Addressing the effectiveness of industrial energy efficiency incentives in overcoming investment barriers in China

John Romankiewicz
Lawrence Berkeley National Laboratory
1 Cyclotron Rd MS90R4000
Berkeley, CA 94720
USA
jpromankiewicz@lbl.gov

Bo Shen
Lawrence Berkeley National Laboratory
boshen@lbl.gov

Lynn Price
Lawrence Berkeley National Laboratory
lkprice@lbl.gov

Hongyou Lu
Lawrence Berkeley National Laboratory
hylu@lbl.gov

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Abstract

During the 11th Five Year Plan (FYP), China adopted a series of incentive policies, offering financial rewards to industrial enterprises to help them improve their energy efficiency. According to China's National Development & Reform Commission, from 2006–2010, the Central Government of China allocated a total of 133 billion Chinese Yuan (CNY) (€16 billion) in the form of subsidies and rewards for promoting energy conservation and pollution reduction. These incentives certainly played an important role in helping China meet its 11th FYP energy intensity goal, but key questions remain unanswered as to whether the incentive policies were cost-effective and whether industrial enterprises would still invest in energy efficiency improvements without the incentive policies. With these questions in mind, the paper first reviews overall energy consumption in industry as background for understanding recent policies implemented by the Chinese government. Then, the barriers for industrial energy efficiency are outlined with a focus on the financial barriers for both self-financed and third-party financed projects. Additional information is provided on how barriers differ in small and medium enterprises versus large enterprises, examining the avenues enterprises have for accessing needed capital to make energy efficiency investments. The paper provides an overview of the incentive policies offered by the government – both the energy saving rewards offered to large enterprises and the more recent rewards and tax incentives for energy service companies. Lastly, some simple case studies illustrate how incentives typically offered in China alter an industrial project's upfront investment cost and payback period, and thus how they impact energy efficiency investment decisions. This analysis can help determine new ways for public expenditure in the 12th FYP to leverage increased private investment in energy efficiency.

Introduction

China expended a great amount of administrative effort and investment to meet its energy intensity reduction goal of 20 % in the 11th Five Year Plan (FYP). China came very close to meeting that goal, with an overall reduction of 19.1 % (Xinhua 2011). Although energy consumption in the transport and building sectors is growing rapidly, industry's share of energy consumption has remained roughly at 70 % of total energy consumption for the past ten years (see Figure 1). Many of the nation's top policy efforts towards energy efficiency – Top 1000 enterprises program, key energy saving projects, and elimination of outdated capacity – met or surpassed their energy conservation targets (NDRC 2011a, NDRC 2011b). For instance, the key energy savings projects program targeted savings of 240 million tons of coal equivalent (Mtce) but achieved a total savings of 340 Mtce, while the Top 1,000 enterprises program targeted a savings of 100 Mtce and ended up saving 150 Mtce.[1]

Different estimates exist for the total value of incentives paid for energy saving and emissions reduction efforts in the

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1. Note there is overlap between the energy savings of key energy savings projects and Top 1,000 enterprises program as many of the projects implemented by the Top 1,000 enterprises were among the key set of projects.
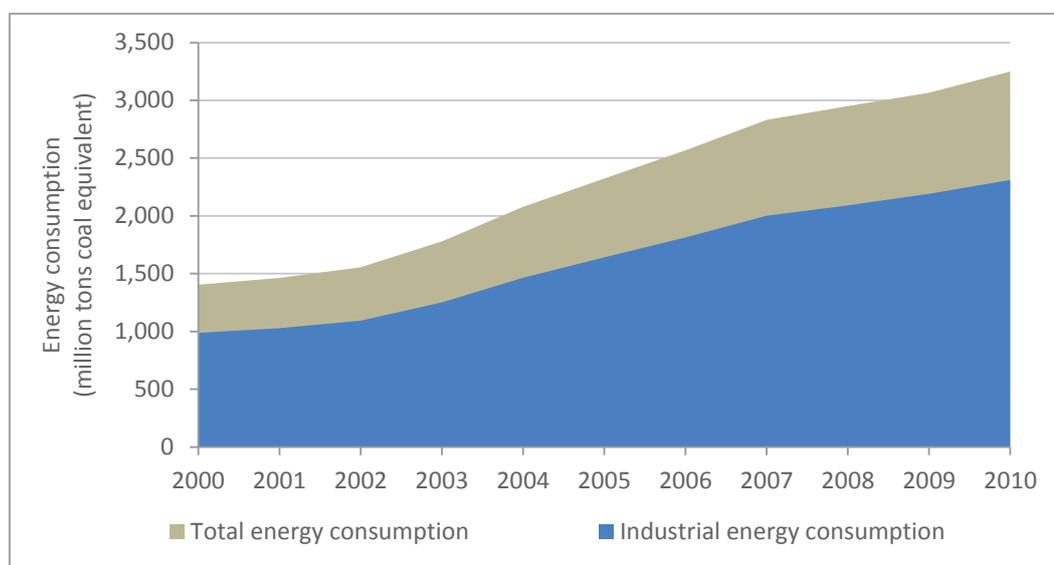
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Figure 1. Total energy consumption and industrial energy consumption. Source: National Bureau of Statistics.

11th FYP, although most Chinese organizations agree they played a key role in driving energy efficiency. The Ministry of Finance's special fund for energy conservation and emissions reduction reportedly paid out CNY 133 billion (€16 billion) in incentive payments in the 11th FYP, with many local governments setting up their own special funds, as well (Xinhua 2011).[2] The Climate Policy Initiative (CPI) at Tsinghua University reported additional funding from central and local governments for energy efficiency of CNY 126 billion (€15 billion) out of a total CNY 859 billion (€103 billion) spent on energy efficiency in the 11th FYP, with the private sector (enterprises) accounting for the remainder of the investment (CPI 2011).[3] When allocating energy savings driven by various mechanisms, CPI broke down the total carbon emissions reduction (due to energy savings) of 1265 million tons of carbon dioxide ($MtCO_2$) into that driven by administrative (37 %), incentive (61 %), and market mechanisms (2 %).[4]

Given that the majority of investment in energy efficiency was driven by enterprises but incentive mechanisms played a major role, one potential conclusion is that the incentives offered by the central and local governments were an effective tool for stimulating enterprise investment. Of course, behind the incentives and financial rewards that many government programs offered, there were educational and training efforts as well as administrative pressure or mandates. Determining the role that incentives played in pushing energy efficiency is of critical importance for informing policymaking in the 12th FYP and beyond.

