NextGen Geothermal Power – NGP

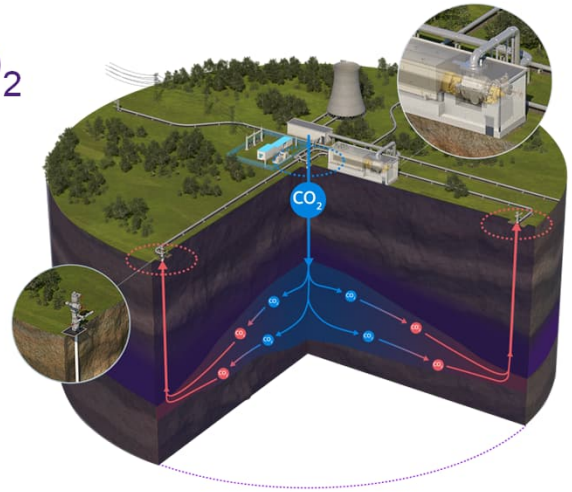
Utilizing CO2 as geothermal working fluid
Transforming CCS facilities into cash generating power plants

Status of November 2024, Peter Rice

GEMS

NextGen Geothermal Power (NGP) is using emitted CO_2 as working media for geothermal power generation

- NGP utilizes CO2 as working fluid and provides an additional value stream to classical CCS projects and transforms CCS projects into renewable power plants
- Due to it´s direct cycle design NGP requires corrosion resistant CO2 turbines, which are similar to the existing steam portfolio



The challenge

- Wind and solar power are not base load capable
- Hydro based geothermal concepts are regionally restricted
- CCS is essential to limit the global warming below 2 ºC but :
  No value add and recognized as „disposal“

NextGen Geothermal Power – NGP

- NGP combines geothermal energy with CCS and transforms CCS to CCUS
- Thermodynamic advantages of CO2 establish a strong natural circulation (thermosiphon)
- NGP supplies renewable and fully dispatchable Energy

