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U.S.-China Clean Energy Research Center Overview & Progress

Dr. Robert C. Marlay, U.S. Director

U.S.-China Clean Energy Research Center

Office of Policy and International Affairs

U.S. Department of Energy

Washington Technology Roundtable

Electric Power Research Institute, Washington Office

February 6, 2012

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History of U.S. - China S&T Cooperation

- **Period I: S&T Cooperation (1978-1990)**
  - Agreement on High Energy Physics (1979)
  - Protocol on Nuclear Physics and Fusion (1983)
  - Protocol on Fossil Energy R&D (1985)
  - Agreement on CO2 Research under the Fossil Energy Protocol (1987)
  - Reduction in Cooperative Activities (1989), due to IPR Issues

- **Period II: Energy Policy Consultations (1991-2000)**
  - Agreement on Superconducting Super Collider (1992)
  - Two Annexes Added to the Fossil Energy Protocol (1994)
  - MOU on Energy Consultations: Reactor Fuel, RE, and EERE (1995)
  - Three Annexes Added to the EERE Agreement (1996)
  - The 1st Oil & Gas Industry Forum (1998)
  - Agreement on Peaceful Use of Nuclear Technology (PUNT) (1998)
  - Revised Fossil Energy Protocol (2000)

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Background & History of S&T Cooperation

- **Period III: Broadened Relationship (2001-2007)**
  - OGIF, APEC, JCC (PUNT)
  - Statement of Intent on Nuclear Non-Proliferation (2003)
  - Joining the ITER; and the CSLF (2003)
  - Sec. Abraham's Visit to China; MOU on Energy Policy Dialogue (EPD)
  - Megaports Initiative; Reduced Enrichment for Research and Test Reactors; and Gen IV International Forum (2004)
  - DOE China Office Opened; Conduct of 1st EPD (2005)
  - APP; 2nd EPD; and 1st Strategic Economic Dialogue (SED) (2006)
  - GNEP (2007)
  - Ten Year Framework (2008) with objectives to pursue energy efficiency, environmental conservation, new energy, and energy security.

- **Period IV: Seven Joint Clean Energy Initiatives (November 2009)**
  - Seven Joint Clean Energy Initiatives (see next slide)

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U.S.-China Clean Energy Initiatives – Period IV


President Barack Obama and President Hu Jintao November 2009

Seven Joint Clean Energy Initiatives (2009)

- Electric Vehicles Initiative
- Energy Efficiency Action Plan
- Renewable Energy Partnership
- 21st Century Coal
- Shale Gas Resource Initiative
- Energy Cooperation Program
- U.S.-China Clean Energy Research Center

WHY CHINA & WHAT's NEW ?

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Why China and the U.S.?

- China and U.S. S&T Cooperation is Important, Because:
  - United States and China are the world's two largest economies.
  - United States and China are the world's largest producers and consumers of energy, and share many common challenges and common interests.
  - China and the United States together account for 40 percent of annual global emissions of greenhouse gases.
  - Both countries are highly dependant on coal for electricity – about 50% in the U.S. and 80% in China.
  - Significant actions by both nations are critical to combat climate change globally.
  - Both are heavily reliant on foreign sources of oil.
  - Both recognize the vital importance of secure, affordable and clean energy.
  - Both face common challenges of diversifying sources of energy and transforming users of energy.
  - Both see strengthening scientific discovery, as a means to inspire economic competitiveness and quality of life through innovation.
  - Both countries are expanding 21st Century infrastructure, most of which has yet to be built and can be significantly influenced by advanced technology.

