Research Paper:
A Tool for Modeling and Optimization of Residential Electricity Consumption

presented by:
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Outline

- Who we are
- Motivation and related concepts
- Focus and Objectives
- The Model
- Technology
- Screenshorts
- Conclusion and Outlook
- Its all open source @ sourceforge.net!

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Who We Are

- Students (8): Michael Belasus, Christian Bley, Mark Eilers, Michael Erlmann, Christian Hinrichs, Malte Hurrelmann, Ulrich Denecke, Moritz Eysholdt
- Supervisors: Prof. Michael Sonnenschein, Dr. Ute Vogel, Jörg Bremer, Barbara Rapp
- University of Oldenburg, Germany

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What We Did

- Projektgruppe DIEM: Demonstrator InHouse-Energiemanagement
- One year of work, approx. 16 hours per person per week

A Tool for Modeling and Optimization of Residential Electricity Consumption

Motivation #1: Electricity Supplier

- Adjust imbalances of power supply and power demand
  - Demand varies based on consumer habits
  - Supply of renewable energy based on weather conditions: sun, wind, waves, etc.
  - Production of balancing energy is expensive
  - Storage of electricity is difficult and expensive

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Demand Side Management (DSM)

...summarizes all utility activities that influence power consumption on the customer's side of the meter.

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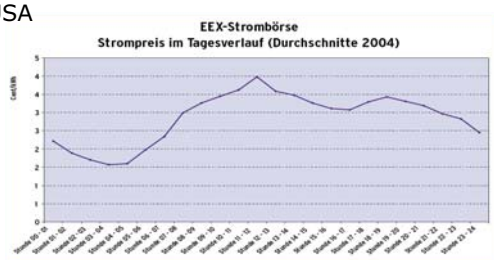
Fluctuating Power Tariffs

- Already available for major customers
- Field tests with residential electricity consumers
  - Eckernförde, Germany
  - California, USA



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Motivation #2: Electricity Consumer

a) Minimize electricity consumption
  - Efficient devices
  - Avoid unnecessary consumption

b) Minimize electricity costs
  - (a)
  - Shifting loads to times when cheap electricity is availabe

Our Focus

- Private households
  - Consumption in 2004 in Germany: 140TWh
  - This equates to 27% of the total consumption
  - Tend to have a lack of awareness for power consumption

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Our Solution

- Model and simulate the whole household's power consumption, including:
  - Devices and their usages
  - Tariffs
  - Loads

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Objective #1: Awareness

- Create awareness among the users for the impact of single devices on the total power consumption
  - Basic requirement to reduce power consumption

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Objective #2: Detect hidden devices

- Detect hidden devices by comparing measured loads with simulated loads
  - Devices
    - that consume electricity permanently or periodically
    - that the consumer might be oblivious about

Standby?

Boiler?

Heater?

Objective #3: Device Substitution

- Suggest devices with same functionality but less power consumption
  - We classify devices based on
    - Energy efficiency grade
    - Functionality

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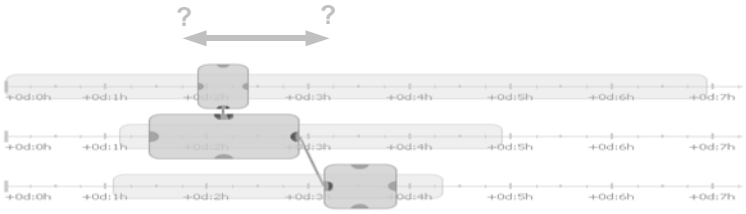
Objective #4: Schedule Optimization

- Optimize the activation intervals of devices based on a fluctuating tariff while preserving user defined constraints

-->Load Shifting



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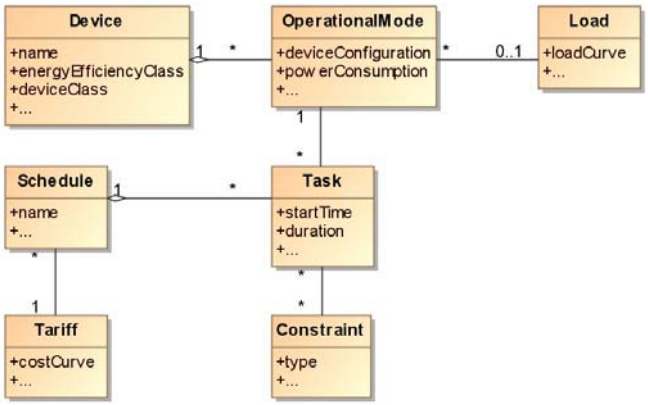
Model



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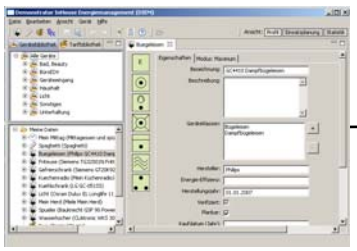
Architecture

Client: Desktop Application



Server: Web Application

* 0..1

The Server is optional

Client

- Eclipse-Technology:
  - RCP: Editors, Views, Perspectives
  - EMF: Data Model, XML-Support
  - GEF: Graphical Editors

