Optimalisation of retrofitting activity for selected locations

Appendix II to the document: User4GeoEnergy calculator, the U4GEcalc, User's manual

Deliverable number: 5/WP6

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Date:	30 September 2023

User's manual
U4GEcalc

It is a simplified version of the tool developed to describe the operating conditions of a geothermal system. Despite its limited functionality, necessitated by the ease of use, it is a full-fledged tool that quantitatively and qualitatively describes the impact of the requirements set by the recipient on the effects of the operation of the geothermal system.

The presented calculator takes into consideration geothermal parameters like wellhead temperature and fluid outflow. Then user has to select a site location and describe the parameters of district heating such as peak heat source (and fuel), power demand for central heating and hot tap water preparation, designed temperature of supply and return of circulating water in a district heating. Also dominant type of heating (e.g. panel radiators) has to be chosen. It is essential to know that there are assumptions that every user has the same parameters e.g. radiators, heat exchangers, and structure of heat losses in an energy system. Using data from TMY (Typical Meteorological Year) and parameters provided by the user, the calculator estimates the district heating's primary characteristics. Then user determines how much and in what way prevent heat losses choosing from different retrofitting activities. After that, the calculator generates new characteristics. On the summary table are gathered, it contains all important data inserted by user and calculated by the calculator. That form of presenting data is straightforward and easy to compare (column current and after). The calculator provides a summary of energy production, the share of geothermal power and energy in the structure of production. Heat losses are calculated according to new heat demand. There are also financial parameters like total cost, CAPEX, OPEX, SPBT and environmental parameters. Calculator based on a comprehensive database containing energy prices, prices of fossil fuels, heating devices, construction materials, emission fees etc.

The primary purpose of the calculator is to show that cooperation between the final energy user and heat source, operated by a district heating operator, can be profitable to both sides.

Instruction

This manual has been created in order to help navigate through the U4GEcalc calculator and use it in an easy and effective way. All input data required and results of the calculator were explained below using exemplary location (Galanta – Slovakia). The process of using this tool has been divided into steps. Each step is described with an appropriate print screen of the user's view and explanation.

Step 1 – Basic information

A language and location selection Figure 1. A user of the software can select a preferable language and consider location.

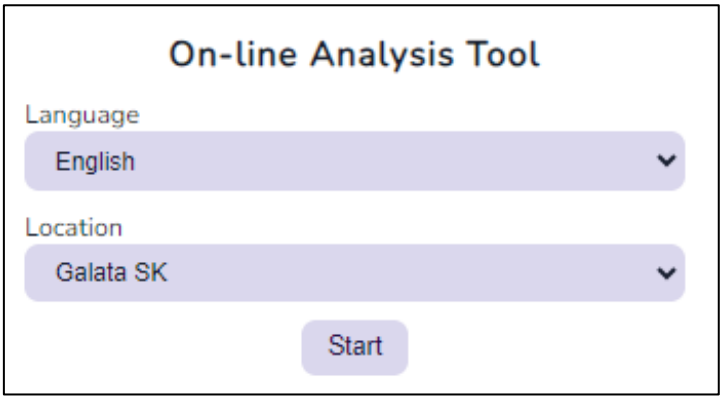

Figure 1. *Basic settings*

Here, using a drop-down list user can choose the language of the interface and location for further analysis. In this case, English and Galanta (Slovakia) were selected. If your site is not on the list, there is still a possibility to use the calculator. Choose a location with as similar climate conditions as your area has and insert further necessary data. Results will be estimated.

All the time user can check the advancement using the progress bar available at the very top page (Fig.2).

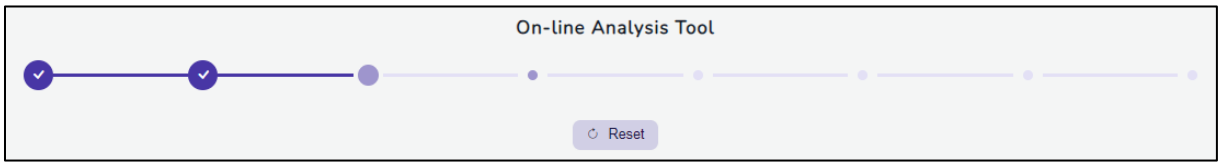

Figure 2. *View of progress*

It is possible to reset all inserted data and come back to the beginning or just click the particular point on the progress bar to move to a specific moment of the process.