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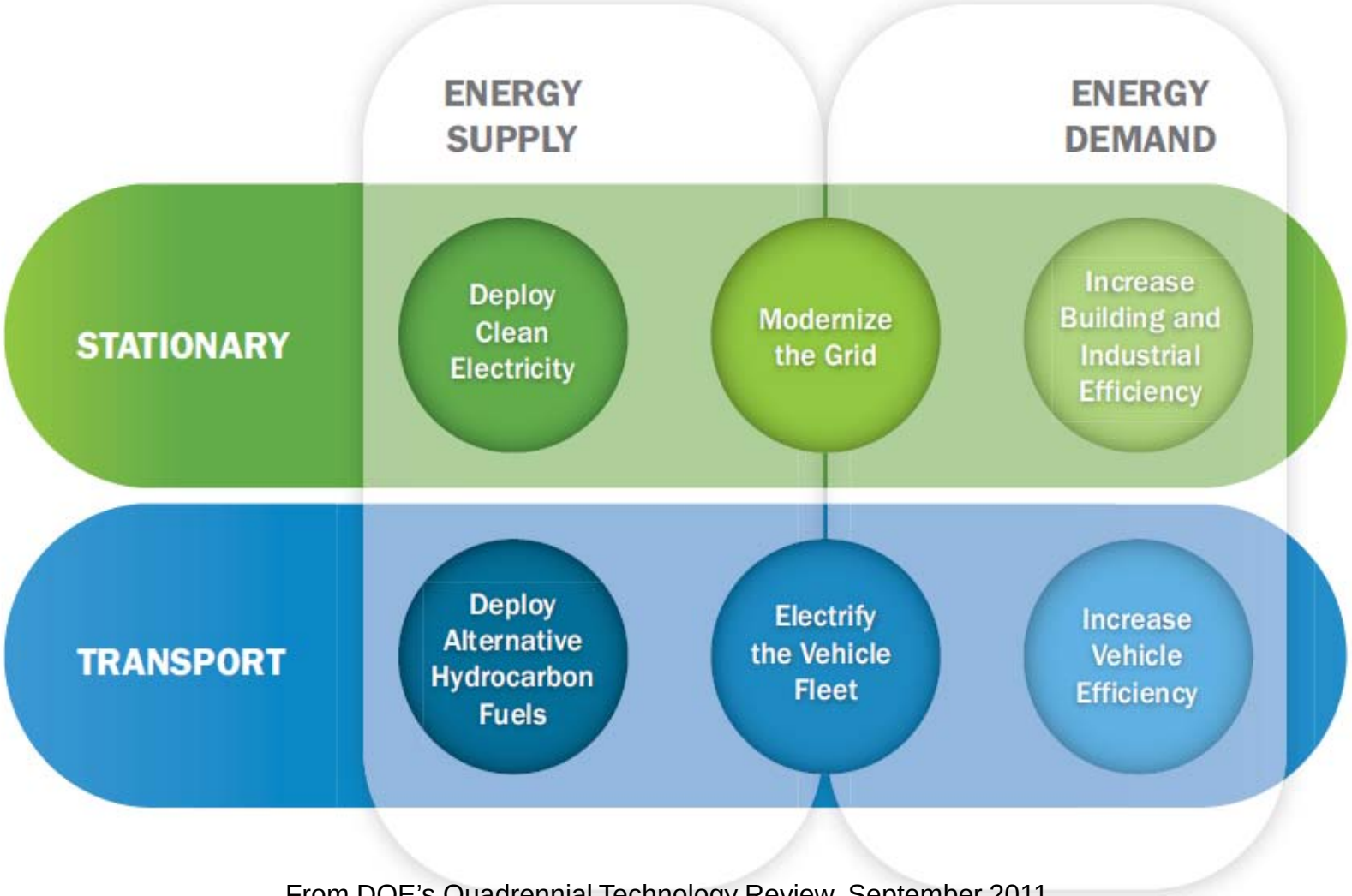
Common Elements of Clean Energy Technology Strategy



From DOE's Quadrennial Technology Review, September 2011

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The Promise of Combining Strengths

- Each Country Brings S&T Strengths to the Table
- U.S. Strengths:
  - World Class Research Universities, Institutes & National Laboratories
  - Pioneering Businesses, Entrepreneurs, and Technology-Based Private Partners
  - Well-Developed Financial & Legal Infrastructure
  - Excellence in Large-Scale Computational Models & Simulations
- China Strengths:
  - Large and Growing Presence in Basic & Applied Research
  - Facility in Translating Scientific Advances into Prototypes
  - Facility in Carrying out Large-Scale Pilot Projects & Demonstrations
  - Facility in Authorizing Site Use for Demonstrations and Experiments
  - Expertise in Rapid, Large-Scale Technology Deployment
  - Largest and Fastest Growing Energy Market; Test Bed for New Technologies
- Both Countries Gain from Accelerated Deployment of Clean Technologies

