McKinsey Global Institute

Leapfrogging to Higher Energy Productivity in China

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Preface

This perspective on China's energy demand was developed as part of a yearlong effort by the McKinsey Global Institute (MGI) and McKinsey's Global Energy and Materials (GEM) Practice to understand the microeconomic underpinnings of global energy demand. The global report, with detailed sector-level analyses, is available without charge at the McKinsey Global Institute website.[1]

A group of leaders from McKinsey's Global Energy and Materials Practice, Pedro Haas, Scott Nyquist, and Matt Rogers, collaborated with us in leading the global effort. The project team was led by Jaana Remes and Jaeson Rosenfeld, Senior Fellows at MGI. The project team included Arpit Agarwal, Florian Bressand, Rahul Gupta, Anders Havneraas, Maya Jolles, Paul Langley, Shawn Liu, Fabrice Morin, Laurent Poncet, Sebastian Roemer, Erin Tavgac, and Peter Yeung. And we benefited from support from many colleagues around the world, and would particularly like to thank Peter Berg, Ivo Bozon, Odd Christopher Hansen, Scott Andre, Warren Campbell, Tim Fitzgibbon, Morten Jorgensen, Mike Juden, Alan Martin, Augusto Moreno, Greg Terzian, and Benedikt Zeumer. We would also like to thank our senior external advisors Adrian Lajous and Robert Mabro for their valuable input. We also thank Janet Bush for providing editorial support.

The research on energy demand in China benefited from the knowledge of many experts. We want to thank our McKinsey colleagues, Thomas Luedi, Oliver Ramsbottom, Michael Wang, Jin Yu and David Xu for sharing their energy and

1 *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity*, McKinsey Global Institute, May 2007 (www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp).

industrial expertise. We owe special thanks to David Fridley, Mark Levine, Jiang Lin, Lynn Price, and Nan Zhou from the Lawrence Berkeley National Laboratories for their valuable contributions on both the microeconomics of commercial sector demand in China and on Chinese energy demand more broadly. We would also like to thank the Energy Research Institute and Sinopec Research Institute for their valuable input.

This work is part of the fulfillment of MGI's mission to help global leaders understand the forces transforming the global economy, improve company performance, and work for better national and international policies. As with all MGI research, we would like to emphasize that this work is independent and has not been commissioned or sponsored in any way by any business, government, or other institution.

July 17, 2007
Shanghai

Diana Farrell
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Leapfrogging to higher energy productivity in China

As one of the largest and most rapidly expanding economies in the world, China is also one of the globe's fastest-growing consumers of energy. Today, China is still at a relatively early stage in its economic development, and measured by energy consumption per capita, the country only consumes a fraction of the energy that developed economies do. Yet the gap will narrow in the years ahead as industrialization continues and wealthier consumers aspire to the same level of comfort and convenience already enjoyed by households in developed economies. China's challenge is to meet its growing energy demand with sustainable sources of energy supply—without compromising the quality of the country's environment. On both these fronts, the choices China makes on energy productivity—the level of output its economy can achieve from the energy it consumes—are critical.

China's government is already working hard to use energy efficiently, taking concrete steps toward reducing the ratio of energy inputs to GDP by 20 percent by 2010. Yet China has the opportunity to go even further and take the lead in developing economically and environmentally sustainable energy solutions. New research by the McKinsey Global Institute (MGI) and McKinsey's Global Energy and Materials Practice finds that China has an enormous opportunity to shift its energy demand to a slower growth path.

A concerted effort to boost energy productivity could slow the pace of energy demand growth in China from 4.4 percent to 2.8 percent per year through 2020. This would leave energy demand in 2020 as much as 23 percent below the level expected under current policies. Lower energy demand would also mean that by 2020 China could cut its projected oil imports by up to 15 percent and its CO_2

emissions by at least 20 percent—while also helping reduce other environmental costs.[1]

The good news is that pursuing these energy productivity solutions can have a positive impact on businesses and the overall economy. In fact, China's significant labor-cost advantage means that its return on investment from the energy productivity solutions that we describe in this paper is likely to be far greater than the 10 percent or higher returns seen elsewhere in the world. As a result, improving energy productivity would not compromise the comfort and welfare of Chinese consumers. To the contrary, an effort to improve energy productivity would spur new markets for demand-side innovation and thereby offer a rich business opportunity to manufacturers, utilities, and other companies.

China has set a level of aspiration in many areas that has stunned the world in its ambition and drawn applause for the pace of execution. We believe that a concerted program to boost energy productivity would be a major new opportunity for China to achieve yet another success.

CHINA IS THE SECOND-LARGEST ENERGY CONSUMER IN THE WORLD TODAY

In 2003, global energy consumption reached 422 quadrillion British thermal units (QBTU)—the equivalent of 200 million barrels of oil per day. China's end-use energy demand totaled 60 QBTUs, or 14 percent of global total[2]—making the country the world's second-largest energy consumer after the United States.[3] Because of the high share of CO_2-intensive coal in the Chinese fuel mix, China contributed a higher proportion—17 percent—to the world's CO_2 emissions in 2003.

As in other developing regions, the majority of China's energy demand currently comes from industry—57 percent in 2003.[4] This industrial demand consists of

1 Our yearlong research project examined the underlying microeconomic drivers of energy demand in each end-use segment in the United States, China, and other major demand regions; how company and consumer behavior affect energy demand; and the impact of energy policies. We then built a model of global energy demand and productivity evolution to 2020. The full research report is available free at www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp.

2 We use end-use energy demand as the basis of our analysis. This equals primary energy demand in aggregate but allocates power-sector energy consumption and losses to the corresponding end-use segments.

3 The United States consumed 92 QBTUs of energy in 2003, 22 percent of the global total.

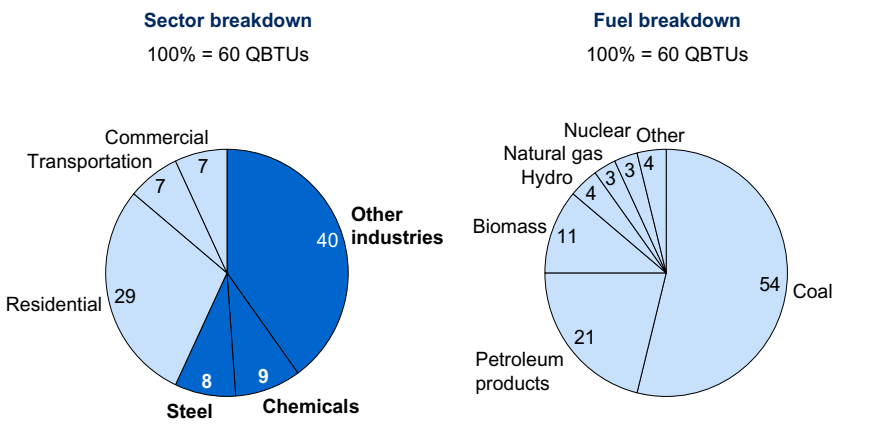
4 The share of industrial sector is lower for end-use energy demand than for final energy demand. This reflects the fact that the share of electricity and associated distribution losses is larger in residential and commercial sectors, and thus their share in end-use demand is correspondingly larger.

some energy-intensive sectors such as chemicals (9 percent of energy demand) and steel (8 percent), as well as a broad range of other industries such as food processing, apparel, and other manufacturing. Residential energy demand is the second-largest energy consumer with 29 percent of the total. Transportation and commercial buildings accounted for roughly 7 percent each (Exhibit 1). Looking at different fuels, coal accounted for 54 percent of Chinese energy demand in 2003—much higher than the 24 percent share coal has in worldwide energy demand. Petroleum products accounted for a 21 percent share of China's energy usage, with the rest fragmented across nuclear, hydroelectric, natural gas, and biomass.

