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THE POWER OF CHINA'S ENERGY EFFICIENCY POLICIES

Thibaud VOÏTA

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Centre for Energy

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Executive Summary

In just a few years, China has gained the status of an energy efficiency champion. From 2010 to 2015, while China's Gross domestic product (GDP) grew at a rate of 7.8%/year on average, the energy intensity fell by 18.2% (exceeding the national goal of a -16% reduction) and dropped from 0.617 to 0.505 Million tonne of oil equivalent (Mtoe) per unit of GDP (at 2010 constant price). Such impressive results have led the International Energy Agency (IEA) to call China a "global efficiency heavyweight".[1]

Over the past decades, energy efficiency in China has gained unique political momentum and has become a central part of the local political landscape. Energy efficiency was first included in the five-year plans, in the mid-2000s. It was a first sign of China's acceleration towards greener policies. In addition, energy efficiency has played a role in number of key Chinese economic policies: the market liberalisation and privatisations of the 1990s, the quest for energy security, economic development, the fight against climate change, and to a lesser extent the fight against pollution and the trade war with the United States (US). It is also an important element of China's industrial policy, as industry consumes well over half of the 1,924 Mtoe of the country's overall energy used, according to the IEA. This compares with an average of 20% in the rest of the world. Finally, energy efficiency has even managed to become a component of China's development diplomacy, as Beijing exports its expertise to developing countries as part of its aid (even if the country may also be using large infrastructure projects abroad to export its production overcapacities).

Various factors can explain all these successes:

- Very strong leadership: targets being defined at the highest level through complex consultation processes and then set as national priorities, with strong pressure on local officials to meet these targets;
- Clear objectives: Five-year plans include clear quantitative targets, to be met at a certain date;
- Adaptability: the national targets are adapted at the local level, taking into consideration local characteristics;

1. "Energy Efficiency Market report 2016", last retrieved on March 20, 2018., available at: www.iea.org.

- A dynamic market for energy service companies, with 5,800 companies operating in 2016 with energy performance contracts worth of 15 billion United States Dollars (USD);
- A progressive shift of the economic structure towards the service sector and less energy intensive industries.

However, China still needs to do much more if it really wants to become a global leader in energy efficiency. Its energy intensity is well above the global average, and is far from reaching average level of European countries of the Organization for economic cooperation and development (OECD). The country needs to address important challenges, in terms of policy design (at the national level), implementation (at the local level), Monitoring, Reporting and Verification (MRV), and green finance. This is especially so after institutional reforms in 2018 that have left many questions unanswered.

Other potential threats to China's national energy intensity relate to the evolution of economic growth. Although the country seemed recently to have managed to decouple its energy-consumption from economic growth, 2017 data show that China's greenhouse gas (GHG) emissions were still growing that year, and even worse, are leading world emissions. Further resources need to be invested in energy efficiency in order to address these climate change issues, especially at a time when industry is still absorbing such an important share of China's energy production. On the one hand, stronger economic growth may lead to new investments in inefficient infrastructure (e.g., buildings with poor insulation) and the further development of overcapacities. This could have a very negative impact on China's national energy performance. On the other hand, a slowdown could lead local governments to support the same type of inefficient investments in order to boost growth, as was the case after the 2009 economic crisis.

But this is unlikely to prevent China from fostering its energy efficiency companies and promoting its expertise abroad, seeking to become a world leader in this field.

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Introduction

During the 2000s, China raised energy efficiency to the level of a national priority in its national plans. Such importance given to energy efficiency, especially since 2006, is unprecedented among emerging economies. The way China deals with energy efficiency illustrates a common saying in the field, according to which "energy efficiency is everywhere and nowhere at the same time".[2] This means that energy efficiency measures can be applied in number of sectors (the main ones being appliances, industry, transportation, power generation, buildings, lighting, and agriculture) but its results in terms of improved energy performance can barely be seen. Yet energy efficiency is everywhere in the national policies: it helps reinforce China's energy security and secure the energy resources needed to fuel its growth. It is key in China's economic strategy, specifically for heavy industry, and energy efficiency is also indirectly mentioned in the "Made in China 2025" plan that identifies key technologies for the country to invest in.[3] It is also central in China's climate strategy, as energy efficiency allows energy demand to be constrained and reduced, while lowering coal consumption, reducing its share in the energy mix and also helping to improve air quality. Finally, energy efficiency is also playing a key role in Beijing's international development strategy, through recent projects such as the Belt and Road Initiative (BRI), the Asian Infrastructure Investment Bank (AIIB), or the New Development Bank. China intends to use its global reputation in these areas to export its knowhow, for instance in South-East Asia.

In addition to being ambitious, China's policies are highly successful. China's energy intensity improvements have indeed been impressive, especially during the decade of 2006-2015. As energy prices have long been regulated in China in order to preserve economic growth and social development, the government has had to rely on other policy tools to promote energy efficiency. This has been done through sets of objectives in Five-Year Plans (FYPs). The 11th FYP's target of reducing energy intensity (calculated as units of energy per unit of GDP) by approximatively 20% between 2006 and 2010 was met, though the process was not smooth, with

2. See for instance "Energy Efficiency May Be the Key to Saving Trillions", *The New York Times*, November 30, 2014.

3. Made in China 2025 has its own English website: english.gov.cn.

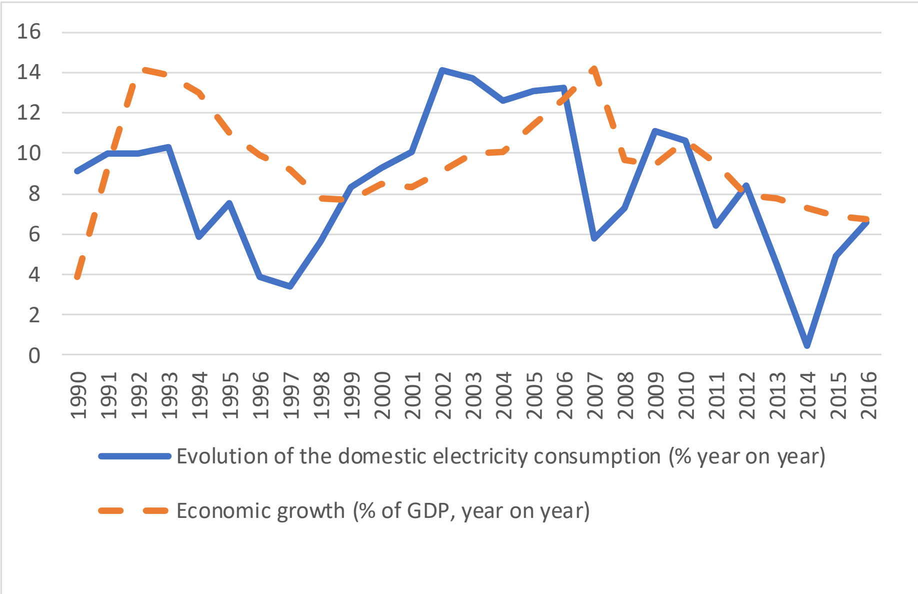
emergency measures taken in 2010 to achieve the target.[4] These difficulties may have led the government to set a more modest objective for the 12th FYP covering the 2011-2015 period, with an announced cut in energy-intensity of 16%, which was in fact overachieved with a 18.2% reduction.

According to Dai (2017), for the 2006-2015 period, China's energy intensity decreased by 33.8%. From 2010 to 2015, while China's GDP grew at a rate of 7.8%/year on average, the energy intensity fell by 18.2% and dropped from 0.617 to 0.505 Mtoe (at 2010 constant price) per unit of GDP. The elasticity of energy consumption also decreased rapidly, from 0.76 to 0.14 over the period.[5] In addition, almost 1.12 billion toe were saved (while the country's total energy consumption in 2016 reached more than 3,000 million toe, or Mtoe),[6] so that 3.8 billion tonnes of CO2 emissions were avoided. Between 2011 and 2015, China managed to decouple its energy consumption and GDP growth: national energy demand grew by 3.6%, less than half of the GDP growth of 7.8% during the period.

Finally, the IEA recently praised China as a "Global Efficiency Heavyweight", mentioning among other figures, the 350 million tonnes of coal consumption and 1.2 billion tonnes of CO2 emissions avoided through efficiency gains for 2014 alone. As a matter of comparison, in 2016 national coal production amounted to 3,410 million tonnes. In addition, the saved use of coal led to an economy of USD 230 billion that would otherwise have been needed to build new power plants to generate the electricity.[7] Figure 1 shows how electricity consumption is slowly decoupling from economic growth (especially since 2010).

