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The economic case for China's sustainable urban transformation

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Policy insight

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Summary

There is a strong economic case for transforming the development trajectory of China's cities. Urban infrastructure investments and spatial policies that drive development towards 'clean, compact and connected' (CCC) cities can generate vast economic rewards and bring long-lasting environmental and social benefits. Urban areas that allow people to breathe, move and work productively increase prosperity, health, resilience and a sense of wellbeing among residents. Conversely, polluted, inefficient and congested cities will not only undermine China's carbon neutrality goals, but also diminish the country's economic growth potential and further expose urban areas to the environmental risks of climate change.

China's 14th Five-Year Plan emphasises that the country must continue to pursue its human-centric 'new urbanisation' strategy to guide the development of its cities, recognising the importance of cities to China's future economic and ecological goals. A section of the plan calls for the full realisation of China's development of human-centric, low-carbon and compact cities, which is aligned with the CCC cities framework.

CCC cities have both benefits that are measurable and others that are not so easy to quantify but are equally important to China's economy. The benefits of reduced infrastructure spending, productivity gains from reduced commuting time, and jobs created from low-carbon urban investments, for example, can be measured. Those not immediately found on a ledger include increased innovation potential due to agglomeration effects, and far-reaching positive impacts for the wellbeing and health of urban residents. Further, an urban development model based on CCC cities creates an opportunity for China to secure market competitiveness in resource-efficient solutions and innovations central to the future global low-carbon economy.

Made rapidly, strategic investments and supportive measures for CCC cities can also support a national carbon dioxide emissions peak by 2025, a target some climate economists have suggested is necessary to place China on a viable pathway to reach carbon neutrality by 2060.

Recommendations

- Embed the 14th Five-Year Plan's human-centric 'new urbanisation strategy' into the centre of forthcoming sectoral and municipal implementation plans.
- Include and prioritise robust indicators within the municipal government performance system that reflect and encourage adherence to the 'new urbanisation strategy'.
- Ensure a holistic cost-benefit analysis that is consistent with principles of the 'new urbanisation strategy' is carried out on urban infrastructure projects.
- Improve the international competitiveness of Chinese cities by systematically benchmarking their sustainable urban development progress against global peers.
- Incentivise low-carbon urban development by assigning specific verifiable emission reduction responsibilities and prioritise city-level carbon inventory systems.

1. Introduction

The unprecedented scale of China's transformation into an urban-majority country over recent decades is one of the most significant features of the past half century globally. China's urban story is not only evident in the cityscapes of Shanghai and Shenzhen: it can also be measured across a wide range of economic and social indicators, from income levels to life expectancy. However, in China environmental and climate challenges are growing increasingly urgent – and costly – to address, including air pollution, urban sprawl, natural disasters and greenhouse gas emissions. There is a strong economic case for China to continue its urban transformation in a way that is sustainable in the long term; this report presents that case.

The problems of the past and a commitment to the future

Cities and how they are built – their 'urban form' – have strong lock-in effects that can last for decades, if not centuries. Amplified urban sprawl feeds inefficiencies that affect productivity and innovation, and expands into prime agricultural land, reducing resilience to natural disasters and health pandemics. Increasingly evident is how climate change and fossil fuel use in China are threatening the economic stability of its cities. Although the government has taken significant steps towards alleviation, these problems are starting to undermine the economy, hampering efforts to attain the goal of higher quality growth.

China's growth over the past few decades has been largely driven by the productive activities within its urban areas. The strength and quality of China's growth in the coming decades depends on how its cities develop further. If its urban areas allow people to breathe, move and work productively, the whole country will benefit from increases in prosperity and wellbeing. Conversely, polluted, inefficient and congested cities will undermine China's growth. In recognition of this, China has envisioned a concept of development called 'ecological civilisation', which melds the balancing of environmental protection with economic growth and a host of social goals.

In September 2020 President Xi Jinping announced China's climate goal to reach carbon neutrality, or net-zero carbon emissions, by 2060, and a carbon dioxide emissions peak before 2030. This historic move underscores China's commitment to a sustainable model of development. Xi Jinping's reaffirmation of this pledge at the Leaders Summit on Climate in 2021, and stated intention to further develop strategies by the time of the UN climate conference COP26, scheduled for November, illustrates building momentum.

The 14th Five-Year Plan: a critical time period

How China steers its development in cities within the 14th Five-Year Plan period of 2021 to 2025 will determine how quickly it can reach high-quality growth overall. China's continued promotion of the human-centric 'new urbanisation' strategy in the 14th Plan is a significant positive move towards making its cities more sustainable. China's urban vision is clear as the strategy includes compact development, and liveable, green, innovative, humane and resilient city concepts. With the right low-carbon and sustainable infrastructure investments and spatial policies in the implementation plans that follow, China could accelerate towards making this vision a reality and put itself in a stronger position to reach its 2060 carbon neutrality goal. If done rapidly, it could mean that many of its cities could peak their carbon dioxide emissions before 2025, allowing a national peak by 2025, a target some climate economists have suggested is necessary to place China on a viable pathway to reach carbon neutrality by 2060 (He and Zou, 2020).

Strategic decisions for how cities handle climate change adaptation and mitigation during the 14th Five-Year Plan period will have a long-lasting impact for decades and centuries to come. As China prepares for another 200 million of its citizens to be integrated into urban areas by 2050,

the choices made today to build clean, compact and connected cities will have significant implications for its economic, social and environmental future.

