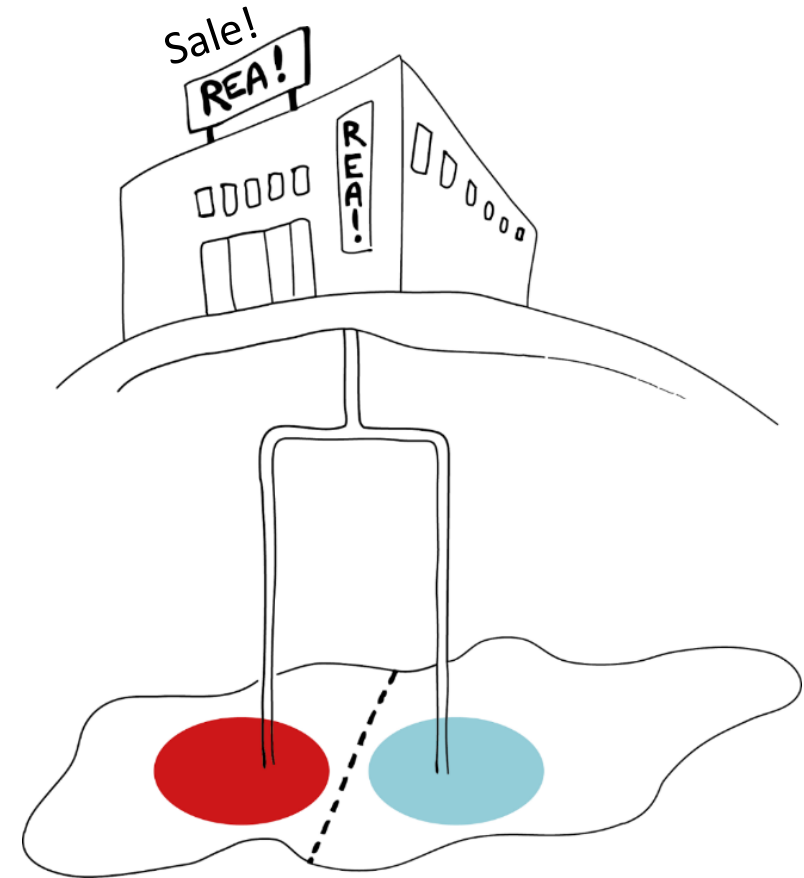
- COP/SPF: 4-7

### Free cooling

—COP/SPF : 40(!)

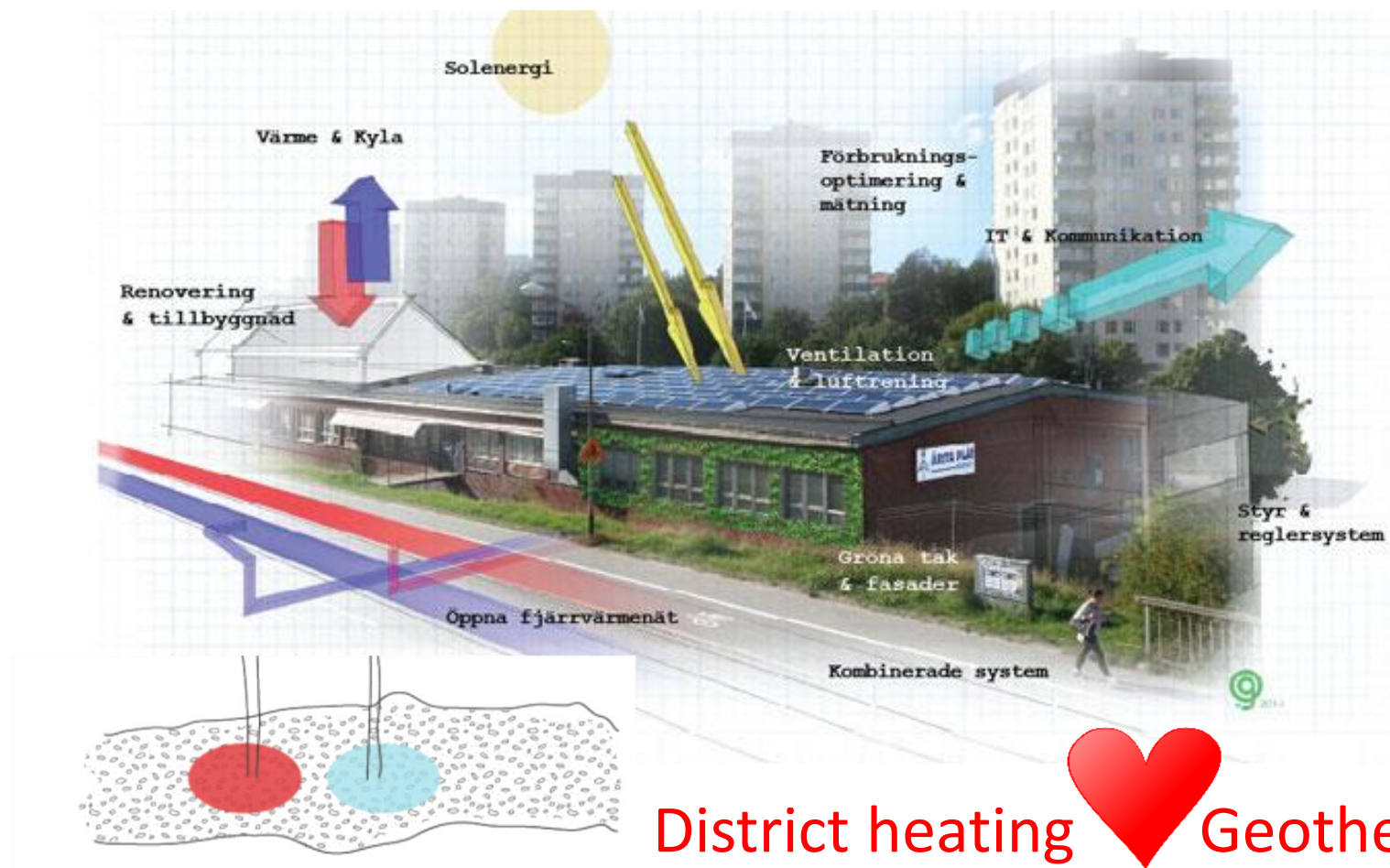
Payback time, often  $\ll$  10 years (3 years)

Explain the big interest!





