2.3 China: bureaucratic and market hurdles to move from a central towards a decentral energy system

Antony Froggatt, Liao Maolin, Wei Shen, and Zhou Weiduo

2.3.1 Introduction

In its submission to the Paris Climate Summit in 2015, China committed to peak levels of CO2 by 2030. Following the ratification of the Paris Agreement in September 2016, the National Development and Reform Commission (NRDC) released the Energy Revolution Strategy (2016–30) to put in place domestic measures to ensure the pledge was met. This included a commitment to lower the carbon intensity of GDP by 60–65 per cent below 2005 levels, increase the share of non-fossil energy of the total primary energy supply to 20 per cent, and increase its forest stock volume by 4.5 billion cubic metres, compared to 2005 levels, by 2030 (Carbon Action Tracker 2018).

Meeting these commitments will be challenging as China's energy system is dominated by fossil fuels, as can be seen in Figure 9, where coal accounted for 60 per cent of energy consumption in 2017. These figures also highlight the rapid increase in growth of energy consumption during the first decade of this century, however it is important to note that this trend has tailed off in recent years. China's National Bureau of Statistics' 2017 assessment of National Economic and Social Development (NBSC 2018) show that the Chinese economy grew by 6.9 per cent during that year, an increase of 0.2 per cent over the previous year. While in 2017, total energy consumption increased by 2.9 per cent, leading to a decrease in energy intensity of 3.7 per cent, carbon intensity fell by 5.1 per cent as a result of a gradual move away from coal. During 2017,

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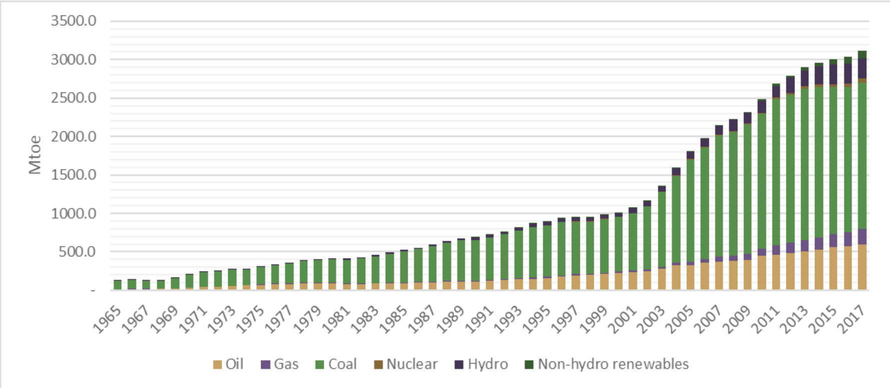

Figure 9: Energy consumption in China 1965–2017.
Source: BP Statistical Review of World Energy (2018).

the consumption of coal grew by 0.4 per cent, which although only slight, was an increase for the first time in three years. There has been an increase in the use of 'non-coal and oil sources' (the government statistics include natural gas, nuclear, hydro, and other renewable sources) which rose to 20.8 per cent of the energy mix, an increase of 1.3 per cent.

There are a number of drivers of change in the energy sector, which have impacts over different timescales. An overarching consideration is the economic transition towards innovation and a more service-led economy. While decarbonisation, along with energy security, are important drivers of change in the energy sector, urban air pollution remains highly influential. (McMullen-Laird et al. 2015) Even the official government statistics suggest that of the monitored 338 cities at prefecture level and above, 29.3 per cent reached the required air standard, however, 70.7 per cent failed to do so. (NBSC 2018) In some cities, such as Beijing, pollution levels have been reduced as a result of the switch from coal to gas and the closure of older factories (Bloomberg 2018).

The grid system is run by two companies, State Grid and China Southern Grid, which have a monopoly of retailing to all customers except large consumers that can self-generate. They are vertically integrated, owning transmission and distribution networks as well as generation and retail. In 2014 the companies were not evenly matched in relation to geographical coverage, size or by assets; State Grid is four times larger than China Southern Grid (Pollitt, Yang & Chen 2017).

