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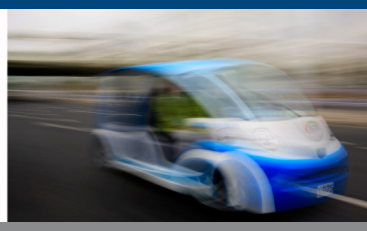

Briefing Paper 7

China's economic and energy transition:
Trends and implications for climate change

August 2016

Executive Summary

This paper explains the key dimensions and implications of the economic and energy system transformations currently occurring in China, away from an old development model focused on energy and coal-intensive heavy industrial development, towards a new model in which economic development is characterised by a greater share of services and high-technology manufacturing, and in which energy is supplied by a rising share of zero-emissions energy sources.

Key findings:

- The structure of the Chinese economy is changing in ways that are slowing the growth in gross domestic product (GDP) and accelerating the decline in the amount of energy required to produce a unit of GDP. This has resulted in a dramatic slowdown in China's energy consumption growth in recent years.
- At the same time the transformation in China's energy mix away from coal has accelerated due to supportive policies and investments in renewable and nuclear energy combined with direct regulatory controls on coal production and consumption, motivated by strategic industrial development objectives and concerns about energy security, air pollution and climate change.
- The combined result has been an historic decline in coal consumption since 2013-2014 and a plateauing of Chinese carbon dioxide emissions—a necessary condition for the decarbonisation of the global economy consistent with global climate change objectives.
- China now has an outstanding opportunity to decarbonise (strongly reduce its emissions in absolute terms) while growing its prosperity. However, institutional, administrative and political challenges and risks stand in the way of such a 'deep decarbonisation' scenario in China. International cooperation can help to manage those risks, while drawing on China's strengths to accelerate global emissions reduction efforts.

Introduction

A companion Melbourne Sustainable Society Institute (MSSI) briefing paper highlighted changes in the model of development favoured by China's national leaders from an 'industrial' civilisation model, which predominated from 1978 to roughly 2011, to an 'ecological' civilisation model that has commenced in 2016 with the recent promulgation of China's 13th Five-Year Plan for economic development (the interim five years being a transitional period in terms of the dominant developmental concept).[1] That briefing paper explains in detail the kinds of policies that the current Chinese government has instituted in these last five or so years, especially in the energy and transport sectors.

The present briefing paper complements that analysis by highlighting the economic dimension of China's ongoing transition away from the old industrial model of growth. Following some brief historical context, this briefing paper shows how developments on the demand side and the supply side of Chinese economic activity, particularly in sectors that use and supply energy, have combined to stem China's previous rapid growth in energy use, coal consumption, and carbon dioxide emissions.

This means China's next decade or so will likely be characterised by, at worst, only moderately increasing carbon dioxide emissions—paving the way for these to decline in absolute terms in the near future. This alone is a welcome change of trajectory. But the economic transformation has also unleashed forces that could complicate aspirations for the rapid decarbonisation of China's economy. These and other risks and opportunities associated with China's changing economy and energy system, and their implications for international climate and economic policy, will also be discussed.

China's changing economy: recent historical context

China's economic growth model has begun to change substantially in recent years. The growth model that predominated in China from the beginning of the reform era in the late 1970s through the first decade of this century was characterised by rapid 'catch-up' growth in GDP, frequently registering double-digit rates, very high savings and investment rates, exceptionally low proportions of expenditure on domestic consumption, high profit shares of income and a strong export orientation.[2]

In the period 2000-2013 China also made immense investments in heavy manufacturing industries such as steel, cement and aluminium production—which consume large amounts of electricity and direct fossil fuel inputs—and in the expansion of coal-fired power generation to supply electricity to those industries.[3]

This model of growth brought with it benefits such as job creation and poverty reduction. However, there is now widespread recognition within China that this model is neither sustainable nor desirable. The environmental, natural resource and public health implications of this resource-intensive growth model have been widely discussed elsewhere[4] and summarised in the companion briefing paper by MSSI's Parr and Henry.

