Americans for a Clean Energy Grid

Issue Brief: China's Emerging Network of Electricity Superhighways

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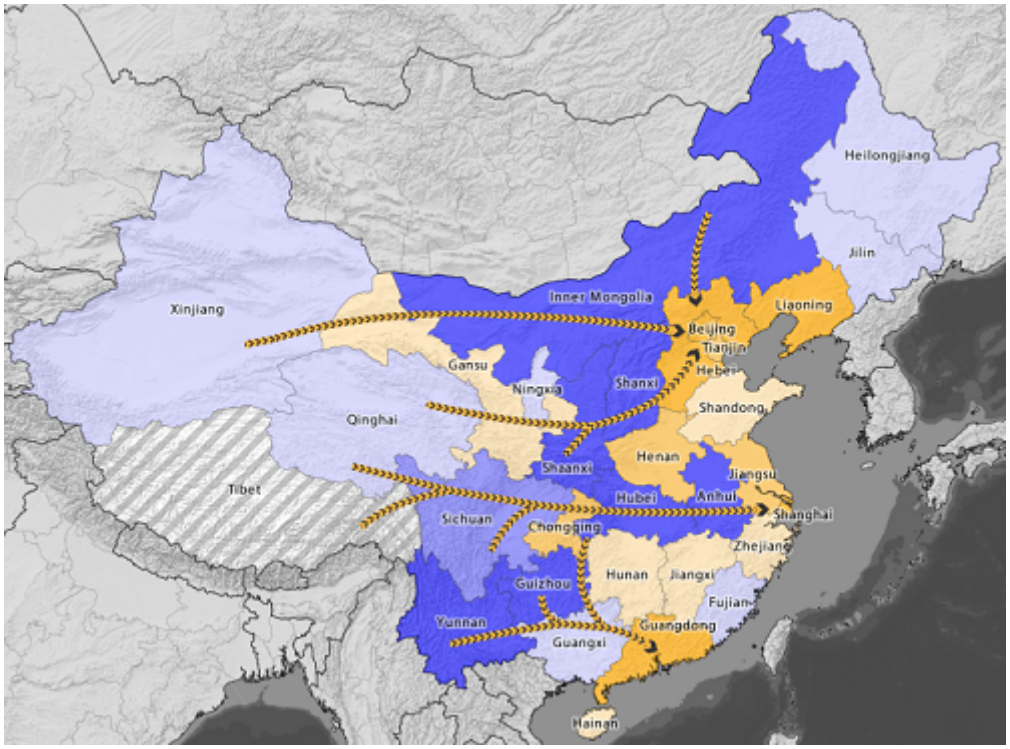

Source: The Wilson Center [i]

Having achieved middle-income status, China now is energetically tackling a host of demographic, economic development and environmental issues with an array of policy initiatives. These initiatives include significantly improving environmental protection enforcement, rightsizing its ferrous and non-ferrous metals, concrete, building materials and other carbon-intensive industries, building the world's largest and most robust renewable energy portfolio, decisively reducing and rationalizing its coal and thermal power footprint and vigorously investing in new economy industries, including electric vehicles, AI and a full complement of internet services.

Key among these various efforts is the build-out of the world's most sophisticated and extensive network of electricity superhighways. The North-South and West-East backbones of this emerging electricity transmission system are each comprised of several Ultra-High Voltage (UHV) transmission corridors. Since 2006, China has built a total of 19 UHV transmission lines at a cost of several billion USD each and an additional 10 UHV Direct Current (DC) lines and 27 UHV Alternating Current (AC) lines are either under construction or in development.[ii] At 30,000 kilometers, China's network of UHV transmission lines is by far the largest in the world; [iii] by 2020 its capacity will be the equivalent of *60 Hoover Dams*.

The driving force behind this ambitious effort to construct a network of UHV transmission lines is the reality that the sources of 21st Century power generation (particularly wind, hydro and solar power) increasingly are (or perhaps should be) located inland, while electricity demand is concentrated vast distances away in the exceedingly populous Eastern China. Presently, China's capacity to produce renewable energy exceeds one-third of total electric generating capacity (approximately 600,000 MW in total, comprised of ~300,000 MW of hydropower; ~150,000 MW of wind power and ~130,000 MW of solar power), and is growing exponentially faster that thermal power.[iv] At the same time, the seven largest consumers of power in China—including Beijing Tianjin, Zhejiang and Guangdong—together account for nearly 40% of China's total electricity consumption.[v]

An essential piece of the puzzle of China's energy transformation is the location of China's high-resource renewable energy areas: Western China. Those resources would be inaccessible to the energy hungry east coast of China but for the emerging network of electricity superhighways that China is developing. Here are just a few of the highlights of this remarkable burgeoning UHV transmission network:

