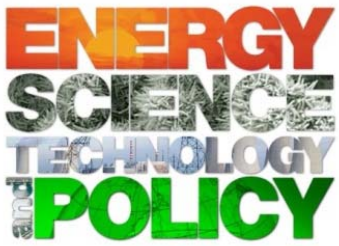
39-613 Energy Transport & Storage

Fall Semester 2016 (**Ver. 1.2** - 10/18/2016)



Class Meeting: Tuesdays & Thursdays 9:30-11:20, WEH 5415

Instructor: David Landis
Scott Hall 5105
412-268-7672
DaveL@cmu.edu

Office Hours: Monday 3 - 4:00pm
Wednesday 10:30 - 11:30am
Thursday 1:30 – 2:30pm
(Changes & additional office hours as posted to Blackboard)

Required Text: NONE (see Blackboard for required and supplemental reading assignments)

Evaluation: 30pts: Homework Assignments
10pts: Class Participation
10pts: Quizzes (HW, assigned reading, lecture & class discussion topics)
25pts: Comprehensive Final (at time scheduled by registrar)
15pts: Project Presentation (primarily individual evaluation)
10pts: Project Report (primarily group evaluation)

COURSE POLICIES AND PROCEDURES:

ADMISSION & PREREQUISITES: students enrolled in the EST&P master's program; others with engineering BS degree and permission of instructor

COMMUNICATIONS: blackboard postings and associated email announcements are the primary communications medium in 39-613. You are responsible to read your Andrew account email announcements and to check the course Blackboard site.

ATTENDANCE: Attendance AND Class Participation is required. Active participation in class is an essential component of the course and your grade. This includes energy news / topics discussions, course subject matter discussions, and project presentation Q&A. You are responsible to contact the instructor in advance regarding excused absences.

ACADEMIC INTEGRITY: students in 39-613 must adhere to all EST&P, CIT and University policies on academic integrity. You are advised to pay strict attention to rules and penalties regarding plagiarism, cheating, and unauthorized assistance. Homework must be your own individual work; project reports / presentation materials must yours and your team members' work with proper reference citations. TurnItIn.com may be used by the instructor to evaluate any and all written reports submitted for credit. http://www.cmu.edu/academic-integrity/index.html http://engineering.cmu.edu/current_students/graduates/policies_academic_integrity.html

OTHER: all Carnegie Mellon academic policies will be followed in 39-6 13, including reasonable accommodations for students with disabilities who are registered with the EOS office.

LEARNING OBJECTIVES: students will gain a fundamental understanding of the technologies, costs and benefits involving the various alternatives for energy transport and storage. These include energy carriers (hydrogen and electricity) as well as traditional fossil fuel and renewable energy delivery alternatives. In addition, students will be able to:

i.) perform technical/economic analysis of the transport and storage of fossil and nuclear fuels for energy generation; including infrastructure costs and options in fuel transport & storage, and storage/disposal costs for combustion byproducts and spent fuel;
ii.) identify the various components of electric power transmission and distribution systems; calculate the effects of power factor on transmission/distribution sizing and delivered power costs;
iii.) perform tradeoff analysis comparing long distance High Voltage AC vs High Voltage DC transmission and given requirements and constraints, calculate the optimal low cost solution for power transmission;
iv.) can identify the appropriate electric storage technologies for applications including frequency regulation, day/night load shifting, upgrade deferral, and smoothing of intermittency with renewables (Given system constraints on cost, location, size, intermittency, and cycle time). Perform tradeoff analysis considering cost and performance of specific technology solutions using electric power storage methods including pumped hydro, CAEO, and batteries (Lithium-Ion, Lead-Acid, redox-flow, etc.)
v.) can explain the fundamentals of Smart Grid technology in electric power transmission and distribution, and the role that smart grid plays in managing electric power storage. Can explain the benefits of distributed energy resources and microgrid technology and where it is feasibly applied.

CLASS #	TOPIC	ASSIGNMENT
#1 Tue 10/25	**1. Overview, Motivation, and Context** What happpens between supply and demand?	
#2 Thur 10/27	**2. Centralized vs. Distributed Energy:** fossil, renewables & micro-grids	**HW #1** assigned (fossil + HOMER intro)
#3 Tue 11/1	**3. TRANSPORT & Storage: Coal** and **Nuclear:** fuel cycle, processing, transportation & storage	Project team + region assignments
#4 Thur 11/3	**4. TRANSPORT & Storage: Natural Gas** and **Petroleum** transport & storage	
#5 Tue 11/8	**5. Electricity TRANSPORT I: Electrical Grid,** Power Transmission / Distribution, Smart Grid	HW#1 due **HW#2**: Pwr. Distribution
#6 Thur 11/10	**6. Electricity TRANSPORT II: Issues Connecting Renewables to the Grid** e.g. solar, hydro, wind, geotherm, biomass -- variable; intermittent	Quiz #1 Independent writing proposal
#7 Tue 11/15	**7.a. Project PDRs** (5-min, designated facilitator) **7.b. STORAGE:** overview: alternatives, options, physical / electrical characteristics, tradeoffs	Project PDR: 2-3 slide due 11/14 5pm: scope + preview
#8 Thur 11/17	**8. Micro Grids:** distributed generation & storage; distributed energy resources	HW#2 due **HW#3** (HOMER µgrid)
#9 Tue 11/22	**9. STORAGE:** grid scale and distributed storage state-of-the-art	
#10 Tue 11/29	**10. Smart Grid (power + information flow)** Stakeholders; T&D, AMI, energy informatics	Quiz #2
#11 Thur 12/1	**11. Special Topics** in energy transport and storage	HW#3 due Quiz (Blackboard)
#12 Tue 12/6 **at 8:15am**	***12. Project CDR Presentations begin at 8:20am, 25*** minute talk, 7 minute Q&A	All presentation .pptx files due 12/5 by 5pm
#13 Thu 12/8 **at 8:15am**	***13.a. Project CDR Presentations*** **13.b. COURSE WRAP UP:** Review & Summary	Independent writing extended abstract
12/12 1-4PM room TBD	**COMPREHENSIVE FINAL EXAM** (open reference)	Project reports due 12/11 by 6pm

Team Projects Assignment: Evaluate regional energy Transport & Storage infrastructure & status for an assigned region. Make projections of future regional T&S needs, challenges and shortfalls (~25yrs). Evaluate options (qualitatively and quantitatively) and recommend optimal new and modified energy transport & storage infrastructure and practices needed for the assigned region.

An important message from CMU's Provost (and your instructor)**: "*Take care of yourself.*** *Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.*

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help"