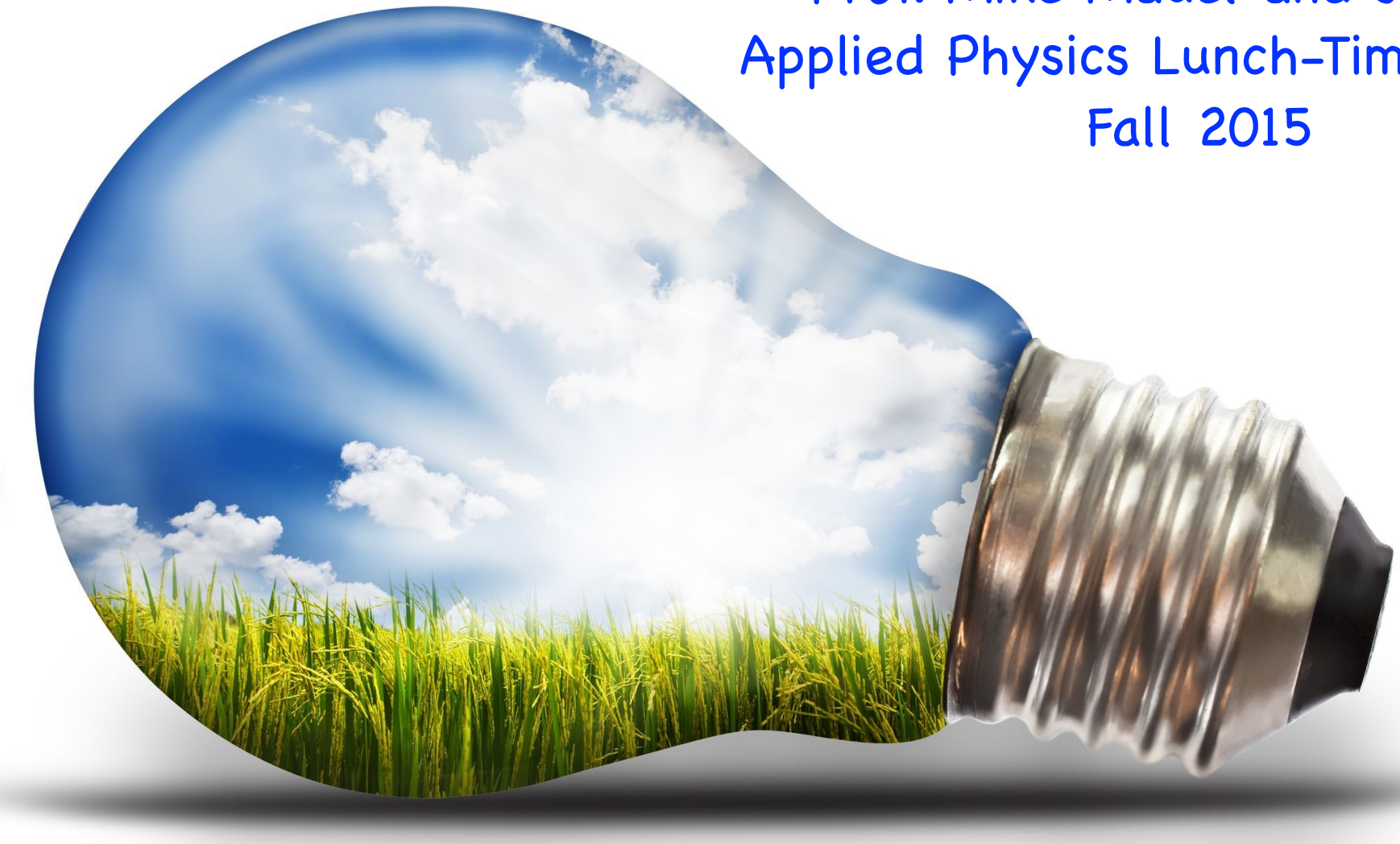
Ideas for Innovation in Energy and Climate