## My Mission #2

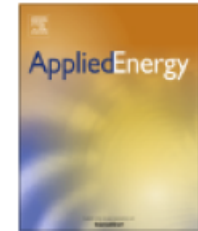


District heating ♥ Geothermal storage



Contents lists available at ScienceDirect

Applied Energy

journal homepage: [www.elsevier.com/locate/apenergy](http://www.elsevier.com/locate/apenergy)

## Smart Energy Systems for coherent 100% renewable energy and transport solutions



B.V. Mathiesen<sup>a,\*</sup>, H. Lund<sup>b</sup>, D. Connolly<sup>a</sup>, H. Wenzel<sup>c</sup>, P.A. Østergaard<sup>b</sup>, B. Möller<sup>d</sup>, S. Nielsen<sup>b</sup>,  
I. Ridjan<sup>a</sup>, P. Karnøe<sup>a</sup>, K. Sperling<sup>b</sup>, F.K. Hvelplund<sup>b</sup>



## Conclusion from article:

*“...short and long term storage options, such as batteries and **large thermal storages**, ... are key components in 100% renewable energy systems and so are the infrastructures and **grids that enable such storage...**”*

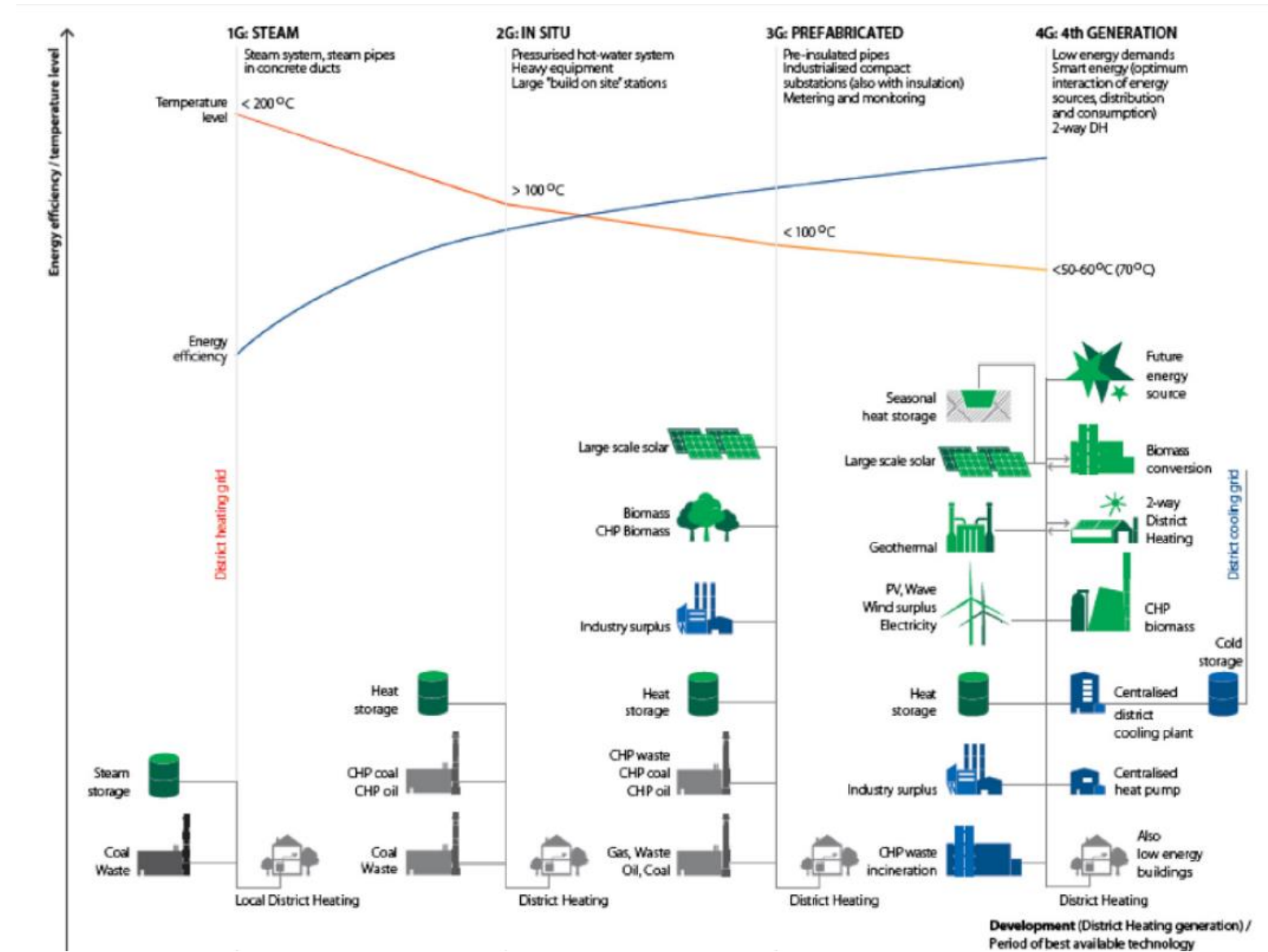
*“...district heating plays an important role in the implementation of future sustainable energy systems. However, the present district heating system must undergo a radical change into **low-temperature district heating networks** interacting with low-energy buildings as well as becoming an integrated part of smart energy systems.”*