Exhibit 1

CHINA ENERGY DEMAND IN 2003 WAS 60 QBTUs WITH 57 PERCENT FROM INDUSTRY AND 54 PERCENT IN COAL

End-use energy demand by sector, primary demand by fuel, 2003

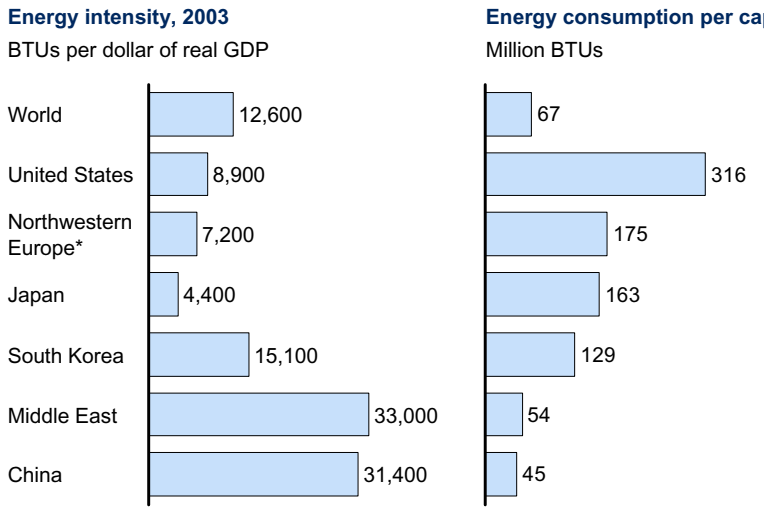


Source: IEA; MGI Global Energy Demand Model 2007

In 2003, China's energy intensity—the energy used to generate its GDP—stood at 31,000 BTUs per dollar of GDP. This is high relative to developed regions, reflecting China's lower share of services, which are less energy intensive than industrial activities, and a lower proportion of high-value-added activities—a pattern observed in other developing regions too. Yet China's energy consumption per capita—45 million BTUs, which is equivalent to almost a gallon of oil per day—is only 14 percent of the per-capita consumption in the United States and 28 percent of that in Japan (Exhibit 2).

Exhibit 2

CHINA'S ECONOMY IS ENERGY INTENSIVE, WHILE PER-CAPITA CONSUMPTION REMAINS LOW BY GLOBAL COMPARISON



* Northwestern Europe includes Belgium, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Switzerland, and the United Kingdom.

Source: McKinsey Global Institute analysis; MGI Global Energy Demand Model 2007

CHINA'S ENERGY DEMAND WILL MORE THAN DOUBLE TO 2020 DRIVEN BY BOTH INDUSTRY AND CONSUMER DEMAND

With the current policy environment, China's energy demand will grow 4.4 percent annually to 2020, more than doubling from 60 QBTUs in 2003 to 124 QBTUs in 2020 (Exhibit 3). In this base-case scenario, China will contribute a third—34 percent—of global energy demand growth to 2020.[5] Continuing growth in industry's energy demand and the expansion of consumer demand for energy will stimulate this rapid energy demand growth. Fast-rising incomes are helping to vault millions of Chinese citizens into a bracket that is recognizably middle class, thereby enabling them to aspire to, and increasingly attain, the same level of comfort and convenience as their counterparts in developed economies. The result is an associated increase in consumers' residential and transportation energy use.[6]

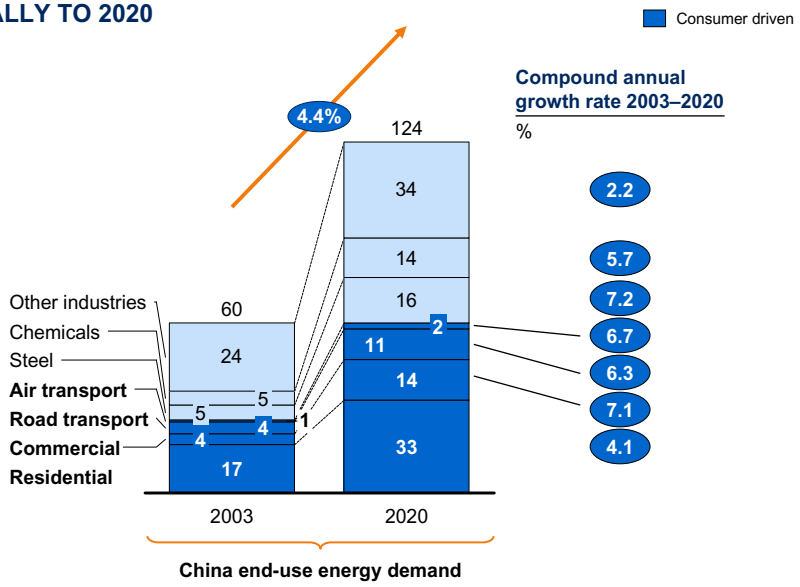
5 Our base-case scenario assumes 6.7 percent GDP growth to 2020 in China and a $50 per barrel oil price. We also assume a realistic capture rate of energy efficiency that contributes to the energy policy goals of the government. This capture rate varies by sector. On aggregate, our base-case scenario shows a 12–16 percent reduction in energy intensity from 2005 levels by 2010, indicating that more than half of the government target set for 2010 will be met. For the full set of assumptions behind each of the sector analyses, see the full research report at www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp.

6 For the story of how China's middle class is evolving, see Diana Farrell, Eric Beinhocker, Ulrich Gersch, Ezra Greenberg, Elizabeth Stephenson, Jonathan Ablett, Mingyu Guan and Janamitra Devan, *From 'Made in China' to 'Sold in China': The Rise of the Chinese Urban Consumer,* McKinsey Global Institute, November 2006 (www.mckinsey.com/mgi/publications/china_consumer/index.asp).