2.3.2 Growth in renewable energy

Despite its heavy dependency on fossil fuels and its massive levels of coal consumption China has become a – if not *the* – key country in the global shift

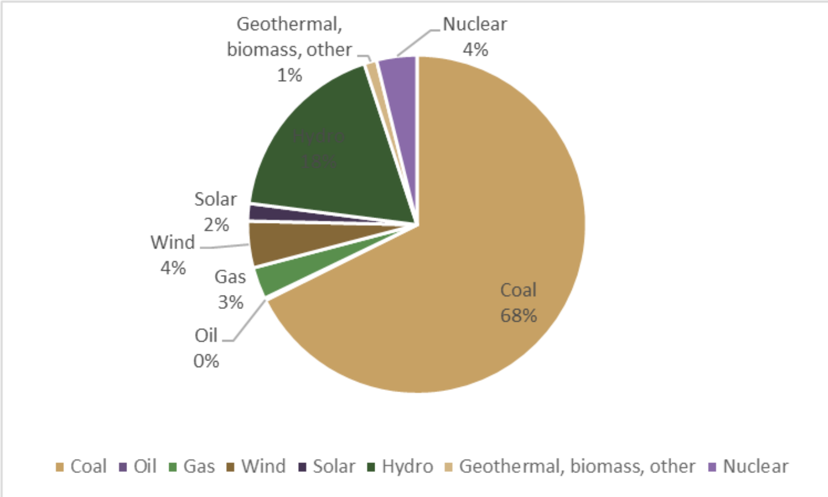

Figure 10: Source of electricity in China in 2017.
Source: BP Statistical Review of World Energy (2018).

towards the greater use of renewable energy, due to its manufacturing base and, more recently, renewable energy deployment rates. China is the world's largest producer of solar PV panels and wind turbines. The annual utilised amount of renewable energy resources in China has steadily increased since 2005. In the power sector in 2017, renewable energy produced 1627 TWh of electricity (25 per cent of the total), with large hydro the largest source, making up 18 per cent of the total, as can be seen in Figure 10.

Hydropower, despite its controversy, remains a significant part of China's energy mix and its growth according to the International Hydropower Association has been 'remarkable'. Although the rate of growth has slowed, in 2017 9.12 GW of capacity was added, leading to a total of 341 GW. Growth for hydro is still on the Government's agenda as new projects, including a 16 GW project in Beihetan, are being developed as it strives to meet the 13th Five-Year Plan target of 380 GW installed capacity by 2020 (IHA 2018).

However, despite the relatively low percentage of power that is coming from new renewable energy, particularly solar and wind, its growth has been rapid and unprecedented globally (see also Figures 11 and 10). In 2017, China added 52.8 GW of solar PV capacity and 19.5 GW of wind, as can be seen in Figure 11.

However, there are concerns in China and internationally about the effect of government measures to control the rate of new solar deployment. In the first half of 2018 the government announced new measures to slow the approval for new subsidised utility-scale PV projects in 2018 and put a 10 GW annual cap on distributed generation (DG) (Renewables Now 2018). The government

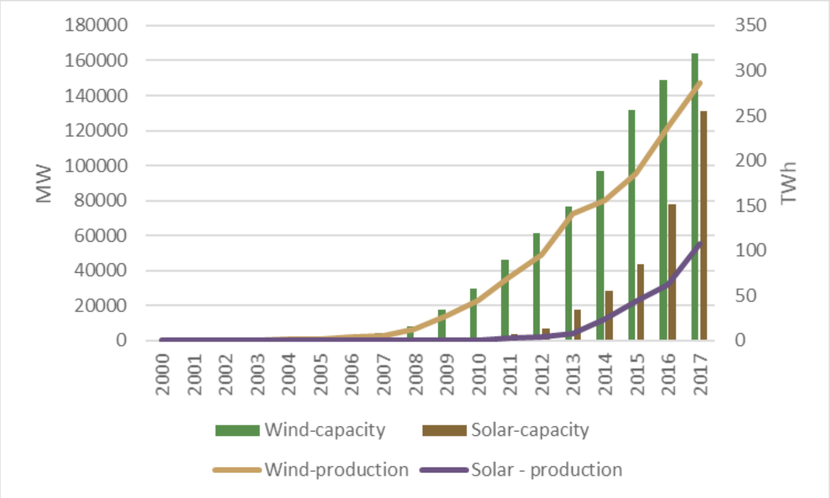

Figure 11: Growth in solar and wind deployment in China (2000–2017)–MW/TWh.

Source: BP Statistical Review of World Energy (2018).

has also cut feed-in tariffs (FiTs) for solar PV and announced that new utility-scale projects would have to compete in auctions.

Furthermore, in mid-June 2018, government announced that biomass and waste to energy plants would no longer be eligible for energy subsidies. (Reuters 2018). Biomass remains an important provider of renewable energy and at present the annual biomass resource for energy use in China displaces about 460 million tons of standard coal (320 mtoe).

