

## Perspective

## Five tips for China to realize its co-targets of climate mitigation and Sustainable Development Goals (SDGs)



Chi Zhang<sup>a,e,\*</sup>, Wenjia Cai<sup>b</sup>, Zhu Liu<sup>b</sup>, Yi-Ming Wei<sup>c</sup>, Dabo Guan<sup>b</sup>, Zheng Li<sup>d</sup>, Jinyue Yan<sup>a,e</sup>, Peng Gong<sup>b,\*</sup>

<sup>a</sup> School of Chemical Science and Engineering, Royal Institute of Technology, Teknikringen 42, Stockholm SE-100 44, Sweden

<sup>b</sup> Ministry of Education Key Laboratory for Earth System Modeling, Department of Earth System Science, Tsinghua University, Beijing 100084, China

<sup>c</sup> Center for Energy and Environmental Policy Research & School of Management and Economics, Beijing Institute of Technology, Beijing 100081, China

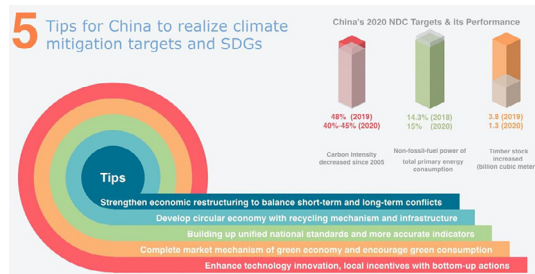
<sup>d</sup> Key Laboratory for Thermal Science and Power Engineering of the Ministry of Education, Department of Energy and Power Engineering, Tsinghua University, Beijing 100084, China

<sup>e</sup> School of Business, Society and Engineering, Mälardalen University, Västerås SE-721 23, Sweden

## HIGHLIGHTS

- Summarized China's current practices that gain co-benefits towards meeting SDGs
- Pointed out the shortcomings in the regional and sectoral aspects with China's NDCs
- Proposed five recommendations for climate policy with Covid-19 pandemic concerns

## GRAPHICAL ABSTRACT



## ARTICLE INFO

## Article history:

Received 18 August 2020

Received in revised form 1 September 2020

Accepted 2 September 2020

Available online 5 September 2020

## Key words:

Climate change

Sustainable Development Goals

Climate policy

China

## ABSTRACT

In 2018, a total of US\$166 billion global economic losses and a new high of 55.3 Gt of CO<sub>2</sub> equivalent emission were generated by 831 climate-related extreme events. As the world's largest CO<sub>2</sub> emitter, we reported China's recent progresses and pitfalls in climate actions to achieve climate mitigation targets (i.e., limit warming to 1.5–2°C above the pre-industrial level). We first summarized China's integrated actions (2015 onwards) that benefit both climate change mitigation and Sustainable Development Goals (SDGs). These projects include re-structuring organizations, establishing working goals and actions, amending laws and regulations at national level, as well as increasing social awareness at community level. We then pointed out the shortcomings in different regions and sectors. Based on these analyses, we proposed five recommendations to help China improving its climate policy strategies, which include: 1) restructuring the economy to balance short-term and long-term conflicts; 2) developing circular economy with recycling mechanism and infrastructure; 3) building up unified national standards and more accurate indicators; 4) completing market mechanism for green economy and encouraging green consumption; and 5) enhancing technology innovations and local incentives via bottom-up actions.

## 1. Introduction

The world needs to reduce 15 gigatons (Gt) of carbon dioxide equivalent (CO<sub>2</sub>e) annually to curb warming to 1.5–2°C above the pre-industrial level. As the world's largest emitter of CO<sub>2</sub>, China produced

9.8 Gt CO<sub>2</sub>e or 28.8% of global total emission in 2019 (Dudley, 2020). Without mitigation, China's annual CO<sub>2</sub> emissions can reach 16 Gt by 2030 (Liu et al. 2015). To undertake the responsibility, China sets up its Nationally Determined Contributions (NDCs) in 2015 to reach its emission peak around 2030 and to lower its CO<sub>2</sub> emission per unit of GDP in 2030 by 60–65% from the 2005 level (IEA, 2015). With four-year

\* Corresponding author.

E-mail addresses: [artemis.zhangchi@gmail.com](mailto:artemis.zhangchi@gmail.com) (C. Zhang), [penggong@tsinghua.edu.cn](mailto:penggong@tsinghua.edu.cn) (P. Gong).



