China & World Economy / 44–61, Vol. 31, No. 1, 2023

China in the Global Response to Climate Change

*Ross Garnaut**

Abstract

China has a huge national interest in the success of the international effort to hold human-induced increases in temperature to 1.5 degrees – and therefore in global net emissions falling to net zero by 2050. China is essential to the success of the global effort – as a supplier of competitively priced equipment for the zero emissions world economy and as the world's largest current source of greenhouse gas emissions. Success is more likely for China and the world with international specialization in goods production for the zero emissions economy. This will require open international trade, with China supplying equipment and drawing zero emissions semi-processed goods from abroad. Success is more likely and will be achieved at a lower cost if there is close cooperation across national boundaries.

Keywords: China, climate change, international cooperation, zero carbon
JEL codes: F64, Q50, Q54

I. Introduction

China has experienced sustained strong growth in economic output with even stronger growth in foreign trade over the 44 years of reform and opening to the outside world. China has moved from being a poor country with a small economy of marginal importance to global development, to a higher-middle income country that is centrally important to every major international question and for whom international changes have implications for success at home.

Nowhere is China more critical to global outcomes, or global outcomes more to China, than on climate change. The international community's success in controlling human-induced increases in temperature depends on Chinese approaches to decarbonisation at home and abroad. In turn, the Chinese government's success in achieving its development goals depends on the world managing effectively the challenge of climate change.

*Ross Garnaut, Professor Emeritus, Melbourne Institute of Applied Economic and Social Research, University of Melbourne, Australia. Email: ross.garnaut@unimelb.edu.au.

Close cooperation between China and the rest of the world will substantially reduce the costs of decarbonisation in both. This will occur through four main mechanisms: mutual support and encouragement for what is a difficult and complex structural transformation in all countries; China supplying capital goods for the new energy and industrial technologies; countries with relatively abundant and rich solar and wind resources and reasonably low cost of capital supplying China with zero emissions energy and goods embodying renewable energy; and the developed countries and China supplying capital, capital goods, and technology for zero emissions development throughout the developing world.

II. The climate change challenge to global development

There is global scientific consensus that continuation of historic relationships between economic activities and emissions of carbon dioxide and other greenhouse gases into the atmosphere would lead to large increases in temperatures all over the world–far beyond the average increase of 1.1 degrees above pre-industrial times that has already occurred. Higher temperatures would destabilize many aspects of modern economy and society. Chinese atmospheric physicists have contributed substantially to the world's stock of knowledge about these matters.

Chinese scientists have drawn attention to the vulnerability of China to global warming: the challenge of warming to water supply and agricultural output in the North China plain; the destabilization of water flows in the Changjiang, Huanghe, and other great rivers from deglaciation of the Qingzang Plateau; and the impact of rising sea levels and the increased intensity of extreme weather events on human settlement and activity on that large part of Chinese economic output near the river deltas and other low-lying areas of coastal China. China, like all countries in the western Pacific, around the Indian Ocean, and across Eurasia, would be damaged by destabilization of the international political and economic order from the effects of climate change in Southeast, South, Central, and West Asia. Chinese scientists have had institutionalized access on climate issues to the Chinese leadership for at least one and a half decades, and this has informed Chinese domestic policy and participation in international discussions.

At and immediately after the November 2015 Paris meeting of the United Nations Framework Convention on Climate Change (UNFCCC), all the United Nations (UN) members agreed to work together to hold human-induced increases in average global temperatures below 2 degrees and as close as possible to 1.5 degrees. Each country would define its own nationally determined contributions, and the conference of the parties would meet every five years to review progress and to strengthen national contributions towards the agreed goals. The first of the five-year reviews was to have occurred in Glasgow in late 2020, but was postponed until the following year because of COVID disruption at that time. All developed countries and several of the largest developing countries strengthened their national commitments at Glasgow.

China has been part of the UN discussion of climate change from the early years, including the Rio Earth Summit in 1992 that established the UNFCCC, and the Kyoto Conference in 1997 that laid the foundations for international cooperation in reducing emissions. It played an important role in the Paris conference of the parties of the UNFCCC, and the adoption of the goal of holding temperature increases below 2 degrees and as close as possible to 1.5 degrees. It played an even more influential role in the Glasgow conference, with its stronger focus on the 1.5-degree objective.

