ENGINEERING TOMORROW

# Heat Production Optimization

SDU / Danfoss student project case

# Heat Production Optimization - introduction

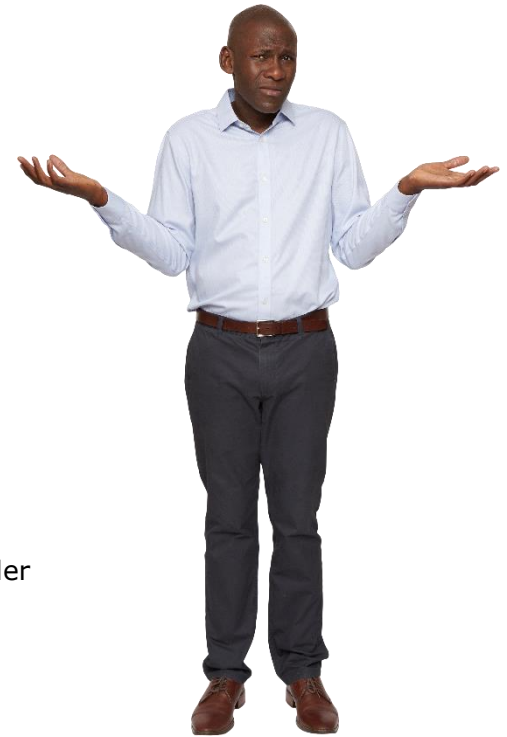
**What are you developing**

- Heat production optimization for a district heating utility
  - Secure heat availability for all buildings in the district heating network
  - Produce heat for the lowest costs
  - Utilize the electricity market for the highest profit or lowest costs

- 5 Components
  - Asset Manager (AM)
  - Source Data Manager (SDM)
  - Result Data Manager (RDM)
  - Optimizer (OPT)
  - Data Visualization (DV)

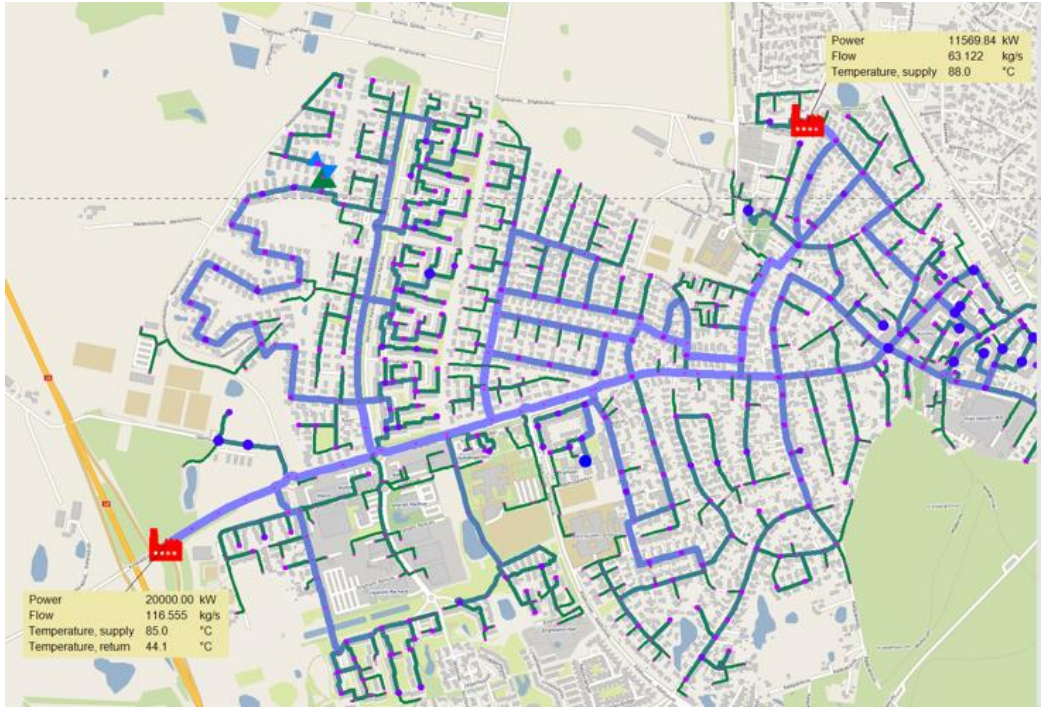
- 2 Scenarios
  - Single heating area, one gas boiler, one oil boiler
  - Single heating area, one gas boiler, one oil boiler, one gas motor, one electric boiler

