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China's Green Innovation Strategy under Xi Jinping

Dr. Avinash Godbole*

Abstract

One of the principal consequences of China's rapid, export-led industrialisation has been its emergence as the world's largest carbon emitter since 2008-09. In keeping with the size of its population and economy it is also the world's biggest energy producer. It accounts for half of the world's coal usage each year. In 2017, China surpassed the US to become the world's largest net oil importer. Its megacities in the north, including Beijing, experience severe smog each winter and China's water challenge is marked by severe shortages and pollution. The pollution challenge in the country is largely linked to transportation, the energy mix, and emissions standard improvement and implementation in the large industries. The environmental experience appears to have entered a loop pattern -- recurring each year with a new case in a new place with similar story of good laws and lax compliance. Environmental damages and the government's action has become an issue of public accountability and governance in China. Over the past few years China has achieved significant landmarks in its environmental journey. An important element of this new strategy is the expansion of renewable energy in the country's overall basket. This paper looks at China's environmental and energy strategies under Xi Jinping administration.

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China is the world's biggest energy producer. It is also the largest carbon emitter since 2008-09. China alone accounts for half of the world's coal usage each year. Its megacities in the north, including Beijing, experience severe smog each winter. China's water challenge is marked by the issues of severe shortages and pollution. The pollution challenge is largely linked with emissions standard improvement and implementation in China's large industries like coal, iron and steel, and aluminium but also with residues from fertilizers and pesticides used in the agriculture sector. The long term solution to air pollution is in changing the energy basket which will necessarily be slow. Reducing dependence on coal can only be gradual and is being done alongside expansion of renewable energy in the country's overall basket. China's environmental challenges will remain high for the foreseeable future given its huge coal and oil dependence, loopholes in implementation of reforms, and resistance from coal producing provinces and fossil fuel dependent economic sectors to a higher-cost alternative energy strategy. Yet significant changes are underway in energy and environment policies that promises a better future.

The environmental story of contemporary China appears to have entered a loop pattern—issues recurring each year with a new case in a new place with similar story of good laws and lax compliance. Even then, significant changes are underway. In the recent past China has achieved significant landmarks in its environmental journey. It has established the largest solar panel farm in the world. China will close more than 100 large coal fired power plants in the near future (Xinhua, 2017). It has committed to spending nearly $360 billion on renewable energy by 2020. During the National People's Congress (NPC) in 2014, Li had said, "We will resolutely declare war against pollution as we declared war against poverty" (Greenstone, 2018). Over the last four years, there has also been a significant level of change in pollution levels in Beijing and other cities in the north that used to regularly experience smog during winter months.

Environmental damages and the government's action in protecting the environment has become an issue of public accountability and governance in

China. It is a big part of the National People's Congress (NPC) reports each year as well. On the other hand, prestige is one of the important drivers of China's global strategy and the government is highly sensitive to criticism and negative publicity. China was billed as one of the core reasons for the failure of the Copenhagen climate change talks. From Copenhagen to Paris, within seven years, China has altered its negotiating strategy on climate change in a substantial manner (for more see, Godbole 2016). A mix of domestic pressure and concern for international image have forced China's changing approach to the questions of environment and pollution. China is seeing it as an opportunity to promote innovation and research on these issues.

This paper looks at China's environmental and energy strategies under Xi Jinping's administration. It begins by discussing the political context of the process. Then it discusses the policy framework, in particular the Ministry report and the FYP processes and outcomes. It also looks at the targets and outcomes of 11th and 12th FYPs and the progress made under 13th FYP so far, the changing energy basket in China. Environmental innovations in China, especially in the energy and transportation sectors and their scope will be discussed subsequently.

Political Support for Environmental Protection

The report of the Secretary General Hu Jintao at the 18th Party Congress had set a few targets to be achieved by the next government. He had in effect set targets between then and the next congress. He had said;

"We should strengthen conservation efforts all the way, drastically reduce energy, water and land consumption per unit of GDP, and use such resources in a better and more efficient way. We should launch a revolution in energy production and consumption, impose a ceiling on total energy consumption, save energy and reduce its consumption. We should support the development of energy-efficient and low-carbon industries, new energy sources and renewable energy sources and ensure China's energy security" (Hu Jintao, 2012).

