CERC Overview – Water-Energy Technologies

Dr. Robert C. Marlay, Ph.D., P.E.
U.S. Director
U.S.-China Clean Energy Research Center
International Affairs
U.S. Department of Energy

University of California, Berkeley, California
15 – 16 March 2017
High-Level Initiative Attracts Top Talent

Phase I (2010 – 2015; Renewed to 2020)

- CERC-ACTC Annual Meeting, October 2016
- CERC-BEE at 2016 CERC Steering Committee Meeting, July 2016
- CERC-CVC Annual Meeting, August 2016

Phase II (New Tracks, 2016– 2020)

- CERC-WET Annual Meeting, December 2015
- CERC-TRUCK Joint Meeting, December 2016
- CERC-IP, Joint Training, November 2015
VISION: To build a shared foundation of knowledge, technologies, human capabilities, and relationships that position U.S. government, non-governmental organizations and industries, and our peers in China, to thrive in a future with constrained energy and water resources.
**Goals**

- **Technology:** Accelerate development and deployment of clean energy technology for the benefit of both countries;
- **Business:** Facilitate relationship building and market access by participating businesses to create jobs and speed technology deployment;
- **IP:** Protect IP, encourage its development, and improve US-China interactions regarding IP; and
- **Diplomacy:** Enhance bilateral S&T cooperation between U.S. and China, w/spillover effects for diplomacy.

**Principles**

- **Mutual Benefit:** Equality, mutual benefit, and reciprocity;
- **Respect for Law:**
  - The applicable legislation of each country; and
  - Effective protection of intellectual property rights
- **Timely Exchange of Information:**
  The timely exchange of information relevant to cooperative activities; and
- **Non-Military Use:** The peaceful, non-military uses of the results of collaborative activities.
**New Model**

for Enhanced S&T Collaboration

<table>
<thead>
<tr>
<th>Cooperation (Traditional)</th>
<th>Collaboration (CERC)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Plans Coordinated, but Separate</td>
<td>Work Plans Developed Jointly</td>
</tr>
<tr>
<td>Independent Work on Similar Projects</td>
<td>Work Together on Same Projects</td>
</tr>
<tr>
<td>Interactions Characterized by Research Visits,</td>
<td>Research Characterized by Division of Labor</td>
</tr>
<tr>
<td>Personnel and Student Exchanges</td>
<td>Among Participants on Joint Tasks</td>
</tr>
<tr>
<td>R&amp;D Focuses on Institutional Strengths</td>
<td>Joint R&amp;D Exploits Complementarities</td>
</tr>
<tr>
<td>Relationships Collegial</td>
<td>Relationships Interdependent</td>
</tr>
<tr>
<td>R&amp;D Results Shared Externally</td>
<td>R&amp;D Results Can Arise Jointly</td>
</tr>
<tr>
<td>Benefits are Mainly Academic; Transfer of Knowledge via Technical Papers &amp; Reports</td>
<td>Benefits are Embedded among Partners and Extended by Interests in Commercialization</td>
</tr>
<tr>
<td>No guaranteed IP Rights in Other's Territory; IP Provisions Not Flexible</td>
<td>Guaranteed Right to IP in Other's Territory; IP Terms &amp; Conditions May be Negotiated</td>
</tr>
<tr>
<td>Few IP Advantages for R&amp;D Partners</td>
<td>Potentially More Attractive IP Platform</td>
</tr>
</tbody>
</table>

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

Steering Committee

U.S.: Secretary of Energy Perry, DOE
China: Minister WAN Gang, MOST

U.S.: NUR Bekri, NEA
China: CHEN Yiming, MOHURD

Secretariat

U.S.: Assistant Sec. Int’l Affairs, DOE
Director Robert C. MARLAY, DOE
Director Alan YU, DOE

China: Vice Minister YIN Hejun, MOST
Associate Counsel CAI Jianing, MOST
Director General LI Ye, NEA
Deputy Director General HAN Aixing, MOHURD

Executive Committee for Advanced Coal Technology Consortium
Executive Committee for Building Energy Efficiency Consortium
Executive Committee for Clean Vehicles Consortium
Executive Committee for Water-Energy Technologies Consortium
Executive Committee For Medium- and Heavy-Duty Trucks Consortium

MOST: Ministry of Science & Technology; NEA: National Energy Administration; MOHURD: Ministry of Housing and Urban-Rural Development
Executive Committee for Water-Energy Technologies

