

Geothermal Safety Systems to Enhance Social Acceptance

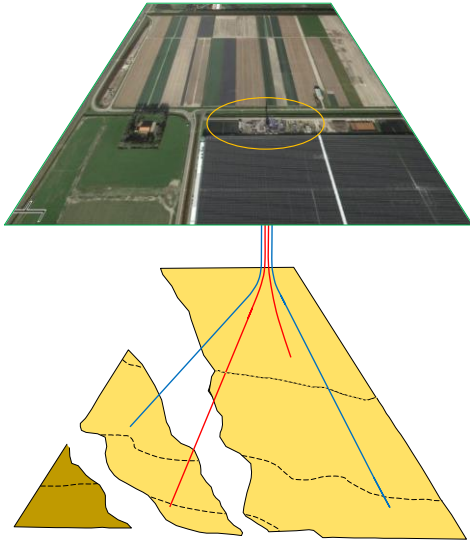
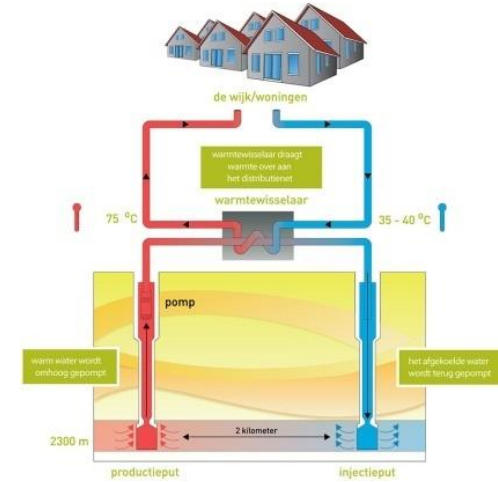
15/10/2021 by Dirk Brinkgreve



Introduction

Well Design & Drilling Management Consultancy

- Since 2006 supported 27 of 30 projects in NL by WEP;
- Drilled >145 km to date for geothermal energy;
- Multiple projects currently in preparation;



Typical location



Upscaling / Shifting towards

More and more in or near city limits



Bad press examples



Staat van de Sector Geothermie

Staatstoezicht op de Mijnen

- 2017: Groningen project, on hold
- 2017-19: Pijnacker project, revival after 2 years shutdown
- 2017-20: Authority warning signals, integrity issues
 - >> sector subject to enhanced surveillance
- 2019: Grubbenvorst on hold, resulting in bankruptcy
- 2020: Nieuwegein, location banned, on hold
- 2021; Rekenkamer / government audit office; “drinkwater at risk from drilling for geothermal energy”

AD, 2020

Ook ná schrappen van twee boorlocaties in Nieuwegein blijven bewoners kritisch op aardwarmte

Verlies aardwarmtebedrijf € 14 miljoen na sluiting

gfactueel, 2020

Het failliete aardwarmtebedrijf CLG Geothermie in Horst leed ruim € 14 miljoen verlies in 2019 door gedwongen stillegging na bevestigingsrisico's.

