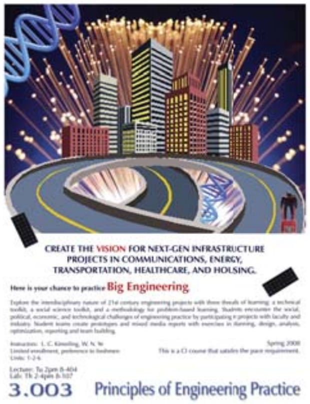

3.003 Principles of Engineering Practice

Engineering the Future of Solar Electricity

Project 1A,B

A: Solar Electricity Generation System Constraints

rate limiting factors

B: Materials Selection

Constraints, FOM analysis

Engineering the Future of Solar Electricity

Problem

- What fraction of US/global power consumption?
- Timeline for deployment?
- Markets and applications?
- Roles of Government, Users, Investment, Performance, Sustainability?

Constraints

- Design-limiting attributes and specifications
  - Figures-of-Merit, estimates, rules-of-thumb

Project 1 Judges

Dr. Hichem M'Saad

- PhD, Materials Science and Engineering

  MIT, 1994
- Corporate Vice President and GM of Silicon Sector Group

  Applied Materials, 1997-2008
- CEO and Founder

  Volta PV, Renewable Energy and PV Systems Integrator

Professor Gavin Conibeer

- PhD, Engineering Materials

  University of Southampton, 1994
- Deputy Director and Senior Research Fellow

  School of Photovoltaic and Renewable Energy Engineering, UNSW

University of Tokyo

- Website
  - Post interim reports for comment
  - *April 22, 6:30-7:30p (pizza and video conf)*
- UT teams
  - Name and Logo
  - Assignment UT1 and UT2 (April-May)
    - Learning from Koseki and Salvucci
    - Learning from Toriumi and Fitzgerald
  - Assignment UT3 (May-July)
    - Engineering Solar Electricity
  - *May 22: MIT-UT Solar Symposium*

P1A: Social and Political Factors

- Solar technical language
- Solar benefits
  - Availability, security, reduced transmission losses, grid independent, grid load leveling
- Greenhouse reduction
- Jobs

P1B: Materials Factors

- Materials
  - Absorption: energy gap
  - Charge collection: p-n junction, diffusion length
  - Reflectance: AR coating, texture
  - Current extraction: contacts, shading
  - Light trapping: optics

PiC: Engineering Practice

- Module
  - Interconnection, shading, uniformity
- Manufacturing
  - Extraction of materials, process flow, thin film vs. wafer, throughput, yield
- Deployment
  - Reliability
  - Control circuits, compatibility
  - SWAP: size, weight and power
  - Safety, skill set

Project 1A,B,C,D Execution

- Each project status review will be presented by a team leader.
  - Take notes from meeting before
  - Manage delivery of commitments
  - Report results to the group (BIRAC format)
    - Goal
    - Progress
    - Next steps

- U Tokyo is part of your team
    - Post on new global website

Project 1A: *due 4-6*
Electricity Generation System Constraints

Applications: FOM Comparisons

- Strengths
  - Attributes of solar electricity
  - Optimization plot
    - x vs. y with maximum for solar attributes
- Weaknesses
  - Barriers
    - Crossover point to solar advantage
- Competition
  - Local power
    - Gasoline: energy/unit volume

Engineering Practice

1. Problem Definition (B)
2. Constraints (I)
3. Options (R)
4. Analysis (A)
5. Solution (C)

Project Planning

- Timeline
- Resources
- Problem Definition

Engineering the Future of Solar Electricity
Teams: local power; grid connected power

- Project 1A: *due 4-6*
  - Electricity Generation System Constraints
- Project 1B: due *4-13*
  - Materials Selection
- Project 1C: *due 4-27*
  - Solar Cell Solar Cell Design
  - Module Manufacturing Platform
- Pentachart Summary Presentations: due *5-4*
- Project 1D: *due 5-6*
  - Final Report and Presentation

Infrastructure Change Issues

- New technology requires changing multiple components.
- Multi-vendor interoperability must be considered.
- Expected rewards in one area are sometimes accompanied by risks of disruption in other more critical application areas.
- Capital cost of infrastructure upgrade vs. sunk cost of existing.
- Missing or incomplete backward compatibility leading to replacing more equipment than will benefit from the upgrade.
- Incomplete value-chain availability, particularly in early stages of new technology.
- New skills availability and adoption.
- Changes in Economic Marketplace.

The Solar Cell

1) Principles of operation
2) Relevant performance metrics
3) Design for performance
4) Design for manufacturing
5) Design for application
6) What scale of production is consistent with (6)?

Project Execution

- One Project assignment is given and divided into parts for concurrent engineering by teams.
- One solution will be submitted per team. All members of the team receive the same project grade.
- Teams will complete four project stages during the term.
  - Plan; Initial Findings; Solution Consistency among Teams; Final Presentation to Panel of Experts
- The final deliverables are:
  - 20 minute presentation (5-10 slides), during which all workgroup members must speak.
  - Two days later, edited slides and a final two-page report.