U.S. Committee Members

- **Dr. Diana BAUER**, Director, Energy Systems Analysis and Integration, Energy Policy and Systems Analysis, DOE
- **Robie LEWIS**, Program Manager, Crosscutting Research, Fossil Energy, DOE
- **Regis CONRAD**, Director, Division of Crosscutting Research, Fossil Energy, DOE
- **Hoyt BATTEY**, Program Manager, Hydropower Market Acceleration and Deployment, Energy Efficiency & Renewable Energy, DOE
- **Bob VALLARIO**, Program Manager, Integrated Assessment, Biological and Environmental Research, Science, DOE

Chinese Committee Members

- **KANG Xiangwu**, Consultant, Division of Resources and Environment, Department of S&T for Social Development, MOST
- **XIAO Yaowen**, Division of Resources and Environment, Department of S&T for Social Development, MOST
- **LIU He**, Director, Research Institute of Petroleum Exploration & Development
- **ZHU Ronggai**, China National Petroleum Corporation Representative
- **WANG Jianhua**, Deputy Director, China Institute of Water Resources and Hydropower Research
- **BAO Shujun**, Secretary-General, China Institute of Water Resources and Hydropower Research
- **YAO Zixiu**, Deputy Secretary-General, Research Institute of Petroleum Exploration & Development
## Leadership of CERC Research Teams

<table>
<thead>
<tr>
<th>Advanced Coal Technology</th>
<th>Clean Vehicles</th>
<th>Building Energy Efficiency</th>
<th>Water-Energy Technologies</th>
<th>Medium- and Heavy-Duty Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>WVU</td>
<td>Director James WOOD</td>
<td>ANL</td>
<td>Director Don HILLEBRAND</td>
<td>LBNL</td>
</tr>
<tr>
<td>WVU</td>
<td>Collaboration Manager Qingyun SUN</td>
<td>ANL</td>
<td>Deputy Director Michael WANG</td>
<td>LBNL</td>
</tr>
<tr>
<td>WVU</td>
<td>Ops Manager Sam TAYLOR</td>
<td>ANL</td>
<td>Deputy Director Khal AMINE</td>
<td>LBNL</td>
</tr>
<tr>
<td></td>
<td>ANL</td>
<td>Ops Manager Yan ZHOU</td>
<td>LBNL</td>
<td>Ops Manager Carolyn SZUM</td>
</tr>
<tr>
<td>HUST</td>
<td>Director ZHENG Chuguang</td>
<td>THU</td>
<td>Director OUYANG Minggao</td>
<td>MOHURD</td>
</tr>
<tr>
<td>Huaneng</td>
<td>Chief Engineer XU Shisen</td>
<td>THU</td>
<td>Deputy Director WANG Hewu</td>
<td>THU</td>
</tr>
<tr>
<td>THU</td>
<td>Chief Scientist YAO Qiang</td>
<td>THU</td>
<td>Deputy Director QIU Xinping</td>
<td>CABR</td>
</tr>
<tr>
<td>THU</td>
<td>Ops Manager DU Jiuyu</td>
<td>MOHURD</td>
<td>Program Manager PENG Chen</td>
<td>IWHR</td>
</tr>
</tbody>
</table>

WVU: West Virginia University; ANL: Argonne National Lab; LBNL: Lawrence Berkeley National Lab; UC: University of California; THU: Tsinghua University; MOHURD: Ministry of Housing and Urban-Rural Development; CABR: China Academy of Building Research; RIPED: Research Institute of Petroleum Exploration and Development; CNPC: China National Petroleum Corporation; IWHR: Institute of Water Resources and Hydropower Research; TJU: Tianjin University
# CERC’s Five-Year Funding Plan

## CERC Awards (Over 5 Years)

<table>
<thead>
<tr>
<th>Technology Area</th>
<th>U.S.</th>
<th>China</th>
<th>Total Project Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DOE</td>
<td>Partners</td>
<td>MOST &amp; Partners</td>
</tr>
<tr>
<td>CERC-ACTC*</td>
<td>$12.5M</td>
<td>≥$12.5M</td>
<td>$25M</td>
</tr>
<tr>
<td>CERC-CVC*</td>
<td>$12.5M</td>
<td>≥$12.5M</td>
<td>$25M</td>
</tr>
<tr>
<td>CERC-BEE*</td>
<td>$12.5M</td>
<td>≥$12.5M</td>
<td>$25M</td>
</tr>
<tr>
<td>CERC-WET*</td>
<td>$12.5M</td>
<td>≥$12.5M</td>
<td>$25M</td>
</tr>
<tr>
<td>CERC-Truck</td>
<td>$12.5M</td>
<td>≥$12.5M</td>
<td>$25M</td>
</tr>
</tbody>
</table>