Exhibit 3

CHINA END-USE ENERGY DEMAND WILL GROW AT 4.4 PERCENT ANNUALLY TO 2020

QBTUs



Source: McKinsey Global Institute analysis; MGI Global Energy Demand Model 2007

Industry—China's industrial energy demand will grow by 3.8 percent a year to 2020, much more quickly than worldwide growth of 2.1 percent. By that point, China's industrial energy demand will account for 23 percent of the global total. With strong GDP growth, demand for basic materials in particular will soar. As a result, China's steel production will grow by 6.7 percent annually to 2020, when the country will represent 43 percent of global steel production. Energy demand from the steel industry will grow even more quickly by 7.2 percent annually: despite continuing improvements in energy efficiency, the average energy intensity of steel production will increase as scarcity of scrap steel will lead to a rising share for more energy-intensive integrated steelmaking. Energy demand from the chemicals industry will also grow rapidly—at 5.7 percent annually—with slower growth (2.2 percent annually) in the broad group of other industries.

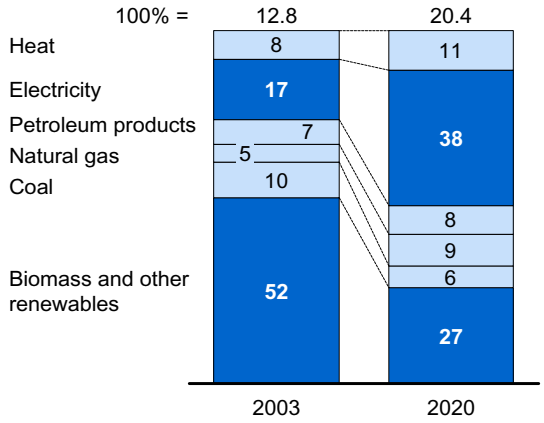
Residential sector—China's residential energy demand will expand at 4.1 percent a year to 2020. This growth rate is below the rate of the expansion for China's overall energy demand. This reflects the fact that although underlying demand for energy services will grow rapidly, the mix of energy sources will be shifting toward more efficient fuels, helping curb demand growth. The share of biomass (e.g., wood and dung) drops from 52 percent to 27 percent of overall residential demand, while the share of more efficient electricity increases from 17 percent to 38 percent (Exhibit 4).

Exhibit 4

LARGE FUEL-MIX SHIFT IN THE RESIDENTIAL SECTOR AWAY FROM INEFFICIENT BIOMASS REDUCES RESIDENTIAL SECTOR ENERGY DEMAND GROWTH

China residential sector fuel mix

QBTUs, %



Note: These figures do not add up to 100% due to rounding.

Source: McKinsey Global Institute analysis; MGI Global Energy Demand Model 2007

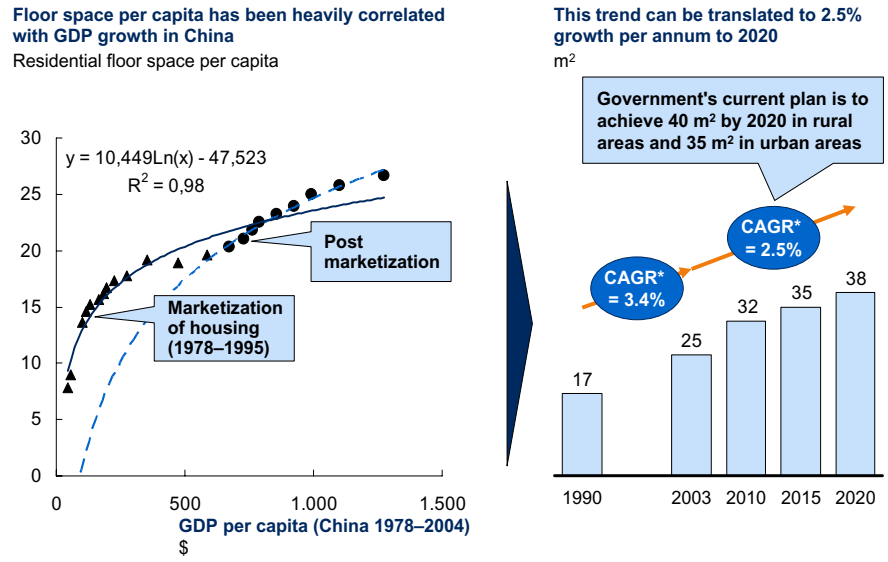
As incomes rise, Chinese consumers want more spacious houses and new, larger appliances. China's floor space per capita today is 25 m^2, at the low end of the global spectrum. This reflects both China's relatively lower levels of income and the fact that, until recently, the provision of housing was a state affair. Floor space per capita started taking off in China in 1995 when housing privatization began to gain momentum and is expected to continue growing and reach 38 m^2 per capita in 2020 (Exhibit 5). The penetration of energy-consuming appliances will also be an important contributor to energy demand growth in this sector. In urban areas, the increasing range and size of appliances is driving energy demand; in rural areas, the increasing penetration of basic appliances such as refrigerators (with only 20 percent penetration today) will continue to be the most important factor.

Commercial sector—Energy demand from China's commercial sector will grow by 7.1 percent a year and triple by 2020—accounting for 48 percent of global commercial sector energy demand growth during this period.[7] This explosive expansion reflects the increasing share of a range of services in China's economy as incomes rise. We expect commercial floor space to increase by 4.8 percent a year to 2020. The penetration of energy-consuming

7 The commercial sector includes all buildings not used for residential, manufacturing, or agricultural purposes. The main types of commercial buildings are office and retail buildings, hotels and restaurants, and buildings used for schools and hospitals.

Exhibit 5

CHINA'S FLOOR SPACE PER CAPITA IS EXPECTED TO REACH 38 M^2 BY 2020



* Compound annual growth rate.

Source: WEFA WMM; NSS 2002 data; literature search; McKinsey Global Institute analysis

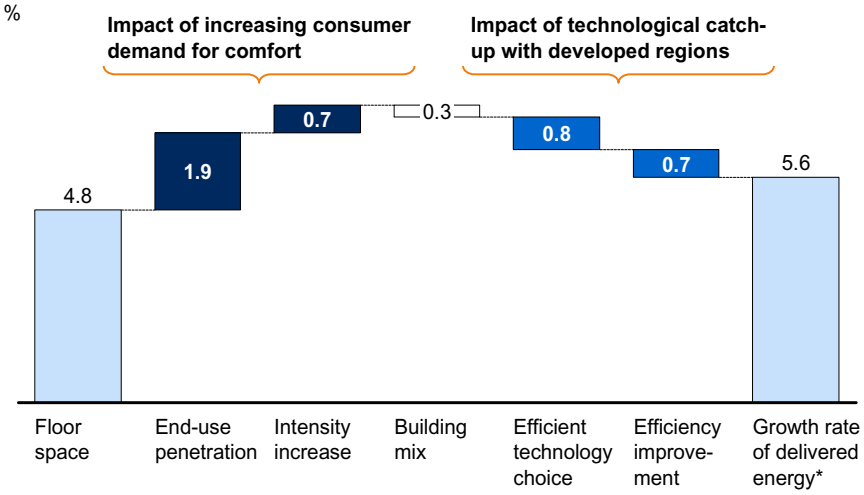
appliances will also rise. Commercial buildings typically adopt basic heating and air-conditioning first, and space-heating penetration will increase from 35 percent in 2000 to 55 percent in 2020. Other power-intensive appliances and equipment—computers in office buildings and advanced medical equipment in hospitals—will then follow. On top of these developments, it is frequently the case that the intensity of energy use also increases. Retail stores, for example, replace neon lights with more customer-friendly lighting, or thermostats are set lower or higher, depending on the climate, to increase customer comfort. As a result, even after accounting for higher energy efficiency, China is the only region in our base-case scenario in which final energy demand outgrows floor-space growth because the increased penetration of appliances will outweigh efficiency improvements (Exhibit 6).