After each step, click *Next* to move forward (next step) or *Back* to come back (previous step). Both buttons are at the bottom of the page.

Step 2 – Geothermal resources

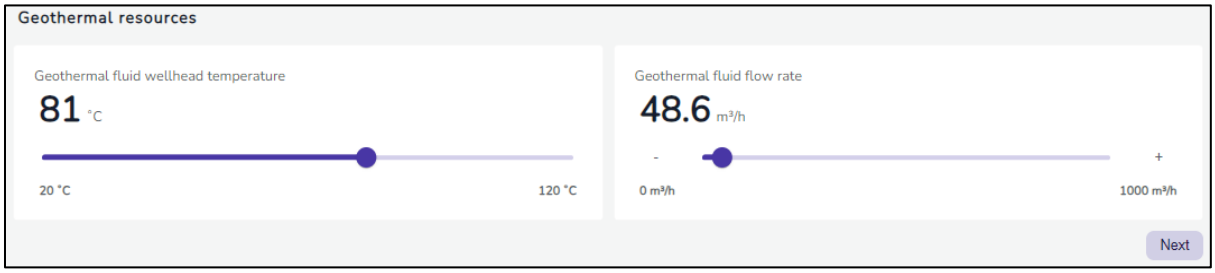

Figure 3. *Geothermal resources*

In this step, the user can input the geothermal wellhead temperature and fluid flow rate. The calculator uses default values of just mentioned parameters gathered in the database, but the user can modify these values using sliders.

Step 3 – Peak energy source

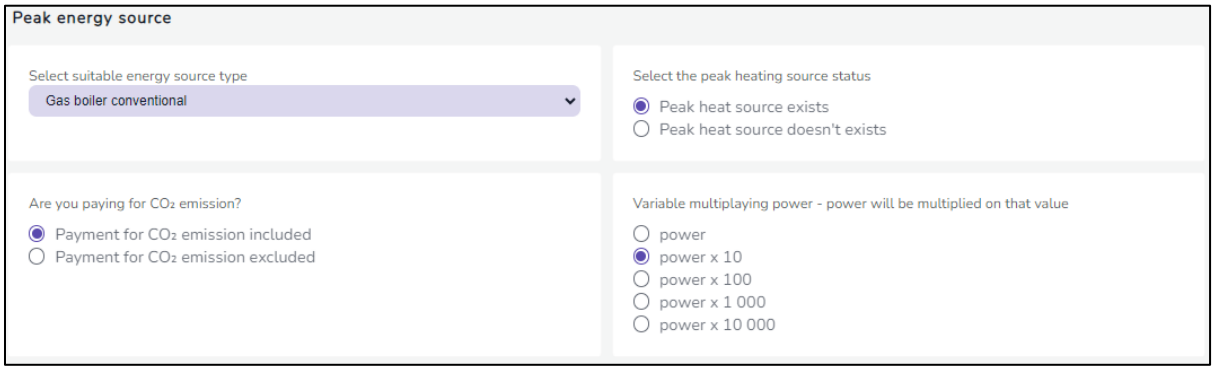

Figure 4. *Peak source of energy*

The next step is the description of the heat peak source, which works with geothermal source. From the drop-down list user can choose the proper one. There is also a question of whether a peak heating source exists or not (impact on future investing costs). Users should also decide if CO_2 emissions payments are paid by the heating plant. The last one is the variable multiplying factor. This parameter was introduced for better scaling sliders in the case of power selection/definition/redefinition. If the power of the heating plant is higher than available on the slider, use the proper multiplying factor to increase the range (concerns also the power of hot tap water). The result of multiplying is visible in the next step.