Fig. 1. China's practices in combatting climate change and achieving Sustainable Development Goals.

efforts, the top-down strategy for climate mitigation has benefited multiple Sustainable Development Goals (SDGs). First, China's carbon emission, compared to the 2005 level, decreased by 48% in 2019. This figure is larger than the 45% goal by 2020 (NBS, 2020) (SDG 13). Partly contributed to this success are eight regional pilot emission trading systems (ETS) that have been launched since 2013. Second, the conservation of natural resources has surpassed the goal of 1.3 billion cubic meters by 2020 as the volume of China's forest stock increased by 3.8 billion cubic meters in 2019 (MEE, 2020b) (SDG15). Third, the non-fossil-fuel power accounted for 14.3% of the country's total primary energy consumption, closing in the target of 15% by 2020 (UNFCCC, 2018). China also significantly reduced the cost of renewable energy (Yan et al., 2019) (SDG 7) and improved air quality level. In 2019, 46.6% of 338 cities at or above prefecture level in China met national air quality standard (including pollutants assessment of SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO and O<sub>3</sub>). This number is 25% greater than that of 2015 (MEE, 2020b). Finally, China's life expectancy surpassed 76.7 years according to the World Population Review in 2019 (SDG 3) (World Population Review, 2019). In the same year, the State Council of China further released the Healthy China 2030 Actions, aiming to further improve the overall environmental and health conditions (The State Council, 2019; Zhang and Gong, 2019).

## 2. China's practices to achieve the co-targets of climate mitigation and SDGs

Through a top-down integrated mechanism, China established different actions and practices that co-benefit towards meeting SDGs along with climate change mitigation (Fig. 1). The government, for example, merged several national agencies<sup>1</sup> into the Ministry of Ecology and Environment (MEE) in 2018 (Xinhua News Agency, 2018). The MEE oversees the realization of climate- and SDG-relevant objectives in industry, fiscal policy, finance, energy, investment and technology, from the national level down to the city, county or township level. Local governments are responsible for river system management, using the "river chief mechanism" in 2016 (Xinhua News Agency, 2016). More than 300,000 river chiefs were appointed, who face a lifetime accountability for water quality in their jurisdiction under public scrutiny (Xu, 2017) (SDG 6 and 14). By 2019, this project improved the water quality of major rivers compared to the 2012-2016 conditions (e.g., pollution-induced water scarcity in northern China) (Ma, 2020). Over 74.9% of 1,931 surface water sections under the national monitoring program met Grade I–III water quality standard, a 10.4% increase from that of 2015 (MEE, 2020b).

In 2007, China set up a leading group, chaired by the Premier, to tackle climate change and energy conservation and emission reduction (SDG 7 and SDG 13), followed by a series of top-down amendments, from constitutional legislative amendments to national-level designs of

climate change mitigation and sustainable development by the State Council (Xinhua News Agency, 2015). These changes resulted in several targeted measures and actions associated with renewable energy (SDG 7), such as: 1) replacing coal with natural gas projects (MEE, 2016) and Blue-Sky Protection Campaign (MEE, 2018), 2) fining or closing down polluting entities or those who are responsible for depleting natural resources. China also targets special events and opportunities to promote its programs. For instance, during the APEC conference, China Africa Cooperation Forum, National Day Parade Ceremony and G20 summit. China carried out short-term measures such as temporarily halting enterprises that did not meet the environmental protection standards. Additionally, China has promoted social awareness about the importance of environmental protection and sustainable development through various activities such as the "national low carbon day" (Xinhua News Agency, 2013) so that people recognize the importance of good governance during this process (Cai et al., 2018).

However, challenges remain in achieving the balance between climate mitigation and economic growth. Even before the COVID-19 outbreak, the turnaround trends of global economy led China to increase steel and coal consumption in 2017 and 2018 to maintain its economic growth. This circumstance steered China away from the targeted sustainable development path. To achieve SDGs by 2030, China needs to lower its annual growth rate of emission (below 2%), and to increase the share of non-fossil fuels in primary energy consumption to around 20%. This target has not been achieved because China's CO<sub>2</sub> emission annual growth rate was 3.4% in 2019 (Dudley, 2020). Although the average annual growth rate of China's national CO<sub>2</sub> emission dropped by 0.5% between 2014 and 2016, China's CO<sub>2</sub> emission in 2018 remained high (~9.8 Gt or 28.8% of the world total) (Dudley, 2020).