Accelerating the pace of well-planned and managed cities within this period requires greater economic productivity, resource efficiency, less fossil fuel use and greater resilience against natural disasters and disease pandemics. Now more than ever, in the midst of the global COVID-19 pandemic, the importance of strengthening cities to increase their resilience is incontrovertible.

China in the world

China can lead on the transition towards a zero-carbon economy and benefit from being at the forefront of the new global growth story, where physical and human capital will be increasingly complemented by natural and social capital (Stern et al., 2020). Its goals are in line with international aspirations to achieve the Paris Agreement and its temperature goal of holding global warming to well below 2°C, pursuing efforts for a 1.5°C maximum increase.

Countries around the world are setting targets for net-zero emissions of greenhouse gases, or carbon neutrality, and investing heavily in low-carbon infrastructure projects to stimulate economic recovery from the COVID-19 pandemic and aid the transition to a zero-carbon economy. National governments, local policymakers and related stakeholders, including urban planners, developers, architects and community organisations, are pursuing policies to promote the development of sustainable cities, with better planning of density and for mixed-use development, public and non-motorised transport, energy-efficient buildings and green spaces, among many other features.

If China accelerates the urban development plans it has outlined in the 14th Five-Year Plan, it has the opportunity to better compete in a carbon-constrained world and achieve market leadership through its innovations. If it moves too slowly, it may find itself being overtaken by competitors, and even confronted with restrictions on its high-carbon exports.

2. Context

Climate change and fossil fuel use threaten the economic stability of China's cities

China faces significant climate change-related disaster risk, which could override the gains made in reducing poverty and prevent further growth. China is regularly among the top three nations most affected by disasters annually in terms of disaster frequency, lives lost and economic damage (World Bank, 2021a). Due to the country's large size and varying physical characteristics, the impacts of climate change on China are and will continue to be diverse.

Global warming of more than 1.5°C above pre-industrial levels is expected to cause extreme weather events, including strong heat waves, tropical storms, severe rainfall and droughts in regions across China (Weijie, 2020; Hoegh-Guldberg et al., 2018). In particular, the country has very high exposure to typhoons and flooding, including flash, riverine and coastal flooding (World Bank, 2021a), and the United Nations Office for Disaster Risk Reduction has estimated US$18 billion as the average annual loss from floods in recent years (UNDRR, 2014). Floods cause major damage to agriculture and therefore to food security, a major concern for the government (see Box 1 below).

More than 194 million people – over 13 per cent of China's total population and a fifth of the urban population – live in coastal zones less than 10 metres above sea level and 92 per cent of these in urban or peri-urban areas (Coalition for Urban Transitions, 2021). While these at-risk low-elevation coastal zones are a small fraction of the total urban land area, they are home to critical infrastructure and high-value real estate.

Fossil fuel consumption also causes a threat to Chinese cities in a more direct manner: through air pollution. Despite notable improvements in air quality in many Chinese cities, air pollution in the form of ozone and particulate matter (PM) contributes an estimated US$40 billion a year in economic losses through social costs, including early death, equivalent to about 0.7 per cent of GDP (Zhang et al., 2018). At the higher end, some estimates value the health impacts of $PM_{2.5}$ exposure alone at 10 per cent of annual GDP (World Resources Institute, 2021).

Health costs are not the only impacts of air pollution on Chinese cities and their citizens. Air pollution can affect rainfall patterns and the water cycle, reduce solar energy yields and affect plant and food crops from blocked sunlight and ozone loss (Seddon et al., 2019). Exemplifying the far-reaching effects of pollution, studies have even linked high levels of air pollution to a reduction in expressed happiness (Zheng et al., 2019) and a significant reduction in intelligence (Zhang et al., 2018). This harms the development of human capital, the foundational driving force for economic growth.

Replicating the existing sprawling urban form will have severe lock-in effects

Rapid urban transformation has been central to China's economic success story. At the start of the Reform and Opening Up period in 1978, just 18 per cent of Chinese people lived in urban areas, which has grown to more than 60 per cent today (World Bank, 2021b). China's urban population of 840 million people is roughly equal to the populations of the United States, EU and UK combined (World Bank, 2018). Nearly a third of the world's urban land expansion between 2000 and 2014 occurred in China, bringing the country's urbanised area to around 35,000km^2 (greater than the size of Belgium) (Ahmad and Colenbrander, 2020).

China's dramatic transformation has come at considerable cost, not least in terms of greenhouse gas emissions. About 85 per cent of energy-related carbon dioxide emissions are generated in China's cities (Dhakal, 2009, 2010). Despite decades of rapid urbanisation, China remains more than 5 percentage points less urbanised than countries of similar income level (World Bank, 2019)

and in the next three to four decades, the urban population is expected to grow significantly further to reach an estimated 75–80 per cent of the total population (Gu et al., 2017), with accompanying increases in fossil fuel consumption.

How cities are built – their urban form – can have strong lock-in effects that can last for decades if not centuries. Urban form is defined as a city's physical characteristics, including the density, size and settlement shape, and its infrastructure, from the layout of the street and road network, to transport structures, to buildings and their materials and their spatial arrangement and public spaces. A city's form can significantly affect travel behaviour patterns, such as whether people travel by car or other forms of transport, and land use decisions that can drive substantial energy use[1] (Madden and Liu, 2017; IPCC, 2018).

