Strategies for Accelerating Commercialization and Deployment of Innovative Technologies and Practices

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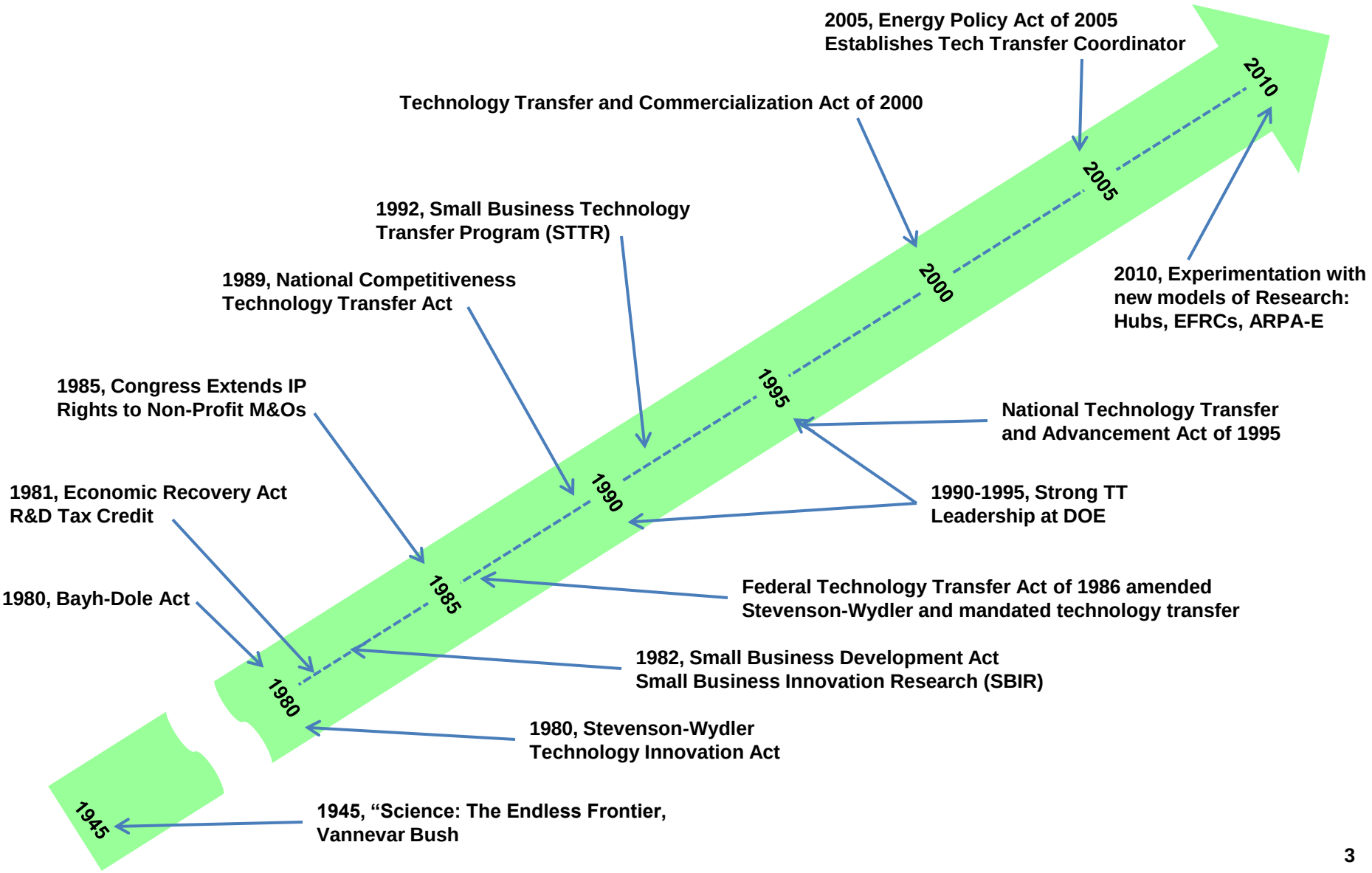
Three Thrusts

- **Creating Business from Ideas**
  - **Innovation Policy**
  - **Stimulating Innovation & Entrepreneurship**
  - **Experimentation With New Innovation Models**
- **Early Stage Market Entry**
  - **Policy Incentives and Mandates**
  - **Systematically Address Non-Technical Barriers to Commercialization and Deployment**
- **Full-Scale Implementation**
  - **Internalizing Market Externalities**
  - **Phase-Out of Incentives and Mandates**
  - **Shaping Market Behavior**

