JPMorgan's Hands-On China Series
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Transcript – Doug Ogden
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JPMorgan

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NEW REPORT

Investment Opportunities in China's Clean Energy Technology

In this presentation to global investors, Douglas Ogden, Director of the China Sustainable Energy Program in Beijing and Executive Vice President of The Energy Foundation in San Francisco, discussed the numerous opportunities for clean energy technology investment in China.

These opportunities depend on social investment in upstream policies that shape markets conducive to modern, clean energy technologies.

China's traditional energy technologies, based predominantly on oil and relatively dirty coal, are priced well below social costs, skewing China's market in favor of inefficient, outmoded, and heavily polluting energy technologies. The current unsustainable situation has enormous public health and environmental costs.

These conditions, however, are being gradually reversed through concerted public policy and legal institutional capacity building supported by international non-profits, multilateral banks, and the business community.

Engagement in policy development and implementation can be a highly successful strategy for creating market opportunities for clean energy technologies: Witness the progress over the last 8 years that have ushered in:

- China's advanced fuel economy standards—driving markets in advanced engine technologies;
- The national renewable energy law and wind concessions—creating $2 billion in wind energy investment over the last 4 years;
- Top-1000 enterprise energy efficiency program—catalyzing vast potential for efficient equipment sales;
- Commercial and residential building codes—launching localized markets in advanced building materials;
- Energy efficiency power plants—creating opportunities for efficient consumer appliances;
- Generation performance standards—promoting power plant desulfurization equipment opportunities;
- Tailpipe emissions standards—launching advanced vehicle technologies; and
- New bus rapid transit systems—creating new markets for efficient buses.

All of these various laws, policies and incentives are among the most advanced globally, and are in the early stages of delivering significant market opportunities for energy efficiency and renewable energy technologies.

These laws, policies, and incentives have been developed through grants and "best practice" policy engagement, bringing international policy practitioners to China to provide training and co-development, with government-affiliated research institutes, of new policy recommendations.

This talk focuses on energy market opportunities, the social investment approach of the China Sustainable Energy Program, progress to date, and opportunities for the future.

About Doug Ogden

Douglas Ogden is executive vice president of the Energy Foundation in San Francisco, and director of the China Sustainable Energy Program (CSEP) in Beijing, a partnership of major donors including the David and Lucile Packard Foundation, the William and Flora Hewlett Foundation, Bob and Randi Fisher, and others. CSEP focuses on energy efficiency and renewable energy policy development in the People's Republic of China.

Formerly, Doug coordinated the Energy Foundation's renewable energy and integrated/U.S. energy policy grant-making. He practiced environmental law and litigation with the Seattle law firm Foster Pepper & Shefelman, and taught for two academic years at Zhejiang University in Hangzhou, China (1983-85).

He has a masters of public administration from Harvard's Kennedy School of Government (1995), a juris doctor from the University of Washington (1989) (editor, Washington Law Review), a certificate in Chinese law from the East China Institute of Law and Politics (Shanghai, 1987), and a bachelor of arts from Stanford (1982).

He serves on the boards of various for-profit and not-for-profit organizations.

About JPMorgan's Hands-On China Series

JPMorgan has assembled a roster of specialists on China, veterans with years of experience and independent opinions on all aspects of the country's development. As practitioners, these China hands will guide investors with knowledge gained from direct involvement in issues facing China's future.

Jing Ulrich
Managing Director
Chairman, China Equities

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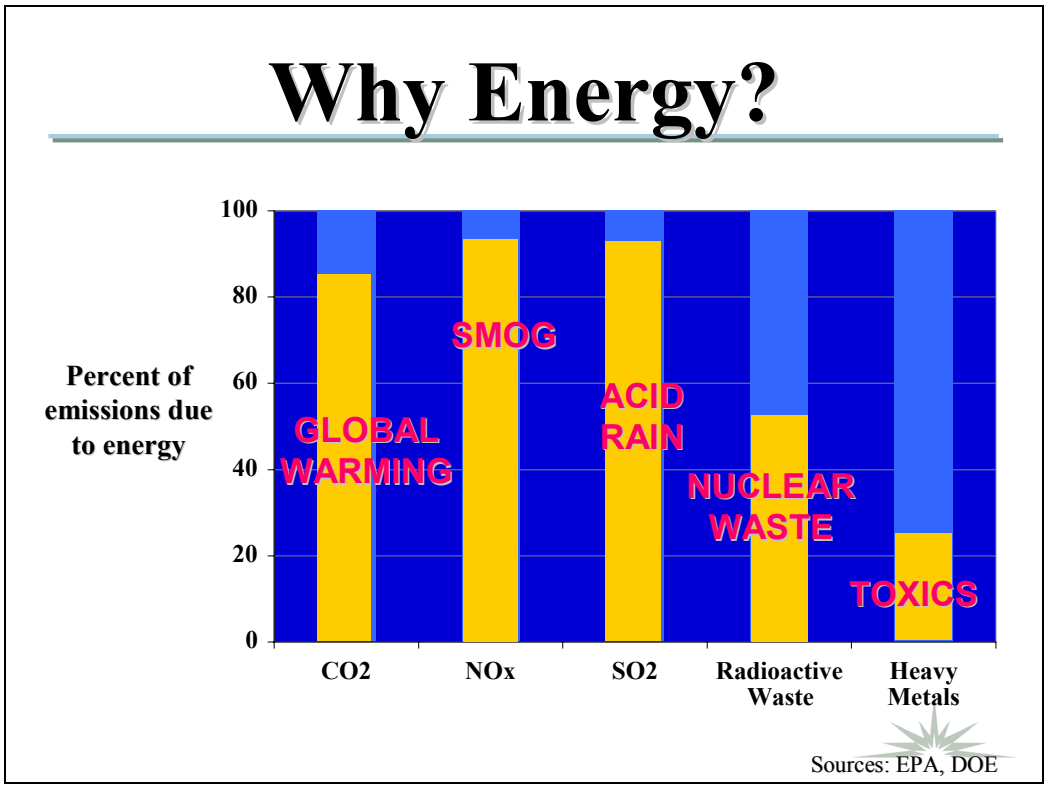
Investment Opportunities in China's Clean Energy Technology