In all likelihood, this was a response to the two previous winter seasons of serious smog in northern China. In November 2011, residents had reported that smog in Beijing was getting worse each year. Also in December that year, nearly 700 flights out of Beijing had to be cancelled due to heavy smog.

Subsequently when the pollution levels rose to unprecedented levels in January 2013, Premier Li Keqiang came out and said that the pollution levels experienced by Beijing and other cities were outcomes of accumulated problems and would take a long time to rectify. Two months later, during his first address at the National People's Congress, Li said that China's environmental challenges would be addressed with "an iron fist, firm resolution and tough measures" (Lin, 2013).

> **environmental pollution....has become the leading cause of social unrest in China....**

The reason why the Party leadership is keen to address environmental pollution is not only due to its negative impact on the country's image and the governance capacity and impact but also because it has become the leading cause of social unrest in China (Economy, 2018, p. 160). Not in My Backyard (NIMBY) protests have become commonplace in China. The most successful and popular NIMBY protest in China was against the PX plant in Xiamen. Increasing environmental awareness amongst masses coupled with growing role of environmental NGOs can be attributed for causing such local protests. As China expands its nuclear energy capacity, there have been a number of NIMBY protests against development of nuclear plants closer to the population centres. In August 2016, the city of Lianyungang saw protests by ten thousand citizens. The citizens were agitating against secrecy and lack of role in the decision-making process (Economy, 2018; p. 160). Chemical and fertilizers plants and storage facilities and incinerators and recycling units are other projects that are regular targets of NIMBY protests in China.

At the 19th Party Congress Xi Jinping's words on pollution and environmental crisis had only become even more stringent than before. At the report presented to the Congress, Xi described a new principal contradiction facing China; "What we now face is the contradiction between unbalanced and inadequate development and the people's ever-growing needs for a better life" (Xi Jinping, 2017). He followed it up by issuing a lot of policy directives for the period until the next party congress in 2022. Major directives from the point of view of this paper include: "moving industry up the value chain, cutting overcapacity, promoting innovation, improving the environment, addressing the regional imbalances" (Xi Jinping, 2017).

In short, the new principal contradiction highlights the challenges of unsustainable growth and the urgency that the party attaches to addressing those challenges. Long before this, Wen Jiabao had warned that "the Chinese economy was quickly becoming unstable, unbalanced, uncoordinated, and unsustainable" (for more see, Godbole, 2017). One important outcome is that China has reconciled itself to the fact that it may not enjoy double digit growth rates and would rather hope to have what it calls qualitative growth. China aims to expand its share in the value-added chain and move away gradually from being the factory of the world.

In keeping with this general thrust for change, a new Ministry of Ecology and Environment was launched in March this year at the National People's Congress as part of the "war on pollution" initiated in 2014. The MEE is a super-Ministry that succeeds the less than effective former Ministry of Environment Protection (MEE) created in 2004. It has been given a number of powers earlier held by the Ministries of Agriculture, Water Resources and the National Development and Reform Commission, thereby enabling it to formulate policies regarding agricultural pollution, water and climate related policies, in addition to the powers previously held by the MEE. However, China's environmental monitoring institutions have always lacked real power. Powerful regional elites and sectors such as energy, mining and transport, keen to grow and preserve their economic power, resisted a stronger environmental agency to keep costs down and profits up. The current changes are a desperate attempt by Xi jinping to control the vested interest and prevent large scale social upheaval.

The 13th FYP (2016-2020)

The 13th Five Year Plan (FYP) in particular is built around twin themes of environment and innovation (China Policy Observer, 2016). One of the stated objectives of the 13th FYP is to "...guide the new normal in economic development, and comprehensively advance innovative, coordinated, green, open, and shared development..." (NDRC, 2014). The 13th FYP, presented and approved in March 2016 also has announced some ambitions targets that complement its commitments under the Paris Agreement (Seligsohn, 2016). Under the 13th FYP, China aims to achieve drop in energy intensity by 40 to 45 per cent, aims to achieve 15 per cent of its primary energy from non-fossil resources and raise the forest stock by 1.5 billion cubic metres (Zhang, 2015).

