D.4.2.1. Report on functionalities of the DRGIP

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1. Introduction

This report describes the functionalities of the Danube Region Geothermal Information Platform (hereinafter referred to as DRGIP), the joint and harmonised entry point for all spatially-referenced information collected and evaluated during the DARLINGe project.

The report is based on D4.1.1. Report of conceptual model of the DRGIP (December 2017) and working meetings of DARLINGe project consortium in Zagreb (Croatia), Belgrade (Serbia) and Szeged (Hungary), which were intended to determine the contents and the way of their interactive representations on the portal.

The structure of this report is as follows:

In chapter 2 we summarize what the DRGIP is and why its' development is important.

In chapter 3 we briefly introduce the course of working meetings.

In chapter 4 we introduce the modifications of the conceptual model of the database upon decided functionalities.

In chapter 5 we describe the proposed concept of the DRGIP and its functionalities.

In chapter 6 we describe the follow-up activities.

2. Role and requirements of DRGIP

DRGIP (The Danube Region Geothermal Information Platform) is one core output of the DARLINGe project and represents the joint and harmonised entry point for all spatially-referenced information collected and evaluated during the project. It will be hosted at the GeoZS (PP4) server and will provide evaluated and processed data in a user-friendly innovative tool, demand-tailored to stakeholders needs. It jointly presents all spatial technical and non-technical information of WP5-7. Using it, faster and especially easier growth of the geothermal energy sector in the Danube Region is expected.

This output will hopefully act as an interface between experts from public authorities, private market (e.g. geothermal project developers, or energy suppliers) and the scientific community as well as the inhabitants of the project area. It intends to address both, stakeholders from pilot areas as well as other areas of Danube Region and beyond.

The development of DRGIP will follow the rules, standards already used in previous projects such as OneGeology-Europe, EuroGeoResource, Minerals4EU etc.

The results of the DARLINGe project will also complement and support GeoERA (Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe) which has the overall goal of integrating the national geological surveys information and knowledge on subsurface energy, water and raw material resources, to support sustainable use of the subsurface in addressing Europe's grand challenges. The GeoERA transnational research projects will among other things address the development of interoperable, pan-European data and information services on the distribution of geo-energy including geothermal energy.

The DRGIP will contribute to an effective and lasting system designed for welcoming various datasets related to geothermal resources and facilitating data updates and maintenance, and for facilitating their visualization and their use.

3. Course of WP4 working meetings

In order to determine the contents and functionalities of the DRGIP, we have organized several WP4 working meeting. The main intension was to create the final list of database parameters, results in form of maps, reports or figures to be included and be represented on the portal.

For efficient and effective meeting, each partner had to provide:

- List of typical use-cases in order to obtain as extensive picture of the final results;
- Details on functionalities (how the content should be shown on the portal);
- Info on wishes from their stakeholders (what they want to see from the portal).

The first two WP4 working meetings were organized in April 2018, from 9-10 April 2018 in Zagreb (Croatia), hosted by HGI-CGS and 24-25 April 2018 in Belgrade (Serbia), hosted by FMG (Figure 1 and Table 1).

Figure 1: WP4 working meeting in Zagreb (upper) and Belgrade (lower) in April 2018.

Table 1: Number of participants in the first two WP4 working meetings

	Zagreb meeting	no. of persons	Belgrade	no. of persons
Participating organization	9. - 10.4.2018		24.-25.4.2018	
GeoZS	yes	5	yes	4
HGI_CGS	yes	3	no	
Zara	yes	2	no	
Sremski Karlovci	no		yes	1
MBFSZ	yes	4	no	
MANNVIT	yes	2	no	
FZZG	yes	3	no	
FMG	no		yes	2
IGR	no		yes	2
MFAT	no		no	
GSRS	no		yes	2

The third WP4 working meeting was organized together with WP5 and W6 working meeting in Szeged in 7-9 May 2018, hosted by InnoGeo (Figure 2), when the consortium among others agreed on the final concept of the DRGIP.

Figure 2: Meeting in Szeged in May 2018.

The decisions made at the meetings led to the modification of the conceptual model of the database and the setting up the concept of the DRGIP.

4. The modifications of the conceptual model of the database

In order to determine the contents and functionalities of the DRGIP some changes on conceptual data model were made. In current reporting period we made some additional major changes in database model regarding INSPIRE directive and some minor changes based on data collected so far (based on Slovenian cases).

Changes were the following:

- First we changed the **names of unique ids** in main tables to be less complicated for developers and users (object, reservoir, user and user site).
- We also changed the **structure of some code lists** to be easier to enter the data accordingly (object type, vertical datum, object activity, country, reservoir type, temperature interval, aquifer porosity and hydraulic connections).
- We added some fields in table *object* which appeared necessary according to gathered data (sampling feature id, local id of object, top and bottom of screened interval and comments). We also renamed field open depth to operational depth.
- Some tables were **deleted** from the model, which was a common decision on the partners meetings and workshops (country legislation and level of publicity/data are all public).
- What concerns **INSPIRE** data specifications; we changed the structure of observations and measurements data package.
- In table *observation* we added field depth (m), because it comes together with data collected.
- We changed the name of table *results* in *value* and **added some new fields in it** (connection to parameter list, connection to domain – time series, connection to void reason table and remark on observation).
- We **added some new tables**: table *observed property* and its code list, table *parameter* **-** to connect observation and value and table *void reason value* (which is INSPIRE mandatory table).
- We also updated INSPIRE code lists.
- For any missing data in datasets, reasons, why there are no data, it will be described according to INSPIRE voidable rules.
    - Here are two INSPIRE examples:
      EXAMPLE1: When the elevation of the water body above the sea level of a certain lake has not been measured, then the reason for a void value of this property would be 'Unknown'. (The correct value for the specific spatial object is not known to, and not computable by, the data provider. However, a correct value may exist. 'Unknown' is applied on an object-by-object basis in a spatial data set.)
      EXAMPLE2: When the "elevation of the water body above the sea level" has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be 'Unpopulated'. (The characteristic is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. NOTE The characteristic receives this value for all objects in the spatial data set.)
    - And DARLINGe examples would be:

a) When the elevation of the borehole mouth above the sea level of a certain borehole has not been measured, then the reason for a void value of this property would be 'Unknown'.

b) If the fields value_num and value_txt in table VALUE are not filled with data for certain object, the field void_reason_value in the same table must be entered (obligatory) corresponding the code list below (Table 2).

Table 2: The code list for the field "void_reason_value".

C_VOID_REASON_VALUE	
VOID_REASON_VALUE	**VOID_REASON_DESC**
unknown	The correct value for the specific spatial object is not known to, and not computable by the data provider. However, a correct value may exist. For example when the —elevation of the water body above the sea level‖ of a certain lake has not been measured, then the reason for a void value of this property would be _Unknown'. This value is applied only to those spatial objects where the property in question is not known.
unpopulated	The property is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the —elevation of the water body above the sea level‖ has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be _Unpopulated'. The property receives this value for all spatial objects in the spatial data set.
withheld	The characteristic may exist, but is confidential and not divulged by the data provider.

- The names of all tables are also renamed – labelled with numbers to easily track the sequence of data mapping.

Previous and current versions of the conceptual model of DARLINGe database are shown in Figures 3 and 4.

