MINTernship Program

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Projects available at KIT for research interns from the University of North Carolina at Charlotte (UNCC)

Summer 2018

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# Table of contents

1. Port-Hamiltonian Modeling of Combined Heat and Power Plants .................. 1

2. Implementation and Automation of a Characterization Technique for Lithium Ion Batteries ........................................................................................................................................................................... 2

3. CFD-Study: Evaluation of Radiant and Convection Heating Systems for Renovated Buildings based on Thermal Comfort Criteria ................................................................. 3

4. Analysis and Simulation of the UK Energy market ........................................... 4
1. Port-Hamiltonian Modeling of Combined Heat and Power Plants

Abstract of the project

Combined heat and power (CHP) represents a key technology for a sustainable future energy supply. A CHP plant is a complex system which covers multiple physical domains (gas, electricity, heat). Due to this complexity, model-based methods are required for the control of such systems.

Port-Hamiltonian systems combine the ideas of port-based modeling (Bond graphs) and classical Hamiltonian mechanics. Due to their multi-physical nature and their ability to treat complex networked systems, they provide a promising approach for the modeling and control of CHP plants. Thus, in this project we want to investigate the port-Hamiltonian modeling of CHP plants.

The project is in cooperation with Viessmann which is an international CHP manufacturer headquartered in Germany.

Tasks

- Revision of the essential physical equations
- Formulation of a Bond graph for the CHP plant
- Derivation of a port-Hamiltonian model
- Extension of the model by the plant’s control systems
- Simulation and validation

Requirements

Competences in mathematical modeling and control engineering

Language skills

English

Software skills

MATLAB

Other skills

Good team player

Minimum Duration of the project

10 weeks

Type of research project

Project in a research institute

Responsible Professor

Prof. Sören Hohmann

Supervisor/Mentor of the project

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Faculty, Institute or Name of the Company

Faculty of Electrical Engineering and Information Technology, Institute of Control Systems

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D-76131 Karlsruhe
Germany
2. Implementation and Automation of a Characterization Technique for Lithium Ion Batteries

Abstract of the project

More and more energy is generated by renewable resources such as sunlight, wind, rain, tides, waves and geothermal heat. Because renewable resources possess a volatile character the energy has to be stored if there is oversupply in order to use it if the energy demand is higher than energy production. A possible storage technology is a lithium ion battery. At the Institute of Control Systems two related research topics are investigated. The first considers single cells. First, a fractional model with physical interpretable parameters is derived. On this basis, new methods for online parameter identification are developed. The second topic focuses on the monitoring of every cell in a battery pack which is important to minimize the balancing current. To this, different observer strategies are developed and benchmarked. To validate the new methods of both topics precise information of the investigated batteries is needed. Therefore, special measurements are performed in the laboratory. To perform these measurements at our own we want to develop a toolchain designed for our measuring equipment.

Tasks

- Familiarization with the current measuring equipment and the relevant theory
- Development of different realization options
- Implementation and optimization of the options
- Validation and benchmark

Requirements

Knowledge in electrical engineering or control engineering or related areas, interest in measurement engineering

Language skills

English

Software skills

MS Office, MATLAB/SIMULINK

Other skills

-

Minimum Duration of the project

10 weeks

Type of research project

Project in a research institute

Responsible Professor

Prof. Sören Hohmann

Supervisor/Mentor of the project

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Faculty, Institute or Name of the Company

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3. CFD-Study: Evaluation of Radiant and Convection Heating Systems for Renovated Buildings based on Thermal Comfort Criteria

Abstract of the project

This internship is part of a project “called LowEx” coordinated by KIT university and Fraunhofer ISE in cooperation with industry partners like Viessmann, Bosch, Stiebel Eltron. The aim of the LowEx project is to develop energy efficient solutions such as low-temperature heat pumps and improved radiant and convection heating systems for renovation of multi-family houses (more information about the LowEx project: goo.gl/SfS3Tp).

When renovating residential buildings, high living standards and human health must be ensured. For this, thermal comfort is a key issue. Towards the goal of the LowEx project and with a focus on the thermal comfort theme, the building science group (fbta) of KIT evaluates the performance of radiators and convectors based on heating capacities and thermal comfort using CFD simulations and experiments in a laboratory called LOBSTER (www.lobster-fbta.de).

During this internship, the research focus will be on energy analyses and CFD simulations of the radiant and convection heating systems. The results of simulations will be validated by experimental data.

Tasks

- Extension of available CFD models
- Energy analysis and simulation of different types of radiator and convector heating systems in buildings

Requirements

- Basic understanding/interest in the field of heating systems, ventilation and fluid mechanics
- Interest in learning CFD software

Language skills

Fluency in English

Software skills

Data analysis software such as excel, R and MATLAB

Other skills

N.A

Minimum Duration of the project

6 weeks

Type of research project

Project in a research institute

Responsible Professor

Prof. Andreas Wagner

Supervisor/Mentor of the project

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Faculty, Institute or Name of the Company

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## 4. Analysis and Simulation of the UK Energy market

<table>
<thead>
<tr>
<th>Abstract of the project</th>
<th>In liberalized electricity markets, market participants and researchers use market models to simulate wholesale prices, which are necessary for investment decisions or power plant dispatch as an input for power grid simulations. To ensure the accuracy of simulated results it is necessary to have detailed and in-depth knowledge about the respective market area and market participants.</th>
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| Tasks | The student’s task is to analyze the Energy Market in the UK. Specific tasks can include:  
- Based on internally and publicly available sources, the student analyzes the consistency of the demand and supply data. The findings are then validated using an existing electricity market model by comparing simulated wholesale prices with historic values (e.g. for the year 2016)  
- The UK only recently introduced a capacity market. While the goal is similar to PJM’s capacity market, to secure the appropriate amount of generation resources, there are differences in the implementation. The student will perform a comparative analysis of PJM’s and UK’s capacity market with a focus on modelling aspects. |
| Requirements | Experience and interest in energy economics related topics, especially energy markets |
| Language skills | Fluency in English |
| Software skills | - |
| Other skills | Result orientated way of working, ability to work independently |
| Minimum Duration of the project | min. 10 weeks, up to 12 weeks |
| Type of research project | Project in a research institute |
| Responsible Professor | Prof. Wolf Fichtner |
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