At Glasgow, for the first time, all developed countries accepted that they would reduce greenhouse gas emissions to net zero by 2050. China, Indonesia, and Russia committed to net zero by 2060 and India by 2070. These were big steps forward from earlier positions. But big as the commitments were, they did not add up to net zero by 2050 for the world as a whole. Meinshausen et al. (2022) have suggested that the nationally determined commitments can be reconciled with the global goals by each group of countries moving forward by 5 years, the time at which they will reach net zero: the developed countries to 2045; China, Indonesia, Russia, and other countries at intermediate levels of development to 2055; and India and other lower income developing countries by 2065.

China will have large influence on whether the world succeeds in achieving zero net emissions by 2050.

China is now the country with by far the world's largest greenhouse gas emissions, currently accounting for around thirty percent of the global total. This is more than all currently developed countries combined. This is not surprising, since China has a much larger population than the sum of developed countries, is the locus of much more than its population share of global manufacturing capacity, and the Chinese people are now enjoying in abundance the material benefits of modern economic growth. But it means that there will be no solution to the global problem without China moving purposefully and early to zero net emissions.

China is home to around half of the world's energy-intensive manufacturing. This is an important reason for China's high emissions. Steel is the biggest of these industrial activities, with China accounting for over half of global steel production and 60 percent of global steel emissions – contributing over 4 percent of total global emissions from all sources (Song, 2022). China's rapid deployment of and large-scale investment and production in new technologies is critically important to global decarbonization of industry.

China currently accounts for around half of the new installation of zero emissions power generation capacity – solar, wind, hydroelectric, biomass, and nuclear energy. China is demonstrating that zero emissions technologies can be installed rapidly at an immense scale. Solar power output increased 40 times to 331 terawatt hours in the 8 years to 2021, and wind by 5 times from a higher base to 656 terawatt hours. Zero emissions electricity of all kinds grew rapidly over these years, including nuclear, hydroelectric, and biomass. Zero emissions energy supplied approximately all of the increased Chinese power generation over this period.

Chinese coal use doubled to over 4 billion tonnes in the decade to 2013, accounting for virtually all of the increase in global coal consumption, reaching over half the world's total at the end of the decade. This was the proximate cause of China accounting for most of the world's increase in greenhouse gas emissions over this period. The rapid deployment of zero emissions power generation after 2013 saw the stabilization of Chinese coal use, with the level in 2021 being similar to that in 2013.

The arithmetic of structural change and continued strong growth in renewable power generation holds out the prospects of coal-based electricity generation declining at an accelerating rate from now on. Now that Chinese renewable electricity output represents a substantial proportion of the total, current rates of growth force large annual reductions in generation from fossil carbon. When there is excess total generation capacity, economic forces lead to utilization of renewable rather than fossil carbon capacity, as it does not have high operating costs from purchase of coal, gas, or oil. The continuing decline from now on in the coal share of power generation would support early peaking of total carbon dioxide emissions. China, being at the global forefront of the shift to use as well as production of electric motor vehicles, also assists early peaking.

China is also by far the world's main producer of the capital goods for the zero emissions economy, including photovoltaic panels, wind turbines, inverters for turning direct into alternating current, batteries, hydro-electric and nuclear generators, transmission cables, electrolyzers for producing green hydrogen from renewable energy, and electric vehicles. China's capacity for low-cost production of this equipment on an immense scale reduces the cost of the transition to zero emissions all over the world.

The new technologies of the zero emissions world make heavy demands on a range of minerals and metals which were less important in the zero emissions world (Sandiford, 2022). These include silicon for solar panels, and lithium, vanadium, graphite, cobalt, nickel, titanium, magnesium, manganese, rare earths, and other materials. The International Energy Agency has called these "critical minerals." Following Sandiford (2022), I prefer the term "energy transition minerals." China has become the dominant world supplier of many of these materials. However, Chinese natural resources are not particularly large or rich for many of them, especially in comparison with Chinese economic size and domestic demand for energy transition minerals. The processing of energy transition minerals – notably silicon – makes heavy demands on zero emissions energy and other inputs into industrial processes that are not relatively abundant in China.

The movement to a zero emissions economy also leads to greatly increased demand for some materials that were of large importance in the old economy, notably copper and aluminum.

Global output of energy transition minerals will need to increase rapidly to meet global demand – the International Energy Agency says seven-fold in the decade to 2030. It will not make economic sense for China to remain a large exporter of many of these inputs into zero emissions production. Chinese enterprises and their technology and experience can play a large role in scaling up production in other countries. The development of new sources of energy transition minerals outside China supports emissions reduction and economic development in China as well as in the rest of the world.

