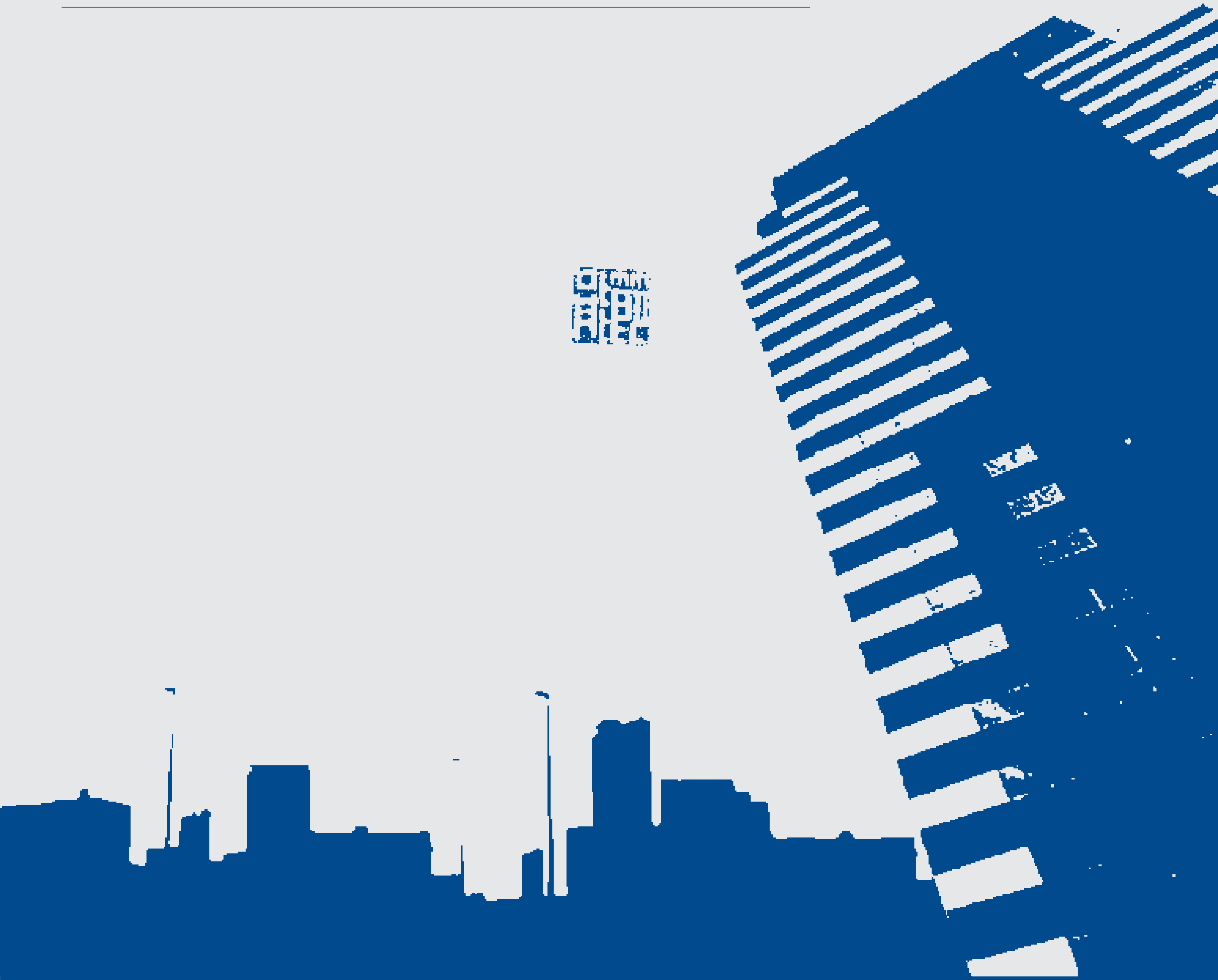
Understanding Energy in China

- Geographies of Energy Efficiency



APERC

Asia Pacific Energy Research Centre

Understanding Energy in China

Geographies of Energy Efficiency

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Foreword

We are honoured to present here *Geographies of Energy Efficiency*, the second part of APERC's report on Understanding Energy in China.

The first part of this report identified energy efficiency and conservation as a priority of China's national energy policy. Our objective here has been to explore how China is pursuing energy efficiency and conservation and to what result. This report provides information on the implementation of China's energy efficiency and conservation policies that we expect will be of interest to both Chinese and international audiences.

This work is published by the Asia Pacific Energy Research Centre as an independent study and does not necessarily reflect the views or policies of the APEC Energy Working Group, individual member economies, or other contributors. We hope that it will serve as a useful basis for discussion and analysis both within and among APEC member economies for the enhancement of energy security, the promotion of regional cooperation, and in furthering sustainable development.

Kenji Kobayashi

President

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Executive Summary

China has a long history of pursuing energy efficiency and conservation. Now, having recognized the threat to energy security, sustainable economic growth, and the environment that is posed by rapid energy demand growth, China has placed energy efficiency and conservation (EE&C) as its highest priority energy strategy. Since issuing the Medium- and Long-term Plan for Energy Conservation in 2004, several important high-level actions have been taken to put China on a path toward less energy-intensive development. These have been greeted by observers with praise but also some skepticism.

The 11th Five-Year Plan has been the proving ground for China's resource-conserving, environmentally friendly development strategy. China's leadership and observers around the world are watching to see if the national energy efficiency and conservation policies can reduce the rate of energy growth of this rapidly growing industrial economy.

Previous studies, including the first part of APERC's China energy study, have pointed to the challenges of implementing energy policy in this economy, in which the forces of development, market reform, industrialization, urbanization and globalization have been unleashed. That is why this report has focused on implementation—to understand how the energy efficiency policies of the central government are being implemented by the provinces, local governments, sectors, and enterprises of China. Evidence of success in implementation provides an indication of the feasibility of the strategy, which dramatically impacts the world energy outlook. Moreover, successful implementation strategies might inform further efforts toward energy efficiency, both in and out of China.

To provide a better standard of living, the government aims to achieve a 2020 per-capita GDP four times that of 2000. China's leadership has recognized two looming obstacles to achieving this goal by energy intensive development. On the one hand, an insecure supply of energy may impede growth. On the other, rapid and unregulated growth in the energy sector might provide the necessary energy supply, but at an environmental cost that would threaten the improved standards of living that are the ultimate objective. Thus, reducing the economy's energy intensity by 20 percent was set as an obligatory target in the 11th Five-Year Plan (2006–2010).

This important change in China's national energy policy is implemented first by the universal adoption of supporting, binding provincial energy intensity targets. The provinces have then responded by further decomposing those targets within their jurisdiction and by the adoption of policies and measures, which respond to centrally-issued requirements (e.g. measurement and reporting) or convey national regulations to their jurisdiction. Evidence gathered to date shows that all provinces have taken action toward achieving their targets and that many provinces are well on their way toward delivering on this contribution to the national objective. However, a minority of provinces are not progressing at the planned pace, and many central measures have yet to achieve universal adoption.

The simple fact that data with regard to achievement of energy efficiency and conservation objectives is available represents a level of success. It shows that progress toward achieving change is being measured, which is a key step in accountability. In fact, a clear method has been established to evaluate the performance of provinces and key energy using enterprises. Various regulations and laws, issued both by central and provincial governments, suggest that the scores from these evaluations will effectively motivate action by turning the pre-existing methods of administrative performance review, reward, and public praise to the task of spurring energy efficiency and conservation.

Recent years have featured several attempts to reorganize the national energy agencies in order to clarify and consolidate responsibility for energy policy. The National Development and Reform Commission remains the key oversight body for implementation of energy efficiency and conservation in the 11th Five-Year Plan. But aggressive energy saving goals require that implementation activities push farther and deeper into the various sectors, which requires greater collaboration among the various Ministries and departments that are responsible for those sectors. Administration in China is vertically integrated, thus achieving the participation of various ministries enables the local offices of those ministries to deliver on the EE&C measures. Facilitating this collaboration is the objective of the recently established National Energy Commission.

China is large and diverse in many measures and especially so in terms of energy efficiency. From one province to the next there are large differences in energy intensity, and within a given industry there are vast differences in efficiency between top performers and laggards. To some extent this variation has been recognized in the pursuit of the EE&C agenda. Different provinces have been assigned different targets according to their situation. Industries are being pushed to benchmark against the top-performers in order to guide their improvements. And local governments have flexibility to experiment with different approaches to meeting their assigned targets. A one-size fits all approach does not suite China's distinct geographies of energy efficiency, and the growing diversity of approaches is promising.

Within the power sector, the heat rate of thermal power plants and transmission and distribution line losses are focused on as key indicators of energy efficiency. China has over 6,000 thermal power units, more than three-quarters of which have a capacity of less than 100 MW. The efficiency of the small thermal units is well below that of the large, over 600 MW, high-efficiency units that China has recently been deploying. Current policy aims to improve the overall efficiency of the power sector by shutting down small and aging plants. This policy is often unpopular with the small plants' local stakeholders, but it has nonetheless succeeded in eliminating 23.4 GW of small power plants in 2007, and the average heat rate of thermal power stations improved from 356 to 345 grams coal-equivalent per kWh.

Continued culling of the small thermal power plants is likely to produce further efficiency gains. Recent increases to investments in transmission and distribution support this consolidation of capacity and are also expected to improve grid stability and reduce line losses. While working with the national generation and grid companies to improve supply-side efficiency, the government has also encouraged local governments to develop combined heat and power, which a large project in Beijing has shown to offer very high system efficiency.

China's iron and steel industry is by far the largest in the world and it is responsible for 18 percent of China's final energy demand. It is also remarkably geographically dispersed and fragmented?the industry includes small producers using outdated technologies but also massive production groups with more than 30 million tonnes of relatively modern production capacity. As part of China's broad economic reform process, the government reduced its direct operating control in the industry. As steel producers became independent, their inefficiencies were revealed. Correcting these inefficiencies led to a period of energy intensity improvements that continued until 2002. Now, the government is utilizing its close ties with the industry to promote further efficiency improvements through more aggressive industry restructuring.

Through agreements with provinces and individual companies, China has succeeded in eliminating over 46 million tonnes of inefficient steelmaking capacity. New capacity is required to meet the government's requirements as to efficiency of scale, processes, and equipment. Furthermore, more than 250 iron and steel enterprises are engaged in the Top-1000 Energy Consuming Enterprise program, which requires them to achieve specific energy intensity reductions, under the scrutiny of the provincial governments. Technology specifications and energy saving targets are thus amply provided, but finance is a potential weak link. Industry consolidation and foreign investment may provide some of the financing for energy efficiency improvements, but additional government financial support could hasten the deployment of efficient technologies.

China's manufacturing industries play a dual role in the drive to improve energy intensity. First, they are improving the energy efficiency of the products that they supply to the Chinese market. And second, they are reducing their own energy intensity by increasing the value added of their products while improving the energy efficiency of their facilities. China's coastal manufacturing hubs, and especially the special economic zones within those areas, are the incubators for this process. Despite the increasing privatization of businesses in these areas, the government maintains close cooperation with industry. Local officials are responding to EE&C objectives by favouring low energy intensity businesses in their jurisdiction. At the same time, manufacturers are motivated to bring efficient products to the marketplace by the central government's promotion of those products. Continued efforts to deregulate energy prices will push manufacturers to further improve the efficiency of their operations. Success in the coastal development areas may subsequently be transferable to less-developed regions of China.

Though today the residential and commercial sectors are considerably less important than industry in China's total energy consumption, they are areas of rapid demand growth. There is a large potential for energy efficiency in these sectors and the government has sought to improve their efficiency for many years. Recent policies have introduced higher energy reduction targets, particularly in the building sector, and expanded coverage by including more products under performance standards and labelling programs. Supervision and enforcement of these policies and programs is essential to slow the pace of energy growth in these sectors.

Recent programs have provided enterprises with both incentives for producing efficient products for the residential and commercial sectors, as well as penalties for failure to comply with minimum energy performance standards. Importantly, these provisions are backed by recent amendments to China's Energy Conservation Law. Early evidence indicates that provincial and local governments are strengthening supervision and enforcement activities during the 11th Five-Year Plan period. The rapid expansion of building floorspace and appliance usage creates a challenging environment in which to develop such supervision, but also shows its necessity. The vast infrastructure that is now being deployed will shape future energy consumption in these sectors for decades to come.

One area where China has a uniquely large potential for reducing energy demand is among the state-funded institutions. These institutions are responsible for a massive building stock; over 100 million square meters, which includes both office buildings and residential housing. The energy consumption per unit area of these buildings is much higher than similarly purposed buildings in Europe and Japan. A process was initiated in 2001, under the leadership of the Government Offices Administration of the State Council (GOASC), to understand energy usage of state-funding institutions, and then design and implement an EE&C program to reduce that usage. The program that has emerged from this process includes building energy monitoring, building retrofits, improved vehicle management, and government procurement of energy efficient products. GOASC reports that electricity consumption per square meter of building area fell from 81.3 kWh in 2005 to 73.1 kWh in 2008 as a result of these programs.

China has deployed a wide variety of implementation strategies to its diverse geographies of energy efficiency. Just as importantly, it is gathering continuous feedback on the performance of these strategies and using it to make adjustments and improve performance. This process, which in China is sometimes referred to as 'feeling the way across the river', will provide experience that will guide the expansion of China's energy efficiency and conservation programs in the remainder of the 11th Five-Year Plan and beyond, as China strives to create a resource conserving and environmentally friendly development path.

內容概要

長期以來中國政府一直致力於節約能源資源、提高能源效率的工作。為了保障能源安全，推動可持續經濟發展，以及減少因經濟的高速增長對環境（可能）產生的破壞，中國視節能工作為其能源（發展）戰略的重中之重。自 2004 年頒布《節能中長期規劃》以來，中國採取了一系列行動，以使中國未來能夠走一條低能耗的發展道路。雖然外界對此褒獎有加，但不乏許多懷疑的聲音。

“十一五國民經濟和社會發展規劃綱要”為中國走資源節約型和環境保護型的發展道路提供了（堅實的政策）基礎。不僅中國自己的領導們而且全世界的觀察家們都期待著看中國中央層面的節能政策是否能真正幫助減少其工業迅速發展對能源的需求。

以往的研究，包括亞太能源研究中心之中國專案的一期報告明確了在目前經濟情況下中國能源政策執行時遭遇的各種挑戰，如經濟的快速發展、工業化和城市化、市場化改革和全球化等等都是其中的因素。我們的報告著力於對政策執行的研究，全力瞭解中央層面的能效政策是如何被各個行業、地區和企業所執行。在中國，（一些）政策的成功執行已經給（我們預測）這個能源節約戰略能否最終成功提供借鑒，這種預測將對全球能源展望產生（深遠的）影響。此外，成功的政策執行戰略將會引致更多的能效方面的努力，努力的範圍將超越中國個體。

中國政府確定將使人均國民生產總值在 2020 年期間達到 2000 年的四倍，努力提高人民的生活水準的目標。同時，政策制定者們也清楚這個目標的實現將伴隨著能源需求總量的增加，經濟發展與能源消耗量的增加是一對悖論。一方面能源供應安全（的缺乏）會阻礙經濟的增長。另一方面，不對能源的快速發展進行（適時、適地和適式的宏觀）調控雖然在一定程度上能夠提供所需的能源，但是隨之付出的環境方面的代價會破壞業已改善的生活水準，而後者是（中國現有）政策的最終目標。因此，在“十一五”期間減低能源強度 20% 成了一個強制性的指標。

中國能源政策中（相當）重要的變化在地區層面表現為：中央把降低能源強度的總體指標在地區層面進行分解、落實；地區把降低能源強度的指標與地區整體經濟社會發展結合起來，並按照中央政策要求執行政策或者使國家條令附有法律效應。到目前為止，事實證明中國所有地區採取了（相應的）措施來實現它們各自的節能目標，許多地區的節能成績也在幫助推動“十一五”期間 20% 這個整體目標的最終實現。儘管如此，有些地區沒有完成其預定的年度節能目標，而且許多中央層面的節能措施還沒有能夠在各地獲得有效的實施。

與節能目標有關的各種資料表明了中國在節能方面已經取得的成就。節能努力所引起的各種變化一直在被評估著，這是各級政府實施的目標責任制裏的關鍵點。事實上，一種比較清楚的方法已經被採納，用來給各個地區和主要用能單位的節能表現進行打分。各種各樣由中央和地方政府頒布的條例和法令表明評分的結果在使行政命令、獎勵和公衆獎勵變成真正地激勵節能努力的各項行動是十分有效的。

中國近幾年進行的一系列機構調整目的是為了理清並加強能源政策（使之獲得更有效執行）。中國國家發展和改革委員會承擔起了最主要的“十一五”節能政策的執行工作。該雄心勃勃的節能目標需要在各個能源部門獲得更多和更深的執行，也就迫使各個政府主管部門進行更多的協調與配合。中國特有的自上而下的行政機構設置使得政策及有關政策執行的各項指令較易在地區層面上獲得傳遞。

中國疆域遼闊差異性相對較大，在能效和節能措施方面尤為如此。各個地區的能源強度有很大不同；在同一個行業，效率最高的和落後（的企業）之間差異也很大。中國在節能努力的過程中考慮到了這些差異性，行業設定了能效的基準，以該行業中最高能效為標準來指導改進整個行業的效率。對於地方政府而言，其執行政策的靈活性比較大，可以採用各種不同的措施來實現其節能目標。一刀切的 . 法不適合中國能效工作的特殊性，即各地存在著很大的差異性。因此，措施與措施之間的區別將越來越明顯。

火電廠熱耗率和輸配電損失是電力部門效率 (高低) 的關鍵指標。中國擁有超過 6,000 個火電機組，超過四分之三的機組容量小於 100 百萬瓦。這些小火電機組效率遠低於 600 百萬瓦以上之大型機組，裝置此大容量之機組，中國一直是居於世界的領先地位。目前政策（之一）是藉

由關閉小型和老舊之機組以提升電力部門之整體效率。雖然這項政策往往不受當地小電廠持有者的歡迎，但在 2007 年，還是成功地關閉了 23.4 億瓦的小型火電廠，使整體火電機組平均熱耗率由每千瓦時 356 克標準煤耗降至 345 克。

持續淘汰效率低之小火電廠可進一步提高火電機組的效率。近年來增加了在輸配電系統的設備投資，這將整合（整個行業的）發電能力，也可提高電網的穩定性和降低系統線路損失。國家發電公司與電網公司通力合作以積極改善電力供應側效率的同時，政府也鼓勵地方政府或企業集團發展熱電聯產系統，北京（高碑店）一處（熱電聯產）有很高的系統效率。

到目前為止，中國的鋼鐵行業（就其生產總量來講）位列世界第一，它占了中國終端能源總需求的將近 20%。該行業以遍布全中國、整合性較差以及擁有較多低能效的小廠為特徵，但也擁有超過 3000 萬噸先進的生產力。作為中國經濟改革過程的一部分，政府減少了對該行業的（行政干預）。鋼鐵生產商們越變得獨立，它們的低效率也越顯現出來。（克服這些低效率的）過程刺激了能源強度的改進，一直到 2002 年。現在政府利用其與該行業的緊密關聯通過更加大幅度的行業重組和推動先進的高能效技術的使用來提高能效。

通過與地方和行業簽訂目標責任書，中國已經成功地關閉了超過了 4600 萬噸的落後鋼鐵生產能力。新建生產能力其規模、能效水準、生產過程和生產設備必須符合政府的要求。除此以外，有超過 250 個鋼鐵企業參加了千家企業節能活動，該活動要求這些企業在地方政府的監督下達到特定的降低能源強度的目標。政府雖然對技術規格和節能目標的設定十分清楚，但是財政支持被看成是節能工作中很薄弱的環節。企業兼併和吸收國外資金可以為能效的提高提供一定的財力支援，同時政府的資金支援能夠促進提高能效技術的廣泛傳播。

中國的製造業在推動中國降低能源強度上起著雙重的作用。首先，它們幫助推動提高產品能效。其次，它們通過提高設備的能源效率以提高其產品的附加值來降低企業自身的能源強度。中國沿海的製造中心，特別是中國在沿海地區的經濟特區是製造業能效提高過程的孵化器。雖然這些地區私營企業比較多，但是政府與行業的合作依然十分密切。地方政府為了實現其節能、提高能效的目標傾向於在其管轄的區域裏招商引資那些低能耗的企業。同時，製造商們在政府（各種措施）的不斷推動下致力於把節能產品帶到市場上。能源價格逐漸從政府管控中鬆綁也使得製造商們（有更多機會）來提高它們的能效。沿海地區節能成效能夠被普及到中國內地一些欠發達的地區。

雖然住宅和商業部門在中國能源消費中（占的比重）沒有工業部門那麼大，但是這部分增長得很快。這個部門的能源效益提高潛力很大，政府很多年以前已經開始著手此項工作。最近幾年的政策給住宅和商業部門設定了更高的減少能源消耗的目標，特別是在建築領域，即擴大了建築節能所涉及的範圍並對所用產品提出了性能標準和標識的要求。政策的執行和（對執行效果）的監督對減緩住宅和商業部門的能源消耗的增長趨勢十分重要。

目前節能行動激勵廠家把高能效產品提供給住宅和商業部門的消費者，也對那些不能按照要求 . 事的廠家實行懲罰。重要的是，這些獎懲條例受到《中國節能法》的修改案的法律支援。事實證明，“十一五”期間，地方政府正在加強監督和政策執行。（但是）新的建築面積的迅速增加，家電的普及給節能政策的執行帶來的困難，但（另一方面）也（進一步）顯示了節能的必要性。

中國有一個地方有著很大的節能潛力，那就是政府機構節能。政府機構擁有超過 1 億平方米的建築總面積，提供辦公和工作人員住宿使用。這些建築的能源消耗量大大超過相同建築在歐洲和日本的能源消耗量。在國務院機關事務管理局的領導下，從 2001 年開始進行政府機構節能行動以在政府機構普及節能的知識以及（逐步）制訂和執行節能的各項措施。這些措施包括對建築能耗的監控、對建築的翻修、加強對所屬車輛油耗的管理以及政府採購節能產品。國務院機關事務管理局通過統計資料證實節能行動最終使公共機構建築用電從 2005 年的每平方米 81.3 度電降低到了 2008 年的 73.1 度電。

中國採取了各種不同的政策執行策略以滿足其有較大差異性的各地能效的提高的要求。重要的是它不斷地通過監控進行評估獲得對其制訂的政策的回饋並根據回饋進行政策的調整和改進政策的業績。對於中國來説目前的節能行動也可稱為“摸著石頭過河”，這些行動可以給中國提供節能的經驗和教訓，為“十一五”剩下的幾年所用，也可以為今後的節能目標服務，因為中國正努力地致力於走一條資源節約型和環境保護的發展道路。

Introduction

China is presently engaged in a massive effort to control its rising energy use while promoting the rapid growth of its economy. The numbers involved evidence the magnitude of the challenge: in real terms, China's 2007 GDP was more than double that of 2000; the electric power sector added more than 90 GW of capacity in just one year; and 100 million tonnes of coal-equivalent energy savings are to be achieved by engaging nearly 1,000 of the economy's largest energy-using enterprises.[1] Though the Chinese leadership has demonstrated its eagerness to learn from international experience, there is simply no precedent for the proposed development path. The policies and programs that China has introduced are necessarily unique given the challenge that is confronted, and original approaches are being developed to implement these policies and programs in the country's economy.

It is not just the scope of China's energy efficiency endeavours that sets them apart. China's administrative structure both enables and requires new approaches with a "Chinese character". Within the structure of a mixed economy, referred to as "socialism with Chinese characteristics", the government retains considerable authority to shift the economy's allocation of resources toward energy efficient industries and products.[2] The vertical integration of government agencies means that those in the central government that are responsible for defining energy efficiency policies are also present at the local level to monitor implementation. Pre-existing lines of communication, responsibility, and accountability can be turned toward the objectives of energy efficiency. The initial impression is that it is an ideal environment in which to make rapid progress in improving energy efficiency.

But the actual situation is much more complicated and often defies understanding by the international community. China is an economy in transition, both planned and market-driven, and it is experiencing rapid development. Majority state-owned companies that respond well to government reward systems operate alongside private enterprises that respond more readily to price signals. The economies of some coastal provinces host advanced manufacturing facilities and a vibrant service sector, while the economies of interior provinces remain predominantly agrarian. Evaluations of China's energy efficiency polices at the national level do not capture the variation found across these geographies of energy efficiency in China.

China is home to some of the most advanced green companies—such as solar cell and wind turbine manufacturers—but on the other hand, as of 2000, coal use per unit of electricity in the power sector was more than 20 percent higher than the level in advanced economies.[3] The most advanced provinces of China have an average per-capita gross regional product of CNY66,000, while the figure for interior provinces is about one fifth that.[4] In some special economic zones, industries pay market prices for energy, but in most of China retail energy prices remain subsidized.[5] According to a recent study, one province has published building-specific energy use data for 526 public buildings, but obtaining reliable energy use data for many other provinces remains difficult.[6] To achieve the energy efficiency targets of the central government, the implementation of energy efficiency policies in China must succeed in all of these settings.

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[1] (NBS 2008b); (CEPYEC 2008); (NDRC 2006a)
[2] (CPC 2007)
[3] (NDRC 2004)
[4] (NBS 2008b)
[5] (TEDA 2008)
[6] (Zhao, Wu and Zhu 2009)

China's growing experience in implementing energy efficiency policies holds lessons for many observers. Other economies in transition can learn from the mix of approaches that China is developing; even within China itself, one province can learn from the experiences of another. Energy businesses must understand the depth and breadth of energy efficiency programs both to gauge the impact of China's development on international energy markets and to understand this enormous potential market for energy efficient products and services. And certainly, those who wish to understand China's commitment to mitigating the environmental impacts of development should understand the many, varied geographies of energy efficiency in China.

Context of the Current Work

This is the second report in APERC's study of energy in China. The first report described national energy polices through 2006. A brief recap of key points from that report is provided at the end of this introduction. Since the writing of that report, some major developments have taken place. China's leadership adopted the goal of quadrupling per-capita GDP by 2020, while at the same time increasing the share of light industry and services in the economy.[7] Progress has been made toward achieving the 20 percent energy intensity reduction target that was set in the 11th Five-Year Plan. However, having achieved reductions of 1.79 percent in 2006, 4.04 percent in 2007, and 4.59 percent in 2008, there remains a 9.6 percent gap to be closed by the end of 2010.[8]

Box 1: The Energy Intensity Indicator

An increase or decrease in aggregate energy intensity does not necessarily mean that energy efficiency has improved or worsened. In China, the energy intensity indicator has been widely adopted because it provides useful information regarding the evolution of energy consumption. Because the economy of China changes so rapidly, it makes sense for a broadly applicable indicator to be normalized to the current economic condition, represented by GDP. Energy intensity in turn serves as a reasonable proxy for energy efficiency, so long as its co-dependency on the economic structure is kept in mind. In this report, we make use of the concepts of energy efficiency, energy conservation and energy intensity. These key terms are defined at the end of this introduction.

The scientific literature has given much attention to Chinese energy efficiency and conservation, as it has an important place in China's energy policy agenda and a potentially large impact on the global economy and environment. Recently, Zhou, Levine and Price provided a review of China's national energy efficiency programs, which sounds an optimistic note on China's prospects for reaching the 20 percent target.[9] Several reports have focused on unraveling the influence of a number of contributors to the overall energy intensity of China's economy. Hofman and Labar use econometric techniques to understand the separate influences of structural change, wealth, privatization, fuel switching, and energy prices on energy intensity in China since 1990. Based on an analysis of province-level data, the authors conclude that, over the 1990 ? 2004 period, both structural change and intra-sector efficiency improvement contributed to reductions in energy intensity, with the latter being the more important driver.[10]

Some studies have noted the diverse states of energy intensity encountered among China's

[7] The per-capita GDP target is relative to 2000. (President Hu 2007)

[8] (NBS 2009), (NBS 2008b) and (NBS 2008a)

[9] (Zhou, Levine and Price in press)

[10] (Hofman and Labar 2007). Where "structural change" means an increasing importance of relatively low-energy industries in the economy and intra-sector efficiency improvement refers to a reduction of the energy used by a given industry to produce an equivalent output.

provinces. Hu and Wang apply data envelopment analysis to compare the relative efficiency of China's provinces in producing GDP from inputs of energy (including an estimate of biomass), labour, and capital stock. Their analysis identifies an efficiency "frontier", defined by the provinces that produce the highest GDP with the lowest inputs. The authors also show that when all factor inputs are considered, the regions plot a U-curve of energy efficiency development—total factor energy efficiency is high for undeveloped regions (the west), low for moderately developed regions (the centre), and highest for the most developed regions (the east).[11] This result is consistent with studies, such as that of Wei et al, which show higher technological acquisition among the enterprises of the economically advanced coastal provinces.[12]

What has yet to be addressed by the literature is the question of how policies to promote energy efficiency are being implemented at the local level. In order to fill this gap, this second phase of APERC's China energy project focuses on energy efficiency and conservation policy implementation by regions, sectors and enterprises. Whenever possible, we attempt to take a bottom-up view of this implementation, asking how enterprises, sectoral groups and regional governments are responding to the national policies (see Figure 1).

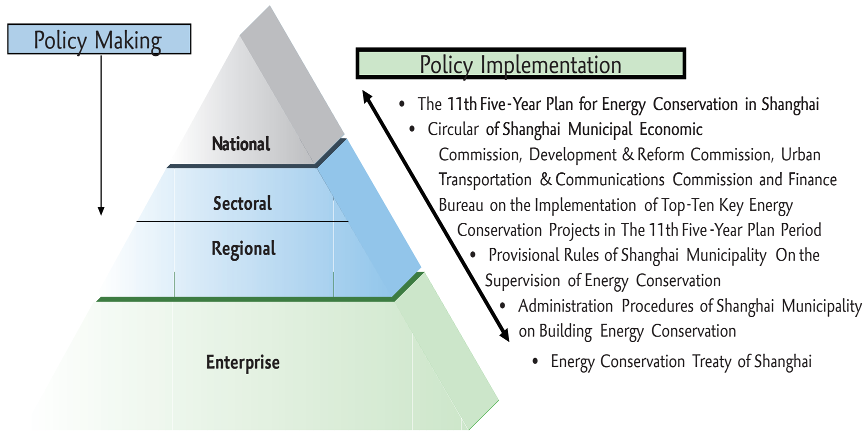

Figure 1: Implementation, area of focus

Scope and Structure of this Report

The main question that this report sets out to answer is, "How have China's policies that promote energy efficiency been translated into action?" Our approach to answering this question has two parts, as presented in the two main sections of this report. First, we provide a background on China's policy apparatus that is necessary for understanding the context of the implementation activities. Then, we focus on several key areas of implementation to get into the specifics and describe how implementation is being carried out. We will also present case studies that clearly illustrate implementation activities. In each chapter we highlight areas where implementation appears to be succeeding and also where improvements could be made.

The first section, providing context, includes Chapters 1 and 2. Chapter 1 reviews the national energy efficiency agenda, its origins, and the high-level implementation strategy. The fundamental forces motivating the drive for energy efficiency are identified as primarily relating to energy security, environmental protection, and economic development. The

[11] (Hu and Wang 2006)
[12] (Wei, Min and Zhaoyang 2007)

strategy is found to include both administrative, legal and economic tools and a unique process for assigning responsibility. It is supported by an evolving institutional structure and well-defined principles for measuring and evaluating success.

Chapter 2 introduces a framework for organizing and comparing the various geographies of energy efficiency in China. After the high variability in energy efficiency performance within this framework is described, the factors behind these differences are explored. This chapter proposes that to explain the implementation of energy efficiency and conservation policies in China, they must be framed in the context of economic growth, liberalization, industrial restructuring, energy security, and environmental awareness.

The second section of the report then focuses on several sectors in order to develop a more complete picture of implementation activities in some key geographies. Chapters 3 through 7 focus on manufacturing, heavy industry, residential/commercial, power, and public sector energy efficiency activities. Again, rather than restricting the study to the general descriptions that would be possible in a national overview of these sectors, we look at specific regions. For the most part, we have focused on regions near the leading edge of energy efficiency in China: the Beijing-Tianjin Boahai Rim, the Shanghai-Jiangsu-Zhejiang Yangze River Delta, and the Guangdong Pearl River Delta.

Selected Findings from "Understanding Energy in China"

The first phase of this study, "Understanding Energy in China", explored eight topics concerning Chinese energy development in the context of reforms ongoing since about 1979. The second phase of the study, "Geographies of Efficiency", looks into one of these topics, exploring energy efficiency and conservation in depth. In doing so, it builds on these important findings from the first report.

China's "Medium- and Long-term Energy Conservation Plan" released in 2004 outlines the government's strategy for reducing energy consumption in key sectors and products through the year 2020 [p.105].

Conservation has long been prioritized in China's energy development policy. However, the rapid economic growth and increasing importance of market forces in recent years has required the development of new approaches to energy efficiency and conservation [pp.21-26].

Ten key conservation projects described in the 11th Five-Year Plan are expected to deliver roughly half of the plan's targeted 20 percent energy intensity reduction [p.109].[13]

The top 1,000 energy-using enterprises, accounting for one-third of national energy use, have been enlisted by the government to lead improvements in energy efficiency [p.109].

Although the energy intensity of China's industrial sector declined 62 percent between 1981 and 2005, it remains 25 to 60 percent higher than the advanced international levels [p.102].

Major energy-using industries are targeted to achieve early-1990s international energy efficiency levels by 2010 and to approach the advanced international levels by 2020 [p.107].

A few relatively wealthy coastal provinces have achieved the nation's lowest energy intensity levels [p.110].

Energy efficiency standards for buildings exist, but enforcement has proved difficult [p.108].

[13] The share of the energy intensity target here is revised downward from the figure in the previous report.

Energy prices have gradually become more market-based, with coal prices completely liberalized by 2002. However, continued government control of the prices of energy products to end-users often mutes a price signal that could stimulate conservation [p.35].

China has rich coal resources, but has faced occasional shortages when rapid demand growth ? commonly over 10 percent per annum and peaking at 19 percent in 2003—temporarily exceeded production capacity or, more often, overwhelmed the transportation infrastructure [p.49, p.55].

Thermal power station efficiency increased from 20.6 percent in 1987 to 34.3 percent in 2006. Recently, policies have encouraged the construction of large (over 300 MW) relatively efficient, supercritical coal units, and the elimination of small (under 50 MW) low-efficiency units [p.86, p.114].

Electric power generating capacity grew at over 15 percent per year from 2002 to 2007, with increasing industrial demand as the major driver of growth. Recent moves have attempted to address past underinvestment in transmission and distribution relative to generation [p.85].

Basic Facts of China's Energy and Economy

The purpose of this section is to indicate the scale and trends of China's energy economy, as well as some basic information on the policy environment. This should help readers who are less familiar with the subject to understand the context of the energy efficiency policies and programs discussed in this report. However, this is by no means a comprehensive review of China's energy economy. We encourage readers to consult the report "Understanding Energy in China" for more information.

In 2007, China's population was 1.32 billion, up from 1.27 billion in 2000 (NBS 2008b).

With a 2007 GDP of CNY24.9 trillion (USD3.2 trillion), China was the world's third-largest economy, after the United States and Japan (IMF 2008).

Secondary industry (mining and quarrying, manufacturing, production and supply of electricity, water and gas, and construction) provides nearly half of China's GDP (NBS 2008b).

The economy is highly export oriented. In 2007, exports totalled USD1.22 trillion, of which 70 percent originated from just four coastal provinces—Guangdong, Jiangsu, Shanghai, and Zhejiang (NBS 2008b).

Wealth is unevenly distributed across China's provinces; per-capita income ranges from just CNY10,000 in Gansu to nearly CNY66,000 in Shanghai (NBS 2008b).

China is the world's largest energy producer and second-largest energy consumer (IEA 2008).

Energy intensity declined steadily from 230 kilotonnes coal-equivalent per billion 2005 CNY in 1990 to 110 in 2002. After then rising above 120 in 2005, it fell to around 115 in 2007 (NBS 2008b) and (NBS 2008a).

China's primary energy mix includes: coal (73 percent), oil (21 percent), gas (4 percent), hydro (3 percent), and nuclear (less than 1 percent) (NBS 2008a).

Large domestic coal resources and the economy's heavy reliance on that fuel have been a source of energy security. However, since becoming a net oil importer in 1996, China's energy imports have steadily grown (NBS 2008a).

China's energy resources are located far from the coastal industrial centres; four central provinces ? Shanxi, Inner Mongolia, Shaanxi, and Henan—provide more than 50 percent of domestic energy production (NBS 2008a).

Definitions of Commonly Used Terms

Energy

Energy refers only to commercial energy, and doesn't include the direct household combustion of biomass, unless otherwise specified. Both tonnes of oil equivalent (toe) and tonnes of coal equivalent (tce) are used as units of measure.

Currency Values

This report generally uses Chinese Yuan (CNY). Currency values are nominal, unless a base year is specified in the text. Dollars are used for international comparisons, with conversions made at market exchange rates.

Energy Intensity

Energy intensity refers to the quantity of energy used per unit of output value. To be consistent with Chinese policy language, units of tce per CNY are typically used.

Energy Efficiency

For a given process or piece of equipment, energy efficiency is the ratio of useful energy output to energy input. When the energy efficiency of China's economy as a whole is referred to, this means the ratio of useful energy output to energy input of the entire collection of processes and equipment in the economy. This proves a useful concept at times; however, because "useful energy output" is not commonly measured, energy efficiency is rarely quantified.

Energy Efficiency & Conservation (EE&C)

This term refers to the entire suite of policies and activities having the objective of reducing energy consumption. In practice, the objective of such policies and activities is often specified in terms of energy intensity.

Region

Region is a general term used to refer to geopolitical units in China, including provinces, counties, cities, and districts.

Province

This specific geopolitical unit in China includes true provinces, autonomous regions and the municipalities directly under the national government. The complete list of these is shown in Table 1.

Table 1: The provinces of China

Western		Interior		Coastal	
甘肃	Gansu	安徽	Anhui	北京	Beijing*
青海	Qinghai	重庆	Chongqing	福建	Fujian
四川	Sichuan	贵州	Guizhou	广东	Guangdong
西藏	Tibet	黑龙江	Heilongjiang	广西	Guangxi
新疆	Xinjiang	河南	Henan	海南	Hainan
云南	Yunnan	湖北	Hubei	河北	Hebei
		湖南	Hunan	江苏	Jiangsu
		内蒙古	Neimenggu	辽宁	Liaoning
		江西	Jiangxi	山东	Shandong
		吉林	Jilin	上海	Shanghai
		宁夏	Ningxia	天津	Tianjin
		陕西	Shaanxi	浙江	Zhejiang
		山西	Shanxi*		

*Though Beijing is not a coastal province, it is near the coast and more similar to the coastal provinces

Making Energy Efficiency a National and Regional Policy Priority

Energy efficiency and conservation can contribute significantly to the sustainable energy economy that China is seeking for its future. In order for this to be achieved, many policies have been announced and enforced since the adoption of the "reform and open-up" policy and especially during the 11th Five-Year Plan.[1] In 2006, the first year of this plan, a large campaign of energy efficiency and conservation activities was begun. Since 2007, that campaign has become especially active.