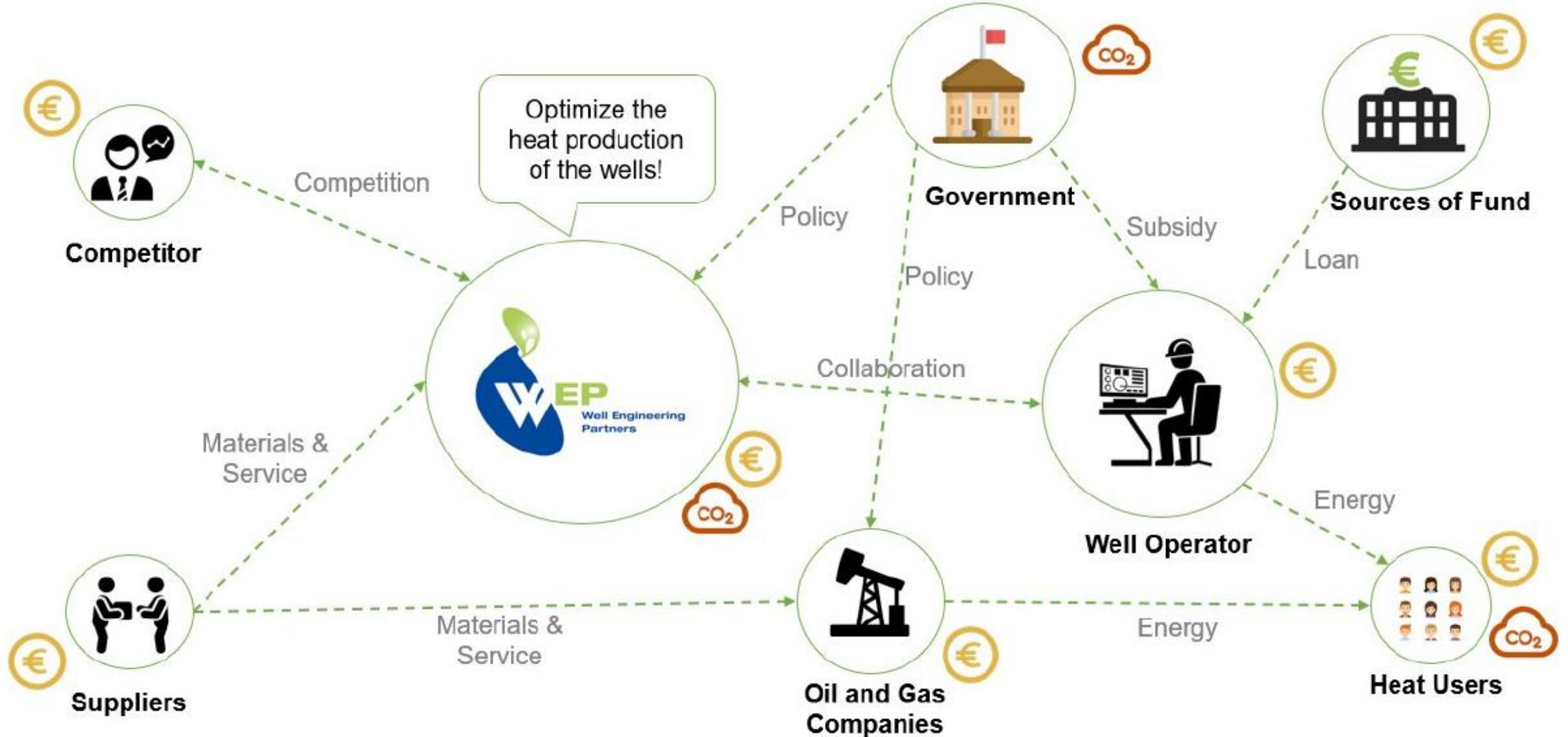
Drinkwater in gevaar door boren naar aardwarmte

AD, 2021

Not In My Back Yard

**NOT IN MY
BACKYARD**

Stakeholder management



HSE-documentation / Risk evaluations

Health, Safety, and Environment (HSE) is key priority in all phases:

