5. China: Emerging Global Power in Clean Energy?

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China's electricity supply is still strongly dependent on coal, but a strong domestic renewable energy industry is driving rapid deployment of wind and solar energy. Further progress will depend on the implementation of planned power sector reforms. In transport, the continued proliferation of automobiles is driving growth in CO_2 emissions. Investments in an electric vehicle industry may offer opportunities for decarbonisation in the long term. China's initiative to promote green finance during its G20 presidency is in line with its ambitions to promote overseas markets for its emerging clean energy industry.

Whether the international community is able to live up to the ambitious climate targets agreed in Paris will to a significant degree be decided in China. For the past decade, China has been the largest global emitter of greenhouse gases and now accounts for approximately 30 percent of global emissions. This is twice the share of the US, the second-largest emitter. At the same time, China has become a central driver of global renewable energy development. In 2015, it accounted for approximately one third of global installed capacity in both wind energy and solar photovoltaics and more than one third of new investment in the renewable energy sector (see Figure 1). Similarly, China is an international frontrunner in electric vehicles, albeit based on an electricity mix that remains dominated by coal-based power generation.

Impressive growth of renewable energy versus continued reliance on coal

The development of China's wind and solar energy over the past decade has been impressive, growing from slightly more than 1 GW in 2005 to a total of 200 GW in 2015. In the field of solar water heating, China's 341 GW of installed capacity accounts for 71 percent of the global market. With a total of 296 GW of installed capacity, the largest share of China's renewable energy is generated by hydroelectric dams, representing almost 28 percent of global hydropower capacity (REN 21, 2006/2016). Since 2010, investments in renewable energy capacity have begun to outpace additions in fossil and nuclear energy and now represent approximately 60 percent of newly installed capacity (Mathews & Tan, 2015). In 2014, renewables, including hydropower, represented 23 percent of the country's electricity generation (IEA, 2015a) and approximately 11 percent of final energy (REN 21, 2016). Despite their strong growth, wind and solar power only account for less than three percent of total electricity generation (IEA, 2015b).

The remainder of China's electricity system remains dominated by coal. Coal-fired power generation represents three quarters of annual power generation and 80 percent of energy-related CO_2 emissions. To date, nuclear energy (2%) and natural gas (1.8%) only represent minor shares in China's electricity mix (IEA, 2015a,b).

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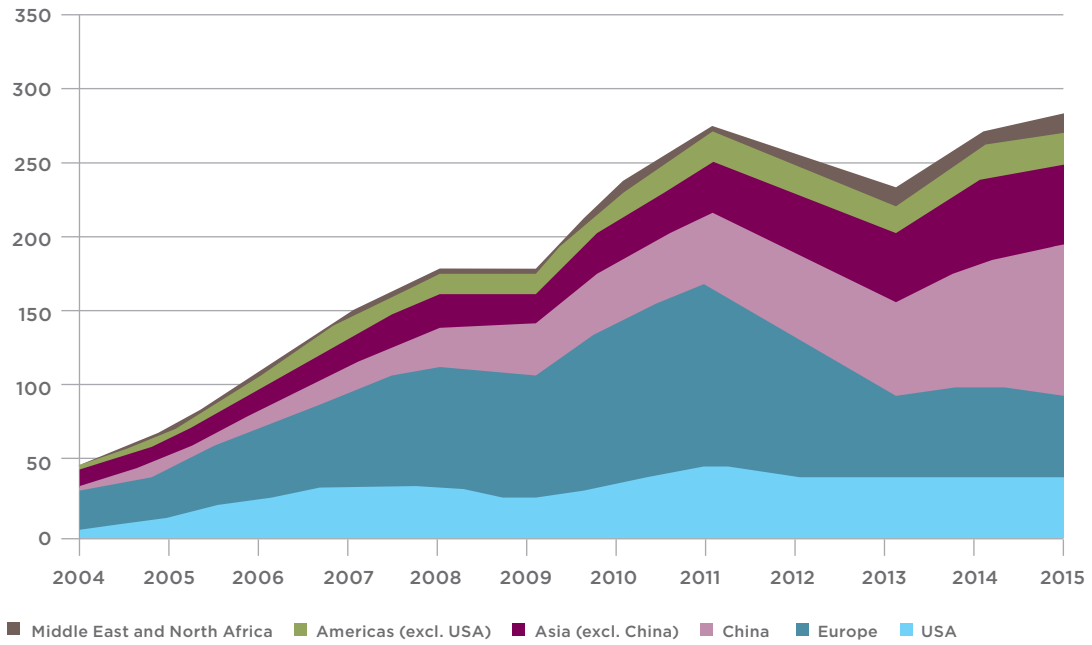
Figure 1: China takes over global leadership in renewable energy investment from Europe

