

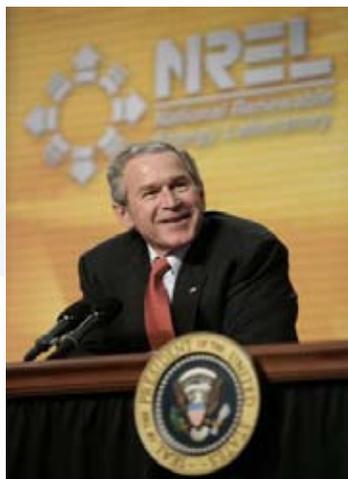
# NREL Overview

**DOE/NSF EPSCoR Program Review 2007**  
**July 23, 2007**

Bobi Garrett

Associate Director, National Renewable Energy Laboratory

# Call for Action

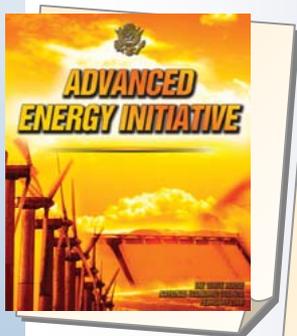


**Supply Diversity**

**Environmental Stewardship**

**Energy System Reliability**

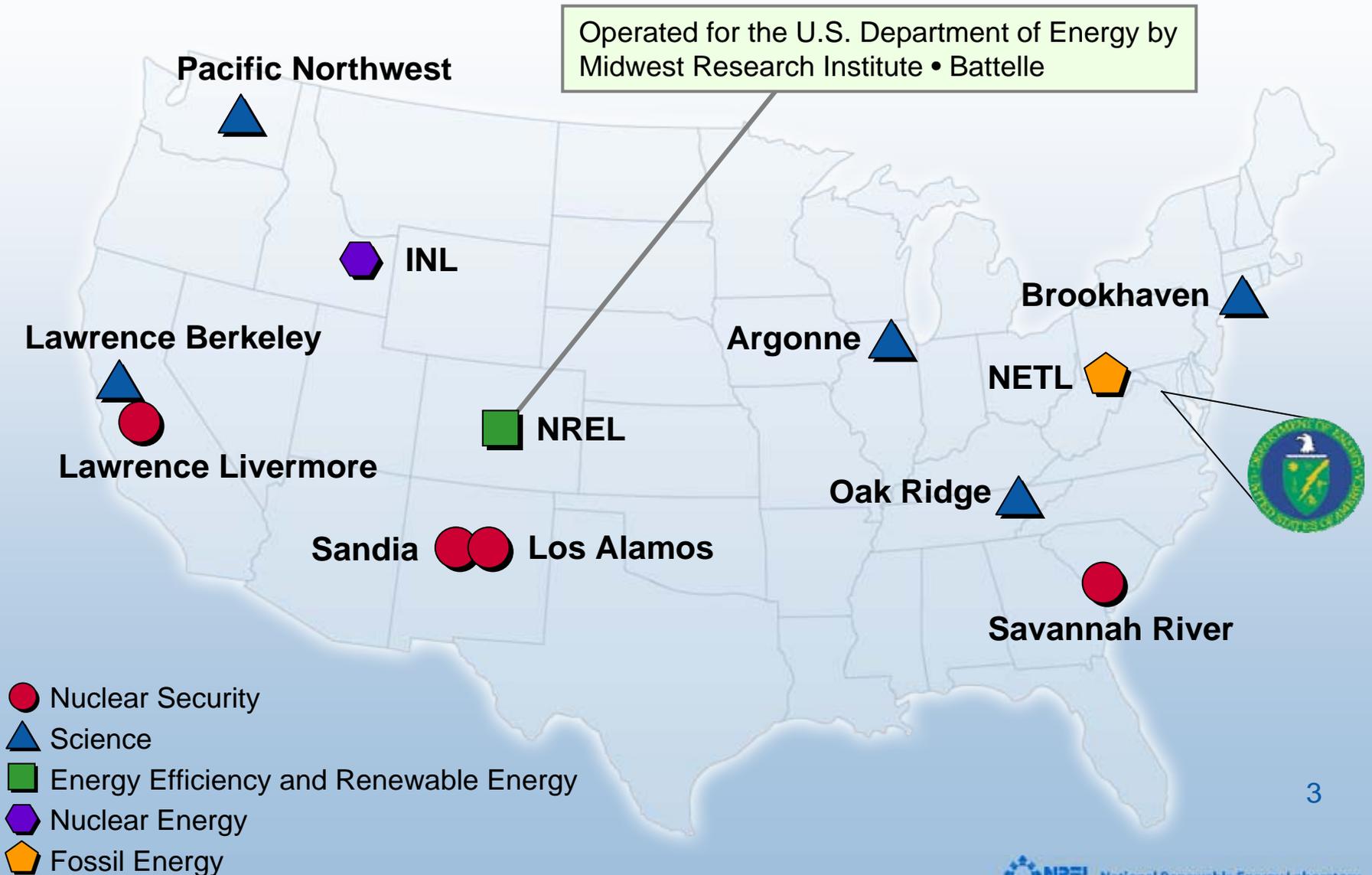
**Energy Productivity**



**Mission: Develop renewable energy and energy efficiency technologies and practices, advance related science and engineering, and transfer knowledge and innovations to address the nation's energy and environmental goals.**

**NREL's mission aligns with DOE energy goals**

# Major DOE National Laboratories



# What Makes NREL Unique?

- Only national laboratory dedicated to renewable energy and energy efficiency R&D
- Research spans fundamental science to technology solutions
- Collaboration with industry and university partners is a hallmark and unique facilities enable collaborations
- Research is market relevant because of a systems focus



# Energy Efficiency and Renewable Energy Technology Development Programs

## Strategic Analysis



### Efficient Energy Use

- Vehicle Technologies
- Building Technologies
- Industrial Technologies



### Renewable Resources

- Wind
- Solar
- Biomass
- Geothermal



### Energy Delivery and Storage

- Electricity Transmission and Distribution
- Alternative Fuels
- Hydrogen Delivery and Storage