- 2 Periods
  - Winter period
  - Summer period

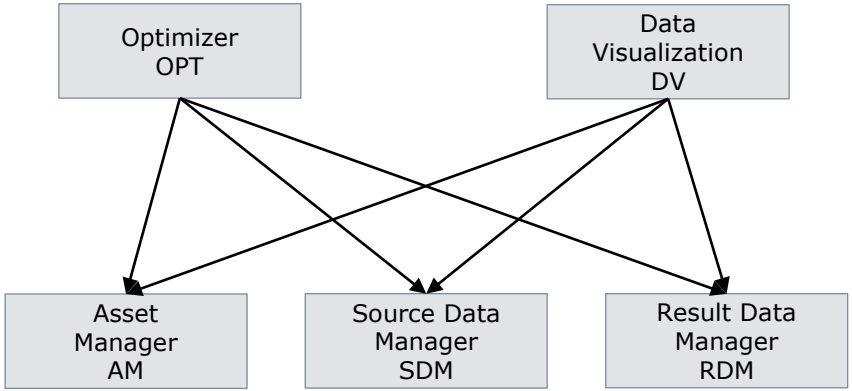


# Heat Production Optimization – district heating net

An example of a district heating net



# Heat Production Optimization - system overview




**All should implement the base modules**

- Asset Manager (AM)
- Source Data Manager (SDM)
- Result Data Manager (RSD)

**Specialize and select to implement one of the modules**

- Optimizer (OPT)
- Data Visualization (DV)

You are free to implement both modules

# Heat Production Optimization – modules

**Asset Manager (AM)**

Source repository for static system information

- Heating grid information such as:
  - Name
  - image
- Production unit information such as:
  - Name
  - Image
  - Produced heat
  - Produced / consumed electricity
  - Consumption of primary energy
  - Production costs
  - Produced $CO_2$ emissions

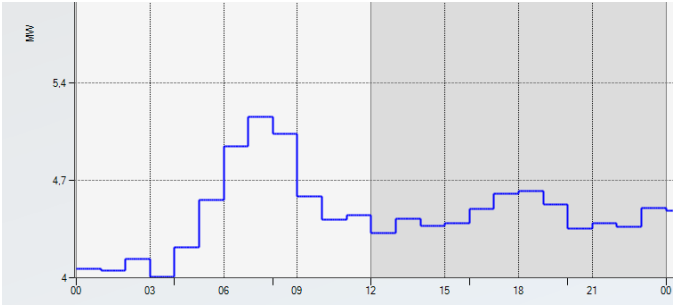
# Heat Production Optimization – modules

**Source Data Manager (SDM)**

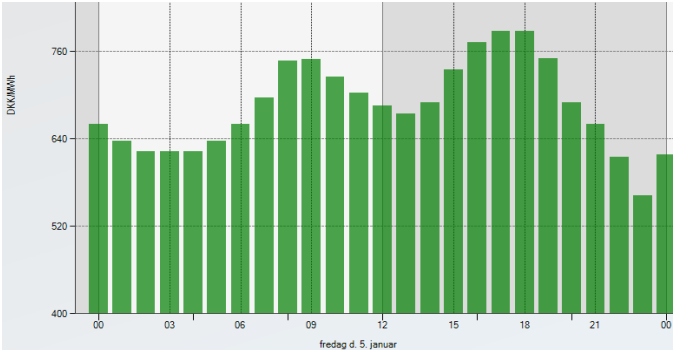
Source repository for dynamic system information

- Time series for heat demand in heating grid
- Time series for electricity prices