## *District heating - phases of development*

1. *First generation, 1880-1930*
  - *Steam*
2. *Second generation, 1930-1970*
  - *Hotwater > 100 C°*
3. *Third generation, 1970 – now a day*
  - *Hotwater < 100 C°*
4. *Fourth generation, ??*

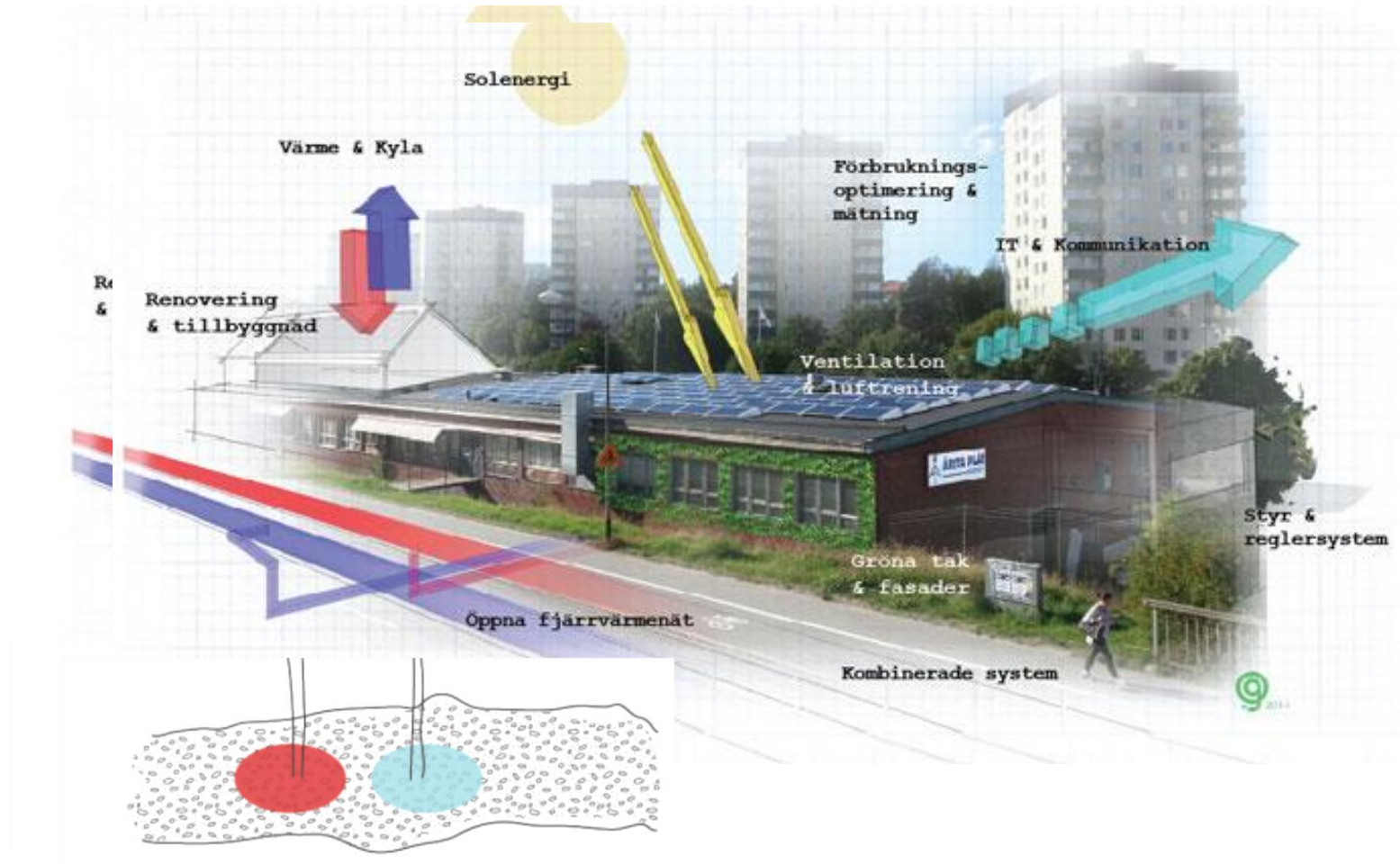
## ***Demands, 4th generation of district heating***

- 1. Lower temperatures/ Lower energy losses*
- 2. 2-way DH (give & get)*
- 3. Integrate low-temperature sources of energy, as different sur-plus energy sources and solar heat*
- 4. Include large scale storage*





