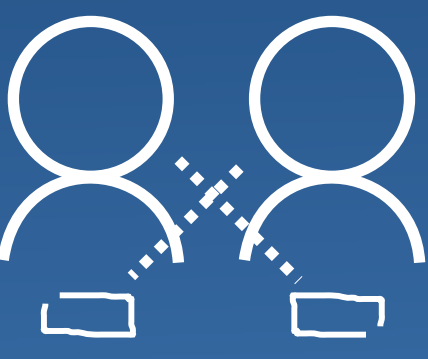


# Abstract



The objective of this project is to discuss the design and implementation of an agent-based approach for decentralized control in a heating grid - a heating grid consisting of basic CHP plants, boilers, storages and residential loads. .



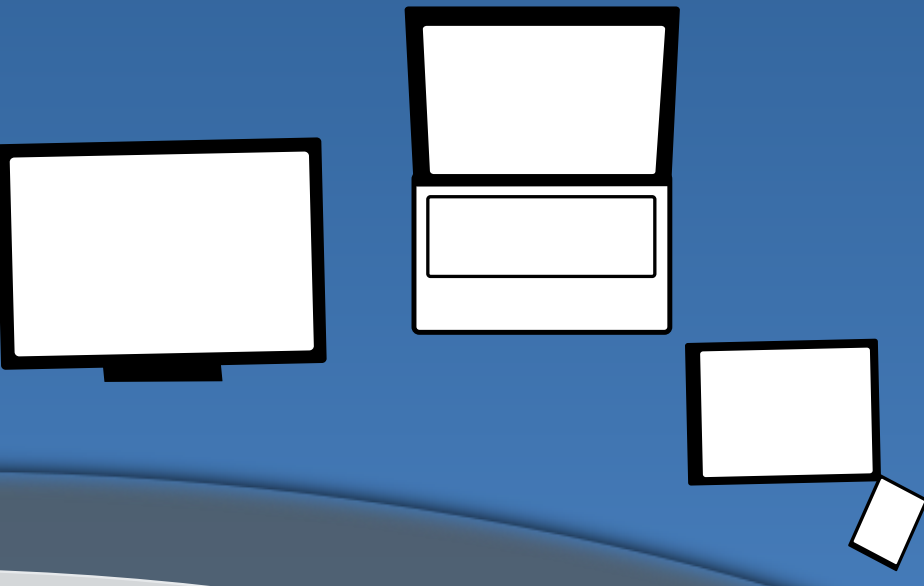
An agent-based application development involves model design, agent specification, application design, application realization and scenarios studies.



This application uses JADE to develop the agents and MATLAB/SIMULINK to provide a simulated environment. The simulation results indicate that the proposed agent-based application can operate each heat unit to meet the future heat consumption by using a priority-based decentralized control.

# Motivation

By a significant proportion of district heating in the German energy network, the control aspect towards the operation of heat units are of high importance. Given this fact, an agent-based approach is well suited for control and management systems in heating grids.



# Design

In this project, JADE (Java Agent DEvelopment Framework) is selected for application development. It simplifies the implementation of multi-agent systems through a middleware that complies the FIPA specifications. The idea behind an agent-based model is to break down a centralized system into a decentralized system.

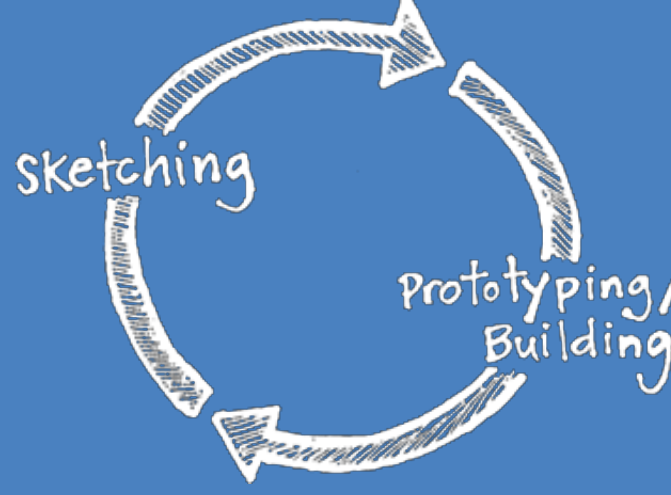
### Steps

Model Design: Combined Heat and Power plant  
Boiler, Storage, Household.