Step 4 – Heating

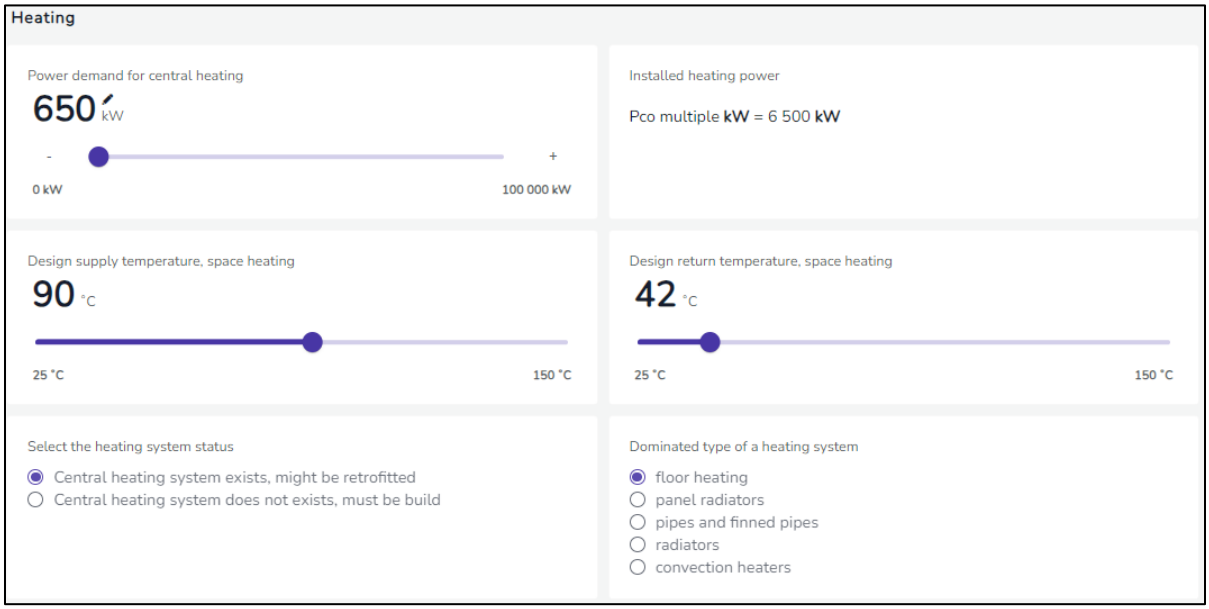

Figure 5. *Heating*

In this section user need to insert power demand for central heating. On the right, installed heating power is visible. It is a result of multiplying power demand for central heating (e.g. 650 kW – step 4) and variable multiplying power (e.g. 10 – step 3). Then, there are designed parameters of circulating water in the district heating network, such as temperature of supply and temperature of return. At the end, the user has to assess whether central heating exists or not. If not, it must be built (means additional investing expenses). The last thing is to evaluate the dominant type of heating system in user houses (it is assumed that all energy users is equipped on the same type of heating systems).

Step 5 – Hot tap water

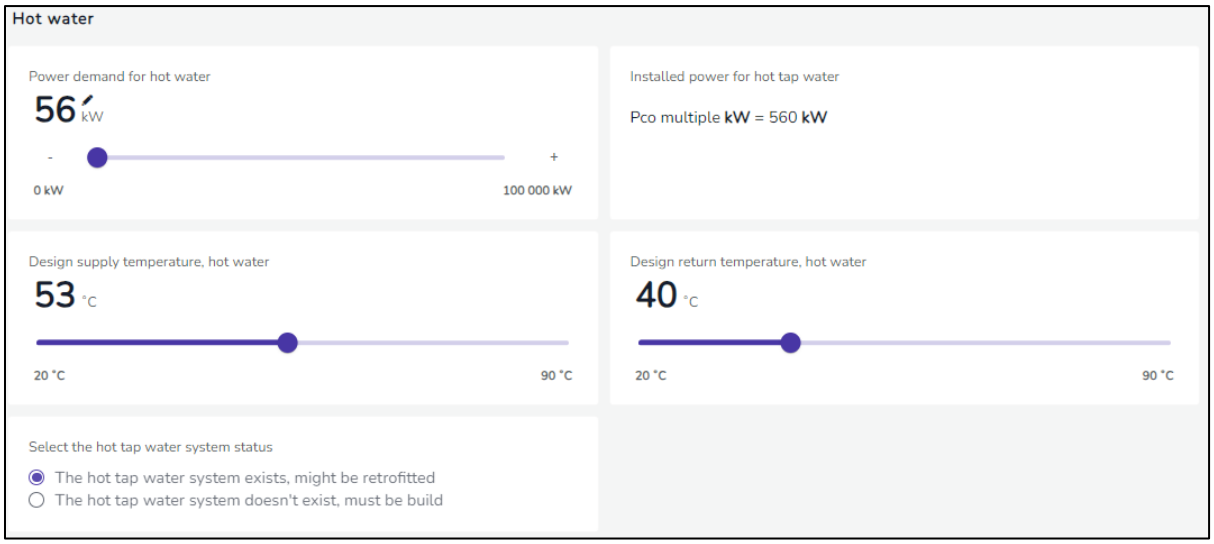

Figure 6. *Hot tap water*

Here the tool user has to insert power demand for preparation of hot tap water considering multiplying factor selected. On the right, the final installed power for hot