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CERC Protocol

- CERC Protocol Signed, Nov. 2009
- Calls for Joint U.S.-China Clean Energy Research Center (Virtual, not Physical)
- CERC Goals:
  - Spur Innovation of Clean Energy Techs
  - Diversify Sources of Energy Supply
  - Improve Energy Efficiency
  - Accelerate Transition to a Low-Carbon Economy
  - Avoid the Worst Consequences of Climate Change
- Three Areas for Initial Cooperation – Clean Coal; Clean Vehicles; and Efficient Buildings
- Open to Other Areas in the Future

Signing of CERC Protocol Nov. 2009

Steven Chu, U.S. Secretary of Energy
Liu Yandong, PRC State Councilor (S&T, MOST)
Gary Locke, U.S. Secretary of Commerce
Wan Gang, PRC Minister of S&T:

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New Model for Enhanced Collaboration

Cooperation (Traditional)

- Work Plans Coordinated, but Separate
- Independent Work on Similar Projects
- Interactions Characterized by Research Visits, Personnel and Student Exchanges
- R&D Focuses on Institutional Strengths
- Relationships Collegial
- R&D Results Shared Externally
- Benefits Mainly Academic. Transfer of Knowledge via Technical Papers & Reports
- No guaranteed IP Rights in Other's Territory. IP Provisions Not Flexible
- Few IP Advantages for R&D Partners

Collaboration (New) *

- Work Plans Developed Jointly
- Work Together on Same Projects
- Research Characterized by Division of Labor Among Participants on Joint Tasks
- R&D Exploits Complementarities
- Relationships Interdependent
- R&D Results Can Arise Jointly
- Benefits are Embedded among Partners and Extended by Interests in Commercialization
- Guarantees a Right to IP in Other's Territory. IP Terms & Conditions May be Negotiated
- Potentially More Attractive IP Platform

* Jointly Funded Research Projects, as Defined by Mutually Agreed-Upon Technology Management Plans

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Five-Year Funding Plan

Planned CERC Awards (Over 5 Years)

Technology Area	U.S.		China		Total Project Funding	On Track
	DOE	Partners	MOST	Partners		
Clean Coal	$12.5M	≥ $12.5M	$12.5M	$12.5M	$50.0M	☐
Clean Vehicles	$12.5M	≥ $12.5M	$12.5M	$12.5M	$50.0M	☐
Eff. Buildings	$12.5M	≥ $12.5M	$12.5M	$12.5M	$50.0M	☐
				Planned	**$150.0M**	☐

Note: $ = U.S. Dollars
M = Millions

CERC GOVERNANCE

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CERC Governance

Steering Committee

U.S.
Secretary Steven Chu, DOE

China
Minister WAN Gang, MOST
Administrator LIU Tienan, NEA
Vice Minister QIU Baoxing, MOHURD

Secretariat

U.S.
Assistant Secretary David Sandalow, DOE

China
Vice Minister CAO Jianlin, MOST
Deputy Director General MA Linying, MOST
Director General LI Ye, NEA
Deputy Director General HAN Aixing, MOHRUD

Executive Committee for Clean Coal Consortium

Executive Committee for Buildings Consortium

Executive Committee for Clean Vehicles Consortium

MOST: Ministry of Science & Technology; NEA: National Energy Administration; MOHURD: Ministry of Housing and Urban-Rural Development

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CERC Directors & Secretariat Support

U.S.