Another major theme currently being discussed among Chinese policymaking and research organizations is that there is very little or no "low-hanging fruit" left in the realm of energy efficiency policy (CPI 2011). This phrase is usually thrown

around by policymakers without rigorous definition of what it actually means. McKinsey, in their widely studied carbon abatement cost curve, referred to the low-hanging fruit as any abatement option with a negative net cost assuming a discount rate of 4–10 % depending on the sector (McKinsey 2007). Chinese policymakers are likely referring to ease of policy administration when using this phrase, for instance the relatively straightforward administrative approach for programs like the elimination of outdated capacity and the focus on a consolidated approach to top energy consumers like the Top 1,000 Energy-Consuming Enterprise Program (Top 1,000 enterprises program). They are also likely referring to short payback periods of less than two or three years. In saying that the low-hanging fruit is gone, they are implying that the remainder of energy efficiency opportunities are "high-hanging", that is, that there are various institutional and financial barriers to investment or the opportunities are so widely dispersed that administrative programs would have difficulty making an impact. Thus, the government has been increasingly using the phrase "market mechanisms" in various policy documents for the 12th FYP, suggesting that the private sector must continue to play a large role in energy efficiency improvement (State Council 2011).

While determining the role that incentives play in industrial energy efficiency investment is the primary goal of this paper, a secondary focus on policy administration will be applied to better understand the direction of Chinese policymaking in the 12th FYP. To understand how certain industrial energy efficiency policies are administered in China, the paper will begin with a description of industry structure to offer insights into the Top 1,000 enterprises program of the 11th FYP and the Top 10,000 enterprises program of the 12th FYP. After this initial description, the paper will then detail barriers to energy efficiency investment faced throughout industry and incentive policies administered in the 11th FYP, explaining the extent to which incentives change investment decisions. Finally, some simple case studies will be used to portray investments typically seen in the 11th FYP, which will help to inform future incentive policymaking.

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2. For this paper, the exchange rate used is €1 = CNY 8.

3. Private sector includes state-owned enterprises.

4. According to CPI, administrative mechanisms include command and control regulations and strengthening of standards, incentive mechanisms include subsidies and rewards, and market mechanisms include energy pricing and ESCOs.
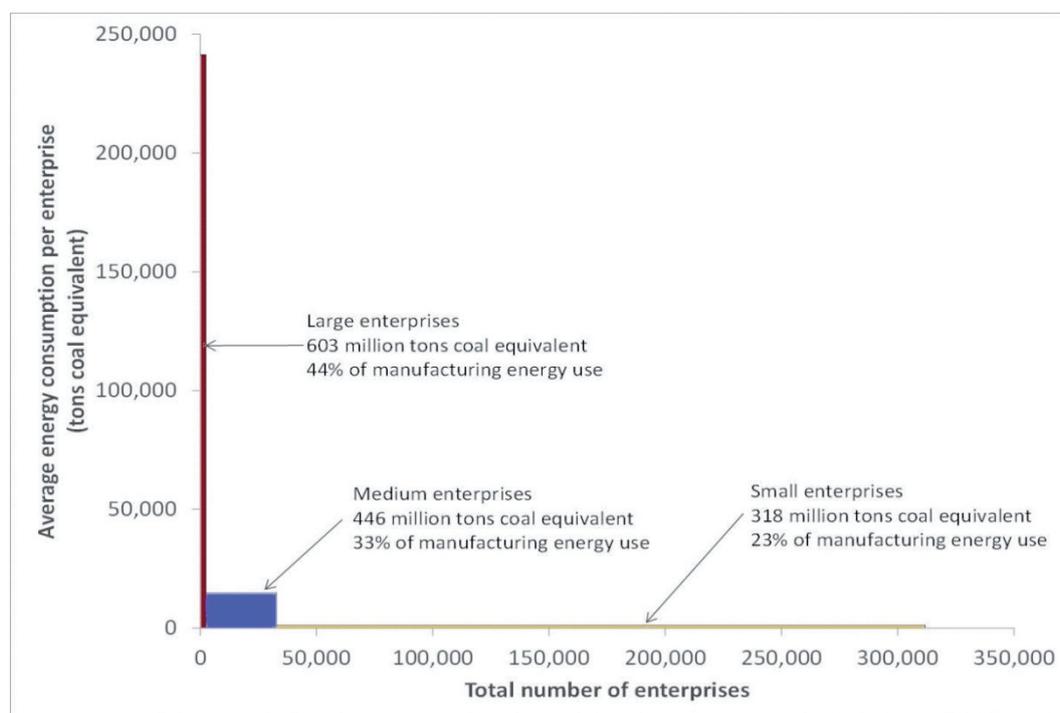
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Figure 2. Simple power curve for Chinese manufacturing energy consumption The area of each box represents the total energy consumption, data source: ERI 2009.

Table 1. Breakdown of energy consumption for large, medium, and small manufacturing enterprises in China (2007).

Type of enterprise	Number of enterprises	Percent of enterprises	Percent of total manufacturing GDP	Total energy consumption (Mtce)	Percent of manufacturing/national energy consumption	Average energy consumption (tce)
Large	2,498	1%	31%	603	44% /21%	241,372
Medium	30,298	10%	30%	446	33% /16%	14,737
Small	278,977	89%	39%	318	23% /11%	1,141

INDUSTRY STRUCTURE: ENERGY CONSUMPTION IN LARGE, MEDIUM, AND SMALL ENTERPRISES

While it is not always productive to generalize industry into a few categories, the exercise is particularly useful in the case of China, whose industry is incredibly diverse and industrial energy consumption highly significant. Since industrial energy consumption data are not available for each individual enterprise, a simple power curve for general categories of large, medium, and small manufacturing enterprises has been constructed in Figure 2[5]. The y-axis depicts the average energy consumption for each category while the x-axis measures the number of enterprises in each category. The area of each box then depicts the total energy consumption of that category.