China's model for urban development has been often characterised by low density, sprawling urban expansion following energy-intensive investments, which is inefficient. Although the exact proportion of carbon dioxide emissions attributed to urban form is not easily calculated, a number of studies show a correlation between urban form characteristics and carbon dioxide emission levels in Chinese cities (Chuanglin et al., 2015). For example, one study of 104 cities in China found that those with more centralised and compact urban forms are associated with lower per-capita emissions (Wang et al., 2017).

Box 1. China's food security in the context of climate change

While 20 per cent of the world's population live in China, it has only 7 per cent of the world's arable land (China Ministry of Agriculture, 1982–2017). This relatively low per-capita endowment of arable land – at 0.09 hectares per person, versus 0.47 for the United States, for example – has made ensuring a stable food supply to all Chinese citizens a top-level government priority (World Bank, 2018a). The government has established a 'red line', or strict minimum, for national agricultural land to remain above 1.8 billion mu (120 million hectares) (National People's Congress, 2021). Rapid urbanisation in China with its rural-to-urban parcel conversion process continues to encroach on this land, while more food is being consumed by growing urban populations (Cui and Shoemaker, 2018; World Bank, Development Research Center of the State Council, 2014).

Natural disasters also threaten food security (Mbow et al., 2019): floods and droughts over the last four decades caused more than 50 per cent of total grain losses (Guo and Kebiao, 2019). Environmental degradation in terms of soil, water and air pollution also poses major challenges, with toxic organic compounds and heavy metals identified, impacting food safety and security (Hu et al., 2019). The potential volatility of food prices can have significant impacts on the agricultural sector and especially on the livelihoods of China's rural and lower-income urban residents. The production of food is likely to face further challenges in the context of climate change, again highlighting the importance of protecting agricultural land from unnecessary urban sprawl.

Source: Tillu et al. (2021)

China's urban sprawl is particularly unique because its cities have relatively dense urban centres surrounded by fragmented patchworks of alternating urban and undeveloped pieces of land in the rest of the municipality. Thus, China's definition of land within a city boundary includes both urban and rural areas. While much attention on Chinese cities has focused on the central urban core, where most residents live, much of the economic and environmental inefficiencies lie in the urban sprawl that extends into the periphery.

This pattern has made it difficult for China's cities to achieve the full economic benefits that come with agglomeration, as well as causing substantial environmental costs. The piecemeal,

[1] Energy use in cities comes from embodied energy, from manufacturing and distribution of construction materials; operational energy, from heating and cooling and appliances; and fuel for transport, both public and private modes.

disjointed tracts of built-up and rural land that make up Chinese cities result from policies on land ownership, conversion quotas and the land acquisition process (Wu and Gaubatz, 2020). Chinese cities are thus much less dense than would be expected compared with other developing cities around the world: a considerable majority of Chinese cities have seen their population density decrease over time, which is the inverse trend compared with the rest of East Asia (World Bank, Development Research Center of the State Council, 2014).

If China continues on this urbanisation path to accommodate its next 200 million urban residents, the lock-in effects from land use decisions and urban infrastructure choices could lead to serious economic consequences from worsening environmental and social impacts. Amplified urban sprawl feeds pollution, traffic congestion, social inequities – affecting productivity and innovation – and the loss of limited prime agricultural land, threatening food security and reducing resilience to natural disasters (see Box 1 above). Further urban sprawl would lock in even higher levels of energy consumption for years to come, decreasing the overall liveability of cities. These and other pressures, described by the government as 'urban diseases',[2] have caused China's leadership to produce a new model of urbanisation.

[2] The concept of 'urban diseases' includes air pollution, traffic congestion, housing and water scarcity among others, and was first given this label by the Chinese government in 2012.

3. Clean, compact and connected cities for China's low-carbon and sustainable urbanisation model

Clean, compact and connected – CCC – cities are in line with China's human-centered 'new urbanisation strategy'

The shape and layout of cities greatly affects their ability to thrive. The benefits of clean, compact and connected (CCC) cities are significant (Coalition for Urban Transitions, 2019) and bring a wealth of interconnected economic, social and environmental advantages.

CCC cities are aligned with China's aspirations for 'human-centred' urban development and with transitioning to low-carbon and sustainable cities. The human-centred city concept has been asserted by the leadership since the early 2000s and has become the focus of numerous central government plans and strategies as a means to alleviate urban stressors.[3] The National New Urbanisation Plan (2014–2020) and the Opinions on Urban Planning and Management (2016) are just two of such strategies that emphasise urban liveability through limiting sprawl and ensuring the best use of existing land through sustainable transport, compact road networks and mixed-use development, among other themes such as balancing development with ecological protection and urban–rural integration.

The 14th Five-Year Plan contains a section that calls to continue this concept over the five-year period. The Plan includes qualifying adjectives to describe this type of urbanisation, such as liveable, innovative, smart, green, low-carbon, humane and resilient, to guide China's urban growth in the context of easing migration between rural and urban areas and rural revitalisation.

Figure 1 on the next page summarises some of the characteristics of CCC cities:

- *Compact* can include economic density, with a high density of people living and working in a given area; morphological density, making the most efficient use of available land and built space to meet people's needs; and mixed land use or mixed-use development, locating residential, employment, retail and leisure opportunities close to one another.
- *Connected* can include ease of travel within cities to points of interest and amenities via sustainable transport, including non-motorised transport modes, and equitable access to a network of green spaces within neighbourhoods. Internet connectivity brings another important type of connectedness as part of an urban infrastructure service.
- *Clean* can include cleaner forms of energy use, transport, low-carbon industries and improved waste management. CCC cities are more liveable with a higher quality of life, achieved through cleaner air, more convenient and shorter trips through walking, biking and public transport, and a safe and affordable living environment.

