

The Role of Policy Design and Market Forces to Achieve an Effective Energy Transition: A Comparative Analysis Between the UK and Chinese Models



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The interplay between policy design and market forces has been crucial in driving the global energy transition from fossil fuels to renewable energy sources. However, models adopted by countries are based on different historical approaches and have therefore evolved differently over time, while also influencing each other.

In this chapter, the UK and China have been chosen as two countries which have achieved successes in decarbonising their respective economies through the deployment of significant levels of renewable energy resources; however, each has adopted a differing energy transition strategy.

The UK electricity market was one of the first globally to be privatised and deregulated in the late 1980s and early 1990s, following similar earlier initiatives in the natural resources and telecommunications sector. This experience and the subsequent market adjustments which were undertaken by the UK Government and the regulator laid the groundwork for similar processes which have taken place within the European Union and further afield. The entry of new market players initially in conventional gas-fired power generation during the 1990s and subsequently in renewables starting in the 1990s—but more substantially over the past 20 years—have brought non-utility private sector expertise into the deployment of new technologies. It was this track record which enabled the UK to design incentives for renewable energy—starting with tariffs and moving to auctions—with a strong likelihood that they would bring about successes in terms of deployment of new renewable capacity. It is for this reason that the UK has been selected to represent a noteworthy example of how regulation can harness market forces to play a decisive role in the shift towards renewable energy.

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China, on the other hand, began its journey towards decarbonisation later, its motivation was driven partly by the availability of natural renewable resources—such as wind and sun—which in turn would reduce the country's need to import primary energy and secondly, abate emissions which were becoming particularly significant in urban areas risking a public backlash. China epitomises a very large and topographically diverse country in which the role of the state has been instrumental not only in policymaking aspects of the energy transition, but crucially also in funding, building, owning and operating renewable energy power plants.

1 The UK: A Case Study of Market-Led Energy Transition

As an island endowed with some of the best renewable resources in Europe, in particular wind, tidal and wave power resources, the UK has been chosen as a case study to show how a major economy is capable of achieving ambitious renewable energy targets whilst ensuring economic growth. However, Britain's transition away from coal, like many of its European neighbours, has been neither a smooth nor a linear process.

Importantly, in June 2019, the UK became the first G7 economy to commit to reducing greenhouse gas emissions (GHG) to net-zero by 2050, as compared to the previous less ambitious target of an 80% decrease from 1990s levels.

The UK is also one of a handful of markets around the world which is currently transitioning from traditional direct government support of renewable energy sources, using feed-in-tariffs for utility-scale renewable energy plants, to the private sector support of renewables. This is predominantly through the use of Power Purchase Agreements ('PPA'), entered into directly with corporations keen to purchase some or all of their power requirements from renewable energy sources.

This section argues that one of the key reasons for Britain's success in promoting a renewable agenda and transitioning away from direct government support has been policy flexibility combined with a commitment to allowing the market to play a crucial role in the energy transition. In this respect, the British model differs from those of other European countries, which were more heavily reliant on direct state support.

The UK has been a pioneer not only in the incentivisation of renewables through the Non-Fossil Fuel Obligation (NFFO) subsidies introduced in 1990s, but also the liberalisation of its electricity market, thanks to wide-ranging reforms implemented in the late 1980s and early 1990s. The role of successive UK Governments since the 1990s has been decisive in paving the way for the energy transition, latterly as capital costs have declined sufficiently enabling the private sector to take a leading role, thanks to the development of 'more competitive forms of price discovery such as auctions or tenders' (DECC 2011).

While these policies can be deemed to have been successful, they mainly supported commercially viable technologies, such as wind and solar, at the expense of promoting commercialisation of technologies such as tidal. Beyond that, they failed

Table 1 UK energy sector, key milestones

1983	The Energy Act encourages the private generation and supply of electricity
1986	Privatisation of British Gas
1988	'Privatising electricity' White Paper
1989	The Electricity Act calls for the privatisation of the UK electricity supply industry
1990	Privatisation of the Regional Electricity Companies (distribution and supply) and two generators National Power and PowerGen
1990	Non-Fossil Fuel Obligation (NFFO)
1990–1998	Liberalisation of electricity supply
1993	'The prospects of coal' White Paper
1997	British Gas splits into Centrica (gas trading and retail) and Transco (pipelines)
2000	The Utilities Act introduces the Renewables Obligation (RO)
2001	Climate Change Levy
2008	Climate Change Act
2013	Energy Act—Electricity Market Reform
2018	Launch of 'The Road to Zero' Strategy
2019	UK commits to net-zero emissions by 2050
2020	COP 26 to be hosted by the UK, jointly with Italy

to provide any incentive for research and development into earlier stage technologies such as wave, notwithstanding the higher priced banding available in recent Renewables Obligation (RO) tenders. Indeed, the government resorted to entering into a long-term PPA to support the construction of the £20 billion Hinkley Point C 3.2GW nuclear power plant at a price of £92.50/kWh but was unwilling to undertake the same for the smaller £1.3 billion 320 MW Swansea Bay Tidal Lagoon Project at a price of £89.90/kWh (UK Government 2011) (Table 1).

2 Early Processes of Decarbonisation

Decarbonisation of the UK energy industry started in the 1970s, well before any global initiative to halt climate change. The primary motivation was economic rather than environmental, and more specifically linked to the depletion of the UK's North Sea oil and gas reserves. A series of policies were launched to reduce the UK's reliance on fossil fuels in the electricity sector, including stronger support for new nuclear power plants as well as other clean-energy sources, the result of which was a 29% decrease in petroleum consumption between 1970 and 2012 (UK Parliament 2018).

As a result, the interplay between a set of economic and policy factors has significantly contributed to accelerating the energy transition. Hence, in order to understand

the roots of Britain's decarbonisation processes, it is necessary to briefly analyse the historical context from which this transition emerged.

Despite having its own domestic sources of coal, the need for the UK to become less dependent on fossil fuels first became apparent as a consequence of the 1973 and 1979 oil shocks. Following the first oil shock, the UK Government formed a Department for Energy in January 1974 (Pearson and Watson 2012). The economic consequences of the two oil shocks were far reaching in the UK and translated into spiralling inflation rates which reached 24% in 1974 (The Guardian 2011). Wage demand began to rise as earnings were eroded and the Trades Unions representing some 280,000 miners played a pivotal role in wage negotiations with the government led by the Conservative Prime Minister Edward Heath (Gouiffes 2009). The UK economy was forced into a three-day working week as miners went on strike which led to frequent blackouts, as coal-fired power plants were shut down due to a lack of coal. Public opinion and the resulting public policy began to favour the search for alternative sources of energy such as renewables. However, these oil shocks also drove heavy investment into the UK North Sea to reduce the need for oil imports and this translated into the UK having access to large amounts of natural gas, which fuelled the boom in gas-fired power plants in the 1990s. At the same time the UK continued to build new nuclear power plants, an industry which had thrived in the UK, having been home to the world's first civil nuclear power station built at Calder Hall, in Cumbria, in 1953, which only closed in 2003. Both nuclear and gas increasingly drove down the overall share of coal, dampening the drive for non-fossil sources of energy. It would be another decade until this trend was to re-emerge (Fig. 1).

