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# Potential of the MPC hybridGEOTABS concept for buildings: Libeznice school

As a part of hybridGEOTABS project, Libeznice school is one of several demonstration cases that employs geothermal heat pump with Thermally Activated Building Systems (TABS) combined with Model Predictive Control (MPC) algorithms for heating and cooling. Benefits and potential of such a system is presented in this article.

**Keywords:** hybridGEOTABS; geothermal heat pump; TABS; Model Predictive Control; integrated design solutions



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## *hybridGEOTABS*

*– Model Predictive Control and Innovative System Integration of  
GEOTABS in Hybrid Low Grade Thermal Energy Systems*

*hybridGEOTABS is a four-year project started in 2016 by an active team of SMEs, manufacturers and research institutes. The project, led by the University of Gent, is a Research and Innovation Action funded under the EU's Horizon 2020 programme.*

*The goal of hybridGEOTABS is to optimise the predesign and operation of a hybrid combination of geo-thermal heat-pumps (GEO-HP) and thermally activate building systems (TABS), alongside secondary heating & cooling systems, including automated Model Predictive Control (MPC) solutions.*

*To know more about the project visit [www.hybridgeotabs.eu](http://www.hybridgeotabs.eu) and contact [hybridgeotabs@ugent.be](mailto:hybridgeotabs@ugent.be)*



*hybridGEOTABS project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723649.*

## Description of Libeznice school

This is an elementary school for 240 pupils in 8 classrooms, which also serve as the premises for afterschool activities. The building is designed in an annular shape on one floor with an eccentric round atrium, surrounded by a multifunctional foyer, integrating a corridor, children's lockers and a common area. The annular shape is inspired by our Solar System. The school's cafeteria has a flexible layout allowing easy rearrangement, creating space for performances by the Elementary Art school, or lectures with film screening.

The building is called "Rondel" and represents our Solar System with the Sun in between and 8 planets around.

## Technical systems

From the technical installations point of view, the building is equipped with a TABS heating and cooling system (one circuit in the ceiling of the building), independent low-temperature ventilation units for each classroom and a hot water circuit. The source of energy is a ground coupled heat pump with heating power of 55 kW and cooling power of 65 kW. There are 6 boreholes on the primary side of the heat pump. The heat pump operates in the three regimes:

- i) heating;
- ii) passive cooling;
- iii) active cooling (compressor is active).



Libeznice school building.

The GEOTABS system is controlled by a predictive controller (MPC) that takes into account weather forecast, model of thermodynamics of the heat pump and TABS. Moreover, spot market electricity prices are included in the MPC problem formulation which results in a higher consumption, in situations when the price of electricity is low (surplus of the electricity in the grid), and lower consumption in other moments (demand side management). The algorithms benefit from the huge thermal capacity of the TABS system.

Each classroom is equipped with an air handling unit (AHU), with the air inlet passing through the recuperation unit, which decreases energy use by ventilation. The commonly used areas (corridor and cafeteria) has its own AHU. The heat for the AHU is supplied by the secondary side of the heat pump, whereas cold is provided either by the heat pump in active cooling mode or by the borefield in passive cooling mode.

Further, during the summer period when the heat pump operates in active cooling mode, i.e. providing cold on the primary side to the cold emission systems, it releases heat from the secondary side to the borehole, thereby the heat pump regenerates the borehole. In its turn the regeneration of the borefield has positive influence on the heat pump operation during the heating season.

## Building performance

The measurements over 2018 show the heat delivered by TABS was 30.3 MWh/a corresponding to 30.3 kWh/m<sup>2</sup>.a, at the same time values for the cooling delivered were 28.7 MWh or 28.7 kWh/m<sup>2</sup>.a.

## System integration/MPC

The MPC strategy applied optimises energy flux supplied to the TABS to keep the room temperature in the required band by means of pre- and over- heating the building. The algorithms employ the model of building dynamics, thus with weather forecast (and other disturbances) , provided the model optimises all the system's heat/cold sources and operates in the most efficient way. The controller chooses operation mode of the building with respect to the required temperature set points (heating, active cooling, passive cooling, and heat injection to the borefield. By these means MPC shifts heat pump operation towards the period of lowest electricity price, and reduces peaks load demands, both of which have positive reflectance on the heat pump coefficient of performance (COP).

**Table 1.** Technical specifications of Libeznice.

|   |   |
|---|---|
| <b>Net Floor Area</b>                       | 1,000 m <sup>2</sup>  |
| <b>Conditioned Floor Area</b>               | 1,000 m <sup>2</sup> (area that is heated and/or cooled)  |
| <b>Average U-value of building envelope</b> | 0.27 W/m <sup>2</sup> .K  |
| <b>Geothermal borefield</b>                 | 6 boreholes 120 m depth   |
| <b>Total Annual Thermal Energy Use</b>      | 92 MWh heating, 10 MWh cooling  |
| <b>Domestic Hot Water Heating System</b>    | Heat pump provides heat both for TABS and domestic hot water preparation                                |
| <b>Ventilation</b>                          | Decentral   |
| <b>Primary heat production</b>              | 55 kW geothermal heat pump  |
| <b>Primary cold production</b>              | Passive: geothermal borefield, active: 65 kW geothermal heat pump                                       |
| <b>Secondary heat/cold</b>                  | Air handling units  |
| <b>Auxiliary heat production</b>            | Electric boiler 24 kW   |
| <b>Thermal storages</b>                     | 500 litre hot water storage tank, 500 litre cold water storage and 500 litre domestic hot water storage |

## Demonstration buildings

The school in Libeznice is one of multiple demonstration building candidates within the EU-H2020-hybridGEOTABS project where MPC may be demonstrated. These demonstrations will show what the actual energy savings, thermal comfort and flexibility values are and thus validate the true potential of the MPC hybridGEOTABS concept. ■

## Acknowledgement

Funded by the European Commission under the Horizon 2020 Programme: project number 864242 (proposal name "MPC-; GT").