At Paris, China had committed to reduce its CO2 emissions per unit of GDP by 60-65 per cent of the 2005 level by 2030. This was in addition to the commitment of peaking CO2 emissions by 2030 (Zhang, 2015). This has been committed on the basis of achievements of the 12th FYP of increasing the share of non-fossil energy from 8.3 per cent to 11.4 per cent by 2015. The target for the 13th FYP is to take this to 15 per cent by 2020 (Johnson, 2017). As of 2015, the share of non-fossil energy in China's composite energy basket stood at 12.6 per cent and coal was at 64 per cent. In 2012, these figures were at 9 and 66.6 per cent respectively (complied by the author from the website of National Bureau of Statistics, People's Republic of China). In general, the 13th FYP aims to move China's economy from energy intensive growth to service-oriented, diversified and less carbon-intensive one (Seligsohn, 2016). This follows from the national pilot carbon emissions trading system (ETS) launched in seven Chinese cities and provinces. These include Beijing, Shanghai, Guangdong, Tianjin, Shenzhen, Hubei, and Chongqing. The selected cities and provinces accounted for 18 per cent of China's population and account for 28 per cent of its Gross Domestic Product

As of 2015, the share of non-fossil energy in China's composite energy basket stood at 12.6 per cent and coal was at 64 per cent.

(GDP) and 7 per cent of its national carbon emissions as of 2013 (Zhao, 2016). The cumulative trading volume in the seven pilot markets reached 160 million tons, worth nearly 2.5 billion yuan by the end of 2016. China is expected to launch its national ETS by the end of 2017 (China Daily, 2017). Recent research and evidence from reduced number of pollution incidents suggests that China is well on the way to surpass its 13^{th} FYP targets.

Upgrading of Standards and Benchmarks

In the past, there was a substantial gap between the global environmental benchmarks and Chinese emission limits. For a long time, China used its developing country status to justify this difference. However, research suggested that this was taking a heavy toll on the Chinese people. For example, various studies attribute between 300,000 to 750,000 annual premature deaths in China to pollution caused mainly by coal dependence (Health Effects Institute, 2016). This was the period when China's emission standards were also much lower than the WHO standards. An important aspect of this debate is whether China did that in order to attract dirty but cash -rich industries as it wholeheartedly embraced globalisation. The nature of Chinese industrial activities and its relation with its global counterparts sometimes tend to justify the tag of pollution haven attached to China's method of industrialisation. Another study found that air pollution causes 1.6 million premature deaths annually (Levin, 2015). This shows that the extent of air pollution in China is highly underestimated or underreported.

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There is another similar case study of denial by Chinese authorities. As far as urban air pollution is concerned, China lived in a denial mode making defensive postures until innovative use of social media by the likes of the US Embassy in Beijing and independent photographers and micro-bloggers forced the city administrators to literally come clean on this issue. When the US Embassy's twitter account went on to declare Beijing's air pollution as 'crazybad', the first reaction was that such act by the embassy was outside the purview of its capacity and role in Beijing.* Second, it was also nationalist in that this act of monitoring and sharing Beijing's air pollution data was seen as infringement of boundaries. Then came the denial that monitoring at one location that was the busiest in the city was not representative of the overall picture. Only after these stages did Beijing agree to monitor pollution on the PM scale.

2011 was the last year when air pollution in Beijing was measured based on 'blue sky days' method, when Beijing recorded 286 blue sky days. Shifting from the 'blue sky days' method to scientific calculation and dissemination of data on the PM10 and then to PM2.5 measures was the major recent innovations. In shifting from PM10 to PM2.5, the government put pressure on the agencies in that its achievements in controlling PM10 began to look like failures on the PM2.5 scale. Moreover, public awareness has led to increased pressure on the basis of PM2.5 data because of its potent impact.

While Beijing started sharing PM2.5 data in January 2012, "(other) cities in the Beijing-Tianjin-Hebei region, Yangtze River Delta and Pearl River Delta, as well as southwest China's Chongqing municipality and all provincial capitals, were stipulated to implementing this index by October 2012" (Xinhua, 2012). This move came after pressure from citizens for implementing stringent measures for air pollution. The other cities from this list started sharing the PM2.5 data only after February, 2013. China's Minister of Environment, Zhou Shengxian, subsequently announced that additional 113 cities would start monitoring and sharing the PM2.5 data by the end of the year 2013 (Xinhua, 2012).