tap water (after multiplication by variable multiplying power). Then, there are designed temperatures of supply and return water for preparation of hot tap water. At the very end, question if hot tap water system exists or not. If not, it must be built (it means additional investing expenses).

Step 6 – User's characteristics

After inserting all necessary data, the characteristics of energy user's are generated. In fact, the figures describe the way of power control of the whole district heating system. The assumption is being made that the district heating becomes a part of users. The energy source has to fit the demands of users and the district heating. Users now can check how different parameters change during a year (used data from Typical Meteorological Year for location – organized from minimum to maximum temperatures). It is possible to observe variations of supply and return temperature in district heating, flow of water, or how power demand is covered by different sources of energy during a year. The last one presents covering the desired power demand by energy sources in relation to time in a year and outside air temperature.

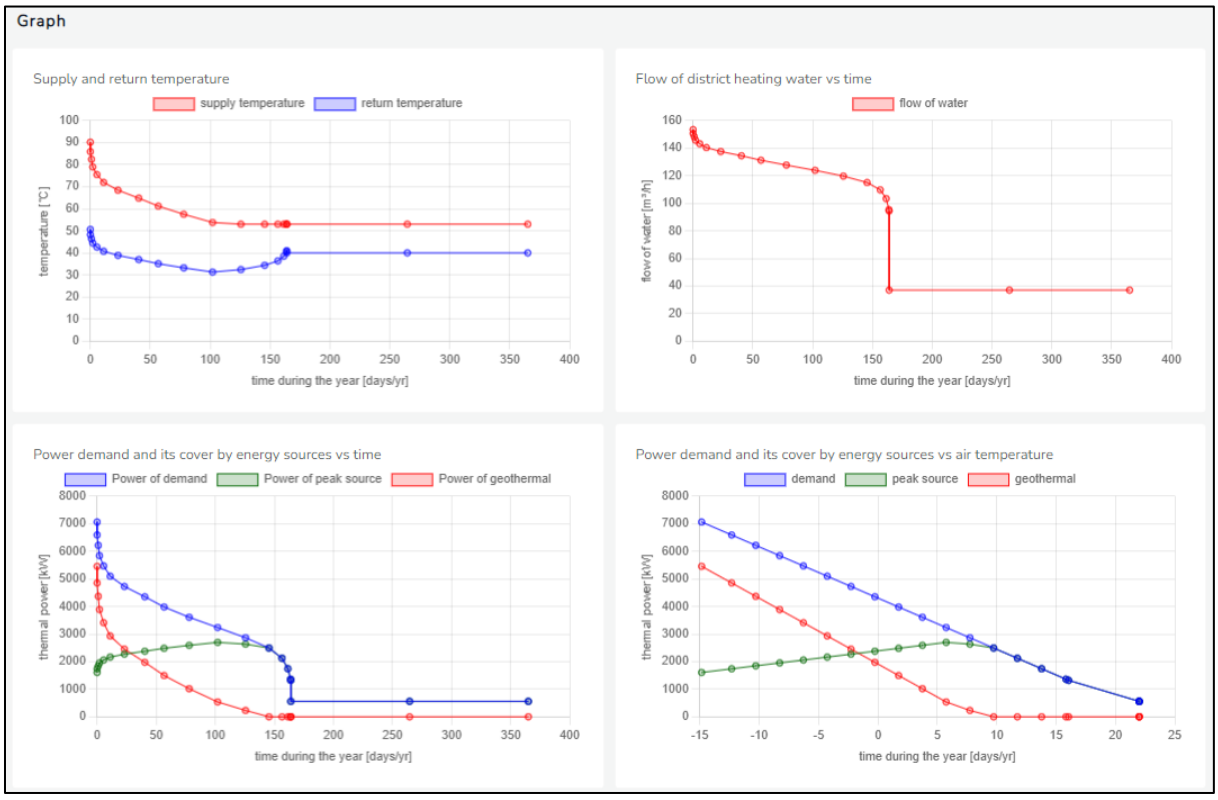

Figure 7. *User's characteristics*

Step 7 – Retrofitting

Next, the tool user has to decide whether the peak heat source will be replaced or not (change of heat peak source). Then, there is presented the assumed structure of heat losses in the analyzed energy system (the assumption can not be modified by the online tool user, but it is easy to adjust to a real situation in the algorithm itself). The heat loss structure presented in Figure 8 is typical for many systems. As one can see, heat losses involve external walls, roofs, floors on the ground, windows and external doors, ventilation and transmission lines (district heating) (Figure 8).

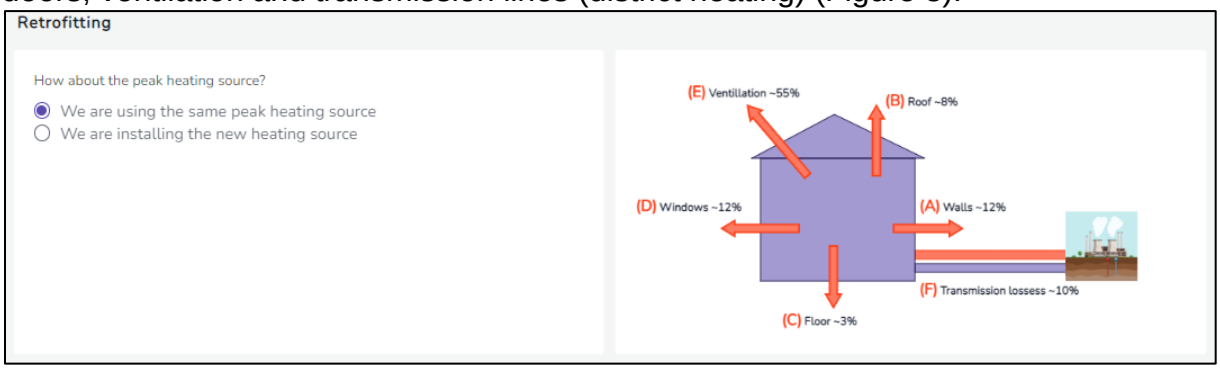

Figure 8. *Retrofitting activities*

Now is the time to conduct retrofitting activities (Figure 9). Also using sliders the tool user can simulate a decrease of heat losses as a result of thermal retrofitting actions. For example, doing some adjustments in the ventilation system as a result, there is 10% reduction of heat losses by ventilation. It means that heat losses for ventilation decrease from 55% to 49,5% etc. (0,55·0,9=0,495) (Figure 8).