4. "In Crackdown on Energy Use, China to Shut 2,000 Factories", *The New York Times*, August 9, 2010.
5. Defined as the percentage change in energy consumption needed to achieve 1% change in national GDP.
6. 3,006 Mtoe according to IEA, 2017 and 3123 Mtoe according to Enerdata's *Global Energy Statistical Yearbook 2017*, last retrieved on April, 27, 2018, available at: yearbook.enerdata.net.
7. "Energy Efficiency Market Report 2016", last retrieved on March 20, 2018, available at: www.iea.org.

Figure 1. Comparison of the economic growth and of the evolution of electricity consumption (1990 – 2016)



Source: Enerdata and calculations by the author.

China's energy efficiency strategy says a lot about the way policies are designed, and about the key future orientations of the current leadership. This research memorandum therefore analyses the role of energy efficiency in the overall Chinese policy mix, and discusses its impact on key issues for China, including: the fight against climate change, the search for sustained economic growth, the reduction of its reliance on coal, and the potential impact on international trade. The memo focuses on industrial energy efficiency, as industry represents the biggest share of the national energy demand, using 972 Mtoe in 2016 and 1,275 Mtoe if transformative industries are included.[8] This is well over half of China's total energy demand of 1,924 Mtoe, according to IEA. Other sectors such as construction and transport will be addressed in another memorandum, to be published in autumn 2018.

This memo first analyses the evolution of the definition of energy efficiency in China, and its role in the overall national energy policies. It then outlines the complex – but efficient – political process that has allowed Beijing to set ambitious goals, and to push for implementation of its policies. It also assesses the main challenges of the current policy process and seeks to identify current and future policy directions.

8. According to the IEA (2017), demand in transformation industries "includes energy demand from blast furnaces and coke ovens (not part of final energy consumption) and petrochemical feedstocks".

Energy Efficiency in the Policy Mix: from Productivity to Climate Change

A saucer full of concepts: efficiency, conservation, intensity

Energy efficiency is always difficult to grasp, and the concept has been translated in different ways in China since the 1970s, each of them revealing different political purposes.

Energy efficiency is often defined as using less energy to provide the same service or using the same amount of energy to produce more. As such, energy efficiency does not necessarily mean energy use reduction – for instance, more energy-efficient equipment in a factory can be used to produce more without rising energy costs, instead of using less energy (and therefore diminishing energy bills) to produce the same amount of goods. Energy efficiency is often measured through energy intensity, a proxy calculated by dividing the amount of energy used by the units of output produced.

The improvement of energy intensity has been part of the national objectives of China's FYPs since 2006, but again, an improved energy intensity until very recently did not necessarily mean reductions in energy use. Using energy intensity as a target forces companies to improve their energy performance, while diminishing the risks of adverse economic consequences that energy use reduction targets may entail (i.e. firms would need to reduce production in order to meet the target, or heating companies would have to cut their services, etc.). In 2016, the government took a step further by combining energy-intensity and energy use targets under the name of "double limitation" (*shuangkong*, mentioned in State Council, 2017).

By contrast, the energy conservation concept refers to the reduction of energy use. It is often employed in China to qualify measures that would be labelled energy efficiency measures elsewhere (this is reflected in the name of several key national institutions in the field: for instance, the Energy Conservation Centre or China Energy Conservation Association). In a recent survey, some Chinese researchers combined energy efficiency and conservation, which they define "as any action that reduces energy demand through the improved use of materials and better energy efficiency or through structural shifts from energy-intensive activities to more service-oriented activities".[9] This combination of efficiency and conservation introduces the idea that energy efficiency policies can be used as a way to support "structural shifts" in the economy.

Table 1. Energy efficiency related concepts

Concept	Definition	Energy reduction involved
Energy efficiency	Energy efficiency helps deliver more services with the same input, or the same services with less energy input	Not necessarily
Energy conservation	Reduced use of energy	Yes
Energy intensity	Amount of unit of energy used per unit of GDP. Used as a proxy to measure the evolution of energy performance.	Not necessarily
Double limitations (*shuangkong*)	Combination of energy-intensity and energy use targets	Energy use limitation

These moving definitions of energy efficiency reflect policy goals that have changed during the past decades.

The different policy goals of energy efficiency in China

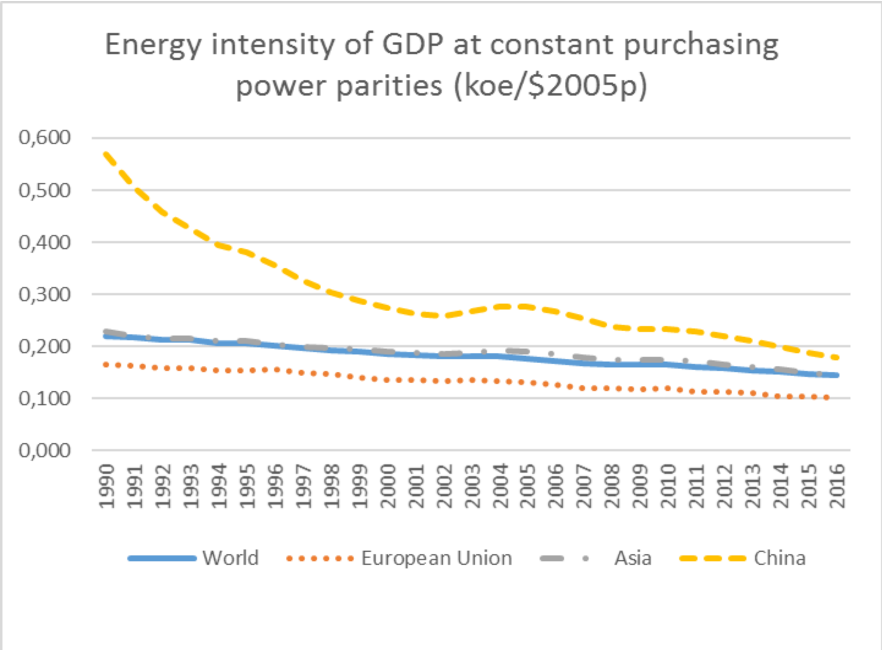
The 1990s: energy efficiency and competitiveness

The first phase of China's impressive energy efficiency improvement happened during the 1990s and went quite unnoticed as it was a side-effect of economic policies. Back then, China had to restructure an old and inefficient industrial structure, in order to prepare for World Trade Organisation (WTO) membership in late 2001. This meant accelerating the modernisation of the China's industrial structure left over from the Maoist era. One of the main features of Mao's economic policies, a few decades before, had been to duplicate industrial capabilities, in order to make every

9. Tian Z., Zhang X. and Zhu X, (eds.) (2017), p. 1.

province self-sufficient and to be able to face economic disruption, in case part of the territory was invaded by foreign powers.[10] Local jurisdictions were called upon to establish their own industrial bases, which resulted in a number of small- to medium-sized structures with cheap and highly energy-inefficient equipment. Rationalising the economic structure was therefore a top priority of the economic policies led in the 1990s by the then-Premier Zhu Rongji: policies aimed at the introduction of market mechanisms, price reforms and the streamlining of industry. These measures led to a growth of total factor productivity and to sectoral shifts in industry, as well as productivity improvements in heavy industry subsectors. In addition, an unexpected result at that time was that rationalisation came along with improvements in the energy performance of the industrial sector: energy intensity steadily decreased by approximately 70% between 1980 and 2000 (see the evolution of energy intensity since 1990 in Figure 2).[11] Cuadros A. and Orts V[12] also see a direct link between the acceleration of liberalisation the economy in 1993 and the decline of energy intensity in the following years.

Figure 2. The evolution of China's energy intensity compared to the world, Asia and the EU (1990-2016)



Source: Enerdata.

10. Poncet S. (2004) "The Fragmentation of China's Domestic Market," *China Perspectives*, 55, Sept.–Oct.

11. Fisher-Vanden K., Jefferson G. H., Liu H., Tao Q. (2004).

12. Cuadros A., Orts V, (2014) "Energy Intensity and Its Policy Implications in China", *in* Yao S., Herrerias M. J. (eds.) *Energy Security and Sustainable Growth in China*, Hampshire: Palgrave Macmillan, pp. 209 – 235

The first half of 2000s: energy efficiency and energy security

China's energy intensity started increasing again in the early 2000s (see Figure 2). This led Beijing to adopt measures to improve energy performance. Improving energy intensity then became a matter of energy security, as national energy consumption was increasing rapidly, driven largely by the industrial sector and using mostly coal. These factors combined would eventually to lead to blackouts. In the 1990s, China had started to become an importer of energy, notably oil. Therefore, energy security became a high priority on the political agenda as China's dependence on external energy supplies was growing. The 10th FYP from 2001 to 2005 included energy intensity goals, with targets in specific sectors and a list of priority technologies. These measures were rebranded as "energy conservation" policies.[13] For the first time since the 1980s though, the targets were not met mostly because of the rapid expansion of heavy industry, as shown in the evolution of energy intensity of the 2000 decade. This pushed China to set more stringent targets, which became a national priority in the 11th FYP (2006-2010).

