



# 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)

**6.128** FY 2008 Appropriations (\$ billions)

**4%** NSF's share of total annual federal spending for R&D

**44%** NSF's share of nonmedical basic research at academic institutions

**1,900** Colleges, universities, institutions receiving NSF funding (all 50 states)

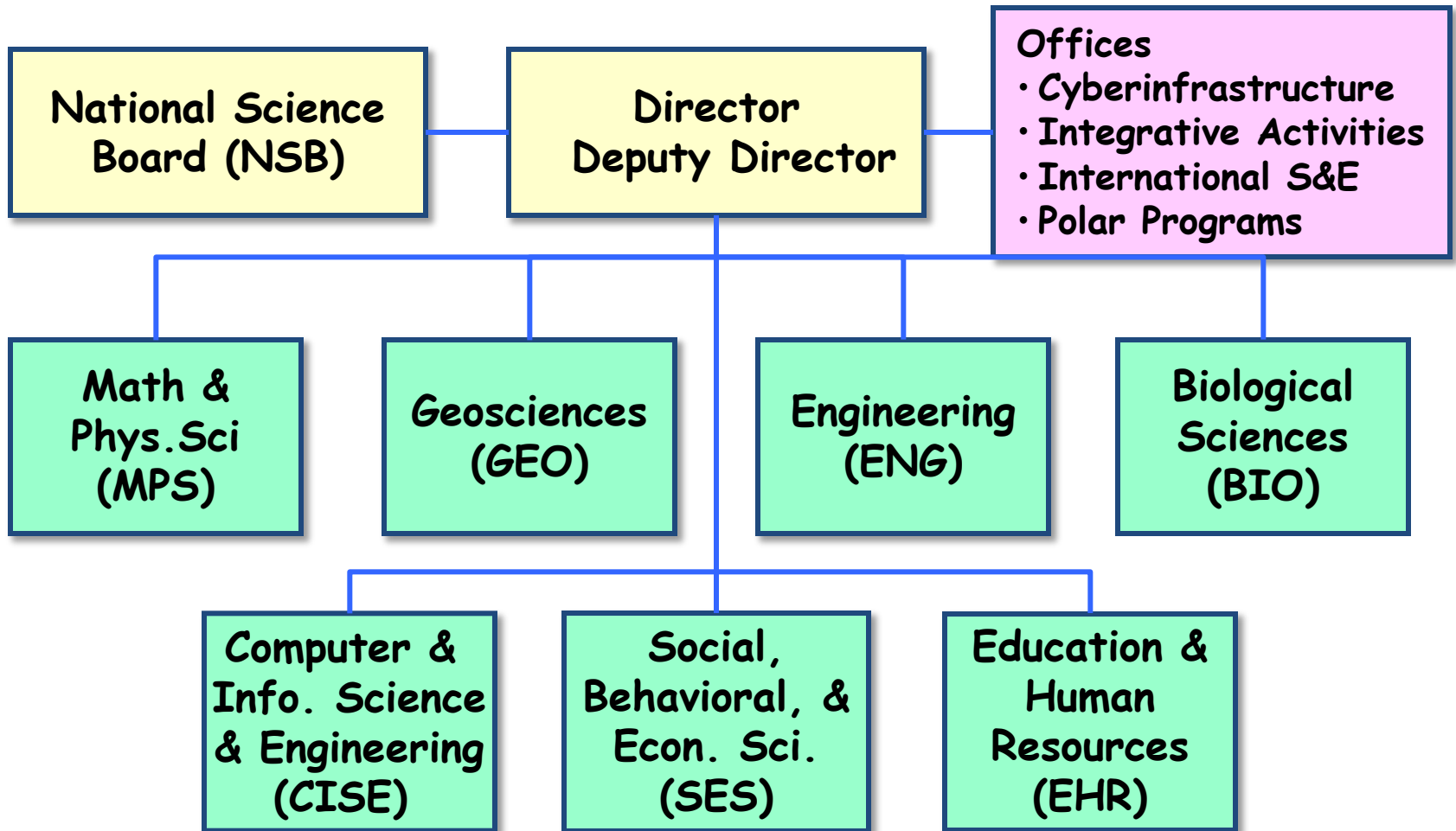
**11,162** Competitive awards funded (25% success rate)