The adverse economic and financial legacies of this growth model have, however, typically been less well understood in the climate change community. In response to the global financial crisis of 2007–2008, which caused a dramatic downturn in Chinese exports, Chinese state-owned banks engaged in a major expansion of credit that resulted in large amounts of bank debt being accumulated by local governments and commercial (especially state-owned) enterprises to finance investment, especially in property construction and infrastructure. This in turn stimulated demand for yet more energy-intensive basic materials like steel and cement, accelerating the expansion in these sectors that had been occurring in the preceding years.[5] Total debt in the Chinese economy quadrupled from an estimated US$7 trillion in 2007 to $28 trillion by mid-2014.[6]

As demand in many parts of China's construction and heavy-industrial sectors passes saturation points, continued political-economic incentives to invest in these areas have caused a range of economic and financial challenges. Much of the stimulus-induced investment was not allocated to profitable projects, causing widespread excess capacity in construction and heavy industry, diminishing returns on capital, weakening industrial competitiveness and productivity growth, and saddling Chinese banks with large and rising portfolios of non-performing loans.[7] Deeper problems with credit

quality are being revealed as the economy slows.[8] These vulnerabilities in China's financial sector have, according to the International Monetary Fund, 'reached the point that addressing them is an urgent priority' lest they threaten China's long-term growth and development.[9]

These adverse impacts from the resource-intensive 'industrial' phase of China's recent development have occurred against a backdrop of long-term changes in China's labour market. As China's working-age population begins to decline and the large pools of 'surplus' labour migrating from the countryside to urban areas begin to dry up, upward pressure on wages is signalling the end of China's comparative advantage in low-wage, export-oriented manufacturing.[10] Additionally, China has faced a difficult external economic environment since the global financial crisis due to weaker growth in Europe, the United States and elsewhere. A growing political backlash in those regions against more liberal international trade, from which China's export-oriented economy benefitted greatly in the 2000s, will put further pressure on China to turn toward local demand as a future driver of growth.

In short, the main drivers of China's old growth model —cheap labour and low value-added exports, and capital investment focused on construction, infrastructure and heavy industry—are slowing or, in some sectors, going into reverse.

These changes in economic activity have been met with the articulation and, increasingly, implementation of a new economic strategy by China's current generation of leaders.[11] Together, the changes in activity and strategy add up to a new model of growth.[12] This 'new normal' is understood in Chinese policymaking circles as involving a shift towards economic growth of a higher quality but lower rate, with a particular emphasis on four sub-themes: *services, innovation, reduced inequality and environmental sustainability*.[13] These themes feature strongly in China's 13th Five-Year Plan, released in March 2016.[14]

This combination of changes in economic activity and economic strategy/policy are now playing out on both the demand side and supply side of China's economy in ways that have major implications for energy and climate change.

The evolution of China's energy demand

Consider first the nature, scale and pace of change in China's wider economy and its implications for energy demand. These changes can be gleaned from an analysis of recent Chinese economic data and associated dynamics from the period 2014-2015 and the first half of 2016, especially when these data are compared with data from the heavy industry growth phase of around 2000 to 2013. Three trends are especially important.

First, the pace of Chinese GDP growth is slowing for structural reasons. The data in Figure 1 show GDP growth falling from an average of 10.5% per annum over the period 2000-2010 to below 7% in 2015.[15] Growth has fallen further in the first half of 2016, with official statistics recording growth of 6.7% year on year.[16]

China's falling GDP growth rate is explained in part by changes in the composition of economic activity in China as the economy moves gradually away from growth based on construction and heavy industry and toward services and high-tech manufacturing.[17] This change in economic structure helps to explain why the annual decline in the energy intensity of China's GDP (the amount of energy inputs required to produce a dollar of economic output) has accelerated over the past two years at the same time as GDP growth has slowed (Figure 2). Under the old growth model, industry—a very large consumer of energy—expanded rapidly, ultimately accounting for 44% of GDP in 2013, an exceptionally high level compared with countries at similar levels of development.[18] As the share of industry in an economy declines relative to the household, commercial and transport sectors, the energy requirement of economic activity tends to fall.[19] This appears to be what is now happening in China, and this in turn is putting downward pressure on the energy intensity of China's GDP.[20]

These structural changes affecting the composition of GDP have occurred on top of an ongoing trend of energy efficiency improvement *within* industries. Together, the changing composition of China's economic activity (across industries) and the increasing energy efficiency (within industries) account for the recent acceleration in the decline in the energy intensity of China's GDP depicted in Figure 2.