China is important to decarbonization through the developing world as a source of investment in the zero emissions economy. Chinese investment and trade is highly influential in determining the balance between old and new technologies and industries in the development of other countries. China's official development institutions, with those of Japan and South Korea, until recently supported the expansion of coal-based electricity systems in Asia and Africa. Decisions to cease financing new coal-based power stations in the lead-up to the Glasgow UN conference on climate change in 2021 were of large global significance. More positively, Chinese financing of new investment in the zero emissions industry and processes and application of zero emissions technologies is making a substantial contribution to other countries' decarbonization.

III. The Chinese economic development context of the energy transition

Over the first two decades of economic reform, China's economic output increased 5 times and its foreign trade 12 times. Consumption levels greatly increased for nearly half of the world's people in poverty. From being an isolated, autarchic economy, China, through the 1990s, absorbed about half of the FDI flows to developing economies (Garnaut, 2018).

The pace of change was maintained over the second 20 years of the reform period. The economy in 2017 was 5.3 times as large as in 1998, and international trade 12.6 times.

China now is the largest participant in international trade and the largest trading partner of most countries.

The expansion of foreign trade eased bottlenecks that otherwise would have constrained Chinese economic growth. Energy and metallic minerals were drawn from abroad, in quantities and qualities that would not have been available for Chinese development if the old commitments to self-sufficiency had continued. This was most obviously the case with energy and steel-making raw materials, where China became the world's largest importer of oil, gas, coal, and uranium, and overwhelmingly the largest importer of iron ore. Increased supply of engineering equipment and technology from the advanced industrial economies also removed or loosened what would otherwise have been binding constraints on Chinese growth.

The growth in Chinese demand required rapid expansion of the global supply of many goods and services. To induce the new supply of energy, global oil, gas, coal, and metallic minerals prices increased by several hundred percent in the first one and a half decades of this century. Higher prices of energy and metallic minerals on world markets greatly increased incomes and investment in resource exporting countries – lower terms of trade for China was the other side of the coin to higher terms of trade for exporters of commodities.

Growth in Chinese output and trade was of huge benefit to the Chinese people, but also to people all over the world. It greatly expanded markets for industrial raw materials and foodstuffs and for the engineering inputs into modern development. After China passed the Lewisian turning point in economic development around 2005 (Garnaut and Huang, 2006; Cai and Huang, 2013), labor became increasingly scarce, and wages began to rise. From this time, China offered a rapidly expanding market for the labor-intensive manufactured goods of low-income developing countries in Southeast and South Asia. As domestic labor costs rose, Chinese investment abroad in the production of labor-intensive goods enhanced growth in Southeast and South Asia and Africa. Chinese investment in infrastructure secured larger markets for Chinese capital goods and contributed to development in many developing countries. As Chinese incomes grew, the Chinese market became important for a wide range of high-value services and consumer goods, including tourism, education, and the top end of apparel and food. For the most industrially advanced developed economies, first of all, Japan and Germany, and South Korea for specialized industrial products, it offered a rapidly growing market for high quality engineering goods.

The availability of competitively priced manufactured goods from China lifted supply constraints on growth in other countries. Massive expansion of Chinese exports of manufactured goods reduced the inflationary impact of economic growth throughout the world. It contributed to a period of relatively strong expansion without inflation that came to be known as the "great moderation" (Garnaut and Llewellyn-Smith, 2009). High Chinese rates of saving from rapidly growing incomes allowed the rest of the world, notably the United States, to reduce taxation rates and increase public expenditure without early upward pressure on interest rates. Greater financial integration in the absence of effective domestic regulation created vulnerabilities to financial system dislocation – as the world learned at great cost in the global financial crisis of 2008–2009 (Garnaut and Llewellyn-Smith, 2009).

The climate-induced energy and industrial transition was supported by trade and other international cooperation. This is illustrated in the reduction in costs of photovoltaic panels over the past one and a half decades. In the early twenty-first century, climate policies in the European Union, supplemented by national policies in Germany and some other member countries, greatly increased incentives for the deployment of solar photovoltaic electricity. The new demand was initially mainly supplied by domestic production of photovoltaic panels in Europe. At around this time, Chinese graduates from advanced electrical engineering programs at Australian universities were returning home. Several identified a business opportunity in applying their new knowledge commercially to link the growing solar photovoltaic market in Europe with Chinese comparative advantage in manufacturing production at a large scale. Support from Chinese provincial governments facilitated the early development of new companies manufacturing solar panels. Exports to Europe allowed early production at a considerable scale, which reduced costs. Lower costs of equipment made solar power more competitive with fossil energy abroad and also in China. Exports and domestic sales continued to expand, further reducing costs. Learning by doing and increased scale in manufacturing more than technological change have continued to bring down costs. Now, two decades into the virtuous circle of expanding output and falling costs centered on Chinese manufacturing capacity, the cost of new renewable energy is much lower than the cost of new coal or gas generation in most countries, even after taking into account the cost of storage to balance the intermittency of solar and wind generation. With the high contemporary global prices of coal and gas, the cost of fuel alone for fossil carbon power generation exceeds the total capital and running costs of solar and wind in places with good natural resources for renewable energy. The reduction in renewable energy cost has established a commercial base for decarbonization of electricity, even in countries without supportive domestic policies. It has also established the foundation for decarbonization of many areas of industrial production that had once depended on fossil carbon and hydrocarbon with high greenhouse gas emissions.

