

# SYLLABUS: Energy Management for a Sustainable Future

Draft, incomplete –as of August 17, 2015

**(U) Fall 2015 15.S42 and 11.S195, Energy Minor Elective**

12 credits (3-0-9)

**Lecture:** Tuesday, Thursday: 1-2:30PM (56-154)

<https://stellar.mit.edu/S/course/15/fa15/15.S42/>

**Lead Instructor: Harvey Michaels**

Lecturer - Energy Management Strategy

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## Summary:

*Energy management* is a growing segment of the sustainability industry, applying science and business innovations to optimize home and building energy use, incorporating renewable energy and intelligent building-to-grid networks. This subject explores energy management practice and innovation through:

- building technologies including systems, analytics and controls
- energy/grid economics and policy
- strategies: community, social norms, apps and behavior, management finance and marketing innovations

To address climate change, among our greatest challenges, scientists agree that energy management is the largest single component of an achievable solution.

The skills acquired provide a foundation in this rapidly growing, innovation-oriented, multidisciplinary field for student professional interests, as well as the background to engage in related research and thesis topics.

### *Instructor Bio:*

Harvey Michaels teaches energy management strategy at the MIT Sloan School of Management, and participates in research with MIT Sloan Sustainability Initiative, Center for Energy and Environmental Policy Research, Climate CoLab, and MIT Energy Initiative. He provided leadership to the formation of MIT's *Efficiency Forward* Campus initiative, and serves as an advisor to cities including Boston and Cambridge, as well as Massachusetts utilities on community energy and climate action.



Harvey previously founded two leading energy management companies: Aclara Software which provided the analytics for utility customer efficiency and smart grid; and XENERGY (now DNV-GL) which innovated in efficiency services, financing, resource studies and analysis systems.

## **Format:**

The class is composed of:

- *Structured lectures and assignments* on skill topics of energy supported by readings, discussion, three brief assignments (one per segment 1-3), and meetings with guests - leaders in energy management practice.. Students will actively prepare for these guests with prior research, questions, and ideas they would like the guest to consider.
- *Action Learning* – A small group project will apply course content to help develop transformative thinking, by considering innovative approaches, collaborating effectively, and practicing communication skills on how to achieve the greater scale of energy management needed to partly solve the climate problem. Three class groups are anticipated, and likely topics are:

*Topic 1: Improving energy management in MIT dorms and living groups.* Applying technologies, retrofits, and behavior tools, the students will propose a strategy to permanently reduce energy, peak demand, and carbon footprint where they live. This will build on lessons learned from the prior dorm competitions to suggest an approach for student involvement over the long term in continuous improvement of dorm efficiency.

*Topic 2: Applying building analytics to reduce energy use in a typical campus building.* With use of the detailed continuous commissioning data now being collected on several campus facilities, using systems developed by local analytics businesses (some founded by recent MIT grads), the team will consider how to estimate the potential for cost-effective efficiency improvements, and suggest an approach for long-term application of big data to facility efficiency.

*Topic 3: GIS data map of community-scale carbon footprint, and ideas on how to estimate efficiency potential and spur community action.* Students will build on GIS layering of satellite, energy, and facility records of Cambridge neighborhoods (there are three MIT faculty-developed systems), to consider how energy maps may translate into greater efficiency adoption.

## **Segment 1: Weeks 1-4: Developing Perspective on Energy Management**

September 10 – October 8

The first weeks provide the opportunity for students to engage all facets of energy management at a summary, yet strategic level. The objective is to give the students an overall perspective, prior to more detailed examination of components to follow. At this segment's conclusion, class members will bring forward their own topics of interest in a brief foundational assignment.

In the first class segment, attention is placed on:

- Establishing a foundation and motivation to pursue advanced energy management with a summary of principles for energy efficiency, site solar energy, and building-to-grid control and storage.

- Economic and Policy Perspectives: size of the opportunity and the relationship of energy management costs to the cost of energy supplies, as well as the government/regulatory policy landscape and trends.
- Efficiency and climate: related chemistry, relationship to building energy, and climate policies that impact buildings such as EPA clean air rules that require fossil power plants to seek carbon offsets.

The final sessions include student discussion of foundation topics, and first consideration of interest in action learning options. As a group, we will participate in the MIT Solve Conference October 6, on sessions related to buildings and climate.

## **Segment 2: Weeks 5-8 Energy management technologies**

October 8 – October 29

During these weeks, students will develop a working understanding of the technology building blocks of an energy management solution at building scale. Students will prepare with readings, and complete an assignment that will apply the content to a building energy management strategy. Students will prepare questions and observations to engage guest lecturers. Topics include:

- Electric energy management: focus on lighting and air conditioning, as well as building-charged electric vehicles.
- Thermal energy savings: focus on heating, cooling, hot water system and building shell improvements.
- Energy Information and Control Technologies: Analytic techniques, energy bill disaggregation, Infrared thermography, diagnostics, IoT.

## **Segment 3: Weeks 9-11 Linking Buildings to People, and the Power Grid**

November 3 – November 19

During these weeks, students will begin their action learning project, while exploring the broader palate of emerging technologies and innovations in the energy management field. Students will prepare with readings, and complete an assignment that will apply the content, and prepare to engage guest lecturers. Topics include:

- Clean energy in buildings: Site Solar, batteries, distributed generation.
- Market strategies: retrofit services, financing, overcoming market barriers, mobilizing people and communities.
- Utility Demand-side Management: how to work with the opportunities of utility-funded incentives, rates, programs that encourage energy management.
- Smart Grid: grid connection to intelligent building technologies for demand response.

## **Segment 4: Weeks 12-14 Enabling Energy Management Innovation and Scale**

November 24 – December 10

Segment 4 will have lectures on dimensions of approach and strategy, applied to the energy management case, to assist with the development of the action learning project:

- Developing a quantified strategy proposal with attention to feasibility and scalability.
- Considering how to engage a broader community and distill ideas.
- Evaluating an existing process with the objective of improvement.

In addition, in this segment, groups put forward their case presentations for critique by their classmates, and collaborate on a final group paper.

**Key Readings:** All reading materials for the class are posted on the Stellar site:

- During the first segment 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 segments 2 and 3, 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 list may be revised depending on speakers and class interests.
- The Stellar site also contains categorized resources to aid in 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 format, class members are key contributors, as evidenced by preparation, thoughtful contribution, and regular attendance. - 25%
- Foundation topic – In the first segment, each member will bring forward a foundational topic of current significance to energy management enablement. - 20%
- Assignments – On two occasions, class members will be asked to prepare complete an assignment that will apply the content of the segment of response to a choice of questions – 25%
- Final project – The action learning group project case paper and presentation should describe how to achieve a significant impact as measured in energy and carbon benefits, with attention to originality, feasibility, and scalability. – 30%