- U.S. Director, U.S.-China CERC
  - Dr. Robert C. Marlay, DOE
- Director, East Asian Affairs
  - Dr. Casey Delhotal, DOE

China

- China Director, U.S.-China CERC
  - Counselor LIU Zhiming, MOST
- Director, Americas and Oceania
  - WANG Qiang, MOST

Roles and Responsibilities:

- Provide Inter-Governmental Coordination for CERC between the U.S. and China
- Facilitate Intra-Governmental Coordination for CERC within Respective Countries
- Provide Technical and Analytical Support for Steering Committee and Secretariat
- Provide Leadership for CERC Consortia within Respective Countries
- Coordinate Support and Guidance on Diplomatic and Legal Matters

PROGRESS TO DATE

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Joint Work Plans
CERC Signing Ceremony

Signing of Joint CERC Work Plans (January 18, 2011)

Front Row (left to right), CERC Steering Committee: Zhang Guobao, Vice Minister, PRC National Reform and Development Committee, and Administrator, National Energy Administration; Steven Chu, Secretary, U.S. Department of Energy; Wan Gang, Minister, PRC Ministry of Science & Technology; Not Shown, Qui Baoxing

Back Row (left to right): Bob Marlay, U.S. DOE, U.S. Director, U.S.-China CERC; Ouyang Minggao, Tsinghua University, PRC Director, CERC Vehicles; Li Peigen, President, Huazhong University of Science and Technology, Representing PRC, CERC Coal; Dennis Assanis, University of Michigan, U.S. Director, CERC Vehicles; Jiang Yi, Tsinghua University, PRC Director, CERC Buildings; Mark Levine, Lawrence Berkeley National Laboratory, U.S. Director, CERC Buildings; Xu Shisen, Clean Energy Research Institute, Huaneng Energy Group, PRC Technical Program Manager, CERC Coal; Not shown: Liang Junqiang, PRC Ministry of Housing and Urban-Rural Development, PRC Technical Program Manager CERC Buildings

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Progress Overview

Protocol Establishes 3 CERCs: Coal, Vehicles, Buildings	Nov 2009
U.S. Awards $7.5M to Three U.S. Consortia	Sep 2010
China Organizes CERC Teams & Leadership	Nov 2010
U.S.- China Sign Joint Work Plans (U.S.-China Summit)	Jan 2011
U.S.- China Teams Carry Out Joint Research Planning	Jan-Sep 2011
China Commits $7.5M to Three Chinese Teams	Apr 2011
Joint Workshop on Intellectual Property (HUST/Wuhan)	May 2011
Joint Signing of 3 Technology Management Plan	Aug-Sep 2011
U.S. & China Sign Endorsement Letters to 3 TMPs	Sep 2011
U.S. Awards $7.5M (2nd Year Funding) to Three U.S. Consortia	Sep 2011
More than 100 Research Activities Defined, Mostly Joint	Sep 2011
Joint Research Begins; Technology Demos Planned	Oct-Dec 2011
First U.S.-China CERC Annual Report on Plans and Progress	Mar 2012

INTELLECTUAL PROPERTY

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Good News on IP

- "Intellectual Property Deal Cuts a Primitive Path to U.S.-China Energy Collaboration", by Joel Kirkland, *Climate Wire*, November 28, 2011
- "U.S. and China Strive for Fruitful but Competitive Developments in Clean Technology", by Joel Kirkland, *Climate Wire*, November 29, 2011
- "China Fuels Energy Innovation", by Brian Spegele, *Wall Street Journal*, December 6, 2011
- LP Amina, High-Efficiency Coal Technology, $10 Million Deal with Zhejiang Energy Group, Fengtai City, China
  - Negotiations Reached Difficult Stage -- Provincial Governor, Ambassador Locke, State & DOE Embassy Staff, TMP, Minister WAN Gang, MOST, all Weighed-In
- Duke Energy, Recently Renewed Its Commitment to CERC
- FE's James Wood, DAS for Coal R&D, states that "IP work under CERC is impressive, and potentially very valuable to U.S. companies."
- More Work on IP Ahead

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Innovation on Intellectual Property