The China Sustainable Energy Program



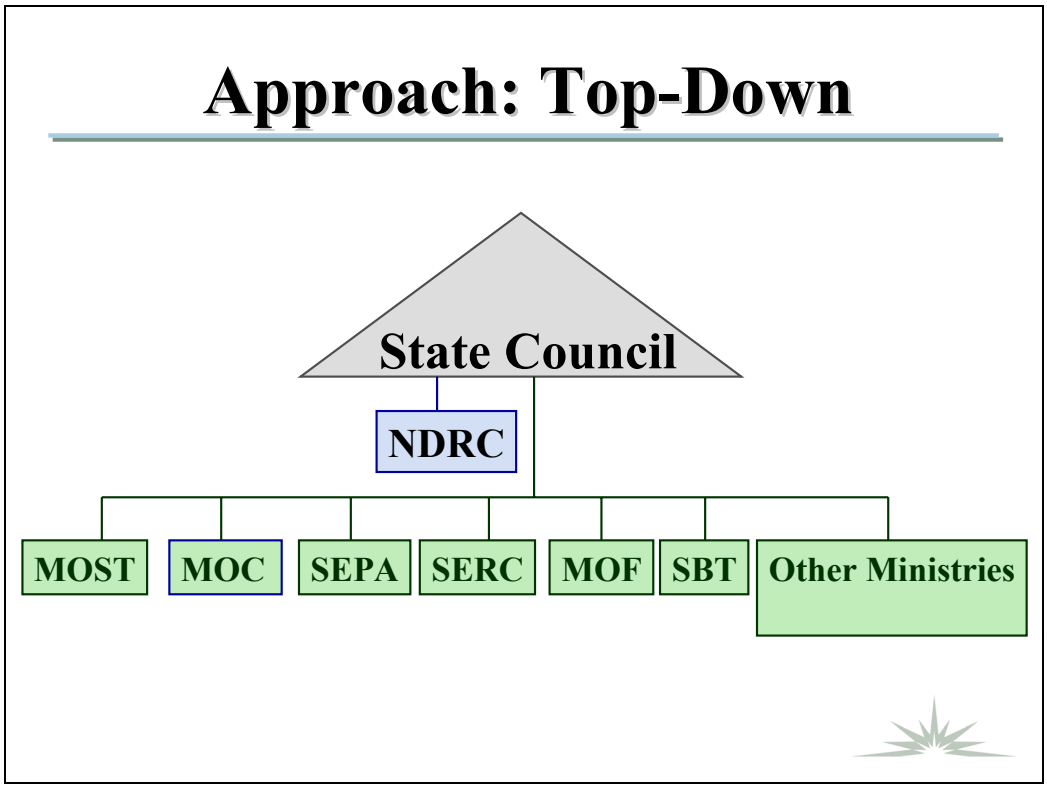
The concept of social investment is about working upstream on the types of policies and incentives that help shape markets for clean energy technologies. The China Sustainable Energy Program invests approximately US$10,000,000 per year ($65,000,000 to date in China) with an additional US$25,000,000 a year for our US programs. All programs promote energy efficiency and renewable energy technology policy.

We work on energy because the world cannot solve some of its most intractable environmental challenges without focusing on energy. For example, energy causes nearly all of the global warming pollution, nearly all of the urban smog, nearly all of the acid rain, more than half of the nuclear waste, and many of the airborne toxics. We cannot solve these enormous challenges without focusing on energy.

Our grants programs focus on developing sector-specific technology policies. There is a basket of public policies in each of these sectors that move private investment into energy efficiency and renewable energy.

We have a dozen Chinese nationals in our Beijing office. We also manage a Chinese NGO called "The China Sustainable Transportation Centre," which has another half-dozen people. These staff are energy policy experts in their own right, and serve as a bridge between China's government-affiliated research institutes and international policy practitioners. Thus our program aims to

introduce international "best practice" policies, and builds bridges for China to co-develop policy initiatives with those who have implemented advanced efficiency and renewables policies internationally. The program emphasizes training and capacity building of, by and for the Chinese.



Our approach is both 'top down' and 'bottom up'. Our grantees work at the ministerial level to identify champions; we often develop a steering committee around the individual and feed the committee with best practice policies and policy analysis, developed by Chinese and international grantee teams. The steering committees include the decision makers who then can move these policies through the central level, as appropriate.

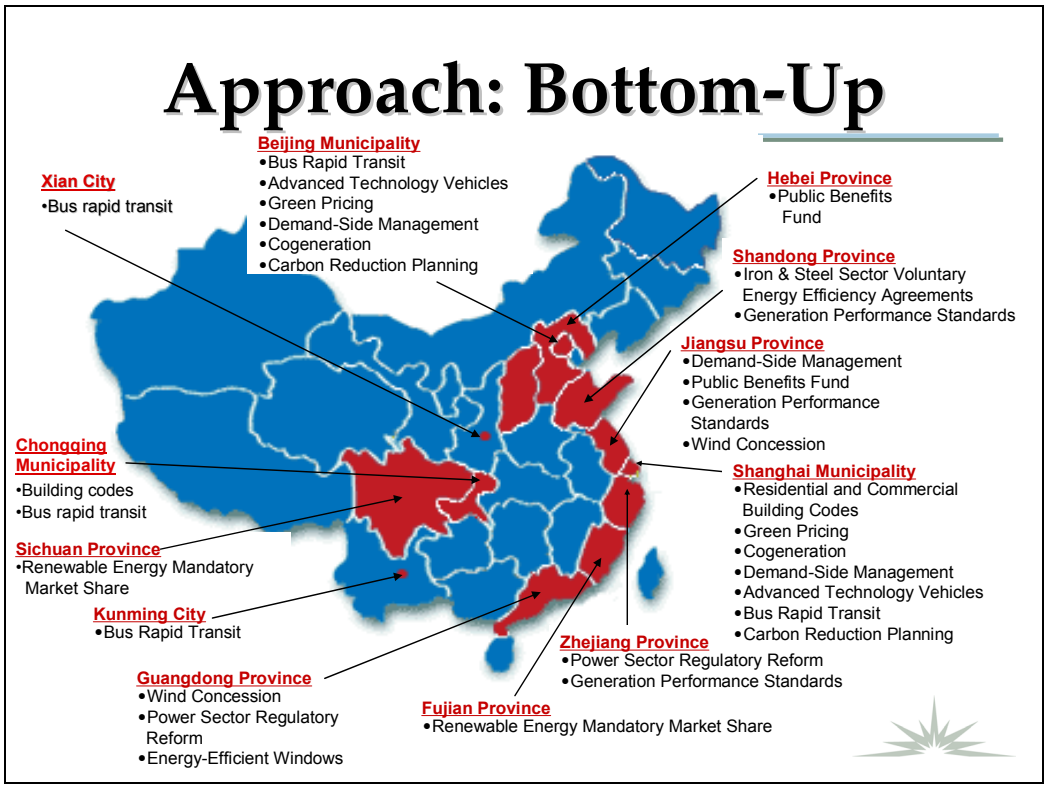
Senior Policy Advisory Council

MEMBERS

CHEN Qingtai	Vice President, Development Research Center of the **State Council**
CHEN Yuan	Governor, **China Construction Bank**
FU Zhihuan	Chairman, Finance and Economics Committee, **National People's Congress**
HUANG Yicheng	Former **Minister of Energy**
MAO Rubai	Chairman, Environmental Protection & Resources Conservation Committee, **National People's Congress**
LOU Jiwei	Vice Minister, **Ministry of Finance**
PAN Yue	Vice Administrator, **State Environmental Protection Administration**
QIU Baoxing	Vice Minister, **Ministry of Construction**
QU Geping	Former Chairman, Environmental Protection & Resources Conservation Committee, **National People's Congress**
SONG Mi	Vice Chairwoman, **State Electricity Regulatory Commission**
XU Kuangdi	Vice Chairman, Chinese People's Political Consultative Conference; Former **Mayor, Shanghai**
YANG Jike	Former Vice Chair, **Chinese Peoples' Political Consultative Conference**
ZHANG Guobao	Vice Chairman, **National Development and Reform Commission**

We have a unique structure in that we have what is called a 'Senior Policy Advisory Council' of ministers which meets annually, including at the Great Hall of the People on several occasions. These individuals help with strategic guidance for all programs. At our next annual meeting we will be convening a sub-set of China's governors and provincial economic commissions to focus on implementing China's national energy intensity improvement target (China is to cut the amount of energy consumed per dollar of economic output 20% by 2010) at the provincial level and within the industrial sectors.