Table 1 provides the specific numbers behind Figure 2, as well as some additional information on the percentage breakdown for manufacturing gross domestic product (GDP). The classifications for large, medium, and small enterprises were defined by the former State Economic and Trade Commission (now the Ministry of Commerce), former State Develop-

ment Planning Commission (now National Development and Reform Commission [NDRC]), the Ministry of Finance, and National Bureau of Statistics in May 2003. Essentially, the defining criterion is based on total assets.[6] For industry, small enterprises have less than CNY 40 million (€5 million) in assets, medium enterprises have CNY 40–400 million in assets, while large enterprises are above CNY 400 million (ERI 2009).

These values coincide with the common understanding of China's industry. Large enterprises producing the bulk of building materials, chemicals, and other raw materials for China's economy are small in number but account for the highest percentage of energy consumption at 44 %. Small enterprises are more commonly high-tech or value-added manufacturing operations which require less energy (23 %) but account for a higher portion of total GDP (39 %). On the one hand, it could be claimed that since the large enterprises account for only 1 % of the total number of enterprises but 44 % of energy consumption, they should be the primary focus of government policy. On the other hand, it could be argued that small to medium enterprises make up 99 % of the total number of enterprises and therefore cannot be ignored. Additionally, structural transition may make these enterprises more important within the

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5. In Chinese statistics, industrial energy consumption data are normally broken down into mining/extraction, manufacturing, and power/gas/water supply. Manufacturing refers to any industry that transforms raw materials into products, such as paper, steel, chemicals, etc. For this paper, only manufacturing enterprise data has been used to maintain a stricter definition of industry.

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6. There are additional criteria for sales and number of employees.

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Table 2. Description of Top 1,000 and Top 10,000 enterprise programs.

Program	Number of enterprises	Energy per enterprise threshold	Percentage of national energy consumption	Total energy saving target (total accomplishment)
Top 1,000	1,008	>180,000 tce	33%	100 Mtce (150 Mtce)
Top 10,000	Roughly 17,000, including ~15,000 enterprises, 160 large transport companies, and ~2,000 buildings	>10,000 tce for industry and large transport companies >5,000 tce for large commercial buildings	60%	250 Mtce (TBD)

broader economy. The simple power curve shown in Figure 2 would have a similar shape if it contained the energy consumption of each specific enterprise: a very steep height for the very large enterprises that account for the bulk of industrial energy consumption and a very long tail for the myriad of small enterprises that still collectively account for a significant portion of energy consumption but individually have relatively small consumption.

The Top 1,000 enterprises program, modelled after voluntary agreements in Europe and piloted at two iron and steel plants in Shandong province, sought to take advantage of this consolidation of energy use in the largest enterprises. The Top 1,000 enterprises program **began in 2006 and was implemented** throughout the 11th FYP, focusing on improving energy efficiency in the country's top 1,008 energy-consuming enterprises. Each enterprise in the program consumed at least 180,000 tce, and the aggregate of all enterprises accounted for 33 % of national energy consumption and 47 % of industrial energy consumption in 2004 (see Table 2).[7] Since many of these enterprises did not know what energy efficiency measures to implement or how to implement them, significant technical and administrative support was needed, such as facility audits, assessments, benchmarking, monitoring, and information dissemination (Price 2009). The program was characterized by the fact that the top 1,008 were well-dispersed across various industries (iron and steel, chemicals, power, petrochemicals, building materials, non-ferrous metals, coal mining, paper, and textiles) as well as across the country's geography, with 81 enterprises in the northwest, 268 in the north, 102 in the northeast, 97 in the southwest, 192 in the south-central, and 268 in the east. As such, administrative functions and responsibilities could be spread across the provinces through a top-down approach. The program was successful, having reportedly saved 150 Mtce throughout the 11th FYP, 50 % above its target of 100 Mtce (NDRC 2011b).

Given the success of the Top 1,000 enterprise program yet honest acknowledgment that a significant portion of available efficiency opportunities have now been implemented, China's NDRC and other associated ministries have decided to expand upon the program, creating the Top 10,000 enterprises program. The number here is symbolic; there are actually 15,000 enterprises in the program as well as 160 large transport companies (such as shipping companies). The lower threshold for energy consumption per enterprise is 10,000 tce. Large

public and commercial buildings are also now included in the program with a threshold of 5,000 tce. In all, there are around 17,000 entities involved in the program, reportedly accounting for 60 % of national energy consumption.

The target of the Top 10,000 program is 250 Mtce by 2015, which is 2.5 times greater than the Top 1,000 goal and 1.67 times greater than the Top 1,000 achievement. The program covers 60 % of national energy consumption, while the Top 1,000 covered 33 %. The target seems ambitious in light of this fact, especially since many of the efficiency opportunities were taking within the Top 1,000 enterprises during the 11th FYP. The program will also be administered in a top-down fashion with targets disaggregated to provinces and cities and will contain similar implementation tools to the Top 1,000 program such as energy conservation working groups, energy audits, benchmarking, and energy management systems and training (NDRC 2011c). Referring again back to Figure 2, this program will help China address the bulk of major energy consumers, but the "long tail" of small industrial energy consumers will not be directly impacted by the Top 10,000 program.

BARRIERS TO INDUSTRIAL ENERGY EFFICIENCY INVESTMENT IN CHINA

The barriers to industrial energy efficiency investment in China are similar to those in the rest of world, including both financial and institutional barriers, outlined in Figure 3. For financial barriers, these are further broken down into financial barriers where energy efficiency investments are financed by the enterprise themselves or by a third-party.