- CERC Protocol Recognizes that:
  - Protection of IP is One of the Most Important Steps to Promote Innovation
- Participants in Both Countries Now Have an Agreement on an IP Framework, namely:
  - "Technology Management Plan" (TMP) Regarding the Exploitation of IP Rights
  - Clear in Both Languages
- The TMP Provides Strong Protection for:
  - Existing (or Background) IP Used in the CERC
  - New IP that is Created as Part of the CERC
  - Allows for Sub-Agreements Specific to Each Research Project & Its Participants
- Owners of Background IP Control the Use of that IP
- CERC Protocol Differs from Prior S&T Agreements between U.S and China:
  - The IP Annex Requires that "a right" be Conferred by the Inventing Party to the Non-inventing Party.
  - The TMP further Defines this "Right"
- Where IP is Created in a Jointly-Funded Research Project, the Project's Participants in Both Countries Have the Right to Obtain a License to the IP
- Disputes, if Any, May Be Resolved in Neutral Settings Under International Law

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CERC Signing Ceremony
Intellectual Property Endorsements

Letters of Endorsement

- Ensure Government Support of Underlying Agreements (TMPs)
- Strengthens IP Protections
  - Protects Existing (Background) IP
  - Protects Newly Created IP (Inventions)
- Encourages Sharing the Best of IP
- Facilitates Negotiations of Terms & Conditions
- Clarifies Rules of Engagement
- Supports Fair Resolution of Disputes

Two governments sign endorsement letters supporting the jointly agreed upon & signed Technology Management Plans *

Observers:
Secretary of Energy Steven Chu
Minister of Science & Technology WAN Gang
Deputy Minister MOST CAO Jainlin

Signatories:
Assistant Secretary David B. Sandalow
Deputy Director General MA Linying

Country Directors of CERC:
Dr. Robert C. Marlay (for U.S.)
Counselor LIU Zhiming (for China, Not Shown)

* TMP, regarding the exploitation of intellectual property rights pursuant to paragraph ILB,2,(d) of Annex I-Intellectual Property (hereinafter "IP Annex") of the CERC Protocol, Beijing, September 23, 2011

RESEARCH FOCUS

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Leadership of CERC Research Teams

	Coal		Vehicles		Buildings	
U.S.	WVU	Director Dr Jerald J Fletcher	UM	Director Prof Huei PENG	LBNL	Director Dr Mark D. Levine
	LLNL	Tech Pgm. Mgr. Julio Friedmann	UM	Deputy Director Jun NI (Research)	ORNL	Deputy Director Dr. Patrick Hughes
	WVU	Collaboration Mgr SUN Quingun	UM	China Liaison Prof essors PENG & NI	LBNL	China Liaison Dr. YAO Yuan
	WVU	Operations Manager Sam Taylor	UM	Operations Manager Carrie Morton	LBNL	Operations Hongyou LU
China	HUST	Director Dr ZHENG Chugang	Tsinghua	Director Dr OUYANG Minggao	MOHURD	Director Dr LIANG Junqiang
	Huaneng CERI	Chief Engineer Dr XU Shisen	Tsinghua	Deputy Director Dr WANG Hewu	Tsinghua MOHURD	Tech Pgm. Mgr. Dr JIANG Yi
	Tsinghua	Chief Scientist Dr YAO Qiang	Tsinghua	Deputy Director Dr QIU Xinping		

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Summary of Research Activities

CERC Technical Track	Joint Work Plan Research Areas	Number of Research Activities	Present Extent of Joint Work	Goal for Joint Work
Advanced Coal Technology Consortium	7	44	93%	100%
Clean Vehicles Consortium	7	27	67%	100%
Building Energy Efficiency	7	35	33%	100%
Summary	21	106	~70%	100%

