synergys

Spolufinancováno Evropskou unií

Ministerstvo životního prostředí

SYNERGYS – systems for energy synergies

JTF strategic project for Ústecký region

30.9. 2025
JTPeers Exchange

PRESENTATION

- About geothermal energy
- Geothermal heat extraction – technology
- Research centre RINGEN & project SYNERGYS

About geothermal energy



2D seismic profiles measurements in Litoměřice, 09/2024

The role of geothermal energy in decarbonisation

POTENCIAL*

- GTE covers only about **0.3% of global energy consumption** (i.e. heat and electricity combined)
- **Worldwide** energy **consumption** corresponds to a thermal output of **19 TW** (3000 NPP Temelín)
- **The Earth's heat output is** greater - **44 TW**

Source: PřF UK

EMISSIONS

- The heating sector is the source of more than **40% of the** energy sector's **CO2 emissions**
- The heating sector is fundamentally dependent on fossil fuels - **less than 25%** comes from RES (2020), a situation that has remained unchanged for the last 30 years *Source: IEA, 2021*

UTILISATION

- GTE is a **widely available heat source** suitable for large installations and district heating (2 thousand systems in Czechia)
- GTE is also **usable for cooling** - probably the dominant energy consumer after 2050
- **Only 6% of** installed **CHP** is **ground-water/air** system

Source: ERÚ, AV TČ

*theoretical/technical/economical

Geothermal energy - classification

Shallow

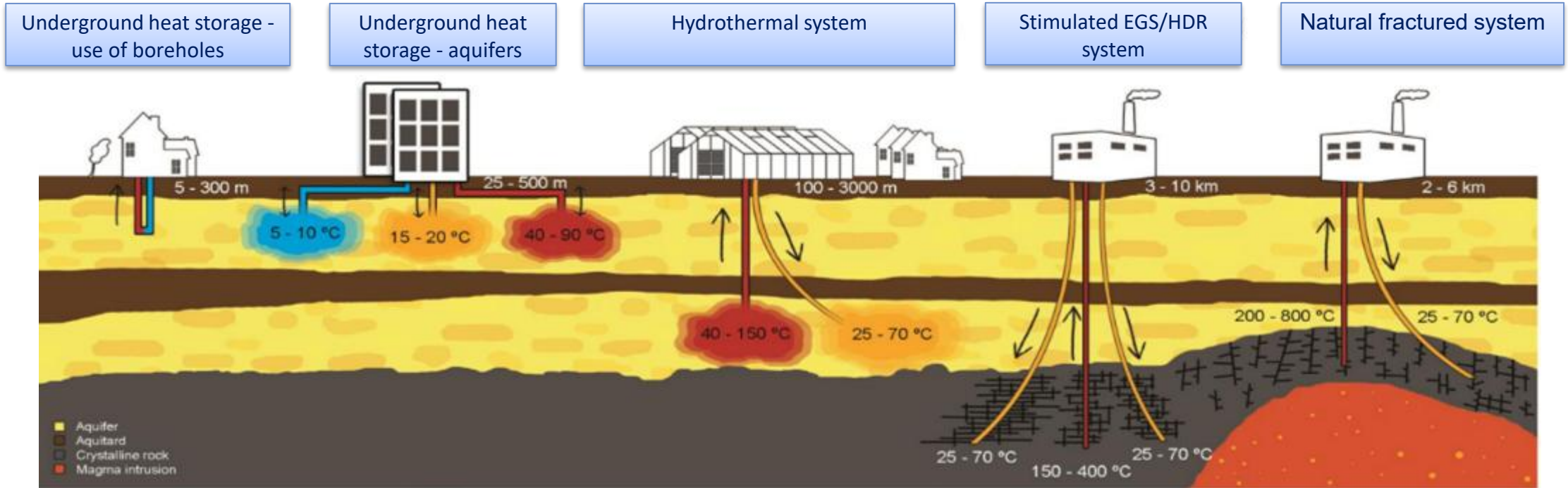
- **Depth: up to 400 m**
- **Temperatures: 10-30 °C**
- Technology: heat pumps (Nt/Vt)
- **Outputs: tens of kW/units of MW**
- Heat supply via CHP
- Combination **heating & cooling**

Medium

- **Depth: approx. 400-1000 m**
- **Temperatures: approx. 15-80 °C**
- Technology: vt heat pumps
- **Output: units MW**
- Heat supply via CHP
- Primary heating

Deep

- **Depth: from approx. 2000 m**
- **Temperatures: 80>°C**
- Technology 1: hydrothermal source
- Technology 2: stimulated "dry" source
- **Outputs: units/tens of MW**
- Direct heat supply to the system/building
- Primary heating, supplementary electricity



