Breakout Session II
Group B

Wednesday, October 21, 2009
Given the results of the first break-out sessions, what is the most promising approach to the development of an efficient, robust system capable of the production of direct-solar fuels, i.e. of harvesting photons and producing infrastructure-compatible high energy density liquid fuels in a single reactor?

Technical Steps –
1. Cost out systems
2. Critiques
   a. Synthetic biology
      - tools partially there, genomics, metabolomics and proteomics to create and study new pathways are needed
      - integrating early activities with engineering strategies for scale-up (e.g. light shading, heat management, CO2 absorption)

b. Diversity exploration of natural systems
   i) Cultivate and use as a host
   ii) Non-cultivatable – use as a source of genes
   iii) Targeted exploration
   iv) Can we hunt for 10X more diversity? What is resource limitation (people [expertise] or equipment [e.g. submarines])
c. Artificial photosynthesis
   i) Can we hunt for better catalysts?
      - photocatalysts, materials problems
      - dark catalysts, anode and cathode for water splitting, CO2 reduction
      - C-C bond formation
   ii) Integrate components into a balanced functional systems
   iii) Membranes –

3. Stages
   a. Initial development phase – all direct solar to fuels are here in 2009

Promising - Definition
   1. Cost (bio least cost?) vs. efficiency (inorganic best?)
   2. Large scale – dent in national fuel supply
   3. Capturing CO2
      a. Power plants – lowest hanging fruit
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Major Challenges –

Targeting awards to develop cost competitive alternatives to fossil fuels – or to address global warming (carbon capture)

Ask proposers to justify their proposal as a transformational potential.
  - Integrated into cost-effective and scalable systems

Topics of Interest In FOA
A. Synthetic biology
  - Harvesting and extraction of biofuels
  - Toxicity
  - Photo-bioreactor design
  - Overall photo efficiency (photo flux capture photons/unit time/area - energy – 5% is minimum viable efficiency???)
B. Diversity exploration of natural systems
- finding the natural systems
- targeted way –
  i) Not just sequencing genomes
  ii) integrated into cost-effective and scalable systems
  iii) cultivating systems as hosts to produce biofuels
  iv) transferring genes from systems to culturable hosts

C. Artificial systems
- making a hybrid system
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Potential –

1. Synthetic Biology (recombinant algae and cyanobacteria primarily)
   - New Prototypes
   - 5 – years, better understanding of electron transfer and metabolic pathways
     - scalable strain (blue light, less waste heat, exported hydrocarbons)
   - 10 – years – optimized strains (streamlined metabolic pathways), minimal maintenance
     - 15 years, commercialized production

2. Diversity of natural systems
   - 5 years – New tools to do synthetic biology, discovery of new biofuel-related genes, better hosts
     - 10 years – Better enzymes, more efficient chemistries
     - 15 – New hydrocarbon production on pilot scale
3. Artificial photosynthesis
   a. Molecular systems (purely artificial material – not integrated with biomaterials – no porphyrins)
      - Today, Conceptual devices
      - 5 yrs, Integrated systems
      - 10 yrs. Working prototype
      - 15 yrs. Commercial level (economically viable)
   b. Biomolecular systems may have different time line
   c. Hybrid systems may have different time line