2.3.3 Phases of the development of distributed energy development

Over the last decade the rate of connection of renewable energy to the electricity distribution grid in China has fallen behind that in other countries, despite various government attempts to stimulate its growth. During the period from 1990 to 2000, the implementation of distributed energy in various fields and industries was attempted. In China the phrase 'distributed energy', tends to be related to 'combined heat and power generation' or 'combined cooling-heating-power cogeneration', without the specific objective of developing what is now defined as 'distributed energy' more widely in a global sense.

From 2000, some larger distributed energy projects began to be put in place in cities such as Beijing, Shanghai, Guangzhou, etc., however, these were still focused on the development of distributed natural gas. Larger cities were chosen to pilot developments due to the high set up costs, which these areas, with better developed economies and a higher capacity to afford energy prices, were better able to absorb.

The 11th Five Year Plan (FYP) 2006–10 further recognised the need to strengthen the distribution networks for both gas and electricity, and for the further development of combined heat and power and 'distributed cogeneration' with clean energy as the fuel will be developed. Furthermore, energy storage and integrated technologies for heat, power, and refrigeration for micro gas turbines were defined a key frontier technology for the FYP. The plan recognised the potential of renewable energy, including wind, biomass, and solar and the need to scale up to increase commercialisation. Renewable energy was also to be developed for rural energy development, with specific targets on the development of solar thermal, small-scale wind, and biogas digesters. (NDRC 2007)

The 12 FYP (2011–15) called for the further development of large and decentralised renewable energy. This included medium and small hydro resources, including pump storage, as well as solar, biomass, and geothermal. It also called for the strengthening of the grid and the effective development of wind. Specific installation targets were proposed for wind (70 GW) and for solar (5 GW), which were met and exceeded, with installed wind capacity in 2015 at 131 GW and solar at 43 GW. The plan also calls for the government to 'promote the extended application for distributed energy systems' (NDRC 2011).

In 2013, the State Council issued 'Several Opinions on Promoting Healthy Development of the Photovoltaic Industry' (hereinafter called Development Opinions), which proposed to vigorously explore the distributed photovoltaic power generation market. This encourages all types of power users to construct distributed photovoltaic power generation systems in accordance with Power Line Communication. Furthermore, it not only has clear requirements to promote the integration construction of photovoltaic building and large-scale demonstration and application of distributed photovoltaic power, but also encourages the promotion of photovoltaic power in the areas of urban street lighting, urban landscape, communication base stations, traffic lights, etc.

Distributed generation and in particular solar is also seen as a tool for poverty alleviation. In October 2014, the Solar Energy for Poverty Alleviation Programme (SEPAP) jointly issued by the National Energy Administration and the State Council suggested that carrying out photovoltaic poverty alleviation projects, by utilising barren hills and agricultural greenhouses in poverty-stricken areas or facilities to construct photovoltaic power plant, could directly increase the income of the poor. In April 2016, the National Energy Administration along with five further departments, jointly issued Opinions on the Implementation of Photovoltaic Power Generation to Alleviating Poverty to further clarify the specific rules and regulations about the implementation of photovoltaic poverty alleviation projects.

The current and 13th FYP 2015–20 for Energy Development, published by the National Energy Administration, based on the larger Economic and Social

Development plan, further develops the concept of decentralised energy and sets more ambitious targets for the deployment of renewable energy. The plan set proposals for total energy consumption from DG to grow by more than 2.5 per cent per year and for the energy intensity of the economy to improve by 15 per cent. Non-fossil energy consumption should reach more than 15 per cent; natural gas consumption should reach 10 per cent, and the proportion of coal consumption should fall to below 58 per cent. During this period there should be 210 GW of wind power, and 110 GW of solar, of which 60 GW, should come from distributed sources. By the end of 2017, installed wind capacity had reached 164 GW, so was on track to meet its target, while solar had already exceeded it, with 131 GW.

The 13 FYP also calls for clean energy technology development, including the support of smart grid, energy micro-grid, electric vehicle and energy storage technology, and the development of distributed energy networks including the acceleration of the development of the smart grid, and the active promotion of the intelligent substation, and intelligent dispatch system construction (NEA 2016). According to the Renewable Energy 13th FYP, by 2020, total RE electricity installations will reach 680 GW, with electricity production of 1900 TWh (in 2017 this had reached 1627 TWh) and account for 27 per cent of electricity production. The plan proposes that by 2020, the wind tariff should reach grid parity, meaning that the feed-in price for wind will be the same as for coal plants. In parallel to the main Energy FYP, there are 14 supporting FYPs, such as the Renewable Energy 13th FYP, Wind FYP, Electricity FYP etc., which were all released around the same time (Livzeniece 2017).