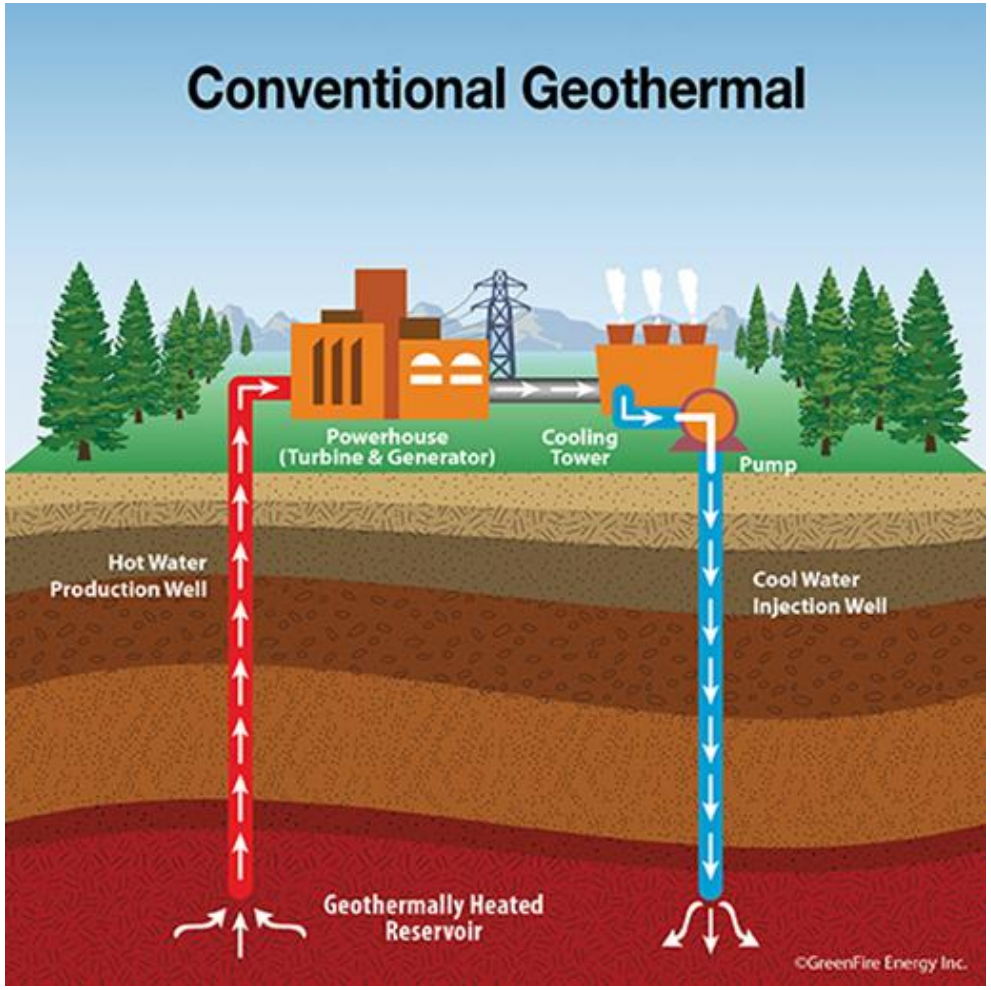
Geothermal heat extraction – technology



Drill core samples from 500 m well– RINGEN 2024

1. Hydrothemal systems

- Open systems
- Natural underground water reservoirs
- Typical temperature 20-150 °C
- High efficiency
- Long-term durability is an issue
- CZ: Děčín (32°C, 50 l/s, 7,6 MWth HP)

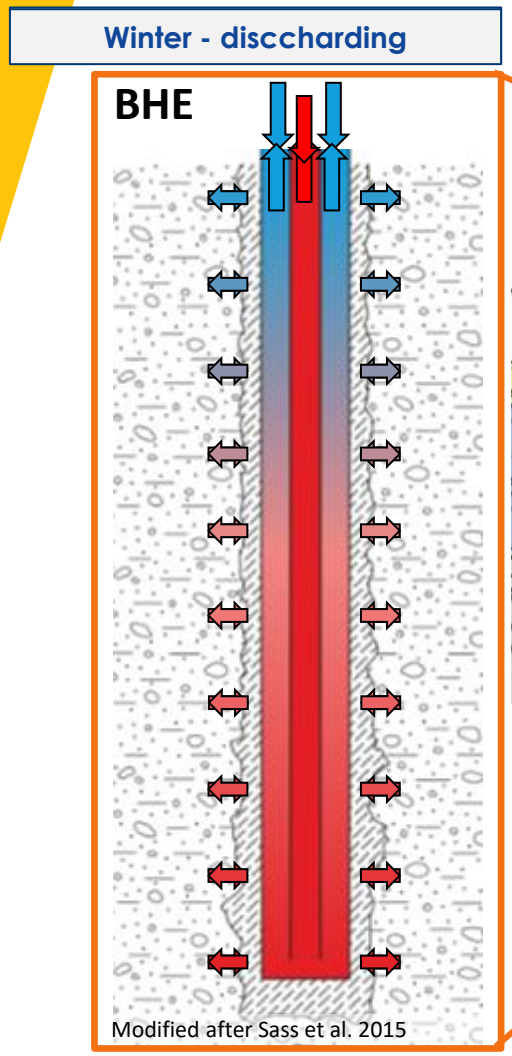


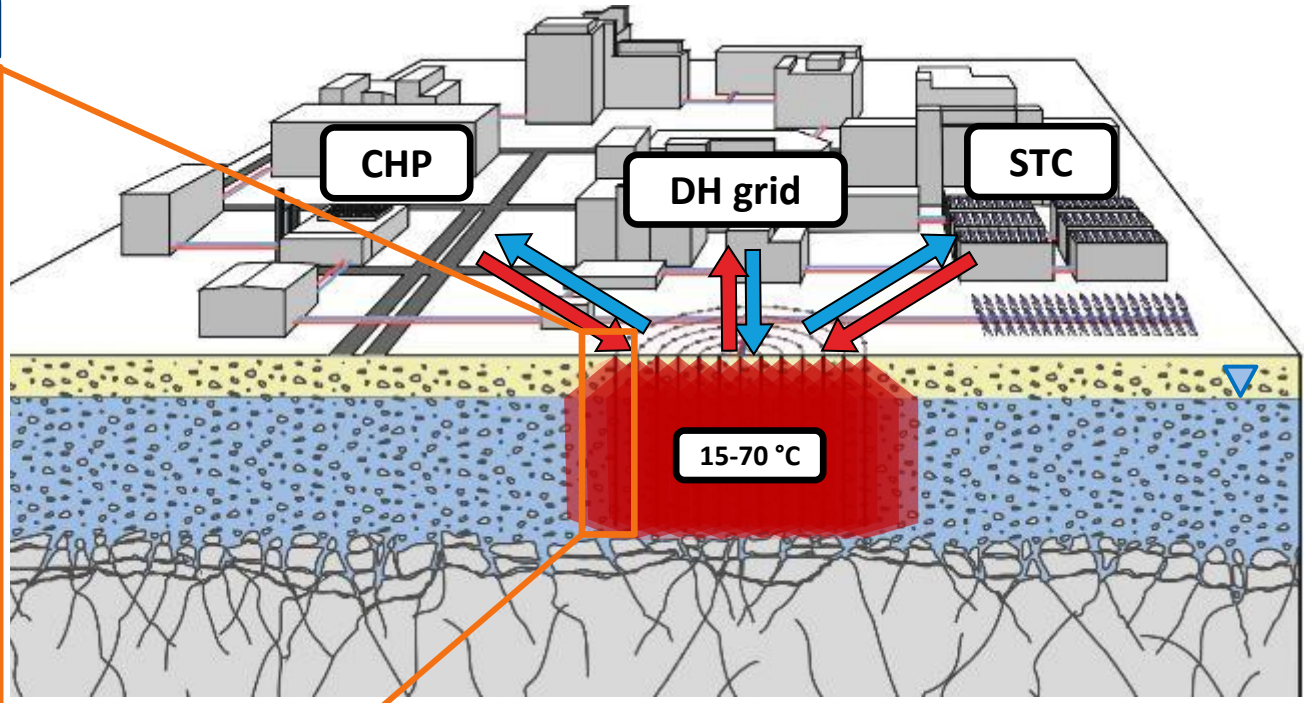
Zdroj: https://www.greenfireenergy.com

2. Shallow geothermal and heat storage UTES

- Smaller houses using heat pumps but extenstion to MW possible
- Typical depth100-500 m
- Various technology of storing energy BTES/ATES/MTES

BTES - seasonal heat storage





BHE = Exchanger
CHP = Combined Heat and Power
STC = Solar-Thermal Technology
DH = district heating (CZT)

Charging/discharging speed depends on
rock type (thermal conductivity)
presence of water (thermal conductivity, capacitance)
hydrogeological conditions (porosity, water flow)