If an enterprise is seeking to make the investments required themselves, the usual barriers are a comparison of the upfront capital requirement with the available cash the company may have on hand or the opportunity cost of investment in energy efficiency as compared to other business investments. It is common around the world for small to medium enterprises (SMEs) to have small profit margins and, therefore, little cash available to invest. This is commonly referred to in the literature as the hidden costs of investments and is related to the payback time that an enterprise would need in order to make the investment (UNIDO 2011, BNEF 2011). In China, it is common for industrial managers to expect a two-year payback on their investment (Chandler et al. 2011). At a recent US-China energy efficiency conference, a U.S. energy manager said that two-year payback periods are commonplace, but that switched to one-year payback periods during the economic crisis which is still impacting some companies today (Hladun 2011). In the end, this results in abatement options that appear economically attractive, according to studies such as the McKinsey cost curves (McKinsey 2007), but are not frequently adopted. McKinsey used discount rates of 4–10 % to calculate the net present value

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7. Note that the breakdown of large enterprises as previously described and the Top 1,000 enterprises are significantly different because the former breakdown is based on financial assets while the latter breakdown is solely based on the biggest energy consumers (which also include the largest power generation companies).
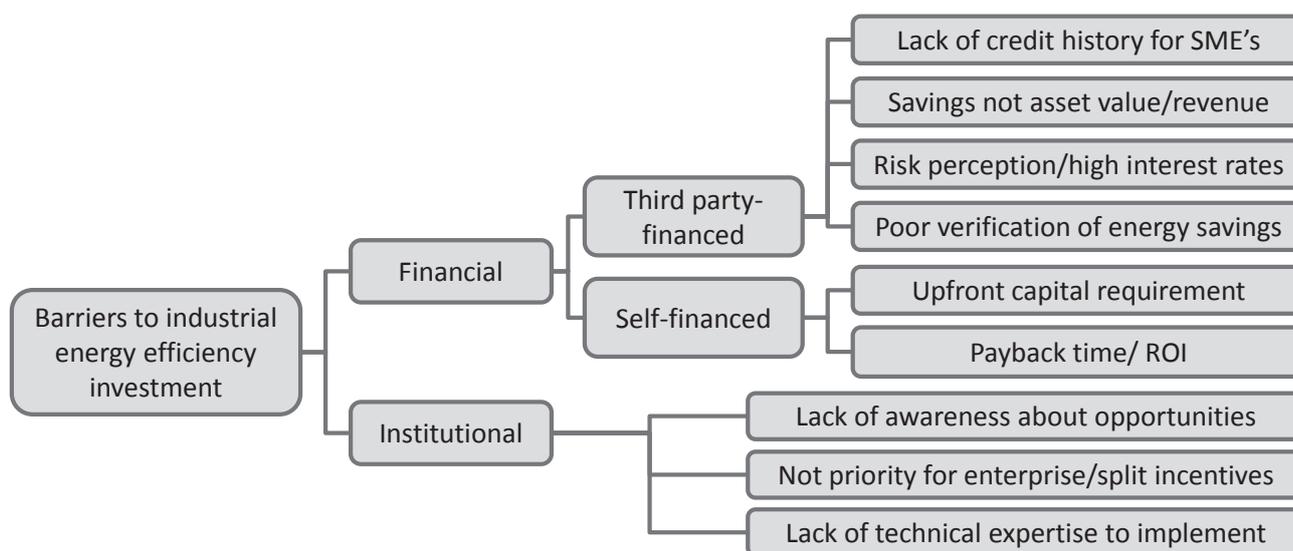
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Figure 3. Financial and institutional barriers to industrial energy efficiency investment.

(NPV) of various abatement options, but a payback period of two years would correlate to a 50 % discount rate. McKinsey's calculation reflects what is known as a "social discount rate", where the net costs and benefits to society can be expressed over a long time horizon. Since investors in industrial energy efficiency usually invest on short time horizons, they have a much higher *financial* discount rate.

Given the barriers of upfront capital investment and short payback times required, enterprises often seek financing from third parties such as banks or energy service companies (ES-COs), although some enterprises are reluctant to take out loans or participate in any financing that is off of their balance sheet. When financed by banks, the most common barriers are that loan officers are inexperienced in lending to energy efficiency projects or SMEs may have a lack of credit history. Small project sizes and high transaction costs are also frequently seen barriers. Additionally, most asset-based lending requires significant asset value or revenue streams whereas energy efficiency projects lead to savings, not new revenue. The investments are thus perceived as being very risky, with the additional concern of lack of trust in how the energy savings are measured and verified. In China, even outside of the realm of efficiency, SMEs in general have had difficulty getting competitive loan rates due to the tightening of bank lending policies, forcing SMEs to turn to private lenders. These lenders are charging astronomical interest rates, often in the range of 72–96 % or even as high as 120 % (China Daily 2011). These private lenders are actively seeking very high profits, so their high interest rates do not necessarily reflect their risk perception.

China's "Green Credit" policy was launched in July 2007 to serve the dual purpose of increasing the amount of lending to energy efficiency and environmental protection (EEEP) projects and decreasing the amount of lending to energy intensive, heavy industry projects. Indeed, the amount and percentage of loans given to EEEP projects has increased quickly in the past few years, according to the China Banking Association (CBA). As shown in Figure **4**, total lending to EEEP projects was 6.5 times higher in 2009 than in 2005 at CNY 856 billion (€103 billion) and accounted for 9 % of total loans in 2009

(CBA 2010). These loans served only roughly 4,100 enterprises, however, which is a very small fraction of total enterprises, so it is likely the case that these loans are mostly serving large enterprises and the upper tier of medium enterprises, with very little reach, if any, into the small enterprise domain. Although the Green Credit policy has guided the banking industry to link financing with enterprises' energy and environmental performance, it was criticized for not establishing the evaluation criteria necessary to judge that performance and make investment decisions accordingly.