[billion US Dollars]



Source: Author's graph based on FS-UNEP (2016)

Strong policy support for energy efficiency drives decrease in energy intensity

In the past decade, China has seen significant improvements in the energy intensity of its economy. Over the period 2004–2013, China increased its end-use energy productivity (gross domestic product/total final energy consumption) by 29 percent (IEA, 2015c). This is largely due to a strong policy framework aimed at boosting energy efficiency in industry, which accounted for almost half of final energy use in 2012 (IEA, 2014). The Ten Key Projects and Top 10 000 Enterprises programmes have introduced measures to boost energy efficiency in industrial processes and mandated the retirement of inefficient production facilities (NDRC, 2014). Total funds invested in energy efficiency under the 11th Five-Year Plan amounted to an estimated USD 120 billion (Qi, 2013).

Despite these efforts, China's energy consumption per unit of GDP remains significantly above the world and OECD averages.[2] This is partly related to heavy reliance on energy-intensive industries such as aluminium, steel and cement, where China accounts for 46 percent, 50 percent and 60 percent of global production, respectively. Similarly, the carbon intensity of China's economy remains significantly above world averages (Mathews & Tan, 2015).

Key targets and projected trends in China's energy mix

Key targets for the future development of China's energy sector have been set in the Energy Development Strategic Action Plan for the years 2014 to 2020. It foresees a share of 15 percent non-fossil energy (including nuclear and renewables) in the primary energy mix by 2020. To achieve this, a cumulative

[2] According to the World Bank's Development Indicators, energy intensity (expressed in MJ per unit of GDP, adjusted for purchasing power parity) was at eight in China in 2012, compared with OECD and global averages of five and six respectively.

installed renewable energy capacity of 650 GW and 58 GW of nuclear energy are planned. This is complemented by the commitment made in the joint US–China announcement on climate change to reach a share of 20 percent of non-fossil energy in primary energy consumption by 2030. These reductions in the share of fossil energy will accompany a continued increase in energy consumption, which the plan aims to constrain to 3.5 percent annually until 2020 (compared to an average of more than 5% over the past decade). This implies that total fossil energy consumption is expected to rise in the medium term (BP, 2016).

Simultaneously, China aims to limit the share of coal to less than 62 percent of primary energy demand by 2020. Even if the renewables targets are met, this implies a shift within the mix of fossil-based energy use, to increased shares of gas and oil. The share of natural gas in the energy mix has been targeted to double, from five percent in 2013 to 10 percent in 2020 (IEA, 2015d). The use of oil and related emissions is expected to increase significantly due to the projected quadrupling of car ownership by 2030. Energy-related emissions in the industrial sector, on the other hand, are expected to decline as a result of a structural shift away from heavy industry. Total CO_2 emissions are intended to peak no later than 2030.

Growing role of the transport and residential sectors

In 2012, China's transport sector still only accounted for 14 percent of total final energy consumption and six percent of CO_2 emissions, compared to global shares of 27 percent and 14 percent respectively (IEA, 2016b; IPCC, 2014). In the past decade, however, emissions have increased sharply, and, due to the rapid adoption of passenger vehicles, are expected to see further growth in the future. In 2010, China became the world's largest market for automobiles. Despite significant investments in public transport infrastructure, the market is expected to continue to grow at five percent annually in the coming years, with particularly strong growth in larger vehicles. These changes in purchasing behaviour may neutralise efficiency gains from the recent implementation of more stringent fuel economy standards. If accompanied by strong emission reductions in the power sector, the electrification of the transport sector may offer a pathway to decarbonisation in the long term. Strong policy support in this field, including subsidies of up to USD 10 000 for the purchase of electric cars, has recently made China the world's largest market for electric vehicles (IEA, 2016a).

In the residential sector, energy use grew by 35 percent over the period 2002 to 2012 (IEA, 2015c). In 2012, it accounted for 22 percent of total final energy consumption, thus equalling the global average (IEA, 2014/2016b). Floor space per capita is expected to increase by 40 percent by 2030, which implies continued growth in energy consumption for heating and cooling (Grubb et al., 2015).