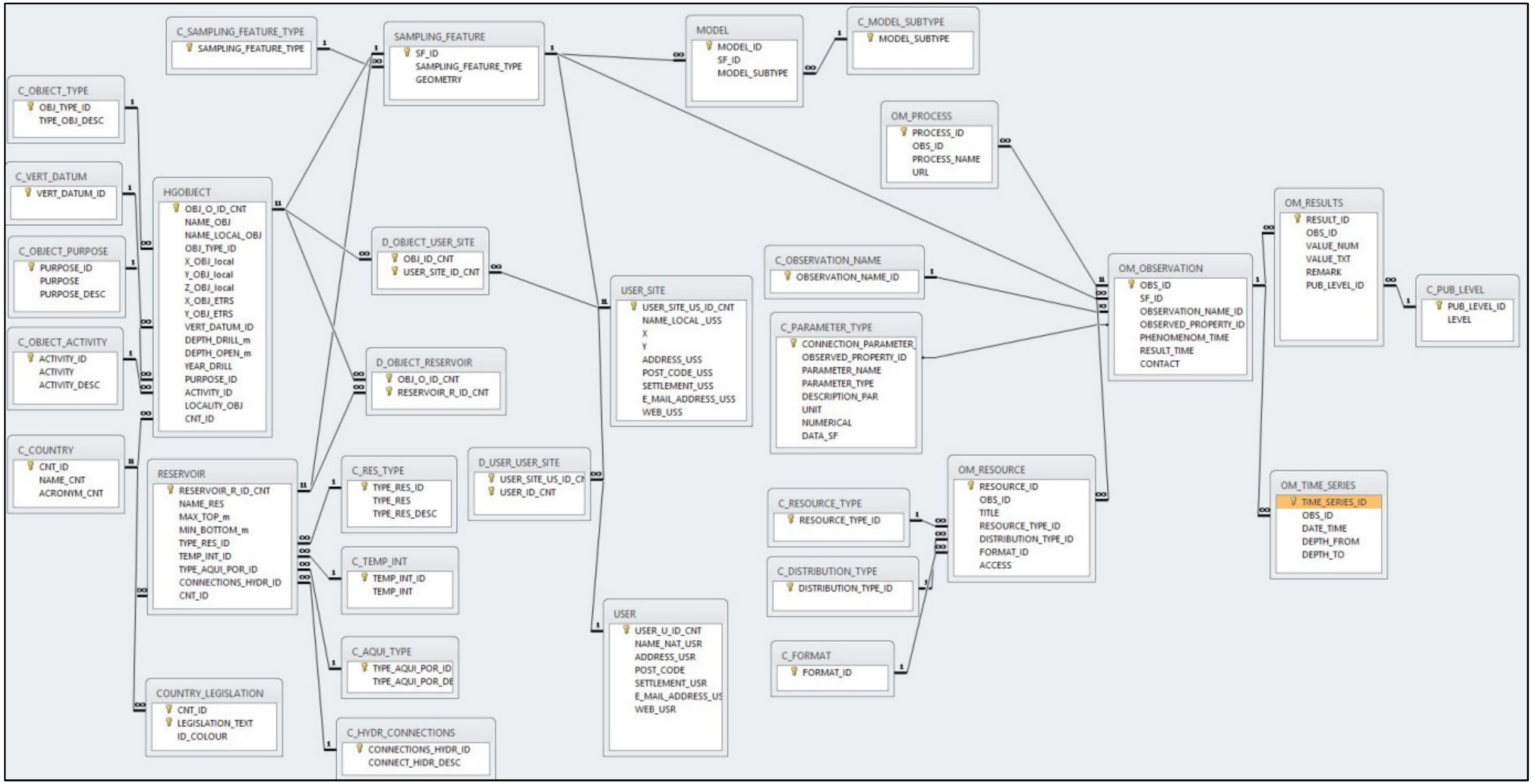

Figure 3: Previous version of conceptual model of DARLINGe database - status 31.12.2017

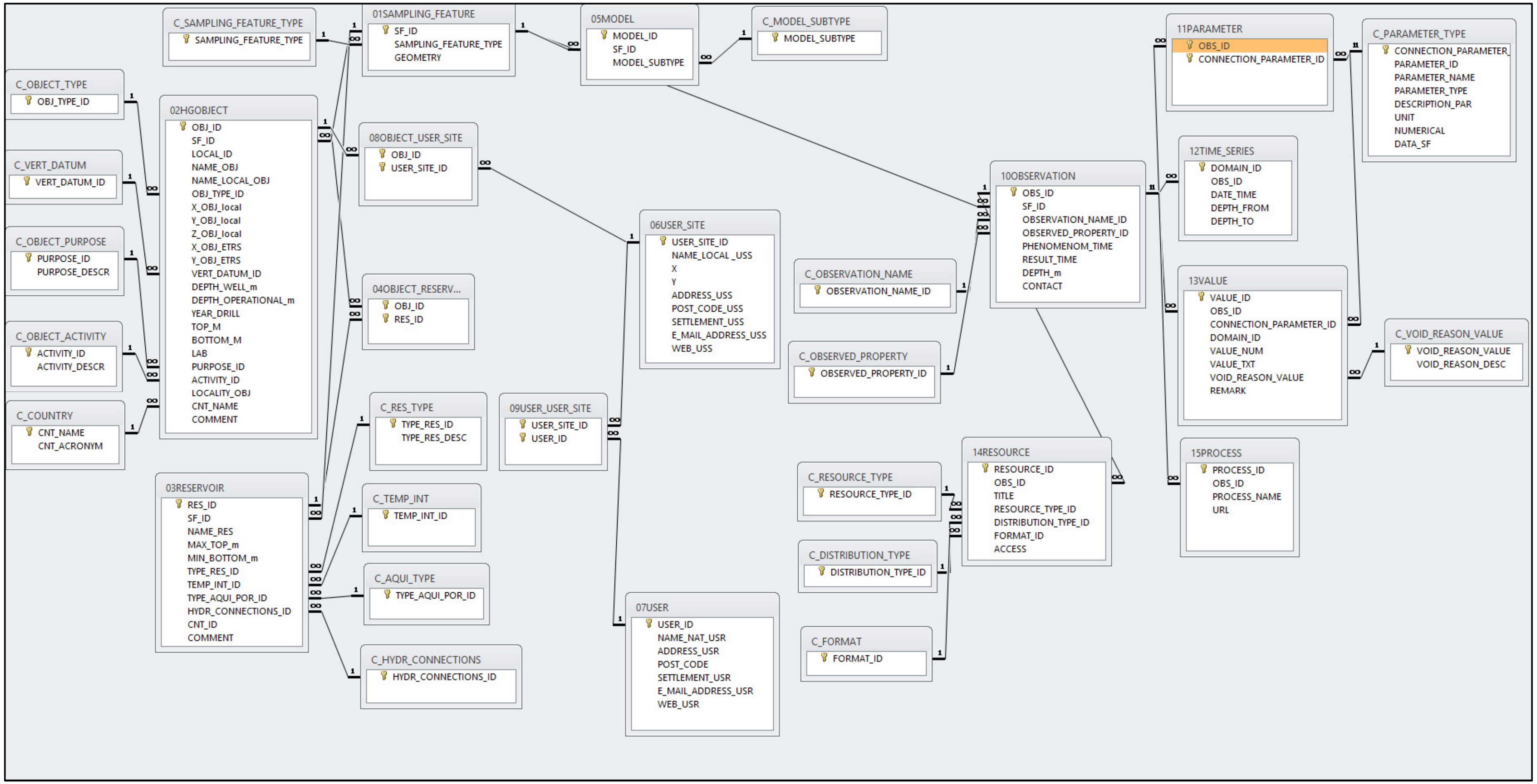

Figure 4: Current version of conceptual model of DARLINGe database - status 30.6.2018

5. The proposed concept of the DRGIP and its functionalities

The conceptual model of the DRGIP (Figure 5) follows the proposed ROAD MAP for the implementation of the DRGIP:

1. Conceptual model – final version should be confirmed in Period 2;
2. Setting up DARLINGe Geodatabase v1.0 (empty database) – INSPIRE Data Specification – distribution to all PP;
3. First data input – Geodatabase DARLINGe v 1.1;
4. Last data input – Geodatabase DARLINGe v 1.2;
5. Creating services 1st time;
6. Implementation of the DRGIP v.1;
7. Testing DRGIP v.1 by PP:
   - Geodatabase DARLINGe v 1.3,
   - Creating services 2nd time,
   - Corrections of the DRGIP;
8. The final version DRGIP;
9. Creating service of the entire geodatabase / or physical distribution of the last geodatabase.

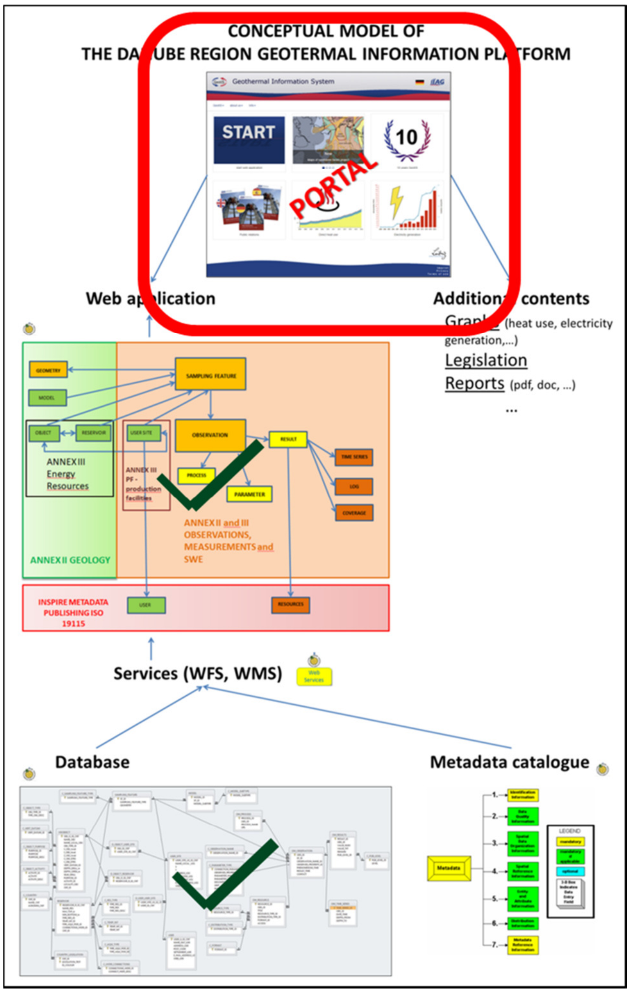

Figure 5: Conceptual model of the DRGIP - status 31.12.2017

The conceptual model of the database was set in compliance with INSPIRE, some modifications were made due to some functionalities desires of the consortium (details on modification are presented in chapter 4 of this report). Prior to setting up the portal, it was necessary to define its basic structure and functionalities.

5.1 Structure of the DRGIP

The Danube Region Geothermal Information Platform will be an access point to data, gathered for the whole project area as well as for the three pilot areas (Figure 6). For the project area the scale of data will be 1 : 500,000 and for pilot areas in scale 1 : 100,000, while functionalities of the DRGIP will be the same for both scales.

Figure 6: Darlinge project and pilot areas.

All materials on DRGIP will be in English only, except for the material , which will be translated to national language by certain project partner for their own purposes (out of project scope).

Material as well as specific information on project website and DRGIP will not be duplicated, but there will be links connecting both sites.

There will be clearly visible disclaimer for appropriate/inappropriate use of data, privacy, etc. (see example at Figure 7).