As in other countries, a sudden increase in global hydrocarbon prices led policy-makers to rethink the need for an energy policy focusing on the country's security of supply. As Elliott (2019) convincingly argues, the development of UK policies in this regard was also strongly influenced by a set of utopian ideas developed mainly in the USA and the UK by the Alternative Technology movement of the late 1960s and early 1970s (Elliott 2019). However, although the 1973 oil crisis introduced renewables into the policy debate, capital costs were still too high and the immediate consequence was to strengthen the UK's development of nuclear and gas-fired power generation sources.

As will later be demonstrated, the debate between nuclear and renewable energy as the most effective way to decarbonise the economy has raged in the UK over the last three decades and is yet to reach a conclusion. The UK has undoubtedly achieved remarkable successes in its building of nuclear capacity, but the rapid reduction in new nuclear builds over the past 20 years, as well as the well-publicised delays and cost overruns in the construction of new plants, has shifted the policy onus in favour of renewables (EDF Group 2019). In Britain, investment in nuclear has historically been framed primarily as necessary to ensure national energy security, and only more recently has the rationale been extended to cover the industry's contribution to the decarbonisation of the economy. However, Fig. 2 shows that nuclear as a share of the UK electricity sector actually grew from the 1970s and peaked at almost 30% in the late 1990s, before declining to below 20% today. This share is likely to decline

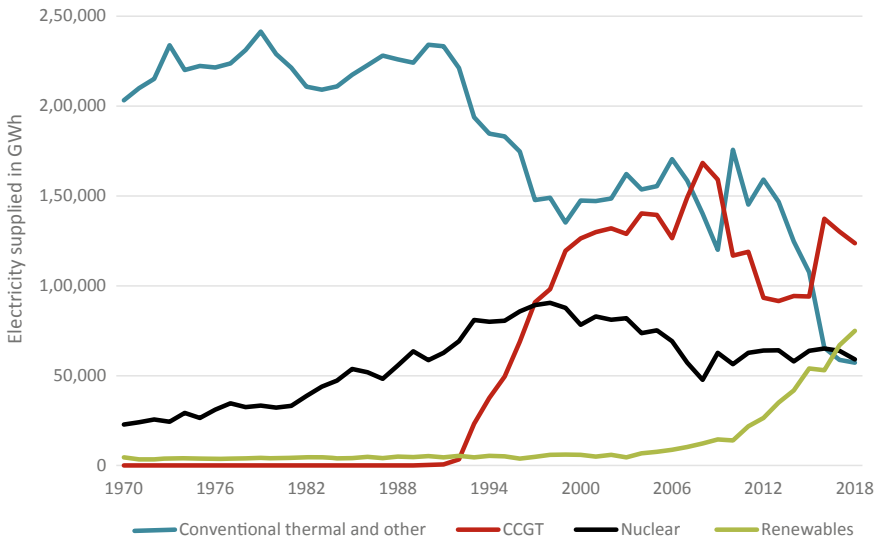


Fig. 1 Electricity supplied in the UK between 1970 and 2018, by source type (GWh). *Source* UK Government (2019) Digest of UK Energy Statistics (DUKES). Department for Business, Energy and Industrial Strategy. Available from <https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019>

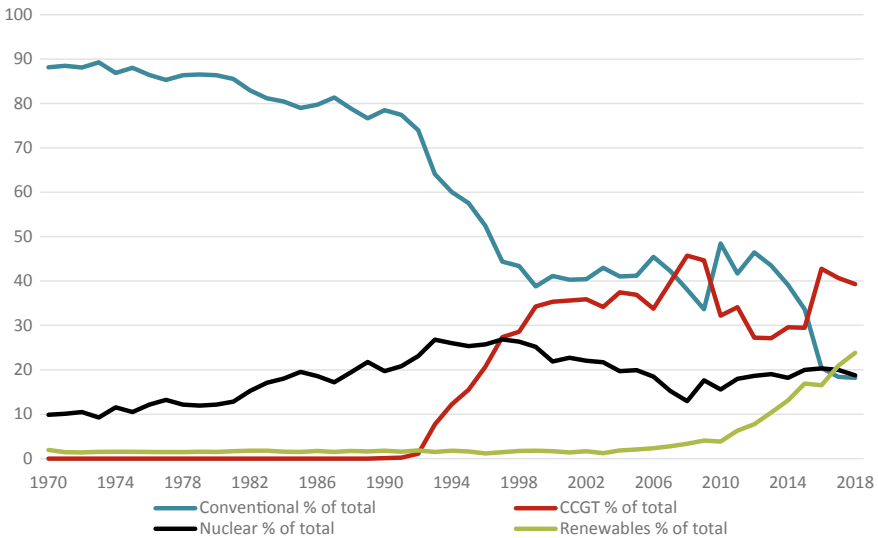


Fig. 2 Share of conventional, nuclear, CCGT and renewables in total electricity supplied between 1970 and 2018 in the UK (%). *Source* Dukes energy statistics, 2019

further despite the construction of the 3.2 GW Hinkley C plant, as many of the older plants are retired and not replaced.

In 1979, David Howell, Secretary of State for Energy in the government led by Prime Minister Margaret Thatcher, spearheaded a new nuclear programme, aimed at increasing the country's nuclear capacity in the face of growing geopolitical uncertainty that threatened energy imports (Pearson and Watson 2012). However, the government's overall support for nuclear in the context of energy security, even in the face of growing public hostility following the 1979 Three Mile Island and 1986 Chernobyl accidents, was not the only factor in promoting the first phase of decarbonisation of Britain's economy.

A key element of this early decarbonisation was the shift from public to private ownership of the energy sector, which took place throughout the 1980s and into the 1990s, starting with the privatisation of British Gas in 1986, followed by the break-up of the Central Electricity Generating Board (CEGB) and the sale of the Regional Electricity Companies (RECs) in 1990. Nuclear was retained in public hands until it was partly privatised through a flotation of 28% of the shares in 2006 (Horrocks and Lean 2011). It was subsequently fully privatised when it was purchased in its entirety by EDF 2 years later (World Nuclear Association 2019), although it could be argued that with EDF being fully owned by the French Government at that stage, it was not a pure privatisation. Throughout the 1990s, electricity companies, which had recently been privatised, undertook a shift in the building of new power plants from coal-fired to natural gas generation, as a result of the increased availability and competitive price of North Sea gas.

The so-called 'dash for gas' led to a replacement of old coal plants, which had efficiencies of between 20% and 30%, with newer and more efficient Combined Cycle Gas Turbines (CCGT), with efficiencies of between 40% and 60%, and which ultimately led to the closure of a significant number of deep mines owned by British Coal.¹ Overall between 2005 and 2016, the average UK power fleet improved efficiencies by 5.9% (European Environment Agency 2018). From 1913 when there were 3,024 deep coal mines in the UK employing 1,107,000 people, the numbers had plummeted to 20 mines employing some 12,000 people in 1999 and ultimately down to 5 mines employing 1,000 people in 2019 (UK Government 2019).