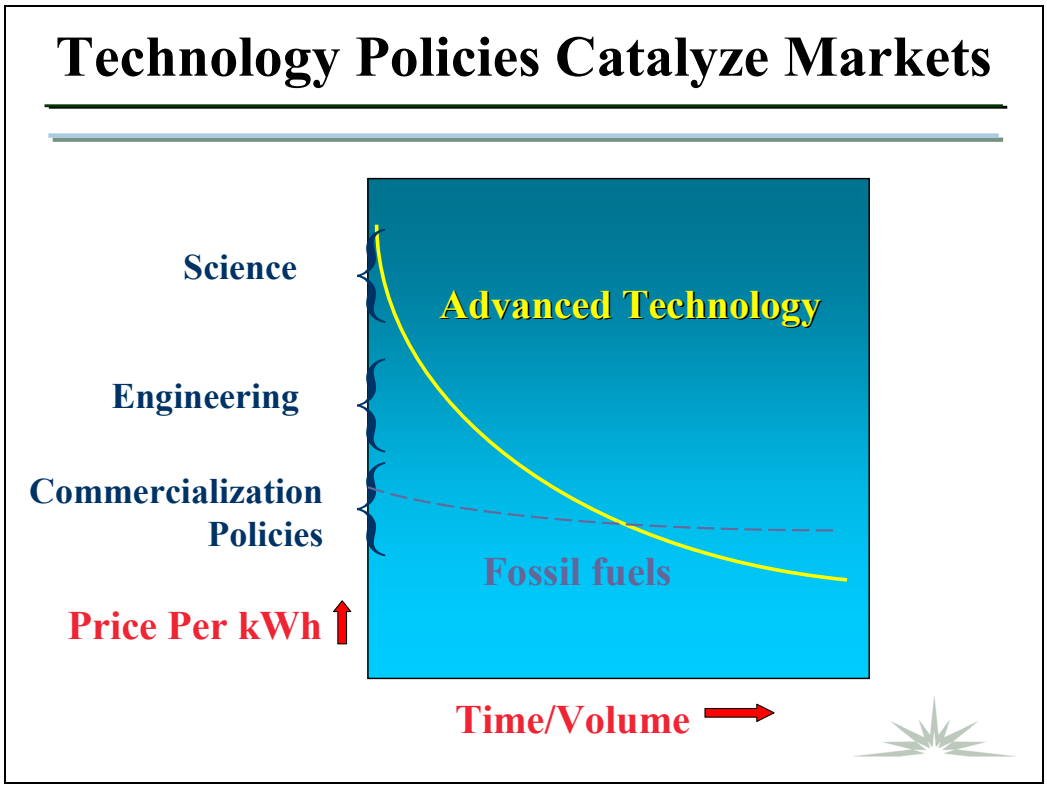
We also work with a second tier of government officials—26 directors-general of the main implementing ministries work closely with our Chinese grantees and provide guidance to make our investments in policies relevant to their policy development needs.



Once policies have been adopted in Beijing, we are often requested to support pilot projects at the local level. We currently have over 50 pilots underway in a dozen provinces, as means of demonstrating how these policies can attract private investment into the latest efficiency and renewables technologies.

Coal and cars

To achieve a sustainable, clean energy future, the focus needs to be on two things: coal and cars. The United States has a fairly filthy energy mix, with coal providing 60% of the electricity and more cars than any other country. More than a third of energy in the US and over 70 per cent in China comes from coal, mostly in the electricity sector. There are technologies available that can replace coal and reduce the demand for oil, and policies can be the main driver for substituting clean technologies and thus addressing the problems wrought by coal and cars.



A sustainable energy future can be implemented in two ways. Firstly, by upward pressure on the price of fossil fuels (through environmental regulation). Secondly, by downward pressure on new, advanced energy efficient and renewable energy technologies (via pricing and other incentives). The aim is to bring us to a point shown by the intersection in the graph above and to bring advanced technology into the market place.

Advanced technologies follow a declining cost curve over time. Policy can speed up this curve. R&D investment can bring costs down some.

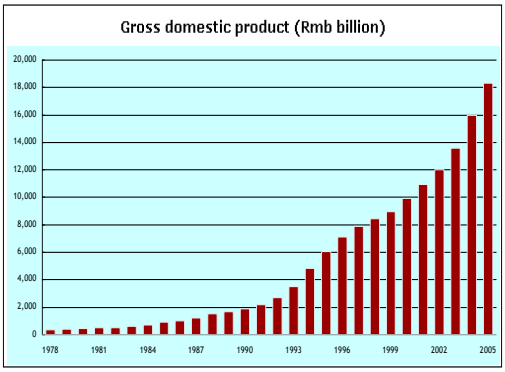
As technologies move through the prototype stage and ripen, we focus on commercialization policies—targeting the crucial phase of moving technologies into the market. This is the point where a new technology is in small volume and has yet to experience the production economies of scale needed to compete with old, less efficient technologies, which thus are cheaper Policies can drive production volume for new solar, wind, energy efficient lighting, refrigeration, air-conditioning and so on. At the same time, regulations can be encouraged that make fossil fuels comparatively more expensive. For anyone interested in energy efficiency and renewable energy, the main competitor is cheap coal, so we need both regulation on dirty fossil fuels and incentives for the clean solution technologies.

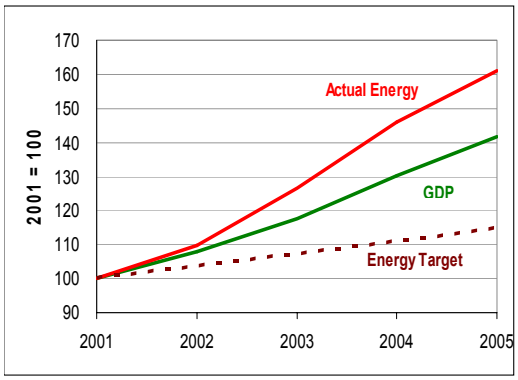
If you are interested in market share for these advanced technologies, you should be investing in the policy space as a necessary prerequisite to gaining market share against cheap coal.

Growth in China

Energy growth in China has been staggering. GDP has increased over 9 per cent per annum for the last 25 years; energy consumption has grown over 10 per cent; electricity usage has grown over 15 per cent; coal usage has been up 20 per cent year on year and now stands at over two billion tons a year. Staggering growth is underway. Actual energy consumption well exceeds the pace of GDP growth, by between 1.2 and 1.4 times.