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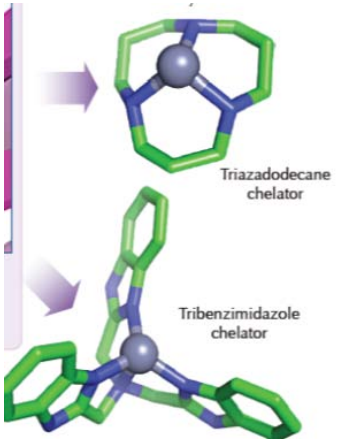
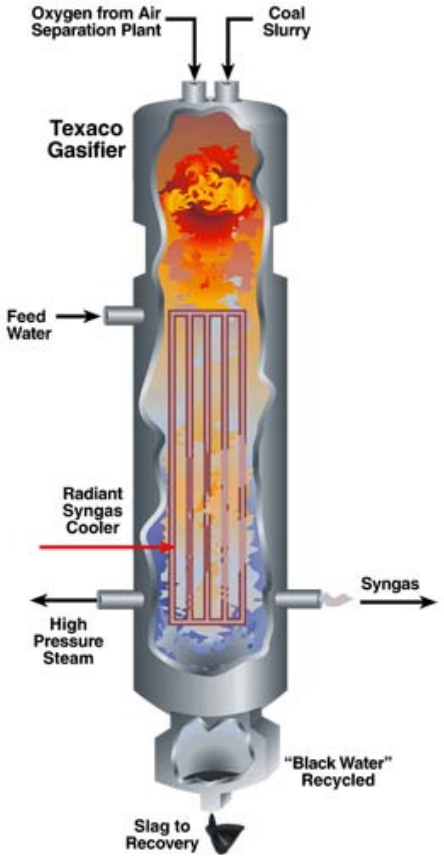
Advanced Coal Technology

Advanced Coal Conversion, Including IGCC with CCS

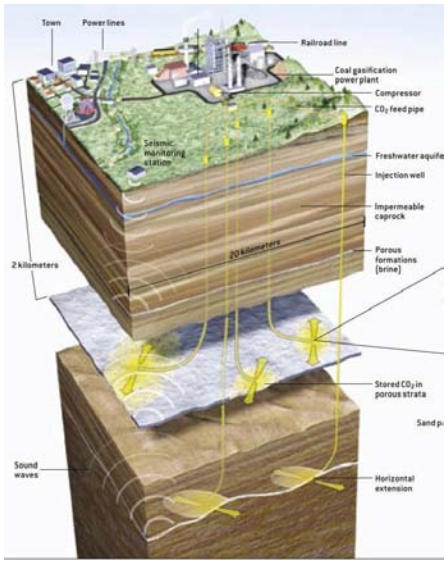
CO2 Utilization, Including Micro-Algae for Fuels



Novel CO2 Capture



Oxy-Fuel Combustion



CCS Technology & Geologic Storage

B&W amine test center, OH

Post-combustion CO2 Capture

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Advanced Coal Technology Partners

U.S.

- **Project Lead**
  - West Virginia University (WVU)
- **Partners:**
  - Babcock & Wilcox (B&W)
  - Duke Energy (Duke)
  - General Electric (GE)
  - GreatPoint Energy
  - Indiana Geological Survey (IGS)
  - Lawrence Livermore National Lab (LLNL)
  - Los Alamos National Lab (LANL)
  - LP Amina
  - National Energy Technology Lab (NETL)
  - U.S.-China Clean Energy Forum (CEF)
  - University of Wyoming (UWy)
  - University of Kentucky (UKy)
  - World Resources Institute (WRI)
  - Wyoming State Geological Survey (WGS)

China

- **Project Lead**
  - Huazhong Univ. of Science and Technology
- **Partners:**
  - Ctr. for Energy & Power, Ch. Acad. of Sciences;
  - China Huaneng Group Clean Energy Res. Inst.
  - China Univ. of Mining and Technology
  - China Power Engineering Consulting Group Corporation (CPECC)
  - ENN (XinAo Group)
  - Huaneng Power Int'l., Inc
  - Inst. for Rock & Soil Mechanics, Chinese Academy of Sci.
  - NW Univ. of China
  - Shanghai JiaoTong University
  - Shenhua Group
  - Tsinghua University
  - Yanchang Petroleum
  - Zhejiang University, Hangzhou