*Funding has been awarded for 5-year period, 2016-2020

Planned ≥$250M

---

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

**Key:**  
ACTC  –  Advanced Coal Technology Consortium  
CVC  –  Clean Vehicles Consortium  
BEE  –  Building Energy Efficiency Consortium  
WET  –  Water-Energy Technologies Consortium  
TRUCK  –  Medium- and Heavy-Duty Trucks Consortium
WET Topic Areas

- Water Use Reduction at Thermoelectric Plants
- Climate Impact Modeling
- Treatment and Management of Non-Traditional Waters
- Improving Sustainable Hydropower Design and Operation
- Data Analysis to Inform Planning, Policy, and Other Decisions

Reheat air combined cycles simulation

Expected changes in cooling water technologies between 2013 and 2022

Grand Coulee Dam

Climate-Scale Precipitation Database

California's Complex Water Conveyance System
<table>
<thead>
<tr>
<th>Technology Consortium</th>
<th>Joint Work Plan Research Areas</th>
<th>Research Activities</th>
<th>Joint Research Activities</th>
<th>Present Extent of Joint Work</th>
<th>Goal for Joint Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Coal Technology a</td>
<td>5</td>
<td>17</td>
<td>12</td>
<td>71%</td>
<td>100%</td>
</tr>
<tr>
<td>Clean Vehicles</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>83%</td>
<td>100%</td>
</tr>
<tr>
<td>Building Energy Efficiency</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Water &amp; Energy Technologies</td>
<td>5</td>
<td>31</td>
<td>19</td>
<td>61%</td>
<td>100%</td>
</tr>
<tr>
<td>Medium and Heavy Trucks</td>
<td>5</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>100%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>24</td>
<td>59</td>
<td>41</td>
<td>69%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Joint Research Projects Must Meet the Following Criteria:

1. Beneficial Outcomes for Both Countries (Not One Country Alone)
2. Evidence of Joint US/China Research Collaboration (e.g., Joint R&D Plan, Foreign Partner, Division of Labor, and Interdependencies)
3. Emphasis on Innovation and/or Novel Approaches, with Potential for Intellectual Property (IP)
4. Potential Path to Commercialization and/or Implementation of Resulting Knowledge or Technology
5. High Relevance to CERC Goals and Technical Objectives
6. Strong Scientific and Technical Merit
7. Quality of the Research Team, including Leadership, Key Personnel, and Expertise, and Supporting Resources, Equipment, and Facilities
10-Point Plan for Each CERC Project

Specify for Each Major CERC Research Project a Jointly-Developed 10-Point Plan

1. Research Objective
2. Background and Technical Approach
3. Task Statements
4. Roles and Responsibilities of Collaborating Leads, Performers, Partners
5. Equipment, Resources, Sites, Facilities to be Supplied
6. Work Schedule, with Interim Milestones (or Decision Points)
7. Deliverables and Dates
8. Estimated Costs (or Person-Hours Equivalents) and Commitments
9. Reporting Requirements (Interims, Final)
10. Technology Management Plan and with Sub-Agreements

