FEASIBILITY CONSIDERATIONS REGARDING THE IMPLEMENTATION OF A GSHP SYSTEM FOR AN INDUSTRIAL FACILITY

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1. Introduction

Application: Diary factory

Location: Ialomita County

Technological information:

- **200 kW Heat pump / 40 GSHEs x 90m deep for pre-heating the technological water and DHW production (heating only)**
- **The technical project does not specify the inter-connection with the other heat sources on the facility platform (boilers, etc…)**

Supplementary information:

- **Hydro-geological study**
- **Geotechnical study**
- **Technical projects for HVAC, sanitary, pipeline networks**

2. Input data

Number of boreholes: 40

Distance between boreholes: 10 m

Boreholes depth: 90 m

Total length of boreholes: 3600 m

Type of the BHE: double U

Soil thermal conductivity: 1,6 W/mK

Soil heat capacity: 2,4 MJ/m^3K

Average outdoor temperature: 10,6°C

Geothermal heat flux: 0,04 W/m^2

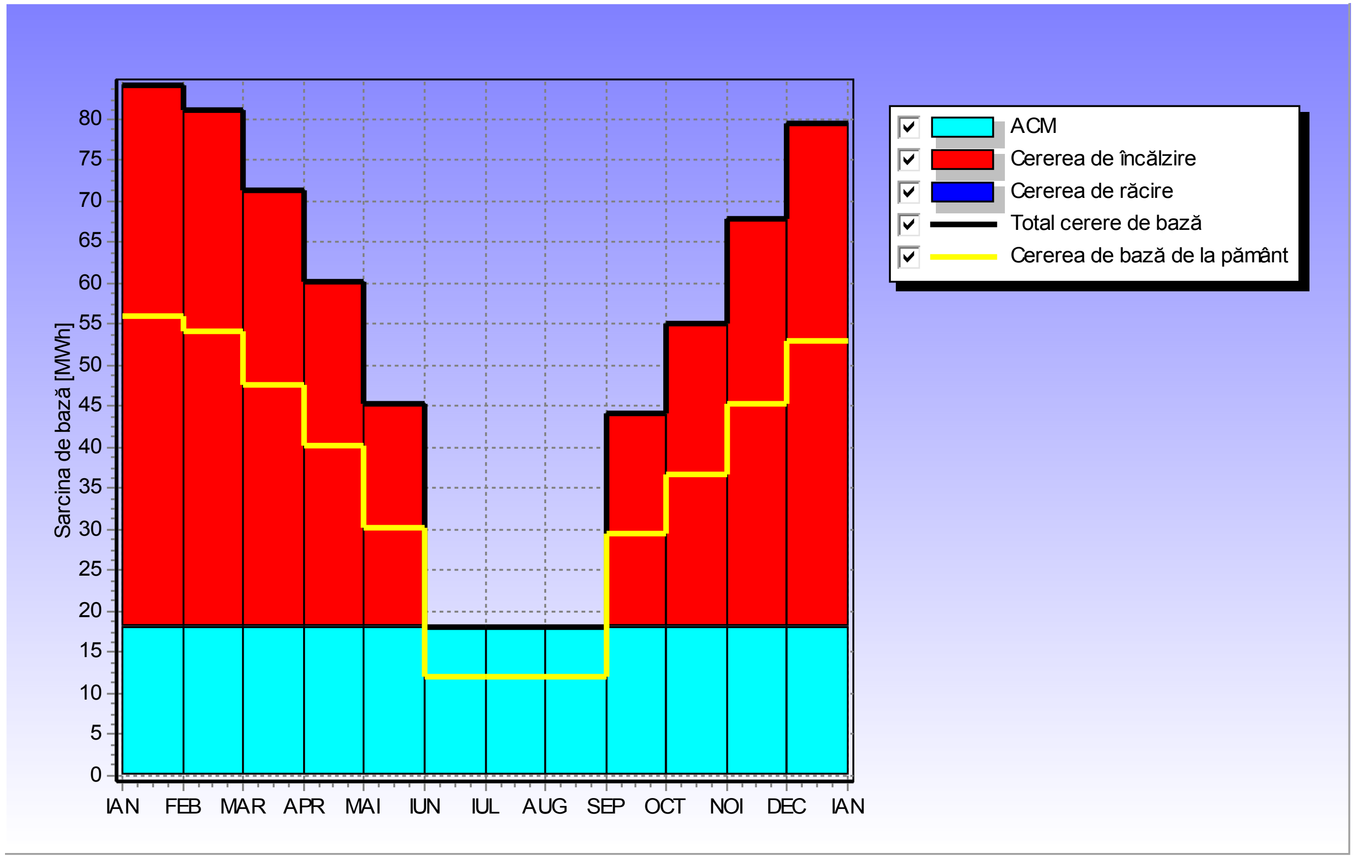
Heating fluid: Solution ethylene-glycol – water, t solidification =-21°C