2.3.4 Lessons from the five-year plans

The IEA and others note that the distributed energy goals, particularly those for gas, have not been met, which is 'unusual in China'. The IEA highlight that to accelerate the deployment of distributed energy a number of improvements could be made which include (IEA 2017):

- Setting out detailed development goals for distributed energy at different government levels: in particular, for national government to provide guidance to local provincial and municipal governments for subnational plans to harmonise with the national plans.
- Distributed energy integration policies: while there may be a recognition of the need to develop distributed generation and that it needs to be connected to the grid, there remain disputes on how and who pays for the connection. Therefore, 'the development of distributed energy will be greatly promoted by introducing standards on integration and operation to clarify the technical demand, procedures for integration and the obligations and responsibilities of each stakeholder'. This can be achieved in China through defining

the obligation of the grid companies to provide access and integration services, to simplify integration procedures, and to strengthen regulation.
- Coordinating the development of energy infrastructure: optimising decentralised energy needs to ensure that the scale and layout of new sources needs to be matched both the renewable resource and the existing distribution network.

2.3.5 Developing distributed solar energy systems in China: challenges and prospects

The Chinese solar PV industry has gone through several developmental stages since the late 1990s (Zhang, Andrews-Speed & Ji 2014).

Solar PV was initially encouraged for lighting and other off-grid activities to enable energy access for remote and nomadic communities. In 1996 the national government introduced a programme designed to help those communities without access to the grid in Western China, through the Brightness Programme. This was expanded between 2002–2007 to North-Western China, through the Renewable Energy Development Project, which reached an estimated two million people. In 2009 the government further promoted the use of solar with the Golden Sun Programme, to encourage its use in the Tibetan plateau (Geall, Shen & Zeren 2017).

However, these developments were relatively small, and before 2012 Chinese solar panels were often sold for export, particularly to the EU and the US markets. Yet the EU and the US trade dispute with China has had devastating impacts on Chinese panel exporters (Meckling & Hughes 2018). In 2013, the Chinese government launched ambitious feed-in tariffs for developing domestic solar energy market (State Council 2013) to rescue the Chinese solar panel manufacturers in crises amid rising protectionist policies (Lewis 2014; Shen 2017). China has since become the world's largest solar nation. Since 2015, China has moved ahead of Germany, becoming the largest investor in solar energy capacities with a total of 131 GW installed in 2017. However, the majority of these investments are for large-scale solar parks, and the distributed solar system[5] only accounts for 13 per cent of the total installed, with around 10.32GW (NEA 2017). This is in contrast to other big solar nations like Germany and the United States, where distributed systems take the lion's share of the market. An interesting question being, why is there such a notable difference?

[5] In the Chinese context, distributed solar systems refer locally consumed small-scale projects with 35 KV or below voltage level for grid connection, which includes both roof-top systems and mini solar parks. The electricity can be used either for self-consumption or for sale.

Currently, there is a dramatic (yet diminishing) gap between the manufacturing capacity of PV panels and their deployment into power generation facilities such as solar parks. In 2016 Chinese companies produced 53 GW solar PV modules and panels (Ministry of Industry and Information Technology 2017), while annual deployment within China was around 35 GW (NEA 2017). The 18 GW gap is mainly for exports, particularly to the emerging markets and, much less nowadays, to the western markets. Considering there are many Chinese manufacturers still not operating at their full capacity, the actual gap between manufacturing and domestic deployment capacity could be even higher. As a result, there has been a constant pressure of capacity over-supply in Chinese solar industries throughout the years of its development. Such pressures drove PV panel producers to focus on the large-scale projects to increase sales in the short run. In addition, for project developers and investors, large projects are also preferred due to their economies of scale. Small and distributed systems are often associated with high transaction costs. Lastly, most of China's North Western provinces, such as Xinjiang, Qinghai, Ningxia, and Gansu, are vast and sparsely populated, with sufficient sunlight intensity, therefore ideal for developing large solar parks.

