SUMMARY OF QUESTIONNAIRE 1 (ACT. 3.1)

The first questionnaire that was filled out by the project partners was related to Act. 3.1 – assessment of existing techniques and best practices for the utilization of NSGE. The questionnaire was subdivided into three parts.

Part A - Existing techniques of utilization of NSGE

A.1 Commonly used techniques of utilization

In order to get an overview of commonly used techniques of utilization of NSGE in all partner countries, partners were asked to fill out a corresponding table. The compiled version of this table is illustrated in Table 1.

<u>The table shows “sources” vs. “techniques”.</u>

Defined **“sources”** of geothermal energy are either a) mainly groundwater (aquifers), b) natural ground sources (rock formations without significant aquifer) or c) artificial ground sources (energy piles, tunnel walls, etc.). Defined **“techniques”** are either withdrawal for I) heating or II) cooling only, for III) seasonal use (heating & cooling) or for IV) storage purposes.

As indicated with blank circles, mainly the artificial ground source techniques like tunnel walls and energy piles are not commonly used. The usage of NSGE-systems for cooling purposes only is a big topic in Germany but up to date in none of the other countries. The most common applications are groundwater and ground source installations for heating purposes and for seasonal use. Storage facilities are present in many of the countries, mainly in the form of single aquifer usage and BHE fields and to a lower extent in the form of thermally activated building elements.

Techniques	**Sources**			
	LEGEND o not commonly used ● commonly used • commonly used only in 1 country	**a) Groundwater**	**b) Natural ground source**	**c) Artificial ground source**
	I) Withdrawal (heating only)	• single well ● doublets ● multi well	● single BHE ● BHE field ● heat collector	● energy piles o tunnel walls
	II) Withdrawal (cooling only) o direct o indirect • both	o single well ● doublets ● multi well	• single BHE ● BHE field o heat collector	• energy piles o tunnel walls
	III) Seasonal (heating & cooling)	● single aquifer usage	● single BHE ● BHE field ● heat collector	● energy piles o tunnel walls
	IV) Storage	● single aquifer usage o multi aquifer usage	● BHE field	o abandoned mines • thermally activated building elements

Table 1: Compiled table – overview of commonly used techniques of NSGE-utilization in all partner countries.

B.1 Data availability

To get an overview about data availability, partners were asked to fill out a corresponding table. Questions to be answered were:

1. Whether data has to be reported to authorities (does the data have to be reported to local/regional/national authorities in any kind of format and extent)?
2. Whether the access to the data is possible (can your institution get access to the data)?
3. Whether your institution can get access to the data in a database-format (like an Access/Excel/ArcGIS/etc. database)?
4. Whether you would have the allowance to publish the data (would you in general be allowed to publish the data (maybe you can state whether you would be allowed to publish exact numbers, only very general summaries, nothing at all, etc.).

Those questions were to be answered regarding to

- Numbers of installations
- Locations of installations
- Users of installations
- Operating / performance data
- Monitoring data

As assumed, the availability of data is very heterogeneous in the participating countries. In most of the countries, new BHE and GWHP installations have to be reported to authorities in some way. Thus, locations of installations and information about users are often available to the project partners, but not always in a database-format like excel or access. Information about operating/performance data or monitoring data is sparsely available. For heat collectors, thermally activated building elements and thermoactive geostructures, locations and numbers have to be reported in only few cases. Thus, data is sparsely available.

All answers can be looked-up in the attached completed questionnaires.

Part B – Best practice examples from existing plants

For every participating country, one partner was asked to provide a list of max. 10 best practice examples from a technical or economical point of view (compilation in Table 2). To be able to present a concise compilation of current best practice examples with many different techniques and/or topic-related examples, 2-3 sites from this list per country shall be selected for data-gaining.