This has also led in giving more powers to the MEE as far as implementation compliance is concerned. For example, one of the important new developments in the last five years has been to treat Beijing-Tianjin-Hebei (BTH region) economic development as well as pollution in an integrated manner. This strategy is called Jing-Jin-Ji integrated development strategy. In 2014, Xi Jinping had called this integrated development plan as a "major

* Initially, authorities in China was also critical of the US embassy in Beijing and its consulate in Shanghai for measuring and sharing the PM2.5 data on social media and called it a jurisdictional violation of China critical of the US for measuring its domestic pollution problems. China's then Vice Environmental Minister Wu Xiaoqing had said that it was unfair that the US Embassy was releasing the data based on one measuring station and that it's API did not correspond to China's standards' benchmark (Economy, 2018).

national strategy" (Xie and Ma, 2017). As part of this, in 2017 officials from the MEE pulled up Tianjin municipal officials for lax implementation of the MEE laws and regulations. It clearly said the local bureau of the MEE as well as the government had failed to control water as well as air pollution and were falling short of "what the central government required it to do, what a municipality should do, and what the public expects" (Pinghui, 2017). MEE had found that Tianjin's PM2.5 level pollution had risen 27.5 per cent in the first quarter of 2017 and despite that the quality of coal being sold in the city was way below the standards set. Similarly, vehicular emissions checking and industrial effluents treatment implementation were found to be below par (Pinghui, 2017). Tianjin officials have been given 30 days to come up with a concrete plan on how it would start implementing the rules and regulations. Recently, similar 'study tour' based assessments have been made in case Shanxi and Anhui provinces as well (MEE, 2017). These study tours are also part of overseeing the implementation of the supply-side reforms, particularly in the provinces dependent on natural resource extraction and utilisation for economic purposes.

Energy Policy Innovations and supply-side Impediments

On this front a lot of change has taken place in China. While early efforts were aimed at demand side restructuring and reduction, the recent efforts have aimed at cleaning up the demand side structures and reducing energy dependence on coal and increasing the share of renewables in the overall energy basket.

China achieved its biggest energy efficiency targets by implementing the two specific programmes in the 11th and 12th FYPs (2011-2015). A Program called Top-1000 was initiated in April 2006 to target and improve the efficiency numbers of the highest energy consuming companies. Put together, these companies were responsible for one third of the country's energy requirement (Lewis, 2011). While the top-1000 program exceeded its plan period target, the overall energy intensity improvement of 14.4 per cent missed the target of 20 per cent (Ma, 2010). Encouraged by the success of the Top-1000 Program, as part of the 12th FYP, the goal for energy efficiency improvement was of reduction of energy intensity by 16 per cent for the 10,000 of highest national energy consuming companies. This aimed to save 250 Metric tonne of coal equivalent (Mtce) of energy in the five year period. Estimates suggest that this program achieved 65 per cent of its targets.

On the supply side as well, the recent trends have been highly encouraging. It is believed that China has peaked its coal consumption sometime in 2015-16. This is based on the data that China's domestic coal production declined for the third consecutive year (2013-2016). At 9 per cent, the decline was steepest in 2015-16. Also in the same period, China's coal imports declined to 266 metric tonnes (mts), down by 72 mts from the 327 mts in 2013 (Buckley, 2017). In the same period, China's electricity demand grew by an average of 4.5 per cent annually. This achievement, some argue, amounts to reducing the over-dependence of China's economic growth on coal and signifies its gradual rise in the value-added chain in the global economy (Ma, 2017). Peaking of coal consumption will also alter China's aggregate emissions and substantially improve its energy intensity ratio over the next few years.

At the same time, there is a conflict of interest between Beijing and provinces as far as outlook on coal is concerned. Coal extraction, as well as electricity generation is a provincial prerogative and it not only generates substantial amount of revenues for the provinces but also creates a significant number of job opportunities, particularly in provinces like Inner Mongolia, Shanxi, and Xinjiang. That is why provinces are keen to expand coal production and utilisation whereas Beijing is keen to reign in the coal dependence. In January 2017, China's central National Energy Administration had cancelled permission for 103 projects under construction or planned. By doing so it has prohibited 120 GW of coal fired power from coming online. This is consistent with the State Council's target of cutting down coal production by 500 million tonnes by 2020 (Ren, 2017).

