Canopus

Novel drilling technology for creating long multilateral structures

8th Geothermal Get Together, Virtual Conference, Mar 17 2021

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Why Geothermal?

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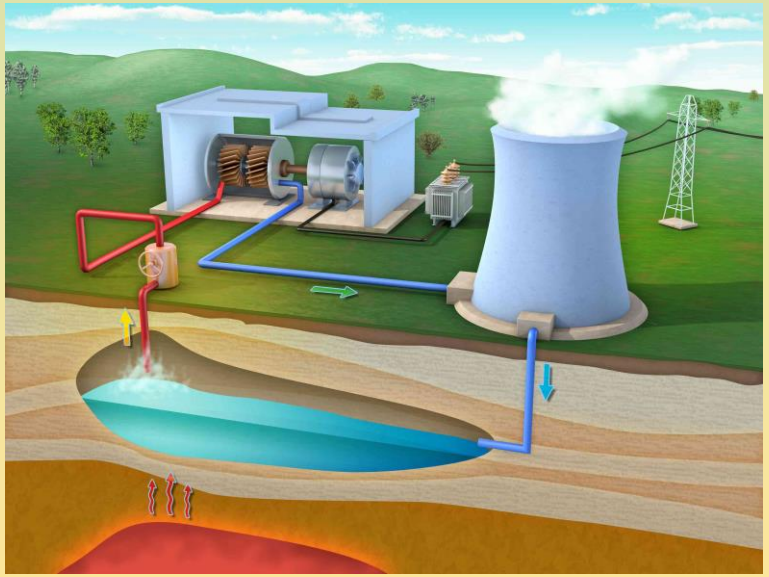
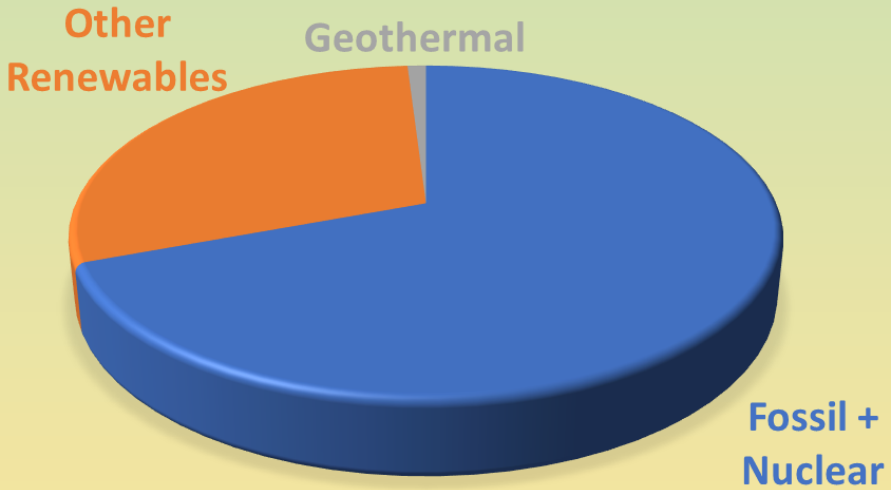
Advantages
- Renewable energy source
- 24/7 available
- >>1,000 year energy supply



But…



Only 2 % of global energy
Only 1 % of Dutch heat demand

Reason: Hard to do economic developments. 70% of cost in well construction. <u>To reduce €/kWh</u>:

Innovation needs
- ✓ E2 better drilling technology
- ✓ E3 Better reservoir stimulation
- ✓ E5 Better well designs

Why multilaterals?