Six Decades of Evolving Innovation Policy

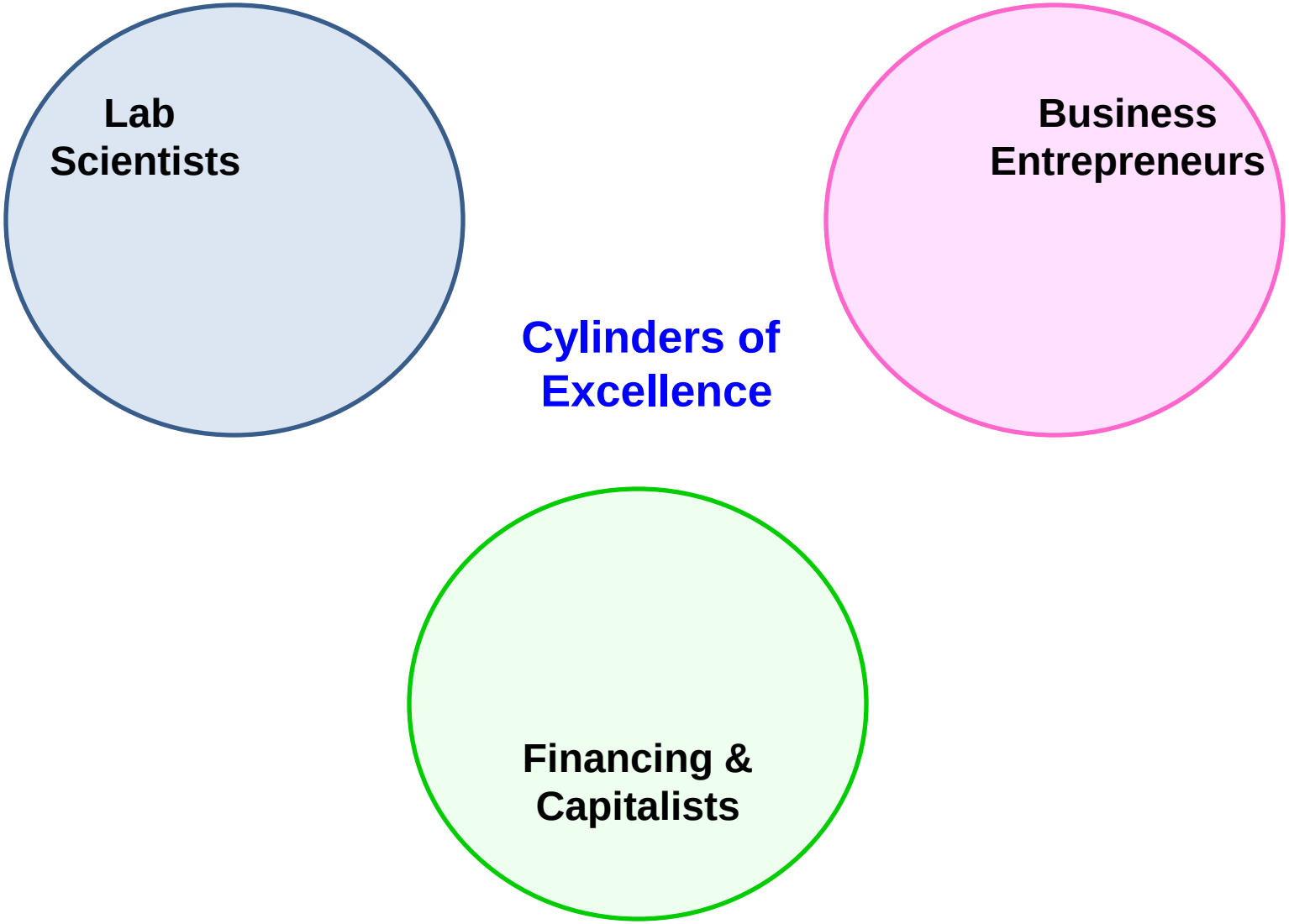


U.S. Technology Transfer History

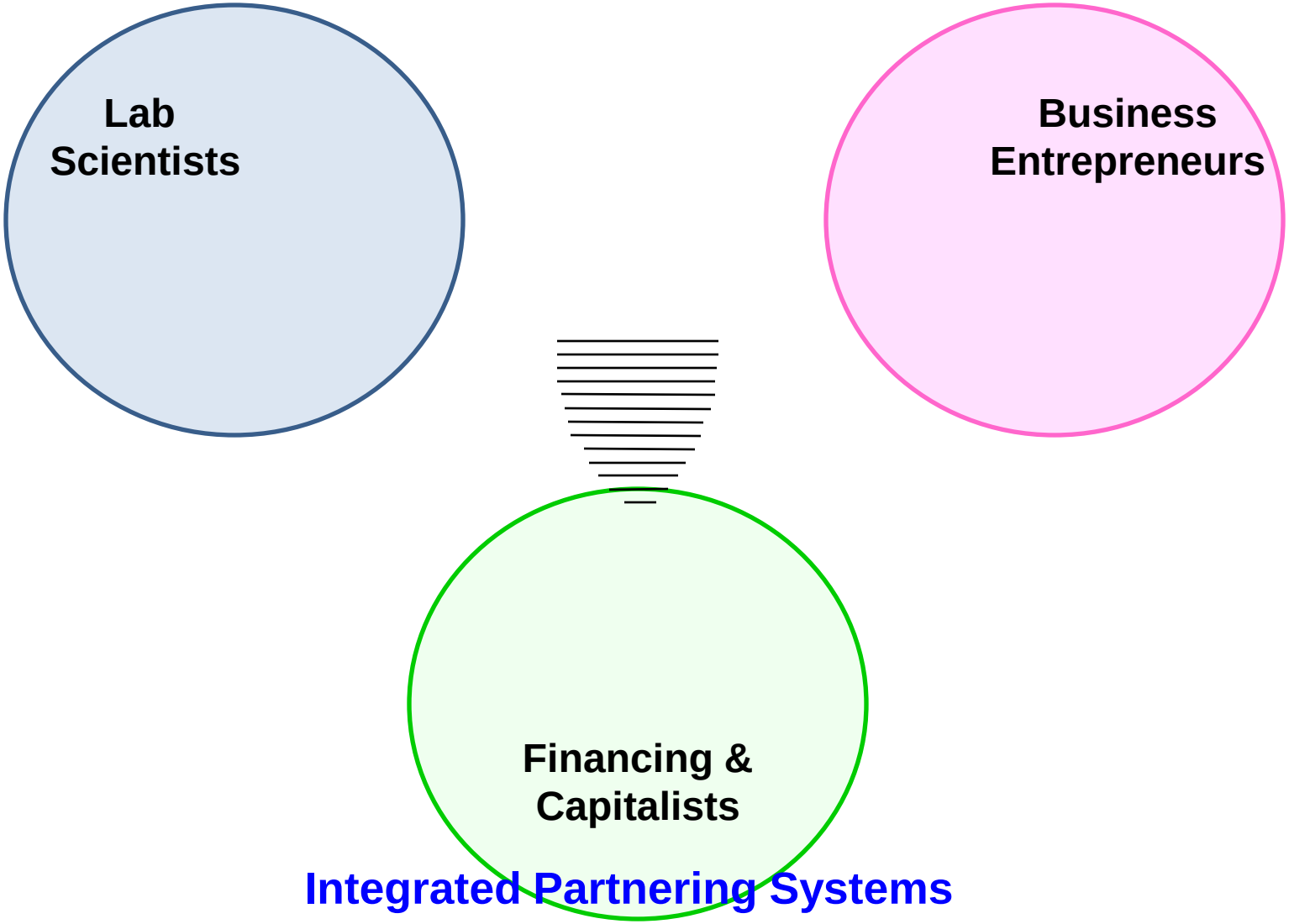
- In 1945, "Science: The Endless Frontier," an influential report by Vannevar Bush, emphasized the importance of basic research to a strong economy.
- Bayh-Dole Act of 1980 "Changed the World"
  - Ownership of Intellectual Property Shifted to R&D Performer
  - Codified "Rules of Engagement" for Ownership of Inventions
  - Established Protections for Government, Anti-Competition, Foreign Risks
- The Stevenson-Wydler Technology Innovation Act of 1980 established the foundation for technology transfer at the national laboratories.
- Effects Over 20 Years Are Dramatic
- The 1981 Economic Recovery Tax Act established the Research and Experimentation Tax Credit
- In 1982, the Small Business Development Act established Small Business Innovation Research (SBIR) programs within the major federal R&D agencies
- In 1989, National Competitiveness Technology Transfer Act
- In 1992 the Small Business Technology Transfer (STTR) program, was created
- The Omnibus Trade and Competitiveness Act of 1988 created the Advanced Technology Program (ATP) at the DOC/NIST.
  - ATP provided seed funding, matched by private sector investment
- In 2007 the ATP was terminated and replaced by the Technology Innovation Program (TIP) at DOC/NIST

Stimulating Innovation and Entrepreneurship

What is the Problem?

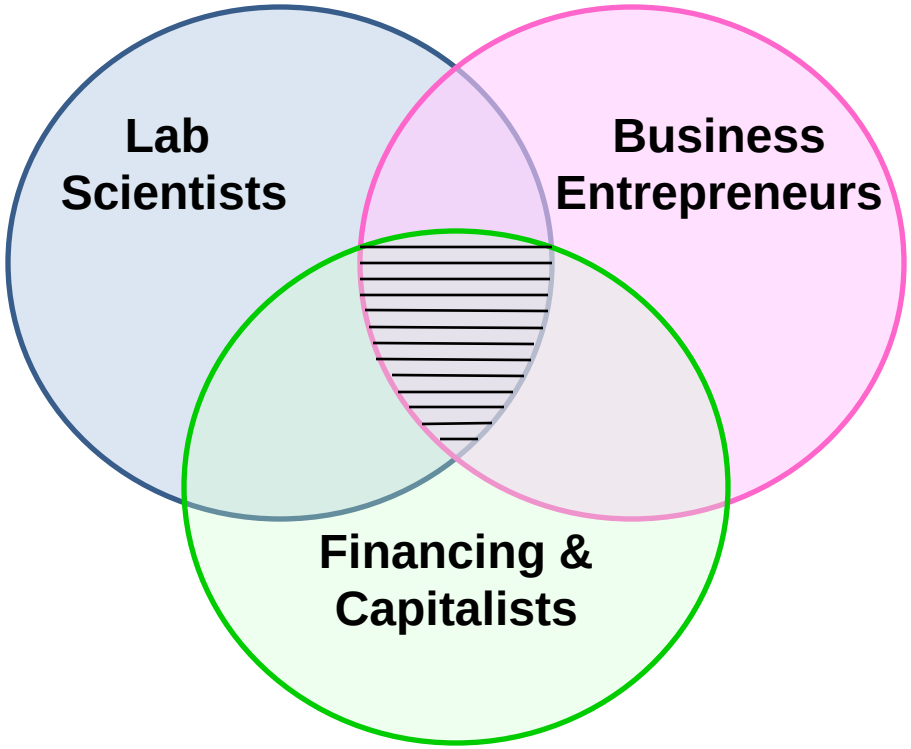


What is the Solution?



Integrated Partnering Systems

What is the Solution?



Integrated Partnering Systems

Modalities for Bringing Partners Together

Economic Policies

- Intellectual Property
- Licensing
- Technical Consulting
- Regional Development Authority
- Science Parks / Econ. Clusters

Innovation Policies

- R&D Tax Credits
- Open Source Software
- Open Innovation Systems
- Internet-Based Problem Solving
- Industry Growth Forums
- Entrepreneurs-in-Readiness

Research Policies

- Hubs
- ARPA-E
- EFRC
- Prizes
- CRADAs
- User Facilities
- WFO/NFE
- SBIR/STTR

Personnel Policies

- Personnel Exchanges
- Entrepreneur Sabbaticals
- Entrepreneurs-in-Residence
- Inventor Payback (Royalty Sharing)

ARPA-E: Advanced Research Projects Agency – Energy
EFRC: Energy Frontier Research Centers
WFO/NFE: Work for Others/Non-Federal Entities

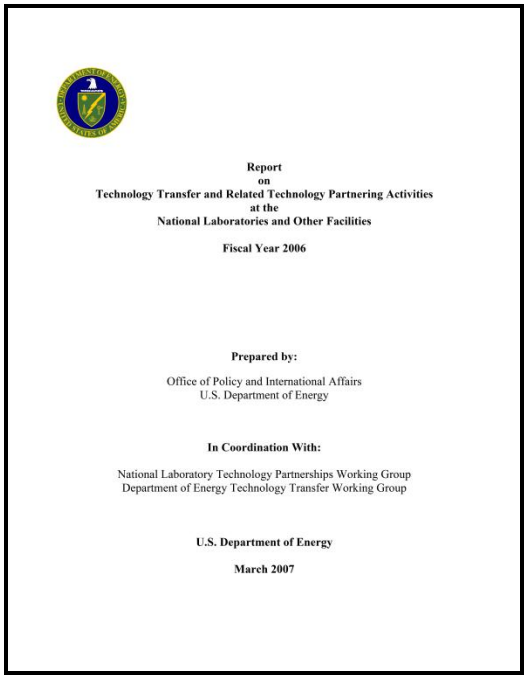
CRADA: Cooperative Research and Development Agreements
SBIR: Small Business Innovative Research
STTR: Small Business Technology Transfer

Traditional Partnering Mechanisms

- **Intellectual Property**
  - Invention Disclosures
  - Patent Filings
  - Patents Issued
- **Cooperative Research and Development Agreements (CRADA)**
  - Performing Work for Non-Federal Partner
  - No Resource Commitments from the Federal Partner to the Non-Federal Partner
- **Licensing**
  - May Include Royalties and Income (Royalty Sharing)
- **Work for Others (WFO)**
  - Performing Work for Non-Federal Sponsors
  - WFO Permits Reimbursable Work
- **User Facilities Agreements**
  - Permits Non-Federal Entities to Conduct Work at Federal Labs or Facilities
- **Technical Consulting**
  - Laboratory Assistance to Small Businesses or Individuals
- **Personnel Exchanges**
  - Allows Federal Lab Employees to Work at Partners' Facilities and Vice-Versa

"Third Arm" of Government S&T Business

- **In FY 2006, DOE and its laboratories and facilities negotiated and executed 12,437 technology transfer-related transactions**
  - **631 New or Active CRADAs**
  - **2,416 Work-for-Others Agreements - Non-Federal Entities (NFE)**
  - **5,916 Licenses of Intellectual Property**
  - **3,474 User Facility Agreements**
  - **1,694 Inventions Disclosed**
  - **726 Patent Applications Filed**
  - **438 Patents Issued**
  - **351,000 Downloads of Open-Source Software**
  - **$251.1M in Work-for-Others (NFE)**
  - **$44.3M "Funds-In" for CRADAs**
  - **$35.6M Licensing Income**
  - **$18.3M in Earned Royalties**
- **Robust Technical Enterprise**



Report
on
Technology Transfer and Related Technology Partnering Activities
at the
National Laboratories and Other Facilities

Fiscal Year 2006

Prepared by:

Office of Policy and International Affairs
U.S. Department of Energy

In Coordination With:

National Laboratory Technology Partnerships Working Group
Department of Energy Technology Transfer Working Group