Performance parameters
Efficiency 50 - 80 %

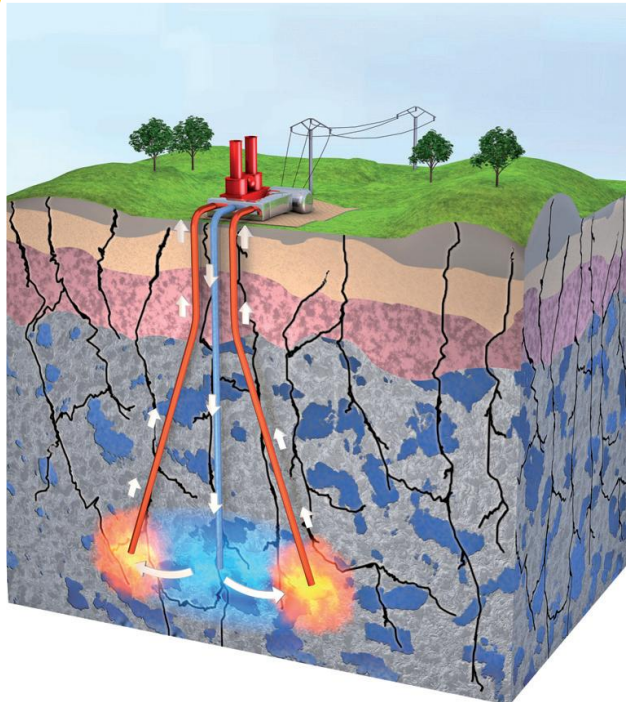
Capacity in GWh

Funded by the European Union

PUSH IT

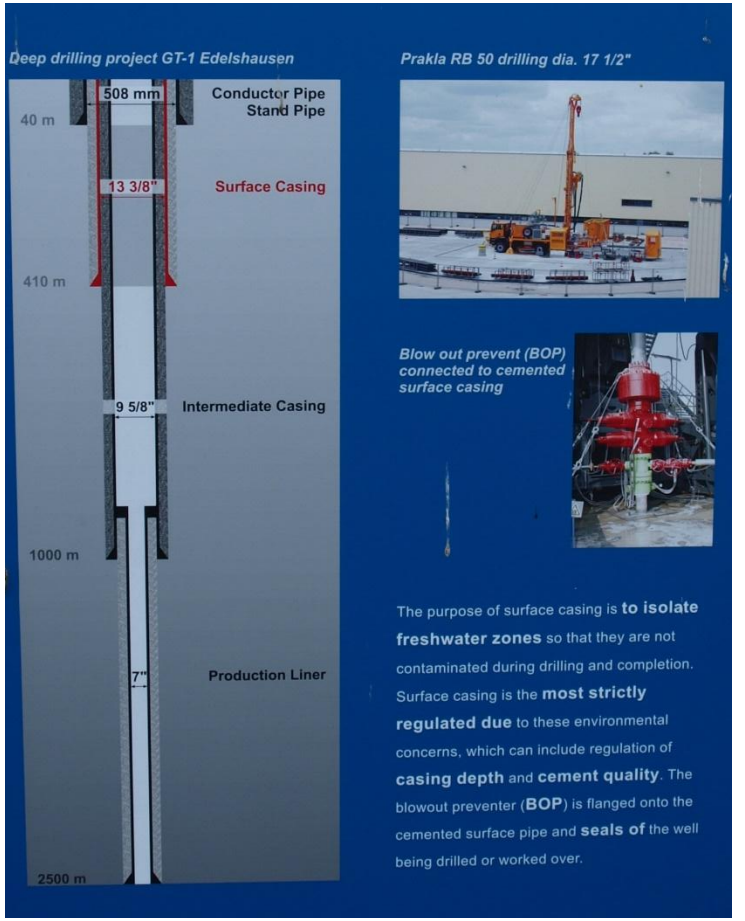
3. Stimulated systems

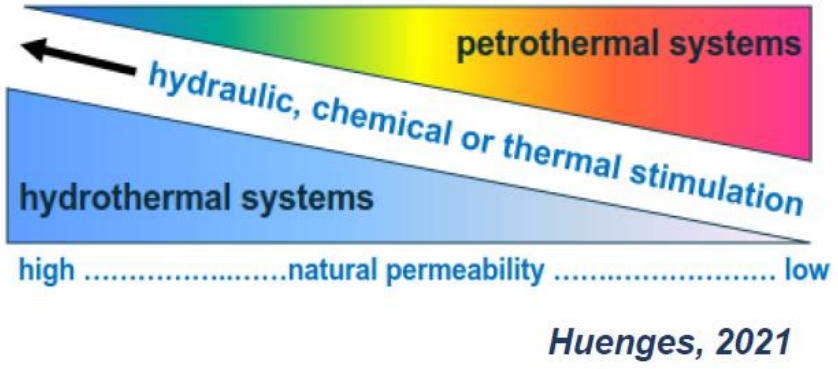
- Open systems (closed loops possible?)
- Hot dry rock - usually no watter present
- Typical temperature100+ °C (1 km = +30 °C)
- High risks& high efficiency
- Exploration well & stimulation needed



- **Hot Dry Rock**
- **Hot Wet Rock**
- **Hot Fractured Rock**
- **Enhanced Geothermal System**







