National Renewable Energy Laboratory
Innovation for Our Energy Future

National Laboratories in US-China Cooperation

US-China Cooperation in Science, Technology and Innovation

National Academy of Sciences

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Robin L. Newmark
Director, Strategic Energy Analysis Center

NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy operated by the Alliance for Sustainable Energy, LLC

US-China clean energy: Cooperation in multiple dimensions

- Government-to-government umbrella agreements
- Government technical institution collaborations
- Commercial partnerships
- Public-private partnerships

GOVERNMENT-TO-GOVERNMENT UMBRELLA AGREEMENTS

US-China Strategic and Economic Dialogue

Identifying areas of interest, establishing high-level engagements

Electricity Production and Transmission Action Plan

- Best practices electricity planning; utility operation and management
- Increasing levels of intermittent resources on grid (wind, solar, geothermal)

Clean and Efficient Transportation Action Plan

- Clean and efficient vehicle technologies (PHEVs, EVs, biofuels production)
- Design and modality of transportation systems (multi-nodal transportation planning policies and operation)
- Improvement and utilization of existing transportation infrastructure

Energy Efficiency

- Energy efficiency in buildings and communities (20% energy savings target, cooperation on technical, analytical, and policy development and training)
- Industrial energy efficiency (industrial audits, financing arrangements, training and collaboration on implementing demonstration projects)

Framework for EcoPartnerships (7)

- New models for energy security, economic and environmental sustainability
- Denver/Chongqing (transportation); Greensburg/Mianzhu (disaster recovery)

New Clean Energy Initiatives November 2009

Clean Energy Research Center (CERC)
- Building EE, CCS, Clean Vehicles
- Consortium to be developed for each area

Renewable Energy Partnership (REP) (NREL lead)
- Renewable energy roadmapping, regional deployment, grid modernization
- Advanced renewables: wind, solar, biofuels
- Policy and financing

Electric Vehicles Initiative
- Standards development, demonstrations, roadmap

Shale Gas Resource Initiative
- Resource assessment, technical cooperation, investments

Energy Efficiency Action Plan
- Green buildings/communities, industrial EE, standards, advanced EE technology, public-private engagement

Cooperation on 21st Century Coal
- IGCC feasibility study, GreenGen, coal gasification, CCS,
- Public and private partnerships

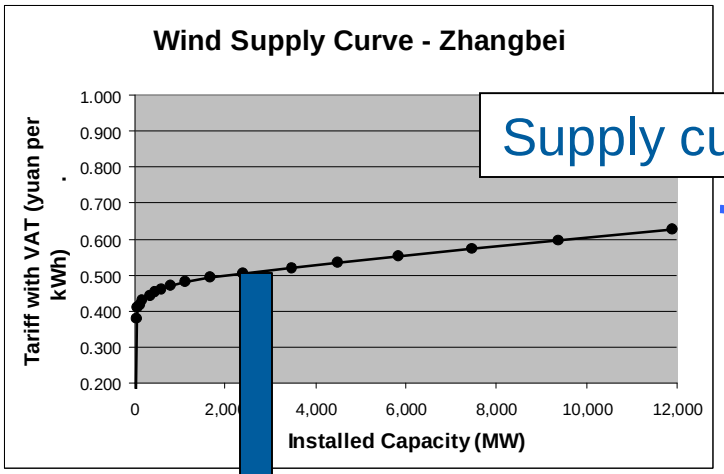
GOVERNMENT TECHNICAL INSTITUTION COLLABORATIONS

Wind power cooperation under the US-China Renewable Energy Program (USCREP)

- National renewable electric technology planning analysis starting with wind
- Cooperative R&D on wind turbine wake effect modeling
- Technical exchanges on wind technology standards, testing, certification and interconnection standards

