

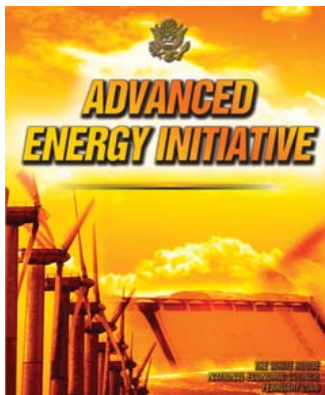
# NREL Overview



**Dr. Dan E. Arvizu**  
**Laboratory Director**

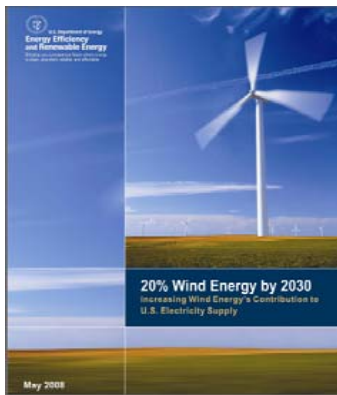
**August 2008**

# Setting the Bar Higher – Gigawatt-Scale Renewables



## Solar Vision

*10% U.S. electricity  
by 2025*



## Wind Vision

*20% U.S. electricity  
by 2030*



## Energy Independence & Security Act 2007

*36 billion gallons of renewable  
fuels by 2022*

Requires investment in new infrastructure:

- Overall in U.S. = \$2 trillion
  - Worldwide = \$22 trillion
    - Biofuels
    - Wind
    - Solar
- } \$2 trillion (est.)

# Getting to “Speed and Scale” – Key Challenges

## *Implementing Renewable Gigawatts at Scale*



NREL 340-1

### **B A R R I E R S**

- Cost of renewable electricity
- Performance and reliability
- Infrastructure robustness and capacity
- Dispatchability of renewables

## *Displacement of Petroleum-Based Fuels*



NREL 139-1

### **B A R R I E R S**

- Cellulosic ethanol cost
- Life cycle sustainability of biofuels
- Fuels infrastructure, including Codes/Standards
- Demand and utilization, including intermediate blends

## *Reducing Energy Demand of Buildings, Vehicles, and Industry*



NREL 196-1

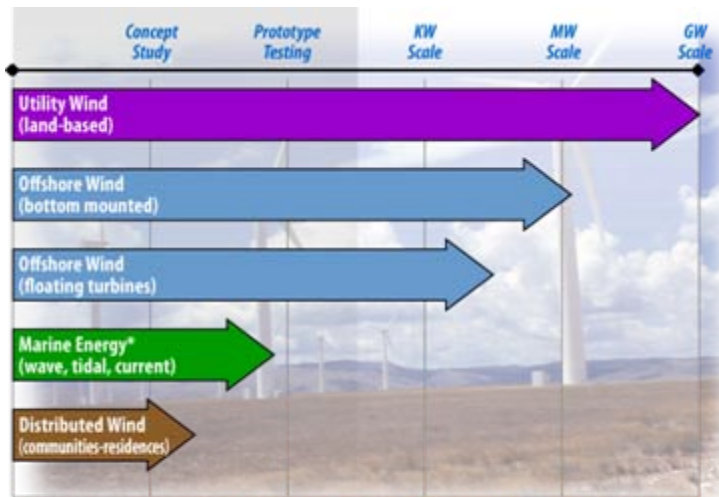
### **B A R R I E R S**

- Coordinated implementation of model building codes
- Market does not value efficiency
- Cost of energy efficient technologies
- Performance and reliability of new technologies