Huenges, 2021

Research centre RINGEN & project SYNERGYS



RINGEN opened in 2020

Geothermal project Litoměřice - milestones

2004
Introduction to the EGS system & tour of the EU

2007
drilling of exploration well LT1 up to 2.1 km

2014
RINGEN - establishment of a research centre

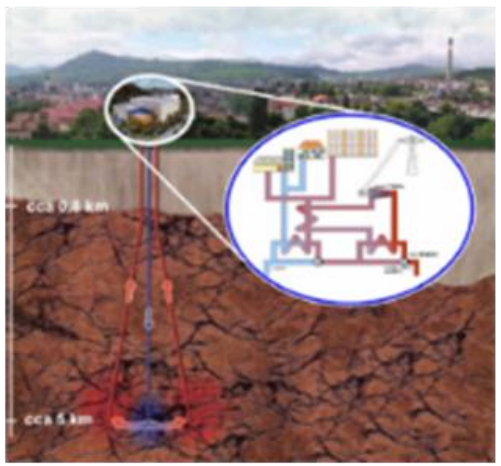
2020
RINGEN - start of operation

2020
Fair Transformation Fund announced

2021
strategic projects for 3 regions (MSJ, UK, KVK) approved

2023
SYNERGYS project launch

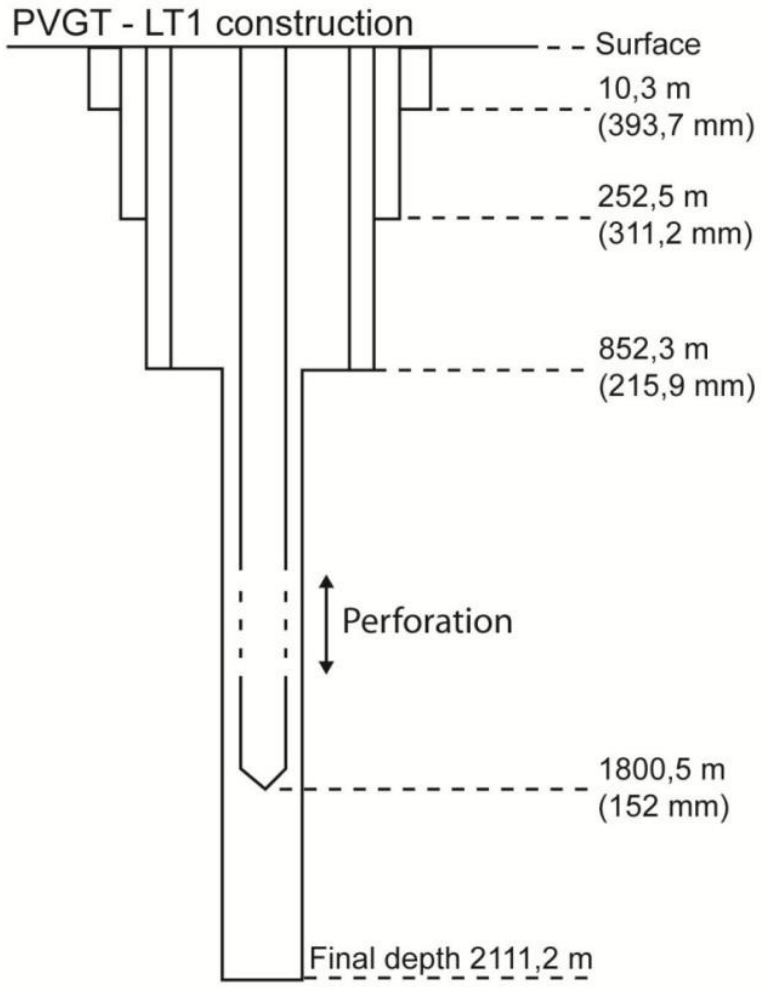




Step 1: GTE exploratory well realised 2007

- TVD 2.111 m
- confirmation of the thermal gradient
- clarification of the geological profile & thermal properties
- investment € 4 mil.

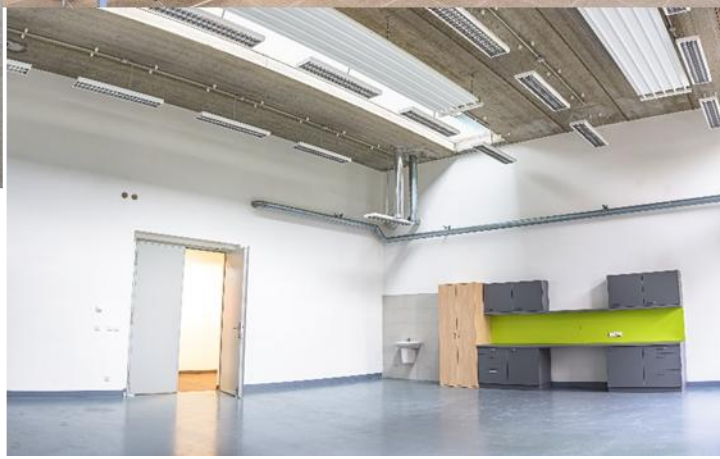




Step 2: **RINGEN** – research centre for geothermal energy utilisation – launched in 2020







Total of 2000 m2
6 labs
1000 m2 of storage space

&

PVGT exploratory well 2,1 km
Seismic monitoring network (incl. boreholes)

Step 3: SYNERGYS



Implementation: **2022-2027**

Expected budget: **€ 50 milion (€ 40 mil. INV costs) – EU Just Transition Fund**

Main goals:

- to address problems and challenges related to **energy transition of the coal regions**
- to increase **energy efficiency** and **replace fossil fuels** in **district heating systems**
- to develop & integrate **new clean energy resources** and **underground energy storage systems**
- **complex of pilot technologies**: deep GTE source, borehole thermal energy storage (BTES) in various depths (100-500m), **green H_2** unit & **PV power plant** (1MW) & other waste energy sources
- to develop a brand **new geoenergy sector** absorbing experts from mining industry & fossil energy sector
- to expand **cooperation between public R&D and business** sector

Project leader & partners

- **Faculty of Science /RINGEN, Charles University**
- University Centre for Energy Efficient Buildings, Czech Technical University in Prague (UCEEB)
- Czech Geological Survey - leader
- University J.E. Purkyně in Ústí n.L.
- Institute of Geophysics, Academy of Science
- Town of Litoměřice

&

international expert network: GFZ Potsdam, TU Darmstadt, EOST Strasbourg, TU Delft, Fraunhofer institute IEG



Project main outputs (plan)

- a **complex testing area** with experimental novel energy sources and scientific background with 60 shallow wells (100-500m) and 2 deep wells (~ 3 km)
- enhanced **geothermal (EGS) plant** up to 2 MWth output/10 GWh
- underground **thermal energy storage** BTES – up to 10 GWh capacity/3MWth
- integrated **geoenergy laboratory**
- photovoltaic system **hybrid PV panels** (~100 kW) (combined heat&electricity)
- **H2 unit** (0,5MW/8t) & **fuel cell unit** (100 kW) for all-year electricity coverage
- first **training centre for geoenergy** and related fields
- **unique data** and information available **in open access** regime
- many other technologies integrated (HT heat pumps, co-generation units etc.)

RES Installed power (elektricity & heat): cca 2,5 MW (1,8 MW heat a 0,7 MW electricity)
Electricity storage capacity: 7,5 MWh
RES electricity production/ year: 644 MWh
RES heat production/ year: 1 165 MWh