The second half of 2000s: energy intensity and climate change

During the second half of the 2000s, Beijing pushed energy efficiency as a means not only to address security issues, but also to accelerate the economic transition and, in the 2010s, to reach China's climate objective.

The 11th FYP marks an important shift toward environmental goals. First, its (very ambitious) objective was to improve energy intensity by approximately 20%.[14] Then, in order to reach this target, several policies were put in place, to be further developed in the next FYPs (see Table 2). All the policies adopted also resulted in an improvement of the competitiveness of China's industry and prepared the transition towards a growth model relying less on heavy industries. Results of the Plan confirmed the new importance of the fight against climate change and of the protection of the environment: not only was the energy intensity

13. State Economic and Trade Commission (2014).

14. As an anecdote, the author had the chance to listen to an informal conversation between officials of what was then the State Environmental Protection Administration and executives from companies, right after the publication of the 11th FYP. They all agreed that the 20% energy intensity reduction target was unrealistically high and would never be met!

improved by 19.06%, but renminbi (RMB) 1.3 trillion (approx. EUR 17 billion) were invested in the fight against climate change; chemical oxygen demand was reduced by 12.45%; SOX emissions were reduced by 14.29%; and, importantly, energy consumption grew during these five years at a much slower pace than economic growth (respectively 6.8% and 11.4%). The 11th FYP was even more successful if we consider that the objectives were met despite the fact that the 2009 economic crisis led to a surge of investments in the heavy industry and in inefficient projects.

The objectives of the 12th and 13th FYPs (2011-2015 and 2016-2020) confirmed the new orientation of the 11th FYP (see Table 3). Some of the projects were extended, including for instance the "TOP 1,000" that initially targeted the 1000 biggest energy-consuming companies of the country. It was extended to 10,000 companies in the 12th FYP and then to 30,000 in the 13th FYP.

Table 2. Main energy efficiency related policies of the 11th FYP (2006-2010)

Policy	Description
The Ten Key energy efficiency Projects	Promotion of specific measures: coal-fired industrial boilers, cogeneration, waste heat and pressure, petroleum conservation and substitution, efficient motors, energy systems, building efficiency, green lighting, government agency energy conservation projects, energy saving monitoring and testing, and technology service system-building projects.
The Top 1000 Energy-consuming enterprises programme	List of approx. 1,000 companies, representing 33% of China's national energy consumption; with mandatory measures to be taken (energy audits, energy use reporting, energy conservation measures, etc.)
Closures of small plants	Closure of small plants totalling approx. 50GW of energy use.

Table 3. Energy efficiency related goals of the 12th and 13th FYPs (2011-2015 and 2016-2020)

Topic	12th FYP		13th FYP
	Targets	Results	Targets
Carbon intensity reduction	17%	Target overachieved with a 20% reduction	18%
Energy intensity reduction	16%	Target overachieved with an 18.2% reduction	15%
Energy consumption cap	None	None	5 Gtce/ 3.5 Gtoe
% of non-fossil fuels in primary energy consumption	11.4%	Target overachieved with 12% of non-fossil fuel in primary energy consumption	15%

In these years, China increasingly positioned itself in global climate governance. In the late 2000s, Beijing had been accused of provoking the failure of the Copenhagen UN climate change conference COP 15 in 2009, and of refusing to support environmental issues.[15] Economic growth seemed to be the first priority, with little care for the environment. China refused any commitment that could potentially harm its economic growth. This actually started to change right before COP 15, when the State Council set up a carbon intensity reduction target of 40 to 45% by 2020, using 2005 as a baseline (these targets were actually met in 2017).[16] Following this announcement, China launched many initiatives in the run-up to COP 21, and actively developed its climate diplomacy. This new move translated into national policies as well, with for instance the introduction of a carbon intensity goal in the 12th FYP. While the energy intensity results of the 11th FYP impressed many, they did not lead to any significant energy use reduction. As mentioned above, energy intensity does not necessarily entail reductions in energy use, and numerous plants decided to take advantage of their improved energy performance to increase output.[17]

15. See for instance a paper published by the environment author and activist, Mark Lynas, "How do I know China wrecked the Copenhagen deal? I was in the room", *The Guardian*, December 22, 2009. His point of view generated heated debates on China's online forums.

16. "China meets 2020 carbon target ahead of schedule: Xinhua", *Reuters*, March 17, 2018.

17. In 2011, the author visited a petrochemical plant in the South of China which originally had two production lines. They were under pressure to improve their energy performance, as their equipment

From 2011 onwards – towards energy use and GHG emission peaks

Starting with 12th FYP, additional targets came to complement the energy intensity goal, and somehow changed its nature. The first involved carbon intensity, which introduced an environmental dimension to the targets. Then, the 13th FYP (running to 2020) includes an energy consumption cap. These combined targets are to be considered as intimately linked and are called the "double limitation" or *shuangkong* of energy intensity and energy consumption (as mentioned above; State Council, 2017). The *shuangkong* has changed the role of energy intensity in the FYPs: improved energy performance should now help the country limit its energy consumption and GHG emissions. This objective was complemented in 2017 with an additional goal, announced in the 2016-2030 Energy Production and Consumption Revolution Strategy. It aims for energy intensity to reach current, average global levels (see Figure 2 for a comparison of energy intensities in different regions of the world).

The importance of energy efficiency as a climate-policy tool can also be seen in China's Nationally Determined Contribution (NDC).[18] Energy efficiency and energy conservation stand as one of the pillars of China's low-carbon strategy. Key sectors are mentioned in China's NDC, with specific energy efficiency measures targeting power generation, industry and cities (through buildings and transportation). It lays out the main objectives for the coming decades in terms of energy efficiency, these objectives being likely to be then transposed into future FYP implementation plans. Energy efficiency is also present in other sections (though not necessarily mentioned), for instance the "low carbon way of life" (for example, through the "promotion of low-carbon consumption throughout society", and the mention of "moderate consumption", or "low carbon products" that could refer to energy-efficient equipment and reduced energy use through changing behaviour), "low-carbon development growth pattern", "science and technology", "financial and policy support", or "carbon emissions market".

Finally, energy efficiency could also play a role in the fight against air pollution. Energy efficiency measures do not *per se* necessarily have a positive impact on air quality or more generally pollution. However, small

was deemed inefficient. However, instead of replacing the existing equipment, they built a third production line, using best-in-class technologies. The third production line was enough to reduce the overall energy intensity of the factory, and to meet the targets set by the local government. However, its operations resulted in an increase of energy use.

18. NDCs consist in contributions in the fight against climate change submitted by countries in preparation of COP 21.

and vague paragraphs are dedicated to energy efficiency in China's pollution plans (paragraphs 15 of State Council, 2013 and 12 of State Council, 2018) Moreover, the 2018 plan that calls for a "fight for the blue sky" that may be used to promote energy efficiency policies. The new Ministry for Ecology and Environment seems to be willing to coordinate some actions by the NDRC and other ministries to close down small and inefficient factories and to phase-out inefficient boilers.

New developments following trade tensions with the Trump administration

The election of Donald Trump and the recent start of a trade war with China in an effort by Washington to reduce its record high trade deficits in goods with China may also have an indirect impact on China's energy efficiency policies.

There is so far little information about the impact which possible US tariffs on Chinese exports could have on China's clean energy policies, and more specifically energy efficiency. However, China seems to be trying to adopt every possible means to limit the impact of such a trade war with the US and energy efficiency may be part of its policy options. Indeed, energy efficiency can have a positive impact on goods competitiveness: by reducing the amount of energy needed in the production process, it reduces costs at the factory level. In addition, products with an improved energy performance may also be more competitive, as they have a positive impact on consumer bills. Finally, it should be also noted that high energy efficiency standards can also be used as an indirect trade barrier to block foreign goods that are not able to meet them.

This could create new challenges for European companies as Chinese companies could become even tougher competitors. As energy performance is improving in China, energy efficiency standards could also reach new levels, above European levels. European multinationals would then need to adapt their products to be able to remain on the Chinese market. For instance, China could work on new ambitious fuel standards that would go beyond the Euro 7 standard under preparation. This would have important consequences for the European car makers.

China's Secret to Successful Policy Designs

Over the past decades, China has managed to put in place a very efficient policy framework that has allowed not only the setting of ambitious targets, but also (and maybe more importantly) their successful implementation.