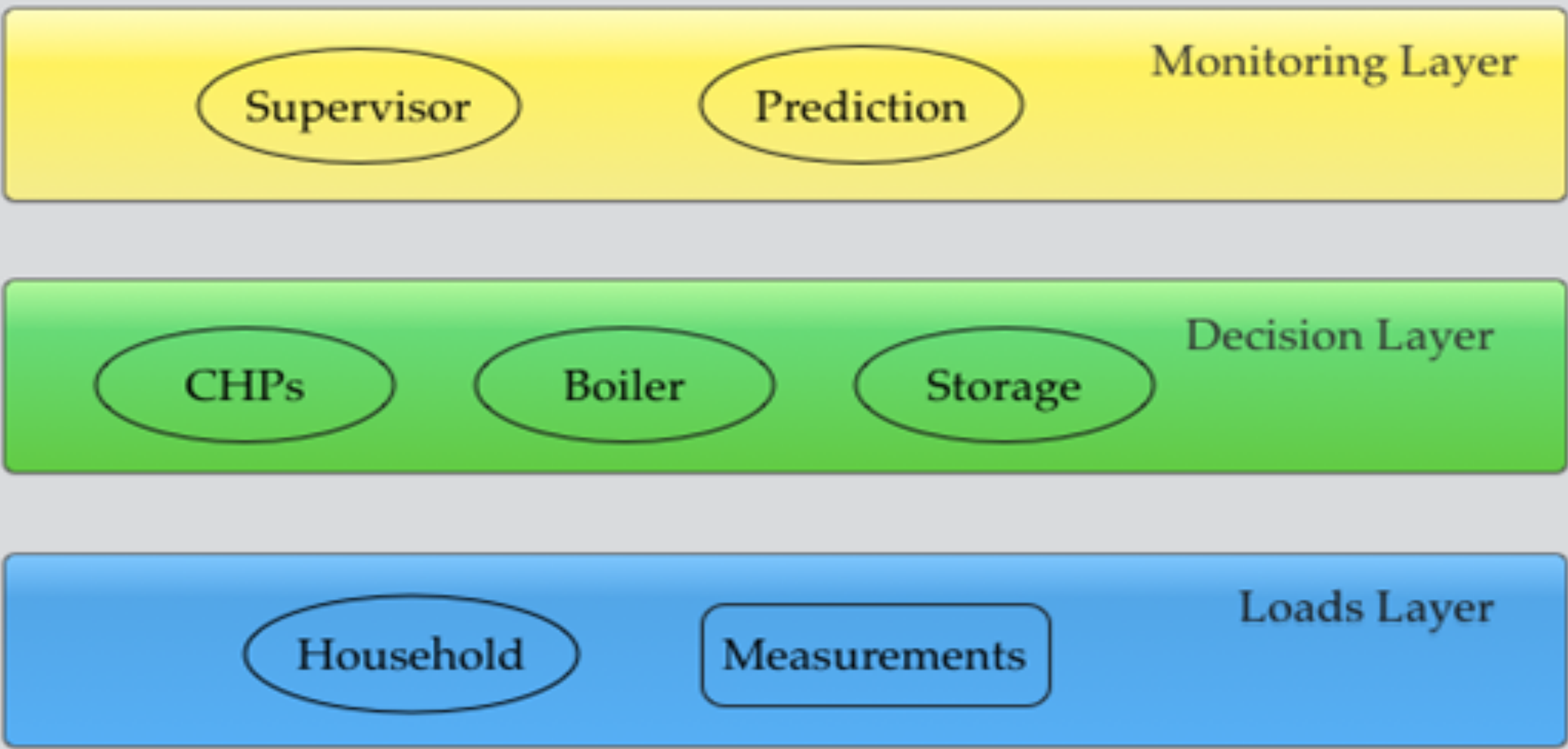
Agent Specification: Household agent, Prediction agent, Heat Unit agents, Supervisor agent  
TCP agent.