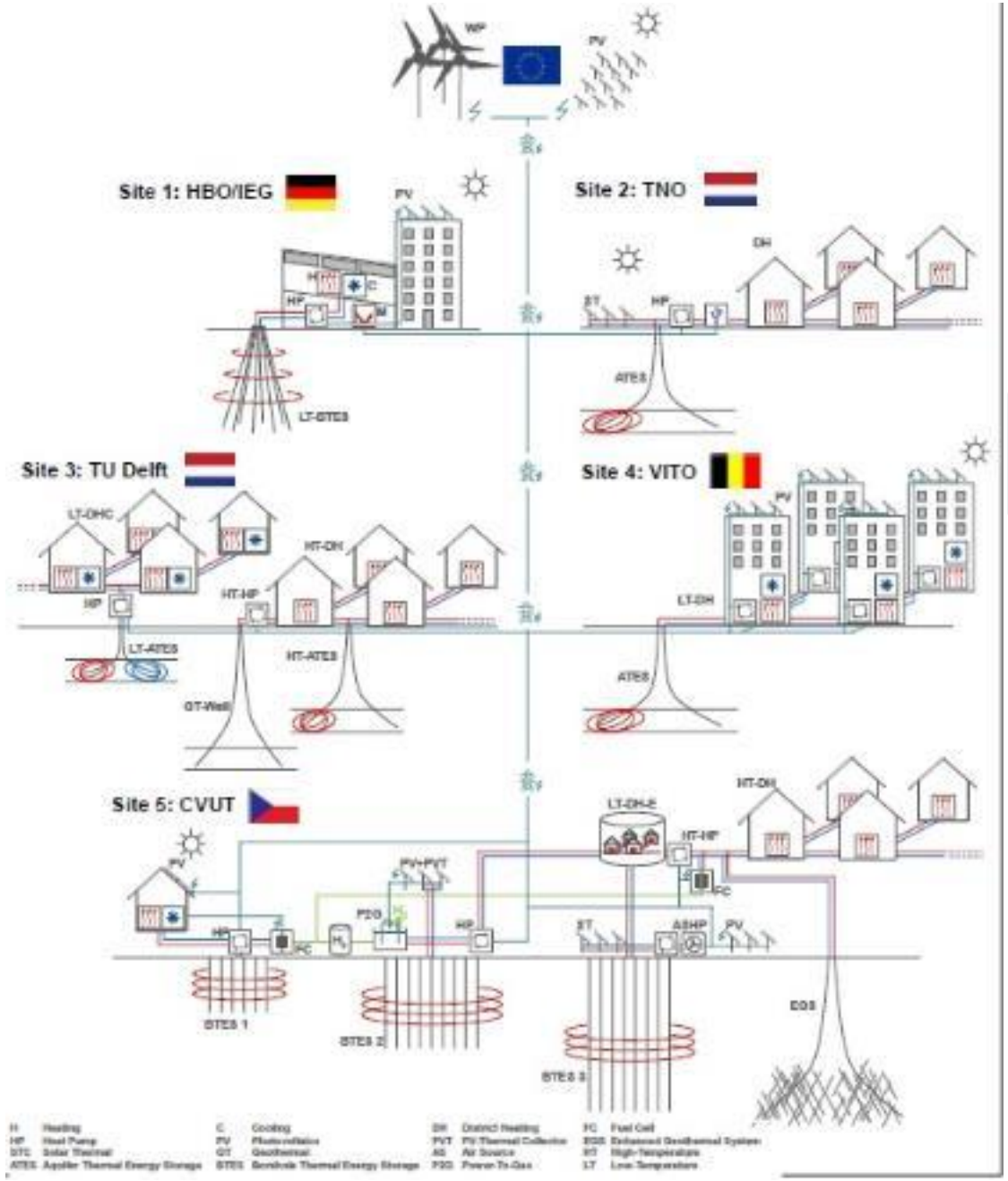
Exceptionally complex project

- EN BTES
- LT heat pumps
- PV
- heating & cooling

- LT+HT ATES storage
- LT GTE drilling
- LT+HT heat pumps
- LT+HT SCZT
- heating & cooling

- LT+MT+HT BTES storage
- HT GTE EGS drilling
- LT+HT heat pumps
- PV+FV-hybrid+FTe panels
- H2 electrolyzer
- H2 fuel cell
- Battery storage
- KG unit
- HT SCZT + CZT emulator
- heating & cooling & electricity