Developing national plans: the backbone of energy efficiency policies

China operates in a top-down way: policies are decided at the central level, with the establishment of specific national targets and the identification of measures/technologies that will help decision-makers to achieve them. The plans established at the central level later have to be detailed and adapted at different administrative levels. The plans, introduced in 1953 as a key element of central planning, summarise the objectives and policies – the best known of these plans are the FYPs mentioned above. These plans are completed by other plans, strategies, targets or others with different timelines, allowing Beijing to set longer-than-five-year policy goals. As for energy efficiency, the FYPs are complemented with the 2016-2030 Energy Production and Consumption Revolution Strategy, published by the NDRC and NEA in 2017, as well as China's Nationally Determined Contribution and to a lesser extent other initiatives that may indirectly influence energy efficiency. These include: the State Council's "Made in China 2025" policy, which aims at reducing China's reliance on energy-intensive industries; the 2013 Action Plan for Prevention and Control of Air Pollution; and the 2016 Energy Technology Revolution Innovation Plan (2016 – 2030) (IEA, 2017, pp. 503 – 505). Finally, the national Emission Trading Scheme, announced in late 2017, is also likely to push power companies to adopt more energy-efficient technologies.

Numerous actors are consulted in this process, including academics and industry associations.[19] The plan is often published after its official beginning, though experience shows that officials from all levels already know its content beforehand.[20] More detailed plans are published later: for

19. *Hu Angang Xiangjue 'Shierwu' Guidingzhiding Guocheng: Daxi 11ge Buzhao* [Hu Angang Details the Process of the 12th Five-Year Plan: The Usual 11-Step Process], *Xinhua Finance*, October 29, 2010.
20. Based on discussion with local officials, in 2010 before the official announcement of the 12th FYP.

provinces and localities, and for specific sectors. The 13th FYP for Energy Development was issued during the last days of 2016 and officially published early 2017 (State Council, 2017). The energy FYP is complemented with another series of sub-plans: on coal, oil, gas, power, renewables, shale gas, coalbed methane, nuclear, hydropower, wind and solar power, biomass, geothermal and energy technology innovation (IEA, 2017).

The key to policy success: setting the right targets

More specifically, energy intensity targets have been allocated on a provincial basis since the 12th FYP. The 11th FYP results had highlighted regional disparities, with provinces outgrowing the 20%-energy-intensity objective, and others failing to reach it: Beijing turned out to be the best-in-class with a 26.59% energy intensity reduction, while Xinjiang "only" managed an 8.91% reduction (Ohshita *et al*, 2011). In order to address these issues, the central government has progressively re-adjusted its policies to local characteristics. It now recognises that provinces do not have similar local conditions, and that policies should be tailored to fit local characteristics. As a lesson learnt, the national target of the 12th FYP was declined in provincial targets, under the logic that the richest province should have the most ambitious policies and lead the effort. The 13th FYP went even further with an energy use cap for each province, which is to be combined with the energy-intensity performance, according to the *shuankong* criteria mentioned above. The target allocation is based on the top-down approach and supported by modelling work.

Regional disparities appear clearly when looking at the targets: in the 12th FYP, four provinces (Hainan, Tibet, Xinjiang, and Qinghai) were lagging far behind the others, with a 10% target whereas the next group of provinces was to reach a 14% target. Overall, the 13th FYP targets are more modest. The highest target is a 17% energy-intensity reduction, which is assigned to the richer provinces/cities of Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Guangdong, and Shandong (see Table 4) (Ohshita *et al.*, 2011 and Wang Y., 2018). Tibet is the only province without any energy consumption cap. The reasons for these changes are probably that under the 12th FYP, areas with an 18% target have likely already picked the "low-hanging fruit", i.e. the easiest energy efficiency measures to implement. Moving forward is now more challenging and requires more resources and/or technologies.

Table 4. Assignment of energy intensity targets in different provinces during the 12th and 13th FYPs

Targets	18 %	17 %	16 %	15 %	14 %	10 %
Provinces (12th FYP)	Tianjin Jiangsu Shanghai Zhejiang Guangdong	Liaoning Beijing Hebei Shandong	Heilongjiang Jilin Shaanxi Shanxi Henan Anhui Sichuan Chongqing Hubei Hunan Jiangxi Fujian	Inner Mongolia Gansu Ningxia Yunnan Guizhou Guanxi	None	Hainan Tibet Xinjiang Qinghai
Province (13th FYP)	None	Beijing Tianjin Hebei Shanghai Jiangsu Zhejiang Shandong Guangdong	Anhui Fujian Jiangxi Henan Hubei Hunan Chongqing Sichuan	Shanxi Shaanxi Liaoning Jilin Heilongjiang	Inner Mongolia Guangxi Guizhou Yunnan Gansu Ningxia	Hainan Tibet Qinghai Xinjiang

Source: State Council (2017), Wang Y. (2018).

Provincial officials are then under political pressure to achieve the targets. Their progress in achieving energy intensity is reviewed every year by the central government, and the results of their evaluation are then published on the NDRC website so that they are widely accessible to the public. Strong pressure is therefore put on local governments, while the central government tries to raise the attention from all stakeholders. Finally, the policies are refined and improved while the plan is implemented. This can be seen both as a strength and as a weakness: the policies are flexible, but they can be difficult to predict. For instance, the detailed plan for energy (State Council, 2017), which includes specific priority measures and targets for each province, was only released in January 2017.

Finally, energy saving targets for companies are also allocated through a top-down method, consisting of several steps. It begins with the identification of base-year consumption for each targeted company. Industry associations then conduct surveys in these companies, which lead to the formulation of an energy-saving target range for each firm. Finally, the targets are set after rounds of negotiations and consultations.

Towards new leadership in international on energy efficiency policies

Improvement of China's national energy intensity has been supported by foreign organisations. The most active probably is the Energy Group of the Lawrence Berkeley National Laboratory, which has been extremely active over the past years.[21] Its activities have also been supported by another foreign but very influential organisation in the field, the Energy Foundation. Other international NGOs that are very active in China include the Regulatory Assistance Project (RAP), the Natural Resources Defence Council (NRDC) and the World Resources Institute (WRI). At the same time, the World Bank, the International Finance Corporation (IFC), the United Nations Development Programme (UNDP) and the Asian Development Bank (ADB), as well as the European Commission, GIZ (German aid) and AFD (the French Development Agency) have supported numerous projects, and helped China build its energy efficiency capacities.

In the 2010, the trend started to reverse, China beginning to export its knowledge and to use its achievements to promote its international aid and diplomacy. As an example, the NDRC organised in 2014 a South-South knowledge exchange tour in Beijing and Xi'an, supported by the World Bank. The workshops that took place brought together representatives from mostly South-East Asian countries: Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Singapore, Thailand and Vietnam, reflecting its China's interest to work with ASEAN countries.[22] China also established and leads the Top Ten Energy Efficiency Best Practices and Best Available Technologies Task Group (TOP TENs) within the International Partnership for Energy Efficiency Cooperation (IPEEC).[23] It was endorsed by G20 leaders to become part of the G20 collaboration.[24] China is also collaborating more and more often with the IEA (see for instance IEA, 2017) and as new "Association country" is likely to have a growing influence within the organisation. China also hosted the Clean Energy Ministerial (CEM) in Beijing in 2017.

China's energy efficiency experience also plays an important role in the expansion of Chinese companies abroad, and in new international

21. Their website includes much information about their work, and number of high-quality reports, available at: china.lbl.gov.

22. "Bringing China's Energy Efficiency Experience to the World: Knowledge Exchange with Asian Countries", June 27, 2014, available at: www.worldbank.org, last retrieved on April 2, 2018.

23. TOP TENs webpage on ipeec.org, last retrieved on April 10, 2018. TOP TENs lists best available technologies and best practices with the aim to "show to businesses and policy makers the practical and scalable energy savings solutions currently available and to support the accelerated uptake of innovative energy savings solutions".

24. "G20 Action", available at: ipeec.org, last retrieved on April 10, 2018.

initiatives where Beijing plays a key role: be it the Belt and Road Initiative (BRI), the Asian Infrastructure Investment Bank (AIIB) or the New Development Bank (NDB). The BRI has helped the Wasion Group, a company focusing on advanced metering distribution and energy management, to develop its activities in almost 30 countries. Wasion is also very well-positioned in developing and emerging markets such as Bangladesh, Indonesia, South Africa, Tanzania and Egypt. Cheung Kong Infrastructure (CKI) is another important player, specialised in smart metering, though it comes from Hong Kong and not mainland China. CKI has adopted a strategy based on aggressive acquisition. A recent and important purchase occurred in July 2017, when the company acquired Germany's Ista, one of the largest companies in smart-metering and energy management with activities in Denmark, France, Germany, Italy, the Netherlands and Spain (Buckley *et al*, 2018). In addition, the NDB recently expanded its sectors of activities to include energy conservation, with a USD 200 million loan in Jiangxi to improve industrial energy efficiency,[25] and energy efficiency is also a pillar of AIIB's *Energy Sector Strategy* (AIIB, 2018).