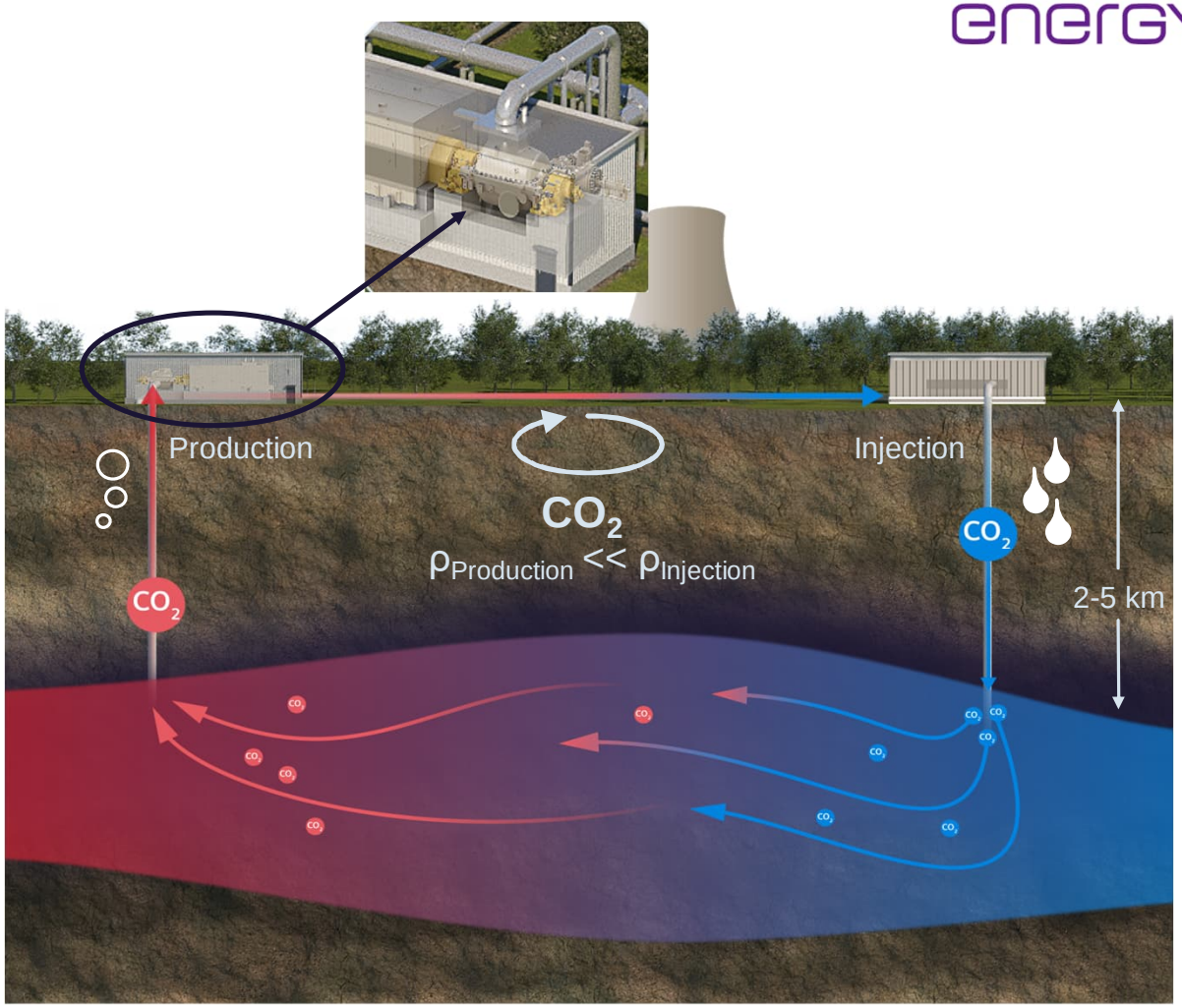
Value Proposition

- Cost competitive LCOE, below 100€/MWh
- Utilization of CCS projects leads to reduced financing risks for NGP
- By utilizing CO2 as working medium low temperature reservoirs can be economically exploited

NGP is using emitted CO2 as working medium

- CO_2 is injected in sedimentary basins that host permeable reservoirs overlain by cap rocks
- heated by geothermal energy, CO2 flows to the surface and expands in a turbine to generate electricity and is reinjected again (closed CO2 loop)

➢ NGP combines geothermal energy with CCS and transforms CCS to CCUS



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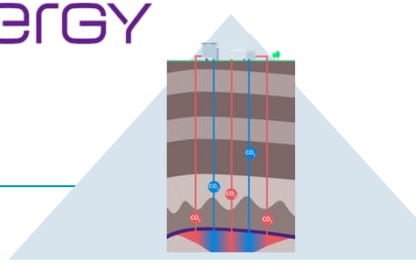
Development Steps for NGP

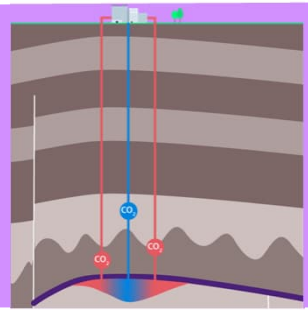
Actual system proven in operational environment (TRL9)

Commercial NGP Plant > 30 MW



System completed and qualified (TRL8)

Small Commercial NGP Plant ~5 MW



Technology validated in relevant environment (TRL 5)

Circulation Test to be conducted, equipped with the necessary measuring instruments

Basic Research (TRL 3)

Technical and economic investigations and comparisons to existing energy technologies

Technical comparison, LCOE comparison, Market definition, Portfolio fit

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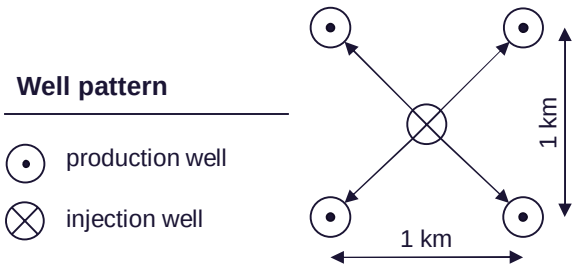
Use Case comparison – NGP vs. Conv. Geothermal