China's Energy Growth





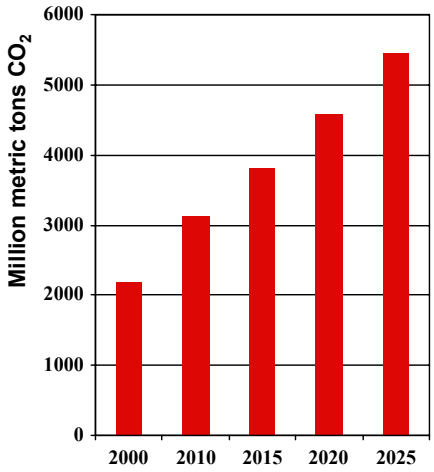
- GDP: Rising at 9.6 %
- Energy: Rising at 11%
- Electricity: Rising at 15.5%
- Oil up 18% in 2004 (1/3 US)
- 2020 Goal: 4X GDP, 2X Energy, Urbanization nearly 2X

Source: International Energy Outlook, 2004

A different path is possible, and China is taking steps to catalyze that alternative path. For example, per capita carbon dioxide emissions in California are now one third of the national average in the United States. California has managed to keep its energy growth flat for 30 years despite tripling its GDP and population migrations into the State. So it is possible to keep energy growth managed through energy efficiency policies.

China: Coal Dependence

Carbon Dioxide Emissions from Coal Use



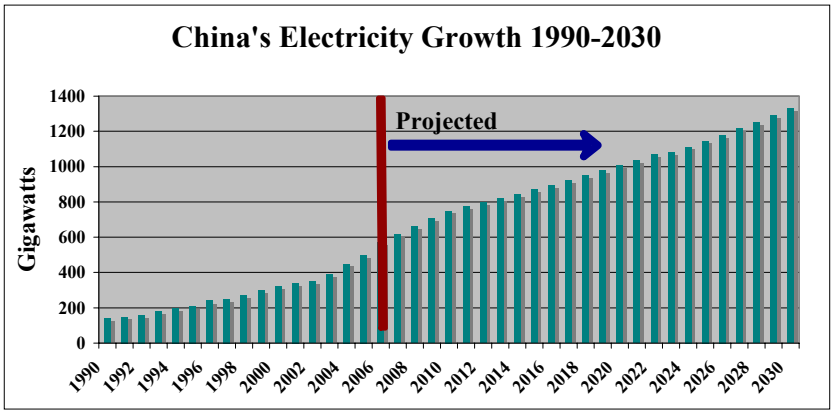
- China consumed 2.2 billion tons of coal in 2005
- More coal per year than the U.S., Russia, and India combined.

Source: EIA 2004

China's coal dependence is growing. 2.2 billion tons of coal were consumed in 2005. This equates to more than is used by the next three top consumers combined - the US, Russia and India.

Electrification

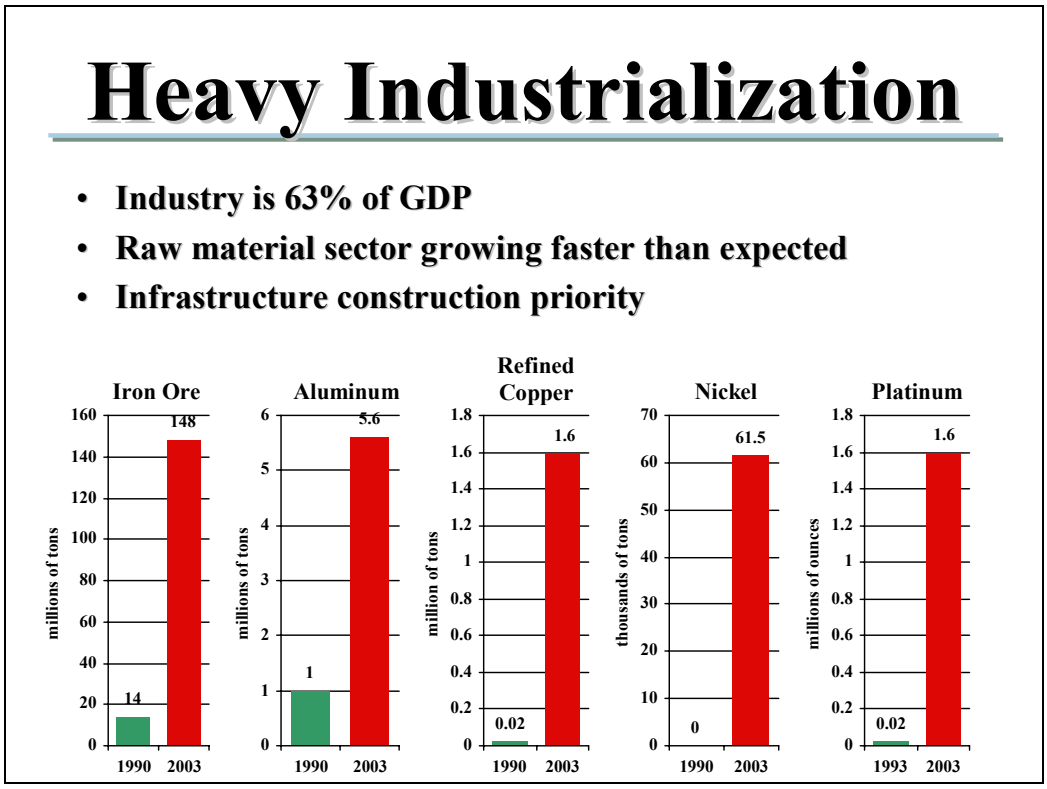
China's Electricity Growth 1990-2030



- 516 GW in 2005
- Coal = 392 GW in 2005 (21% more coal plants than US)
- Coal plants emitted ~ 2.5 billion tons CO_2 in 2005
- NDRC: Coal to Rise to 570 GW (45%) 2006-2010
- Conventional Coal Could Rise to 988 GW in 2030, Emitting ~ 6.3 billion tons CO2

Sources: LBNL; NDRC; Interfax

There are several trends driving this kind of expansion, such as electrification, industrialization, and urbanization. Regarding electrification, China has been building a 1,000 megawatt coal plant every week for the last three years. If this continues at the current pace, we can expect 6.3 billion tons of CO2 to be coming out of China's electricity sector by 2030.