Financing by ESCOs offers another route to energy efficiency finance, although banks and other lenders are usually still involved. ESCOs commonly use one of two contract types – guaranteed savings or shared savings. These contracts are characterized by three types of risk: 1) performance risk which is the capacity of the project to reach the savings it claims to achieve, 2) credit risk which is the capacity/willingness of the ESCO or customer to repay any loan taken out for the project (which will impact future credit ratings), and 3) default or repayment risk which is the risk that the customer will not repay the lender. In a guaranteed savings contract, the ESCO provides a guarantee of savings and assumes all performance risk in the project, but the customer gets the project financed by a lender, where the customer assumes the credit risk and the lender assumes the default risk. In a shared savings contract, the lending agreement is between the ESCO and the lender, but any savings (from the implementation of energy efficiency measures) is shared between the ESCO and the customer. In this case, the ESCO assumes both credit and performance risk.

Shared savings is the more commonly used contract in China, largely because of incentives the government offers for ES-COs that use this type of contract, discussed in the next section. This shared savings model has made ESCOs in China largely a project financing vehicle, and to the extent they can work with SMEs will be very beneficial for industrial energy efficiency as a whole (Taylor 2011). In practice, however, most ESCOs do not have significant equity and have trouble getting financing from a bank to extend to their customers. A guaranteed savings model might work better here, but industrial customers

are often reluctant to borrow money in China. In line with its emphasis on market mechanisms in the 12th FYP, China's State Council is also actively promoting the ESCO industry. Additionally, the establishment of various tax incentives and reward payment policies for the ESCO industry in 2010 and 2011 caused the industry to grow roughly ten-fold between 2006 and 2010, then doubling again in size from 2010 to 2011 (Table 3) (EMCA 2010, EMCA 2011). Other estimates put the number of ESCO companies even higher at 1,730 companies in 2011, based on the number of companies that had registered with the Ministry of Finance (MOF) and NDRC for those incentive policies. According to Shen Longhai, an adviser at the Energy Research Institute of NDRC and former head of the Energy Conservation Service Industry Committee of China Energy Conservation Association (EMCA), there are three types of ESCO companies prevalent in China now: 1) ESCOs that are also technology providers and use energy service contracts as a way to push and sell their technology, 2) ESCOs that do not have any technologies but do offer financing, and 3) ESCOs that simply provide project management (Shen 2011).

Common institutional barriers include a lack of awareness about the various energy efficiency measures any given industrial enterprise can implement, some of which vary widely between industries. Since the enterprise lacks this awareness, they likely also lack the in-house technical expertise to properly implement the energy efficiency measures. These barriers are commonly addressed through energy efficiency awareness campaigns, training programs, and vendor marketing. Finally, even if the enterprise is aware of the opportunities available, they may simply not be a priority for their business, given that available capital tends to be directly invested in growing operations that produce additional revenue, especially in a fast-growing economy like China's.

Johnson Controls published a comprehensive survey in 2011 on energy efficiency in China that covers multiple sectors. One question asked industry respondents what they believed to be the top barrier to pursuing energy efficiency in their enterprise. The results for the most common answers are shown in Figure 5. The barriers listed line up consistently with those outlined in Figure 3, with insufficient payback cited as the most frequently indicated barrier although all barriers were cited with roughly the same frequency within a margin of error (Johnson Controls 2011).

INCENTIVE POLICIES FOR INDUSTRIAL ENERGY EFFICIENCY IN CHINA

In general, incentive policies are used to address and overcome investment barriers or simply to stimulate investment in new industries. For instance, feed-in tariffs for renewable energy provide a price premium for renewable energy generation over conventional generation, addressing a barrier to investing in higher priced renewable energy. Rebates are often offered for efficient appliances that have a higher price tag than their less efficient but cheaper competition. Tax credits or tax holidays are also often used to stimulate investment in new industries.

The use of incentive policies for industrial energy efficiency during China's 11th FYP largely revolved around the energy savings rewards program (formally known as Fiscal Rewards for Energy-Saving Technical Retrofits), which was first established in 2006. This program has been extended into the 12th FYP. More recently established and high-impact incentive policies

have been the tax holidays offered to ESCOs. Incentive policies less frequently used by industry were interest rate subsidies on loans and the sale of carbon credits as financed by the Clean Development Mechanism (CDM). CDM project applications were often limited by the number of methodologies available; the main popular methodology used in CDM industrial energy efficiency projects in China (ACM 12) was for waste heat recovery technology (UNFCCC 2012).

Table 4 summarizes the energy savings rewards program as it has been applied in the 11th and 12th FYPs, providing incentives for energy efficiency measures taken in direct support of the Top 1,000 and Top 10,000 enterprise programs, energy efficiency performance standards, and ten key energy savings projects program. In general, the incentives are only offered for projects in five main areas:

- coal-fired industrial boilers and kiln retrofits

- waste heat and waste pressure utilization

- oil conservation and substitution

- motor system energy conservation

- energy system optimization

The process for granting the rewards has two steps. First, enterprises submit applications for their energy efficiency projects to the provinces for initial approval. Successful applications are then forwarded on to NDRC and MOF for further approval. After validation by NDRC and its approved validation bodies, MOF will grant 60 % of the total incentive amount (projected savings multiplied by the regional incentive amount) in an upfront payment for the enterprise to carry out the program. The remainder of the payment is made after validation entities have verified the actual savings of an implemented project and submitted verification reports to MOF for review (NDRC 2011d). The amount of the incentives offered has increased from CNY 200–250 (€24–30/tce) for every ton of coal equivalent energy saved in the 11th FYP to CNY 240–300 (€29–36/tce) in the 12th FYP. In line with the Top 1,000 enterprises program expanding to become the Top 10,000 enterprises program, the minimum targeted *energy savings* requirement remained at 10,000 tce for enterprises but was lowered to 5,000 tce to include buildings. Additionally, a new minimum threshold requirement for the *energy consumption* of the enterprise applying was established at 20,000 tce. This threshold level is about 36 % higher than the average energy consumption of a medium-sized enterprise as defined in Table 1. Additionally, in the 12th FYP, the enterprise must have been operating for at least three years at the time of application.