In the landmark 1993 white paper 'The prospects for coal—Conclusions of the government's Coal Review', the UK Government endorsed the principle that:

Competitive markets provide the best means of ensuring that the nation has access to secure, diverse and sustainable supplies of energy in the forms that people and business want, and at competitive prices (Department of Trade and Industry 1993).

This argument, inspired by Thatcherism, would also influence later energy policies of the Conservative government of John Major (1990–1997) and also New Labour under Tony Blair. Indeed, the 1993 White Paper also stated:

The coal industry must take its place within a competitive energy market. It must compete with other fuels and other suppliers to meet the needs of its customers at commercial prices. Its dominant market is in electricity generation (UNFCCC 2019).

¹See: <https://netl.doe.gov/sites/default/files/gas-turbine-handbook/1-1.pdf>.

Another interrelated factor that contributed to the decreasing importance of coal in Britain's energy mix was the bitter confrontation between the government of Margaret Thatcher and Arthur Scargill, the then President of the National Union of Mineworkers (NUM), which culminated in the 1984 and 1985 miners' strike, ultimately leading to the shutdown of many mines in the UK.

The share of coal in the energy mix declined throughout the 1980s and the 1990s, as a consequence of the decline of the country's domestic production along with growing imports of natural gas making CCGTs more economically viable. This trend was also one of the main factors in the decentralisation of the electricity system, made possible by the emergence of Independent Power Producers (IPPs) in the aftermath of the privatisation and deregulation of the electricity industry.

While the need to transition to a low-carbon economy was increasingly reiterated at international summits throughout the 1990s, the country had already achieved significantly reduced levels of coal in the energy mix thanks to an increasing reliance on nuclear and gas. Overall, during this period, a substantial decarbonisation of Britain's economy was mainly driven by a need to ensure energy security through the support for nuclear, and by economic factors that made gas-fired generation increasingly cost-competitive with coal.

3 Reducing Greenhouse Gas (GHG) Emissions

As mentioned, in this first phase of decarbonisation of the UK energy mix, the main driver was not so much represented by environmental concerns, although this certainly played a part, but by geopolitical and market factors. However, in the 1990s, the need to reduce Greenhouse Gas emissions (GHG) was perceived as increasingly important in global public opinion and by governments.

Such a growing awareness was reflected in Britain's policymaking. The UK Government's white paper on the environment, entitled 'This common inheritance', was published in 1990, setting out a strategy to stabilise CO₂ emissions. Although the document was criticised by environmentalists for not going far enough, it was nevertheless hailed as a landmark, especially for stating the principle that polluters should pay.

Meanwhile, the UN Framework Convention on Climate Change (UNFCCC), held in Rio in 1992 to prevent human interference with the climate, increased the pressure on governments to stabilise greenhouse gas emissions.

1988	Establishment of the Intergovernmental Panel on Climate Change (IPCC)
1992	Earth Summit takes place in Rio de Janeiro
1995	COP1 takes place in Berlin
1997	Adoption of the Kyoto Protocol

(continued)

(continued)

2001	COP7, Marrakesh Accords
2005	EU Emission Trading
2005	Entry into force of the Kyoto Protocol
2015	COP21, Paris Agreement

Source United Nations Framework Convention on Climate Change

The origins of the UK promotion of renewable energy can be found in the Electricity Act of 1989. In it, the government established a mechanism whereby producers of non-fossil fuel based energy would participate in tenders submitting a minimum price for a 15-year contract which would underwrite their project. The scheme, known as the Non-Fossil Fuel Obligation (NFFO)—together with Northern Ireland NI NFFO and Scottish Renewable Obligation (SRO)—paid the generator the then wholesale electricity or pool price plus a technology premium linked to the specific technology being utilised (International Energy Agency 2013).

Buyers of the renewable electricity were the recently privatised Regional Electricity Companies (RECs) who were obliged to source a fixed percentage of their power from non-fossil sources. The RECs contracted collectively through the Non-Fossil Purchasing Agency Ltd (NFPA) with renewables generators, while the above market costs were reimbursed by a levy passed onto consumers (Department of Trade and Industry 1999).

Generators had up to 5 years to commission their plants, but no penalties were imposed for either delays or failure to build a power plant. The scheme was rolled out in five orders, in 1990, 1991, 1994, 1997, with a total of 3,639 MW contracted, but only 1,198 MW of capacity was actually built (The National Archives 2006). The NFFO mechanism supported nuclear, as well as renewables.

4 A Market-Led Decarbonisation

Britain pioneered the privatisation of energy assets and has led the way in developing market-based tools for the promotion of renewable energy. The advent in 1997 of the New Labour Government led by Tony Blair ensured a continuity with the market-oriented approach to the energy transition implemented by the previous Conservative governments. By the 2000s, the UK's decarbonisation was no longer only driven by economic factors, as was the case of the previous decade with the 'dash for gas', but by environmental concerns crystallised in international commitments, as demonstrated by the initiatives implemented by the governments of Tony Blair, who was in power from 1997 to 2007.

In 2000, the Utilities Act replaced NFFO with Renewables Obligation ('RO'), a market-based incentive based on green certificates to promote the development of large-scale renewable generation in the UK. Arguably, RO encapsulated Britain's attempt to promote the development of renewable energy through market-based

mechanism, rather than more top-down approaches predominant in other European countries, and even more so later in China.

The RO, which came into effect in England and Wales, and Scotland, in 2002 and in Northern Ireland in 2005, required UK electricity suppliers to purchase an increasing share of their electricity in the form of Renewable Obligation Certificates (ROCs) either from their own renewable sources, or by purchasing from qualifying power producers. The RO was paid for over a 20-year period and was banded by technology, with landfill gas generators earning the lowest band of 0.25 of a ROC, increasing to double the price of a ROCs for wave, tidal, dedicated biomass and Combined Heat and Power producers. Overall renewable power producers would benefit from three key income streams. This consisted of the wholesale electricity price and the ROC payment, divided into the fixed buyout element as described above and a variable element paid by non-compliant suppliers and shared amongst renewable generators. Finally there was a levy exemption certificate paid by all industrial and commercial consumers to renewable producers (Climate Change Levy).

In 2017, the RO closed to new generation capacity. Overall, the market-based mechanism of RO ended up favouring specific technologies, such as wind and biomass, developed by large groups through utility-scale projects. Innovative technologies that were less market ready were discarded, such as the proposed tidal project over Severn Barrage in 2010. Other measures implemented in this period include, in 2001, the Climate Change Levy and the establishment of the Carbon Trust. A landmark step was represented by the 2003 White Paper, which set the future government priorities:

In reducing carbon dioxide emissions, our priority is to strengthen the contribution of energy efficiency and renewables. They will have to achieve far more in the next 20 years than previously. We believe such ambitious progress is achievable, but uncertain (UNFCCC 2019).