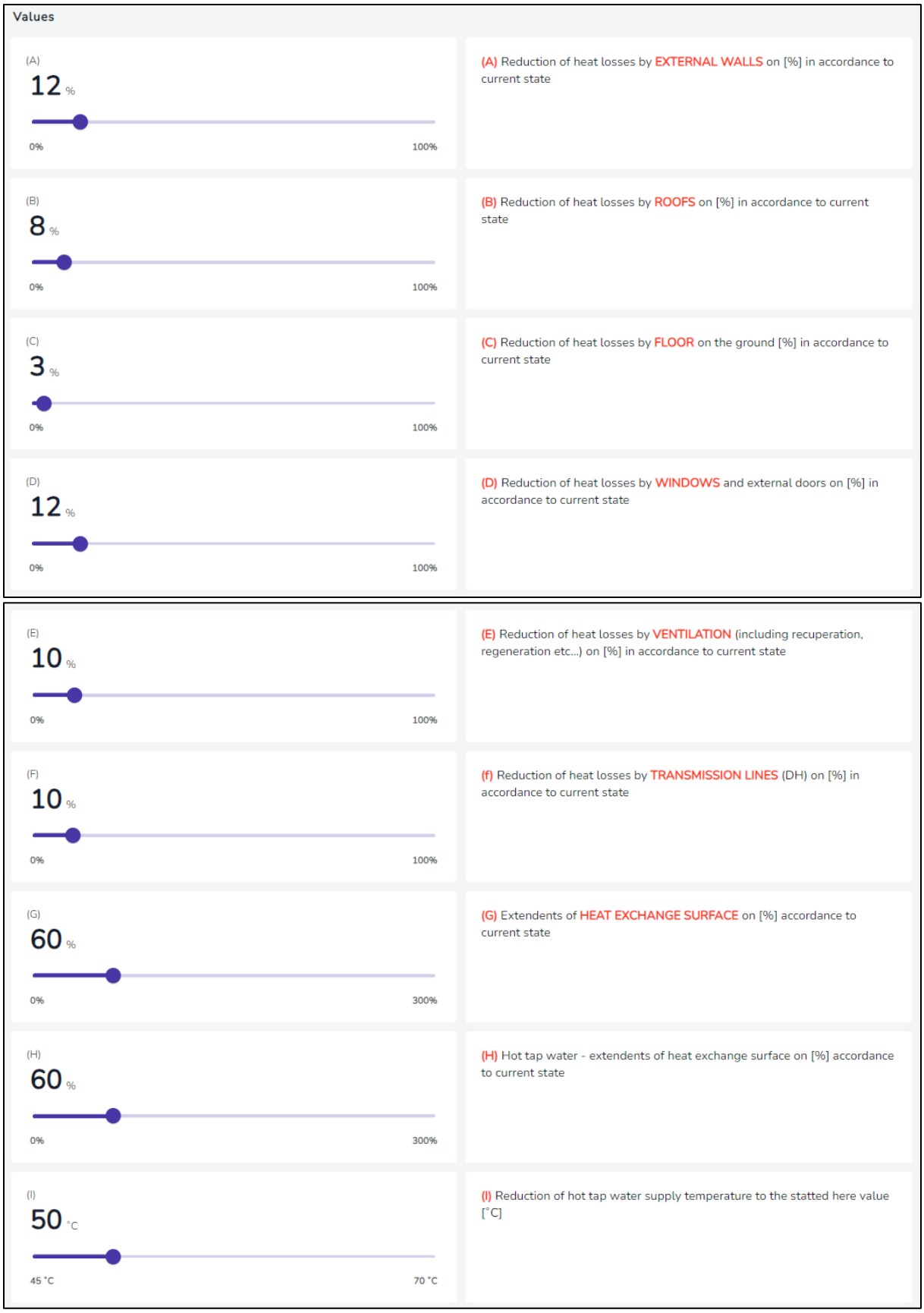

Figure 9. *Exemplary thermal retrofitting activities*

The last three retrofitting activities are a bit different. The tool user can simulate the extension of heat exchange surface, e.g. 60% extension of panel radiators surface means that surface of radiators is 60% bigger than in current state (bigger size of radiators, by e.g. adding heating plates etc.). Similar is with hot tap water exchange surface. In that case the extension is referring to heat exchangers district heating water / cold tap water. Last one is simply a reduction of temperature to prepare hot tap water, where the maximum value is the current state. The reduction of supply temperature of hot tap water can be assumed e.g. in a case when we are going to reduce heat losses by the district heating. Smaller losses allow the supply similar temperature of hot tap water based on the lower temperature of the system supply, supported by the energy source.

Step 8 – Summary of thermal retrofitting

Like in step 6 the tool user get complete new characteristics after thermal retrofitting (update to step 6). The same parameters are available. The same results may change drastically, and some are nearly imperceptible compared to current state. That is why the final summary table (Figure 12) with more precise data is included.