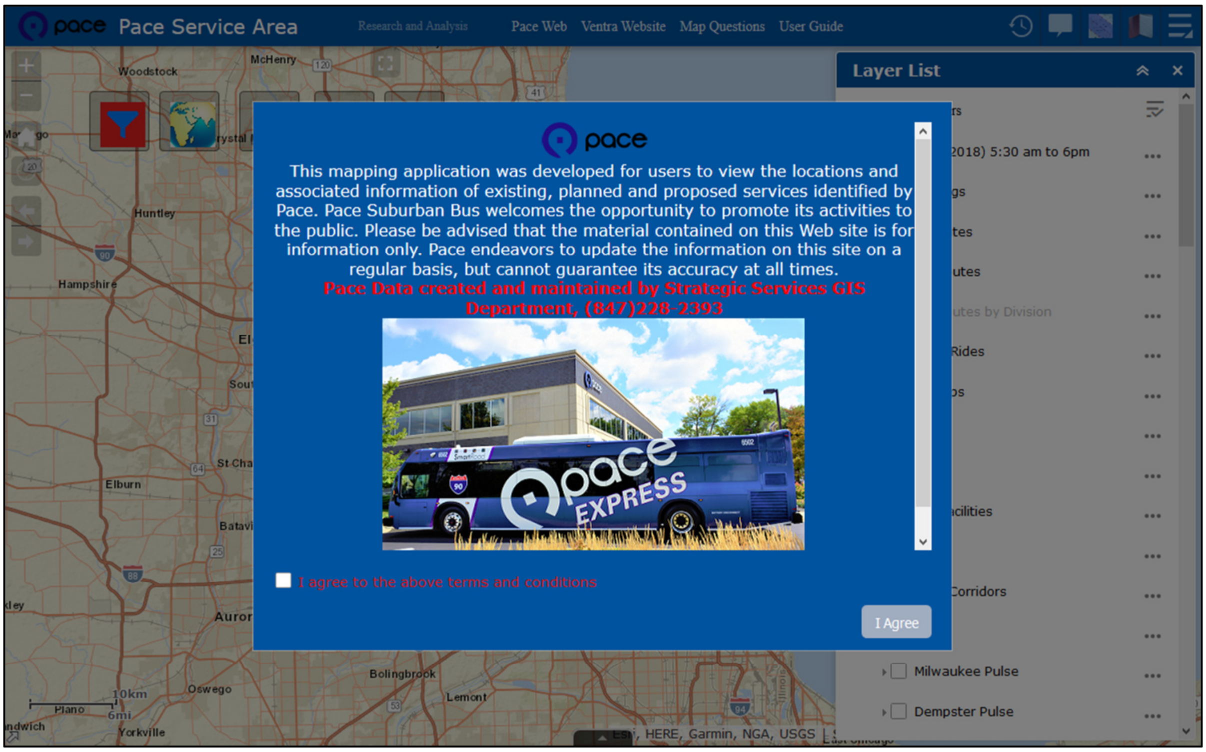

Figure 7: Disclaimer at the start of the web map viewer - as a splash screen – source: http://maps.pacebus.com/PaceServices/ (ESRI based map viewe)

The main structure of the DRGIP consists of a web viewer (main part) and 5 additional modules: benchmarking, legislation, economics, publishing and geothermal dictionary (Figure 8).

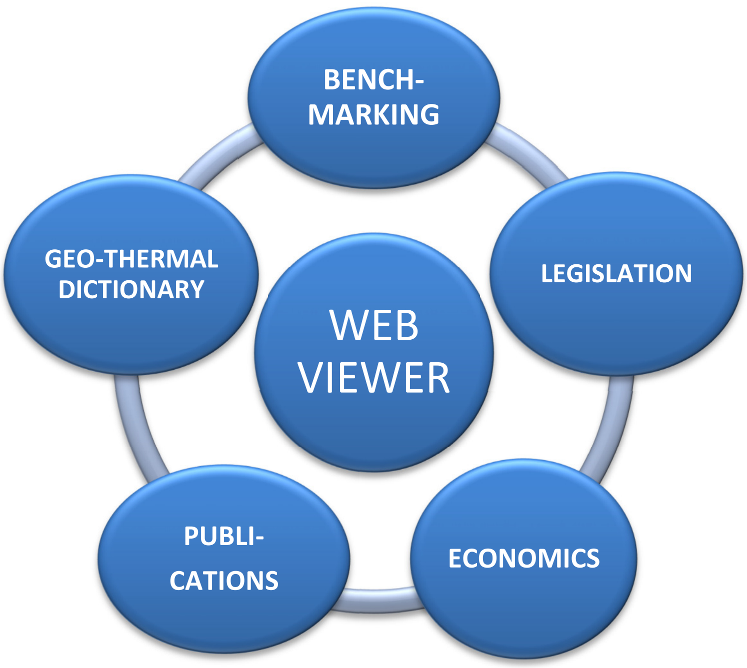

Figure 8: Structure of DRGIP

5.2 Web viewer

Web viewer will represent an efficient, useful and easy way to view and access information on spatial referenced datasets (boreholes, maps, etc.), collected and evaluated during the DARLINGe project.

Data presented on the web viewer will be:

- OBJECTS (data on point, e.g. boreholes);
- PROFILES (data on lines, e.g. geological cross-sections);
- MAPS (data on polygons and grids).

There will be an export function, which will allow:

- Export of data on object (in excel format; example Figure 9 and 10)
- Downloads of maps from the DRGIP will be limited to pdf, jpg or png only (stylized with legends, logos, etc.). Digital layers will be available upon request and with the agreement of the authorship (in connection to metadata catalogue).

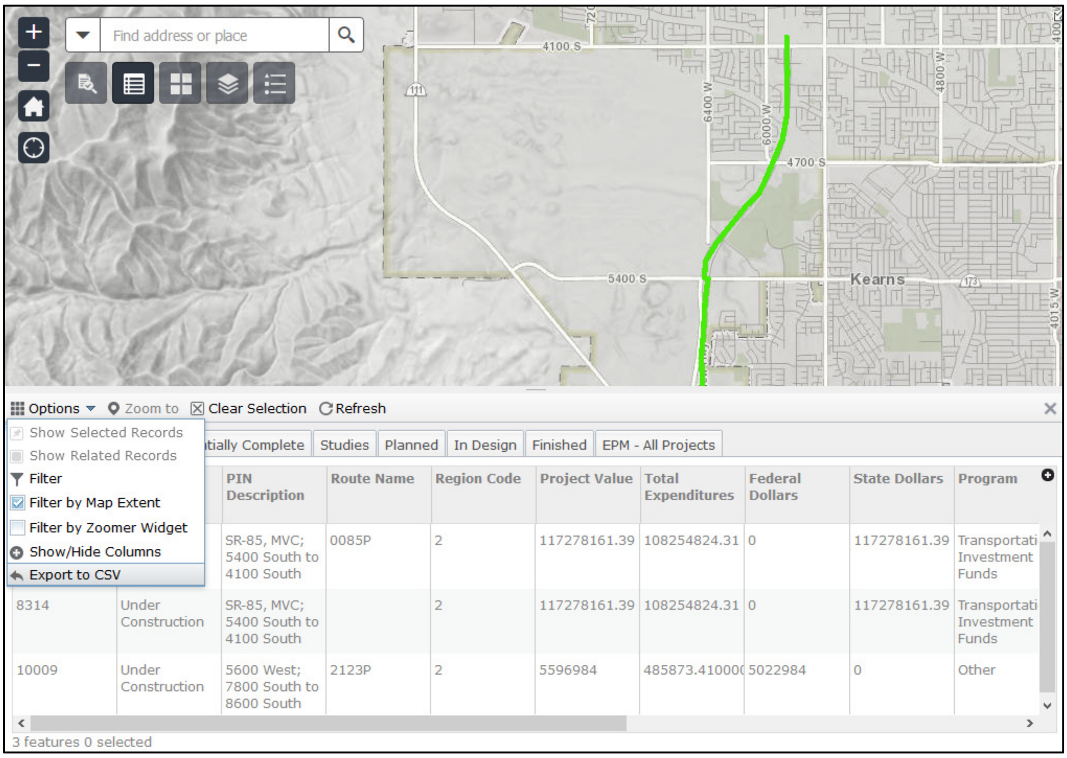

Figure 9: Exporting data from attribute table to Excel stylesheet data (part 1) – source: http://maps.udot.utah.gov/uplan_data/documents/apps/UDOTProjectsApp/ (ESRI based map viewer)

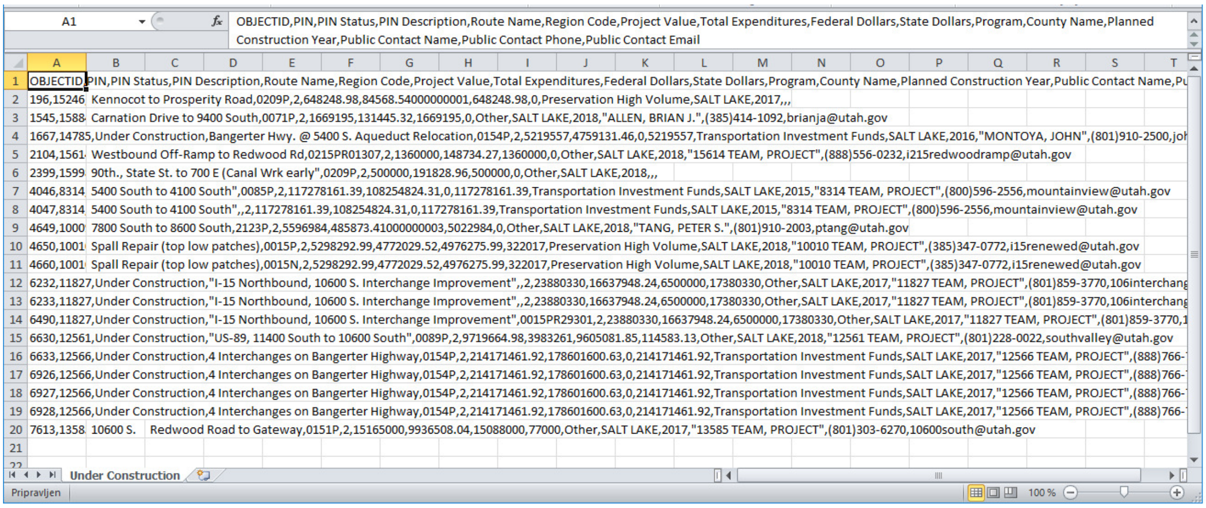

Figure 10: Exporting data from attribute table to Excel stylesheet data (part 2) – data from source described in Figure 9

5.1.1 Functionalities on object data

Objects (boreholes and wells) will be represented as points, covering different thematic:

1. Boreholes or wells in connection to utilization, geothermal and hydrochemistry data. Tables 3, 8 and 9 shows all parameters, that will be available on DRGIP within different thematic.
2. User site data.