The launch of the current energy efficiency and conservation campaign represents a major change, not just for policy makers but also for individuals and institutions that must implement the new policies. To describe the scope and implications of this major change in energy policy, this chapter answers the following questions:

- What are the key factors motivating this high-profile energy conservation agenda?
- How is this important change in China's national energy policy represented at the provincial level?
- What kind of institutional structure supports the change? Specifically, where do the lines of authority flow in the implementation?
- How is progress toward achieving the change being evaluated?

Factors Motivating China's Energy Conservation Agenda

The 11th Five-Year Plan for National Economic and Social Development gives concrete form to the vision for maintaining economic growth while exercising control over energy consumption. The plan calls for a 20 percent reduction of energy intensity by 2010, the equivalent of reducing energy consumption from 1.22 tonnes to 0.97 tonnes of coal per CNY10,000 of GDP.[2] This initiative was created in response to two pressing challenges faced by China's leadership. First, it must sustain economic development and thereby continue to improve standards of living. At the same time, it must curb the rapid rise of energy consumption that brings social, environmental and economic ills that threaten to erode the gains in economic development.

Energy Security

China has a goal of quadrupling per-capita GDP between 2000 and 2020.[3] Officials have recognized that rapidly rising domestic energy consumption is the greatest obstacle to achieving that objective. For example, to achieve per-capita GDP of CNY31,000 for a population of 1.4 billion at the 2007 energy intensity level would require a 120 percent energy supply increase.[4] And to provide such a massive increase in the energy supply would require substantially higher energy imports as well as tremendous investment in the infrastructure for domestic west-east transfers of domestic energy resources.

The reduction of energy intensity has been embraced as the primary means of overcoming this obstacle and is considered of national strategic importance. Premier Wen Jiabao described the energy intensity reduction target as "of vital importance" to achieving efficient economic

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[1] For an overview of these policies, see (Levine, Zhou and Price 2009).
[2] (State Council 2006b)
[3] (President Hu 2007)
[4] APERC estimate based on data from (NBS 2008b) and (NBS 2008a). CNY31,000 represents a quadrupling of income, measured in real CNY with 2000 as the base year.

growth, and recent policies characterize it as the most important feature of China's emerging approach to energy security.[5]

Environmental Protection

Social, economic and environmental problems posed by greenhouse gas emissions have attracted the attention of the world community. As one of the world's largest and fastest growing emitters, China is often at the centre of international debates on global warming. Also, China's domestic pollution has been identified as a serious threat to public health and local ecosystems.[6] Slowing energy growth and eliminating inefficient and heavily-polluting energy users are the cornerstones of China's approach to addressing these problems.

The period of 2002 to 2007 saw China's rapid economic growth surpassed by growth in total energy consumption. In 2007, total energy consumption reached 2.66 billion tce (+74 percent over 2002) and GDP exceeded CNY25 trillion (+69 percent over 2002 in real terms).[7] The growing share of coal in China's energy mix means the greenhouse gas elasticity of GDP is actually larger than that of energy. The share of coal in total energy consumption increased from 71.0 percent in 2000 to 72.8 percent in 2007.[8] The resulting rapid climb of China's greenhouse gas emissions has attracted the close attention of the other APEC economies.

If it is assumed that energy intensity and the fuel mix would otherwise have remained near their 2005 values, then achieving the same economic growth while reducing energy intensity by 20 percent also reduces greenhouse gas emissions to 20 percent below the business-as-usual level. According to the latest figures reported by the Chinese government, from 2005 through 2008 energy intensity was reduced by 10 percent, equivalent to about 700 million tonnes per year of avoided carbon dioxide emissions.[9] Emissions of local and regional air pollutants have also been avoided, but here the impact is more difficult to quantify because of simultaneous efforts to deploy pollution control equipment, such as flue gas desulfurization units.

Long-Term Economic Growth

Since 1978, the development strategy of China has been to catch up with the world powers, which has been interpreted as rapid growth of total aggregate GDP. Accordingly, growth has been characterized by simple, unrestrained duplication of productive capacity, which has indeed achieved rapid growth but at the price of similarly rapid resource consumption and environmental damage.[10] In 2006, China's leadership embraced the objective of building a sustainable and harmonious society.[11] The proposed 20 percent reduction target affirms the Chinese government's resolution to depart from a resource-intensive growth trajectory, and it tests the viability of the alternative path that the government has set forth. The successful implementation of the energy intensity reduction policy would give credibility to the leadership's vision for sustainable development.

The energy intensity target is not a perfect measure for tracking progress toward energy security, environmental protection, and economic stability, but it allows all these objectives to be pursued under one common banner. As a new constraint index, the target has raised some doubts, particularly with regard to the absence of a scientific basis and the practicality of targeting a large reduction of energy intensity in the midst of industrialization. However,

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[5] (Premier Wen 2007) and (State Council 2006c)

[6] (World Bank 2007)

[7] Comparison based on data from (NBS 2008b), (NBS 2008a) and (NBS 2009).

[8] (NBS 2008a)

[9] Savings are estimated relative to a frozen energy-intensity baseline. Progress toward the energy intensity target from (NBS 2009) and (NBS 2008a). Baseline CO2 emissions from (APERC forthcoming).

[10] (President Hu 2007)

[11] (CPCCC 2006)

the aggressiveness of the target appears not to arise from a lack of understanding of how challenging it is, but rather from the motivating forces of energy security, environmental protection, and economic sustainability.

The Emergence of a New National Energy Conservation Policy

During the 1980s and 1990s, China's energy efficiency and conservation polices contributed to a considerable decline in energy intensity. And yet, those policies did not hold the key position in China's development plan that they have now been given. As we wrote in the first phase of the China project:

> Officially given equal status alongside supply enhancement, conservation policies have helped China realize dramatic energy intensity and efficiency gains through the reform period. Central conservation policies though have sometimes struggled to keep pace alongside rapid investment-driven supply expansion in a growing economy.[12]

From the 6th Five-Year Plan (1981–1985) to the 10th Five-Year Plan (2000–2005), Chinese energy efficiency and conservation (EE&C) policies were one part of a grand development policy. In that position, their importance depended upon how well they complemented energy security, the latter being required for the attainment of the key objective—economy growth. In August 2006, the general office of the State Council issued its "Decision of the State Council on Strengthening Energy Conservation Work", which stated, for the first time, that the Chinese government would put EE&C at the heart of China's energy policy.[13]

Implementation of the National Energy Conservation Policy

A key feature of the Chinese government's implementation of the 20 percent target is the creation of complementary regional targets. In other words, assigning shares of the total energy conservation target to regions and districts is the primary strategy to ensure the implementation of the policy. However, the national government has not simply set goals and then left the regions to devise their own strategies. The national government has introduced administrative, legal and economic tools to facilitate the regional efforts. The provinces, with these tools and additional measures each province may define, have developed their implementation plans.

Administrative Means

As might be expected in a centrally planned economy like China, some of the most potent tools that are being used to carry out the energy conservation agenda are top-down regulations and programs. Among such measures, there has been a major focus on eliminating "backward" (meaning outdated and inefficient) productive capacity (see Table 2). Beginning in 2004, a new phase of industrial development began, in which energy saving and emission reduction are key objectives. Unlike previous expansions that at best added more efficient processes and at worst duplicated inefficient methods, this new development targets the displacement of backward capacity with new, more efficient capacity.

[12] (APERC 2008), p.9
[13] (State Council 2006c)

Table 2: Sample of policies to eliminate backward capacity

Title; Issuing Agency (issue date)	Key Issues
Opinion on Clearing and Standardizing Coke Industry; NDRC, MOF, MLR, MC, SAIC, EPA, BSC, SERC, etc... (2004.6.29)	Nine ministries and commissions promulgated this joint notice with the intent to efficiently use rare resources and reduce pollution. The recommendations are to limit the disorderly development of the coke industry, strictly implement market access management in the coke industry, retrofit coke furnaces for energy conservation and environmental protection, and control production volumes.
Provisional Regulations of Promoting Industrial Structural Adjustment; State Council (2005.12.2)	Together with the "Guidance Directory for Industrial Restructuring", this policy specifies the objective, principles, and key points of industrial restructuring at present and in the future. Additional policies and measures have been adopted in support: for example, imported items included in encouraged investment projects will be exempted from import duty and import VAT; for products or technologies included in restricted categories, investment management departments will provide no support, financial organizations will provide no loans, and planning departments will not grant permits; for items listed as eliminated, enterprises not eliminating those items as required within a specified period will be shut down by local government departments.
Coal Industry Development Policy; NDRC (2007.11.29)	Coal industry development policies are established on the basis of the Coal Law, Mineral Resources Law and "Several Suggestions to Promote the Chinese Coal Industry" promulgated by the State Council. These laws specify practices that are encouraged, restricted or forbidden, and cover development plans, industrial layout, industrial access, industrial organization, industrial technology, safe production, trade and transit, conservation and utilization, environmental protection, labour protection, and assurance measures. They also define measures for realizing development goals in the coal industry.
Steel Industry Development Policy; NDRC (2005.7)	Development Policies for the Iron and Steel Industry and "A Notice to Control Total Yield, Accelerate Backward Capacity Elimination and Promote Restructuring in the Iron and Steel Industry" express the goals of limiting total capacity of steel production to about 400 million tons, and eliminating backward iron and steel production capacity of 100 and 55 million tons, respectively, during the 11th Five-Year Plan.
Comprehensive Proposals for Energy Conservation and Emission Reduction; State Council (2007.6)	Promulgated in June 2007, this policy identified the following capacity for elimination during the 11th Five-Year Plan: electric power units (50 GW), construction materials (250 million tons of cement capacity and 30 million weight cases in glass capacity), and also capacity in the following industries aluminium electrolysis, iron alloy, calcium carbide, coke, coal, flat glass, alcohol, monosodium glutamate and citric acid. Elimination of inefficient capacity is expected to save 118 Mtce within that period.
Implementation Outcomes; NDRC (2007)	In 2007, the following capacity was eliminated: 14.38 GW of small thermal power units; 46.59 million tons of backward iron making capacity; 37.47 million tons of backward steelmaking capacity; 52 million tons of backward cement capacity; 15 million tons of backward small coke capacity; and 2,322 small coal mines.

Source: Policies and outcomes as reported in (IEEJ and ERI 2008)

A number of other top-down administrative measures have been taken, ranging from broad, multi-industry benchmarking regulations to equipment-specific efficiency mandates. Many of these measures rely heavily on the provinces for implementation. And thus, even when formulated and issued by the highest levels of the national government, implementation may begin only after a local, district office designs a plan of action with a local enterprise. In such cases, the assignment of a share of the national energy-saving target provides the motivation, and the centrally-issued rule provides the mechanism for delivering energy savings (see Table 3).

Table 3: Recent administrative programs and regulations to reduce energy consumption

Title; Issuing Agency	Key Issues
Ten Key Energy Saving Projects in the Medium- and Long-term Plan of Energy Conservation; NDRC	The 10 key conservation projects include: upgrading boilers, kilns and motors; adding district heating; fuel switching; use of exhaust heat and pressure in iron and steel; conservation in buildings; conservation in government; and high-efficiency lighting. This plan also calls for improved technical assistance centres in provinces and major industries, and optimizing industrial energy systems.
1000-Enterprise Implementation Plan Of Energy Conservation Action; NDRC	The objectives of this program are to bring the energy use efficiency of the top 1000 industrial energy consumers to the advanced level in China, raise some to the best international level, and save 100 million standard tons of coal. The 1000 enterprises are required to form energy management teams, measure and report energy consumption, prepare energy conservation plans and submit these to the provincial government, fund retrofits, develop energy-saving incentive programs, and carry out education campaigns.
Energy Efficiency Benchmarking of Key Energy-Consuming Enterprises; NDRC	This policy directs key energy-consuming enterprises to analyse their energy efficiency relative to that of advanced domestic and foreign enterprises, then to use the result of this analysis to design and implement measures that will achieve higher efficiency. Industry associations are expected to collect and organize the required data.
Further Strengthening Oil Saving And Power Saving Work; State Council	This regulation describes specific measures to be taken in the following areas: oil transportation, oil boilers, electric motors, electric air conditioners, electric lighting, and electric office equipment. It also requires improved management practices, including real-time online monitoring of all major power-consuming enterprises, and pricing policies favouring conservation.
Reinforce Energy Consumption Statistical System; NBS and NDRC	This plan calls for improved tracking of energy supply, circulation and consumption, to be informed by multiple methods in order to collect accurate data. Regional governments and enterprises are requested to implement systems appropriate for their needs, for the requirements for energy regulations, and for the statistical needs of the national government. Specific reporting methods and frequencies are described for various energy businesses and energy consumers.

Sources: (NDRC 2004), (NDRC 2006a), (NDRC 2007b), (State Council 2008b), (NBS and NDRC 2007)

Legal Means

The administrative offices have been the most active in setting the energy efficiency and conservation agenda in China, but in pursuit of that agenda the government uses a combination of political, legal and economic tools. Since issuing the amended Energy Conservation Law on 28 October 2007 (outlined in Appendix G), China has used an increasingly legalistic approach to pushing forward energy efficiency and conservation. Often, an administrative requirement is given legal enforceability under existing legislation such as the Energy Conservation Law.

One example of this growing use of legal means is provided by the Energy Conservation Regulation for Civil Buildings. This regulation, issued by the State Council in 2008, requires a number of actions to be taken in the pursuit of energy efficiency in buildings using a wide range of parties, including government offices, builders and developers, and building owners.[14] A central feature of the regulation is the requirement that these parties abide by building energy standards, and non-compliance is stated to be punishable under applicable laws. In this case, the Energy Conservation Law gives the government the authority to develop building energy standards and to punish violators.[15] The scope addressed by the revised Energy Conservation Law and some of the key issues are presented in Table 4.

[14] (State Council 2008a)
[15] (NPC 2007)

Table 4: Coverage of the revised energy efficiency and conservation law

Domain	Key Issues
Institutions	· Include EE&C work in development plans. · Include EE&C as a criterion in the reward system for personnel. · Review energy impacts of fixed assets investment projects. · Departments of the State Council are responsible for national energy conservation. · Local government departments are responsible for EE&C within their jurisdiction. · State-funded institutions will be leaders in EE&C implementation.
Regulations and Standards	Relevant State Council Departments shall collaborate with the department of standards to develop EE&E standards. Requires: · Mandatory energy conservation standards for the construction sector · Mandatory energy efficiency standards for products, equipment and processes · Policies for energy conservation in major energy-consuming industries · Mandatory and voluntary product labelling · Fuel efficiency standards for commercial transport · Prohibits enterprises from providing energy at a fixed fee. · Prohibits power plants that are not compliant with State rules.
Energy Consumption Monitoring	· Statistics departments at all government levels are to develop improved energy statistics systems. · Key energy-consuming entities must contract energy managers and provide annual reports on EE&C activities. · Central heat will be measured and fees charged.
Enforcement	· All governments are asked to strengthen supervision of EE&C and to "penalize illegal acts of energy use according to law". · Departments in charge of construction must enforce energy standards. · All entities and individuals are given the right to report energy waste.
Financial	· Governments are to provide funds for research, development, demonstration, and popularization. · Preferential tax and credit policies will be implemented to encourage EE&C. · Pricing policy will be conducive to EE&C. · Specific legal liabilities are set forth for violations of the various articles.

Sources: (NPC 2007)

Economic Means

China has introduced four types of economic tools to promote energy efficiency and conservation: financial, tax, pricing, and government procurement. Financial tools include direct funding of energy efficiency projects in industry and buildings, subsidized loans, and loan and credit guarantees. Access to financing may be provided by central or provincial governments (Figure 2). How these funds are budgeted varies, but both central and local government funds are engaged. As one example, the Ministry of Construction's interpretation of the regulation to improve energy conservation management in government offices and large public buildings calls for the application of both "central finance funds" and funds from "governments at all levels".[16] Government funds are also provided to help eliminate backward production capacity, for research and development, and to subsidize high-efficiency products.

[16] (MOF 2007)

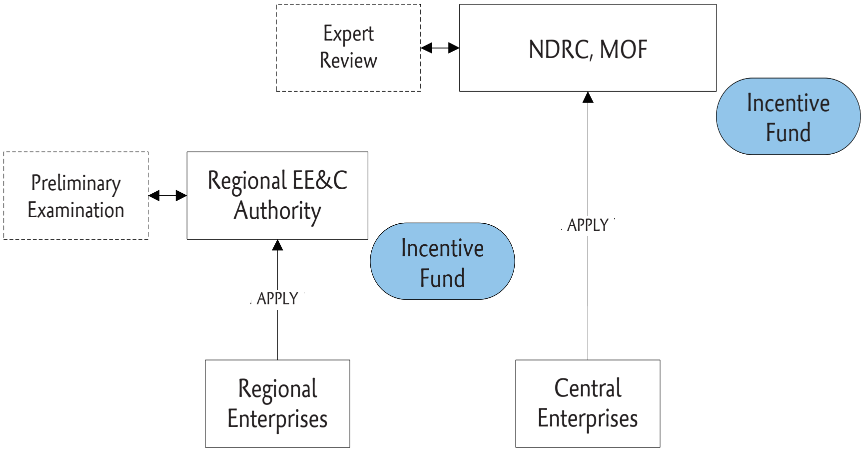

Figure 2: Financial incentives to apply energy saving technologies, process diagram
Source: (IEEJ and ERI 2009)

Some previous studies have questioned the adequacy of government funding levels.[17] However, a recent major spending package allocated CNY210 billion to energy conservation, emissions reduction and environmental protection, suggesting that greater attention is being given to these areas.[18] Efforts are also being made to attract more sources of funding by introducing other finance mechanisms, such as energy management contracting.

Tax incentives for energy efficiency and conservation cover the full spectrum of private enterprise taxation. The government offers reduced value added tax (VAT) rates, sales tax rates, and income tax rates.[19] R&D costs may be deducted from pre-tax income, and purchases of energy efficient equipment may qualify for accelerated depreciation or investment tax credits.[20] Export tax rebates and fuel taxes may also be favourably adjusted for companies using energy efficient production methods.[21] Importantly, the 2007 amendment to the Energy Conservation Law added a new chapter to outline incentive measures that encourage energy efficiency and conservation.[22]

The updated Energy Conservation Law also provides a legal basis for energy pricing reforms to engage market forces in the pursuit of efficiency and conservation.[23] Specific price policies are described in detail in administrative measures. For example, the State Council has instructed regions to implement differential electricity prices for eight high energy consumption industries, wherein enterprises using inefficient technologies that are listed for "elimination" or "restriction" will face higher electricity prices.[24] On the other side of the meter, a 2007 rule intends to reduce the prices paid to small thermal generators for their output.[25] In spite of these and other price reforms, it remains true that many energy consumers do not pay the market price of supplying that energy, which tends to discourage energy efficiency and conservation.

Since adoption of the energy intensity reduction target in the 11th Five-Year Plan, the Chinese government has placed greater emphasis on these economic tools. This has been

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[17] (IEEJ and ERI 2009)
[18] (Wang and Zhang 2009)
[19] (Wang and Zhang 2009)
[20] (MOF and SAT 1999)
[21] (MOF and SAT 1994)
[22] (NPC 2007), Chapter V
[23] (NPC 2007), Article 66
[24] (State Council 2006a)
[25] (NDRC 2007a)

reflected in budget increases and the more frequent use of taxation and pricing levers. Government procurement of energy efficient products was mandated to expand from central and provincial government purchases in 2005 to all government levels in 2007.[26] Also in 2007, from the central budget, CNY23.7 billion was allotted for energy efficiency and conservation: CNY7 billion for incentive funds, CNY2 billion for phasing out backward production capacity, CNY3 billion for energy statistics and supervision, and the remainder for other activities.[27]

As mentioned above, central government funds are complemented by local sources. Every province is required to establish an energy efficiency and conservation fund from the local budget.[28] Shanxi (the largest coal producing province) established a CNY1 billion fund, Shandong (a coastal, industrial province) a CNY300 million fund, Yunan (a south-western province) a CNY200 million fund, and Jiangsu (a south-eastern province) a CNY100 million fund, etc.[29]

Assignment of Regional Targets

The most important feature of China's strategy to improve energy intensity is the creation of a chain of responsibility that reaches all the way from the single national target down to the shares of the target that must be achieved at the local level. In this manner, an enormous challenge that is difficult to resolve is broken down into smaller, more-specific and therefore more-manageable targets. However, the success of this strategy depends on the ability to transfer reliable information both up and down the chain of responsibility in a timely manner. Historically, more than a year might have been required to transmit policy information from the national level to the local level. The formulation of the local targets provides some insight into how this communication is now operating. The following table outlines the procedure to assign the local targets.

Table 5: Process of target decomposition

STEP 1	National Target Set (October 2005): The reduction of energy consumption per unit GDP (i.e. energy intensity) by 20 percent, relative to 2005, was proposed as a national objective for the 11th FYP period by the leadership of the Communist Party of China.
STEP 2	Target Definition (March 2006): The outline of the 11th FYP listed energy intensity and eight pollutant emissions reduction targets, specified that the target would be legally binding and included a regional and sectoral comprehensive performance evaluation system.
STEP 3	Decomposition System Establishing (August 2006): "The Decision of the State Council On Strengthening Energy Conservation Work" set forth a plan for realizing the target by dividing it among provinces. Participating departments were specified and the method of evaluating progress defined so as to be clear to all relevant organizations, public and private.
STEP 4	Central-Regional Negotiations (March -September 2006): After the national target was announced, many provinces moved to define their own targets. If the provincial target was compliant with the national target, then it was confirmed by the NRDC as the legally binding commitments. The NDRC then negotiated with the remainder of provinces that did not propose targets or proposed a target below the national 20% target to set an acceptable figure.
STEP 5	Final Decomposition (September 2006): Once agreement with the central government was achieved, the designated provincial targets were further broken down to cities, towns, relevant industries and key enterprises.

By the end of 2006, 21 provinces had adopted the national target of 20 percent, four provinces had set higher targets (22 to 30 percent), and six provinces had set lower targets (12 to 17 percent).[30] This assignment of the national target to regions was in itself an important

26 (MOF and NDRC 2004)
27 (Yu 2008)
28 (NDRC 2007c)
29 (Yu 2008)
30 (State Council 2006b)

implementation success as it created the first link in a chain of responsibility. However, because regional targets were first proposed by the regional government and then sent to the central government for approval, some regions did not adequately assessed their potential, and therefore offered a target higher than what they later found realistic to achieve. For example, Shanxi and Neimenggu subsequently reduced their targets from 25 to 22 percent and Jilin from 30 to 22 percent.[31]

Success has been reported toward achievement of the final provincial goals. According to the comprehensive evaluation of target realization conducted in 2008:

- Beijing, Tianjin, Liaoning, Shanghai, Jiangsu, and Shandong were surpassing their targets.
- Jilin, Zhejiang, Anhui, Fujian, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Yunnan, Shanxi, Gansu, Qinghai, Heilongjiang, Jiangxi, Henan were achieving their targets.
- And Hebei, Shanxi, Neimenggu, Hainan, Guizhou, Ningxia, Xinjiang were not meeting their targets.[32]

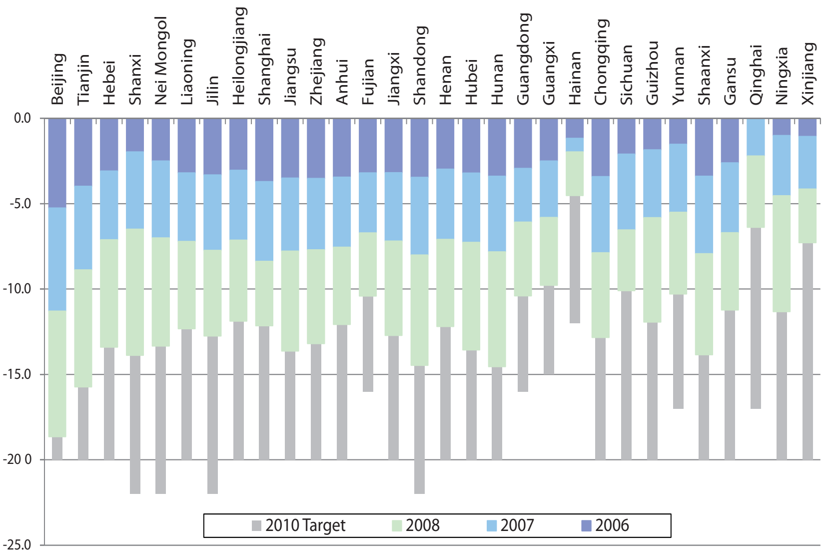

Figure 3: Progress toward achieving provincial energy intensity targets (2006–2008)
Source: (IEEJ and ERI 2009), (NBS 2008c), and (NBS 2009)

Almost all levels of the government administration have set up an office for overseeing work toward the target requirement. To date, 37 provincial energy conservation centres have been established to supervise implementation. The centres are estimated to have a staff of 30 to 40 each.[33] Some of these centres predate the 11th Five-Year Plan, and have simply undertaken new responsibilities under the new policies (see Box 2). These centres have also been established in local governments. On a recent visit by APERC staff, the administration of the Tianjin Economic Development Area (TEDA) also reported having a specific office in charge of energy saving and emission reduction.[34]

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[31] Comparison based of targets presented in (IEEJ and ERI 2009) versus those in (State Council 2006b).
[32] (IEEJ and ERI 2009)
[33] (SECIDC 2009)
[34] (TEDA 2008)

Box 2: The Shanghai Energy Conservation Supervision Centre

This centre was the only one of its kind in the early 1970s, and has now become one of the most important in China. Regarding energy efficiency improvement policy, the centre was strengthened greatly in the last four years, though the government has stopped short of interfering directly in enterprise-level management. Major activities undertaken by the centre are the development and implementation of standards and regulations. The Shanghai Energy Conservation Supervision Centre oversees production quality of manufacturing enterprises and conducts on-site inspections of the use of energy-intensive manufacturing equipment.

Three important features of China's political economy are hinted at in the relatively rapid diffusion of energy efficiency and conservation targets throughout the economy. First, the institutional structure in China extends both laterally (that is, across provinces) and vertically (from the national to local level). Second, the central government has a close relationship with local governments. And third, the government maintains strong authority over firms, public and private. These important features that shape the implementation of the national energy efficiency and conservation policy are explored in the following sections.

Institutional Structure Supporting the Energy Conservation Agenda

Institutions are both developers and implementers of policy. The capacities and relationships of institutions therefore have a large bearing on the success of major initiatives, such as China's energy efficiency and conservation. In the last several years, the organizational leadership for energy efficiency and conservation has been strengthened considerably. In order to improve coordination among the various organizations that have a role in pursuing energy efficiency, a National Energy Leading Group was created in late May 2005. Subsequently, in June, a "Ministry-level Joint Conference System for Constructing an Energy Saving Society" was set up and an "Office for Constructing an Energy Saving Society" was opened under the National Development and Reform Commission. In June 2007, energy saving and emission reduction was taken up by a "National Leading Group to Address Climate Change and Energy Conservation and Pollutant Discharge Reduction", a group headed by Premier Wen Jiabao.[35]

The rapid creation of such high-level groups to address energy conservation suggests that the energy conservation policy is high on the list of the leadership's priorities. However, it has also led to some confusion as to lines of authority and responsibility.[36] In this report, we focus on the institutions engaged in making, reviewing and implementing China's energy efficiency and conservation policies. Specifically, we will identify the institutions that exist to enforce implementation of the 11th Five-Year Plan's 20 percent reduction target, which of those institutions hold the greatest authority, and the relationships that link such institutions with each other and with enterprises.

Institutions Responsible for Energy Efficiency and Conservation

The Chinese National People's Congress (NPC) is the highest organ of state power in the People's Republic of China. As such, it is the chief policy-making organ. Its main functions and powers include creating laws, delegating authority, formulating policy, and supervising other governing organs. The NPC has the right to examine and approve the plan for national economic and social development and report on its implementation, and to examine and approve the state budget and report on its implementation.[37] Further, the NPC approves the establishment of provinces and decides on administrative systems to be instituted. It also

[35] (NDRC 2009) and (Xinhua News Agency 2008b)
[36] (Downs 2008)
[37] (IEEJ and ERI 2009)

exercises other functions and powers as the supreme state power. The outline of the 11th Five-Year Plan was approved at the 10th NPC and with it the 20 percent reduction target that now underlies China's drive for energy efficiency and conservation.[38]

The actual drafting and implementation of the Five-Year Plan for national economic and social development is tasked to the administrative organ of the government, the State Council. On issues of energy efficiency and conservation, the National Development and Reform Commission (NDRC) plays a crucial role in both the design and the execution of policy. The State Council has designated the NDRC as the lead agency in charge of completing all regulations necessary for achieving the 20 percent target and overseeing their implementation.[39]

The relationship between the State Council and the NDRC is bidirectional: the NDRC proposes regulations and the State Council examines and approves them (see Box 3). The departments of the NDRC include the Department of Resource Conservation and Environmental Protection, the Department of Climate Change, and the Department of Price. These and other departments of the NDRC share the task of formulating and implementing national energy efficiency and conservation policies.[40]

Box 3: The National Development and Reform Commission

The National Development and Reform Commission (NDRC) 国家发展和改革委员会 (Guójiā Fāzhǎn hé Gǎigé Wěiyuánhuì), formerly the State Planning Commission and State Development Planning Commission, is a macroeconomic management agency under the Chinese State Council, which has broad administrative and planning control over the Chinese economy. Since 2008, the Commission has been headed by Zhang Ping.

The NDRC's functions are to study and formulate policies for economic and social development, maintain the balance of economic development, and guide the restructuring of China's economic system. The NDRC has 28 functional departments, bureaus, and offices with an authorized staff of 890 civil servants.[41]

Implementing the 20 percent policy is an inter-disciplinary challenge that cannot be completed by any one administrative office. In 2008, a high-level coordinating body called the National Energy Commission (NEC) was created to coordinate the activities of the NDRC and other ministries.[42] Some of the key ministries collaborating with the NDRC in the implementation are the Ministry of Communications (MOC), the Ministry of Housing and Urban Rural Development (MOHURD, formerly the Ministry of Construction), the Ministry of Finance (MOF), and the Ministry of Science and Technology (MOST). Other agencies below the ministerial level also play important roles, including the General Administration of Quality Supervision, Inspection and Quarantine (GAQSIQ), the Certification Centre for Energy Conservation Product (CCECP), the State-owned Assets Supervision and Administration Commission of the State Council (SASAC), the Ministry of Industry and Information Technology (MIIT), and the State Environmental Protection Administration (SEPA).

Institutional Relationships

The typical process of the various central government institutions implementing an energy efficiency and conservation regulation is as follows. First, the NDRC drafts and proposes a regulation, either independently or jointly with another ministry. Second, the State Council

38 (Xinhua News Agency 2006)
39 (State Council 2006c)
40 (NDRC 2009)
41 (NDRC 2009)
42 (Downs 2008)

reviews and approves the regulation and forwards its decision to the relevant ministries and state agencies. Finally, the affected ministries and agencies formulate appropriate implementation plans, which are communicated to regional offices.

This basic process suggests some key dependencies in a successful implementation. First, this process requires several units within the NDRC to reach agreement on a policy that is compatible with the many objectives of the NDRC and is acceptable to the affected ministries. The relationship of the NDRC and the other main departments is a key component of energy efficiency and conservation policy implementation, especially the realization of the 20 percent target. Second, the follow-through must be assessed across both institutional and geographic boundaries. To be effective, national policies require provincial and local institutions to be willing and able to implement them. The case studies presented at the end of this chapter explore the implementation activities of two important local institutions.

Participation of Enterprises

The form of ownership of Chinese enterprises is an important factor in determining how the enterprises are involved in implementing energy efficiency and conservation policies. Two important criteria by which enterprise ownership in China may be differentiated are domestic vs. foreign ownership, and state vs. private ownership. Figure 4 below shows different types of enterprises, and their possible ownership arrangements. The group of enterprises referred to as "national enterprises" or SOEs (state-owned enterprises) is relatively small, only 138 companies, but some of these are quite large.[43] However, many more companies that are registered as joint stock or limited liability companies may include the government as a majority or minority owner. Similarly, a foreign investor, either an individual or enterprise, may have a majority or minority stake in such companies. Joint ventures, incorporated as limited liability companies, are a common way for foreign enterprises to participate in the Chinese economy.[44]

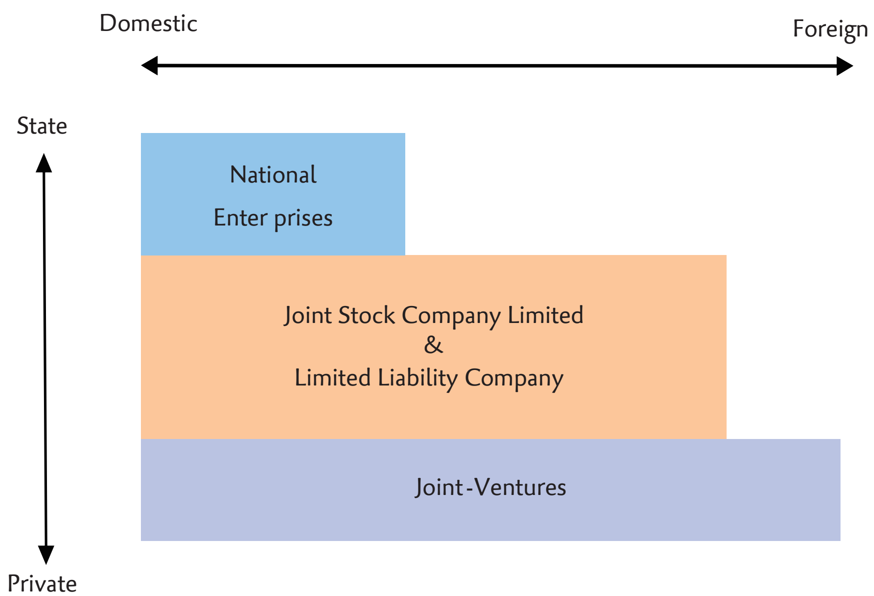


Figure 4: The spectrum of enterprise ownership

[43] (SASAC 2009)
[44] (NPC 2006) and (NPC 2005)

The way that energy efficiency and conservation regulations are implemented by company managers is influenced by the extent of private ownership. Among China's private enterprises, for example, those in Zhejiang province (south-eastern China) and Guangdong (southern China), it is common for owners to actively manage their company. For example, the Zhejiang Zhongnan Group, located in Hangzhou city (the capital of Zhejiang province), is a private enterprise that is well-known for designing and fabricating architectural materials. The owner is also the president and general manager. Having recognized the opportunity in the government's push for improved building energy performance, this company has begun to produce energy efficient building materials.[45]

According to data published by the State Administration for Industry and Commerce, by the end of 2008 there were 6.57 million private enterprises, representing 68 percent of the total of 9.71 million registered enterprises.[46] Certainly, not all of these companies have such direct owner involvement, nor are all so well-positioned to benefit from the enhanced energy efficiency and conservation regime. There are two additional types of government-industry relationships that have been successfully used in China to push for reduced energy intensity. Voluntary agreements in which government and industry agree to a reduction target and a cooperative plan of action have now been widely deployed under the Top-1000 Enterprise Program.[47] For medium-sized and small enterprises, energy intensity supervision is conducted by the district and street community. For example, the Binjiang district of Hangzhou Hi-Tech Industry Development Zone (HHTZ) overlooks the energy efficiency and emission reduction performance of companies in that district. In such cases, the threat of public condemnation in the local community for inadequate conservation efforts can be a powerful lever to encourage enterprise participation.[48]

For state-controlled enterprises, the government has more direct options for implementation and enforcement. The most important way to incorporate energy intensity reduction into the management objectives of state-owned enterprises is by including it as a metric in the annual personnel evaluations. The national enterprises are supervised by a specific organization, the State-owned Assets Supervision and Administration Commission (SASAC). According to SASAC's implementation plan, the commission has established "energy efficiency and emission reduction" as an important component of the annual evaluation of key personnel in the national enterprises.[49]

Measuring Progress on the Energy Conservation Agenda

As an ambitious target that engages all sectors of the economy in implementation, the energy intensity target poses a considerable enforcement challenge. Consequently, an extensive monitoring and evaluation program has been designed to provide frequent feedback on the performance of the various parties. This enables the government organs to identify problem areas and modify their implementation approach on an ongoing basis throughout the period of the 11th Five-Year Plan. The focus of this section of our report is to explain this evaluation program. First we describe the guiding principles of the evaluation, and then we discuss the evaluation process.

Guiding Principles

Since the outline of the 11th Five-Year Plan was issued in 2006, the reduction of energy intensity has been defined as a binding requirement. The State Council's public declaration

[45] (Zhejiang Zhongnan Group 2009)
[46] (MOCom 2009)
[47] (NDRC 2006a)
[48] (HHTZ 2009)
[49] (NDRC; NSB; SEPA 2007)

of specific provincial targets describes them as restrictive indicators with legal force, and directs that the targets be further broken down into those for cities, counties, industries and enterprises. It further called upon the National Bureau of Statistics (NBS) and NDRC to develop a clear evaluation system and to use that system to monitor and report on the progress of the provinces toward their targets.[50] Thus, from early on it was clearly the intent of the central government to strictly hold regional officials to account for energy efficiency and conservation performance.

The guiding principles for evaluation were subsequently described in the "Implementation Plan for the Evaluation System of Energy Consumption per Unit GDP" (hereafter the "Evaluation Plan"). The Evaluation Plan includes the criteria by which provinces and the key energy-consuming enterprises will be reviewed. The major scoring criteria are fulfilment of the annual energy conservation target (40 percent) and implementation of various conservation measures (60 percent).[51] Hence, without making progress toward the conservation target, a province or enterprise will not achieve a passing grade, but modest progress toward the target can be greatly supplemented by evidence that the recommended conservation measures have been implemented. The rewards and penalties associated with high and low performance are shown in Table 6.

Table 6: EE&C progress evaluation rewards and penalties

	High Performance	Low Performance
	(> 80 points)	(<60 points)
Province	Praise and reward	Barred from annual awards and honours; state approval of new, high energy-consuming projects withheld; must submit plan for improvement; possible punishment by supervision department.
Enterprise	Praise and reward	Criticism; barred from annual awards and honours; approval of new projects withheld; must submit plan for improvement; SOE managers will be answerable to SASAC.

Source: (NDRC 2007c)

Evaluation Process

In order to ensure rigorous and fact-based evaluations, the Evaluation Plan calls for self-appraisals of the covered entities to be complemented with reviews by oversight bodies. Thus, key energy-consuming enterprises must report on their progress to the responsible departments of the provincial governments, which gather a team of experts to review and report on the enterprises' work. Similarly, the provinces report on their progress to the State Council and NDRC, and the NDRC will then form an expert team to check the provinces' progress.[52] Thus, before the provincial and enterprise achievements are aggregated to assess the overall progress toward the national goal, the achievement reports have undergone at least one external review.