Technological Innovations in Energy Sector

Various agencies in China are also aiming to encourage research and development in clean energy. In 2016, the NDRC and NEA announced the

Energy Innovation Action Plan (2016-2030). This plan aims to address issues in areas like resource insecurity, energy restructuring, pollution, energy inefficiency, and grid inflexibility (CNESA, 2016). It includes 15 key missions listed below:

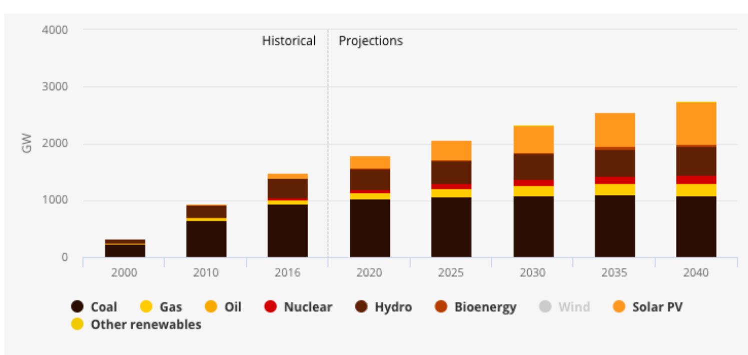
- Coal mining risk reduction
- Unconventional, deep, and deep-sea oil and gas extraction
- Clean and efficient coal technologies
- Carbon capture and storage
- Advanced nuclear power
- Spent fuel reprocessing and radioactive waste disposal
- High-efficiency solar power technologies
- Large-scale wind power
- Hydrogen and fuel cell technologies
- Biomass, ocean and geothermal power
- High efficiency gas turbine technology
- Advanced energy storage
- Key grid modernization technologies
- "Energy Internet" technologies
- Energy saving and energy efficiency technologies (CNESA, 2016)

This policy aims to expand research in next generation technologies such as high-efficiency concentrated solar power (CSP) technologies and high-capacity distributed thermal storage systems. It also aims to work on energy storage capacity to address peak demand and supply mismatch and develop methods for speedier integration of pilot projects into the mainstream. Similarly, the programme aims to work on hydrogen technologies, transportation and storage and fuelling stations, standards as well as business strategies (CNESA, 2016). In addition, the 'Energy Technology Revolution Key Innovation Action Roadmap' (ETRKIAP) issued by the National Development and Reform Commission (NDRC) and the National Energy Board expands on the specific innovation goals, timescale, operational measures and strategic direction on the 15 key innovation missions. The aim is to develop domestic standards and measures as well as develop heat/cold storage technologies and storage standards and research on thermo-chemical technology; and make breakthroughs on liquid metal batteries (Ming, 2016). The plans and targets announced in the EIAP and the ETRKIAP are consistent with the 13th FYP strategies as well.

The Chinese Academy of Sciences (CAS) has recently announced a plan of integrated energy research project. It aims to achieve breakthroughs in 39 core clean energy technologies, complete 23 industrial application demonstrations, and form five world-leading achievements in the area before 2023. It targets replacing more than 100 million tonnes of oil and gas resources and reducing emissions of coal-fired pollutants by 40 per cent to 50 per cent (Chen, 2018).

Solar Energy

China can be considered to be singularly responsible for the global crash in prices of solar power equipment. Projections suggest that China's non-renewables' share of gross energy basket is likely to stagnate due to the rapid pace of development and installations of the renewable energy generation capacity. The International Energy Authority's (IEA) outlook published in 2017 points in that direction. By 2040, the share of coal in China's energy mix is likely to drop to 40 per cent if the present trend continues.



China's Installed Energy Capacity: Status and Projections

(Image Source: International Energy Agency, 2018)

While the recent reports suggest a trend of slowdown, China's solar energy sector enjoyed its best period between 2013 and 2017. China established the world's largest solar panel farm in early 2017.* It has committed to spending nearly $360 billion on renewable energy by 2020.