[3] Throughout the 2000s, President Xi Jinping emphasised 'people-oriented' or 'people-centered' urban development. Numerous plans and strategies reflect this aspiration, including the National New Urbanisation Plan (2014–2020), the first major national plan promoting sustainable urbanisation. China's 13th National Five-Year Plan (2016–2020), which dedicated a chapter to people-centered (or 'new') urbanisation, set the stage for a series of other national documents, such as the Guidelines for Urban Development and Management (2016) and the Guidelines on Strengthening Environmental Remediation and Urban Rehabilitation of Cities (2017). All of these promote a form of compact, connected and clean development in cities.

Figure 1. Clean, compact and connected cities

Source: Climate Emergency, Urban Opportunity (Coalition for Urban Transitions, 2019)

Direct cost savings

Direct cost savings are the most immediate benefits from infrastructure development associated with cities that are more compact because less land, materials and energy are needed to connect to people and places when they are closer together (Coalition for Urban Transitions, 2019). The investment needs are less for large infrastructure systems such as public transport, telecommunications lines, waste management and water supply and sanitation. Further, in less sprawling cities per-capita operating costs of infrastructure and public services are reduced for more users, as are individual energy and transport costs.

The positive effects of dense urban form in these areas have been extensively studied (Ahlfedlt and Pietrostefani, 2017), and it has been estimated that China could save up to US$1.4 trillion by pursuing more compact, connected urban growth that successfully integrates land and transport development (Zhang et al., 2013).

Productivity and innovation

Urbanisation, productivity growth and innovation are closely related (Stern and Zenghelis, 2018). Beyond the direct cost savings mentioned above, a well-established body of literature has illustrated the link between compact and connected cities and economic productivity and innovation, especially in cities with efficient public transport networks that enable residents to commute to work and access services easily (Coalition for Urban Transitions, 2019).

Agglomeration generates economic benefits in three primary ways, as summarised by the Coalition for Urban Transitions (ibid.) – through sharing, matching and learning benefits:

- *Sharing benefits:* Where many firms seek a common set of inputs, suppliers of those inputs are able to specialise and achieve economies of scale. This in turn means that purchasers benefit from lower costs and/or increased productivity.
- *Matching benefits*: Larger markets allow firms to find a better fit with their specialised needs, by employing workers with distinct skills and/or by linking to suppliers with distinct products. Greater specialisation of both labour and firms enables greater efficiency.

- *Learning benefits:* Close geographical proximity of workers and firms enables more frequent interactions both within and across sectors. This facilitates the spread of existing knowledge, in particular tacit knowledge that is hard to codify in documents or formulas.

A study conducted by the London School of Economics and Political Science for the Coalition for Urban Transitions showed that in Europe a 10 per cent increase in population density is linked to an increase of 1.9 per cent in gross value added. Most studies suggest that productivity patterns in Asian cities are generally consistent with these agglomeration effects (Asian Development Bank, 2019). A study of 200 Chinese cities in the 1990s showed that workers' real incomes and output per worker were higher in bigger cities (Au and Henderson, 2006). Another study, of 120 Chinese cities, showed that a doubling in city size was associated with firm productivity increases of 3 to 8 per cent (World Bank, 2009).

The liveability of cities is also directly tied to a city's ability to attract human capital. Liveable cities are better able to compete in the marketplace for high skilled and high wage workers and businesses from across China and globally, thus boosting their economic and innovative capacities. A higher-paying job market can also benefit lower-skilled workers due to a spillover effect. The connection between innovation, talent and liveable urban spaces is a virtuous cycle that has been recognised and used in city branding strategies to promote economic development.

Box 2. 'Good density'

Most studies on the benefits of compact cities relate to developed countries. There has been significant debate over whether promoting concentrated urban density makes sense in the developing country context, where many cities are already very densely populated (Jenks and Burgess, 2000). For instance, China's cities have a much higher population density than US or European cities (with more than three times the average population density in China than in the US and almost twice more than in Europe), and some of the benefits associated with higher density seen in others places, such as decreased commuting times, are not clearly found across Chinese cities in some studies (Engelfriet and Koomen, 2017). There are, of course, negative effects to being overly dense, such as overcrowding. The goal should be to design areas in a way that attains 'good density' (Urban Land Institute and Coalition for Urban Transitions, 2018). Rather than further densifying already high-density areas, this means balancing population size and infrastructure development across a city to ensure connectedness between housing and jobs, coordinated with services and amenities, all to promote an improved quality of life.

Although the government has stated in recent years that managing population density and urban sprawl are priorities, remote sensing data show that urban sprawl is continuing to take place across China. In the central and western regions, cities continue to sprawl outwards (Wang et al., 2019), while in many eastern cities, although the pace of sprawl has decreased, populations have been forced by increased housing prices to move into the city fringes. Thus, China's cities still have much scope to become more compact.