# Conclusion: Geothermal Energy/Storage will play a key role in the energytransition of the future





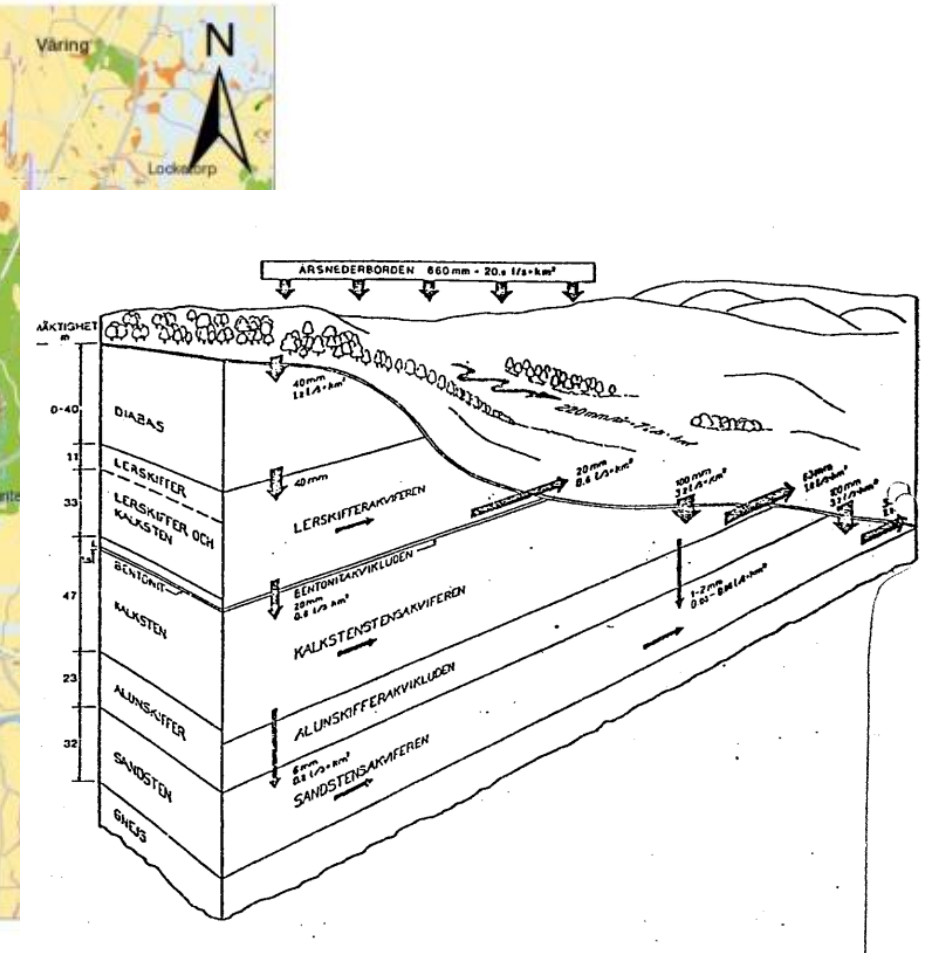
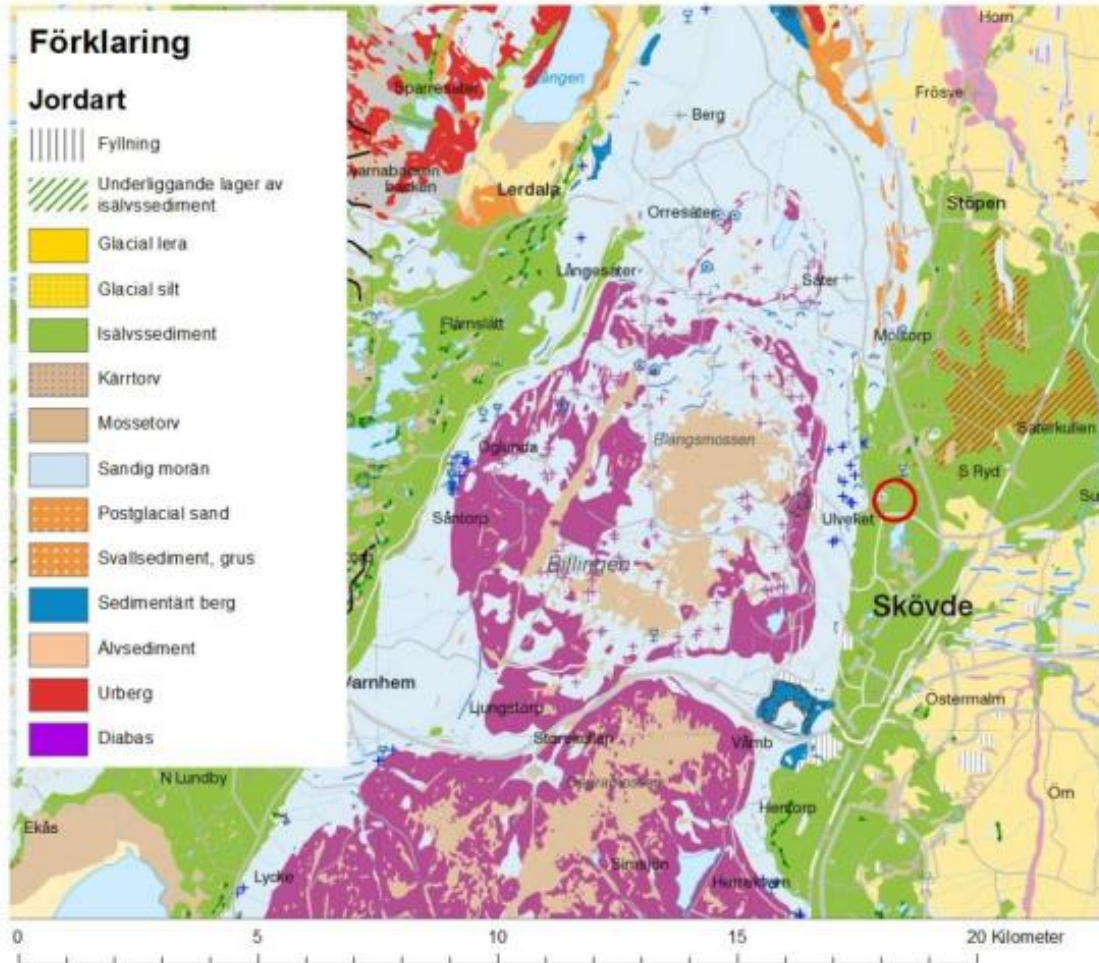
# Geoenergy och WSP