Prof. Mike Mauel and students

Applied Physics Lunch-Time Seminar

Fall 2015



Current Events (10/7/2015)

- (Yesterday, 10/6) Takaaki Kajita and Arthur McDonald awarded Nobel Prize in Physics "for the discovery of neutrino oscillations, which shows that neutrinos have mass" (http://www.nobelprize.org/nobel_prizes/physics/laureates/2015/press.html)

- (Last Wed and Thurs, 9/30-10/1) 51 countries filed their Climate Action Plans with the UN in preparation for the December climate summit in Paris (http://www.washingtonpost.com/news/energy-environment/wp/2015/10/02/51-countries-just-released-their-climate-plans-and-theyre-still-not-enough/)

- (Last Thurs, 10/1) Climate Action Tracker (CAT) reports plans show progress but "first round of climate plans for 2025 and 2030 will not hold warming below 2°C," (http://climateactiontracker.org/news/224/INDCs-lower-projected-warming-to-2.7C-significant-progress-but-still-above-2C-.html).

Task for Next Week

- I will present and summarize each Team's Ideas
- Before hand:
  - Discuss your ideas with your Team members. Be prepared to comment/disagree/amplify my presentation
  - **Everyone**: Send any revisions or additions before end of weekend…
    - Why you think this is an energy/climate opportunity worthy of further consideration
    - Your reasoning why this is should be considered a "short-term" or a "long-term" effort

Send by email to mauel@columbia.edu
before C.O.B. next Tuesday

Innovation Teams

Blue	Green	Yellow	Orange	Red
Jonathan Fletcher	**Aton Baleato-Lizancos**	**Sean Ballinger**	**Joshua Cohen**	**Richard Cresswell**
Michael Wang	**Omar Mahmood**	**Seth Olsen**	**Jason Williams**	**Lucas Zeppetello**
Kevin Murphy	Alex Battery	Tyler Cowan	Drew Feldman	Ben Israeli
Edwin Vargas	James Page	Lauren Riddiford	Farrah Simpson	Derek Tropf
	Yumou Wei	Chen Zhang		

Idea Summary

- Infrastructure, public transportation
- Nuclear Fusion
- Advanced Fission
- Artificial Clouds
- Carbon Capture and Storage
- Methane capture and use
- Nano-tech to improve cooling efficiency
- Distributed energy generation and storage for all sorts of mechanical systems
- "Light Traps" to improve solar power effectiveness
- Helping communities with solar power choices

Each Team has at least one "near term" and one "long term" energy/climate idea

Blue Team

- Infrastructure for Electric and Self-Driving Cars
  - Becoming commercial reality
  - Potential for significant GHG reductions in the transportation section
  - For electric cars to be the vehicle of choice, infrastructure (charging stations, batteries, repairs, road sensors, ...) needs to be installed in the short-term
- Nuclear fusion research as a long-term, and essentially limitless, source of clean energy.
  - Research now; nuclear fusion "infrastructure" and commercial technology on the longer time frame

Green Team (1)

- Expansion of public transportation
  - Improvements in subway, bus, rail infrastructure
  - Incentives to encourage greater use of public transportation
  - Development of higher efficiency electric motors
  - Potential to reduce GHG through public electric transportion routes displacing petri-based highways.
- Artificial Clouds
  - Develop confidence in the climate effects of atmospheric particulates
  - Engineer high reflectance for incoming visible light and low absorption for IR

Green Team (2)

- Carbon Sequestration for reduced GHG coal
  - R&D to develop safe, permanent, and local sequestration methods
  - Put into place cost incentives ("sanctions") that make CCS the right economic choice
  - Not likely a short-term option, but may be the "quickest" option for sustainable energy
- Capture and use methane from petroleum and coal operations and from livestock, industry and landfills
  - Because methane is a potent GHG, efficient capture of released methane may have a near-term but lasting impact.