## 3. Five tips for China to realize its climate mitigation and SDG targets

To facilitate the realization of both climate mitigation targets and SDGs, we proposed five recommendations (Fig. 2):

### 3.1. Restructure the economy to balance short-term and long-term conflicts

During the implementation of NDC in multiple consecutive five-year-plans, conflicts arise between national policy and local economy. In the short term, the policy to reduce energy consumption and to shift towards renewable energy can save 100 Mt coal and reduce 180 Mt CO<sub>2</sub>e every year. Yet this energy-saving reformation shuts down below-standard conventional power plants and affects local economy. Employment in fossil fuel extraction industry decreased by 0.84 million in 2018 compared to 2016 (CEIC, 2020a, 2020b, 2020c, 2020d). Because reformation of energy policy also affects manufacturing industries (e.g., cements, steel, crude copper, aluminum, and coking plants), most of the 262 resource-based cities in China experienced a shrink in industrial output and a further increase in unemployment (CEIC, 2020a, 2020b, 2020c, 2020d; Liu et al., 2018). The value of

<sup>1</sup> National Development and Reform Commission (NDRC), Ministry of Natural Resources (MNR), Ministry of Water Resources (MWR), Ministry of Agriculture (MOA)

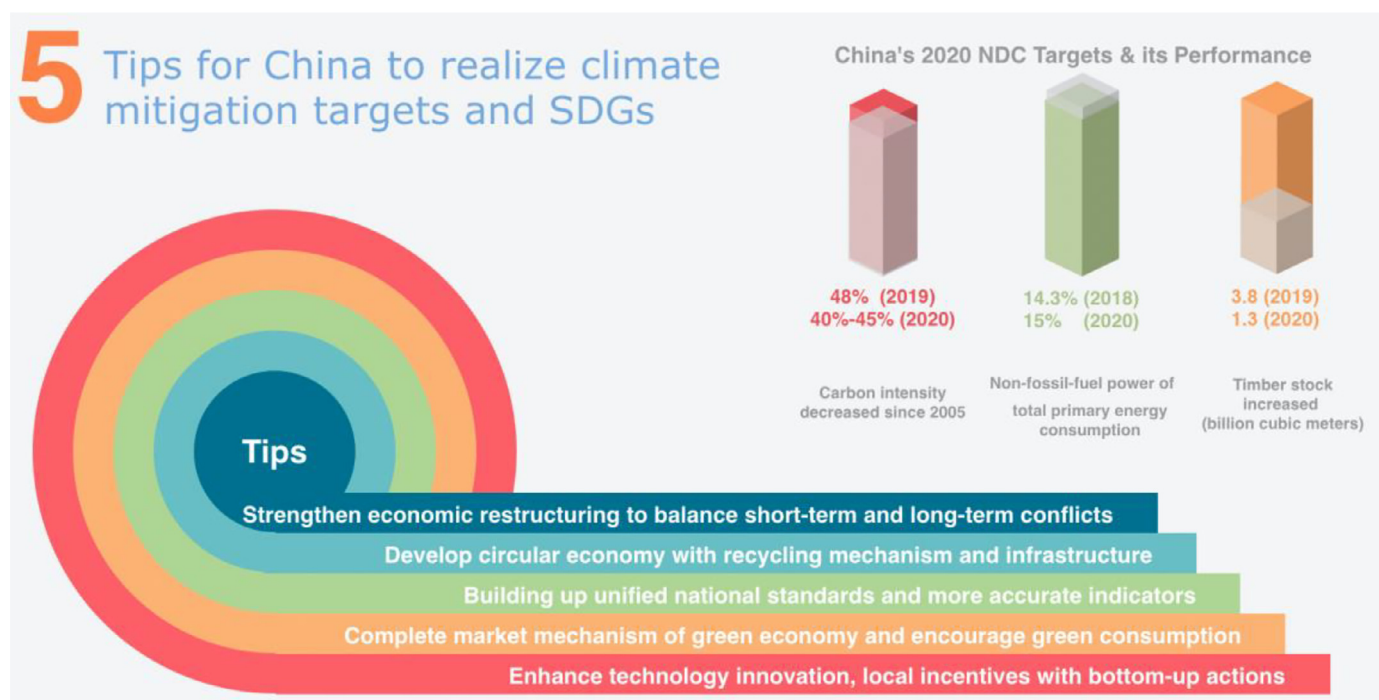


Fig. 2. Five tips for China to realize its climate mitigation targets and Sustainable Development Goals.