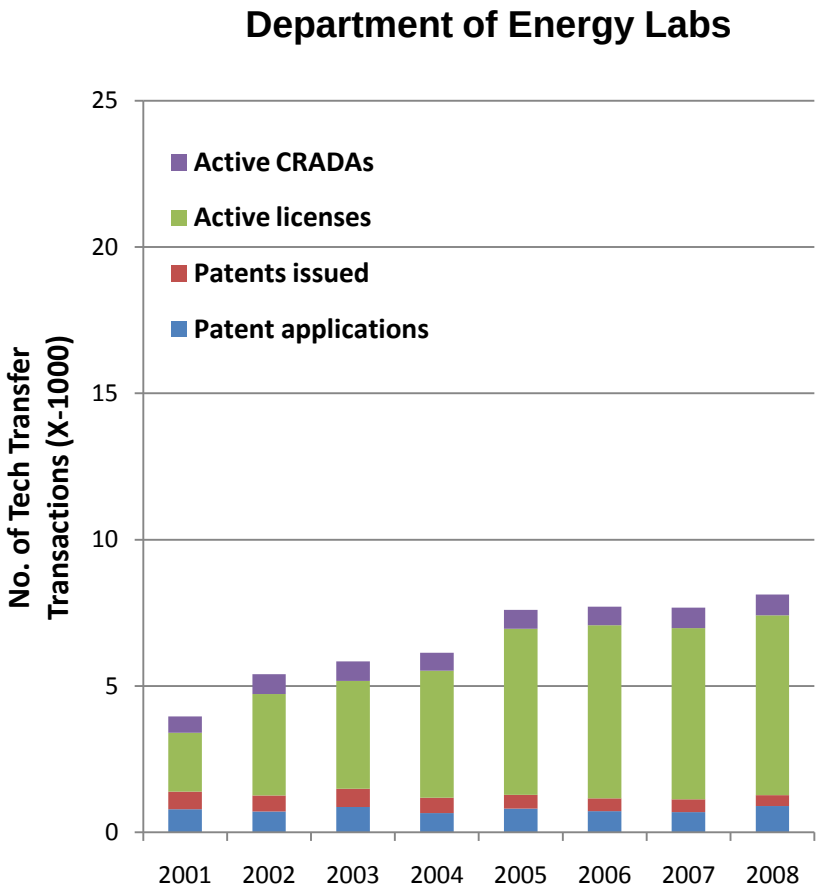
U.S. Department of Energy

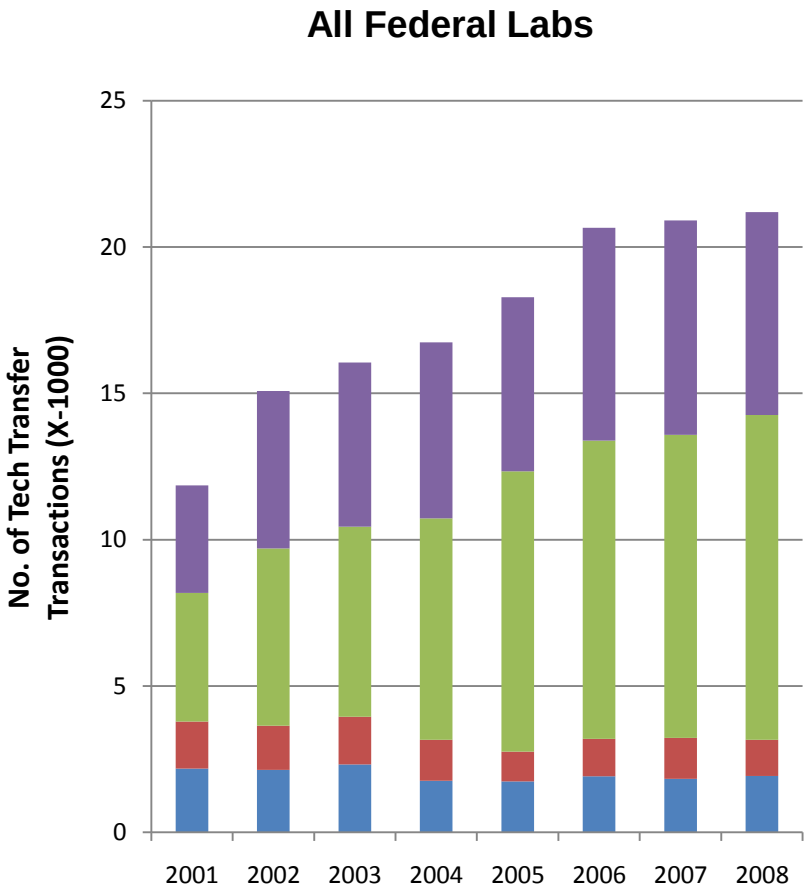
March 2007

http://technologytransfer.energy.gov/

Report on Technology Transfer and Related Technology Partnering Activities at the National Laboratories and Other Facilities Fiscal Year 2006, Office of Policy and International Affairs, U.S. Department of Energy, March 2007

U.S. Technology Transfer Transactions

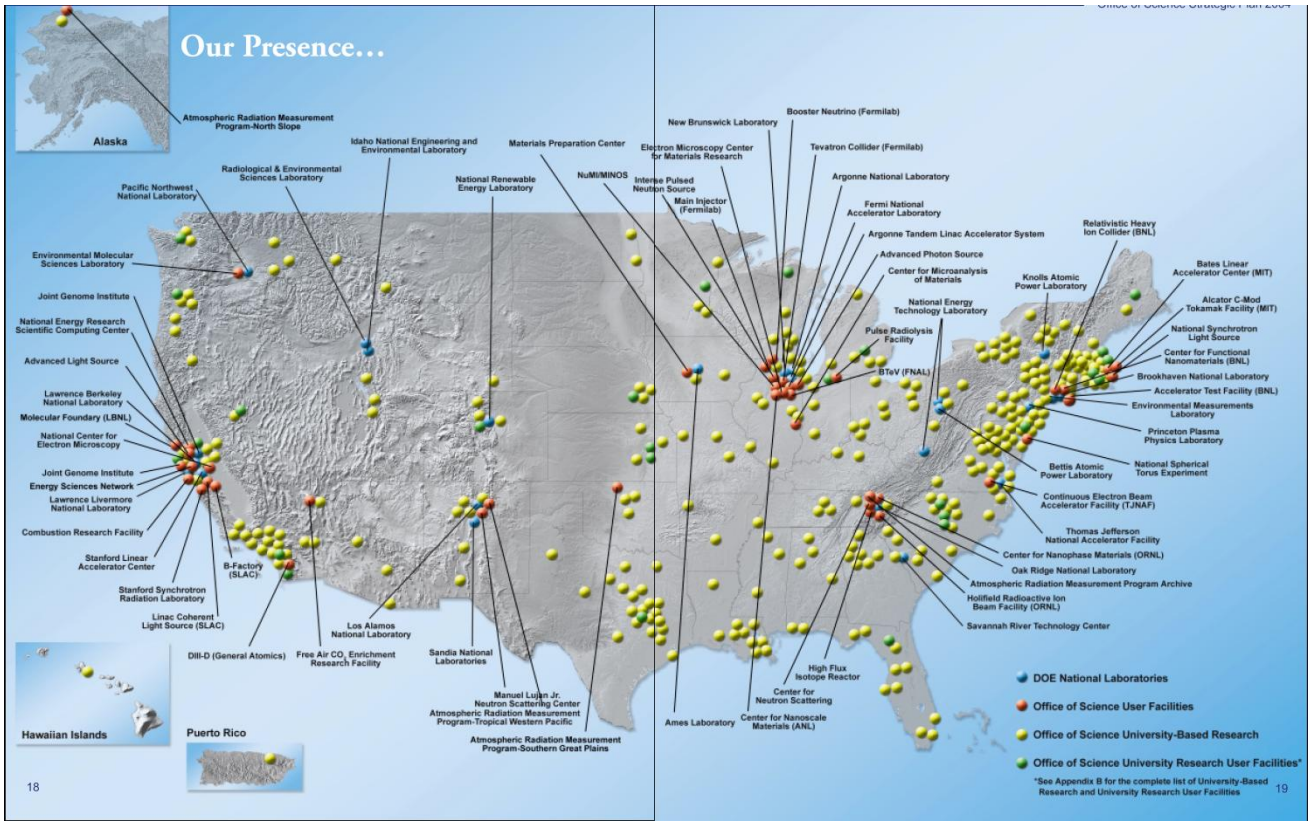


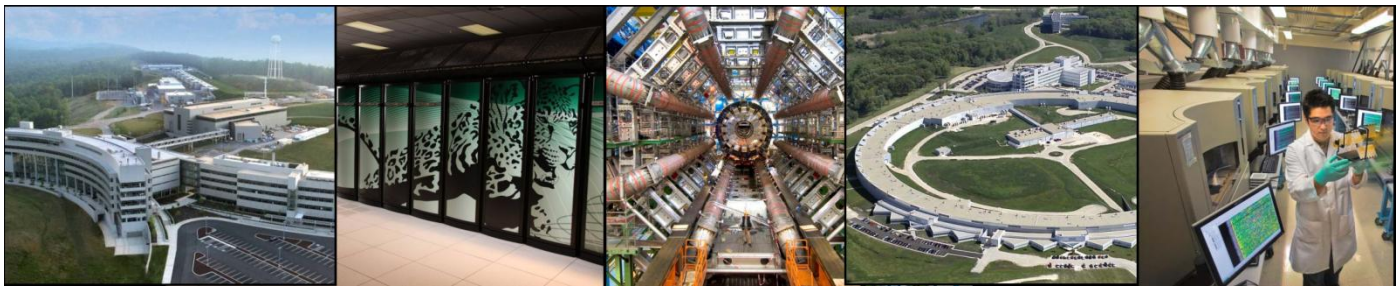


Sources: National Science Foundation, National Science Board, "Science And Engineering Indicators 2010,"
U.S. Federal Agencies: USDA, DOC, DOD, DOE, EPA, HHS, DOI, NASA, DOT, & VA, (2001-2007).
Data for 2008 are forthcoming

DOE User Facilities

The atomic resolution microscope. ***National Center for Electron Microscopy at Lawrence Berkeley National Laboratory***





