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An Investment Capacity Calculator for Geothermal Power Plant, District Heating and Greenhouses Investments: Geothermal Investment Tool

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ABSTRACT

Geothermal Investment Tool is a new application which is developed for international geothermal investors, professional employers in geothermal investments and power plants, academicians who are working in geothermal area and all interested people related with geothermal.

The power plant, district heating and greenhouse capacities can be easily calculated by using the some thermophysical properties of geothermal fluid (wellhead temperature, pressure, flow rate and re-injection temperature) with “Geothermal Investment Tool”. In addition internal electricity consumption of production well pumps and injection pumps, total BOP electricity consumption can be computed and then net electricity generation for sale and annual revenue can be calculated with advanced calculation option using detail information such as plant inlet pressure, injection pressure, local component contribution etc.

This application which is prepared to create an easy calculation method for geothermal investors, academicians and professional employers in geothermal market is developed to facilitate the geothermal investment capacities calculations.

1. INTRODUCTION

Geothermal Investment Tool is a free mobile application which is developed for using of local and international geothermal investors, professional employers in geothermal investments and power plants, academicians who are working in geothermal area and all interested people related with geothermal.

The power plant, district heating and greenhouse capacities can be easily calculated by using wellhead temperature, pressure, flow rate and re-injection temperature with “Geothermal Investment Tool”. This application can be downloaded free from Apple Store and Google Play.

This tool is developed for geothermal investments in Turkey and the next version of Geothermal Investment Tool will be developed for international geothermal investments by using international meteorological data and international geothermal power electricity unit prices and American Units.

Geothermal Investment Tool is developed to be helpful all interested parties, not as a commercial expectation.

2. USING OF THE APPLICATION

Geothermal Investment Tool is an user friendly application.

Some of the features of the application:

- The application has three modules: power, district heating and greenhouse capacity calculations.
- Application has two language options, English and Turkish.
- Application has the ability to store your last calculations in memory for future use.
- Each module have individual input screens, so their inputs do not get mixed.
- Application can be used with both Android and iOS operating systems.
- Do not have unit selection at the input screen. It will be added at later versions.
- Application has its own thermodynamic table for water.