Table 3: Parameters to be shown on DRGIP in connection to utilization data.

Parameter	Remark
Object name	
Local object name	
Object settlement	
Reservoir name	
Reservoir type	
Reservoir temperature interval	
Country	
User name (national language)	
street, number	
post code	
Settlement	
web	
X (national)	
Y (national)	
Z (national)	
Vertical datum local system	
X (ETRS89)	

Y (ETRS89)	
Well depth (m below surface)	
Operational depth (m below surface)	
Year of completion	
Top of screened interval (m below surface)	
Bottom of screened interval (m below surface)	
Total lentgth of screened sections within the screened interval (m)	
Object type	
Object purpose	
Type of utilization	in combination to utilization maps
Yield at which average outflow temperature occurs (l/s)	in categories
Average outflow temperature at wellhead (°C)	in categories
Total annual production in 2015 (m3/year);	in categories (also for other years if data available)
Total annual reinjection in 2015 (m3/year)	in categories (also for other years if data available)
Maximum discharge (l/s)	in categories
Maximum reinjection rate (l/s)	in categories
Geothermal doublet well pairs	as a pararell feature
Is water reinjected in the same reservoir?	
Type of water production	
Type of utilization permit	
Licensed maximum annual production (m3/year)	
Licensed maximum annual reinjection (m3/year)	in combination to utilization maps
Liceced maximum momentary discharge (l/s)	in combination to utilization maps
Problematic free gases	
Problems of operation	
Changes during production	
Comment on changes during production	
Type of aquifer porosity	yes - field basement

Categories used for utilization data are as presented from Table 4 to 7:

Table 4: Categories used on DRGIP for Total annual production in 2015 (m3/year).

Total annual production in 2015 (m3/year)	
class	**range**
1	below 200.000
2	200.000 - 400.000
3	400.000 - 600.000
4	600000 - 800.000
5	nad 800.000
6	na (as not available)

Table 5: Categories used on DRGIP for Maximum discharge (l/s).

Maximum discharge (l/s)		
class	class range	
	from	to
1	0	0,99
2	1	4,99
3	5	9,99
4	10	14,99
5	15	19,99
6	20	24,99
7	30	49,99
8	>50	
9	na (as not available)	

Table 6: Categories used on DRGIP for Maximum reinjection rate (l/s).

Maximum reinjection rate (l/s)		
class	class range	
	from	to
1	1	4,99
2	5	9,99
3	10	14,99
4	15	19,99
5	20	24,99
6	30	49,99
7	>50	
8	na (as not available)	

Table 7: Categories used on DRGIP for Thermal water utilisation as range of average outflow T.

Thermal water utilisation as range of average outflow temperature		
class	class range	
	from	to
1	20	29,9
2	30	39,9
3	40	49,9
4	50	59,9
5	60	69,9
6	70	79,9
7	80	89,9
8	90	99,9
9	100	109,9
10	na (as not available)	

Table 8: Parameters to be shown on DRGIP in connection to geothermal data.

Parameter		Remark
name of location		
coordinates (D48)	GK x	
	GK y	
coordinates (ETRS89-Lambert Asimuthal-equal area)	Lon	
	Lat	
	z	
outflowing temperature related to a certain yield	temperature	5° range classes
	yield of water	In combination to utilization maps
comments		if any
Longer comments		if any

Table 9: Parameters to be shown on DRGIP in connection to chemistry data.

Parameters		archive data	data from pilot areas
Object name		yes	yes
Local object name		yes	yes
National object ID		yes	yes
x coordinate ETRS		yes	yes
y coordinate ETRS		yes	yes
z coordinate (above sea level)		yes	yes
Top of screened interval (m)		yes, if it is different from utilization data	yes
Bottom of screened interval (m)		yes, if it is different from utilization data	yes
Date of sampling	yyyy-mm-dd	yes (because of T, ph, etc.); default value when you don't have day/month	yes
Laboratory		no	yes
field outflow water temperature	°C	yes	yes
field pH		yes	yes
field EC	µS/cm	no	yes
laboratory pH		no	yes
laboratory EC	µS/cm	no	yes
Alkalinity - m (field)	mmol/l	no	yes
Alkalinity - p (field)	mmol/l	no	yes
Total hardness	CaO mg/l	yes	yes
Carbonate hardness	CaO mg/l	yes	yes
Hydrogeochemical type of water	text	yes	yes
K	mg/l	no	yes
Na	mg/l	no	yes

Parameters		archive data	data from pilot areas
NH4	mg/l	no	yes
Ca	mg/l	no	yes
Mg	mg/l	no	yes
Fe total	mg/l	no	yes
Mn total	mg/l	no	yes
NO3	mg/l	no	yes
Cl	mg/l	yes	yes
SO4	mg/l	no	yes
HCO3	mg/l	no	yes
OH-	mg/l	no	yes
H2S	mg/l	no	yes
CO3	mg/l	no	yes
H2SiO3	mg/l	no	yes
CO2 dissolved	mg/l	no	yes
CO2 free	mg/l	no	yes
CO2 total	mg/l	no	yes
TDS	mg/l	yes	yes
Separated gas; O2	vol%	no	yes
Separated gas; N2	vol%	no	yes
Separated gas; CH4	vol%	no	yes
Separated gas; CO2	vol%	no	yes
Separated gas; Ar	vol%	no	yes
Separated gas	l/m3	no	yes
Separated CH4	l/m3	no	yes
Dissolved gas	l/m3	no	yes
Dissolved CH4	l/m3	no	yes
Total gas	l/m3	no	yes
Total CH4	l/m3	no	yes
Gas / water ratio of separated gas	l/m3	yes, in categories	yes
Gas/water ratio of separated methane (free methane content)	l/m3	yes, in categories	yes

On the point data there will be different possibilities to query and filter among data (Figures 11 to 16):

1. Info on one object
   When selecting an object, you will get a list of all data available for selected object.
2. Info within an area
   When selecting a free area or predefined polygons, such as reservoir, or country, you will get info on objects within selected area at the same time.
3. Info on object attributes

User will be able to search within different attributes: the desired depth, T, etc. The search will return results within predefined value or classes: from-up to, over, under, same as, etc.

4. Extra functionality for chemistry data will be circular diagrams, drawn directly from the database.
5. Intersecting two dataset
   Example: Functionality "Show me all objects in one reservoir according to the country".
6. Functionality, to be available for the pilot areas: "Show me lithology on the top of Basement top map".