Regional governments are responsible for developing their own evaluation system for measuring the progress of the cities, counties, industries and enterprises in their jurisdiction. For example, in its 2008 implementation plan, the City of Hangzhou, in Zhejiang province, assigns responsibility for achieving a 4.4 percent reduction of energy intensity to several districts and counties. Then, referring to Zhejiang's evaluation policy, the plan designates energy conservation as a criterion for the performance evaluation of those units. Responsibility for gathering the data needed for evaluation of both small and large energy-using enterprises

[50] (State Council 2006b)
[51] (NDRC 2007c). See Appendix E for the full scoring table.
[52] (NDRC 2007c)

is assigned to the Trade and Economy Bureau and Municipal Economic Committee of the district and county governments.[53] This shows the process whereby a city government responds to the responsibility of a provincial target and evaluation plan by dividing that responsibility among the counties and districts in its jurisdiction and requiring them to supply data to show progress.

As required by the State Council, a 2008 midterm implementation assessment was carried out with the oversight of the NDRC. For this assessment, expert evaluation teams were sent to all the provinces to assess the work on energy efficiency and conservation. The provinces' actual energy conservation was estimated, and the implementation of legal, administrative, economic, and capacity-building measures was recorded.[54] The full results of this comprehensive assessment are discussed at length in Chapter 2.

Implications

Energy efficiency and conservation are at the heart of China's new energy agenda, and the Chinese government has invested unprecedented political will in delivering on this agenda. In doing so, the leadership is motivated by energy security, environmental protection, and economic sustainability.

Establishment of the 20 percent national target is an important political resolution. The use of corresponding regional targets in pursuit of the national goal reflects the central government's awareness of the differing social and economic conditions in China. The final regional targets are the result of negotiations between the central government and regional governments.

Assignment of regional energy intensity targets is a new implementation approach, and it is possible that the government has been "feeling its way across the river". This has resulted, for example, in the re-evaluation of several provincial targets.

For the Chinese government, the energy intensity reduction target of the 11th Five-Year Plan represents not just a near-term target but also the opportunity to establish a culture of energy efficiency and conservation that will endure far into the future. Seen in this light, meeting the plan's 20 percent target is an important objective but only one measure of success.

To some extent, China's typical institutional structure is able to promote the current policy's implementation. This structure has evolved to accommodate the disaggregation of policies to convert high-level objectives into bottom-up implementation.

Though communication and working relationships are strong among all levels of organizations, China lacks a single organization that can completely carry out the nation's energy efficiency and conservation endeavours. This situation is sometimes an obstacle to effective implementation.

To dramatically reduce the energy intensity of the entire Chinese economy requires the participation of both state-owned enterprises and the large and growing private sector. However, private enterprises naturally prioritize their own market competitiveness and profitability. Thus far, incentives for voluntary participation and only partial use of energy price as an implementation tool have limited contributions from the private sector.

[53] (Hangzhou City 2008)
[54] (IEEJ and ERI 2009)

Case Study: The Hangzhou High-Tech Zone and the Tianjin Economic-Technological Development Area

The Hangzhou High Technology Industry Development Zone (HHTZ) was established in 1990 and received approval as a base state-level SEZ for the electronics industry, culture, and education in March 1991. HHTZ is focusing on developing microelectronic and information technologies, biomedicine, new materials, optical-mechanical-electrical integration and computer applications by hosting private start-up businesses. HHTZ is jointly managed by the municipal government and provincial government with the former playing a dominant role in the administration. The Administration Commission of Hangzhou High-Tech Industry Development Zone is responsible for local administration. The Commission provides "one-stop-service" for enterprises, and all business-related issues can be dealt with in one office hall.

HHTZ is not only dedicated to the transfer of high technologies and commercialisation, industrialisation and internationalisation of scientific technological achievements, but also has an important impact on local economic development. HHTZ is called a "Paradise Silicon Valley" and has the highest profit per employee index among SEZ's in China. The SEZ is designed specifically to host non-energy-intensive industries that produce high value added products. Thus, since the inception of the industrial estate, three government-owned chemical companies previously located within the zone were required to relocate to other areas.

One of the country's first state-classified development areas, the Tianjin Economic and Technological Development Area (TEDA) was established in 1984. It is home to four pillar industries: electronics and communications, biotechnology and pharmaceuticals, machinery manufacturing, and food and beverages. TEDA is one of the top performing development areas of its kind in the country, according to the Ministry of Commerce's annual evaluations of overall economic strength, infrastructure development, operating cost, human resources support, environment and technological innovation. Its administration and public utilities services are ISO9000 certified, and TEDA has become northern China's centre for manufacturing and a base for high-tech commercialisation.

TEDA mainly focuses on the markets of northern China. TEDA's investors benefit greatly from the local low-cost supply chain, proximity of educational and research centres, and good access to transportation. The Tianjin logistics hub provides connections to the railway grid, the largest international trading port in northern China, and an international airport.

SEZs as a Factor in Improving Energy Intensity

The HHTZ authority explained that companies under its jurisdiction are required to achieve energy efficiency comparable to the top international performance of similar industries. The central government's target for the Zhejiang province ? a 20 percent energy intensity reduction for the 2006-2010 time frame ? is distributed over the province, and hence HHTZ has a corresponding target. Subsidies for energy savings are available under the current Energy Conservation Law and other legislation, and companies are to make their decisions on energy efficiency investments based on cost-revenue competitiveness analysis.

The HHTZ administration has a special policy on decreasing the energy intensity of the zone's value added. The approach includes restructuring a few companies and facilitates the development of IT industries. In order to keep energy intensity low, the HHTZ administration has introduced, for new businesses, requirements for low energy consumption, high value added, and natural resource preservation. For example, in April 2009, new manufacturing operations in HHTZ began producing PV panels, further improving the image of HHTZ as locus of research and development, business opportunity, and IT and electronics synergy. However, the energy-intensive process of producing raw semiconductors for PV modules is required to be conducted outside of HHTZ, in "less-developed areas of China", leaving all the related external costs and burdens out of the HHTZ geography and accounting. According to the HHTZ administration, in two years, seven enterprises will either move out of HHTZ or will transform their major technologies.

The HHTZ administration's efforts to improve energy intensity within HHTZ include publicity campaigns to explain the environmental advantages of using energy-saving equipment and facilities, thus teaching and persuading the people and businesses about their social responsibility. The HHTZ administration has no mechanisms for adjusting energy prices. However, enterprises are free to choose operating hours to minimise operation costs, as electricity tariffs at night are nearly 50 percent less than the daytime level.

TEDA has the target of reducing energy intensity by 20 percent during the 2006-2010 period, despite the fact that its current absolute energy intensity level is about one-fifth that of China overall. The infrastructure development gives the TEDA administration the ability to independently control energy utilities and set prices. Beginning in 1984, several companies were established to handle energy and utility services in TEDA, such as water, electricity, gas, and heat supply. Electricity prices are set by TEDA itself through its own wholesale and distribution entities, and though electricity prices are higher than in neighbouring areas, high-quality service is guaranteed for consumers. TEDA's energy efficiency office opened as a separate formal entity in 2007, after a regulatory framework was created that allows the administration to judge investment proposals on the basis of energy intensity.

Industry accounts for 70 to 80 percent of the electricity consumption in TEDA. A policy of a 30 to 50 percent subsidy from the central government for investment in energy efficiency improvement was adopted in 2007. This incentive is a factor when TEDA's investment bureau considers new projects. New investment proposals are audited to control the profile of new energy demand. If a particular incoming industry is too energy intensive, it might be recommended that the TEDA investment bureau not accept that new investment. The administration's preference for low energy intensity and NRE, together with the availability of numerous financial incentives, has led to the recent rapid growth in TEDA of equipment manufacturing for the wind energy sector.

The administration is making use of several opportunities to reduce energy intensity within TEDA. Energy consumption by industrial facilities and office buildings has generally been considered after construction is completed, but this is changing now in an attempt to anticipate, during the planning stage, various performance measures. Building efficiency data is currently being collected for Tianjin in order to compare TEDA building energy use with other domestic and foreign levels. TEDA uses energy efficient street lighting, such as in an LED demonstration project. Important events in connection with the public relations, information sharing and capacity building in TEDA include compulsory annual reports on energy efficiency (not optional as before), and the development of an information education and service centre.

Case Study Sources: (HHTZ 2009), (HHTZ 2008), (TEDA 2008), and (TEDA n.d.)

Defining the Geographies

To attain the long-term objective of reducing the energy intensity of its economy, China must engage a large and diverse group of players in the process of policy implementation. The primary objective of this study is to understand how these actors have thus far responded to the central government's energy efficiency policies. Each player operates in a specific context, and the word "geographies" is used to describe this context, including the physical location, economic position, administrative regime, and so on. Such geographies can be specified at various layers, and diversity is present in all of these layers. In addition to aiding our understanding of the players, geographies provide a framework for interpreting the similarities and differences among implementation measures and outcomes.

In 2006, 31 provinces in China began work toward achieving energy intensity reduction targets, as ordered by the State Council. However, after three years of implementation efforts, these provinces differ dramatically in their energy efficiency improvements. Understanding these differences and some of their underlying causes may improve future performance. This chapter will describe a framework for cataloguing China's geographies of energy efficiency, review the considerable diversity present in these geographies, and identify several important layers of geographies that are focused on in subsequent chapters. This chapter is divided into three sections that address the following issues:

1. The first section identifies the energy efficiency geographies of China. Special attention is given to describing the variations that are found in a few key layers.
2. The second section describes the policy requirements for the key layers. By linking policy goals to the geographies, this section provides the context necessary for evaluating how national policies are acted on at the local level.
3. With several important layers of geographies and the national policy goals that are applied within them described, the third section turns to uncovering the important factors that cause distinct geographies of the same layer to have very different targets and outcomes.

Identifying China's Geographies of Energy Efficiency

Though there are many possible ways to catalogue the players of energy efficiency implementation, our approach is to classify according to the region, the economic sector, and the type of company. Each of these attributes has multiple possible values. As such, geographies can be specified as a vector of these attributes, including vectors with one or more attributes left unspecified. The table below shows a sample of possible attribute values. From these values it is possible to construct multiple vectors to represent multiple geographies. For example, "Province—Manufacturing—State-owned" describes one type of geography; and "District—Manufacturing" describes another.

Table 7: A vector definition of geographies

Attribute	Possible Values
Region	Province; Municipality; District; and County
Sector	Power; Residential & Commercial; Manufacturing; and Heavy Industry
Firm Characteristics	State-Owned; Private, Domestic-Owned; and Foreign-Owned

Using just the sample of attribute values provided in the table above it would be possible to specify 100 distinct geographies. However, not all of these are important for the understanding of implementation behaviour. The most important energy efficiency geographies in China are identified by considering the measures and the outcomes of the recent energy efficiency and conservation endeavours. A review of recent regulatory measures reveals which geographies have been used to target energy efficiency implementation. Similarly, reviewing the variation of outcomes shows which geographies indicate important differences that have influenced implementation.

Regions: Provincial Targets

China's provinces have all been assigned a share of the national 20 percent energy intensity reduction target. The difference in these energy intensity improvement targets is extensive, ranging from 12 percent for Hainan province (Southern China) to 30 percent for Inner Mongolia (Northern China).[1] In their efforts to achieve their respective targets, the regions have pursued various measures.

A recent investigation by the NDRC revealed considerable variation among the provinces and independent cities in the measures that they have put in place. A total of 18 measures were found to have been employed by the 31 provinces.[2] However, not all of the measures have been implemented by every province. For example, five of 31 provinces—Beijing, Neimenggu, Henan, Guizhou and Sichuan—have yet to establish energy intensity statistics, audits and monitoring systems. And six regions—Shanxi, Gansu, Xinjiang, Henan, Guangxi and Heilongjiang—have not created programs for Energy Evaluation of Fixed Assets Investment Projects (see Table 8).[3]

Among the 18 measures, one of the most challenging to implement appears to be to create an Energy-Saving Reward System. This measure involves creating a system to recognize individuals that make outstanding contributions to energy conservation, and to reward those top performers with prizes, such as salary bonuses.[4] At the time of the review, nine of the 31 provinces had either not created such a system or it was not possible to determine if they had or had not.[5] It is interesting that the capital of China, Beijing, had not yet established the reward system.

[1] State Council (2006); The target for Inner Mongolia was later reduced to 22 percent ERI and IEEJ (2009)
[2] Here, as elsewhere in the document, autonomous regions, and the municipalities directly under the national government are included under the heading of "provinces".
[3] ERI and IEEJ (2009)
[4] (State Council 2006b)
[5] (IEEJ and ERI 2009)

Table 8: Evaluation of measures implemented by the provinces

	Beijing	Tianjin	Shanxi	Gansu	Xinjiang	Hebei	Nei Mongol	Zhejiang	Anhui	Liaoning	Shandong	Henan	Hubei	Hunan	Guangxi
Administrative Measures															
Treaty on Responsibility of Energy-Saving Target	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Statistics, Audit and Monitoring	n	y	y	y	y	y	n	y	y	y	y	n	y	y	y
Energy Evaluation of Fixed Assets Investment Projects	y	y	n	n	n	y	y	y	y	y	y	n	y	y	n
Eliminating Backward Productive Capacity	y	y	y	y	y	y	y	y	y	y	y	y	n	y	y
Laws & Regulations															
Implement Mandatory Standards for Building Energy Saving	y	y	y	y	y	y	n	y	y	y	y	y	y	n	y
Implement Standards for Energy Intensive Products	y			y	y	n	y	n		y	y	n	y	y	
Issue of Energy Conservation Law (2007) and Regulations	y			y	y	y		y	y	y	y	y	y	y	y
Economic Measures															
Energy-Saving Funds	y	y	y	y	y	y	y	y	y	y	y	n	y	y	y
Energy-Saving Reward System	n			n	y	n		y		n	y	y	y	y	y
Key Energy-Saving Projects	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Energy-Saving Mangement in Key Enterprises and Sectors	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Promote Energy-Saving Products & Technology	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Capacity Building															
The Establishment of the Coordination of Energy-Saving	n	y	y	y	y	y	y	y	y	y	y	y	y	y	y
EE&C Supervision Organization	y	n	y	y	y	y	y	y	y	y	y	n	y	n	n
Complete Energy Auditing System	y	y	y	n	y	y	y	y	n	y	y	y	y	y	y
Energy Measurment Apparatus	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
EE&C Promotion and Training Work	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y

	Guizhou	Jiangsu	Shaanxi	Shanghai	Chongqin	Jilin	Heilongjiang	Hainan	Sichuan	Yunnan	Guangdong	Fujian	Jiangxi	Ningxia	Qinghai
Administrative Measures															
Treaty on Responsibility of Energy-Saving Target	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Statistics, Audit and Monitoring	n	y	y	y	y	y	y	y	n	y	y	y	y	y	y
Energy Evaluation of Fixed Assets Investment Projects	y	y	y	y	y	y	n	y	y	y	y	y	y	y	y
Eliminating Backward Productive Capacity	y	y	y	y	y	y	y	y	y	y	n	y	y	y	y
Laws & Regulations															
Implement Mandatory Standards for Building Energy Saving	n	y	y	y	y	y	y	y	y	y	y	y	n	y	y
Implement Standards for Energy Intensive Products	y	y	y	y	y	y	y	y	n	y	n	y	y	y	y
Issue of Energy Conservation Law (2007) and Regulations	y	y	y	y	n	y	y	y	y	y	n	y	y	y	y
Economic Measures															
Energy-Saving Funds	y	y	y	y	y	y	y	n	y	n	y	y	n	y	y
Energy-Saving Reward System	y	y	y	y	y	y	y	y	y	y	y	y	y	n	y
Key Energy-Saving Projects	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Energy-Saving Mangement in Key Enterprises and Sectors	y	y	y	y	y	y	y	y	y	y	y	y	y	n	y
Promote Energy-Saving Products & Technology	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Capacity Building															
The Establishment of the Coordination of Energy-Saving	y	y	y	y	y	y	y	y	y	y	n	y	y	y	n
EE&C Supervision Organization	y	n	n	y	n	y	n	n	y	y	y	n	n	y	y
Complete Energy Auditing System	n	n	n	y	y	y	y	y	y	y	y	n	n	y	y
Energy Measurment Apparatus	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
EE&C Promotion and Training Work	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y

Source: (IEEJ and ERI 2009)

The mid-term evaluation of performance relating to the 20 percent target, carried out in the first half of 2008, shows uneven progress of the provinces toward completion of their goals. Only Beijing had completed over 50 percent of its target; Tianjin had completed between 40 percent and 50 percent; while 15 provinces had achieved between 30 percent and 40 percent; 10 provinces had achieved between 20 percent and 30 percent; and three achieved lower than 20 percent (Table 9).[1]

Table 9: Province diversity in progress toward 11th Five-Year Plan targets

Target Achievement	Provinces*
Over 50 percent	Beijing
40 percent to 50 percent	Tianjin
30 percent to 40 percent	Fujian, Shanghai, Shaanxi, Guangxi, Jiangsu, Guangdong, Zhejiang, Anhui, Hubei, Jiangxi, Liaoning, Shandong, Heilongjiang, Henan and Gansu
20 percent to 30 percent	Yunnan, Sichuan, Hunan, Chongqing, Hebei, Guizhou, Neimenggu, Shanxi, Jilin, and Ningxai
Below 20 percent	Xinjiang, Hainan, Qinghai
No data	Tibet

*Provinces listed in order of achievement, highest to lowest; data not available for Tibet

Source: (IEEJ and ERI 2009)

The variation exhibited by the regions and independent cities in terms of targets, measures adopted, and progress toward their goals identifies this as an important layer of China's geographies of energy efficiency.

Sectors: Detailed Objectives and Measures

China's Medium- and Long-Term Energy Conservation Plan identifies key industries, transportation, and buildings as three important sectors for energy conservation. The eight key industries, which this report also refers to as subsectors, are electric power, iron and steel, nonferrous metals, oil and petrochemicals, chemicals, building materials (cement, glass and others), coal, and machinery manufacturing.[2] Consistent with the plan, the objectives and measures that have been developed to comply with the 20 percent target vary by sector and subsector. Some examples include updated building energy standards faced by the building sector, minimum efficiency thresholds for new plants in the steel subsector, and closure orders for inefficient segments of the power subsector. Industry has received considerable attention from regulators, and objectives and measures have been specified for several subsectors, including iron and steel, other metallurgy, and cement. Detailed, sector-specific objectives and measures illustrate the sectoral geographies of energy efficiency.

In 2007, the NDRC signed responsibility statements (officially known as the Responsibility Statement on Shutdown and Elimination of Backward Steel Production Capacity) with the governments of 28 steel-producing provinces and also with Baoshan Steel Co., the world's fifth-largest steel producer. As specified in the responsibility statements, these areas will collectively shut down and eliminate backward iron and steel smelting capacity of 89.16 and 77.77 million tonnes, respectively, during the 11th Five-Year Plan. This is expected to ultimately affect more than 900 enterprises.[3]

Consistent with their varying targets, measures, and baselines, the sectors have shown different levels of progress in adopting new technology and processes to improve energy efficiency. For example, from 2000 to 2006, the penetration of coke dry quenching in the steel

[1] (IEEJ and ERI 2009)
[2] (IEEJ and ERI 2009)
[3] (IEEJ and ERI 2008)

industry increased more than seven-fold but the volume of building materials produced by efficient processes grew only 12 percent (see Table 10). Clearly, the economic sectors represent important geographies of efficiency, among which many distinct approaches to implementation must be deployed. For this reason, the subsequent chapters of this report are spent analysing the implementation experience of each of four key sectors: power, heavy industry, manufacturing, and residential/commercial.

Table 10: Adoption of energy efficient processes and technologies, by sector

Industry	Measure	2000	2006
Power Sector	Capacity share of units >= 300 MW	40.7	54.7
Steel	Use of continuous casting (%)	82.5	98.6
	Use of coke dry quenching (%)	6	40
	Use of top-pressure recovery turbine (%)	50	100
Coking	Share of machine coke in total coke production (%)	72	88
Electrolytic Aluminum	Use of large, prebake cell (%)	52	80
Building Materials	Production share of dry processed cement (%)	12	50
	Float glass share of total plate glass production (%)	78	90
	New building materials to the total (%)	28	40
Combined Heat & Power	CHP share of the total thermal installed capacity (%)	13.4	18.6
Fluorescent Lamps	Domestic sales of compact fluorescent lamps (million)	125	600

Source: Compilation of data from China Electricity Council (CEC), China Iron & Steel Association (CISA), China Coking Industry Association (CCIA), China Nonferrous Metals Industry (CNMI), China Building Materials Industry Association (CBMIA) and China Association of Lighting Industry (CALI).

Firms: Focusing on Key Energy Users

A sample of the implementation performance of nearly 1000 firms is provided by the Top-1000 Enterprise Program. The "1000-Enterprise Implementation Plan of Energy Conservation Action" defines the scope of the program, specifies implementation plans, and sets forth the basic principles of an evaluation program. The evaluation program is defined in greater detail in the "Implementation Plan for Evaluation System of Energy Consumption per Unit GDP" (referred to as the Evaluation Plan), which requires provincial energy conservation administration departments to evaluate the performance of the Top-1000 Enterprise Program participants in their territory.[4] In August 2008, the NDRC posted results from one round of evaluations. This post reviews the performance of the Top-1000 Enterprise Program through the year 2007 based on three categories: "target completion progress", "implementation of measures", and "result of appraisal".[5] There is considerable diversity in the firm-level results, pointing to firm characteristics as yet another key dimension for understanding implementation activities.

Target Completion Progress

This is the most straightforward of the three evaluation categories. It simply addresses whether the firm is delivering the energy intensity reduction for which it assumed responsibility. Among the 998 enterprises that joined a "Treaty on Responsibility of Energy-saving Targets", 953 were evaluated by the regional governments where they are located.[6] A large majority of the evaluated companies, 879 enterprises (92.2 percent), were successfully meeting their annual energy saving targets while 74 (7.8 percent) were not.[7]

[4] (NDRC 2007c)
[5] (NDRC 2008)
[6] Of the remaining enterprises, three had gone out of business, 15 had been taken over, and 26 had ceased production.
[7] (NDRC 2008)

Implementation of Measures

This category reviews the actions that have been taken by the firms toward improving energy efficiency. More than 96 percent of the Program enterprises had established some sort of energy leadership group that included top-level managers; over 91 percent of the enterprises had divided the Five-Year Plan target into more detailed targets for individual years, workshops, and teams, and had tied workers' benefits to target completion. Around 73 percent of the companies had invested in the elimination of inefficient techniques, technologies and/or equipment. Collectively, the investment by Top-1000 Enterprises reached CNY50 billion and more than 8000 projects had been initiated with a total energy saving potential in excess of 20 million tce.[8]

In an interesting example of the close interaction that the Top-1000 Enterprise Program fosters between these companies and the local governments, almost 90 percent of the companies had adopted an energy review by the local government as a precondition to undertaking new projects. Other measures introduced by some companies included establishing a position for energy monitoring and statistics, creating an energy information platform, and improving energy metering capability.[9]

Result of Appraisal

According to the evaluation, 391 of the 953 enterprises had surpassed the contribution for which they were responsible. Another 564 were judged to be meeting their responsibilities and 32 were listed as basically completing their responsibilities, meaning that they were meeting their energy-saving objectives but deficient in some other regard. Enterprises identified as not fulfilling their responsibility numbered 74.[10] See Appendix D for a description of the evaluation criteria.

According to the Evaluation Plan, this evaluation will be an important tool for assessing the performance of managers of the state-owned or state-controlled companies, which represent almost one-third of the participating enterprises.[11] Results of the evaluation will be submitted to the SASAC, which is expected to develop an appropriate accountability system. The Evaluation Plan states that enterprises exceeding the targets of their responsibility will receive public praise and pioneering efforts will be rewarded. It also warns that non-fulfilling enterprises that do not submit well-defined plans for correction will be denied the annual praise, honourable title, and other preferential measures. In addition, enterprises that are not fulfilling their responsibilities are not allowed to build new energy intensive projects or acquire more industrial land.[12]

Participation in the Top-1000 Enterprise Program does appear to have a positive bearing on the energy efficiency progress of a firm. But clearly there are other factors that contribute to success within this complex layer of China's geographies of energy efficiency. Chapters 3 through 6 provide some insight into additional enterprise characteristics that lead to success in energy efficiency endeavours.

Energy Efficiency Objectives of China's Geographies

As discussed in the preceding section, policy-makers have not demanded equal contributions to meeting the energy reduction target from all regions, sectors or firms. The expected contribution of these geographies, if accompanied by suitable compliance

[8] (NDRC 2008)
[9] (NDRC 2008)
[10] (NDRC 2008)
[11] (People's Daily Online 2004)
[12] (NDRC 2007c)

mechanisms, is likely to influence their implementation of measures. Moreover, when we speak of the performance of a geography it is often with respect to its expected performance, as defined by a target. Therefore, to facilitate effective comparisons of the implementation results among the regions, sectors and firms, this section introduces their respective energy efficiency mandates.

Regions: A Comprehensive Requirement

The energy intensity reduction targets that guide the energy efficiency efforts of China's provinces and independently administered municipalities have been referred to several times. Here, we will step back for a moment to describe their origin and scope. The targeted 20 percent reduction in energy consumption per unit GDP that underlies the regional targets was set as part of China's national, five-year planning cycle. Specifically, China's political leadership, the Central Committee of the Communist Party, expressed its support for such a target and it was subsequently given substance in the 11th Five-Year Plan, which covers the period of 2006 through 2010. From this point, the administrative organs of government developed a plan of action.

In June 2006, the NDRC issued a plan for achieving the national target by dividing the responsibility among the regions. This plan is known as the "Indicators Plan to Reduce Energy Consumption per Unit GDP of the Region during the 11th Five-Year Plan". In accordance with this plan, regional responsibilities were established as follows:

- **Target Requirement**—Regions were required to adopt an energy intensity reduction target. Many regions had already declared corresponding 20 percent reduction targets in their respective Five-Year Plans, and these were confirmed by the central government. But for all regions that did not declare a target, or declared a target of less than 20 percent, a target indicator that would support the national target was decided by negotiation between the central and local government (see Table 11).
- **Decisive Factors**—In determining the targets, several regional characteristics were explicitly indicated for consideration; these included the development level, industrial structure, energy intensity per unit GDP, total energy consumption, energy consumption per capita, and energy self-supply level.
- **Main Executive Measures**—As part of their efforts to achieve their assigned targets, but also as objectives in and of themselves, the regions were expected to implement measures to: optimize the industrial structure (i.e., increase shares of light industry and services and decrease the share of heavy industry); strictly limit energy intensive industry; promote the use of energy efficiency technology; and strengthen management along the entire chain of energy production, transportation, and consumption.
- **Evaluation Procedure**—To ensure compliance with the requirements set forth in the plan, a program of evaluation and reporting was designed. Since 2006, the National Bureau of Statistics (NBS), the NDRC and the Office of the National Energy Leading Group have been required to report every six months on every region's energy consumption per unit GPD. Further, a mid-term evaluation was set for 2008 and was completed in that year. A final, comprehensive evaluation is to be held by the end of 2010.[13]

[13] (State Council 2006b)

Table 11: Provincial energy intensity reduction targets

Anhui	20%	Henan	20%	Shandong	22%
Beijing	20%	Hubei	20%	Shanghai	20%
Chongqin	20%	Hunan	20%	Shanxi	22%
Fujian	16%	Inner Mongolia	22%	Sichuan	20%
Gansu	20%	Jiangsu	20%	Tianjin	20%
Guangdong	16%	Jiangxi	20%	Xinjiang	20%
Guangxi	15%	Jilin	22%	Xizang	na
Guizhou	20%	Liaoning	20%	Yunnan	17%
Hainan	12%	Ningxia	20%	Zhejiang	20%
Hebei	20%	Qinghai	17%		
Heilongjiang	20%	Shaanxi	20%		

Source: (State Council 2006b)

Sectors: China's Medium- and Long-Term Energy Conservation Plan

Though it predates the 20 percent intensity reduction target, the "China Medium- and Long-Term Energy Conservation Plan" remains an important guide for the energy efficiency efforts in key sectors. The Plan was issued in November 2004 and is meant to guide work through the year 2020. It proposes 10 Key Energy Saving Projects and key areas of energy efficiency and conservation endeavours that touch all sectors. Beginning in 2005, the NDRC partnered with other administrative departments to organize 10 working groups with more than 100 experts and scholars. The work of these groups resulted in the "Implementation Plan for 10 Key Energy Saving Projects in the 11th Five-Year-Plan". The plan includes an objective and implementation strategy for every key project. The main projects impacting the power, residential/commercial, manufacturing and heavy industry sectors are described in the table below.

The 10 Key Projects represent a very different approach from the regional allocation of energy savings targets. Rather than giving responsibility to specific entities for providing a specific outcome, the 10 Key Projects offer implementers a guide for where and how to achieve energy savings. The two approaches could certainly be complementary. On the other hand, regions, sectors, and firms may have rejected some of these top-down measures in favour of strategies that better suited their geography. The sector-focused chapters explore this question.

Firms: Two Programs for Key Firms

During the 11th Five-Year-Plan period, two major programs have been introduced to push firms toward greater energy efficiency and conservation. These programs are the "Top-1000 Energy Consuming Enterprises Program" and the "Key Energy Consuming Enterprises Mark Energy Efficiency Standards". Similar to the regional targets and sectoral strategies discussed above, these programs introduce enforceable targets and an implementation strategy, but they do so at this third important level of geographies—the firm.

Table 12: Objectives and strategies from the Medium- and Long-Term Energy Conservation Plan

Key Project	Objective	Implementation Strategy
Coal-fired Industrial Boiler (kiln) Retrofits Projects	Increase coal-burning industrial boiler efficiency by 5 percent to save 25 Mtce; increase coal-burning furnace and kiln efficiency by 2 percent to save 10 Mtce	Retrofit low efficiency industrial boilers | Build regional processing and distributing centers for boiler coal | Eliminate lagged industrial boilers and rebuild current kilns.
District Cogeneration Projects	Increase central heating of urban areas from 27 percent in 2002 to 40 percent by adding 40 GW of cogeneration; achieve savings of 35 Mtce	Constructing primary cogeneration and industrial cogeneration for building heating, distributed CHP and CHP cooling | Introduce thermal power plant models with low calorific value fuel and utilize of straw and others biomass fuels where appropriate.
Residual Heat and Pressure Utilization Projects	Save 7 Mtce.	In iron and steel, building materials, and chemical industries, adopt technology to use residual heat and pressure difference (TRT) and to recover and utilize combustible gases.
Petroleum Saving and Substituting Projects	Save or substitute 38 Mtoe	In the electric power, petrochemical, metallurgical, building material, chemical and transport industries, replace fuel oil with clean coal, petroleum coke and natural gas | The progress of the coal liquefaction projects and the development of substitute fuels—alcohol fuel and biomass diesel - will be accelerated.
Motor System Energy Saving Projects	Increase motor efficiency by 2 percent to save 20 TWh electricity annually	Retrofit inefficient motors | Introduce variable speed controls on large and medium-sized motors | Improve the efficiency of motor-driven processes.
Energy System Optimization Projects	Improve systems to the highest domestic level or close to the advanced international level of the same industry	Make energy systems efficient in key energy intensive industries—metallurgy, chemicals, refining, acetylene, synthetic ammonia, iron and steel, etc...
Building Energy Conservation Projects	Achieve 50 percent energy saving in residential and public buildings, to save 50 Mtce	Require 50 percent energy saving (over 1980) for new residential building and public buildings | In 4 municipalities of the northern cold district and cold district, implement a 60 percent saving standard | Build examples of low energy consumption and super low energy buildings | Promote the production of new wall materials and other energy efficient building materials.
Green Lighting Projects	Save 29 TWh of electricity.	Focus on the promotion and utilization of high efficiency lighting products and the retrofitting to the production line of energy saving lights

Source: (IEEJ and ERI 2009)

Top-1000 Energy Consuming Enterprises Program

The Top-1000 Enterprise Program implementation plan begins by noting that the energy consumption of the major industrial energy consumers represented 33 percent of China's total energy consumption in 2004. The subsectors included in the program scope are iron and steel, non-ferrous metals, building materials (e.g., cement), textiles and paper. The "1000 enterprises" is actually shorthand for all those companies with annual energy consumption above 180 ktce. A total of 998 enterprises were ultimately included in the program, which aims to achieve 100 Mtce of annual energy savings by improving the energy efficiency of these top companies. The benchmark efficiency targets of the program are for all companies to achieve the same energy per unit of physical production as the advanced domestic level in the business and for some companies to reach the international advanced level or to be world leaders.[14] The measures that have been taken since the introduction of the program are show in Box

[14] (NDRC 2006a)

4. As described in the previous section, firms have been given strong incentives to fulfil the requirements, as failure to do so will result in reduced economic benefits for managers and limits on the firm's ability to expand.

Box 4: Requirements for firms in the Top-1000 Energy Consuming Enterprises Program

"Treaty on Responsibility of Energy-saving Target": In these treaties, the enterprise and the NDRC formally agree to a binding energy intensity reduction target.

Energy management system improvement: Systems may be improved by advanced technology, and/or by the introduction of new personnel, procedures and responsibilities. All enterprises are expected to establish an energy management post.

Energy audit and plan: Enterprises must conduct an energy audit, using a third party if they choose, and then devise an energy efficiency and conservation plan that is indicated by the results of the audit.

Human resources training: Energy conservation training is expected to be provided to employees. Operators of major energy consuming equipment are required to receive training, but more general education to promote an energy conserving culture is also encouraged.

Source: (NDRC 2006a)

Key Energy-Consuming Enterprises Mark Energy Efficiency Standards

The energy efficiency of China's industrial enterprises ranges from world-class to very inefficient. Wei, Liao and Fan identify differing progress in the energy efficiency of the iron and steel sector at the provincial level, suggesting a widening gap between the most efficient and least efficient producers.[15] And though plant-level efficiency data is scarce, Price et al describes the large potential for energy efficiency improvement at two relatively modern steel companies.[16] One way of assessing the energy efficiency improvement potential of a company is by comparing its product energy intensity (energy used per physical unit of output) with that of other companies in the same business. This process, commonly referred to as benchmarking, can show companies where they have opportunities to improve efficiency. This initiative to promote benchmarking by China's energy intensive enterprises has been introduced in order to push inefficient companies toward the industry's advanced international level of efficiency.

This program assigns roles to industrial companies, industry associations, and governments. The main implementer is the company, which is expected to select a benchmark based on shared business characteristics, then identify its areas of low performance, and finally adopt measures to close the performance gap. Industrial associations are to support these activities by providing instructions, and by tracking and reporting on progress. All levels of government are expected to promote this work with the NDRC as the main supervisor and evaluator. The industrial associations participating in this program include China Iron & Steel Association (CISA), China Cement Association (CCA), China Petroleum and Chemical Association (CPCIA), and China Nonferrous Metals Association (CNIA).[17]

Understanding the Geographies

The first section of this chapter described three important layers in China's geographies of energy efficiency: regions, sectors, and enterprises. As part of this description, we identified variations in energy efficiency progress that are exhibited by the different geographies in each

[15] (Wei, Liao and Fan 2007)
[16] (Price, et al. 2003)
[17] (IEEJ and ERI 2009)

layer. The second section described the programs and performance targets that have been deployed to each of these layers, with the understanding that these exert an important and non-uniform force on geographies for greater efficiency. But the relative stringency of policy measures is not the only force determining how quickly geographies progress toward greater energy efficiency. In this section, we point to additional factors that help complete the story of varying energy efficiency performance within the three layers of geographies, and which merit consideration when tailoring implementation approaches.

Region: Economic, Administrative and Natural Characteristics

Regional differences in energy efficiency progress include economic, administrative and environmental factors. This section does not attempt to catalogue all the factors that influence regional variations in energy use, efficiency and conservation. Instead, we will highlight some important examples in the categories of economic, administrative and environmental factors. Then, as we delve further into the geographies in subsequent chapters, we will look for these sources of variation to influence the implementation strategies.

Economic Sources

The level of economic development and the industrial structure are critical determinants of regional energy intensity. Among China's 31 regions, there is enormous diversity of per capita GDP; ranging from under CNY7,300 per capita in Guizhou to CNY65,600 per capita in Shanghai.[18] This huge discrepancy in regional wealth discloses a key element of the efficiency story—the various regions of China are at very different stages of development. As a whole, the economy is in the midst of industrialization, but some regions remain in a preindustrial, agricultural economy, where others are already advancing beyond an industrial economy to a modern service economy with tertiary industries, such as finance, as the leading industries. Most Chinese regions are between these two levels, and secondary industry holds the largest share of the economy. Beijing and Shanghai represent the highly developed regional economies, with tertiary industries representing about 70 percent and 50 percent of GRP, respectively (see Figure 5).

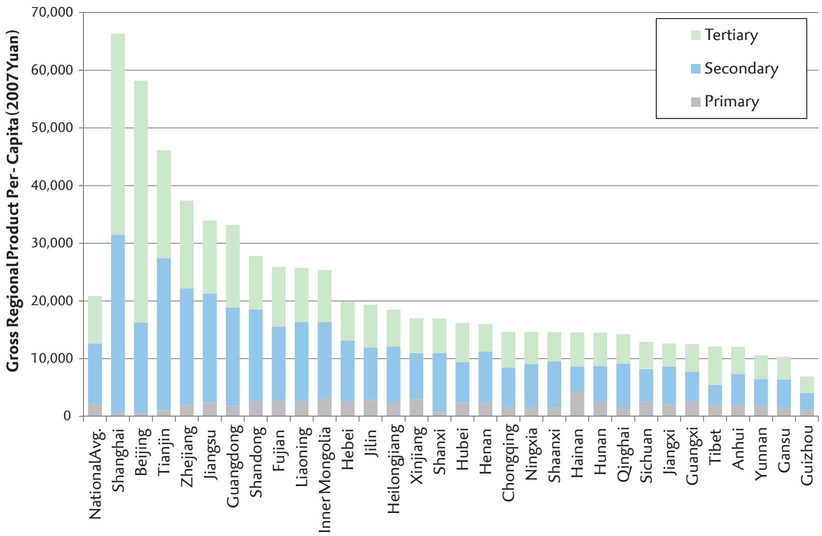


Figure 5: China's regional economic diversity

Source: (NBS 2008b)

[18] 2007 CNY. APERC calculation using data from (NBS 2008b) and (NBS 2008a).

For the nation as a whole, many studies have concluded that there is a positive relationship between GDP growth and energy consumption.[19] But the regional economic differences suggest that this effect will not be uniform across regions. Indeed, Hu and Wang's analysis of total-factor energy efficiency suggests that wealthy provinces tend to exhibit declining energy intensity.[20] The weakening relationship between GRP and energy consumption as provinces develop may result from the increasing importance of non-energy intensive economic activity in more economically advanced regions and the improving ability of such regions to acquire or develop more technologically advanced and efficient equipment. This suggests that the implementation approaches for promoting energy efficiency must differ according to the level of regional development.

Environment Sources

China is a large country that spans a wide range of climates, from the extremes of the Himalayan Plateau and the Taklamakan Desert to the comparably mild, densely-populated, eastern seaboard. Energy use, most obviously that for heating and cooling of buildings, is strongly dependent on climate. For this reason, the country's building standards divide the country into five zones—1) the very cold region, 2) the cold region, 3) the warm region, 4) the hot summer, cold winter region, and 5) the hot summer, warm winter region.[21] The regions of China also have vastly different natural resource endowments. The central and western provinces enjoy rich coal deposits, but fossil energy resources are relative scarce in the coastal provinces. But the latter are clearly advantaged by their relatively easy access to international markets. The need to efficiently transport energy and other resources from regions rich in resources to fast-developing regions figures strongly in China's energy conservation and industrial development policies.

