



How China is Forging a New Green Industrial Model

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China—and to some extent Brazil and India (which we may christen the BICs)—are staging a “Great Convergence” in terms of industrial strength and incomes. This reverses the past two centuries of the Great Divergence, which has separated them from the West. In the process, the BICs are lifting millions of people out of poverty. But in the great transformation that lies ahead, there is a significant problem to contend with: the model of industrial capitalism that has served the West so well—and which has been held out as a model for the BICs as well—will not “scale” to lift vast new populations out of poverty. A new model of industrial capitalism has to be developed, and in some people’s eyes it is inconvenient that China is leading the way.

China is busily forging new institutional arrangements and new “green” strategies of industrialization while simultaneously pursuing fossil-fuelled “black” industrial growth. These green strategies are based on three main components: (i) renewable energies and low-carbon technologies, (ii) resource efficiency and circular economy initiatives, and (iii) eco-finance. However, while these new strategies and institutions—in effect, a new green model of industrial capitalism—are being developed, China is

continuing to ramp up its black energy and resource supplies. Which strategy wins—the black or the green—is clearly a matter of great moment, for China itself and for the world.

Why a New Model is Needed

Industrial capitalism has been the most powerful transformative agent in the world’s history. Its appearance in Britain in the second half of the seventeenth century was powered by access to new fossil fuels such as coal, and it unleashed astonishing gains in productivity associated with rises in income. Industrial capitalism proved so attractive that it was widely emulated elsewhere. Karl Polanyi aptly called this period the “Great Transformation,” in the sense that nothing would be the same again.¹ The appearance of capitalism in cities led to demands for independence and liberties that today we take for granted in the West, and which are now spreading worldwide. The worldwide trajectory of industrialization and modernization continues to lift more and more people out of poverty—particularly in the BICs.

In his most recent book, *The Next Convergence*, Nobel laureate Michael Spence shows

1. Polanyi’s text was originally written and published in 1944; see Polanyi (2001).

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that a new pattern of growth is emerging.² He foresees that the divergence between incomes and wealth that characterized the first two centuries of industrial capitalism is being reversed. Giant countries like China and India are starting to catch up with the West. According to Spence, there is a distinct possibility that by 2050 no less than 75 percent of the world's population could be living moderately comfortable lives—up from only 15 percent in the year 1950. Thus, by 2050, 6 billion people of an estimated world population of 8 billion could be middle income.

Figure 1 (prepared with my collaborator Dr. Hao Tan) shows the developmental dynamics. The convex, outer curve shows projected global growth and the inner curve shows the rapid transformation of much of that population into a global middle-class.

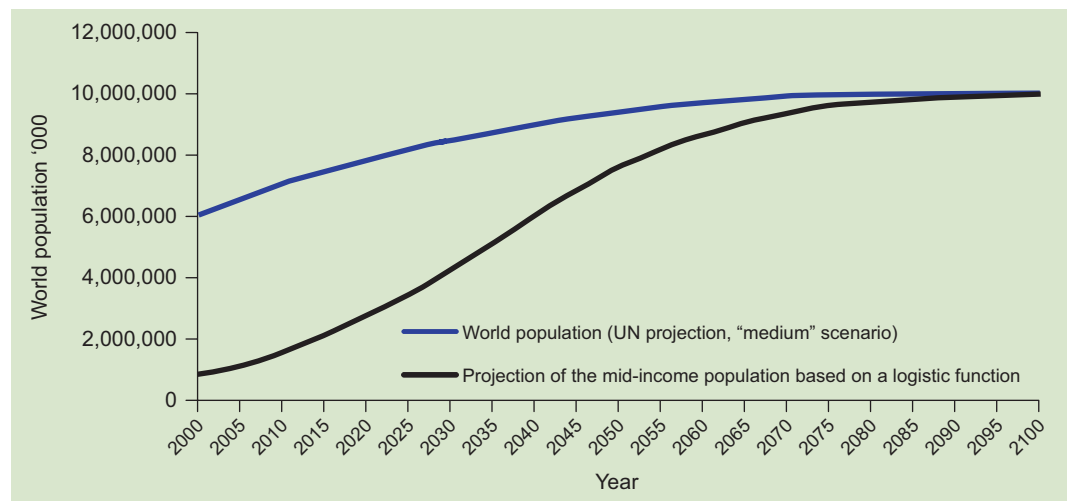
Six billion people raised out of poverty—six times more than the one billion who enjoy a middle-income standard of

living today—would be an extraordinary achievement. But can the model of industrial capitalism that was developed by and for the West—by Britain, Europe, the United States, and finally Japan—allow for a **sixfold expansion** in its energy and resource impact on an already overstretched planet? Can the number of cars on the planet be increased from something under one billion to four or five billion? Can the vast steel and cement industries that are building the infrastructure of China and India expand sixfold or more?