Country	Technique and/or topic	Brief description – why may this site be selected for a best practice example?
AUT	BHE field Hotel Mondschein	High altitude (1400 m) winter sports hotel has been renovated and has implemented a BHE field (10 x 160 m) for heating the building. Heating capacity 44 kW.
AUT	BHE field Gipfelstadl Wagrain	High altitude (1800 m) alpine hut has implemented a BHE field (15 x 127 m). 90 kW
AUT	BHE field Hotel Crystal	High altitude (2000 m) winter sports hotel has implemented a BHE field (76 x 120 m).
FRA	Music School, Moutiers, 73	Building heating trough HP + single well for groundwater heat withdrawal Altitude: c.a. 480 m Interest: the school has been both extended and renovated. 2 systems for heat distribution: Radiators in the renovated part and radiant ceiling heating in the new part
FRA	School, Pers-Jussy, 74	Building heating trough HP + 12 100-m deep BHE. S = 1930 m². Heating only. No backup (e.g. gas boiler). Extraction from the BHE field / year: 67 MWh, injection of 20 MWh. Interest: heat emission by air
FRA	Industrial building of the society Ewigreen, Manosque, 04	Building heating trough HP + 2 6-m deep wells on aquifer. S = 2000 m². Heating only. No backup (e.g. gas boiler). Peak power: 156 kW (heating), 102 kW (cooling) Interest: simultaneous production of heating and cooling
FRA	Monastery, Ganagobie, 04	Building heating trough HP + 9 100-m deep BHE. S = 1000 m². Gas boiler in backup. Peak power: 50 kW (heating). The diner room, church, hall are heated by the GSHP through heating floor. Interest: the site shows that geothermal energy can be integrated even in old buildings
FRA	Parador Resort, Vence 06	Building heating trough HP + 24 100-m deep BHE (no antifreeze). Peak power: 112 kW (heating), 103 kW (freezing). The diner room, church, hall are heated by the GSHP through heating floor. Interest: simultaneous production of heating and cooling
GER	Snow and ice free railroad switch (Farchant or Oberstaufen)	Normally electric heating panels are attached to a switch to keep it ice free during winter, but Triple-S invented a system for passive or active heating via HP with a specially designed heat exchanger. Enhanced to the system is a weather station, which monitors the relevant atmospheric parameter to anticipate the correct heat demand.

GER	Public outdoor swimming pool at Benediktbeuern (groundwater spring)	Sine 2011 a heat pump (HP) replaced the oil heating, which consumed 44.000L fuel oil per season. The HP has a total heating capacity of 160kW and uses the water from a springs at the mountain side. Previously the springs provided drinking water for the municipality, but because of contamination problems they had to be abandoned, leaving the pipeline and the water unused.
GER	GWHP (heating&cooling), company “Grob” (Mindelheim)	The machinery at this site produces heat during operation, which has to be dissipated. This is done by thermal groundwater use from 8 wells distributed all over the site of the company. Groundwater is available in sufficient quality and quantity and near to surface to achieve high efficiency. The use of groundwater for heating office buildings and further cooling system are also foreseen.
GER	Heating and cooling of a detached house with GeoCOAX BHE (Kranzberg)	At Kranzberg, Bavaria five 47 m long BHE use GeoKOAX heat exchanger (http://geokoax.com) to heat and cool a detached house. The GeoCOAX producer claims to have certain advantages compared with conventional BHE-types and in an ongoing research the TUM wants to compare GeoKOAX performances from this site with double U-pipes. This is why the application is equipped with temperature and flow sensors.
GER	Ludwigshöhe Kempten BHE	At Kempten, Bavaria 75 double U BHE with 150 m depth each are installed for the heating of 22 accommodation units. A detailed FE-model was validated with depth-related temperature measurements at two locations: first, at the groundwater monitoring well, to record the impact of BHEs operation and second, at the groundwater monitoring well, to record the impact of BHEs operation.
SLO	Seasonal use – BHE field	Mini district heating system in combination with biomass in remote mountainous nucleated settlements.
SLO	Seasonal use – BHE field	Specific heating and cooling regime for elementary school and kindergarten with passive cooling of gym hall. BHE in aquitard with elevated heat recovery.
SLO	heating only – doublet	Touristic site in typical Alpine valley of Soča river with specific Camp season: 15.3. - 31.10, a combination of HP water-water doublet and of 2 stoves: on wood and heating oil.
SLO	heating only – heat collector - horizontal	GCHP system; the longest horizontal collectors' pipelines in Slovenia so far (over 6 km of pipelines with 140 kW of rated power), heating of swimming pool water all year round.
SLO	heating only – doublet	HP doublet, chilled water from the HP is used in winter for making the artificial snow.
SLO	Seasonal – single aquifer usage	Industrial facility - transport, trade and timber-processing company with possibility of aquifer thermal energy storage.

IT	GWHP Pontebba, Friuli-Venezia Giulia,	The refrigerating system of the ice rink of Pontebba (Udine) relies on an open-loop groundwater heat pump (GWHP). It was installed with European funds and Region Friuli-Venezia Giulia, as an observer, is interesting in putting this best practice under the spotlight.
IT	BHE Cervinia-Valle d'Aosta	The bar "Pit-stop" on the popular alpine ski slopes of Cervinia is located at 2400 m a.s.l.. Heating and DHW is provided by 6 BHEs (5 x 200 m, 1 x 100 m) and a 60 kW heat pump. It is probably the highest GSHP in all Europe.
IT	BHE Croviana, Trento	The HVAC system of an inter-modal station (bus and trains) is based on 70 BHEs, each one 70 m deep.
IT	BHE Claviere, Piemonte	Block of flats for second homes. BHEs were drilled in a limestone aquifer with very high groundwater velocities, resulting in an outstanding geo-exchange performance.