SYNERGYS

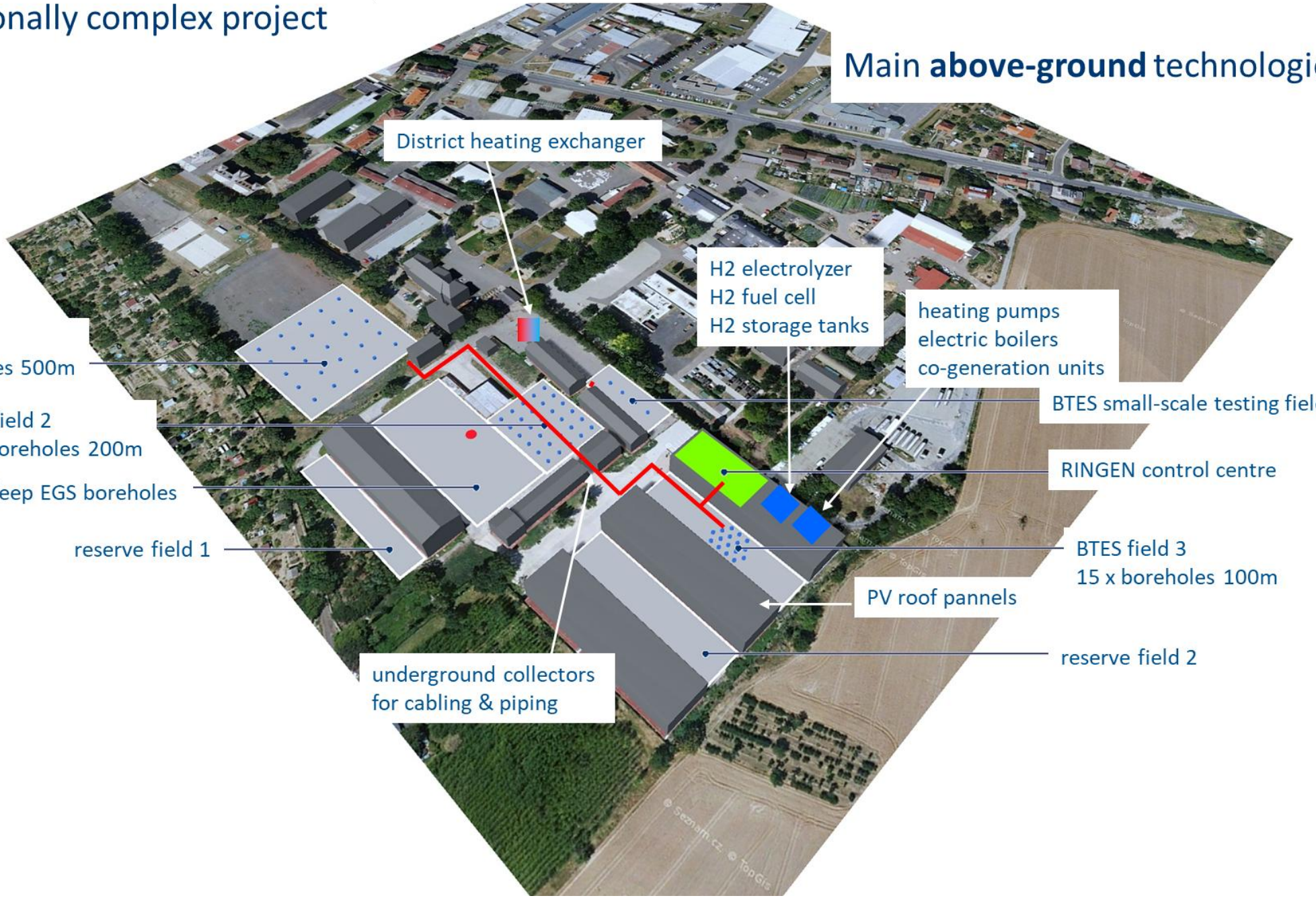


- EN ATES
- LT heat pumps
- FTe panels
- LT SCZT
- heating & cooling

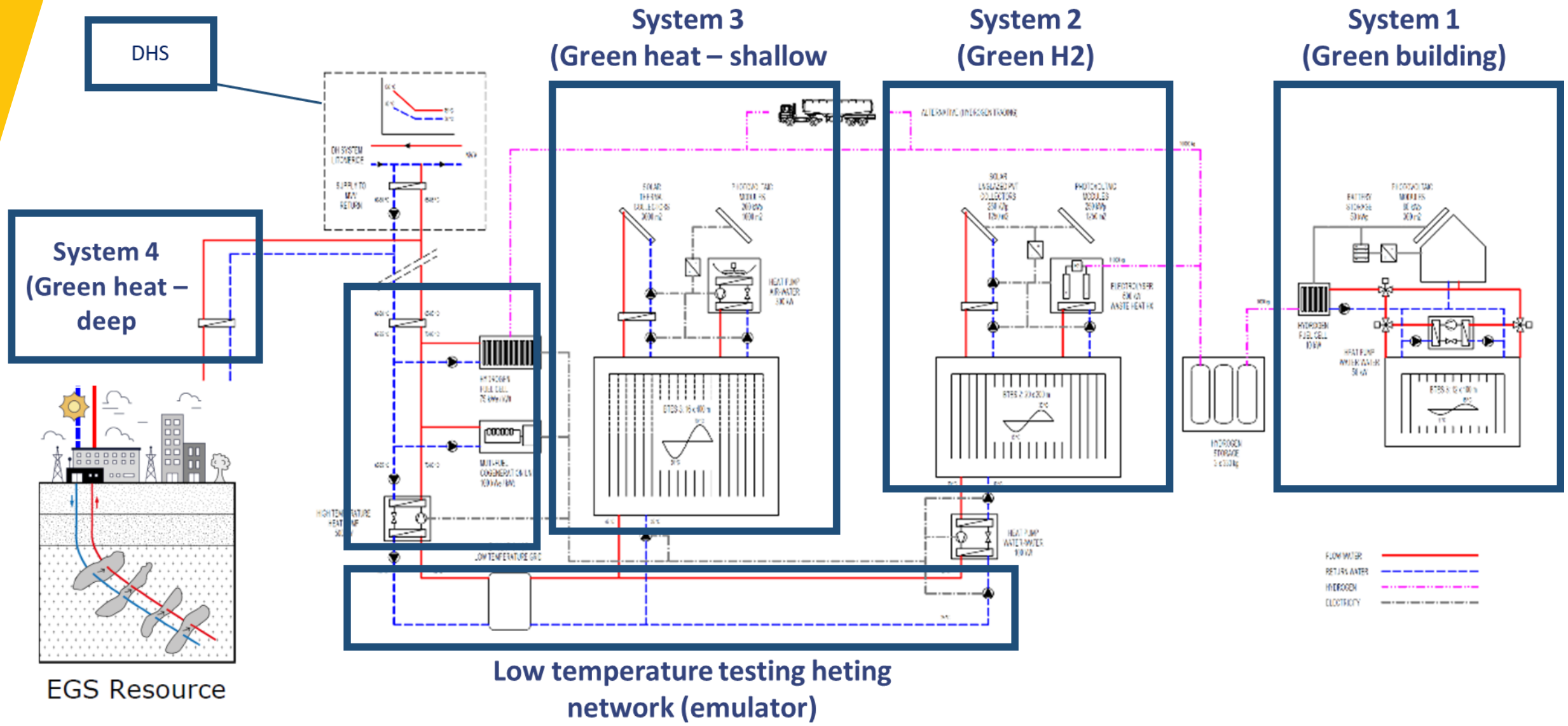
- EN ATES
- LT SCZT
- PV
- heating & cooling