One approach to compact cities being adopted in China is the concept of '15-minute life circles'. Many Chinese cities have embedded this concept into their masterplans, including Shanghai as a frontrunner. It dictates that cities should be redeveloped or built by focusing on providing essential services and public spaces within a 15-minute walking distance. This is similar to initiatives like Paris's '15-minute city' and other similar schemes in Barcelona, Detroit, London and Portland.

Source: Tillu et al. (2021)

Urban resilience

Constructing clean, compact and connected cities can strengthen urban resilience – defined by the ability of a city to survive, adapt and grow despite the chronic stresses or acute shocks it experiences, such as natural disasters, economic crises, public health issues and social unrest (Resilient Cities Network, 2021). Section 2 above outlined some broad economic costs of inaction for mitigating and adapting to various climate shocks.

China could improve enforcement of its many policies in line with the CCC cities approach, resilience and nature-based solutions for climate change mitigation and adaptation. One of the most explicit policy tools to curb urban sprawl and preserve natural environments is the use of development-limiting restrictions or 'urban development boundary' lines (Zhang, 2019). This policy, pushed heavily by the central government since 2013 with mixed adoption results, was recently reinstated by the Ministry of Natural Resources, to be applied to provinces and cities.[4]

China is also one of the first countries to explicitly attempt coordinated, ecosystem-based management across local, regional and national scales. Incorporated into the national Environmental Protection Law in 2015, the Ecological Redline Policy demarcates priority land areas with high-value ecosystem services and prevents them from being built up for urban use. With recent mandates for regional and local government collaboration to enforce this policy, large areas of land are predicted to be protected from urban expansion (Ju et al., 2020). This and other policies are due to be updated under the new, unified national territorial and spatial planning, and could benefit from alignment with CCC development.[5]

Finally, China's Sponge City pilot programme of dozens of cities, launched in 2013 to support urban water management, is gaining renewed attention amid fresh concerns about urban resilience and due to focus on the United Nations Biodiversity Conference, to be held in China in October 2021. Stronger enforcement mechanisms for these policies and initiatives, and re-examination of other planning guidelines such as land conversion quotas and floor area ratio regulations for buildings, could accelerate resilience rewards.

[4] Proposed at the 2013 Central Urbanisation Work Conference by Xi Jinping. There has been a requirement to include 'Urban construction boundaries' in city masterplans by the China Town and Country Planning Act since 2006.

[5] The new National Territorial and Spatial Plan merged several sectoral plans previously implemented by different ministries to eliminate overlapping mandates and increase efficiency. Part of this is a new governance system that includes planning for urban development boundaries, agricultural redlines, and the ecological redline policy (the 'three red lines'), productivity-based land supply, carbon and pollutants intensity, constrained land supply, and development intensity.

4. Benefits of low-carbon and sustainable urban infrastructure investments

Return on investment

The returns on low-carbon urban infrastructure investments are significant. New analysis for the Coalition for Urban Transitions suggests that a package of technically-feasible low-carbon measures taken today could cut global emissions from certain urban sectors by almost 90 per cent by 2050. These sectors include green construction and retrofits, renewable urban energy, active and clean forms of mobility, and material and waste efficiency. The investments required to reduce urban emissions would be US$1.83 trillion (about 2 per cent of global GDP) per year, but they would generate annual savings worth US$2.80 trillion in 2030 and US$6.98 trillion in 2050. This yields a net present value of US$23.9 trillion (Coalition for Urban Transitions, 2021).

China could implement a package of low-carbon measures similar to those proposed to cut global emissions. Analysis specific to China by the Coalition for Urban Transitions indicates that it could produce significant economic returns and help reduce urban emissions from urban buildings, transport and waste by 48 per cent in 2030 compared with today (1.94 gigatonnes of carbon dioxide equivalent [$GtCO_2$-e]) and 89 per cent in 2050 (around 3 $GtCO_2$-e). Together these measures would bring a net present value of US$7.7 trillion (CNY50 trillion) by 2050, based on energy and material cost savings alone. Realising this opportunity would require annual investments of US$170 billion (CNY1.1 trillion) per year between 2020 and 2050 – equivalent to about 1.3 per cent of China's annual GDP (ibid.) – but this could generate annual savings worth US$200 billion (CNY1.3 trillion) in 2030 and US$610 billion (CNY4 trillion) by 2050.

These numbers are likely to be considerably underestimated as they do not take into account potentially higher energy prices, nor faster technology learning rates. Moreover, while commercial loans typically generate returns of 4.4 per cent in China, these investments would collectively yield 12.1 per cent (Vivid Economics, 2021).