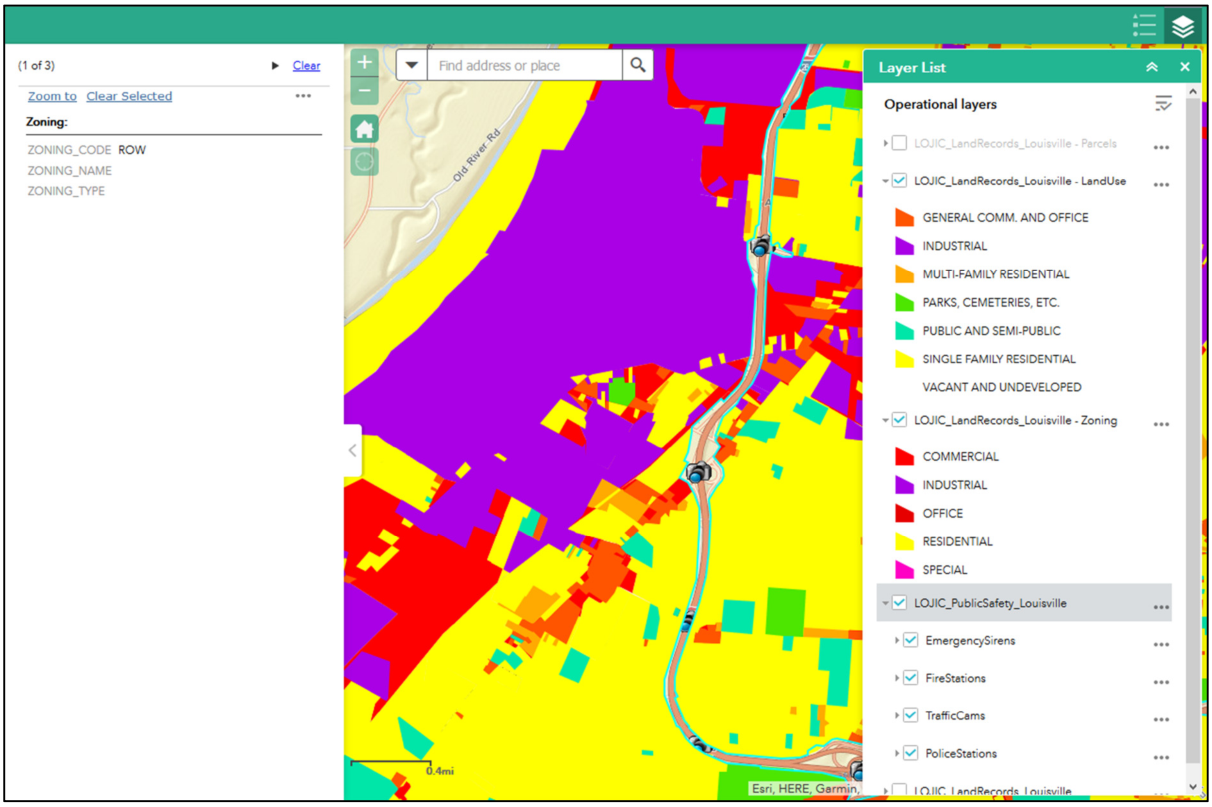

Figure 11: Querying multiple overlapping layers – results are changing in left side panel (part 1) – source: http://gis.calhouncounty.org/WAB/V2.6/widgets/PopupPanel/index.html (ESRI based map viewer presentation)

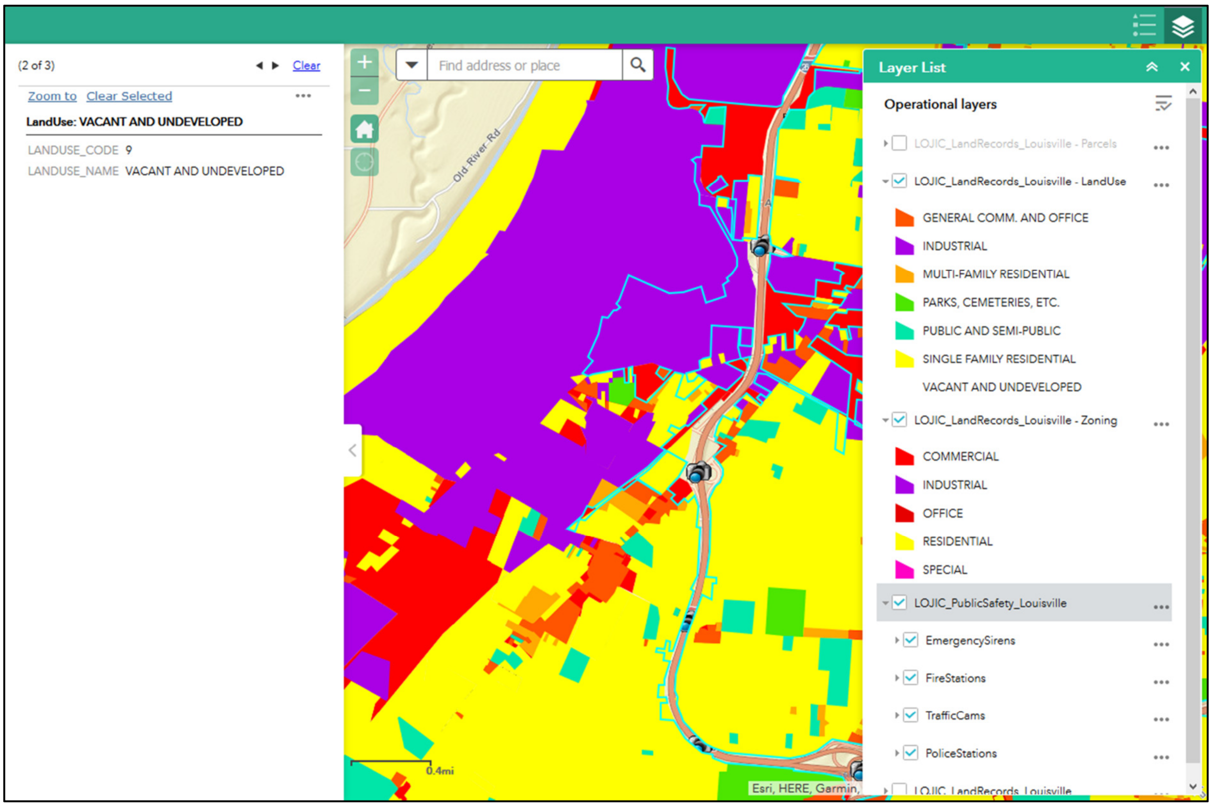

Figure 12: Querying multiple overlapping layers – results are changing in left side panel (part 2) – source: http://gis.calhouncounty.org/WAB/V2.6/widgets/PopupPanel/index.html (ESRI based map viewer presentation)

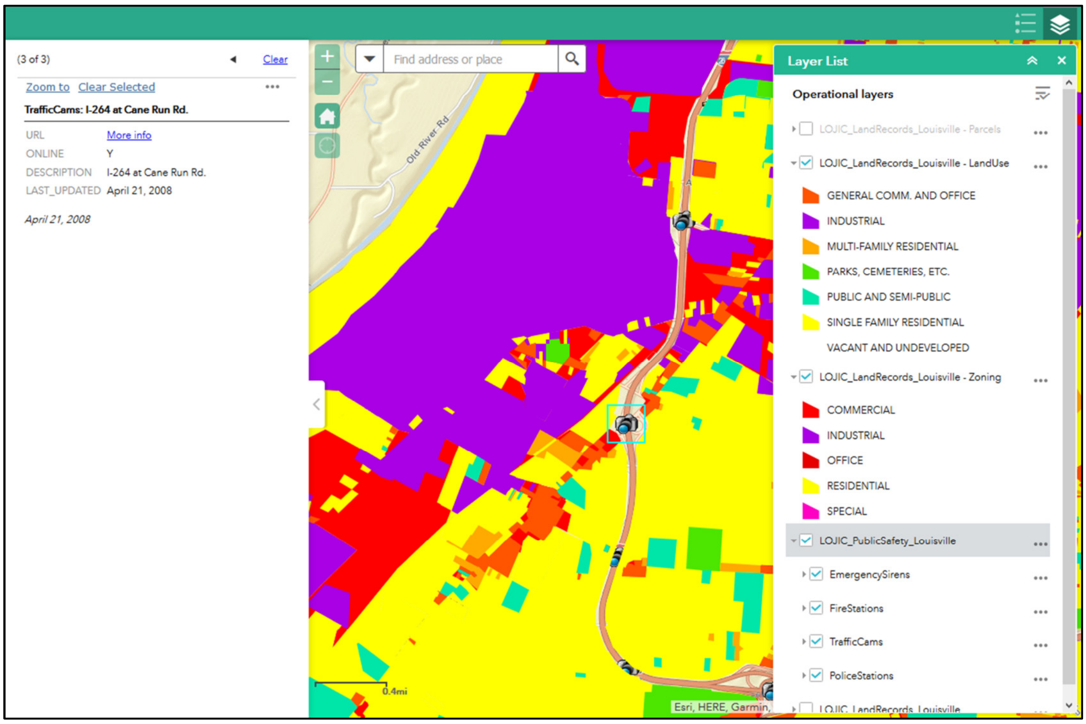

Figure 13: Querying multiple overlapping layers – results are changing in left side panel (part 3) – source: http://gis.calhouncounty.org/WAB/V2.6/widgets/PopupPanel/index.html (ESRI based map viewer presentation)

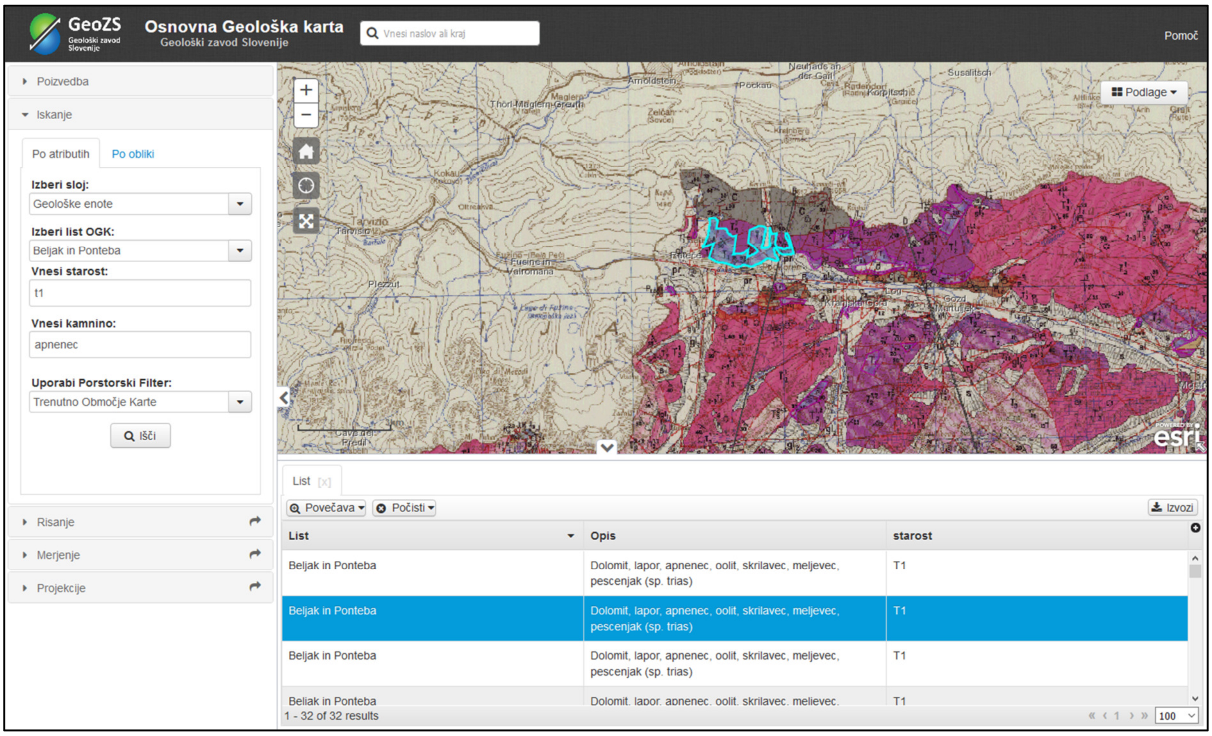

Figure 14: Attribute based query – source: http://biotit.geo-zs.si/ogk100/ (ESRI based map viewer)

