NREL Overview

National Association of State Universities and Land Grant Colleges (NASULGC) Executive Directors

May 20, 2004

Stanley R. Bull
Associate Director, Science and Technology
National Renewable Energy Laboratory
Major DOE National Laboratories

Operated for the U.S. Department of Energy by Midwest Research Institute • Battelle • Bechtel

Defense Program
Office of Science
Energy Efficiency and Renewable Energy
Office of Nuclear Energy
Fossil Energy

Pacific Northwest
INEEL
Lawrence Berkeley
NREL
Lawrence Livermore
Los Alamos
Sandia
Oak Ridge
Argonne
Brookhaven
NETL

National Renewable Energy Laboratory
National Renewable Energy Laboratory

- 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
- Research programs *linked* to market opportunities
NREL Funding and Staffing

Funding in 2003 Dollars

- **Funding**
- **Payroll Staffing**

- **$ Millions (2003 dollars)**
- **Number of People**
NREL FY 2003 Program Portfolio

$230 Million

- Solar – 25%
- Biomass – 15%
- Distributed Energy and Electricity Reliability – 8%
- FreedomCAR and Vehicles – 9%
- Wind – 13%
- DOE – 10%
- Other – 10%
- WFO – 4%
- Buildings – 6%
- Geothermal – 2%
- Basic Science – 2%
- FEMP – 2%
- Hydrogen – 4%
- Other – 10%
- DOE – 10%
- Other – 10%
- WFO – 4%
- Buildings – 6%
- Geothermal – 2%
- Basic Science – 2%
- FEMP – 2%
Where NREL’s Funding Goes

- Program Subcontracts: 40%
- General Procurements: 11%
- In-house Costs: 49%
NREL Technical Staff

Disciplines and Education

- PhDs 61%
- Masters 21%
- PhDs 22%
- Masters 42%

- Scientists 54%
- Engineers 33%
- Technicians* 13%

*Includes research technicians

Source: McCorkell, 04/31/04
South Table Mountain Site
South Table Mountain Site

- Visitors Center
- Solar Energy Research Facility
- Field Test Laboratory Building
South Table Mountain Site

Outdoor Test Facility

Outdoor Test Area

Thermal Test Facility

Alternative Fuels User Facility
South Table Mountain Site

Solar Radiation Research Laboratory
SAIC Heliostat
High-Flux Solar Furnace
Shipping and Receiving

Mesa Top Test Area
Denver West Leased Facilities
Science and Technology Facility
University Relations

Students, Post Docs, and Professionals
Adjunct Faculty Appointments
University Advisory Committees
University Subcontracts
## Summary of NASULGC Participation in EE’s FY 2003 Portfolio

<table>
<thead>
<tr>
<th>Method of Participation</th>
<th>NASULGC Institutions Participating</th>
<th>Awards to NASULGC Institutions</th>
<th>Total FY 03 Awards to NASULGC Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NREL to Institution</td>
<td>51</td>
<td>257</td>
<td>$8.8M</td>
</tr>
</tbody>
</table>
U.S. Energy Consumption by Sector - 2002

Source: Energy Information Administration / Annual Energy Review 2002 Tables 2.1a-2.1d
U.S. Energy Consumption by Fuel – 2002

- Petroleum: 39%
- Natural Gas: 24%
- Coal: 23%
- Renewable: 6%
- Nuclear: 8%
- Wind: 2%
- Hydroelectric: 46%
- Biomass: 46%
- Solar: <1%

Source: AEO 2004 tables (released in December 2003) based on US energy consumption. Overall breakdown Table A1 (Total Energy Supply and Disposition), and Renewable breakdown Table A18 (Renewable Energy, Consumption by Section and Source).
Major NREL Thrusts

Wind
Solar
• Photovoltaics
• Solar Thermal

Biomass
• Biorefineries
• Biosciences

Geothermal

Hydrogen
• Production
• Storage
• Delivery and End Use
• Systems Integration

Distributed Energy
• Distribution and Interconnection
• Thermal Systems
• Superconductivity

Vehicle Technologies
• Hybrid Vehicles
• Alternative Fuels Utilization

Building Technologies
• Building Efficiency
• Zero Energy Buildings

Federal Energy Management

Basic Energy Science
• New Materials
• Chemical and Biological Sciences

Analytical Studies

International
Research Focus in Wind

• Low-windspeed turbines
• Advanced power electronics
• Better aerodynamic blades, new materials
• Technology transfer to ocean-based systems
National Wind Technology Center

NWTC Research Building 251

Blade Test Facility

2.5 MW Dynamometer Test Bed Facility

Turbine test field
Research Focus in Solar

- Higher efficiency devices (cells, collectors, etc.)
- New nanomaterials applications
- Predictive solid-state theory
- Advanced manufacturing techniques
- Higher component reliability
National Center for Photovoltaics Facilities

Solar Energy Research Facility

Outdoor Test Facility

Outdoor Test Area
SunLab Facilities

Heliostate at the National Solar Thermal Test Facility (Sandia)

High-Flux Solar Furnace (NREL)

Approved by Tom Williams, 11/4/98
Research Focus in Biomass

- The Biorefinery – new thermochemical and biochemical conversion technologies
- Solutions to under-utilized waste residues
  - Agriculture
  - Forestry
  - Urban
- Advanced agriculture (energy crops) enabled by plant genomics and bioscience
NREL Bioenergy Facilities

Alternative Fuels User Facility

Thermochemical Process Development Unit

Bioethanol Process Development Unit

Field Test Laboratory Building
Research Focus in Geothermal

• More accurate, less expensive drilling
• Gains in conversion efficiency
• Corrosion resistant components
• Reservoir engineering (aquifer recharge, etc.)
Research Focus in Hydrogen and Fuel Cells

NREL Focus
• Renewable H₂ Production
• Carbon-based Hydrogen Storage
• Infrastructure/Codes and Standards
• Fuel Cell Integration (mobile and stationary)
• Systems Integration and Analysis (production through end use)
Research Focus in Electric Infrastructure

- Interconnection standards and testing
- Grid/distribution system integration
- Hybrid systems optimization
Research Focus in Transportation (FreedomCAR)

- Transition – hybrids, then fuel cells
- Systems modeling (digital functional vehicle)
- Cleaner lubricants, improved fuels
- More efficient/comfortable cabin environment
Research Focus in Buildings

• Zero-energy homes
• High-performance commercial buildings
• Emerging technologies
  – Solid state lighting, prismatic lenses
  – Building envelope research
  – Advanced windows
Buildings and Thermal Systems Center

Thermal Test Facility
Research Focus in Basic Sciences
Nanoscience

- Quantum dots linked by single-wall nanotube segments
- Perform charge separation on nanoscale after photon absorption
- Drive chemical reactions such as water splitting (H₂ production)
Computational Sciences

Computer cluster in NREL's computer room

Computational science simulation

National Renewable Energy Laboratory
The U.S. Department of Energy’s
National Renewable Energy Laboratory

Stanley R. Bull
Associate Director, Science and Technology
303-275-3030
stanley_bull@nrel.gov

Golden, Colorado