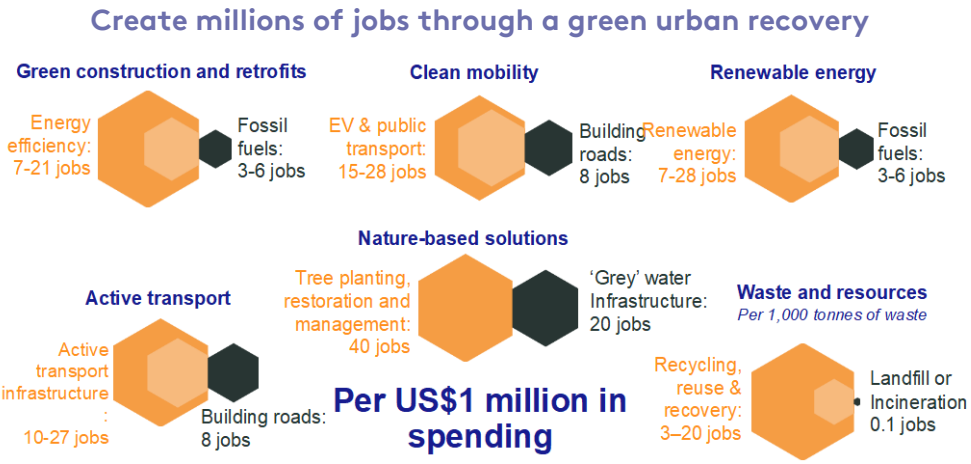
Investment in low-carbon jobs

A lesson from the 2008 financial crisis is that green stimulus policies often have economic and environmental advantages over a traditional fiscal stimulus (Ahmad et al., 2020). Ample research shows that investing in low-carbon urban infrastructure[6] can create more and higher-paying jobs than investments in traditional infrastructure, as illustrated in Figure 2. For example, renewable energy creates more jobs than fossil fuel investments by a large margin.

The analysis above indicates that adopting the same package of low-carbon measures – cutting emissions from urban buildings, materials, transport and waste – could support 15.2 million jobs in China in 2030, mostly in energy efficiency in the buildings sector, and 3.5 million jobs in 2050, mostly in electric vehicles. For comparison, in 2017 China's automotive industry employed about 1.6 million people (Coalition for Urban Transitions, 2021). A recent study shows that the job creation rate of renewable energy industries, such as wind power and solar energy, and of the energy efficiency sector, is between 1.5 and three times that of traditional energy industries in China (Varro and Fengquan, 2020).

[6] Low-carbon urban infrastructure in this section refers to investments in the buildings, energy, transport, materials and waste sectors.

Figure 2. Low-carbon sectors out-perform traditional sectors in job creation



NB: For Clean R&D, the certainty around the direct job growth potential per US$1 million in spending is insufficient to provide a comparison. For all sources view The Economic Case for Greening the Global Recovery through Cities, Coalition for Urban Transitions, 2020

Weaning China off fossil fuel dependence

One of the benefits of transitioning away from a high-carbon urban model, especially by promoting low-carbon transport and renewable energy, is lowering China's dependence on imported oil. China is by far the world's largest importer of oil, with more than 10 million barrels being imported each day on average (US Energy Information Administration, 2020). Dependence on oil puts China's economy at potential risk from supply disruption and price fluctuations. As a more compact urban form means fewer car journeys are needed and thus reduces fuel consumption, CCC cities can help the Chinese economy decouple from the volatility of the global oil market (Rentschler, 2013).

China is also the world's largest subsidiser of fossil fuel energy, which is contributing to preventing a faster transition to renewable energy – see Box 3.

Box 3. Fossil fuel subsidies

Global fossil fuel subsidies play a significant role in keeping energy prices below their true market price, thus slowing the transition towards sustainable energy sources. It is estimated that globally, subsidies remain around US$5 trillion a year. China is the world's largest subsidiser* of fossil fuel energy, contributing around US$1.5 trillion a year. If global fossil fuel prices were more in line with their true costs, this would lead to significant economic welfare gains of more than US$1.2 trillion per year through reduced environmental damage, increased fiscal revenues and the adoption of new sustainable technologies. More than half of these gains would be felt in emerging and developing economies in Asia, including China.

**Defined as fuel consumption times the gap between existing and efficient prices (i.e. prices warranted by supply costs, environmental costs, and revenue considerations).*

Source: Tillu et al. (2021), drawing on Coady et al. (2019)

5. Industry leadership potential

If China were to make an early entry in emerging low-carbon urban infrastructure and technologies, it could secure the country's competitiveness in the global low-carbon economy. Research shows that countries that successfully invest early in technologies and capabilities have better success in diversifying into future products and markets (Mealy and Hepburn, 2017). Cities across the world will increasingly be seeking to adopt a low-carbon urban development model to meet domestic and international climate change and sustainability goals. Chinese companies that develop capabilities in the technologies and innovations that accompany a low-carbon development model domestically will compete more successfully in global markets.

The increasing adoption of connected technologies is driving the growth of the global smart cities[7] market, which is expected to double in size by 2025, reaching US$820 billion (Research and Market, 2020). While China has made significant strides in smart city development, South Korea is currently a leading global supplier of smart city solutions and technologies, a position gained in large part due to its domestic promotion of smart cities over the past decade (originally termed 'ubiquitous cities') (Business Korea, 2019).

The countries in the Belt and Road Initiative (BRI) are markets that China can target with its low-carbon infrastructure and technologies, to help those countries build more sustainable cities and avoid the severe economic, environmental and social consequences that China experienced due its earlier urbanisation model (Hepburn et al., 2020). Exporting low-carbon urban technology, goods, talent and services into the many BRI countries would unleash long-term economic dividends for Chinese companies. Moreover, it could lock Chinese standards and technologies into low-carbon urban infrastructure over the long term.

China's accelerated adoption of low-carbon infrastructure can also have the potential to support the transition of low-carbon technologies worldwide, not only in the BRI countries. The scale of China's market and the power of Chinese manufacturing can rapidly lower the cost of technologies and products. For example, China's entrance into solar panel manufacturing greatly reduced the cost of the technology and was a critical turning point for solar adoption globally (Vivid Economics, 2020). There is potential for China to make similar contributions in emerging technologies such as energy storage and carbon capture.