Example of a time series for heat demand with a 1-hour time resolution




Example of a time series for electricity prices with a 1-hour time resolution



# Heat Production Optimization - modules

**Result Data Manager (RDM)**

Sink repository for optimization results

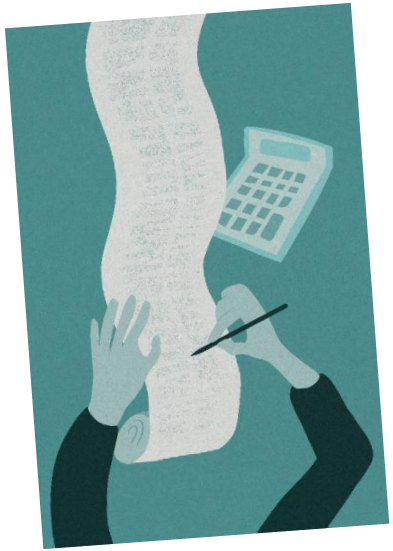
- Heat production
- Electricity production / consumption
- Expenses and profit
- Consumption of primary energy
- Produced $CO_2$ emissions

# Heat Production Optimization - modules

**Optimizer (OPT)**

Kernel module for optimization of energy production

- Secure heat availability
- Produce heat for lowest costs
- Produce electricity with highest profit
- Consume electricity with lowest expenses

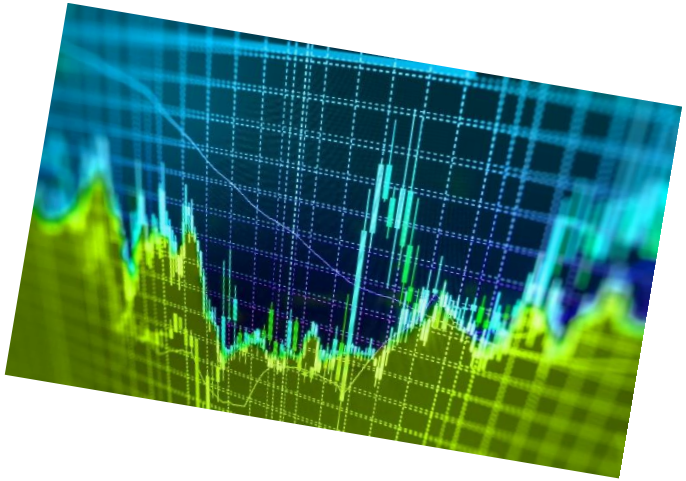


# Heat Production Optimization - modules

**Data Visualization (DV)**

Visualization of results via diagrams and charts

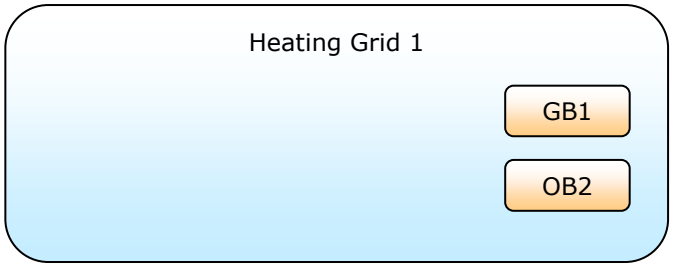
- Settings for production units
- Heat demand in heating grids
- Heat production
- Electricity production / consumption
- Electricity prices
- Expenses and profit
- Consumption of primary energy
- Priorities of production units (net production costs)



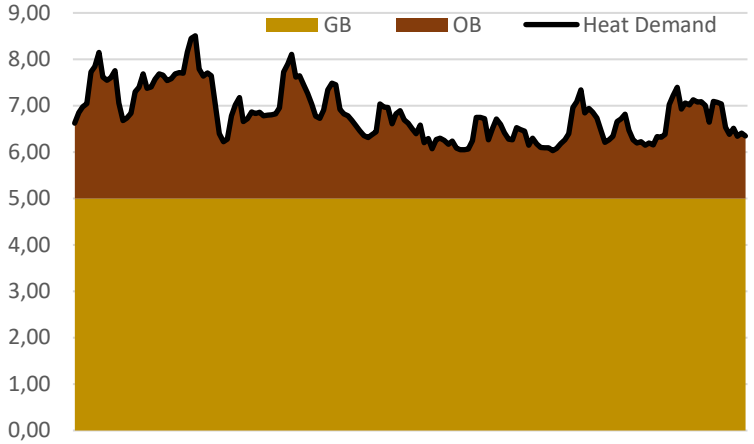
# Heat Production Optimization - scenario 1