25. More information on the Project description page, available at: www.ndb.int, last retrieved on May 2nd, 2018.

The Implementation Challenges

Such impressive results should not hide the challenges that China is facing with its energy efficiency policies. In the 2000s and 2010s, the country managed to pick the so-called low-hanging fruit by putting in place the most obvious policies to meet the easiest inefficiency challenges. As its national energy intensity improves, China needs to refine its policies, create new incentives and adopt new and more complex technologies.

Bargains at the central government level

The Chinese institutional setting can be considered at the same time as a strength and as a weakness.

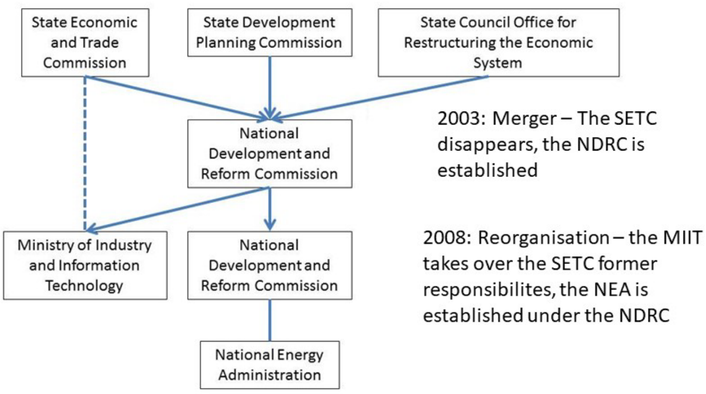
A strength, as the government and the relevant ministries have been able to push energy efficiency policies, to support their implementation, and to raise it as a national priority on the political agenda. The size of the country and of its population, the pace of economic growth all make these tasks even more challenging. Most of these efforts have been led by one of the most prominent actors, the NDRC. It is a ministry-level organisation, which has been, as Hart et al. (2017) summarise, "responsible for developing policy and regulations that affect the national economy and guiding economic reform. NDRC is responsible for drafting the national energy development strategy; implementing planning, policies and standards in the energy and other industrial sectors; developing new energy and promoting energy efficiency; and developing climate policies. It is responsible for greenhouse gas accounting regulations and leads China's efforts to develop a national carbon market. The NDRC acts for the State Council in reviewing and approving infrastructure projects throughout China. The departments of the NDRC and the National Energy Administration, an independent agency within NDRC engage in developing climate policy (...)".[26]

Despite the leading role (at least until 2018) of the NDRC, rivalries exist between different organisations and might have a negative influence

26. Hart *et al.* (2017), p. 8.

on policy design and implementation. Energy efficiency, given its very broad scope, is prone to confusion: it covers very diverse sectors, from industry, to buildings, power generation, appliances, transportation and others, and therefore usually involves a number of different stakeholders, both private and public. For instance, until March 2018, energy efficiency in the industry sector was covered mostly by the NDRC but also by the Ministry of Industry and Information Technology (MIIT) through its Department of Energy Conservation and Resource Utilization. There happens to be a long history of tensions between the two bodies, and their ancestors the State Development Planning Commission (or State Planning Commission) and the State Economic and Trade Commission (SETC) which merged in 2003, in order to form the very powerful NDRC. This merger created a series of institutional issues and tensions. The NDRC was therefore later split up in two parts again, through the establishment of the MIIT in 2008, a Ministry that can be seen as the successor of the SETC. The MIIT inherited of the industrial function of the NDRC (which it had itself obtained from the SETC – see Figure 3). Figure 4 below, lists the main actors and summarise their roles.

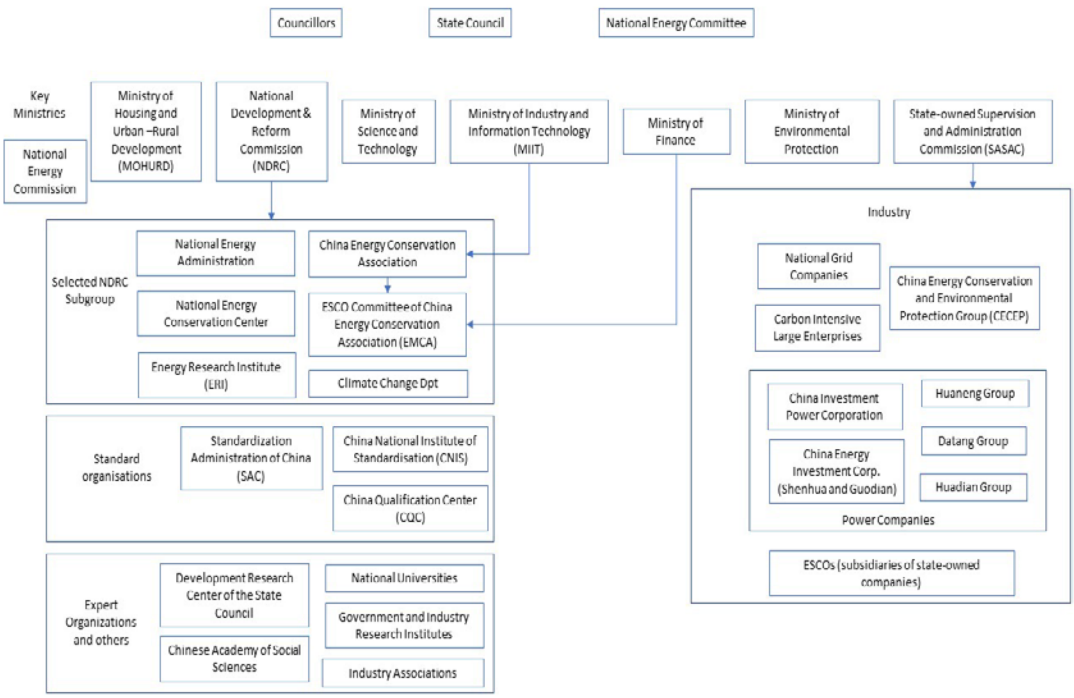
Figure 3. Evolution of the main ministry-level organisations in charge of energy efficiency (2003-2008)



Source: Assessment by the author

However, the NDRC remained the main player. The institutional move of 2008 enacted the establishment of a National Energy Administration (NEA), whose role on energy efficiency matters has been very limited. At that time, rumours were announcing the possible establishment of a Ministry of Energy, which would have been impossible because of pressure from the NDRC that did not want to lose its energy portfolio. The NEA was seen as a second-best solution, to replace the Ministry of Energy but it ended up as a department of the NDRC. The same NDRC also established a National Energy Efficiency Conservation Centre, in charge of the implementation of energy efficiency policies. Other important bodies, though not entirely dedicated to energy efficiency also depended on the NDRC: the Energy Research Institute (ERI), an official think-tank, and the Climate Change Department (see Figure 4). A new development took place in March 2018, as the National People's Congress (NPC) announced the establishment of the Ministry of Ecology and Environment (MEE). Though it seems that the NDRC remains in charge of energy efficiency policies, the MEE is very likely to initiate and coordinate new policies, for instance on standards. This new institutional setting could generate tensions between the different bodies involved: it could generate healthy competition between the ministries or could hamper decision-making.[27] This new institutional setting transforms the whole decision process in China's energy sector, and its consequences will need to be closely watched in the coming years.

Figure 4. Institutions in charge of energy efficiency, prior to March 2018



Source: Assessment by the author.

