CITIES
Centre for IT Intelligent Energy Systems

DTU

Market environment for integrated energy system management

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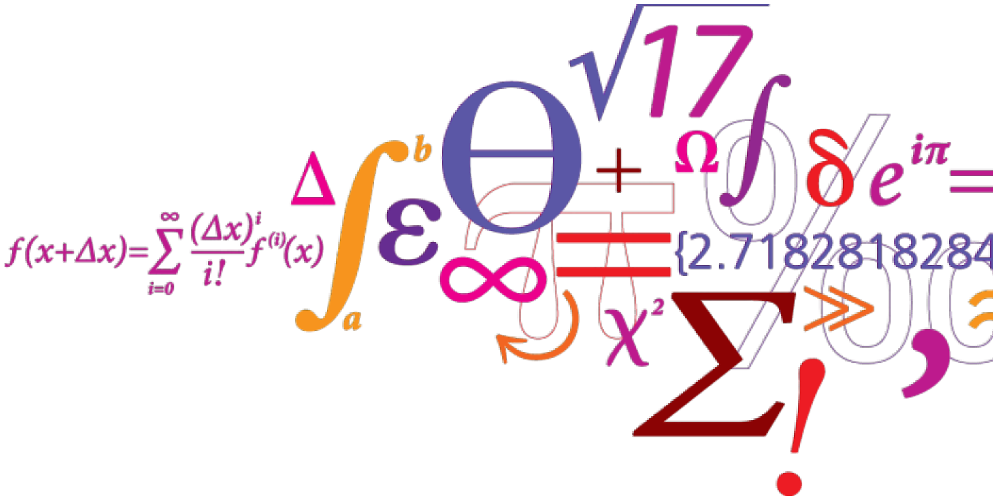

CITIES meeting
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DTU Electrical Engineering
Department of Electrical Engineering

Outline

- Master's thesis
  - Title: "Decomposition Techniques for Large-Scale Market Clearing"

- Current work

- Future work

Energy system as a whole

- Total **energy system** consists of various networks and models that are highly interconnected (e.g. el-gas-heat)

- Results in **large-scale** and **complex** networks

- Advanced techniques of **optimization** and **decision making under uncertainty** are required

MSc Thesis - Motivation

- Increased penetration of **renewable power production** in the power system
- Main **characteristics** of power produced:
  - Stochasticity
  - Non-dispatchability

  } Stochastic programming
- Solve stochastic unit commitment in **large-scale** power systems
- Results in more **complex** problems
- **Decomposition techniques** (e.g. Progressive hedging and Benders decomposition)
  - **Aim**: reduce computation time
  - Small trade-off in terms of suboptimality

Problem formulation

- Formulation of stochastic unit commitment as Mixed-Integer Linear Program (MILP)

- The model aims at **minimizing** expected total cost of operating the system subject to the appropriate constraints:
  - Requirements of power production units
  - Power system constraints

- Decomposition techniques → **promising tools** for solving large-scale problems

Results - Conclusions

- Computational results show that the **run-time** is at most half of what is needed to solve the original problem

- **High quality** solutions achieved

- Proposed model demonstrates great potential for solving real-world stochastic unit commitment in **tractable run-times**

- These techniques are a must-have when considering **complex market structures**

Renewable energy

- Increased penetration of renewables requires system **flexibility**
- Increased flexibility by **coupling** different energy system infrastructures
- Provide **reliable forecasting** in production and demand side
- Examine how forecasting **affects** market clearing procedure
- Forecasting: **key element** for decision makers in order to take optimal decisions and minimize potential risk of unexpected outcomes

Dealing with market clearing and forecasting in electricity-only setup within 5s-Future electricity markets project → Generalized in CITIES

Future work

- Develop **market structures and mechanisms** for the operation of integrated energy systems
- Take into account the **constraints** of various elements of the total energy system
- Develop models that take into account each system **own complexities** and **interactions** between different players as well as potential **synergies** among them
- **Coupling** of different markets and **designing** markets for multi-energy carriers
- Increased **uncertainty** in production and demand side
- E.g. gas-fired plants, el-gas-heat markets, storage facilities

Thank you for your attention !