So international trade has been of large importance to Chinese economic growth from early in the reform period, and now for reducing the cost of Chinese transition to zero net emissions. It has been important in the whole world through the early twenty first century for sustaining growth with moderate inflation. And it is now of crucial importance for facilitating and reducing the cost of the shift from fossil carbon to renewable energy.

There is an important sense in which the shift to renewable energy is necessary for completion of the Chinese journey to a high-income country, and more widely to the continuation of global development. Even if there had been no climate change problem, global development based mainly on fossil energy would have become increasingly difficult through the twenty-first century (Garnaut, 2022). The cost of structural transition from backward low-income to modern high-income economies would have increased, and the chances of success diminished. The ever-increasing demand would drive ever-increasing costs of oil, gas, and coal. The coal, oil, and gas resources that have highest quality, that are most easily and cheaply extracted, and that are most accessible to centers of demand are used and exhausted first. Over time, the fossil carbon frontier shifts to more costly resources and world prices rise. Increased scarcity of oil, coal, and gas would have emerged as an increasingly tight constraint on global growth if the world had remained comprehensively dependent on them for energy. The terms of international trade would have continued to move against China and developing countries that had less than their shares of fossil carbon natural resources. However, the greater emphasis on renewable energy everywhere and a less energy-intensive pattern of growth in China over the past decade have eased those constraints on Chinese and global development (Garnaut et al., 2013).

We saw the process of global development putting upward pressure on fossil carbon process and threatening to constrain global development in fast forward in the period of exceptionally strong Chinese economic growth in the decade to 2012. World prices of oil, coal, and gas rose by 400 and 500 percent over a decade.

The relationship between global growth, energy demand, and fossil energy prices began to change about a decade ago. Nearly all of the growth in energy demand over recent years has been met from renewable sources.

The world reached peak global coal use almost a decade ago – although the surge in global demand following the COVID fiscal and monetary expansion and post-COVID recovery may temporarily lead to a new peak. Peak production of cars that run on combustion of petroleum came in 2017 – since then, the whole increase in demand, and more, has come from electric vehicles. This has stopped the tendency for global fossil energy prices to rise with global economic growth that had been so powerful in the first decade of the century – although the disruption of Russian exports following the following its war with Ukraine has temporarily pushed prices to extremely high levels.

The imperative of reducing and then ceasing emissions of carbon dioxide into the atmosphere has accelerated what would have been a gradual but inexorable reduction of reliance on fossil energy, driven by familiar economic forces. By accelerating the process, the decarbonization of the world economy eases what would have emerged as an increasingly tight constraint on Chinese and global development.

This reduction in the growth in prices of commodity imports and improvement in China's terms of trade is just one of the ways that China benefits from movement to a zero emissions global economy. The increasing use of zero emissions energy reduces China's dependence on imports of energy raw materials from countries that are potentially politically or economically unstable. As the country with the strongest comparative advantages in producing the capital equipment for the zero emissions economy, China's economic development can be strengthened by exports of these goods to support the global energy and industrial transition. The shift to zero emissions transport, industry, and residential and commercial heating reduces air pollution, which became a source of serious health problems and degradation of the quality of life in many parts of China through the decades of carbon-based economic growth (Chen et al., 2013). Air pollution has become politically contentious within China. It will be removed by comprehensive decarbonization of industry, electricity, household heating, and transport. Most fundamentally, China benefits from timely global achievement of zero net emissions by avoiding the immense economic, political, and environmental costs of high degrees of global warming.

Chinese trade and economic cooperation with the developed countries has met difficulties over the past 5 years. Geostrategic tensions have damaged confidence in international economic exchange. This inevitably affects cooperation in trade, investment, and technological exchange related to the energy and industrial transition. Increased trade restriction has been most important in China–US relations, but significant in relations with many other developed countries. The increases in barriers to US imports during the Trump Presidency were greatest against China, and these have not been reduced under President Biden. China itself has imposed restrictions on the normal conduct of trade with several countries.

