

Background and Motivation

In general, the first planning phase of designing heat generation and distribution projects, especially in the context of municipal energy planning, mainly consists of developing feasibility studies or potential assessments regarding the available energy sources. **Providing information about geothermal potential is a critical key factor in implementing geothermal energy into heating and cooling networks throughout Europe.** In the context of the SAPHEA project, a catalogue of scenarios to integrate geothermal energy into district heating and cooling grids and a directory of parameters and information needed for geothermal energy feasibility studies or geothermal potential assessments has been developed by the SAPHEA project team. The directory is classified according to the minimum information that is needed for a qualitative assessment and/or a quantitative assessment, providing a first state-of-the-art protocol for assessing the geothermal potential on a pan-European scale.

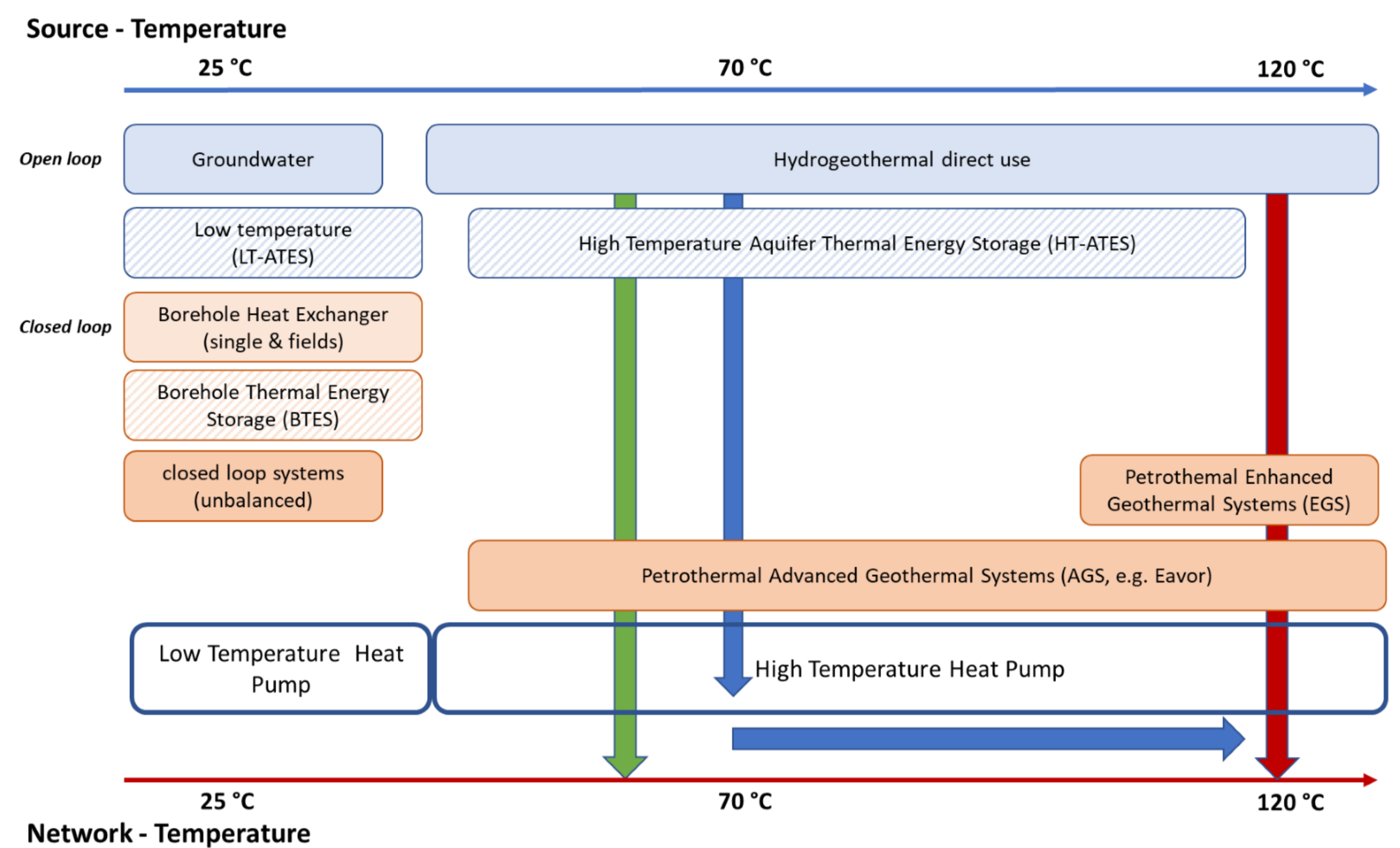
Scenario Catalogue

- Depending on source and sink temperatures, various scenarios for linking the suitable geothermal energy technology to the specific grid are feasible
- Geothermal systems can be classified based on their depth, which relates to temperature
- The corresponding DHC is defined by the operating temperature level
- All identified scenarios are classified into three categories depending on their state of development:
 - basic scenarios** defined as state-of-the-art installations which are widely used
 - complex scenarios** involving combined installations with more intricate system design
 - future scenarios**, which are installations that are in development and not yet state-of-the-art
- For every identified scenario, **the catalogue describes the technology, relevant constraints and limitations as well as examples on projects in Europe**