**44,441** Proposals evaluated through competitive merit review process

**197,000** People NSF supports directly (researchers, fellows, trainees, teachers, students)



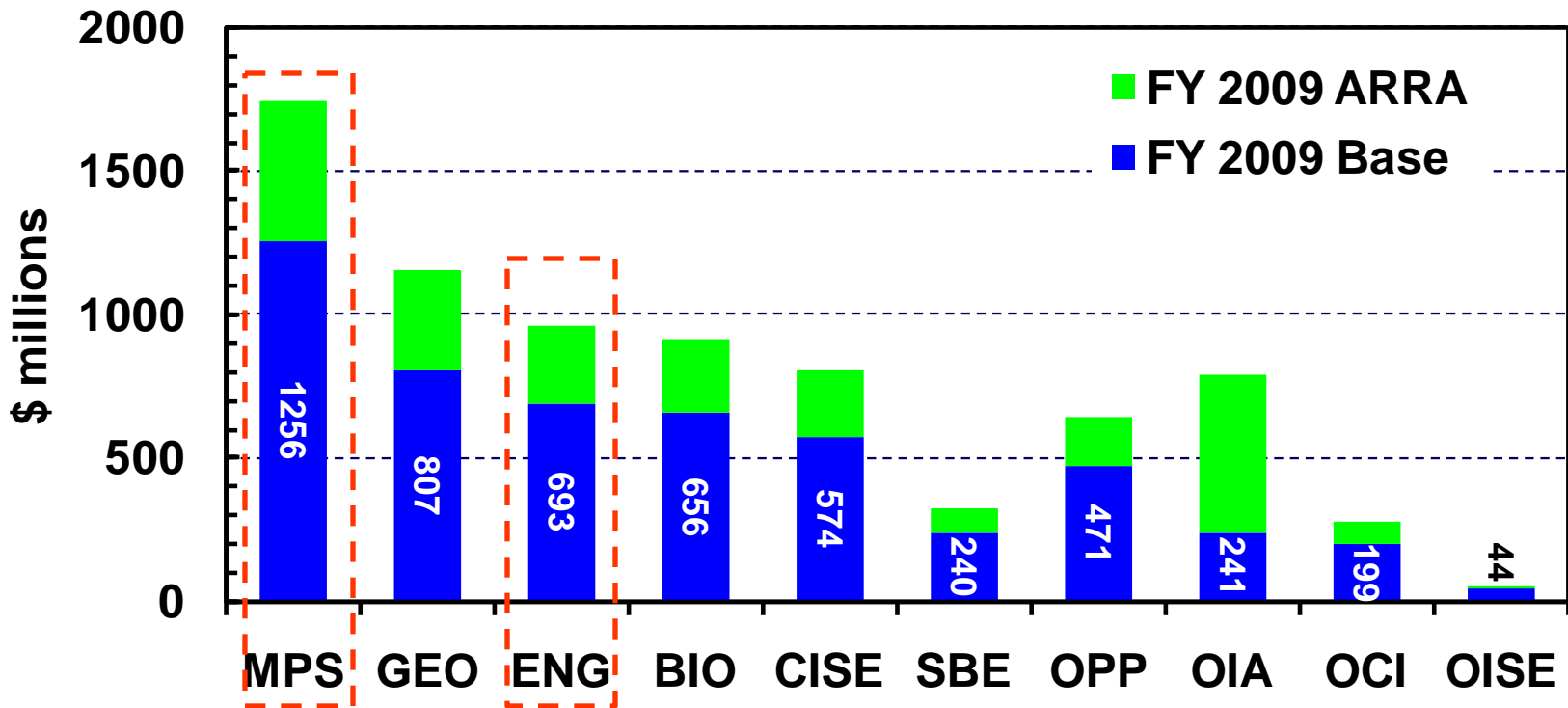
# Organizational Structure



## Directorates



# NSF Research Budget FY 2009 (\$5.18 billion base, \$2.5 billion ARRA)



**Mathematical & Physical Sci.**

Geosciences

**Engineering & SBIR**

Biological Sciences

Computer, Information Sci. & Eng.

Social, Behavioral & Econ. Sci

**MPS**

**GEO**

**ENG**

**BIO**

**CISE**

**SBE**

Office of Polar Programs

Office of Integrative Activities

Office of Cyber Infrastructure

Office of International Sci & Eng.

