SYLLABUS: Enabling Energy Efficiency: Practice and Innovation

3-0-9 Fall 2013
Lecture: Wednesday, Friday: 2-3:30PM  (9-354)

Instructor: Harvey Michaels
Lecturer and Research Director - Energy Efficiency Strategy Project
Massachusetts Institute of Technology, DUSP Environmental Policy and Planning
77 Massachusetts Avenue, Room 9-328, Cambridge, MA 02139
508-740-9233 hgm@mit.edu

How do we Scale a Good Idea?  When homes and buildings are fully upgraded to save energy, the electricity and gas needed to provide comfort, light and other end uses is cut by half. With innovations in policy, business models, media tools, and technologies, the total energy use in all buildings could be dramatically reduced: as a result in January 2013, the Presidential State of the Union Address offered a US goal to achieve a 20% reduction in all electric and gas use by 2030 through a 50% reduction in building energy waste. This goal makes economic sense, as the cost to upgrade homes and buildings to save energy is much less than the cost of energy no longer needed as a result.

Further, research evidence continues to grow that greenhouse gas emissions must be reduced to sustain a livable Earth. An aggressive plan, like those put forward in Copenhagen, requires the developed world to reduce carbon emissions by 5% per year. Efficiency opportunities which pay for themselves with energy savings can easily address over half of what we need to do between now and 2050, and it is impossible to accomplish the carbon reduction goal without energy efficiency. However, achieving deep efficiency gains across all homes, buildings, and communities has proven to be a challenging objective.

Enabling Energy Efficiency: Practice and Innovation – is a subject designed to develop class member capabilities to participate in the growing opportunities in building-related energy efficiency policy, programs, services, information technologies, physical systems, and business strategy. The skills acquired provide a foundation of technology, economic, business and planning tools to address the student’s professional objectives as well as the background to engage in related research and thesis topics.

Assisted by frequent guests, including leading practitioners in energy efficiency policy, business, or technology innovation, we will explore how to mitigate efficiency’s market and regulatory barriers. Over the semester, class members evaluate innovative strategies and put forward their own approaches to achieving scalable energy efficiency, including analyses from multiple perspectives; and offer brief but compelling policy or business case presentations and written assignments.

Classes develop working knowledge of the multiple dimensions energy efficiency, including:

- **Technologies:** new green buildings, retrofits, controls, renewables, microgrids
- **Societal policy:** Utility and government incentive programs, building and retrofit ordinances, and appliance standards
- **Internet control/feedback systems**, and the impact of consumer and community behavior.
- **Energy resource planning and evaluation**, integrating efficiency with renewable supply options and smart grid technologies.
- **Business, government, and community delivery models:** such as:
  - **Community Engagement:** Creating effective partnerships with cities and community based entities, such as recent Boston and Cambridge climate and buildings programs, and
Marketplace innovations: New business approaches, and policies promotive of innovation, such as efficiency technology and financial services, digital energy information, and control technologies, that all add to our leadership in these important emerging fields.

In each dimension, we consider the history, current status, future trends, and key issues and controversies. A particular focus this semester will be on the connection of building efficiency and climate policy, advanced technologies including “intelligent buildings” and behavior-based efficiency, energy bill disclosure and community efficiency program models, as well as new business approaches.

Skills: Through class work, assignments, and software tool instruction, class members develop capability in building energy analysis, economic resource planning principals and methods, energy information and behavioral analysis, strategy development, and evaluation methods. The focus on energy efficiency also serves as a case study, providing a more general framework to analyze and articulate promising energy innovations in policy and business, including renewable energy, carbon policy, integrated electric planning, transportation and electric vehicles, advanced utility grids and microgrids, and community planning and engagement.

Practice Capabilities: An important focus for the class is to develop capability to frame and articulate strategies in professional environments, including:

- Focused guest interviews with government/industry leaders.
- Written short assignments to propose, analyze strategic approaches to scaling transformative ideas.
- Presentations and discussion leadership with class peers, as well as with guests/leaders.

Subject Overview: Class members will develop a working knowledge in all aspects of energy efficiency, and apply this knowledge and tools to developing strategies for large scale efficiency.

- Looking back, we will critically examine three decades of uneven progress in enabling energy efficiency though programs, policies, and business models.
- Looking forward, we will consider the opportunity today to accelerate the growth of efficiency, and related opportunities for class members in research, business development, and practice.
- In the final segment, each of the members will articulate a position, with documentation, on a policy or business approach to successfully achieving large scale, credible, and quantifiable energy efficiency resources.