No.	Basic Scenario	Source T (°C)	Grid T (°C)
B 01	Shallow geothermal & Free cooling - DC Network	5-25	0 - 15
B 02	Groundwater + decentral LTHP - LT Network	10	10 - 25
B 03	Hydrothermal Direct Use - HT Network	90 <<	80 - 120
B 04	Hydrothermal Direct Use - MT Network	40 - 90	40 - 60
B 05	Groundwater + central HP - MT/HT Network	10 - 30	25 - 90
B 06	BHE + central HTHP/BTES - MT/HT Network	-4 - 30	25 - 90
B 07	BHE + decentralized LTHP - LT Network	-4 - 25	10

No.	Complex Scenario	Source T (°C)	Grid T (°C)
C 01	Basic + LT ATEs + LT/MT/HTP - LT/MT Network	30 >	40 - 60
C 02	Hydrothermal + HTHP - MT/HT Network	30 - 90	60 - 120
C 03	Hydrothermal + Sorption Chiller - DC Network	60 - 100	6 - 15

No.	Future Scenario	Source T (°C)	Grid T (°C)
F 01	Basic + HT-ATES - MT/HT Network	90 >>	90
F 02	Advanced Geothermal Systems (AGS)	90 >>	90
F 03	Enhanced geothermal system (EGS)	90 - 120	90
F 04	Deep BHE + HTHP - MT/HT Network	20 - 50	90

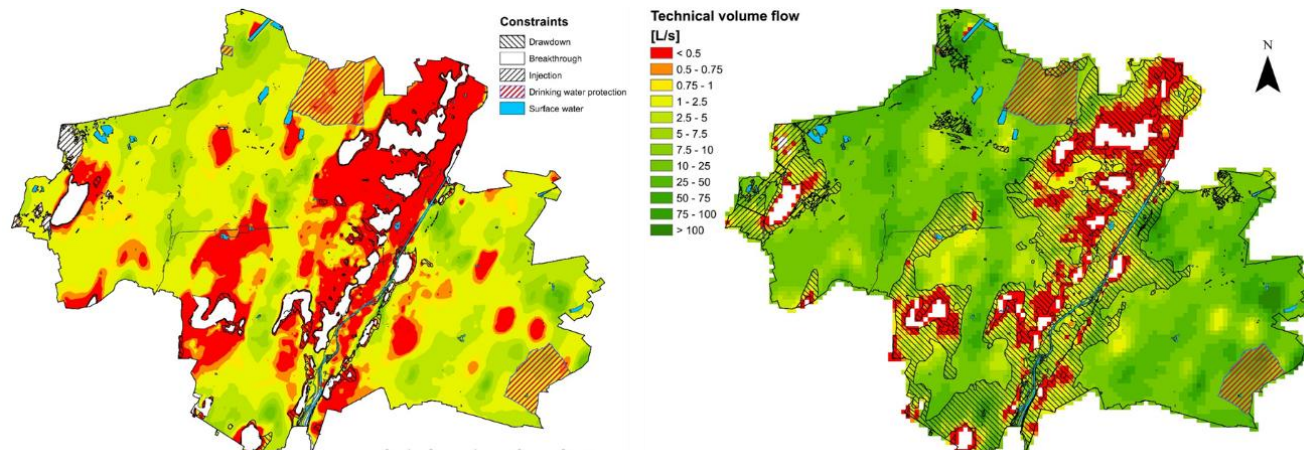


Directory of Parameters, Methodology and Datasets

The scenario catalogue serves as the basis for the development of a **directory of parameters, methodology, and open accessible data** needed for geothermal energy feasibility studies.