Yellow Team (1)

- Nano-structured materials for enhanced radiation cooling of "anything" (including clothing) to improve cooling efficiency and energy
  - Research now; and. perhaps, practical technology on the longer time frame
- "People-power" energy storage systems.
  - Example: exercise machines that generate electricity, stored in batteries, and used to power buildings. Taken together, using mechanical work in many contexts to charge distributed energy storage systems.
- Capture and use methane from petroleum and coal operations and from livestock, industry and landfills
  - Because methane is a potent GHG, efficient capture of released methane may have a near-term but lasting impact.

Yellow Team (2)

- Molten Salt Reactor (MSR) is an a "generation IV" advanced fission reactor that can be smaller and potentially less-prone to proliferation by using advanced thorium fuel cycles.
  - R&D required, new chemistry and neutron resistant materials; also, will likely require new regulatory rules
- Use advancements in nano-structured, "designer", materials to create an efficient "light trap" directing much more light to photovoltaic cells, reducing cost, and improving efficiency.
  - Research is needed to identify candidate materials systems and demonstrate efficiency

Red Team (1)

- Infrastructure modernization and "smart cities"
  - Energy efficiency optimization in public transportation, efficient buildings, internet access for optimization of logistics, city-wide optimization of solar panels, energy storage, ...
  - "If we want to truly live more energy efficient lives, we should make our cities adapt alongside with us."
- Advancing nuclear fusion energy using "smart" optimization of magnetic confinement configuration.
  - Systematic parameterization, computer-aided selection, to shorten development time

Red Team (2)

- Working with communities and consumers implement small-scale solar power systems. Bring intelligence to solar power choices and community plans
- Capture and use methane from livestock and improve efficiency of meat production
  - Climate-friendly livestock practices represent an engineering challenge, especially implementing these best practices on a global scale the livestock sector includes millions of very poor people without the infrastructure or ability to employ these technologies.

Idea Summary

(3) Infrastructure, public transportation

(3) Nuclear Fusion

Advanced Fission

(1) Artificial Clouds

(4) Carbon Capture and Storage

Methane capture and use

(1) Nano-tech to improve cooling efficiency

(1) Distributed energy generation and storage for all sorts of mechanical systems

(1) "Light Traps" to improve solar power effectiveness

(1) Helping communities with solar power choices

Each Team has at least one "near term" and one "long term" energy/climate idea

Idea Summary

- Infrastructure, public transportation
- Helping communities with solar power choices
- Distributed energy generation and storage for all sorts of mechanical systems

- Carbon Capture and Storage
- Methane capture and use

- Nuclear Fusion
- Advanced Fission

- "Light Traps" to improve solar power effectiveness
- Artificial Clouds
- Nano-tech to improve cooling efficiency

Next Steps

- What is the "prior" or state-of-the-art for your idea or project?
- What is the status of the technology? Who are the key advocates and experts?
- If additional R&D is required, can the key questions and metrics of success be defined?
- Where are the sources of R&D funds? Start-up funds?

Task for Next Two Week

- Discuss your ideas with your (New) Team members.

  Try to reach consensus on at least one near-term objective and one long-term goal.
  (Be bold! But also be objective, technically sound, and realistic.)

- **Everyone**:
  - Find three references, of any type or source, that provides background or technical aspects of your idea
  - Write at least one key issue, having a quantitative answer, that must be resolved in order to assess whether or not your idea or plan is worthy of further consideration

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Next Week

Prof. Vijay Modi
Director of Sustainable Engineering Lab

Prof. Modi lead the UN Millennium Project effort on the role of energy and energy services in reaching the Millennium Development Goals (MDG's). Currently, he is focused on making consumer-scaled versions of technology that is normally super-sized available to developing countries. "The key is to figure out how to make innovation happen in a low-cost market." He adds that the engineer's dream is not only a new device but one that is maintenance free. "Why not create a small-scale generator that is robust?"