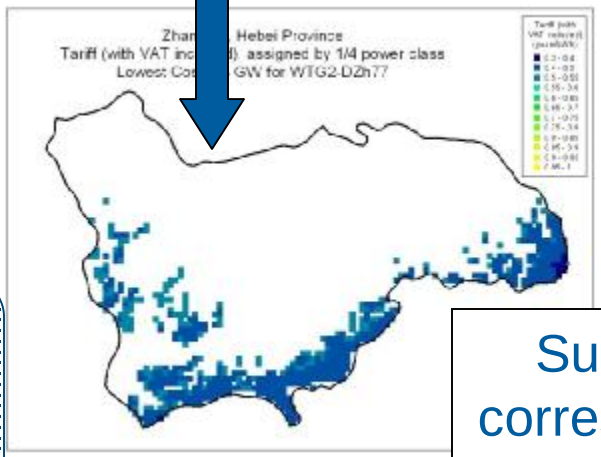
Geographic-economic wind supply analysis

- Building capacity in China's lead institution for wind power analysis and planning
- Geographically-tied supply curves have been extended to cover the whole country
- Ongoing work
  - Refining data and methods
  - Adding solar
  - Adding simple transmission representation



Supply curve

Geospatial supplycurve



Supply map corresponding to one point

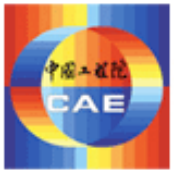
Participants:

US: NREL, Center for Resource Solutions

China: HydroChina, State Grid Energy Research Institute, Chinese Meteorological Agency

US-China Cooperation on Electricity from Renewables

CHINESE ACADEMY OF SCIENCES



中国工程院

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THE NATIONAL ACADEMIES

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- **Comparatively assess resource potential in China and the U.S. for grid-scale electricity generation (for the Chinese also small distributed)**

- **Explore near-term market opportunities for mature technologies**

- **Recommend priorities for enhanced collaboration, with a focus on cost reduction, improved efficiency and grid connectivity, and storage.**

U. S. - China Cooperation on Electricity from Renewables

Chinese Academy of Sciences/Engineering
U.S. National Academy of Sciences/Engineering
Site Visit at the National Renewable Energy Laboratory (NREL), October 5 and 6, 2009, Golden and Boulder, Colorado

1. Academician Prof. Zhongxian Zhao, China Chair 2. Academician Dr. Larry Papay, U.S. Chair 3. Dr. Dan Arvizu, NREL Director

U.S. Committee Members/Hosts: 4. Helena Li Chum and 5. Rich Bain, NREL; 6. Jana Milford, CU, Boulder

China Committee Members:ZhengHouZhi, Yan Luguang , XuJianzhong, FeiWeZhoFengqi , Xiao Liye, Liu Fengsong , Wang FengZhi , Zhao Daiqing, XuHaiyan, Wang Zhenhai , Wang Xifan ,LuoZhongyang , Cao Jinghua, Zhao Ying; Staff: Liao CuipingLu Yao

U.S. NRC Staff: Derek Vollmer, David Lukofsky

COMMERCIAL PARTNERSHIPS

US-China Private Sector Partnerships and Investment: Recent examples

Private Sector Partnerships

US Partner	China Partner	Activity
Duke Energy	Huaneng Power International	Discussions for building wind power plant in US
Duke Energy	ENN Group	Development of commercial solar projects in the US and joint technology development in coal-based clean energy, biofuels, natural gas, smart grid, energy efficiency and carbon-capturing algae
US Renewable Energy Group; Cielo Wind Power	Shenyang Power Group; A-Power Generation	Proposed $1.5 billion 600 MW in Texas financed mostly by Chinese commercial banks and ARRA funds; A-Power announced plans to build 1,100 MW capacity wind turbine plant in US; project has experienced controversy
AMSC Windtec(TM)	Dongfang Turbine Co., Ltd	American Superconductor Corp. will design and with Dongfang jointly develop 5 MW offshore wind turbine; Dongfang has exclusive rights with AMSC as supplier

China Investments in the US

Company	Activity
Suntech	Planned construction of 120-MW (30 MW initially) PV plant in Goodyear Arizona
Motech	Acquisition of GE Energy's Delaware 24 MW crystalline silicon solar module assembly operation
Goldwind S&T Ltd	First entry into US market: 3x 15 MW turbines in Pipestone Minnesota 70% ownership