Industrial ambitions drive the expansion of renewables and nuclear

With the joint US–China announcement on climate change ahead of COP21 in Paris and the recent ratification of the Paris Agreement, China has clearly signalled its ambition to act as a leader in the global fight against climate change. Concerns about urban air pollution and energy security act as additional motivations for the expansion of non-fossil energy. Arguably the most powerful driver, however, is China's industrial ambition in the sector.

To meet its renewable energy targets for 2020, solar power will have to more than double to 100 GW, while wind power is expected to grow by more than 50 GW to reach 200 GW total capacity. Underpinning these ambitious targets is a strong renewable energy industry, identified as a strategic emerging industry in China's 12th Five-Year Plan (2011–2015). The growth of its renewable energy industry has also spurred significant job creation in China. The renewable energy sector now provides 3.5 million jobs in the country, representing more than 40 percent of the global total. Building an internationally competitive renewables industry has been particularly successful in the solar PV sector, where Chinese suppliers of solar cells and modules have dominated production since approximately 2009. Chinese producers now account for approximately two thirds of total production and approximately three quarters of global exports. While China is also the largest global producer of wind turbines, its wind energy firms remain strongly dependent on sales in the domestic market (REN21, 2016; UNEP, 2014).

The continued expansion of nuclear power is also underpinned by industrial policy ambitions. Despite the more stringent safety requirements introduced after the nuclear disaster in Fukushima, installed capacity is projected to grow to more than 100 GW by 2030 (IEA, 2015d). Twenty nuclear reactors are currently under construction (The Economist, 2016). The resulting expertise in the design, construction and operation of nuclear reactors will support Chinese export ambitions in the sector.

Power sector reforms as critical precondition for continued renewable energy deployment

Although the shares of wind and solar energy in the Chinese electricity mix remain modest, the country is experiencing significant challenges with its efficient integration into the power system. This is reflected in the significant curtailment of renewable power, in particular wind energy. According to the Chinese Renewable Energy Industries Association, curtailment of wind power reached a record high of 15 percent in 2015. This has significant economic consequences for wind farm operators, who lost an estimated 18 billion yuan (USD 2.8 billion) as a result (Ying, 2016). Tackling these challenges of system integration will be critical to increasing the share of renewable energy in China's electricity mix going forward.

The causes of wind power curtailment are manifold. The mismatch between the location of China's major wind power capacities in the north and northwest, and major load centres along the coast represent a major challenge (IEA, 2015a). A further challenge relates to the fact that grid expansion frequently lags behind the installation of wind turbines (Luo et al., 2016). These technical challenges are further compounded by a variety of political and institutional barriers to increased renewables integration. Most importantly, grid companies still lack incentives to reduce curtailment as they do not participate in the related costs, and the existing pricing system does not incentivise flexibility among fossil-based generators.

In principle, a number of power sector reforms to tackle these issues were already introduced with the Program of Electricity System Reform announced by the State Council in 2002. However, the implementation of the reform package has not been enforced to date. Renewed reform efforts signal that important improvements can be expected in the near future. In March 2015, the policy document Deepening Reform of the Power Sector, also known as Document #9, was issued jointly by the State Council and the Central Committee of the Communist Party. This high-level policy document calls for "effective, market-based pricing for electricity" and states that power sector policy should, among other things, be guided by "energy savings, emissions reductions, and increased use of renewable and distributed generation" (Dupuy et al., 2015).

Tackling the political economy of coal

Despite important progress in promoting renewables, experts are concerned that economic interests at the local and provincial levels may continue to favour coal-based generation, a concern that extends beyond the management of power system integration. A report by Greenpeace, first published in 2015, has drawn attention to the fact that the current market environment in China has given rise to a so-called "coal power bubble" (Myllyvirta et al., 2016). The slowdown in economic growth, coupled with simultaneous structural shifts away from heavy industry, has led to a significant slowdown in the growth of coal consumption. Following a significant slowdown in 2012 and 2013, growth rates even turned negative in 2014 and 2015 (Yeo, 2016). Nevertheless, coal-fired capacity grew by 190 GW between 2011 and 2015. An additional surge in positive permitting decisions during the first half of 2015 is attributed to a transfer of additional decision-making power from the central to the provincial level.

The central government is now stepping in to slow the development of further capacity. In March 2016, Chinese media reported that the government had ordered a halt on construction of 250 new coal-fired power plants (Johnson, 2016). This complements previous measures to shut down smaller, less efficient plants and replace them with larger, higher-efficiency power plants. In Beijing and other major cities, concerns about air pollution have driven the replacement of coal-fired power plants with new gas-powered electricity generation.