Fuxin's heavy industry has declined by nearly 67% in 2017, followed by a GDP drop from 9.9 US\$ billion in 2013 to 6.1 US\$ billion in 2017. Unemployment also increased accordingly by more than 30% from 2014 to 2016 (CEIC, 2020a, 2020b, 2020c, 2020d; Mi et al., 2017). These numbers are expected to grow amid economic recession due to COVID-19 pandemic as demand for coal in China fell by 6.8% in the first quarter of 2020 (China National Coal Association, 2020), and is projected to decline by 5% throughout the year (IEA, 2020).

In the long term, the provincial and municipal governments are pressured by tax shortage from the decline of conventional fossil fuel industry and the ambitious targets at the national level to shift towards renewable energy. The central government used the top-down mechanism to allocate local reformation targets in energy sectors, but the possible economic recession is born locally (World Bank, 2019). To avoid it, individual welfare and environmental investment/cost per capita should be considered as indicators in climate actions. In addition, a large regional disparity at provincial level including health (SDG 3), employment (SDG 8) and climate (SDG 13) should be discretionally considered in policy making to achieve both the SDGs and climate mitigation targets.

### 3.2. Develop circular economy with recycling mechanism and infrastructure

While considerable illegal recycling operations can be stopped by cutting off all imports of low-quality recyclable goods to China, it does not stop the sewage and garbage disposal problem. Data from the World Bank suggested that in 2015, China generated 210 Mt of municipal solid waste, only 48 Mt less than the United States (Kaza et al., 2018). In March 2017, the central government released the plans for building a standardized compulsory household waste sorting system in 46 major Chinese cities by 2020, aiming for a national recycling rate over 35% by 2020 (NDRC, 2017). Waste sorting is a prerequisite for circular economy and more sustainable cities (SDG 11) that requires government investment, promotion, supervision, as well as individual awareness and action (i.e., more responsible consumption) (SDG 12). In addition, it requires waste treatment infrastructure and recycling technology, but so far, landfill and incineration are still the

predominant means of municipal solid waste disposal in China. To accelerate landfill leachate treatment, biogas and waste heat utilization, waste treatment infrastructure and technology (SDG 9) should become a priority.

### 3.3. Build up unified national standards and more accurate indicators

As stricter environmental regulations are applied in the urban areas, there is a shift in pollution centers to the rural regions as for the case of the heavy polluting Capital Steel factory. It moved from Beijing to Tangshan, Hebei province in 2008. In 2019, 13 iron and steel groups with factories in the main districts of Tangshan city were again moved to the rural counties in Hebei (NDRC, 2019). Therefore, applying the same standard between the urban and the rural regions is critical, not only to curb the amount of pollution, but also to encourage industry innovations (SDG 9) and sustainable communities (SDG 11).

Meanwhile, emission intensity (CO<sub>2</sub> emissions per unit of GDP) is considered one of the most widely used indicators for climate actions (SDG 13) (Xu et al., 2020). Yet it does not identify the net CO<sub>2</sub> emission added each year. While China's emission intensity fell at a rate of over 3.8% annually (greater than the global average of 2.7% since 2015) due to increasing GDP, China's total energy consumption increased by 3.3%. Total CO<sub>2</sub> emissions also increased by 2.2% in 2018 (NBS, 2020), the second-year increase after a leveled-off emission between 2014 and 2016 (Dudley, 2020). Because the increasing demands for renewable energy offset the influence made by decreasing fossil-fuel consumption, changes in fossil fuel emission should instead be used to emphasize the effectiveness of mitigation strategies. More indicators, such as emission per unit of cement or steel production in industry with high fossil-fuel demand can also be used for different industrial outputs.