1. EXPLORATION & DESIGN PHASE
2. REALISATION PHASE
3. EXPLOITATION PHASE
4. P&A PHASE



Permits / License to Operate



Well Designs

- # Code of Practice



Well Design / Code of Practice

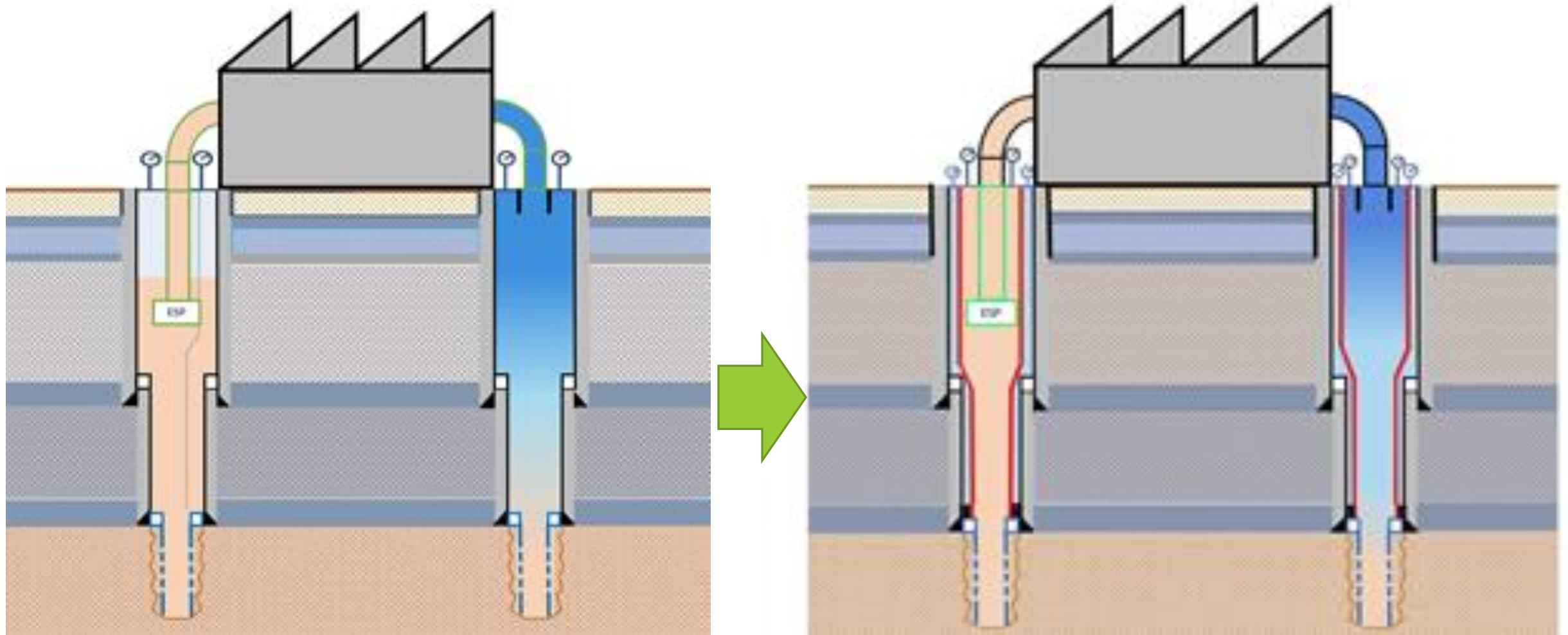
- Where we stand now
 - Learning curve ongoing, still looking for the perfect well
 - Hydrocarbon well approach (regulations),
 - Code of practice: durable well design
- CoP:
 - Guidance for geothermal well design
 - Incorporates previous learnings and most recent insights
 - Inspired by oil&gas standards and practices
 - Defines minimum requirements
 - Well Integrity Management System total Life Cycle



**Industriestandaard duurzaam
putontwerp voor
aardwarmteputten**

Publicatie: Januari 2021

Well Design / Code of Practice



source: Geothermie NL

QRA - Quantitative Risk Assessment

- Mandatory deliverable for industries involving hazardous substances (BEVI)
- Risk quantification for external safety
- Calculate location-specific risk (10⁻⁶ contour) to assess acceptability of risks
- No overlap allowed of residential or high capacity objects

DNV·GL

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QRA - Quantitative Risk Assessment

Drilling:

- BARM: Decree general rules environment mining (EZK)
- Calculation method as per SodM “Interim manual (2010)”

- **Scenarios:**

- a. Blow-out;
 - b. Leak;

- **Input variables:**

- a. Well design;
 - b. Outflow potential;
 - c. Statistical data / Failure Frequencies (gas well, see table);

