

Systemic Change in STEM Department of Energy Workforce Development for Teachers & Scientists

Bill Valdez Director July 2008



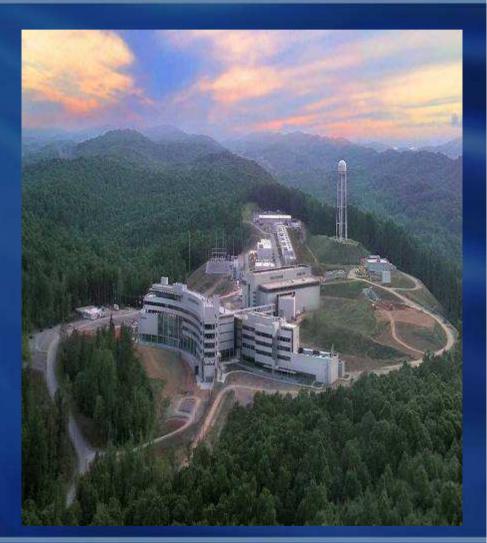
National Goal

he Office of Workforce Development for Teachers and Scientists will prepare a diverse workforce of scientists, engineers, and educators to keep America at the forefront of innovation. The Department of Energy will utilize its unique intellectual and physical resources to enhance the ability of educators and our Nation's educational systems to teach science and mathematics.

- Prepare a diverse workforce of scientists, engineers, and educators to keep America at the forefront of innovation.
- Utilize DOE's unique intellectual and physical resources to enhance the ability of educators and our Nation's educational systems to teach science and mathematics.
- Implement a proactive, data-driven, and results-focused model that promotes and strengthens the greater STEM education and research community.

Finding and Training the "Best and Brightest"

- DOE National Laboratories
 - World-class research facilities
 - Conducting state-of-theart cutting edge research
- Cutting Edge Research Requires Top Scientists
 - Law requires U.S. citizens at the laboratories



U.S. Trains the Workforce of the World

- The U.S. possesses an immense capacity for training the world's scientists
 - Large percentage of research conducted at the university level is by foreign nationals
 - Approximately one third of graduate students in the sciences are foreign nationals
 - The U.S. needs to utilize this capacity with its own citizens
- Large Pool of U.S. Talent to Draw From
 - 3 − 4 % of the U.S. population are involved in STEM-related fields
 - 15 20% of the U.S. population is science literate or a science attentive audience
- Other Countries Have Similar Needs for Native-born Scientists
 - Trained in the U.S.
 - Bring Skills Back Home

National Needs Delivered Locally

- Define Large Scale Goals in terms of the Local Delivery Mechanisms
 - Implement at the local level
 - Local outcomes percolate up to National & Transnational Levels
 - Local goals must align with higher level goals
 - Local programs coordinate to create national platform
- Understand the local conditions
 - Industrial Needs: chemical, pharmaceutical, electronic and technology
 - Rural/urban
 - Diverse workforce
- National Imperatives
 - GDP & national economy
 - National security
- Training a Workforce Locally to Meet National Imperatives

Pipeline Approach

- Kindergarten through Post Docs
 - "Life long learners"
 - "K through grey"
- Integrated Highly Leveraged Partnerships
 - Sustainability
 - Long-term thinking

DOE Technical
Workforce

Headquarters National
Laboratories
100,000 Contract employees
15,000 Federal employees

Extended DOE Technical Workforce
Technical workers in industries, University
and College related to DOE mission areas

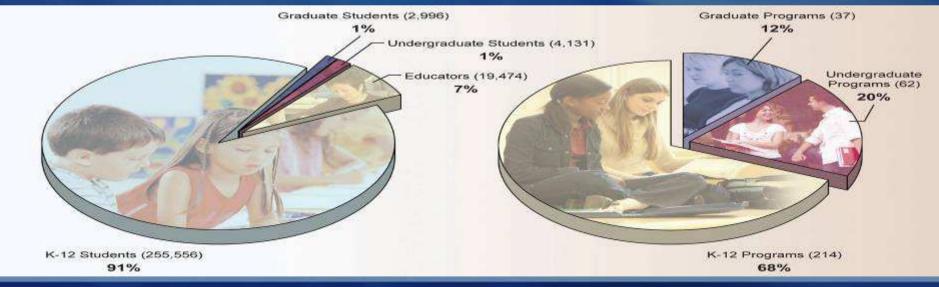
National Technical Workforce
7.4 million workers in STEM-related fields

<u>Undergraduate and Graduate STEM Students</u> 500,000 U.S. University students studying STEM Fields

Middle School and High School Students
Approximately 25,000,000 students

Resource Requirements

- Extremely Resource Intensive Process
 - \$14 trillion dollar U.S. economy
 - \$600 billion expenditure on K-12 education each year
 - \$135 billion Federal R&D budget
 - \$3 billion Federal investment in STEM Education
- Scale and Scope
 - How to maximize impact