Changes in the fuel mix in this sector will further contribute to higher energy demand growth. Space heating provides us with an illustration: its share of commercial-sector demand will decline from half in 2005 to one-third in 2020 while the share of power-intensive end uses such as air-conditioning, lighting, and office equipment will double to 50 percent. Simultaneously, the mix of space-heating technologies will move away from coal boilers to more efficient technologies such as natural-gas boilers and electricity-powered heat pumps. Overall, the share of coal in China's energy usage in the commercial sector will drop from 49 percent to 12 percent between 2003 and 2020. At the

Exhibit 6

INCREASING ENERGY USES PER SQUARE METER WILL MORE THAN OFFSET PROJECTED ENERGY-EFFICIENCY IMPROVEMENTS

Key drivers of China commercial sector energy demand growth, 2003–2020



* Growth rate of delivered energy is below the growth rate of energy use because of increasing share of power, and associated generation losses, in end-use demand.

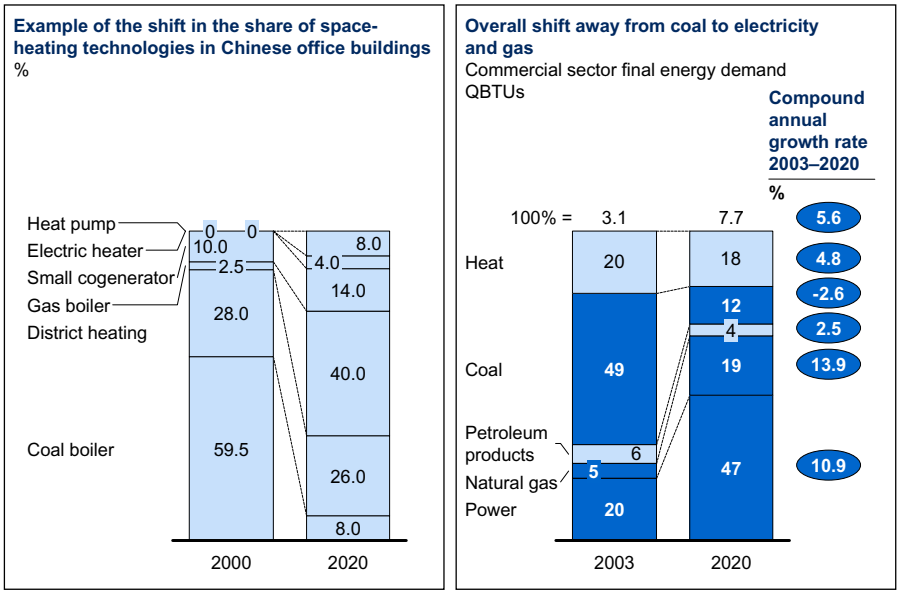
Source: Lawrence Berkeley National Laboratory (LBNL) China Energy Group; McKinsey Global Institute analysis

same time, the share of power and natural gas will more than double and triple to 47 percent and 19 percent respectively (Exhibit 7).

Road transportation—China's road transportation energy demand will grow

Exhibit 7

TECHNOLOGY SHIFTS WILL DRIVE SIGNIFICANT CHANGE IN FUEL MIX



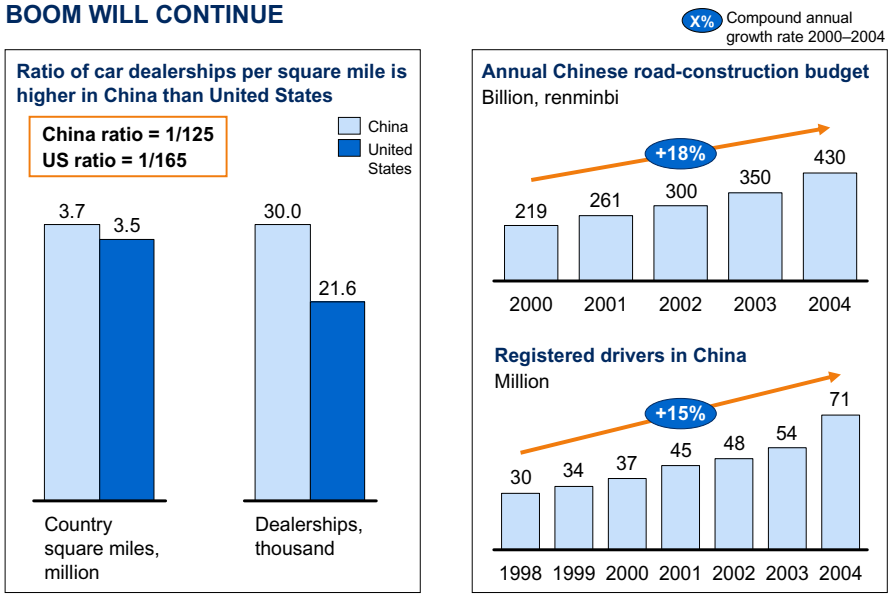
Source: LBNL China Energy Group; McKinsey Global Institute analysis

by 6.3 percent a year in our base case, nearly triple the pace of the global figure of 2.2 percent. This robust growth will largely reflect an explosion in the number of vehicles on the country's roads as Chinese incomes rise and as auto manufacturers increasingly produce affordable models for this burgeoning new market.

China's vehicle sales posted a compound annual growth rate of 8 percent in 1995–2000, but this then exploded to 23 percent between 2000 and 2005. The evidence suggests that this trend will continue. For instance, the country now has a higher ratio of car dealerships per square mile than the United States. The number of potential clients for these dealerships—licensed drivers—more than doubled in 1999–2004. China's annual road-construction budget also doubled in 2000–2004 (Exhibit 8). In our base-case scenario, we