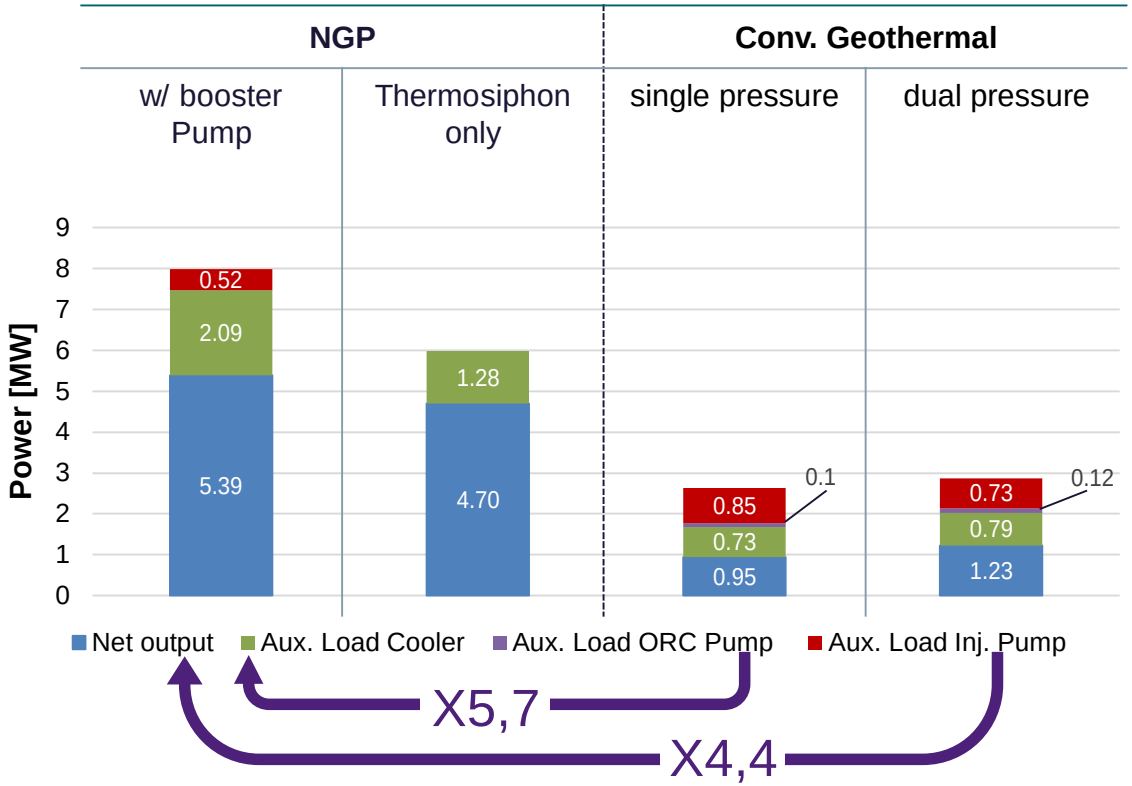
Geologic conditions

Well field scale [#Inj. / #Prod.]	1 / 4 (5-spot-system)
Depth	2500 m
Well diameter (casing diameter @ target)	18 5/8“
Permeability-thickness product (κh)	100 mD * 150 m (15.000 mD·m)
Temp. gradient	35 K/km