In April 2010, the central government mimicked the energy savings rewards program as applied to large enterprises and began implementing it for ESCOs. Any ESCO implementing shared savings contracts and providing at least 70 % of the capital in the related energy conservation project, will receive an award of CNY 240/tce (€29/tce), supplemented by awards of at least CNY 60/tce (€7/tce) by local governments (MOF 2011a). In fact, the local awards may be much higher than this. The Shanghai government is matching the national reward with an additional CNY 360/tce (€43/tce) and the Beijing government is matching with an additional CNY 260/tce (€31/tce). For ESCOs that do not qualify for the national reward, the Beijing
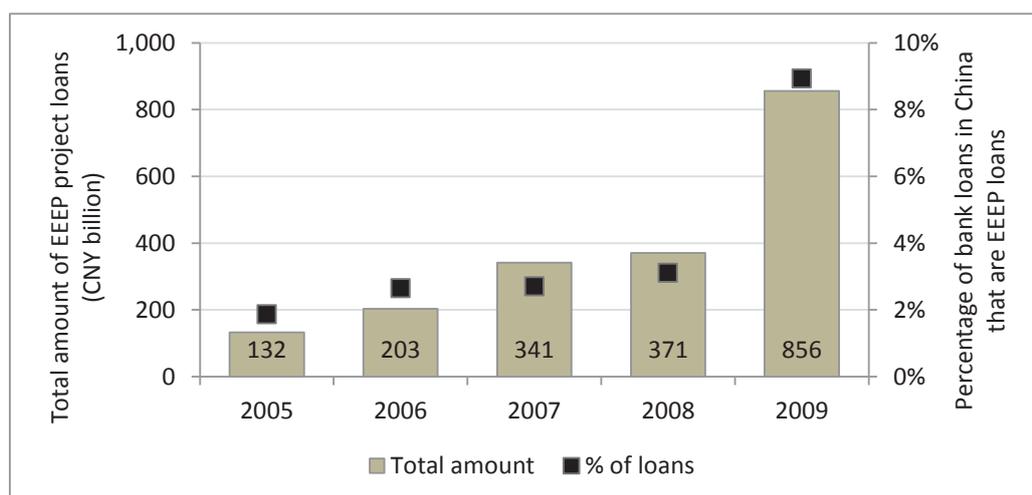
Figure 4. Amount of money loaned to energy efficiency and environmental projects in China, 2005−2009, Source: CBA 2010.

Table 3. Growth in ESCO and energy efficiency service industry, Source: EMCA 2010, EMCA 2011.

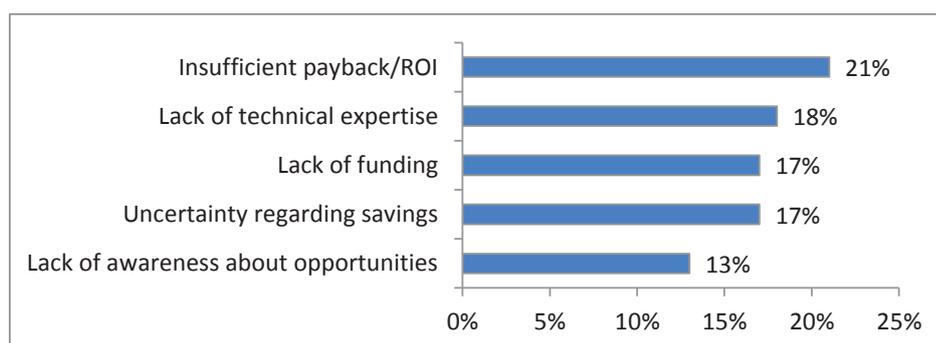|	2006	2010	2011
ESCO companies	89	782	1,472
ESCO project investment – CNY billion (€ billion)	1.3 (0.2)	28.8 (3.5)	41.2 (5.0)
ESCO project energy savings per year (Mtce)	0.9	10.6	16.5
Total number of employees in energy efficiency service industry	16,000	175,000	378,000
Total value of energy efficiency service industry – CNY billion (€ billion)	4.7 (0.6)	83.6 (10.1)	125.0 (15.1)

Figure 5. Top barriers in industry to pursuing energy efficiency. As measured by percentage of those surveyed. Results taken from Johnson Controls 2011.

Table 4. Comparison of energy savings rewards offered in 11th and 12th FYP plans to large enterprises, medium enterprises, and ESCOs.

Description	11th FYP	12th FYP	New policy for ESCOs (2010)
Reward for eastern region – CNY/tce (€/tce)	200 (24)	240 (29)	240 (29) from central govt.
Reward for central/western region – CNY/tce (€/tce)	250 (30)	300 (36)	>60 (7) from local govt.
Targeted energy savings (tce)	>10,000	>10,000 (>5,000 for buildings)	500-10,000
Minimum energy consumption (tce)	Not applicable	20,000	Not applicable
Administrative requirements	Enterprises must have comprehensive energy measurement, accounting and management systems		Contracts must be shared savings
	Projects must be approved by local economic and trade commission	Enterprise must have been operating for >3 years	ESCOs must advance more than 70% of the capital in the projects
	Must be one of the five following projects: Coal-fired industrial boilers (furnaces), waste heat and waste pressure utilization, oil conservation and substitution, motor system energy conservation, and energy system optimization		

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Table 5. Funding for energy efficiency investments in 11th FYP – CNY billion (€ billion) Source: CPI 2011.

Sector	Program	Central government funding	Local government funding	Private funding
Industry	Top 1000 enterprises	–	–	287.4 (34.4)
	Ten key energy projects	31.5 (3.8)	15.8 (1.9)	186.0 (22.3)
	Eliminating outdated capacity	20.2 (2.4)	10.2 (1.2)	–
Buildings	Building energy efficiency	15.2 (1.8)	13.4 (1.6)	–
	Building codes	–	–	194.3 (23.3)
	Building retrofits	–	–	36.4 (4.4)
Other	ESCO	2.0 (0.2)	1.6 (0.2)	29.0 (3.5)
	Energy saving products	16.2 (1.9)	0.0 (0.0)	–
Total = CNY 859 billion (€ 103 billion)		**85.1 (10.2)**	**41.0 (4.9)**	**733.1 (87.9)**

government is offering CNY 450/tce (€54/tce) or a direct payment equivalent to 15–20 % of the project cost (Shen 2012). This reward policy has caused positive developments, such as the Bank of Beijing's announcement in April 2011 that it would extend a special credit line worth CNY 10 billion (€1.2 billion) to members of the nation's ESCO trade group, China Energy Conservation Association (also known as EMCA). The reward policy is somewhat constrained, however, in that it continues to only cover the same five energy efficiency projects in industry as for the Top 1,000 and Top 10,000 enterprise programs (NDRC 2011d).[8] At the end of 2010, having only been actively implemented for roughly six months, the national policy was already reported to have given out CNY 2 billion (€240 million) in subsidies (NDRC 2011e).