### Priority-based Decentralized Control:

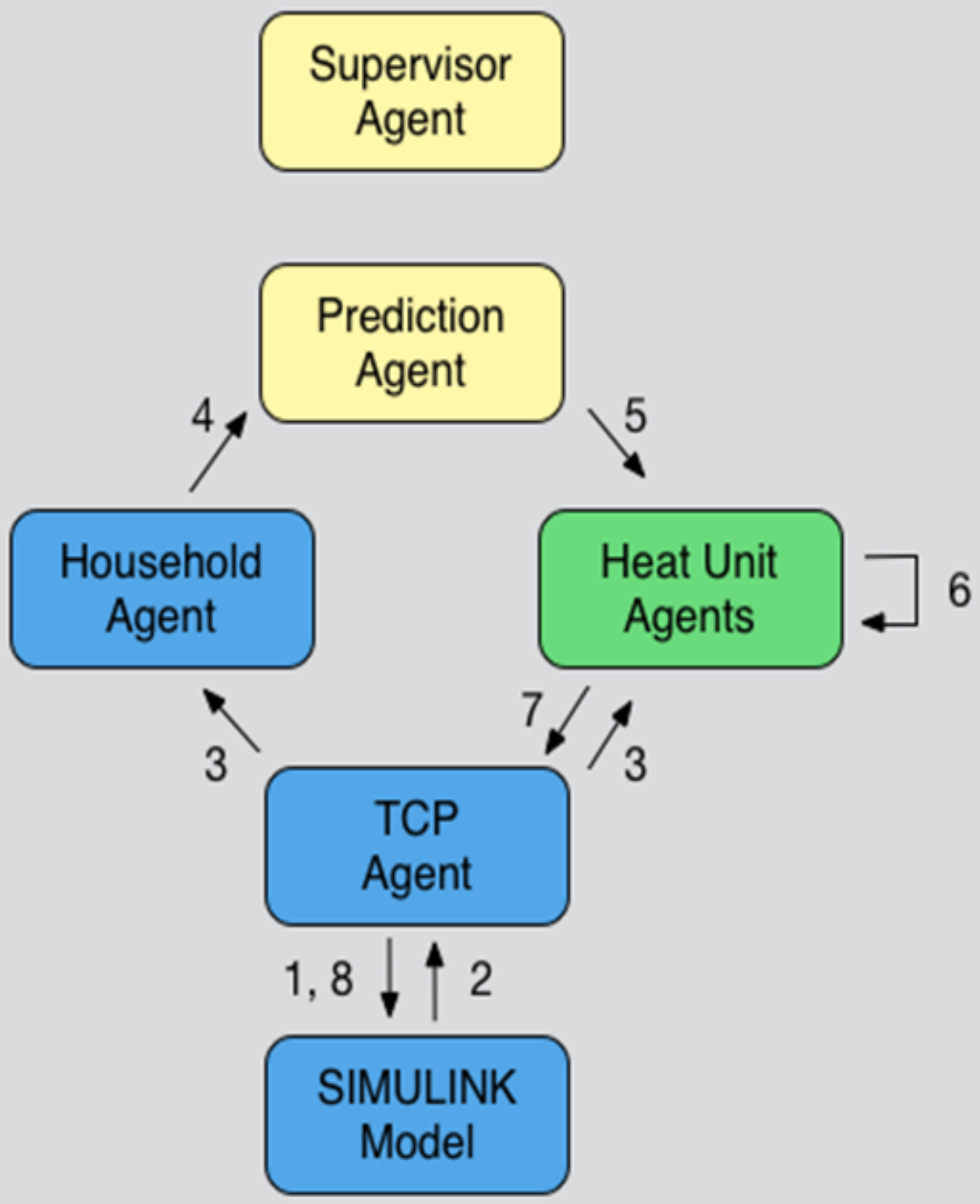
Heat Units are assigned priority considering the environmental and financial aspect. The highest priority heat unit agent has the first right to make decision. In the control strategy, a storage charging/discharging control algorithm as well as Energy Management System (EMS) algorithm are used.