The class is structured in three segments:

Segment I. Energy Efficiency “Boot camp”: In the first class segment, we explore the paradigm of promoting efficiency as a resource, comparable to drilling for oil or building electric stations, and establish our process to discover paths to achieving energy efficiency at greater scale in society. Specific attention is placed on:

1. Establishing a foundation and our motivation to pursue advanced efficiency with a summary of principles.
2. Understanding the state of efficiency in society: size of the opportunity, value, issues.
3. Economic Perspectives: the relationship of efficiency costs to the cost of alternative energy supplies.
Classes in the first segment include (weeks 1-4)

- Introduction and perspectives (1/1)
- Demand-Side of Energy and Utility Economics (1/2)
- Greenhouse Gas Impacts from Efficiency (2/1)
- Residential and Commercial Building Efficiency Technology (2/2)
- Intelligent Efficiency and Demand Response
- Enabling Smart/responsive Energy behavior (3/1)
- State and Federal Efficiency Programs (3/2)
- Remaining barriers (4/1 and 4/2)

Segment II. Energy Efficiency State of the Art: Current and Emerging Practice Methods in Business, Programs, and Policy (weeks 5-10): With articles and discussion, we will review leading ideas for innovation in achieving efficiency at scale. Each week in the second segment, we will examine and discuss case studies, supported by speakers and an examination of tools and methods used in efficiency planning and execution. During the class, with the support of guests from government and industry, we examine and consider:

- **Efficiency Policy**: We consider current and pending energy legislation worldwide impacting buildings, such as building codes, energy efficiency resource standards, appliance standards.

- **Advanced Buildings and Services**: We examine the opportunities to build extremely low energy use homes and buildings cost-effectively, and how we can achieve their widespread adoption.

- **Behavior-based Efficiency**: We consider how to drive the market for building upgrades, as well as consider new approaches to behavioral response to information, benchmarking, and disclosure.

- **Intelligent Efficiency Systems**: We look at the relationship of energy efficiency to the Smart Grid, with specific examination of grid connection to intelligent building technologies for efficiency and demand response.

- **Efficiency and the “Utility of the Future”**: How can energy efficiency programs integrate with renewables, electric vehicles, and distributed generation to minimize energy use and carbon emissions, and possible directions for new regulatory models.

- **Efficiency Planning Methodology**: Planning, implementing and evaluating utility efficiency programs and considering elements of plan-making:
  - Estimating Impacts and establishing cost-effectiveness.
  - Developing demand-side energy plans and economic analyses.
  - Designing Implementation Strategies
  - Evaluation methods: Process and Impact

- **Mobilizing Communities** has been an area for invention for the class and its students, including methods for community:
  - Goal setting, campaigns, and monitoring for efficiency and carbon.
  - Broadening the reach of utility programs through community-based marketing.
  - Innovations in program design and delivery, including property tax financing of consumer efficiency improvements, and social marketing approaches (Web 2.0).
Segment III. Synthesis - Scaling Up Efficiency. (Weeks 10-13). With articles, reflection and discussion, we will review leading ideas for innovation in achieving efficiency at scale. We consider as a class: Which ideas have the potential to change everything? And how do we go from a good idea to reality and scale?

Students build on the framework and methods of the class to consider their own bold but realizable opportunities for efficiency. Students describe a case study example with presentation, discussion, and then a final paper of a policy or business option that they find of interest, addressing how their method compares with supply options, as measured by the critical dimensions of quantity of energy delivered, cost, pollution created (esp. greenhouse gases), timing, and safety.

Key Readings: All reading materials for the class are posted on the Stellar site: https://stellar.mit.edu/S/course/11/fa13/11.168/index.html The materials are open to all MIT and non-MIT class participants.

- During the first segment (weeks 1-5) class members will read and consider key reading materials prior to each class discussion, as indicated. Optional materials are also offered for each Segment 1 topic.

- During segment 2 (weeks 5-10), the week’s readings will be parsed among class member groups based on interest, and each group will bring ideas and points for discussion to class. The segment 2 list may be revised depending on speakers and class interests.

- The Stellar site also contains categorized resources to aid in Segment 3 project analysis and to support individual in-depth interests.

Assessment: Student performance in this class is based on multiple factors including:

- Effective participation - As a seminar, class members are key contributors, as evidenced by preparation, thoughtful contribution, and regular attendance. - 20%

- Foundation topic presentation – In the first half of the class, each member will research and provide brief oral and written report on a foundational topic of current significance to efficiency enablement. - 20%

- Journal – On occasion, class members will be asked to prepare a one page response (or PowerPoint slide) to a question based on the readings, discussion, and the professor/guest lecturers for that week. – 20%

- Final project – As described above, class members will develop an efficiency opportunity (business, policy, or program) case paper and presentation to class, which will be designed to achieve a significant impact as measured in energy and carbon benefits, with attention to originality, feasibility, and scalability. - 40%

Bio: Harvey Michaels teaches energy efficiency with focus on strategy innovation, and directs the MIT Energy Efficiency Strategy Project, which conducts business/policy studies of utility, community, and smart grid-enabled efficiency deployment models. Harvey also participates in the MIT Energy Initiative and the Campus Energy Task Force, and serves as an advisor to Massachusetts utilities on community energy programs.

From 1997 to 2007, Harvey led Nexus Energy Software (now Aclara Software) which builds utility efficiency and customer service Web sites, as well as Meter Data Management systems. Before founding Nexus, Harvey was president of XENERGY (now part of DNV/KEMA Consulting and Con Edison Solutions), which specialized in efficiency resource studies and analysis systems.