**OPP**

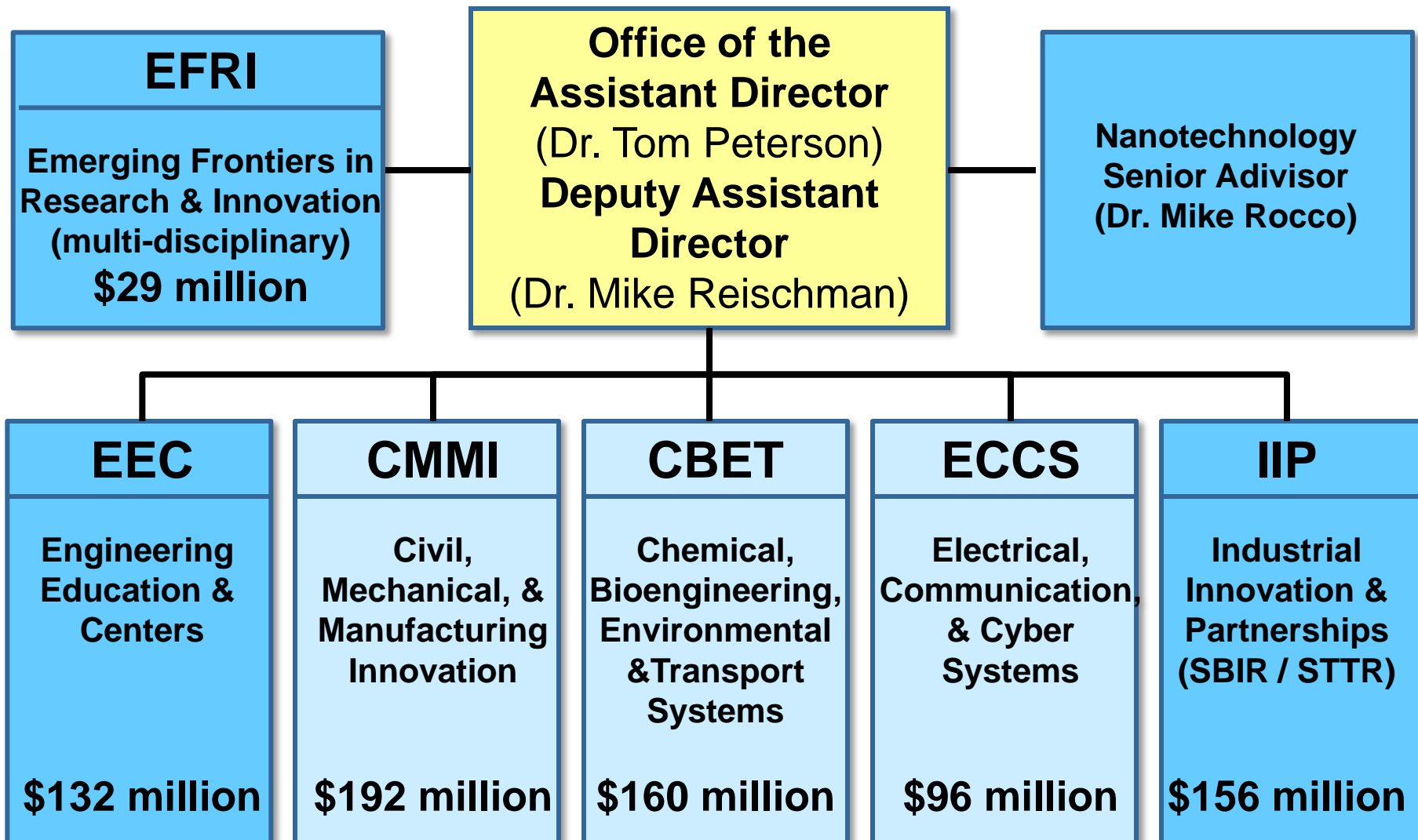
**OIA**

**OCI**

**OISE**



# Directorate for Engineering (\$764.5 million FY 2010)





# National Need & Grand Challenge: Sustainable Production of Energy



## 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*

White House Issues: Energy & Environment

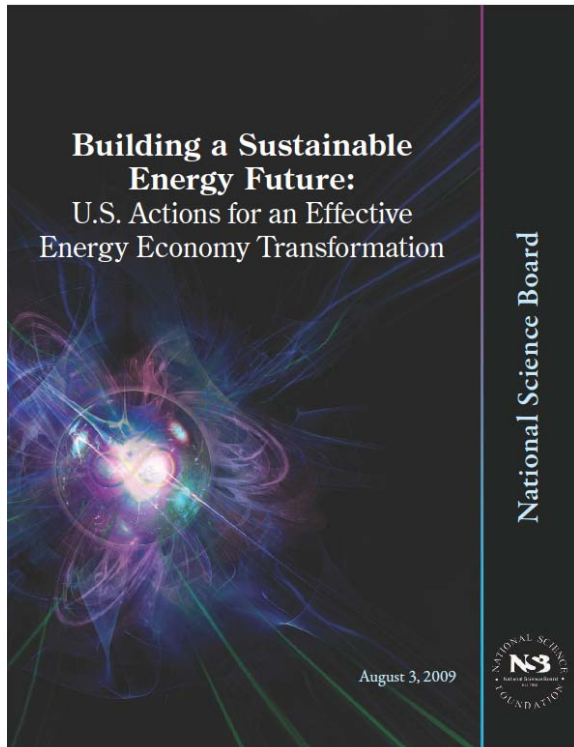
<http://www.whitehouse.gov/issues/energy-and-environment>