### 3.4. Complete market mechanism of green economy and encourage green consumption

Emission reduction and pollution policy should shift according to the shift in pollution sector, from the traditionally high-emitter production sector (e.g., energy and manufacturing) to the consumer sector (e.g.

transportation and construction). The shift in policy should be reflected in the establishment of market mechanisms for future green economy (SDG 8) and sustainable development (SDG 11). China has run eight pilot carbon ETS since 2013 and constructed its national carbon-trading system since 2018. Until 2019, the contribution of emission abatement from the eight ETS projects reached 92.8 Mt CO<sub>2</sub>e or around US\$ 304 million (China National Coal Association, 2020). With a fully operational national ETS in 2021, China's ETS will be able to cover 33% of its domestic carbon emissions (~3.5 Gt CO<sub>2</sub>e) (Mu et al., 2018; Wang et al., 2018). In the near future, the study should focus on the measuring, reporting, and verifying trading credits.

Likewise, renewable energy power plants should grow based on incentives rather than rely on government subsidy. For instance, the distributed photovoltaic system can be integrated with added values into the farmland irrigation or dairy business (Zhang et al., 2016; Zhang et al., 2018). For other renewable energy systems, improved business models and financial incentives from the demand side are needed for building up a more sustainable market and encouraging green consumption by: 1) integrating national emission trading market mechanism; 2) enhancing more competitive business model for renewable energy industries; 3) increasing customer awareness of sustainable products and services.

### 3.5. Enhance technology innovation and local incentives with bottom-up actions

In several regions of China, renewable energy power plants established by a top-down approach were abandoned because of the lack of local demands and the short of economically viable technology to transmit the generated power. In Gansu Province and Xinjiang Uyghur Autonomous Region, for example, the rate of abandoned wind power reached 30% (Wang et al., 2019). Similarly, the rate of abandoned solar power in Jiuquan City, Gansu Province and Golmud City, Qinghai province was over 20% (Qi et al., 2019). Although the NDRC and National Energy Administration (NEA) have launched the “Three-year Clean Energy Consumption Action Plan”, the market demand and end-user consumption need to be incentivized using bottom-up approaches.

Bottom-up actions should emphasize on technology innovation (SDG 9), education by academia or non-governmental organization, and public monitoring or participation (Yang and Yang, 2019; MEE, 2020) (SDG 17). Monitoring platforms should be established by independent organizations to better motivate public participation in evaluating emission reduction programs.

## 4. Conclusions

During the last few years, China has established multiple projects in air pollution control, renewable energy promotion, water and soil treatment, and forest recovery to achieve multiple SDG targets. While numerous top-down mechanisms (e.g., allocating new organizations, setting medium-term goals, taking actions, amending law and regulations) have dominated the course of actions, bottom-up mechanisms should be promoted via emission trading, international academic cooperation, technology transfer, market incentive, and business model innovation in green economy. More sustainable China requires a long-term vision, unified national standards with solid multi-sectoral cooperation between government and individuals.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix

The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. The 17 Goals interconnect and in order to leave no one behind, it is important that we achieve each Goal and target by 2030.

(SDGs website: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>)



Fig. A. 17 Sustainable Development Goals.