## Hierachical Agent-based System Architecture

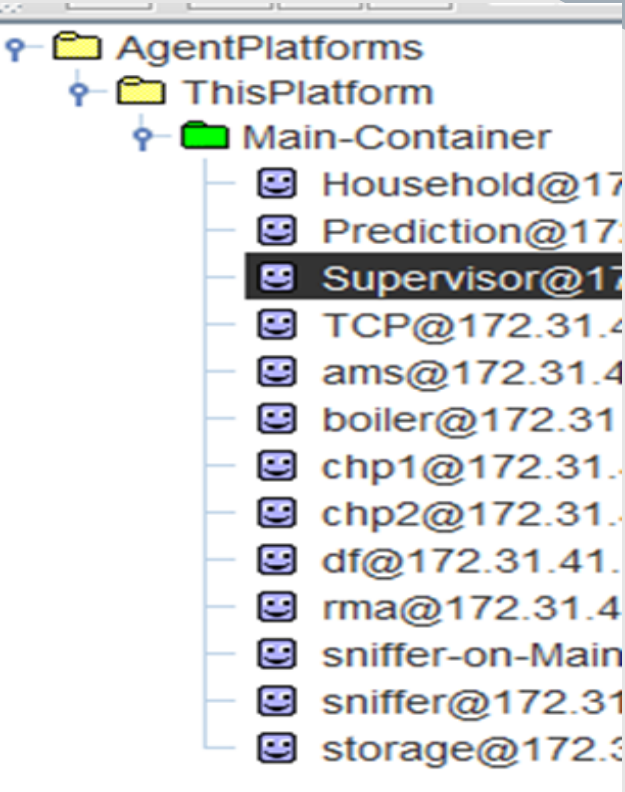
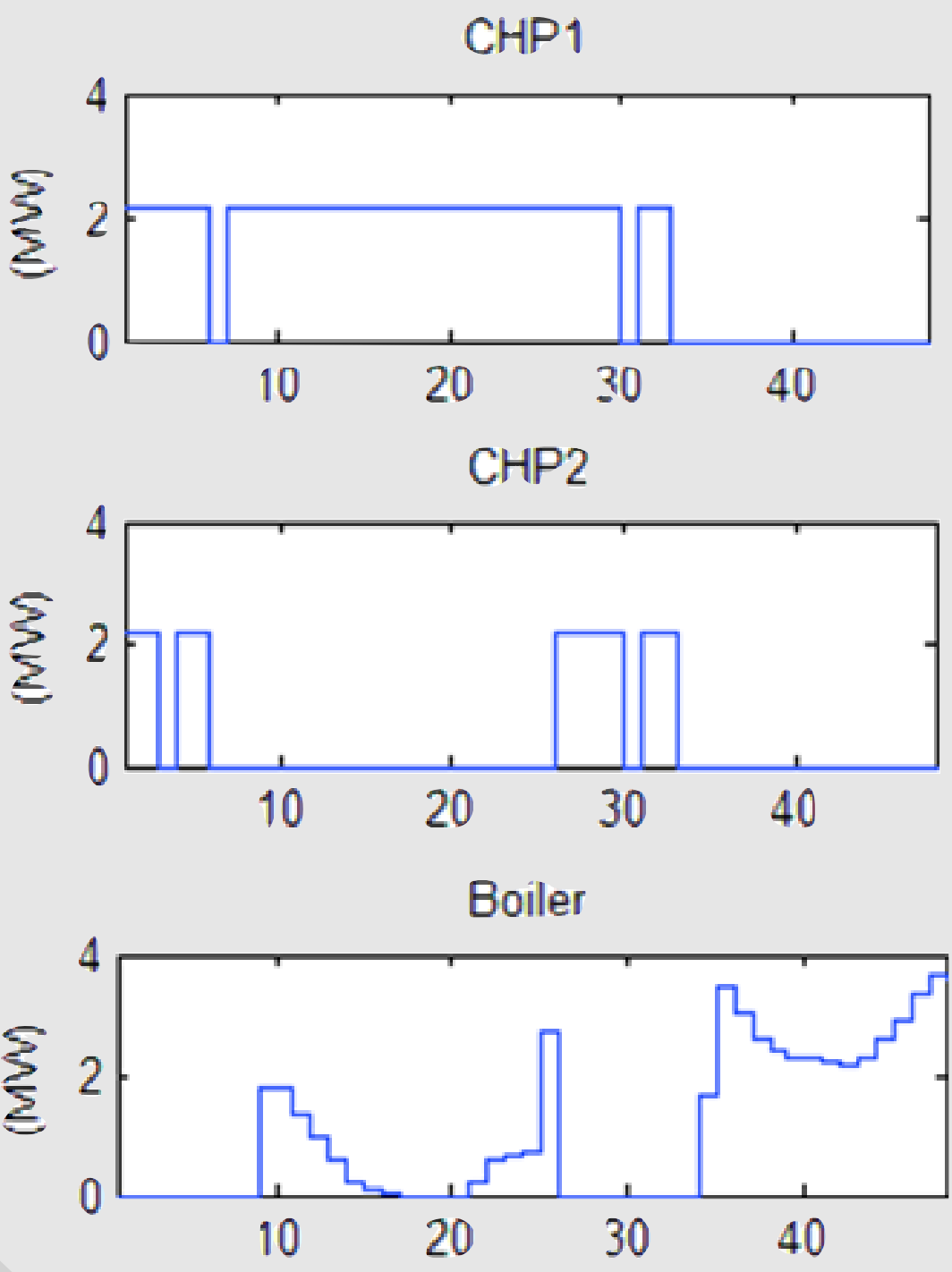


