IGERT

University of Texas at Austin

Sustainable Grid Integration of Distributed and Renewable Resources

IGERT* External Advisory Committee Meeting

October 4, 2011

ECJ 10th floor

UT-Austin

*Integrative Graduate Education and Research Traineeship Program

Tuesday, October 4:

8:15 Continental Breakfast

8:45-9:00 ***Welcome***

9:00-9:15 ***Introduction of Advisory Committee, UT Investigators, and Program Overview***,
Tom Edgar

9:15-9:45 ***Pecan Street Project Update***
Brewster McCracken

9:45-10:30 ***Discussion of interdisciplinary curriculum, recruitment, outreach, and website,***
Michael Webber, Tom Edgar, Alexis Kwasinski, Ross Baldick, and Pam Cook

10:30-10:45 ***Break***

10:45-11:45 ***Introduction of new Trainees: Aria Berliner, Robert Crawford, and Arturo Gutierrez***
IGERT Trainee Presentations – Education and Research (10 min. each)

Akshay Sriprasad
Hunter Estes
Matthew Charlton
Dave Tuttle
Gregory Dahlberg

11:45-1:00 ***Lunch***

1:00-1:45 ***IGERT Affiliates – Education and Research*** (6 min. each)

Charlie Upshaw
Josh Rhodes
Amir Toliyat
Wesley Cole
Robert Fares
Steve Bourne
Kody Powell

1:45-2:05 ***Report on Trip to Munich***

Hunter Estes
Dave Tuttle
Akshay Sriprasad
Gregory Dahlberg

2:05-3:05 ***Meeting of Advisory Committee with IGERT Trainees***, Pam Cook and Darlene Yanez

3:05 ***Break***

3:15-3:45 ***Write up program evaluation report***

3:45-4:00 ***Discuss evaluation with IGERT Executive Committee***

4:00 ***Meeting adjourned***

6:30 ***Dinner at Threadgill's - 301 West Riverside Drive - Austin, Texas 78704***

External Advisory Committee Members

Pat Chapman	Solarbridge
Mike Hightower	Sandia National Labs
John Hoffner	CH2M Hill
Bill Kramer	NREL
Brewster McCracken	Pecan Street Project
Karl Rábago	Austin Energy
Peter Sauer	University of Illinois U-C
Noel Schulz	Kansas State University
Jeff Tester	Cornell University

UT – Austin IGERT Grant Overview

Sustainable Grid Integration of Renewable and Distributed Resources

- 20 faculty from Architecture, Engineering, Business, Law, and LBJ School and 11 IGERT Fellows/year ($3 million over 5 years)
- Student research projects carried out in areas of power distribution, energy storage, business utility/consumer models, systems modeling and integration, and building-integrated solar energy (two year fellowships)
- Coordination of interdisciplinary course sequence from the five schools
- Based around goals of the Pecan Street Project
- Internships in industry/government organizations and study abroad (TU München)

Executive Committee

- **Thomas Edgar** , PI
  Chemical Engineering
- **Ross Baldick** , Co-PI
  Electrical and Computer Engineering
- **Suzanne Barber**, Co-PI
  Electrical and Computer Engineering
- **Alexis Kwasinski**, Co-PI
  Electrical and Computer Engineering
- **Michael Webber**, Co-PI
  Mechanical Engineering

Participating Faculty

- David Adelman
- David Allen
- John Butler
- Ulrich Dangel
- James Dyer
- Matt Fajkus
- Robert Hebner
- Kara Kockelman
- Arumugam Manthiram
- Jeremy Meyers
- Buddie Mullins
- Atila Novoselac
- Rod Ruoff
- Surya Santoso
- Alexandre da Silva
- Keith Stevenson

Administration

- **Pam Cook**, Project Coordinator
- **Darlene Yanez**, Assessment Coordinator
- **Sarah De Berry-Caperton**, Administrative Associate

IGERT Trainees (Two Year Fellowships)