	Blow-out	Leakage	
	Verticaal	Verticaal	Horizontaal
Productie of injectie (per productiejaar)	$7,17 \times 10^{-5}$	$1,06 \times 10^{-4}$	$1,98 \times 10^{-5}$
Wire Line (WL) (per activiteit)	$2,25 \times 10^{-5}$	$4,18 \times 10^{-5}$	$7,14 \times 10^{-6}$
Coiled Tubing (CT) (per activiteit)	$5,54 \times 10^{-4}$	$4,43 \times 10^{-4}$	$1,11 \times 10^{-4}$
Work Over (WO) (per activiteit)	$1,09 \times 10^{-3}$	$9,47 \times 10^{-4}$	$2,27 \times 10^{-4}$
Snubbing (per activiteit)	$6,63 \times 10^{-4}$	$5,30 \times 10^{-4}$	$1,33 \times 10^{-4}$
Drilling (per put)	$3,91 \times 10^{-4}$	$1,43 \times 10^{-4}$	$5,93 \times 10^{-5}$
Completion (per put)	$8,05 \times 10^{-4}$	$6,01 \times 10^{-4}$	$1,56 \times 10^{-4}$

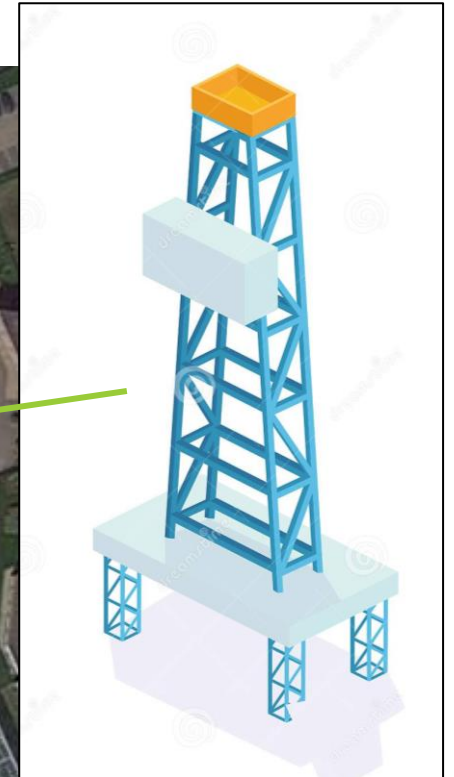
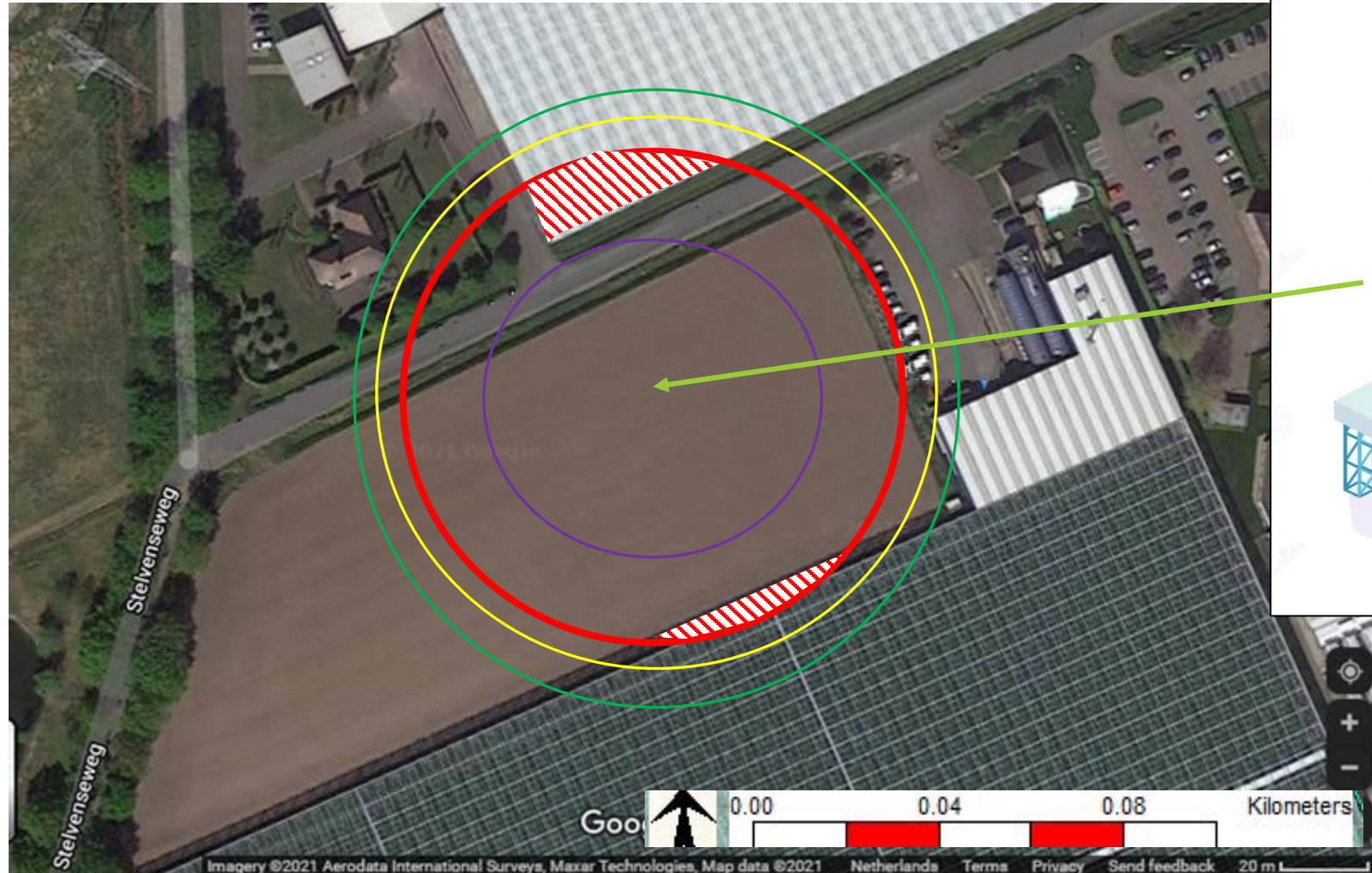
source: SodM, Interim manual 2010