Figure 1: Chinese GDP growth rates, 2000–2015

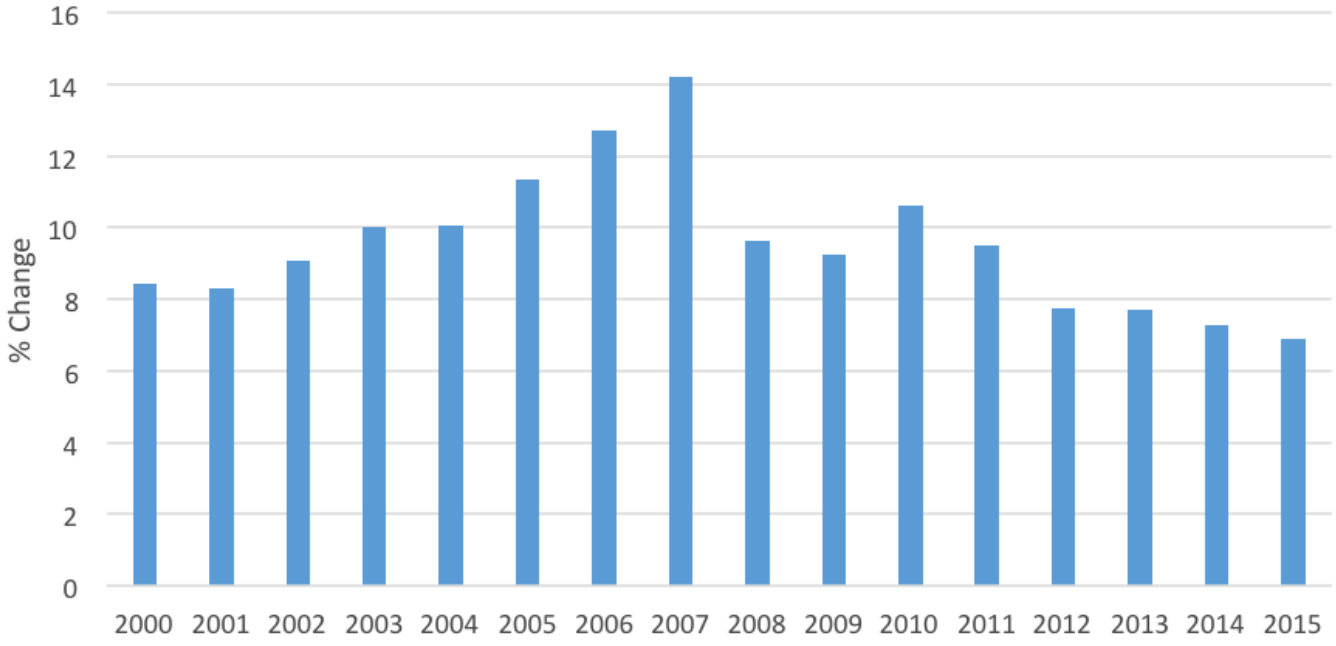

Image source: Fergus Green and Nicholas Stern, 'Managing economic change and mitigating climate change: China's strategies, policies and trends', in Ross Garnaut, Ligang Song, Cai Fang and Lauren Johnston (eds), China's new sources of economic growth: Reform, resources and climate change (2016b, ANU Press) ch 18, Fig. 18.1. Original data sources: NBS 2016a and World Bank, GDP growth (annual %), 2016, data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