While endorsing renewables, the government's support for nuclear had waned, as the issue of nuclear waste disposal began to be addressed:

There are also important issues of nuclear waste to be resolved, including legacy waste and continued waste arising from other sources. We do not make specific proposals for building new nuclear power stations.¹⁷

Hence, in 2003 the UK seemed to be on the verge of a major shift to a whole new energy policy, focusing virtually exclusively on the development of renewable energy, even at the expense of nuclear, which had represented the backbone of the country's energy security in the previous decades. However, such an attitude was short-lived. At the beginning of his third term, Prime Minister Tony Blair again backed nuclear power, to ensure the attainment of Britain's decarbonisation goals whilst at the same time contributing substantially to its energy security. The renewed support for nuclear was contained in the 2007 White Paper, which set the new energy priorities of the government. It expressed concerns about the country being too dependent on a limited number of technologies and positioned nuclear as an important element in the diversification of energy sources, with the additional benefit of reducing carbon emissions (UK Government 2007).

This position was reiterated by Tony Blair's successor Gordon Brown in his foreword in 'Meeting the energy challenge. A white paper on nuclear power', published by the then Department for Business Enterprise and Regulatory Reform (BERR) in January 2008, stating:

Nuclear power is a tried and tested technology. It has provided the UK with secure supplies of safe, low-carbon electricity for half a century. New nuclear power stations will be better designed and more efficient than those they will replace. More than ever before, nuclear power has a key role to play as part of the UK's energy mix. I am confident that nuclear power can and will make a real contribution to meeting our commitments to limit damaging climate change (UK Government 2008).

As Pearson and Watson (2012) point out, one of the main reasons behind the shift may have been the fact that, by 2004, the UK had again become a net energy importer as a result of dwindling cheaply recoverable gas supplies from the North Sea, after having been a net exporter for several years previously.

The new commitment to nuclear was part of a broader political will to address the decarbonisation of the economy. In this respect, in 2008, the government of Gordon Brown launched the Climate Change Act, which set forth legally binding targets to reduce GHG emissions by 80% from 1990 levels by 2050.

However, during the coalition government formed by the Conservative and the Liberal Democrat Parties and led by David Cameron between 2010 and 2015, Britain's path towards decarbonisation suffered some setbacks. In the Conservative Party Manifesto 2015, it was stated:

Onshore wind now makes a meaningful contribution to our energy mix and has been part of the necessary increase in renewable capacity. Onshore windfarms often fail to win public support, however, and are unable by themselves to provide the firm capacity that a stable energy system requires. As a result, we will end any new public subsidy for them and change the law so that local people have the final say on windfarm applications (The Conservatives 2015).

This halted new onshore wind projects despite an abundance of wind resources. Concurrently, the cancellation of incentives for utility-scale solar saw activity plummet in that sector too.

In 2013 the UK Government passed the Energy Act, with the aim of reforming the energy sector to enable it to attract £100 billion of infrastructure required to bring it up to date (OFGEM 2019). These Electricity Market Reforms, which importantly introduced a Capacity Market to ensure long-term security of supply, also impacted renewables by phasing out the RO support and replacing it with a Contract for Difference (CfD):

A Contract for Difference (CFD) is a private law contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government-owned company. A generator party to a CFD is paid the difference between the 'strike price' – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the 'reference price' – a measure of the average market price for electricity in the GB market. It gives greater certainty and stability of revenues to electricity generators by reducing their exposure to volatile wholesale prices, whilst protecting consumers from paying for higher support costs when electricity prices are high (UK Government 2015).

A key element of these reforms was that the government was able to decide on when and the level of capacity it would make available for each CfD auction, which in turn is divided into two pots, one for established and one for emerging technologies. To date, three auctions have taken place with a total of almost 10GW allocated; the first round (AR1) ran from October 2014 to March 2015, the second (AR2) from March to September 2017 and the third was launched in May 2019. The only sector to have seen significant growth has been offshore wind, which reached a total of 19GW. AR1 awarded 1.2GW, comprising two offshore wind farms (the 714 MW EA1 and the 448 MW Neart na Gaoithe) (BEIS 2019), 11 projects were awarded in AR2 totalling 3.3GW, while in the third six projects totalling 5.5GW of installed capacity received CfDs. In fact, prices in the third-round saw offshore wind achieve £39.65/kWh, as opposed to £92.50/kWh which the government negotiated bilaterally with EDF for the construction of the new Hinkley C nuclear reactor (The National Audit Office 2017).

5 Towards Net-Zero

In June 2019, Theresa May, the then UK Prime Minister, passed legislation to cut emissions to zero by 2050. The announcement took place almost a month before the formal dissolution of her cabinet, on 24 July 2019, and it was likely made in order for her to secure a legacy beyond Brexit.

It is highly significant that her successor, Boris Johnson, setting out the priorities of his new government in his first speech at the House of Commons on 25 July 2019, supported this policy stating:

Our kingdom in 2050—thanks, by the way, to the initiative of the previous Prime Minister—will no longer make any contribution whatsoever to the destruction of our precious planet, brought about by carbon emissions, because we will have led the world in delivering that net-zero target. We will be the home of electric vehicles—cars and even planes—powered by British-made battery technology, which is being developed right here, right now (House of Commons 2019).

Despite the optimistic tone, however, the UK's path towards decarbonisation is set to face a number of challenges. Currently, besides repowering existing wind farms, it is extremely difficult to develop onshore wind projects. Yet according to a report prepared by Vivid Economics for RenewableUK (2019) (Vivid Economics 2019), the deployment of 35GW of onshore wind—the UK's cheapest renewable technology—by 2035, could lead to a 7% decrease in electricity costs, together with a set of wide-ranging set of socioeconomic benefits.

6 Subsidy-Free Shift

Whilst auctions can be seen as a backward step in the UK's history of allowing the private sector to drive decarbonisation, in that it places a greater onus on government to decide when to allocate new capacity and how much, the primary drivers of new projects that will contribute towards the Net-Zero by 2050 target are likely to come from the private sector. Indeed, the UK is a pioneer in the development of projects that do not rely on government subsidies, or subsidy-free projects. The 10 MW Clayhill solar project with 6 MW of co-located storage situated in Milton Keynes and inaugurated in September 2017, exemplifies this new trend as it required no subsidy and instead signed a long-term Power Purchase Agreement (PPA) with EDF.

Such subsidy-free projects rely on a burgeoning market for corporates for whom the need to become greener and more sustainable is leading them to enter into PPAs directly with developers of renewable energy projects, effectively cutting out the middleman—i.e. the UK Government. As most projects must compete with low power prices, they attract a mix of predominantly debt to make them competitive, and lenders to these projects require the terms of the power purchase to be as robust as those previously in place when the projects were effectively underwritten by the government. As a result, corporate PPAs tend to favour large companies with deep balance sheets, capable of entering into long-term contracts, enabling the power developers to seek long-term debt funding. However, the financial and corporate sectors are leading the way in creating 'synthetic' PPAs, in which the obligation to purchase electricity is shared between several buyers at differing conditions and is wrapped or underwritten by utilities, banks and increasingly oil companies who are keen to enter into the renewable energy market. Whether all this potential results in many new projects coming online is still open to debate, as the whole corporate PPA sector is still in its infancy, with 7 projects totalling 804 MW having been built and operating as at Q4 2019.²

7 Electrification of Transport

Although the UK had been able to achieve significant success in the decarbonisation of its electricity production, it is increasingly being acknowledged that the main challenge is the need to achieve higher rates of decarbonisation of heat and transport, where progress had been much slower. For the electrification of transport, the launch in July 2018 of 'The Road to Zero' represented a major turning point. The document set the objective of 'all new cars and vans to be effectively zero emission by 2040' and of 'almost every car and van to be zero emission' by 2050 (UK Government 2018).