# Technology Options Are Evolving

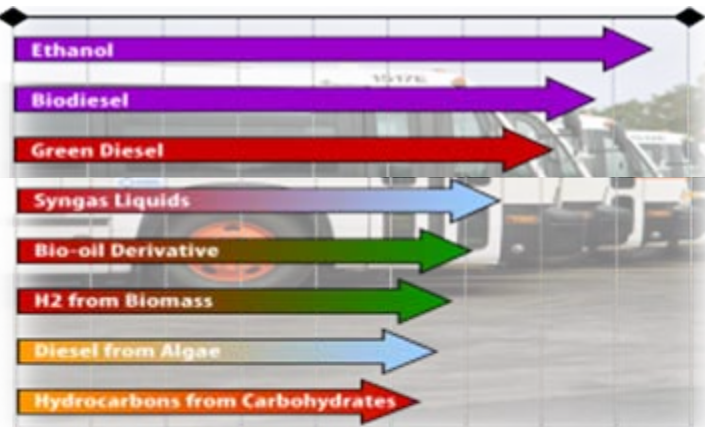
## Wind & Water



Organizations Leading the R&D

- Industry Leaders with Government Support
- Government Laboratory Contactors
- Government-Industry Partnership
- Academia & Small Startups

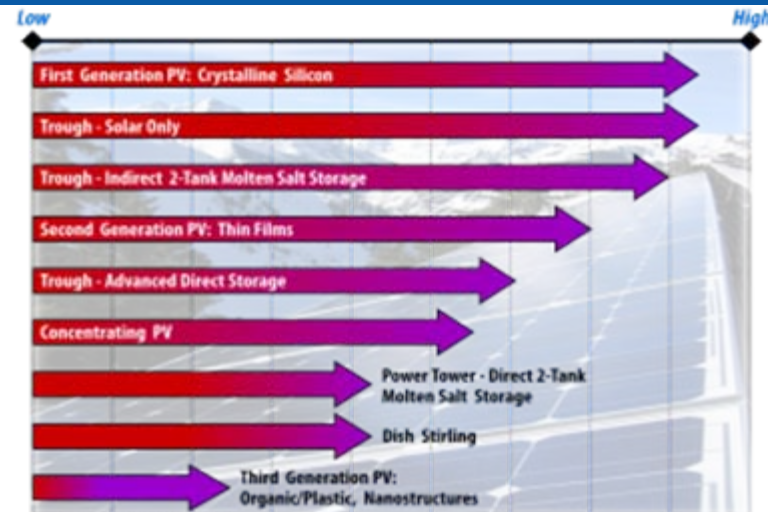
## Biofuels



Organizations Leading the R&D

- Grain/Agriculture
- Coal
- Chemical
- Petroleum
- Forestry
- Academia & Startups