Simply asking the questions this way is to answer them. The Western model cannot “scale” to accommodate the aspirations of Brazil, India, and China, and all the other peoples waiting to enjoy the fruits of industrialization. Urban congestion, pollution, waste generation, the demands on fossil fuels, the resource wars that would have to be fought to extend and defend oil supply lines—all these conspire to prevent such an outcome. These impediments do not even include the global warming impact of continued and expanded carbon emissions. Just

2. See Spence (2011b), as well as his commentary for Project Syndicate (Spence 2011a).

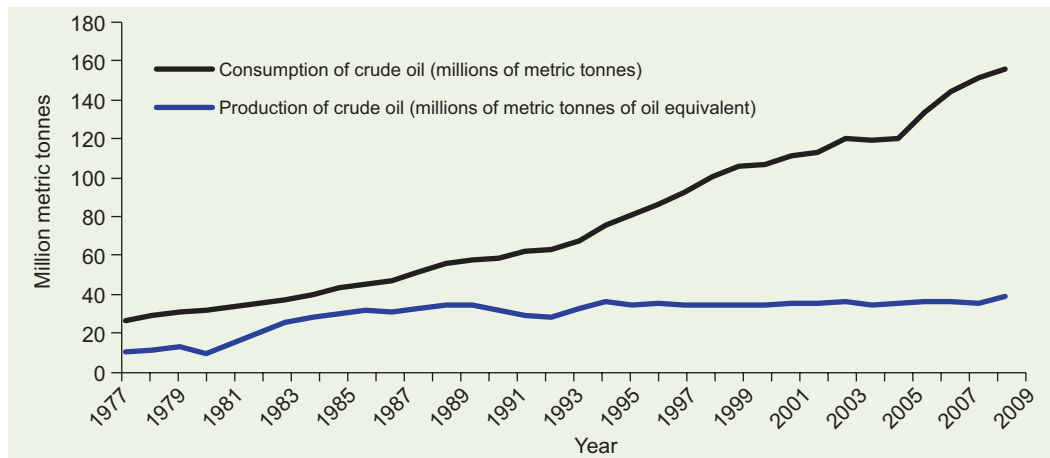
Figure 1. World Population: How There Could Be Six Billion Middle-Income People by 2050



Source: Author (with acknowledgment of input from Dr. Hao Tan). Original data from the United Nations Development Programme (UNDP).

Note: The projection is based on the assumption that by 2050 the middle-income cohort will be 75 percent of the world population.

Figure 2. India's Looming Oil Gap



Source: Author (with acknowledgment of input from Dr. Hao Tan).

enumerating the consequences of extending the “business as usual” path of “black growth” is to reveal why it cannot “scale.”

The constraints under which China is developing industrially are well illustrated by its growing dependence on imports of oil. This is disastrous, both in terms of the sums that have to be paid for these imports and the energy insecurity it engenders. China became dependent on imports in 1994, and ever since the gap between consumption and domestic production has been widening (just as it did in the United States after domestic oil production peaked in 1970).

India’s oil dependence problem (or the widening gap between oil production and imports) is even worse than China’s (figure 2). China and India’s oil imports are highly vulnerable to shocks, including rising oil prices, dependence on a handful of suppliers, and growing tensions with existing industrialized countries and their “carbon lock-in.”

As countries like China and India become dependent on oil imports, they are more likely to come into conflict with Western countries (the United States and Europe) and Japan, themselves highly dependent on oil imports. Competition for fossil fuels

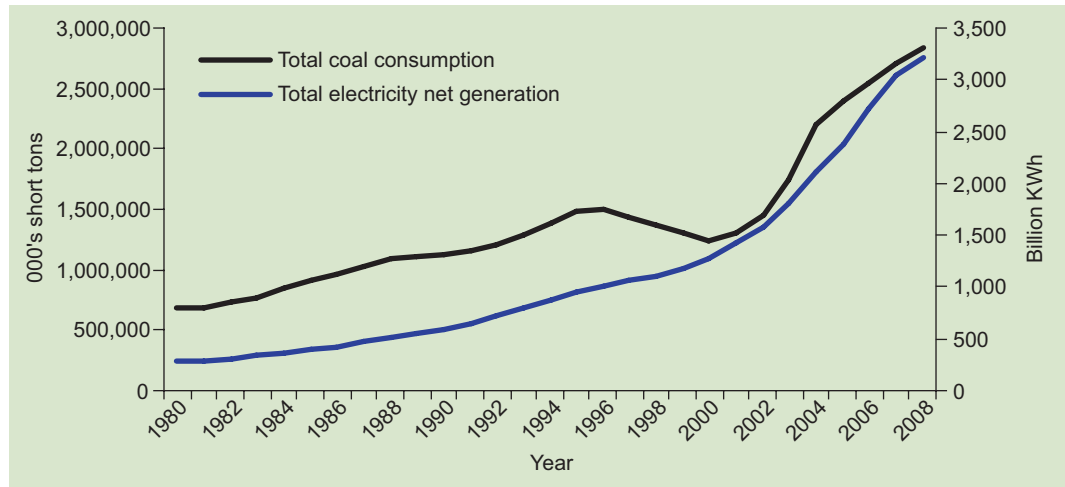
makes **resource and oil wars** more likely in the twenty-first century.