Well pattern



Power Cycle Variants



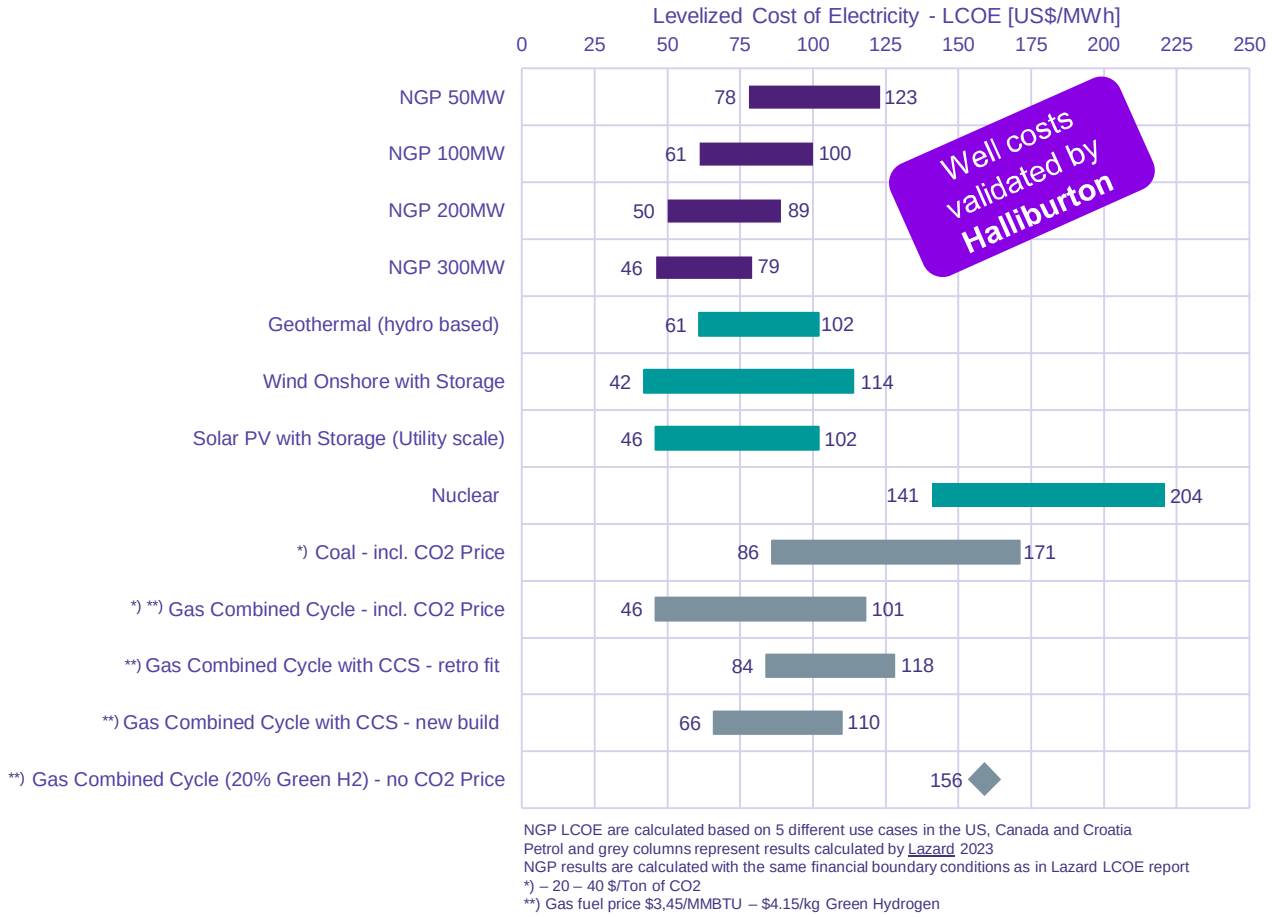
The net power output of NGP is up to 6 times higher than for conventional geothermal.

Assuming the same geologic boundary conditions.

Similar results can be found here: Adams et al. 2015 https://doi.org/10.1016/j.apenergy.2014.11.043

LCOE - NextGen Geothermal Power

NGP represents a competitive alternative to existing emission-free base-load capable energy technologies.