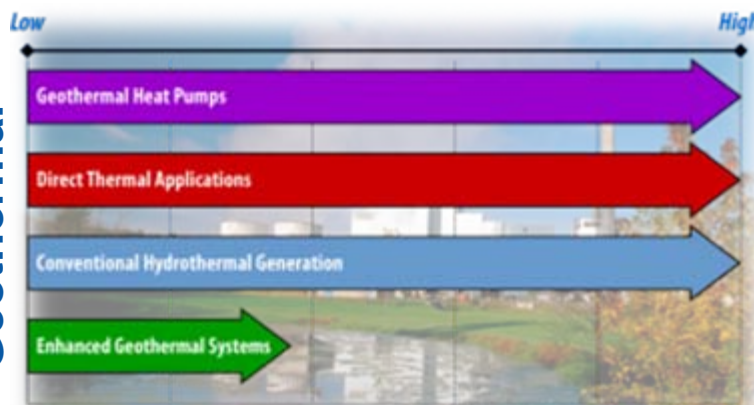
## Solar



Organizations Leading the R&D

- Lab/Academia
- Industry

## Geothermal



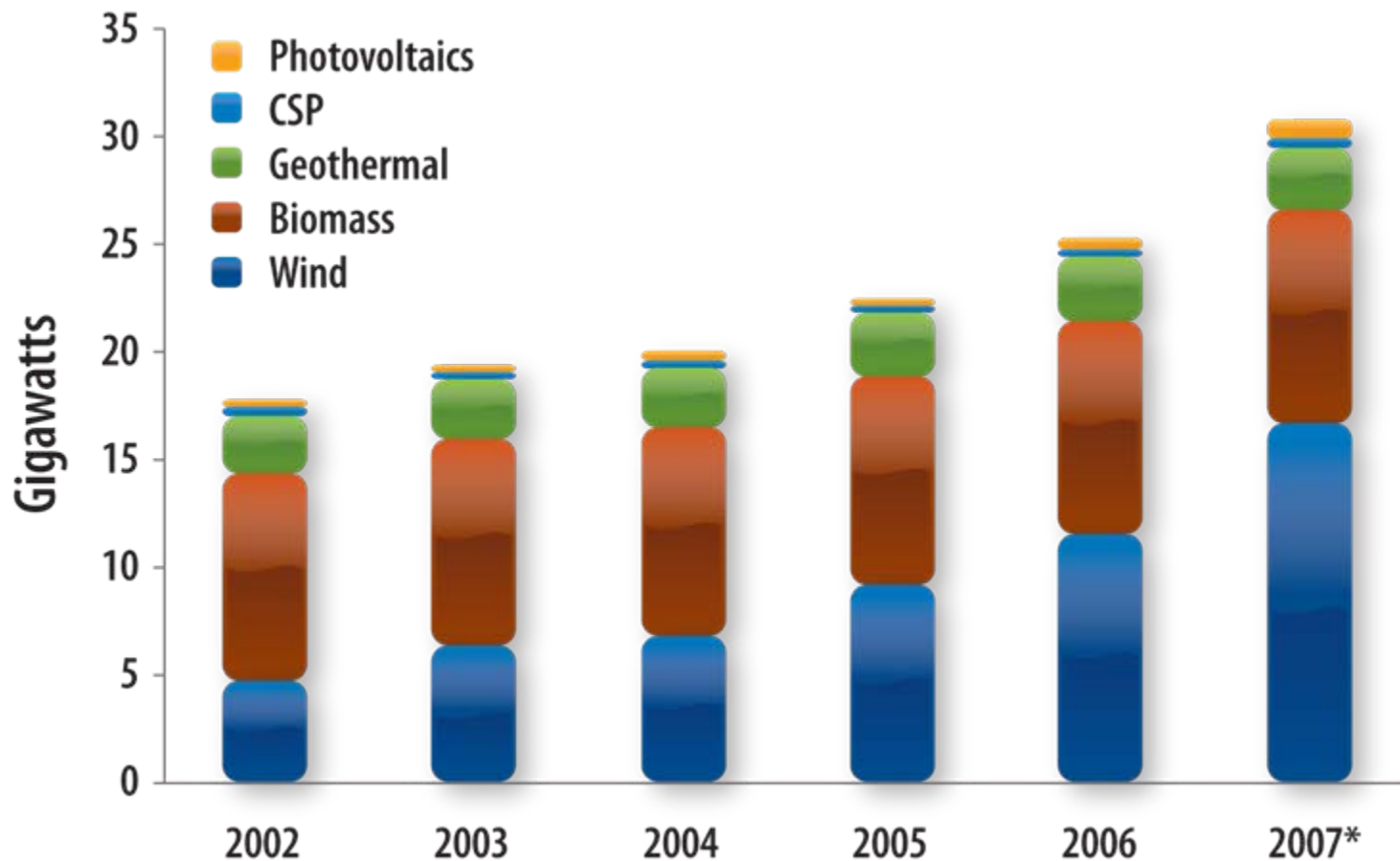
Organizations Leading the R&D

- HVAC Industry
- Industry, Academia, DOE
- Industry
- DOE, Academia, Industry