China’s (and to some extent India’s) answer to the perils of resource scarcity and environmental degradation is **not** to turn its back on growth and industrial development. Rather, they are building a new, green industrial system based on renewables and resource efficiency that reduces reliance on fossil fuel and resource imports—alongside the “black” industrial system based on fossil fuels. This can most aptly be called a “black and green” development model.

China’s Black and Green Development Model

Since 2001, when it joined the World Trade Organization, China has built the world’s largest manufacturing system, powered by the world’s largest energy system—and fuelled, for the most part, by coal and other fossil fuels. By 2010, China’s electric power capacity exceeded 1 terawatt (TW) (1,000 gigawatts [GW]). China is replicating the steps of earlier industrializers, from Great Britain, to Europe, to the United States; it is also following the twentieth-century growth leaders, including East Asian tigers like

Figure 3. China's Black Face: Build-up of Thermal Power



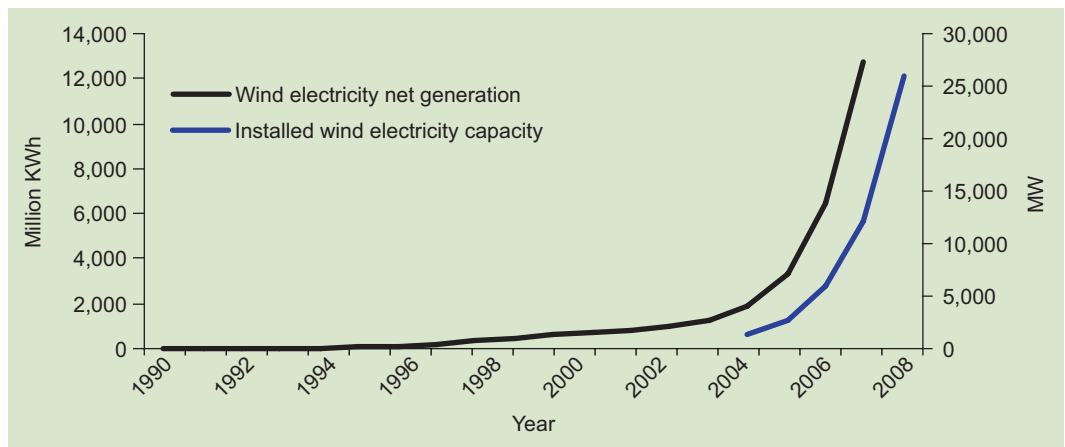
Source: Mathews and Tan (2013).

Japan, the Republic of Korea, and Taiwan, China. All these countries utilized fossil fuels to build their formidable industrial systems. China is doing it on a vaster scale than anyone else—adding 50 billion watts of coal-fired electric power each year (or a one-gigawatt thermal power station every week) as well as scouring the world for coal, oil, and gas supplies. China's rapid buildup of fossil fuel electric power generation is following a well-known course as shown

in figure 3, which I prepared with my collaborator Dr. Hao Tan.

China's leaders recognize that this strategy will not scale. The country is sensibly planning ahead by building its renewable energy industries as fast as it can, and so far with notable success. In wind power, for example, China has risen from a marginal position in 2005 by doubling its wind power capacity each year. It was the world leader by the end of 2010 (figure 4).

Figure 4. China's Green Face: Expansion of Wind Power



Source: Mathews and Tan (2013).

In solar photovoltaic (PV) power systems, China has built its export-oriented industry so successfully that it has attracted the unwelcome attention of the U.S. Department of Commerce.³ By 2010, China was adding more power-generating capacity in hydro, nuclear, and “new” renewables than in conventional thermal power stations. This was an extremely important milestone, for China and for the world, and its 12th Five Year Plan has notable goals of raising these levels. China’s leadership, specifically the National Development and Reform Commission (NDRC), anticipates that electric power generating capacity will be rated at 1.6 TW by 2020. Of this total, the NDRC anticipates that 500 GW (0.5 TW) would be generated from renewable sources—hydro, wind, solar. In other words, **renewables would account for 30 percent of electric power capacity by 2020.** These planning targets are not just paper exercises but are backed by investment, with differential interest rates offered by China’s state-owned banks. China is already having a big impact on the global market for renewables. In particular, it is driving down the cost curve for solar photovoltaic systems in dramatic fashion. The latest data on the global experience curve reveals that China has been the force driving down the costs of solar PV to below US\$1 per watt—which has long been the target of policy makers—with costs declining by 45 percent per year (Bazilian et al. 2012). This brings solar PV within reach of households not just in China, but all around the world. In fact, the price decline is so steep that it may drive some manufacturers out of business, including in China itself.