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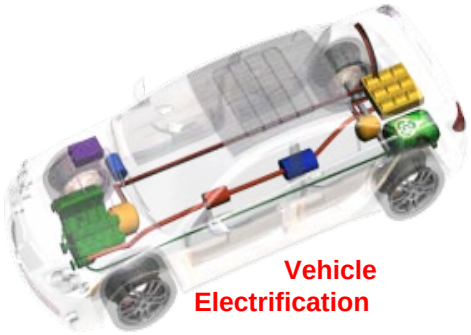
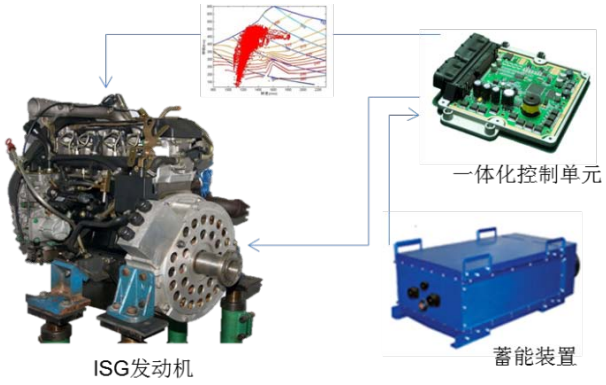
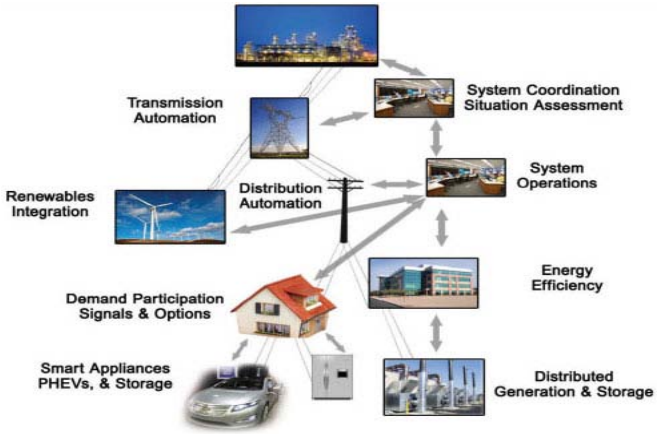
Clean Vehicles



Vehicle Electrification

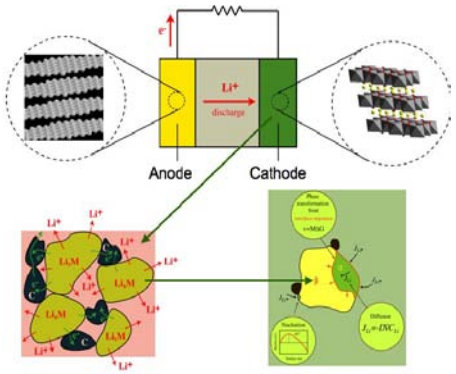


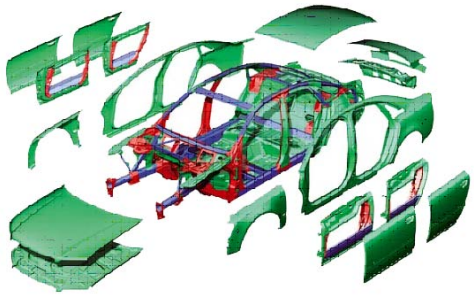
Biofuels & Clean Combustion



Vehicle Grid Integration

Adv. Batteries & Energy Conversion





Lightweight Materials &Structures

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Clean Vehicles Partners

U.S.

- **Project Lead:**
  - University of Michigan (UM)
- **Partners:**
  - A123 Systems
  - American Electric Power (AEP)
  - BorgWarner
  - Chrysler, Engine
  - Delphi
  - FirstEnergy
  - Ford Motor Company (Ford)
  - Fraunhofer USA
  - Huntsman
  - Magnet
  - Massachusetts Institute of Technology (MIT)
  - Oak Ridge National Laboratories (ORNL
  - Ohio State University (OSU)
  - Sandia National laboratories, Livermore (SNL)
  - Toyota Motor Company (Toyota)
  - Transportation Research Center (TRC)

China

- **Project Lead**
  - Tsinghua University
- **Partners:**
  - Beijing Institute of Technology
  - CHANA
  - China Potevio
  - Chinese Academy of Sciences
  - Geely Automobile
  - SAIC
  - Shanghai Jiao Tong University
  - Tianjin University
  - Tongji University
  - Wuhan University of Technology
  - Wanxiang