# Harvesting Past Investments

## First Generation Technology

U.S. Renewable Electricity Installed Nameplate Capacity

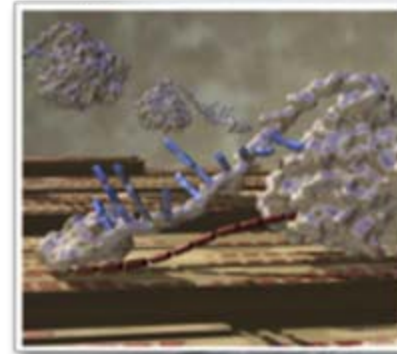


Sources: Chalk, AWEA, IEA, NREL, EIA, GEA

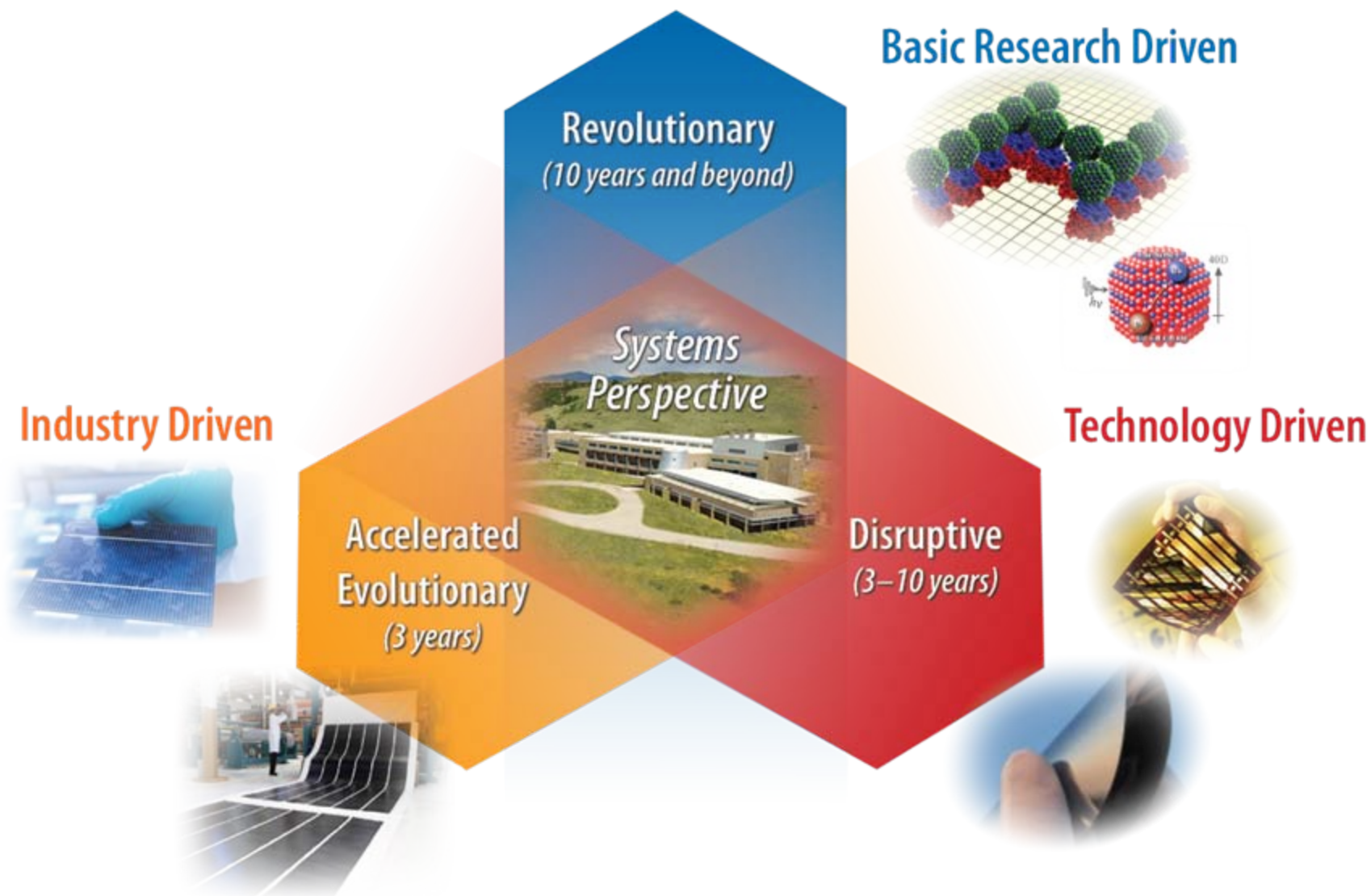
# Technology Innovation Challenges Remain