Exhibit 8

SEVERAL INDICATORS SUGGEST THAT CHINA'S CAR PENETRATION BOOM WILL CONTINUE



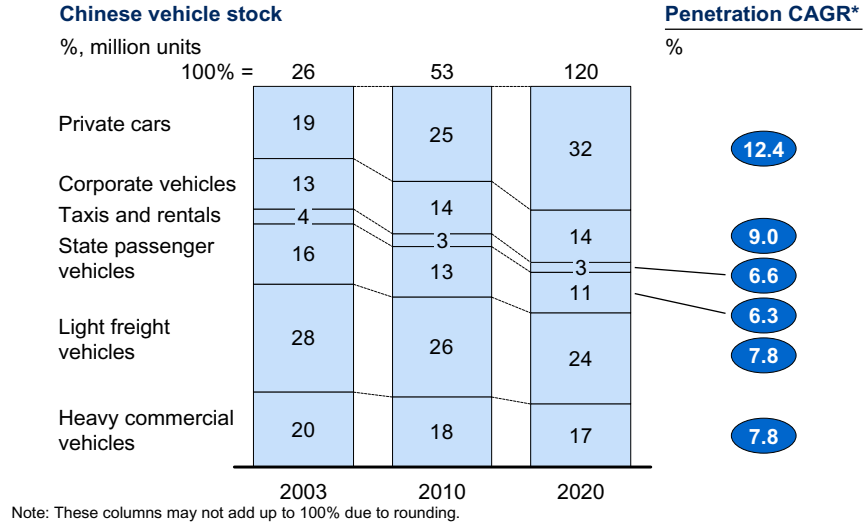
Source: Global Insight; press search; McKinsey Global Institute analysis

expect China's vehicle stock to grow by close to 10 percent a year to 2020, expanding from 26 million vehicles in 2003 to 120 million in 2020—an increase of 350 percent (Exhibit 9).

Under the current policy environment, we expect China's energy productivity to increase at a compound annual growth rate of 2.2 percent between 2003 and 2020—double the rate at which global productivity will rise—reflecting the fact that China's GDP growth rate of 6.7 percent is projected to exceed the country's

Exhibit 9

CHINA'S VEHICLE STOCK WILL GROW BY 350 PERCENT TO 2020; PRIVATE CARS WILL INCREASE THEIR SHARE TO A THIRD



Note: These columns may not add up to 100% due to rounding.

* Penetration compound annual growth rate = GDP compound annual growth rate x vehicle-type income-growth elasticity x vehicle price elasticity.

Source: Global Insight, February 2006; Fourin Report – China's Taxi Market; China Info Bank; expert interviews; McKinsey Global Institute analysis

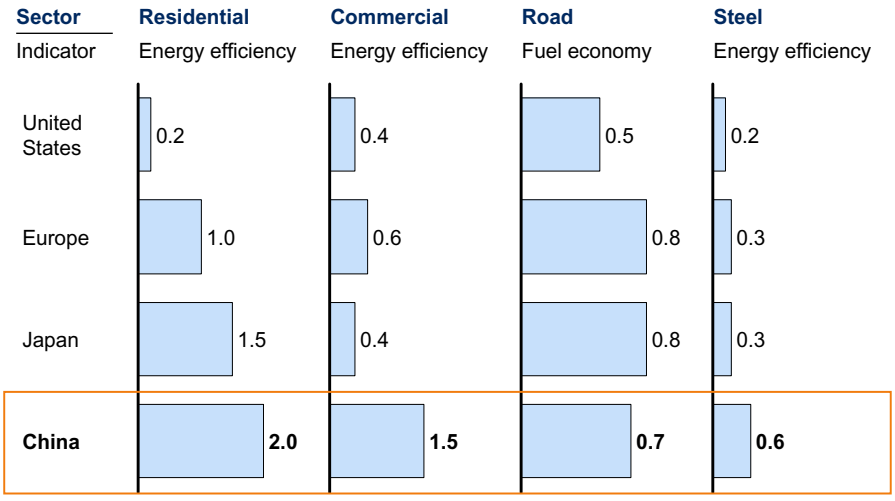
energy demand growth rate of 4.4 percent. Behind the robust productivity growth we foresee are significant efficiency improvements that we assume for all end-use segments in our base-case scenario (Exhibit 10). These efficiency gains reflect both the policies that China has already established to meet its energy

Exhibit 10

WITH CURRENT POLICIES, CHINA WILL SEE SIGNIFICANT ENERGY-EFFICIENCY IMPROVEMENTS

Annual improvement of energy productivity indicators, 2003–2020

%



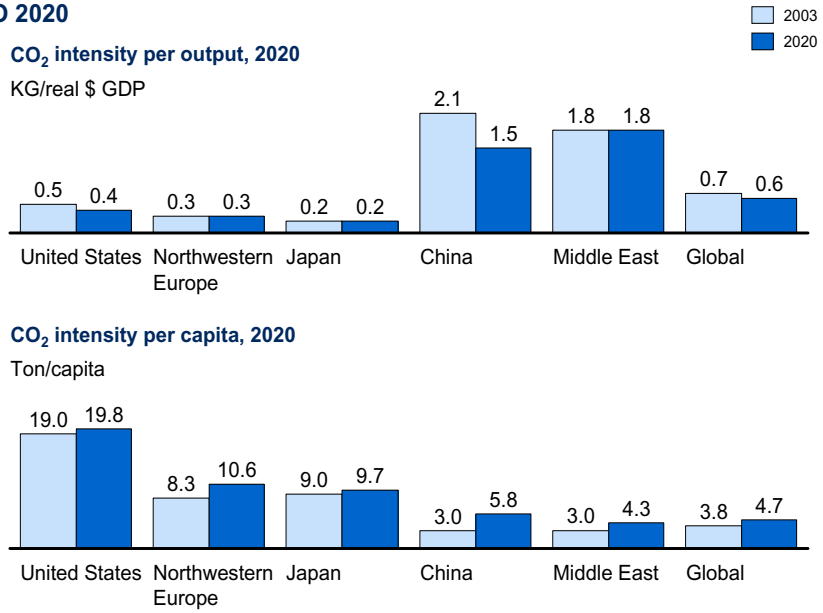
Source: EIA; LBNL China Energy Group; McKinsey Global Institute analysis

intensity goals to 2010 and the fact that there are large opportunities to boost energy efficiency across all end-use segments.[8]

With rapid energy demand growth, China's CO_2 emissions will more than double by 2020, contributing 38 percent of global energy-related emissions growth to 2020 and increasing the country's share of global emissions to 24 percent. However, China's per-capita emissions will continue to be significantly below developed economies—about 30 percent of the US level and 55 percent of the Northwestern Europe level (Exhibit 11).

Exhibit 11

CHINA'S ECONOMY WILL REMAIN ONE OF THE MOST CO_2-INTENSIVE TO 2020



Source: MGI Global Energy Demand Model 2007

As one would expect, our energy demand projections for China are sensitive to GDP growth assumptions. With a GDP growth rate that is 2 percent higher or lower, our annual energy demand growth projections are 5.3 percent and 3.4 percent, respectively—a range of 107–144 QBTUs around our base-case projection of 2020 demand. In contrast, the global oil price has a very small impact on overall Chinese energy demand. Assuming an oil price of either $30 or $70 per barrel would swing overall Chinese energy demand by only 2 QBTUs either way. This is because petroleum products represent only 21 percent of overall demand—and most other energy prices that end users face, most notably coal, do not necessarily correlate with the oil price. Road transportation is the sector in

8 In our base-case scenario, the energy productivity of China in 2020 is 30 percent below 2005 level, or 50 percent above the energy intensity target set by the government for 2010.

which oil prices impact energy demand most as consumers reduce their mileage in response to higher fuel prices. We expect fuel demand to grow at 5.8 percent a year with $70 oil and 6.6 percent a year at $30 a barrel. However, the range is relatively narrow because the rapid increase in car penetration will continue to be the main driver of fuel demand growth even at higher oil prices.

