Energy informatics

Interdisciplinary Education, Training and Research

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UNIVERSITETET I OSLO

Energy Informatics: Concerned with leveraging *information and communication technology* to achieve *sustainable energy systems*

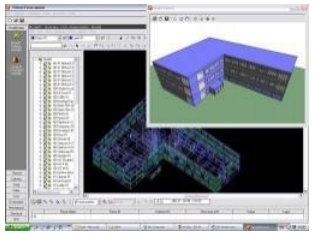
Energy

Manage energy more sustainably

More sustainable computer systems

Informatics

Role of Information Technology

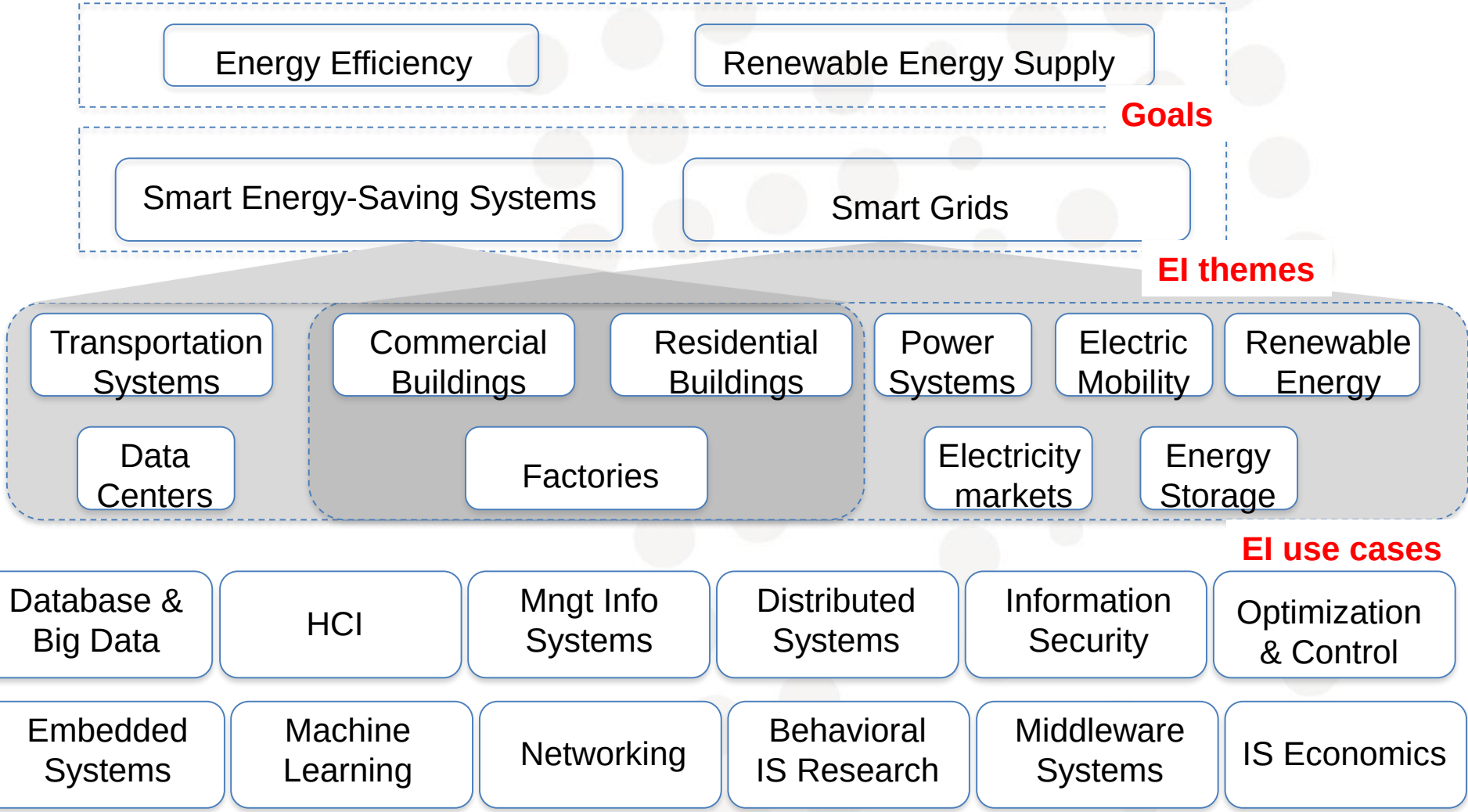


- Reduce ***energy consumption***
  - Analyze energy consumption
  - Actively avoid wasting energy by intelligent automatic control
- Enable further ***electrification***
  - Replace over-provisioning with intelligent control
  - Enable electric heating and mobility
- Enable deep ***renewable integration***
  - Help to make electricity demand more flexible
  - Enable intelligent control of flexible loads and energy storage
- Assess the ***impact of technology deployment***
  - Simulate impact of renewables, energy storage, and energy-saving technology

Why education in energy informatics?

- **Observation**: To realize the future energy system, the Energy sector is facing the two challenges: 1) applying state-of-the-art ICT knowledge, e.g., machine learning, big data; 2) short of talents
- **Urgent need:** graduates who have good knowledge of ICT and good understanding on how to apply ICT techniques in the energy sector

Energy informatics: scope



After: Goebel et al, 2013

EDUCATION & TRAINING

Energy Informatics: a new Master/PhD level course from Spring 2017

Goal

Provide a good understanding of how to apply ICT methods, tools and techniques in energy systems

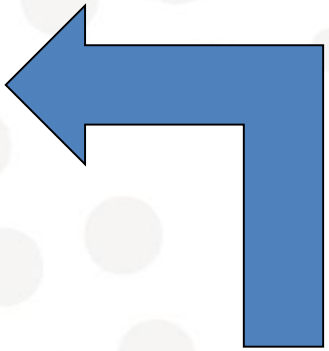
Features

