Brazil-China Wind Energy Technology Cooperation

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During the past five years, Brazil and China surged up to be new leaders in the global wind energy sector. China's 91 GW of installed wind capacity is the highest in the world and Brazil has also accumulated 3.4 GW, growing at an even faster rate than China. [1]These two emerging countries also share similar grand wind energy expansion goals for the future. [2] To accommodate the burgeoning renewable energy market, both Brazil and China are dedicated to acquiring and further developing the relevant technology. Recognizing the mutual benefits of collaborating in technology, Brazil and China have cooperated since 2011 on the development of wind technology at multiple levels.

Through the use of a case study and a thorough literature review, this paper analyses Brazil and China's bilateral technology cooperation on wind energy. The research seeks to answer three main questions:

- What is the extent of Sino-Brazil wind technology cooperation?
- What drives the cooperation between the two countries?
- Has the technology cooperation been successful?

We endeavor to accurately depict the extent and the impact of Sino-Brazil wind energy collaboration.

Extent of Sino-Brazil Wind Technology Cooperation

Research and development cooperation between Brazil and China over wind technology exists at institutional, public and private levels, which are discussed below.

Institutional: Scientific collaboration between Brazil and China dates back to the 1980s when the two countries embarked upon a joint venture to develop and launch three Earth observation satellites to monitor oil exploration activities. This highly successful project encouraged Sino-Brazil bilateral relations and served as a basis for setting up the China-Brazil High Level Coordination Committee (CBHCCC) in 2004, with a sub-committee focusing on energy and mining. Following this endeavor, the government of the People's Republic of China and the government of the Federative Republic of Brazil (2010-2014) signed the Joint Action Plan, which enhances mutual investment and cooperation in the renewable energy sector, and emphasizes further collaboration between the two countries. Data shows Chinese energy investment in Brazil increased dramatically between 2009 and 2010, when the agreement finalized.[3] In 2013, energy investments from China to Brazil reached USD $22.2 billion, or 69% of total Chinese investment in Brazil.[4]

Public: In 2009, the two countries co-established the Brazil-China Center for Climate Change and Energy Technology Innovation (the Center), which serves as their flagship public sector technology partnership. Through this government sponsorship, Tsinghua University and Federal University of Rio de Janeiro collaborate in research and development activities geared toward developing new energy technologies. [5] FINEP, a Brazilian financing agency for projects of the Ministry of Science, Technology and Innovation, funds the Center's work.[6] The Center also facilitates

[1] "GWEC – Global Wind Statistics 2013 - GWEC-PRstats-2013_EN.Pdf."http://www.gwec.net/wp-content/uploads/2014/02/GWEC-PRstats-2013_EN.pdf (accessed 4/10/2014, 2014).

[2] "China Wind Energy Development Roadmap 2050 - China_wind.Pdf."https://www.iea.org/publications/freepublications/publication/china_wind.pdf (accessed 4/10/2014, 2014).

[3] Denis Best and Joerg Husar, *Energy Investments and Technology Transfer Across Emerging Economies: The Case of Brazil and China* (Paris: International Energy Agency,[2013]), 11.

[4] "China Global Investment Tracker Map."http://www.heritage.org/research/projects/china-global-investment-tracker-interactive-map (accessed 4/10/2014, 2014).

[5] "The China-Brazil Center: Wind Power and Biodiesel are to be the Main Areas of Cooperation | Coppe." http://www.centrochinabrasil.coppe.ufrj.br/en/projects-and-research/the-china-brazil-center-wind-power-and-biodiesel-are-to-be-the-main-areas-of-cooperation/ (accessed 4/10/2014, 2014).

[6] Ilan E. Cuperstein, *Sino-Brazilian Technology Cooperation:The Case of the China Brazil Center of Climate Change and Energy*

information exchange through joint seminars, conferences, academic events and policy advisory meetings[7]. This partnership, provides a forum where stakeholders from premier engineering universities, private companies, government agencies, development banks and NGOs can regularly convene to discuss research, policy, technology transfer, innovation, and climate change mitigation issues within the renewable energy field[8]. Since its inception, the Center has hosted over 25 events in more than eight cities. Of most relevance are the World Bioenergy Symposium and the events organized during the United Nations Conference on Sustainable Development (Rio+20) in 2012[9]. Another noteworthy collaboration in academia is Brazil's 'Science without Borders" program which has assisted engineering student exchange between the two countries[10].