## Agent Interactions

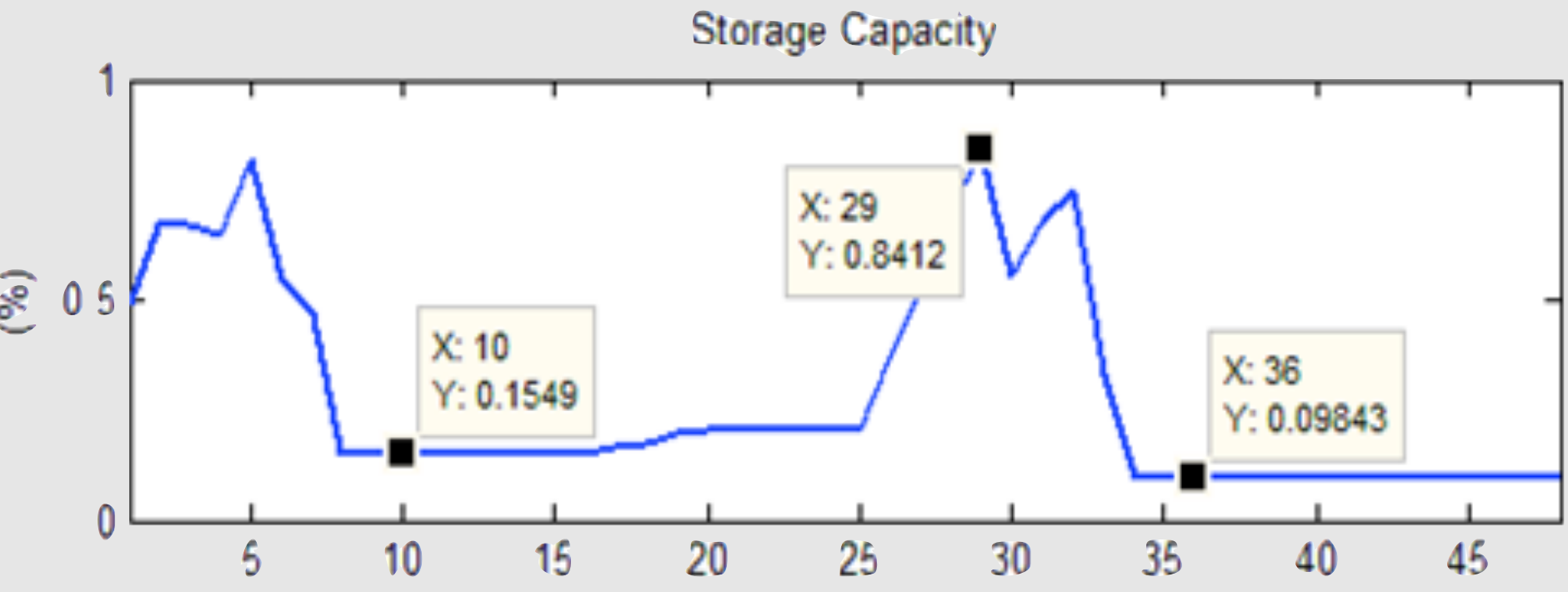
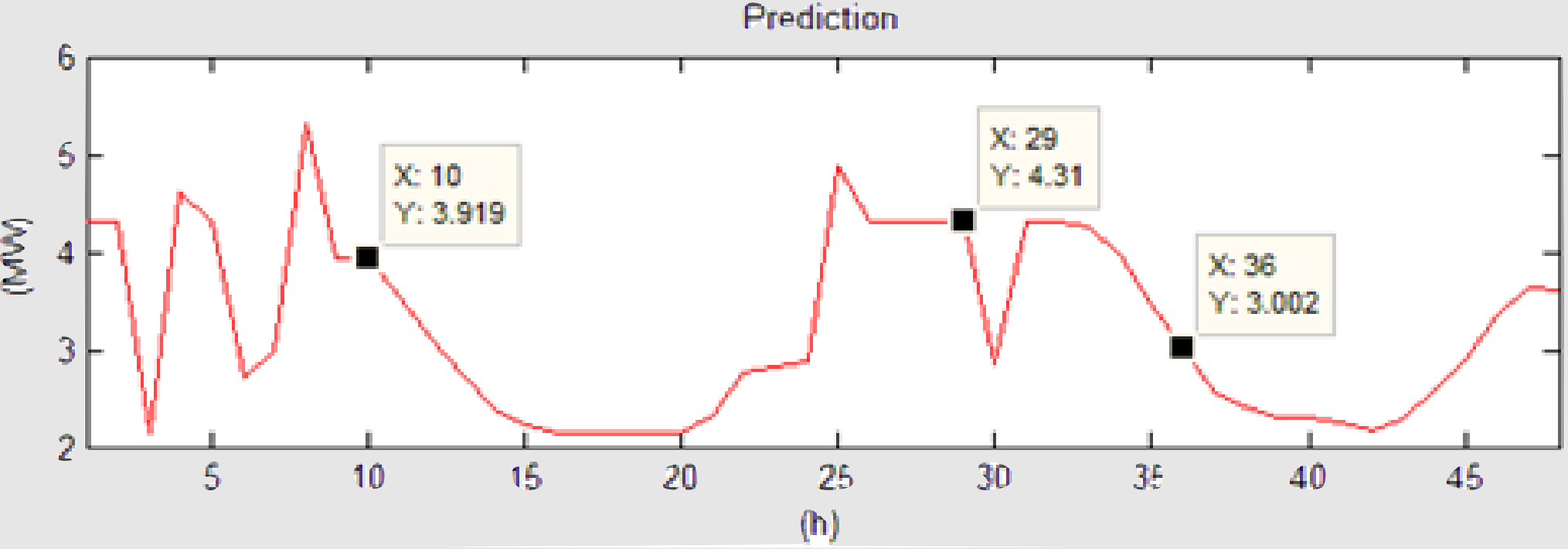