The external and internal restrictions on international trade are damaging to Chinese and global development. However, the international setbacks and the COVID epidemic and the policy response to it have slowed without stopping growth in Chinese trade and output. Annual Chinese output growth averaged 5.75 percent between 2017 and 2021. Total international trade expanded more rapidly than the economy over these four years – exports in US dollars increased by nearly half and imports by an eighth. Chinese foreign trade has continued to grow strongly in 2022 despite the tightening of COVID restrictions.

Trade in goods and services that are important in the energy and industrial transition to net zero emissions have grown more rapidly than trade in general, in China, the US, and the world as a whole. It is important to achievement of net zero emissions in the world as a whole, in China and in each other country, that it continues to do so. Its continuation lowers the cost of transition and assists its reconciliation with continued global development.

Open trade is more valuable to countries with relative endowments of economic resources that are very different from the world as a whole because the gains from trade are particularly high. China and the other densely populated high-income countries of Northeast Asia – Japan and South Korea – are exceptional for their high ratios of capital to natural, including renewable energy resources. So are the countries of central and northern Europe. The densely populated low-income countries of South Asia are exceptional for their high ratios of labor to capital and natural including renewable energy resources. Australia stands out for its immense endowment of natural including renewable energy resources to population, supported by high human and physical capital per person and low-cost access to global capital markets. These countries with relative resource endowments that are very different from the rest of the world receive the largest gains from trade, and lose most from restrictions on open trade. Other important parts of the world economy, notably North America, have relative resource endowments close to the global average, and so receive smaller if still considerable gains from open international trade. All countries gain from the technological improvement that comes from trade across international borders in technology and goods embodying new technology. All countries gain from greater competition in open international markets.

IV. Domestic policies to achieve zero net emissions

Achievement of a zero emissions economy over only a few decades requires innovation and structural transformation at an extraordinary pace in all economies. Our experience of economic development tells us that the required rate of change is more likely in economies in which market exchange plays an important role in allocating resources and setting prices.

However, market exchange leads to economically efficient outcomes only if external costs and benefits from market transactions are recognized, and policy interventions are made to correct or compensate for external effects. Two externalities are especially important in movement towards a zero carbon economy. One is the cost that carbon emissions from an economic activity impose on people everywhere who are not party to the transaction generating the emissions. Professor Nicholas Stern has called this the greatest market failure that the world has ever seen (Stern, 2007). The second is the external benefit that an innovator confers on others. The first business to apply a new technology incurs costs that are not certain to yield returns. The application provides valuable information to others about whether the early mover succeeds or fails. The first movers discover and contribute to knowledge that overcomes weaknesses in production processes, constraints, and problems in the regulatory environment and the supply of essential inputs. Latecomers avoid important costs by applying knowledge generated by those who went before them.

The first externality can be corrected in two ways: imposing regulatory constraints on activities that generate emissions; or imposing a cost on carbon emissions – a carbon price. Regulatory constraints are effective, but crude, and often unnecessarily expensive. A carbon price will generally achieve the required reduction in emissions at the lowest possible economic cost by systematically encouraging less over more carbon-intensive ways of achieving economic goals.

A carbon price can be set either as a tax at a uniform rate on all greenhouse gas emissions or within the operation of an emissions trading system.

There is some rate of carbon tax that, in combination with payments at the same rate for negative emissions, will achieve zero net emissions at some future date. I have explained elsewhere that the economically optimal tax rate will rise over time at an appropriate interest rate (Garnaut, 2008). The tax can be a large economically efficient source of taxation revenue for as long as carbon emissions are positive. It is economically efficient because it does not distort resource allocation decisions, except by reducing emissions-intensive economic activity as intended. The tax rate is set by reference to economic modeling of the marginal cost of reducing carbon emissions at the point where and time when net emissions are zero. It will lead to the desired amount and rate of emissions reduction if the modeling has correctly identified the cost of emissions reduction. There is a risk that the modeling will lead to the tax rate being set too high (unnecessarily early achievement of zero net emissions) or too low (net zero delayed beyond the desired date).

With an emissions trading scheme, the authorities set the desired levels of emissions year by year along a trajectory of emissions reduction leading to net zero at the desired date (say, 2060, or 2055). The government allocates emissions permits in line with this trajectory. The permits are scarce and valuable and trade amongst participants in the market establishes the carbon price. The price can be expected to rise over time at an appropriate interest rate. The price will be identical to the rate of carbon tax in the case where the modeling by the authorities has correctly defined all economic factors affecting the cost of reducing carbon emissions. If the authorities allocate the permits by auction to the highest bidder, they will receive the same amount of revenue as would be generated by the carbon tax. If the authorities give some permits free to participants in the market, this does not affect the carbon price but transfers potential revenue from the government to the recipient of the free permits.