NGP LCOE are calculated based on 5 different use cases in the US, Canada and Croatia
Petrol and grey columns represent results calculated by Lazard 2023
NGP results are calculated with the same financial boundary conditions as in Lazard LCOE report
*) – 20 – 40 $/Ton of CO2
**) Gas fuel price $3,45/MMBTU – $4.15/kg Green Hydrogen

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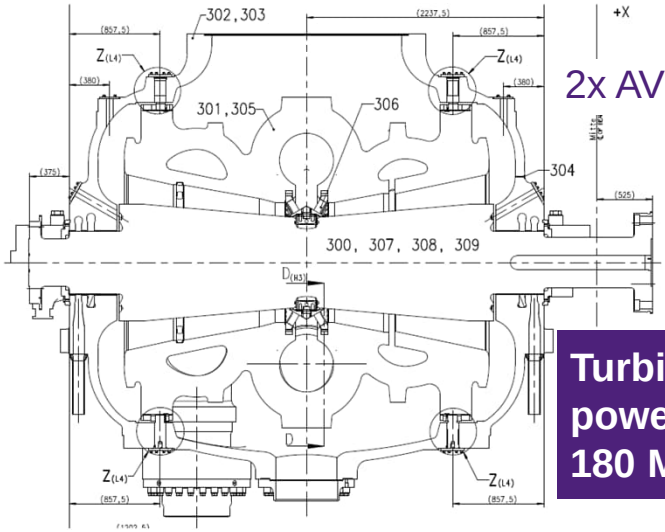
Comparison of I50 steam turbine and NGP turbine

Conventional Steam I50

Bearing distance 5725



2x AV 630

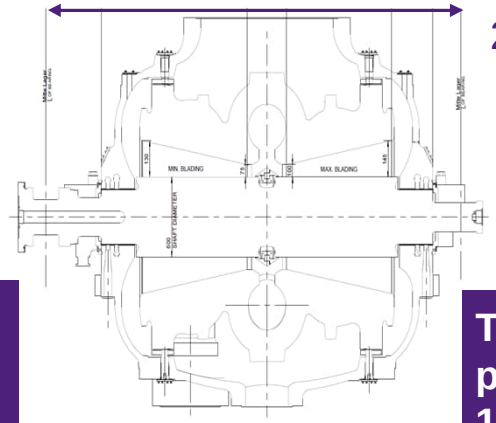
Turbine power: 180 MW

	inlet	outlet
mass flow	346 kg/s	318 kg/s
volume flow	63 m³/s	242 m³/s
pressure	22,5 bar	3,7 bar
temperature	623°C	350°C

NextGen Geothermal Power

x 0,66

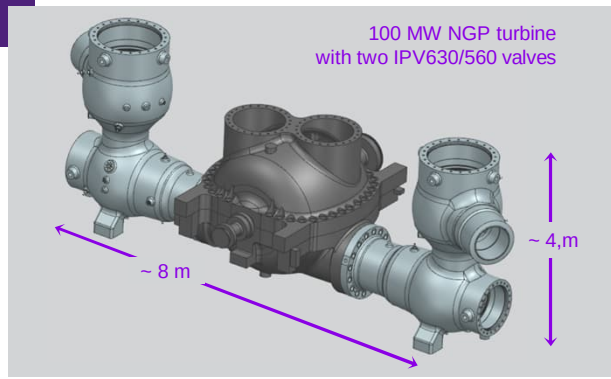
Bearing distance 3850



2x AV 630

Turbine power: 100 MW

	inlet	outlet
mass flow	3332 kg/s	3332 kg/s
volume flow	8 m³/s	14 m³/s
pressure	178 bar	72 bar
temperature	101°C	36°C



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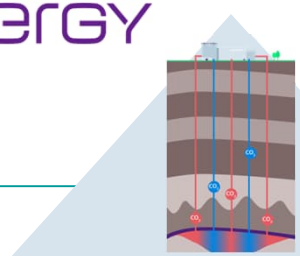

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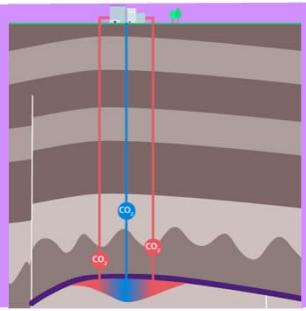