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Server

- Generally: Success and effort of modeling heavily depend on availability of data
- Therefore: A Server as database for:
  - Devices
  - Tariffs
- Users can upload their devices to the server, administrators can verify these
- The server can automatically import tariff descriptions from other servers

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Server

- Runs within Servlet Container (Tomcat)
- Generates HTML via JSPs
- Uses the same EMF data model as the Client
- Persists its data via EMF Teneo, Hibernate and a PostgreSQL Datenbank
- Communicates with the client via XML over HTTP

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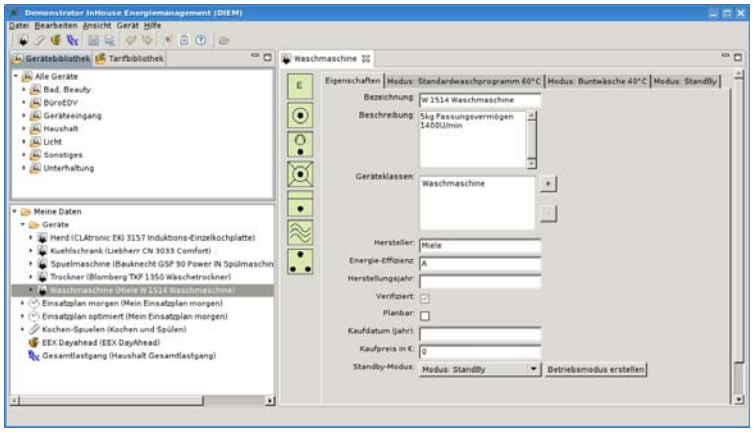

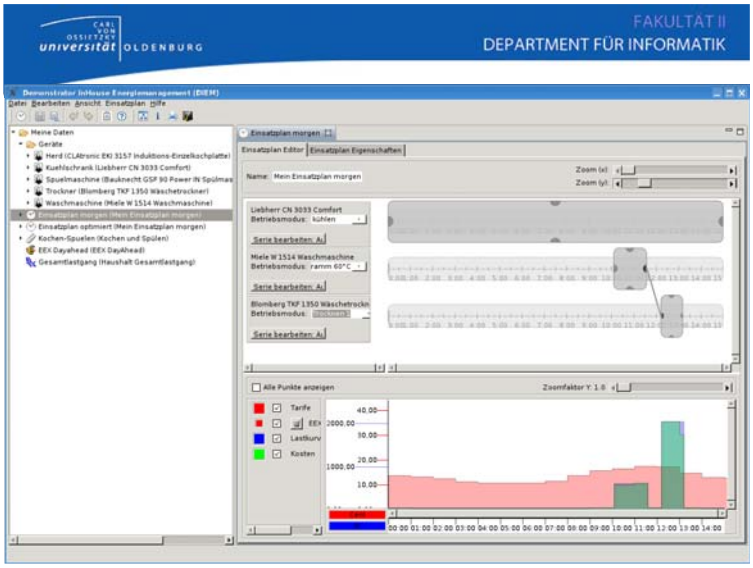

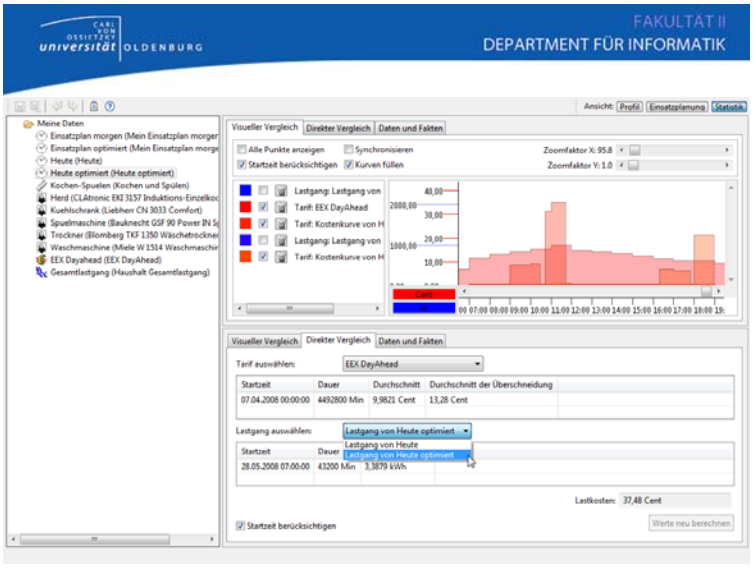

Conclusion

- Pro: It works
  - Find hidden power consuming devices
  - Substitute Devices
  - Schedule optimization
- Contra:
  - The effort of modeling is still tremendous
  - It is difficult and time-consuming to obtain good data, however, this is critical for usable simulation results

Outlook

- Applicability not restricted to private households
  - Tool usable for other fields without adaptation
  - Just the data would have to be changed
- Integration of periphery:
  - Sensors: automatic monitoring of power consumption
  - Actuators: Schedules could be “executed”, modeled devices would be controlled automatically
- Upcoming project: Subtask in the BMWi project eTelligence

Download, Inspect, Modify, Continue or Fork!

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Sources

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