Box 5: Energy-rich provinces and energy intensity

Shaanxi, Neimenggu and Shanxi are the main coal production and export regions of China, where six of 13 large coal bases are located. In the future, 70 percent of added production is planned to come from these provinces, where the development of energy and heavy chemical industry clusters will stimulate local demand. Consequently, the increase of secondary industry, particularly the chemical industry, will almost certainly increase the energy intensity of these provinces.

Xinjiang is a key resource province for all of China where growth of the energy industry is an important part of economic development. The region faces the contradiction posed by simultaneous economic growth and energy efficiency and conservation efforts. In 2006, energy intensity was reduced 1.06 percent and in 2007 a further 3.08 percent. Both of these were substantially less than the targeted 4.4 percent annual reduction. In 2007, Xinjiang had the highest energy intensity of the 31 provinces.

Source: (Xinhua News Agency 2009)

Administrative Sources

China's rapidly evolving energy efficiency and policy environment is likely to prove more difficult for regions with smaller fiscal budgets, fewer personnel, and more limited access to new technologies. These challenges of institutional capacity are recognized in some energy efficiency and conservation policies, which present a staged approach to implementation. For example, the strategy for improving building energy monitoring focuses first on developing the new statistics systems in a handful of key cities, and then aims to deploy those systems to

[19] For example (Yuan, et al. 2008)
[20] (Hu and Wang 2006)
[21] (LBNL 2009)

other regions.[22] Because this report focuses primarily on the most advanced regions of China where the most implementation experience has been gained, the influence of administrative sources of variation receives less attention.

Sector: Development and the Industrial Structure

The contribution of the economic sectors to China's energy efficiency targets is generally looked at in two ways. First, because the various sectors tend to have distinct energy intensities, the share of each sector in economic activity is considered. And second, intra-sector efficiency improvements are examined. China has experienced rapid economic development since 1978 and energy intensity has decreased tremendously over the same period. The changing intensity can be attributed to both the evolving industrial structure and technology. The changing industrial structure reduced energy intensity before 1998, but raised the intensity after 1998. In the years from 1994 to 2005, technological change was the dominant contributor to the decline in energy intensity, but its contribution lessened after 2001. Decomposed technological effects for all sectors indicates that technological progress in high energy consuming industries and household consumption, were the main reasons for reducing energy intensity.[23,24]

China's level of development precludes a rapid shift toward a low-intensity service economy. Heavy industries will remain very important to China's economy for some time. This fundamental situation appears to be a constraint on the energy consumption structure of China and seems to limit the performance of many energy efficiency and conservation policies. However, this constraint is not uniformly imposed on the Chinese economy. Diverse regional development levels and various stages of transition to a market economy will allow some regions to shift toward less energy-intensive industries as part of their approach to reducing energy intensity. In the language of China's policies, these provinces will be able to "optimize the industrial structure".

Box 6: Zhejiang Province and the importance of acknowledging industry diversity

In 2007, Zhejiang Province achieved an energy intensity of 0.828 tce per CNY10,000, much lower than the 11th Five-Year Plan target of 0.98 tce in 2010. For the 1,311 key energy consuming enterprises in the region, the energy intensity per unit of value added was reduced 23 percent within the first two and a half years of implementation. Electricity production achieved an efficiency of 312 grams coal-equivalent per kWh and backward cement production was almost completely eliminated. The "low hanging fruit" has been quite rapidly and effectively picked.

In an interview, You Xioping (deputy to the NPC, Chairman of the Board of Huafeng Group Company) suggested that the regional evaluation of energy consumption neglects the industrial diversity to the extent that some of the energy intensive plants with high energy efficiency potentials are effectively exempted from the constraint. Mr. You proposed to establish an evaluation system based on different industries and subsectors. This would facilitate further energy efficiency implementation, even in Zhejiang.

Source: (You 2009)

[22] (MOC and MOF 2007)
[23] (Wang and He 2009)
[24] (Hofman and Labar 2007)

Firm: Capacity, Value and External Drivers

Experience has shown that the successful implementation of EE&C measures in firms generally requires skilled personnel, access to technology, the ability to invest in the measures, and motivation. Motivation may be either internal, such as profit-seeking, or external, such as legal and regulatory requirements. With regard to the profit-seeking motivation, some firms are well-positioned to benefit from the government's emphasis on EE&C, such as those offering energy efficient products (see the case study in Chapter 1). Other firms that find energy purchases representing an important part of their operating costs may be motivated to invest in more efficient processes or equipment to reduce those costs.

There are many levels for firm-level diversity in China as elsewhere in the world. However, China does have the unique characteristics of an economy in transition, where many firms are shifting from more to less government involvement. This process has several implications for the implementation of energy efficiency and conservation measures that are touched upon in other chapters of this report. These include: the distinct transparency of operating costs between government-administered versus independent firms; differing access to capital, particularly the access to funds for investing in new technology; and the relative importance of profit maximization to the firm's principal owners.

Implications

China's geographies of energy efficiency are numerous and each exhibits unique characteristics in its approach to the new national vision for energy efficiency and conservation. In this chapter, we have introduced a framework for identifying such geographies, determining their responsibilities and implementation activities, and describing their similarities and differences.

China's 20 percent energy intensity reduction target and the decomposition of energy efficiency and conservation goals to the geographies brought great progress in Chinese energy efficiency and conservation. China's future EE&C efforts will strive for larger savings. Further tailoring implementation approaches to the geographies should yield additional benefits.

The design of China's development policy, under which the coastal areas have been first to open up and reform, foretells to some extent the need for a staged implementation of EE&C. The coastal areas have become much wealthier than the central and western areas. The coastal provinces therefore have better access to technologies and financial resources to develop and demonstrate EE&C measures.

Power Sector Expansion Makes Way For Upgrades

To cope with the rapid growth of electricity demand that has caused frequent power shortages since 2003, China's electricity sector has focused on expanding its generation capacity. It has succeeded in this at an unprecedented speed. As power shortages have diminished, the electricity sector has made efficiency and environment improvement its top priority. At present, the policy to improve the efficiency of the power generating sector has put the industry on the right track, and efforts are also under way to improve efficiency in the transmission and delivery sector.

Upon the unbundling of generation, grid operations, and services at the end of 2002, China's electricity sector took on the reform of the supply structure. In addition, achieving 100 percent electrification before the Beijing Olympic Games was considered a more important national goal than rationalising the demand structure through such measures as demand side management (DSM). Thus, this chapter describes the supply side, where electric power sector policies have focused. There is also great energy conservation potential on the demand side. This is not addressed in this chapter, but the other chapters of this report discuss many demand-side measures.

This chapter first reviews the development and structure of China's electric power sector, which provides fundamental information for considering efficiency policy in the electricity industry. Second, it introduces the key energy efficiency and conservation policies in the sector, including the shutting down of small thermal power plants, improving transmission and delivery systems, and developing combined heat and power (CHP) plants. Finally, it discusses the implementation of these key power sector policies and some preliminary results. A case study at the end of the chapter describes the results obtained by one large CHP project in Beijing.

Background

During the past two decades, China, of all the APEC economies, recorded the largest increase in primary energy consumption in the electric power sector. The increase amounted to 612 million tonnes oil equivalent (Mtoe) per annum. More than 90 percent of the increase was met by coal-fired power generation, and the remainder was met by hydro, nuclear and oil-fired generation.[1] China also made the greatest improvement in energy efficiency at coal-fired power plants among the APEC economies by shutting down smaller units. In recent years, China has accelerated the replacement of small units with high-efficiency ones, such as supercritical and ultra-supercritical thermal power plants. As a result, the energy efficiency of power generation in terms of the amount of coal that is used to generate one kilowatt hour of electricity has been reduced from over 400 grams down to about 330 grams, a 17 percent decrease since the early 1980s.[2]

[1] (NBS 2008a)
[2] (NBS 2008a)

Institutional Structure

In 2002, as part of a large reform effort,[3] the State Power Corporation of China was unbundled into power generation companies, power grid companies, and engineering and service companies, as shown in Figure 6.

On the government side, the National Development and Reform Commission (NDRC) is responsible mainly for the industry's development plan, and the State Electricity Regulatory Commission (SERC) is responsible for business operations, including electricity tariff setting. At present, there are two major power grid companies—the State Grid and the China Southern Power Grid, while the generating sector comprises five national-level power generating companies and many other regional companies and IPPs.

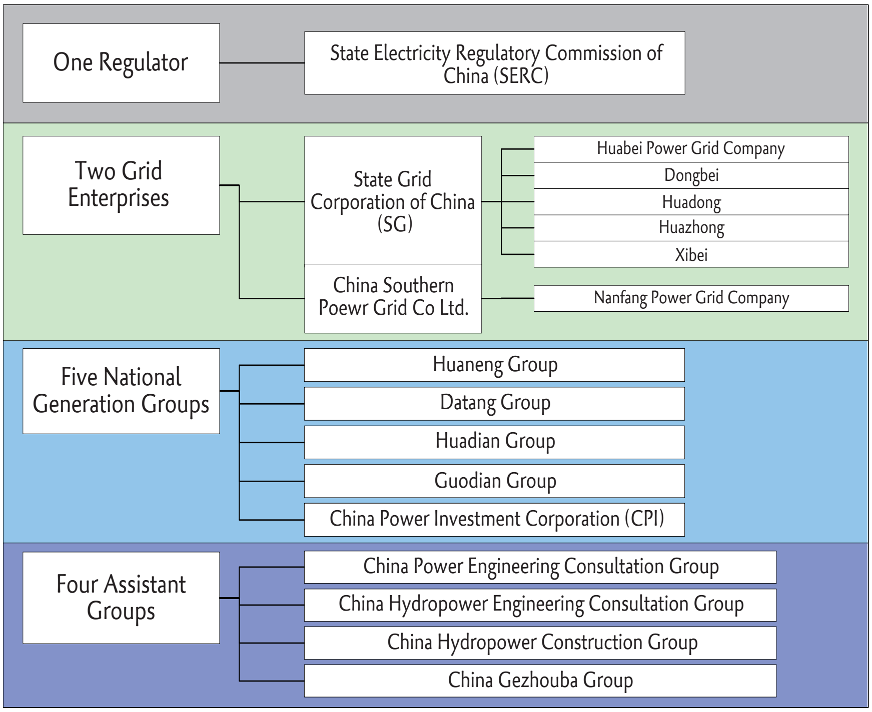


Figure 6: Structure of the electricity sector
Source: Compiled from (CPIA 2006)

Figure 7 illustrates the system for the flow of electricity. The five major generating companies and those owned by local governments supply 90 percent of all electricity, while private and foreign IPPs supply the rest. Two main grid companies are responsible for managing the transmission and delivery of electricity to end users through grid companies at the provincial and county levels.[4] The State Grid Corporation of China owns five regional grid companies including Huabei (covering Beijing, Tianjin, Hebei, Shanxi, and Shandong) with

[3] This reform of the Chinese government system aimed to modernise and rationalise the industrial system by introducing market mechanism and competition into the state-owned companies. The former State Development Planning Commission (SDPC) became the National Development and Reform Commission, which maintains responsibility for industry development policy. The former State Economic and Trade Commission (SETC), which was responsible for management of state-owned companies, was divided by sector and restructured into various units. The State Electricity Regulatory Commission was created as a unit of the State Council to be responsible for implementation of electricity policy.
[4] Some of these companies serve multiple counties, but not an entire province. In such cases, they may be referred to as prefectural distribution companies.

installed power generation capacity of 129.2 GW, Dongbei (East Mongolia, Liaoning, Jilin, and Heilongjang) with 55.8 GW, Huadong (Shanghai, Jiangsu, Zhejiang, Anhui, and Fujian) with 164.6 GW, Huazhong (Jiangxi, Henan, Hubei, Hunan, Chongqing, and Sichuan) with 154.3 GW and Xibei (Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang) with 47.1 GW. Another grid company, China Southern Power Grid Co., Ltd., owns Nanfang Grid Company (Guangdong, Guangxi, Hainan, Guizhou, and Yunnan) with 128 GW.[5]

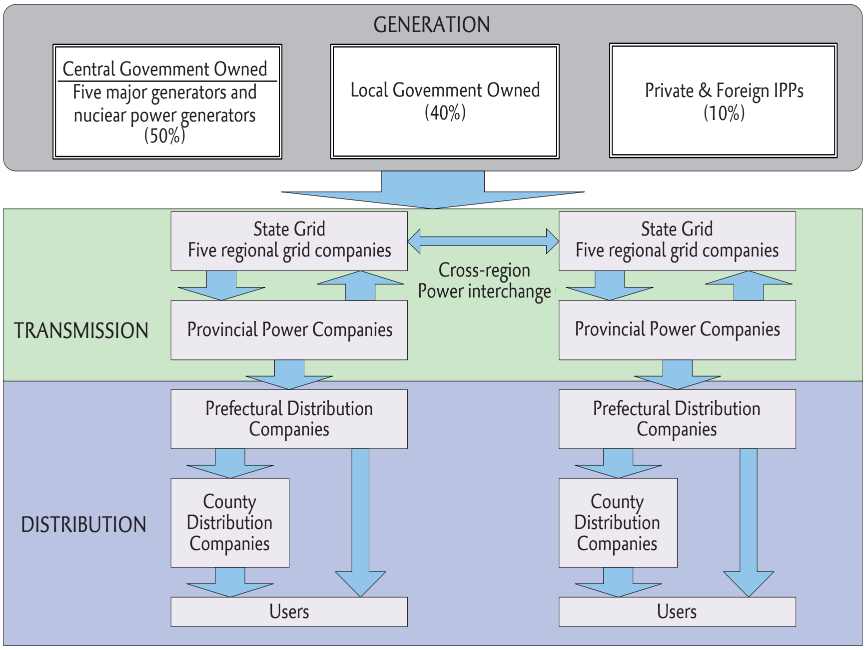


Figure 7: Flow of electricity
Source: Compiled from (CPIA 2006) and(Ni 2006)

Power Sector Development and Structure

During the past two decades, China's installed power generation capacity and amount of generation have grown rapidly (Figure 8). During this period, the annual increase in electricity generation has fluctuated widely from 3 percent in 1998 to 16 percent in 2003. Annual capacity additions have shown similar volatility, ranging from 5 percent in 2002 to 21 percent in 2006.

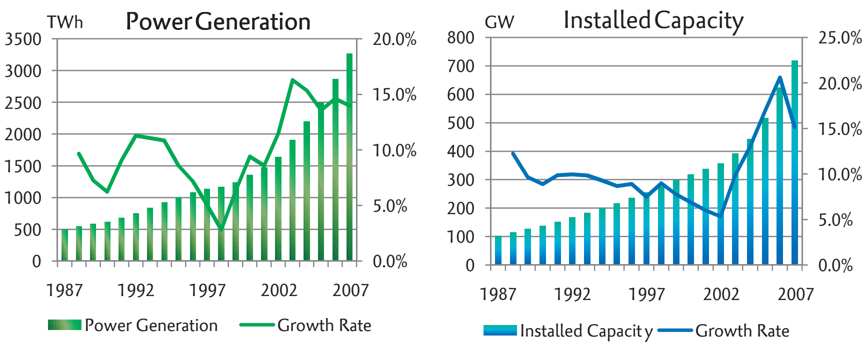


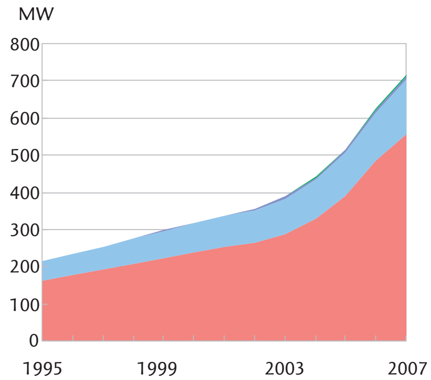
Figure 8: Power generation in China, 1987–2007
Source: (CEPYEC 2008)

[5] (CEPYEC 2008)

The growth rate of electricity generation slid from over 11 percent in 1993 to 3 percent in 1998 as the economic setback accompanying the Asian currency crisis caused serious demand stagnation and substantial excess capacity. The growth rate then picked up to 16 percent in 2003. During the period of stagnation, various policies were implemented to stimulate electricity demand, which pushed the economy toward the serious power shortage that occurred in 2003. Then, to accommodate rapidly rising demand, power generation capacity expanded at double-digit rates until 2007.

Fuel Type of Installed Capacity and Generation

During the 1990s, when energy prices were relatively low, coal-fired and hydro power stations were the dominant power sources in China, as shown in Figure 9. Other electricity sources such as nuclear and renewable energy remained at merely symbolic levels to demonstrate the industry's modernisation. As China's power generation capacity recorded robust increases in the past decade, most of the increase was delivered by coal-fired units, though hydro power continued to claim part of the increase, particularly as the Three Georges Dam Hydro project began operation in 2003.



	Installed Capacity 2007		Capacity Increase 1995 to 2007	
	GW	%	GW	%
Themal	556	77	393	78
Hydro	148	21	96	19
Nuclear	9	1	7	1
Others	5	1	5	1
Total	718	100	501	100

Figure 9: Installed capacity by energy source: 1995–2007
Source: (IEA 2008), (CEPYEC 2008)

In 1993, China's first nuclear power plant began operation with a capacity of 1200 MW. However, nuclear development was relatively slow until recently. Total nuclear power capacity reached 8,850 MW in 2007.[6] After being hit by the serious power shortage in 2003 and 2004, China changed its nuclear power policy to fully develop this secure, non-fossil energy source. Now China is building several other nuclear power plants and considering many more.

In summary, in the past two decades, thermal power maintained its dominant share in the generation capacity mix at around 75 percent, followed by hydro at 21 to 25 percent, while nuclear power remained at about 1 percent. In 2007, renewable energy (other than large hydro) accounted for almost 1 percent, reflecting the efforts of the Chinese government to develop non-fossil energy. As shown in Figure 10, thermal power is dominant in the power source mix of all six regions, though the regional availability of hydro power causes some diversity in the power mix.

[6] (CEPYEC 2008)

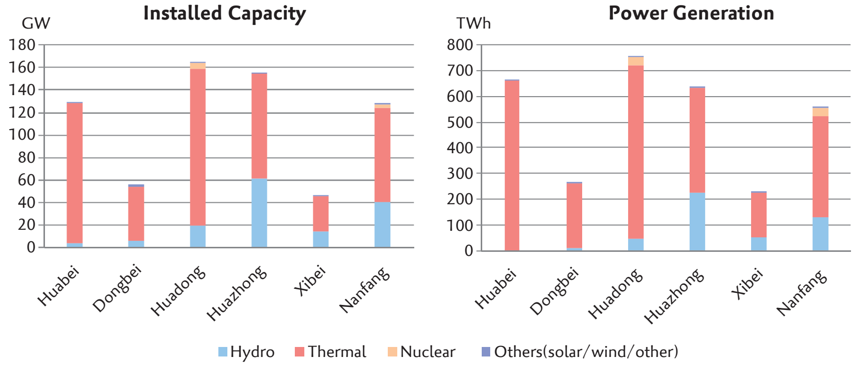


Figure 10: Power generation in six grid areas (2007)
Source: (CEPYEC 2008)

Energy Efficiency in the Electricity Sector

In considering energy efficiency in the electric power industry, the heat rate of power generation and transmission line losses are major factors.[7] They have steadily improved, as illustrated by Figure 11, though line losses have fluctuated in recent years. This irregular movement may have been caused by the flustered responses of the power grids to cope with the serious power shortages that began in 2003, as well as bulk construction of large thermal stations and the start-up of remote power sources like the Three Georges Dam Hydro power station and mine-mouth coal-fired plants.

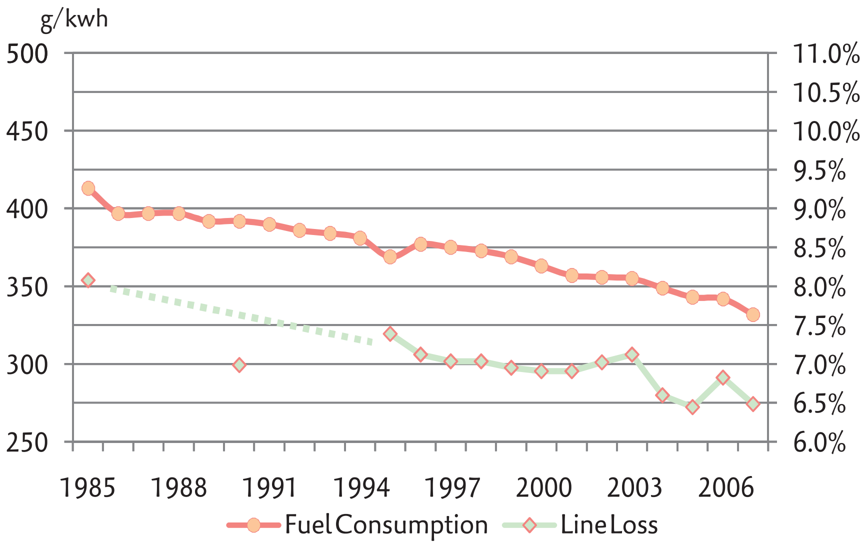


Figure 11: Unit fuel consumption and line loss
Source: (CEPYEC 2008) and (NBS 2008a)

Coal consumption for thermal power generation has substantially increased in recent years. The power sector consumed 272 million tonnes of coal and accounted for 25.8 percent of total coal demand in China in 1990. The amount increased to 1,305 million tonnes and 50.5 percent in 2007, as shown in Figure 12. Thus, energy efficiency at coal-fired power stations is the largest issue on the supply side of the power industry in China.

[7] Heat rate is also sometimes referred to as "unit fuel consumption"

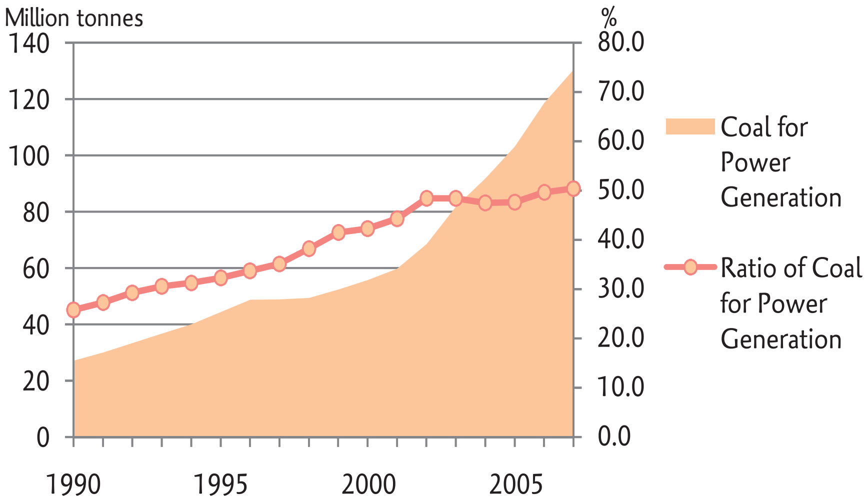


Figure 12: Coal for power generation
Source: (NBS 2008a)

Policies to Improve Efficiency

As the most important policy to improve energy efficiency in the electric power sector under the 11th Five-Year Plan (2006-2010), China is replacing obsolete, low-efficiency facilities with advanced ones in the power generation, transmission, and distribution sectors. This program also specifies increasing the grid network and connectivity among the six major grid areas.

In the 11th Five-Year Plan, thermal power generation efficiency was set to be reduced from 370 g/kWh in 2005 to 355 g/kWh in 2010. To accomplish this, the government is encouraging the construction of large ultra-supercritical coal-fired units above 600 MW that will achieve energy efficiency as high as 44 percent. Replacing smaller, less efficient units with these modern ones can reduce greenhouse gas emissions per unit of electricity output by more than one-third.

China designated the following power sector development policy components, aiming for a more secure, efficient, and resource-conserving power supply:

- Develop advanced power generation facilities, such as large-capacity mine-mouth power plants, waste coal utilization power plants, large hydro power facilities, large-capacity gas combined-cycle plants, gas turbine peak shaving plants, water-saving power generation plants and nuclear power plants.
- Develop power generation technologies with larger capacities and higher efficiency, such as supercritical and ultra-supercritical thermal units with a minimum capacity of 600 MW.[8]
- Restrict construction of conventional medium-sized and small units with a capacity of 300 MW or less that are situated in high-voltage power grids.
- Develop large-capacity, long-distance power transmission technology and upgrade grid operation technology.
- Develop combined heat and power (CHP) supplies for medium-sized and large cities in the northern heating zones.[9]

Energy efficiency is expected to be enhanced through improvement and optimization of

[8] (Zheng and Xu 2006)
[9] (NDRC 2006b)

facilities and their operation. By these policies, the modernization of China's electric power sector is being accelerated; though the sector still has a huge amount of aging, inefficient facilities. The above policy will be further refined in the next five-year plan following a review of implementation progress.

Implementation

The NDRC formulates China's general energy efficiency policy and it also reviews and approves the facility construction plans of the power industry. The SERC reviews and controls the electricity market, electricity tariffs, and the operation of electricity companies. As most of the grid companies and the generating companies belong to the central or local governments, the government is also in a position to direct their management. For example, the government can advise on facility construction plans and monitor how these power companies pursue the national policy. They can also ask grid operators to give dispatch priority to high-efficiency generators to improve the system's average generation efficiency.

The NDRC and SERC thus provide two channels by which the central government policy for improving energy efficiency can be communicated to on-site operators. However, a large share of the government-owned generation capacity is actually administered by the provinces, so the cooperation of these facilities requires coordination of the central and provincial governments.

Phasing Out Small Power Stations

Smaller power plants built under the past rural development programs are a major cause of low efficiency in China's power generating sector. Despite efforts to replace them with larger, more-modern plants, there were 4,804 units with a generating capacity of less than 100 MW at the end of 2006. Their share of total generating capacity was 18.8 percent. The industry association estimated that the installed capacity of small plants (under 135 MW), with high fuel consumption rates amounted to 150 GW.[10] On the other hand, large units of over 600 MW accounted for only 2.1 percent in terms of number of units and 18.4 percent in generating capacity, as shown in Table 13. The Chinese government has started the ambitious program to phase out the smaller units with firm resolve, though this may cause local administrations to lose businesses and jobs.

Table 13: Thermal power generating units, by capacity (end of 2006)

Capacity of Generating Units	Number of Units		Generating Capacity	
MW	Units	%	GW	%
>600	132	2.1	82	18.4
300–600	508	8.1	162	36.3
200–300	241	3.9	50	11.1
100–200	558	8.9	69	15.5
100>	4,804	77.0	84	18.8
Total	6,243	100.0	447	100.0

Source: (CEPYEC 2007)

As a part of its policy to accelerate the closing of smaller thermal power plants, the central government ordered grid companies to reduce electricity prices for the power from small thermal generators. According to the Circular of the State Council, this ruling applies to conventional thermal power generators with a unit capacity of less than 50,000 kW, those with a unit capacity of under 100,000 kW that have been operating more than 20 years, and those with a unit capacity of less than 200,000 kW that are operating beyond their designed service

[10] (CPIA 2008)

life and have an electricity price higher than the benchmark grid price for local coal-fired thermal units.[11]

Consistent with the Regulations on Electric Power Supervision, the NDRC and SERC share responsibility for supervising electricity prices. They are authorized to impose fines up to CNY1 million on generation and grid companies that violate state regulations.[12] In addition to the above directive, the energy efficiency improvement of each generation company is monitored by the government authorities. Because energy efficiency has become more important in national plans, this metric may be a factor in annual performance evaluations. Therefore, power companies are reluctant even to operate low-efficiency plants.

The displacement of the many small, inefficient plants in China will take more time to complete, but the program is being implemented ahead of schedule. Figure 13 shows the capacity of small thermal power units that were closed in the six grid areas during the first nine months of 2007. All together, small thermal power plants with capacity totaling 23.4 GW were closed in 2007, greatly exceeding the national goal of 10 GW. This has substantially contributed to the improvement of energy efficiency.[13]

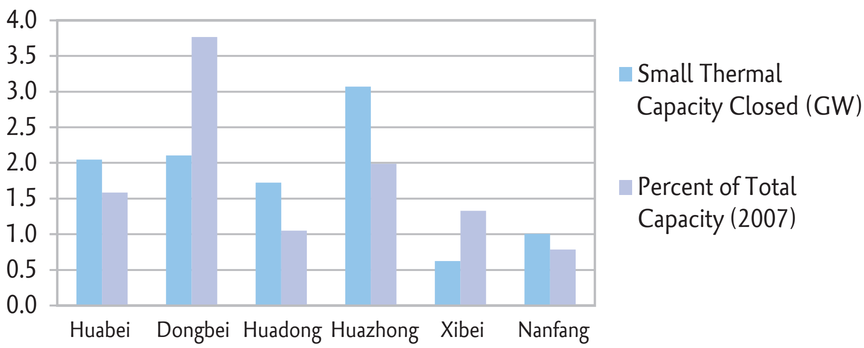


Figure 13: Small thermal power plants closed in six regional grids (Jan–Oct 2007)
Source: (CEPYEC 2008)

In 2007, the average thermal power station fuel consumption decreased from 356 g/kWh to 345 g/kWh in standard coal equivalent. The internal use at thermal power plants was reduced from 6.76 percent to 6.62 percent of generation, total carbon dioxide emission was reduced by at least 10 percent and transmission losses were reduced from 7.04 percent to 6.97 percent.[14] In total, closing small thermal plants is estimated to have saved 10.92 million tonnes of coal, and to have reduced SO_2 and CO_2 emissions by 0.6 million tonnes and 21 million tonnes, respectively.[15]

Improvement of Power Transmission and Delivery Efficiency

One of the biggest burdens for China's electricity sector is the uneven distribution of primary energy resources and electricity market centers. To cope with this, China has been implementing a west-to-east power transmission plan. Long-distance power transmission capability is being expanded through three major trunk lines (north, central, and south) that

[11] (NDRC 2007a)
[12] (State Council 2005b)
[13] (CPIA 2008)
[14] (CPIA 2008)
[15] (CPIA 2008)

connect the power sources in the West to the demand centers in the East. The current total transmission capacity via the three routes is 47.5 GW.[16]

At present, these trunk lines are mostly built with a maximum capacity of 500kV for DC and AC transmission, while a 1,438-km 800kV transmission line connecting Yunnan and Guangdong and a 654-km 1,000kV transmission line connecting Shanxi, Henan and Hubei are under construction. The west-to-east power transmission policy also aims to develop the economies of the central and western regions.[17]

One critical component of the energy efficiency policy in the electricity sector is to increase transmission capacity, reduce transmission loss, and raise supply reliability in order to accommodate the increasing demand. Present efforts are expected to significantly increase transmission efficiency and reduce transmission losses to 7 percent by 2010.[18] In addition, continued efforts need to be made in areas to optimise grid operating modes and transformer tap configuration, and also to strengthen passive power compensation and its regulation capability. Because the scaling-up of power plants and introduction of unstable renewable energies are being accelerated, grid management with wider coverage may also be required to enhance energy efficiency improvement in the transmission and delivery sector.

Combined Heat and Power (CHP)

Construction of CHP plants is an important measure to address air pollution in urban areas, as well as to improve energy efficiency. The Rules on the Development of Heat and Power Generation, issued in 1998, call on the local authorities and departments to support the development of CHP plants. Specifically, local authorities are required to create a local heat and power cogeneration plan. The planning commission is assigned responsibility to review and approve the plans. Large projects (greater than 25 MW) are to be approved by the NDRC, where smaller projects may be authorized by the local planning commission.[19] To promote CHP, the State Council has set out clear rules governing its construction and connection to the electricity grid. According to these rules, the fee for connecting to the electricity grid is exempted for new and expanded CHP facilities. It also stipulates that local authorities should support CHP projects for their efficient and harmonious operation. To this end, CHP plants and local electric power authorities are to collaborate to balance power dispatch with the heating load. The local power authorities that do not collaborate to achieve the efficient utilization of CHP plants may face penalties under the Energy Conservation Law and the Unfair Competition Law.[20]

Implication

There are small thermal power stations throughout China, built during the time of rural development. These stations reduce overall generation efficiency and cause serious air pollution. Thus, replacing them with large, state-of-the-art plants conserves resources and improves air quality. However, it is a thorny policy for China to urge rural villages to give up businesses, jobs and tax income. A huge capital investment is required to replace the small plants with larger ones, though the reduced fuel costs due to greater efficiency offer some compensation. Despite these hurdles, the Chinese government is implementing the policy to phase out smaller thermal power plants with the firm resolution to improve energy efficiency and air quality.

[16] (CPIA 2008)
[17] (CPIA 2008)
[18] (CPIA 2008)
[19] (SPC 2000)
[20] (NDRC 2004)

China's medium-sized thermal power plants (those smaller than 300 MW) are inefficient by advanced world standards. In China, these still account for more than 40 percent of total thermal capacity. Replacing these aging plants offers an opportunity to further reduce resource use and environmental impact in the future.

Only recently, 600 MW-class ultra-supercritical units were introduced, and the trend is moving to the 1000 MW-class ultra-supercritical units. In the next stage, the power sector's resource conservation and energy efficiency policy will be diversified to include non-fossil power generation, long-distance transmission, local distribution grids and DSM. To implement these policies while simultaneously ensuring that the power sector adequately supports regional development, the roles of local authorities will continue to be important.

Case Study: CHP Units of Beijing Huaneng Thermal Cogeneration Plant

The first phase project of the CHP plant of the Huaneng Power International Development Company and Beijing Municipality was a key state construction project. This project included four units with a total electricity supply capacity of 650-770 MW, heat supply of 3182 GJ/h, and steam supply for industry of 500 t/h. Construction of the project started in April 1995 and was completed in June 1999. Four generation units have been put into operation to date.

Because the plant is located in central Beijing, environmental protection and clean production were given top priority in its development. The boilers of the plant use ultra-high-pressure technologies, and the plant also features low-NOx burners, liquid ash removal, and other state-of-the-art technologies.

Combined heat and power production is a means of reducing energy consumption that has great potential in China. The Huaneng plant's total installed capacity of 845 MW supplies 10 percent of Beijing's power requirements, 70 percent of the city's steam needs, and covers 30 percent of its central heating load. This facility has the largest heating capacity of any CHP in the country. The annual average thermal efficiency of the generation unit is more than 60 percent, which is 20 percent higher than that of a conventional power plant. During the heating period, the unit thermal efficiency is as high as 84 percent. Since 1999, the plant has achieved an estimated savings of more than 400 million tce of fuel. In the summer of 2008, the use of waste heat for cooling was being studied in a pilot project; this may ultimately raise the average thermal efficiency by another 10 percent or more.

The emission level of pollutants from the boilers is in full compliance with both the national standard and the Beijing municipal standard (the latter is stricter than the national standard). The exhaust gas is monitored by the Beijing Municipal Environmental Protection Bureau 24 hours a day, and the discharged ash is 100 percent recycled. The factory also has installed three sewage treatment systems with combined annual processing of more than 10 million tonnes. The company is proposing a second-phase project to construct two 300 MW coal-fired generation units.

CHP plants can realize a very efficient energy supply system when the customers have sufficient heat requirements. The high potential efficiency and the industrial sector's large appetite for heat and high-quality steam suggest a promising area for CHP deployments. Large building complexes that require heat and steam are other, relatively easy applications, though seasonality of demand and geographic concentration are important constraints. Careful consideration of CHP in the design of city and district development plans will facilitate the most effective use of this highly efficient technology.

Case Study Source: (China Huaneng Group not dated)

Forging a World-Class Iron and Steel Industry

China's iron and steel industry is young, and the use of state-of-the-art technologies is becoming more common. Most of China's iron and steel production capacity was introduced over the past decade. The new capacity improved the industry's average technical energy efficiency and enabled the production of higher value added products. However, there are still challenges, such as the backward capacity that remains.[1]

China's iron and steel industry continues to evolve and, in doing so, it advances toward policy targets. Energy efficiency is strongly emphasized in China's iron and steel industry policy because it addresses long-term aspirations for natural resource conservation and environmental protection while strengthening businesses. The implementation of iron and steel policy involves planning and coordination across government institutions at various levels, and up and down the government from the national level to provinces, municipalities, and districts.

Background

China's steel production increased at an average annual rate of 6.8 percent from 1990 to 2000, extending the country's lead in world steel production. Annual steel output grew exponentially over the eight years from 2000 to 2008. Average production increased 3.9-fold, from 129 million metric tonnes in 2000 to 502 million metric tons in 2008.

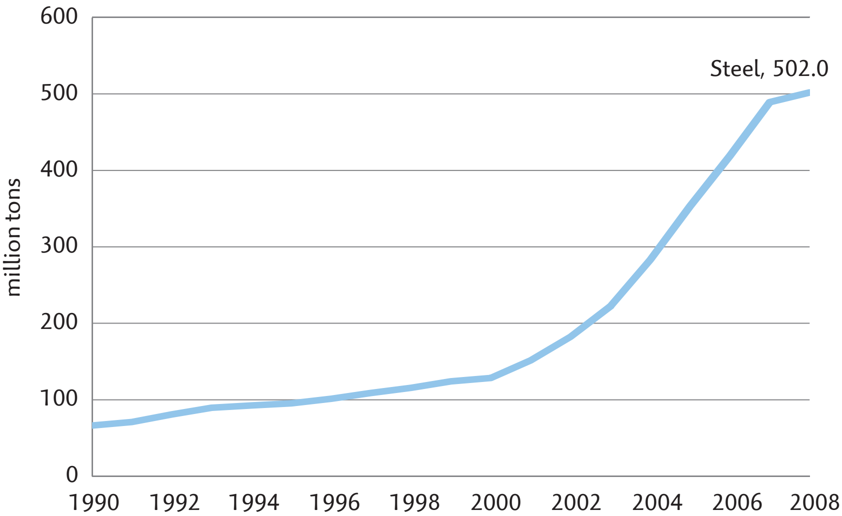


Figure 14: Steel production of China
Source: data from (World Steel Assoc. 2009)

The industry experienced year-on-year increases of over 70 million tonnes in 2005 and 2007, over 60 million tonnes and 65 million tonnes in 2004 and 2006, respectively, and 40 million tonnes in 2003. During the world economic downturn of 2008, China's steel production growth decelerated, but output still increased 2.6 percent, or 12.7 million tonnes, to bring total production to over 500 million tonnes. Steel production in the rest of the world fell 3.7 percent in 2008. China's steel production in 2008 was comparable to that of the EU27, Japan, the United

[1] Backward capacity, also called lagging capacity, means production facilities that are outdated and inefficient.

States, India and Brazil combined.[2]

China's iron and steel industry accounts for the largest share of value added in the industrial sector, at 7.7 percent (in 2006), consumes the largest share of final energy consumption in industry, at 29 percent, and is China's second most energy intensive industry in terms of final energy consumption per value added.[3] Energy intensity in iron and steel production declined rapidly until 2002, but has remained relatively steady in recent years (Figure 15).