As China applies new low-carbon infrastructure and innovations in cities, it can also become more attractive to foreign direct investment (FDI), which is a priority for the government. Moreover, new talent and companies drawn to China's new liveable urban environments will entice other companies to set up business in these cities, inducing further FDI and embedding foreign companies and the latest technologies into China's supply chains.

[7] Smart cities use digital and telecommunication technology to improve the efficiency of services, operations and resources.

6. Urbanisation and regional rebalancing

One of China's long-term national goals has been to narrow the gap between the economically advanced and export-oriented coastal megacities and China's less developed interior. In May 2020 the State Council released new guidelines for the long-standing 'Go West' strategy that reinforce the need to develop China's western regions through the promotion of innovation and modern industries.

The economic opportunities afforded by China's first tier coastal cities drive significant internal migration flows away from the interior region. These migration flows can be considered a type of internal 'brain drain', pulling promising human capital away from interior cities, and in some ways this has hindered the local development of knowledge-based industries and contributed to unbalanced regional development (Science Daily, 2014). Further, lower-skilled migrant workers from rural areas in the interior are overwhelmingly drawn to the first tier cities, often bypassing opportunities in cities closer to home in favour of the coastal cities. The economic and social costs to China's interior regions of this migration are hard to measure but are likely to be significant.

Urbanisation strategy can play a central role in rebalancing development across the country through support for the smaller, well-planned CCC cities in the interior (Ahmad et al,, 2020; Qi et al., 2020). In addition, existing cities in the interior could better retain and draw human capital flows by improving their economic and social offerings. However, many of these cities still heavily rely on high-carbon industries. Though they may not be able to shift their economies from high-carbon industries immediately, taking steps towards a transition is wise. Many other interior cities are at a development stage where they have the opportunity to leapfrog the previous carbon-intensive city layouts by fully considering lock-in implications early on and avoiding them.

As China's more developed regions move away from high-carbon industries, there is the potential for the gap of economic competitiveness with interior regions to grow even further. If interior cities are locked out of the new low-carbon economy, they may experience an even more difficult future transition, further widening the disparities between China's developed and underdeveloped regions. More than half of China's potential for emissions abatement in urban areas by 2050 lies in cities that have currently fewer than one million residents (Vivid Economics, 2021), so ensuring these smaller interior cities are on a low-carbon development path will be crucial for China to meet its climate and environmental objectives.

7. Concluding remarks and recommendations

While the numbers outlined for investment returns and job creation are compelling, they fail to capture the true scope of benefits from investing in CCC cities. The figures do not yet include the many economic benefits from reduced air pollution and congestion, the increase in innovation, industry leadership and economic activities stemming from rebalancing and agglomeration in more CCC cities, or the many intangible attributes that result from a better standard of living.

Myriad physical and mental wellbeing co-benefits can be unlocked by CCC cities. The value from a better quality of life and increased prosperity is often not visible, but is significantly present. For example, the benefits of having access to parks and green spaces can have extensive positive effects on emotional wellbeing, from exposure to nature and engendering a sense of community (Kruize et al., 2019). These improvements in wellbeing and health reduce the burden on health systems and also the number of working days missed (Hepburn et al., 2021). Current economic models fail to capture both the powerful dynamics and the very attractive qualities found in less tangible forms of capital, such as social capital, natural capital and some forms of human capital (Stern et al., 2020). As a result, the benefits outlined above likely grossly underestimate the full range of economic and social benefits of CCC cities.

Climate change is the key global issue contemporaneous with China's rise to economic prominence. The global response to this environmental challenge will in large part determine the material and social wellbeing of our planet in the coming decades. This reality is already transforming the global economy towards new low-carbon and sustainable business models, a trend that will undoubtedly accelerate. 2021 will be a pivotal year, as the major economies emerge from the COVID-19 pandemic, boosted by recovery measures. China is at a unique juncture to drive an ambitious sustainable and low-carbon transformation, riding on strong economic tailwinds.

A focus on an urban development model of CCC cities during the 14th Five-Year Plan period can place China on a long-term trajectory for better quality economic growth and further demonstrate China's commitment to and leadership of the global cooperative actions against climate change. It is also a critical step in ensuring competitiveness in a carbon-constrained world. To act at scale will require massive investment in low-carbon and sustainable urban infrastructure, a transition to cleaner energy and a rethink of the urban form of Chinese cities and their planning, and carry long-term implications for China and the world's economic and environmental trajectory. Although the challenges to achieve this are great, the economic benefits of action are greater still and vastly outweigh the costs.

Recommendations

1. **Embed the 14th Five-Year Plan's human-centric 'new urbanisation strategy' into the centre of forthcoming sectoral and municipal implementation plans.**

There is immense latent economic potential in Chinese cities. The 14th Five-Year Plan's call for more liveable cities through compact spatial policies, environmental protection, and improved transport, promotes key elements of a sustainable urban development path, and is a crucial opportunity to unlock vast economic gains from improved productivity, greater efficiencies and investments in low-carbon infrastructure. Clean, compact and connected cities are also found to be more innovative due to agglomeration effects and their ability to attract human capital. These are key to rebalancing capital and migrant flows to the interior. The effects on the wellbeing and health of urban residents stemming from more liveable cities are difficult to capture through economic modelling, but a reduction in air pollution alone has been shown to create significant economic dividends.