# Two Primary Business Lines

Integration from Supply to Efficient Use

## Electricity



- Efficient End Use
- Intelligent Delivery
- Renewable Supply

Technology Utilization

Technology & Systems Development

Foundational Science

## Fuels

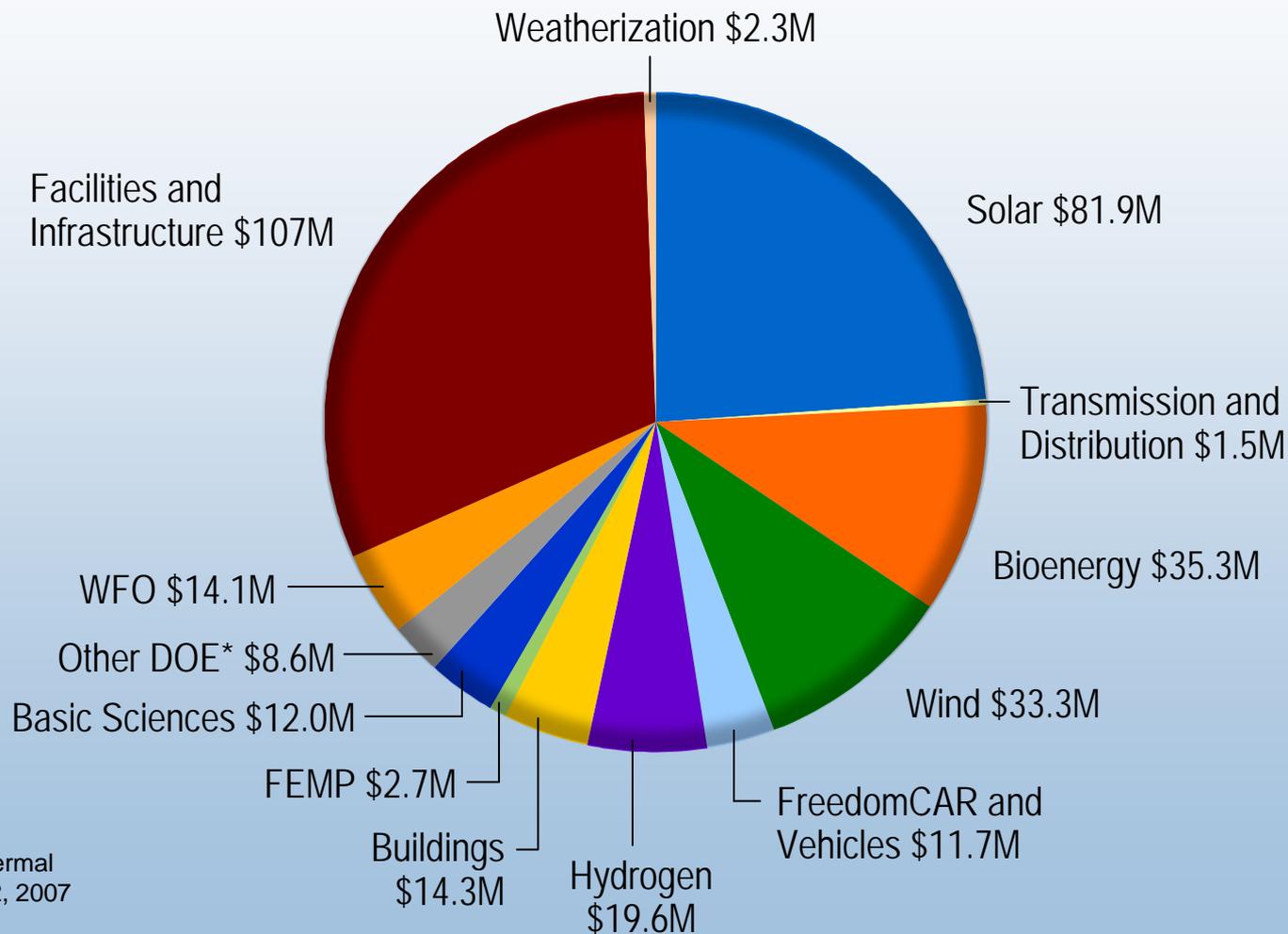


- Efficient and Flexible Vehicles
- Renewable Supply

*From Science to Systems*

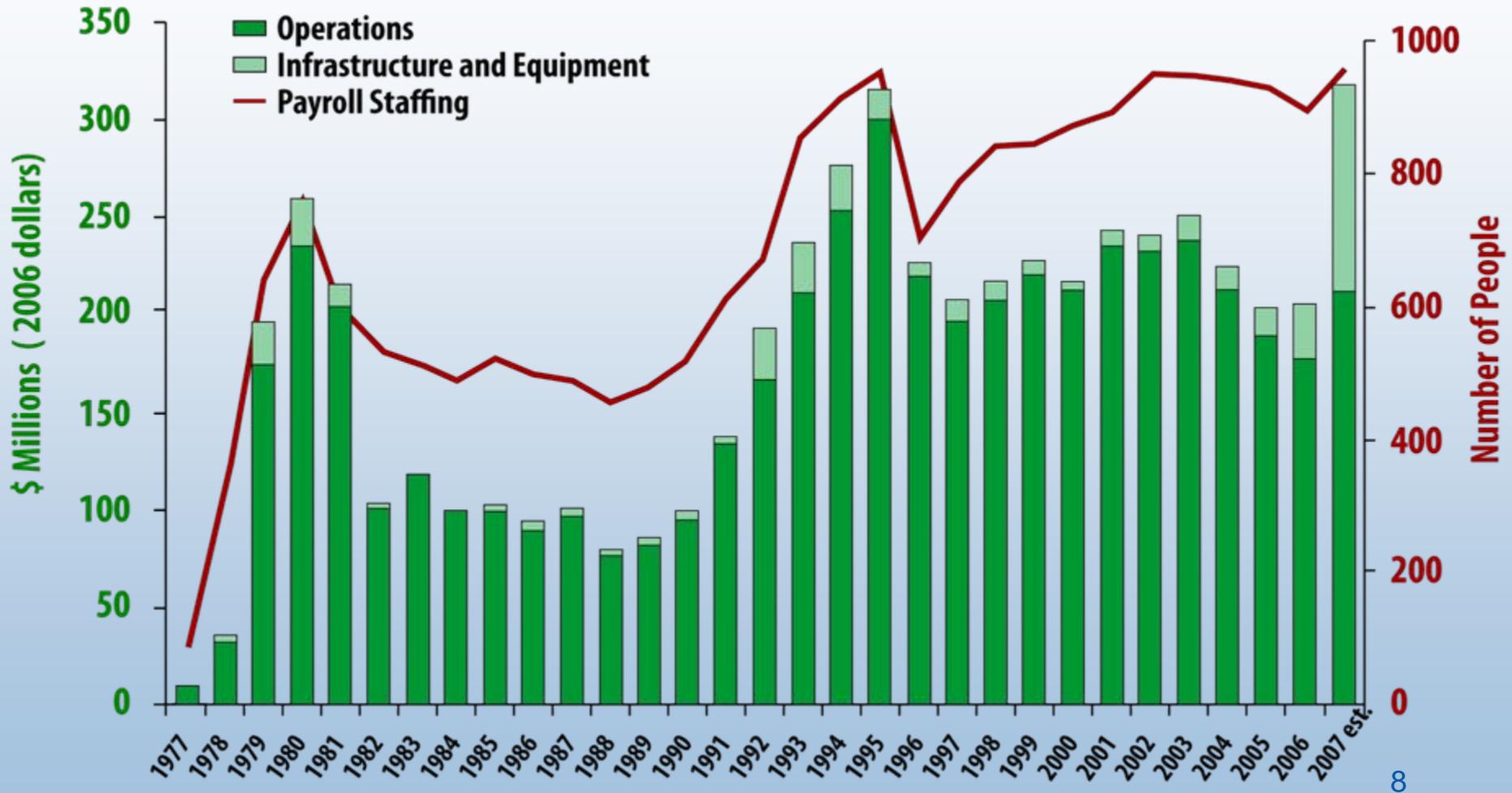
# NREL FY 2007 Program Portfolio

## Estimated \$344.3 Million



\* Includes geothermal  
Updated June 22, 2007

# NREL Funding and Staffing



Updated May 2007

# NREL Buildings Research

## Net Zero Energy Buildings

- Whole building systems integration of efficiency and renewable features
- Computerized building energy optimization tools
- Field experiments and monitoring
- Building integrated PV

## Component Technologies

- Solid State Lighting
- Electrochromic windows
- Advanced HVAC and Combined Heat and Power Systems