Second Year

- **Akshay Sriprasad –** Chemical Engineering (T. Edgar)
- **Hunter Estes –** Electrical and Computer Engineering (A. Kwasinski/R. Hebner)
- **Matthew Charlton –** Materials Science and Engineering (K. Stevenson)
- **Dave Tuttle –** Electrical and Computer Engineering (R. Baldick)
- **Gregory Dahlberg –** Electrical and Computer Engineering (A. Kwasinski)

First Year

- **Rosaria Berliner –** Civil, Architectural, and Environmental Engineering (K. Kockelman)
- **Robert Crawford –** Mechanical Engineering (A. da Silva)
- **Arturo Gutierrez –** Materials and Science Engineering (A. Manthiram)

Affiliates

- **Steve Bourne –** Civil, Architectural, and Environmental Engineering (A. Novoselac)
- **Wesley Cole –** Chemical Engineering (T. Edgar)
- **Robert Fares –** Mechanical Engineering (J. Meyers)
- **Kody Powell –** Chemical Engineering (T. Edgar)
- **Josh Rhodes –** Mechanical Engineering (M. Webber)
- **Amir Toliyat –** Electrical and Computer Engineering (A. Kwasinski)
- **Charles Upshaw –** Mechanical Engineering (M. Webber)

Pecan Street Project
Mueller Demonstration Project

- DOE Smart Grid Funding $10.4 million + $15 million matching/ infrastructure (12/2009), also CAPCOG, Doris Duke Foundation
- Data collection from pilot group of homes to see how various technologies affect electricity usage, bills, utility finances, environmental outcomes, and overall system performance
- Industrial affiliates program initiated (~$500 k/yr)

IGERT Curriculum

- Interdisciplinary courses offered
- List posted on website
- Five new courses under development

IGERT Enrichment

- Weekly meetings and presentations (since 10/10)
- Ethics seminar (2/2011)
- Study abroad (May-June, 2011) – TU Munich (Werner Lang – liaison)
- IGERT Project: Church energy audit (March-August, 2011)
- Commercialization Short Course (PSP – August 17-19, 2011)
- Outreach events

Outreach Project – Energy Evaluation of University United Methodist Church

- Large church adjacent to campus
- Student teams studied lighting, chiller operation, building envelope, HVAC
- Students met with Austin Energy experts in beginning/end
- Smart meters provide data on overall energy use
- Report is posted on IGERT website

New Student Recruitment

- On-line application on IGERT website
- http://research.engr.utexas.edu/igertsustainablegrids
- 2010 class (existing UT students nominated by faculty)
- 2011 class (selection of students who applied, nominated by UT faculty)
- 2012 class (outreach to targeted schools)

IGERT Curriculum – New Courses

1. Modern Control Theory (Edgar)
2. Intro to Electric Power and Locational Marginal Pricing Short Course (Baldick)
3. Technology Commercialization Short Course (Webber)
4. Advanced Topics in Power Electronics (Kwasinski)
5. Animation of Home Energy Management Systems (Barber)

Modern Control Theory with Application to Energy Systems – Spring 2012

(Thomas Edgar)

- **Control Theory** – linear systems, state space analysis, continuous/discrete time, nonlinear programming formulations, optimal control, model predictive control, Kalman filter, recursive parameter estimation, adaptive control
- **Control Applications**

Introduction to Electric Power
(three-day short course proposed Spring 2012)
Professor Ross Baldick

- **Course Motivation:** The electric power industry forms a central part of the context for the IGERT. The class will provide a non-technical introduction to the electric power industry as a whole, reviewing similarities and differences with other industries, the main components of power systems, power flow, locational marginal pricing, and including issues related to wholesale and retail restructuring of electricity markets, transmission access, "loop flow," regulation, and risk hedging.
- **Learning objectives:** Students will gain the following knowledge to facilitate their understanding of the electric power industry: Basic definitions of electric power quantities; Similarities and differences between electric power and other industries; Components of an electric power system, Electric transmission and power flow; Offer-based economic dispatch; Hedging energy price risk; Locational marginal prices; Hedging transmission price risk; Transmission planning. The students will use a software tool, PowerWorld, to develop understanding of power flow. IGERT trainees and industrial attendees will both participate in this short course, providing opportunities for cross-fertilization between students and practitioners.
- **Course Deliverables:** A series of quizzes will be conducted throughout the course. There will be a small "capstone" design project conducted in the last section of the course that will illustrate design and planning of electric power systems, and the implications of differing regulatory structures.