## The Next Generation

- Wind Turbines
  - Improve energy capture by 30%
  - Decrease costs by 25%
- Biofuels
  - New feedstocks
  - Integrated biorefineries
- Solar Systems
  - Improved performance through, new materials, lower cost manufacturing processes, concentration
  - Nanostructures
- Zero Energy Buildings
  - Building systems integration
  - Computerized building energy optimization tools



# Achieving the Potential Requires A Balanced Portfolio

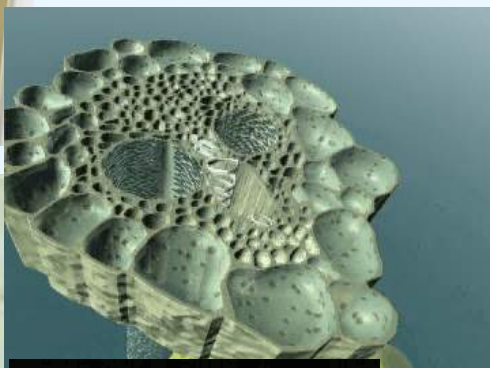




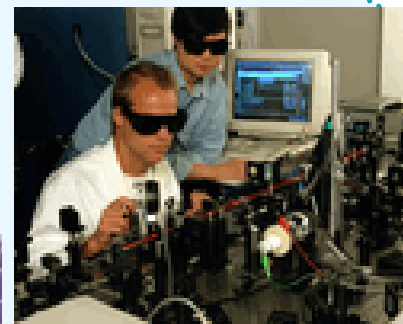
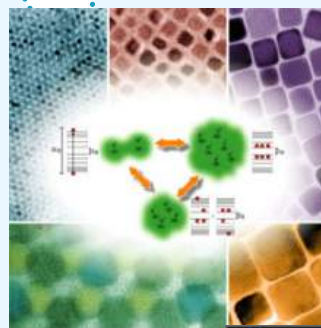
# Translational Science is Key to Speed and Scale



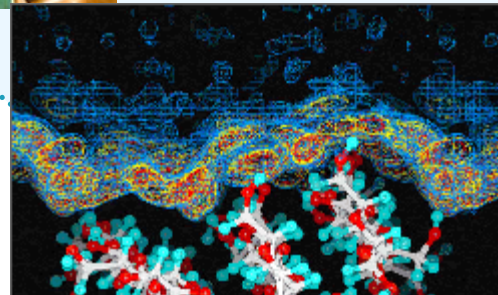
**Systems Biology**



**Computational Science**



**Photoconversion**



**Connecting new discoveries, via applied research, to the marketplace**

Discovery Research

Use-inspired  
Basic Research

Purpose-Driven  
Exploratory Research

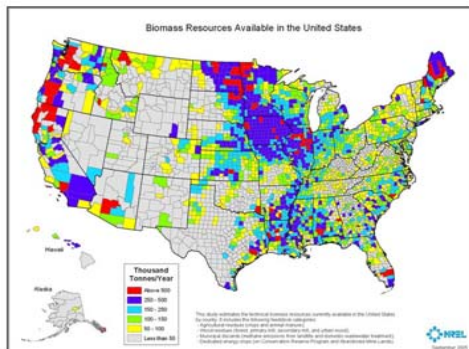
Applied Research  
& Development

Technology Maturation  
& Deployment



# Managing the Lab-to-Market Interface

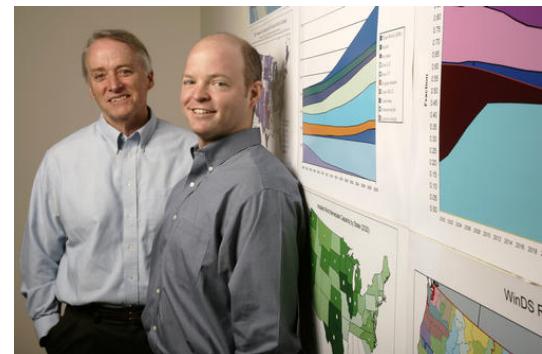
- Partner with industry, universities, other federal agencies, international community and state/local governments to deploy clean energy solutions
  - Hawaii training, DuPont CRADA, Xcel/SolarTAC
- Contribute timely and definitive analyses on technology, policy, and market issues that impact commercialization
- Provide investment community with credible information (industry growth forums)