The preference for large-scale projects over small-scale distributed solar systems is a consequence of a combination of market rules and regulations in China, as this is a consequence of geography and pressure on manufacturers to install a lot of panels very quickly. In particular, policies and regulations at the provincial and local level can impact upon the rate of deployment, especially relating to housing regulation and grid access, which can slow down the deployment of renewables at the distributed level. It has become clear, however, that focusing only on large-scale solar parks in the barren Western and remote inland regions is not sustainable in the long-run. The mushrooming solar parks in these areas present tremendous pressure for the grid companies to accommodate all the newly installed solar capacities, as some of them are far from the main grid networks.[6] Even if some of these can be connected, electricity cannot be consumed within the local region as Western provinces are relatively under-developed and the energy demand is consequently low. Yet, long distance transmission to the coastal developed provinces is not only economically unviable but also technologically difficult. As a result, curtailment of energy generation from solar parks has been increasingly rampant.[7] Therefore, Chinese policy makers believe distributed systems are the future of the industry

[6] Although China achieved 100 per cent rural electrification in 2016 (Geall, Shen & Zeren 2017), the capacity and reliability of the grid connection in many places is still inadequate to meet the accommodation and distribution requirement of large renewable energy facilities.

[7] In some provinces, the curtailment can be as high as 30 per cent, which means one third of installed capacity would remain idle and not generating any electricity.

and have been designing various policy tools since 2015 to promote this.[8] The key purpose of these new policies is to 'distort' market preferences for large projects over distributed solar system.

Some concrete measures for promoting distributed solar systems include:

- Provinces with existing curtailment problems must be prohibited from construction of large-scale projects; distributed systems only to be allowed.
- Simplification of the approval process for distributed systems to lower the bureaucratic hurdles. Government approvals on land use and access to rooftops, and environmental or social impacts are to be exempted.
- Grid companies to be required to provide unconditional grid connecting services to distributed solar systems.
- Additional subsidies or tariff support to be provided by both national and local government. In China, there have been significant delays in the payment of subsidies. However, the subsidy payment for distributed solar systems is prioritised.
- Access to upfront capital.
- Some localities legally require that high energy consumption enterprises have to install roof-top solar systems; some also require that all the newly constructed rooftops, once exceeding a threshold area, are to be installed with solar systems; generated 'clean energy' from rooftop solar installations would be counted towards the contribution made by Corporations for achieving energy saving and emission reduction targets as set by the government annually.
- Distributed solar systems to be further promoted as a poverty alleviation programme.[9]

These policies only take effect gradually. In 2016, the frenzy of investment in large-scale infrastructure in the north-western provinces was restricted, with their share of newly added capacity dropping to less than 30 per cent. Meanwhile, there has been a notable increase of investment in distributed systems, mainly among the eastern coastal provinces. The annual instalment of distributed solar capacities doubled compared to the previous year, reaching a

[8] Since late 2014, NEA issued several specific policies to promote and regulate distributed solar systems (NEA 2016; NEA 2017). These policies require local government to provide more generous subsidies and assured grid connections. NEA senior officers have stated clearly in different public speeches and media conferences regarding their preference of distributed system over large-scale solar parks.

[9] In 2014, China announced an ambitious plan to help alleviate rural poverty through the deployment of distributed solar systems in poor areas. The solar energy for poverty alleviation programme (SEPAP) initiative aims to add over 10 GW capacity and benefit more than 2 million households from around 35,000 villages across the country by 2020.

record high of 4 GW. However, there are still significant technical, political, and economic constraints for the further development of distributed systems, as explained in the following section.

Roofs

It is estimated that only 30 per cent of buildings in urban areas have suitable roofs. In rural areas the situation is even worse, which has become a major problem for companies trying to implement SEPAP (solar energy for poverty alleviation) programmes.

In addition to issues of quality, the allocation of ownership, distributing revenues of electricity sales, and sharing the payment obligation are all reasons why rooftop solar installation is not as high as it might be; these are barriers that must be addressed.

Grid connection

As mentioned, rural grids are often less robust in China, and this significantly constrains the expansion of distributed solar systems at village level. In addition, local grid officers also often lack sufficient knowledge and expertise to deal with growing applications for household solar systems, and consequently are reluctant to accept applications for connecting the distributed system. Delaying or denying applications is also not unusual.