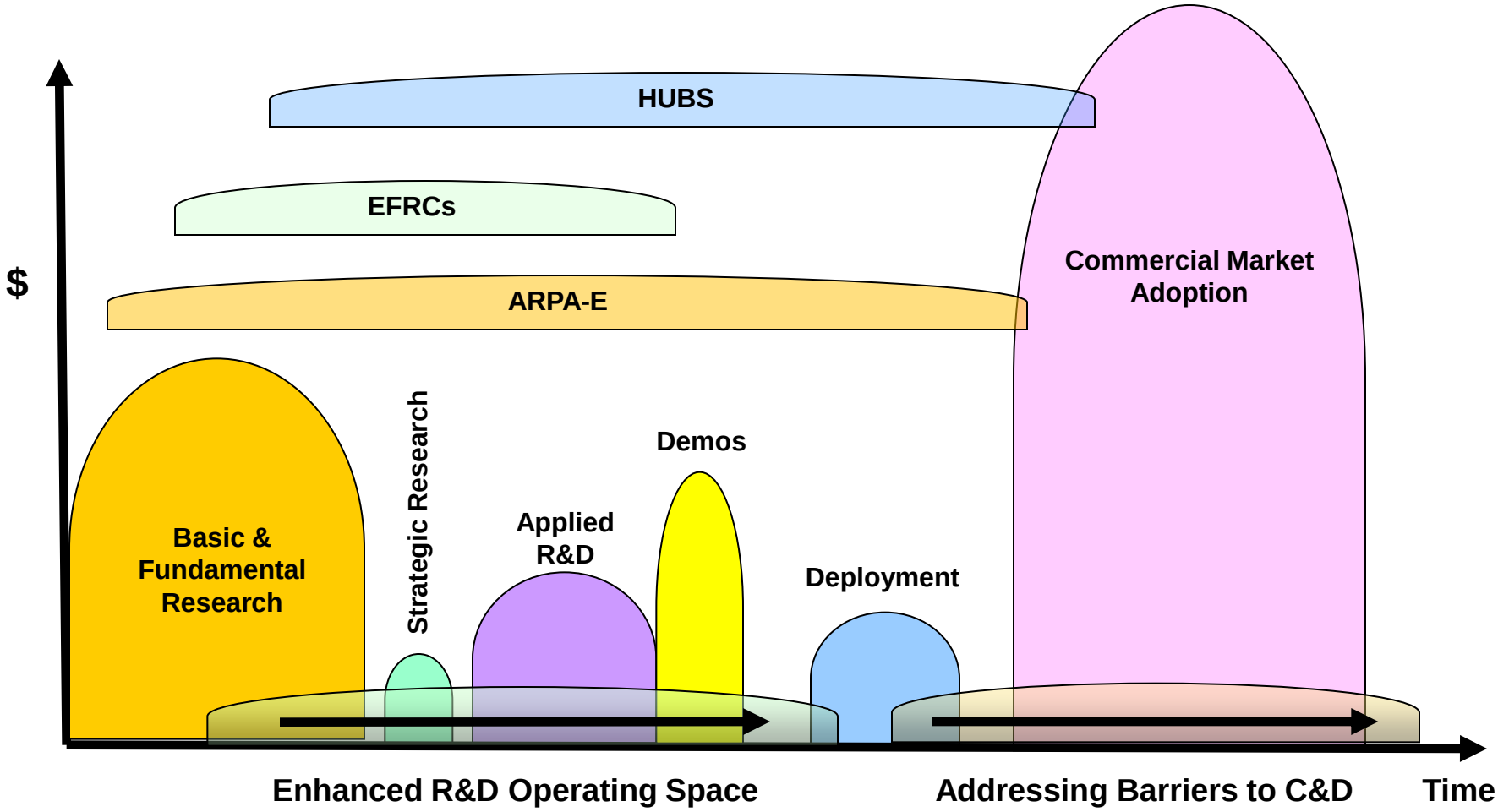
Experimentation With New Models of Research and Innovation

New Models

- Energy Innovation Hubs (Hubs)
- Energy Frontier Research Centers (EFRCs)
- Advanced Research Projects Agency-Energy (ARPA-E)
- "Prize-Incentivized" Private Sector Research
- Promote Economic Development
  - Industry Growth Forums
  - Regional Development Authority
- Science Parks
- Entrepreneurs-in-Readiness
- Open Innovation Systems
  - Open Source Software
  - Internet-Based Problem Solving
- Entrepreneur Sabbaticals
- Entrepreneurs in Residence
- Bold Efforts; Not Trivial Pursuits; $500 - $700 M/yr

New R&D Management Constructs

R&D Management Structures to Speed Progress and Address Key Barriers



New Energy R&D Modalities

	Energy Innovation Hubs	Energy Frontier Research Centers	ARPA-E
Investigators and Institutions	• Large set of Investigators • Multiple S&E Disciplines • Led by Labs or Universities, Nonprofit Organizations or Private Firms • Modeled on the Three Bio-energy Research Centers.	• Self-Assembled Group of ~6-12 Investigators. • Led by DOE Laboratories or Universities. • About Two Thirds of 46 EFRCs are led by Universities	• Single Investigator, • Small Group, or • Small Teams.
Location	• Lead Institution Provides a Central Location • Strong Scientific Leadership • Empowered Central Research Management	• Mostly Multi-Institutional Centers, • Clearly Defined Lead Institution Responsible for Management.	• Variable Depending on Project
Diversity of Disciplines per Award	• Many	• Several	• Few
Period of Award and Management	• 5 Years • Managed by DOE Offices • Board of Advisors Coordinate	• 5 Years • Managed by DOE-SC-BES	• 5 Years • Managed by ARPA-E • Reports to Secretary
Award Amount	• ~$22M in the first year • up to $10Mfor start-up • ~$25M / year in subsequent years.	• $2–5M per year	• $0.5–10M per year
Core motivation	• Integrate From Fundamental Research Through Potential Commercialization	• Fundamental Research Linked to New Energy Technologies or Technology Roadblocks • Linked to Scientific Grand Challenges	• High risk translational research • commercial impact in the near-term

Prize Incentivized Research

- **H-Prize -- Conquer the Challenges of Converting to the Hydrogen Economy. Awards Every 2 Years in Three Areas:**
  - **Technological Advancements**
    - **4 Prizes Biennially - $1.0M max Each**
  - **Prototypes**
    - **1 Prize Biennially - $4.0M max**
  - **Transformational Technologies**
    - **4 Prizes Biennially - $10.0M max Each**

September 2009, Phillips Electronics became the first to enter DOE's L-Prize Competition. Included in "Time Magazine's" 50 Best Inventions of 2009

- **L-Prize -- Bright Tomorrow Lighting Prizes:**
  - **60-Watt Incandescent Replacement Lamp Prize ($10M)**
    - **First submittal September 2009 (Phillips Electronics)**
    - **First awards expected October/November 2010**
  - **Parabolic Aluminized Reflector Type 38 Halogen Replacement Lamp Prize ($5M)**
  - **Twenty-First Century Lamp Prize ($5M)**

Science Parks – Land-Based Facilities

- **Science & Technology Parks**
  - Oak Ridge (Tennessee)
  - Sandia (New Mexico)
  - Ames (Iowa)
- **Innovation Clusters Include:**
  - Spin-Off Companies
  - Venture Capitalists
  - Entrepreneurs
  - Lab Resources and Facilities
  - Office Space

Sandia Science & Technology Park

Open Innovation Models

- **Open Government Paper: "Strategy for American Innovation"***
  - **Example: data.gov**
- **Open-Source Software**
  - **Main Principle and Practice is "Peer Production by Bartering and Collaboration"**
  - **Example: Multiphase Flow with Interphase eXchange (MFIX) Software**
- **Internet-Based Networking (Expert Groups, etc.)**
- **Internet-Based Problem Solving**
  - **Example: InnoCentive – Seekers and Solvers**
    - **(Spin-off from Eli Lilly)**
  - **Others: YourEncore, NineSigma,**

*National Economic Council and White House Office of Science and Technology Policy (September 2009)

Entrepreneurs-in-Readiness

In FY09 LLNL Established its Entrepreneurs-in-Readiness

Naveen Bisht
Started 3 software companies

Tony Lazar
Started 2 successful healthcare companies

Mike Lyons
Started and funded multiple Hi-Tech companies

Richard Caro
Founder and advisor to laser and medical device firms

Barry Nelson
Company founder and investor

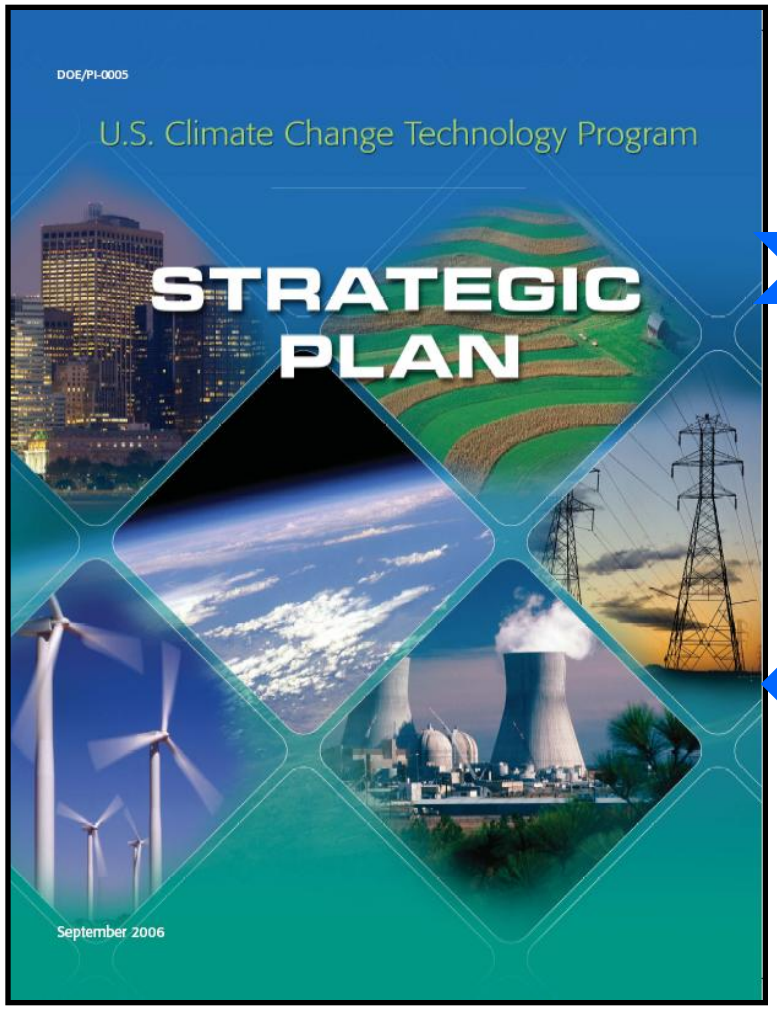
Farzad Naimi
Co-founder of 5 international companies

