

# Breakout Session Charges

**Pathways to Transformational  
Breakthroughs in Energy: *The  
Technology “Pull” for Science and  
Opportunities through Science “Push”***

# Technology Barriers

- Looked at different areas
  - Generation
  - Transmission/storage
  - Conservation/use
  - Transportation

# Technology Barriers

- Generation (Conversion and advanced fuels, renewables)
  - Solar photovoltaic (revolution to increase efficiency to 50% and affordable (\$100/m<sup>2</sup>)--need to overcome technology barrier)
  - Bioconversion 80% yield from lignocellulose, low cost pretreatment
  - Affordable clean coal—CO<sub>2</sub> capture (low cost and environmentally safe)
  - Embedded /Micro-generation within the process itself (does not require grid)
  - Geothermal energy
  - Wind/wave—important on national scales?

# Technology Barriers

## Transmission/storage

- Storage
  - Electricity--battery (incremental rather than revolutionary?)
  - Heat
  - Chemical (H<sub>2</sub> and others, such as biofuels)
  - Catalysis
  - Nano-science could provide a breakthrough
- Long-distance transmission/distribution with near zero loss

# Technology Barriers

- Conservation/use
  - Lighting—solid state
  - Low voltage dwelling
  - Low energy buildings
  - Retrofit housing/ buildings
  - Full system approach to industrial processes (energy, environment and economic modeling)
  - Virtual transportation, telecommunication

# Technology Barriers

## Transportation

- Light weight materials
  - Cheap efficient materials
- Infrastructure for biofuels
- New fuels (?) to be adapted into internal combustion engine
- H<sub>2</sub> storage
- Electric cars

# Technology Barriers

- What criteria were used by your group in distinguishing the “grand challenges”
  - Big impact
  - Significant project, require concerted effort, across international borders
  - Require appropriate partnerships, eg. ITER

# Technology Barriers–Grand Challenge

- What is the highest priority subset of these barriers
  - Solar PV increase efficiency >50% at \$100/m<sup>2</sup>
  - Clean coal with CO<sub>2</sub> capture. Affordable and environmentally safe
  - Multimode storage of energy; electricity (battery) and heat
  - Step change in catalysis (Bio and non-bio)
  - Low loss transmission and distribution
  - Full system approach to industrial processes
  - Vehicle light weighting cheap and efficient materials

# Science Push

- **Criteria**
  - Revolutionary
  - High impact
  - Cross cutting
- **Major areas**
  - Nano sciences/ materials
  - Bioscience/ bio solutions
  - Computational sciences

# Science Opportunities

- Nano sciences/ materials
  - Interfaces
    - Batteries
    - Fuel cells
    - Solar cells
    - Catalysis
  - Leading to innovative materials
  - Atomic scale engineering
  - Nano-biology
    - Organic/inorganic interfaces
    - Biogeneration of semiconductor materials
  - Biomimetic self-organizing/ healing/ diagnostic

# Science Opportunities

- **Biosciences**
  - Fuel conditioning
  - Genomic, post genomic
    - Bioproduction of H<sub>2</sub>
    - Sequestration
    - Bio fuel cells
  - Designer biomass
  - Bio-catalysts—enzymes/ biorefinery

# Science Opportunities

- Computational sciences
  - Paradigm shift in computational sciences
  - Multi-scale (space and time) modeling integrated approach
  - Predictive modeling
  - Emergent properties from complex systems
  - Active intelligent control
  - Quantum computing

# Science-Technology Conceptual Framework

- Linkage between basic science (long-term goal) and industrial technology (short-term) is missing
- Is a strategic need. Can private-public partnership fill the gap?
- Framework required, examples are:
  - Multidisciplinary consortium - Link program (UK)
  - Fraunhofer (Germany)
  - Sematech (USA)
  - UARC (University Affiliated Research Centers) (USA)
  - Technology centers (UTECH, UK)
  - DARPA (USA)
  - CNRS-Public Industry partnership (France)
- Technology pull (catalyzed by government policy)

# OTHER FEEDBACK

- Follow up workshop
- International framework for collaboration