Figure 2: Growth rates in the energy intensity of China's GDP, 2006-2015

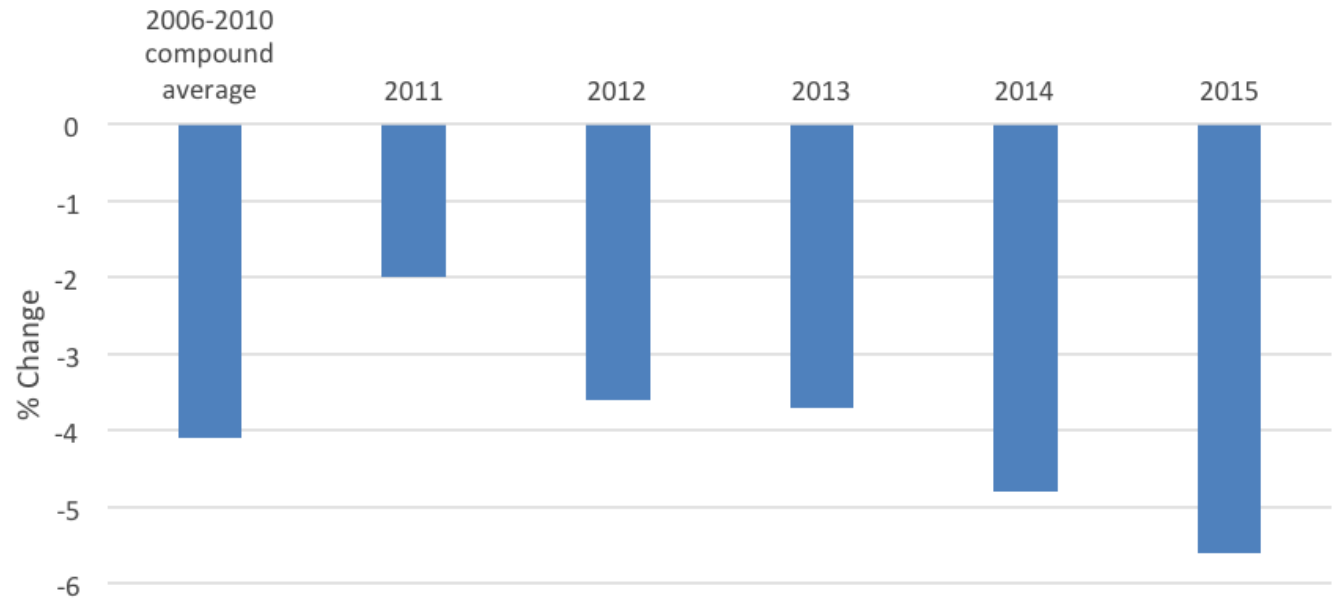

Image source: Green and Stern 2016b, Fig. 18.2. Original data sources: data for 2011-2015 from NBS 2016a; the 2006-2010 compound average figure was computed from the aggregate 19.1% reduction reported for the period of the 11th Five-Year Plan: see, e.g., Joanna Lewis, 'Energy and climate goals of China's 12th Five-Year Plan', 2011, Pew Centre on Global Climate Change, c2es.org/docUploads/energy-climate-goals-china-twelfth-five-year-plan.pdf.

Figure 3: Chinese primary energy consumption growth rates, 2000-2015

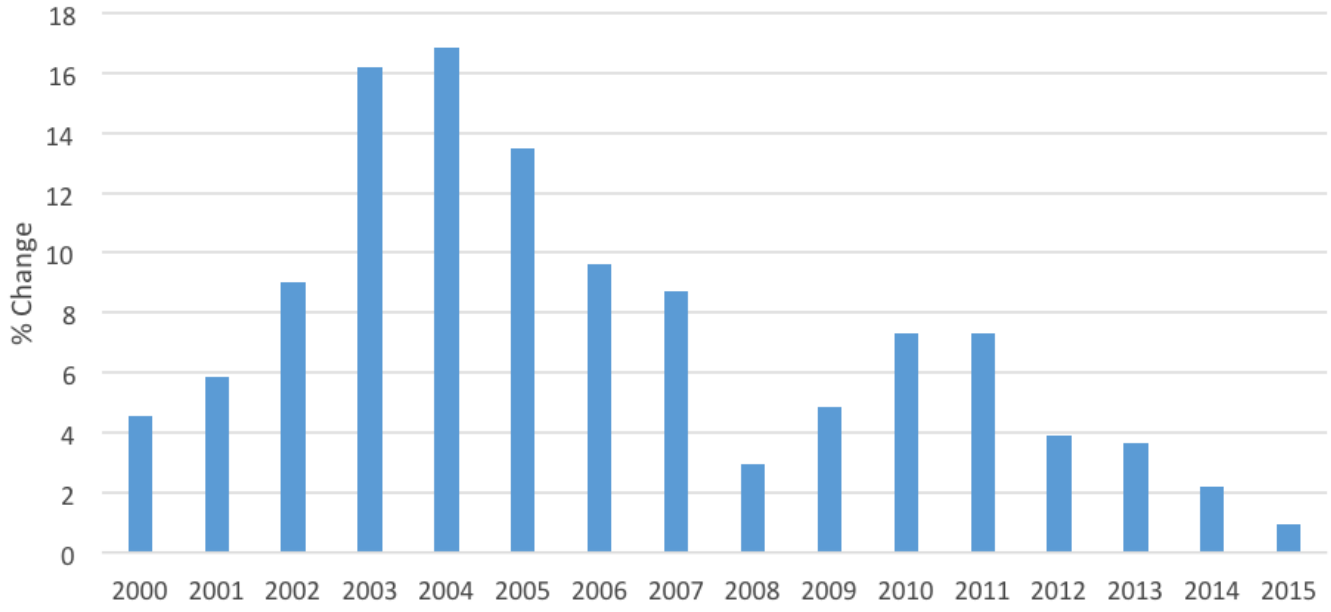

Image source: Green and Stern 2016b, Fig. 18.1. Original data sources: NBS 2016a and World Bank, GDP growth (annual %), 2016, data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

The combined effect of a slowing economic growth rate and falling energy intensity of GDP has been a dramatic slowdown in the growth of China's total primary energy consumption—from a compound annual rate of more than 8% per year between 2000 and 2013 to less than 1% year-on-year in 2015 (Figure 3). Slower energy demand growth in China, all else equal, means slower growth in the demand for Chinese and imported fossil fuels.