Additional support for ESCOs has come in the form of tax reductions and tax holidays. New tax policies implemented, starting in January 2011, include exemption from income taxes and value added taxes (VAT) for ESCO contracts meeting requirements similar to those for the energy saving rewards. The ESCO will not pay any income tax for the first three years of the associated qualifying project, and only 50 % of the income tax rate for the second three years of the project (MOF 2011b). One analysis found that the VAT reform was able to reduce the tax rate on waste heat power generation from 14.5 % to less than 10 % and, in some cases, almost to zero (Chandler et al. 2011).

Another area where incentives were provided for industrial energy efficiency is MOF's provision of incentive payments to local governments in support the elimination of outdated capacity and the associated economic transition. The exact incentive amount was determined based on a number of factors, including the target of capacity to be phased out in the local government's jurisdiction and progress towards that goal as well as how the incentives would be used by the local government (MOF 2011c).

The final type of incentive offered for industrial energy efficiency is interest rate subsidies. The subsidy effectively lowers the interest rate of a loan to an energy efficiency project by one or two percentage points. One study claims that the interest rate subsidy is ineffective, especially for energy efficiency loans where the term of the loan is very short and the expected returns are usually quite high (Chandler 2011).

A recent study by the Climate Policy Institute at Tsinghua University estimated the total amount of incentives used by central and local governments as well as private sector investment in energy efficiency investments in the 11th FYP. Their estimates are summarized in Table 5. The total amount invested was CNY 859 billion (€103 billion) according to their estimates (CPI 2011).

Depicted in a bar chart format, it can be seen that central and local government funding only accounted for around 15 % of the total, with private sector (albeit much of it state-owned enterprises) accounting for the bulk of investment in energy efficiency (Figure 6). The ratio of private investment to government funding was around 6:1 for industry and 8:1 for building. Industry accounted for the bulk of investment at 64 % as opposed to buildings (30 %) and other sectors (6 %), such as ESCOs and energy saving products (subsidies for energy efficient light bulbs, air conditioners, and vehicles). According to the study, industry accounted for over 90 % of energy saved due to government funding in energy efficiency, supporting at least a preliminary conclusion that the incentives used in industry were much more effective at inducing investment in energy efficiency than those used in buildings or other sectors, although there are many other investment factors at play (CPI 2011).

CASE STUDIES ON INVESTMENT CONDITIONS FOR INDUSTRIAL ENERGY EFFICIENCY PROJECTS IN CHINA

Basic information on industrial energy efficiency projects at large enterprises applying for energy saving rewards was gathered from the websites of local governments and economic commissions in China (Yowargana 2009). In Table 6, the location, efficiency measures, upfront investment, and expected energy savings are outlined for each of five projects studied. Each of the projects applied for funding from at least one of the five key energy saving projects that are defined for the energy saving rewards. A range of investment size from CNY 10–134 million (€1–16 million) is seen as well as range in expected energy savings of 20,000–80,000 tce. Payback periods were calculated by dividing the upfront investment cost by the expected annual monetary savings (annual energy savings multiplied by a coal price of CNY 600/ton [€72/ton]). The payback period was then calculated taking into account the energy saving reward of CNY 250/tce (provide €30/tce) of which 60 % is paid upfront once the project has been approved by local authorities, MOF, and NDRC and validated by approved validation bodies.

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8. The policy does also cover building energy conservation and green lighting for ESCOs implementing projects in buildings.
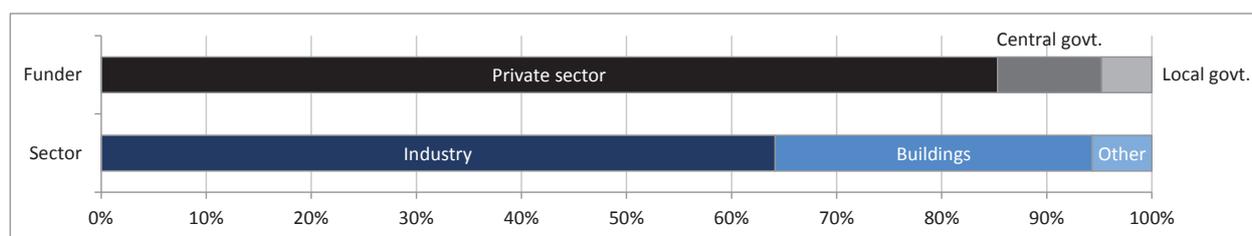
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Figure 6. Breakdown of energy efficiency investment in the 12th FYP Source: CPI 2011.

Table 6. Investment conditions for industrial energy efficiency projects in China.

Description	Project 1	Project 2	Project 3	Project 4	Project 5
City	Xinxiang	Luzhou	Lanzhou	Baiyin	Lanzhou
Province	Henan	Sichuan	Gansu	Gansu	Gansu
Key energy saving projects qualified	Waste heat utilization, energy system optimization	Industrial boiler retrofit	Kiln retrofit, energy system optimization	Waste heat utilization, district heating	Energy system optimization
Investment - CNY million (€ million)	134 (16)	66 (8)	61 (7)	67 (8)	10 (1)
Expected energy savings (tce/year)	81,120	40,000	40,300	25,900	19,100
Payback period (w/o reward) – years	2.0	2.0	1.8	3.1	0.6
Payback period (w/ reward) – years	1.8	1.8	1.6	2.9	0.4

The value of the initial 60 % payment of the reward for projects 1–4 was 5–10 % of the initial upfront investment, so payback periods were only impacted marginally. For project 4, the projected savings were small compared to projects 2 and 3 which had similar size investments, so the payback period was comparatively less attractive. The project may have been pursued either under a longer investment time horizon or due to pressure from government authorities. For project 5, the investment was relatively small compared to the energy savings, so the reward made the already attractive payback period even shorter.