- Very tight collaboration with industry with 10+ invited speakers from industry experts every semester
- Learn and apply state-of-the-art ICT techniques for future energy systems
- Learn through assignments, programming and real datasets

Our teaching topics

Energy Areas

- Smart Grid
- Energy Market
- Demand Response
- Electric Vehicles
- Vehicle-to-Grid (V2G)
- Renewable Energy Forecasting



How ICT can tackle energy issues

Informatics

- Cloud/Fog Computing
- Green Data Center
- Game Theory
- Internet of Things, Blockchain
- Cyber Security
- Machine Learning, Deep Learning

Learning Goals

- **Knowledge**
  - different energy systems - e.g., smart grid, electric vehicles, vehicle-to-grid, storage, transport, buildings, renewable energy resources
- **Good understanding**
  - where and how computer science techniques - e.g., machine learning, apply for future sustainable energy systems
  - connection between principles and their applications in real systems
- **Skills**
  - how to evaluate power systems with real data sets and tools e.g., to assess the integration of renewable resources, storage and electric vehicles
- **Connections**
  - meet power industry invited speakers and executives
  - meet researchers from the field electrical engineering

LUCS Project granted by RCN/SiU

Learning to Understand and Control nation-wide Smart grids of energy prosumers

[simula . research laboratory]

Technische Universität Berlin

GT ARC

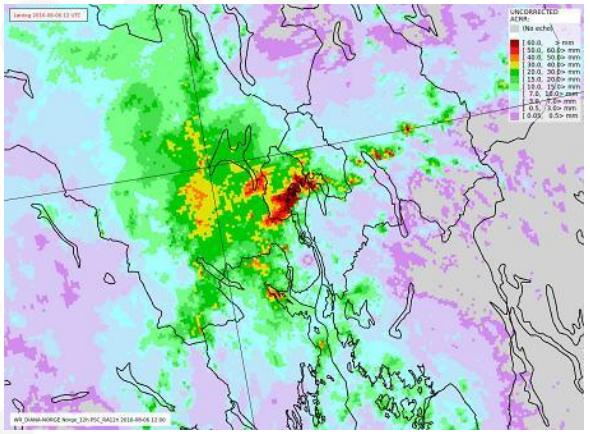
- 2018-2021
- Student and researcher mobility project between universities/research institutes in Norway and Germany
- It will mainly support student mobility, mutual research visits, summer schools, workshops, intensive courses, and development of new courses in the field