Which is better, carbon tax, or emissions trading scheme? The emissions trading scheme is more certain to achieve the desired emissions reduction objective. However, it is associated with a variable carbon price, which may be seen as having disadvantages for producers and consumers of carbon-intensive goods. In truth, either can achieve the desired result: economically efficient transition to zero net emissions.

China has had extensive experience with an emissions trading scheme since it was introduced into a number of provinces and cities in 2017. The scheme was extended to the whole of China in 2022. There are many exemptions, so that it is not yet able to play the role of securing reductions wherever in the economy they can be achieved at the lowest cost. Many permits are allocated for free, so the scheme does not raise the public revenue that would be possible without distortion of economic activity. More permits are allocated than would come from a trajectory defined to reduce emissions to zero at an economically optimal rate. The current price of US$8–9 per tonne of carbon dioxide equivalent is not yet high enough to put China on a path to zero emissions.

The established emissions trading scheme is a start. It can be tightened and extended relatively easily. It provides a foundation for an efficient set of policies to achieve zero net emissions by 2055 or 2060. The discussion of international cooperation later in this paper suggests that tightening and extending the emissions trading system holds prospects for establishing a sound basis for Chinese participation in international trade in the goods and services that will be important in the zero emissions economy. Linkage to international markets will establish and require a much higher carbon price – something like the level now emerging from trade within the European Trading Scheme.

The second externality – one company's innovation conferring benefits on others – leads to underinvestment in innovation in the absence of public financial support. China has many mechanisms for providing fiscal support for innovation in the zero carbon economy. Here the task is not to introduce new mechanisms, but to rationalize them across activities. Public support for public good research in universities and specialized research institutions is warranted and generally provided at relatively high levels. In the early stages of development and commercialization of new technologies and new approaches to economic activity that significantly reduce emissions, the best economic outcomes will be achieved by all innovative investment attracting similar rates of fiscal support. The high rates of innovation in the zero carbon economy reflect appropriately high rates of public fiscal support from national, provincial, and local governments.

V. China–US cooperation on climate change

Cooperation between China and the US played a significant role in the success of both the Paris and Glasgow conferences. Both meetings were preceded by bilateral agreements that announced substantially increased ambitions for national programs. Both countries took the bilateral commitments into the conference as national programs. At Paris, China committed formally to having emissions peak before 2030, and at Glasgow to reaching zero net emissions by 2060.

China's commitment at Glasgow was particularly important for the global effort. It brought the global goal of zero net emissions by 2050 within reach.

It is worth recalling the main elements of the US–China Joint Glasgow Declaration on Enhancing Cooperation, secured by the two Presidents on November 10, 2021 – the eve of the Glasgow conference. The agreement between the two countries began by recognizing the seriousness and urgency of the climate crisis. The two governments agreed to accelerate actions in the critical decade of the 2020s, as well as to cooperate in multilateral processes to avoid catastrophic impacts. They declared their intention to work individually, jointly, and with other countries during this decisive decade, to accelerate the transition to a global net zero economy.

In particular, the two sides expressed the intention to cooperate on:

(i) regulatory frameworks and environmental standards related to reducing emissions of greenhouse gases in the 2020s;

(ii) maximizing the societal benefits of the clean energy transition;

(iii) policies to encourage decarbonization and electrification of end-use sectors;

(iv) key areas related to the circular economy, such as green design and renewable resource utilization; and

(v) deployment and application of technology such as Carbon Capture, Usage, and Storage and direct air capture.

The two countries agreed that action to control and reduce methane emissions in the 2020s was necessary. The two countries would cooperate to enhance the measurement of methane emissions; to exchange information on their respective policies and programs for strengthening management and control of methane; and to foster joint research into methane emission reduction challenges and solutions.

In order to reduce CO_2 emissions, the two countries would cooperate on policies that support high shares of low-cost intermittent renewable energy. The US noted that it had set a goal of 100 percent carbon pollution-free electricity by 2035. China noted that it will phase down coal consumption during the *15th Five Year Plan* (2025–2030) and make best efforts to accelerate this work. The two sides recalled their respective commitments to eliminating support for unabated international thermal coal power generation.

Recognizing that eliminating global illegal deforestation was important to reaching the Paris goals, the two countries would collaborate in eliminating global illegal deforestation through effectively enforcing their respective laws on imports.