Consistent with the market-driven approach that, as we have seen, is a key feature of the UK model to energy transition, the document also clearly states that '[w]

²www.inspiratiacom, dataLive database, 2019.

expect this transition to be industry and consumer led, supported in the coming years by the measures set out in this strategy' (UK Government 2018).

'The Road to Zero' was presented by the UK Government as part of its industrial strategy. Hence, its goal was not only to reduce pollution and decarbonise the economy, but also to ensure that the UK was going to be a leading manufacturer of zero emission vehicles. The importance of this document cannot be overstated, given the sheer scale of its ambition. However, the strategy presented several shortcomings.

According to a letter from Lord Deben, Chairman of the Committee on Climate Change (CCC) published on 11 October 2018, 'existing and newly agreed policies for road transport [...] are insufficient to ensure the reductions in emissions necessary to meet the 5th Carbon Budget in the most cost-effective way' (UK Government 2018).

A report published by the House of Commons on 16 October 2018 conducted a much more abrasive critique of the 'Road to Zero', accusing the government of a 'lack of clarity on the meaning of the 2040 targets' which was 'unacceptable' (House of Commons 2018). The Parliament's report criticised the fact that the 'Road to Zero' did not clearly define the 'conventional' petrol and diesel cars to be phased out, as it did not specify whether conventional hybrids will be banned or not. With conventional hybrids potentially still available on sale after 2040, the goal of achieving a zero-emissions fleet target by then seemed impossible to reach. Such an ambiguity was seen as a major constraint for both car manufacturers and charging infrastructure providers. Hence, the House of Commons' report was asking for more clearly defined and more stringent targets, to allow the industry to make the appropriate investment decisions.

Despite its shortcomings, Britain was, however, effective in establishing a partnership between the public and private sector to develop charging infrastructure for Electric Vehicles (EVs). As announced by the Chancellor of the Exchequer in the 2017 Budget, a fund was later established to increase the roll-out of charging infrastructure in Britain. The Charging Infrastructure Investment Fund (CIIF) was a £400 million investment fund to be set up with £200 million raised by the private sector, matched by £200 million from the government. In February 2019, the private equity firm Zouk Capital was named CIIF's preferred bidder, entering in exclusive negotiations with the government to act as the manager of the fund.

8 China: A Case Study of Government-Led Energy Transition

A world leader in installed capacity of hydropower, solar PV and wind, China has been selected as a case study, as it represents one of the most iconic examples of a successful government-led energy transition. Moreover, the country's policy shifts have a considerable impact on the global energy environment, due to the size and growth of its economy and its high levels of electricity production and consumption.

This can be coupled with China's ambitious cross-border investments in energy, including those within the framework of the Belt and Road Initiative (BRI).

This section outlines the reasons behind China's success in promoting an ambitious renewable energy agenda. Four different drivers will be assessed, including the status of energy dependency, decarbonisation policies and initiatives, the swiftly developing manufacturing sector and the shift to subsidy-free renewables.

Firstly, energy dependency in China underwent significant changes in the 1990s, throughout the Gulf War and beyond. While annual oil imports accounted for less than 5% of total imports at the time of the Gulf War, the country gradually became a major global importer of oil by the 2000s reaching a level of 10.35 million b/d in December 2018 (Dannreuther Roland 2003; Li 2015; S&P Global 2019). This increasing dependency is one of the drivers behind the country's relatively swift transition to renewables, as China aims for energy self-sufficiency. According to a document published by China's National Development and Reform Commission (NDRC)—mentioning the targets set by NDRC—the country's self-sufficiency rate should be above 80% by 2020. In parallel, by 2030, clean energy is set to meet most of the demand, forecasted at 5.6 Btce (3.91 Btoe) between 2035 and 2040, with non-fossil fuel sources accounting for over 50% of the power production (IEA 2018; NDRC 2016).

Secondly, as a consequence of its economic growth, carbon emissions per capita have almost quadrupled in China since 1990 (Wang et al. 2015). As an emerging economy, the country strives to enhance quality of life and to achieve progress through further industrialisation and urbanisation, necessitating that sustainable development be at the forefront of its political agenda. Economic growth has driven up energy consumption significantly and thus, with demand on the increase, the Chinese Government has kick-started a series of decarbonisation initiatives, focusing on electricity generation using clean sources, and more specifically renewables.

Thirdly, the swiftly growing renewable energy manufacturing sector emphasises China's interest in boosting economic growth whilst creating new jobs and increasing exports. Therefore, China considers the manufacturing of renewable energy equipment a strategic industrial area, entitling it to preferential land policies, taxation and loans. China began to promote the use of locally manufactured products for renewables as early as 1999, when the 'Notice on Relative Problems of Further Supporting the Development of New and Renewable Energy' stipulated that projects using such equipment would be granted a preferential investment profit rate of 5% (Fan et al. 2018; NDRC 1999). The investment profit rate is the ratio of investment to rate of returns on capital.

The manufacturing of wind turbines and photovoltaic cells has been designated as a critical industrial sector in China, as a result of which the country has become a global manufacturing leader in both sectors.

Lastly, renewable energy incentives through feed-in tariff policies have played an important role in the rapid roll-out of such projects throughout China. Some of the most noteworthy policies include the 'Improving Policies on Feed-in Tariff of Wind Power' issued in 2009 by NDRC, which announced the launching of tariffs for wind power and dividing the country into four regions with tariffs ranging from 0.51 to

0.61 RMB/kWh. Power costs above coal-fired generation were split between the central government and the operators of the provincial grid (Grau et al. 2012; Zeng et al. 2013; Lewis 2011). Another similar document was released in 2011, addressing solar photovoltaic (PV) power projects and awarding a fixed feed-in tariff of RMB 1.15/kWh for projects reaching the completion stage by the end of 2011 and RMB 1.00/kWh for those approved by July 2011 (Fan et al. 2018).

This section analyses China's challenging transition process to subsidy-free renewables. The country witnessed substantial decreases in project capital costs due to technology-related manufacturing improvements and increasing competition in the renewables market. Between 2000 and 2010, China's total renewable energy supply grew at an average annual rate of 12%, approaching mass production (Zeng et al. 2013). On 31 May 2018, NDRC, the National Energy Board and the Ministry of Finance announced that all subsidies for utility-scale solar projects would be halted in favour of competitive bidding (NDRC 2018).

Below are some of the key milestones the country achieved in the energy sector since the 1950s, including the implementation of the country's iconic five-year plan, the adoption of the first minimum energy performance standards and the launch of the Belt and Road Initiative (Table 2).

On 28 February 2005 the decarbonisation of the Chinese electricity generation sector began, triggering debates amongst academics as to how realistic these targets would be, with a considerable number deeming non-fossil fuel based electricity targets of 20% by 2030 as feasible (Zhang et al. 2018).