27. See Voïta, T. (2018).

The challenge of implementing central level policies at the local level

Policies are decided at the central level but have to be implemented at the local level. This is another challenge.[28]

Given the size of the territory, the local bureaucratic organisation of China is complex, with important disparities between different localities, creating challenges when it comes to policy implementation (see Figure 5). Some local governments do not have the capabilities to implement national-level targets, as they for instance lack human resources (e.g. energy managers, or auditors), or financial resources in the case of the poorest ones. Localities also have their own allegiances or clienteles and try to ignore central government policies, or part of them. As striking example comes from Shandong in the east of the country, where the provincial government chose to maintain its local Shandong Economic and Trade Commission after the State Economic and Trade Commission was merged with the State Development Planning Commission in 2003. In contrast, some local bureaucrats have more capabilities than others. For example, the Suzhou Energy Conservation Centre (in Jiangsu province) developed in the late 2000s and early 2010s a local version of the US "Energy Star" labelling programme, with support from international NGOs (including the Energy Foundation and the Natural Resource Defence Council).[29] The programme was later expanded at the province level and obtained the attention of the MIIT which in late 2017 announced that it was working on similar national plan.[30] Another example of local governments pushing for more aggressive policies is the Alliance for Pioneer Peaking Cities, a group of cities that committed to achieving emission peaks before 2030.[31]

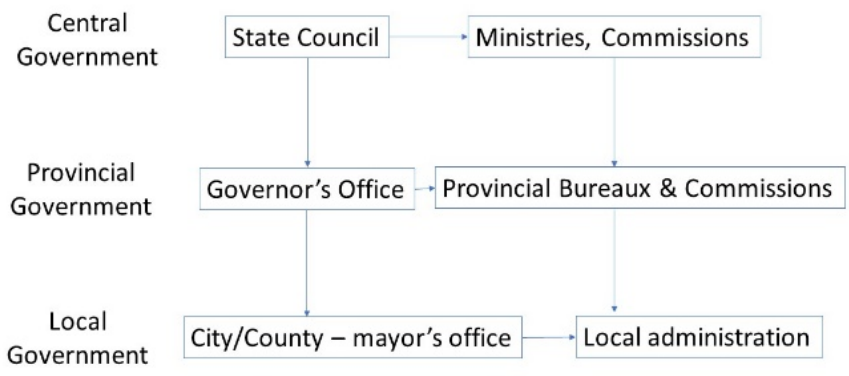
28. Many of the elements mentioned in the following paragraphs will be further developed in a forthcoming study on clean energy in Chinese cities.

29. The programme consists of labels ("stars") granted to appliances and equipment, based on their energy performance.

30. " 'Guojia gongye jieneng jishu zhuangbei tuijian mulu (2017)' he 'nengxiao zhi xing chanpin mulu (2017) gongshi' [Announcement on "a catalogue of National Industrial Energy Saving Technologies equipment (2017)" and "Energy Star Product catalogue (2017)"]", MIIT, available at: www.miit.gov.cn, last retrieved on March 20, 2018; and "2017 Niandu Suzhou shi 'nengxia zhi xing' san xing ji yishang chuangjian qiye mindgan gongshi [Suzhou 2017 'Energy Efficiency Star' of enterprises ranking above three stars", Suzhou Economic and Information Technology Commission, available at: www.szetc.gov.cn, last retrieved on March 20, 2018.

31. "23 Chinese Cities Commit to Peak Carbon Emissions by 2030", WRI, available at: www.wri.org, last retrieved on March 20, 2018.

Figure 5. From the central to the local government: the road of policies toward local implementation



Source: Assessment by the author.

In addition, investments in cleaner energy are not necessarily considered by local leaders as being in their interest. From the 1980s to the mid-2000s, economic growth was the main objective of local officials. The economic development was one of the main national goals, and economic results were an important factor in the central government's evaluation of local bureaucrats. There were few incentives and little appetite for energy efficiency policies or investments, for several reasons, beginning with the important up-front costs of energy efficiency measures. For instance, replacing inefficient equipment in a plant requires not only the acquisition of new equipment, but also some time to install it, during which the production is put on hold. Next, returns on investment of energy efficiency measures were not appealing to many companies: they depend on the price of energy, are difficult to assess and require time. Finally, energy efficiency and its benefits were often not understood, and the appropriate measures require technical capacities and knowledge that the local work force did not necessarily have at the time. Discussions are currently taking place in Beijing about a possible reform of the management of local bureaucrats. In the near future, improvement of environmental issues could become the main criteria for their assessment, instead of local economic growth.

Overinvestment in heavy industries and overcapacities add to these issues. In the past decades, many local officials or entrepreneurs have invested in heavy industry or big infrastructure projects, despite directives from the central government. These directives introduced in the 2000s aimed at limiting the overheating of the economy. However, in 2009, following the economic crisis, the central government promoted local investments to support growth through a Keynesian-type recovery plan. This led to a surge of important industrial and infrastructure investments, aimed at promoting local growth. The original plan from the central government was later expanded by the local authorities and led to a massive lending programme in 2009 which resulted mostly in the expansion of the production capacity of state-owned enterprises. As a result, China's fixed asset investments expanded at an average rate of 18.8% per year from 2009 to 2014. There is no direct evidence of the impact of these investments on national energy intensity. While it had decreased by an impressive 4.59% in 2008 and 3.61% in 2009, it started going up again by 3.2% during the first quarter of 2010, fuelling fears that the country would not reach its 11th FYP energy-intensity reduction target. This led Premier Wen Jiabao to order the closure of 2,000 factories and to increase pressure on local governments. In return, some of them chose to cut heating and/or power to reduce local energy demand drastically.[32]

Data and transparency: monitoring, verification and reporting issues

Data tend to be problematic in China: some would argue that even the central government only has access to unreliable information and data.[33]

It is therefore no surprise that monitoring, verification and reporting (MRV) is also an issue and could actually question the energy intensity improvement of the past years in China. Though many researches are dedicated to improving China's energy performance, very little has been published on energy efficiency MRV issues. Collection of data depends on the sector and is conducted by National Bureau of Statistics (NBS), while the local Development and Reform Commission also plays an important role (Teng, 2012). However, data on energy consumption are not always available. A few years ago, Wang and Chandler (2011) published a paper that questioned the accuracy of China's energy intensity improvement. Their concern stems from, among other things, regular adjustments of national data: for instance in 2000, primary energy consumption had to be revised upward by 6.28% compared to the data initially published; while in the 2005-2007 energy consumption data published by the National Bureau of Statistics (NBS) had to be updated in 2009. Other issues have been raised more recently, especially as the NBS was targeted by the anti-

32. Voïta (2011) and Roland Berger (2016).

33. This was highlighted with irony by a *Foreign Policy* editor, James Palmer: "Nobody Knows Anything about China", *Foreign Policy*, March 21, 2018.

corruption campaign in 2016. At that time, experts were also sceptical about announcements of the government, especially regarding the closure of 100 to 150 million tonnes of steel-making capacity (which represent the equivalent of Japan's total annual steel output).[34] Some of the problems may have been addressed in the past years, but other issues remain. More generally, the question of data accuracy arises at different levels:

- From plants to governments: companies are generally reluctant to share their data, for different reasons. Private companies tend to fear that this information can be used by competitors. In addition, in cases where they are not able to reach the goals set by the government, they would provide officials with fake data, fearing penalties for not achieving their targets. Besides, they are sometimes reluctant to invest in data monitoring mechanisms. For instance, in 2016, plants in the Hebei province were caught trying to hide their actual greenhouse gas emission volumes, by turning off their monitoring systems during night time. Following that, the government enacted new regulations and shut down some plants.[35]
- From the local government to provincial and/or to central government: local officials are evaluated on the basis of their ability to meet targets set by the higher administrative level. Fake data from local governments can be passed on to provincial governments, and then to the central government. Data manipulation or accuracy loss can occur at many steps in the process.
- From governments to public availability: energy consumption or GHG emission are sometimes considered as sensitive economic information by the government. For instance, in 2010, it was said that revealing unauthorised climate change data to foreigners was considered as a breach to national security, and a few local bureaucrats were said to have been arrested for that.

Challenges in financing energy efficiency: the case of the private sector and the ESCOs

Energy efficiency financing tends to be difficult, as it requires important up-front capital that does not generate immediate returns on investment.

34. "Inquiry in China Adds to Doubt Over Reliability of Its Economic Data", *The New York Times*, January 26, 2016.
35. "Chaobiao paifang, feifa shengchan hebei puguang 21 qi huanjing weifa anjian [Hebei: 21 cases of illegal emissions and production]", *Yanzhao City News*, Aug. 19, 2016, and private interview in Beijing, February 2018.

The Energy Performance Contract (EPC) mechanism was developed in order to address this issue. There are many different types of EPCs and an abundant literature on why they work or not. To put it simply, an EPC consists in an agreement between an end-user and a company, called the Energy Service Company (ESCO). The ESCO implements energy efficiency measures at the end-user's (its client's) facilities. According to the EPC, the client does not directly pay the ESCO, but the compensation comes from the money that would have been spent on energy bills without the energy efficiency measures. EPCs and ESCOs are sometimes seen as a silver bullet to disseminate energy efficiency measures with no cost. EPC/ESCO schemes present a number of benefits for the Chinese government. They can lighten governments' burden by reaching out to companies, including private ones that are usually not part of the main policy targets. They can also address financing issues and develop an effective national energy efficiency market that is sustainable.