On-going projects:

- Skövde Hospital, SKaS (ATES)
  - 120 l/s
- Halmstad Incineration plant (HT-BTES)
  - Seasonal storage (90 C°), 30 GWh sur-plus energy
  - Smart thermal grid, satellite storage, 50-65 C°

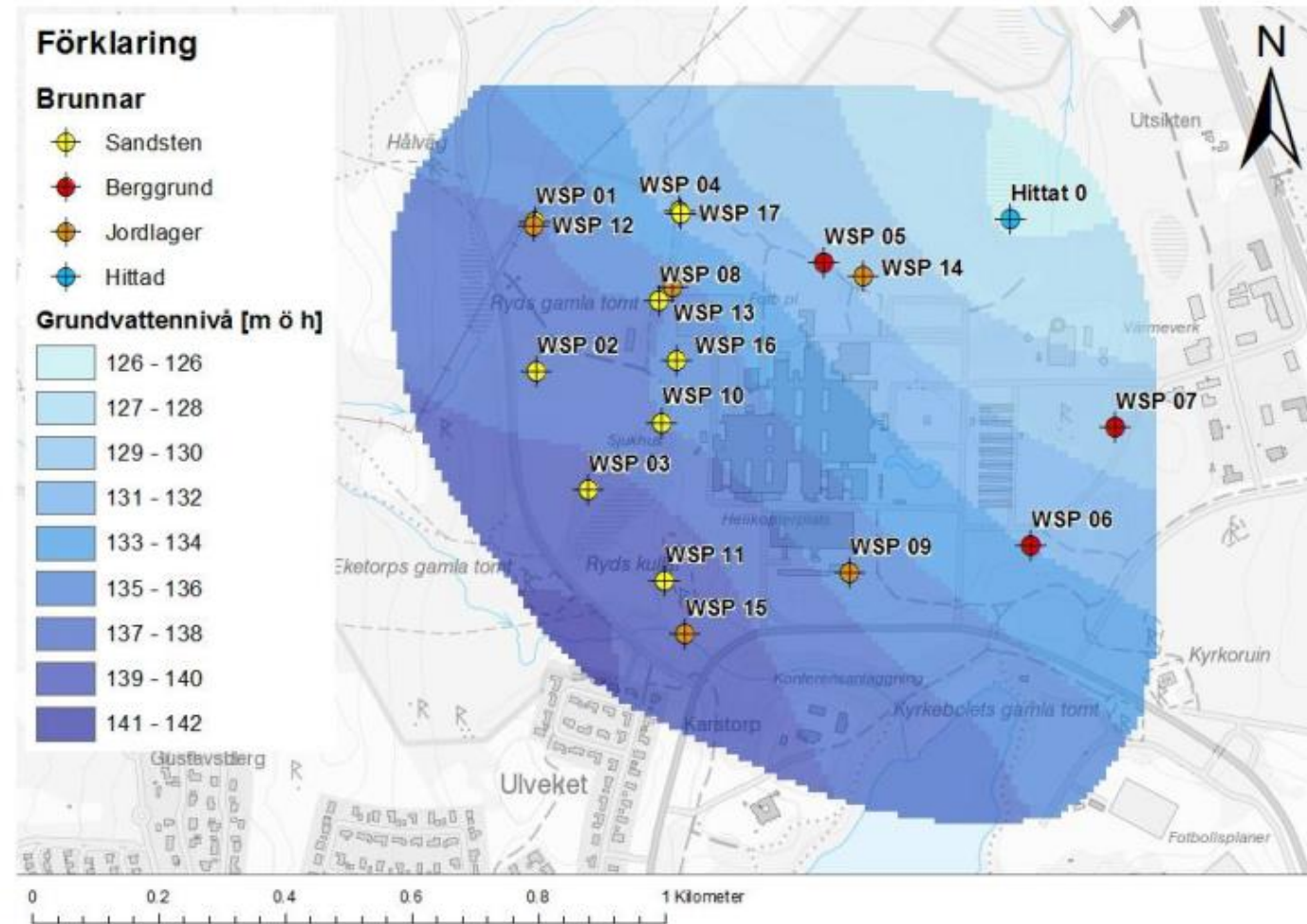


# Skövde Hospital, SKaS (ATES)

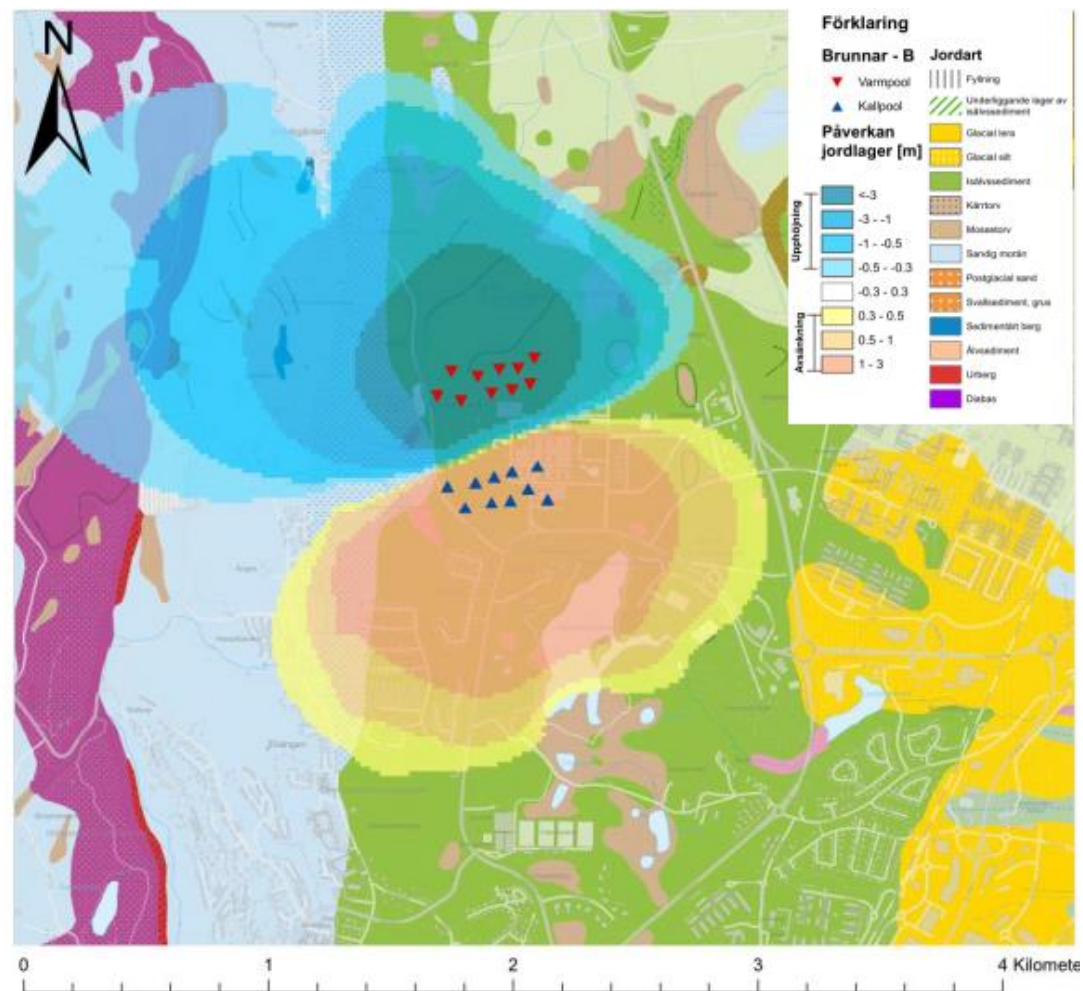




# Skövde Hospital, SKaS (ATES)



# Skövde Hospital, SKaS (ATES) Draw down, $Q=120$ l/s