Flowrate: 0,4 l/s

Annual heating energy: 425,8 MWh/year

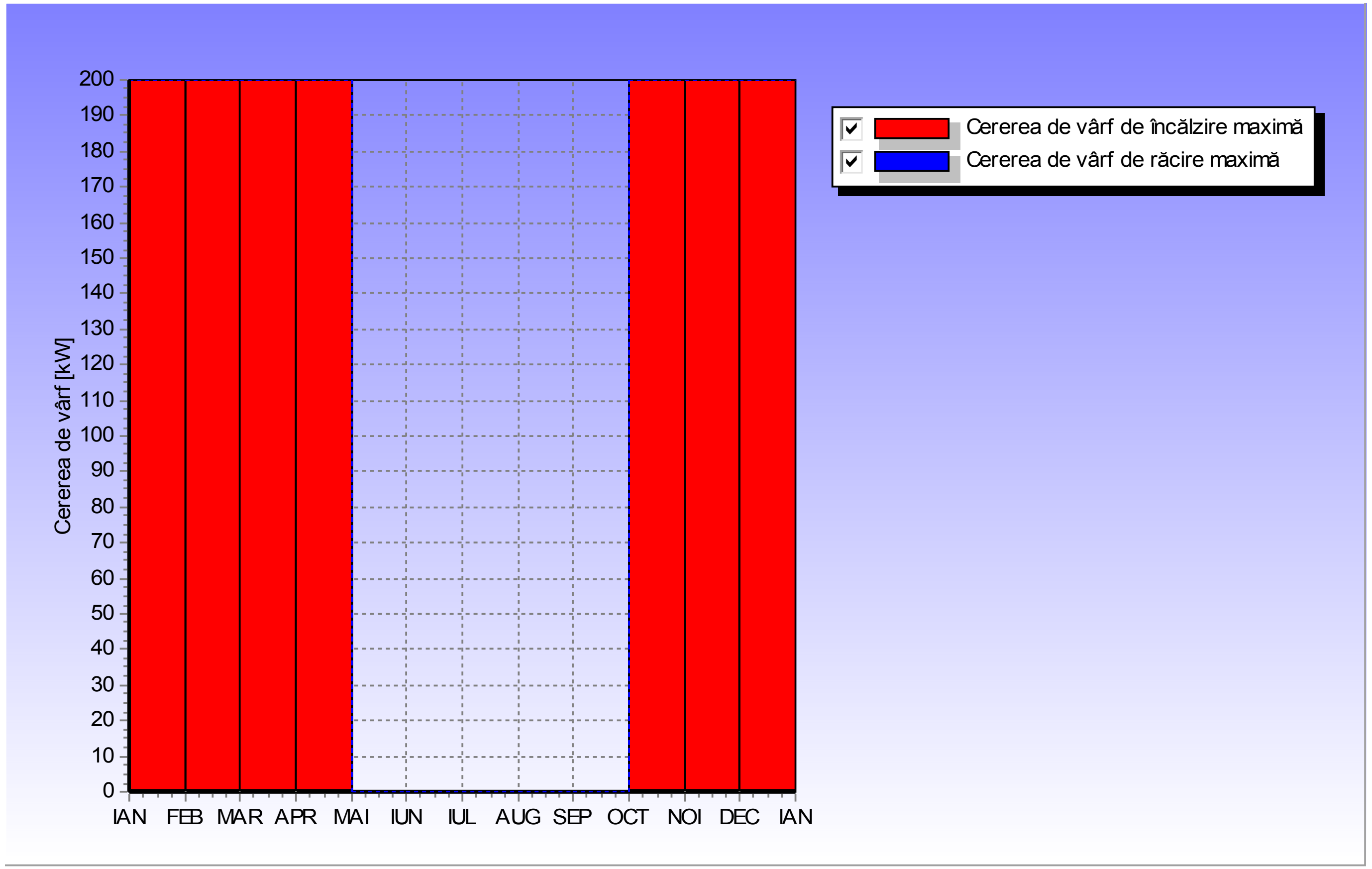
Annual DHW energy: 218 MWh/year

3. Simulations' results provided by the EED software for the initially designed situation



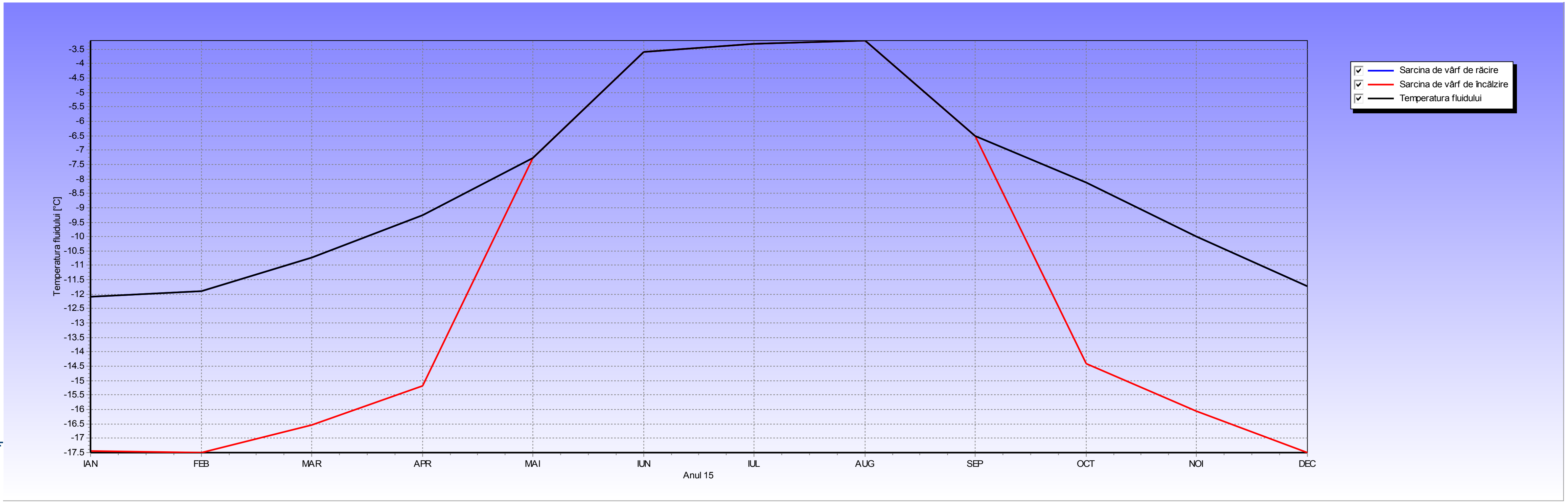
Heating energy base load

3. Simulations’ results provided by the EED software for the initially designed situation



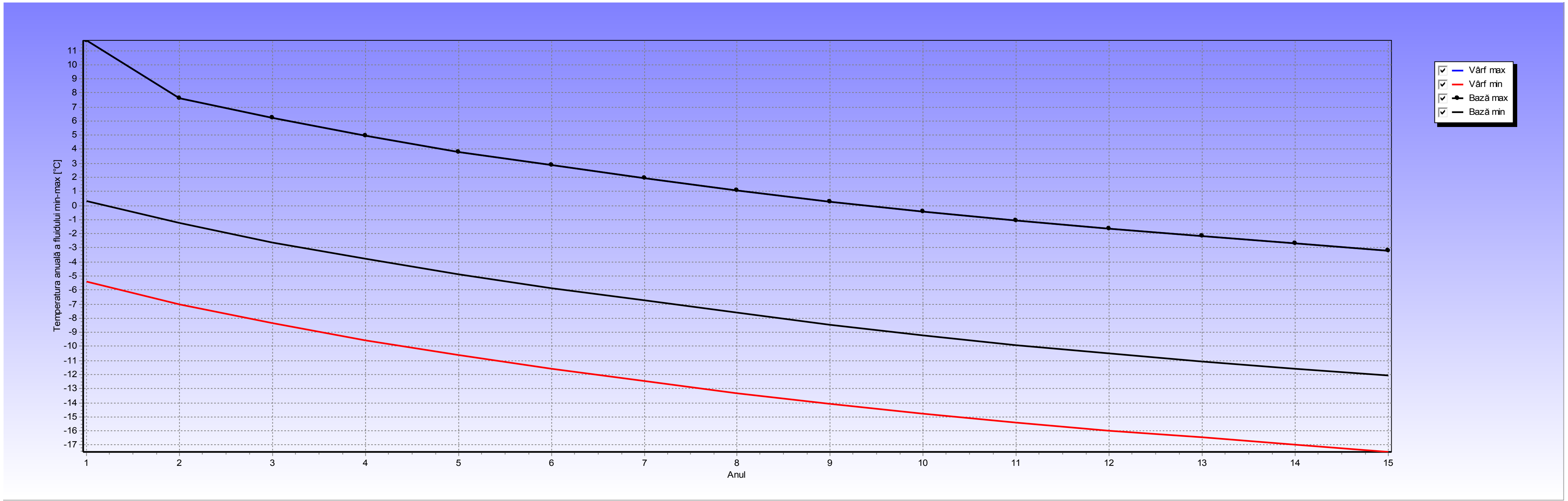
Heating energy peak load

3. Simulations' results provided by the EED software for the initially designed situation



Average fluid temperatures for the base heating load – initially designed situation

