Energy for Sustainability

Program Director - Greg Rorrer* - grorrer@nsf.gov

* Rotator from Oregon State University, Chemical Engineering (24 August 2009)

- Current Program Interest Areas
- Existing Award Portfolio
- Recent Proposal Activity
- Examples of Program Research Projects
Current Program Interest Areas

Energy for Sustainability

Biomass Conversion, Biofuels & Bioenergy

- Inter-disciplinary
  - Collaborative proposals
  - IDR proposals

- International
  - Conferences
  - Workshops

Multi-disciplinary
- Biological Eng
- Chemical Eng
- Electrical Eng
- Mechanical Eng
- Biosciences
- Chemistry
- Materials
- Physics

Wind & Wave Power

Solar Photovoltaic Power & Fuels
Energy for Sustainability Program: Existing Award Portfolio - (September 2009)

Number of Active Awards

- Energy Assessment: 2
- Conferences: 9
- Wind & Wave Power: 11
- H2 Storage: 13
- Fuel Cells: 23
- Solar PV: 24
- Biofuels & Bioenergy: 24

Total active awards: 106

Value of Active Awards ($ millions)

- Energy Assessment: 0.28
- Conferences: 0.29
- Wind & Wave Power: 2.26
- H2 Storage: 2.86
- Fuel Cells: 6.01
- Solar PV: 6.37
- Biofuels & Bioenergy: 6.45

Total value: $24.5 million
Energy for Sustainability Program: Recent Proposal Activity (March 2009 unsolicited)

**ARRA** American Recovery and Reinvestment Act

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Proposals</th>
<th>Base Funding</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>166</td>
<td>17%</td>
<td>50%</td>
</tr>
<tr>
<td>Solar PV</td>
<td>65</td>
<td>9%</td>
<td>18%</td>
</tr>
<tr>
<td>Fuel Cells</td>
<td>37</td>
<td>14%</td>
<td>19%</td>
</tr>
<tr>
<td>Biofuels &amp; Bioenergy</td>
<td>32</td>
<td>22%</td>
<td>31%</td>
</tr>
<tr>
<td>Wind &amp; Wave Power</td>
<td>20</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>H2 Storage</td>
<td>12</td>
<td>33%</td>
<td>50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Awards</th>
<th>Base + ARRA Funding</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>28</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Solar PV</td>
<td>6</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>Fuel Cells</td>
<td>5</td>
<td>19%</td>
<td>18%</td>
</tr>
<tr>
<td>Biofuels &amp; Bioenergy</td>
<td>7</td>
<td>31%</td>
<td>31%</td>
</tr>
<tr>
<td>Wind &amp; Wave Power</td>
<td>6</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>H2 Storage</td>
<td>4</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Engineering of a Microbial Platform for the Conversion of Light Energy into Chemical and Electrical Energy
Claudia Schmidt-Dannert - University of Minnesota

**Goal:** Light-Energy Conversion in Engineered Non-Photosynthetic Bacteria

- Non-photosynthetic microbes: easier to engineer
- Well-understood metabolism
- Useful metabolic properties

Utilization of light energy to:
- Drive metabolically expensive reactions
- Generate electricity

**Example:** Light-dependent current increase in electrochemical chambers containing engineered *Shewanella oneidensis* expressing proteorhodopsin

CBET 0756296
Thermochemical Production of Fuels: Solar Energy After Dark
Sossina M. Haile - California Institute of Technology

Thermochemical cycling of ceria to produce solar fuels from CO$_2$ & H$_2$O

Thermochemical test station:
$\frac{dT}{dt} = 1000$ °C/min; gas analysis

CBET-0829114
Molecular Modeling: Calculate the free energy required for separating cello-oligomers from cellulose crystal surface

AFM Experiments: Determine the force required for separating cello-oligomers from cellulose crystal surface
Copper Zinc Tin Sulfide (CZTS) Based Solar Cells
Eray S. Aydil & Stephen Campbell - University of Minnesota

CZTS is a new and promising photovoltaic material that can be made from abundant and nontoxic elements.

The goal is to develop thin film deposition methods that will lead to breakthroughs in CZTS based solar cells.

CBET- 0931145
Engineering Organic-Inorganic Hybrid Materials for the Conversion of Solar Energy

Cherie R. Kagan - University of Pennsylvania

Tailoring morphology and electronic structure in organic-inorganic hybrids

Spectroscopic and optoelectronic measurements of charge separation and transport important in solar cells

CBET 0854226
Organic photovoltaic cells (OPVs) are limited by poor optical absorption.

Metallic nanostructures permit improved control over the internal optical field (Inset: 200 nm nanoholes in Ag by FIB).

Simulation of OPV on nanoslits shows enhanced absorption with patterning.

Performance could exceed that of conventional transparent conductors like indium tin oxide (ITO).

CBET 0946723
Catalyst-Bound Peroxide Identified as Deactivating Reagent

Quantum Size Effect Activates nano-CdSe for Photocatalytic H₂ Evolution under Visible Light

Structure of HCa₂Nb₃O₉(O₂)

Structure of nano-CdSe
Advances in Wind Turbine Analysis and Design
Marilyn J. Smith - Georgia Institute of Technology

Clockwise from top left:
Simulations of full wind turbines;
Example of vortex shedding from HAWT airfoil, Improved vortex propagation using SAMR

**FUN3D** unstructured overset simulations of upwind HAWT

**OVERFLOW-2** overset simulation of downwind HAWT

Unsteady vortex shedding of a HAWT rotor at moderate angles of attack

Inviscid vortex convection:
- Periodic domain
- Free-stream velocity is 45° angle
- 4 levels of refinement

CBET-0731034