China's has the largest non-fossil energy generation capacity in the world. It spent $102 billion in renewable energy programmes in 2015 alone which was more than double that of the US domestic investment (Slezak, 2017). China is the world's largest manufacturer of solar panels although the sector has faced some uncertainties in recent years. With policy incentives, in 2015, China has also become the largest producer and consumer of solar power, surpassing Germany (Fialka, 2016). The staggering rate of growth can be understood from the fact that China's installed solar power capacity grew from 8.9 GW in 2012 to 77.4 GW in 2016. It now accounts for 1.2 per cent of the electricity produced in China. In 2016 alone China added 34 GW of installed capacity which was 50 per cent of the global installations that year.

Wind Energy

In the wind energy sector, Goldwind is the biggest Chinese company. It became the world's largest turbine manufacturer in 2015 when it surpassed installations by Denmark's Vestas and GE of the US (Clark, 2017). After a sluggish first haft since 2010, China now has 5 of the top 10 wind turbine manufacturers. China had highest number of domestic installations for the third consecutive year in 2016 with new installations of 23 GW. The total installed capacity in China was at 168.5 GW.

Ocean Energy Projects

Various agencies in China have made investment commitments in ocean thermal and tidal technologies to the tune of 3 billion yuan between 2016 and 2020. A five-year plan in this field was released in January 2017. Zhejiang and Guangdong are marked as research, feasibility studies and demonstration provinces. A new (2 billion yuan) marine laboratory campus is being planned for Qingdao, Shandong Province, in collaboration with the European Marine Energy Centre (EMEC). China also plans to construct around

* The Longyangxia Dam Solar Park in Qinghai is spread over 27 square kilometres and has an established capacity of 850 MW. It surpasses India's facility in Kamuthi, Tamilnadu which has established capacity of 648 MW. For more see Josh Ye (2017).

five renewable energy demonstration projects to ensure secure supply of power for islands (Tidal Energy Today 2017). The Jiangxia Tidal Power Station in Zhejiang is the fourth largest in the world with the installed capacity of 3.4 MW (Global Wind Energy Council, 2017). This, however, is a minor sector in the overall energy mix.

China's rise as a renewable energy leader has had both positive and negative impacts. Integration of research and development as well as fast tracking of installations is an important positive measure. Reductions in component prices by as much as 60 per cent have made renewable energy such as solar energy more cost efficient and thus commercially attractive. However, the sector's success hides issues of subsidies and fair competition strategies (Fialka, 2016).

At the same time, China's non-fossil energy sector also faces challenges of curtailment due to the continued preferential treatment being given to the thermal energy sector. Due to this, estimates suggest, 20 per cent of China's wind and solar energy is wasted as renewable energy sector faces curtailment (Ying, 2016). Curtailment is a phenomenon whereby renewable sector has to cut its production based on the demand levels on a real time basis since it takes longer for thermal, hydro or nuclear generators to adjust their production capacity. Curtailments are also likely to increase because of the ongoing US-China trade wars. US and other major countries have consistently accused the Chinese solar sector of being subsidised in an unviable manner. Some of the changes may be underway as a response to the recent trade restrictions (Rapier, 2018).

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It has been observed that the efficiency rates of installed capacities in China tend to be lower than elsewhere. For example, while China installed 164 GW of wind power capacity in 2017 compared to the US installations of 88GW, output in China was at 305,700 gigawatt hours compared to 254,200 GWH in the US. Unit for unit wind and solar capacities in China were producing up to 40 per cent lower than the capacities in the US (Chatsko, 2018). The reasons for this include poor location selections, quality of solar panels, grid distances and continuing prioritization for utilization of conventional capacities.