Table 14: Energy intensity and energy consumption of select industries, in 2006

	Energy Intensity ktoe/CNY100 million	Energy Consumption million toe	Value Added CNY100 million
Non-metallic minerals	30.9	112.9	3656
Iron and steel	21.7	151.8	7004
Chemicals and petrochemicals	15.5	83.8	5399
Non-ferrous industry	9.1	28.9	3198
Machinery	3.9	33	6096
Transport equipments	1.7	8.6	4933

Source: (NBS 1990–2008)

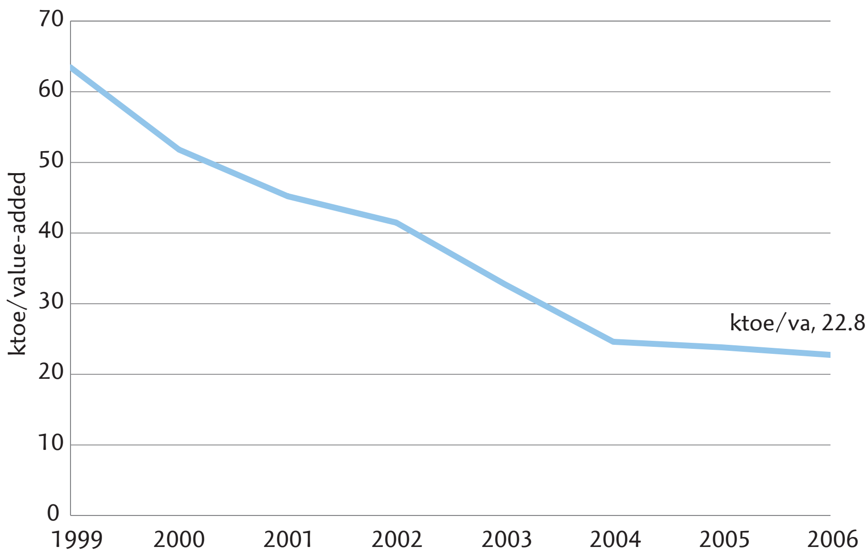


Figure 15: Energy intensity in steel production (constant 2000 CNY)
Source: (IEA 2008) and (NBS 1990–2008)

Liberalization and Corporatization

In the 1990s, China intensified its efforts to reform state-owned companies, as part of the market liberalization that began in 1978. The reform process has involved 'corporatization' and privatization of state-owned iron and steel enterprises, to make the enterprises financially independent and allow the government to discontinue direct subsidies to the industry.[4] This reform reduces the responsibility of the state and allows enterprises greater autonomy. As

[2] (World Steel Assoc. 2009)
[3] (NBS 1990-2008)
[4] Corporatization refers to the process of separating the management and accounts of the business from those of the government. Privatization refers to the transfer of shares of ownership from the government to other

tools of the transition, the process introduced the contract system, share-holding and assets responsibility.[5]

The reform of state-owned enterprises included government investment in world-class steel production and processing.[6] A typical government-funded upgrade involved integrating the latest technology with domestic equipment as much as possible. But these investments were not producing acceptable returns, in part, reportedly, due to poor management. Some 60 steel companies were up for debt-equity swaps in 2000 and the government compelled mergers and other arrangements to strengthen the industry in the following years.[7] Corporatization revealed the industry's inefficiencies, outdated technologies, and other weaknesses, but at the same time it provided an opportunity for change.

Table 15: Raw steel production by province November 2007–November 2008

Province	2008 rawsteel production	2007–2008 % change
	In million tons	
Hebei	104.1	10.9
Jiangsu	66.5	1.6
Shandong	46.3	1.7
Liaoning	39.3	3
Tianjin	27.7	8.1
Henan	23.6	7.8
Hubei	20.0	15.9
Shanghai	19.2	-2.7
Guangdong	18.7	1.5
Shanxi	18.2	-4.1
Anhui	17.6	10.1
Zhejiang	15.8	8.6
Sichuan	14.4	-0.7
Hunan	11.8	-0.6
Jiangxi	11.6	-5
Fujian	10.1	7.1
Inner Mongolia	9.5	15.3
Guangxi	8.4	2.2
Yunnan	7.8	7
Jilin	6.7	19
Beijing	5.8	-38.6
Gansu	5.4	-0.1
Xinjiang	5.2	22.7
Sha'anxi	4.4	-3.9
Chongqing	4.1	1.3
Heilongjiang	4.0	8.4
Guizhou	3.1	4.1
Qinghai	1.0	5.5
Ningxia	0.3	-12.5
Hainan	0.1	14.4
Total	530.8	4.3

Source: (CMA 2008)

Geographies and Capacities

Most of China's iron and steel production capacity is located in the coastal provinces, with a large concentration of production in the northern part of the country, the economy's main industrial centre. In terms of provinces, Hebei is the largest steel producer. Wu'an, a small city in the northeast province of Hebei, is the iron capital of China. Where coal, iron ore and water resources are abundant, significant steel making capacities are also found further inland, such as in Shanxi, Henan and Hubei. Overall, China has significant iron and steel production capacities in 27 of the 31 provinces.

China has four regional steel production bases: the north-eastern base—Liaoning; the northern base—Beijing, Hebei and Tianjin; the eastern base—Shandong, Jiangsu, Shanghai and Anhui; and the south-western base—Hubei, Hunan, Guangxi and Sichuan. The coastal south-western base is expected to see notable capacity expansion in the future, to supply inland provinces and exports to regional markets. The province of Jiangsu has the largest concentration of steel companies and related industries, followed by Shanghai.

5 (Hu and Ping 2005)

6 The state-owned iron and steel companies were divided into two categories of "key" and "local"; these are large state-owned enterprises that, in the case of the former, were directly supervised by the central government and, the latter, by a provincial government, (Wang, et al. 2005). Typical conditions of these companies at that time were reported as being "enormously inefficient: they waste and abuse resources, maintain redundant employees, and serve as increasingly reluctant employers to entire cities" (Brizendine 2001).

7 (Brizendine 2001)

For reasons of pollution, significant capacity is being moved out of Beijing. This will involve moving Beijing Shougang Group's entire production to neighbouring Hebei province where the company will establish 15 million tonnes of production capacity.[8]

Fragmented Industry

China had 71 large and medium-sized iron and steel companies as of 2007. The 10 largest iron and steel producers accounted for about 35.7 percent of the market. This is in contrast to Japan, where the top five steel producers have a combined market share of more than 70 percent.[9] The large number of companies and relatively low market share per company suggests a high level of market fragmentation.

Conforming to the policies and guidance of provincial governments, China's major steel producers significantly expanded their strategic corporate consolidation in 2008, with their ranking in the country changing as a result. In 2008, Hebei's Tangshan Iron & Steel Group and Handan Iron & Steel Group formed Hebei Iron & Steel Group, with a production capacity of 31 million tonnes, becoming China's largest producer. The rank of largest producer was regained the same year by the merger of Shanghai Baoshan Iron & Steel Group (Baosteel) with Guangzhou Iron & Steel Group and Shaoshan Iron & Steel Group creating the Guangdong Iron & Steel Group, with an output capacity of 36 million tonnes. In addition, Wuhan Iron & Steel Group acquired Guangxi Liuzhou Iron & Steel to form Guangxi Iron & Steel Group, with a capacity of 26 million tonnes. And Jinan Steel acquired Laiwu Steel to create Shandong Iron & Steel, with 24 million tonnes capacity. Greater consolidation of the industry strengthens producers' bargaining positions in securing iron ore supplies, enhances opportunities to optimize production to meet demand, and provides greater access to financing for energy efficiency measures.[10]

Technical Energy Intensity and Energy Efficiency

The technical energy intensity of steel production (energy input per physical unit of product output) reached a peak around 1995, most likely due to the deterioration of existing capacity. In the years that followed, technical intensity rapidly declined, levelling off around 2006 (Figure 16). Declining technical energy intensity is a sign of progress; it indicates that companies are implementing energy efficiency options in response to government policies and rising raw material and energy prices.

[8] (Li 2004)
[9] (Fiducia 2008)
[10] (Mok and Wommelsdorff 2008)

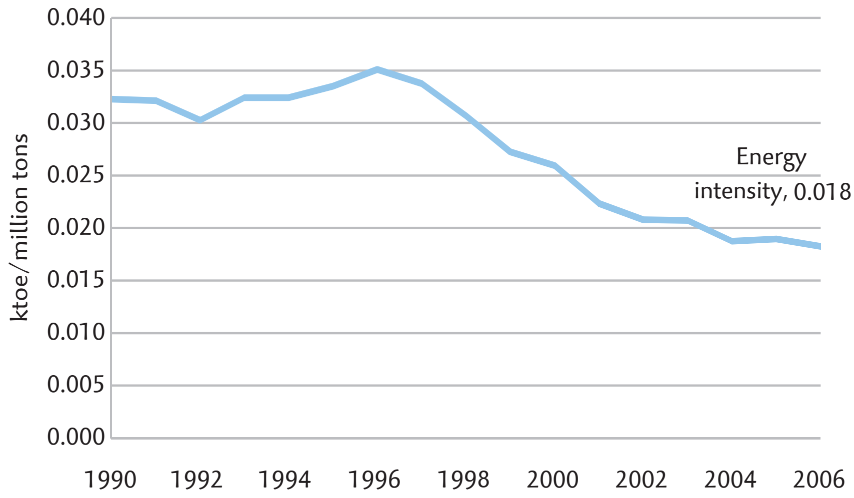


Figure 16: Technical energy intensity in steel production
Source: (IEA 2008) and (NBS 1990-2008)

However, an analysis by Liao, Fan and Wei attributed this improvement in technical energy intensity of China's iron and steel industry mainly to technical change, rather than technical efficiency improvement. Technical change results from the iron and steel industry's rapid expansion, which introduces new technologies, continuous processes, and economies of scale, and yields energy intensity improvements. The analysis found technical change to be increasing, and becoming more rapid after 2000.[11]

Table 16: Most notable efficiency change, 1994–2003

Notable 'Technical change'	Notable 'Technical Efficiency Change'
Liaoning	
Tianjin	Tianjin
Hebei	
Jilin	Jilin
Jiangsu	
Zhejiang	
Shandong	Shandong
Fujian	Fujian
	Jiangxi
	Henan
	Gansu
	Xinjiang
Guangdong	
Inner Mongolia	
Heilongjiang	

source: Yi-Ming Wei et.al

Technical efficiency refers to the energy efficiency of technologies in place. Their efficiency levels could in theory be maintained or improved by retrofits where possible. But this analysis found that technical efficiency is declining, with state-owned enterprises performing worse in this respect than private firms. Technical efficiency deterioration is viewed as a divergence from the best-practice leading edge. The study noted that the divergence is widening and seriously offsetting the substantial efficiency gains made through technical change.[12]

In spite of the considerable improvement to the technical energy intensity of China's steel industry, the average energy intensity in iron and steel production is still above that of the world's most-advanced producers (see Table 17). The decomposition analysis implies that technical efficiency improvement, which is the most common means of enhancing plant energy efficiency, has been difficult. A significant number of plants in 2003

[11] (Liao, Fan and Wei 2007); The analysis covered 25 provinces. Of these, only eight attained notable energy efficiency improvement through change in technical efficiency, specifically, Gansu, Jilin, Jiangxi, Xinjiang, Tianjin, Henan, Fujian, and Shandong. Efficiency improvements due to technical change at various levels was achieved by all the provinces, with Fujian, Guangdong, Inner Mongolia, and Zhejiang having the greatest increases.
[12] (Liao, Fan and Wei 2007)

were outdated in terms of economies of scale, processes and product range. As such, they are not technically viable, nor economically justifiable for efficiency improvements through retrofitting.

Table 17: Average technical energy intensity in key medium and large steel producers (kgce/tonne-product)

	2001	2002	2003	2004	2005	Rate of Change	World's best 2006
Overall energy intensity	**876**	**803**	**792**	**761**	**747.3**	**3.89**	**622**
Coking	153.8	149.6	148.5	142.2	142.2	1.94	
Sintering	68.7	67.8	66.4	66.4	64.8	1.44	
Iron smelting	448.3	454.2	464.7	466.2	456.8	-0.47	
Steel converter	27.8	27.4	23.6	26.6	26.3	1.36	
Electric furnace	241.2	23.2	213.7	209.9	201.2	4.44	
Steel rolling	108.9	101.32	96.3	92.9	88.5	5.06	

Source: (IEEJ and ERI 2009); (NBS 1990–2008)

Policies

Having recognized inefficiencies in the steel sector, the government introduced two policies that targeted specific opportunities to improve efficiency. The government circular of 2000 and the circular of 2005 addressed technical and structural issues of efficiency in the industry to promote economies of scale and high quality iron and steel production. Then, in 2005, a more comprehensive policy was introduced to guide strategic development in the steel industry, with the reduction of energy intensity as the principal objective.

Government Policy Circular of 2000

The policy required small plants to shut down, by 2002, if using any of the following technologies: sintering machines of 18 square meters and smaller; small blast furnaces of 50 cubic meters and under; rolling mills and wire mills with annual capacities of 100,000 tonnes and under; blast furnaces of 100 cubic meters and under; ferroalloy electric furnaces of 1,800 kVA and under; converters of 15 tonnes and under; flat product steel mills of 300,000 tonnes and under, and shape product and wire product rolling mills with annual production of 300,000 tonnes and under. In addition, steel mills with annual output of 100,000 tonnes and under were specified to be closed.[13]

Moreover, the policy forbids the continued construction of plants that would apply the above-listed technologies; the government will not approve any new projects that would apply the above technologies, and it instructs power utilities to discontinue the supply of power and banks to discontinue credit for implementation of such technologies. Other rulings also apply. For example, small state-owned iron and steel companies, in accordance with the law, may be subject to special provisions of the State Council relating to mergers and bankruptcy of state-owned companies.[14]

Government Policy Circular of 2005

The policy circular issued in 2005 aimed to improve efficiency by eliminating backward capacity and furthering industry consolidation. The policy mandated the elimination of 100 million tonnes of backward iron making capacity during the 11th Five-Year Plan, and elimination of 55 million tonnes of backward steelmaking capacity before 2007. The policy is

[13] (State Council 2000)
[14] (State Council 2000)

for flat products to constitute 50 percent of steel production in 2010, the industry to establish two to three internationally-competitive corporate groups with 30 million tonnes production capacity each, and several enterprise groups of 10 million tonnes production capacity each. The top 10 iron and steel enterprise groups are envisioned to have an output share of 83 percent of national production. The transformation of the industry is to be based on market principles that are enforced by laws and regulations, and that adhere to principles of differential treatment and specific guidance.[15]

Policies for the Development of Iron and Steel Industry 2005

The "Policies for the Development of the Iron and Steel Industry" is the first attempt to comprehensively address fundamental aspects of China's iron and steel industry for the future. The following is a synopsis of salient aspects of the policy:

- Iron and steel production capacity is to reach a reasonable level and become competitive with the world's most advanced iron and steel industries.
- Quality iron and steel products are to have a higher production share by 2010, to meet the demand for iron and steel from a broad range of national industries.
- Consolidation and reorganization of the iron and steel industry is to proceed such that the production capacity of iron and output of steel of the 10 largest iron and steel groups reaches 50 percent of the national production capacity by 2020, and ultimately reaches 70 percent.
- The industry layout should be optimized with regard to mineral resources, energy, water resources, transport infrastructure, production centres and distribution centres, overseas resources, and capacity of the environment.
- The policy expects the intensity of coal and water consumption in iron and steel production to evolve as shown in Table 18.

Table 18: Targets for industrial development, energy and water consumption

	2005	2010	2020
Energy per tonne of steel	0.76 tsc	0.73 tsc	0.70 tsc
Energy per tonne of iron	0.70 tsc	0.685 tsc	0.64 tsc
Water per tonne of steel	12 tonnes	8 tonnes	6 tonnes

Source: (NDRC 2005)

- Iron and steel companies with annual production capacity of more than 5 million tonnes are required to strive to have sufficient captive power generation capacity for their own use, and to have surplus capacity to supply demand outside of the industry.

Several specific requirements of the policy are:

- The policy states that any increase in iron and steel production capacity must be balanced by elimination of backward capacity. Capacity may expand in regions with comparative advantages in resources and strategic location (mostly coastal regions), but should be reduced in less competitive regions.
- Iron and steel companies are encouraged to carry out reforms and strategic reorganizations that include alliances, mergers, acquisitions and mutual share-holdings. Introduction of foreign companies and private capital is expected to upgrade the industry and enhance intensification of production.
- The capacity of companies must meet minimum thresholds in order to invest in new production facilities. For basic steel the threshold is 5 million tonnes per year, and for special steel it is 0.5 million tonnes per year. For foreign enterprises investing in China, the comparable thresholds are 10 million tonnes per year and 1 million tonnes per year.

[15] (State Council 2005a)

Such foreign investment is expected to be part of China's reform and reallocation of the domestic iron and steel producers, though, as a general rule, foreign investors may not have a controlling share.

- Mandatory use of devices and processes by new facilities is prescribed, while existing facilities must strive to implement these through retrofits. The policy states that industrial standards are to include:
  - Blast furnace top-pressure recovery turbines (TRTs)
  - Blast furnace granular coal injection (GCI)
  - Coke dry quenching (CDQ) technology
  - Filtering devices, gas desulfurization devices, comprehensive treatment systems for waste water and residues, and
  - Other heat recovery devices in power generation that utilize gases and steam

Further process and equipment specifications include feeding concentrated materials into furnaces, oxygen-enriched coal spraying, iron pre-treatment, large-capacity blast furnaces, converters, large-capacity electric furnaces, continuous casting, continuous rolling, and improved process controls. Enterprises are prohibited from using second-hand, backward and obsolete equipment from domestic manufactures or from abroad. Typical large-capacity blast furnaces are expected to have a volume of at least 3,000 cubic meters, while the volume of converters must be at least 200 tonnes.[16]

Implementation

China's iron and steel policy is implemented under close government supervision. The policy implementation measures don't specify a timeline for adoption of the specific technologies and processes indicated in the policy. However, for every plant in the industry that is not destined for elimination as backward capacity the government assigns mandatory energy saving goals and energy intensity reduction goals. Goals are established by enlisting the participation of the companies in national energy efficiency programs, or are assigned by provincial governments to meet provincial energy intensity reduction targets. Plants are mandated to take various measures to meet the goals. Two of the key tools used in the implementation of iron and steel industry policies are the memorandum of understanding (MOU) and goal-setting.

Assignments of energy reduction goals in the iron and steel industry involve the signing of an MOU of accountability between heads of lower-level governments and major local companies. Government officials, signatories of the MOU, are held directly responsible for the successful execution of the MOU. They are subject to inquiry and evaluation by the State Council, in a process that includes rewards and punishment.

Energy efficiency goals for the iron and steel industry are generally stated in terms of energy saved against base year energy consumption per common unit of physical output; measurement in terms of energy intensity reduction is also used. Goals are based on industry benchmarks and other criteria. In the future, China may use more sophisticated criteria, such as indicators that account for varying technical energy efficiency potentials by region. Planning, coordination, making financing available, and monitoring are other important aspects of the overall implementation of the policy.[17]

Benchmarking

The National Development and Reform Commission decree on the "Implementation Plan on Energy Efficiency Benchmarking of Key Energy-Consuming Enterprises" requires

[16] (NDRC 2005)
[17] (Tian 2009)

provinces to introduce industrial benchmarking programs in order to promote energy efficiency. By comparing their energy use to that of more efficient producers and contrasting their equipment and production methods, enterprises are expected to identify and implement measures that will improve energy efficiency.[18] The following is an example of policy implementation by the Shandong Economic and Trade Commission.

The Shandong policy paper states that, despite achievements of the province in meeting the targets of the 11th Five-Year Plan, enormous potential energy efficiency improvement persists in key energy-consuming enterprises of Shandong. The paper addresses municipal governments, industrial associations, and specific industries on this policy matter. Key energy consuming enterprises, including iron and steel producers, are expected to adopt energy efficiency benchmarks and develop plans to achieve them. Energy efficiency benchmarks are to be based on examples of advanced performance in China and internationally, in specific areas of processes, technology, products, and the industry as a whole.

Shandong has some experience with industrial benchmarking. Two companies participated in a benchmarking pilot program, with guidance provided by Lawrence Berkeley National Laboratory.[19] The current initiative seeks to build on that experience. Shandong's current benchmarking program involves the following steps:

- Expand the number of energy intensive industries in the existing pilot program on benchmarking, to assess energy performance, and for the industry to determine its efficiency and energy saving potential targets based on domestic and international best practices.
- Formulate guidelines for energy efficiency benchmarking in the industries based on experience from the pilot projects.
- Require key energy-consuming enterprises to implement the benchmarking guidelines. Encourage other companies to implement energy efficiency benchmarking voluntarily.
- Summarize and assess the program, further perfecting the guidelines, and promoting the program across the whole province.

Shandong expects implementation of benchmarking to include strengthening enterprise management of energy efficiency. Improved monitoring and supervision of energy saving will be required for reporting on progress toward benchmark targets. Outstanding achievements of energy efficiency benchmarking will be rewarded. Notably, the program design does not mention any special financing for the industry to meet the benchmark targets.[20]

Elimination of Backward Production Capacities

The elimination of backward production capacities and other policy objectives of the 11th Five-Year Plan for the iron and steel industry involve eight ministries and commissions including the NDRC. Enlisting the participation of local governments further adds to the challenge of coordination. To obtain the agreement of relevant parties, responsibility statements are signed with local governments. Such statements define the backward production capacity that must be eliminated. Provisions may also be made for grants and subsidies or differential tariffs to encourage capacity elimination. At the same time, any proposals for new capacity in a province are subject to prior elimination of backward capacity.

On 27 April, 2007, the State Council hosted a work conference on the shutdown and elimination of backward production capacity in the steel industry, with local governments and 10 major steel producers of the provinces of Beijing, Hebei, Shanxi, Liaoning, Jiangsu, Zhejiang, Shandong, Henan, and Xinjiang. At the conference, the NDRC signed the first round

[18] (NDRC 2007b)
[19] (Price, et al. 2003)
[20] (SETC 2009)

of ″responsibility statements on the shutdown and elimination of backward capacity″. These ″responsibility statements″ mandated the shutdown and elimination of backward iron and steel smelting capacity in the 10 provinces. Specifically, 39.86 million tonnes of iron making capacity and 41.67 million tonnes of steel making capacity were targeted for elimination during the 11th Five-Year Plan, involving 344 enterprises. More than half of the capacity was to be eliminated in 2007.

At the end of 2007, the NDRC signed a second round of responsibility statements with Baosteel Co. and 18 provinces, specifically Tianjin, Inner Mongolia, Jilin, Heilongjiang, Anhui, Fujian, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Yunnan, Shaanxi, Gansu, Qinghai and Ningxia. Assigned this time were the shutdown and elimination of iron and steel smelting capacity of 49.31 and 36.1 million tonnes, respectively, by 2010. This round of statements involves 573 enterprises in the 18 provinces. The NDRC signed a separate responsibility statement with Baosteel. Some 46.6 million tonnes of iron production capacity had been eliminated throughout China as of 2007.[21]

Box 7: The Baoshan Iron and Steel Corporation

Baoshan Iron and Steel (Baosteel) Corporation of Shanghai is a large state-owned iron and steel company. The company was assigned by the government to have the most modern iron and steel plant of its time, with Japanese assistance, in the early phase of market liberalization. Then, facing increasing domestic and foreign competition, the company sought to enhance exports. It merged with the state-owned enterprises Shanghai Metallurgical Holding Group Corporation and Shanghai Meishan Group Co. to form Shanghai Baosteel Group Corporation in 1998. The conglomerate became China's largest steel producer, with annual production of almost 20 million tonnes. Boasteel then entered an alliance in 2001 with former domestic rivals Shougang Group and Wuhan Iron and Steel Group Corporation. Recently, Boasteel has been constructing a state-of-the-art facility in Zhanjiang, Guangdong, which is expected to begin production in 2010.

Implementation of Advanced Energy Saving Technologies

The policy of 2005 mandated the use of advanced energy saving technologies that include blast furnace top-pressure recovery turbines (TRTs), coke dry quenching technology, and other heat recovery and energy saving options that are becoming more common in large integrated iron and steel plants. However, heat recovery systems in the iron and steel industry are costly devices. A challenge for China is greater deployment of these technologies.

The challenges of deploying advanced energy saving technologies in the iron and steel industry are illustrated by a case of implementing TRTs in the province of Shandong, as discussed by Wenjia.[22] In 2006, Shandong had 62 large blast furnaces, of which 11 had TRT units. The reason for the low penetration rate of the technology, when policy requires new blast furnaces to have TRTs, is found to not be related to technical barriers or management barriers. Rather, the barriers are operational and financial.

The primary operational barrier is a load imbalance in that plants cannot utilize electricity generated from TRTs. The optimal use of the TRT would be to use the electricity it generates onsite, and import any additional need from the grid. However, a more operationally realistic solution would be to sell electricity generated by TRTs to the grid, specifically to the power utility company, then to re-purchase power as required from the grid, albeit at higher purchase price. But this difference in the selling and purchase prices of electricity does offset the benefits gained from the residual pressure recovery by the iron and steel industry. The possibility for

[21] (IEEJ and ERI 2009)
[22] (Wenjia 2009)

TRT-generated electricity to go on-grid may involve a complex procedure; moreover, the the power industry may not be able to accommodate such an arrangement.

The sheer magnitude of financing needed to implement TRTs may also be a problem for small and medium-sized companies. The following is a case of TRT implementation by Qing Gang, the third-largest iron and steel company in Shandong. The company's production capacity is large by most standards; it has two 350m^3 blast furnaces, one 400m^3 blast furnace, and three 500m^3 blast furnaces. The company's total profit in 2005 was CNY169 million. In 2006, Qing Gang installed two TRT units at a cost of 59 percent of its profits in 2005. The case illustrates the scale of company that is able to finance the installation of TRTs. Financing could be a challenge for smaller companies that also need to invest in a new blast furnace to benefit from economies of scale. The cost of a new blast furnace is CNY400 million.

Coke dry quenching technology was introduced in China through a joint venture of Chinese and Japanese steel producers. The first four coke dry quenchers were built in China in the 1980s, and more than 20 CDQ units were built under the joint venture. China has acquired the technology and has built about 60 CDQ units since 2000. Similarly to TRT technology, the primary barrier to greater diffusion of CDQs is financing.[23]

Table 19: Cost of selected energy recovery technologies

Options	Cost
	million Yuan
Coke dry quenching	150–300
Top-pressure recovery turbine	30–50
Waste heat recovery of sintering plant	40–50

Source: (Wenjia 2009)

The industry is under increasing financial pressure, due to slowing demand for steel and obligatory requirements for energy saving and environmental protection. A key solution for financing is the availability of discount loans. In the case of Shandong, the province had planned to allocate CNY2.1 billion for energy saving and emission reduction in 2007. About CNY580 million was allocated for energy saving and water conservation, and CNY300 million was made available by the provincial finance bureau. Although an effort was made to provide significant funding, the funding available for each plant is limited.

Implications

Energy efficiency is central to China's policies for the iron and steel industry. It is addressed in requirements concerning industry consolidation, the technical aspects of devices, processes, and energy intensity targets of steel production. Both government institutions and enterprises are responsible for assuring its successful implementation. Some of the implementation measures, such as plant closures, incur sizeable, short-term investment costs and social costs. Still, they are deemed necessary for the long-term benefits associated with policy targets.

The role of market forces has become increasingly important since the reforms of the late 1970s, and market forces have contributed to the expansion and competitiveness of the industry in meeting increasing domestic demand. However, market forces alone are not sufficient to address the rapid change dictated by the policies and to address the transformation to optimum production and geographical location of plants in relation to demand centres, resources, and transport infrastructure.

China's approach to improving the energy efficiency of the iron and steel industry involves a broad range of measures that include industry restructuring, government planning and

[23] (Nakano 2008)

regulatory oversight, financing, technology transfer, setting of clear targets, and mandatory technical standards for the industry.

The iron and steel industry is in the process of energy efficiency reform to reduce energy intensity disparities across provinces and enhance steel-producing regions in the coastal areas. Regions with relatively smaller capacities and those that do not have adequate water and other resources may eventually have to phase out iron and steel production.

China is relying heavily on advanced energy technology options to increase energy efficiency in the iron and steel industry. The current policy implies that integrated iron and steel plants embodying economies of scale are the standard for the industry, and that these will allow more viable implementations of mandated energy saving technologies. The proposed solutions for greater diffusion of these technologies include further increasing the sector's consolidation level, enhancing government support, including reducing the import tax, and arranging foreign funding to broaden the financial base. Other measures include increasing R&D investments, speeding up technology transfer and reducing the barriers to technology transfer.

China's iron and steel industry has evolved rapidly over the past two decades. The use of continuous casting has grown from only 20 percent in the late 1980s to nearly 100 percent of production today, comparable to the ratio in advanced steel producing countries. The industry is now producing highly competitive products. Considering the current state of the industry, benchmarking programs seem to offer a promising approach to advance efficiency. Benchmarking programs are now being applied to meet the provincial energy intensity reduction targets of the 11th Five-Year Plan.

A Stratified Approach for Greening Manufacturing

This chapter presents a case study analysis of how policy is being implemented to improve energy efficiency in China's manufacturing sector. This is part of the overall effort to significantly reduce the energy intensity of the Chinese economy, one part of the government's general policy to conserve natural resources and minimise the negative anthropogenic impact on the environment. First, this chapter defines manufacturing as the term is used here, because it is important to separate statistical data for industries with low and high energy intensity. Then general observations are made about the current regulatory framework and recent policy implementation in China, with reference to the case study analysis. A case study of the Shanghai Industrial Boiler Co. then describes a success story in the manufacturing sector. Finally, some implications are derived to provide better understanding of China's approach to improving energy efficiency in manufacturing.

Major Factors Behind Energy Efficiency Policy Implementation for Manufacturing

Manufacturing, as a subset of general industry, must be clearly defined for an understanding of the role this industrial sector plays in the Chinese economy and how energy efficiency policy for this sector is implemented in the regions of China. Chinese statistics separate total energy consumption (which is what remains after primary energy is consumed for electricity and heat production) into seven sectors—farming, forestry, animal husbandry, fishery and water conservation; industry; construction; transportation, storage and post; wholesale and retail trade, hotels, and restaurants; others; and residential consumption. The industry sector contains three sections—mining and quarrying; manufacturing; and electric power, gas and water production and supply (where electric power does not include fuel inputs for transformation into heat and electricity). The manufacturing section includes a very broad set of industries, some energy intensive and some not, ranging from smelting and processing of metals (ferrous and non-ferrous) to recycling and disposal of wastes.

For the purposes of this case study, manufacturing includes only low energy intensive activities. Specifically, six industries were excluded from the manufacturing section ? manufacture of paper and paper products; processing of petroleum, coking, and processing of nuclear fuel; manufacture of raw chemical materials and chemical products; manufacture of non-metallic mineral products; smelting and pressing of ferrous metals; and smelting and pressing of non-ferrous metals.

The remaining subset of the manufacturing section within the industry sector, related to total energy consumption, will be referred to hereafter as "narrowly-defined manufacturing" (NDM), or simply manufacturing. The transition to an NDM base drastically reduces the share of manufacturing in general industrial energy consumption. The trends for total manufacturing and NDM for the eight years following 2000 are presented in Table 20.

Table 20: Structure of energy uses in the PRC (Mtoe)

	2000	2007	AAGR 2000–2007
Total energy consumption	969.5	1857.3	9.7%
Manufacturing	516.3	1092.4	11.3%
Manufacturing share	53.3%	58.8%	116.0%
NDM share	13.2%	12.7%	92.9%

Source: (NBS 2008a)

A general understanding of regional specialisations within the manufacturing statistical definition helps to distinguish the importance of NDM in China's regions. The most economically important regions in terms of export revenue and industrial value added are the Pearl River delta region in Guangdong province, the Yangtze delta region around Shanghai, the metropolitan Beijing-Tianjin area, and the so-called "metal belt" in the north-eastern provinces (see Table 21). The manufacturing index (column 3 of Table 21) is the sum of the province's share of total output of various manufactured products. The table shows that the coastal provinces were very important for manufacturing and export revenues (columns 4 and 5). The coastal provinces are primary areas for special economic zone (SEZ) allocations in China. The nation's capital, seven coastal provinces and two coastal-adjacent provinces are home to more than 50 percent of China's manufacturing, and provided 79 percent of NDM nationally and 87 percent of total China's exports in 2007. These provinces, except for Shanghai, are already among the less energy intensive regions in China (column 6).

Unfortunately, as a result of natural resource distribution, the major manufacturing coastal areas lack energy resources. Economic policy in China, until the 10th Five-Year Plan, focused on increasing GDP/GRP and value added. However, the Chinese economy's rapid growth has challenged domestic and international energy supply and prompted social opposition to environmental degradation. In response, the Chinese government decided to change its social development priorities. A resource conservation policy was endorsed, which includes energy conservation in addition to the top priority of economic growth. This will lead to strict control of investments in energy intensive industries and enforcement of the Energy Conservation Law for technologically upgrading existing enterprises in the manufacturing industry. In order to facilitate production and use of energy efficient technologies and equipment, new mechanisms were introduced when the existing policy was amended recently. This policy is shifting manufacturing toward the greening of its products, those destined for both domestic and international markets. The coastal provinces and particularly SEZs are the major players in the first steps of the policy implementation. As the next step, manufacturing in other areas will be obligated, by regulation and administrative institutions, to adopt higher standards for energy consumption by using green technologies domestically produced in SEZs.

The establishment of SEZs in China triggered rapid growth in the narrowly-defined manufacturing sector, thus significantly improving energy intensity indexes. The mix of state-owned and private enterprises in these zones is gradually changing to a dominance of private ones. However, being directly involved in the administration of SEZs, various levels of government maintain control of the performance of enterprises. Until the recent rise of the importance of environmental and resource issues, the top priority in the evaluation of an enterprise's performance in SEZs was its ability to increase value added (VA). Now, energy intensity and resource management are accorded at least the same priority for governments (see Chapter 1 for a case study of the administration of two SEZs).

Manufacturing in coastal provinces will remain the primary driver of economic growth in China. This is because, first, through producing more energy-efficient products, high value added will be created, eventually by using more energy-efficient technologies in renovated production bases. And second, by further developing SEZs and strictly controlling the local authorities' implementation of energy conservation measures and investments in energy-intensive industries, energy efficiency will be improved. Outside the SEZs, energy efficiency will be improved through a much longer process of technology enhancements in industry by steadily implementing the Energy Conservation Law and other related regulations and policies, including energy price liberalisation.

Two important factors should be mentioned that are necessary for understanding energy efficiency policy implementation in China. The first is the active involvement of traditional social institutions in this process, and the second is the complication that arises from the export orientation of much of China's manufacturing. Historically, Chinese governments worked out well-functioning mechanisms at each level to translate policy from the top downward, utilising the whole set of social and political institutions. Such governmental mechanisms are an important factor in the implementation of resource conservation policy established by China's central government at the start of the current millennium. These institutions are flexible enough to accommodate the local context, and are constructed to seek compromise between the top-down policy approach and local social and business interests.

The export orientation of SEZ enterprises illustrates both a challenge of attribution and an interesting limitation of energy intensity as a proxy for energy efficiency. With regard to attribution, it must be acknowledged that the globalised nature of production and consumption complicates international comparisons of energy intensity—what China's factories produce, the world consumes. The limitation of the energy intensity index is relatively straightforward. When the value of a currency changes the energy intensity also changes, without any change in energy use. Generally, this effect is neutralised by using real, inflation-adjusted currency values. However, currency conversions pose another twist. The strengthening of the CNY to the US dollar would have a tremendous impact on energy intensity objectives if they were represented in dollars. For example, if the exchange rate were to decline from CNY8.2 per US dollar in 2005 to CNY6.0 per 2005 USD in 2010, the average rate of energy efficiency improvement in real dollars for China would exceed 41 percent (column 9 in Table 21). Energy intensity is linked to foreign exchange rates in a real way, as these rates play an important part in the demand for products from Chinese manufacturers, but also in this nominal way, so care is required when evaluating the energy intensity index.

Table 21: Regional economic and energy patterns for manufacturing, sorted by manufacturing index

	Area	Location	Manufacturing index[1]	Export index	NET export	Benchmark in 2005	Decline Rate	Objective in 2010[2]	Decline Rate[3]
			Share of production in total of China	Share of export in total of China	Bn. USD (2007)	Tons of standard coal per 10,000 CNY	2010 to 2005 (%)	Toe per 1000 USD (2005)	2010 to 2005 (%)
	1	2	3	4	5	6	7	8	9
1	Guangdong	Coastal	15.50%	30%	104	0.79	16	0.28	39
2	Jiangsu	Coastal	13.10%	17%	58	0.92	20	0.31	41
3	Zhejiang	Coastal	10.30%	11%	80	0.9	20	0.3	41
4	Shandong	Coastal	10.10%	6%	28	0.88	20	0.29	42
5	Shanghai	Coastal	8.20%	12%	5	2.95	25	0.93	45
6	Beijing	Capital municipality	5.20%	4%	-95	0.8	20	0.27	41
7	Anhui	Neighbour to coastal	5.20%	1%	2	1.21	20	0.41	41
8	Henan	Neighbour to coastal	4.10%	1%	4	1.38	20	0.46	42
9	Tianjin	Coastal	3.70%	3%	5	1.11	20	0.37	41
10	Liaoning	Coastal	3.60%	3%	11	1.83	20	0.61	42
11	Hubei	Centre	2.60%	1%	1	1.51	20	0.51	41
12	Sichuan	West	2.10%	1%	3	1.53	20	0.51	42
13	Fujian	Coastal	1.90%	4%	25	0.94	16	0.33	38
14	Jilin	North	1.90%	0%	-3	1.65	30	0.49	49
15	Chongqing	Centre	1.80%	0%	2	1.42	20	0.48	41
16	Yunnan	South	1.50%	0%	1	1.73	17	0.6	39
17	Hebei	North	1.20%	1%	8	1.96	20	0.66	41
18	Gansu	West	1.10%	0%	-2	2.26	20	0.76	41
19	Shaanxi	Centre	1.00%	0%	2	1.28	22	0.42	43
20	Guangxi	South	1.00%	0%	1	1.22	15	0.44	38
21	Jiangxi	South	1.00%	0%	1	1.06	20	0.36	41
22	Inner Mongolia	North	1.00%	0%	-2	2.48	25	0.78	45
23	Hunan	Centre	1.00%	1%	3	1.4	20	0.47	41
24	Heilongjiang	North	0.80%	1%	7	1.46	20	0.49	41
25	Guizhou	South	0.70%	0%	1	3.25	20	1.09	41
26	Hainan	South coastal	0.30%	0%		0.92	12	0.34	36
27	Shanxi	Centre	0.10%	1%	1	1.48	20	0.5	42
28	Xinjiang	West	0.10%	1%	9	2.11	20	0.71	41
29	Ningxia	West	0.10%	0%	1	4.14	20	1.39	41
30	Qinghai	West	0.00%	0%	0	3.07	17	1.07	39
31	Tibet	West	0.00%	0%	0	1.45	12	0.54	35

Sources: (NBS 2008a), (NBS 2008b), Tables 13–23 and 17–11, (State Council 2006b), and (OANDA n.d.). Notes: 1) Manufacturing index is calculated for 14 items. 2) Objective in 2010 was calculated using 6.0 as rate of 2010CNY to 2005USD. 3) Average annual exchange rate for 2005 is CNY8.2 per USD.