Instead of keeping the human-centric 'new urbanisation strategy' as a separate goal within one part of the 14th Five-Year Plan, to be addressed on its own, cities should be positioned as the central organising unit to address the many long-term structural economic and social goals set across the 14th Five-Year Plan.

Accelerating sustainable urban development during the 14th Five-Year Plan period should mean that many of China's cities peak their carbon dioxide emissions by 2025, making it possible for a national peak by that same year.

2. **Include and prioritise robust indicators within the municipal government performance system that reflect and encourage the 14th Five-Year Plan's human-centric 'new urbanisation strategy'.**

China's system of municipal government performance plays a powerful role in how cities are shaped. The indicators and targets in this system act as scorecards to evaluate city performance, including monitoring the country's Five-Year Plan implementation, and therefore guide the types of urban projects approved and implemented in a city. Since they are tied to government officials' appraisal and promotion, meeting these targets is of the highest priority.

With human-centric 'new urbanisation' included in the 14th Five-Year Plan, the government can seize the opportunity to promote a low-carbon urban transition by thoroughly reforming its government performance system through more robust, practical and comprehensive indicators to measure the outcome of existing spatial development policies and carbon reduction programmes. China's many urban development initiatives are difficult to enforce due to imprecise programme definitions, inadequate spatial resolution tools, and, most significantly, strong short-term economic and political incentives that drive decisions by local governments to build outward. Consolidating some of the original voluntary metrics created for these pioneering initiatives – such as the Sponge City and Low Carbon Eco-cities Pilot Programmes and urban development boundary and Ecological Redline Policy spatial policies – and absorbing them into the government performance system indicators, could bring accountability to China's new urbanisation strategy.

Furthermore, doing so would not only improve the public sector performance of individual municipalities, but would also provide incentives for local governments to cooperate and collaborate on regional development themes, such as air and water pollution within the environment, transport connectivity and public service delivery sectors, and trade.

3. **Ensure a holistic cost-benefit analysis that is consistent with principles of the human-centric 'new urbanisation strategy' is carried out on urban infrastructure projects.**

The economic cost-benefit analysis of urban infrastructure projects should be consistent with low-carbon and sustainable urban development and should take account of the huge economic impacts of damage caused by air pollution, climate change and biodiversity loss. Much of the economic cost-benefit analyses that continue to prioritise 'brown' infrastructure, including building new coal-fired power plants, would likely fail a more holistic measure of the true economic costs over the long term. Thus 'brown' investments, while seemingly cost-efficient in the present, are actually suboptimal and expensive over the longer term. A holistic cost-benefit analysis can boost the real economic efficiency and minimise locking in infrastructure choices that could lead to serious economic consequences from worsening environmental and social impacts. Additionally, projects should consider the full time horizon over which the impacts of new infrastructure occur.

Over the long term, a new system to reflect the costs of such negative externalities on the environment would be instrumental for China's high-quality development. For example, assessing the worth of natural capital by quantifying its economic value through the widespread adoption of natural capital accounting is critical. China is making noteworthy developments to prioritise and recognise natural resources within an expanded definition of economic value, including

piloting tools and analysis to build calculations to measure Gross Ecosystem Product (GEP), or the total economic value of all ecosystem products and services in both monetary and biophysical value, and has launched efforts to create 'natural resource balance sheets'. The Ministry of Finance and the Ministry of Natural Resources are leading on these natural capital accounting pilot programme assessments. Scaling up these efforts for integrated use countrywide can contribute to more holistic cost-benefit analyses. In the long run this could eventually deter high-carbon project investments and encourage low-carbon and sustainable ones.

4. **Improve the international competitiveness of Chinese cities by systematically benchmarking their sustainable urban development progress against global peers.**

Cities are in competition globally for talent and capital. Resource-efficient and liveable cities are best poised to draw the most talented individuals and companies, further sustaining economic growth and leadership. A strong internal system has cities across China competing among themselves on a host of economic and social development indicators. China has actively been learning and applying best practices in sustainable urban development from global cities across many sectors, from waste management to energy-efficient building practices to enforcement measures of spatial policies.

For Chinese cities to compete globally, they could formalise a type of benchmarking scheme for low-carbon and sustainable urban development, systematically comparing themselves over time to cities internationally and making improvements. This would avoid Chinese cities becoming less internationally competitive by being locked into a particular urban development path reinforced through established but suboptimal domestic practices.

5. **Incentivise low-carbon urban development by assigning specific verifiable emission reduction responsibilities and prioritise city-level carbon inventory systems.**

Requiring cities to develop specific and verifiable emissions reduction roadmaps can incentivise and speed up low-carbon urban development in cities and accelerate the economic benefits of an urban transition. Concrete and consistent city-level carbon inventory systems are key to ensuring new urban infrastructure is sustainable. These are necessary in order to measure, report and verify inventories to develop specific and distinct emission reduction actions for the diverse development pathways of China's cities. At present, the methodology for carbon accounting and inventory is more developed at the central and provincial levels and is inconsistent and uncomprehensive at the city level, due to city boundary discrepancies, different definitions of economic development levels and non-centralised statistics.

Some major cities across the country are already on the path towards peaking their emissions by 2025. They have developed carbon roadmaps and are implementing low-carbon investment solutions, while other cities, which rely more on carbon-intensive industries, can aim to peak at a later date. Planning for differentiated timetables for peaking emissions should start now. For all cities, having clear city-level carbon inventories to create specific carbon reduction targets can accelerate their transition to long-term higher quality growth.

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