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Proof of Concept

- Siemens Energy & O&G Partner
- Hungary
- Technical concept approved
- Worldwide unique
- Calc. models validated
- System regulation approved

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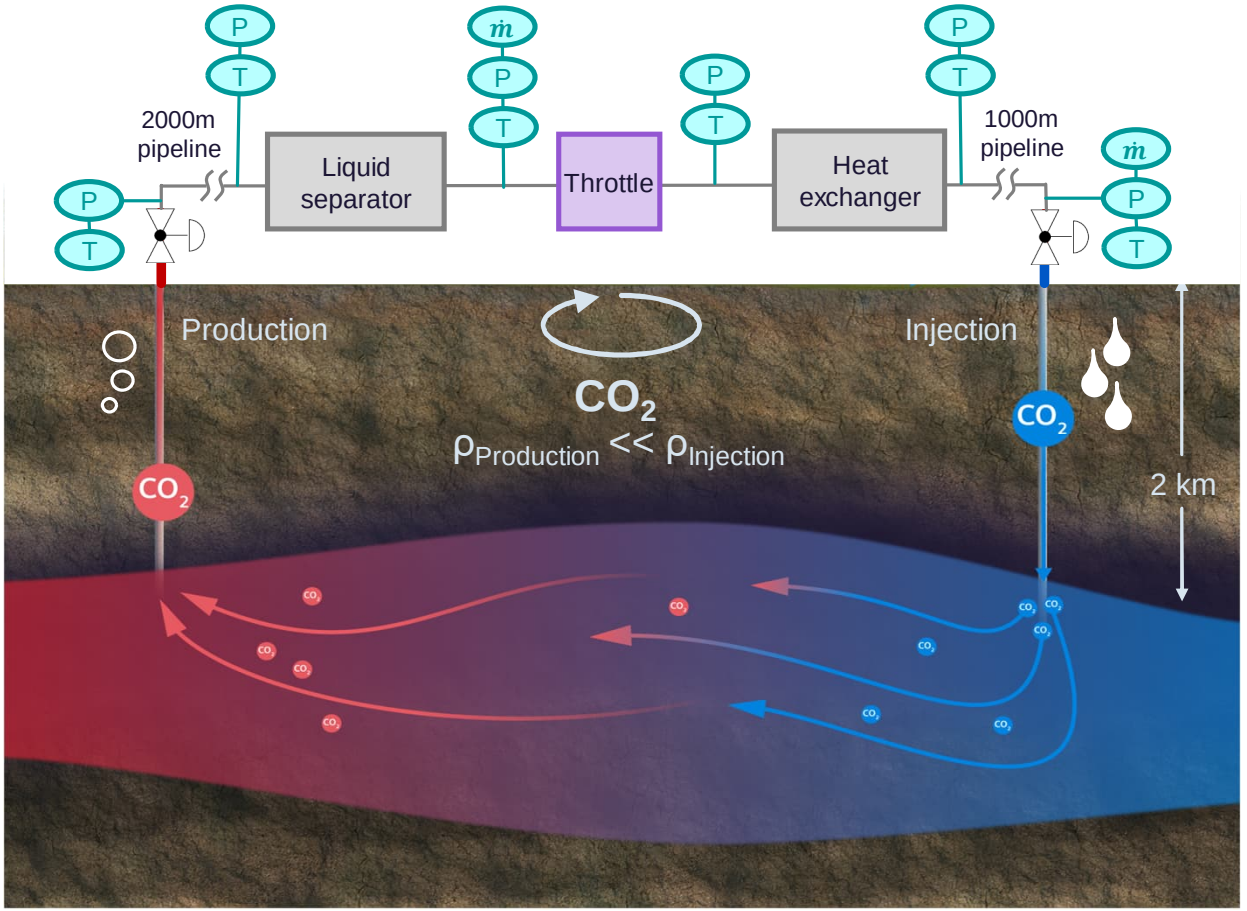
By repurposing existing wells and a depleted oil and gas field we have been able to proof the strong natural circulation of CO2 under real field conditions.