Private: The majority of knowledge sharing in wind energy for Brazil and China occur within licensing, foreign direct investment and joint design activities[11]. Five noticeable wind energy technology collaborations in the private sector have taken place between Brazil and China since 2010. For instance, New Energy and Furnas, subsidiaries of two major power producers, China Three Gorges Corporation (CTGC) and Electrobras, solidified their strategic partnership at the end of 2011.[12] This six-year partnership bolsters technology expertise exchange while jointly targeting commercial opportunities.[13] Whereas the scope of the technology cooperation between the two subsidiaries has not gone public, based on the extensive R&D expenditures of their parent companies it can be deduced that this cooperation will fully utilize the technological capacity available.[14]

Drivers of cooperation

Common goal for wind energy: The world's urgency to shift to low carbon economies leads countries like China and Brazil to pursue cooperation in energy technologies to diversify and advance their industries. China is the largest energy consumer in the world, with coal comprising almost 70 percent of its energy consumption.[15] According to 2012 numbers, Brazil is the 7th largest energy consumer in the world[16], however, unlike China, its energy consumption is more diversified. In fact, over 80 percent of Brazil's energy consumption comes from oil, other liquid fuels and hydroelectricity.[17] Yet both countries have been identified as key drivers of growth for the global wind industry, particularly as by 2018 China is expected to reach an installed capacity of 193 GW while Brazil is predicted to reach a capacity of 11GW[18]. According to a report from the International Energy Association, "[t]he global financial crisis and a reduction in investment in wind energy in the United States and Europe attracted big wind manufacturers to Brazil."[19] Moreover, Brazil offers the ideal climate conditions for China to tropicalize its wind turbines, which coupled with the prospective growth of wind installations in both countries, will serve as important drivers for cooperation in research and development (Ilan E. Cupperstein, personal communication, April 7, 2014).

Technology Innovation (Rio de Janeiro: Brazil-China Center for Climate Change and Innovative Energy Technologies,[2014]), 4.

[7] *Ibid*, 5.

[8] "Brazil-China Center | Coppe."http://www.centrochinabrasil.coppe.ufrj.br/en/conheca-centro/ (accessed 4/10/2014, 2014).

[9] Ilan E. Cuperstein, *Sino-Brazilian Technology Cooperation:The Case of the China Brazil Center of Climate Change and Energy Technology Innovation* (Rio de Janeiro: Brazil-China Center for Climate Change and Innovative Energy Technologies,[2014c]), 9.

[10] *Ibid*, 9.

[11] Joanna I. Lewis, *Building a National Wind Turbine Industry: Experience from china, India and South Korea* (Washington DC: International J. Technology and Globalization, Vol. 5, Nos. 3/4,[2011]), 2.

[12] Denis Best and Joerg Husar, *Energy Investments and Technology Transfer Across Emerging Economies: The Case of Brazil and China*, 19.

[13] *Ibid.*, 20.

[14] "EU R&D Scoreboards: 2013 EU Industrial R&D Investment Scoreboard." http://ec.europa.eu/invest-in-research/index_en.htm (accessed 4/10/2014).

[15] "China - Analysis - U.S. Energy Information Administration (EIA)."http://www.eia.gov/countries/cab.cfm?fips=CH (accessed 4/10/2014, 2014).

[16] "World Energy Statistics | World Energy Consumption & Stats."http://yearbook.enerdata.net/ (accessed 4/10/2014, 2014).

[17] "Brazil - Analysis - U.S. Energy Information Administration (EIA)."http://www.eia.gov/countries/cab.cfm?fips=br (accessed 4/10/2014, 2014).

[18] Denis Best and Joerg Husar, *Energy Investments and Technology Transfer Across Emerging Economies: The Case of Brazil and China* (Paris: International Energy Agency,[2013]).

[19] Ibid., 19

Government policies: In the 2000s, Brazil developed and implemented programs, incentives and policies to foster the growth of its renewable energy industry, including the "Program for Incentive of Alternative Electric Energy Sources (Proinfa)". Proinfa encourages businesses to invest in renewables like biomass, small hydro plants, and wind.[20] Since 2009, energy auctions have contracted about 6.7GW of installed power.[21] Towards the end of 2012, the Brazilian Development Bank (BNDES) issued a new system to eliminate the 60 percent national-content requirement and allow producers to qualify for preferential funding upon meeting three of four new criteria. These are based on the national-content of the different components of the industry[22]. China has instituted market-based pricing schemes, energy efficiency measures, and competition among energy firms, while also making greater investments in upstream hydrocarbon plays and renewable energy projects. By 2017, the government aims to cap coal use to below 65% of total primary energy consumption; by 2020, they hope to raise non-fossil fuel energy consumption to 15% of the energy mix as a function of their 12th Five-Year Plan[23]. Furthermore, the Medium-and-Long-Term National Plan for Science and Technology reinforces research and development that strives to better manage energy resources and encourages academia and industries to pursue international cooperation.[24]