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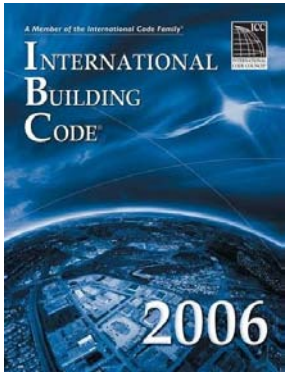
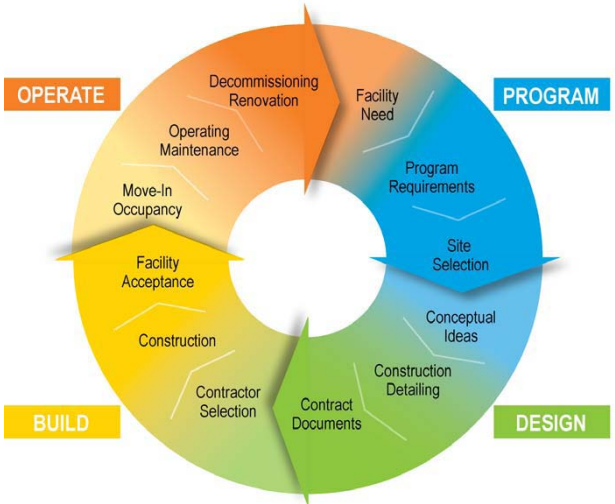
Buildings Energy Efficiency

Very Low Energy Buildings, Including RE Integration

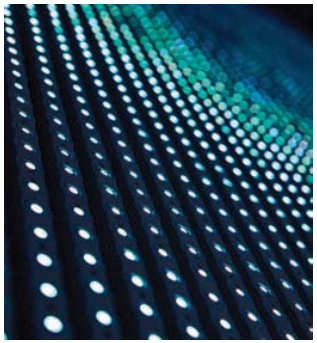
High Efficiency Building Envelops, Including Cool Roofs



Commercialization & Market Related Research



Building Energy Use Monitoring & Simulation



Building Equipment, Including Solid State Lighting

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Buildings Energy Efficiency Partners

U.S.

- **Project Lead:**
  - Lawrence Berkeley National Laboratory (LBNL)
- **Partners:**
  - Bentley
  - CertainTeed Corporation Saint-Gobain (CertainTeed)
  - ClimateMaster
  - Energy Foundation China Sustainable Energy Program
  - GE Global Research (GE)
  - Honeywell International Incorporated (Honeywell)
  - ICF International (ICF)
  - Massachusetts Institute of Technology (MIT)
  - National Association of State Energy Officials (NASEO)
  - Natural Resources Defense Council (NRDC)
  - Oak Ridge National Laboratory (ORNL)
  - Pegasus Capital Advisors (PCA)
  - Schneider Electric
  - The DOW Chemical Company (DOW)
  - UC Davis (UCD)

China

- **Project Lead**
  - Ministry of Housing and Urban-Rural Development (MOHURD)
- **Partners:**
  - Beijing Industry University
  - Center of Science and Technology of Construction of MOHURD
  - China Academy of Building Research (CABR)
  - China Building Standard Design Institute
  - Chinese Green Building Council
  - Chongqing University
  - Guangdong Provincial Academy of Building Research
  - Leye Energy Service, Beijing
  - MOHURD Center for Building Energy Efficiency
  - Shenyang Architecture University
  - Shenzhen Institute of Building Research
  - Southeast University
  - Tianjin University
  - Tongji University
  - Tsinghua University

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Summary

- Much Work to Do – Much Benefit to Gain
- In the Near-Term, U.S. and China will benefit:
  - From leveraged research and, possibly, breakthroughs
  - Demo platforms and accelerated technology deployment
  - Opportunities created domestically for clean energy technology manufacturing, sales and installations, with potential for export
- In the Long-Term, U.S. and China will:
  - Accrue to itself and its peoples the benefits of greater deployment of clean and affordable energy technology at scale, including
  - More efficiency, lower energy use and costs, and lower pollution and reduced greenhouse gas emissions.

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CERC LOGO

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U.S.: http://www.us-china-cerc.org
China: http://www.cerc.org.cn/