United States Education Infrastructure

K-12	
Number of Public School Students	48,132,5181
Number of K-12 Students	51,610,8062
Number of School Districts	15,3971
Number of Elementary Schools	95,2012
Number of Secondary Schools	38,1612
Number of Public Schools	94,1122
Number of Teachers	3,044,0121
Number of STEM Teachers	1,700,0001
Number of 504/IEP Students	$6,727,000^3$
Number of Charter Schools	1,0104
% of Public Schools with Internet Access	99%4
Number of Title I Schools	8,7704

Higher Education	
Number of 4-year Colleges and Universities	2,5334
Number of 4-year Undergraduate Students	10,726,1814
Number of STEM Undergraduate Students	~400,0001
Number of Graduate Students	$2,157,000^3$
Number of STEM Graduate Students	~100,0001
Number of Schools of Education	1,2065
Number of Pre-Service Teachers degrees awarded (2001)	106,300 degrees awarded (2003) ³
Number of Community Colleges	1,6834
Number of Community College Students	6,545,8634

Local Reform Programs

Local Education Reform Programs Are Costly

- Battelle \$20 Million program
 - Partnership with Ohio State University
 - The Metro School established in 2006 with 100 ninth-graders
 - University faculty will train teachers at the school (learning laboratory)
- GE \$100 Million program
 - Reaching four school districts
 - Curriculum, teacher training, administrative reforms
- DOE ACTS \$60,000 per teacher
 - Three year investment
 - Teachers become district liaisons

National Laboratories with WDTS Funding

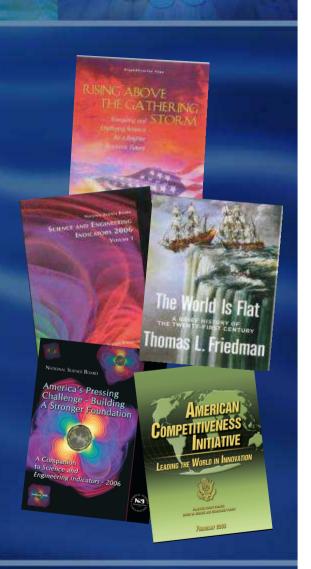
Local Reform Programs...



The Department of Energy's 17 national laboratories and more than 50 world-class scientific user facilities are extraordinary platforms that reach students and educators .Form National Networks across the country. In addition, the Department provides grants to more than 300 major universities and has partnerships with thousands of businesses. This scientific enterprise continually works at the frontiers of human knowledge and is a resource available to all U.S. Booster Neutrino (Fermilab) Atmospheric Radiation Measurement Program-North Slope New Brunswick Laboratory citizens interested in pursuing educational and career Idaho National Engineering and Environmental Laboratory Alaska **Materials Preparation Center** opportunities in science and technology. Electron Microscopy Center for Materials Research Toyatron Collider (Fermilab) Radiological & Environmental Sciences Laboratory **Argonne National Laboratory** National Renewable Energy Laboratory Intense Pulsed Neutron Source Pacific Northwest Fermi National Accelerator Laboratory Relativistic Heavy Ion Collider (BNL) Argonne Tandem Linac Accelerator System Advanced Photon Source Environmental Molecular Sciences Laboratory Bates Linear Accelerator Center (MIT) Center for Microanalysis of Materials Knoils Atomic Power Laboratory Joint Genome Institute Alcator C-Mod Tokamak Facility (MIT) National Energy Technology Laborator National Energy Research Scientific Computing Center National Synchrotron Light Source Center for Functional Nanomaterials (BNL) Advanced Light Source Brookhaven National Laboratory Accelerator Test Facility (BNL) Lawrence Berkeley National Laboratory nental Measurements Laboratory Molecular Foundary (LBNL) Princeton Plasma Physics Laboratory National Center for Electron Microscopy National Spherical Torus Experiment Joint Genome Institute **Energy Sciences Network** Lawrence Livermore National Laboratory Thomas Jefferson National Accelerator Facility Combustion Research Facility Center for Nanophase Materials (ORNL) Stanford Linear Accelerator Center Oak Ridge National Laboratory Atmospheric Radiation Measurement Program Archive Stanford Synchrotron Radiation Laboratory Sandla Holifield Radioactive Ion Beam Facility (ORNL) Linac Coherent Savannah River Technology Center Light Source (SLAC) Los Alamos National Laboratory Sandia Nationa DIII-D (General Atomics) Free Air CO, Enrichment Research Facility DOE National Laboratories Center for Manuel Lujen Jr. Neutron Scattering Center **Neutron Scattering** Office of Science User Facilities Atmospheric Radiation Measurement Program-Tropical Western Pacific Ames Laboratory Puerto Rico Office of Science University-Based Research Hawaiian Islands Atmospheric Radiation Measurement Program-Southern Great Plains Office of Science University Research User Facilities

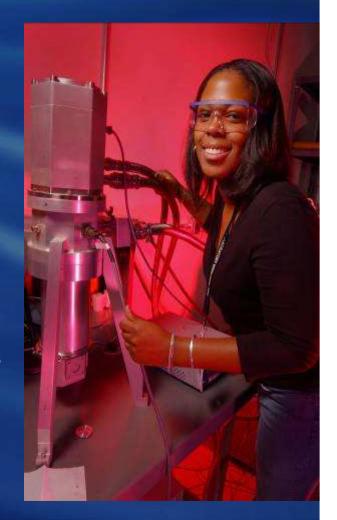


- The Role of Department of Education
- The Role of National Science Foundation
- The Mission Agencies
 - American Competes Act
 - Provide experiential learning opportunities
 - Hands on experiences
 - Mentored
 - Apprenticeships
- DOE's Crosscutting Role is Unique
 - Take lead role in brings various stakeholders together



