Enabling China's Clean Energy Drive

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China's energy sector is undergoing a radical transformation driven by policies engendered by the country's 13th Five-Year Plan (2016-2020). Already a long-time leader in renewable energy installations, China is now accelerating its shift to more efficient and less polluting power technologies, such as nuclear and cleaner coal. This domestic transition is also underway with a view to export markets for energy technology, as China aims to stamp its authority on the global energy sector. It also plays out in the context of rapid economic growth and increasing energy demand of around 7 percent per year.

China's Energy Transformation

The air pollution seen in major cities, such as Beijing, has prompted the Chinese government to take aggressive steps to clean up its energy sector with a push for lower-carbon technologies.

China has a stated target of meeting 15 percent of primary energy demand with renewables by 2020 and 20 percent by 2030 with both medium and long-term plans to increase renewables' contribution to the national energy mix. The latest five-year plan includes specific measures to optimize the development of wind energy and photovoltaic energy in northern regions and coastal areas, as well as to accelerate the development of solar and wind power in the central, eastern, and southern regions.

Encouraged by this overarching policy, renewable installations have boomed; by 2020, total wind generation capacity is expected to top 200-gigawatts and total solar generation is predicted to reach more than 100-gigawatts.

The 13th Plan also states that China will begin construction of 60-gigawatts of hydropower capacity, giving priority to hydro development in the southwest while coordinating the development of end-use markets and power transmission routes. In addition, the country aims to reach 40 gigawatts of total pumped storage capacity by 2020, according to the International Hydropower Association (IHA).

Drive for Efficiency, Reliability, and Stability

Giant hydro projects like the more than 22-gigawatt Three Gorges and the near 14-gigawatt Xiluodu are relatively well known even outside of China, but to deliver the federal mandate many other significant hydro projects are currently being built.

China's hydro development has been typically characterized by very large-scale projects. In August 2017, for example, China Three Gorges Corporation (CTGC) began construction of the USD 6.3 billion, 16-gigawatt Baihetan hydropower station located on the lower reaches of the Jinsha River, between the borders of Sichuan and Yunnan provinces in southwest China. Now, projects are also increasingly being focused on expanding China's clean energy capacity by enabling other types of low-emission energy production. One key technology that can support variable output renewables like wind and solar is pumped storage hydropower. Pumped storage forms a major plank of China's future energy complex.

Demands for Efficient Design

Large infrastructure projects and the growing complexity of modern, more distributed, and variable energy networks are placing increasing demands on the designers and developers of energy infrastructure. Building information modeling (BIM) is a relatively new concept to the energy industry that can make a dramatic impact on such developments. BIM is an intelligent model-based process that integrates all relevant information required for planning, design, construction, and operation.

Efficiency is the most important aspect in the industry, with power producers looking for ways to cut costs. Using a BIM approach will cut down capital costs as well as reduce design and construction time, helping power producers meet their goals.

BIM is being applied in Chinese pumped storage projects, for example. HydroChina Zhongnan Engineering Corporation used BIM applications from Bentley Systems, Inc. to develop a standardized design and approach for pumped storage power stations to speed up the design process and meet the demand for large-scale power station construction in China. The standardized design will also provide a basis for planning, cost control, capital management, and centralized bid invitations.

The team addressed all aspects of a pumped storage power station, including the dam, plant, water channel, hydro generator, building, and substation, moving from one-off designs to repeatable schemes for power generation capacities of 4x300 megawatts and 6x300 megawatts by utilizing Bentley's 3D design applications.

While major engineering projects like large hydropower installations can benefit from BIM, more distributed renewable energy generation projects can also take advantage of BIM applications. For instance, wind farms involve turbines, towers and their bases, as well as roads, cabling, and substation elements.