Policies

Chapters 1 and 2 describe the general scope of current policy and institutions in China mandated to improve energy efficiency. The chapters discuss a few important excerpts from the laws and regulations that are particularly important regarding the manufacturing sector of the Chinese industry. The Energy Conservation Law of the People's Republic of China, amended in 2007, is a key driver of energy efficiency and conservation in the manufacturing sector:

- Article 58 requires that institutions shall "formulate and promulgate the catalogue of energy-saving technologies and products for popularisation, and guide energy-consuming entities and individuals in using advanced energy-saving technologies and products".
- Article 61 says "the State implements supportive policies including tax preferences for production and use of energy-saving technologies and products in need of support and listed in the catalogue set forth in Article 58 hereof".
- Article 67 has an important effect on policy implementation, as it mandates that "people's governments at various levels shall commend and award those entities and individuals who have made outstanding achievements in the research, popularization and application of energy sciences and technologies and report on acts of serious energy waste".
- The seriousness of the policy to improve energy efficiency in manufacturing is shown in Article 70: "Where anyone manufactures, imports or sells energy-consuming products or equipment not in compliance with statutory standards for energy efficiency, the department in charge of product quality supervision shall order the same to stop production, import and sales thereof, confiscate the energy-consuming products or products illegally manufactured, imported or sold and any illegal proceeds, and impose a fine of more than 100 percent but no more than 500 percent of the illegal proceeds. Where the circumstance is serious, the administration for industry and commerce shall revoke the business license".[1]

The following are excerpts from "Introduction to the Energy Conservation Work in Hangzhou High-Tech Zone", a document by the administration of the Hangzhou High-Tech Zone (HHTZ), published in 2008. This provides first-hand evidence of current policy implementation in SEZs in China:

- The district leader shall ... on behalf of the district government sign a Letter of Responsibility on Annual Energy Conservation Target with key energy consumption enterprises.
- The new industrial projects must be compliant with relevant national, provincial and municipal standards. New projects with integrated energy consumption per CNY10,000 production value of more than 0.05 tonnes of standard coal will not be approved, in principle. New projects with high energy consumption must be strictly controlled.
- The Administration will conduct transformation of high energy consuming enterprises and high pollution by means of withdrawals and shutdowns.
- The Administration has realised the importance of the population's attitude toward resource (and energy) conservation, and thus information spreading is used for purposes of social advertisement: Establish the reporting system on energy consumption index.... Implement a quarterly publicising system on energy consumption, and enterprises performing badly in terms of energy conservation and consumption reduction would be publicised.... Publicise energy conservation slogans and the related energy conservation and consumption policies through newspapers, websites, promotional books and

[1] (NPC 2007)

banners, etc. to enhance the people's energy conservation awareness.[2]

The last but maybe most important mechanism for energy efficiency policy implementation is human resource management. Capacity-building and human resource performance evaluation processes in China are growing to new dimensions. In a section of the "Implementation Plan for Evaluation System of Energy Consumption per Unit GDP" that discusses Rewards and Penalties, the National Development and Reform Commission recommends that cadre administrative departments evaluate leaders in provincial governments using the results of provincial progress toward energy intensity reduction as an important criterion.[3]

This quick observation gives some idea of the leverage that governments and administrations at different levels in China have available to implement long-term policies for resource conservation in general and improvement of energy efficiency in particular. In economic-geographical terms it positions the SEZs to lead as a production base for advanced and green technologies for the rest of the economy.

Implications

The following implications can be drawn from an analysis of the case studies in the manufacturing sector conducted by the APERC team during trips to various regions of the People's Republic of China in 2007-2008.

In previous stages of energy efficiency policy implementation in China, the advantages of the centralised economy were used in a reasonably proper manner. Research, design and development activities of state-owned enterprises were concentrated at pivotal facilities, such as the Shanghai Industrial Boiler Company and Institute of Shanghai Industrial Boilers working in tandem. In order for energy efficiency to be promoted on a national scale, advanced technologies and know-how were then duplicated, transferred, and copied throughout the economy.

Currently, due to the ongoing privatisation process in China, this policy is being transformed in order to separate and differentiate activities, such as government funding of R&D through financial mechanisms. The most efficient equipment is being promoted, and poorly performing equipment is being made known by means of lists of "recommended" and "non-recommended" items at the national and province level.

Strong government control of energy intensity indicators at all levels of state-business interactions (from the central level to the municipal and even neighbourhood level), and strong commitment of officials to the nation's objectives are important factors for policy implementation.

Relocating industrial bases from downtown areas to megacity outskirts or rural areas provides the opportunity not only to improve manufacturing energy efficiency through renovation and upgrading of equipment and construction of buildings compliant with the latest and best standards, but also to drive local economic activity, logistics, and so on.

Producers of equipment and appliances have an additional incentive to add to their catalogues more energy efficient and environmentally-friendly products. This award is to be included in the economy-wide list of recommended energy-efficient goods, thus being well-advertised nationally.

The energy price deregulation trend will cause production costs to rise, and so it will provide an economic incentive for manufacturers to conserve energy.

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[2] (HHTZ 2008)
[3] (NDRC 2007c)

Case Study: The Shanghai Industrial Boiler Co., Ltd. (SIBC)

The Shanghai Industrial Boiler Company (SIBC) has been manufacturing industrial boilers and pressure vessels since its establishment in 1931. SIBC is one of the key enterprises in the Chinese energy equipment manufacturing industry. SIBC products have advanced designs that are rated highly according to major indicators—energy saving, high heat efficiency, clean environment, and operating reliability. Some of these boilers have received awards from China's Machinery Industry Ministry and the Shanghai municipality. SIBC products are delivered to consumers in China and are exported to developing economies all over the world.

Progress and Drivers of Product Improvement

The Shanghai Industrial Boiler Company has seen more than four waves of product improvements. A policy for energy efficiency improvement was enforced in China in the 1970s, in the wake of coal shortages and rising pollution problems. The Shanghai municipality was greatly affected by these problems. SIBC took advantage of the unique opportunity of being the most advanced industrial base in the then Ministry of Light Industry and its proximity to research facilities. The industrial achievements in boiler efficiency were assisted by the Shanghai Industrial Boiler Institute, at that time a central government organisation of the former Machinery Ministry. The efficiency of the company's main products—small boilers with capacities of up to 20 tonnes of steam per hour—was improved by 10 to 15 percent, to reach 65-70 percent efficiency. At the same time, the design and manufacturing capability of the boiler works itself were upgraded.

The second stage of production improvement was a response to the challenge posed by rising concern about energy supply disruptions and environmental issues. In the 1980s, the boiler company acquired US technologies to further improve energy efficiency and environment indicators. The mean coal boiler efficiency increased to state-of-the-art levels, and emission indexes fell significantly. The latest step in SIBC production line enhancement was prompted by the growing access to natural gas in such areas as Beijing-Tianjin, the Yangtze River delta and the Pearl River delta in Guangdong province. The new market for small natural gas boilers for industrial and civil use is booming, and SIBC is reaping the benefits of being the most advanced company to enter this market and keep its products up to the world-class benchmarks. The expansion of the natural gas infrastructure in China is providing exclusive opportunities for the company, which is not hesitating to gain momentum and extend its business.

Importance of SIBC in China's Progress in Improving Energy Efficiency

The Shanghai Industrial Boiler Company and the Institute of Shanghai Industrial Boilers are credited for introducing high standards and regulations at the national level. The series of boiler manufacturing capability upgrades was crucial to the overall progress of China's drive for energy efficiency improvement, following the incorporation of R&D results in new products. Advanced coal technologies developed by SIBC have been transferred to over 150 boiler manufacturing enterprises throughout China.

There are several factors that provide incentives for and facilitate this particular business. Historically, the Shanghai Industrial Boiler Company, as a leader and advanced manufacturer of energy equipment, has had a close relationship with the central government. High quality and good performance have enabled the company's products to be placed on the all-China lists of recommended products and services. These lists were officially established by the new Energy Conservation Law, which entered into force in April 2008. The government support for energy efficient products through their promotion is one of the important drivers that enable SIBC to match world-class performance indicators for such equipment. Another driver is the improvement of the company's commercial image that comes from receiving awards from governments at different levels—central to municipal—for outstanding product performance: ASME, Honour Certificate, Famous Certificate, High and New Technology Certificate, and other awards.

A former state-owned enterprise, SIBC was privatised in 2003, and the government currently holds just 20 percent of its shares. Having become a publicly-traded company, SIBC is basing its business policy on government guaranties that the current energy efficiency policy is long-term due to its sound implementation at all levels of government. Additionally, penalties for not complying with technical standards are strict, and include a fine of CNY1 million per boiler that must be paid by the company to any customer that buys a "nonconforming" boiler. Reportedly, SIBC has never been fined, as its products fully comply with best-technology indicators.

SIBC as an Energy Consumer

At the time of the survey team's visit to the SIBC production site, its production facilities were moved to another site 50 kilometres away because of the start of construction of the Shanghai World Expo. It should be mentioned that this relocation was not initiated by any factors other than city development plans. However, this incidentally provides an example of how existing manufacturers can upgrade their capacities, improve efficiency, and simultaneously increase provincial value added at the same time new opportunities are created for logistics, incremental traffic improvement, and services within the Shanghai municipality. Additionally, relocating the production base from the centre of cities of millions of inhabitants to their outskirts will significantly improve local environments, while introducing state-of-the-art technologies will not deteriorate the environment at the new locations. SIBC is subject to various inspections and audits, in line with the existing regulatory framework for energy saving, energy efficiency improvement, and recycling issues. This provides ongoing pressure for energy efficiency improvement. No doubt SIBC will capitalize on this opportunity to improve the company's own energy efficiency while relocating its production facilities to the city's outskirts.

Case Study Sources: (SIBC n.d.) and (SIBC 2009)

Toward Efficient Living: The Residential and Commercial Sectors

Energy consumption in the residential and commercial sectors of China has steadily and rapidly increased in step with the country's economic development. These sectors' roles in energy saving receive attention from the government due to their potential for improvement. In fact, a number of administrative rules have been issued over the past 20 years to reduce energy consumption in these sectors.

This chapter describes the background of energy use in the residential and commercial sectors and identifies the factors that affect the energy efficiency of the sectors. Next, the relevant energy efficiency policies are introduced. Finally, the approaches to implement those policies and achievements to date, or expected achievements, are described. Then implications drawn from this analysis are presented at the conclusion of the chapter.

Background

Based on IEA data, in 2006 the total final energy consumption of the residential sector in China reached 341 Mtoe and accounted for 28.3 percent of the total (Figure 17). This is a substantial decline of 23.6 percentage points from 51.9 percent in 1976 (Figure 18). Still, the residential sector is the second largest energy consumer after the industry sector. The commercial sector consumed 43 Mtoe in 2006, accounting for just 3.6 percent of total final energy consumption (Figure 19). In contrast to its small share, however, the commercial sector's energy consumption grew at a leading rate of 7.7 percent a year on average between 1976 and 2006, if non-energy use is excluded.

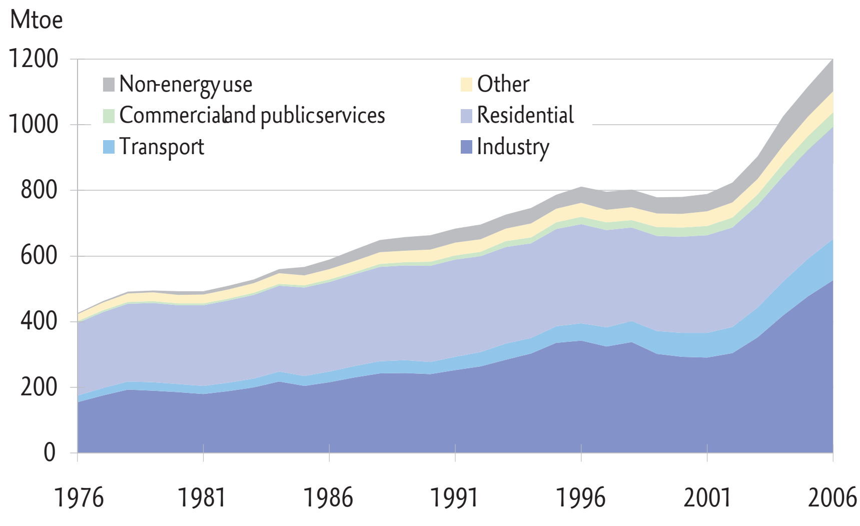

Figure 17: China's final energy consumption by sector
Note: "Other" includes agriculture/forestry and non-specified subsectors. Source: (IEA 2008)

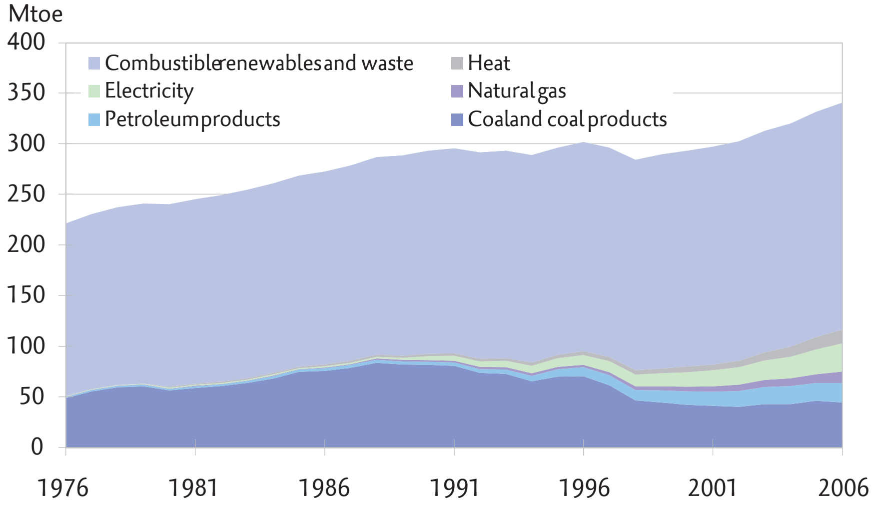

Figure 18: Final energy consumption of the residential sector
Source: (IEA 2008)

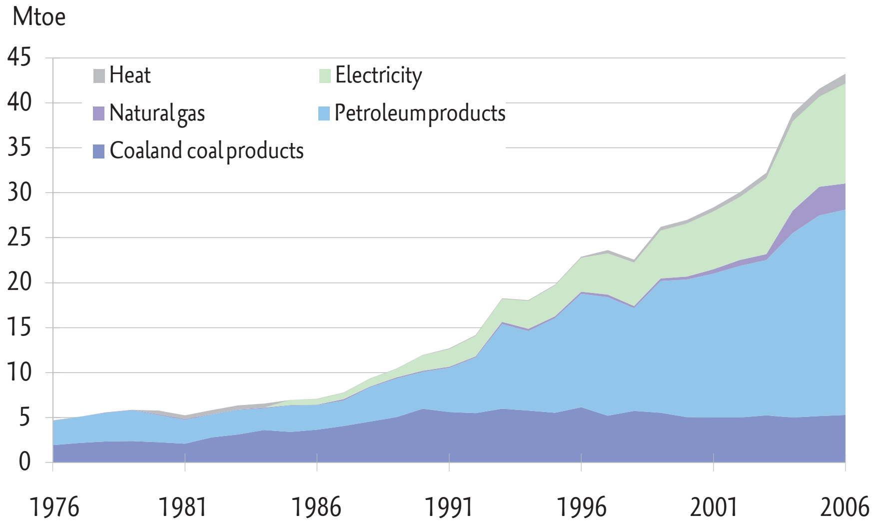

Figure 19: Final energy consumption of the commercial sector
Source: (IEA 2008)

The following two examples illustrate how energy consumption has substantially increased in the residential and commercial sectors as a consequence of rapid economic development. First, China has seen lifestyle changes accompanying income growth, such as the pursuit of comfort and convenience. This is reflected in significant increases of home electrical appliance ownership nationwide, including in rural areas. Figure 20 below shows the ownership of electrical appliances per 100 urban and rural households for four major appliances—washing machines, air conditioners (ACs), refrigerators, and colour TVs. Ownership of home electrical appliances has nearly reached the saturation point in urban households. As for colour TVs in particular, urban households typically own more than one. Although there is a wide ownership gap between urban and rural households, ownership of all appliances has steadily grown in rural areas with high annual growth rates for the last decade.[1] This trend is expected to continue, and the gap between urban and rural households is likely to narrow in the future.

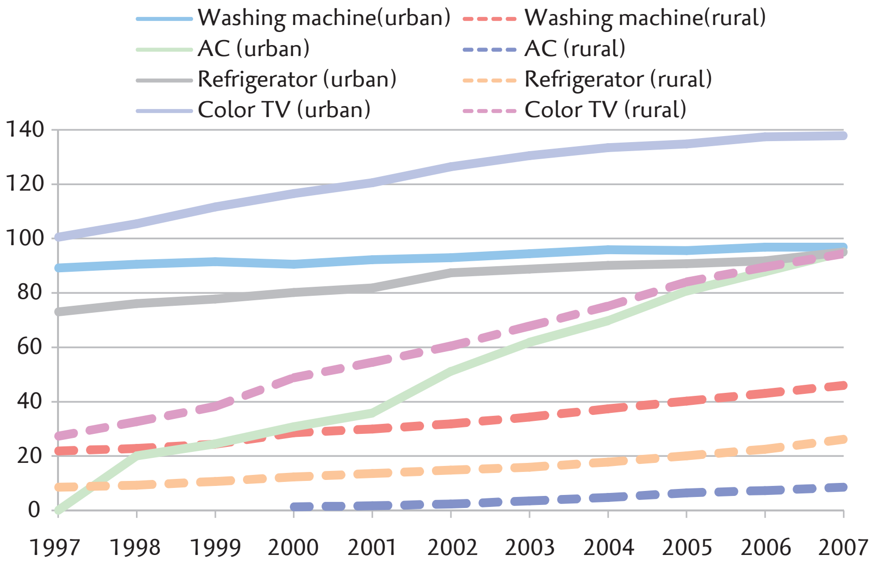

Figure 20: Ownership of electric appliances per 100 urban/rural households
Source: (NBS 2008b)

The second example is that China has been in a rush to construct new buildings, which has boosted energy consumption. A general trend has been noted that annual additions of building floor space are positively related to Gross Regional Product (GRP) per capita, at least until GRP per capita reaches around USD13,000 (2005 PPP) and then building growth moderates (Figure 21). Such robust development is seen in the focus regions of this report—especially in Jiangsu, Zhejiang, and Guangdong.

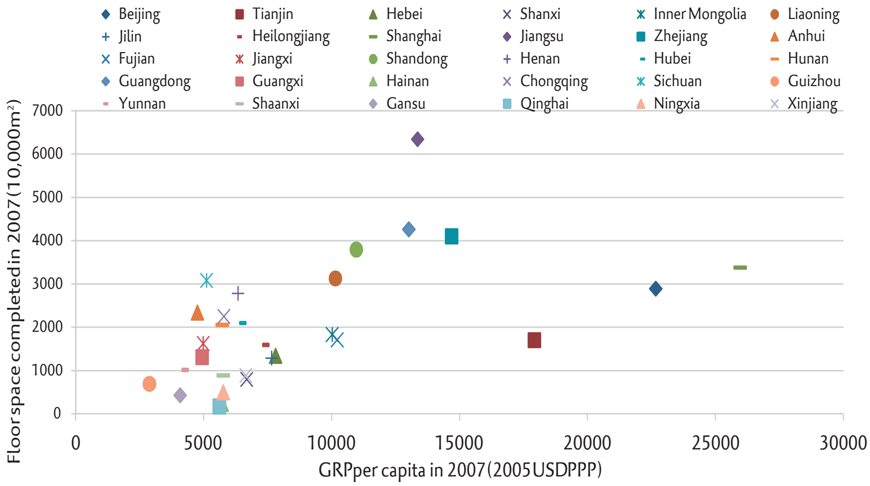

Figure 21: Floor space of buildings completed and GRP per capita (2005 USD PPP) in 2007
Source: (NBS 2008b)

[1] The annual average growth rate of the appliances between 1997 and 2007 in rural households is 7.7 percent for washing machines, 11.9 percent for refrigerators, and 13.2 percent for colour TVs. AC ownership grew at an annual average of 30.6 percent between 2000 and 2007 in rural households.

Building construction apparently continues to boom even nationwide. As Figure 22 indicates, many of the regions that are at around the GRP per capita level of USD5,000 show significant increases in the growth rate of floor space additions since 1999 when the average annual growth rate of floor space of new buildings is considered.

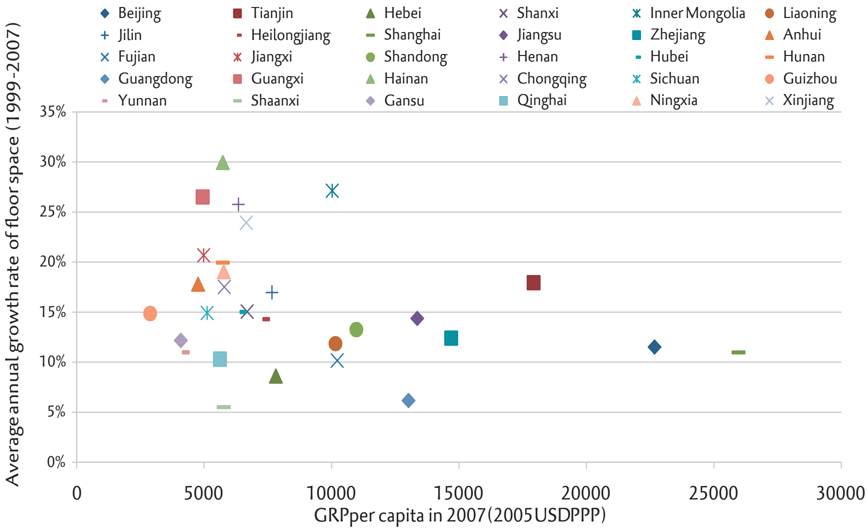

Figure 22: Average annual growth rate of floor space and GRP per capita (2005 USD PPP) in 2007

Source: (NBS 2008b)

Factor analysis can also identify the influence of several key drivers of energy consumption in the residential sector. Electricity is used as a proxy to indicate the change in energy consumption over the last decade in the residential sector, and provincial energy intensity is the electricity consumption per gross regional product (see Table 22). A breakdown of the growth of residential electricity consumption in the regions of the four pillars—Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Guangdong, Chongqing and Sichuan—over the period 1998 to 2007 shows that declining energy intensity has slowed the growth of energy consumption. However, the modest improvements in energy intensity are overshadowed by large increases in per-capita income. In most cases, population growth also appears to contribute to increased energy consumption. This indicates that the balance of influences in the residential sector over the past decade has been overwhelmingly on the side of increasing electricity consumption. Therefore, strong policies with effective implementation are required to restrain the growth of energy consumption in the residential sector.

Table 22: Residential energy decomposition, 1998–2007

Province	Intensity	Income	Population	Residual	Change in Electricity
Beijing	-33.2	550.9	79.0	66.4	663.1
Tianjin	-55.2	306.3	40.9	-59.9	232.1
Shanghai	-8.7	419.9	165.1	160.2	736.4
Jiangsu	-165.6	1711.9	52.7	-257.0	1341.9
Zhejiang	-96.0	1335.1	93.8	-43.6	1289.4
Guangdong	-393.9	2303.7	461.5	-230.1	2141.1
Chongqing	-132.1	666.4	-23.5	-248.6	262.2
Sichuan	-67.7	1004.4	-13.6	-132.4	790.7

Source: APERC analysis with data from (NBS 2008a)[2]

Policies

Policies to improve energy efficiency or promote energy conservation have been actively developed, especially after China entered the period of the 11th Five-Year Plan, although a series of policies for energy efficiency were in place since the 1980s. The amended Energy Conservation Law that came into force in April, 2008 is another milestone. It is expected to be more effective in reining in the residential and commercial sectors' energy use because of its expanded coverage, clarified energy conservation standards and duties of relevant departments, and strengthened incentives and legal liabilities.[3]

The importance of energy efficiency standards in the residential and commercial sectors can be seen in the China Medium- and Long-Term Energy Conservation Plan (referred to as the 2004 Plan below) which was addressed by the NDRC in 2004 and later integrated into the 11th Five-Year Plan.[4] The 2004 Plan was a comprehensive strategy that aimed to promote rational energy use, reduce energy intensity, and alleviate obstacles to energy conservation and environment protection. The 2004 Plan listed "10 key projects" as an important area that had substantial potential for energy conservation. Four projects of the 10 are related to the residential and commercial sectors: Building Energy Conservation Projects, Green Lighting Projects, Government Agency Energy Conservation Projects, Energy Saving Monitoring and Testing, and Technology Service System Building Projects.[5]

This section identifies three major aspects of energy efficiency standards in the residential and commercial sectors: one, building design and materials; two, electrical appliances and equipment used in buildings and residences; and three, information on energy efficient products.

First, energy efficiency standards for building design and materials play an important role in energy saving.[6] At the national level, energy efficiency standards for buildings date back to 1986 when the Design Standard for Civil Building Energy Conservation was adopted. This required energy efficiency to be improved 30 percent from the initial year of the standard. The

[2] The factor analysis uses a Divisia index method. For a discussion of decomposition methods, see (Ang and Zhang 2000).
[3] (IEEJ and ERI 2008)
[4] The China Medium- and Long-Term Energy Conservation Plan elucidates a plan to meet the objectives of energy conservation and the focus of development by 2010 and a proposal for attaining the objectives by 2020; (NDRC 2004).
[5] The other six projects are Coal-Fired Industrial Boiler Retrofit Projects, District Cogeneration Projects, Residual Heat and Pressure Utilization Projects, Petroleum Saving and Substituting Projects, Motor System Energy Saving Projects, and Energy System Optimization Projects; (NDRC 2004).
[6] Energy efficiency of building materials is mainly related to insulation in floors, walls, and ceilings. In addition, equipment such as windows and doors is critical in building energy efficiency, since heat loss from these components is substantial.

standard was later increased to 50 percent in an amendment in 1996. Then, the Administration on Energy Conservation of Civil Buildings, which replaced the aforementioned standard, was adopted on 1 October, 2000. In the case of some large cities such as Beijing, Shanghai, and Tianjin, achievement of at least 65 percent of the energy efficiency standards is required. There are also energy conservation design standards based on various climate conditions.[7]

More recently, the Energy Conservation Regulation for Civil Buildings (referred to below as the 2008 Regulation) was adopted at the State Council in July, 2008 and became effective on 1 October of that year.[8] It stipulates roles and responsibilities for the national government, the relevant ministries, and local governments. It also promotes the use of renewable energy sources such as solar and geothermal for energy conservation work. The 2008 Regulation also specifies what work and what roles individuals are expected to perform in building construction and renovation. China's target is to save 100 million tonnes of standard coal by improving the energy efficiency of buildings by 2011.[9]

The second major aspect of energy efficiency standards in the residential and commercial sectors is that improving energy efficiency in lighting and electric home appliances as a way to save energy in buildings. China's first product efficiency standards were introduced in 1989 when minimum energy performance standards (MEPSs) were adopted. Initially, eight home electrical appliances were subject to the MEPSs. These were refrigerators, room air conditioners, washing machines, television sets, automatic rice cookers, radios and recorders, electric fans, and electric irons. The standards have since been revised to expand coverage and to account for technical development. Currently, 22 major home and commercial electrical appliances and other equipment are regulated under the MEPSs.[10] In the future, the energy efficiency standards are expected to expand further.[11]

China has underscored the importance of using energy efficient lighting. "Green Lighting Projects" were listed as one of 10 key projects of the 2004 Plan because approximately 13 percent of national electricity use was accounted for by lighting equipment, and electricity use by incandescent lamps (ILs) was 2.6 times greater than that by fluorescent lamps.[12] The Green Lighting Programme originally launched in 1996 is being promoted during the 11th Five-Year Plan (2006-2010) in partnership with the United Nations Development Programme and the Global Environment Fund, both of which worked with China on this programme in the 10th Five-Year Plan period as well. In the background to this programme is that China is not only one of the largest consumers but also one of the top manufacturers of lighting products, both ILs and compact fluorescent lamps (CFLs). Energy savings and CO2 and SO2 emission reductions are expected through transformation of the local lighting products market as ILs are phased out and CFLs are promoted.[13]

[7] (IEEJ and ERI 2008)
[8] Civil buildings are residential buildings, state organizations' office buildings, and other public buildings used in commerce, service industry, education and health; (State Council 2008a).
[9] Out of 100 million tonnes of standard coal (mtosc), 61.5 mtosc will be saved by strict energy efficiency control in new buildings, 16 mtosc by two types of heating supply system retrofitting - heating supply system retrofitting and installing heating meter and retrofitting, 11 mtosc by better operation management of the governmental office buildings and large public buildings, and 11 mtosc by the application of renewable energy in buildings such as solar energy, geothermal energy and biomass energy; (Cai, et al. 2009).
[10] In addition to the initial eight appliances, other appliances included in the MEPS are florescent lamp ballasts, small electric motors, compact florescent lamps, linear fluorescent lamps, HPS lams, HPS lam ballasts, instantaneous gas water heaters, external power supplies, and commercial packaged air conditioners; (N. Zhou 2008).
[11] (NDRC 2009)
[12] (NDRC 2004)
[13] According to the NDRC, if 150 million energy efficient lamps are replaced, 29 billion kilowatt-hours of electricity could be saved annually, along with annual reductions of 29 million tonnes of CO2 and 0.29 million tonnes of SO2. (Xinhua News Agency 2008a)

The third aspect is the use of labelling programmes as a method to provide the public with information about the energy efficiency of products. Adapted from the EU categorical energy labelling programme, mandatory energy information labelling was initiated in March 2005. It covered household refrigerators and room air conditioners and then was expanded to cover more products including equipment other than home appliances (Table 23).[14] As of February 2009, more than 800 enterprises with over 50,000 products are registered for the programme.[15] Similar to the US Energy Star programme, also, the China Standards Certification Center (CSCC) administers the voluntary energy efficiency endorsement labelling programme, which covers 50 types of products of over 300 participating manufacturers.[16]

Table 23: Designated products under energy labelling programme in China

March 1 2005	March 1 2007	June 1 2008	March 1 2009
Household Refrigerator	Electric washing machine	Self-ballast flourescent lamp	Frequency-conversion air conditioner
Room air conditioner	Unit air conditioner	High-voltage sodium lamp	Multi-connected air conditioner
		Medium-and-small-sized three-phase induction motors	Display
		Cold water chillers	Copier
		Domestic instantaneous gas water heater and gas heater	Electric water heater
			Induction cooker

Source: (Xin 2009)

Furthermore, in 2008 China established a building energy efficient certification system to inform consumers about energy efficiency of buildings. The certification system includes assessment of three kinds of items—basic, compulsory, and optional—and indicates five levels of building energy efficiency.[17]

Implementation

Implementation of Building Energy Standards

The 2008 Regulation indicates the roles of the national and regional governments' implementation process. At the government level, the construction administrative department of the State Council is in charge of supervising and managing energy conservation in civil buildings nationwide, while the construction administrative departments of various local people's governments are responsible for administering the energy efficiency improvement of buildings in their jurisdiction. Also, relevant departments in regional governments such as the urban planning department are required to take the energy efficiency standards into consideration.

[14] The energy efficiency label includes 1) the name of the manufacturer, 2) specifications and type of product, 3) energy efficiency grade, 4) energy consumption, and 5) the code of the applicable national standards for energy efficiency; (NDRC and GAQSIQ 2004). Approximately a quarter of household electricity consumption is accounted for by refrigerators, followed by air conditioners (Brockett, et al. 2004).

[15] (Xin 2009)

[16] (N. Zhou 2008)

[17] The basic item is the unit energy consumption by heating, ventilation and air conditioning (HVAC) units. The compulsory item is the requirements that must be reached by enclosed structures and HVAC units. Examples of the optional items for additional scores are renewable energy, energy recycle technique, cooling and heating storage techniques. (Cai, et al. 2009).

The private sector's participation in achieving the standards is also provided for in the 2008 Regulation, which states that building designers and engineers, construction companies, and building owners must follow the compulsory energy efficiency standards and use appropriate materials and electrical appliances. For example, not only are the construction companies required to use energy efficient materials, but also the engineering supervision companies must monitor if the construction company under contract is compliant, especially in installing heat insulation in walls and ceilings. Furthermore, the 2008 Regulation also reminds owners or users of buildings to operate them appropriately.

The 2008 Regulation spells out the liability of a party that fails to meet the regulations. The legal responsibilities specified in the 2008 Regulation should encourage government officials to comply with the regulations and achieve the target. If these officials fail to follow the regulations, they could be subject to legal penalties. Similarly, at the enterprise level, the construction companies, the building designers and engineers, and the manufacturers of electrical appliances and equipment should be motivated to comply with the regulations because of the negative consequences of noncompliance. On the other hand, the honour or award given by the government in cases of high performance brings valuable prestige that enterprises can show in promoting their products.

There is also evidence of local actions to promote compliance. Guidelines on the use of building materials and design in residential buildings have been issued in major cities such as Beijing and Shanghai. For instance, Shanghai issued the Administration Procedures of Shanghai Municipality on Building Energy Conservation in 2005 (referred to below as the 2005 Shanghai Procedures) to strengthen administration of building energy conservation and to foster use of energy efficient materials for buildings. The 2005 Shanghai Procedures encourage mandatory energy conservation standards to be met in all stages of building construction from design to supervision.

Because the 2005 Shanghai Procedures promote strengthened supervision and administration by municipal and district administrative departments of construction, Shanghai has strived to establish an energy efficiency supervision system for government office buildings and large public buildings. In order to monitor building energy consumption effectively, the Shanghai government has provided funds directly to the building owners who were in charge of design, construction, operation, and maintenance of energy efficiency supervision systems, and directed the Shanghai Architectural Scientific Research Institute to establish a monitoring platform.[18]

Improvement of the supervision system is necessary to enhance the effectiveness of energy efficiency programmes and projects. Strict inspection seems to work to improve compliance with the energy efficiency standards. After investigating the compliance level of more than 3000 projects in 2005, the Ministry of Housing and Urban-Rural Development of China (MOHURD) increased the level of scrutiny.[19] As a result, the share of the projects that were designed to meet the energy efficiency standard increased from 58.5 percent in 2005 to 95.7 percent in 2006 and 97 percent in 2007, and the share constructed to satisfy the standards also improved from 23.3 percent in 2005 to 53.8 percent in 2006 and 71 percent in 2007.[20]

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[18] (Zhao, Wu and Zhu 2009) point out some obstacles that are observed in the regions they studied with regard to the national energy efficiency supervision system: 1) incomplete understanding of the importance and urgency of such a system, 2) inadequate financial incentive policy, 3) lack of technology to support the system, and 4) lagging progress in energy consumption statistics, energy audit, and energy efficiency public notice.

[19] MOHURD, which was reorganized from the former Ministry of Construction and set up in 2008, is responsible for not only building energy efficiency supervision and management but also policy development on urban and rural planning and development, and the building industry on the whole; website: http://www.mohurd.gov.cn (Chinese).

[20] (Cai, et al. 2009)

Implementation of Energy Efficiency Standards for Home Electrical Appliances and Equipment

Energy efficiency standards are primarily implemented at the national level. The State Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) is the main authority administering the standards. Under AQSIQ, the Standardization Administration of China (SAC) is in charge of reviewing and approving new energy standards and China National Institute of Standardization (CNIS) is responsible for developing standards. CNIS and CSCC offer technical support to NDRC, which develops energy efficiency policies. At the regional government level, local AQSIQ branches take a part in implementation processes such as organizing national product quality testing and enforcing actions against offenders.[21]

Manufacturers participate in implementation processes to comply with the mandatory energy efficiency standards in several ways. To meet the standards, usually the manufacturers aim to produce energy efficient products. Consequently, the main effect of the MEPS is to facilitate elimination of inefficient products from the market. In the case of appliances and equipment used in buildings, it is estimated that an energy savings of approximately 15-30 percent could be attained if advanced energy efficient products were used.[22] Additionally, the manufacturers play an important part in establishing energy efficiency standards because the government asks for their input in order to set appropriate targets.[23] The case studies presented at the end of this chapter give further details on this process.

The existing mandatory energy efficiency standards have been revised to be more stringent in line with the development of technology. The standards for refrigerators have been revised three times already since their introduction in 1989; these standards were revised in 2000, 2003, and 2009. In the latest revisions, the energy efficiency levels of the five grades of refrigerators were upwardly revised from the 2003 version. The revisions are necessary to encourage the manufacturers to improve their products to meet higher standards comparable to international ones.[24]

Green Lighting Projects have demonstrated some achievements in energy saving. For the previous China Green Lighting projects, the UNDP reports that 25.5 billion kWh of cumulative savings in lighting energy was achieved in 2004.[25] The projects also promoted technology development: for instance, increasing the working lifetime of electric lamp ballasts and some high-efficiency lamps, and producing lighting equipment that met the product standards. In the 2004 Plan, the NDRC estimated that, regarding Green Lighting Projects, electricity can be reduced 70 to 80 percent if high-efficiency florescent lamps are substituted for incandescent lamps and 20 to 30 percent if electronic ballast is substituted for traditional inductive ballast.[26]

But there are obstacles blocking the wide use of energy efficient products. For instance, the level of compliance with the standard seems unclear due to weak and incomplete enforcement. Zhou (2008) observes that compliance rates vary by product type and by region.[27] Consistent enforcement nationwide is necessary.

High up-front costs for the end-users are also an obstacle to the use of energy efficient products. A long time is needed before energy efficient products yield financial benefits in many cases, even though advanced technology for energy efficiency improvement is available.

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[21] (N. Zhou 2008)
[22] (SGEC 2009); (Tellhow 2009)
[23] (SGEC 2009)
[24] The most efficient models of Chinese refrigerators in certain small sizes have become comparable to world-class efficiency levels such as EU and US standards; (Fridley, et al. 2009).
[25] (UNDP 2007)
[26] (NDRC 2004)
[27] Beijing demonstrated higher compliance rates compared to Guangzhou and Hefei; (N. Zhou 2008).

Hence, it is necessary for the government to provide end-users with financial incentives such as tax rebates and low interest rates in order to encourage them to apply. One of the key revisions to the Energy Conservation Law in 2008 was the addition of Section V, which defines a role for the state as provider of incentives—including subsidies, tax benefits and credits—for energy efficiency projects, and support in developing efficient products.[28]

As one strategy for improving energy efficient technology, some private companies choose to work jointly with foreign companies that own advanced technologies. For instance, Tellhow Technology Co., Ltd., which is based in Beijing and specializes in manufacturing and installing intelligent building systems, took advantage of a joint venture. In 2006, Tellhow Technology Co., Ltd. reached an agreement to establish a joint venture, Beijing Tellhow Intelligence Technology Ltd., with Panasonic Electric Works Co., Ltd. (the Japanese electrical products manufacturer) and Mitsui & Co., Ltd. (the Japanese trading company). Panasonic's advanced building energy-saving techniques and systems and Mitsui's management know-how were combined with Tellhow's advantages in the infrastructure and buildings market in China. While Tellhow acquired opportunities to increase its market share in energy-saving buildings, its counterparts found benefits in this project such as expanding their business in China.[29]

Implementation of Product Labelling Programme

The labelling programme is designed to give manufacturers an incentive to produce energy efficient goods and to give consumers the information to select those goods. After China faced pressures in the areas of energy security and the environment as a result of rapid industrialisation and urbanisation, the national government recognised the need to change the labelling programme from voluntary to mandatory for selected appliances as an important energy conservation tool.