In fact, as we shall see, changes in China's energy supply mix mean that fossil fuel growth has slowed dramatically and coal consumption has actually *declined* over this period in which overall energy demand growth slowed.

The energy supply-side: towards a cleaner energy mix

Coal has long been the dominant source of energy consumed in China, accounting for around two-thirds of primary energy consumption in 2014.[21] Between 2000 and 2013, Chinese coal consumption grew at a compound average rate of more than 8% per year.[22] By the end of that period, China was consuming half of the coal consumed in the entire world.

Over the past decade or so, China has taken strong measures to diversify its energy supply. This diversification has been motivated primarily by concerns about energy security (growing reliance on imported fossil fuels), air pollution (as public pressure for clearer skies became acute over the last five years), and 'green' industrial policy (as the government seeks to foster innovative industries in zero-emissions technologies such as solar, wind and nuclear energy).[23] The results of these and other initiatives can be measured partly in terms of expansion in non-coal energy capacity (Figure 4). For example, China installed a record-breaking amount of wind and solar power in 2015 (more than 30 gigawatts [GW] and 18 GW, respectively), as well as 18 GW of hydroelectric and 6 GW of nuclear power.

The non-coal energy capacity expansions of recent years have also contributed greatly to changes in China's electricity generation mix, such that coal-fired power generation has fallen for the past two years as generation from other sources has expanded.[24] These shifts in the electricity generation mix, along with changes in industrial energy consumption, add up to a profound change in China's overall energy supply mix (Figure 5).

Figure 4: Electricity generation capacity in China by source

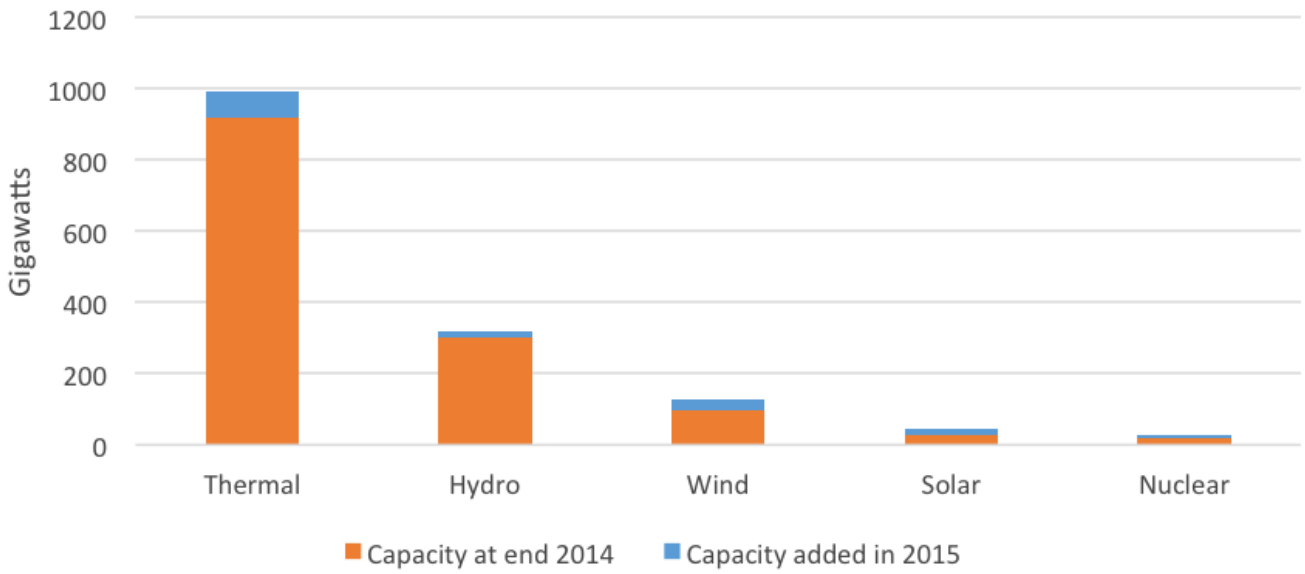

Image source: Green and Stern 2016b, Fig. 18.4. Original data sources: data for 2015 total capacity from NBS 2016a; capacity additions in 2015 inferred from difference between NBS 2016a data and 2014 data from China Electricity Council, 'China power industry situation and prospects', 10 March 2015, cec.org.cn/yaowenkuaidi/2015-03-10/134972.html.
Note: 'Thermal' category includes coal, gas, biomass, cogeneration and wastes and is not disaggregated in Chinese statistics. The 'total' figure is as reported in NBS 2016a and is, for reasons that are not clarified, greater than the sum of the components also reported therein.

