District Energy Management for Smart Grids

Distributed Stochastic Constrained Control for Large Scale Complex Systems

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Smart Thermal Grids with Uncertain Demand Profiles

Description

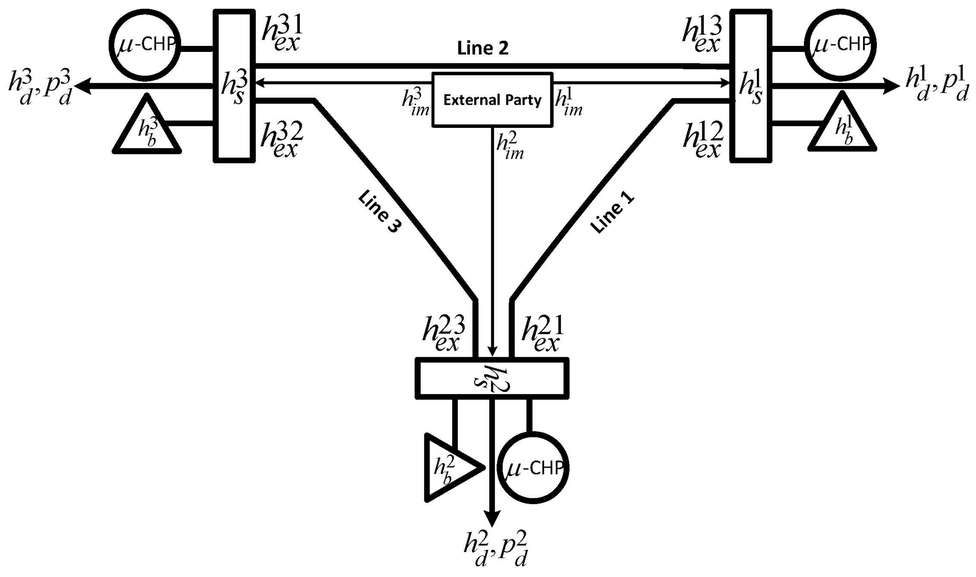
- New concept in energy grids interconnecting several households (agents)
- Improve the efficiency, reliability, and sustainability of the distribution of energy
- Agents have a potential to contribute to the overall energy balance

Main Objectives

- Online control and decision-making in a distributed setting
- Satisfaction of the energy balance with probabilistic performance guarantees
- Formulation as a distributed model predictive control problem

Requirements/Outcome

- Rigorous theoretical aspects with practical research
- An excellent experience for career in either industry or academia
- A background in convex optimization (knowledge in optimal control is useful)



Coordination frameworks:

- Market mechanism (price-based scheme): dual decomposition
- Negotiation approach (resource allocation): primal decomposition

Smart Thermal Grids with Seasonal Storage Systems

Description

- Smart thermal grids with time varying interactions via ATES Systems:
  - A large scale natural subsurface storage for thermal energy
  - An innovative method for thermal energy balance in smart grids
- Agents may affect each other's operations through overlapping:
  - Storage of large quantities of thermal energy in underground aquifers
  - Reduction of energy usage and emissions of the energy systems in buildings

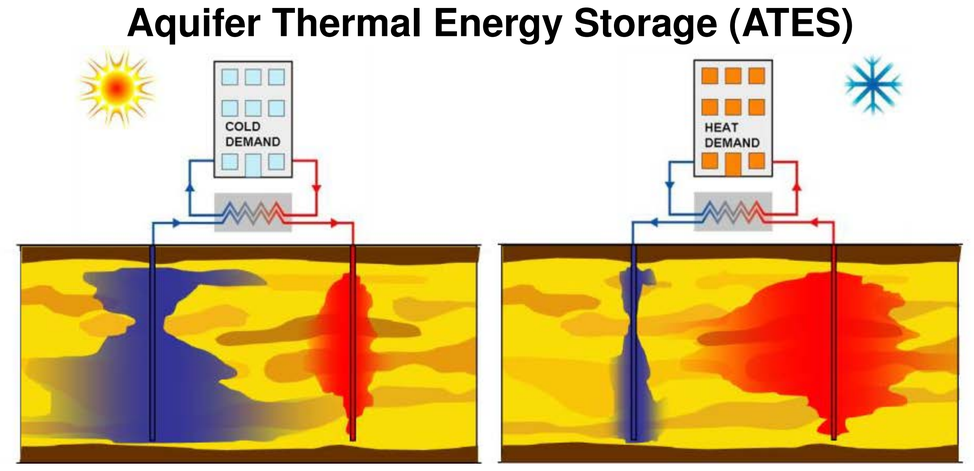
Main Objectives

- Extension of previous study to incorporate ATES systems
- Definition of a time varying objective functions depending on the neighboring dynamics:
  - Desired building temperature reference tracking
  - Penalty terms to update decision of agents with respect to the overlapping events
- Providing probabilistic guarantees for distributed model predictive control

Requirements/Outcome

- Rigorous practical research with mathematical aspects
- An excellent experience for a career in either industry or academia
- A background in convex optimization (knowledge in optimal control is useful)

Aquifer Thermal Energy Storage (ATES)



Warm season:

- Thermal energy for the cooling
- Water is injected into warm well
- Water is taken from cold well

Cold season:

- Thermal energy for the heating
- Water is injected into cold well
- Water is taken from warm well

Smart AC Power Grids with Uncertain Generations

Description

- AC optimal power flow (OPF) to achieve a more accurate representation of smart grids
- Transmission system operator challenge due to unpredictable wind power generation
- Reserves scheduling is a crucial secure power system operation to meet generation and demand

Main Objectives

- AC OPF reserve scheduling formulation using Semi Definite programing (SDP)
- A sophisticated distributed scheme based on formulating a large scale SDP fashion
- Satisfaction of the energy balance with probabilistic performance guarantees

Requirements/Outcome

- Rigorous mathematical aspects with practical research
- An excellent experience for a career in either industry or academia
- A background in convex optimization (knowledge in optimal control is useful)