The programme is primarily implemented at the national level, similar to the mandatory energy efficiency standards for electric appliances. The NDRC, the AQSIQ, and the National Certification and Accreditation Administration (CNCA) are responsible for establishing the energy efficiency labelling system. The NDRC, AQSIQ, and CNCA implement the programme by creating a catalogue of products that are required to display energy efficiency labels, while the NDRC and CNCA formulate and promulgate uniform specifications for the labels.[30]

At the regional government level, the energy conservation administrative department of the local people's government, the local quality and technical supervision department at each level, and the entry and exit inspectors and quarantine inspectors at each level are in charge of supervision and inspection regarding the energy efficiency labels in each jurisdiction. In addition, the local energy conservation administration authority and the local quality supervision authority are to impose penalties on activities that violate the regulations.[31]

Manufacturers or importers of designated products are required to conduct tests in their own capacity or by means of an accredited testing institution in order to determine the energy efficiency grade of the products, based on the national standards. They are also obliged to use the energy efficiency labels as specified in the regulations, to report to the authorities about such items as their business license and testing results, and to accept supervision and inspection. If a manufacturer or importer fails to follow the regulations, the local energy conservation administration authority and local quality supervision authority first order the problem to be corrected. If the company does not fix the problem, its activities are made public. If the problem is considered serious, a fine of less than CNY10,000 is imposed on the

[28] (NPC 2007).
[29] (Mitsui & Co., Ltd. 2006)
[30] (NDRC and GAQSIQ 2004)
[31] (NDRC and GAQSIQ 2004)

manufacturer or importer.[32]

Implications

A challenge that China faces with regard to energy efficiency in the residential and commercial sectors is the need to improve energy intensity without impending economic development. As the factor analysis illustrated, increasing income increases energy consumption in the residential sector. Energy efficiency, especially as implemented through building and product standards, offers a promising approach to improving energy intensity while increasing the competitiveness of domestic manufacturers.

The role of enterprises is crucial in improving energy efficiency. Some assignment of responsibility, including the penalties for non-compliance and awards for exceptional performance that are specified in the national policies, spur action at the local level. The bottom-up approach of the manufacturers will improve the effectiveness of policies implemented at the national level.

As for the government, a nationwide monitoring system for civil buildings will be needed to strengthen implementation of energy efficient policies. To this end, further action such as establishing a comprehensive data gathering system and increasing the capacity to monitor appropriately will be necessary.

Finally, public consciousness and awareness of energy saving is still a difficult barrier in the residential and commercial sectors. It takes time to change not only public consciousness but also attitudes and behaviour. Therefore, it is essential to continuously inform the public about how much energy can be saved through the use of energy efficient appliances and equipment.

[32] (NDRC and GAQSIQ 2004)

Case Study: The Swan Goose Electrical Co., LTD and Tellhow Science-technological Co., Ltd.

Hangzhou Swan Goose Electrical Co., LTD (HSE) is located in the Hangzhou Economic Development Zone and is a major affiliate of Swan Goose Industry. HSE is one of the top Chinese producers of electrical equipment for buildings, and is a "Potevio" label carrier (formerly China Putian, Potevio is a Chinese state-owned company). Swan Goose has more than 50 percent of the domestic market for lighting and low-current switching equipment. The company is involved in the entire value chain of research, design and manufacture of components in three production facilities. All of the facilities, including HSE, are ISO 14000-certified and comply with national and international manufacturing standards, including rational and efficient use of energy for manufacturing. Swan Goose, a parent company of HSE, is an important industrial player in developing and lobbying for technical standards and regulation at the central government level, and the company participates in developing seven national standards related to efficient energy consumption in buildings. HSE produces a broad range of world-class products in energy saving lighting systems of various types, lighting fixtures, switches, intelligent control systems, and floor heating systems.

The Tellhow Technology (THT) research centre, an affiliate of Tellhow Science-technological Co., Ltd. is located in the Beijing Economic Development Zone and specialises in the manufacturing and installation of intelligent building systems. These systems feature the monitoring of energy use and general energy consumption control in buildings. Tellhow is also a certified energy service company for large public buildings in several Chinese regions, and is one of more than 150 ESCOs in Beijing. The research and production base of Tellhow is under the jurisdiction of the special economic development zones in China.

Progress and Drivers of Product Improvement

As a major industry player, HSE targets high international standards for the products that it manufactures. This enables the company to expand its domestic and overseas market shares. HSE therefore seeks to produce the best energy efficiency equipment and government-recommended energy-saving products. During APERC's site visit, the HSE management explained that the company's goal is to increase value added and improve product quality while reducing production costs.

During the site visit to the Hangzhou production facility, HSE management explained that the NDRC periodically issues a list of new products and specifications that it requests to be produced on an industrial scale by Chinese manufacturers. The awards for business enterprises who manage to win such government contracts stimulate innovation in technology and management. In 2008, HSE won an award of CNY6 million, or just under USD1 million. In addition to their cash value, such awards are considered highly prestigious.

Estimates by THT indicated the potential for 30 percent energy savings in large public buildings following the installation of energy management systems, where lighting could account for up to 30 percent of that savings, air conditioning 50 percent, office equipment 10 to 20 percent, and other devices about 20 percent. China has set an energy policy target of 20 percent of all government buildings having an energy management system installed in 2010, and using energy efficient devices and office equipment. Tellhow is looking to gain a significant share of the market for energy management systems for intelligent buildings, and especially in government buildings. The general plan is that the ESCO provides actual capital investment and guarantees the performance of the equipment installed. More specifically, the government and private businesses are not required to cover any of the capital costs, and ESCOs are expected to be able to recuperate their investments from the saving occurred over an agreed time frame with the owners of the building. For their part, the ESCOs are supposed to get the investment capital through commercial bank loans. However, investment prospects in the current global economic downturn are challenging.

Manufacturers as a Factor in Improving Energy Efficiency

China has great potential for energy saving in residential, commercial and industrial lighting. Estimates by HSE show that light control systems are an important aspect of energy saving, and electricity consumption for lighting in existing residential buildings could be reduced 25 to 35 percent. China has 43 billion square meters of floor space in existing buildings, and almost 2 billion square meters of new space is being added every year.

China's energy conservation targets indicate objectives for manufacturers like HSE, whose business is expected to impact China's energy intensity by increasing value added through expanding production while providing the country with energy saving equipment.

Manufacturing Bases as an Energy Consumer

Being itself a large manufacturer, HSE must improve the energy efficiency of its production processes. The main efforts involve implementing its own technologies in its offices and industrial buildings, and applying the most advanced technological equipment to the production process. Achievements in energy and resource savings in 2008 at HSE production facilities include reducing water consumption in the PVC plant by 30 percent and saving energy in work areas by 15 percent. A strong corporate policy for excellent management performance, attention to the management of human resources, and close scrutiny of technological innovation for both products and manufacturing technologies helps this company provide significant input for China's overall energy intensity improvement.

Case Study Sources: (SGEC 2009), (SGEC n.d.), (Tellhow 2009), and (Tellhow n.d.)

Achieving Energy Efficiency in State-Funded Institutions

The term "state-funded institution" (SFI) refers to state organs, public institutions, and corporations that are funded or partly funded by the state treasury. It includes offices; education, culture and health facilities; housing; and military facilities.[1] In China, there are 45 million government personnel (2004 data), so state-funded institutions are a very large energy consumer. Total energy consumption of SFIs reached 97.4 Mtce in 2007, up 115.6 percent from 1995. Electricity use reached 170.9 billion kWh, which included that of more than 730 million rural residents. The electricity consumption per unit area of state office buildings and large public buildings is 10 to 20 times the level of residential buildings and one and a half to two times that of similar buildings in Europe and Japan.[2]

Though energy consumption by public facilities is just 5 percent of the total, the SFI actions demonstrate the government's efforts to achieve the national energy consumption target.[3] This chapter explores step by step China's SFI energy efficiency efforts since 2001. The following questions will be addressed: How does this policy extend from the central government to localities? Who is in charge of policy making and implementation? How do the implementers coordinate with each other? What are the results at this time? What is the next step in the work?

What follows is the result of an interview of personnel of the Government Offices Administration of the State Council that was conducted by the study leader. The data and information presented in this chapter are directly from the interview, except where otherwise indicated by footnotes.

Background

On 2 August 2008, the State Council promulgated the "Regulations on Energy Conservation by Public Institutions", requiring public institutions to strengthen energy management by designating a person responsible for energy statistics, to submit their annual energy consumption report by 31 March of every year, to use the achievement of the energy saving goals of the public bodies in the evaluation of managers (referred to as the "responsibility system"), and to use sub-metering and real-time monitoring to identify and correct the waste of energy. The regulation also introduced the possibility of imposing administrative sanctions on public institutions that violate the regulations.

The regulation specifies that SFIs are to consume energy within the scope of energy consumption quotas established by the relevant authorities; strengthen energy consumption expenditure management; and report to the Government Offices Administration in the local People's Government, in detail, any energy consumption beyond the quota. It provides maximum energy-use performance standards for energy consuming systems and equipment such as air-conditioning, elevators, and lighting, and for key energy consuming facilities such as network rooms, canteens, boiler rooms, and so on. The regulation further requires SFIs to take specific energy conservation measures, such as strengthening maintenance and inspection

[1] Article 2 of "Regulations on Energy Conservation by Public Institutions", which was adopted at the 18th executive meeting of the State Council on 23 July, 2008, was promulgated and came into force on 1 October, 2008. Decree No. 531 of the State Council, signed by Premier Wen Jia Bao. In the English version of the regulations prepared by GOASC, "SFI" was translated as "public institutions"; (GOASC 2009), p.2. APERC keeps the use of "SFI"

[2] (Q. Wang 2009)

[3] (NBS 2008a)

of energy-consuming systems and equipment, and implementing the responsibility system for energy management personnel. It also encourages SFIs to adopt energy management by contract, setting forth the energy conservation target and requirements in the property service contract.

Policy

Since 2001, the Government Offices Administration of the State Council (GOASC), jointly with relevant departments, developed a strategy for energy conservation in SFIs. Institutions managing SFIs at all levels of government have participated in this effort and achieved positive results. From 2001 to the present, the SFI energy conservation work has gone through three stages:

The First Stage (2001–2003): Advocacy and Preparation

In November 2001, the former State Economic and Trade Commission (SETC), MOF and GOASC signed the "Action Proposals on Energy Conservation for Government Organizations" addressing SFIs at all levels. In November 2002, the SETC, MOC, GOASC and the CPC Affairs Management Bureau surveyed the state of energy consumption by inspecting a sampling of 80 government organizations nationwide. After the results were reported to the SETC on 20 November 2002, Premier Wen Jiabao summarised the result, stating that the SFIs have huge energy-conserving potential, which may be realized by energy conservation building renovations, governmental procurement of energy-conserving products, and improvement of energy management. In 2003, the same organizations again surveyed the energy consumption status of some government organizations. These investigations were the basis for a series of investigation reports, which in turn laid a solid foundation for the policy formulation for government organizations.

The Second Stage (2004–2007): Promotion

In November 2004, the NDRC issued the "Medium- and Long-Term Energy Conservation Plan", and made the "Project of Energy Conservation for Government Organizations" one of the "Top 10 Key Projects of Energy Conservation" during the period of the 11th Five-Year Plan. According to the arrangement, the GOASC is responsible for energy conservation in government organizations. In 2005, the GOASC, jointly with relevant departments of the government, drew up the "Implementation Plan on the Project of Energy Conservation for Government Organizations" (referred to below as the Plan), and set out the main target, focus, implementation steps and measures on energy conservation for government organizations during the 11th Five-Year Plan period. The Plan has since guided the implementation of government organizations.

The GOASC jointly with the NDRC, MOF, MOC, and CPC Affairs Management Bureau, the PLA general logistics department issued a series of guidance documents to promote work on energy conservation in government organizations. Governments at all levels have responded with actions such as improving energy statistical measurement, carrying out energy conservation reconstruction of key energy-consuming systems, implementing government procurement of energy-conserving products, and strengthening the management of fuel saving for vehicles used by government organizations.

The Third Stage (since 2008): Improving the Legal System

In the amendment of the Energy Conservation Law (2007), a section on energy conservation by SFIs was amended, which laid the legal basis for further promotion. To implement the amended law, GOASC invited 30 departments of the CPC central committee and the state and experts from relevant research institutes to hold a seminar to draft "Energy Conservation Regulations for SFIs" (referred to below as the Regulations). They established a drafting group and an experts group, and carried out investigation and drafting. After completion, the Regulation draft was officially printed and distributed to CPC central committee and state departments and the governments of provinces, autonomous regions and municipalities directly for comments, and 282 opinions and suggestions were received. At the same time, five research groups conducted investigations in 16 provinces and municipalities including Liaoning, Jiangsu, Guangdong, Shanghai, Chongqing, and others. On this basis, through repeated revision, the Regulation (the version for review and approval) was made. On 23 July, 2008, "Energy Conservation Regulations for SFIs" was adopted by the 18th standing conference of the State Council. The Regulations came into force on 1 October, 2008.

Work Plan for the Future

The future work will focus on the following three points:

1. Improving statistics and monitoring
2. Setting up a long-term mechanism for energy conservation and emission reduction
3. Concentrating on reducing the use of power, gas, oil and water.

Implementation

In 2006, the NDRC, GOASC, MOF, Administration Bureau under the CPC Central Committee and General Logistics Department jointly distributed the "Circular on Strengthening Energy Conserving Work of Central Governmental Bodies" as the guiding paper for the work. In 2007, the GOASC distributed the "Circular on Further Strengthening the Work of Energy Conservation and Emission Reduction of Central Governmental Bodies" and "Emergency Circular on Implementing Work of Energy Conservation and Emission Reduction of Central Government Bodies", which effectively initiated the energy conservation work in SFI.

The Dimensions of Implementation

Modification of Buildings and Energy Consuming Systems for Energy Conservation

The central government bodies have more than 100 million square meters of office building and residential housing floor area. Reconstructing these buildings and their systems to conserve energy is the top priority of energy conservation work. In addition, energy conservation retrofits at those facilities will be a good model to be demonstrated to the public. The three major initiatives in building energy conservation at SFIs are described below.

First, energy conservation assessments are being made of all new projects. This entails conducting a comprehensive assessment of energy conservation potential in the preliminary designs of proposed new building and renovating projects of 17 office buildings under the NDRC and the Ministry of Science and Technology (MOST) (floor area of about 450,000 meters), and others. The designs are then optimized to conserve energy. A preliminary assessment shows CNY500 million in initial investments can be saved. CNY4,200,000 in operating costs can be saved every year, from 530 kWh in electricity conservation.

Second, "flat-to-slope" reconstruction of roofs on buildings of the central governmental bodies is being organized and launched, with a goal of reconstructing 377 residential buildings (263,000 square meters of roof area) and thereby improving thermal insulation. In the course of maintaining and rebuilding facilities of central state bodies (about 620,000 square meters of floor area), energy conserving renovation of doors, windows and outer walls have been carried out at the same time.

Third, reconstruction for power conservation and gas conservation is being promoted. In particular, power conservation diagnosis and reconstruction of air conditioning systems is being carried out, and power conserving diagnosis and reconstruction of air conditioning systems of office buildings of 22 ministries and commissions such as the Ministry of Foreign Affairs (with floor area of 1,052,000 square meters) is being completed. Lighting systems in the office areas are being reconstructed, and the heating systems of boilers are undergoing diagnosis and reconstruction for energy conservations. Specific measures and objectives of this initiative are shown in the table below.

Table 24: Measures and objectives for energy saving building modifications in state-funded institutions

Measures	Objective
Transform 1,420 coal-fired boilers	
Survey, diagnose and retrofit heating system gas boilers.	Achieve savings of 20% in at least 1,250,000 square meters of heated area.
Perform energy-saving retrofits on 95 gas stoves in dining facilities.	
Retrofit a total of 2,500 gas stoves.	Save 25–30%, and thereby conserve up to 7 million cubic meters of gas.

Rigorous Management of Official Vehicles

Several specific measures are being undertaken to reduce the fuel consumption of government vehicles. These measures include closer tracking of government vehicle use, retirement of inefficient vehicles, and seasonal vehicle use restrictions. Specific objectives include:

- Reduce the vehicle fleet of 95 departments by 30 percent, in the process retiring 721 inefficient vehicles.
- Purchase more than 400 low-emission economy cars for government organizations.
- Eliminate “high-emission vehicles”.
- Implement a “One Card for One Car” refuelling system and specified service stations for official vehicles to prevent unauthorized refuelling of private cars.
- Reduce the vehicle fleet. Beginning in June 2009, the central state bodies should eliminate 50 percent of official cars and suspend the use of 6,141 cars.
- Ban vehicles with even- and odd-numbered license plates on alternate days from 20 July to 20 September.

Pursue Government Procurement of Energy Conservation Products

Products included in the energy conservation products list are to be preferred by SFIs. This list includes such products as air conditioners, computers and printers. The 2007 budget allocation for the purchase of energy-conserving products is up to CNY1,541 million. Additional products will be selected for popularization based on continued investigation of their energy-saving potential.

Set Up an Energy Consumption Measurement and Statistics System

The development of a system to track the energy consumption of SFIs is being implemented in two phases. In the first phase, a pilot project will meter electricity, water, gas and heat consumption of 10 experimental units, set up a statistical information platform of energy consumption and implement a monthly energy consuming report and quarterly announcement system. Following the conclusion of the pilot project, the system is being extended to all central government bodies to establish a solid foundation for realizing quantitative management of energy-saving reconstruction and energy conservation at government organizations.

Outcomes

Through the extensive energy conservation work at the central government bodies, the GOASC reports impressive progress. For 2008, targets of 20 percent fuel conservation and 5 percent oil conservation were set. Based on the sampling of energy, water and oil consumption of the STI, these targets were exceeded. Official statistics put the total consumption of the central and state bodies and various departments and units at 287,329,000 kWh of electricity, 4,008,600 tonnes of water, and 6,446,500 litres of fuel by public service vehicles in 2008. The estimated results of the energy saving initiatives are shown in the following tables.

Table 25: Electricity savings by SFI

	2005	2006	2007	2008
Sampled Usage (million kWh)	**250**	**262**	**265**	**254**
Change from previous year		4.80%	1.15%	-4.15%
Per capita (kWh)	**2806**	**2555**	**2415**	**2288**
Change from previous year		-8.95%	-5.48%	-5.26%
Per square meter (kWh)	**81.28**	**80.73**	**77.26**	**73.15**
Target				-5.00%
Change from previous year		-0.68%	-4.30%	-5.32%

Table 26: Oil savings by SFIs

	2007	2008
Sampled Usage (million liters)	**822.37**	**644.65**
Change from previous year		-21.61%
Target		-20%
Institutions that met their target	93	62%
Institutions that did not meet their target	35	38%

Table 27: Water savings by SFIs

	2005	2006	2007	2008
Sampled Usage (million tonnes)	**3.715**	**3.604**	**3.558**	**3.137**
Change from previous year		-2.99%	-1.28%	-11.83%
Per capita (tonnes)	**47**	**38**	**37**	**30**
Change from previous year		-19.15%	-2.63%	-18.92%

Implications

The GOASC is the main player in the energy conservation by SFIs, responsible for all the details of policy, regulation issuance and policy implementation. Naturally, the process involves extensive collaboration with other departments of the central government.

The policy is still applied to the regions in a top-down manner. However, the process has been planned and promoted to motivate the SFIs to carry out the measures on their own initiative.

Though SFIs' share of total Chinese national energy consumption is modest, the government's actions serve to popularize new technologies and to provide a model of implementation for other organizations.

The future work of the GOASC is expected to be more challenging. Though implementation has initially been completed by motivated SFI's, the organization may need to provide more hands-on leadership in the future. Maintaining the motivation of regional governments and coordinating execution across all levels of government will be the biggest challenge for the GOASC.

Works Cited

Ang, B.W., and F.Q. Zhang. "A survey of index decomposition analysis in energy and environmental studies." (Energy) 25, no. 12 (2000).

APERC. *APEC Energy Demand and Supply Outlook 2009.* Tokyo: Asia Pacific Energy Research Centre, forthcoming.

APERC. *Understanding Energy in China.* Tokyo: Asia Pacific Energy Research Centre, 2008.

Brizendine, Thomas and C. Oliver. "China's steel sector in transition." *The China Business Review,* 2001.

Brockett, Debbie, David Fridley, Jieming Lin, and Jiang Lin. *A Tale of Five Cities: The China Residential Energy Consumption Survey.* American Council for An Energy-Efficient Economy, 2004.

Cai, W.G., Y. Wu, Y. Zhong, and H. Ren. "China building energy consumption: Situation, challenges and corresponding measures." (Energy Policy) 37, no. 6 (2009).

CEPYEC. *China Electric Power Yearbook 2007.* Beijing: China Electric Power Yearbook Editing Commission, 2007.

CEPYEC. *China Electric Power Yearbook 2008.* Beijing: China Electric Power Yearbook Editing Commission, 2008.

China Huaneng Group. *Brief introduction of Huaneng Beijing Thermal Power Plant.* China Huangeng Group, not dated.

CMA. "Chinamining.org." China Mining Association. December 2008. http://www.chinamining.org/News/2008-12-17/1229495303d20261.html (accessed July 2009).

CPC. Socialism with Chinese Characteristics. 30 September 2007. http://english.peopledaily.com.cn/90002/92169/92211/6275043.html (accessed June 11, 2009).

CPCCC. "Communique of the Sixth Plenum of the 16th CPC Central Committee, Central Committee of the Communist Party of China." *Xinhua News Agency*, 2006, 11 October ed.

CPIA. *China Power Industry Development Annual Report (2005).* China Power Industry Association, 2006.

CPIA. *China Power Industry Development Annual Report (2008).* China Power Industry Association, 2008.

Downs, Erica. "China's Energy Policies and their Environmental Impacts." The Brookings Institution. 13 August 2008. http://www.brookings.edu/testimony/2008/0813_china_downs.aspx?p=1 (accessed April 2009).

Fiducia. "China's steel market—latest trends and implications: both government regulations and market forces are pushing the world's largest steel industry to consolidate and boost efficiency." Fiducia Management Consultants. 2008. http://www.fiducia-china.com (accessed July 2009).

Fridley, David, et al. *China Refrigerator: Specification Development and Potential Impact.* Berkeley: Lawrence Berkeley National Laboratory, 2009.

GOASC. *Interpretation of Regulations on Energy Conservation by Public Institution.* Government Offices Administration of the State Council, China Environmental Science Press, 2009.

Hangzhou City. “Circular of Hangzhou Municipal People’s Government on Printing and Issuing the Implementation Plan for Energy Conservation of Hangzhou in 2008.” 2008.

HHTZ. *Introduction to the Energy Conservation Work in Hangzhou High-Tech Zone.* Hangzhou High-Tech Zone Administration, 2008.

HHTZ. *Personal communication with staff of the Hangzhou High-Tech Zone* APERC staff. 1-3 March 2009.

Hofman, B., and Kelly Labar. *Structural Change and Energy Use: Evidence from China’s Provinces.* The World Bank, 2007.

Hu, J. L., and S. C. Wang. “Total-factor energy efficiency of regions in China.” (Energy Policy) 34, no. 17 (2006).

Hu, Xiaoling, and Hua Ping. *Globalization and China’s iron and steel industry: modeling China’s demand for imported steel importation.* Business School University of Goucestershire and Centre d’Etudes et de Recherches sur le Developpement International, 2005.

IEA. *Energy Balances of nonOECD Countries.* Database. International Energy Agency. 2008.

IEEJ and ERI. *Measures and Implementation Effect of 11th Five-Year Plan Energy Saving Target (Part I).* Institute of Energy Economics (Japan) and Energy Research Institute (China), 2008.

IEEJ and ERI. *Measures and Implementation Effect of 11th Five-Year Plan Energy Saving Target (Part II).* Institute of Energy Efficiency (Japan) and Energy Research Institute (China), 2009.

IMF. *World Economic Outlook*. International Monetary Fund. October 2008. http://www.imf.org/external/ns/cs.aspx?id=28 (accessed May 2009).

LBNL. *Building Codes*. Lawrence Berkeley National Laboratory. 2009. http://eetd.lbl.gov/ea/China/china_buildings-bc.html (accessed July 30, 2009).

Levine, M. D., N. Zhou, and L. Price. *The Greening of the Middle Kingdom: The Story of Energy Efficiency in China.* Berkely: Lawrence Berkeley National Laboratory, 2009.

Li, Jing. “Polluting steel plants moving out of Beijing.” *China Daily*, 2004, 9 December ed.

Liao, Hua, Ying Fan, and Yi-Ming Wei. “What induced China’s energy intensity to fluctuate: 1997–2006?” (Energy Policy) 35, no. 9 (2007).

Mitsui & Co., Ltd. “Joint Entry to Green Building Engineering Business in China—Investing in Beijing Tsinghua Tellhow Intelligence Tech, A Core Member of Tellhow Group.” Mitsui & Co., Ltd. 1 September 2006. http://www.mitsui.co.jp/en/release/2006/1175675_1210.html (accessed 4 2009).

MOC and MOF. *Implementation Opinions of Strengthening Energy Conservation Management on Government Office Building and Large-scale Public Buildings.* Ministry of Construction and Ministry of Finance, People’s Republic of China, 2007.

MOCom. *Chinese enterprises are 70% private*. Ministry of Commerce, People’s Republic of China. 22 April 2009. http://english.mofcom.gov.cn/aarticle/newsrelease/commonnews/200904/20090406190354.html (accessed May 2009).

MOF and NDRC. *The Circular of Ministry of Finance and National Development and Reform Commission on Printing and Distributing the Implementation Opinions on Government Procurement of Energy-conserving Products.* Ministry of Finance and National Development and Reform Commission, People’s Republic of China, 2004.

MOF and SAT. *Circular About Comprehensive Utilization Of Some Resources And VAT Policy On Other Products.* Ministry of Finance and State Administration of Taxation, People’s Republic of China, 2001.

MOF and SAT. *Circular of Finance Ministry and State General Administration of Taxation On Several Incentive Policies on Enterprises Income Taxes.* Ministry of Finance and State Administration of Taxation, People's Republic of China, 1994.

MOF and SAT. *Notification by Finance Ministry and State General Administration of Taxation Regarding the issuing of Temporary Rules on Enterprise Income Tax Credit by the Investment on Technology Transformation of Domestic-made Equipment.* Ministry of Finance and State Administration of Taxation, People's Republic of China, 1999.

MOF. *Implementation Opinions of Strengthening Energy Conservation Management on Government Office Building and Large-scale Public Buildings.* Ministry of Finance, People's Republic of China, 2007.

Mok, Kristy, and Tim Wommelsdorff. *The global crisis—driving consolidation in China's steel sector.* Stainless Steel World, 2008.

Nakano, Naokazu. "Sectoral approach in steel industry: JISF's comments from APP Steel Task Force Activity." Vancouver: Chair for Energy Technology Committee of the Japan Iron and Steel Federation, The 6th PIC Meeting, 2008.

NBS and NDRC. *Reinforce Energy Consumption Statistical System.* National Bureau of Statistics and National Development and Reform Commission, People's Republic of China, 2007.

NBS. *China Energy Statistical Yearbook 2008.* Database. National Bureau of Statistics, People's Republic of China. 2008a.

NBS. *China Statistical Yearbook (various years).* Database. National Bureau of Statistics, People's Republic of China. 1990-2008.

NBS. *China Statistical Yearbook 2008.* Database. National Bureau of Statistics, People's Republic of China. 2008b.

NBS. *Communique on Energy Consumption per Unit of GDP by Regions in 2008.* online document, National Bureau of Statistics, People's Republic of China, 2009.

NBS. *Report of energy consumption per unit of GDP in 2007.* National Bureau of Statistics, People's Republic of China, 2008c.

NDRC. National Development and Reform Commission, People's Republic of China. 2009. http://en.ndrc.gov.cn (accessed June 2009).

NDRC. *1000-Enterprise Implementation Plan of Energy Conservation Action.* National Development and Reform Commission, People's Republic of China, 2006a.

NDRC and GAQSIQ. *Administration Rules on Energy Efficiency Label.* National Development and Reform Commission and the State General Administration of Quality Supervision, Inspection and Quarantine, People's Republic of China, 2004.

NDRC. *China Medium and Long Term Energy Conservation Plan.* National Development and Reform Commission, People's Republic of China, 2004.

NDRC. *Circular on Reduction of Network Power Price of Small Thermal Power Generating Sets to Speed up Closing down Small Thermal Power Generating Sets.* National Development and Reform Commission, People's Republic of China, 2007a.

NDRC. *Energy Efficiency Benchmarking of Key Energy-Consuming Enterprises.* National Development and Reform Commission, People's Republic of China, 2007b.

NDRC. *Evaluation of 1000 enterprise energy saving progress.* National Development and Reform

Commission, People's Republic of China, 2008.

NDRC. *Implementation Plan for Evaluation System of Energy Consumption Per Unit GDP.* National Development and Reform Commission, People's Republic of China, 2007c.

NDRC. *Policy for development of the iron and steel industry.* National Development and Reform Commission, People's Republic of China, 2005.

NDRC. *Policy outline of China Energy Conservation Technology.* National Development and Reform Commission, People's Republic of China, 2006b.

NDRC. *Report on China's economic, social development plan.* online reprint, National Development and Reform Commission via China View, 2009.

NDRC; NSB; SEPA. *The Programs and Approaches for Energy-saving Emission Reduction Statistics Monitoring and Test Implementation.* National Development and Reform Commission, People's Republic of China, 2007.

Ni, Chun Chun. "China's Electricity Power Industry and Its Trends." 15th IEEJ Seminar, 2006.

NPC. *Company Law of the People's Republic of China.* National People's Congress, People's Republic of China, 2006.

NPC. *Energy Conservation Law of the People's Republic of China.* The National People's Congress, People's Republc of China [as reproduced in IEEJ and ERI (2008)], 2007.

NPC. *Law on Sino-foreign Cooperative Joint Ventures.* National People's Congress, People's Republic of China, 2005.

OANDA. "Historical currency exchange rates." *OANDA.com.* OANDA Corporation. http://www.oanda.com/convert/fxhistory (accessed June 2009).

People's Daily Online. "NBS releases China Top 1,000 Industrial Enterprises list." *People's Daily Online*, 2004, 3 June ed.

Premier Wen, Jiabao. "Report on the Work of the Government." *GOV.cn.* People's Republic of China. 5 March 2007. http://english.gov.cn/official/workreports.htm (accessed May 2009).

President Hu, Jintao. "Hold High the Great Banner of Socialism with Chinese Characteristics and Strive for New Victories in Building a Moderately Prosperous Society in all Respects." People's Daily Online, 2007, 15 October ed.

Price, Lynn, Y. Jiang, E. Worrell, W. Du, and J.E. Sinton. *Development of an energy conservation voluntary agreement pilot project in the steel sector in Shandong Province: Report to the State Economic and Trade Commission, People's Republic of China.* Berkeley, CA: Lawrence Berkeley National Laboratory (LBNL-51608), 2003.

SASAC. State Owned Assets Supervision and Administration Commission, People's Republic of China. 2009. www.sasac.gov.cn/ (accessed June 2009).

SECIDC. *Personal communication with staff of the State Energy Conservation Information Dissemination Center* APERC staff. June 2009.

SETC. *Options on Carrying Out Energy Efficiency Benchmarking of Key Energy Consuming Enterprises.* Shandong Economic and Trade Commission, 2009.

SGEC. http://www.hongyan.com.cn (accessed 2009).

SGEC. *Personal communication with staff of the Swangoose Electrical Co., Ltd.* APERC staff. Zhejiang. 3 March 2009.

SIBC. http://www.sibw.com.cn (accessed 2009).

SIBC. *Personal communication with staff of the Shanghai Industrial Boil Company, Ltd.* APERC staff. 1 March 2009.

SPC. "Rules on the Development of Heat and Power Cogeneration (Revised)." State Planning Commission, 2000.

State Council. *Circular of General Office of the State Council on Forwarding the Opinions of NDRC on Improvement of the Policy Regarding Differential Electricity Price.* State Council, People's Republic of China, 2006a.

State Council. *Circular of the General Office of the State Council for Transmitting the Opinions of the State Economic and Trade Commission on Clearing up and Restructuring Small Steel Plants.* State Council, People's Republic of China, 2000.

State Council. *Circular on Controlling Overall Volume, Washing out the Laggard Productivity and Accelerating Structure Adjustment for Steel Industry.* State Council, People's Republic of China, 2005a.

State Council. *Energy Conservation Regulation for Civil Buildings.* State Council, People's Republic of China, 2008a.

State Council. *Further Strengthening Oil Saving and Power Saving Work.* State Council, People's Republic of China, 2008b.

State Council. *Official Reply of the State Council on the Energy Consumption Reduction Indicator Plan of Unit Gross Production of Every Area during the Eleventh Five-Year Plan Period.* State Council, People's Republic of China, 2006b.

State Council. *Regulations on Electric Power Supervision.* State Council, People's Republic of China, 2005b.

State Council. *The Decision Of The State Council On Strengthening Energy Conservation Work.* State Council, People's Republic of China, 2006c.

TEDA. *http://www.teda.gov.cn.* http://www.teda.gov.cn (accessed June 2009).

TEDA. *Personal communication with the administration of the Tianjin Economic-Technological Development Area* APERC staff. 20 November 2008.

Tellhow. http://www.tellhow.com (accessed 2009).

Tellhow. *Personal communication with staff of Tellhow Technology Co., Ltd.* APERC staff. Beijing. 5 March 2009.

Tian, Zhiyu. "Energy saving goals, policies and experiences in China." Energy Research Institute, National Development and Reform Commission, People's Republic of China, 2009.

UNDP. *Barrier Removal for Efficient Lighting Products and Systems in China (China Green Lights).* UNDP-GEF Project Writeups, 2007.

Wang, Junsong, and Canfei He. "Technological Development, Structural Change and Chinese Energy Consumption Efficiency." (China Population Resources and Environment) 19, no. 2 (2009).

Wang, Qing Yi, Feng Xiang Tu, Cheng Zhang Zhu, and Bang Cheng Wang. *China's National Comprehensive Energy Strategy and Policy: Subtitle 4, Energy Efficiency and Conservation.* The Energy Foundation, 2005.

Wang, Qingyi. "Final Energy Consumption and Energy Efficiency of China in 2007." (Energy Efficiency and Environmental Protection), no. 2 (2009).

Wang, W., and M. Zhang. "Spending details revealed for economic stimulus package." *Shanghai Daily*, 2009, 7 March ed.

Wei, Yi-Ming, Hua Liao, and Ying Fan. "An empirical analysis of energy efficiency in China's iron and steel sector." (Energy) 32, no. 12 (2007).

Wei, Zou, Xu Min, and Wang Zhaoyang. "The Research on the Knowledge Characteristics of Chinese Large and Medium Size Industrial Enterprises." (Wireless Communications, Networking and Mobile Computing), no. September (2007).

Wenjia, Cai. "GHG reduction opportunities in China's iron and steel sector." Beijing: Sectoral Study and Policy Implementation Workshop, Tsinghua University, 2009.

World Bank. *Cost of Pollution in China (conference edition).* The World Bank, 2007.

World Steel Assoc. "World crude steel production decreases by 1.2% in 2008." World Steel Association. January 2009. http://www.worldsteel.org/?action=newsdetail&id=257 (accessed April 2009).

Xin, Zhang. "Overview from Chinese Perspective." Sydney: Motor Energy Performance Standards Australia 2009, 2009.

Xinhua News Agency. "NPC adopts major economic policy changes." *China Daily,* 14 March 2006.

—. "Govt Promotes Green Lighting." *China.org.cn*, 26 December 2008a.

—. "Highlights of China's Institutional Restructuring Plan." *People's Daily Online*, 16 March 2008b.

—. "Xinjiang will Strike-Hard." *People's Daily Online,* 17 April 2009.

You, Xiaoping. *The indicators of Energy Conservation and Emission Reduction should be set up according to the sub-sectors* Zhejiang Business Network. 5 March 2009.

Yu, Cong. "Recent Experience with Energy Efficiency Policies and Measures in China." Asia Clean Energy Forum, 2008.

Yuan, Jia-Hai, Jian-Gang Kang, Chang-Hong Zhao, and Zhao-Guang Hu. "Energy consumption and economic growth: Evidence from China at both aggregated and disaggregated levels." (Energy Economics) 30, no. 6 (2008).

Zhao, J, Y Wu, and N Zhu. "Implementing effect of energy efficiency supervision system for government office buildings and large-scale public buildings in China." (Energy Policy) 37, no. 6 (2009).

Zhejiang Zhongnan Group. "Personal communication with staff of the Zhejian Zhongnan Group." March 2009.

Zheng, Shan-he, and Hong Xu. "Ultra-Supercritical Technology: the Electric Power Development Choice in China." Qingdao: Second Annual Conference on Ultra-Super Thermal Power Technology Collaboration Network of China, 2006.

Zhou, N., M.D. Levine, and L. Price. "Overview of Current Energy-Efficiency Policies in China." *Energy Policy,* in press.

Zhou, Nan. *Status of China's Energy Efficiency Standards and Labels for Appliances and International Collaboration.* Berkeley: Lawrence Berkeley National Laboratory, 2008.

Appendix A

Abbreviations

CCECP—Certification Center for Energy Conservation Product

CPC—Communist Party of China

CPCCC—Communist Party of China, Central Committee

GAQSIQ—General Administration of Quality Supervision, Inspection and Quarantine

GOASC—Government Offices Administration of the State Council

MIIT—Ministry of Industry and Information Technology

MOC—Ministry of Communications

MOCom—Ministry of Commerce

MOF—Ministry of Finance

MOHURD—Ministry of Housing and Urban Rural Development

MOST—Ministry of Science and Technology

NBS—National Bureau of Statistics

NDRC—National Development and Reform Commission

NEC—National Energy Commission

NPC—National People's Congress

SASAC—State-owned Assets Supervision and Administration Commission of the State Council

SAT—State Administration of Taxation

SC—State Council

SERC—State Electricity Regulatory Commission

SEPA—State Environmental Protection Administration

TEDA—Tianjin Economic-Technological Development Area

HHTZ—Hangzhou High-Tech Zone

Appendix B

Energy Efficiency Cooperation between Japan and China

China's energy consumption per USD1 million GDP in 2007 was 727 tce, 2.36 times more than the world's average. The current energy utilization efficiency in China is 33 percent, 10 percent lower than that of the international advanced level.[1] Similarly, China's energy consumption per unit of eight major products was, on average, 20 percent higher than that of the international advanced level.[2] According to the relevant studies, compared with the international advanced level of energy consumption per unit of product and energy consumption for end-use equipment, the current energy conservation potential in China is about 300 million tce.[3] To achieve its aggressive energy efficiency and conservation agenda, China is pursuing international cooperation as one important strategy for technology development and financing.

Potential

The potential scope of cooperation for energy conservation in China is very broad. Industry, buildings, and transportation all present promising opportunities for international cooperation. Strengthened international cooperation offers several ways for China to accelerate its energy conservation efforts. International cooperation can provide access to advanced technologies and processes. Such technologies can be acquired directly from abroad or be jointly researched and developed. International cooperation also provides access to capital, which is needed for introducing new, efficient facilities and upgrading backward capacity.