Exceptionally complex project

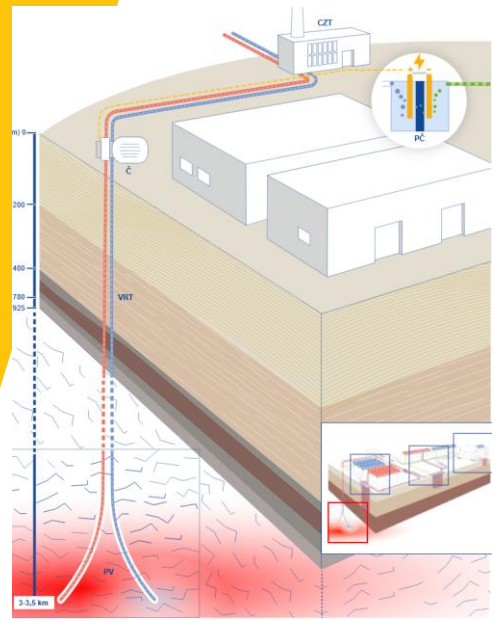
Main **above-ground** technologies



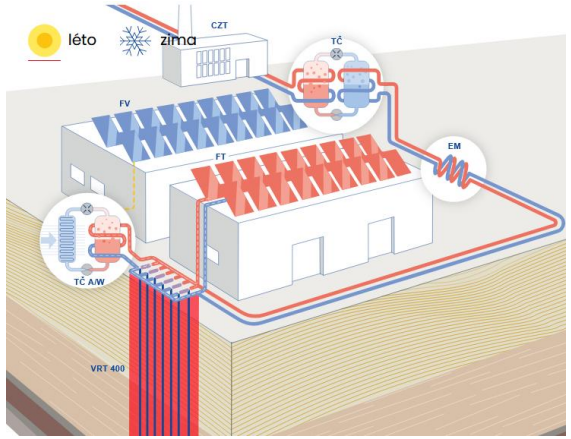
SYNERGYS energy system



4 systems for energy synergries

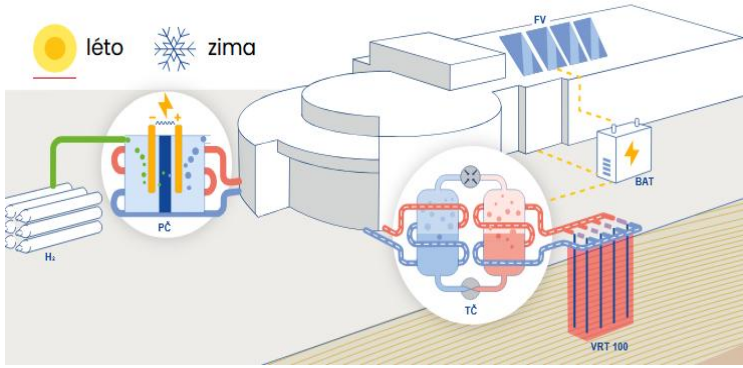


System 4
DEEP GREEP HEAT

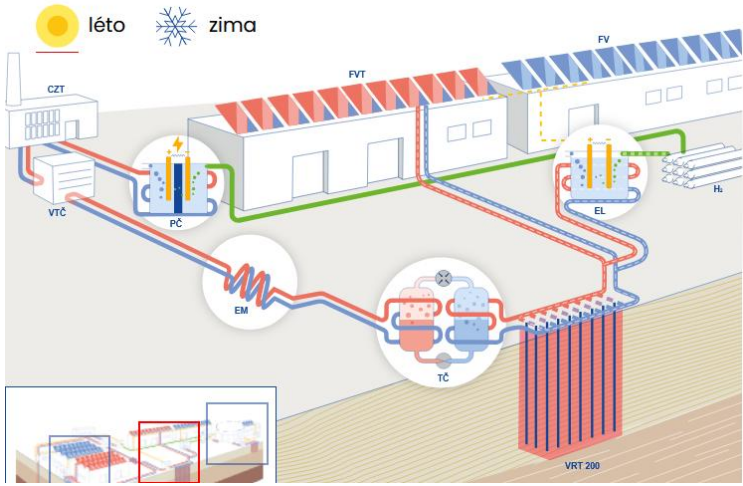


System 3
SHALLOW GREEN HEAT

- **INTEGRATION:** The energy transformation of large and medium-sized heating sources will require integrated solutions using various renewable energy sources
- **INNOVATION:** The introduction of innovations requires testing in practice and over the long term
- **DATA**: Investments in new technologies requires large amounts of data and information on investment and operating costs
- **MANAGEMENT:** integrated technologies need to be managed and used effectively according to their characteristics at a given time and place
- **APPLICATION:** testing sites and research will enable errors to be eliminated and recommend procedures in other locations with significantly lower risk of failure