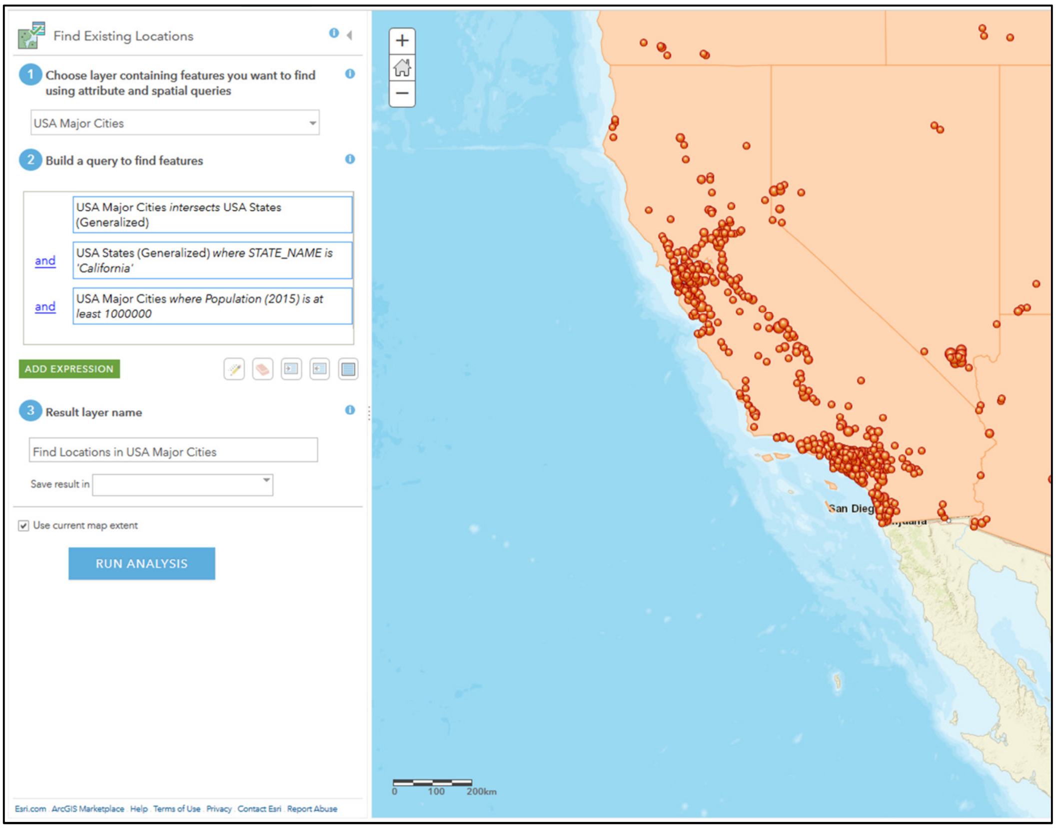

Figure 15: Filtering data based on different criteria from intersecting layers (similar to intersecting boreholes and reservoirs layer), e.g.: Cities (cities layer) in California (states layer) with population over one million (condition) (part 1) – source:

https://www.arcgis.com/home/webmap/viewer.html?webmap=...(custom ESRI based map viewer with layers from Browse Lliving Atlas layers)

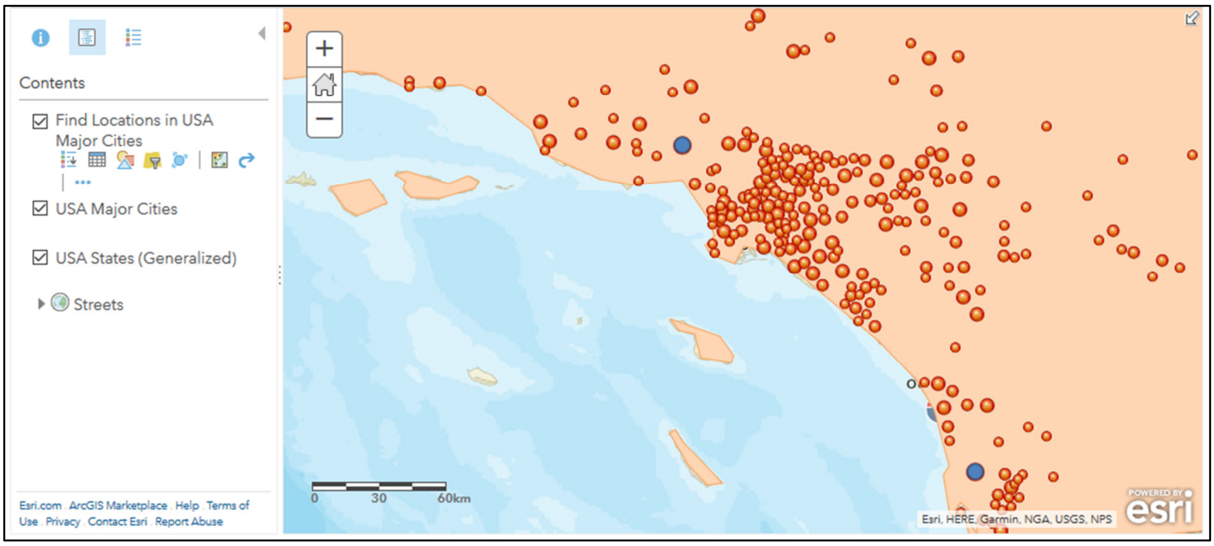

Figure 16: Result of data filtering described in Figure 15 (part 2) – source: https://www.arcgis.com/home/webmap/viewer.html?webmap=...(custom ESRI based map viewer with layers from Browse Lliving Atlas layers)

5.1.2 Functionalities on line data

Lines (in this case geological profiles) will be represented as lines. Choosing one line will redirect user to pre-made figure of selected geological profile in pdf (Figure 16 and 17).

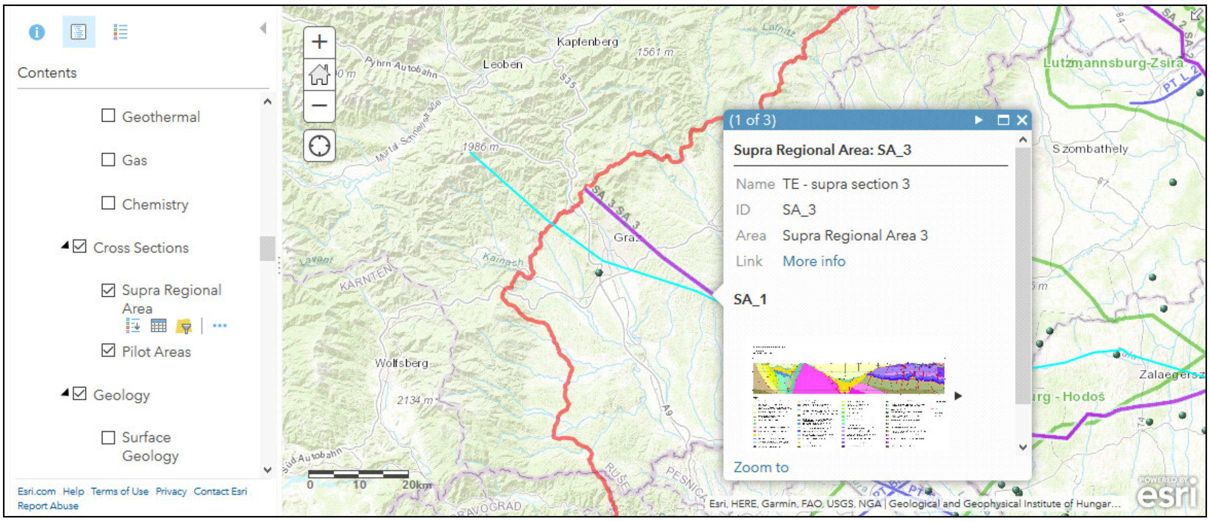

Figure 17: Querying geological profiles (part 1) – source: https://www.arcgis.com/home/webmap/viewer.html?webmap=f82fe0f737174219a354f4209ea7448a (ESRI based map viewer)