- *Note: exploitation phase “GeoPlant” also requires a QRA, less impact on external safety*

QRA – example

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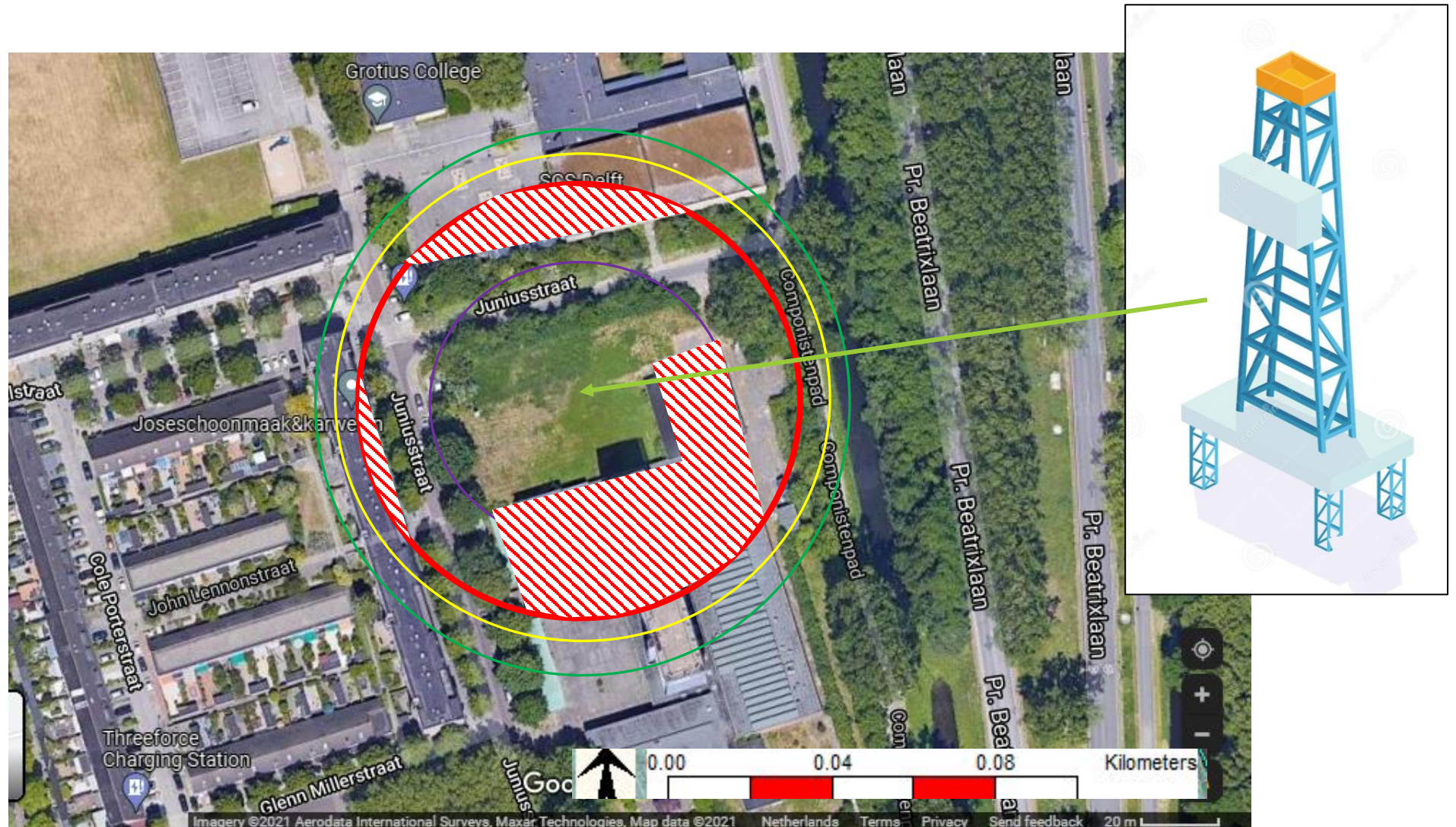
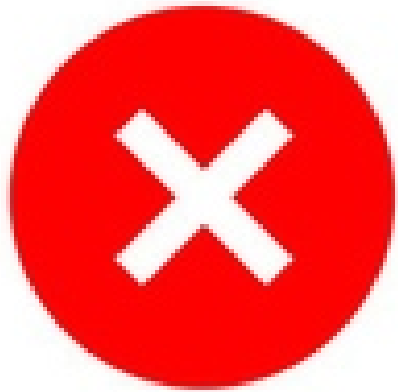
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QRA – example