Thermal Test Facility



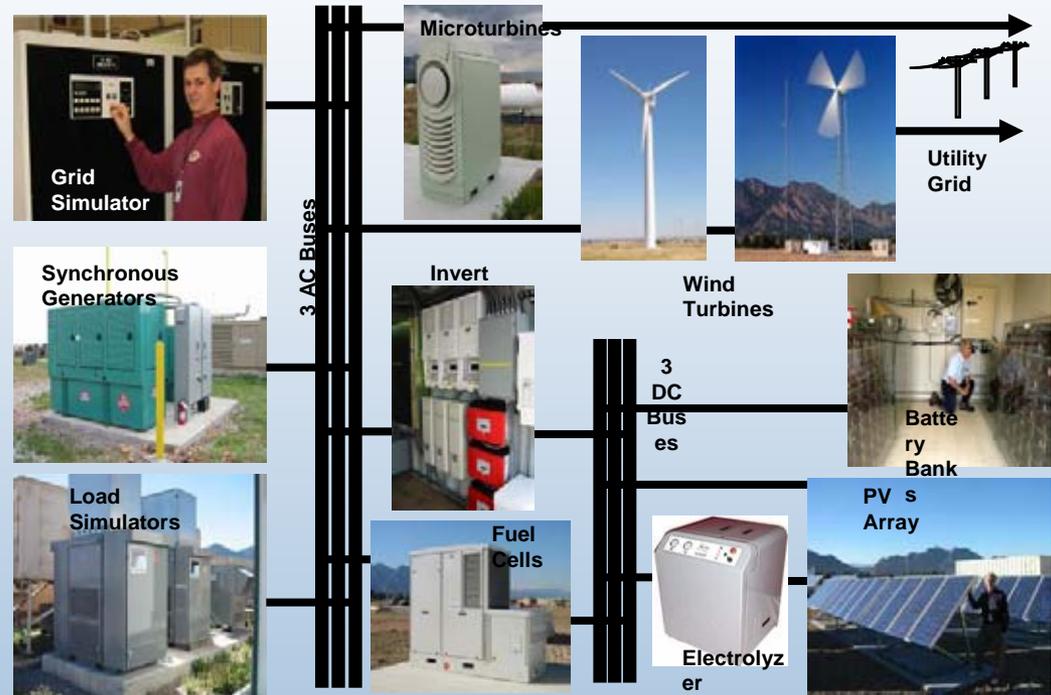
HVAC Test Loop



# Distributed Energy Systems

## Distributed Energy System Integration

- Distributed Power
  - Standards Development
  - Interconnection Testing
  - Microgrids
- Advance Power Electronics
  - Advanced functionality
  - Modular/scaleable power electronics
- Systems Integration
  - DE system modeling and simulation
- Renewable Electrolysis



Distributed Energy Resources Test Facility



# Wind

## System Performance/Reliability

- Wind resource assessment
- Aerodynamic modeling
- Structures and fatigue research and structural design codes
- Advanced component development (e.g., Controls/Power Electronics)
- Prototype validation and testing
- Systems integration



**Blade Test Facility**



**Turbine Test Facility**



# Solar

- Solar Resource Assessment
- Photovoltaics
  - Predictive Solid State Theory Materials and Devices
  - Higher Efficiency Devices
  - Advanced Manufacturing
  - Measurement and Characterization
- Concentrating Solar Power
  - Reflective Materials
  - Trough System Analysis



**Solar Radiation  
Research Lab**



**Solar Energy  
Research Facility**



**Science & Technology  
Facility**

**Outdoor Test Facility**



# Vehicle and Fuels R&D

## Current Vehicle and Fuel Status

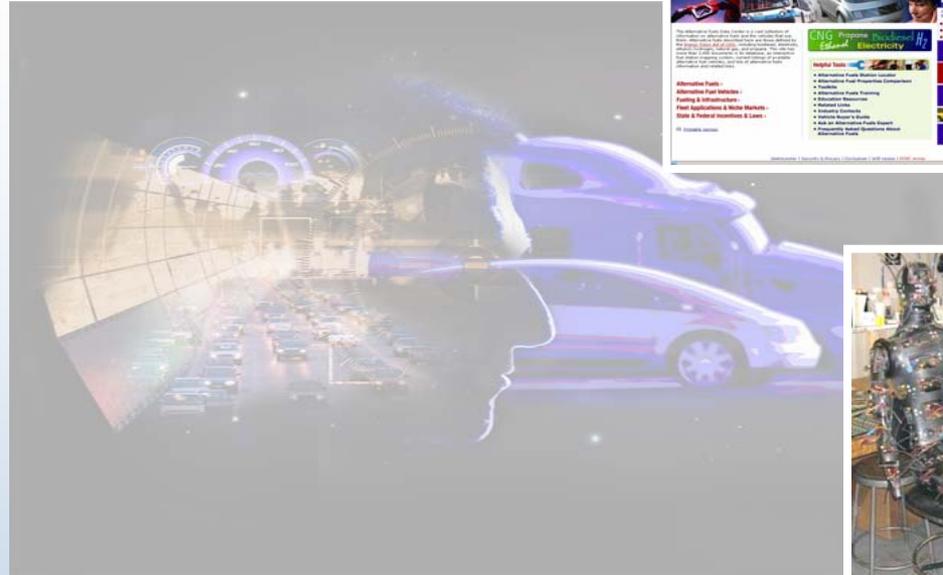
- 131 million cars, 95 million trucks in U.S. today
- 378 million gallons of gasoline and 168 million gallons of diesel used per **day**
- U.S. light-duty vehicles (cars and trucks) responsible for 4% of world CO2 emissions