Figur 8. Influensområde i jordlager för Fall B med varm- respektive kallpool placerade i nord-sydlig riktning,  $Q= 120$  l/s. Brun-gult område visar uttag av grundvatten, dvs. en trycknivåsänkning i jordlagret, blått område visar infiltration och därmed en trycknivåhöjning i jordlagret.

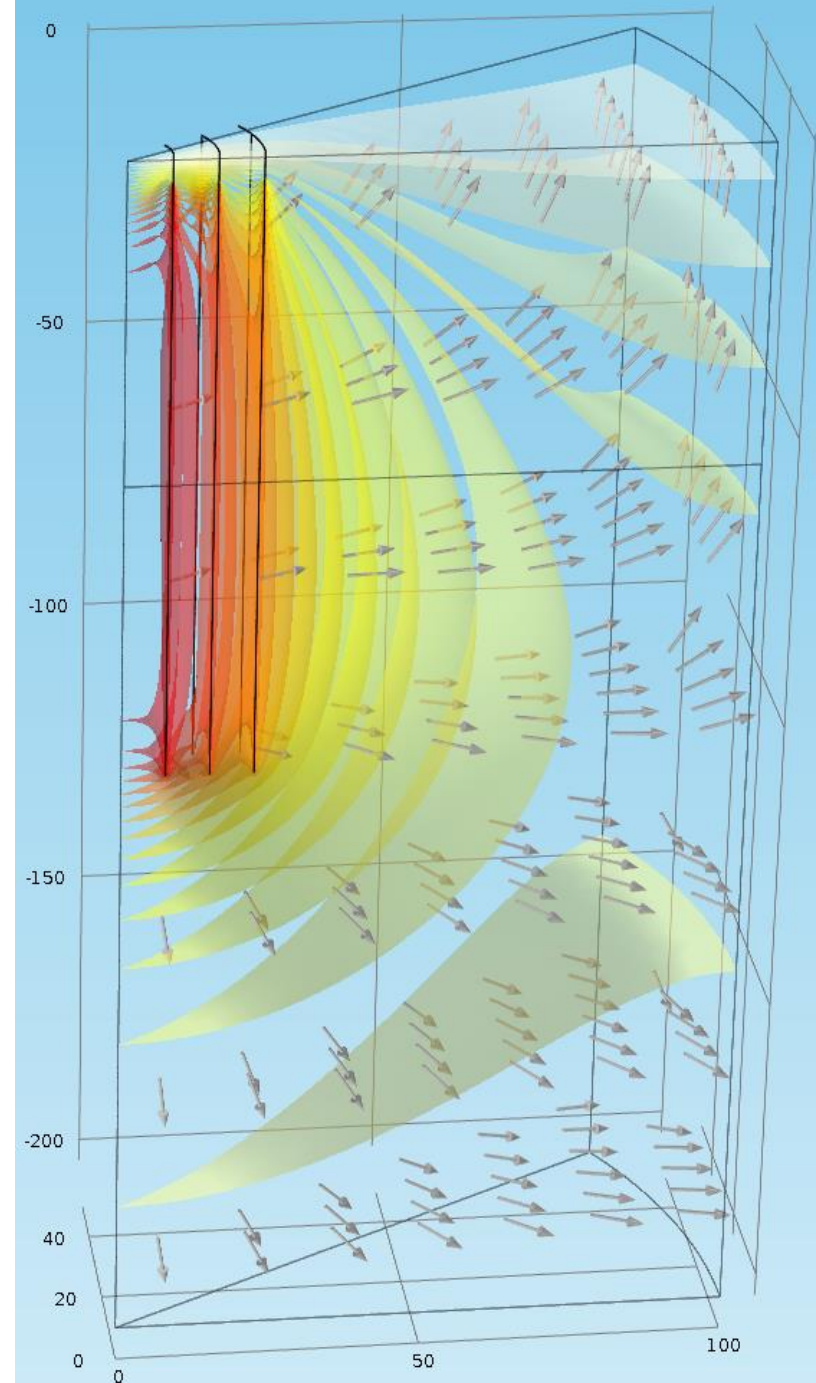
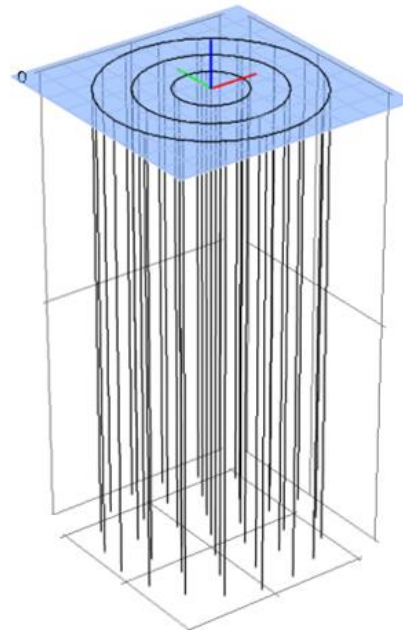
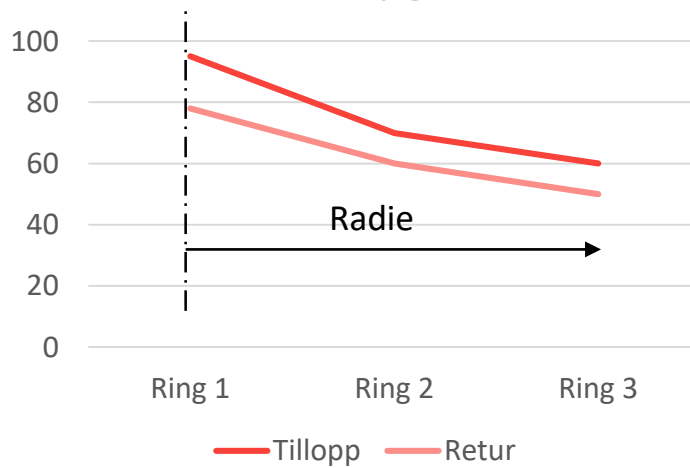
# HT-BTES