Since information was not available on the total assets of these enterprises (it is known by definition of "large enterprises" that their assets must be at least CNY 400 million), it is difficult to assess how large the investment is in relation to the size of their assets, revenue, and cash and thus difficult to determine how large the investment barrier is from a perspective of self-financing. For enterprises with large revenues and plenty of cash on hand, a payback period of 3–5 years may be perfectly acceptable although that enterprise may have options for non-energy-related investments with more attractive returns. For enterprises with fewer monetary resources, a payback period of less than two years will be sought e (Chandler et al. 2011). If the energy efficiency measures do not meet that requirement, then the enterprise will not be willing to invest in the project on its own. It may also be reluctant to rely on outside financing. The payback periods for the projects mentioned above are outlined in Figure 7 based on projected energy savings and initial upfront investment costs without the energy saving rewards. Radially, the most attractive investments are the ones closest to the y-axis while the investments closer to the x-axis have longer payback periods.

For future studies, a more complex model will be used to account for all expenses such as capital investment, operations and maintenance costs, fuel costs (electricity, coal, gas, oil), and taxes as well as all income such as energy savings, energy sales, incentives, tax breaks, and carbon credit sales. Further data collection is needed on large enterprises as well as small enterprises and any ESCO-led investments.

Conclusions

Currently, the major themes in Chinese policymaking for industrial energy efficiency are the expansion of administratively focused policy programs to continually address efficiency improvements in the largest enterprises (Top 10,000 enterprises) and the beginning of the use of market mechanisms to stimulate energy efficiency improvements in the myriad of small to medium enterprises. Since financial barriers are more likely to exist for the smaller enterprises that have more difficulty accessing capital for energy efficiency investments, there is a need for the Chinese government to design policy to address these barriers effectively and without high administrative burden. Initial evidence suggests that the energy saving rewards paid to large enterprises in the 11th FYP often made already attractive investment conditions more attractive and may have been unneeded for enterprises with access to ample capital. More research is needed to understand how incentives policies and the larger industrial energy efficiency policy framework impacted other pertinent financial barriers not treated in this paper as well as institutional barriers, such as technical capacity and awareness of efficiency opportunities. The more recently implemented energy saving rewards and tax policies for ESCOs also need to be assessed for their impact on investment conditions in small to medium enterprises. If those incentives prove to be effective in getting smaller enterprises to invest in energy efficiency, then this area should be a focus for government spending in the 12th FYP.
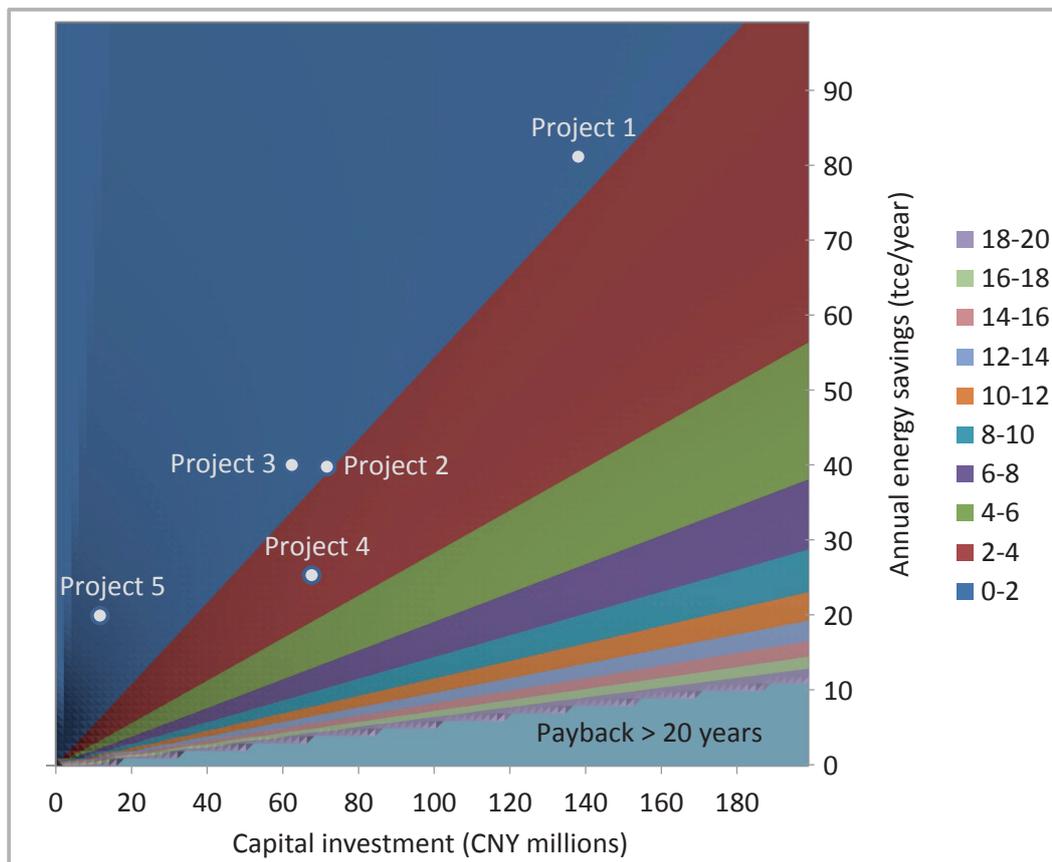
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Figure 7. Payback period in two-year intervals as a function of capital investment and energy savings, assuming a CNY 600/ton coal price, 1 ton coal = 0.7143 ton coal equivalent, and no energy saving rewards.

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