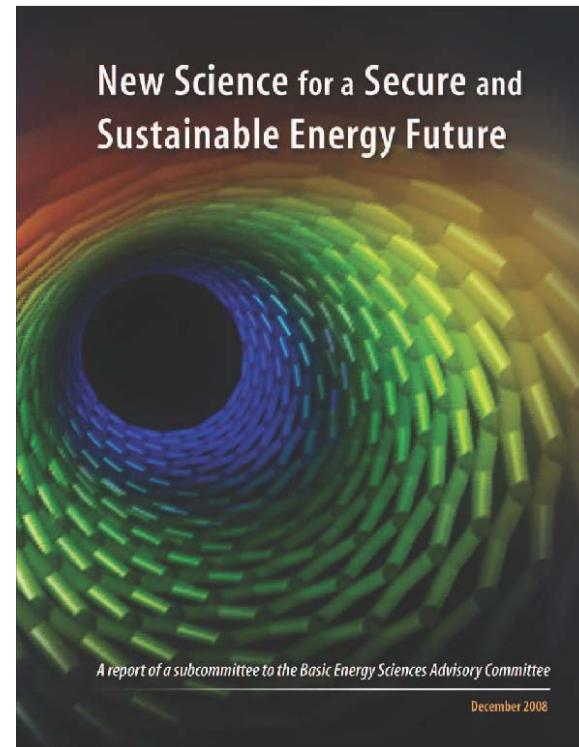
# National Need & Grand Challenge: Sustainable Production of Energy

## *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** National Science Board,  
*Building a Sustainable Energy  
Future* (2009)