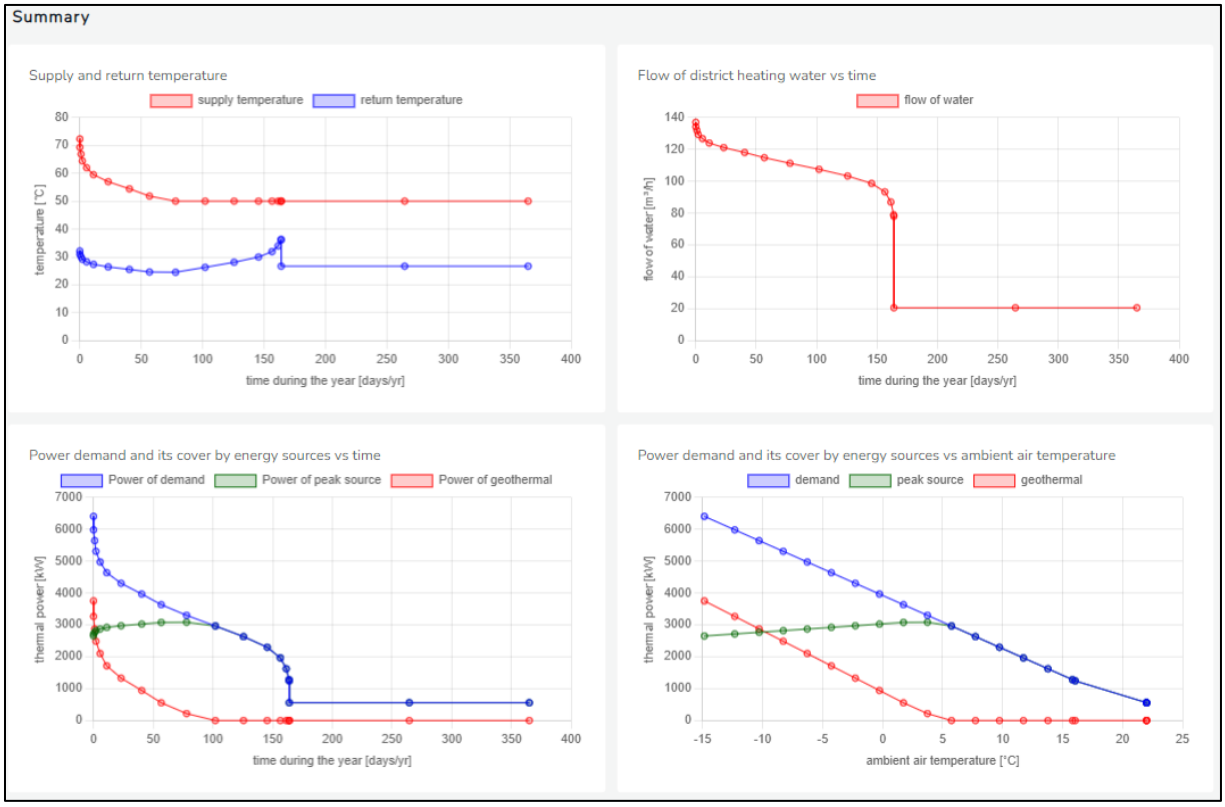

Figure 10. *Summary of thermal retrofitting activities*

Step 9 – Final results

In the final step the tool user get the ultimate results. Fundamental and the most important parameter values can be compared (Figure 11).

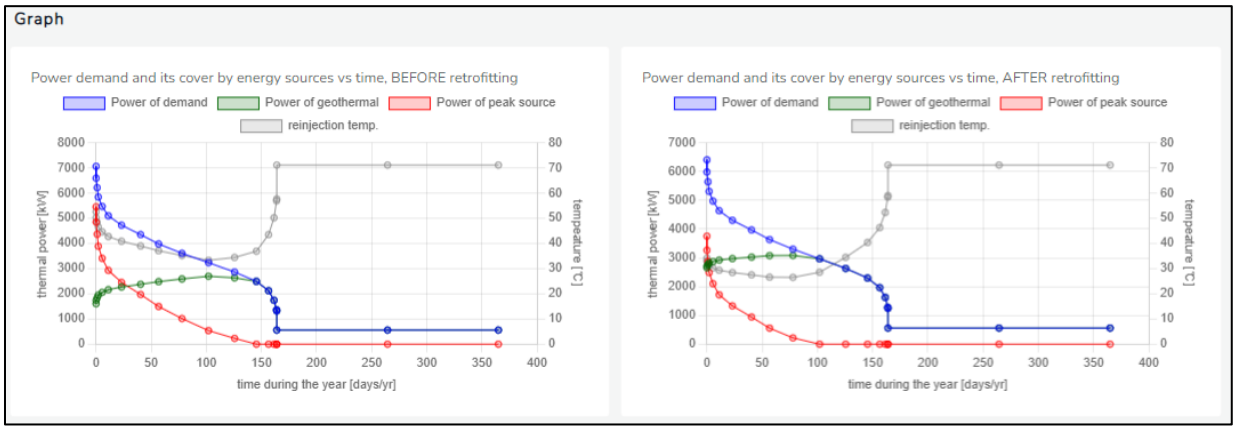

Figure 11. *Final graphs*

Below graphs there is also a more detailed table which includes comparison of states before and after thermal retrofitting (Figure 12). In the table all data inserted by the tool user are reminded. The user now can check and compare the results of retrofitting activities using calculated values. The structure of heat losses can be compared, also new required temperatures of supply and return of district heating, shares of energy production in heating plant etc. The reduction of emission of pollutants is calculated in reference to the previous structure of energy production. At the bottom of the table financial aspects inc. CAPEX, OPEX, SPBT and energy price reduction for final user are available.

