Energy Systems Integration 101

National Renewable Energy Laboratory

Golden Colorado, July 21-25, 2014

The International Institute for Energy Systems Integration [1] presents an introductory course on Energy Systems Integration (ESI). The course will cover the concept of ESI at all scales (from residential to continental) across multiple energy (and non-energy) domains e.g. electricity and gas nexus, electricity and water nexus, gas and transport etc. from a technical, market and regulatory perspective. The course is designed for graduate students and practitioners working in the field to give them a perspective on the state of the art in ESI. Each of the first four days will consist of 4 hours of lectures and 4 hours of projects work, with some hands on numerical modelling and forecasting exercises. The final day will be for each team to report out on their project.

Curriculum

The ESI subject is vast and the course is designed to illustrate the breadth and importance of the area while highlighting some specific methods and applications at a level of detail that is challenging and useful to the students.

Introduction

- Energy Systems Integration (ESI) – what is it and why is it important.
- Benefits of ESI – a set of concrete examples and some quantification of benefits and values.

Energy systems domains and interactions

- Gas/electricity nexus, what is it, why is it important, what are the opportunities, what are the research challenges, what tools are available and what tools need to be developed, and modeling challenges.
    - Similarly the water/energy nexus and transport/energy nexus will also be covered.
- The role of the residential homes and campus/district-level energy systems in the future. What are the energy vectors, what services do they enable and how best to integrate the technologies including heat pumps, combined heat and power and smart meters.
- Integration of variable renewables into the energy system (local and regional scales), long term planning of the networks and short term operations and the need for stochastic approaches (optimization, control, forecasting etc.).

[1] In association with the National Renewable Energy Laboratory (NREL), Centre for IT-Intelligent Energy Systems (CITIES), Joint Institute for Strategic Energy Analysis (JISEA), Pacific Northwest National Laboratory (PNNL), Electricity Research Centre (ERC) of University College Dublin, Iowa State University (ISU).

Methods, tools and applications

- Simulation tools and techniques including optimization codes, unit commitment and dispatch etc.
- Optimization of networks; all energy networks (e.g. gas, electricity, heat) should be planned and operated in an optimal manner individually and in particular when they are coupled.
    - Campus level heat and electricity modelling, control and optimization.
- Why is greybox modelling, forecasting and control important in ESI and what are the methods best suited to the applications? This topic will have a hands-on greybox modelling and forecasting exercise – using R – to be downloaded by students – there will be a detailed pre instructions so as students are well prepared.

Regulatory, policy and business models

- Policies that are supportive of harnessing the benefits of ESI.
- Business models in ESI in particular on the gas electricity interfaces.
- Transactive control, what is and why is it important in the future integrated energy system

Project work

The students will be allocated to teams of four at the start of the week and will be assigned a country or region. For their assigned country or region they will be asked to prepare a slide deck answering the following questions.

- What will be the energy mix of this region be in 2030 & 2050.
- How "integrated" will the energy system be both across domains and scales?
- Give examples of the above and justify them on the basis of their benefits (economically, reliability, security of supply, environmental) e.g. thermal capacity in buildings for grid services.
- Identify technical and/or policy/regulatory innovations required to get to this future energy system.
- What tools techniques will be required to inform this?

Instructors

- Prof. Mark O'Malley, ERC, University College Dublin
- Dr. Ben Kroposki, Dr. Jaqulein Cochran, Mark Ruth & Patrick Sullivan, NREL
- Prof. Henrik Madsen, CITIES, Danish Technical University
- Prof. Jim McCalley, Iowa State University
- Rob Pratt, PNNL
- Others TBA

The course is sponsored by iiESI with the generous support of NREL, CITIES, PNNL, ISU, ERC, and Xcel Energy. There is no fee for this course but participants will have to cover their own transport and accommodation costs. There is a limited number of available seats so register soon.

To register for the course, please go to https://www.surveymonkey.com/s/BKFZLLC. For further information contact Judy Will at NREL (judy.will@nrel.gov).