Human Energy™



*The miracles of science™*



# Technology Development Programs



## Efficient Energy Use

- Vehicle Technologies
- Building Technologies
- Industrial Technologies



## Renewable Resources

- Wind and water
- Solar
- Biomass
- Geothermal



## Energy Delivery and Storage

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

# What Makes NREL Unique?

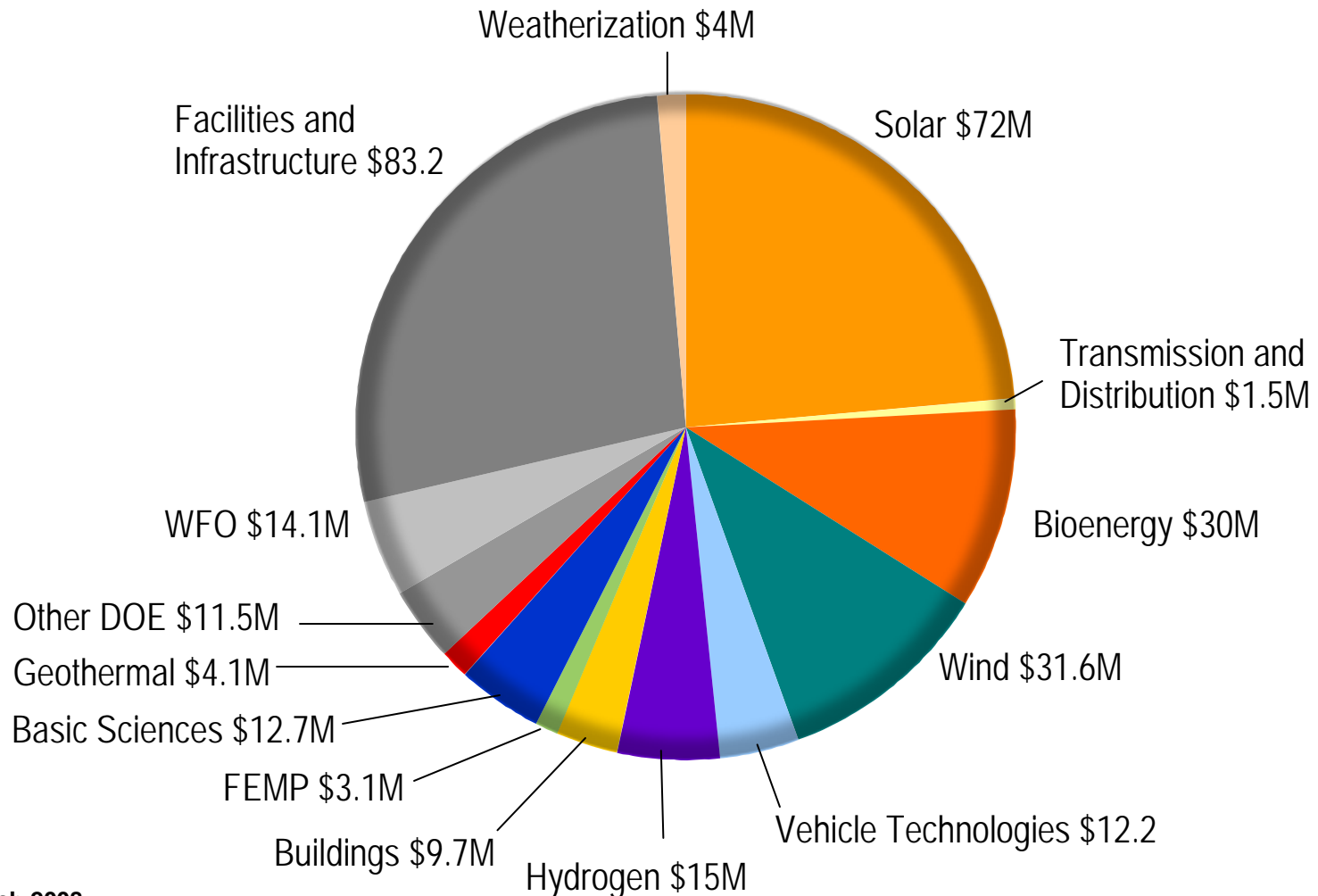
- Only national laboratory dedicated to renewable energy and energy efficiency R&D
- Collaboration with industry and university partners is a hallmark
- Ability to link scientific discovery and product development to accelerate commercialization