Jointly Sign and Date Before Work Begins*

*This document is not legally binding. This document does not commit the participating or affiliated institutions identified in the Plan, or any CERC participant, to any allocation of resources, or create any legal rights or responsibilities.
<table>
<thead>
<tr>
<th>Technology Consortium</th>
<th>U.S.</th>
<th>China</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Coal Technology</td>
<td>34</td>
<td>60</td>
<td>94</td>
</tr>
<tr>
<td>Clean Vehicles</td>
<td>40</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>Building Energy Efficiency</td>
<td>41</td>
<td>32</td>
<td>73</td>
</tr>
<tr>
<td><strong>Water &amp; Energy Technologies</strong></td>
<td><strong>72</strong></td>
<td><strong>29</strong></td>
<td><strong>101</strong></td>
</tr>
<tr>
<td>Medium and Heavy Trucks</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>187</strong></td>
<td><strong>221</strong></td>
<td><strong>408</strong></td>
</tr>
<tr>
<td>Technology Consortium</td>
<td>U.S.</td>
<td>China</td>
<td>Total Participants</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>Lead</td>
<td>Partners</td>
<td>Lead</td>
</tr>
<tr>
<td>Advanced Coal Technology</td>
<td>WVU</td>
<td>19</td>
<td>HUST</td>
</tr>
<tr>
<td>Clean Vehicles</td>
<td>ANL</td>
<td>20</td>
<td>THU</td>
</tr>
<tr>
<td>Building Energy Efficiency</td>
<td>LBNL</td>
<td>29</td>
<td>MOHURD</td>
</tr>
<tr>
<td>Water &amp; Energy Technologies</td>
<td>UC</td>
<td>17</td>
<td>RIPED</td>
</tr>
<tr>
<td>Medium and Heavy Trucks</td>
<td>ANL</td>
<td>7</td>
<td>TJU</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5</td>
<td>92</td>
<td>5</td>
</tr>
</tbody>
</table>
U.S. Partners

- University of California, Berkeley
- California Energy Commission (Sacramento, CA)
- Deltares, USA (Silver Spring, MD)
- Duke Energy (Charlotte, NC)
- Energy Foundation (San Francisco, CA)
- Glacier Technologies (El Paso, TX)
- Lawrence Berkeley National Laboratory (Berkeley, CA)
- Porifera, Inc. (Hayward, CA)
- Southern California Gas Company (Los Angeles, CA)
- Southern California Edison (Rosemead, CA)
- Stockholm Energy Institute (Somerville, MA)
- University of California, Davis (Davis, CA)
- University of California, Irvine (Irvine, CA)
- University of California, Los Angeles (Los Angeles, CA)
- University of California, Merced (Merced, CA)
- University of California, Office of the President (Oakland, CA)
- Walt Disney Imagineering (Glendale, CA)

China Partners

- Research Institute of Petroleum Exploration & Development (RIPED) (Beijing)
- Asia-Europe Water Resources Research and Utilization Center (Hunan)
- China Institute of Water Resources and Hydropower Research (Beijing)
- China Power Engineering Consulting (Group) Corporation (Beijing)
- China Three Gorges Corporation (Beijing)
- China Yixing Industrial Park for Environmental Science & Technology (Jiangsu)
- Dano (Beijing) Oilfield Services Co., Ltd (Beijing)
- Guodian New Energy Technology Research Institute (Beijing)
- Hunan Yongqing Environmental Science & Technology Co., Ltd (Hunan)
- Institute of Engineering Thermophysics, Chinese Academy of Sciences (Beijing)
- International Applied Energy Technology Innovation Institute (Zhenhai)
- National Development and Resource Commission, Energy Research Institute (Beijing)
- North China Electric Power University (Beijing)
- Peking University Water Center (Beijing)
- Power Construction Corporation of China (Beijing)
- School of Resource and Earth Science, China University of Mining and Technology (Jiangsu)
- Shanxi Yanchang Petroleum Co., Ltd (Shaanxi)
- Shenhua Group (Beijing)
- The Institute of Seawater Desalination and Multipurpose Utilization, SOA (Tianjin)
- Tsinghua University, School of Environment (Beijing)
- Yalongjiang River Basin Hydropower Development Co. Ltd (Chengdu)
Signs of Research Success (Phase I)

- Tangible outcomes and impacts
- Relationships continue to expand and deepen
- Researchers have access to unique experimental platforms
- Industrial partners gain market knowledge and build relationships
- Large-scale business ventures explore ways to collaborate with CERC
- Shared data accelerate new technology deployment
- Additional private partners seek to join
- Other countries are taking notice
Year-Long Audit by General Accountability Office

Process:
- Large GAO Audit Team
- Visited Every U.S. Site
- Interviewed CERC Leaders
- Interviewed Project PI’s
- Interviewed Most Industrial Partners

Findings:
- CERC Operating as Formulated
- Results Documented
- Goals, Metrics, Indicators

Recommendations:
- Incorporate Metrics into JWPs
- Set Targets

GAO Report Published July 5, 2016
## Selected Indicators of CERC Outcomes, Phase 1