Figure 5: Total primary energy consumption by source

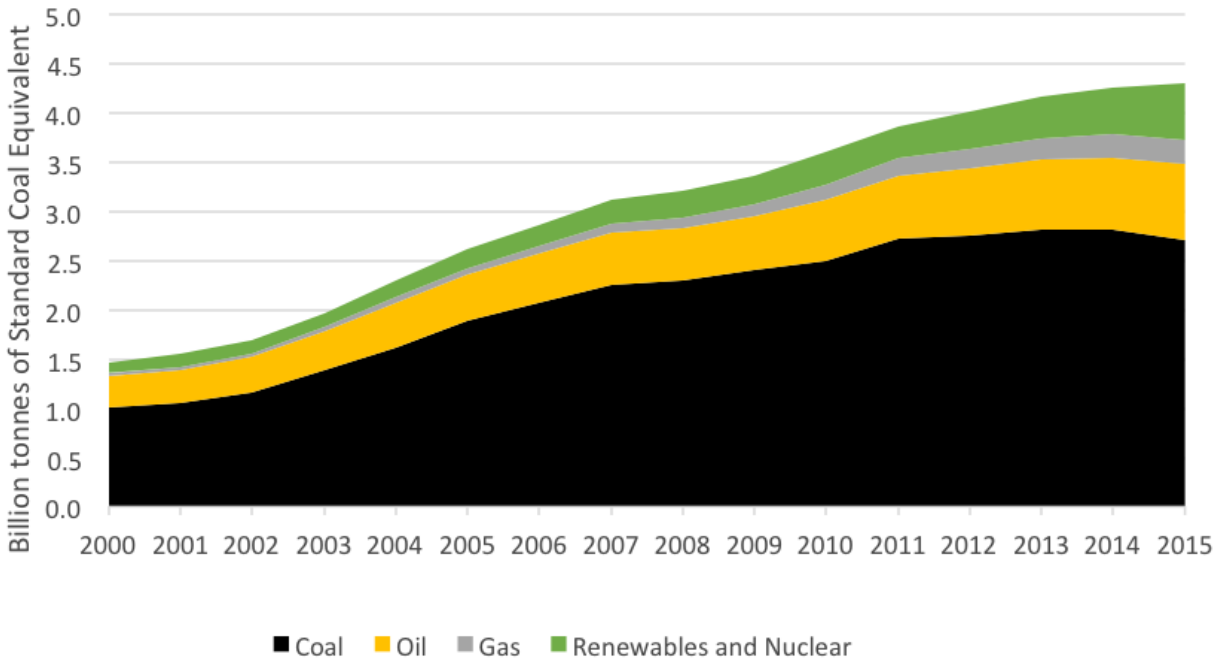

Image source: Green and Stern 2016b, Fig 18.5. Original data sources: NBS 2015a; NBS 2016a.

In 2014-2015, these changes in the energy supply mix combined with the dramatic slowdown in energy demand growth (discussed above) causing a remarkable turnaround in China's coal consumption (see black area of Figure 5). Measured in terms of energy content, China's coal consumption was flat in 2014[25] and in 2015 it fell by more than 3% according to preliminary estimates.[26] After compound annual growth in coal consumption of more than 8% per year between 2000 and 2013, this turnaround is remarkable. The rapid change is also reflected in coal production and import data for 2014 and 2015: coal production fell 2.5% in 2014 and a further 3.3% in 2015, and coal imports fell 10.9% in 2014 and 29.9% in 2015.[27]

Because the decline in China's coal consumption is caused by a combination of forces on the demand and supply sides that are overwhelmingly structural, it is likely that China will never again consume as much coal as it did in 2013-2014. In other words, history will likely show that 2013-2014 marked the peak in Chinese coal consumption.[28]

Future opportunities & challenges: managing growth and decline simultaneously

Looking forward over the next decade or so, how are the factors affecting energy demand and supply likely to evolve?