## Key DOE Goals

- Reduce energy storage cost for a 25 kW battery from \$3,000 to \$500 by 2010
- Reduce cost of inverter/motor from \$40/kW to \$12/kW by 2010
- Identify fuel formulations that will enable replacement of at least 10% petroleum fuels by 2010 (currently at 3%)
- Accelerate adoption and use of alternative fuels and advanced vehicles through policy, consumer education, and demonstration activities

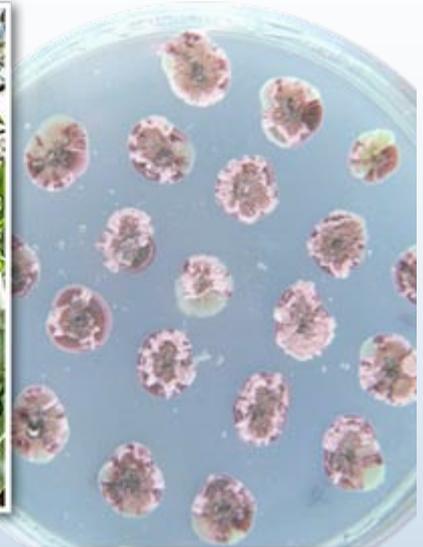
## NREL Research Thrusts

- Vehicle systems analysis, energy storage, power electronics
- Fuels performance, evaluation, and impacts
- Technology evaluation and integration



# Biofuels Research

- Feedstock Characterization/ Chemometrics
- Biochemical Conversion
- Thermochemical Conversion
- Process modeling and life cycle analysis



**Alternative Fuels User Facility**



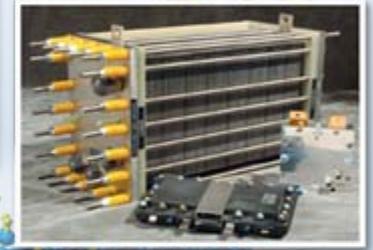
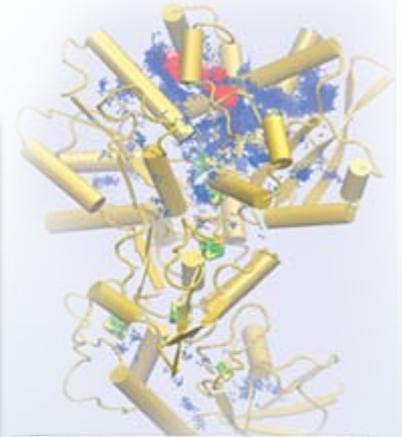
**Biochemical Pilot Plant**

**Pilot-Scale Thermochemical Conversion**



# Hydrogen Production

- Renewable Production
  - Photoelectrochemical
  - Photobiological using algae
  - Biomass Pyrolysis
  - Solar thermal
  - Co-production of electricity and hydrogen w/electrolysis
- Carbon-based nanostructured storage materials
- Fuels Cells
  - Thermal analysis
  - Integration of fuel cells with renewable energy production
  - Integrated control systems
- Technology validation
- Codes and Standards



