



# Master thesis proposals 2022-2023

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## 1. Use of green hydrogen in the heating sector

EU has an ambitious target that to achieve fully decarbonization by 2050. Hydrogen-based technologies have an important potential to accelerate the process of scaling up clean and renewable energy. It, therefore, seems that the deployment of integration of hydrogen-based energy systems with other green heat sources (waste heat, bioenergy, heat pumps, geothermal power,...) could contribute to the decarbonization of the heat sectors in EU. However, its integration of hydrogen in DHNs compared to other alternatives remain little studied.

The main tasks to be carried out in this master thesis are the following:

- Literature review about hydrogen technology development.
- Develop a hydrogen-based energy system for a community, to investigate the optimal design and operation of the system for different economical and environment objectives.

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## 2. Analysis of a 100% renewable energy system in Belgium in 2050

EU has an ambitious target that to achieve fully decarbonization by 2050, but the pathway of this energy transition is still uncertain. The main challenges concern the cost, technology feasibility, resource availability and social acceptance. As each country has its own economic structure and resources, it is essential to carry out studies of various scenarios for specific regions or countries.

EnergyPlan, an open source system analysis tool, is a deterministic model allowing for the definition of national energy strategies by assessing the feasibility of a varieties of technologies. It is used by many researchers, consultants and policymakers worldwide.

The main task of this project will be to use EnergyPlan to addresses the Belgian energy transition and develop a strategy for the energy transition.

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### 3. Technical options for carbon capture from biomass

In collaboration with ENGIE Laborelec.

Bioenergy with Carbon Capture and Storage (BECCS) is a promising technological route to achieve negative carbon emissions. Several technologies can however be used as a basis for this purpose: post-combustion capture, pre-combustion capture, oxy-fuel combustion, chemical looping combustion, ... In this master thesis, the student will first compare these technologies based on a literature review. Some of them will then be selected and modelled to assess their performances in a few realistic case studies.

### 4. Performance analysis and advanced modelling of riothermal systems

In collaboration with Vivaqua.

Riothermal systems allow for the valorisation of heat from sewage water as a cold source for heat pumps. Vivaqua has patented such a system and currently operates two full-scale installations in Brussels. In this master thesis, the student will analyse the operational data retrieved from these two systems to assess their performances and use them to improve the accuracy of an existing thermodynamic model. Such systems will then be compared to their conventional alternatives (geothermal heat pumps, air/air heat pumps, ...) to draw conclusions on the conditions under which they are competitive from the techno-economic point of view. The optimal control of riothermal system can also be investigated, using Model Predictive Control.

### 5. Optimal design and operation of District Heating Networks

In collaboration with Resolia.

Resolia is active in the development and the operation of advanced, decarbonised heat networks. In this master thesis, the student will work on the optimal design and/or operation of heat networks based on geothermal heat pumps, waste heat and/or biomass. Real cases will be used as a basis. The needed hypothesis and data will be provided by Resolia. Depending on the detailed scope of the study, industrial optimisation softwares could be used.

### 8. Techno-economic feasibility of heat recovery from wastewater in a new district

In collaboration with Resolia.

Wastewater is a potential source of residual heat that can be used as a basis for domestic or district heating using heat pumps. The techno-economic feasibility of systems aiming at collecting this waste heat is however not guaranteed. In this master thesis, the student will carry out a techno-economic feasibility study for the specific, real case of a new-built district. The various ways to collect waste heat from wastewater will be compared, and a few technical options will be selected to study their economic and environmental benefits. Both the individual and the collective options will be studied.