Subsidy payment

The dramatic expansion of China's renewable energy industries, particularly in the wind and solar energy sectors, has put the renewable energy subsidy system on the brink of collapse.[10] China's renewable energy subsidy is paid from a national fund that collects additional charges from energy end users. Yet the explosive growth of the solar and wind markets far exceeds the fund's revenue, which has created a mounting shortage of the subsidy. The unofficial estimation of the deficiency of the subsidy can be around RMB 50 to 60 billion by 2016 (Xinhua News 2017). The delay of subsidy payments to the project developers can be several years. In addition, Chinese regulators wish to reach grid parity for wind and solar energy by 2020. Therefore, significant reduction in the subsidy is expected in the coming years and is starting to be seen despite the strong lobbying efforts made by the industry. This expectation is likely to significantly affect investor decisions in the years to come.

Project finance

As distributed projects became increasingly popular, innovative financial arrangements emerged, such as a leasing contract, carbon credit finance, and

[10] Currently, the subsidy programme, Renewable Energy Fund, is mainly collected from the industrial electricity bills.

the energy performance contract (EPC). However, access to project finance is still the largest barrier for many investors in distributed solar systems. Unlike the wind energy sector, where the investors are mainly giant state-owned utility corporations, the investors in solar energy facilities (particularly the distributed systems) are small or medium private enterprises (SMEs). In China's unique political economic system, it is usually difficult for these companies to get access to state-controlled banking services. In addition, the transaction costs and repayment risks attached to distributed systems are very high; projects are dispersed and small in size compared to other energy infrastructure and have very long project cycles for regaining the initial investment, often beyond 15 or even 20 years.

The policy implications for distributed solar systems in China are:

- **First**, clearer policies and regulations are needed to solve the technical issues of the quality of building roofs in rural areas, plus ownership any other legal issues associated with urban residential buildings.
- **Second**, integrating more diversified incentive mechanisms to encourage financial institutions to be actively involved in supporting the distributed systems. Climate, development and energy policy tools, such as carbon offsets, poverty alleviation funds, or green energy certificates, may help to enhance the financial prospect of the distributed system even if government subsidy is to be reduced. However, the integration of these policy instruments requires tremendous coordination among various segments of bureaucratic systems, which is always a big problem in China due to its rather fragmented political system (Andrews-Speed 2012; Mertha 2009).
- **Thirdly,** the grid strategy requires adjustment to present a friendlier approach for distributed systems, prioritising grid upgrade for local consumption and distribution. If all these policy changes were realised – although it is still unrealistic to expect distributed solar systems to dominate the market development in the near future – they would surely play a more important role in China's fast changing energy landscape.

2.3.6 Creating system flexibility

A widely accepted narrative around China's solar and wind development is that the introduction of clear and binding targets in Europe for the deployment of renewable energy and the subsequent rapid deployment of new technologies, led to the establishment of large manufacturing capabilities within China. Then as prices fell and the market slowed in Europe with the economic downturn in 2008, China adopted, and has exceeded domestic targets to maintain its manufacturing capabilities. (Gang 2015). This strategy has led to the global domination of both manufacturing and deployment capabilities.

China is now looking to dominate the manufacturing of the other 'new' technologies to enable the integration of renewables including smaller decentralised generation. In particular, the focus is on batteries, both static and mobile, and electric vehicles.

In 2018, global sales of electric vehicles topped one and a half million for the first time, of which around 1 million were in China. The majority of these sales were from domestic manufacturers, with only 25,000 of these sales from imported vehicles (EV Volumes 2018). As EV sales are expected to expand to 11 million in 2025 and 30 million in 2030, so the need for batteries will increase, leading to lower prices (BNEF 2018), which will benefit grid level storage. In addition, the introduction of smart charging and potential two-way flows of power to EVs will aid system flexibility. China is also dominant in the manufacture of batteries, producing three quarters of the global capacity.

According to Benchmark Mineral Intelligence, China's dominance in the manufacture of batteries is set to continue with 26 large-scale manufacturing plants under-construction and due to be in operation by 2021. These have a combined capability of producing 344.5 GWh of batteries per year (compared to today's capability of 100 GWh), half of which is being built in China (BMI 2017). Whilst a number of the world's largest EV manufacturers have announced they are opening up manufacturing bases in China, including Tesla, BMW, and Volkswagen.

Stationary storage has not, to date, been given the same level of policy support, with a tendency towards other balancing mechanisms such as high voltage transmission (IEA 2016). However, there are examples of significant piloting of new developments, including the construction of 3 MW/12 MWh vanadium redox flow battery (VRB) in Zaoyang, Hubei Province, which is expected to be the test for a 40 MWH project which in turn will be superseded by a 500 MWh project (Energy Storage 2017). There are also further lithium-ion storage projects under development across China, including a 6 MW project by BYD and a 3 MW from China Aviation.