The 80-megawatt Macheng Caijiazhai Wind Farm, designed by the Hubei Electric Power Survey and Design Institute, is one example of a power station that benefitted from BIM solutions. Located on the challenging terrain of ridges and mountain tops near Futianhe Town and Macheng City, an unmanned aerial vehicle (UAV) was used to obtain data and images to build a landform 3D engineering-ready model. This model was then combined with metrological data and analysis results to select appropriate turbine locations. BIM and Bentley applications were also used for collaboration among all the disciplines and to manage input and output materials, design documents, and procurement and project management materials, saving 50 resource days in design and reducing the construction period by 20 days.

Beyond Renewables

Alongside renewables, China is also looking to build more efficient thermal plants, such as coal-fired capacity, rapidly expanding its nuclear generation fleet.

Currently, mainland China has 37 nuclear power reactors in operation and approximately 20 already under construction, with more due to start development. This is part of China's plan to increase nuclear capacity by about 70 percent to reach about 58 gigawatts by 2020. According to the World Nuclear Association, plans are in place for China to reach 150 gigawatts of nuclear capacity by 2030, noting that over the course of the 13th Five-Year Plan, six to eight nuclear reactors are expected to be approved each year.

And, although increasing power demand will see far more thermal capacity built in China over the coming decade, efficiency and specific outputs are improving through the deployment of combined heat and power (CHP) and technologies such as supercritical and ultra-supercritical steam condition power plants. While modern thermal plants are incredibly efficient, combined heat and power applications are the most energy efficient and there is a real effort to boost the use of CHP energy technologies.

This type of development can also benefit from BIM. For instance, the biomass CHP project in Lishui City, Qingyuan County used applications from Bentley to fully describe the characteristics of various systems, equipment, components, and structures during the design, construction, and operation phases. This reduced the design time by approximately 20 percent, according to its developers.

Exporting Expertise

The vast geographical span of China has also prompted development of a more efficient energy transmission system. High levels of curtailment in response to a lack of export capacity is preventing the most effective use of renewable energy assets as China expands its domestic energy production and looks to shift power from renewable energy resource-rich regions in the west of the country to demand centers in the east.

With the national grid largely run by the State Grid Corporation of China, the country is building expertise in ultra-high voltage DC transmission systems of 800-kilovolts and up. New UHVDC projects are already under development while the current five-year plan envisages an investment of some USD 350 billion on grids. By 2020, the capacity of the ultra-high voltage network is expected to be of the order of 300 gigawatts.

Even while China is still developing bigger and more efficient plants and the high voltage DC transmission to push that power east, they are also focused on taking that technology and exporting it.

Already building a UHVDC line in Brazil, this move to develop export capabilities is also expanding into other areas of power technology. For example, China has developed the Westinghouse AP1000 nuclear reactor design to produce the larger CAP1400 reactor and is looking to export to markets in Turkey and South Africa among others. Similarly, large scale hydropower developments in Africa, South America, and Asia are being backed by cutting-edge technology as well as finance.

Outlook for BIM

The future for power technology is increasingly digital in nature, which is a point noted by a growing number of industry observers.

"Power systems continue to evolve at a great rate," said Russell Ray, editor of Power Engineering magazine. "Building information modeling will be invaluable to power producers in the future; we are turning to many more sources of distributed generation such as reciprocating engines, roof-top solar, and combined heat and power. They are much more complex than yesterday's technology. I think BIM is going to be part of the fabric of the power industry."

Certainly, power is an essential component of our lives and BIM is helping to weave that much-needed energy into our changing world. Faced with the challenges of such an ambitious energy strategy, China has turned to advanced technologies like BIM to deliver on its promise. Increasing complexity means it is no longer enough to use a traditional approach to energy development projects, even in the large-scale markets seen in China. By embracing new capabilities and techniques to become far more sophisticated in its approach, China is rapidly adopting an asset performance-focused design process right across the energy sector value chain. This forward-thinking philosophy is not only supporting the realization of its domestic energy goals, but it is also helping China to build on its export economy plans and lead the world in global energy development.