It is likely that the recent decline in the overall growth rate in Chinese economic activity marks the beginning of a long-term structural trend,[29] driven by the labour market and finance/investment dynamics discussed earlier. As the economy shifts away from high investment in capital stock (which directly expands GDP), toward an economy based more on household consumption and productivity growth, economic growth will slow (since it is more difficult to obtain very high growth rates from consumption expansion and productivity improvements), though this will cause living standards to rise because income will be distributed more equally.[30]

Amid the slowing overall rate of growth, some sectors will experience rapid growth while others will continue to stagnate or contract. Household income growth is expected to support strong demand growth in the services, transport and household goods and appliances sectors. China will therefore face a challenge to tame the growth in energy consumption from transport, buildings and appliances. It will need, for example, to implement and enforce high energy efficiency standards in these sectors, create incentives to retrofit existing, energy -inefficient stock, and plan cities in such a way as to encourage public and active transport modes over private vehicle use.[31]

Nonetheless, even if energy demand from these sectors increases, it is expected to be outweighed by falling energy demand from heavy-industrial sectors such as steel, cement and aluminium. As such, in addition to affecting the rate of economic growth, China's structural transition will likely continue to reduce the energy requirements of China's economic activity in the manner discussed earlier.[32]

A similar story of growth side-by-side with decline is likely to play out on the energy supply side. Positively, continued strong growth in renewable and nuclear energy capacity and output, and associated grid and storage infrastructure, are expected during China's 13th Five-Year Plan and well beyond.[33] These developments, along with direct restrictions on coal, will likely continue to reduce coal's share of a relatively flat or slow-growing energy mix, meaning coal consumption is expected to continue to decline in absolute terms, as is coal-fired power generation.[34]

On the other hand, managing the decline of heavy industries, such as steel production, coal mining and coal-fired power generation, is likely to prove a major challenge, given the importance of such industries to economic activity and employment in certain regions and the close ties between state-owned enterprises and local officials in these areas. At the time of writing, the central government had introduced 'supply-side reform' policies aimed to induce restructuring and rationalisation of production, and redeployment of workers in over-capacity industries such as steel production and coal mining.[35] Yet even these significant initiatives are unlikely to be sufficient to address China's inefficiency and excess capacity problems, especially among state-owned enterprises in these sectors; more thoroughgoing reforms to state-owned enterprises are likely to be needed.[36]

In other areas, such as coal-fired power generation (and to a lesser extent in industrial coal applications) there is evidence of large amounts of new capacity being built and planned despite the market already being over-supplied and coal-fired electricity generation falling for the last two and a half years.[37] The best explanation for this wasteful expenditure is that local authorities have been encouraging power station construction by state-owned enterprises to stimulate short-term growth in their regions, with little concern for the weak long-term economic justification for such new plants. While the new plants are likely to be greatly underutilised, 'stranded' assets, their presence will likely exacerbate ongoing disputes between renewable and fossil fuel-based electricity generators over who gets to dispatch electricity into the grid in a flat electricity market. It will complicate the political economy of transitioning away from coal at a time when that transition needs to accelerate.

Implications for climate change, climate policy, and global economic change

What implications does China's changing economy have for greenhouse gas emissions in China and globally? At most, China's carbon dioxide emissions from energy and industry over the next decade will likely grow only very slowly, peaking sometime during this period.[38] It is possible that carbon dioxide emissions, which appear to have fallen in 2015,[39] will continue to fall gradually over this period, which would imply that 2014 was China's peak year for carbon dioxide emissions. The actual scenario will depend on the extent to which the opportunities just discussed are successfully pursued, and the risks are effectively mitigated.

Ultimately, whatever the exact trajectory turns out to be, it is clear that the outlook for China's carbon dioxide emissions has improved radically over the past few years.[40] This is welcome news for the global effort to mitigate climate change. If China's emissions were to continue rising at rates similar to those of the first decade of this century, it would make it extremely difficult for global warming to be restrained to less than 2°C above pre-industrial levels—the conventionally agreed global climate mitigation goal.[41] The emerging outlook for China's emissions trajectory, in contrast, suggests that a mitigation pathway of less than 2°C is more feasible than previously expected.