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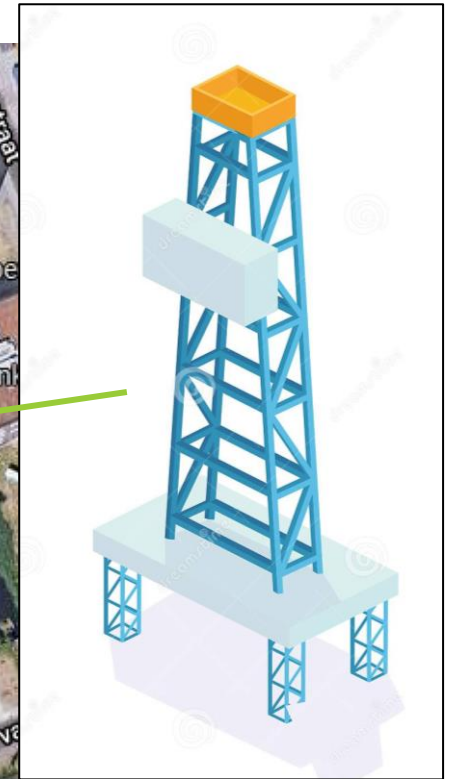
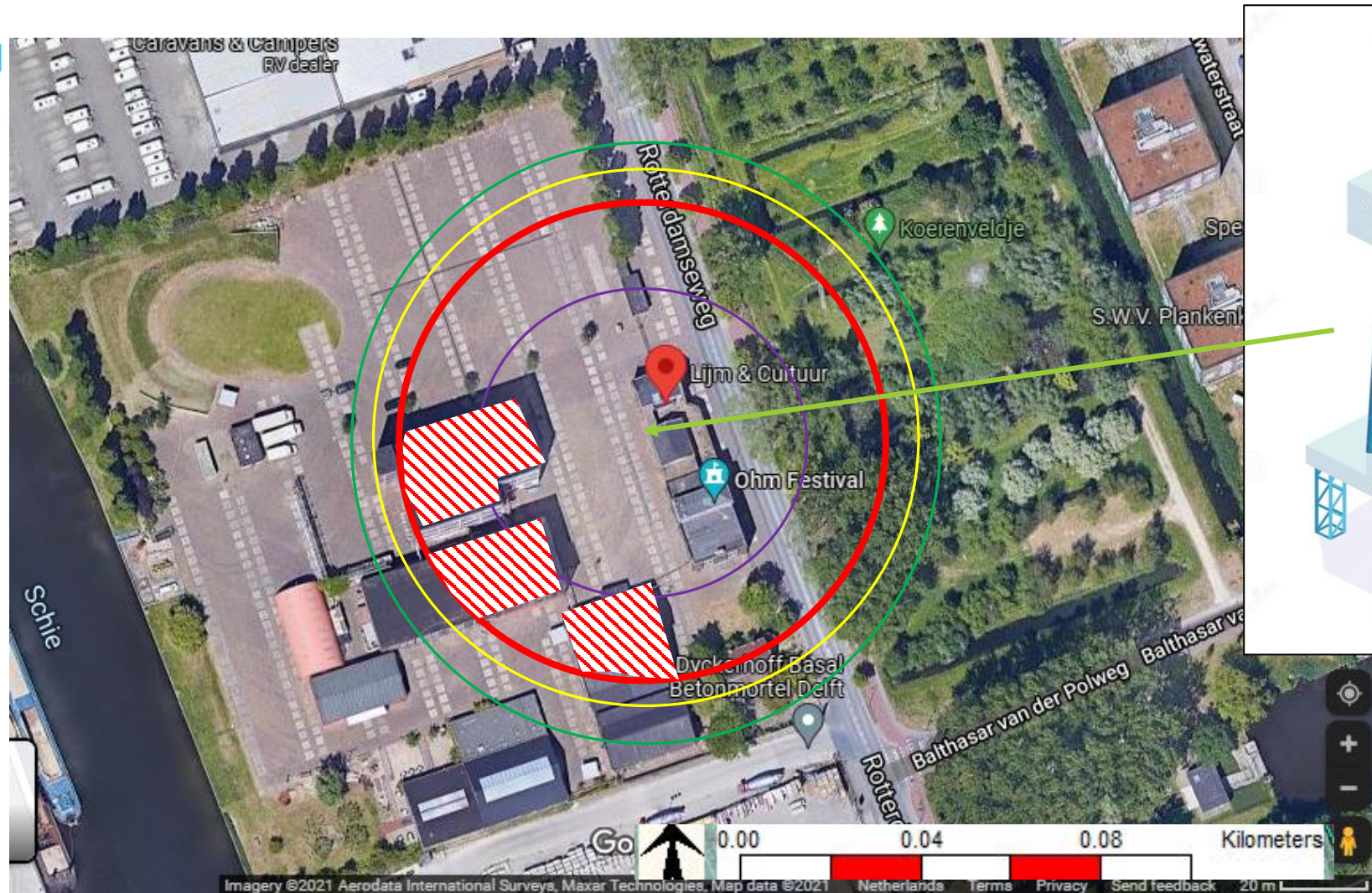
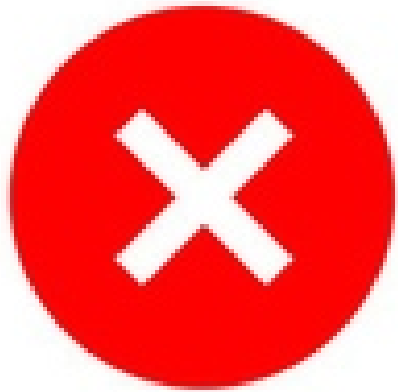
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QRA – example