## References

- Cai, W., Hui, J., Wang, C., Zheng, Y., Zhang, X., Zhang, Q., Gong, P., 2018. The Lancet Countdown on PM2.5 pollution-related health impacts of China's projected carbon dioxide mitigation in the electric power generation sector under the Paris Agreement: A modelling study. *Lancet Planet. Health* 2 (4), e151–e161.
- CEIC, 2020a. China No. of employee: Petroleum, coking & nuclear fuel (1980–2019). <https://www.ceicdata.com/en/china/no-of-employee-by-industry-monthly/no-of-employee-petroleum-coking-nuclear-fuel> (accessed 5 May 2020).
- CEIC, 2020b. China No of employee: Coal mining & dressing (1980–2019). <https://www.ceicdata.com/en/china/no-of-employee-by-industry-monthly/no-of-employee-coal-mining-dressing> (accessed 5 May 2020).
- CEIC, 2020c. China registered unemployment: Urban: Heilongjiang (1980–2019). <https://www.ceicdata.com/en/china/registered-unemployment/registered-unemployment-urban-heilongjiang> (accessed 5 May 2020).
- CEIC, 2020d. China registered unemployment: Liaoning: Fuxin (1980–2019). <https://www.ceicdata.com/en/china/registered-unemployment-prefecture-level-city/registered-unemployment-liaoning-fuxin> (accessed 5 May 2020).
- China National Coal Association, 2020. Coal industry annual development report 2019. <http://pmo9337eb.pic29.websiteonline.cn/upload/370r.pdf> (accessed 25 June 2020).
- Dudley, B., 2020. BP statistical review of world energy. <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/co2-emissions.html> (accessed 20th Aug 2020).
- ETS China, 2020. Bulletin of carbon trading market status of China in 2019. <http://www.tanpaifang.com/tanjiaoyi/2020/0616/71557.html> (accessed 25 June 2020).
- IEA, 2015. Nationally determined contribution (NDC) to the Paris Agreement: China. <https://www.iea.org/policiesandmeasures/pams/china/name-155186-en.php> (accessed 25 June 2020).
- IEA, 2020. Global energy review 2020: The impacts of the Covid-19 crisis on global energy demand and CO<sub>2</sub> emissions. <https://www.iea.org/reports/global-energy-review-2020/global-energy-and-co2-emissions-in-2020> (accessed 25 June 2020).
- Kaza, S., Yao, L., Bhada-Tata, P., Van Woerden, F., 2018. What a waste 2.0: A global snapshot of solid waste management to 2050. The World Bank, Washington, D.C..
- Liu, Z., Guan, D., Moore, S., Lee, H., Su, J., Zhang, Q., 2015. Climate policy: Steps to China's carbon peak. *Nature* 522 (7556), 279–281.
- Liu, Z., Guan, D., Wei, W., 2018. Carbon emission accounting in China. *Scientia Sinica Terrae* 48 (7), 878–887.
- Ma, T., Sun, S., Fu, G., Hall, J.W., Ni, Y., He, L., Yi, J., Zhao, N., Du, Y., Pei, T., Cheng, W., Song, C., Fang, C., Zhou, C., 2020. Pollution exacerbates China's water scarcity and its regional inequality. *Nat. Commun.* 11, 650.
- MEE, 2016. The intensive air pollution prevention and control measures for Beijing-Tianjin-Hebei. <http://www.mee.gov.cn/hjzli/dqwrzf/dqwrzfdjh/201609/P020160922582265655731.pdf> (accessed 10 May 2020).
- MEE, 2018. Three-year action plan for winning the blue sky defense battle. [http://english.mee.gov.cn/News\\_service/news\\_release/201807/t20180713\\_446624.shtml](http://english.mee.gov.cn/News_service/news_release/201807/t20180713_446624.shtml) (accessed 10 May 2020).
- MEE, 2020a. Yearly report on national 12369 complaints. [http://www.mee.gov.cn/xxgk2018/xxgk/xxgk15/202006/t20200611\\_784037.html](http://www.mee.gov.cn/xxgk2018/xxgk/xxgk15/202006/t20200611_784037.html) (accessed 10 May 2020).
- MEE, 2020b. 2019 Report on the state of the ecology and environment in China. <http://www.mee.gov.cn/hjzl/sthjzk/zghjzkgb/202006/P020200602509464172096.pdf> (accessed 10 May 2020).
- Mi, Z., Meng, J., Guan, D., Shan, Y., Song, M., Wei, Y., Liu, Z., Hubacek, K., 2017. Chinese CO<sub>2</sub> emission flows have reversed since the global financial crisis. *Nat. Commun.* 8 (1), 1712.
- Mu, Y., Wang, C., Cai, W., 2018. The economic impact of China's INDC: Distinguishing the roles of the renewable energy quota and the carbon market. *Renew. Sust. Energy Rev.* 81, 2955–2966.
- NBS, 2020. Statistical bulletin of National Economic and Social Development in 2019. [http://www.stats.gov.cn/tjsj/zxfb/202002/t20200228\\_1728913.html](http://www.stats.gov.cn/tjsj/zxfb/202002/t20200228_1728913.html) (accessed 25 June 2020).