<table>
<thead>
<tr>
<th>Overarching Goal</th>
<th>Performance Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Research</strong></td>
<td>• Number of outcomes of technical significance</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>• Number of researchers supported by CERC</td>
<td>1,124</td>
</tr>
<tr>
<td><strong>2. IP</strong></td>
<td>• Number of invention disclosures</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>• Number of patent applications</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>• Number of major IP education and training products developed</td>
<td>11</td>
</tr>
<tr>
<td><strong>3. Markets</strong></td>
<td>• Number of products launched</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>• Number of standards, codes, and market-related policies informed by CERC and promoting clean energy and efficiency.</td>
<td>10</td>
</tr>
<tr>
<td><strong>4. Engagement</strong></td>
<td>• Important diplomatic outcomes attributed, in part, to cooperative activities of CERC</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>• Joint workshops, technical meetings and training sessions</td>
<td>248</td>
</tr>
</tbody>
</table>
1. Sage ElectroChromic Window
2. 3M Daylighting Film
3. New co-axial ground heat exchanger (GHX)
4. ClimateMaster launched the Trilogy integrated heat pump
5. Dow launched LIQUIDARMOR – RS and LIQUIDARMOR – CS
6. 3M 3015 Primerless Membrane
7. Enhancement to DeST, Behavior software module
8. Three occupant behavior modeling tools
9. Online Airtightness Savings Calculator for the U.S., Canada, and China
10. A protocol and software tool for analyzing the performance of DGSHP systems
11. CoolVent for natural ventilation
12. WINDOW 7, IGDB, THERM for use on architectural projects in China
13. Enhancement to EnergyPlus, Behavior software module, Behavior framework schema
14. DER-CAM, webopt and operation DER-CAM
15. Building Energy Benchmarking Tool for commercial offices, hotels, hospitals, and shopping malls
16. "BlueHybrid" software for the design of power split hybrid vehicles
17. Computationally efficient finite element tools for electric machine design
Intellectual Property

The Joint Training on Intellectual Property for the U.S.-China Clean Energy Research Center (CERC)

November 2015
Approach:

- Framework of IP Principles Based on U.S. and Chinese Law
- Mutually-Agreed Rules for Partner Engagement
- Context for Negotiation of Favorable Terms and Conditions
- Platform for Project-Specific Sub-Agreements
- Means for Government Monitoring, Oversight and Encouragement
- Designed for R&D, but Could be Extended to Other Areas
- Emphasis on Education & Training in U.S. and Chinese IP Systems
- Limited Access to Pro Bono Expert Legal Advice from Practitioners

Caution:

- Not a Guarantee of IP Protection
- Not an Avenue for Government Intervention in Court Cases

Companies Must Realistically Assess Risks and Benefits
Technology Management Plan

- Officially Endorsed by Both Governments
- Clearly States Rules of Partner Engagement under CERC;
- Provides for Declaration and Protection of Background IP;
- Defines “a priori” Procedures for Allocating and Protecting Rights to New Inventions;
- Provides for Non-exclusive Licensing of IP under Favorable Terms among Participants;
- Encourages Sub-agreements for Specific IP and Related Terms & Conditions;
- Supports Fair Resolution of Disputes under International Standards;
- Establishes a Role for Government Monitoring and Oversight; and
- Encourages Compliance with Existing Agreements.

Available at: http://www.us-china-cerc.org/Intellectual_Property.html
What Works Well?

- The CERC Collaboration and Mission Attracts Top Scientific/Technological Talent, Cutting-edge Organizations, and Dedicated Individuals
- Joint Activities Build Respect and Trust at All Levels
- CERC’s Top-level Governance Structure and Upfront Agreements Encourage Seriousness of Purpose, Fairness and Flexibility
- CERC’s IP Framework Helps to Relieve Key Concerns of Collaboration
- Five Years Allows Time to Build Meaningful Research Program and Relationships
- Research Friendships and Collaborations Deepen with Time
- Cost-sharing Model Helps to Foster Ownership and Attentive Engagement by Both Countries and Industry
- Industry Advisory Boards Provide Valuable, Unbiased Guidance
- Activities Raise Awareness of Complementary Strengths/Opportunities
- Complementarities can be Powerful and Productive
Past Guidance from Steering Committee

- Aspire to Research with Impact
- Strengthen Engagement with Industrial Partners; Recruit New Partners
- Leveraged Cost-Share
- Leverage Platforms and Resources of Others
- Set Goals & Targets and Measure Progress
- Raise Visibility of CERC Work, Accomplishments, and Outcomes
- Promote CERC as Useful Bilateral, Collaborative Model
- Show Roadmaps that Will Achieve Public Benefits by 2020