# NREL Foundational Science

Discovery Research

Use-inspired  
Basic Research

Purpose-Driven  
Exploratory Research

Applied Research  
& Development

Technology Maturation  
& Deployment

## *Foundational Science*



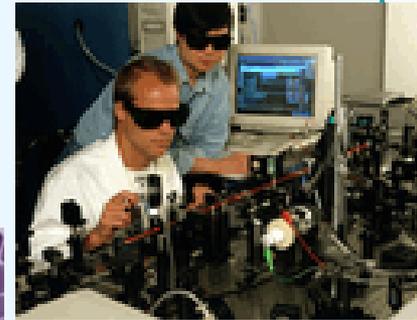
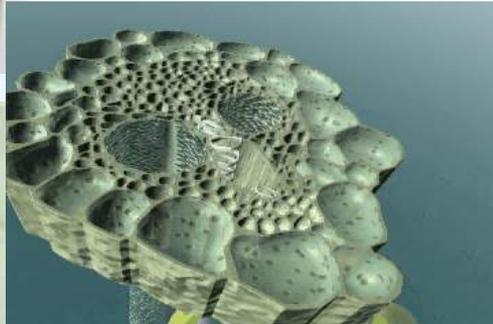
- Basic research for fundamental new understanding, the science grand challenges
- Development of new tools, techniques, and facilities, including those for advanced modeling and computation
- Basic research for new understanding specifically to overcome short-term showstoppers on real-world materials in the DOE technology programs
- Early stage translation of knowledge into proof of concept – generally at a stage where performance and cost can not be estimated
- Foundational research to better understand specific phenomena that underpin technology advances
- Research with the goal of meeting technical targets, with emphasis on the development, performance, cost reduction, and durability of materials and components or on efficient processes
- Learning demos conducted to understand system interaction and to define R&D requirements
- Cost reduction
- Scale-up research
- Prototyping
- Manufacturing R&D
- Technology utilization support (codes & standards, etc.)

Active Management  
of the Interface

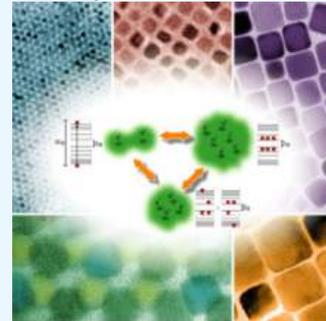
# Three Key Science Areas



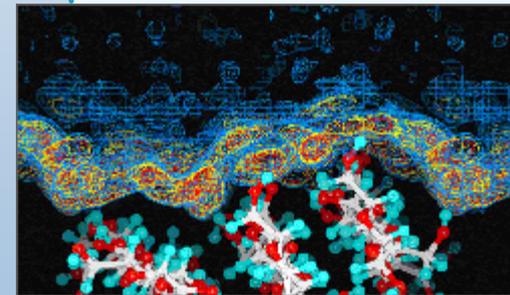
Systems Biology



Photoconversion



Computational Science

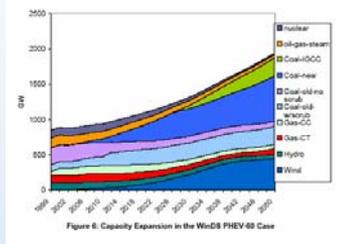


# Role of Analysis at NREL

Integrated technical and economic analyses that advance the understanding of the value of technology in the context of dynamic global, national, and local markets; Policies; energy resources and loads; and infrastructure.

## Impact Analysis

Analyze benefits and impacts of programs, portfolios, and policy options



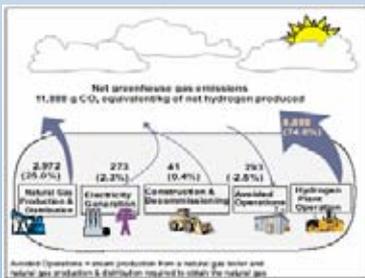
## System

Analyze system performance and technology interfaces in the context of the overall system



## Technology/Component

Analyze technology and component performance and cost



## Resource

Assess resource availability and characteristics



# NREL Site: A Model for Energy and Environmental Leadership

## Science and Technology Facility - LEED 'Platinum'

- First Federal building
- One of only three laboratory facilities
- One of only 28 buildings worldwide

## NREL Site is "Carbon Neutral"

- Onsite renewables (PV and Wind)
- Renewable Energy Certificate (REC) purchases

## Onsite Renewable Energy

- Wind and PV
- Biomass heating plant in progress

## Energy Policy Act and Executive Order Requirements

- Site exceeds all EAct requirements

## Vehicle Fleet

- 48 vehicles, 34 (71%) are alternatively fueled
- Fleet petroleum reduced ~45% since 2000



# The U.S. Department of Energy's National Renewable Energy Laboratory

[www.nrel.gov](http://www.nrel.gov)



**Golden, Colorado**