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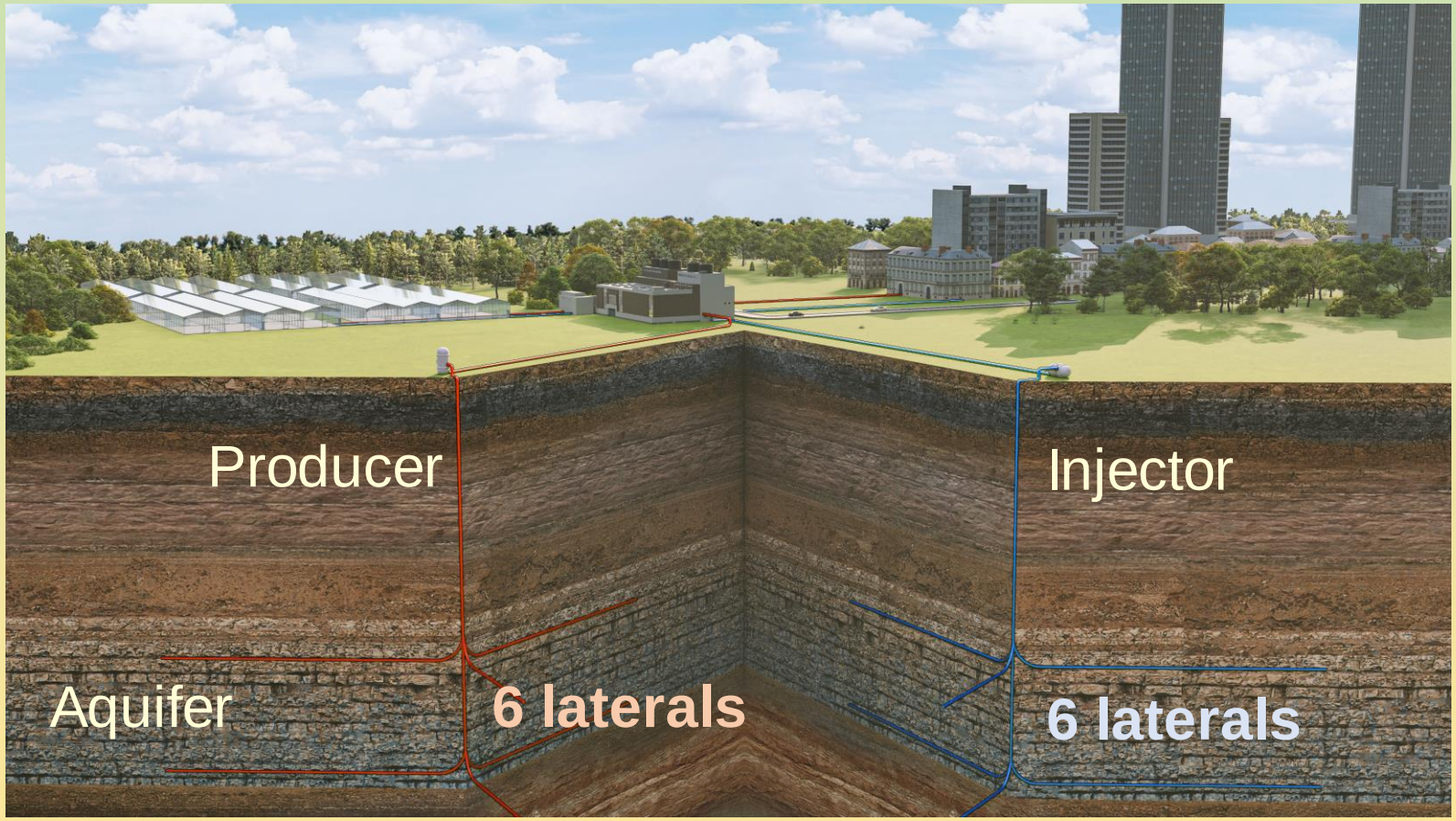
Two 6 inch laterals of **500 m** produce more than **one** 8 ½ inch lateral of **1000 m**

Three 6 inch laterals of 1000 m length give 2.5 x higher production.

Other advantages of multilaterals are

- Reduced risk of low production (compartmentalization and heterogeneity)
- Smaller diameter: revival & (through tubing) well extensions



Like nature: tree root structures and blood vessel networks

Why hardly any Geothermal multilaterals?

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Mechanical drilling

10.000 kg weight on 15 - 20 cm drill bit

- **Vibrations: tough for electronics and hard to steer**
- **One bit per rock type**
- **Horizontal drilling much harder: weight on bit comes from vertical section**
- **Expensive and complex (compleet drilling assembly 20 k€/day)**

Diamond cutter bit and Rotary Steerable drilling assembly

Mechanical drilling is

- **High cost, especially horizontal and long reach**
- **Hard to drill side-tracks**
- **No cost benefit to reduce hole diameter below 8-1/2 inch**

Solution: directional steel shot drilling

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- NO weight on bit
- Efficient drilling through any rock type
- Embodiment within hole size at depth
- Sufficient energy at the bit for drilling
- Good hole cleaning, fast RIH & POOH, Well control, robust & simple, …
- AND DIRECTIONAL CONTROL