The history of Energy Service Companies in China started in the late 1990s and was initiated by the State Economic and Trade Commission, with support from a World Bank programme, the "Energy Conservation Project", now considered as a major success story. The project included grants from various funds and donors (including USD 15 million from the Global Environment Facility and USD 63 million from the International Bank for Reconstruction and Development/World Bank) and led to the establishment of China's first three ESCOs, named Energy Management Companies (EMCs):

- Shandong Rongshihua Leasing Ltd Co.
- Beijing Yuanshen Energy Conservation Tec. Ltd., Co.
- Liaoning Nengfa Weiye Energy Tec. Ltd, Co.

They are based in three different regions (Shandong, Beijing, Liaoning) and are focused on projects in the iron & steel, cement and other energy-intensive industries. Additional funding was raised in each province, from provincial government investment companies, power companies and other state-owned enterprises. In addition, the European Commission provided technical assistance on energy performance contracts and on the implementation of small pilot projects. The first years of the three EMCs were very successful, with approximately 350 energy performance contracts and USD 170 million (approx. EUR 137 million) invested. It is estimated that 1.96 Mtoe have been saved in terms of energy consumption, and that 1.81 million tonnes of CO_2 emissions have been avoided. The World Bank extended its support through a second phase, with a new USD 26 million (approx. EUR 21 million) grant. Other donors stepped in, including the UK. Then a second development phase of China's ESCO market started. The EMC Development and Service Group was established in 2001 and became in 2003 the Energy Management Companies Association (EMCA), as part of the China Energy Conservation Association, and a new commercial loan guaranty programme helped the establishment of six new ESCOs.[36]

The government acknowledged the success and potential of ESCOs/EMCs and decided to include them as a tool to promote energy efficiency finance in the private sector. During the 12th FYP, provincial and local governments were invited to use the booming EMC market to reach new actors that had been left aside from the energy conservation plan of the 11th FYP. In 2010, the central government pushed the development of the market further, with measures such as:

- A business tax and value-added exemption;
- An income tax exemption during the first three years, and half tax rate for the three following years;
- Deduction from taxation of energy-saving expenses for the client of the ESCO;
- The possibility to treat assets transferred to clients after the service period as full depreciation or amortisation; these assets being excluded from the income of the ESCOs (State Council, 2010, Econoler, 2011).

These measures were successful, in the sense that the number of EMCs boomed: as of 2011, there were 1,400 of them, with projects of EUR 5 billion and totalling potential energy savings of 11.55 Mtoe. The market has continued to grow, to 5,800 ESCOs in 2016, with energy performance contracts worth of USD 15 billion. 70% of the EPC are focusing on industry, 21% on construction and 9% on transport (Ming, 2015 and Wang X., 2018). Benefiting from these policies has however turned out to be extremely difficult for foreign ESCOs involved in the Chinese market.[37] Many foreign companies in this field have developed activities in China, but have sometimes had to close their offices for various reasons. For instance, the Korean Energy Management Corp. (KEMCO, now Korean Energy Agency) had opened an office in Beijing and started operating as an ESCO. Its projects included the certification of a waste heat recovery system in a cement factory. However, the KEMCO leadership eventually decided to

36. Zhao (2007), Taylor *et al.* (2008).
37. Private discussions with representatives from foreign companies involved in the ESCO business and with China offices.

close down its office in Beijing, as Chinese law made it impossible to repatriate its local revenues to its headquarter in Korea.[38]

The general success of China's ESCO market masks important disparities and issues. Some issues have not been addressed in the 20 years of ESCO history in China. The most important ones are:

- The size of the companies: most of the ESCOs are small companies with limited registered capital (less than RMB 5 million or EUR 0.65 million), many of them have only managed one or two EPCs. Their lack of guarantees makes it extremely difficult to secure bank loans;
- Institutional issues: the market suffers from the lack of rules in terms of energy saving verifications, accounting, tax rules, and others;
- Political issues: the market still needs support from the government to develop;
- Lack of capacity from the staff;
- Awareness and acceptance of the ESCOs/EMCs by their potential customers.

The most successful ESCOs in China are actually the ones that have been established by big state-owned enterprises, especially in the heavy industry sector, power companies or grid companies. These ESCOs usually only work with their parent company, and as subsidiaries from large companies, they do not have the problems that private ESCOs tend to suffer from. A successful example is Guodian (a state-owned enterprise in the power generation sector) which in 2004 established Guodian Technology & Environment Group Corp. Ltd, listed on the Hong Kong Stock Exchange, and with Energy Conservation Solutions being one of its three business segments. Crossley (2013) also shows how policies led grid companies to establish their own ESCOs. Their development follows a regulation on energy efficiency obligations (EEOs) from 2011. It requires Chinese grid companies to implement energy savings of a minimum of 0.3% in sales volumes and demand savings of at least 0.3% in maximum load (based on the company's previous year's results). Consequently, grid companies have established ESCOs as subsidiaries in order to achieve the required savings.

Experts in Beijing consider that the ESCO market has reached its peak, and that some companies may have to close down in the coming years. One commentator points out that China has about 6,000 ESCOs, compared to 150 in India.[39] Interestingly, out of the three Chinese ESCOs

38. Based on personal conversations with executives from the company.
39. Interviews conducted in Beijing, February 2018.

established in the late 1990s, only one – Shandong Rongsihua – is still active. However, it does not work on energy performing contracting anymore, but converted itself into a leasing company. The two other companies have gone bankrupt (Hong, 2018).

Financing energy efficiency with private companies still remains an issue. Therefore, the NDRC is said to be working on the potential launch of a new national energy efficiency fund, of RMB 50 billion (EUR 6.44 billion). The fund would receive money from the Asian Development Bank (ADB) but also from private sources, and would be managed by a Chinese state-owned company, the China Energy Conservation and Environmental Protection group (CECIC).[40]

40. *Ibid*.

The Challenges Ahead: Completing the Transition towards a More Balanced Low-Carbon Economy

Towards a structural shift

During the 11th and 12th FYPs, energy efficiency policies helped address some of the country's imbalances, and an excessive reliance on heavy industries. By rationalising production, energy efficiency policies are expected to encourage industry restructuring and to put pressure on small and inefficient plants and facilitate their closure.

Energy intensity targets are intimately linked with targets on the share of the service sector in the national GDP. The goal is to move towards a low-carbon economy, relying more on high-value added activities like services and less on heavy industries using cheap labour and relying on goods exports.[41] This objective is clearly summarized in China's NDC. For instance, the first objective for the industrial system is "to embark on a new path of industrialization, developing a circular economy; optimising the industrial structure, revising the guidance catalogue of the adjustment of industrial structure, strictly controlling the total expansion of industries with extensive energy consumption and emissions, accelerating the elimination of outdated production capacity and promoting the development of service industries and strategic emerging industries" (quoted from the unofficial translation of NDRC, 2015).

Energy efficiency also has number of other positive effects, the first being job creation. In 2010, the International Labour Organization recognised that China's green labour market was nascent but very promising, and that non-green business opportunities would disappear (Institute for Labour Studies, 2010). More recently, the American Council for an Energy-Efficient Economy (ACEEE) argued that energy efficiency improvement can redirect investments away from less labour-intensive sectors of the economy: for instance, a retrofit project will create new jobs

41. Voïta (2012).

in the building sector. According to ACEEE calculations in the US, a USD 1 million retrofit investment can support approximately 20 jobs for one year, compared to an all-US-sector average of 17 jobs. The savings generated will also potentially redirect spending away from the energy industry.[42] Energy efficiency has also helped Chinese companies upgrade their equipment, by adopting best-available technologies (BAT), as shown in Table 5. Finally, ambitious standard and label policies have also improved the coverage of the number of appliances available on the market (Khanna, 2016).

Table 5. Impact of the 11th FYP on the dissemination of better technologies (2005-2010)

Share of technology	2005	2010
300 MW+ coal-fired power generator	47	73
1000+ cube meter blast furnace	48	61
Coke dry quenching	Less than 30	More than 80
Waste heat for power generation (clinker kiln)	0	55
Caustic soda (membrane process)	29	84

Source: Wang Y. (2018).

However, as of 2018, China's overcapacity issues have not been addressed, and the industrial sector continues to play an overwhelming role in its GDP and so in total, final energy consumption. Table 6 shows the evolution of the utilisation rates for six heavy industries between 2008 and 2014. Despite impressive improvements in energy intensity, the utilisation rate has decreased in each of these industries. This could actually signal a link between energy intensity improvement and overcapacity. Indeed, as energy efficiency provides energy savings, it reduces production costs, and therefore is not necessarily the best tool to promote the transition toward an economy that is less reliant on heavy industries (Table 7 shows the evolution of energy intensity between 2010 and 2014/2015). By contrast, production cost reduction can be seen as an incentive to produce more, and therefore increase overcapacity problems. It seems that energy efficiency policies are primarily being used by the government as a policy tool to close down factories that do not meet energy performance objectives. It is likely that one of the tasks of the newly established Ministry of Ecology and Environment will be to address these overcapacity issues.