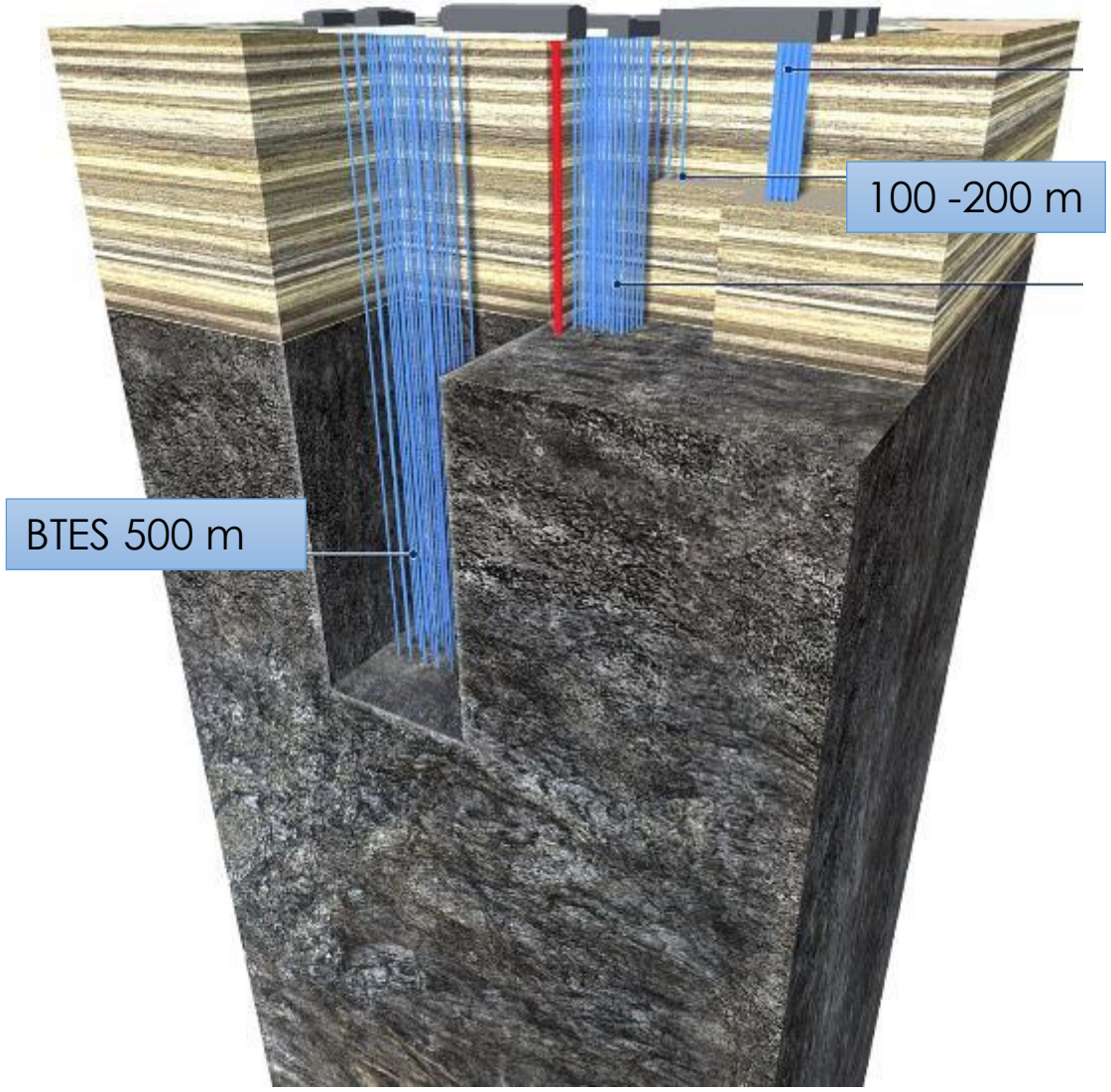
System 1
GREEN BUILDING

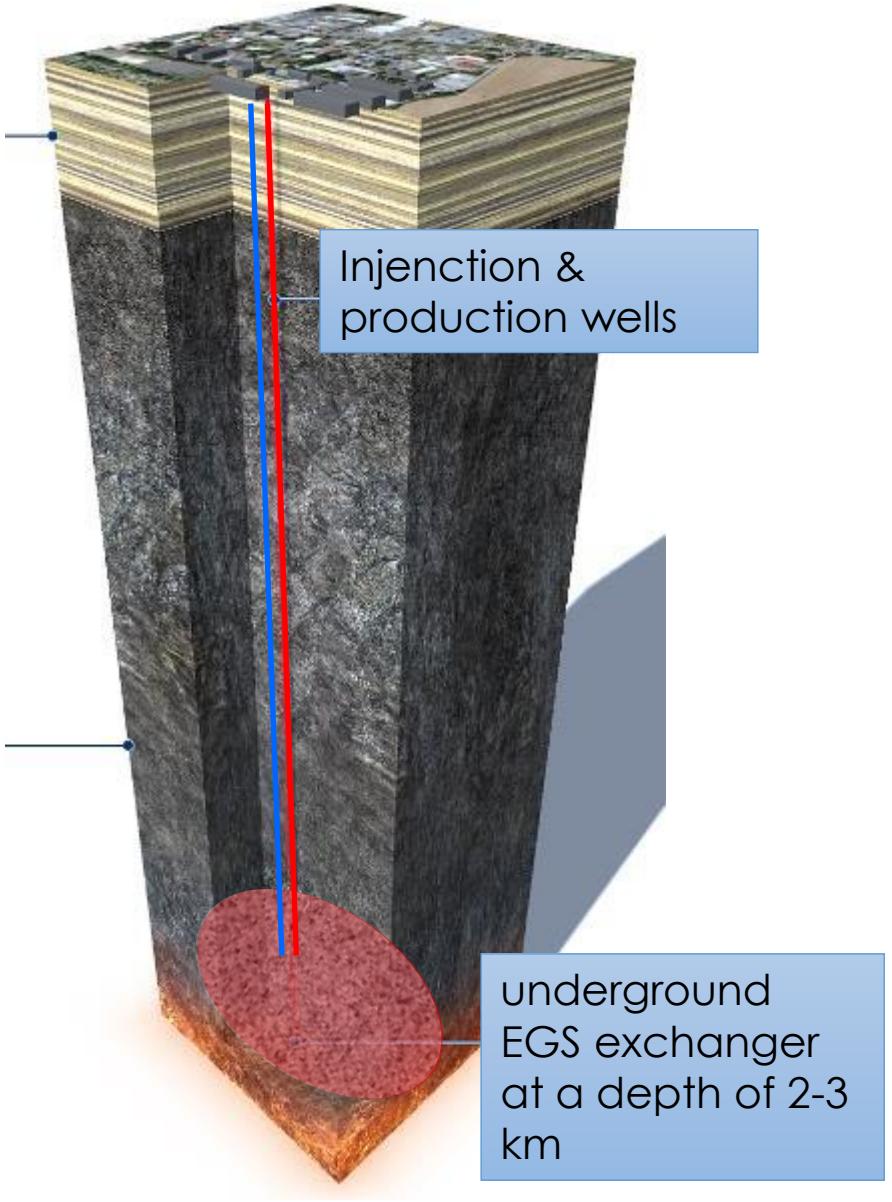


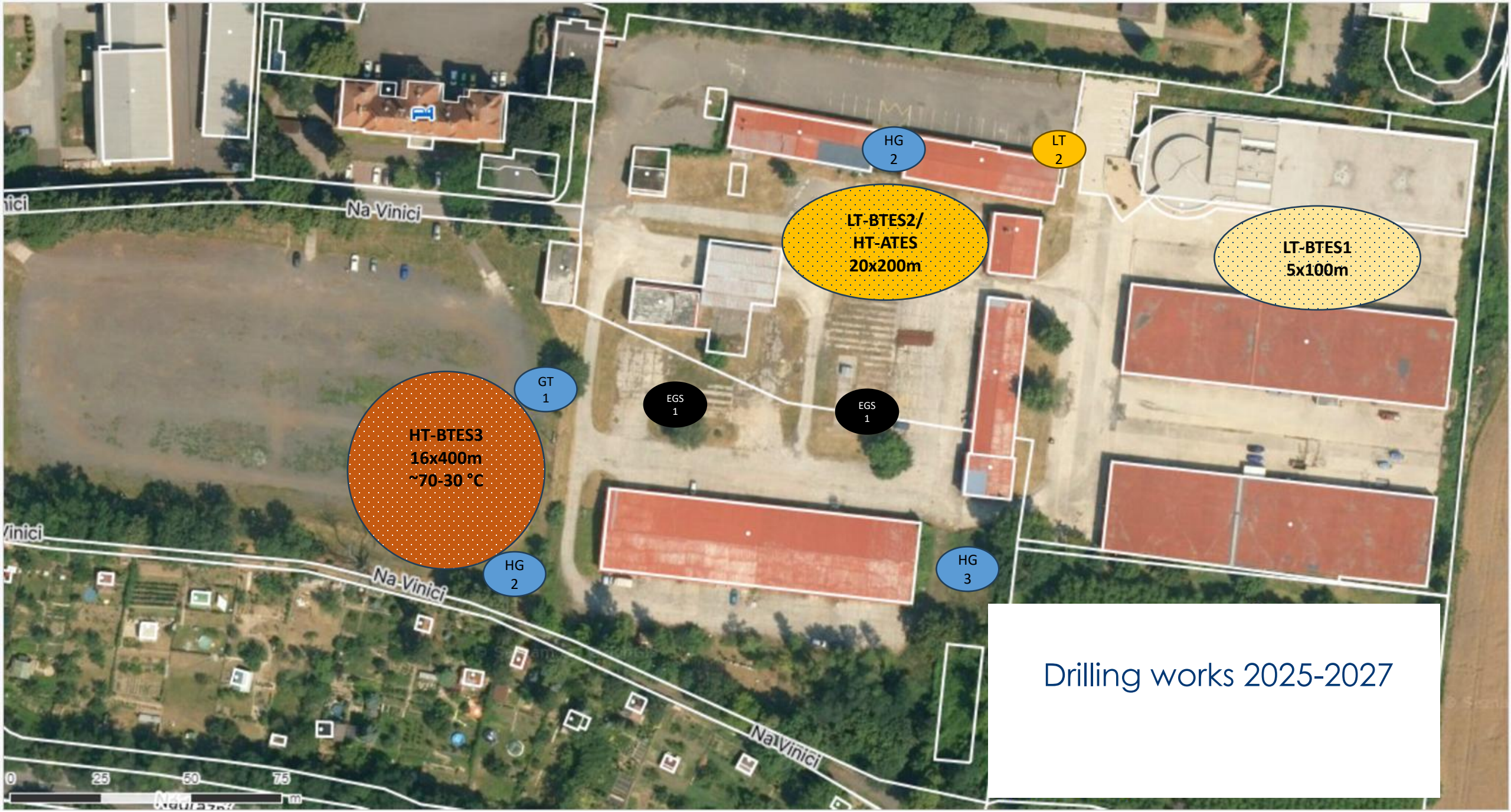
System 2
GREEN HYDROGEN


Kocanda
Českolipská
Na Kocandě
SOU
Na Vinici
Karla IV.
výstaviště Zahrada Čech
RINGEN
Exploratory well
LT1 – 2,1 km
Nádražní
261
Marie Pomocné
zahr. osada
Vodní cvičiště
15
150

main activities - **underground** technologies







Drilling works 2025-2027

Challenges for the district heating sector in Czechia

- heating sector mostly dependent on **coal combustion** (covers 60% of total district heat energy supply) and **natural gas** (covers 25%)
- about **2000 district heat systems (DHS)** in Czechia of which 1800 with installed power > 5MWth, but another 1700 registered DHS with installed power between 0,2-5MWth
- increasing share of renewables in DHS – suitability and readiness of wind/hydro/solar power plants X geothermal
- **integration** of various **novel & conventional technologies** – weaknesses & strengths
- in/stability of the energy sector X social affordability and sustainability
- private business X public interest

Thank you for
your attention!