Robert Siegel
Founder of and investor in network service companies

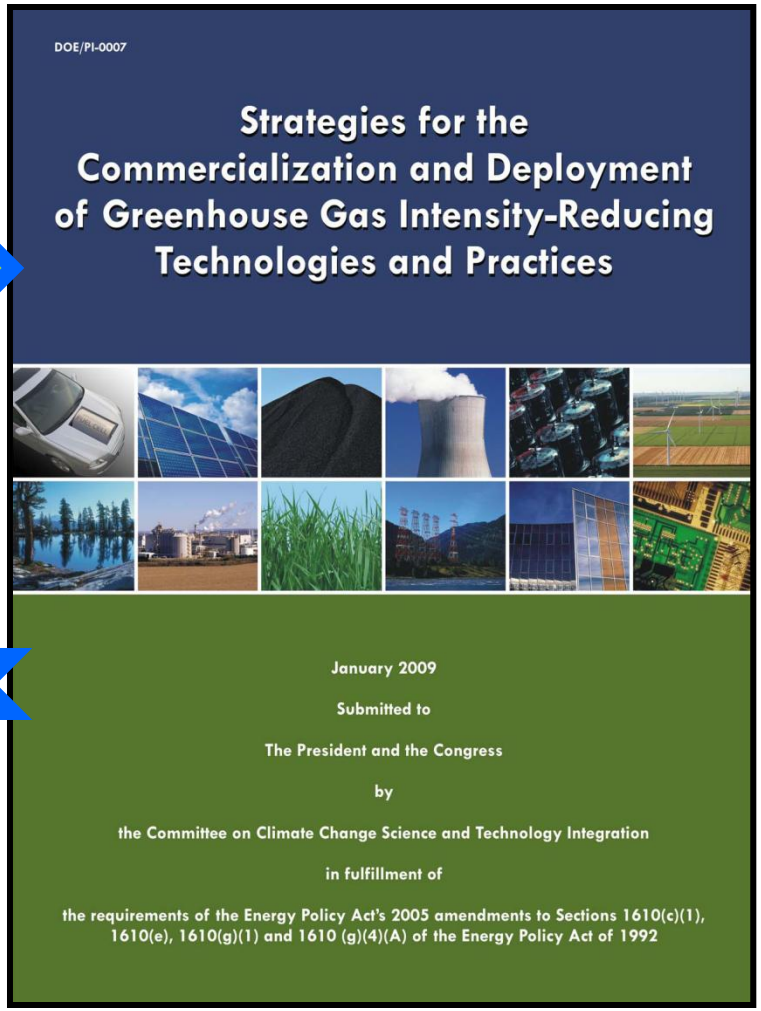
Addressing Non-Technical Barriers to Commercialization and Deployment

National Strategy for C&D

R&D Strategy



C&D Strategy



15 Technology Strands

End-Use Efficiency and Infrastructure

- Transportation
- Buildings
- Industry
- Electric Grid and Infrastructure

Energy Supply

- Low-Emission, Fossil-Based Fuels and Power
- Hydrogen
- Renewable Energy and Fuels
- Nuclear Fission

Carbon Capture and Sequestration

- Carbon Capture
- Geologic Storage
- Terrestrial Sequestration

Non-CO2 Greenhouse Gases

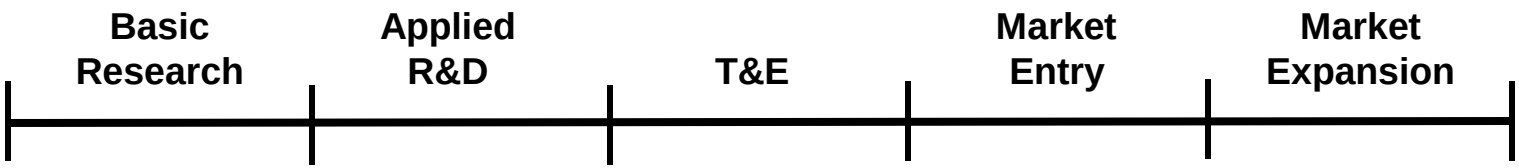
- Methane from Energy and Waste
- Methane and Nitrous Oxide Emissions from Agriculture
- Emissions of High Global-Warming Potential Gases
- N_2O Emissions from Combustion and Industrial Sources

Technologies Suitable for C&D

Technology Readiness Levels

Suitable For C&D

Level 1	Level 2	Level 3	Level 4	Level 5
Fundamental Research	Application specific technology development	Working prototype in validation testing	System readiness validated	Systems in use and operating



Barriers Typology

Cost Effectiveness	Fiscal Barriers	Regulatory Barriers	Statutory Barriers	Intellectual Property Barriers	Other Barriers
High Costs	Unfavorable Fiscal	Unfavorable Regulations	Unfavorable Statutes	IP Transaction Costs	Incomplete and Imperfect Information
Technical Risks	Fiscal Uncertainty	Regulatory Uncertainty	Statutory Uncertainty	Anti-competitive Patent Practices	Infrastructure limitations
Market Risks	Unfavorable tariffs			Weak International Patent Protection	Industry Structure
External Benefits and Costs				University, Industry, Government Perceptions	Misplaced Incentives
Lack of Specialized Knowledge					Policy Uncertainty

6 Barrier Categories
21 Barriers
~50 Detailed Barriers

Barriers are organized into six categories consistent with EPAct 2005 Title XVI.

Major Barriers Inhibiting Deployment of GHG-Reducing Technologies

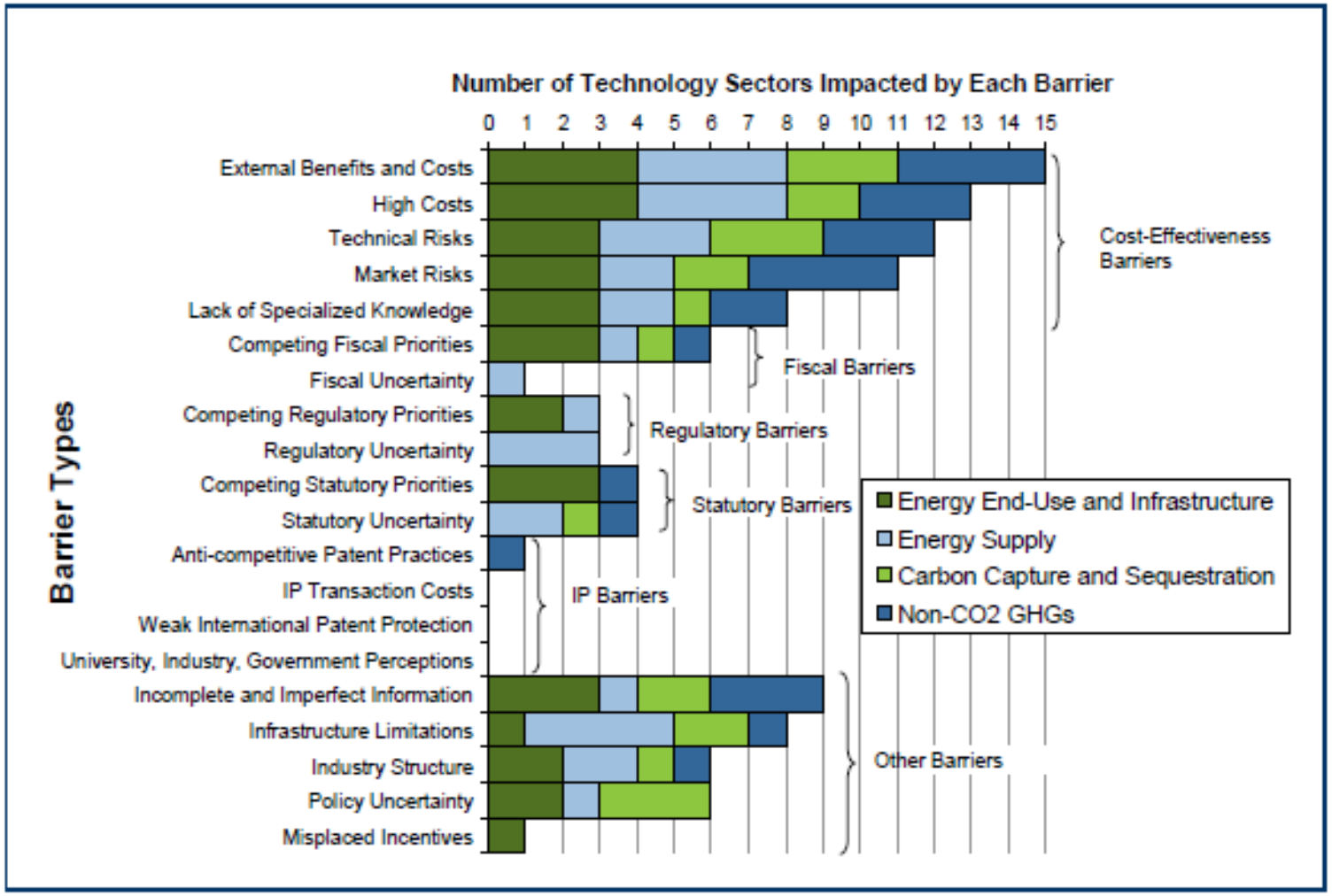
CCTP Goal Area	CCTP Sector	External Benefits and Costs	High Costs	Technical Risks	Market Risks	Incomplete and Imperfect Information	Lack of Specialized Knowledge	Infrastructure Limitations	Competing Fiscal Priorities	Industry Structure	Policy Uncertainty
Energy End-Use and Infrastructure	Transportation	●	●	●	●	●	○	●			
	Buildings	○	●	●	●	●	○		●	●	○
	Industry	●	●	●	●	●	●		○		
	Electric Grid and Infrastructure	●	●						●	○	○
Energy Supply	Low-Emission, Fossil-Based Fuels and Power	●	●	●				○		○	○
	Hydrogen	●	●	●			○	●			
	Renewable Energy & Fuels	●	●	○	●	●		●	●	○	
	Nuclear Fission	○	●		●		●	●			
Carbon Capture and Sequestration	Carbon Capture	●	●	●				●			○
	Geologic Storage	●		●	○	○		○			●
	Terrestrial Sequestration	●	●	○	○	○	●		○	●	○
Non-CO_2 Greenhouse Gases	Methane Emissions from Energy and Waste	○	●	●	●	●		●			
	Methane and Nitrous Oxide Emissions from Agriculture	○	●	●	●	●	●			○	
	Emissions of High Global-Warming Potential Gases	●	●		○	●	●				
	Nitrous Oxide Emissions from Combustion and Industrial Sources	○		●	●				●		
Totals		15	13	12	11	9	8	8	6	6	6

This table lists the 10 barriers judged to be critical or important obstacles to the deployment of five or more of the 15 technology strategies (i.e., CCTP Sector). Symbols indicate that a barrier is judged to be a critical or important obstacle to the deployment of technologies in a particular sector.