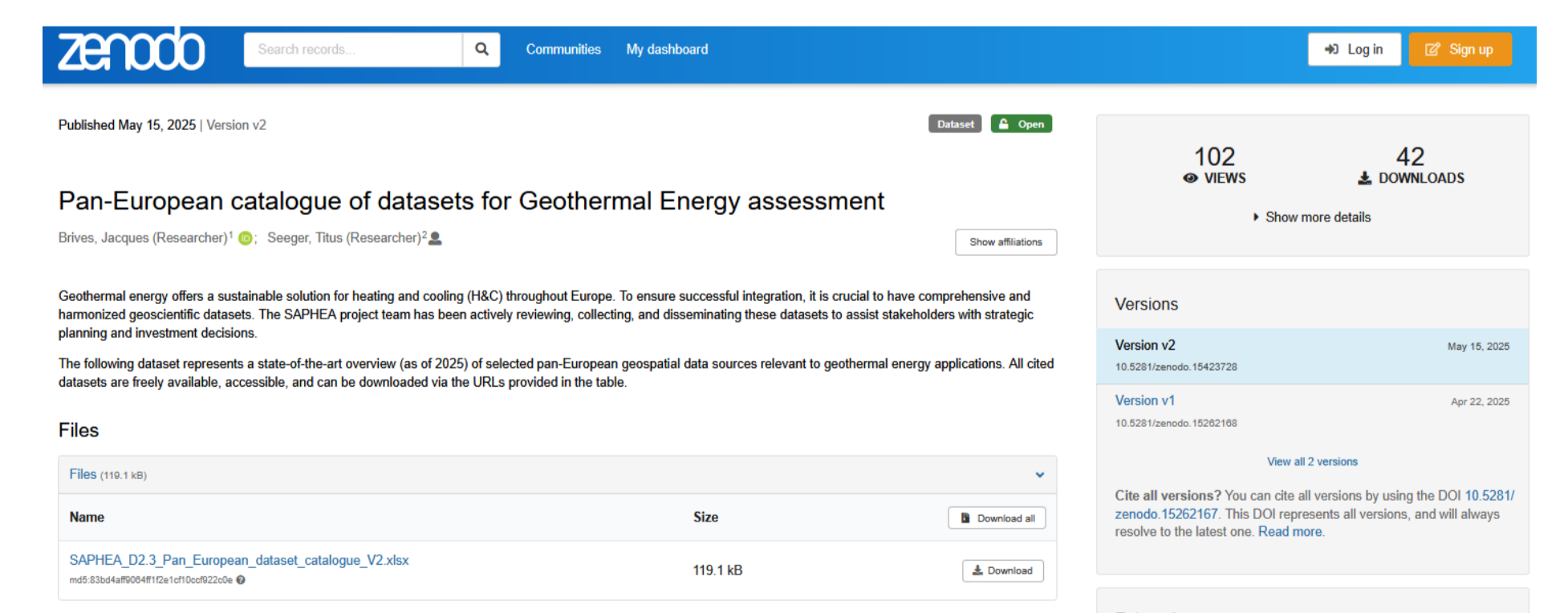
Scenario Set	1	2	3	4	5
Definition	thermal use of shallow groundwater by open loop systems	use of BHE for shallow and middle deep systems	use of hydrothermal reservoirs T > 30 °C	Aquifer Thermal Energy Storage	Advanced and Enhanced Geothermal Systems
Scenarios	B 01, B 02, B 05, C 01	B 06, B 07	B 03, B 04, C 02, C 03	F 01	F 02, F 03, F 04
Source	aquifer	ground	aquifer	aquifer	ground
Primary parameters needed for qualitative and quantitative assessment	<ul style="list-style-type: none"> spatial extent of aquifer hydraulic parameters 	<ul style="list-style-type: none"> lithology thermal parameters 	<ul style="list-style-type: none"> spatial extent of reservoir hydraulic parameters 	<ul style="list-style-type: none"> spatial extent of reservoir cap layer hydraulic and thermal parameters 	<ul style="list-style-type: none"> spatial extent of geological horizon rock properties thermal parameters

The directory outlines the needed critical parameters, **providing methodologies for every scenario set on how to assess the geothermal potential on a qualitative (QL) and quantitative (QN) basis.**

Example: Parameters needed for Scenario Set 1	Unit	Classification	Example for QL assessment of Set 1: Energieatlas Bayern 2020
Spatial Extent of the Aquifer (SEA)	-	QL/QN	
Depth to the Aquifer (DtA)	(m)	QL/QN	
Aquifer Thickness (AT)	(m)	QL/QN	
Saturated Aquifer Thickness (SAT)	(m)	QN	
Groundwater Table Distance to the Surface (GTDtS)	(m)	QN	
Restricted Areas (RA)	(m ²)	QL/QN	
Hydraulic Conductivity/Permeability (HC/P)	(m/s) / (m ²)	QN	
Hydraulic Gradient (HG)	(-)	QN	
Hydrochemical Conditions (HChem)	(mg/l)	QL/QN	
Groundwater temperature (GT)	(°C)	QL/QN	

Dataset Publication

Catalogue of open accessible pan-European spatial datasets linked to the parameters of the directory, as well datasets published from the case study areas of the project partners.



Titus Seeger^{1*}, Jacques Brives², Stefan Hoyer², Marek Hajto³, Nicolo Giordano⁴, Jakob Kulich², Kai Zosseder¹

¹ Geothermal Energy Group, Chair of Hydrogeology, Technical University of Munich, Arcistraße. 21, 80333 Munich, Germany

² GeoSphere Austria, Neulinggasse 38, 1030 Vienna, Austria

³ Department of Energy Resources, AGH University of Krakow, al. Adama Mickiewicza 30, 30-059 Kraków, Poland

⁴ Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, Viale Pier Andrea Mattioli 39, 10125 Torino, Italy

