Building Heating and Cooling Networks with Aquifer Thermal Energy Storage (ATES) System

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Executive Summary

This summary presents the ongoing work carried on along the project of Aquifer Thermal Energy Storage (ATES) Systems in Smart Grids setting, concerning the development of techniques allowing to model the thermal comfort of buildings heating and cooling systems with ATES systems. In particular an aspect so far sufficiently completed in distributed control problems is the explicit consideration of individual (building, greenhouse and etc.) interests of the components of a thermal comfort system. Due to the fact that when dealing with large-scale systems with a strong heterogeneous character, local interests may not be neglected.

A mathematical model for each component that are involved in a building heating and cooling with ATES systems is derived. Great effort has been put into derivation of an accurate and representative single agent model for building heating and cooling with ATES systems. This single agent system leads to a nonlinear mixed-integer stochastic dynamical model. So far an optimal control problem formulation for each sampling time is provided. Due to computational complexity of a single agent problem, the optimal control solution is not straightforward. Our current study focuses on developing a unified framework to address this problem.

A particular success of the project is the collaboration with the Industrial User Group. An excellent user group is gathered together and it is already clear that this group is having a positive impact on the project. We have had couple of meetings to hear their advice for the model derivation of each component.

One of the critical aspect so far rarely contemplated and that have to be kept into consideration is the diversity characterizing the systems in object, yielding very complex interactions between the local agents involved. In smart grid settings, information about their relevance is of critical importance. In order to tackle such an inherent aspect of the project, a basic architecture of distributed setting is considered in this project as follows. An interaction between each agent appears through the aquifer in such a way that the domain of thermal energy storage in aquifer for each agent may overlap by neighboring agents. In the following next steps, we first model the interaction behavior between each agent and then, propose a negotiation approach between agents, leading to the emergence of cooperating agents.