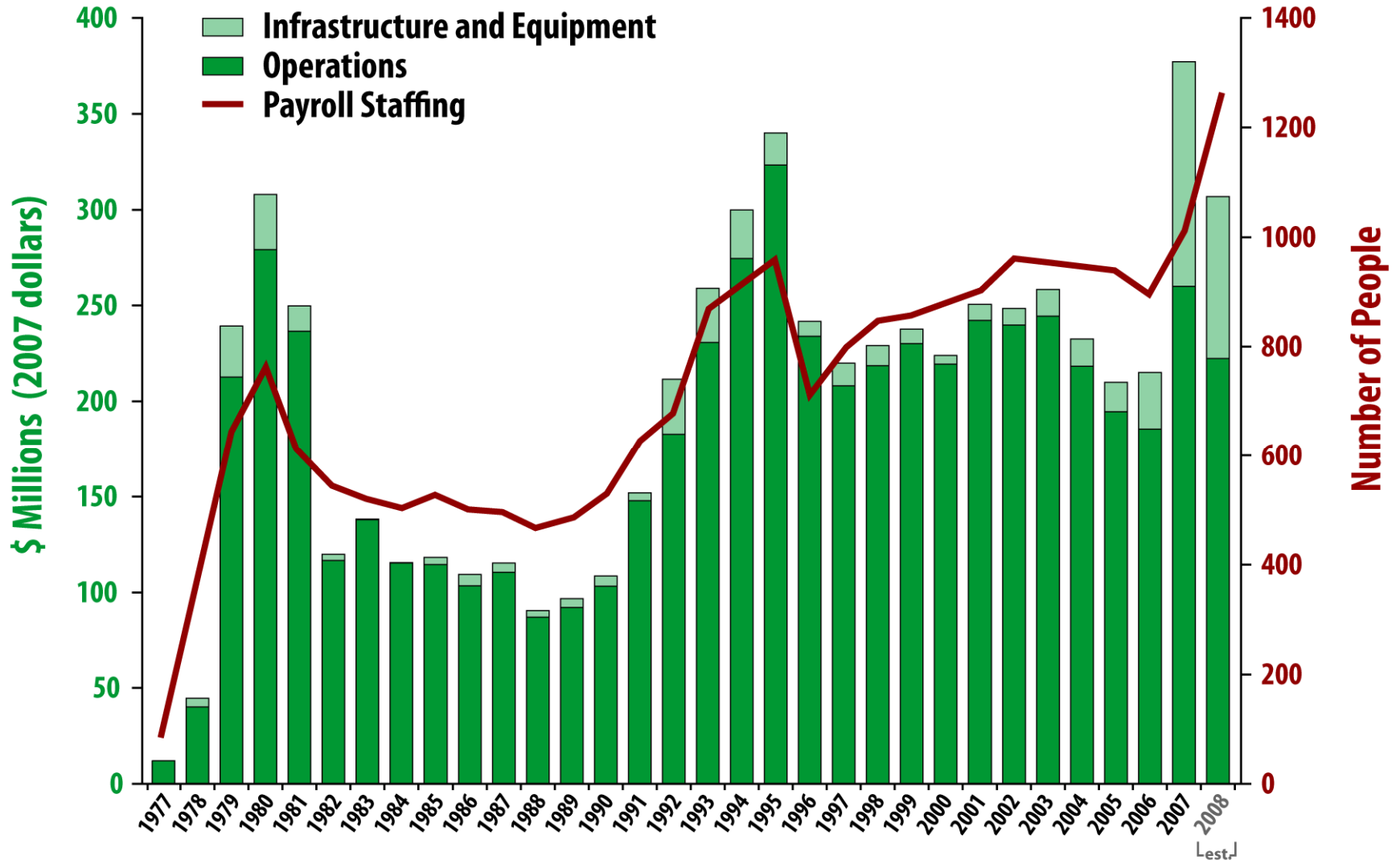
# NREL FY2008 Program Portfolio

## Estimated \$304 Million



Updated March 2008

# NREL Funding and Staffing



# Looking to the Future: NREL's Energy Systems Integration Facility (ESIF)

- 130,000 sq ft. multi-story building with high-bay and low-bay laboratories and offices
- Unique capability for testing and analysis to enable economic, reliable integration of renewable electricity, fuels, storage, and efficiency technologies with existing utility and fuels infrastructure



## Full Systems Evaluation: Integrating Electricity, Fuels, Thermal, Storage, and End-use

### Solar



- Interconnection
- Power electronics
- Building integration
- Thermal and PV system
- Optimization

### Buildings



- Sensors & controls
- PV design and integration
- Modeling and simulation
- System integration

### Hydrogen



- Hydrogen/electric interfaces
- RE electrolyzers
- Storage systems
- Standards
- Fuel cell integration
- Fueling systems

### Wind



- Models, methods for wind interaction
- Mini-grid analysis

### FreedomCAR



- Plug-in-hybrids and vehicle-to-grid
- Battery thermal management