China is also the world leader in the deployment of smart meters with upwards of 469 million in the autumn of 2017; over two thirds of the global total. In 2016 China also exported 130 million units. (Smart Energy International 2018).

2.3.7 Conclusion and prospects

The energy sector in China is changing although, due to the large number of coal power plants, even unprecedently large deployment of new renewable and other technologies result in slow changes in the supply mix. However, there has been a gradual acceptance of distributed renewable sources, especially photovoltaic power. The pattern of the distributed energy industry is maturing, promoting the transition of the power grid in China in the direction of intelligence and micro-grids, as well as boosting poverty alleviation development in China.

The current structure of the power sector and administrative control restricts the development of renewable energy in general, including distributed energy. The reform of the energy market in China is long overdue. Although the reform of the energy industry in China has taken the first step with liberalisation of the coal market, oligopoly competition for oil and gas, and operational (although not ownership) separation of generation and grid, the market-oriented reform is far from complete.

A major barrier to the development of DER remains the lack of a pricing mechanism that accurately prices its value to the system. Therefore, renewable deployment relies on either direct subsidies or fixed prices to ensure development. As with other countries, the Chinese government is keen to reduce the financial support given to renewables as they move towards parity with other generators. This is both understandable and expected. However, it is important that this move is undertaken transparently and in such a way that does not lead to the abrupt halt of the industry. This would have unwelcomed knock-on implications for manufacturers and installers. In the case of China this could also have global implications. The cuts in support for solar PV in the first half of 2018 may well have a disruptive impact across the solar sector in China, and possibility internationally.

China's electricity grids are controlled by two monopolies – the State Grid and China Southern Power Grid – and although policies have been introduced to enable direct power purchases for large users, there are still significant tariff and non-tariff barriers for connections for smaller-scale and distributed generation. This is partly due to a lack of clarity over the roles of the grid operators.

China has many of the components to put decentralised energy front and centre of its energy policy. Furthermore, with large manufacturing capabilities for renewables, storage and smart systems, China also has the capability to capitalise on global trends. However, without governance reforms, enabling smaller actors to enter the market, through regulatory reform and further price disclosure, the opportunity to capture this massive global market and avoid wasted investment could be lost.

2.3.8 References

Andrews-Speed, P. (2012), *The governance of energy in China: transition to a low-carbon economy*. Palgrave Macmillan.

Bloomberg. (2018), *China Is winning its war on air pollution, at least in Beijing*. Retrieved July 16, 2018, from https://www.bloomberg.com/news/articles/2018-01-11/china-is-winning-its-war-on-air-pollution-at-least-in-beijing

BMI. (2017), *Rise of the Lithium ion battery mega factories: What does 2018 hold?* Retrieved July 17, 2018, from see http://www.benchmarkminerals.com/where-is-new-lithium-ion-battery-capacity-located/

BNEF. (2018), *Electric vehicle outlook 2018, Bloomberg New Energy Finance, June 2018*. Retrieved from https://about.bnef.com/electric-vehicle-outlook/#toc-download

BP. (2018), *Statistical review of world energy*. Retrieved from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Carbon Action Tracker. (2018), *China, climate action tracker*. Retrieved March 13, 2018, from http://climateactiontracker.org/countries/china.html

Energy Storage News. (2017), *Chinese government's strategic push for energy storage to yield large flow battery projects*. Retreived July 17, 2018, from https://www.energy-storage.news/news/chinese-governments-strategic-push-for-energy-storage-to-yield-large-flow-b

EV Volumes. (2018), *China plug-in sales for 2017-Q4 and full year – update – 2018*. Retrieved July 17, 2018, from http://www.ev-volumes.com/country/china/

Gang, C. (2015), China's solar PV manufacturing and subsidies from the perspective of state capitalism. *Copenhagen Journal of Asian Studies*. Retrieved from https://rauli.cbs.dk/index.php/cjas/article/viewFile/4813/5239

Geall, S., Shen, W. & Zeren, G. (2017), *Solar PV and poverty alleviation in China: rhetoric and reality*. STEPS Centre Working Paper no. 93, Brighton: STEPS Centre.

