Efficient Energy Management for Heterogeneous Energy Systems

Bachelor Project Proposal, WS 2013/2014 – SS 2014
Software Architecture Group, Prof. Dr. Robert Hirschfeld

Background: How to Mitigate Growing Energy Costs?

Today, there are many heterogeneous energy production systems that work in common but have no shared strategy for maximizing efficiency. On the one hand, there is decentralized heat production using mostly fossil fuels. Unfortunately, the loss of efficiency here is about 25 to 40% due to poor modulation of the participating production units. On the other hand, renewable energy sources are supposed to reach a market share of about 50%, which need to be integrated into the present energy grid, too. Additionally, the "German Renewable Energy Act" promotes private generation and consumption of electric energy. Thus, more and more heterogeneous energy production systems of different sizes with different interfaces need to be considered.

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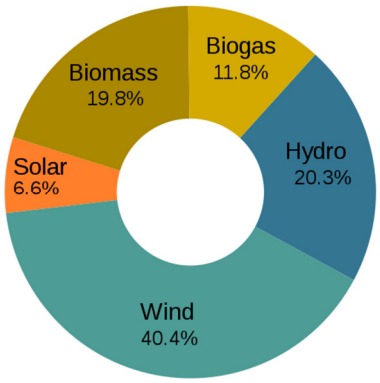
What happened? We decided to stop using nuclear power. As a consequence, we need to focus and extend the use of renewable energy sources. However, it is still unclear how to use them efficiently in the private sector. Often, production units are just added but not integrated in an optimal way. Thus, the costs for power supply are currently at 0.28 ct/kWh and are projected to be even 0.42 ct/kWh in 2020.

The vision is clear: We aim for supporting smart energy grids with cost- and consumption-efficient control mechanisms. We aim for promoting private individuals that want to produce heat and electric energy in a self-sufficient manner.

System Components and Use Cases in Housing Industry



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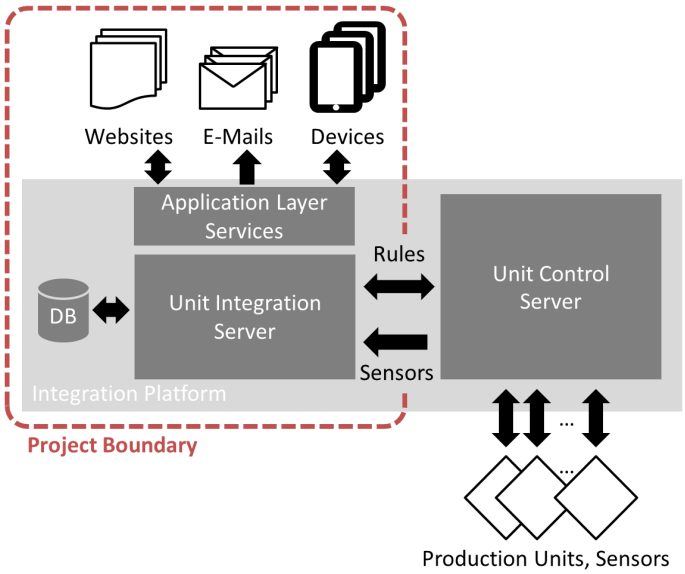
There are many different kinds of devices that are used in housing industry, which produce or convert energy. For example, mini CHP (combined heat and power) units burn gas to produce heat and electric energy for the base load and condensing boilers burn gas to produce heat for compensating peak loads. In addition to production, there are energy storage systems to handle varying loads efficiently such as Li-Ion batteries or heat crystallization storage systems.

All different components need to be integrated to support several stakeholders. Property owners want to monitor single components and control their functionality to improve cost efficiency. Service companies want to satisfy service level agreements and thus maintenance intervals.

Property management can improve bills of utility costs. Tenants benefit from usage histories and the possibility to monitor the energy consumption level by themselves.

The Project

The process of integrating multiple, heterogeneous energy systems is twofold: (1) creating a unified communication interface for all different kinds of production units and sensors and (2) creating a software layer that collects and analyzes sensor data to trigger appropriate rules and strategies for optimizing cost efficiency, CO^2 emissions, or other factors.



In the project the participants will work on the second part of this integration process. An application server should collect sensor data and trigger appropriate rules. A graphical front-end (for example a Website) should provide facilities for users to view data values and to allow for creating and modifying rules. Having this, both manual and automatic control of all involved production units should be possible.

The system should be modular and extensible. New production units and sensors can be included thus having to extend the interfaces for rules and sensor data. Additional endpoints (for example new mobile devices) should be able to communicate with the system with low effort to accommodate changing requirements in the future.

Organization

A group of about six to eight (6-8) students may participate in the project. Organization and tasks will be determined by the project participants. The project will be carried out at the Hasso-Plattner-Institut in Potsdam. Project participants are expected to communicate with our partner via email, chat, or voice on a regular basis. In WS 2013/2014, participants will work on initial design sketches and prototypes. Main steps in design and implementation are to be executed in SS 2014. Expected results include a working software system accompanied by appropriate documentation.

Partner & Contact

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