INTEGRARE Project granted by UiO:Energy and JST:

Intelligent prediction and integration of renewable energy sources into the Norwegian electricity grid

- **2016-2018**
  - **Student and researcher mobility project between University of Oslo and Keio University, Japan**
  - **Addresses the need for transforming the future energy system based on renewables through: a) accurate prediction of WT power generation in Norway; b) designing intelligent energy management considering energy storage**

We define interdisciplinary master thesis projects to train the students



Machine Learning, Deep Learning

- For wind energy forecasting
- For battery health prediction

Green Cloud

- Wind-driven Clouds: investigating the benefits achievable from co-locating data centers and wind farms

Electric Vehicles

- How Many Charging Stations Needed for EVs in Oslo by 2020?

Projects with industry

- Prediction of household level load (with Hafslund (a DSO))

OUR RESEARCH

Our research expertise on Energy Informatics

- Smart Grid/ Energy efficiency

- Control & Optimization

- Green Computing with Fog/Cloud

- Data Analytics

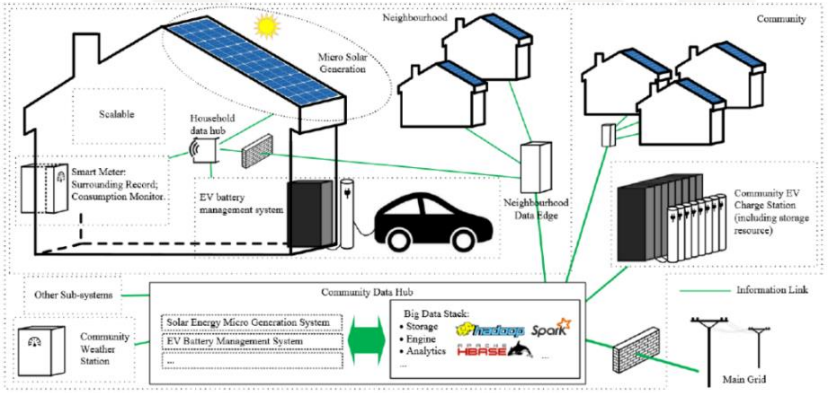
Our current projects related to Energy Informatics sponsored by EU and RCN

- TIDENET (RCN)
- IoTSec (RCN)
- INTEGRARE (UiO:Energy)
- DILUTE (RCN)
- SmartNEM (RCN)
- GreenCharge (H2020)
- LUCS (RCN/SiU)

SmartNEM project granted by RCN

Smart Neighborhood Energy Management (2017-2022)

- **ICT-driven decentralized grid infrastructure integrating prosumers**
  - Fog computing for **real time monitoring** and distributed microgrid **resilience**.
  - Machine learning and deep learning for energy **forecasting**.
  - **Security and privacy**-preservation for smart homes and neighborhoods.
  - Blockchain solutions for local and community level **P2P energy trading**.
  - **Integration of local energy sources** at homes, neighborhoods and community level into the grid.
- **8 PhD scholars are supported**



IoTSec project granted by RCN IKTPLUSS program:

Security in IoT for Smart Grids

- **2016-2020**
  - **Build cyber-secure power network**
  - **Address the business and end users needs**
  - **Apply results in industrial smart grid center**

Challenges and outlook

Interdisciplinary area

- Collaboration with engineering disciplines
- Collaboration with non-engineering disciplines
- Exchange of models, methods and data

Organization

- How to organize an interdisciplinary programme like energy informatics?

Outlook

- Further curricullum development (more specialized courses, project course with industry, EI lab facilities) …
- Will Univ Oslo provide the needed resources?

Questions?