Both countries recognized the importance of developed countries mobilizing jointly US$100 billion per year by 2020 and annually through 2025 to assist developing countries on climate goals and stressed the importance of meeting that goal as soon as possible.

A "Working Group on Enhancing Climate Action in the 2020s" would meet regularly to address the climate crisis and advance the multilateral process, focusing on enhancing concrete actions in this decade.

The US–China Joint agreement provided an important support for Glasgow. It anticipated continuing to provide support for progress to net zero global emissions through the 2020s.

The agreement was suspended in August 2022 by the Chinese government in response to the visit to Chinese Taipei of the Speaker of the US House of Representatives, Nancy Pelosi. Prior to these developments, climate change had remained an open avenue for cooperation between the two countries, even as bilateral tensions escalated on other issues.

Both countries have a strong interest in the international community's movement to zero net emissions by 2050. Both can continue to move purposefully on their own decarbonization and on emissions reduction with third countries, even if there is no formal bilateral cooperation. However, the US–China cooperation has been important for successful outcomes in UNFCCC conferences and has the potential to strengthen each country's own decarbonization efforts and the sum of their respective impacts in third countries.

The bilateral cooperation between the two largest economies and most influential polities has been derailed for the time being by geostrategic tensions, and in particular by discordant perspectives on implementation of the agreed "One China" principle. Strategic rivalry between the US and China is a fact of the contemporary world, and for the time being, it seems inevitable that each country will restrict trade in items that have clear implications for the strategic balance. Global development and prosperity, and more generally the future quality of human society, depends on China and the US being able to manage strategic tension without war or loss of global gains from trade beyond items that have large and clear implications for strategic competition. It is not obvious that restrictions on trade in zero carbon technology and goods would systematically favor either China or the US in their strategic competition. It is therefore to the benefit of both and to the world as a whole that bilateral cooperation on building the zero emissions world economy is resumed. In the unhappy circumstances of long-term continued suspension of bilateral cooperation on climate change, it is important that third countries interact productively with both on reduction in emissions, so that US–China tensions impose minimum damage on the global progress towards zero net emissions.

VI. The role of international economic cooperation

More generally, there is large advantage for climate change mitigation and global development in maintaining open trade in zero carbon goods, equipment for building the zero carbon economy, and in carbon credits.

The understanding of comparative advantage and the gains from trade have been assimilated into Chinese development policy so thoroughly that by the fourth decadal anniversary of reform in 2018, I remarked that China had become a source of education on Ricardian theory and practice (Garnaut, 2018). Professor Lin Yifu's Center for New Structural Economics at Peking University was a source of knowledge on comparative advantage, influencing development planning to good effect in some African countries (Lin and Wang, 2017).

Allowing comparative advantage to guide resource allocation in the building and then maintenance of the zero emissions economy is going to be important to achieving the Glasgow goals, and to maintaining prosperity in both countries and the rest of the world through the transition. This will require open trade in equipment for the transition, in zero emissions goods and in carbon credits.

A decade ago, important steps were taken in support of open trade in "environmental products" within Asia–Pacific Economic Cooperation. These have survived the trade and political tensions between China and the US and its allies in recent years. It would be helpful to extend the early initiatives and to introduce similar initiatives in the WTO. Pending support from all WTO members, plurilateral agreements could be helpful in themselves and encourage wider multilateral efforts.

The European Union is set to introduce taxation on imports after 2025, for goods that embody carbon emissions, imported from countries that do not have similar carbon constraints to the EU. It is likely that the UK and US will introduce similar measures, possibly in concert with the EU. Other developed countries, notably South Korea and Japan, are likely to ensure that their own incentive systems for carbon reduction are of kinds and levels that avoid exclusion from major markets.

It is strongly in the interests of China and its economic partners in the developed world that China is not excluded from developed country markets for goods that are currently made with high emissions but which are capable of being made with net zero emissions. The straightforward means of avoiding catastrophic loss of gains from trade would be through China strengthening the emissions trading scheme and allowing trade with Europe in emissions permits, alongside open trade in environmental products.

China has a particular interest in open trade in two types of products. One is the capital goods of the zero emissions economy, where China is currently the world's largest exporter. It is prospectively a much larger exporter as the world moves to zero net emissions. The second is goods currently made with high emissions that will embody zero emissions in the new economy – zero emissions iron, silicon, aluminum, and other metals, made with renewable energy or hydrogen from renewable energy in countries with rich mineral and renewable energy resources; or zero emissions hydrogen embedded in ammonia or in other forms. Drawing zero emissions materials from countries with rich renewable energy resources will allow China to remove emissions from its own supply chains at relatively low cost, supporting its continued access to and competitiveness in the markets of developed countries.