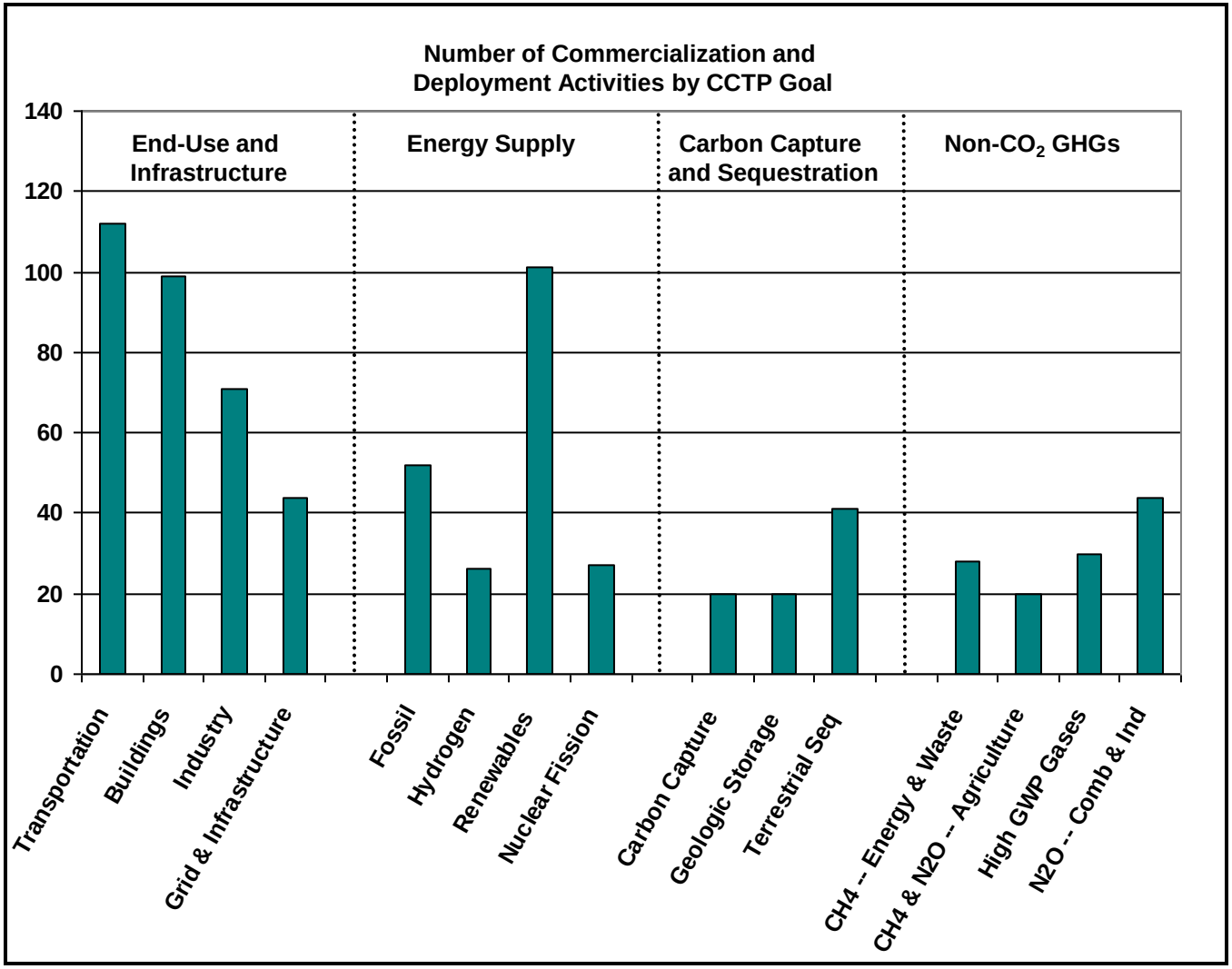
● **Critical to C&D**

○ **Important to C&D**

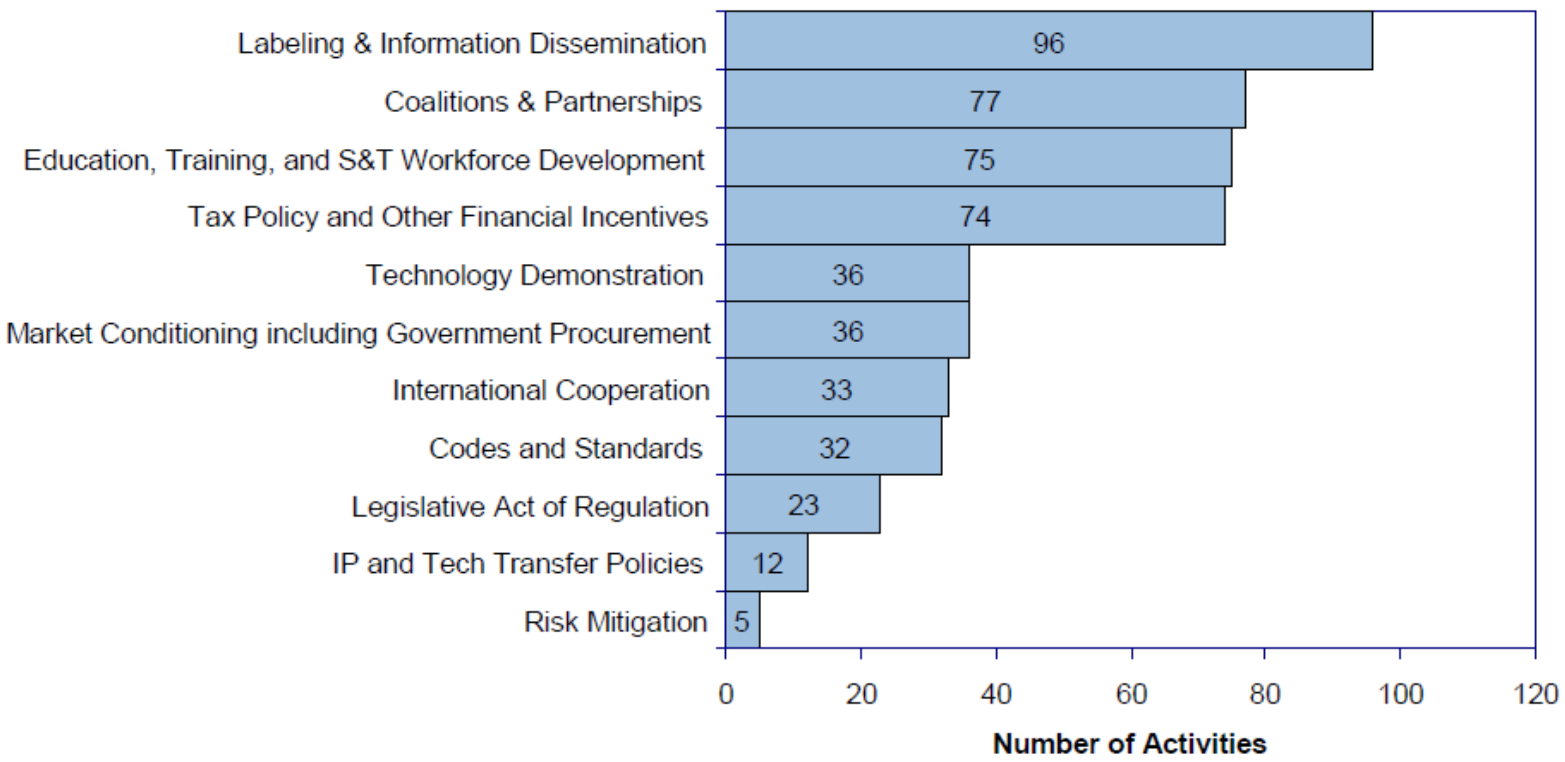
Technologies Affected by Barriers



Inventory of More Than 400 Policies & Measures to Address Barriers to Deployment



Characteristics of Policies and Measures (PAMS)



Source: CCTP/Energetics Deployment Inventory Database dated January 2009

Note: Some activities fit into more than one category, so the total count exceeds the total number of identified activities (306). The figure does not include activities that are authorized but not implemented. See Annex B for details.

Identification of Potential Gaps & Opportunities

Technology Areas	Tax Policy and Financial Incentives	Legislative Acts and/or Regulation
Coal w/CCS	Loan Guarantees; Tax Incentives; Cost-Shared Partnerships	CO_2 Storage – Siting & Permitting; Monitoring and Verification; Liability Indemnification; New Source Review Revisions; Access to Public Lands; Property Rights for Subsurface Areas
Nuclear Fission	Loan Guarantees; Production Tax Credit; Standby Support for Certain Delays	Liability Indemnification; Standard Design Certifications; Early Site Permits; Combined Construction & Operating License; Waste and Fuel Management and Storage
Electric Grid and Infrastructure	Loan Guarantee Program, Waste Energy Recovery Incentive Grants*; SmartGrid Investments Matching Grants*; Additional Incentives for Investments (including Cost Recovery Mechanisms)	Public Utilities Regulatory Policies; Renewable and Distributed Generation Code and Standards; Transmission Pricing (Rate Structures); National Transmission Corridors; SmartGrid Code and Standards*; Utility Energy Efficiency Programs*; Standard Net Metering and Interconnection Policies; Siting Access Rights; Access to Meter and Other Data;
Transportation	Tax Credit; Manufacturing Credit; Consumer Incentives, Manufacturing Incentives*	National Regulatory Policies; Urban and Land Use Planning; CAFÉ*; Federal Fleet*
Hydrogen	Loan Guarantees; Alternative Motor Vehicle and Alternative Fuel Infrastructure Tax Credits; Investor Incentives; Insurance	Safety, Codes & Standards; Stationary Fuel Cell Permitting
Bio-Based Fuels	Credit for installing alternative fuel refueling; Loan Guarantees; Production Tax Credit; Development Grants*	Stable Financial Incentives; National Regulatory Policies; Biofuels Tariff; Federal Fleet*, Standard specifications for fuels*
Wind Power	Loan Guarantees; Production Tax Credit; Clean Renewable Energy Bonds; Development Grants*;	Manufacturing Partnerships*; Stable Financial Incentives; Mandated Federal Procurement of Wind Power;
Industry	Loan Guarantees; Efficiency Tax Credits; Sector Specific Tax Credits	Equipment Standards; Emissions Regulations; Informational Partnerships (e.g.; Manufacturing Extension Partnership), Energy-intensive industries program*
Buildings	Manufacturer and Consumer Efficiency Tax Credits, Tax Deductions for Commercial Buildings; Accelerated Depreciation	Federal appliance and equipment standards; Building Codes*; Government Procurement, Federal Buildings Standards*
Solar Power	Loan Guarantees; Business Energy Tax Credit; Residential & Business Solar Investment Tax Credit; Clean Renewable Energy Bonds; Development Grants*; Production Tax Credit	Manufacturing Partnerships*; Stable Financial Incentives; Access to Public Lands (for concentrating solar power installations); Mandated Federal Procurement of Solar Power