3. Simulations' results provided by the EED software for the initially designed situation



Minimal and maximal fluid temperatures for the base heating load – initially designed situation

3. Simulations' results provided by the EED software for the initially designed situation

Preliminary conclusions

Fluid minimal average temperature is –12.08 °C for the base heating load

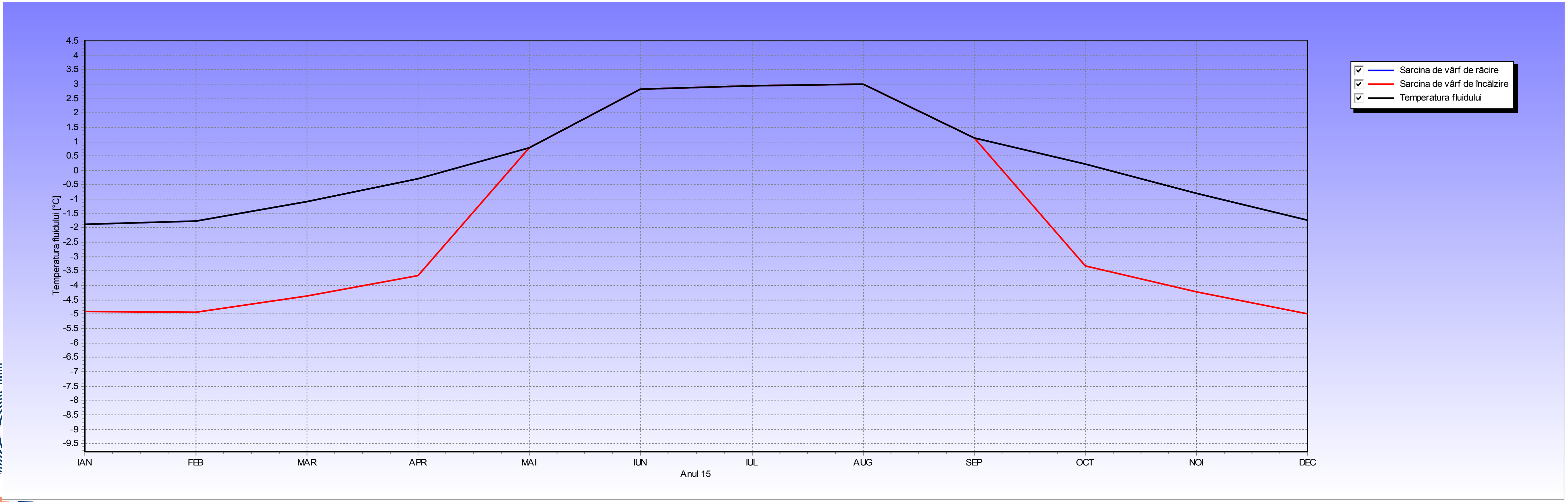
Fluid minimal average temperature is –17.5°C for the peak heating load
Even if the selected fluid – solution of mono-ethylene-glycol in water with the concentration 33% and solidification temperature - 21°C – remains still in liquid phase at such low temperatures, the consequences are as follows:
High viscosity leads to high pumping energy requirements, which reduce considerably the COP of the heat pump;
The low pressure switch (on the fluid's inlet in the evaporator of the heat pump) switches off the heat pump if the inlet temperature is lower than the minimal inlet temperature.
These extremely low fluid temperatures show that the heat pump cannot cope with the heating loads and with the imposed depth of the boreholes (de 90 m).