- in combination with district heating-system

Circular boreholesfield

Higher temperature (in the center)

Radiell tempgradient



## Geoenergi – vad kan du/we bidra med?

1. Kontakta dina kunder! Eller är du fastighetsägare?
  - Industrier med spillvärme
  - Värmebolag, t ex Göteborg Energi
  - Bostadsbolag, t ex Stena, Vasakronan, Wallenstam
  - Kommunala fastighetsbolag
  - Större fastigheter, typ idrottsanläggningar/skolar/sjukhus mm
2. Finns behov kyla/värme?
3. Finns förutsättningar för geoenergi? Lär känna din geologi  
→ Kontakta en geolog/hydrogeolog!



## Energy Transition - what can we do?

- Are you a property owner?
- Get to know your geology/underground conditions
- Contact a geologist/hydrogeologist!
- Spread the knowledge about ATES/BTES/CTES/HT-TES and Smart Grids

Vi märker en kraftigt ökad efterfrågan...

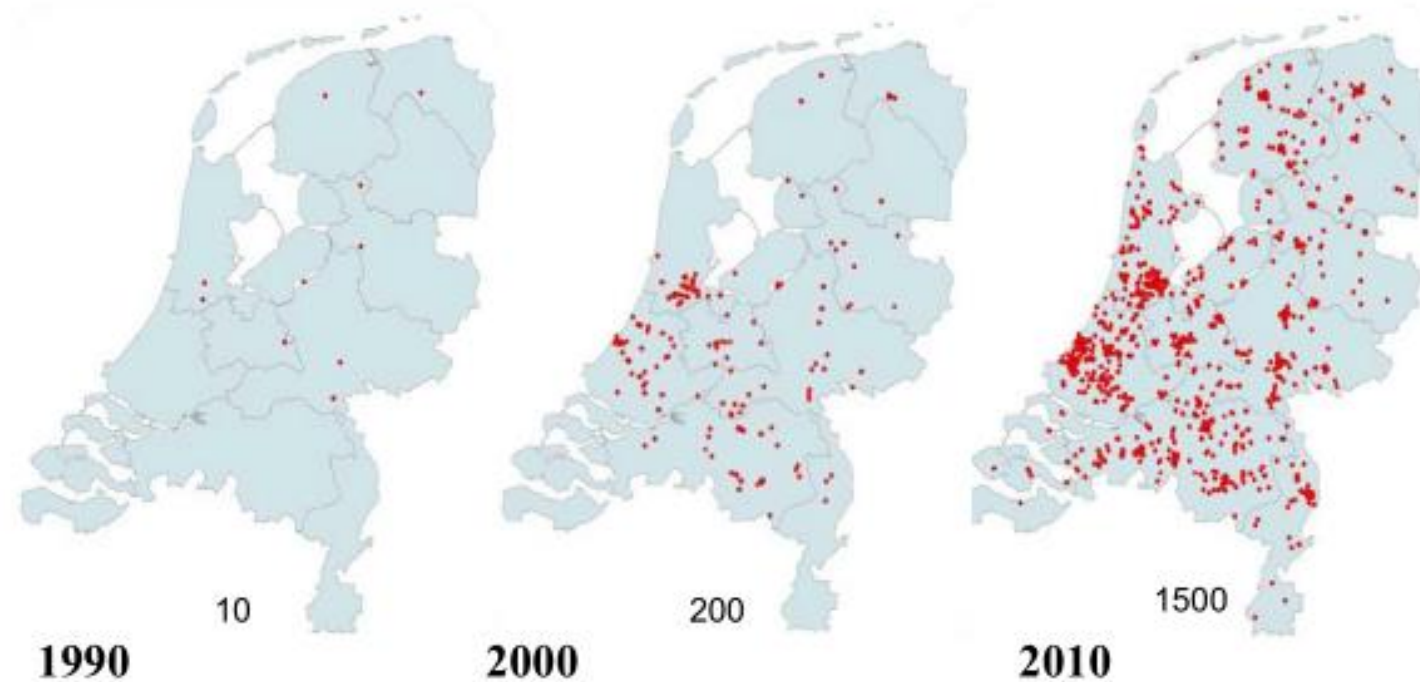
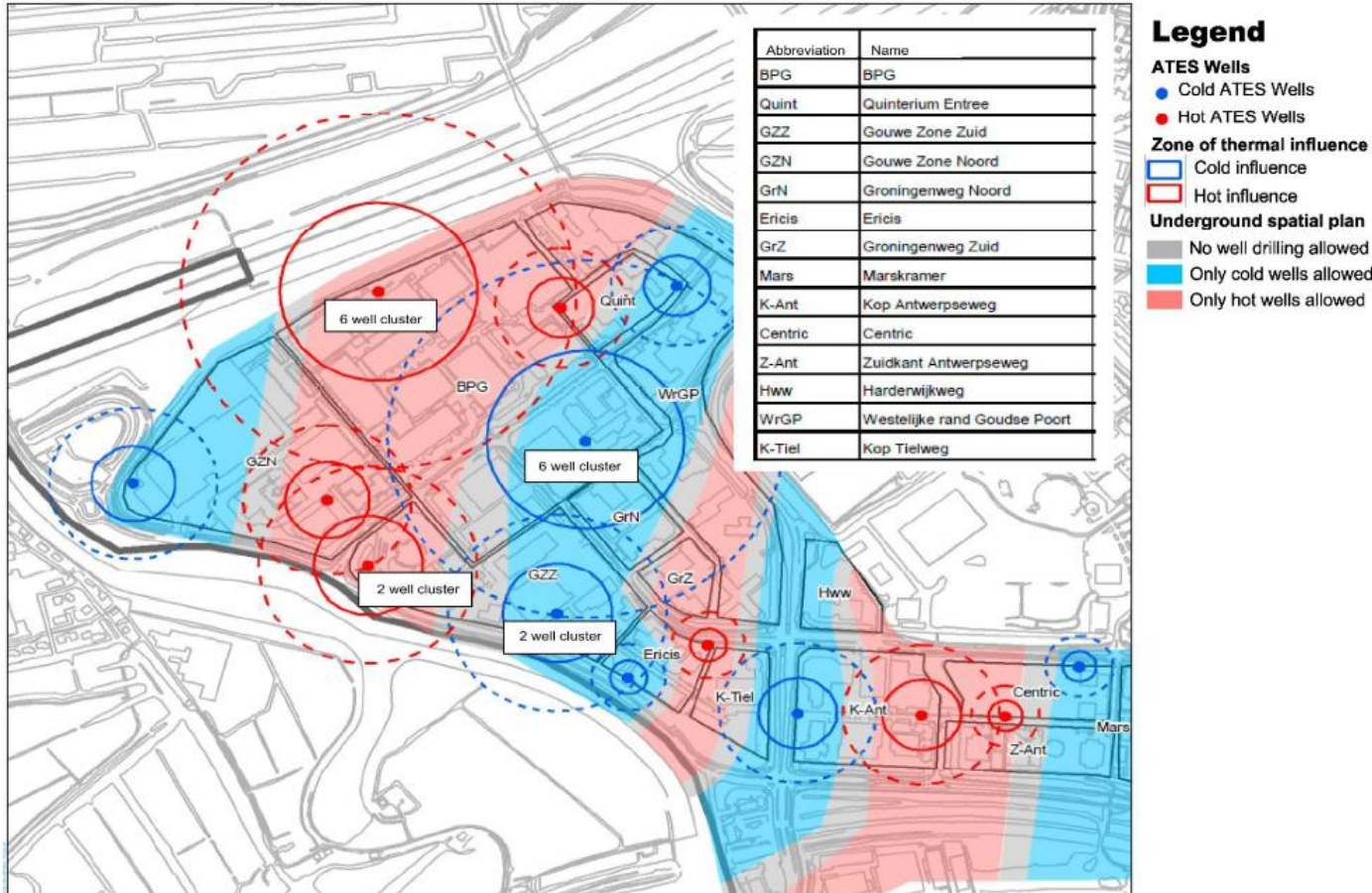


Fig.3. Map over the Netherlands showing the number of installed ATES in operation in 1990 (10), 2000 (200), in the year 2010 (1500). IF Technology estimates that the number of installed ATES system in the Netherlands will continue to grow until 2020. (Bakema, 2010)

**Fig. 4.** Subsurface spatial planning map for the second aquifer in the Goudse Poort in Gouda, the Netherlands. Red, blue, and grey regions indicate areas where hot, cold, and no aquifer thermal energy storage wells, respectively, can be installed. Modified from Witteveen+Bos (2008).



Tack!

*wsp.com*

wsp



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