China is making investments in US projects and in US manufacturing facilities

PUBLIC-PRIVATE PARTNERSHIPS

Example: US-China Biofuels Cooperation

Collaboration among National Labs, US Companies, Chinese Companies

US-China MOU Cooperation for the Development of Biofuels

Negotiated and signed by USDOE, USDA, China NDRC* in December 2007

Lead partners

China: PetroChina (CNP), SinoPec, CNOOC, COFCO, and ZTE

US DOE: ANL, INL, NREL, ORNL, and PNNL

USDA: ARS, FAS, ERS

Feedstock Supply and Logistics

DOE (INL and ORNL) and USDA collaboration with all Chinese partners

- Feedstock production cost factors, supply curves, supply system logistics design, equipment development, environmental impacts, sustainable agricultural practices for agricultural residue feedstocks and selected energy crops
- Feedstock case study collaboration for selected pilot plants

* Now National Energy Administration

US-China Biofuels Cooperation

Biochemical Conversion Joint Research

NREL (lead) with Tsinghua University and PetroChina et al

Advanced solid state fermentation (ASSF) of sweet sorghum
- Characterization of fermentation strains from China for the ASSF process
- Techno-economic analysis of wet vs. dry fermentation production processes

Cellulosic conversion of corn stover and sorghum bagasse to ethanol
- Characterization of US strains for enzymatic hydrolysis on Chinese feedstocks
- Cooperation to be expanded to additional areas

Thermochemical Conversion

PNNL (lead) with Dalian Institute of Chemical Physics and CNOOC

Characterization and performance verification of new Co and Rh catalysts
Evaluation of distributed pyrolysis followed by gasification: proof of concept
Techno-economic analysis of distributed pyrolysis and gasification for synthesis of mixed alcohols

US-China Biofuels Cooperation

Algae Biodiesel and Green Diesel

NREL (lead) with SinoPec and Chinese Academy of Sciences
- Prospecting and characterization of high-lipid content algae strains for biodiesel production

PNNL (lead) with PetroChina et al.
- Hydrogenation of pyrolysis products to produce green diesel
- Green diesel from hydrotreated jatropha oil

Private Sector Partnerships

Honeywell/UOP with CNPC
- Cooperation for producing green transportation fuels using Chinese feedstocks
- Demonstration of UOP/EniEcofiningTM process unit for production of green diesel

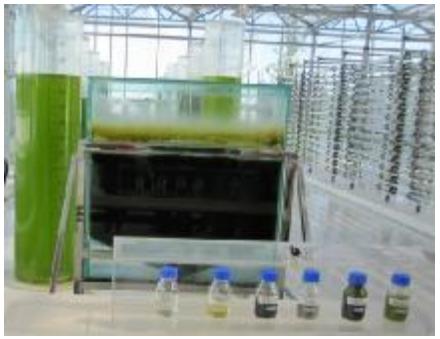
DuPont/PetroChina cooperation for cellulosic ethanol production

SinoPec/COFCO/Novozymes cooperation for cellulosic ethanol production

NREL Cooperative Agreements

Include both technical institutions and commercial partners

Partner	Activities
ENN Group Co., Ltd. (ENN)	Collaboration on buildings energy efficiency and sustainable development at regional and community levels; solar cell production process verification, and algae biodiesel research
Institute of Electrical Engineering (IEE), Chinese Academy of Sciences (CAS)	Solar cell and module measurement testing, linkage to international best practices and round robin testing, certification discussion
China Hydropower Engineering Consulting Group (CHECC)	Collaboration in developing advanced methods for assessment and economic analysis for large scale wind development in China



US-China Energy Cooperation Program (ECP)

- Consortium of US companies doing business in the energy sector in China
- Supported and facilitated by US Foreign and Commercial Service
- Actively engaged in the US-China Renewable Energy Partnership and other public-private partnerships of the US Government

Summary

- Both public and private sector R&D cooperation with China are rapidly growing
- There are enormous opportunities for mutual benefit
  - *Innovations come from both US and Chinese partners*
- There are also challenges
  - *Current efforts are making progress in overcoming barriers*

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Operated for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy by Midwest Research Institute • Battelle

Building the 21st Century:
U.S. - China Cooperation on Science, Technology, and Innovation

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