Heat only optimization

Single grid system with
heat only boilers



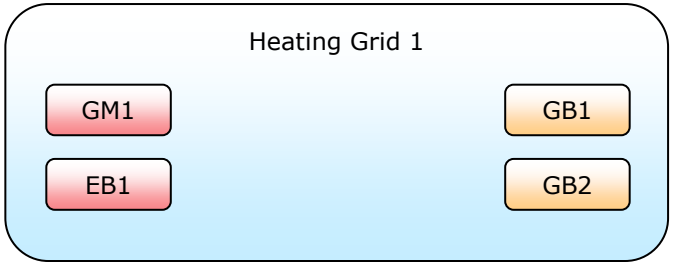

- 1 district heating network
- 1 gas boiler
- 1 oil boiler



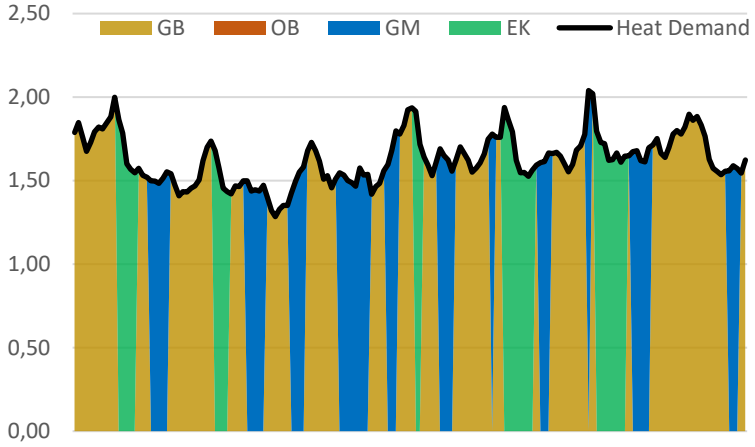
# Heat Production Optimization - scenario 2

Heat and electricity optimization

Single grid system with
heat only boilers and CHPs




- 1 district heating network
- 1 gas boiler
- 1 oil boiler
- 1 gas motor
- 1 electric boiler



# Heat Production Optimization – Danfoss delivery

**Data delivery**

Danfoss will deliver the following data:

- Graphical representation of the district heating network
- Configuration parameters for the heat production units, aka operation points, such as:
  - Graphical representation of the unit
  - Produced heat
  - Produced / consumed electricity
  - Consumption of primary energy
  - Production costs
  - Produced $CO_2$ emissions

- Heat demand and electricity prices for a 7-days winter period both with a resolution of 1 hour
- Heat demand and electricity prices for a 7-days summer period both with a resolution of 1 hour

# Heat Production Optimization – Project process

**What do you need to do**

- Understand the requirements
- Create software architecture definition (with stakeholders!)
- Analysis, design and implementation of the subsystems
  - Define domain objects
  - Define data transfer objects
  - Implement interfaces for data exchange
- Implement tests for the subsystems
- Implement a combined test of the entire system

# Heat Production Optimization – Additional exercises

**What more can you do (if there is time left)**

- If you have chosen to implement the Optimizer, also implement the Data Visualization.
- If you have chosen to implement the Data Visualization, also implement the Optimizer.
- Run scenario 2 with different configurations such as with or without the gas motor and compare the results in terms of revenue, CO2 emissions etc.
- Implement API´s for the communication between the modules.
- Implement an API client to call the API from Energinet.dk to directly read electricity prices from their web server.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