- NDRC, 2017. Plans for building a standardized compulsory household waste sorting system with regulations. [http://www.gov.cn/zhengce/content/2017-03/30/content\\_5182124.htm](http://www.gov.cn/zhengce/content/2017-03/30/content_5182124.htm) (accessed 10 May 2020).
- NDRC, 2019. He Bei Province started 13 iron and steel groups' movement in Tangshan City. [http://www.gov.cn/xinwen/2019-04/21/content\\_5384954.htm](http://www.gov.cn/xinwen/2019-04/21/content_5384954.htm) (accessed 25 June 2020). (in Chinese)
- Qi, Y., Dong, W., Dong, C., Huang, C., 2019. Understanding institutional barriers for wind curtailment in China. *Renew. Sust. Energy Rev.* 105, 476–486.
- The State Council of the People's Republic of China, 2019. Guideline on measures to implement the healthy China 2030 initiative. [http://www.gov.cn/zhengce/content/2019-07/15/content\\_5409492.htm](http://www.gov.cn/zhengce/content/2019-07/15/content_5409492.htm) (accessed 10 May 2020).
- UNFCCC, 2018. China meets 2020 carbon target three years ahead of schedule. <https://unfccc.int/news/china-meets-2020-carbon-target-three-years-ahead-of-schedule> (accessed 10 June 2020).
- Wang, H., Lu, X., Deng, Y., Sun, Y., Nielsen, C., Liu, Y., Zhu, G., Bu, M., Bi, J., McElroy, M., 2019. China's CO<sub>2</sub> peak before 2030 implied from characteristics and growth of cities. *Nat. Sustain.* 2 (8), 748–754.
- Wang, K., Yang, K., Wei, Y., Zhang, C., 2018. Shadow prices of direct and overall carbon emissions in China's construction industry: A parametric directional distance function-based sensitive estimation. *Struct. Chang. Econ. Dyn.* 47, 180–193.
- World Bank, 2019. World Development Indicators 2018. <https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS> (accessed 25 June 2020).
- World Population Review, 2019. Life Expectancy by Country. <http://worldpopulationreview.com/countries/life-expectancy-by-country/> (accessed 25 June 2020).
- Xu, Y., 2017. China's River Chiefs: Who Are They? <http://chinawaterrisk.org/resources/analysis-reviews/chinas-river-chiefs-who-are-they/> (accessed 25 June 2020).
- Xu, Z., Chau, S., Chen, X., Zhang, J., Li, Y., Dietz, T., Wang, J., Winkler, J., Fan, F., Huang, B., Li, S., 2020. Assessing progress towards sustainable development over space and time. *Nature* 577 (7788), 74–78.
- Xinhua News Agency, 2013. The launching ceremony of National Low-Carbon Day. [http://www.gov.cn/govweb/jrzq/2013-06/17/content\\_2427504.htm](http://www.gov.cn/govweb/jrzq/2013-06/17/content_2427504.htm) (accessed 10 May 2020). (in Chinese)
- Xinhua News Agency, 2015. Environmental Protection Law. [http://www.gov.cn/xinwen/2014-04/25/content\\_2666328.htm](http://www.gov.cn/xinwen/2014-04/25/content_2666328.htm) (accessed 10 May 2020). (in Chinese)
- Xinhua News Agency, 2016. Implementation of River Chief Mechanism Nationwide. [http://www.gov.cn/zhengce/2016-12/11/content\\_5146628.htm](http://www.gov.cn/zhengce/2016-12/11/content_5146628.htm) (accessed 10 May 2020). (in Chinese)
- Xinhua News Agency, 2018. The Institutional Reform Plan of the State Council of China. [http://www.gov.cn/guowuyuan/2018-03/14/content\\_5273856.htm](http://www.gov.cn/guowuyuan/2018-03/14/content_5273856.htm) (accessed 10 May 2020). (in Chinese)
- Yan, J., Yang, Y., Campana, P., He, J., 2019. City-level analysis of subsidy-free solar photovoltaic electricity price, profits and grid parity in China. *Nat. Energy* 4 (8), 709–717.
- Yang, Y., Yang, W., 2019. Does whistleblowing work for air pollution control in China? A study based on Three-party Evolutionary Game Model under incomplete information. *Sustainability* 11 (2), 324.
- Zhang, C., Campana, P.E., Yang, J., Yan, J., 2016. Analysis of distributed photovoltaic financing: A case study approach of crowd-funding with photovoltaic water pumping system in microgrids. *Energy Procedia* 103, 387–393.
- Zhang, C., Campana, P., Yang, J., Yu, C., Yan, J., 2018. Economic assessment of photovoltaic water pumping integration with dairy milk production. *Energy Convers. Manag.* 177, 750–764.
- Zhang, C., Gong, P., 2019. Healthy China: From words to actions. *Lancet Public Health* 4 (9), e438–e439.