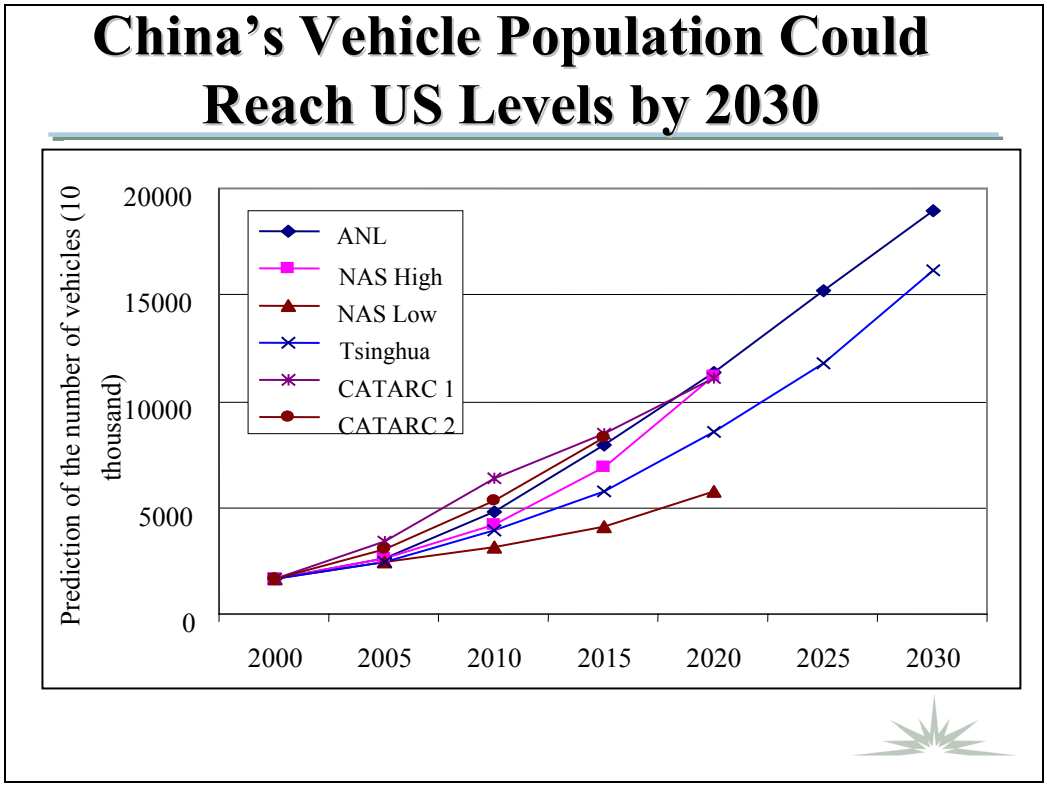
Heavy industrialization is the main driver of China's energy expansion expansion. The graph above shows the staggering multiples of growth in various areas between 1990 and 2003 as China becomes the factory of the world. Nearly 70 percent of China's economic output is from heavy industry. The challenge for China is introducing structural reforms to shift toward light industry from being two-thirds focused on heavy industry.

Although there has been some foreign investment in advanced energy saving technologies in the heavy industries in China, these technologies tend not to be at the cutting edge. All the same, energy intensity has been improving (since investment in technology upgrades typically replaces seriously outmoded, Soviet-era technology). But, China is off track from its national energy efficiency goals; energy usage continues to grow faster than GDP due to expanded industrial output.

Urbanization is another trend that gives cause for concern. China plans to build 400 new cities by 2040, each with over 500,000 people, moving 600 million people, the equivalent of two Americas, into new cities in a single generation. Most new cities are to be aligned in a satellite configuration around China's main cities. Consider the amount of cement, energy, and other infrastructure materials that will need to go into their development.

One of the challenges is how to create sustainable cities, how to require urban growth boundaries and design cities to be "green," including designed around transit systems ("transit-oriented development") with high density along transit corridors so that people do not need to use cars. Green cities also require green buildings; new building codes and incentives can drive new markets

for low-, zero-, and even plus-energy buildings (the latter including microgeneration such as from photovoltaics so that building owners sell electricity into the grid).



China may now only have 30 million vehicles but it is expected it will have as many as the US in the next 20 to 30 years. A growing vehicle fleet implies a greater demand for oil. By 2020, China will import 80 per cent of its oil. It is now burning 6.3 million barrels of oil each day or 2.3 billion barrels per year. Policies must be developed to make mass transit more attractive than using cars, including congestion pricing policies (to tax vehicle use) and well designed transit systems, along with smart urban layouts.

What does it mean for the public and the environment?

Health Impacts

- Air pollution levels exceed WHO standards
- China has 16 of the 20 most air polluted cities globally

Every year:

400,000 premature deaths

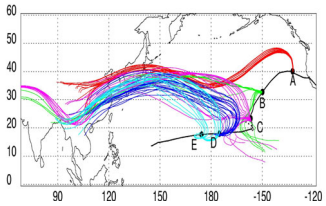
75,155,000 asthma attacks

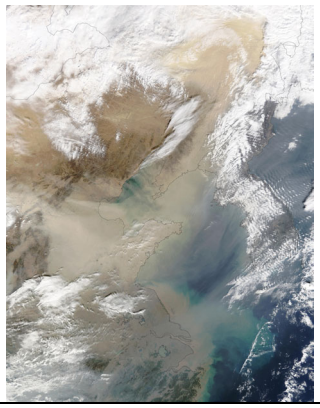
Source: World Bank; World Health Organization

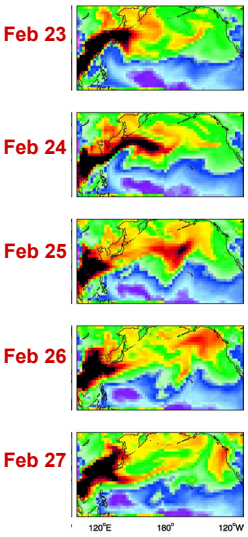
The funders of the China Sustainable Energy Program are mostly interested in what this means for the public and the environment. Due to air pollution, there are 400,000 premature deaths every year, 75 million asthma attacks, and 16 of the 20 most air-polluted cities in the world are in China. Again, these fundamental health challenges can not be solved without addressing energy.

Global Reach of China's Coal Pollution

- **China emits 25% of global mercury**
- **40% of U.S. mercury pollution originates overseas**





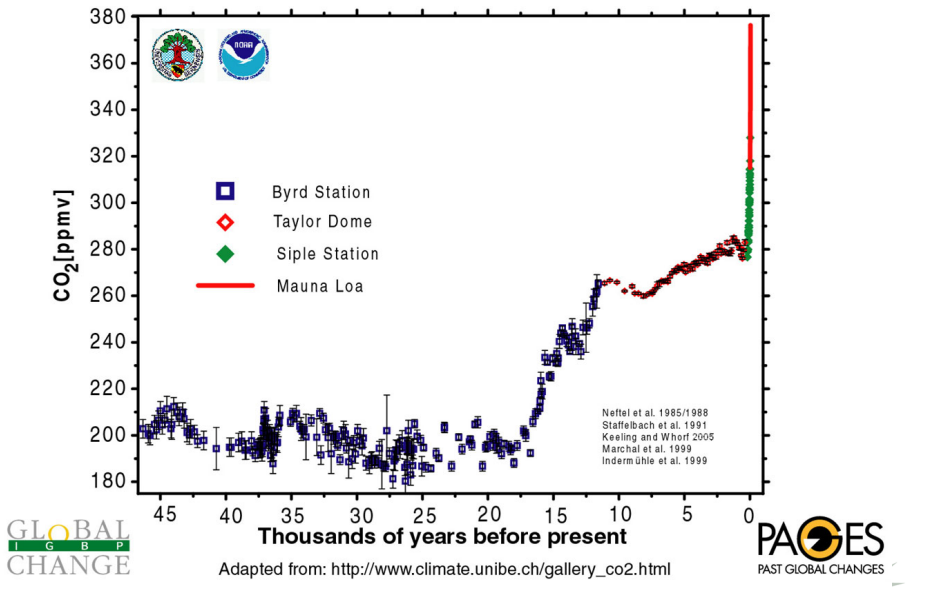


Source: Harvard; USEPA

In Hong Kong, there is concern about the amount of sulfur and particulates in the air and where these originate. A lot of it comes from the Pearl River Delta, where heavy coal-based industry resides. People in the United States are also concerned. On bad air days in California, up to a third of the air pollution originates in China. China is currently emitting 25 per cent of the world's mercury pollution; mercury is a worrisome byproduct of combusting coal. Mercury is a neurotoxin, it damages the IQs of children and can cause birth defects. It is a serious problem that cannot be fixed unless we focus on China's, America's, and other countries' coal emissions.