China’s expansion of fossil fuel generation continues apace, but increasingly this

investment is being matched by expenditure on renewables. They are seen as providing the “heavy lifting” for the future Chinese economy—with equipment built in China and using Chinese technology. As a result, the character of the energy sector is changing. A strong constituency is being created that promises to drive further development and expansion of the renewables sector, following the well-known logistic curve (or S-shaped curve) where early investments create conditions for further investments. China’s backing of renewables is entirely pragmatic, as well as driven by national security concerns. But it does have implications for environmental effects around the world, and in particular for global warming concerns.

Eco-Efficiency in Resources: Circular Economy

At the same time, eco-industrial development is accelerating in China. It now promises to become one of the main industrial development models being pursued. Eco-industrial initiatives go well beyond traditional “recycling” issues. Instead, they aim to solve resource and waste problems by encouraging firms to source their raw materials from wastes generated by other firms—turning “wastes into resources.” This is called in China the “circular economy.”

A number of eco-industrial initiatives have been designed and implemented in pursuit of the goal of the circular economy since the concept was first introduced by Chinese scholars in the late 1990s. For example, in 2005 the NDRC in conjunction with five other ministries launched the first batch of national pilot demonstration projects, while a second batch was launched in 2007.⁴

3. See my article on the escalating U.S.-China solar PV trade dispute at the *European Energy Review* (Mathews 2012).

4. I have elaborated on these developments in my article with Hao Tan (Mathews and Tan 2011).

It cannot be emphasized enough that *the concept of the Circular Economy represents a radical break with the conventional linear economy*, where at one end raw materials are mined or extracted and wastes are dumped at the other—both ends exploiting a sink called “nature” without thought or restraint. Indeed, the very concept of national accounts, measured by GDP, is an expression of the linear economy. “Growth” in GDP—in the absence of increasing returns—means simply growth in throughput.

China so far is maintaining the framework of GDP accounting, while building an alternative circular economy of eco-industrial linkages on the ground. (A brief experiment in “Green GDP” accounting was championed by China’s State Environment Protection Agency, with the support of economists such as Hu Angang, but in the end it was discontinued.)⁵

These initiatives are all backed by strong legislative support, such as the 2006 Renewable Energy Law, which introduced feed-in tariffs into China, and the 2008 Circular Economy Law. With this support, policies are being created that will guide investment into a new, green industrial trajectory.

A tilt towards green development is evident in the 11th and now most recently the 12th Five Year Plan (covering the years from 2011 to 2015). These planning tools are supported by policy and strategic initiatives and strong state encouragement and enforcement of the new direction. Thus, China’s promotion of the green development model is anything but casual and haphazard.

Even if the dangers of global warming turn out to be overstated (itself highly unlikely), China—and the BICs gener-

ally—would in any case accrue enormous advantages by adopting green development strategies. Green development offers the BICs greater self reliance, resilience, and security.

We may call the green development strategy a “big push” after the terminology of Rosenstein-Rodan and other development economists in the 1940s and 1950s. They did not think of development as an incremental process, which would fail for lack of critical mass and interconnections. Instead, they saw it as a state bank-financed big push across several industrial sectors simultaneously.

On development then, and on green energy now, this would have the effect of creating critical mass and building sectoral interconnections that would further stimulate growth. It is high time to take up the “big push” idea again. It currently lies abandoned in the museum of once-interesting but superseded concepts. It is no longer applied by the World Bank or by other development agencies—even though it is as valid today as when it was first formulated.⁶

However, it is applied (in practice, but not explicitly) by China—with great success. I propose that we put the idea to work in the most pressing context today, namely in the building of a green energy sector, as a solution to (i) development ambitions, and (ii) global warming concerns. In the twenty-first century, the green big push is likely to see the creation of ever-expanding “islands” of green economy businesses. These will likely generate increasing returns (revenues) from their links with each other that propagate and grow like a chain reaction—rather than from their links with the conventional fossil fuel economy.

5. A perspective on green growth utilizing the tools of neoclassical growth theory (suitably adapted) is provided by Leipziger (2012) in this series.

6. See Rosenstein-Rodan (1943) for the original argument.

Green development indeed promises to produce a **different kind of industrial capitalism**—one that looks more practicable and achievable than the fossil-fuelled “business as usual” pathway. A world clinging to its fossil-fuelled past and fighting to the death

over the dwindling supplies is a dismal prospect. A much better world is one that harvests abundant energy supplies from renewable sources, recirculates its resources through a circular economy, and thereby creates conditions for international tolerance.

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