IEA. (2016), *Tracking clean energy progress 2017, International Energy Agency*. Retrieved from https://www.iea.org/publications/freepublications/publication/TrackingCleanEnergyProgress2017.pdf

IEA. (2017), Prospects for distributed energy systems in China. Paris: International Energy Agency.

IHA. (2018), *2018 Hydropower status report, 24 May 2018, International Hydropower Association*. Retrieved from https://www.hydropower.org/publications/2018-hydropower-status-report

Lewis, J.I. (2014), The rise of renewable energy protectionism: emerging trade conflicts and implications for low carbon development. *Global Environmental Politics, 14*(4), 10–35.

Livzeniece, L. (2017), *China's new five-year energy plan, Global Wind Energy Council*. Retrieved July 17, 2018, from http://gwec.net/chinas-new-five-year-energy-plan/

Meckling, J. & Hughes, L. (2018), Protecting solar: global supply chains and business power. *New Political Economy, 23* (1), 88–104.

Mertha, A. (2009), "Fragmented authoritarianism 2.0": political pluralization in the Chinese policy process. *The China Quarterly, 200*, 995–1012.

Ministry of Industry and Information Technology (MIIT). (2017), *The operational situation of solar PV industry (in Chinese)*. Retrieved from http://www.miit.gov.cn/n1146290/n1146402/n1146455/c5505841/content.html

McMullen-Laird, L., Zhao, X., Gong, M. & McMullen, S.J. (2015), Air pollution governance as a driver of recent climate policies in China. *Carbon and Climate Law Review, 9*, 243–255.

NBSC. (2018), *Statistical communiqué of the People's Republic of China on the 2017 National Economic and Social Development, National Bureau of Statistics of China*. Retrieved from http://www.stats.gov.cn/english/PressRelease/201802/t20180228_1585666.html

NDRC. (2007), *11th five year plan on energy development, National Development And Reform Commission*. Retrieved from https://china.usc.edu/national-development-and-reform-commission-percentE2-percent80-percent9C11th-five-year-plan-energy-development-percentE2-percent80-percent9D-april-2007

NDRC. (2011), *12th five-year plan (2011-2015) for National Economic and Social Development, National Development And Reform Commission, translation by the British Chamber of Commerce in China*. Retrieved July 17, 2018, from https://policy.asiapacificenergy.org/node/37

NEA. (2016), *13th five-year plan for energy development, National Energy Administration, translation by Asia and Pacific Energy Forum*. Retrieved July 17, 2018, from https://policy.asiapacificenergy.org/node/2918

NEA. (2017). *National Energy Administration, statistics of solar energy development in 2016 (in Chinese)*. Retrieved from http://www.nea.gov.cn/2017-02/04/c_136030860.htm

Pollitt, M., Yang, C.-H. & Chen, H. (2017), *Reforming the Chinese electricity supply sector: lessons from international experience, Energy Policy Research Group, University of Cambridge*. Retrieved from https://www.eprg.group.cam.ac.uk/wp-content/uploads/2017/03/1704-Text.pdf

Renewables Now. (2018), *GTM cuts by 40 percent solar forecast for China*. Retrieved July 17, 2018, from https://renewablesnow.com/news/gtm-cuts-by-40-2018-solar-forecast-for-china-615667/

Reuters. (2018), *China cuts subsidies for some renewable power projects: finance ministry*. Retrieved July 17, 2018, from https://www.reuters.com/article/us-china-renewables-subsidy/china-cuts-subsidies-for-some-renewable-power-projects-finance-ministry-idUSKBN1JB09X

Shen, W. (2017), Who drives China's renewable energy policies? Understanding the role of industrial corporations. *Environmental Development, 21*, 87–97.

Smart Energy International. (2018), *China leads smart electric meter market*. Retrieved July 17, 2018, from https://www.metering.com/industry-sectors/smart-energy/china-smart-electric-meter-market/

State Council. (2013), *Opinions on deepening the institutional reforms on income distribution*. State Council Policy No. 2016(6). Retrieved from http://www.gov.cn/zwgk/2013-02/05/content_2327531.htm (in Chinese)

Xinhua News. (2017), *The 13th five year plan to tackle the difficult challenge of renewable energy subsidy and curtailments*. Retrieved from http://news.xinhuanet.com/energy/2017-07/31/c_1121404901.htm (in Chinese)

Zhang, S., Andrews-Speed, P. & Ji, M. (2014), The erratic path of the low-carbon transition in China: Evolution of solar PV policy. *Energy Policy, 67*, 903–912.