Gulf

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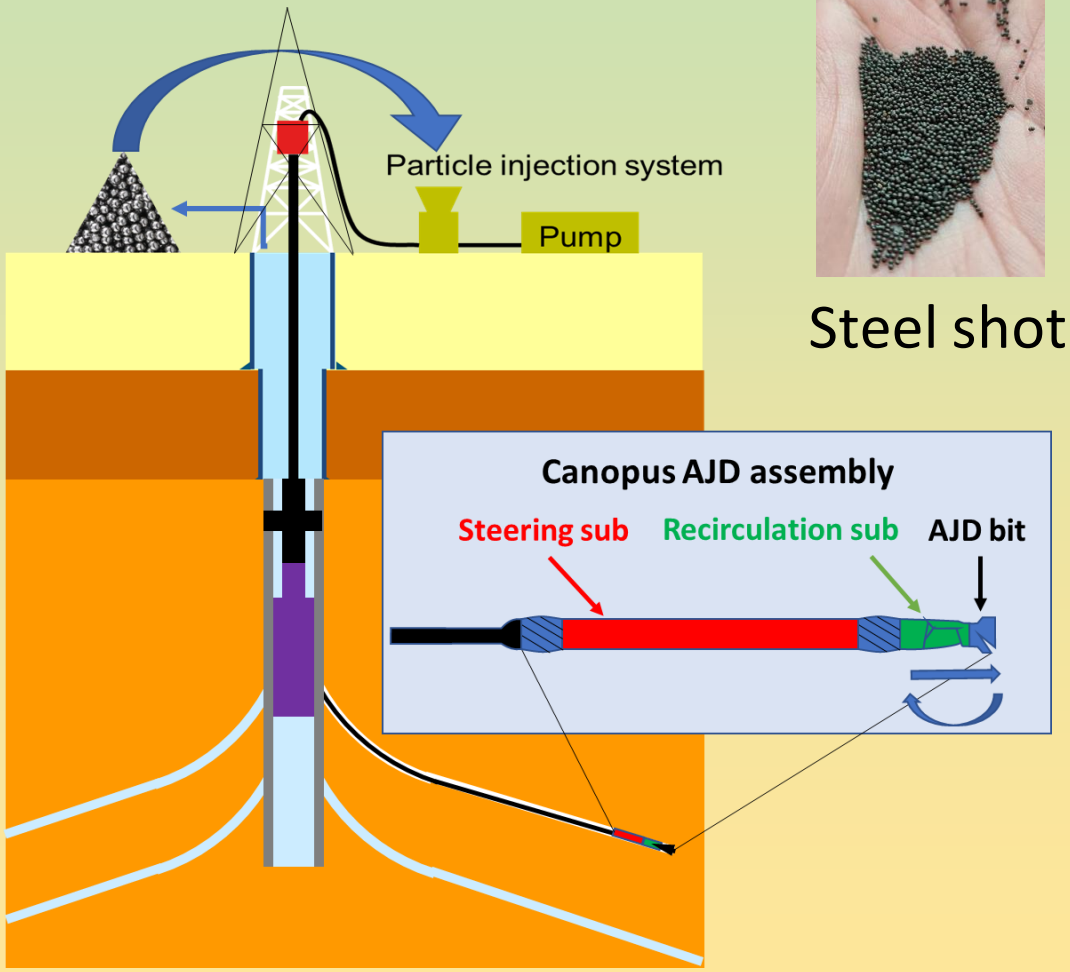
Steel shot recirculation jet bit