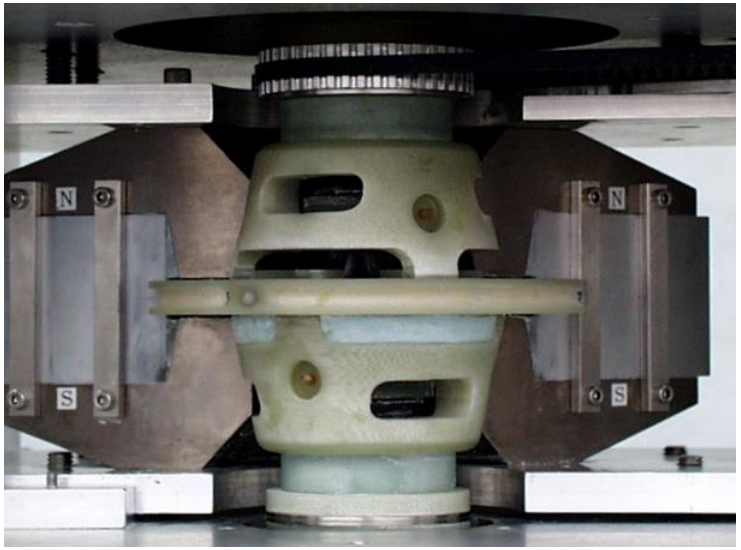
Green: Existing Policies
Red: Policy Options

Recent Examples of Success Stories

Energy Efficiency Success

Magnetic Refrigeration

- Energy-Efficient Refrigerators
- Developed by The Ames Laboratory
- The refrigerators use a powerful permanent magnet, water and a metal alloy including gadolinium.
- Gadolinium grows warmer whenever it comes in contact with a strong magnetic field (the Magnetocaloric Effect)
- The permanent magnet operates without electricity. Power is required only to turn the wheel and circulate water



The magnetic refrigerator consists of a high-powered, rare-earth permanent magnet and a wheel that contains sections filled with the gadolinium alloy.

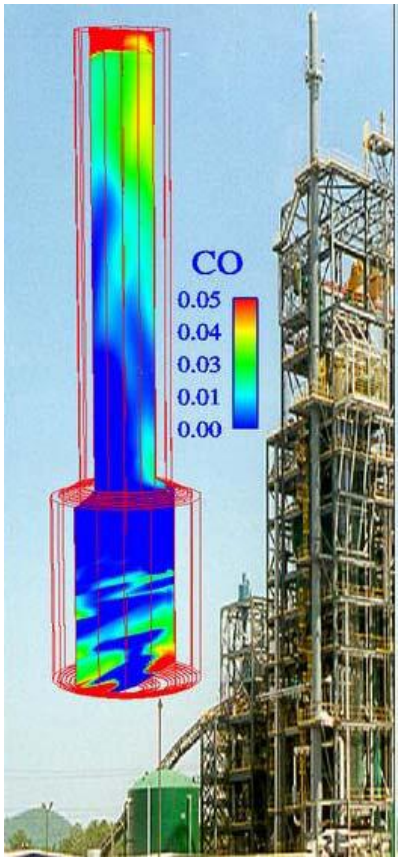
Renewable Energy Success

- **Lightweight, Flexible Photovoltaic Power Systems**
  - **Used since 2004 by the U.S. Army for tents that double as battery chargers**
  - **Based on work done in a DOE Basic Energy Sciences project at the Ames Laboratory.**
  - **“Iowa Thin Film Technologies” (now “Powerfilms Inc.”) formed as start-up company**
    - **Early funding provided by DOE through the Small Business Innovative Research Program**
    - **The company is delivering the world’s most lightweight and flexible solar modules for use in civilian and military portable electronics and satellites.**

Lightweight and flexible solar electric panels incorporated into the fabric of tents to charge batteries for the U.S. military.

Fossil Fuel Efficiency Success

- **Multiphase Flow with Interphase eXchange (MFIX) Software Package**
  - **Developed by NETL**
  - **MFIX simulates heavily-loaded gas-solids flows, commonly encountered in fossil fuel processes and in other industries such as chemical, petrochemical, pharmaceutical, and mineral; and calculates the detailed motion of gas and solids in a general process vessel, allowing for the effects of heat transfer and chemical reactions.**
  - **MFIX is made available to scientists world-wide through open-source code and is being applied to other fields such as volcanology.**
  - **NETL has applied the code in collaboration with Southern Company (SC) and Kellogg Brown & Root (KBR) to improve designs of advanced transport gasification systems.**



MFIX simulation of pilot scale KBR/Southern transport.

Spin-Off Environmental Success

Lead-Free Solder

- Alloy of Tin-Silver-Copper
- Developed by The Ames Laboratory
- Most Electronics must now use lead-free solder
- Heat tolerances make the Ames Lab alloy ideal for high-stress applications such as Under-hood electronics systems in motor vehicles
- Licensed worldwide and remains available for non-exclusive licensing

Market Shares

Chart 1
Wave Solders

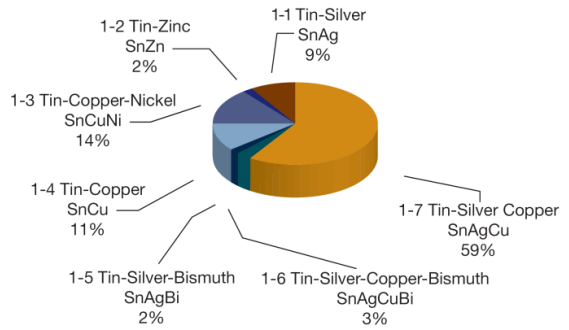
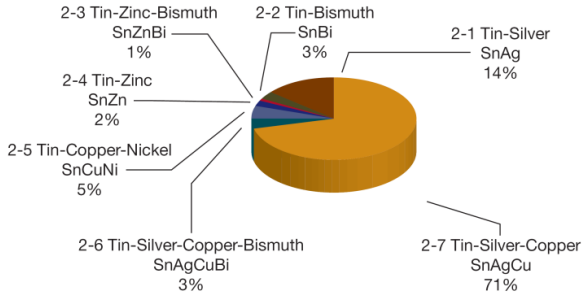


Chart 2
Reflow Solders



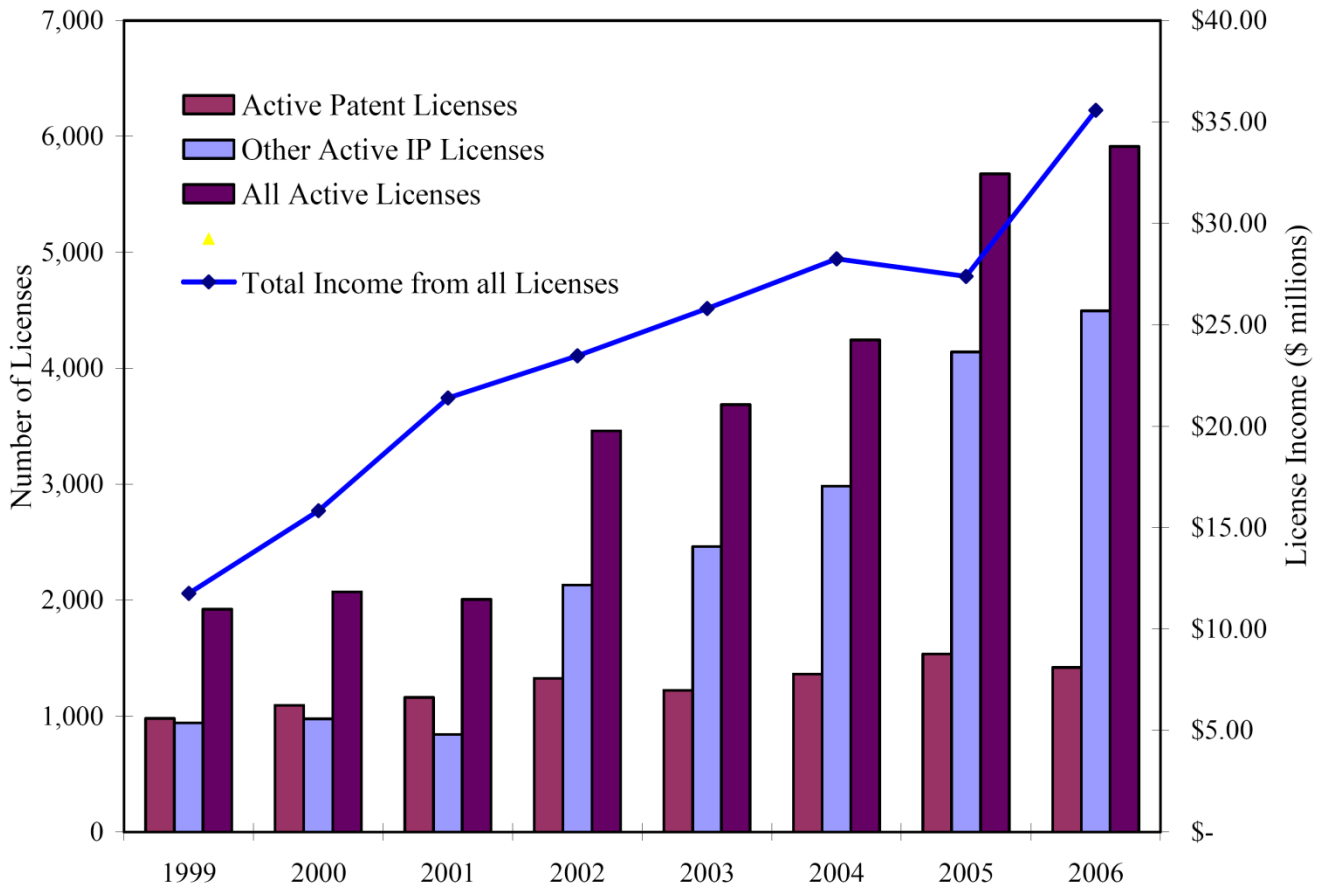
The Ames Laboratory's lead free solder alloy, composed of tin-silver and copper, holds a commanding lead over all the lead free solder alloys used today in the U.S. Asia and Europe, as the two charts above show. Chart 1 highlights the market share for wave soldering. Wave soldering is a process by which electronic circuit boards are slid over a pool of liquefied solder so that chips may then be attached. Chart 2 reveals the market share for reflow soldering. In the case of reflow soldering, electronic circuit boards are screen printed with solder. The solder is then heated in order that chips can be adhered to the boards. Source for all charts: Lead-free Soldering status Survey 2006, *European Lead-Free Soldering Network, released March 2007.*

Spin-Off Security Success

Body Scanner

- Developed by PNNL
- Uses extremely low-powered millimeter waves, which penetrates clothing but reflects off the body
- Two very different markets
  - SafeView (now L-3 Communications) is using it for security screening,
  - Intellifit it using it for body measurement for the clothing industry.