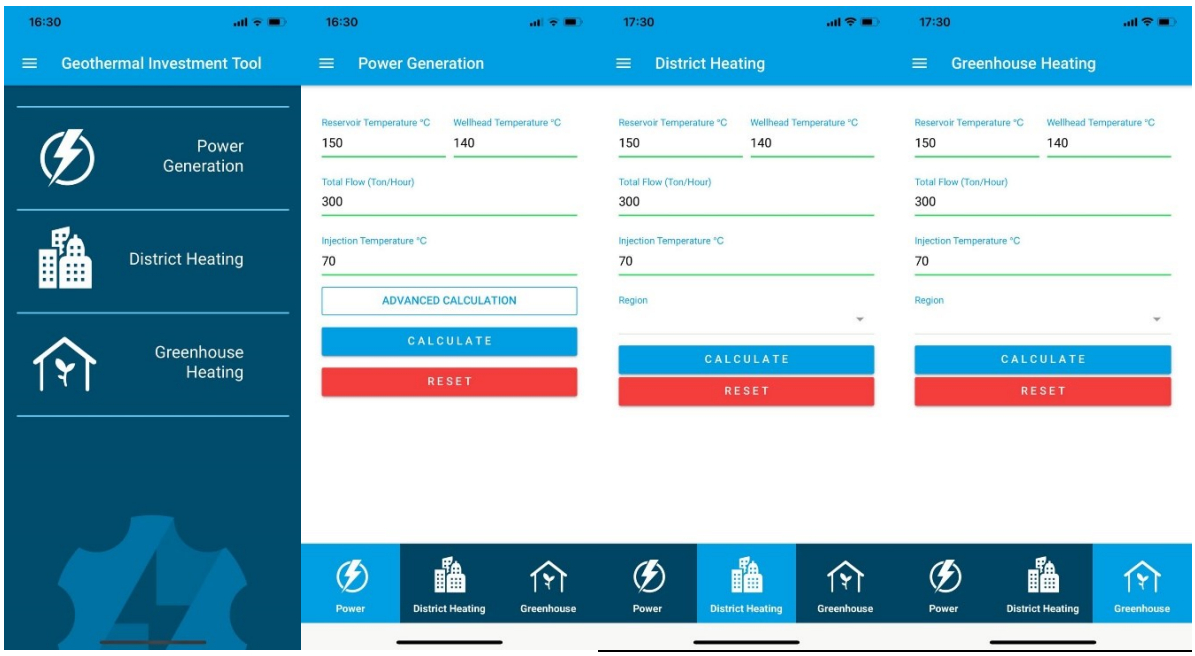

Figure 1: Main Screen, Power Generation Basic Input Screen, District Heating Screen, Greenhouse Heating Screen

2.1 Assumptions

The following assumptions were made during the calculations:

- Reservoir temperature is the measured temperature at the depth of casing shoe (from the depth where the perforated pipe hangs) when the well flows dynamically
- Wellhead temperature is the measured temperature after wellhead master valve.
- It is assumed that all steam which come from the inside of well will be used in power plant, district heating and greenhouse system.
- If the advanced calculation module is not used:
    - The wellhead booster pumps are assumed to give 3 bar head.
    - Re-injection pressures are assumed as 20 bara.
    - Pressure difference between inlet and outlet of ORC plant is assumed max. 2.5 bar.
- Electricity sale fee is assumed 10.5 $cent without local contribution, additional 0.7 $cent for turbine local contribution, additional 0.7 $cent for generator local contribution

2.2 Power Capacity Calculation Module

This module consists of two calculation types: standard and advance calculations. Both have different inputs, assumptions and formulas.

Inputs in the standard calculations are:

- Reservoir temperature,
- Wellhead temperature,
- Total flow rate
- Injection temperatures

Inputs in the advanced calculations are:

- Brine flow rate,
- Steam flow rate,
- Efficiencies,
- Plant inlet and
- Outlet pressures,
- Re-injection pressures,
- Internal consumptions and
- Local contribution of equipment

If left unfilled, application automatically calculates the inputs of the advanced calculations.

Application calculates Power plant BOP electricity consumptions (pump motor electricity consumptions) with assumed pressures and input flow rates.

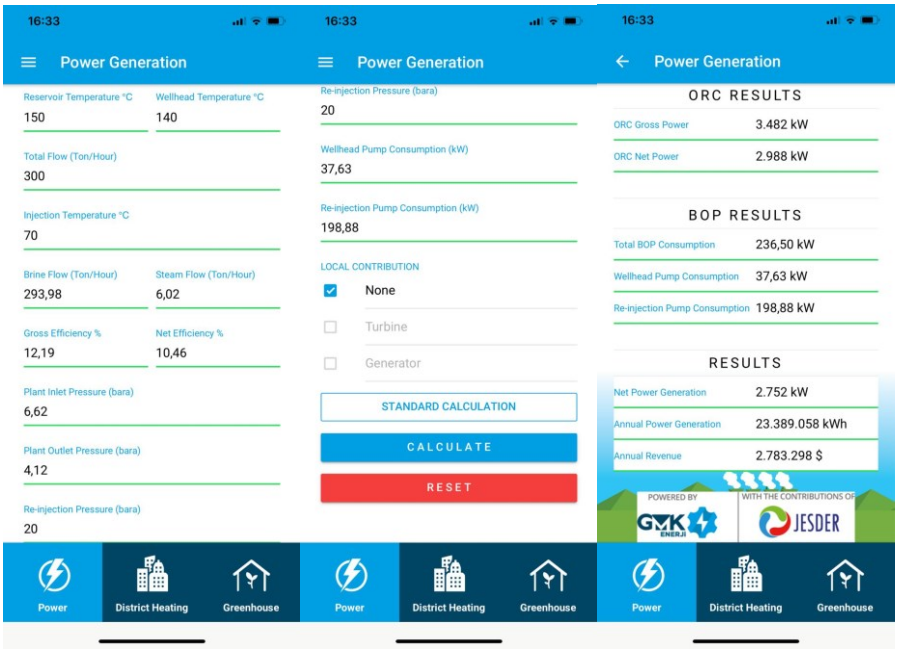

Figure 2: Advance Calculation Inputs and Output Screen

According to 150 ºC and 140 ºC reservoir and wellhead temperature with 300 t/hr flow rate geothermal fluid can produce 3.482 kW gross and 2.988 kW net power by an ORC unit. After internal consumptions the net power production for sale is 2.752 kW with 23.389.058 kWh annual power generation. The internal consumptions automatically varies due to re-injection and plant inlet pressures. Also the unit price of electricity changes according to local contributions.