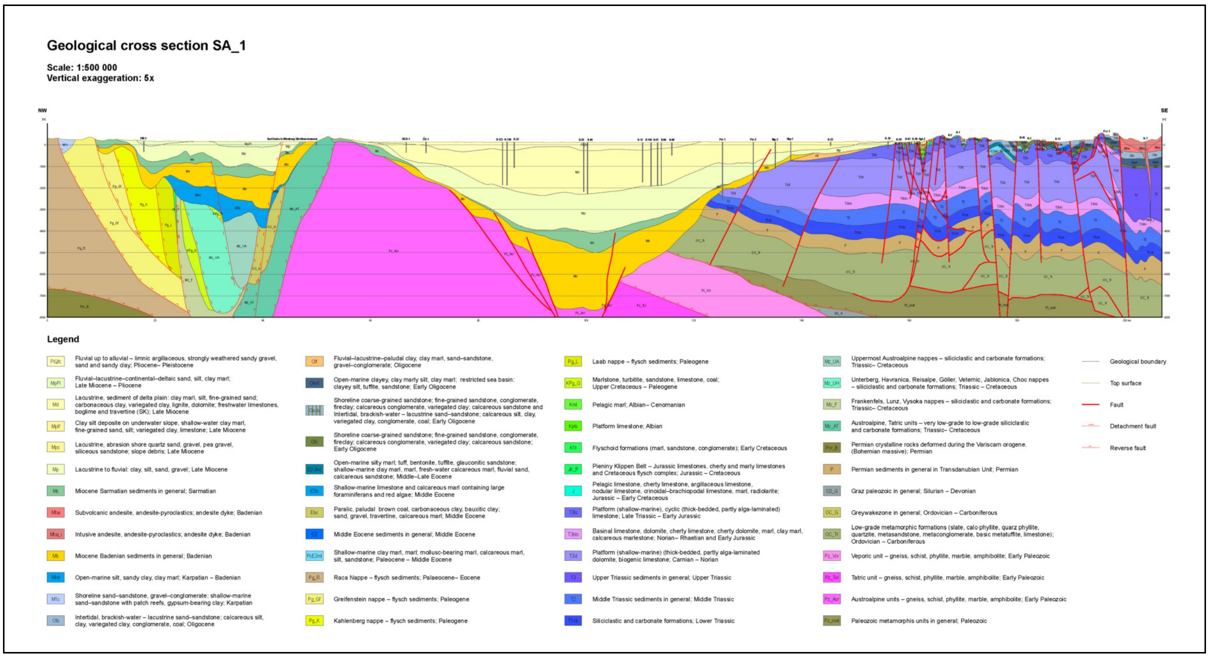

Figure 18: Querying geological profiles - result as an image of data described in Figure 17 (part 2)

5.1.3 Functionalities on polygon and grid data

Countries, reservoirs and sub-regions of resources estimations are some of the polygon data that will be presented on the DRGIP. When selecting a polygon, user will get the basic information on reservoirs in connection to chemistry or data on average depth, temperature, etc. (Figure 19).

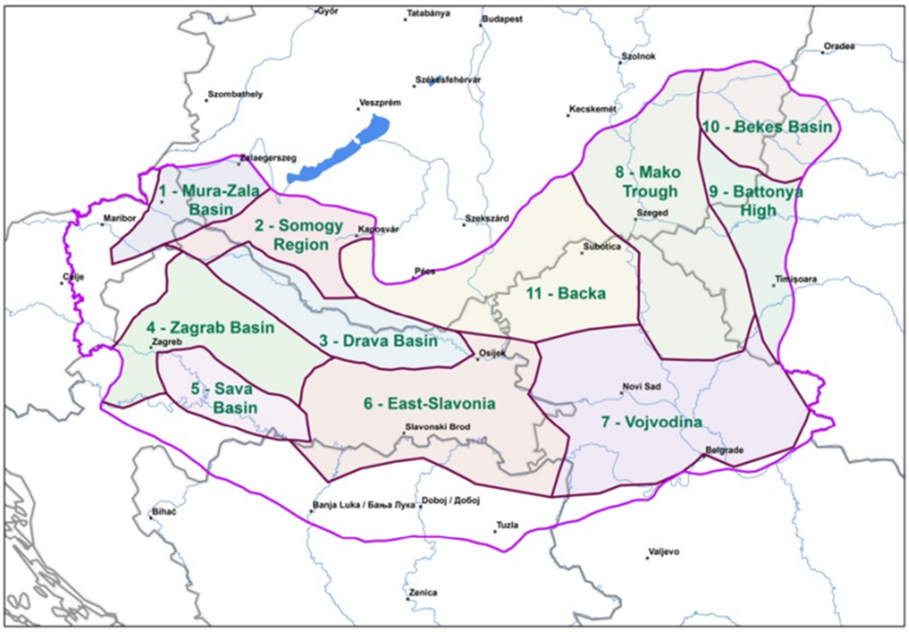

Figure 19: Sub-regions of resources estimation (from reservoir report).

Maps showing geological surfaces, isotherm surfaces or reservoir surfaces will be grids with cell 500 * 500 m (Figure 20). User will be able to get info on a certain point. The results of such search will be so called "virtual well", which will return a) z value on the surface plus b) value of depth of the Basin Fill bottom plus c) value of depth of the Basin Fill top and d) depth of the Basement top.

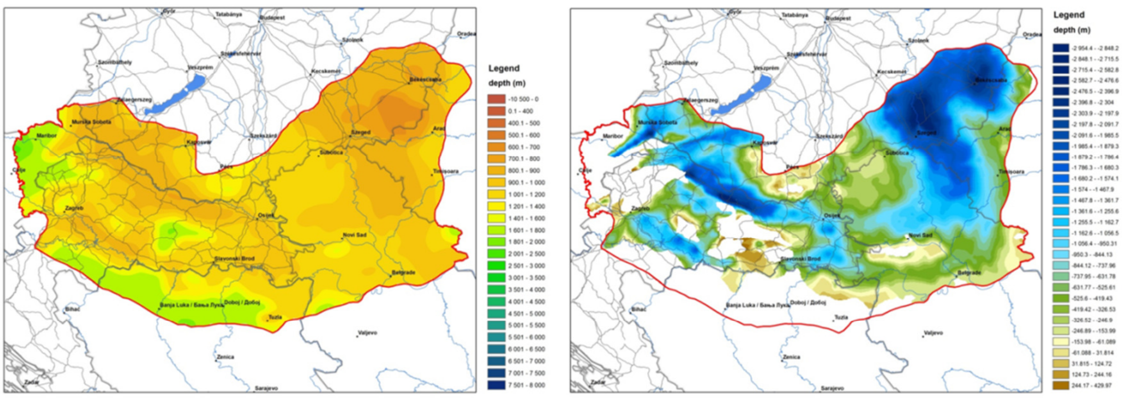

Figure 20: examples of grid data (from reservoir report).

Information on Heat market analysis will be presented as well, showing us:

a) where the largest current consumers are*;
b) where the largest heat market needs are for future utilization* and
c) delineation of geothermal reservoirs with expected temperatures.
   * Heat market analysis will be shown only for cities with district heating infrastructure, and cities above a certain number of populations.

In this way decision makers and investors will be able to:

- gain an understanding of the potential of any given territory;
- carry out a preliminary assessment of the heat market of any settlement and compare the heat demand with the reservoir potential;
- pinpoint already existing systems and have a rough idea of the heat market / reservoir conditions they operate in;
- match investment opportunities with the actual heat demand of a municipality in the context of actual reservoir potential .

Altogether, while not substituting for in-depth analyses and assessments, such information will be very welcome at the preliminary phase of any development as it will form the base of a common understanding regarding both the reservoir potential and the heat demand.

5.3 Additional modules

5.3.1 Benchmarking

The module of benchmarking will consists of:

1. Short introduction on what is benchmarking, its aim and tested area;
2. Short introduction of parameters with link to methodology report;
3. Selection of predefined categories to be shown for analysis (number and type of parameters, six project countries and three pilot areas, delineated basin fill and basement reservoirs. The latter are not sub-divided by temperatures as it would result in too small and subjective dataset for analysis). The selection can be done by using pull-down menu; still optional version is from clicking on the picture with spatial delineation of these categories.
4. Showing the results as comparison of results for predefined categories:

a) Selection of only one parameter.
   A new window is open where methodology is described and graphical results shown for each parameter. One or more countries or reservoirs can be chosen. Example for ''monitoring requirements'':

Table 10: Table shown for monitoring requirements criteria and related points

Monitoring requirements	Yes/No	Points
Regular* measurement of abstracted water cumulative quantity (e.g m^3 in a day or year)	Yes	3
	No	0
Regular* measurement of discharge rate (e.g. l/s on an hourly interval)	Yes	2
	No	0

Monitoring requirements	Yes/No	Points
Regular* measurement of piezometric level in an object	Yes	3
	No	0
Regular* measurement of thermal water temperature (in the well or outflowing)	Yes	3
	No	0
Regular* chemical analysis of thermal water	Yes	2
	No	0
Regular* performance of hydraulic testing of wells to determine their maximum and/or optimal discharge rate (pumping tests, step tests,…)	Yes	1
	No	0
Regular* interpretation of measured values	Yes	3
	No	0
Regular* reporting on monitoring to an authority	Yes	1
	No	0
Need for approval on reported monitoring results by an authority	Yes	1
	No	0
Permanent archiving of monitoring documentation by the user	Yes	3
	No	0

* Regular is not uniformly defined as it stands for fulfilling the legislative requirements of individual countries or permits. Therefore, it may happen that two sites have assigned all points even if the first does e.g. the analyses annually and the second every three years but both according to their official requirements. However, the difference has to be clearly stated in the interpretation

Table 11: Tables shown for calculation of the Monitoring requirements

Name of the indicator	Type	Formula/Summary class	BAD	WEAK	MEDUM	GOOD	VERY GOOD
		Class value (V)	0%	25%	50%	75%	100 %
Monitoring requirements	*Management*	$I_{REQ} = \sum_{i=1}^{n} P_i$	$I_{REQ} \leq 3$	$3 < I_{REQ} \leq 9$	$9 < I_{REQ} \leq 11$	$11 < I_{REQ} \leq 17$	$I_{REQ} > 17$

Figure 21: Plot shown for selection of four categories of one parameter (all basin fill but in four different countries). Number of available objects for analysis also has to be shown somewhere on the plot.

b) Selection of several parameters
When several parameters are selected, similar plot to ***Figure 21*** is made, only with more parameters in vertical. No tables are shown on the same site with the plot, but when with clicking on the parameter a pop-up window appears where individual methodology for each criteria is described as in point a).

c) Summary indicators when all parameters are selected

In case when all parameters (indicators) will be selected, results will be shown also as summary indicators with five classes and a final number – geothermal summary indicator (**Table 12**). The window will show the methodology table and the final, calculated numbers for the selected countries or reservoirs as well as on similar plot as before.