4. Optimized situation from functional point of view

Condition: the minimal value for the average fluid temperature (through the GSHE) is imposed to -5°C

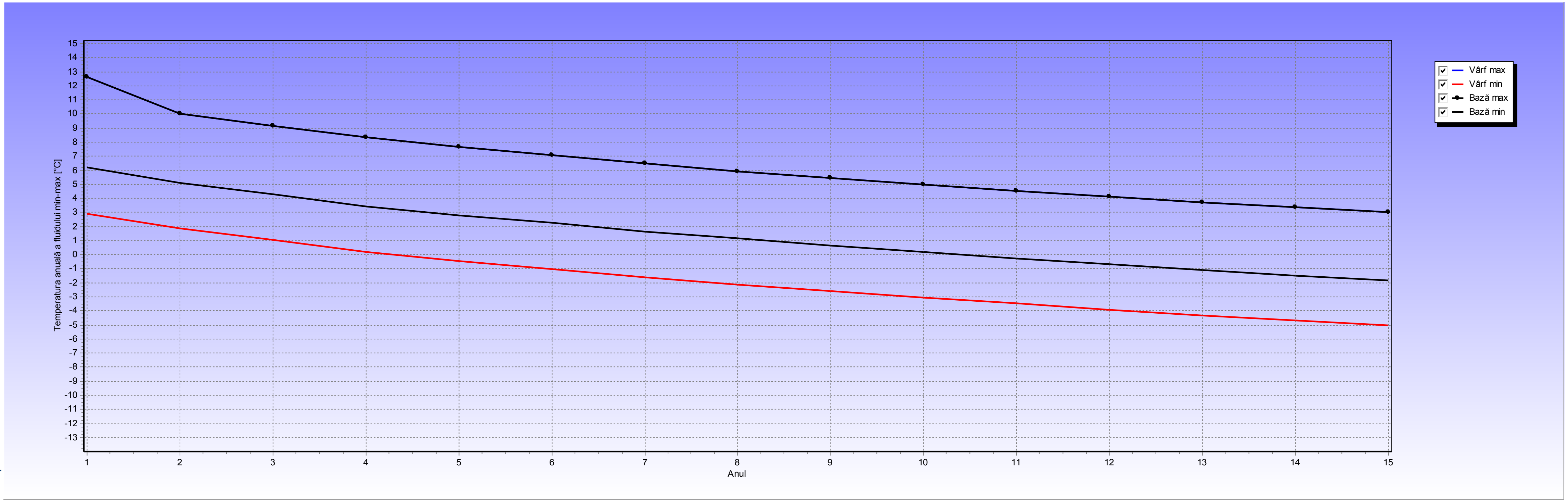
Based on this value, the calculus for the GSHE is repeated, maintaining the same values for:
Physical properties of the soil
Physical properties of the fluid through the GSHE
Configuration of the GSHE
Heating base load and heating peak load

