

## Research Topic for the ParisTech/CSC PhD Program

**\*Field (cf. List of fields below):** 4.Energy, Processes

**Subfield:** Energy Efficiency

**Title:** Default detection for district heating networks using machine learning

**ParisTech School:** MINES ParisTech

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### **Short description of possible research topics for a PhD:**

In the district level, a thermal network is one the most efficient technologies to fulfill the energy requirements (space heating/cooling or domestic hot water). Considering the size of the network (generally composed of thousands houses), default in the network is a recurrent problem and detection of default is a challenge. The most common methods for detection of default aim to model the whole network. However, the model, including production systems, pipelines and substations, needs to be calibrated and this work could be a long and meticulous task. A promising solution is to use machine learning techniques, because we need only to develop one model and the training phase can be performed automatically for any substations or equipments. In this context, the thesis aims to identify the most appropriate machine learning architectures for default detection problems. Different architectures, especially the ones suitable to time series data such as recurrent neural network (RNN), will be tested and compared. It will be necessary to develop a virtual environment in which the state is defined via a physical model. That will allow to test the performance of the “detector” when running online.

**Required background of the student:** Thermodynamics, Heat transfer, Optimization, Process modeling, Programming

### **A list of 5(max.) representative publications of the group:** (Related to the research topic)<sup>1-5</sup>

1. Apostolou, M., Tran, C.-T., Ghazouani, S., Le Bourdier, S. & Zoughaib, A. A Multi-Period MINLP Model for district heating networks design considering production systems architecture optimization. in *ECOS Conference* (2017).
2. Apostolou, M., Salame, S., Barrault, S. & Zoughaib, A. Heat Pumps Architecture Optimization For Enhanced Medium Temperature Geothermal Heat Use in District Heating. *Int. Compress. Eng. Refrig. Air Cond. High Perform. Build. Conf.* (2016).
3. Apostolou, M., Ghazouani, S., Le Bourdier, S., Tran, C.-T. & Zoughaib, A. District heating network design considering fluctuations in the demand and thermal storage means. in *ECOS Conference* (2018).
4. Fable, A., Tran, C. T., Duplessis, B. & Stabat, P. Impact and detection of malfunction on district heating networks. in *10th International Conference on System Simulation in Buildings (will be presented in Dec. 2018)* (2018).
5. Fabre, A., Thomas, R., Duplessis, B., Tran, C.-T. & Stabat, P. Dynamic modeling for evaluation of triple-pipe configuration potential in geothermal district heating networks. *Energy Convers. Manag.* **173**, 461–469 (2018).