2.3 District Heating Calculation Module

This module calculates the number of households that can be heated during winter time with the given geothermal source and region. Region selection is important because every region has different winter temperatures.

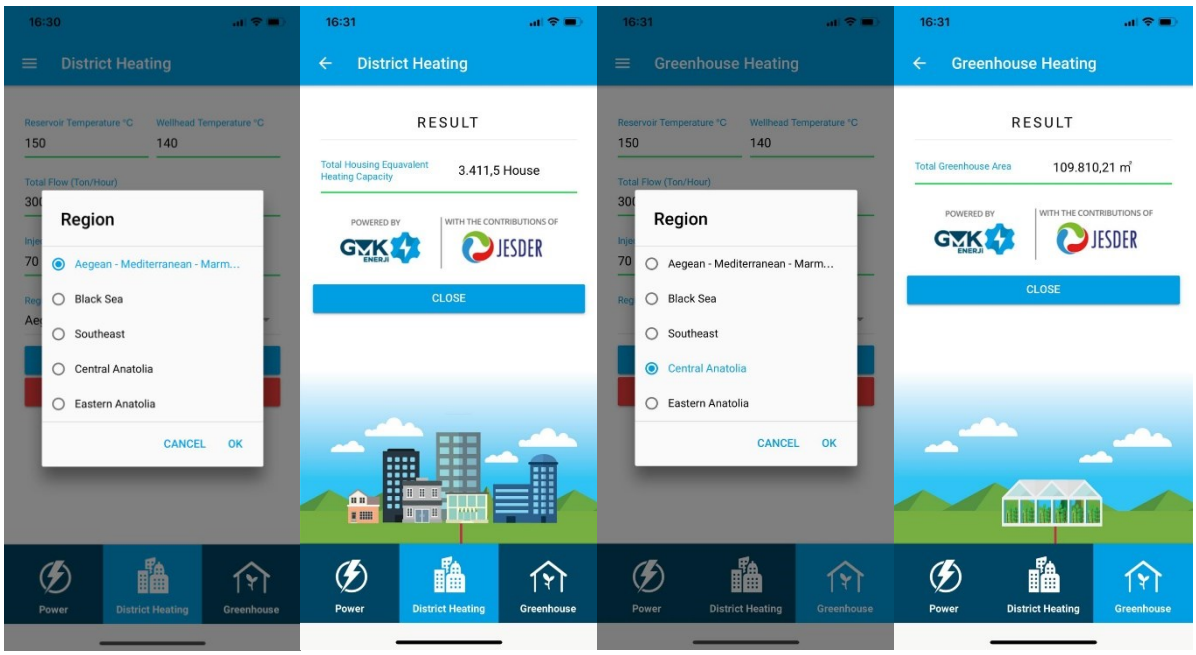

Figure 3: District Heating and Greenhouse Heating Input and Output Screens

According to same reservoir conditions, 3.411,5 houses can be heated at Aegean Region in Turkey.

2.4 Greenhouse Heating Calculation Module

This module calculates how much meter square greenhouse area can be heated during winter time with the given geothermal source and region. According to the same reservoir conditions, 109.810,21 m^2 greenhouse can be installed in Central Anatolia of Turkey.

3. CONCLUSION

Geothermal Investment Tool gives a simple calculation chance for geothermal investments to calculate power production, district heating and greenhouse capacities by using geothermal well conditions. This tool is developed for geothermal investments in Turkey

and the next version of Geothermal Investment Tool will be developed for international geothermal investments by using international meteorological data and international geothermal power electricity unit prices and American Units.

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