Nonetheless, the maths of holding to below 2°C require net-emissions to decline strongly, so that they reach zero in the second half of this century.[42] Accordingly, strong declines in China's emissions will be required. A combination of more stringent climate, energy and innovation policies could allow China to achieve great prosperity across multiple dimensions while strongly decarbonising.[43] But the political economy of such a transition and the complexities of market-oriented regulation and governance in China—some of which were alluded to in the previous section—should not be underestimated.[44]

These opportunities and challenges suggest promising directions for international climate and economic policy. First, with regard to multilateral climate policy and the United Nations Framework Convention on Climate Change (UNFCCC), China's evolving emissions trajectory—including the likelihood of China's official 'peak emissions' target being substantially beaten—highlights the virtue of the 'dynamic' climate governance model embodied in the Paris Agreement, whereby countries are required to update their pledges with more ambitious targets and policies over time.[45] Indeed, with the benefit of a further few years of China's new development model, China is likely to be in a strong position to strengthen its international mitigation commitment ahead of the Paris Agreement's first five-year revision period in 2020.

Second, the focus of international climate cooperation beyond the UNFCCC—including regional, 'club'-based, and bilateral cooperation—should include capacity building and innovation/technology cooperation initiatives that help China overcome the barriers and manage the risks to its decarbonisation identified earlier. International cooperative initiatives for climate mitigation should also be designed with China's strengths in mind, including its strong capacity for incremental and process innovation, the extraordinary scale of the Chinese market (crucial for the large-scale deployment of new clean technologies and products) and its state financing capabilities.

Third, the analysis presented here underscores the fact that mitigating climate change is not just about 'climate policy' strictly construed (international climate agreements, carbon targets, carbon emissions trading etc.); wider macroeconomic policy settings are important determinants of climate change mitigation, especially via their impact on the level and energy intensity of countries' economic activity. Given the greater range of growth and development pathways open to China and other rapidly developing economies in the years ahead compared with developed countries, those growth pathways will be especially influenced by today's fiscal, financial, trade and labour market policies. To ensure that national economic settings are consistent with and facilitate decarbonisation, it will be important for international economic institutions such as the G20 to be highly engaged with processes of decarbonisation.[46] China is ideally placed to advance this agenda as Chair of the G20 in 2016, and given its central involvement in the Asian Infrastructure Investment Bank (AIIB), the New Development Bank, and the One Belt One Road Fund. Developed country members of institutions such as the AIIB also have a responsibility to ensure that international public financial flows are supporting, and not hindering, the decarbonisation of the world economy.

Finally, China's growth and emissions trajectory highlights economic risks and opportunities for other countries. In particular, the structural decline in China's coal consumption and imports, and the major adjustments in its steel and other heavy industrial production, underscore the risks for coal exporters. Meanwhile, China's committed pursuit of green industrial policies to support renewable energy, energy storage and electric vehicles highlight the potential opportunities for other countries to prosper in a decarbonising world by transitioning to a low/zero-carbon economy—if they can adapt their institutions so as to pursue comparative advantages in these industries.

China has set a clear strategic direction for its future green economy and is making large strides to get there. There will be challenges and risks along the way, but also profound opportunities for a more productive economy, healthier society, and cleaner environment.

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43. Green and Stern 2015; Fergus Green and Nicholas Stern, 'A new development model for China: growth, urbanisation and environment at a crossroads', Paper presented by Nicholas Stern at the China Development Forum, Beijing, March 2016c.
44. See Green and Stern 2016b.
45. See Green and Stern 2016a (esp. Section 4).
46. Green and Stern 2016a.

* A note on reference style: to ensure clarity and presentation consistency with the *Briefing Paper* style, full web URL's are not included in the reference list. Readers wishing this information should contact Production Editor, Claire Denby cdenby@unimelb.edu.au

Note: This briefing paper is based primarily on research undertaken by the author and Professor Nicholas Stern at the London School of Economics and Political Science in 2015 and 2016, which is reflected in the following four papers:

Fergus Green and Nicholas Stern, 'China's "new normal": structural change, better growth, and peak emissions', Policy Brief, Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, June 2015.

Fergus Green and Nicholas Stern, 'China's changing economy: implications for its carbon dioxide emissions', *Climate Policy*, published online 16 March 2016, doi:10.1080/14693062.2016.1156515.

Fergus Green and Nicholas Stern, 'Managing economic change and mitigating climate change: China's strategies, policies and trends', in Ligang Song, Ross Garnaut, Cai Fang and Lauren Johnston (eds.), *China's new sources of economic growth: Volume 1; Reform, resources, and climate change*, 2016, ANU Press.

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Briefing Paper 7
August 2016
www.sustainable.unimelb.edu.au/briefing-papers

Published by the University of Melbourne.