Future Workforce Strategy

- Educators: Highly qualified K-16 educators who engage students in authentic science and improve the nation's STEM education capabilities.
- Students: Greatly expanded, more knowledgeable, and more diverse population of skilled scientists, engineers, and mathematicians.
- Workforce Development: Sustained pipeline of workforce-ready talent available to DOE's national laboratories, Federal workforce, private industry, and academia.
- Program Capacity: Leverage expertise and resources through specially-configured, high-impact public/private partnerships that will maximize, expand, and sustain the nation's STEM workforce.





- There Are Many Successful Models:
 - Battelle in Ohio
 - General Electric at the district level
 - Dupont in Delaware
 - SACNAS
- The DOE Model:
 - Utilize structures already in place
 - National Laboratories & National Laboratory Consortium
 - Hands on mentor intensive research experience
- DOE Model Uses a National Platform that is Implemented at a Local Level
 - Model is based on 60-years of experience
 - Is a highly leveraged enterprise

Three Underlying Pre-Conditions

- 1. Catalyst For Change
- 2. Models Adapted to Fit Local Conditions
- 3. Support from Students and Families

Catalyst For Change

- Someone Needs to Step Up and Be the Thought Leader
 - Champion For Change
 - Individual company, person or entity who serve as the catalyst
- Qualities Needed
 - Trusted by all parties
 - Ability to bridge gaps between various interest groups
 - Expert in educational reform
 - Able to negotiate many different partnerships



Models That Fit the Local Conditions

- The Chosen Model should be Unique to the Local Condition
 - U.S. has the premier University system in the world; a tremendous resource base for K-12 education; control is at the local level; NSF serves as the "thought leader" for reform efforts
 - Other countries have different strengths
- Policies and Programs Must be Structured to Meet the Local Conditions
 - Nations have difficulty replicating U.S. University system and send their students overseas to study, but design programs to get them back
 - In the U.S., the unit of structure tends to a single state, such as Idaho or Alabama

Involvement by Students And Families

- Students and Families Must Recognize the Value in a STEM Career
 - Attractive pathways for career success must be apparent
 - Conditions must be created where students and families see the value of a STEM education
- Marketing to Students & Parents
 - Opportunities for careers
 - Rewards
 - Recognition
 - National Science Bowl®
 - Prestige



Six Actions For a Successful STEM Program

- 1. Mentored Relationships Between Students & Educators
- 2. Apprenticeship Opportunities beginning at the earliest possible age
 - Real world experience in STEM
- 3. Competition With Reward
 - Both students and educators
 - Appropriate and meaningful resources and rewards

Six Actions For a Successful STEM Program

- 4. Educator Training
 - Broad reaching effect
 - Effective use of resources
 - Help become better communicators and practitioners
- 5. Dynamic Curriculum Development
 - Develop curriculum that meets local needs
 - U.S. is struggling with this concept
- 6. Sustained Partnerships
 - Takes time to build DOE has been doing this for 60-years
 - Long term thinking Reform takes decades, not years
 - Partnerships with key partners particularly industry

Questions and Comments

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The U.S. Advantage

The United States has tremendous education assets:

- The premier university system in the world
 - 2,400 colleges and universities including most of the Top 100 research universities in the world.
 - 2,400 community colleges two year associate degrees awarded in many technical areas; a unique national asset.
 - Trillions of dollars invested over the past 60 years in the most modern scientific infrastructure.
- An extensive K-12 educational system:
 - Serves 56 million students from widely different backgrounds.
 - Has school districts that rival those of any country's.
 - Produces the seed corn for U.S. universities



The U.S. Issues

The U.S. has serious educational concerns:

- Universities remain strong, but are dealing with changing dynamics:
 - Relationships with industry
 - Globalization
 - Tenure/Administrative Structures promote ossification
- K-12 is under the most stress:
 - No national educational standards
 - Uneven distribution of resources
 - Pressures resulting from immigration
 - Demands for accountability (testing)
 - A disconnect from local economic needs

Emerging U.S. Trends-- Universities

At the university level:

- A re-examination of industry partnerships
- International partnerships
- A movement toward multidisciplinary research as a way to break down barriers between departments
- Tentative movements toward collaborating with the K-12 world particularly with K-12 teacher preparation
- Renewed focus on community colleges as a transition to the workplace and to 4-year degrees, particularly in engineering

Emerging U.S. Trends – K-12

Most attention has been focused on K-12 education:

- The role of testing is being re-examined.
- Science, technology, engineering and math (STEM) education is being re-emphasized.
- The link to economic development is being strengthened, particularly through apprenticeships with industry.
- Models of excellence (Ohio) are being developed and replicated.
- Industry and Foundations (Gates, Microsoft, Kauffman, etc.) are making huge investments