4. Optimized situation from functional point of view



Average fluid temperatures for the base heating load – optimized situation from functional point of view

4. Optimized situation from functional point of view



Minimal and maximal fluid temperatures for the base heating load – optimized situation from functional point of view

5. Conclusions

Synthesis of the technical and financial conclusions

	Initially design situation	Optimized situation from functional point of view
Minimal average temperature for the base heating load	-12.8 °C	-1.87 °C
Maximal average temperature for the base heating load	-3.2 °C	3 °C
Minimal average temperature for the peak heating load	-17.5 °C	- 5 °C
Maximal average temperature for the peak heating load	-3.1 °C	3 °C
Number of boreholes	40 pcs	40 pcs
Borehole's depth	90 m	161 m
Total length of the boreholes	3600	6442
Total cost of boreholes and connecting trenches	93120 EUR	164170 EUR

The prices used in the analysis are:
For boreholes – 24 euro/ml (price valid for double-U BHE, including the pipe, spacers, grouting, distributors flow & return, adjustment valves, flowmeters, VAT)
For the connecting trenches – 8 euro/ml (price valid for pipe, sand bed, The price does not include the fluid in the BHE (anti-freeze), nor the HP equipment, nor VAT.

5. Conclusions

Faulty design of the GSHP system may lead to:

- **Totally inefficient functioning of the HP – low evaporation temperatures, low SPFs**

- **Possible optimization from technological point of view may lead to increased costs for the BHE from 93120 euros up to 164170 euro, meaning more than 76%!!!**

6. Center of Excellence for Shallow Geothermal Energy

- **Logistics of the center: Headquarter, Equipment, Software**
- **Headquarter: in the building of the Faculty for Building Services Engineering Bucharest – enables access to rooms for training courses developed in the EU funded projects Geotrainet, Cheap-GSHPs and GEO4CIVHIC.**
- **Two nZEB houses for demonstration purposes – participants at the Solar Decathlon Competition – to be adapted for shallow geothermal energy**
- **One experimental double-U borehole – documented for ground temperatures, water flowrates (Rehau)**
- **Ground source heat pump (Rehau) – dedicated to the nZEB houses**
- **GSHP system for underfloor heating system in the laboratory – fully operational and documented in a PhD thesis**

6. Center of Excellence for Shallow Geothermal Energy

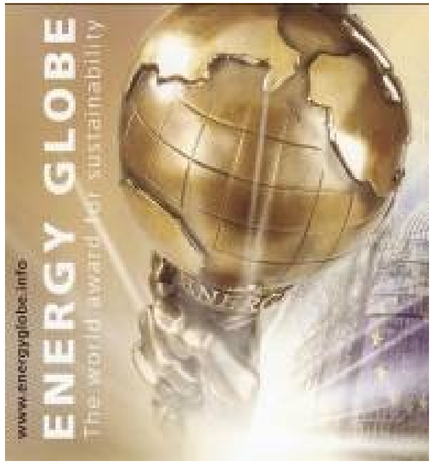
Existing nZEB EFdeN house – Solar Decathlon 2014

New EFdeN house built in Dubai (on wooden structure) – Solar Decathlon Middle East 2018 (to be relocated to the faculty’s campus)

6. Center of Excellence for Shallow Geothermal Energy

- **Logistics of the center: Headquarter, Equipment, Software**

- Headquarter: in the building of the Faculty for Building Services Engineering Bucharest – enables access to rooms for training and sharing research and technical resources
- Equipment – Minivan Mercedes Vitto; TRT GeoCube equipment; power generator.
- Software – EED, GLD, EWS, Polysun, Comsol, DesignBuilder, EnergyPlus, TrnSys



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