Transportation Innovation: Case of Electric Vehicles

As prosperity has grown in China, personal automobiles have become commonplace. China is the world's largest carmaker and purchaser today. A total of 770,000 electric vehicles were sold in China in 2017 and China's home-grown manufacturers accounted for nearly 350,000 or 46 per cent of this number (lee, 2018). This number is projected to cross 1 million in 2018 (Busch, 2018). China accounted for 65 per cent of the global EV market in 2017. The EV market is rapidly becoming a mass market in China whereas it still remains a niche sector in the US and Europe. Three factors have made the EV sector so successful within such a short period of time. First being government support in research and development. The tax support and subsidies offered have encouraged innovation. For example, vehicles with higher range per charge receive more subsidy. Second, government has also offered support in terms of expanding charging network. China will have 120,000 charging stations by 2020. Third, the initial purchase costs as well as maintenance costs are also lower in China. One can buy a hatchback EV in China for 80,000 Yuan which is approximately $12,000. This is comparable to the petrol priced vehicles. On the other hand, there still remains a substantial gap between petrol and EV pricing across the world, with EVs being more expensive to buy and run.

Government support for the EV sector stems from two facts: one, the automobile sales are bound to rise in China for the foreseeable future and vehicle emissions are the fastest growing source of air pollution in China. Two, China became the world's largest oil importer in 2017 surpassing the US. In taking a lead in supporting EV, the government projects the EV sales to rise to 10 per cent of the total personal car sales by 2020. At present it is 4.7 per cent as of 2017. Supporting domestic innovation in the EV sector has not only supported other domestic industries, it is also likely to help China with first movers advantage in other developing markets as the global markets mature within the next decade.

The EV pubic transport is a rapidly rising sector in China. Shenzhen already operates an all-electric city bus network of more than 16,000 buses. Other cities in China are also rapidly following the Shenzhen model as China adds an electric bus fleet of the size equivalent of London every five weeks. These are not only staggering numbers but also significant from the point of view of China's war on pollution (Gray, 2018). With 54 per cent of its citizens now labelled urban dwellers, China is responding rapidly to mitigate their carbon demands as growth leads to greater consumption.

Industry-Academia Collaborations

One of the significant drivers of energy and environmental innovation in China has been the robust industry-university integration (for more see, Yuanjin and Mkhitaryan 2017). Cities like Shenzhen are at the forefront of such research integration models. The autonomy enjoyed by institutions like the CAS has been used extremely productively for collaborations in fields like energy intensity. Universities in the mainland have learnt this tread from their counterparts in Hong Kong. Hong Kong has consistently ranked in the Top-5 in global industry-university collaborations rankings (Yuanjin and Mkhitaryan 2017). In the 2018 Times Higher Education rankings on Industry-University collaboration rankings, 9 mainland Chinese universities were part of the top 50 whereas India had only one entrant, Indian Institute of Technology, Kanpur at 49 (Times Higher Education, 2017). This has also helped China publish growing number of research articles and also register higher number of patents due to better integration between labs and production facilities (Zhou, Tijssen and Leydesdorff, 2016).

Innovation is one of the key components of the Made in China 2025 campaign as well. It also has another component of reducing the production cycle's environmental footprint. This plan is under the aegis of the State Council and was initially formulated by the Ministry of Industry and Innovation Technology (MIIT) (Tse and Wu, 2018).

Conclusion

Conscious of the question over its legitimacy and the acute environmental challenges China faces, the CCP is undertaking massive changes in its environmental administration apparatus as seen from the discussion above. From declaring a war on pollution, to widening the policy ambit and strengthening implementation and supervisory teeth of the new Ministry of Ecology and Environment, to encouraging market mechanism and incentives for research and innovation, the government has done a lot in the last five years or so. Even then substantial challenges remain. China will still be the world's factory for at least a couple of more decades and its coal and fossil fuel dependence is not expected to go away any time soon. Its CO_2 emissions, as per its official commitment is set to peak only by 2030. Which means a minimum of 12 years of rising carbon dioxide emission by the world's largest emitter. Its oil consumption will continue to rise till at least 2030 even as coal consumption is sought to be reduced. Despite the various policy changes so far, average daily levels of PM 2.5 in 2017 were still more than double the WHO's "unsafe" level of 25 micrograms per cubic meter. China clearly will need to strengthen its environmental protection policies and apparatus even more.

The biggest change to have happened in the recent past is the redefinition of the principal contradiction in China. This redefinition should lead to even bigger qualitative changes in China's capacity to protect its environment, upgrade the people's quality of life, and, hopefully, mitigate the very large and ominous Carbon foot-print its industrial policies have left on the global environment.

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