An in-depth analysis of drivers of the government-led energy transition in China, including additional impetus necessary to preserve success on the long term, is detailed in the section below.

Table 2 China energy sector, key milestones

1953–1957	The first Chinese Five-Year Plan
1978	Deng Xiaoping commenced its ambitious programme of reforms, with an emphasis on attracting foreign trade and investment
1981	The State Energy Commission was established
1982–1983	The Ministry of Petroleum was divided in China National Offshore Oil Corporation, Sinopec Corporation and China National Petroleum Corporation
1984	China joined the International Atomic Energy Agency (IAEA)
1988	Formation of the Ministry of Energy
1989	China adopted the first Minimum Energy Performance Standards (MEPS)
1997	Establishment of the State Power Corporation
1997	The Energy Conservation Law entered into force
2003	Abolishment of the State Power Corporation
2003	Launch of the State Electricity Regulatory Commission (SERC)

(continued)

Table 2 (continued)

2005	Adoption of the Renewable Energy Law of the PRC on 28 February
2007	The National Climate Change Program was issued in June 2007
2008	China launched US\$850 billion economic stimulus package in November 2008, with 35% allocated to low-carbon development
2008	Publication of the first white paper on energy, the country emphasising the development of renewable energy as a top priority
2010	The revised Energy Conservation Law entered into effect on 1 April 2010
2011	China overtook US becoming the largest power system world-wide, with an installed capacity of over 1TW
2013	The Belt and Road Initiative was launched by China's president Xi Jinping
2015	After connecting roughly 3 million people in remote areas, China reached 100% electrification rate
2018	China increased its renewables target in the electricity consumption mix from 20% to 35% by 2030
2021	No subsidies will be granted to offshore wind projects from 2021 onwards

9 Paving the Path to Energy Self-sufficiency

As an importer of oil since 1996, China's energy self-sufficiency levels plummeted, while electricity consumption was and continues to be on the rise⁵², as shown in the figure below. To tackle this issue, the country's government implemented a series of strategies, meant to lower dependency on imported oil. Renewable energy sources have become a significant part of the solution, providing new avenues through which the country could develop its national power industry and build a reputation for the use and deployment of sustainable alternatives (Fig. 3).

When assessing China's success in paving a path to energy self-sufficiency, three main factors should be taken into consideration. The first focuses on the ability of renewable power to tackle substantial growth in energy demand, whilst diminishing the need for fossil fuel imports. The second relates to the historical progress China has made with regard to achieving renewable energy technology (RET) self-sufficiency. The third assesses policies and initiatives adopted by the government to enable energy producers, developers, advisers and financiers to learn from the experience of more mature markets in Europe.

China experienced rapid economic growth in a number of industries between 2005 and 2011, including thermal power generation, which grew by roughly 90%, steel production grew by 135% and automotive vehicles by 223%, with proportions of coal, gas and oil used in manufacturing overtaking the entire output from nuclear and renewables (Liu et al. 2013).

Annual electricity generation and consumption in China continued to grow dramatically between 2000 and 2019 (World Bank 2018; IMF 2019; UN Statistics 2019). This growth drove the Chinese Government to seek to accelerate the development and deployment of renewable energy sources, as this was widely perceived as the

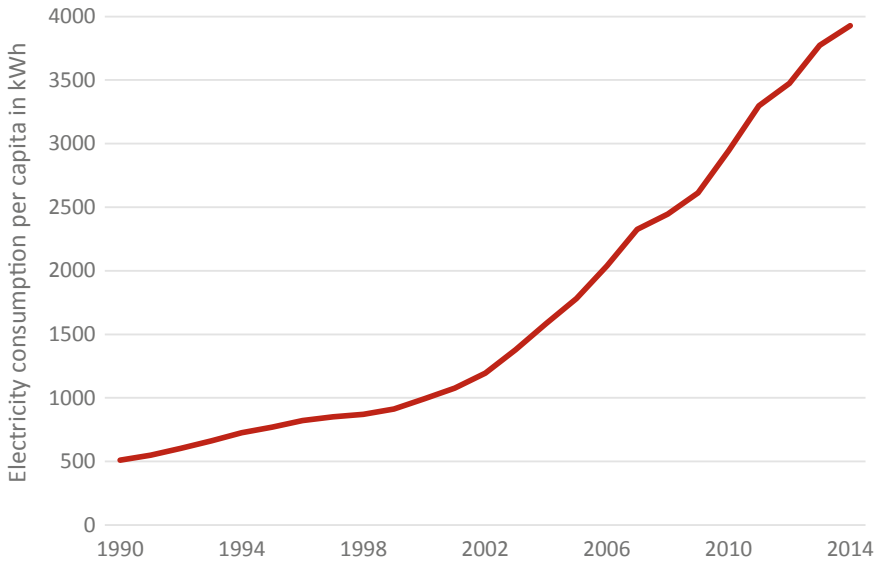


Fig. 3 China's electricity consumption per capita in kWh, between 1990 and 2014. *Source* World Bank (2014) Electric power consumption (kWh per capita). Available from: <https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC>

engine to swift and secure economic development (Liao and Wang 2019). A number of initiatives were implemented to boost renewables production and decrease dependency on oil, gas and coal imports.

Having identified several vulnerabilities within the energy supply sector, the June 2002 Law on Promoting Clean Production was enacted to increase security by diversifying the energy mix (SCNPC 2002). This initiative was not the first to be implemented, as the government had already offered a construction tax credit to the renewables generation sector since 2001 (Zhang et al. 2016).

In September 2007, the Medium and Long-term Program for Renewable Energy Development was published by the Chinese Government, announcing a target of 10% for energy consumption from renewables by 2010 and 15% by 2020 (Gao et al. 2011; NDRC 2007a).

In December 2007, the government's white paper on China's Energy Conditions and Policies also emphasised the importance of energy diversification for the country's security, which, according to the document, could only be achieved through boosting electricity production from renewables. Chinese President Hu Jintao also mentions this in the report of the 17th People's Congress (UN Statistics 2019; Chinese Government Official Platform 2007; IOSC-PRC 2007).

In an attempt to regulate energy consumption, China's Ministry of Finance introduced a tax targeting large vehicles with inefficient energy consumption in 2008 (MOF 2009). In 2010, the government amended the original Renewable Energy

Law, published in February 2005, emphasizing the urgency to roll-out renewable energy (Wang and Chang 2014; Chinese Government Official Platform 2009).

Between 2011 and 2015, throughout its 12th Five-Year Plan, China ramped up installation of offshore wind plants, announcing it aims to achieve 5GW of capacity by the end of 2015 (NEA 2019).

In the latest Five-Year Plan (2016–2020) the Chinese Government plans to increase the share of non-fossil fuels in primary energy demand from 14.3% in 2018 to approximately 20% by 2030 and, in addition, is also aiming to achieve 15% share of clean-energy in total primary consumption by 2020 (Lee 2019; NEA 2016).

Commentators, including S&P Global, agree that a slowdown in the growth of fossil fuels and more specifically oil in total consumption is likely to be achieved over the next 5 to 8 years, as a result of increasingly favourable government support for renewables and its rapid adoption, but also due to an increase in electric vehicles in the country (S&P 2019).