History

The ongoing Japan-China Energy Conservation Forum is a part of an effort to enhance mutually beneficial partnerships between Japan and China in the fields of energy and environment. It was established with the aim of disseminating Japan's technologies and management systems in these fields in China, on a commercial basis. The program was proposed in 2006 and the framework agreed to in a 2007 Memorandum of Understanding between Japan's Ministry of Economy, Trade and Industry (METI) and China's NDRC. The program facilitates demonstration projects, jointly implemented by Japanese and Chinese companies, in the area of energy conservation. Such projects include identification of energy saving opportunities, introduction of high-efficiency equipment, and others. It further serves as a forum for the avoidance and resolution of intellectual property concerns.[4]

Outcomes

To date, three forums have been held, two in Japan and one in China. These forums have identified considerable area for the economies to further cooperation in addressing common

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[1] NBS. China Statistical Yearbook 2008. Database. National Bureau of Statistics, People's Republic of China.
BP. Statistical Review of World Energy 2008. http://www.bp.com/.
People's Bank of China. "Exchange Rate." http://www.pbc.gov.cn/.

[2] The eight products are electric power, iron and steel, nonferrous metal, petrochemicals, building materials, chemicals, light industry and textiles.

[3] Jin Bei. Chinese Enterprises Competitiveness Report 2007. Social Sciences Academic Press.

[4] METI. "Cooperation Agreements reached at the Third Japan-China Energy Conservation Forum." Ministry of Economy, Trade and Industry.
http://www.meti.go.jp/english/press/data/nBackIssue20081128_01.html.

environmental and energy challenges. At the Japan-China Energy Conservation Forum, discussions have focused on developing cooperative relationships in the area of industrial technology. Participants from China proposed establishing a model research laboratory and conducting inter-governmental policy studies.[5]

[5] METI. “Cooperation Agreements reached at the Third Japan-China Energy Conservation Forum.” Ministry of Economy, Trade and Industry.
http://www.meti.go.jp/english/press/data/nBackIssue20081128_01.html.

Appendix C

China and Vietnam, Energy Efficiency Policies

	China	Vietnam*
Basic Information		
Population (million)	1,312	84
GDP, Bn. US$ (2000 US$ at PPP)	5,236	181
Per-Capita GDP (2000 US$ at PPP)	3,992	2,031
Final Energy Consumption (Mtoe)	976,268	37,620
Administrative Measures		
Targets	11th 5-Year Plan, 20% reduction target (2006)	National Energy Efficiency Program (2006), 3–5% (of total final energy consumption) reduction target for the period 2006–2010 and 5–8% target for the period 2010–2015
Tracking and Statistics	Each province is required to develop a system of energy consumption tracking and statistics, in accordance with Implementation Plan For Statistical Index System Of Energy Consumption Per Unit GDP, Implementation Plan For Monitoring System Of Energy Consumption Per Unit GDP, and Implementation Plan For Assessment System Of Energy Consumption Per Unit GDP (2007)	Carrying out a comprehensive survey on energy efficiency and establishing an energy efficiency database system
Assessment for Major Investments	Guidelines for Energy-Conservation Evaluation and Review of Fixed-Asset Investment Projects (2006)	
Education & Awareness Programs	Annual "Conservation Week" carries out various propaganda activities on "energy conservation and emission reduction in national action" through CCTV and related media, so as to improve the public awareness of energy conservation and environmental protection. Key enterprises and key industries are required to strengthen the administration of energy conservation by setting up energy management positions, establishing an energy management system, and training personnel in aspects of energy management.	The second project of the National Energy Efficiency Program, "Education and propaganda to community", carries out activities on Vietnam television (VTV2, VTV1 channels), radio, newspapers and magazines. Since 2007, promotion and education programs have been conducted frequently on the public information system. At the same time, information on Energy Efficiency and Conservation has been provided to all levels of the school system, and building energy efficiency contests have been held.
Laws & Regulations		
Building Energy Codes	Energy Conservation Regulation for Civil Buildings (2008)	Energy Efficiency & Conservation Regulation for Civil Buildings (Building codes, 2004 & 2007)

Vehicle Efficiency Standards	Vehicle Fuel Economy Standards (2008)	Considering for the future
Product Efficiency Standards	Product efficiency standards currently cover refrigerators, room air conditioners, washing machines, television sets, automatic rice cookers, radios and recorders, electric fans, electric irons, various types of lamps, instantaneous gas water heaters, external power supplies, and commercial packaged air conditioners. The State Administration of Quality Supervision, Inspection and Quarantine is in charge of administering the standards.	Vietnam is preparing to develop a set of energy efficiency and conservation standards for fans, air-conditioners, refrigerators, various types of lamps, lamp ballasts, and solar water heaters.
Legal Foundations	The Energy Conservation Law (formulated in 1997, amended in 2007), Promoting Recycling Economy Law and related laws have been passed to promote energy conservation and emission reduction. China's Medium- and Long-term Energy Conservation Plan of 2004 set resource conservation as a basic state policy. Administrative policies have since been issued in support, including the Decision on Strengthening Energy Conservation Work (2006).	Vietnam launched the Energy Efficiency and Conservation Decree 102 in 2004. Now, the Energy Efficiency & Conservation Law has been drafted and is expected to be approved by 2010, replacing Decree 102. The Energy Efficiency and Conservation Office (EE&CO) is being created under the Ministry of Industry and Trade (MOIT) to coordinate and monitor the implementation of the Vietnam National Energy Efficiency Program; a steering committee chaired by the Minister of MOIT has been established.
Economic Measures		
Project Funding	Subsidies for energy efficiency and conservation activities are authorized under such policies as the *Fiscal Incentive Fund Management Methods for Energy-conserving Technological Transformation, Rewards Fund Management Methods for Heating Measurement and Energy-conserving Reconstruction for Existing Residential Buildings in Northern Heating Area, and Provisional Measures on the Management of Financial Subsidy Fund to Promoting High-efficient Lighting Products*. Special funds for energy conservation and emission-reduction have been set up to support projects with subsidies and discounted interest rates. In 2007, CNY23,500 million was allocated from state revenue for energy conservation and emission-reduction.	The government provides technical assistance to enterprises for conducting energy audits, preparing investment reports, providing training courses, etc. Some enterprises may be eligible to obtain financial support from the State Budget—two enterprises have received this support to date.
High-Efficiency Equipment Subsidies	A project, the name of which roughly translates to "People Favoring Energy-Conserving Products", began in 2009. This project popularizes energy efficient products by means of financial subsidies. Eligible products include high-efficient lighting products, energy-conserving cars, and new energy cars. The government has also established a system for procurement of energy-conserving products.	The government promotes energy efficiency and conservation equipment labeling, providing technical support and testing equipment for lighting systems. The government will develop a set of energy efficiency and conservation standards for compact fluorescent lamps, lamp ballasts, and water heaters.

Enterprise Targets	1000-Enterprise Implementation Plan Of Energy Conservation Action (2006)	Developing sample energy management models for distinct production types
Public-Private Partnerships	The government is encouraging energy conservation work to be supported by some market mechanisms, such as energy contract management. The government has also utilized voluntary agreements with industry to further energy conservation.	The work of energy efficiency is supported by market mechanisms. Cost-benefit analysis is intended to promote energy conservation in investment decisions, and time-of-use pricing is being used to encourage load shifting.
Pricing Mechanisms	In pricing policy, Chinese Government is working to provide a stronger signal for energy conservation through energy price. Differential prices are set for electricity, depending on the energy-intensity of the industry or enterprise. Preferential electricity prices once granted to large energy-consuming enterprises have been cancelled. The price received by small thermal power plants for their output has been reduced. Price incentives have been introduced to encourage electricity production from biomass energy, wind energy and solar energy, etc. The *Provisional Measures on Urban Heating Price Control* has been issued to promote payment for unit of heat, rather than fixed or no fee services, in centralized heating systems.	The Vietnamese Government intends to allow international and domestic markets to define energy prices in the period 2010-2015. At present, the coal price is set by a domestic market, except coal used for power generation. Prices of natural gas and petroleum products are almost all based on the international market (plus different taxes), except kerosene for residential households and gas for power generation. The government sets prices of coal and natural gas for power generation in negotiation with the power sector. The current electricity tariff system applies different prices for different sectors and different times (peak, off peak and low peak). It also provides preferential rates for rural residents. Around 2015, this tariff system will be reviewed and become a cost-based tariff system. For this purpose, a road map for increasing the electricity price has been in place since 2000, and adjustments have been made every year.
Tax Incentives	*Comprehensive Utilization of Some Resources and VAT Policy on Other Products* (2001)	None as of yet
Capacity Building		
Technical Assistance Centers	Energy Conservation Inspection Centers and Energy-Conserving Technology Service Centers were set up in each province and municipality. In addition, energy conservation supervision authorities were set up most of the provinces, so as to promote the energy conservation with legal enforcement, as necessary.	Energy efficiency centers were set up in several large cities and provinces (Hanoi, Tiengiang, Ho Chi Minh cities). Further, all Departments of Industry, in each province, have been directed to carry out energy efficiency programs.
Measurement/ Audit Guidelines	Issued energy conservation action plan for 1000 enterprises. Energy audits and energy efficiency benchmarking are to be carried in accordance with *Guidelines for Review of Energy Audit Reports on Enterprises and Energy Conservation Plans* (2006).	Publishing guidance documents for some individual industrial sectors.
Subsidies for Training	Regional funds for energy conservation are available for training.	Workshops and training courses are organized on a one-off basis.
Implementing Effect		
Change in Industry Share of GDP (since 2005)	47.7% (2005), 48.7% (2006). 49.2% (2007), 48.6% (2008)	41.02% (2005), 41.54% (2006), 41.58 (2007)

Energy Intensity Reduction (since 2005)	The 1.79% reduction in 2006 was the first decline since 2003. It was followed by a 4.04% decline in 2007 and 4.59% decline in 2008. Compared to that of 2005, the national average energy consumption per unit GDP in 2008 dropped by 10.1%.	Total final energy supply in Vietnam has decreased each year since 2005. Energy consumption per unit of GDP has decreased dramatically—by 10.2% in 2006 and 7.7% in 2007.

*Data for Vietnam is only through 2007.

Sources:

APERC. *APEC Energy Overview 2008.*

APERC. *China Energy Efficiency and Conservation Policy Database (see Appendix F of this report).*

GSO. "Statistical Data". General Statistics Office of Vietnam. http://www.gso.gov.vn/. (2008).

Vietnam Institute of Energy. *"Meeting with APEC Delegation"* (Presentation). (June 2009).

Appendix D

The following table has been translated and reproduced from the NDRC's *Implementation Plan for Evaluation System of Energy consumption Per Unit GDP*, issued in 2007.

Score Table for Assessment and Evaluation on Energy Conservation Objective Responsibilities of 1000 Key Energy Consuming Enterprises

Indicator	No.	Evaluation Contents	Score	Score Criteria
Energy conservation objective (40)	1	Reduction in energy consumption	40	Fulfill annual planned objective: 40; 90% fulfilled: 36; 80% fulfilled: 30; 70% fulfilled: 25; 60% fulfilled: 20; 50% fulfilled: 15; and less than 50% fulfilled: 0. 10% over-fulfilled: plus 2; and the maximum additional score: 6. The indicator is a determinative indicator, i.e. if not reaching the objective value determined in annual plan, it shall be rated as Unfulfilled.
Energy conservation measures (60)	2	Organization and leadership in energy conservation work	5	1. Set up enterprise principal-headed energy conservation leader team, and periodically study and allocate enterprise energy conservation work: 3; 2. Set or designate special energy conservation management department and provide work guarantee: 2.
	3	Decomposition and implementation of energy conservation objective	10	1. Decompose energy conservation objective and allocate to workshops, teams and individuals every year: 3; 2. Providing evaluation on accomplishment of energy conservation objective: 3; 3. Implement reward & penalty system for energy conservation: 4.
	4	Implementation of advanced energy conservation technology and energy conservation reconstruction	25	1. Single energy consumption per main product or comprehensive energy consumption level ranks among the leading 20% in the same industry among 1000 enterprises: 10; among the foregoing 50%: 5; among the laggard 50%: 0; 2. Allocate specific fund for R&D in energy conservation and increase it year by year: 4; 3. Implement and fulfill annual energy conservation reconstruction plan: 4; 4. Scrap backward and energy-consuming technology, equipment and product as stipulated: 7.
	5	Enforcement of energy conservation laws and regulations	10	1. Implement energy conservation law and auxiliary laws and regulations, and regional laws and governmental regulations as well: 2; 2. Implement energy consumption limitation standard to highly energy-consuming products; 4; 3. Implement energy consumption quota management rules for main energy-consuming equipment: 2; 4. Carry out construction, reconstruction and expansion of project according to energy

				conservation design specification and energy-use standard: 2.
	6	Implementation of energy conservation management work	10	1. Practice energy audit or measurement, and implement corrective measures: 2; 2. Set energy statistical post, establish energy statistical account, and submit energy statistical report as required in a timely way: 3; 3. Deploy energy measurement instruments as stipulated and provide periodical calibration: 3; 4. Provide energy conservation publicity and training: 2.
Subtotal			100	

Notes: 1. Energy conservation objectives shall be set by various enterprises on the basis of the annual objective specified in energy conservation objective responsibility book; any energy conservation objective unfulfilled in one year shall be transferred to the next year.

2. The objective specified in energy conservation objective responsibility book shall be applied as the energy conservation objective in 2010.

Appendix E

The following table has been translated and reproduced from the NDRC's *Implementation Plan for Evaluation System of Energy consumption Per Unit GDP*, issued in 2007.

Score Table for Assessment and Evaluation on Energy Conservation Objective Responsibilities of Various Provincial People's Governments

Indicators	No.	Evaluation Contents	Score	Score Criteria
Energy conservation objective (40)	1	Reduction rate of energy consumption per RMB 10,000 of GDP	40	Fulfill annual planned objective: 40; 90% fulfilled: 36; 80% fulfilled: 32; 70% fulfilled: 28; 60% fulfilled: 24; 50% fulfilled: 20; and less than 50% fulfilled: 0. 10% over-fulfilled: plus 3; and the maximum additional score: 9. The indicator is a determinative indicator, i.e. if not reaching the objective value determined in annual plan, it shall be rated as Unfulfilled.
Energy conservation measures (60)	2	Organization and leadership in energy conservation work	2	1. Set up local statistical, measurement and evaluation system for energy consumption per unit GDP: 1; 2. Establish energy conservation work coordinating mechanism, ascertain responsibility division, periodically hold meetings for studying key issues: 1.
	3	Decomposition and implementation of energy conservation objective	3	1. Gradual decomposition of energy conservation objective: 1; 2. Providing examination and evaluation on accomplishment of energy conservation objective: 1; 3. Periodically publish energy conservation indicators: 1.
	4	Adjustment and optimization of industrial structure	20	1. Proportion of growth rate of the third industry in total growth of regional GDP is rising: 4; 2. Proportion of growth rate of high-tech industry in total growth of regional industry is rising: 4; 3. Formulate and implement energy conservation assessment and audit method for fixed-asset investment projects: 4; 4. Reach the scrapping objective of backward production capability of the year: 8.
	5	Implementation of energy conservation input and key projects	10	1. Set up energy conservation-specific fund and fully funded: 3; 2. Proportion of energy conservation-specific fund in fiscal income is increasing year by year: 4; 3. Implement key energy conservation project: 3.
	6	Development and promotion of energy conservation technology	9	1. Introduce R&D of energy conservation technology into annual sci-tech plan: 2; 2. Proportion of R&D fund for energy conservation technology in fiscal income is increasing year by year: 3; 3. Implement energy conservation demonstrative project: 2;

				4. Formulate a mechanism for promoting energy conservation production and technology and proving energy conservation service: 2.
	7	Energy conservation management in key enterprises and industries	8	1. Reach energy conservation objective of key energy-consuming enterprises (including 1000 enterprises) of the year: 3; 2. Implement annual energy conservation measurement plan: 1; 3. Compliance rate of compulsory energy conservation standards on new buildings fulfills the annual objective: 4; 80% fulfilled: 2; less than 70% fulfilled: 0.
	8	Enforcement of laws and regulations	3	1. Introduce and improve counterpart regulations with energy conservation law: 1; 2. Carry out supervision and inspection on enforcement of energy conservation laws and regulations: 1; 3. Implement energy consumption limitation standard to highly energy-consuming products; 1.
	9	Implementation of fundamental work for energy conservation	5	1. Strengthen construction of energy conservation supervision team and organization: 1; 2. Improve energy statistics system and enhance energy statistical capability: 1; 3. Deploy energy measurement instruments as required: 1; 4. Provide energy conservation publicity and training: 1; 5. Implement energy conservation reward system: 1.
Subtotal			100	

Notes: 1. Annually planed energy conservation objectives shall be set by various regions on the basis of the annual objectives specified in the Response; any energy conservation objective unfulfilled in one year shall be transferred to the next year.

2. The objective specified in the Response shall be applied as the energy conservation objective in 2010.

Appendix F

China's Energy Efficiency and Conservation Policies—Summary Table

The research for this report included the review of many policies on energy efficiency and conservation that have been issued by the central and provincial governments of the People's Republic of China. The full text of all such policies is too long to reproduce in this report. However, in order to provide an orientation to these policies and a guide for readers who wish to consult the original policies for further information, we prepared the following summary table.

Year	Policy	Issuing Agency*	Summary	Source
2000	Rules on the Development of Heat and Power Cogeneration	NDRC	Calls for local authorities to develop heat and cogeneration plans that are consistent with their city heating supply plan and have heat supply as their priority. It identifies construction departments as the administrators of the city heating supply industry and requires that units greater than 25 MW in size (or retrofits greater than CNY50 million in value) are approved by the State Planning Commission. Specific efficiency requirements are defined. Natural gas systems are given strong support, including pricing consideration.	APERC
2000	Opinions of the State Economic and Trade Commission on Clearing up and Restructuring Small Steel Plants	State Council	Small steel plants (with specific sizes delineated according to production equipment) are required to close down. The Economic and Trade Commission at the provincial level is assigned the task of implementing the shut-downs.	APERC
2000	Administration Rules on Power Saving	State Economic and Trade Commission	Issued in accordance with the Energy Conservation Law; State Economic and Trade Commission (SETC) and local departments in charge of power saving are required to establish a reward and punishment system; SETC will establish equipment standards and provincial agencies may develop more stringent standards; fixed asset investment studies must evaluate high efficiency equipment; certain inefficient equipment and practices will be banned; product labelling and the establishment of Energy Services Companies (ESCos) are encouraged; governments above county level are given authority to shut down existing capacity and block new capacity that exceeds efficiency standards; some industrial standards are presented in terms of kWh per ton of product produced.	APERC
2001	Comprehensive Utilization of Some Resources and VAT Policy on Other Products	Finance Ministry and State General Administration of Taxation	The production of energy products from some waste materials is exempted from the value added tax (VAT). The VAT on energy production from some other waste materials, from wind, and on the production of construction materials from waste is reduced by 50 percent.	APERC
2004	Implementation Opinions on Government Procurement	Ministry of Finance and NDRC	Directs government organizations, public institutions and "group entities" to preferentially purchase energy-conserving products. Ministry of Finance and NDRC will issue the Energy	APERC

	of Energy-conserving Products		Conserving Products list. Implement in central and provincial budgets in 2005, in districts and cities in 2006, and comprehensively by 2007.	
2004	Medium and Long-term Plan of Energy Conservation	NDRC	Introduces 10 key conservation programs, including: upgrading boilers, kilns and motors; adding district heating; fuel switching; use of exhaust heat and pressure in iron and steel; conservation in buildings; conservation in government; and high-efficiency lighting. The plan also calls for improved technical assistance centres in provinces and major industries, and for optimizing industrial energy systems.	IEA (2008)
2004	Administrative Rules on Energy Efficiency Label	NDRC and State General Administration of Quality Supervision, Inspection and Quarantine	The rules stipulate how the "China Energy Efficiency Label", informational labels indicating a products energy efficiency performance, will be composed, quantified, verified, etc… Penalties are discussed, including fines up to CNY10,000 for non-compliance.	APERC
2004	Guiding Opinions on the Work of Strengthening Power Demand Side Management	NDRC and the State Electricity Regulatory Commission	The circular calls for the adoption of all "economic, technical and necessary administrative measures," to engage generators, transmission and distribution companies, power users, and other involved parties in demand side management. Authority for DSM programs is assigned to provincial governments. Transmission & distribution companies are assigned responsibility for implementation, including preparation of annual DSM plans. Incentives for load-shifting are considered. Industry groups are asked to prepare best practices and participate in training. Funding sources, including a public goods charge or revolving loan program, are suggested.	APERC
2005	Administration Procedures of Shanghai Municipality on Building Energy Conservation	Government of Shanghai Municipality	The Municipal Economic Commission in designated as the principal authority for energy conservation work and the Municipal Construction and Communications Commission is given authority for building energy conservation. Development, design, and construction units are instructed to abide by building energy conservation standards. Construction permits are to be withheld from projects which do not have energy conservation design documents that satisfy standards. Developers are encouraged to go beyond standards and to voluntarily obtain 3rd party energy certifications. Administrative departments are instructed to conduct timely investigation into reported violations. Violators may incur fines in the amount of CNY5,000 to 30,000.	APERC
2005	Circular on the Strict Implementation of Design Standard for Energy Efficiency in New Residential Buildings	Ministry of Construction	The circular identifies the lack of compliance with building standards by designers and developers as a key problem in implementation. It requires new buildings in urban areas to comply with the Design Standard for Energy Efficiency of Buildings. Section 2 defines responsibilities and describes methods for strengthening implementation, including authorization of building plans by signature and seal representing that the energy conservation review is complete. Section 3 describes enhanced inspection/enforcement procedures by local government offices. Construction supervisors face fines up to CNY1 million for violations, developers face fines up to CNY500,000 or 4 percent of contract	APERC

			price for non-compliance, and builders up to 2 percent of the contract price. Inspectors may lose certification if they do not properly enforce standards.	
2005	Policies for the Development of Iron and Steel Industry	NDRC	Calls for the top 10 iron and steel groups to attain at least 50 percent of total domestic production capacity by 2010 and at least 70 percent by 2020. Producers with more than 5 million tons capacity are asked to become net power producers. Also by 2010, energy consumption per ton of steel and iron of 0.73 and 0.685 tce, respectively, is targeted. By 2020, the same targets are 0.7 and 0.64 tce. Enterprises with more than 5 million tons capacity (in 2005) are allowed to prepare their own development plans, subject to approval of the State Council or NDRC. The paper makes suggestions as to where development should occur; for example, along coastal areas and outside of urban areas. Technical requirements for entrance to the iron and steel market are specified, including the dimensions of furnaces, energy efficiency of furnaces, use of pressure recovery turbines and coke dry quenching, etc... Industry reorganization is encouraged with specific objectives of two internationally competitive producers with capacity of "300 million tons" and several large producers with "capacity of several hundred million tons." Privatization of the industry is encouraged.	APERC
2005	Circular on Controlling Overall Volume, Washing out the Laggard Productivity and Accelerating Structural Adjustment for the Steel Industry	State Council	Notes that policies have had the positive effect of reducing investment growth of the steel industry from 92.6% in 2003 to 27.5% in 2005, and growth of steel consumption from 28% to 22% (same years), and that reduced prices caused by overcapacity have shut down some inefficient capacity; but that development continues with some producers operating at a loss, that only a small fraction of growth is approved by government agencies, and that energy consumption was nearly 300 million tce in 2004, 15% of the national total, while value added was only 3.14% of GDP and its emissions 14% of the industrial total. The poor performance characteristics of "laggard capacity" are described. Goals for the industry are defined, including elimination of 100 million tons of laggard iron-making facilities (by 2010) and 55 million tons of laggard steel-making facilities (by 2007), and concentration of 83% of national production in the top 10 enterprise groups (2-3 30 million ton and several 10 million ton groups). Use of market mechanisms for promoting industry reorganization is preferred, but instability of the industry is to be avoided.	APERC
2005	Regulations on Electric Power Supervision	State Council	Authority for implementing this regulation is granted to the organs of the state council, foremost to the "electric power supervisory organ" (SERC). Any entity is able to report regulatory violations to said authorities and to receive a reward for doing so. The regulatory duties of SERC are specified, including issuance of electric power business licenses, managing grid-access, safety, price-setting, etc... The SERC is authorized to perform	APERC

			inspections, obtain documents, mediate conflicts, perform accident investigations, etc... Electric power businesses, including trading institutions, may be fined up to CNY1 million for non-compliance.	
2006	Provisional Rules Regarding the Administration of a Special Fund for the Development of Recycling Economy in Zhejian Province	Government of Zhejian Province	This document describes the rules for access/use of special funds made available by the provincial finance department for subsidies or interest subsidies to enterprises that wish to implement a demonstration project in the area of the "recycling economy". Eligible projects include: renewable energy, water recycling, developing cascaded energy utilization, etc...	APERC
2006	Implementation Plan of the Ministry of Construction for the Comprehensive Working Plan on Energy Conservation and Emission Reduction	Ministry of Construction	Describes, in detail, a national plan for achieving 100 million tce of energy savings in buildings. The plan includes: strengthening energy conservation work in new buildings; improving existing heating systems; improving energy use in state office buildings and large public buildings; and developing local renewable energy resources. The circular calls for provincial construction administration departments to prepare plans consistent with the Ministry's plan.	APERC
2006	Conversion of Exhaust Heat and Pressure	NDRC	Mandates waste heat and energy capture and utilization. Requires implementation of specific energy saving processes/technologies in the iron and steel sector and in concrete production. Also requires coalbed methane production.	IEA (2008)
2006	Efficiency Upgrade for Appliance Production and Public Lighting	NDRC	Promotes energy efficient lighting	IEA (2008)
2006	Efficiency Upgrade for Coal-burning Industrial Boilers and Kilns	NDRC	Seeks to improve small and medium boiler efficiency by the use of higher quality coal, improved technologies, and better management	IEA (2008)
2006	Efficiency Upgrade for Electric Motors	NDRC	Seeks to improve motor efficiency by promoting high-efficiency motors, variable frequency drives, and by achieving higher efficiencies in motor-driven equipment.	IEA (2008)
2006	Policy Outline of China Energy Conservation Technology	NDRC	Describes an extensive list of research and development objectives for saving energy in buildings, transportation, and energy and industrial processes. It is essentially a white paper that is intended to unify and guide government policies in this area.	APERC
2006	Energy Efficient Products for Government Procurement—Publication of Official Listing	NDRC & Ministry of Finance	Federal, state, and municipal offices must give priority to the efficient products on this list.	IEA (2008)
2006	Improvement of the Policy Regarding Differential	State Council	With the intent of reducing industrial energy consumption by changing the industrial structure and eliminating inefficiency, this requires regions to implement a differential electricity price policy	APERC

	Electricity Price		(DEPP). It notes that while immediate shortages have been reduced by some DEPP implementation, without more universal application resource waste and pollution will continue to grow. Regions are required to eliminate preferential pricing; eight High Energy Consumption industries are identified for DEPP; a schedule of price increases is provided; and implementation responsibility is assigned to the provincial government, which must provide a list of enterprises to the State Power Grid Corporation and China Southern Power Grid Corporation for enforcement. NDRC and the State Electricity Regulatory Commission will provide oversight.	
2006	Energy Consumption Reduction Indicator Plan of Unit Gross Production of Every Area during the Eleventh Five-Year Plan	State Council	Expresses the State Council's agreement with the 20% energy intensity reduction target - from 1.22 tce to 0.98 tce per CNY10000. The target is required to be incorporated into plans at every level, from national, to region, county, city, industry and enterprise, and the indicator is required to be used in performance assessments. The 2005 energy intensity and assigned target are presented for each region.	APERC
2006	Decision on Strengthening Energy Conservation Work	State Council	Describes the decision to put energy conservation in a more strategic position, so that both development and conservation are important, with conservation given preference. Calls for reducing energy intensity 20 percent, to 0.98 tce per CNY10000 (2005) by 2010 and moving industry toward current global efficiency levels using approaches consistent with the socialist market economy system, including actively adjusting the structure of industry to eliminate energy-intensive processes and grow the service sector. Requires the NRDC to push regions and government agencies to implement policies and provide funding for energy saving projects. Also calls for using energy price reform as a tool. This is an overarching mandate for energy conservation.	APERC
2006	1000-Enterprise Implementation Plan Of Energy Conservation Action	NDRC	The objectives of this plan are to bring the energy utilization efficiency of the top-1000 industrial energy consumers to the advanced level in China, to raise some to the best international level, and to save 100 million standard tons of coal. The 1000 enterprises are required to form energy management teams, measure and report energy consumption, prepare energy conservations plans and submit these to the provincial government, fund retrofits, develop energy-saving incentive programs, and operate education campaigns. The plan also discusses provisions for monitoring and enforcing industry compliance, using both incentives and possible penalties.	APERC
2006	Guidelines for Review of Energy Audit Reports on Enterprises and Energy Conservation Plans	NDRC	Provides the guidelines by which provincial energy-conservation administrative departments are required to review the energy audits and energy conservation plans submitted by the enterprises participating in the 1000 Enterprise Program.	APERC

2007	Strengthening Energy Conservation Management on Government Office Building and Large-scale Public Buildings	Ministry of Construction and Ministry of Finance	Government offices (GO) and large scale public buildings (LPB) are reported to have 1.5 to 2 times the energy use per area of similar buildings in developed countries and to account for 22% of national urban power use. This paper presents a plan to save 20% of energy in GO and LPB during the 11th FYP. With regard to new buildings it calls for issuing building permits conditional on building energy demand. For existing buildings, it requires gathering of statistics, audits of major energy users, and hiring of energy managers. The data will be used to develop better standards. To perform energy-saving retrofits, 3rd party contractors may be used. Regional institutions responsible for construction must prepare plans for saving energy in GO and LPB. Energy use of GO and LPB must be included in the evaluations of performance toward the energy intensity improvement objective. Beijing, Tianjin and Shenzhen are to pilot the energy monitoring network; the entire network, to be coordinated by the Information Centre of the Ministry of Construction, should be mostly complete by the end of 2010.	APERC
2007	Aluminium Industry Permitting Standards	NDRC	Various energy efficiency standards for different bauxite mining and aluminium production processes.	IEA (2008)
2007	Guidelines for Energy-Conservation Evaluation and Review of Fixed-Asset Investment Projects (2006)	NDRC	Lists over 150 existing policies/standards/codes that should be considered when making investment decisions. Recognizing that some are rather out-dated, the NDRC states its intention to make amendments where necessary.	APERC
2007	Circular on Reduction of Network Power Price of Small Thermal Power Generating Sets to Speed up Closing down Small Thermal Power Generating Sets	NDRC	Applies to thermal generators with capacity < 50 MW, < 100 MW and more than 20 years old, and < 200 MW and older than design service life. The price of power purchases from these generators must reduce to the "benchmarking network power price". Small generators that will close down "shall transfer the energy output index" to large generators. Public reprimand and disciplinary sanctions are threatened for non-compliance.	APERC
2007	Implementation Plan for Evaluation System of Energy Consumption per Unit GDP	NDRC	This document describes the specific procedures that will be used to evaluate the regions and 1000-Enterprises satisfaction of energy intensity objectives. Sample scoring tables are shown. Penalties for under-achievement are described, as are rewards for achievement and over-achievement.	APERC
2007	Circular on the Implementation of Top Ten Key Energy Conservation Projects in the Eleventh Five-Year Plan Period.	Shanghai Municipal Economic Commission, Development & Reform Commission, Urban Transportation & Communications	The circular states that Shanghai will develop an implementation program and annual implementation plans for the "top ten key energy conservation projects". Administrative units are required to distribute implementation measures to enterprises and institutions so that energy consumers can develop bottom-up approaches to save energy. Districts, counties and enterprise groups, should gather implementation programs from their subordinates and roll them up into a	APERC

		Commission and Finance Bureau	comprehensive plan, containing "real data, feasible measures and clear responsibilities". Initially, units are expected to provide financing for the energy conservation program, however, additional funding may later be made available. Implementation progress will be an important consideration in annual evaluations.	
2007	The Eleventh Five-Year Plan for Energy Conservation of Shanghai	Shanghai Municipality	This plan points out that over the 10th FYP Shanghai reduced energy intensity by 16.5% and that Shanghai leads the nation in many measures of efficiency. It also states that Shanghai created China's first "energy conservation supervision organization" and has investigated more than 2,000 cases of energy conservation regulation violations, with a high correction rate. 26 ESCos are reported to have been established and to have saved 110 thousand tce. Recognizing that energy is in short supply, that demand will continue to grow, and that Shanghai has yet to achieve international advanced efficiency levels, the plan finds that energy efficiency must be further enhanced. It suggests that "10%-30% energy conservation potential universally exists in industries, transportation, construction, and other domestic and commercial sectors..." The plan describes energy saving objectives and measures for specific sectors, processes, and equipment, and describes implementation measures. The plan for saving 9 million tce includes measures such as improving efficiency of industrial motors (potential 2.58 million tce), energy-conserving building envelopes for public buildings (potential 1.19 million tce), a green lighting program (potential 0.68 million tce), etc... Implementation measures include updates to local laws, regulations and standards, scrapping inefficient enterprises, pricing policies, voluntary agreements with industries, etc...	APERC
2007	Implementation Plans and Methods for the Monitoring and Examination of Statistical Work on Energy Conservation and Emission Reduction	State Council	Approves and requires strict implementation of the following plans, termed the "Three Systems", that were developed by the Bureau of Statistics and NDRC: —Implementation Plan for Statistical Index System of Energy Consumption Per Unit GDP —Implementation Plan for Monitoring System of Energy Consumption per Unit GDP —Implementation Plan for Assessment System of Energy Consumption per Unit GDP The circular calls the use of these measures in performance evaluations of government officials and enterprise principals the "primary foundation" to realize targeted energy and emissions reductions.	APERC
2008	Circular on Printing and Issuing The Implementation Plan for Energy Conservation of Hangzhou in 2008	General Office of the City of Hangzhou	This plan for 2008 has an energy intensity target of 4.4% below 2007. Measures for achieving this target include requiring large energy consuming enterprises to reduce intensity by 3.5%, investing CNY750 million in 100 energy conservation projects, waste-heat recovery, etc... To implement the measures, the municipal government signs commitment letters with subordinate administrative units (districts, counties and cities), and instructs economic departments to sign similar letters with the large energy consuming enterprises.	APERC

			Further, large investments in energy-consuming industrial assets will only be allowed if they use less than 0.92 tce per CNY10000, existing inefficient producers will be eliminated, the energy conservation accountability system will be strengthened, monitoring and reporting will be strengthened, the quality of "clean production approval" reviews will be strengthened, more audits and benchmarking will be conducted, and attention will be given to improving building energy efficiency.	
2008	Efficient light bulb subsidy programme	Ministry of Finance	The government will provide upstream subsidies on the sale of 50 million low-energy bulbs.	IEA (2008)
2008 (and 2006)	Vehicle excise tax rates	Ministry of Finance	The excise tax on vehicles is determined according to engine displacement, with the smallest engines taxed at only 1% of the vehicle's value and the largest engines at 40% of the vehicle's value.	IEA (2008)
2008 (and 2005)	Vehicle Fuel Economy Standards	NDRC	Requires passenger vehicles and light-duty cargo vehicles to meet efficiency standards that vary according to the vehicle's weight. There are 16 weight-based categories.	IEA (2008)
2008	Energy Conservation Regulation for State-Funded Institutions	State Council	Calls on state-institutions to show leadership by taking an active role in energy management and implementing technically feasible and economically reasonable measures to reduce consumption. Enforcement responsibilities are given to the government offices administration (GOA) at all levels of government down to county-level. The head of each institution is responsible for implementing measures, and performance in this area will be included in his/her evaluation. The GOA, at all levels county and higher, must formulate an energy conservation plan for state institutions at that same level. Procedures are set forth for conducting energy audits. Specific actions are also prescribed, such as reducing stand-by consumption of office equipment, utilizing natural lighting, and using "intelligent" elevator controls. The act authorizes criticism and/or punishment for non-compliance.	APERC
2008	Energy Conservation Regulation for Civil Buildings	State Council	Calls for saving energy in all state-owned buildings, including residential, office, etc... The construction administration department is given authority for preparing building energy conservation plans at all levels of government down to county level. Energy consumption standards for civil buildings are called for and governments are required to set aside funds for energy conservation improvements. Requires all actors in the construction process to ensure compliance with energy standards for civil buildings. Requires specific measures in new construction, such as installation of unit-level heat metering in residential buildings and use of energy-saving lamps. Energy efficiency retrofits are required to be implemented, "step by step systematically in accordance with actual conditions". Building owners are required to operate buildings in a manner consistent with energy conservation goals. Penalties for non-compliance are specified.	APERC

2008	Circular on Further Strengthening Oil Saving and Power Saving Work	State Council	The circular identifies a "tense supply of petroleum and electric power" as "an important factor curbing…development". It then identifies conservation as the most important solution, and characterizes it both a long-term and imminent task. It then describes specific measures to be taken in the following areas: oil-transportation, oil-boilers, electricity-motors, electricity-air conditioners, electricity-lighting, and electricity-office equipment. It also requires improved management practices, including, real-time online monitoring of all major power consuming enterprises, and pricing policies favouring conservation, for example, "cancel any preferential power pricing policy introduced by regional authorities".	APERC
2009	Opinions on Carrying out Energy Efficiency Benchmarking of Key Energy-consuming Enterprises	Shandong Economic and Trade Commission	This describes a program whereby key energy consuming enterprises in the province will be asked to perform energy benchmarking. First, pilot projects will be completed, then guidelines for benchmarking will be developed, and finally all major energy consumers will be asked to participate. The findings of the benchmarking studies are then expected to be used to make energy efficiency improvements that will save energy, reduce production costs and increase competitiveness.	APERC

*Several agencies may issue the same or similar policy in series or in parallel. The agency indicated here is believed to represent the best primary source of the policy.

Sources:

APERC. Summaries of publically available policies translated and summarized by the Asia Pacific Energy Research Centre.
IEA. *Energy Efficiency: Policies and Measures (database)*. http://www.iea.org/textbase/pm/?mode=pm. Paris: International Energy Agency (2008).

Appendix G

Energy Conservation Law of the People's Republic of China (2007)—Outline

The following outline of the 2007 Energy Conservation Law was prepared by APERC based on a translation of the legislation, as reproduced in the joint study by the Institute of Energy Economics (Japan) and Energy Research Institute (China). The individual articles are not given descriptive titles in the original text of the legislation. *The descriptive article titles presented here are provided by APERC to offer readers a sense of the content of each article. They are not the actual text of the legislation.*

Chapter I—General Provisions

Article 1	Intent
Article 2	Energy definition
Article 3	Energy conservation definition
Article 4	Statement of conservation priority
Article 5	Government responsibility for conservation plans
Article 6	Government accountability system for energy conservation targets
Article 7	Industrial policy for energy conservation
Article 8	Support for research, development, demonstration and education
Article 9	Right to report on energy waste
Article 10	Responsibility of government departments

Chapter II—Energy Conservation Administration

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