Atmospheric CO_2 Concentration

Last Glacial Maximum to Present

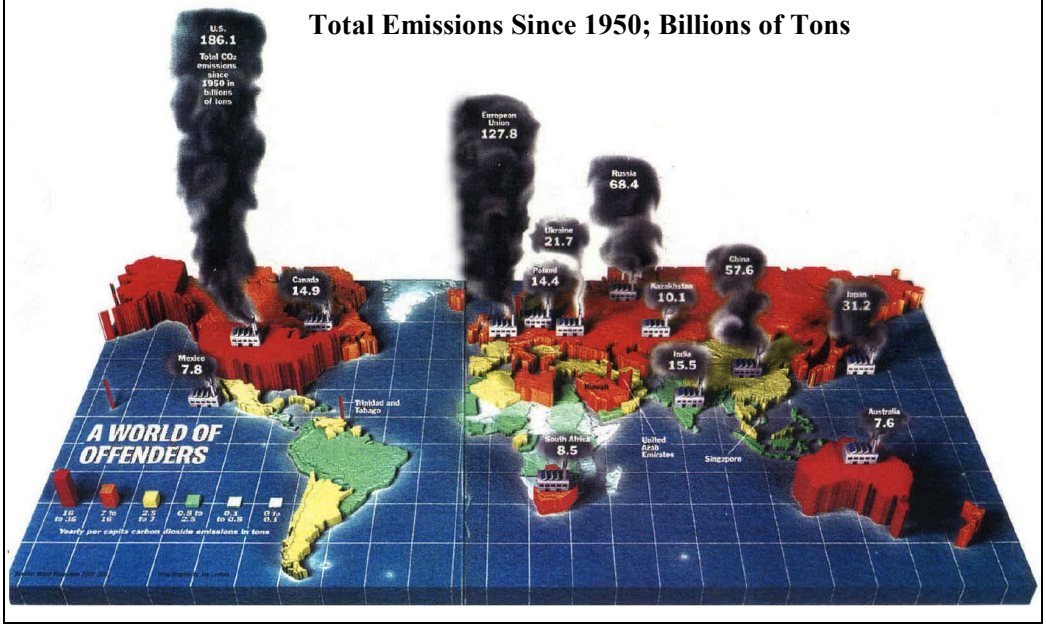


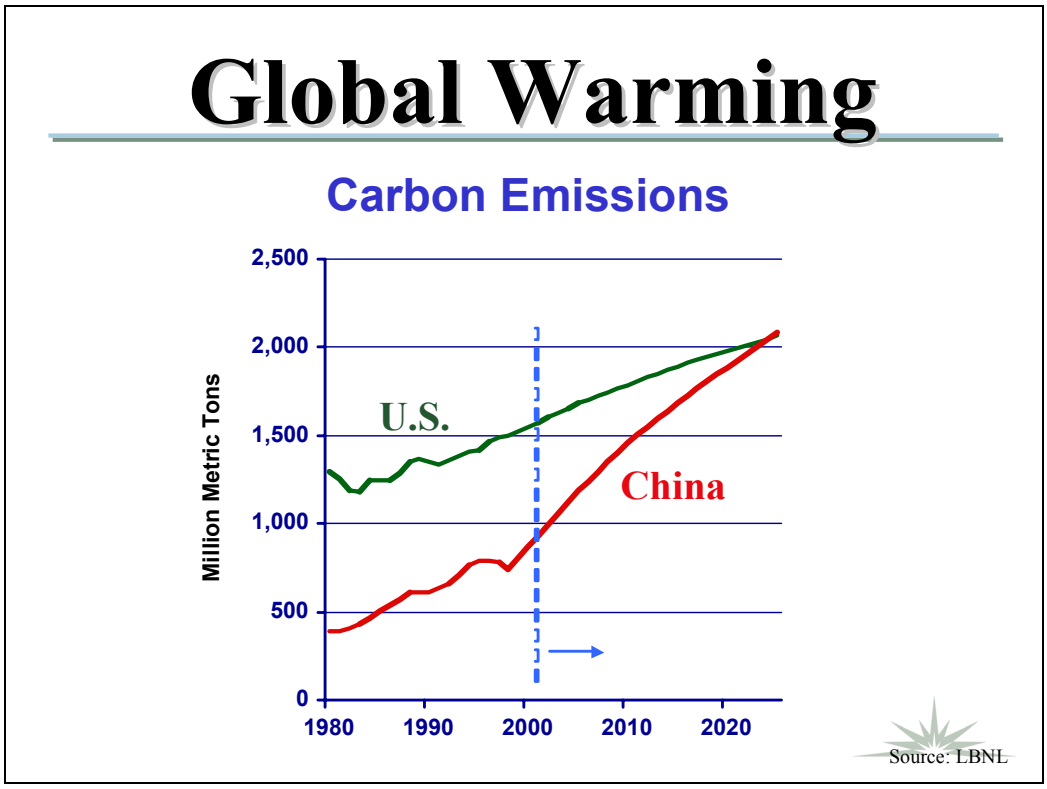
Adapted from: http://www.climate.unibe.ch/gallery_co2.html

Stanford University: Global Climate & Energy Program

Cumulative CO_2 Emissions

Total Emissions Since 1950; Billions of Tons





As we burn fossil fuels, greenhouse gases are accumulating in our atmosphere – global warming. Pre-industrial concentrations of carbon dioxide in our air were 270 parts per million. There is now one-third more CO2 in every breath we take – 380ppm. This is more CO2 in the atmosphere than in the last 450,000 years. And CO2 molecules accumulate in the atmosphere and don't break down for upwards of 100 years, so we're still breathing the byproducts of coal and oil combustion emitted back in 1900, with billions of tons now emitted annually; 29 billion tons of CO2 were emitted globally in 2005, up nearly 18 percent since 2000, and every molecule will be in our great grandchildrens' air supply. There are some serious signs of resultant ecological stress, such as glacial melt in places like Greenland that have profound, and expensive implications for rising sea levels.

There are fundamental ethical issues associated with global warming and cumulative carbon dioxide emissions. The United States is hands down the worst offender. Historically, China has had only about one third of the cumulative emissions as the United States. So a solution for the global climate needs to have some equitable allocation of burden. That said, China is catching up very quickly and may surpass the volume of annual CO2 emissions coming from the United States sometime between 2020 and 2025 (although the International Energy Agency reports that China may surpass the U.S. by as early as 2009).

China, with five times the population of the United States, will build enormous per capita wealth. Per capita GDP is still at one fifth of the level of the United States, and China wants to catch up. Energy consumption per capita will be the challenge for the global environment. If China grows its energy in a one-to-one relationship with GDP, and if each person in China consumes eight times more energy (to have the same per capita energy consumption as your average American), the entire world's CO2 will be 122 per cent greater than it currently is. So China could way more than double the global output of C02. The global environment simply cannot absorb the emissions of a fossil-fueled China.