These strategies appear to be ever more important, now that China and the United States are in a mounting trade conflict, affecting energy commodities flow (Kempe 2019). This current political uncertainty is accelerating the deployment of renewable energy projects.

China's rapid deployment of renewables has seen installed capacity grow from 3 MW in 1994 to over 11GW of solar and 5GW of wind capacity in the first half of 2019⁶⁶. Most of the technology used in these projects was either produced locally or nationally.

The Belt and Road Initiative (BRI) is one of China's best recognised international plans to increase its economic and political influence globally and, amongst other projects, it involves a multi-billion dollar investment program in the energy sector. While to date the main beneficiaries have been large-scale fossil fuels schemes, according to Greenpeace (2019), Chinese equity backed over 12GW of wind and solar projects under this initiative.

Initiatives such as the BRI are ushering a new era of Chinese investment globally, including in Asia, Europe, Africa and Latin America, potentially enabling it to learn from the experiences of early renewables adopters—especially in Europe—further driving its accelerated transition to renewables and thus reducing its dependence on energy imports. China has already showed substantial interest in exchanging knowledge on innovative solutions and legislative improvements in the clean-energy sector. In July 2018, China signed an agreement with the EU to cooperate on meeting power demand with alternative energy (EC 2018).

10 A Leader in RET Manufacturing

As a result of the significant scale that it has been able to achieve, China has evolved its renewables manufacturing base from being a supplier of domestic projects to an export-focused industry. The clean-energy sector expanded much faster than nuclear power and fossil fuels between 2012 and 2017, as the use of renewables gradually

became more efficient, affordable and accessible (Standaert 2019; Tan and Mathews 2014).

To better assess the country's manufacturing sector, this section focuses on wind power, solar PV and hydropower in China.

The country's first grid-connected wind farm was constructed as far back as 1986, using equipment from Denmark (Shi 1997). By the end of 2020, China is set to employ 800,000 people in the sector, according to the Chinese Wind Energy Association (CWEA 2017).

Despite being a relative latecomer to wind generation, the Chinese Government has enacted a number of policies to facilitate the expansion of wind power manufacturing. Primary amongst these were the 2008 Interim Measure of Management of Special Funds for Wind Power Industrialization, the 2009 Notification of Improving Price Policy of Grid-connected Wind Electricity and the Accelerating Smooth Development of the Wind Equipment Industry published in 2010 (Zhao et al. 2012; Dai et al. 2014).

In addition, the Ministry of Science and Technology announced in 2011 that wind turbines are amongst the national key technologies and proceeded to fund the research and development (R&D) departments of both universities and emerging manufacturers (MOST 2012).

The country has also built its wind expertise through mergers and acquisitions, as well as international technology transfer (NDRC 1999; Standaert 2019). Some of the more noteworthy Chinese purchases abroad were the 2016 acquisitions comprised of Australia's Pacific Hydro's wind and hydropower assets by China State Power Investment Corporation for roughly US\$2.1 billion and the UK's Beatrice and Inch Cape Offshore Wind farms by the State Development and Investment Corporation for US\$260 million (Nicholas 2018).

The size of Chinese manufactured turbines has grown from 600 kW in 1997 to Dongfang Electric's 10 MW offshore model revealed in August 2019 (Shi 2007). Other manufacturers of wind turbines in China include Goldwind, Envision, Mingyang, United Power, Shanghai Electric and CSIC Haizhuang.⁷⁵

The solar PV manufacturing sector's boom has been spurred by substantial subsidies, tax rebates, research grants and cheap land, benefits similar to those offered by the Chinese Government to both wind power and hydropower industries. According to multiple studies published in these sectors, the state played a central role in encouraging provincial governments to support local industries by investing in their renewables-associated products and technologies (Beeson 2009; Gang 2015a).

Between 1986 and 2005, advancement in solar PV was still relatively slow due to insufficient expertise in the PV industry and a lack of raw materials and advanced production equipment. However, China experienced a surge in productivity in this sector between 2011 and 2012 (Dai et al. 2014; Gang 2015b; Yang and Pan 2010).

As highlighted in the 2007 Medium to Long-term Renewable Energy Development Plan, industrial development of renewables including solar PV represented an essential national strategy (NDRC 2007b). The document specifically mentioned the need to promote the use of solar materials manufactured locally and to invest in associated R&D activities.

Whilst the country became one of the largest manufacturers and exporters of solar PV technologies globally between 2004 and 2008, the dissemination process within the country was slow (Zhang et al. 2015; Cao and Groba 2013). China's export-oriented strategy led to significant improvements in the quality of solar PV products manufactured domestically and gradually sped up the process of domestic renewables adoption.

Between September 2012 and August 2013, a series of policies, including a resource-based Feed-in-Tariff (FiT) scheme was introduced by the Chinese Government, to provide stronger support to the industry (NDRC 2016; IEA 2013). In 2015, China became the world's largest producer of solar panels, led by companies such as Jinko Solar.

The development of China's hydropower sector began in 1912, with a 0.48 MW power station in Yunnan, in 1912 (Li 2012; Du et al. 2008). The hydropower industry today—which has grown to a total capacity of approximately 352GW or over a quarter of the global installed capacity—occupies a pivotal position in Chinese manufacturing and represents one of the country's most valuable energy sources, as well as enabling it to develop a competitive export offering. The country's Medium and Long-term plan for all renewable energy, adopted in 2007, has a goal to achieve 800GW of installed capacity by 2020 (Beeson 2009), underlining the strong political support for hydropower within all renewable energy sources.

11 A Government-Led Decarbonisation

The decarbonisation process in China has been driven by a mix of climate concerns as well as the need to diversify away from fossil fuels, especially imports. Climate concerns touch upon social issues and how rapid industrialisation which expanded energy intensity has made pollution a major concern for the population (Zhang et al. 2010). In June 2007, China published its national climate change program aimed at speeding up decarbonisation, with wind, solar, hydropower and biomass sources acting as the key drivers to mitigate climate-related concerns (Beeson 2009).

Since 2006 the country's government outlined the importance of sustainable development, which was deemed to be an essential part of its national strategy. Amongst the targets announced was achieving a balance between emission reduction and preserving economic growth (Dai 2015). In 2009, the Chinese prime minister Wen Jiabao reiterated his intentions when he announced the country's aim to reduce CO₂ emissions by between 40% and 45% by 2020, in comparison to 2005 levels (Watts 2009).

Moreover, since 2007, China has seen growing population unrest caused by health, environmental and food safety concerns, including successful protests in Xiamen opposing the manufacturing of paraxylene, 2007 Shanghai demonstrations opposing the route of the Maglev rail project, 2008 and 2012 Sichuan protests and 2013 Kunming and Maoming demonstrations, all significantly contributing to China's shift towards sustainable development (Geall et al. 2014).

In 2018, the Key Work Plan for Industrial Energy Conservation Supervision was published by the Chinese Ministry of Industry and Information Technology. It addressed multiple energy-intensive industries such as the chemical, petrochemical and paper sectors (Chen and Li 2019), and stressed the importance of optimising transportation and improving sector efficiency across the country, while facilitating a shift to EVs.