CHINA HAS HUGE POTENTIAL TO LEAPFROG TO MUCH HIGHER ENERGY PRODUCTIVITY

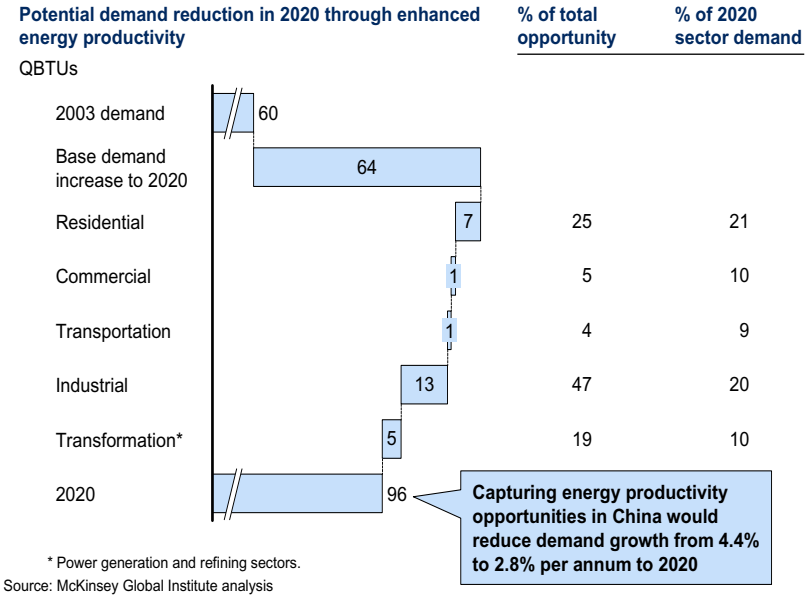
The good news is that there is an economically attractive opportunity to shift China's energy demand expansion to a radically slower growth path through higher energy productivity. China has a golden opportunity to leapfrog old, inefficient technologies and introduce cutting-edge technologies at a relatively early stage of development in many sectors. Unlike developed economies that have a large installed capital base with older technology, a large share of China's capital stock in 2020 is yet to be built. And it is much more cost-effective to adopt high-productivity solutions for new buildings and capital than to retrofit existing ones. For example, the additional cost of double, compared with single, windows for a new building is a great deal lower than replacing existing single windows with new double ones. With the additional benefit of China's significant labor-cost advantage, the potential to seize the opportunity offered by the latest technologies and reduce China's future need for energy supplies and spending is considerable.

We estimate that if China takes advantage only of currently existing technologies that pay for themselves, the country's energy demand growth could slow from 4.4 percent to 2.8 percent per year through 2020. This would reduce total energy demand in 2020 by as much as 23 percent. Virtually all sectors of the Chinese economy can make a contribution to boosting energy productivity, although the largest untapped opportunities lie in industry and in the residential sector (Exhibit 12).

The industrial sector offers the biggest potential. China could cut its industrial energy demand in 2020 by up to 20 percent—13 QBTUs—through higher energy productivity (Exhibit 13). Several technologies and processes are available that would both save energy in many industries and reward those businesses that adopt them with rapid payback times. Among the largest energy-saving opportunities are the recovery of the heat generated in the production of mechanical or electrical power and the optimization of motor-driven systems such as pumps and compressors. Combined heat and power systems generate electricity and thermal energy in a single, integrated

Exhibit 12

THE LARGEST REMAINING DEMAND-ABATEMENT OPPORTUNITIES IN CHINA ARE FOUND IN RESIDENTIAL AND INDUSTRIAL SECTORS

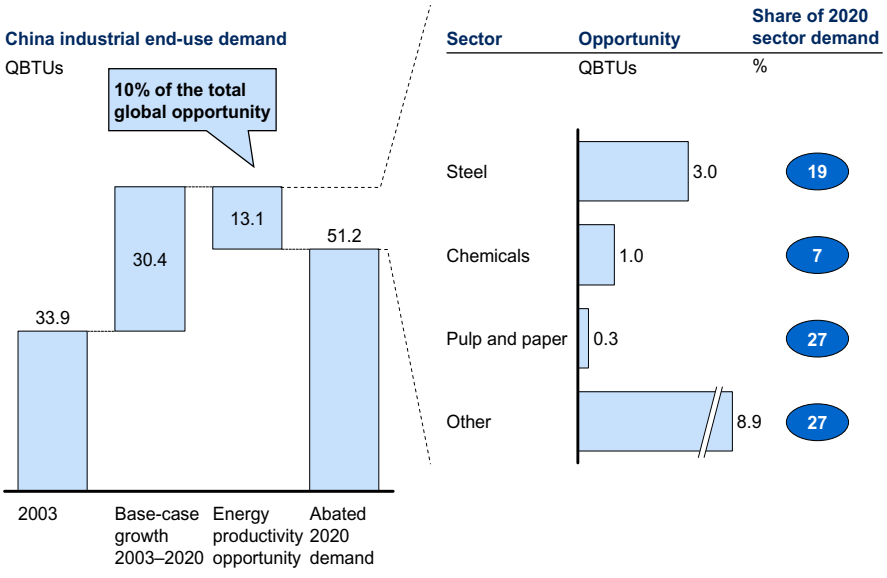


* Power generation and refining sectors.

Source: McKinsey Global Institute analysis

Exhibit 13

CHINA'S INDUSTRIAL SECTOR OFFERS THE SINGLE LARGEST ENERGY PRODUCTIVITY OPPORTUNITY



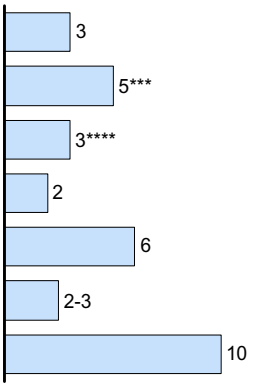
Source: McKinsey Global Institute analysis

system much more efficiently than in separate systems. Optimizing the use of steam across the plants can save up to 5 percent of total steam inputs. In energy-intensive sectors, the optimization of processes has the potential to greatly reduce process times (e.g., in smelting, in transportation between process stages, and through an increase in hot charging), thereby cutting energy losses significantly. Other sector-specific opportunities include near-net-shape casting in the metals industry and membrane technology in the chemicals and food-processing industries (Exhibit 14). Furthermore, replacing old capacity makes economic sense in sectors such as steel where many existing mills are small and consume far more energy per ton produced than do large, state-of-the-art integrated plants.