Summary

Parameter description and [unit]	Current state	After retrofitting
Location: city and country	Galata SK - current state - established by an user	Galata SK
Geothermal resources flow [m³/h] | temp[°C]	48.6 | 81	48.6 | 81
Type of heat peak source	Gas boiler conventional	Gas boiler conventional
Status of heating system at users (radiators)	Central heating system exists, might be retroffited	Central heating system exists, might be retroffited
Status of hot water system at users	The hot tap water system exists, might be retroffited	The hot tap water system exists, might be retroffited
Status of heat peak source	Peak heat source exists	Peak heat source exists
Payment for emission of CO_2 (status)	Payment for CO_2 emission included	Payment for CO_2 emission included
Power and energy lossed by connected objects' elements:	-	-
(A) external walls [kW | GJ/yr ► % of energy]	780 | 5207.5 ► 12	686.4 | 4582.6 ► 11.75
(B) roofs [kW | GJ/yr ► % of energy]	520 | 3471.7 ► 8	478.4 | 3193.9 ► 8.19
(C) floors on ground [kW | GJ/yr ► % of energy]	195 | 1301.9 ► 3	189.2 | 1262.8 ► 3.24
(D) windows and external doors [kW | GJ/yr ► % of energy]	780 | 5207.5 ► 12	686.4 | 4582.6 ► 11.75
(E) ventilation inc. recuperation (if applies) [kW | GJ/yr ► % of energy]	3575 | 23867.6 ► 55	3217.5 | 21480.8 ► 55.07
(F) transmission losses [kW | GJ/yr ► % of energy]	650 | 4339.6 ► 10	585 | 3905.6 ► 10.01
(G) increase of heat exchange surface for heating (eg. radiatiors) [%]	-	60
(H) increase of heat exchange surface for hot water [%]	-	60
(I) reduction of supply temperature for hot water from ► to [°C]	-	53 ► 50
Status of a peak heat source after retrofitting	-	We are using the same peak heating source
Design parameters for heating | hot water [°C]	90/42 | 53/40	72.1/29 | 50/26.7
Power demand: total | heating / hot water [kW] # Energy demand: total | heating / hot water [GJ/yr]	7060|6500/560 # 61054.8|43395.6/17659.2	6402.9|5842.9/560 # 56667.5|39008.3/17659.2
Maximal power utilised: total; geothermal; peak source [kW]	7060 ; 2698 ; 5453	6403 ; 3082 ; 3752
Energy production: total; geothermal; peak source [GJ/yr]	61054.8 ; 44211.5 ; 16843.3	56667.5 ; 49281.1 ; 7386.4
Share of sources in total energy production: geothermal; peak source [%]	72.41 ; 27.59	86.97 ; 13.03
Energy carrier used by a peak source [m³/yr]	534706.39	234489.84
Emission of selected pollutants	-	-
* CO_2 [ton/yr]	1053.64	462.06
* SO_2 [kg/yr]	4.64	2.03
* NO_x [kg/yr]	870	381.53
* total dust [kg/yr]	1.5	0.66
Completeness of input data in terms of price indicators	-	-
Investment expenditures [k€]	0	5289.4
Total cost | CAPEX | OPEX [k€/yr]	610 | 151.4 | 458.6	617 | 415.9 | 201.1
Simple payback time for additional expenditures SPBT [yr]	-	20.5
Energy price reduction for final user [€/GJ]	-	4.54

Figure 12. *Summary table*

We strongly recommend you not to stick to numerical values in the table. Whereas a calculator is a good indicator of the profitability and effectiveness of thermal retrofitting activities.

If necessary contact us: kpierzchala@meeri.eu

Iceland Liechtenstein Norway grants

Norway grants

Improving the energy efficiency of geothermal energy utilisation by adjusting the user characteristics

The User4GeoEnergy project (No. 2018-1-0502) is funded by Iceland, Liechtenstein and Norway through the EEA and Norway Grants Fund for Regional Cooperation

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