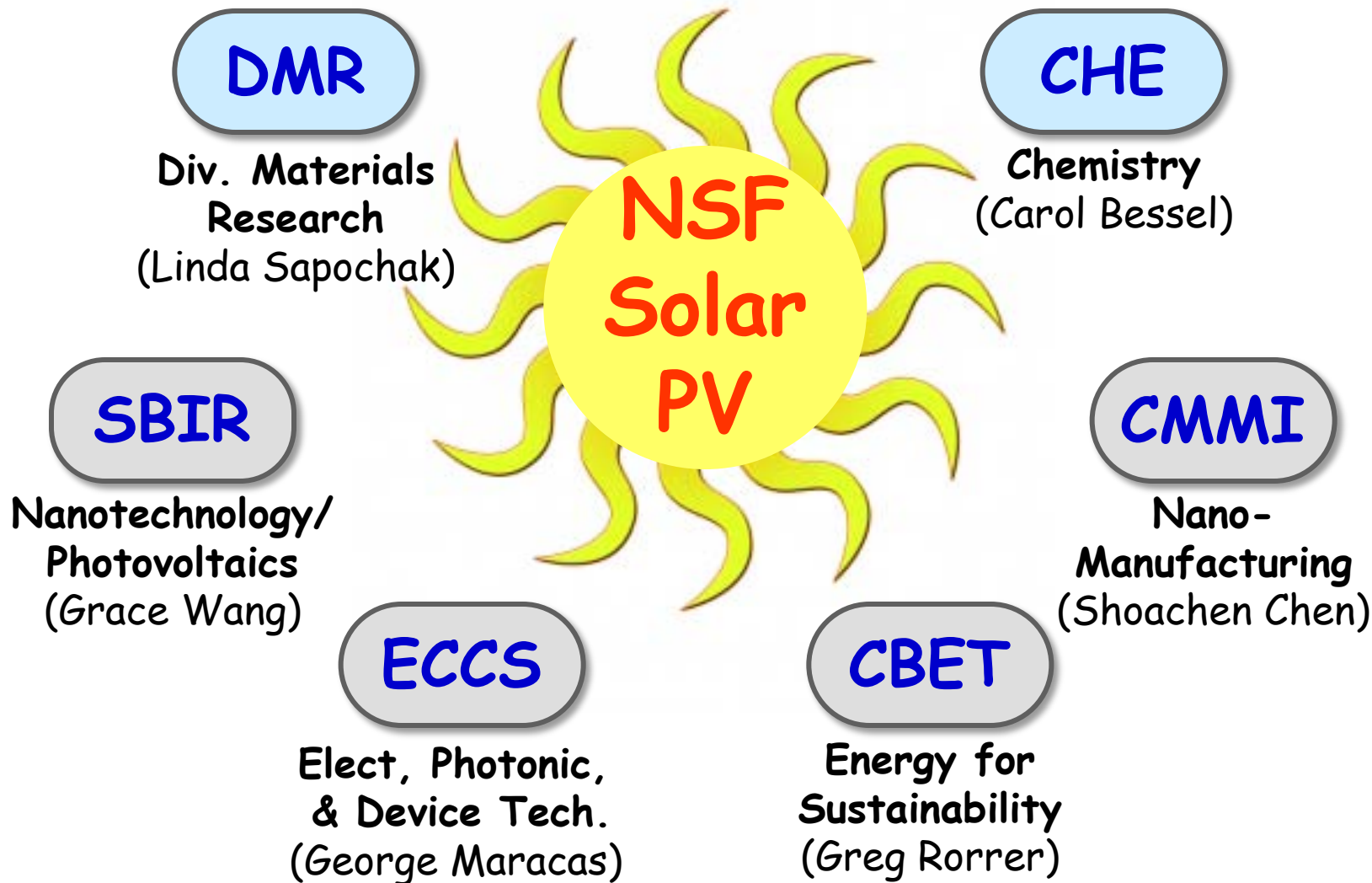


**DOE** Basic Energy Sciences,  
*New Science for a Secure &  
Sustainable Energy Future* (2008)





# NSF Support of Solar Photovoltaics: Major Programs

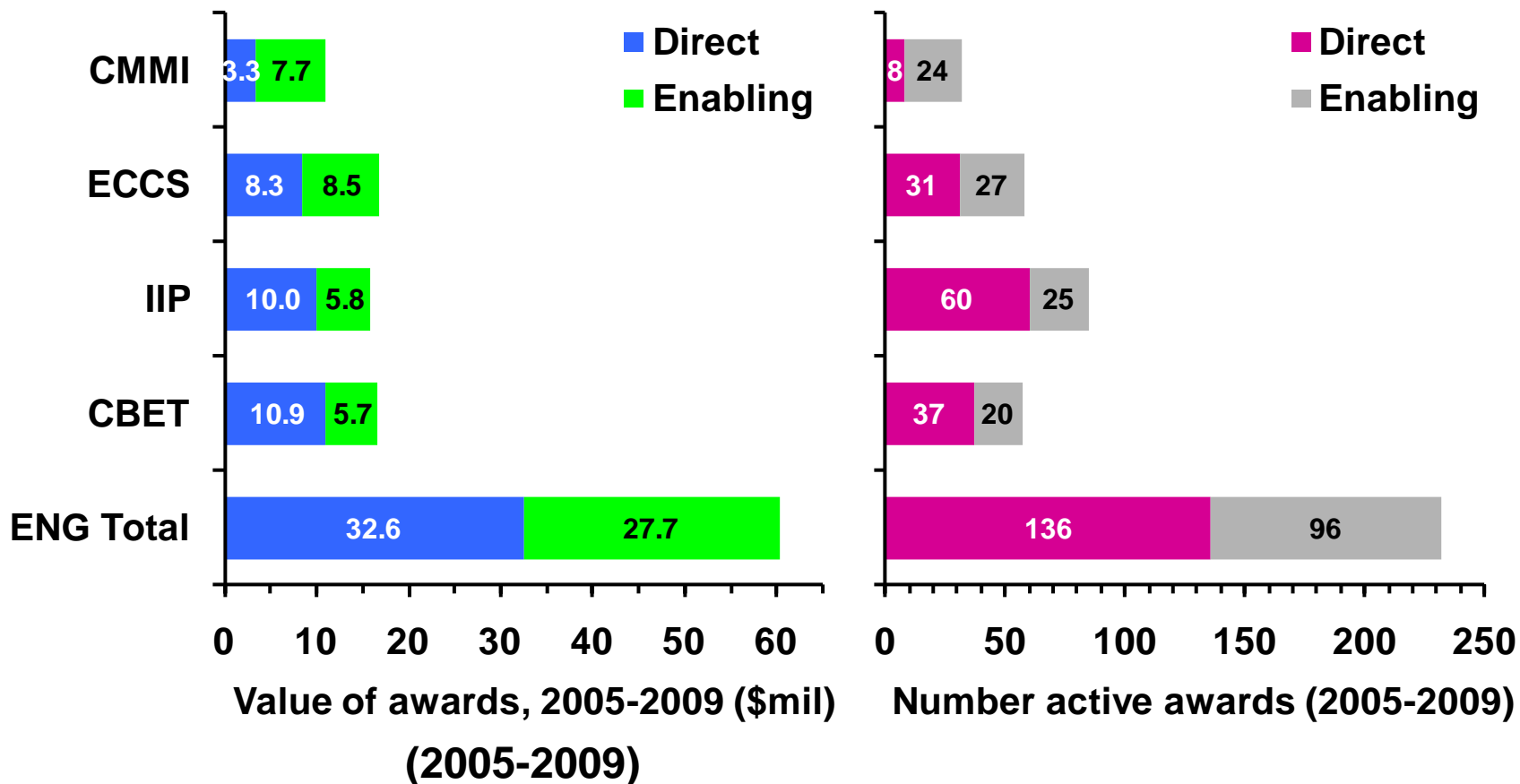






# NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

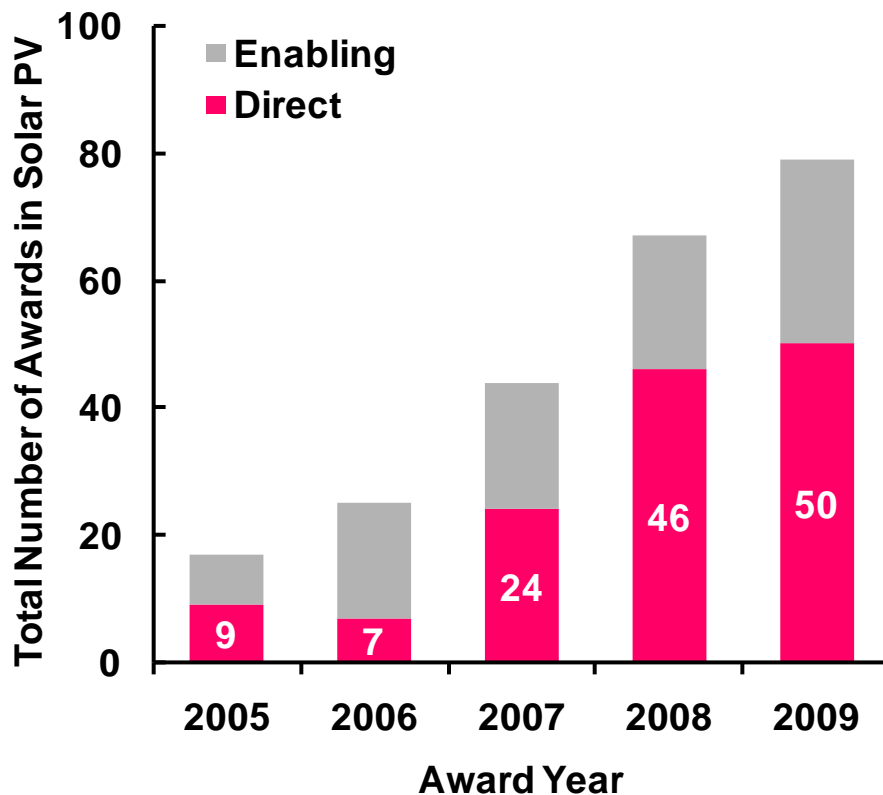
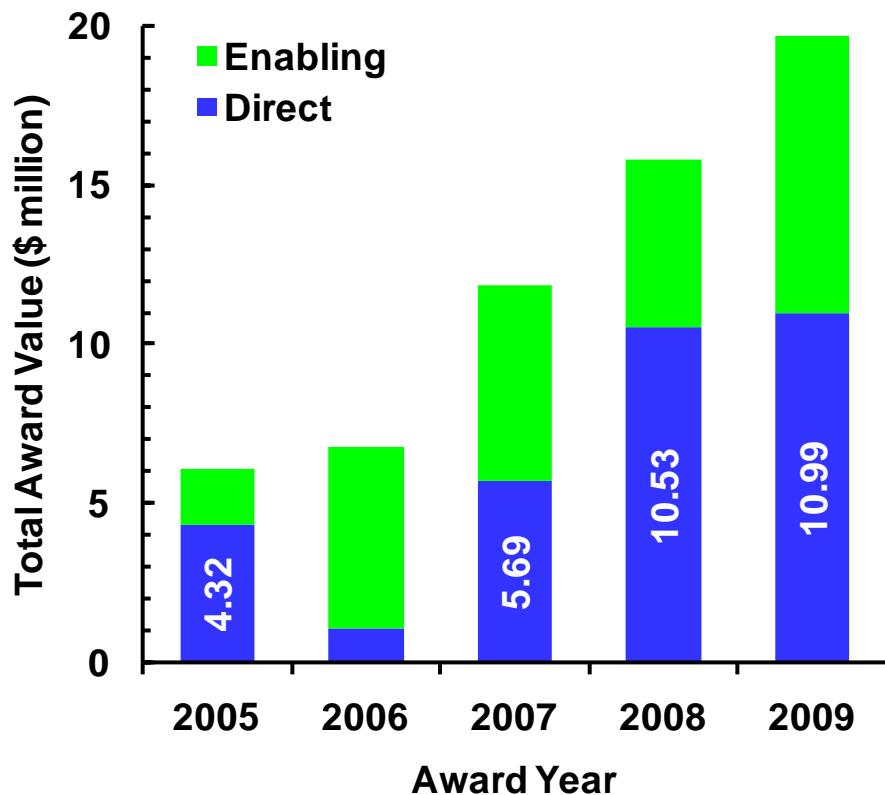
- **Direct:** solar PV material & device focused research
- **Enabling:** foundational research with applications to solar PV





# NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

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





# NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

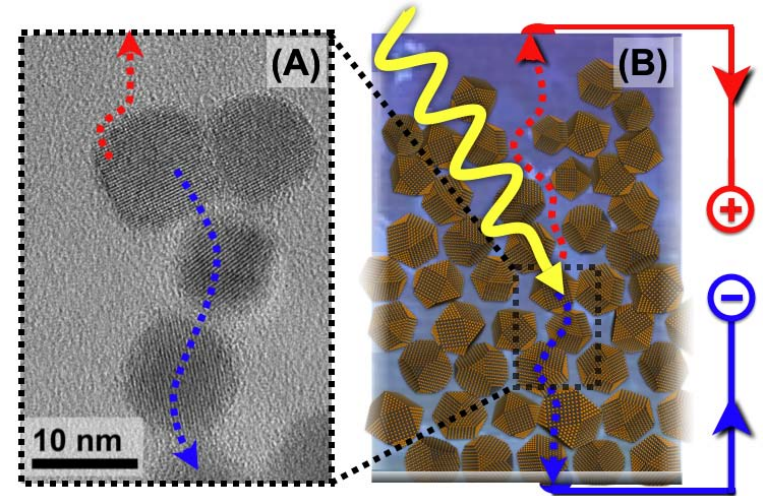
**Innovative integration of new materials & devices for 3<sup>rd</sup> generation PV**

## **Nanostructured semiconductors**

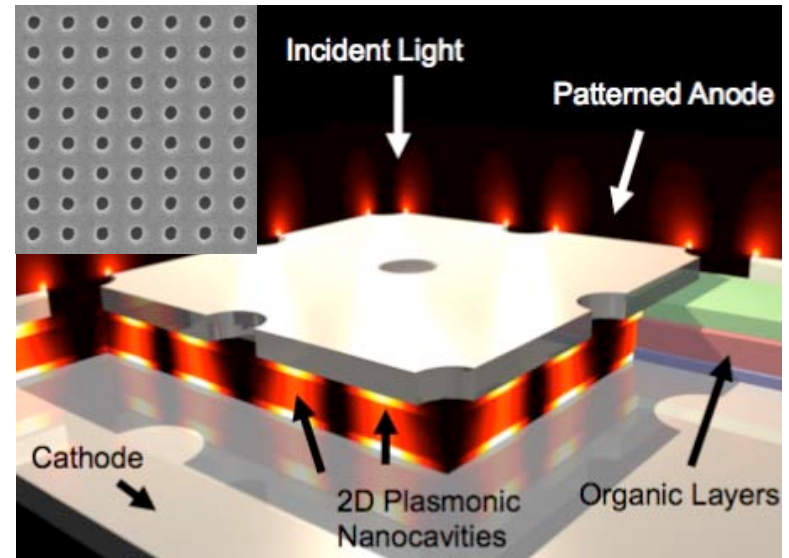
- Nanocrystals (*Hanrath*)
- Nanowires
- Nanotubes (CNT, ZnO etc)