Steel shot drilling system

Steel shot

Steel shot steering method

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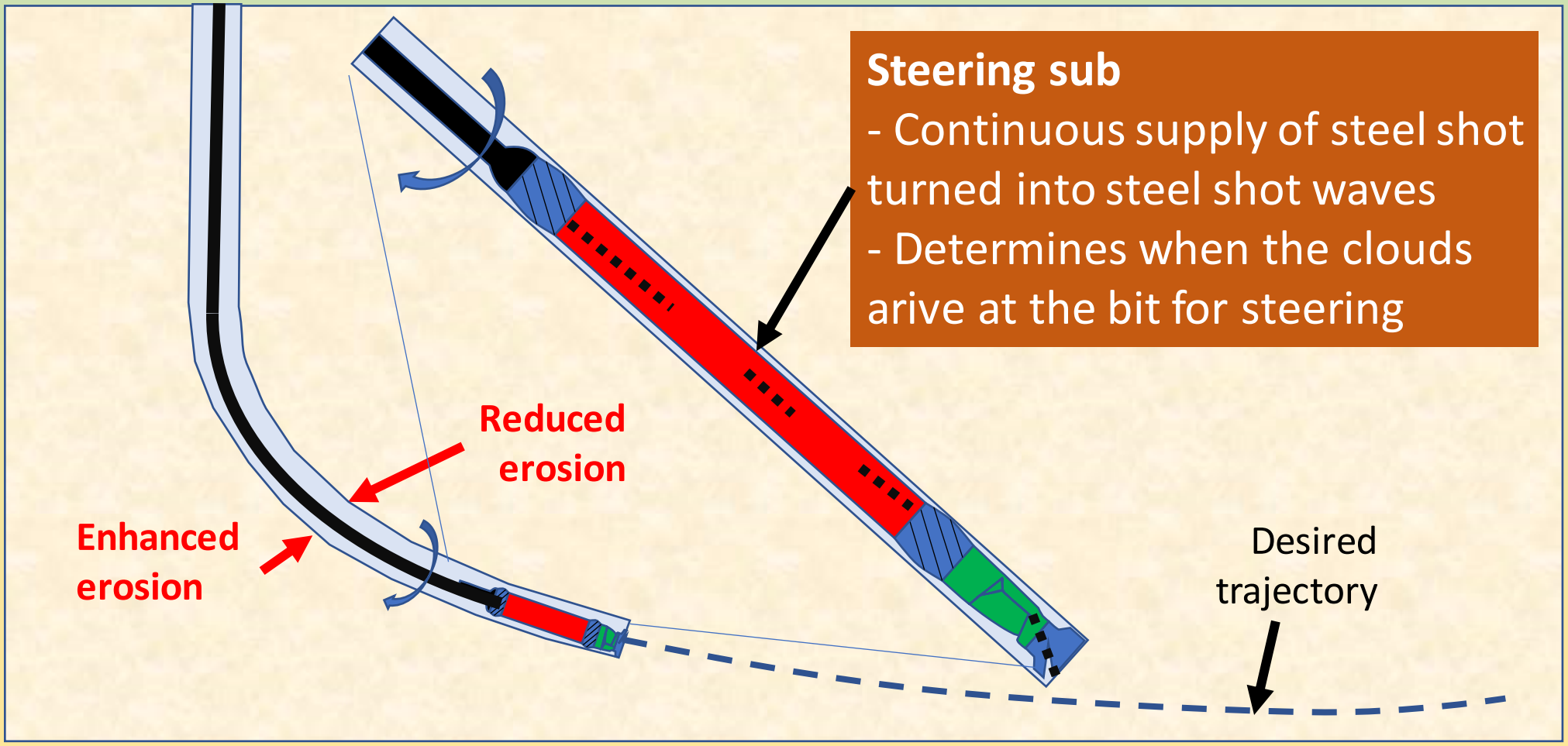


Lab drill test

Timeline

Development of steel shot drilling by Shell and Gulf Oil

<2020

Field pilots steel shot drilling

Prototype steering unit + Demo at TNO

2020-2021

Proof steering in the lab

LAB

Field piloting

2022

Field Proven Base System

PILOTING

Field hardening 5000 hours of operations

2023

Market Ready

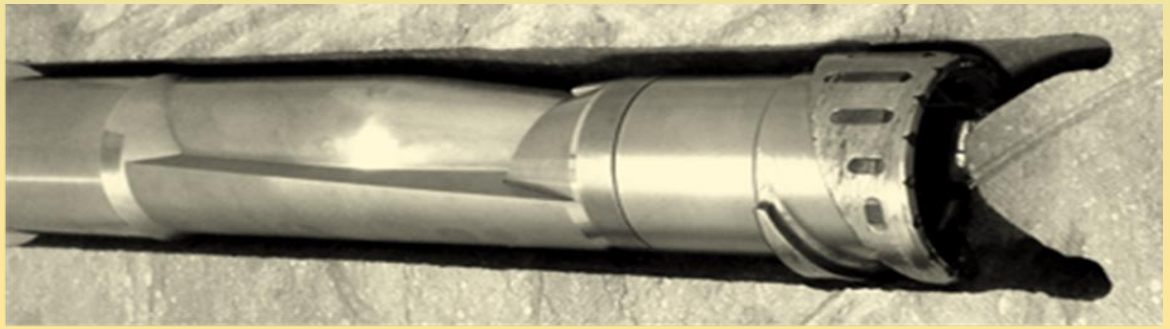
COMMERCIAL & SCALE-UP

Technology Readiness

Technology component	Canopus Steel Shot Drilling	Commercial status & complexity	Technology Readiness Level
Rig	No	Commodity	Commercial
Pump	No	Commodity	Commercial
Injection system	Yes	Components are commodities	Field trialed
Steering Sub	Yes	New to market	Demo prototype in 2021 (TNO-RCSG)
Steel Shot bit (4 to 6 inch)	Yes	New to market	Field trialed

Steel shot injection system

Steering sub



Steel shot bit

Demonstration at TNO 2021

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TKI consortium for DEPLOI

DEPLOI Project at Research Center for Sustainable Geo-energy in Rijswijk (TNO)

- Lab demonstration Canopus steering sub
- Evaluation steel shot well bore transport
- Evaluation rig requirements and operational requirements
- Evaluation impact of multilaterals on specific development opportunities
- Preparation piloting phase

Drill test facility

Well bore solids transport set-up