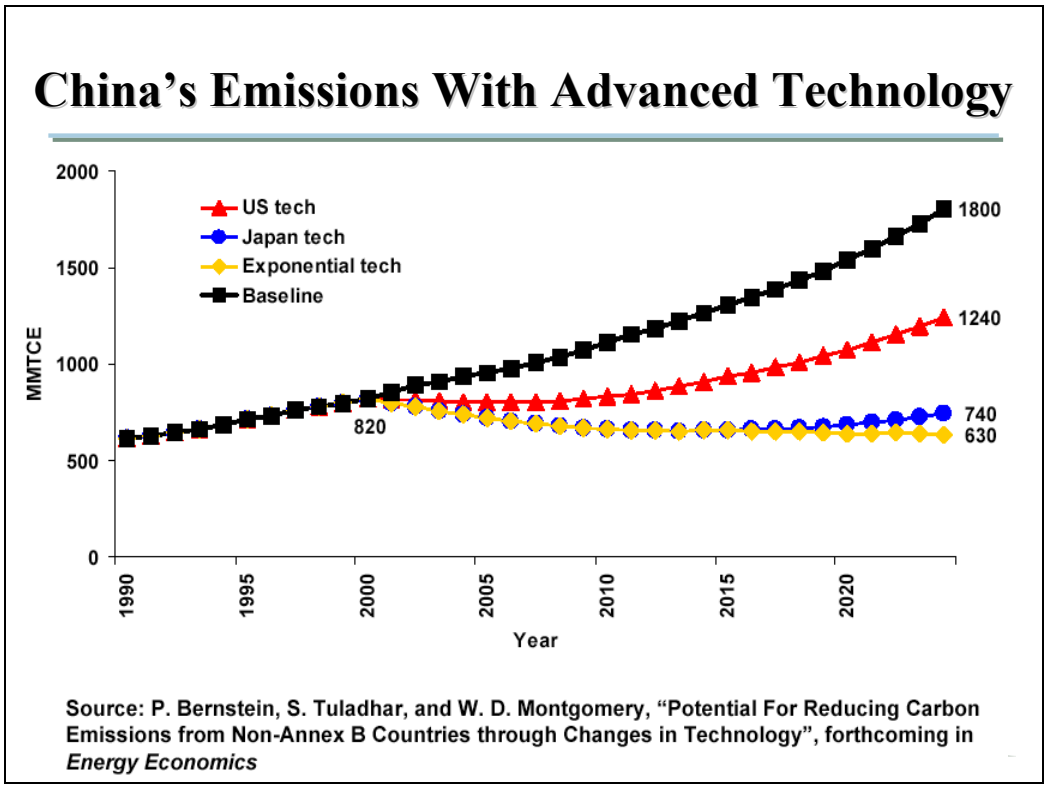
By 2050, China is likely to have an economy the size of the United States. The challenge is how to grow China's energy infrastructure at a fraction of the pace of its GDP.

Solutions

China's development target for 2020 is to quadruple its GDP while only doubling its energy usage. How can this happen given that energy usage is currently growing 1.2-1.4 times faster than GDP?

China's cleanest, cheapest and most readily available energy resource is energy waste. This is also true for Hong Kong, the United States or any other country. There is an enormous amount of energy potential in capturing the amount of energy that is wasted. For example, we estimate that the U.S. could save half of its current energy consumption by requiring, and incentivizing already available, off-the-shelf technology.

The new technologies, however, that are moving into China are still four times less efficient than the state of the art technologies being used by Japan, however; this is largely due to China's lagging development of intellectual property protections. There is a long way to go to encourage advanced technologies in China. But policy leadership can achieve substantial energy savings.



Our various grants have demonstrated that it is possible. China could follow what we refer to as the "exponential technology path" if it really shapes its markets to encourage the latest in energy efficiency technologies.

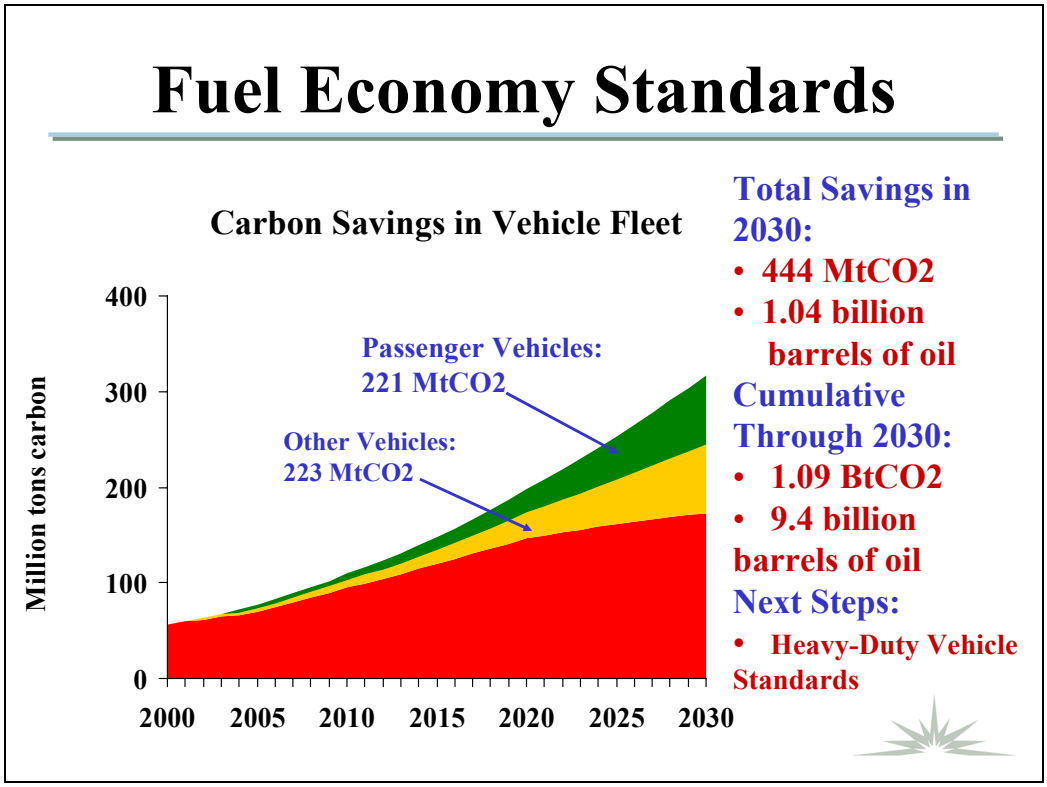
There is historical precedent for achieving this in China. Back in 1980, Deng Xiaoping launched the Four Modernizations, targeting a quadrupling of China's GDP by 2000. But he looked at what it would take if he wanted to similarly quadruple the energy infrastructure. The amount of foreign capital that would have been required would have resulted in having to sell off most of China's energy infrastructure. China closely aligns its energy infrastructure with national security, so Deng was not willing to do this. Instead, China embarked on a massive energy efficiency policy and investment program, and succeeded in quadrupling its economy while only doubling its energy infrastructure through 2000.

But since then, China has fallen off course. Back in the early 1980s, China's government was investing three times more in energy efficiency than it is now. There has been some progress in that the centrepiece of the Eleventh Five-Year Plan is to improve overall energy efficiency nationwide by 20 per cent in just five years. This would essentially return China to its experience from 1980 - 2000, growing energy at half the rate of GDP.

There are various ways to achieve this, and I will spend the balance of this talk describing the policies China has adopted to achieve greater energy efficiency and renewable energy.