# An Agent-based Approach for Decentralized Control in a Heating Grid

Qu Ming



## Agents in JADE



## Future Scope

The project can be extended to a larger heating grid.

Prediction algorithms can be improved to be accurate.

The selling/buying heat energy market function for Household agent can be implemented.

## Scenario Test

## Conclusion

This project presents an agent-based approach for decentralized control in a heating grid. And the supervisor agent, prediction agent, heat unit agents and household agent exchange their messages via a TCP/IP protocol based on IEEE FIPA standard to ensure the system interoperability.

The given scenario indicates that the agent-based system can control the heating grid to protect the storage from overcharging or deep-discharging.

This proposed system illustrates the capability of an agent-based system as a technology for managing the heating grid operation.

## Scenario Test

The scenario shows that the operations of different heat units will meet the future demand.

Here, the system is tested within 2 days with the real household heat consumption data.

Before t=10h, CHP2 switches on/off for three times. Since the switch on/off times have a restriction below 3 times, chp2 won't work any more in this day.

At t=10h, the storage capacity is smaller than the minimum capacity. CHP1 switches on, but the power it produces cannot meet the demand, so another heat generator - boiler is imported.

At t=29h, the storage capacity reaches a high level. The storage itself can meet the required power. So CHP or boiler won't generate any heat at this time.