42. "How Does Energy Efficiency Create Jobs?", undated, available at: aceee.org, last retrieved on April 4, 2018.

Table 6. Utilisation rates for six heavy industries (2008-2014)

Industry	Utilisation rate in 2008	Utilisation rate in 2014
Steel	80%	71%
Aluminium	78%	76%
Cement	73%	76%
Refining	80%	66%
Flat glass	88%	79%
Paper and paperboard	90%	84%

Source: Roland Berger (2016).

Table 7. Energy intensity improvement in key industries (2005-2014/2015)

Industry	2005	2010	2015	Evolution (2005 – 2014/15)
Crude steel (Kgce/tonne)	694	605	572	- 17,5%
Electricity (thermal power supply, gce/kWh)	370	333	315	- 14.9%
Aluminum (AC, kWh/tonne)	14,680	13,694	13,500	- 8.0%
Cement (kgce/tonne)	n.a.	134	124 (2014)	- 7.5%
Ethylene (kgoe/tonne)	682	628	571 (2014)	- 16.2%
Ammonia (kgce/tonne)	1,582	1,356	1,333 (2014)	- 15.7%
Paper and paper board (kgce)	531	380	339 (2014)	- 36.2%

Source: Wang Y. (2018).

In addition, China's economy still relies heavily on industry, despite some ongoing improvements. According to the IEA , industry still absorbs more than half of the energy consumption of the country, compared to a little more than 20% in the rest of the world.[43] According to the World Bank, industry represented about 40% of China's GDP in terms of value

43. IEA (2017), "Part C. China Energy Outlook" in *World Energy Outlook 2017*, Paris: IEA, p. 474.

added in 2016. This is still significantly higher than 27.3% world average, in 2015. However, that share has been decreasing almost steadily since 2006, when it stood at 47.6%, except in 2008, and 2010 (probably as a result of the 2009 stimulus).[44] Finally, different initiatives such as the BRI or the AIIB may not help China reduce its reliance on heavy industry. On the contrary, these programmes could be seen as ways to find new markets for China's heavy industries and to absorb overcapacities, (despite the fact that they are at the time used to promote China's expertise in the energy efficiency field).

Moving away from coal

Coal is the most important source of energy in China and has played a central role in the economy. As of 2015, China consumed 3.96 Gt per year, and thermal power represented 990 GW and 65.7% of the country's installed power capacity. Meanwhile, installed capacity of coal-fired power was 884 GW, representing 89.3% of the national thermal power capacity. The 13th FYP sets a coal consumption target, with the objective of using less than 4.1 Gt per year by the end of the Plan (2020), which is slightly more ambitious than the 4.2 Gt target of the Strategic Energy Action Plan (2014-2020). In addition, China has set restrictions on new coal mines, despite the fact that future capacities had previously been approved, and that the combination of falling coal prices (they may fall by 5% in 2018) with fixed electricity tariffs creates incentives to use more coal power, while benefitting power producers.[45] The 13th FYP Energy plan adds a few details to coal-consumption targets: for instance, paragraph 5 mentions the need to upgrade coal facilities, and paragraph 14 insists on the need to manage coal consumption, but only in provinces with important population, coal consumption and air quality issues: the Beijing – Tianjin – Hebei region (*Jingjiji*), the Changjian Delta (*Changsanjiao*), the Pearl River Delta (*Zhusanjia*) and the North-East provinces (*Dongbei*) (State Council, 2017).

China's coal consumption seems to have reached a peak in 2013, despite pundits' predictions. Coal production declined by 9% to reach 3,410 Mt in 2016, and coal consumption fell by 4.7%. Between 2013 and 2016, investments to boost local growth led to 200 GW of new coal-fired power capacity that remained effectively idle, leading to a record low capacity

44. The World Bank data website, available at: data.worldbank.org, last retrieved on April 3, 2018.
45. "China Outdid Itself Again in Setting 2020 Low-Carbon Targets", *China Dialogue*, January 5, 2017; "As Coal Prices Dip, a Massive China Utility Shows Signs of Life", *Bloomberg News*, April 3rd 2018.

utilisation rate of 47.5% in 2016. Meanwhile, electricity consumption continued to grow in 2016 and 2017, by respectively 5.6% and 6%.[46]

Paired with the development of renewable energy sources, energy efficiency has played a major role in slowing down coal consumption and therefore GHG emission increases. It should however be noted that energy efficiency does not theoretically have a direct impact on the energy mix. As it focuses on end-users, it aims at improving the energy performance, but not at changing the energy mix. Still, important synergies exist between efficiency and renewable energy, and energy efficiency usually supports the increase of renewables' share in the energy mix (IRENA, 2017).

In addition, China has managed to use energy efficiency as a tool to reduce its dependency on coal. The main ways to this end include:

- The country has drastically improved the energy performance of its thermal power plants. Policies encouraging the adoption of the ultra-supercritical technologies for power plants allowed phasing-out old and inefficient plants in the second half of the 2000s, and to replace them with some of the most efficient plants in the world. In 2005, the gross coal consumption rate of power units with more than 6,000 kWh output was 370 gce/kWh. This decreased to 319 gce/kWh in 2014, while the service power rate dropped from 343 gce/kWh to 300 gce/kWh, during the same period. The government issued new policies by the end of 2015 to implement further ultra-low emissions and energy conversion technologies. By 2020, coal-fired power units are to have a gross coal consumption rate < 310 gce/kWh after conservation and < 300 gce/kWh for above-600,000 kWh power units (with the exception of air-cooled units). However, local governments are sometimes reluctant to upgrade their equipment. In addition, the pricing system is not advantageous for combined heat and power generation. Finally, national demand for heating is increasing more steadily than the demand for power. This might create issues when transforming condensing units to enable cogeneration.[47]
- By putting a cap on energy consumption, the *shuangkong* indirectly links energy efficiency to coal consumption. Paragraph 40 of the *Work Programme of the "13th FYP" on Energy Conservation and Emission Reduction* (State Council, 2017) links the *shuangkong* to emissions reduction and makes clear that energy efficiency should help reduce energy demand and thus to reduce the share of coal in the energy mix.

46. "IEEFA Update: China Is Now Three Years Past Peak Coal", IEEFA, February 28, 2017 and "Coal hits a plateau", *Financial Times*, September 19, 2017.
47. Tian *et al.* (2017), pp. 21 and 22.

Conclusion

China's impressive energy efficiency improvements of the past decades are due to a variety of factors. First, from the 1980s to the end of the 1990s, these improvements show that energy efficiency is intimately linked to economic rationalisation. But the most important and interesting time in terms of China's energy efficiency policies is probably the one that started in 2006 and which is still continuing today. During these years, the government has managed to set extremely ambitious targets and ensure that they are met. These successes have been possible, because of:

- Very strong leadership: targets have been defined at the highest level and set as national priorities, with strong pressure on local officials to meet these targets,
- Clear objectives: FYPs include clear quantitative targets, to be met at a certain date,
- Adaptability: the national targets are adapted at the local level, taking into consideration local characteristics.

Some issues remain though. Improvements are still needed in terms of institutional efficiency and MRV methodologies. Other potential threats to national energy intensity relate to the evolution of national economic growth. On the one hand, stronger economic growth may lead to new investments in inefficient infrastructures and the further development of overcapacities. This would have a very negative impact on China's national energy performance. On the other hand, a slowdown could lead local governments to support the same type of investments in order to boost growth, as it happened after the 2009 economic crisis. Finally, as shown in Figure 2, China has still a long way to go before reaching the world energy intensity average (to say nothing of European levels).

However, industrial energy performance (and more generally energy efficiency in all fields) will continue to improve in China. Recent data show for instance that the shift to natural gas has a positive impact on energy intensity.[48] The next step for China is probably now to demonstrate the capacity to innovate and position worldwide corporate champions in the field, capable of rivalling companies such as ABB, Johnson Controls or Schneider Electric. The Wasion Group seems to be taking this path, supported by China's foreign policy and initiatives. Other key players may

48. "China Energy Intensity Slips Further in Q1, as Demand for Gas Rises – data", *Carbon Pulse*, April 27th, 2018.

enter the field, using China's expertise in artificial intelligence to enhance energy management.

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