Exhibit 14

INTRODUCING CUTTING-EDGE TECHNOLOGIES AND METHODS WOULD CURB CHINESE INDUSTRIAL ENERGY DEMAND GROWTH

Technology/method*	Industrial sectors affected	Energy savings as % of 2020 demand within affected sectors (unless otherwise specified)
Heat recovery in production of mechanical or electrical power		
• Cogeneration	Across sectors	3
• Steam best practices (operating and maintenance)	Across sectors	5***
• Plant-level energy system integration	Energy-intensive sectors**	3****
Optimized motor-driven systems	Across sectors	2
Gasification	Refining, pulp and paper	6
Membranes	Chemicals, food processing	2-3
Near-net-shape casting	Steel, metals	10



* In order of largest to smallest by estimated absolute value of energy savings.
** Based on aluminum, chemicals, food processing, steel, pulp and paper, refining.
*** Percentage of total steam energy inputs.
**** Percentage of total energy losses.
Source: U.S. Department of Energy; Lawrence Berkeley National Laboratory; McKinsey Global Institute analysis

The residential sector offers the second-largest opportunity—21 percent of projected 2020 demand, or 7 QBTUs. One of the largest opportunities to improve residential energy productivity is in heating and cooling. For new houses, adopting high-efficiency heating and cooling equipment with tight building shells (including roof, wall, and floor insulation and low-leakage windows) pays for itself in lower ongoing energy costs. Shifting from incandescent lightbulbs to compact fluorescent lighting has an internal rate of return (IRR) of more than 100 percent. Another opportunity is to rely on demand-instantaneous and higher-efficiency water heaters.

China's power sector, which alone accounts for 16 percent of global energy demand growth to 2020, provides another big chance for improving energy productivity. It will make a difference whether China meets burgeoning demand with the latest, high-efficiency capacity such as ultra-supercritical coal plants or advanced combined cycle gas turbines. It also makes economic sense to replace inefficient, old power capacity because future energy savings pay for the investment cost of new, more efficient equipment. Lastly, large opportunities exist to increase the efficiency of the transmission system to reduce associated losses.

We believe our assessment to be a relatively conservative estimate of the overall potential available for China. We have focused on currently available opportunities that do not account for technological innovations, scale benefits, and the learning curve that will accrue over time. Nor do we assess the potential available from comprehensive system redesigns—an area in which China is in a unique position to implement more radical step-changes. Finally, because we focus exclusively on China's domestic energy demand opportunity, we do not assess the growth potential available to Chinese companies if the solutions that are adopted domestically emerge as global technology leaders that are adopted elsewhere around the world.

CONCERTED POLICY EFFORT IS REQUIRED TO CAPTURE THE ENERGY PRODUCTIVITY OPPORTUNITY

China has already shown a determination to tackle the efficiency of its energy demand. It has recently introduced or strengthened several energy-efficiency policies including new standards for the fuel economy of vehicles and reduced incentives for intensive industrial energy use. The government has also encouraged the upgrade of inefficient industrial plants and established a range of policies for the commercial sector such as building codes, office equipment standards, and labeling programs. In April 2007, Premier Wen Jiabao set an ambitious ten point agenda to further improve energy efficiency. We discuss here a few options available for China to meet its policy goals and seize the energy productivity opportunity.

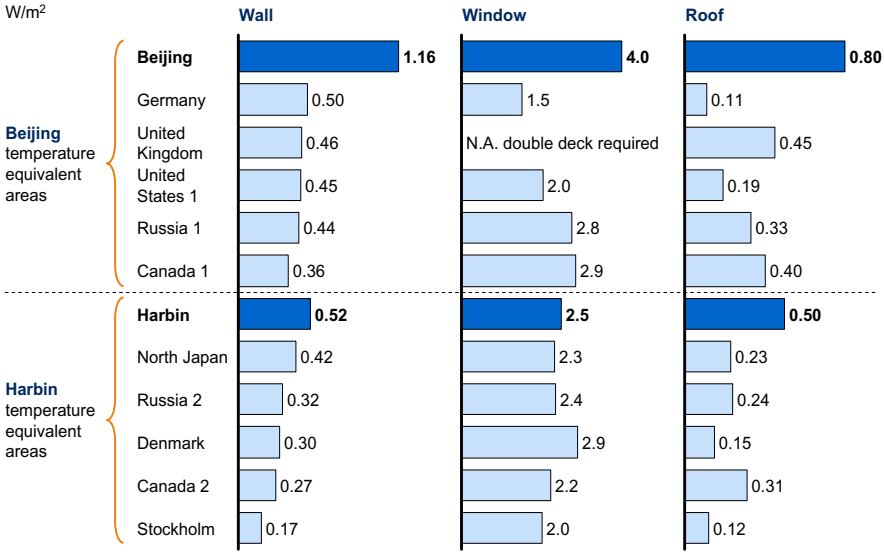
Raise and broaden energy-efficiency standards. Tighter energy standards can help capture the energy productivity opportunity and the associated economic benefits. While China has recently taken a number of steps in this direction, it can continue to broaden the set of appliances that are made subject to standards and speed up the rate of adoption of progressively tighter standards. Continuing to adjust residential building standards to global benchmarks in similar climates

would provide incentives for capturing higher energy productivity (Exhibit 15). Standby-power reduction is another area in which the government can take its recent efforts further by expanding the range of products subject to mandated standards. As the range and number of appliances continue to increase, this will be an increasingly large opportunity: a recent study of standby-power usage in Guangzhou showed average usage at 37 watts, representing up to 16 percent of total winter residential power consumption.[9] China could also require energy users to shift to compact fluorescent lighting as Australia, among others, has done recently.

Exhibit 15

CHINA HAS POTENTIAL TO IMPROVE HEATING EFFICIENCY THROUGH HIGHER-EFFICIENCY BUILDING SHELLS

Building-standards comparison – limitation of heat leakage in wall/window/roof



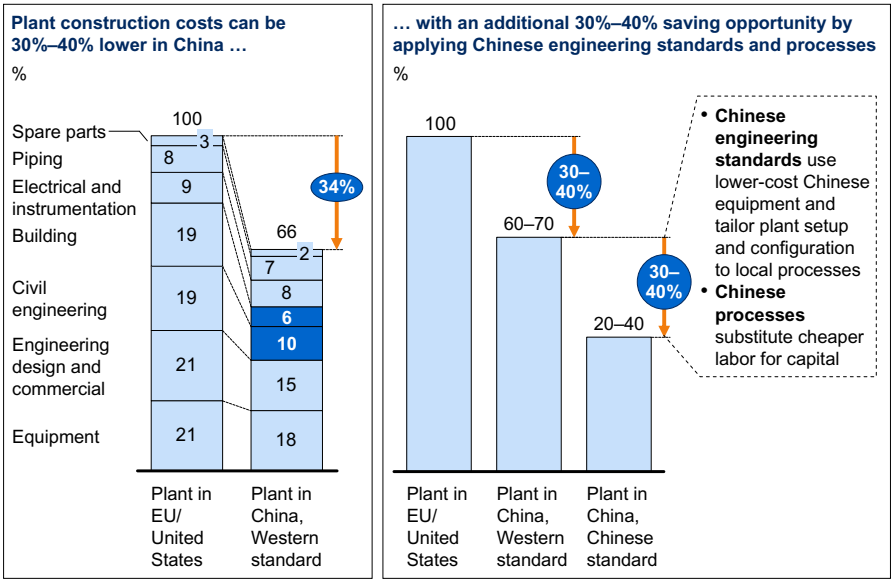
Source: ERI; literature search

Beyond having an impact on its domestic energy consumption, China's energy standards have the potential to help shift the global energy productivity frontier. China has a proven track record in pushing global manufacturing costs down by combining local engineering with local manufacturing processes optimized for low-cost labor (Exhibit 16). By applying these same skills to energy-efficient technologies and appliances, China can reduce the costs of the initial investment required and expand the range of solutions that are economically viable. This can create large market opportunities for Chinese companies while expanding the global opportunity from higher energy productivity.