Trends in DOE Licenses and Income



Report on Technology Transfer and Related Technology Partnering Activities at the National Laboratories and Other Facilities Fiscal Year 2006, Office of Policy and International Affairs, U.S. Department of Energy, March 2007

Back-Up

Energy Innovation Hubs – Modus Operandi

- Multi-Disciplinary Team
- Goal–Oriented, Technology-Specific
- Concentrates Talent to Speed Research
- Managed by Top Teams of Scientists, Engineers
- Enough Resources & Authority to Act Quickly
- Modeled After MIT's Radiation-Lab (Radar) and Bell Labs (Transistor)
- Truly Collaborative Work, Under One Roof
- Hand-off to Private Sector
- $20-$35 M/yr

Energy Innovation Hubs -- Status

- **Current ($65.4M)**
  - **Fuels from Sunlight ($22M / RE)**
  - **Improved Energy Efficient Building Systems Design ($22M / EE)**
  - **Modeling/Simulation Tools for Advanced Nuclear Reactors ($21.4M / NE)**

- **FY 2011 ($107M)**
  - **Batteries and Energy Storage (New - $34M / SC)**
  - **Fuels from Sunlight ($24.3M / SC)**
  - **Improved Energy Efficient Building Systems Design ($24.3M / EE)**
  - **Modeling/Simulation Tools for Advanced Nuclear Reactors ($24.3M / NE)**

Energy Frontier Research Centers – Modus Operandi

- Reach Out to Larger Research Community
- Mainly University-Based, with Lead Institution
- Problem – Oriented Research
- Keyed to Basic Research Needs Assessments and Grand Challenges in Science
- Focused on Key Barriers to Progress
- Small Group of PI's; $2-5M/Year
- Topics (Similar to Basic Research Needs Assessments):
  - Solar Energy Utilization
  - Bio-Fuels
  - Catalysis
  - Energy Storage
  - Geosciences for Nuclear Waste and CO_2 Storage
  - Advanced Nuclear Energy Systems
  - Materials Under Extreme Environments
  - Hydrogen
  - Combustion
  - Superconductivity
  - Solid State Lighting

Energy Frontier Research Centers – Status

- **Current:**
  - **46 Awards in FY 2009**
  - **Continued in FY 2010**
- **FY 2011:**
  - **Two New Categories in FY 2011**
    - **New Materials**
    - **Basic Research Needs in Energy**
- **About $100 M/year (w/ARRA, $777 M over 5 Years)**

ARPA-E – Modus Operandi

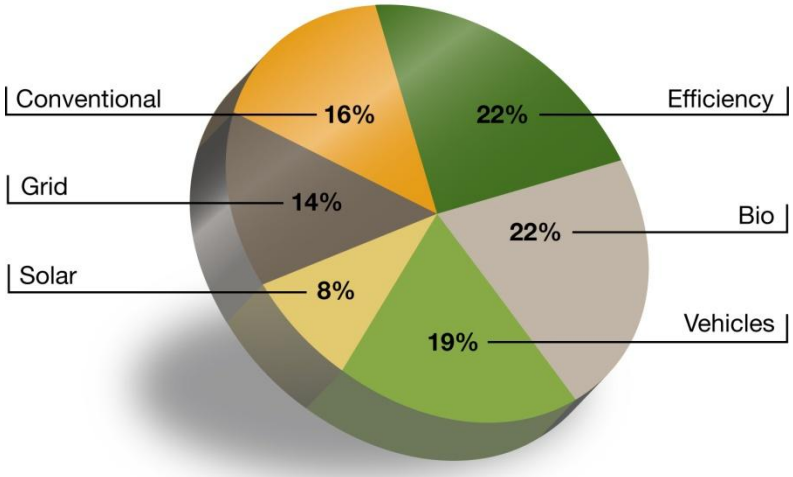
- TT – “Transformational” and “Translational” Research
- Specific Projects of High-Risk, High-Payoff
- Bold Ideas, Not Increments to Existing Technologies
- Pick Up at Early-Stage, Not Supported by Angels or VCs
- Small Integrated Teams – “Skunk Works”
- Dedicated to Moving Technology to Market
- Over Arching Focus – “Accelerating Science to Market”

ARPA-E – Status

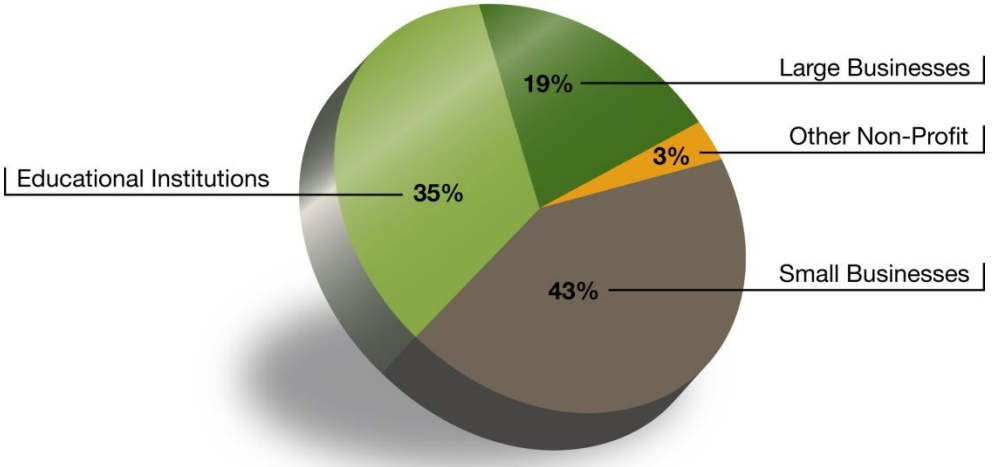
- **Current**
  - **$400M from Recovery Act (ARRA)**
  - **1st Solicitation = $150M; 37 Projects Awarded**
  - **2nd Solicitation = $100M, Issued December 7, 2009, Ongoing**
    - **Electrofuels**
    - **Innovative Materials & Processes for Advanced Carbon Capture Technologies (IMPACCT)**
    - **Batteries for Electrical Energy Storage in Transportation (BEEST)**
  - **3rd Solicitation = $100M, Issued March 2, 2010, Ongoing**
    - **Grid-Scale Rampable Intermittent Dispatchable Storage (GRIDS)**
    - **Agile Delivery of Electrical Power Technology (ADEPT)**
    - **Building Energy Efficiency Through Innovative Thermodevices (BEET-IT)**
  - **All "Recovery Act" $ to be Obligated by September 30, 2010**
- **FY 2011**
  - **$300M Requested in FY 2011**

ARPA-E Awards by Category

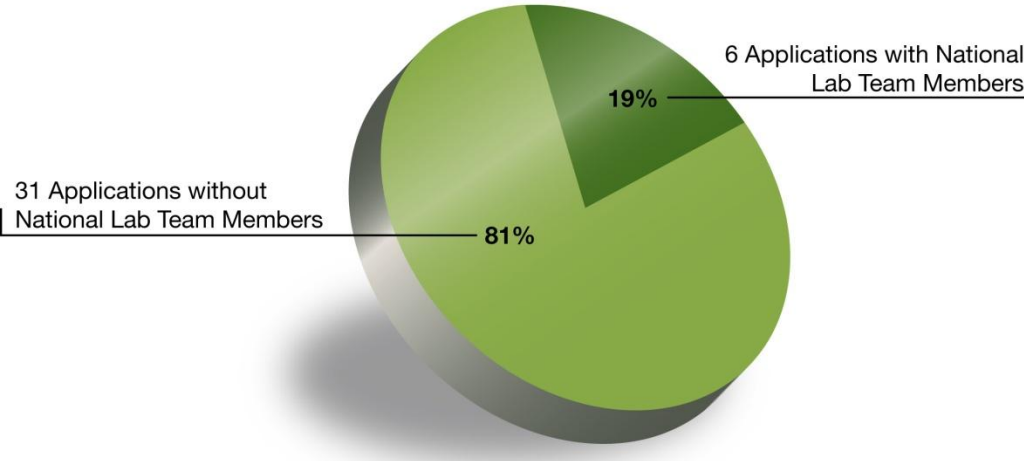
Application Distribution by Topical Panel



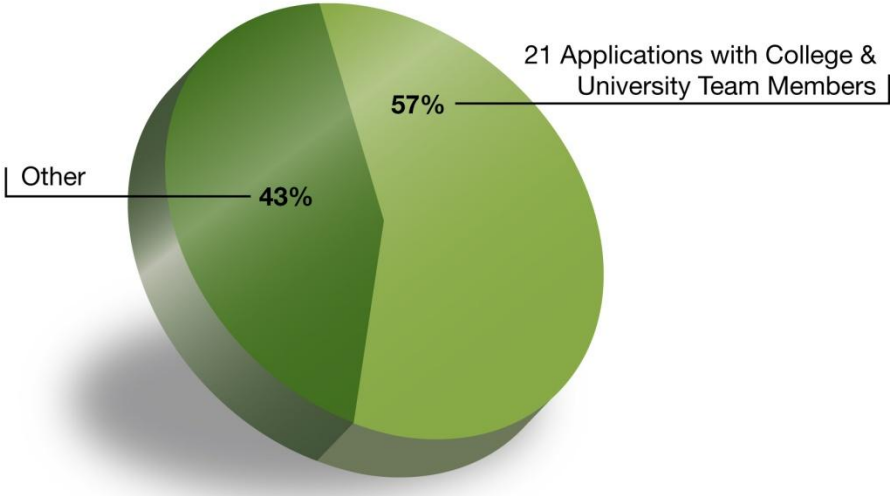
Lead Organization Type for Selected Projects



National Lab Participation



College & University Participation



Single-Investigator & Small-Group Research

- **Single-Investigator and Small-Group Research (SISGR)**
  - Will significantly enhance the core research programs in BES, and
  - Pursue the fundamental understanding necessary to meet the global need for abundant, clean, and economical energy.
- **Awards are planned for three years, with funding in the range of:**
  - $150-300 K/yr for single-investigator awards, and
  - $500-1,500 K/yr for small-group awards
- **Areas of interest include:**
  - ***Grand Challenge Science:*** ultrafast science; chemical imaging, complex & emergent behavior
  - ***Use-Inspired Discovery Science:*** basic research for electrical energy storage; advanced nuclear energy systems; solar energy utilization; hydrogen production, storage, and use; geological CO2 sequestration; other basic research areas identified in BESAC and BES workshop reports with an emphasis on nanoscale phenomena
  - ***Tools for Grand Challenge Science:*** midscale instrumentation; accelerator and detector research (exclude capital equipment supports)