Advanced Topics in Power Electronics

(Redeveloped course. Regularly offered in fall of odd years)
Assistant Professor Alexis Kwasinski

• **Course Motivation; New Content:** Analysis of power electronic circuits involves understanding complex topics related with nonlinear circuit design, control systems theory, and materials physical properties. Power electronic circuits are essential components in the development of sustainable energy systems, particularly for integration of renewable energy sources and energy storage devices. This re-developed course now focused on topics germane to issues found in power electronic circuits applied to sustainable energy systems.

• **Learning objectives:** This course has two main goals:

• The first goal is to discuss technical topics related with advanced power electronics. Newly added topics addressing the new focus on sustainable systems include effects of real sources (fuel cells, PV cells, wind generators energy storage devices) in power electronic circuits, maximum power point tracking, grid interaction with microgrids and power electronics converters for renewable and alternative energy systems.

• The second goal is to prepare the students to conduct research or help them to improve their research skills.

• **Course Deliverables:** Homework assignments, which are assigned every 2 weeks, include comprehensive questions that usually require students to conduct some research to answer them. This research work may include performing literature reviews, model and simulating a system or component, and identifying suitable tools to solve numerical problems. The course also includes a project that mimics the work required to prepare a conference paper and presentation. At the end of the course students submit a short paper and present their work to the rest of the class.

Home Animation (proposed Fall 2013) Professor Suzanne Barber

- **Course Motivation:** A home in the future will automatically "animate" or adjust to its occupants including the occupants' preferences, location in the home, time of day, type of activity, and energy conservation demands.
- **Learning objectives:** Students will learn through experience by designing a home animation system for an given home structure and customer (hopefully, volunteers from the Pecan Street project or The University of Texas). The home animation design must satisfy constraints of the home, meet customer requirements and take full advantage of current and envisoned technology available from the commercial sector and R&D labs. Students will gain the following knowledge and skills to utilize in their design teams: systems engineering, requirements engineering, system design, project management, teamwork and communication methods.
- **Course Deliverables:** Each deliverable will be documented in a report and a presentation delivered to the course instructor and respective customers.
  - System Vision document describing the stakeholders and home animation system design concept and intent.
  - System Requirements delivered in a system requirements document complete with traceability to the system project scope definition and stakeholders providing respective requirements.
  - System Design specification detailing multiple system views (Capability View, Solution View and Deployment View) and system uses. Students will deliver and present the Home Animation System Design in two milestone: Initial Design Review and Final Design Review.

Smart.Clean.Energy

Weeklong short course August 2011 and Jan 2012)

Professor Michael Webber, ATI & PSP

- **Course Structure:** Weeklong Short course, August 15-19, 2011
  - **3-day Energy Technology & Policy (Webber)**
  - **1-day Smart Grid (Pecan Street Project)**
  - **1-day Energy Commercialization (Austin Technology Incubator)**
- **Instructors:** Webber & UT professors (Business, Policy, Engineering); Pecan Street Project Staff; Entrepreneurs; Executives from Fortune 500 companies (Sony, Best Buy)
- **Participants:** Industry, regulators, entrepreneurs, investors, students
- **Course Motivation:**
  - Bring together a general multidisciplinary education on energy with a deeper dive on the smart grid and commercialization
  - Bring together professionals, students, investors, regulators, and entrepreneurs
- **Next Offering**: either December 12-16, 2011 or January 9-13, 2012