VII. Disruption from the COVID crisis and the Russian–Ukraine War

Long-term progress on the energy and industrial transition has been affected by the dislocation of the COVID pandemic, and now the disruption of global energy markets from the Russian–Ukraine war.

The Glasgow meeting was postponed by a year as a result of COVID, but its outcome does not seem to have been weakened by the delay. The global economic recession caused by the COVID restrictions reduced carbon emissions in 2020, and there was a sharp shift in recovery from recession, but these were temporary phenomena that had no long-term consequences.

The disruption of the global coal, oil, and gas markets from the war in Ukraine is a larger challenge to the transition. High energy prices in Europe, spreading to the rest of the world, have elevated the priority of short-term energy security and cost over reductions in emissions. This has been a setback for movement to net zero in the short term, especially in Europe. However, it has drawn attention to the greater energy security in the longer term of reduced reliance on fossil carbon and hydrocarbon imported from potentially unreliable sources. Renewable energy, drawn from local sun and wind, is inherently more secure. The long-term effect of the fossil carbon market disruption may be to accelerate the energy transition.

VIII. Conclusions

China has an immensely important role in reaching the agreed international goal of holding temperature increases close to 1.5 degrees by achieving zero net global emissions by 2050. Success is more likely and will be achieved at a lower cost if there is close cooperation across national boundaries. Within that success, China is a major source of capital goods for the global transition and a major importer of energy-intensive goods that are more economically supplied from countries with richer relative endowments of renewable energy resources. Geo-political tensions with developed countries are potentially a risk to the required cooperation. China and its partners throughout the world share an acute interest in ensuring that disruption of trade is confined to goods and services in which China or other countries have real and substantial security interests. This would allow the world to continue to benefit from specialization in line with comparative advantage in goods that are important in the energy and industrial transition to zero net emissions.

References

Cai, F. and Y. Huang, 2013, "Macro-economic implications of the turning point," in Y. Huang and F. Cai, eds, *Debating the Lewis Turning Point in China*, London: Routledge.

Chen, Y., A. Ebenstein, M. Greenstone and H. Li, 2013, "Evidence on the impact of sustained exposure to air pollution on life expectancy from China's Huai River policy," *Proceedings of the National Academy of Sciences*, Vol. 110, No. 32, pp. 12936–41.

Garnaut, R., 2008, *The Garnaut Climate Change Review*, Melbourne: Cambridge University Press.

Garnaut, R., 2018, "Fourty years of economic reform and the challenges ahead," in R. Garnaut and L. Song, eds, *China: Fourty Years of Economic Reform and Growth*, Canberra: Australian National University Press.

Garnaut, R., 2022, *The Superpower Transformation: Making Australia's Zero Carbon Future*, Australia: La Trobe University Press in conjunction with Black Incorporated.

Garnaut, R. and Y. Huang, 2006, "Continued rapid growth and the turning point in China's development," in R. Garnaut and L. Song, eds, *The Turning Point in China's Economic Development*, Canberra: Asia Pacific Press [online; cited August 2022]. Available from: doi.org/10.26530/OAPEN_459745.

Garnaut, R., F. Cai and L. Song, 2013, "China's new strategy for long-term growth and development missions in the new economy," in R. Garnaut, F. Cai and L. G. Song, eds, *China: A New Model for Growth and Development*, Canberra: Australian National University E Press.

Garnaut, R. and D. Llewellyn-Smith, 2009, *The Great Crash of 2008*, Melbourne: Melbourne University Press.

Lin, J. Y. and Y. Wang, 2017, *Going Beyond Aid: Development Cooperation for Structural Transformation*, Cambridge: Cambridge University Press.

Meinshausen, M., Z. Nichols, R. Burdon and J. Lewis, 2022, "The diminishing carbon budget and Australia's contribution to limit climate change," in R. Garnaut, ed., *The Superpower Transformation: Making Australia's Zero-Carbon Future*, Melbourne: BlachInc with Latrobe University Press.

Sandiford, M., 2022, "The net zero opportunity for Australian minerals," in R. Garnaut, ed., *The Superpower Transformation: Making Australia's Zero-Carbon Future*, Melbourne: BlackInc with Latrobe University Press.

Song, L., 2022, "Decarbonising China's steel industry," in R. Garnaut, ed., *The Superpower Transformation: Making Australia's Zero-Carbon Future*, Melbourne: BlackInc with Latrobe University Press.

Stern, N., 2007, *The Economics of Climate Change*, London: Cambridge University Press.

(Edited by Shuyu Chang)