National Science Foundation
Investments for Solar Photovoltaics in the Engineering Directorate

Greg Rorrer
Program Director
Energy for Sustainability

Division of Chemical, Bioengineering, Environmental, and Transport Systems (CBET)

Engineering Directorate

Carl Wamser, Portland State University
### NSF at a Glance (FY 2008)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2008 Appropriations ($ billions)</td>
<td>6.128</td>
</tr>
<tr>
<td>NSF’s share of total annual federal spending for R&amp;D</td>
<td>4%</td>
</tr>
<tr>
<td>NSF’s share of nonmedical basic research at academic institutions</td>
<td>44%</td>
</tr>
<tr>
<td>Colleges, universities, institutions receiving NSF funding (all 50 states)</td>
<td>1,900</td>
</tr>
<tr>
<td>Competitive awards funded (25% success rate)</td>
<td>11,162</td>
</tr>
<tr>
<td>Proposals evaluated through competitive merit review process</td>
<td>44,441</td>
</tr>
<tr>
<td>People NSF supports directly (researchers, fellows, trainees, teachers, students)</td>
<td>197,000</td>
</tr>
</tbody>
</table>

*Source: NSF FY 2010 Highlights*
NSF Research Budget FY 2009
($5.18 billion base, $2.5 billion ARRA)

Mathematical & Physical Sci.  MPS  Office of Polar Programs  OPP
Geosciences  GEO  Office of Integrative Activities  OIA
Engineering & SBIR  ENG  Office of Cyber Infrastructure  OCI
Biological Sciences  BIO  Office of International Sci & Eng.  OISE
Computer, Information Sci. & Eng.  CISE
Social, Behavioral & Econ. Sci  SBE
Energy & Environment

"So we have a choice to make. We can remain one of the world's leading importers of foreign oil, or we can make the investments that would allow us to become the world's leading exporter of renewable energy. We can let climate change continue to go unchecked, or we can help stop it. We can let the jobs of tomorrow be created abroad, or we can create those jobs right here in America and lay the foundation for lasting prosperity."

- President Obama, March 19, 2009
National Need & Grand Challenge: Sustainable Production of Energy

Priority Guidance for NSF
“The National Science Foundation (NSF) should continue to increase emphasis on innovation in sustainable energy technologies and education as a top priority.”


NSF Support of Solar Photovoltaics: Major Programs

- **DMR**
  - Div. Materials Research
  - (Linda Sapochak)

- **CHE**
  - Chemistry
  - (Carol Bessel)

- **SBIR**
  - Nanotechnology/Photovoltaics
  - (Grace Wang)

- **ECCS**
  - Elect., Photonic, 
    & Device Tech.
  - (George Maracas)

- **CMMI**
  - Nano-Manufacturing
  - (Shoachen Chen)

- **CBET**
  - Energy for Sustainability
  - (Greg Rorrer)
NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

- **Direct:** solar PV material & device focused research
- **Enabling:** foundational research with applications to solar PV

### Value of Awards, 2005-2009 ($mil)

<table>
<thead>
<tr>
<th>Program</th>
<th>Direct</th>
<th>Enabling</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMMI</td>
<td>3.3</td>
<td>7.7</td>
</tr>
<tr>
<td>ECCS</td>
<td>8.3</td>
<td>8.5</td>
</tr>
<tr>
<td>IIP</td>
<td>10.0</td>
<td>5.8</td>
</tr>
<tr>
<td>CBET</td>
<td>10.9</td>
<td>5.7</td>
</tr>
<tr>
<td>ENG Total</td>
<td>32.6</td>
<td>27.7</td>
</tr>
</tbody>
</table>

### Number of Active Awards (2005-2009)

<table>
<thead>
<tr>
<th>Program</th>
<th>Direct</th>
<th>Enabling</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMMI</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>ECCS</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>IIP</td>
<td>60</td>
<td>25</td>
</tr>
<tr>
<td>CBET</td>
<td>37</td>
<td>20</td>
</tr>
<tr>
<td>ENG Total</td>
<td>136</td>
<td>96</td>
</tr>
</tbody>
</table>
NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

- **Direct**: solar PV material & device focused research
- **Enabling**: foundational research with applications to solar PV

![Bar charts showing total award value and total number of awards in solar PV from 2005 to 2009.](attachment:image.png)
NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

Innovative integration of new materials & devices for 3rd generation PV

Nanostructured semiconductors
  • Nanocrystals (*Hanrath*)
  • Nanowires
  • Nanotubes (CNT, ZnO etc)

Light flow manipulation
  • Plasmonic structures (*Holmes*)
  • Photonic structures
Innovative integration of new materials & devices for 3rd generation PV

- Earth-abundant materials (Aydil)
- Dye-sensitized solar cells
- Organic photovoltaics
- Organic-inorganic hybrid materials (Kagan)
- Self-assembled systems
- Biomimetic/bioinspired systems
Overview of Photovoltaics Thrusts through SBIR/STTR Program at NSF

Support of Solar Photovoltaics in the MPS Directorate at NSF
CBET Energy for Sustainability Program: Three Current Emphasis Areas

Renewable Natural Resources

Biomass Conversion, Biofuels & Bio-Energy

Renewable Energy Technologies

Environmentally Benign Materials & Processes

Wind & Wave Power

Solar Photovoltaic Power & Fuels

Renewable Energy Technologies

- algae
- plant biomass

- wind
- solar
NSF Support of Academic Science & Engineering Research (FY 2008)

- Computer Science: 86%
- Biology (non NIH): 67%
- Mathematics: 60%
- Social Sciences: 59%
- Environ. Sci.: 52%
- Engineering: 41%
- Physical Sciences: 41%
- All Sci. & Eng.: 21%

Source: NSF Survey of Federal Funds for Research and Development