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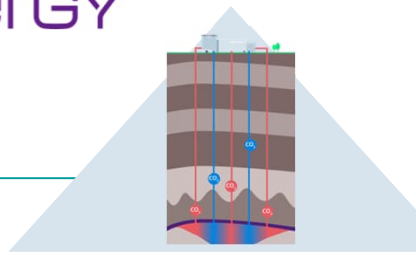

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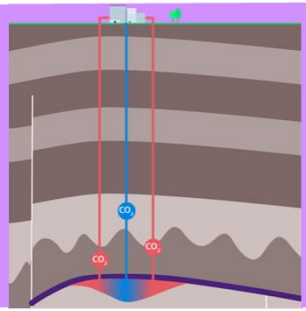

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Demonstrator key facts

- East Europe
- 3 MW_{el}
- Start of operation 2027
- Overall CAPEX ~ 30m€
- LCOE ~115 €/MWh*
  *) including 40% public funding
- Local O&G Company
  Oil & Gas Partner
- Siemens Energy
  Technology Partner
- GEMS

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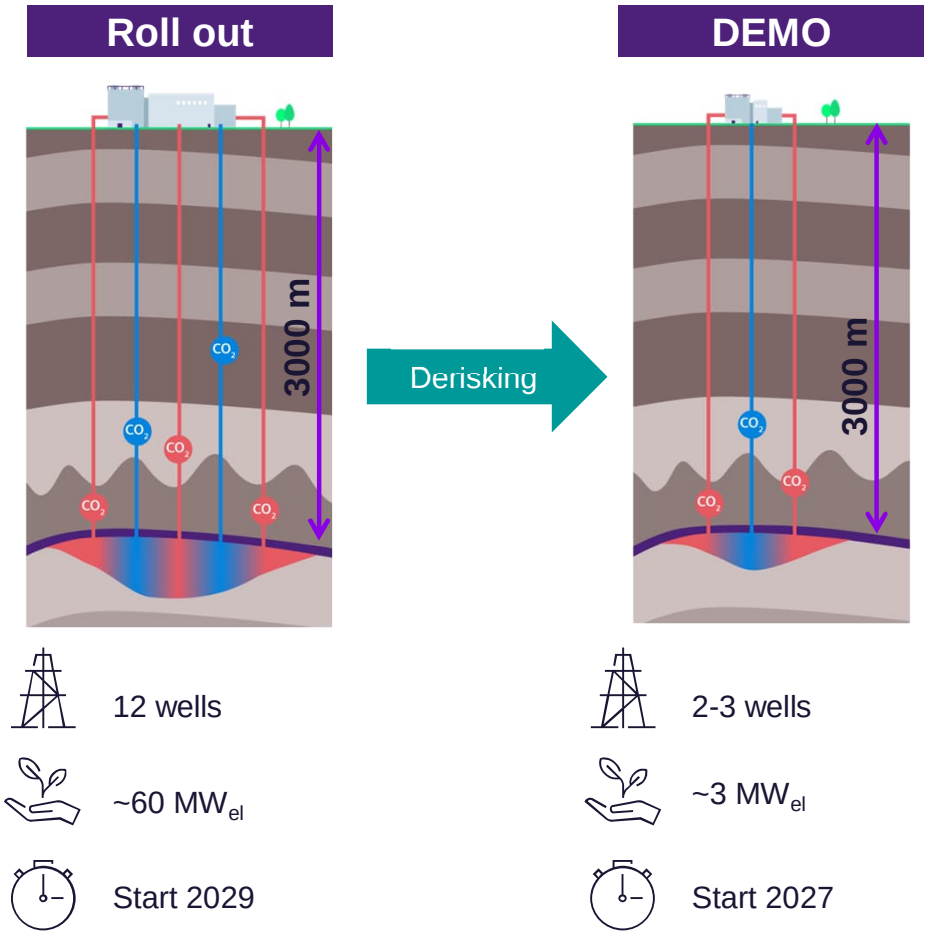
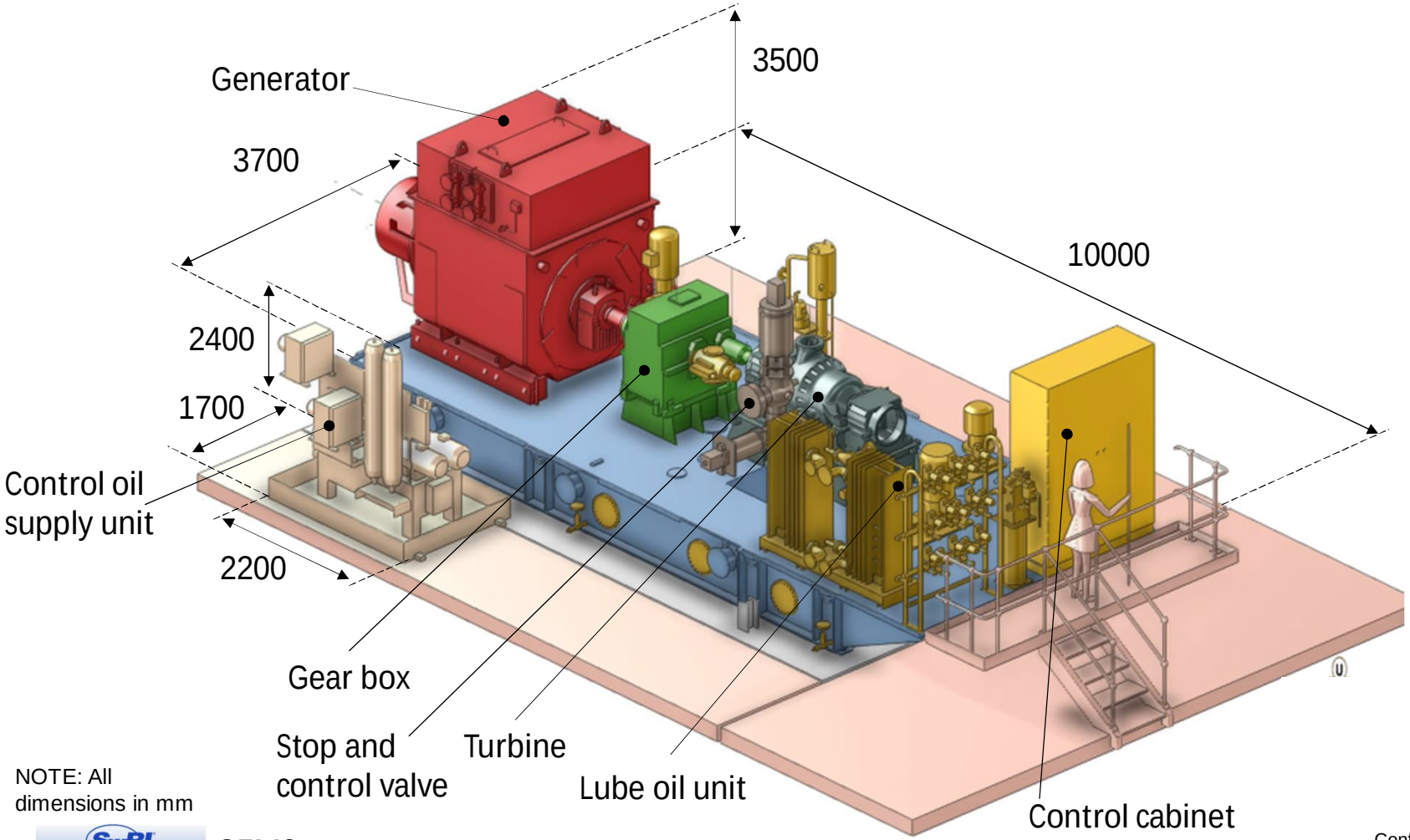
The demonstrator location provides the potential to build an **NGP power plant up to 60MW**



Backup

5MW Turboset Footprint estimate



NOTE: All dimensions in mm

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