- Power electronics

### Biomass



- Biofueled gensets and engines



# NREL: Leadership by Example

## TEAM Initiative

- DOE's effort to maximize energy efficiency and renewable energy generation across the DOE complex

## Science and Technology Facility achieves LEED 'Platinum'

- First Federal building

## NREL Site is "Carbon Neutral"

- Onsite renewables (Mesa Top and NWTC PV)
- Renewable Energy Certificate (REC) purchases

## Renewable Fuel Heating Plant

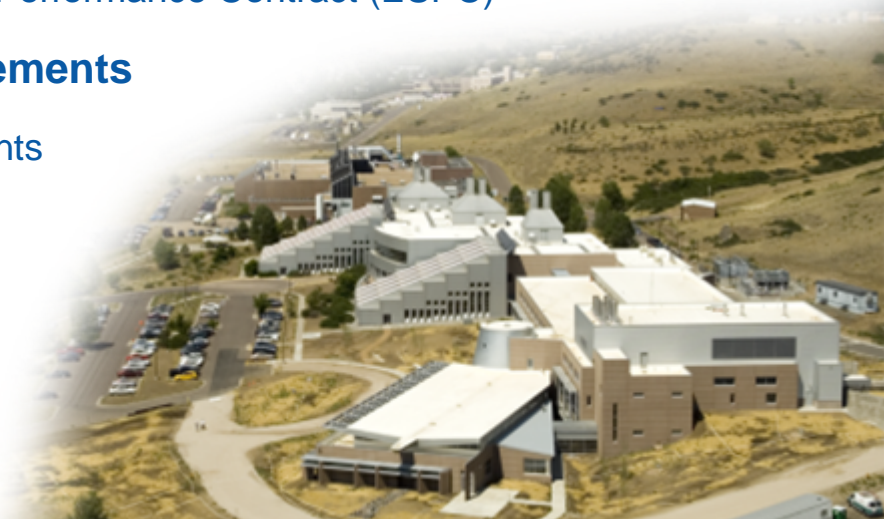
- Will offset 75% of current South Table Mountain campus natural gas use (significant on-site RE project)
- Financed and installed through Energy Savings Performance Contract (ESPC)

## Energy Policy Act and Executive Order Requirements

- Currently exceeding EAct requirements
- Meet or exceed new Executive Order requirements

## Vehicle Fleet

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



# An Integrated Approach is Required







**NREL**

**National Renewable Energy Laboratory**

*Innovation for Our Energy Future*



Visit us online at [www.nrel.gov](http://www.nrel.gov)



# Looking Ahead – NREL's Campus of the Future