Increased international engagement in the global energy sector

The priorities of China's energy transition targets go hand in hand with an evolving international energy policy agenda. The expansion of gas-fired power in the Chinese electricity mix, in particular, is heavily dependent on the ability to secure a reliable supply of natural gas resources. While previously the development of domestic shale gas resources seemed likely, the outlook is now significantly lower, due to a combination of local challenges and low global gas prices. Hence, China's efforts to diversify its supply of foreign natural gas are being pursued with renewed vigour. This includes the further development of liquefied natural gas (LNG) terminals as well as a number of pipeline projects, including the so-called Power of Siberia pipeline project and the Central Asia–China pipeline (Clemente, 2016). Concerns regarding security of supply have also spurred cooperation among ASEAN countries in moving forward the Trans-ASEAN Gas Pipeline project, aimed at integrating regional gas markets.

China's engagement in the international natural gas sector is in line with its efforts to increase its engagement in global energy markets. In the past, this has been primarily driven by a concern that Chinese energy security is heavily dependent on Western energy firms, and on the US military as the main guarantor of supply security in the Middle East. Among other things, this has given rise to engagements aimed at securing oil supplies from a number of African countries. With the rise of renewable energy, China has also developed significant economic interests in the continued growth of overseas markets for its renewable energy industry.

The global expansion of Chinese energy companies is being backed by China's growing financial power, which has further increased in the wake of the global financial crisis. According to Kong and Gallagher (2013), cumulative energy-related foreign direct investment for the period 2000 to 2015 was USD 258 billion, of which more than USD two hundred billion was invested after 2008. The vast majority of this is financed by China's so-called policy banks (i.e. Export and Import Bank of China and China Development Bank).

To date, more than 90 percent of Chinese foreign direct investment has flowed into the oil and gas sector and fossil-based power generation. However, this picture may be beginning to change. A review of Chinese overseas investments in the wind and solar energy sectors shows a sharp increase since 2007; Investments grew from under USD five billion to almost USD 32 billion in 2012 (Tan et al., 2013). In Africa, Chinese contractors, mainly state-owned enterprises, constructed approximately 30 percent of African capacity additions in the electricity sector, with a particular focus on hydropower (IEA, 2016c).

Financing of clean energy has also featured in a number of multilateral initiatives led by China. In the G20, China has spearheaded the working group on green finance, and the Shanghai-based New Development Bank recently announced its first loan package, totalling USD 811 million in renewable energy projects. The China-led Asian Infrastructure Investment Bank has the stated aim to be "lean, clean and green". Despite this commitment, observers have voiced concerns that energy-related financing in countries like Indonesia may ultimately support the country's planned additions in coal-based power generation (Nassiry & Nakhooda, 2016).

China's growth in nuclear power, coupled with its financial strength, is also likely to support an increasing role in the construction of nuclear reactors around the world. While the long-term goal is to export home-grown nuclear technologies, China is building on its expertise in the deployment of established foreign reactor designs to penetrate the market, primarily in emerging economies (Wübbeke & Ting, 2016). If realised, a joint venture with French EDF for the construction of the Hinkley Point C nuclear reactor in the UK would represent the first project in an OECD country.

Finally, China's increased engagement in global energy issues is accompanied by its progressive integration into the existing architecture of global energy governance as well as increased bilateral cooperation. Increased multi-lateral cooperation in energy is a declared goal of the 12th Five-Year Energy Sector Plan, and China is now a member or has established collaborative relationships with all major multi-lateral organisations in the energy sector. Among other

activities, China engages in institutionalised bilateral exchange with a focus on renewable energy and energy efficiency, with Germany, Denmark and the US (IEA, 2016d).

China as a partner for a global energy transition

The development of China's renewable energy industry since the turn of the century has strongly enhanced its commitment to the domestic deployment of renewable energy. As China increases its active involvement in global energy concerns, it will use its growing influence to promote renewable energy investments as a part of an ambitious industrial policy agenda. This can be an important driver for opening new markets for renewable energy in developing and emerging economies. Increased collaboration between China and traditional donor countries, on financing renewable energy infrastructure, can provide additional impetus for boosting renewable energies along with access to modern energy services. The related initiatives on green finance and energy access in Africa and the Asia-Pacific region within the G20 offer a suitable starting point for this. Additionally, such enhanced collaboration could help promote the decarbonisation of overseas investments by both OECD and emerging economies.

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