Evaluation of cooperation

Institutional: The bilateral agreements signed between the two governments, CBHCC and Joint Action Plan, laid the foundation for technological cooperation in the energy sector. Increased Chinese investment in the Brazilian wind industry and other major areas of cross-border collaboration is a reflection of this improved intergovernmental dialogue.[25] Strengthened Sino-Brazilian collaboration at inter-governmental levels, however, is not reflected at their respective domestic level. BNDES's national-content funding regulation poses a threat to Chinese firms seeking to expand into the Brazilian wind market. Brazil's international collaboration and domestic industrial policies are not aligned and are contradictory to each other's objectives, hindering further collaboration with China. Investment in neighboring South American countries, such as Argentina, Chile and Venezuela, with similar natural resources but lax regulations may be more attractive for Chinese investors.[26]

Public: A long-standing bilateral relationship between the two countries contributed to the creation of the Center and established a platform for the development of technology cooperation. In particular, the government's initial brokering of collaboration between recognized educational institutions marked an important step toward fostering the renewable energy industry in both countries. In 2011, the Center signed a memorandum of understanding (MOU) to establish a wind energy specified research. Under the terms of this memorandum, China would provide the necessary equipment, while Brazil would supply the land and human capital to conduct research on improving Chinese products. Unfortunately, the joint venture did not materialize as China was unwilling to meet the national-content requirements unless Brazil guaranteed sales for the equipment produced. Although Brazil has since modified its national-content requirements to promote greater flexibility, China does not feel confident in the capabilities of this endeavor and will not commit to investing in a plant. Furthermore, although Brazil has improved its incentives infrastructure to attract and promote collaboration in renewable energies, its domestic

[20] "Programme of Incentives for Alternative Electricity Sources (PROINFA) | World Resources Projects."http://projects.wri.org/sd-pams-database/brazil/programme-incentives-alternative-electricity-sources-proinfa (accessed 4/10/2014, 2014).
[21] "Brazil Windpower 2014."http://www.brazilwindpower.org/en/about.asp (accessed 4/10/2014, 2014).
[22] Best and Husar, *Energy Investments and Technology Transfer Across Emerging Economies: The Case of Brazil and China* (Paris: International Energy Agency, 2013), 20.
[23] "China - Analysis - U.S. Energy Information Administration (EIA).", http://www.eia.gov/countries/cab.cfm?fips=CH ed., Vol. 2014, d).
[24] "Erawatch Medium- and Long-Term National Plan for Science and Technology Development 2006-2020."http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/cn/policydocument/policydoc_mig_0004 (accessed 4/10/2014, 2014).
[25] Denis Best and Joerg Husar, *Energy Investments and Technology Transfer Across Emerging Economies: The Case of Brazil and China* (Paris: International Energy Agency,[2013]).
[26] "China Global Investment Tracker Map."http://www.heritage.org/research/projects/china-global-investment-tracker-interactive-map (accessed 4/10/2014, 2014).

bureaucracy continues to stymie efficiency. For instance, operations at the Center have suffered because grant award disbursement can take years to be issued (Ilan E. Cupperstein, personal communication, April 7, 2014). This poses a serious threat to an industry in which fast-paced technological innovation is critical. Moreover, the absence of cross-patent application of wind technology between China and Brazil suggests that further policy reforms must take place to encourage greater cooperation.[27] Lastly, the Center lacks private sector involvement, which may severely constrain execution of R&D projects.

Private: Initially, wind technology was transferred to China without active local R&D support. Licensing, FDI and joint ventures were the primary means of acquiring advanced technology from early innovators, namely Denmark, the Netherlands, Germany and the United States.[28] With the rapid development of China's wind industry, outward FDI targeted acquisition of foreign companies with desired technological capacity. For example, CTGC's partial acquisition of a Portuguese renewable energy subsidiary firm equipped China with the wind technology expertise that CTGC lacked.[29] However, evidence of extant joint R&D efforts between China and Brazil's wind energy corporations is lacking. Data on wind energy firms' active technology collaboration is limited, which suggests that this is an area of further study.[30]

Lessons Learned

South-South Cooperation: There is a general positive outlook for the successful development of increased South-South cooperation. While technology cooperation between China and Brazil has been fruitful in other renewable energy sectors, according to the limited amount of data available, the wind industry has not seen the same results.

Improvement of Government Policies: Brazil's BNDES requirements, or similar government regulation curbing FDI, may have deterred China from pursuing further research and development collaboration with respect to wind energy. Moreover, China's paradoxical North-South mentality breeds reluctance to co-develop technology with Brazil.

Involvement of Private Sector: There is an over-reliance on government subsidies and incentives for R&D collaboration. It is clear that the wind industry can benefit from increased involvement of the private sector.

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[27] Cross-patent application data collected from WIPO patent database; Duan Liping, "Analysis of the Relationship between International Cooperation and Scientific Publications in Energy R&D in China," *Applied Energy* 88 (2011), 4229-4238.

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