## **Light flow manipulation**

- Plasmonic structures (*Holmes*)
- Photonic structures



*Tobias Hanrath, Cornell University*



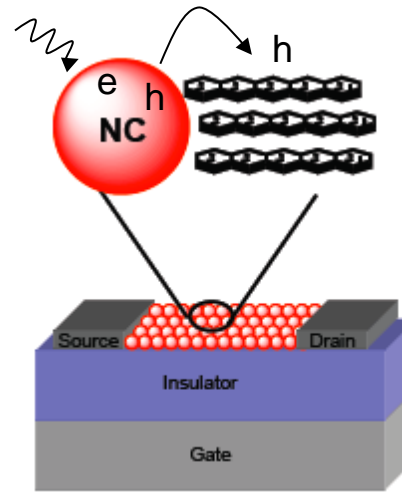
*Russel Holmes, Univ. Minnesota*



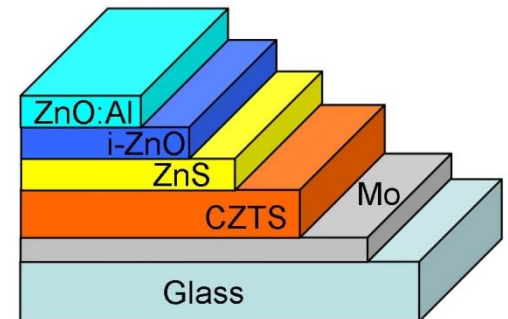
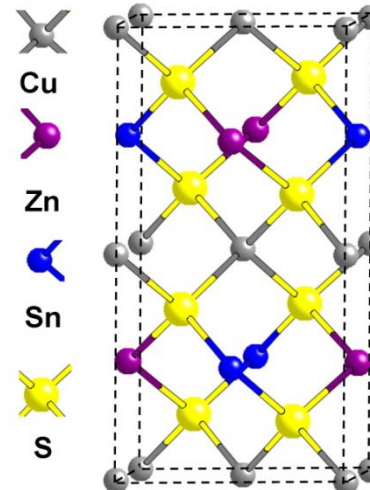
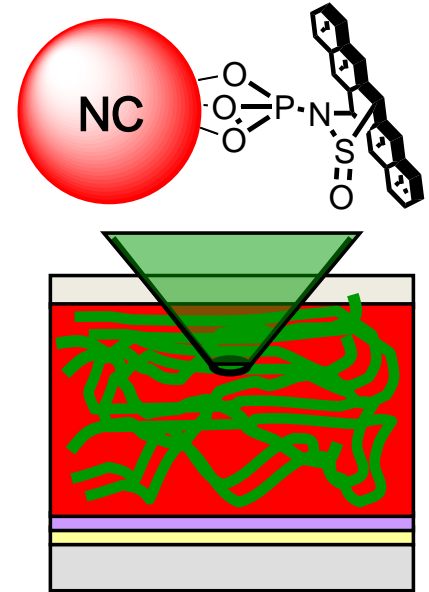
# NSF Engineering Investments in Solar Photovoltaic (PV) Materials & Devices

## Innovative integration of new materials & devices for 3<sup>rd</sup> generation PV

- Earth-abundant materials (*Aydil*)
- Dye-sensitized solar cells
- Organic photovoltaics
- Organic-inorganic hybrid materials (Kagan)
- Self-assembled systems
- Biomimetic/bioinspired systems



*Cherie R. Kagan  
Univ. Pennsylvania*



*Eray Aydil,  
Univ. Minnesota*



# Up Next

**Grace Wang**, Program Director

*Engineering Directorate*

*Industrial Innovation & Partnerships, SBIR Program on Nanotechnology*

## **Overview of Photovoltaics Thrusts through SBIR/STTR Program at NSF**

**Carol Bessel**, Program Director

*Mathematical & Physical Sciences (MPS) Directorate*

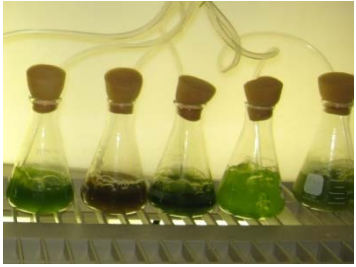
*Division of Chemistry*

## **Support of Solar Photovoltaics in the MPS Directorate at NSF**





# CBET Energy for Sustainability Program: Three Current Emphasis Areas



algae

**Biomass Conversion,  
Biofuels & Bio-Energy**



plant biomass

*Renewable Natural Resources*  
**Renewable  
Energy Technologies**  
*Environmentally Benign  
Materials & Processes*



wind



solar

**Wind & Wave  
Power**

**Solar Photovoltaic  
Power & Fuels**





# NSF Support of Academic Science & Engineering Research (FY 2008)