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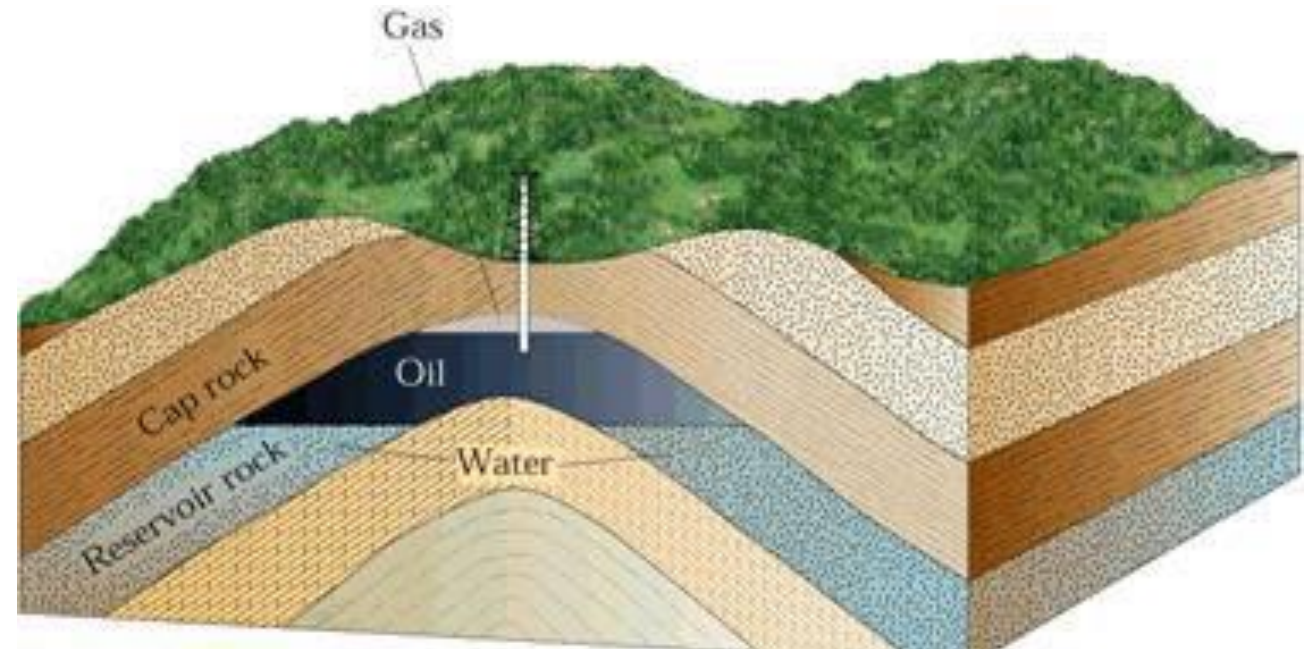


QRA - discussion

Limitations / Concerns in current QRA calculation method:

- No guidance / instructions on how to calculate the outflow potential
- Failure frequencies for geothermal well drilling and exploitation missing

Where oil/gas drilling is looking for unique structures where oil/gas can accumulate, geothermal uses offset wells and seismic analysis to avoid precisely these structures. For this reason, the assumed failure frequencies of gas wells are extremely conservative.



Summary / Conclusions

For smooth upscaling:

- Stakeholders, general public & investors to be informed
- Keep implementing the many Risk Assessment tools available (& mandatory) for all phases of the life cycle of a geothermal well (...but speed-up the permit approval period...)
- Development of Geo-Industry standards, not limited to “Well design code of practice (2021)”

Upscaling challenges:

- Geothermal energy development within city limits, public will notice → focus on near-city, industrial areas first?
- Current QRA calculation method too conservative, contours too large to match city limits developments. Authorities to reconsider QRA methodology. → QRA Protocol?
- Let's prevent the “NIMBY” mentality from developing by emphasizing the benefits and be transparent on how risks are being mitigated

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