9 Jiang Lin, "A Trickle Turns into a Flood: Standby Power Losses in China," Lawrence Berkeley National Laboratory, 2002.

Exhibit 16

REDUCING COSTS OFFER ADDITIONAL OPPORTUNITIES TO SHIFT GLOBAL ENERGY PRODUCTIVITY POTENTIAL



Source: McKinsey

Mandated standards are not the only option available. Government can seek voluntary energy-efficiency agreements with state-owned enterprises (SOEs) and other large companies, setting industry-specific targets for energy-efficiency improvements over time. Voluntary targets and "top runner standards" are common in Japan and help spur competition to develop more efficient technologies. The Chinese government is already using higher voluntary efficiency standards for buildings and appliances procured for government use, and it could expand the range of products for which these standards are set or make them mandatory. The government could also consider allowing some regions to take the lead in adopting tighter energy-efficiency standards earlier than the rest of the nation, as California frequently does in the United States. The private sector can play a role too. Companies that understand the economic potential of higher efficiency can choose to leapfrog beyond government-mandated standards and reap the benefits. For example, a group of manufacturers, marketers, or retailers could form a consortium to set new efficiency standards for specific appliances.

Strengthen enforcement. To affect energy consumption, energy-efficiency standards need to be implemented and enforced. As in many other regions around the world, this is a major challenge in China. Building codes offer an example. Only a few major cities, such as Shanghai, have implemented them, and recent estimates put the nationwide compliance rate for new construction below 5 percent. Experience elsewhere suggests that improving compliance will require

additional resources and enhanced government audit capabilities (to help target audits to the highest-impact targets and to reduce corruption) as well as clear, consistent penalties imposed on violators. Another option to consider is to enable third parties to provide certification of compliance—for example, through standard processes required for real-estate sales or financing (e.g., as house inspections in real-estate transactions in the United States) or a strengthened energy-efficiency appliance certification program (i.e., China Standards Certification Center).

Set incentives for utilities to promote energy efficiency. Utilities and other energy intermediaries can play a key role in promoting energy efficiency among their customers. Typically, utilities are rewarded for the volume of electricity or other services delivered, encouraging them to focus on expanding supply rather than energy efficiency among their customers. Instead, the government can set targets for energy efficiency or energy demand growth that provide incentives for utilities to implement technologies and programs that improve energy productivity. In the United States, recently introduced energy-efficiency resource standards (EERS) have set targets for utilities to reduce electricity consumption—and have generated energy savings of up to 1 percent annually.

Emerging technologies are opening new avenues for improving energy efficiency in the large, fragmented residential sector. Utilities can establish technologies for two-way communication between themselves and their customers that facilitate changes in the way consumers use energy. With advanced metering, for instance, consumers can see how their electricity consumption varies over time. This information, coupled with differential pricing (charging premium prices for energy used during peak times and vice versa), gives customers an incentive to shift their consumption patterns away from peak times. By doing so, demand for expensive peak-power generation capacity can be reduced. Companies such as CenterPoint Energy, Entergy, and Pacific Gas and Electric (PG&E) are already implementing these technologies in the United States.

Energy pricing and other incentives should not discourage the efficient use of energy. China is already moving to remove such hurdles to greater energy efficiency by replacing remaining fixed heating costs with metered service and seeking to remove subsidies to energy-intensive industries.

Expand financing for energy-efficiency investments. One of the barriers to capturing higher energy productivity is a lack of financing for up-front investment, even when investments would pay for themselves in future energy savings. China's government may want to consider ways to channel a larger share of

funds from the country's pool of financial assets toward energy productivity investments, which not only make economic sense but also set a course for more sustainable future growth with lower ongoing spending on energy. One option is to create a fund with sufficient scale to provide low-cost loans for energy-efficiency investments tailored appropriately to both large-scale projects (e.g., incentives to incorporate the latest energy-efficient technologies as part of industrial upgrades) and small-scale loans (e.g., retrofitting compact fluorescent lighting).[10] For industries, government can also encourage energy-efficiency investments through tax incentives.

Another option for expanding financing is to facilitate the expansion of energy service companies (ESCOs). These companies can, for example, combine the engineering expertise needed to reduce energy consumption with financial services that would help large customers such as municipalities, universities, schools, and hospitals to bridge the gap between their current expenditures and future energy savings. In new housing developments, ESCOs could help builders find new ways of financing positive-return investments in energy-efficient homes and commercial buildings.

Increase awareness and available information on energy productivity opportunities. Many consumers and businesses are unaware of the economic implications of their current energy use. The government can help them make more knowledgeable choices by providing information and increasing energy awareness. For households, public institutions can provide information about the financial benefits of more efficient choices through advocacy programs, as well as expanding and promoting the use of energy-efficiency labels. The government can also seek the support of retailers to collaborate in providing information and offering energy-efficient lightbulbs, appliances, and other products. For companies, central and regional authorities can use demonstration projects to increase awareness of the savings achievable through more efficient energy use, as well as collect and report the relative energy consumption patterns among businesses.

The government can also lead by example by improving its own energy productivity. By doing so, the government can both set a standard for the rest of the society and, given the scale of the public sector, create a significant market opportunity for companies to compete in offering energy-efficient appliances and solutions.

10 A rough estimate of the capital required to meet the energy-efficiency goals is 50 billion renminbi annually, according to Sinton, Stern, Aden, and Levine and their coauthors from the Lawrence Berkeley National Laboratory. For details, see http://china.lbl.gov/publications/nesp.pdf.

The lessons learned and the scale achieved from government procurement can help suppliers reduce the production costs of more energy-efficient products—a process that we have already seen in the case of some telecommunication equipment.

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Given its cost advantage and rapid economic growth, China is now in a unique position to lead the rest of the world in developing innovative energy solutions. The country's voracious appetite for energy has served to intensify the discussion about how to secure sufficient energy supplies without undue environmental cost. China has an unrivaled opportunity to meet this challenge through higher energy productivity. This is the next frontier for China to achieve resounding success.

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