Table 2: Compiled table – overview of best practice example proposals

Part C - Descriptions of planned activities in the Case Study areas

C.1 Austria - Saalbach

Specification of geographical extent:

The Case Study area comprises two communities – Saalbach-Hinterglemm and Leogang and measures about 200 km². The two communities are situated in the far west of Salzburg, bordering Tyrol. The bigger settlement areas are at about 800 m – 1000 m above sea level, mountain peaks reach altitudes of up to 2.600 m.

Objective of detailed investigation:

About 6.000 people live in this region with more than 2 million guest-nights every year, predominantly in winter. This makes clear why the focus within the Case Study was put on the near surface geothermal energy potential related to touristic infrastructure like alpine huts, mountain-stations or hotels.

An important question is, to which extent the elevation, the gradient and the orientation of the hillside does influence the geothermal usability of the shallow underground in this high-altitude region. To answer these questions, the available spatial parameters like air temperature or solar radiation are being linked with sparsely available parameters like ground temperatures. As there are no ground temperature measurement stations in the area, a measurement campaign is planned. From the combination of these parameters, temperature distributions for the shallow underground are being simulated.

The outcomes of the detailed Case Study assessment shall be transferrable to the whole Alpine Region of Austria in the end.

C.2 France – Bauges Geopark

Specification of geographical extent: Regional extent

The Case Study is encompassed in the Bauges Geopark. The focus will be on the northern and southern edges close de Chambéry and the banks of the Annecy Lake as those are the most populated areas.

Objective of detailed investigation:

We will focus on urban areas such as Montmélian (south of Bauges Geopark), which has been involved in covering most of its thermal energy demand with solar energy. To fill the seasonal mismatch between demand and resources, storages are needed for instance in underground thermal energy storage (UTES). This seems to be a major bottleneck since the Geopark is experiencing a constant population growth in its outer edges (valleys) which are directly connected to major urban centres such as Chambéry and Annecy. These problematics of population growth in the vicinity of major centres is common in the whole Alpine Space.

The investigation aims at estimating the efficiency and costs of solar panels coupled to UTES for heating production at the scale of a small district network. The investigation will first start by compiling and analysing the abundant literature about UTES. Computation will then be carried out in state-of-the-art software such as TRNSYS to estimate the system efficiency and costs in different configurations (technologies, etc.).

C.3 Germany – Oberallgäu/Sonthofen

Specification of geographical extent: Regional extent

Oberallgäu is the southernmost district in Germany and it covers an area of 1,528 km^2 with a population of about 150.000 people. The district contains two towns, Immenstadt and the district capital Sonthofen and 26 municipalities, which are mainly located on altitudes from 700 m to 900 m a.s.l. In the very south of the district there are some of the highest mountains of the Allgäu, culminating in the Hochfrottspitze (2649 m). The Iller river (a tributary of the Danube) runs through the district from south to north.

Objective of detailed investigation:

The objective is to perform a NSGE evaluation in typical alpine surroundings, which are representative for all German areas in the alps. This area has a special need for a NSGE potential assessment, because of the complex hydrogeological and geological situation. At the suitable areas, a huge NSGE potential is expected. The creation of local scale maps shall prevent miscalculations due to a lack of knowledge at the planner side.

The participating municipalities and cities foster renewable energies and set themselves ambitious aims for climate protection. Many good practise examples are already available in the district.

The scientific questions to be answered are:

- How can thresholds for NSGE usage in alpine environments be defined?

- Which are the driving environmental factors for usage constraints?

The quantification of those constraints will be a major task.

C.4 Italy – Region Valle d´Aosta

Specification of geographical extent: Regional extent

The surveyed region in the Valle d´Aosta covers an area of about 3.200 km^2. Most of the territory is mountainous, and hence scarcely populated. The population is concentrated in the main valley Dora Baltea which is about 80 km long. Some of the lateral minor valleys are also populated.

Objective of detailed investigation:

Pit Stop bar is located at 2400 m a.s.l., and so it is probably one of the highest geothermal plant in Europe. It will be studied as a Case Study of GSHP in extreme climates and as an example of integration of difference heat sources like solar thermal panels or wastewater heat recovery. The Maison Lostan is a very interesting case of utilization of shallow geothermal energy in historical buildings.

A census of existing shallow geothermal plants is in progress and will be completed by the end of the year.