Innovation and technology have played a significant role in the country's decarbonisation policies. In light of this, this section explores the electrification of transport as an essential driver of decarbonisation, as well as providing a boost to the clean-energy industry. EVs have become a key priority of China's transition to low-carbon mobility; the industry is dominated by major state-owned enterprises (SOEs) and, as well as more recently, joint ventures between international car automakers and SOEs.

In 2010, the Chinese Government announced an investment of RMB100 billion (US\$14bn) in the EV sector and declared EVs a 'key strategic industry for the next 5 years' (Tyfield et al. 2014). Other favourable policies for e-mobility included the 2004 automobile industry development policy (amended in 2009), the 2007 comprehensive programme of work in energy saving and emission reduction and the 2009 eV initiative joint action plan, amongst many others (Chinese Government Official Platform 2013).

In 2010, the government released a notice on the expansion of energy saving and new energy vehicle demonstration to public services, which was one of the initiatives that has driven the emergence and growth of EV buses and taxi fleets (MOF 2010). Public authorities continued to implement favourable policies and initiatives to facilitate the roll-out of EVs nationally. This including the adoption of EVs in 2013 and the 2014 guidance on accelerating the deployment of EVs, as well as the implementation plan for government agencies and public institutions to buy new EVs (Du et al. 2008; Zhang et al. 2010; MIIT 2014).

China has become a global player in EVs and associated charging infrastructure. In the second half of 2018, the country had built 300,000 public EV chargers, accounting for more than 50% of the global EV charging market (Pyper 2019). In the same period, China announced the sale of approximately 1.3 million EVs, 62% more than in 2017, with roughly 2.6 million vehicles on the street by the beginning of 2019 (Hove and Sandalow 2019).

The surge in EV sales could be explained by the support schemes the government put in place, including allowing local governments to offer additional subsidies of up to 50% of the national subsidies already offered (MOF 2016; Manthly 2018). Non-financial incentives such as exemption from license plate lotteries and restrictions also had a major contribution to the swift increase in EVs popularity in the country.

12 From Tariffs to Zero-Subsidies

The path from tariff-based to subsidy-free renewable energy projects in China has not been a straight-forward transition, with the market sensitive to tariffs being phased out. It has been argued that the reason behind an apparent loss of momentum in China's renewables deployment has been the uncertainty surrounding government funding and regulatory support for green energy.

The feed-in tariff system in China has been based on competitive bidding, which takes place prior to the tendering process (Han et al. 2009) and obliges bidders to present the lowest possible prices. However, as many of the bids were unrealistically low, projects were not built and the country moved towards a fixed FiT, especially for technologies such as solar PV and wind (Martinot 2010; Chan 2009).

At present, China needs to tackle multiple issues, including low consumption problems, the pressure on the government to continue providing substantial subsidies and a very high percentage of fossil fuels in the overall energy mix.

To date, China has approved 224 subsidy-free wind and solar projects, which are estimated to add 21GW of installed capacity (Yu 2019). A joint statement by NDRC and NEA mentioned that roughly 60% of the capacity will be installed in six provinces, namely, Heilongjiang, Guangdong, Shanxi, Guangxi, Henan and Hebei (NDRC 2019).

The country's renewables industry and more specifically its wind and solar PV sectors are poised for long-term growth, with capital costs on a downward trajectory and likely to fall to levels equal or less than those of coal power stations.

13 Conclusion

This chapter showcases two examples of jurisdictions which have adopted differing strategies in achieving a decarbonisation of their respective economies.

The UK has been presented as a global leader in the deployment of renewable energy capacity primarily through onshore and offshore wind, as well as through solar. As one of the first countries in the world to privatise and deregulate its electricity sector, the UK has one of the longest track records in empowering the private sector to deliver a market-based approach which extended to decarbonisation.

Whilst other countries such as Germany have been extremely successful in the first phase of state-led deployment of renewables primarily through feed-in-tariffs, it is the UK's market-based approach which has stood the test of time. As technology costs continue to decline, governments are withdrawing direct support and instead favouring the direct participation of private sector buyers who are interested in purchasing renewable electricity through private PPAs. This recent development is therefore renewing the UK's position as a pioneer in the subsidy-free era.

The UK Governments' role in decarbonising the economy has by no means been a smooth process. Yet its reliance on market-led policies has ensured the engagement of

the private sector throughout the various phases of its evolution. However, insufficient emphasis has been placed on newer technologies, which instead have been forced to rely on other forms of investment. Historically, the UK Government has preferred to remain technology agnostic. Whilst banding of ROCs and Pot 2 under the CfD regime has allowed some higher cost projects such as offshore wind and waste to energy projects to flourish, little of the UK's vast, untapped wave and tidal resource potential has been captured. In particular, for larger scale projects requiring longer time horizons like the Swansea Bay tidal lagoon project, a lack of support such as that provided to nuclear projects such as Hinkley Point C has effectively hampered the project's fruition, despite strong private sector interest.

One of the central hypotheses of China's decarbonisation strategy has been the rapid increase in energy dependency; decarbonisation can therefore be viewed partly as one of a series of energy policies and initiatives aimed at achieving greater energy self-sufficiency. The rapid deployment of renewables across the country has been at the centre of China's strategy, with the majority of involvement in these projects coming from domestic companies and more specifically major SOEs, including equipment manufacturers, investors, banks and utilities.

The expansion of China's renewables manufacturing sector, optimization of workforce and enhancement of equipment quality has led to the creation of an export-focused industry worth trillions of dollars— with solar PV module exports alone accounting for approximately £4 billion in Q1 2019 (CCCME 2019). Multinational conglomerates such as Jinko Power and Dongfang deploy 'made in China' renewables technologies, including solar panels and wind turbines globally. The growth in the RET manufacture sector is therefore an essential driver of the Chinese renewables market.

Moreover, global climate concerns and the pressure to decarbonise the energy and transport infrastructure sectors have contributed significantly to speeding up China's transition to renewables. The country boasts the world's largest fleets of electric vehicles and auxiliary charging infrastructure and it is on the right path to ensure an efficient transition to clean energy.

Notwithstanding their significant differences, the examples of the decarbonisation pathways undertaken by China and the UK analysed in this chapter, demonstrate how direct government involvement through SOEs together with direct incentives are equally effective as market-enabled policies with direct incentives. Both examples present viable strategies that can be adopted by governments either wishing to adopt top-down decarbonisation strategies, or those wanting to foster a greater role for the private sector as developers and owners and operators of renewable energy and other asset categories such as EV infrastructure.

Typically, emerging economies often need to attract foreign direct investment, as part of their strategies to open up their markets. For these countries and amongst the various policies that are in place, the government needs to foster a specific market-friendly approach to attract foreign companies. Furthermore, these policies need to remain in place for the duration of the specific renewable energy incentives. The temptation to change such policies to suit a government's budgetary constraints—as has happened in markets such as Spain and Italy over the past decade—will only have

the effect of disincentivising private sector companies from making investments in emerging countries.

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