Table 12: Overview of summary indicators and their classes

Summary indicator/ Class value	BAD	WEAK	MEDUM	GOOD	VERY GOOD	Example	
	0%	25%	50%	75%	100 %	Points	%
MANAGEMENT (I_{MAN})	$I_{MAN} \leq 5$	$5 < I_{MAN} \leq 10$	$10 < I_{MAN} \leq 15$	$15 < I_{MAN} \leq 20$	$I_{MAN} > 20$	*18.75*	*75*
TECHNOLOGY & ENERGY ($I_{T\&E}$)	$I_{T\&E} \leq 5$	$5 < I_{T\&E} \leq 10$	$10 < I_{T\&E} \leq 15$	$15 < I_{T\&E} \leq 20$	$I_{T\&E} > 20$	*10*	*50*
ENVIRONMENTAL (I_{ENV})	$I_{ENV} \leq 7$	$7 < I_{ENV} \leq 14$	$14 < I_{ENV} \leq 21$	$21 < I_{ENV} \leq 28$	$I_{ENV} > 28$	20	*50*
SOCIAL (I_{SOC})	$I_{SOC} \leq 0$	$0 < I_{SOC} \leq 25$	$25 < I_{SOC} \leq 50$	$50 < I_{SOC} \leq 75$	$I_{SOC} > 75$	*50*	*50*
GEOTHERMAL SUMMARY (I_{GEO})	$I_{GEO} \leq 5$	$5 < I_{GEO} \leq 10$	$10 < I_{GEO} \leq 15$	$15 < I_{GEO} \leq 20$	$I_{GEO} > 20$	*14,3*	*50*

5. Input of data of website visitor's – individual comparison to predefined categories (guided) – Figure 21

It will also be possible to compare new inputs to the pre-existing as shown above. In this case, it will be needed to first do the step 3, with the selection of parameters, countries and reservoirs to which the portal visitor wants to compare itself. Then an empty form with all indicators will open and he will have to type in its values according to the methodology (similar as step 4 a). Results will be shown numerically and as plot just as explained for step 4.

5.3.2 Legislation

The national regulatory framework report analysed the licensing procedures in each of the six partner countries, using questionnaire and flow-charts. The user will be able to compare the results from different countries by:

- Choosing a country and all answers from the questionnaire related to selected country will appear.
- User will be able to compare answers for specific questions between different countries, by selecting the relevant question;
- Flow-charts showing steps of licensing will be available for each country.

Location and contacts of the national responsible authorities will be available as well (by selecting the relevant country).

5.3.3 Economics

This module will consist of two parts.

<u>The first part</u> will focus on economic aspect of investment.* The following variables need to be examined and compared when the economic feasibility of the investment is assessed:

- Investment costs (Euro);
- Produced geothermal energy (GJ/year);
- Investment costs per unit of produced geothermal energy (Euro/GJ);
- Operation costs (Euro/year);
- Payback period (year);
- Decrease in natural gas use (million m3/year);
- Decrease in CO2 emission (tCo2/year);

*In case partners will be able to collect these data it will be included into DRGIP, otherwise not.

<u>The second part</u> will focus on geothermal potential for CO2 mitigation.

When different fossil fuels are used, CO2 emission calculator can serve as a model to calculate the reduction of CO2 (Figure 22).

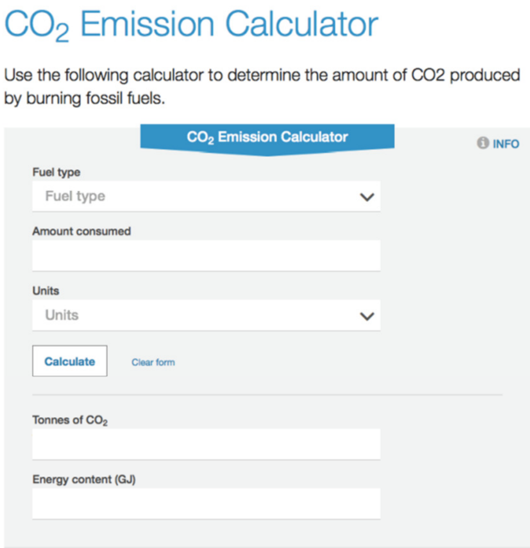

Figure 22: Examples of CO2 emission calculator ©https://www.eecabusiness.govt.nz/tools/wood-energy-calculators/co2-emission-calculator/)

Environmental protection is one more benefit from geothermal resources. Generating the heat from geothermal, greenhouses gas emission is avoiding potentially and quite amount of emissions can be saved. There can be ceration CO2 emission from geothermal, but only in cases of high-temperature geothermal systems (temperature above 150 0C) which are mostly used for power generation. The CO2 emissions from Icelandic geothermal power plants is in range 26–181 g/kWh (Armannsson et al., 2005), while Geothermal plants in California emitting in average 122 g/kWh (Bertani &Thain, 2002). In general, to produce one kWh from geothermal using resources with temperature >2000C 90g of CO2 will be emitted, but from natural gas 600 gCO2/kWh, using oil 890 gCO2/kWh and using coal 955 gCO2/kWh (Fridleifsson et al., 2008).

In DARLINGe project area the temperatures vary between 20°C and 90-110°C and focus is on heat energy production, thus emission of CO2 is almost neglectable and further on can be consider as non-existent. Mitigation CO2 potential for the project can be visible using CO2 Emission Calculator model. On the fig. 22 is shown example of calculator (EECA, 2017) which implies three input parameters for calculation: fuel type (natural gas, coal, fuel oil, diesel, petrol, and electricity), amount assumed and units (GJ, tonne, litre, cubic metre, kWh). The EECA calculator is using "standard emission factors to determine the greenhouse gas emissions of different fossil fuel. These standard emission factors are published by the Ministry for the Environment and represent national averages for the different fuel types. The greenhouse gas emissions are presented as tonnes of CO2equivalent (tCO2-e). Standard calorific values of the fossil fuels are used".

When all parameters are known calculations can be done. The similar model of calculations will be used for CO2 emission potential reduction by using the geothermal resources in DARLINGe project area.

Calculator is based on known value of average amount of energy that can be obtain from one geothermal well (yield and temperature are figurative). To generate this same amount of energy from another fossil fuel certain amount of CO2 will occur and by simple resource substitution CO2 savings can be done. The several models of calculator will be reachable, on the county level and on the reservoir level.

Armannsson, H., Thrainn, F., Kristjansson, B. R., 2005: CO2 emissions from geothermal power plants and natural geothermal activity in Iceland, Geothermics, 34, 286–296.

Bertani, R., Thain, I. (2002). Geothermal power generating plant CO2 emission survey. IGA News 49, 1–3.

Fridleifsson, I., et al., 2008: The possible role and contribution of geothermal energy to the mitigation of climate change, IPCC Scoping Meeting on Renewable Energy Sources, Proceedings, Luebeck, Germany, pp. 59-80

EECA, 2017. Energy Efficiency and Conservation Authority (https://www.eeca.govt.nz)

5.3.4 Publications

This module will focus on dissemination of different publications regarding geothermal energy related data of Danube Region, such as:

- reports
- scientific journals
    - open source (full text, optional link)
    - restricted (abstract and link)
- presentations (ppt or pdf)
- maps
- **Danube region geothermal strategy**
- **geothermal action plans**
- **geological risk mitigation scheme for three pilot areas**

The module Publishing is introduced in the DRGIP following the similar concept in the German GeotIS and with this DRGIP shows ambition to be a central information platform for gathering and presentation of geothermal data of Danube Region.

5.3.5 Geothermal dictionary

The Glossary will contain basic geothermal terms described in a popular manner.

6. Status

The risks that arise in setting up the portal are possible unknown functionalities, which are not addressed yet and may appear as a desire in the later stage of implementing DRGIP. There is an option not to include them in the DRGIP due to lack of time. Also the conceptual model of the database will not change or cannot be modified anymore, and the version, dated June 2018 is the final one.

That is why, GeoZS, as a responsible partner for setting up the DRGIP will not agree or accept any unexpected changes on the proposed structure of the portal.

Nevertheless, the main idea of the DRGIP is to develop and implement a pragmatic, effective and user-friendly tool, which will allow users interested in geothermal energy aspects to view and gather consistent, live and usable data even after project termination.