- **Rapidly Growing Total Use:** China's electricity superhighway network presently supplies 4% of the nation's total power demand (at total, Chinese consumption of 6.3 trillion kWh/year, 4% equals 252 billion kWh; in 2016, UHV transmission lines supplied 172.5 billion kWh of power).[vi]

- **Hydropower from the Upper Yangtze River to Shanghai:** Until this week, the longest UHV DC line in the world, having a capacity of 6400 MW, connects the Xiangjiaba Dam on the Yangtze River (between Yunnan and Sichuan Provinces) to Shanghai, a distance of 1287 miles.[vii]

- **Massive "Exports" of Renewable Energy from Sichuan Province**: In 2017, Sichuan Province produced 321.5 billion kWh of clean energy, 139.9 billion kWh of which were exported to other regions in China, making Sichuan China's number one producer and exporter of clean energy. With a transmission capacity of 30,000 MW, the Sichuan Grid deploys eight UHV AC power lines and four UHV DC lines to interconnect with the East China, Central China, Northwest and Tibetan power grids.[viii]

- **The Central Role of the Ningxia Autonomous Region:** With 45,100 MW of installed power generating capacity, the Ningxia Autonomous Region now supplies 19 Provinces, Directly Administered Cities and Autonomous Regions in China, including Qinghai, Tibet, Shandong, Shanghai, Zhejiang, Jiangsu, Hubei and Hunan.[ix] Through a 1300 km, 660kV UHV DC transmission line that originates in Ningxia Province and terminates in Shandong Province, an average of 29 billion kWh/annum is transmitted from Ningxia.[x] In 2016, the world's highest voltage transmission line (800kV) from Eastern Ningxia to Zhejiang Province was completed and put into service, supplying an additional 8000 MW of West-East transmission capacity.[xi] Construction on an 800kV Shanghai to Shandong UHV transmission line was started in 2017 and will be completed at the end of October 2018. With these three large inter-regional DC lines, total electricity transmission capacity from Ningxia will grow to 20,000 MW, resulting in 50 billion kWh/year in electricity "exports."[xii]

- **Wind Power from Gansu Province to Tianjin City**: Recently, Gansu Province and Tianjin City reached a framework five-year agreement for Gansu Province to supply Tianjin City with 2 billion kWh/annum. Of the total electric power supplied to Tianjin City, one-third will be generated from Gansu Province's 20,680 MW of wind power capacity, the fourth largest concentration of wind power in China. The distance between Gansu Province and Tianjin is approximately 1500 km.[xiii]

- **Thermal Power from Inner Mongolia to Eastern China:** A 2013-2020 UHV Transmission Lines Construction Plan calls for the construction of 11 UHV transmission lines by 2020 to serve all of Inner Mongolia's coal fired and renewable energy power plants.[xiv]

- **World's Longest and Most Advanced UHV Transmission Line:** As of October 3, 2018, the world's longest (3304.7 km), highest voltage (1100 kV) and most technologically sophisticated UHV transmission line began transmitting electricity.[xv] The Changii, Xinjiang Province to Guquanzhen, Anhui Province UHV transmission line, which represented an investment of 40.7 billion RMB (~$6 billion USD), originates in Xinjiang Province, stretches through Gansu, Ningxia, Shaanxi and Henan Provinces and terminates in Anhui Province. The Changji---Guquan 1100 kV UHV transmission line has a designed capacity of 12,000 MW. When fully operational it will be transmitting 66 billion kWh/year from power sources in Western China to Eastern China.[xvi]

To be sure, China is still in the early stages of the energy transition, which will be essential to its next stage of economic development. China still accounts for some 45% of all coal consumed worldwide and of the energy mix in China presently, fully 60% continues to be derived from thermal power.[xvii] Yet, the early shoots of this energy transformation are emerging. As the pieces of this puzzle are assembled, we soon will see more clearly the extent of the energy transition that China is undergoing and the essential role of a robust grid delivering renewable energy from the west and north to the east and south, in forming China's 21st Century energy infrastructure.

About the Author

A lawyer and China specialist fluent in Mandarin Chinese, Lou Schwartz is president of China Strategies LLC. Through China Strategies, Lou provides for-profit, not-for-profit, and government clients research and analysis, due diligence, merger and acquisition, public and private equity investment and other support on a wide range of matters involving China's legal system, economic development and trade and investment, with a particular emphasis on China's energy transformation and its efforts to address climate change. In 2009, Lou was asked to serve on the Strategic Advisory Board of ACORE'S China Programs. For many years Lou taught classes at the University of Pittsburgh School of Law and its College of Arts and Sciences, as well as Carnegie Mellon University on law and development in China. Lou has lectured widely and been published extensively in both English and Chinese on China's energy sector. Lou earned his B.A. and Masters in East Asian Studies from the University of Michigan and Harvard University, where he studied Chinese language and literature, economics and law, among other disciplines. Lou also has a J.D. from George Washington University Law School.

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