China has adopted some of the world's most advanced fuel economy standards for motor vehicles. This initiative started with our Senior Policy Advisory Council. We held an event in the Great Hall of the People with the National People's Congress and encouraged the National Development and Reform Commission to be at the centre of a steering committee to analyze international best practice fuel economy standards. Chinese government-affiliated research institutes did the comparative policy analysis in cooperation with international experts. China has now adopted

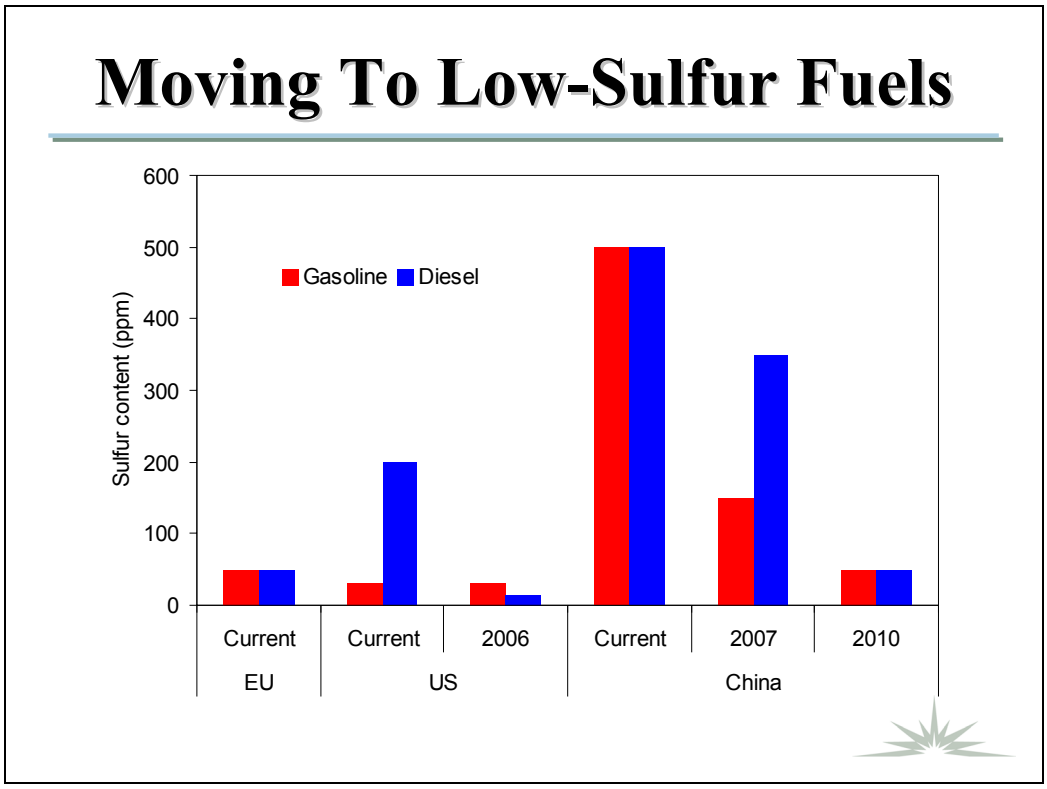
standards that are 20 per cent more rigorous than under US law. The engines that you see in the many sport utility vehicles in the United States will be illegal on China's streets starting in 2008.



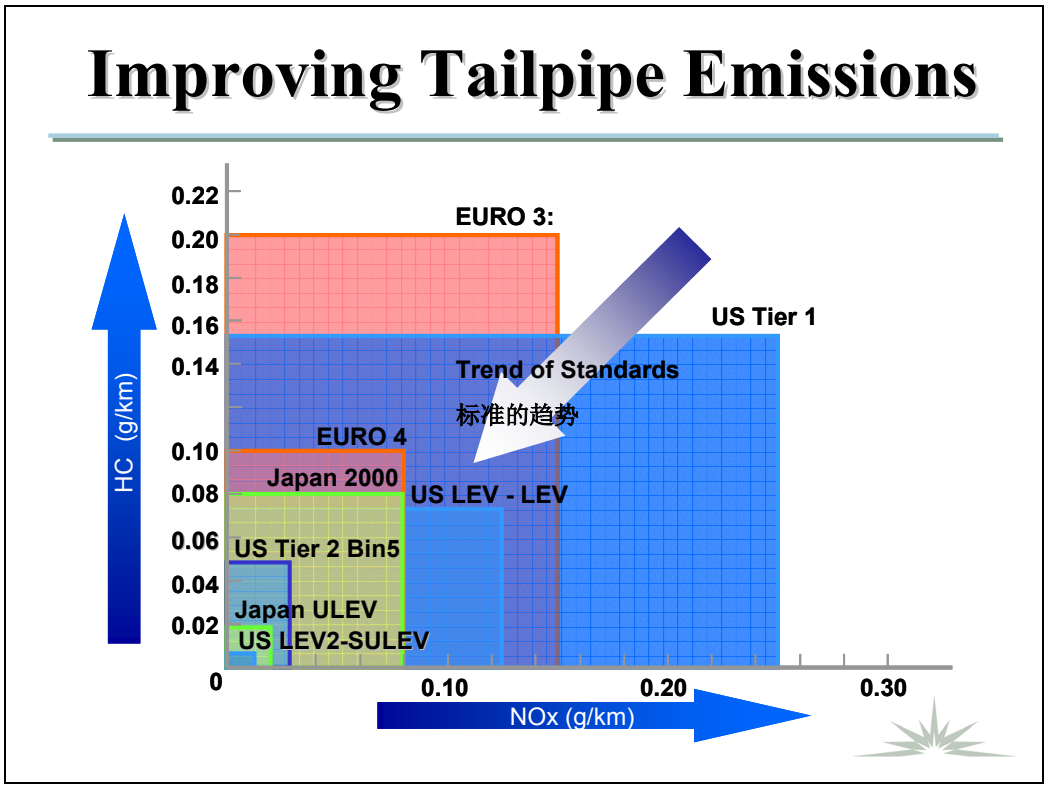
The energy savings can be seen in the graph above. The new passenger vehicle standards will save over 220 million tons of CO2 in 2030.

There are also new commercial vehicle standards slated for approval this year. Overall, both standards will save 9.4 billion barrels of oil cumulatively through 2030. This is an example of how you can, by working upstream in the policy stage, create a market for advanced vehicle technologies, such as hybrid vehicles like the Toyota Prius.

For a hybrid vehicle to emerge in China's market, two things should be implemented - fuel economy standards and tailpipe emissions standards; increasing both drives investment into the most modern, cleanest vehicle technologies. China is currently following Euro tailpipe emissions standards, aiming to implement Euro-4 by 2010. Beijing and Shanghai are moving a little faster, with Beijing aiming to adopt Euro-4 by the end of 2007.



Euro Standards will require that China move to clean low-sulfur fuels. The majority of China's urban air pollution is from dirty fuels belching from vehicle tailpipes. China has over 800 parts per million (ppm) sulfur in a gallon of gasoline, and over 2,000 ppm sulfur in a gallon of diesel. International standards are moving to 15 ppm! China has a target to reach 50 ppm by 2012. This will help China reach the targeted Euro-4 tailpipe emissions standards.



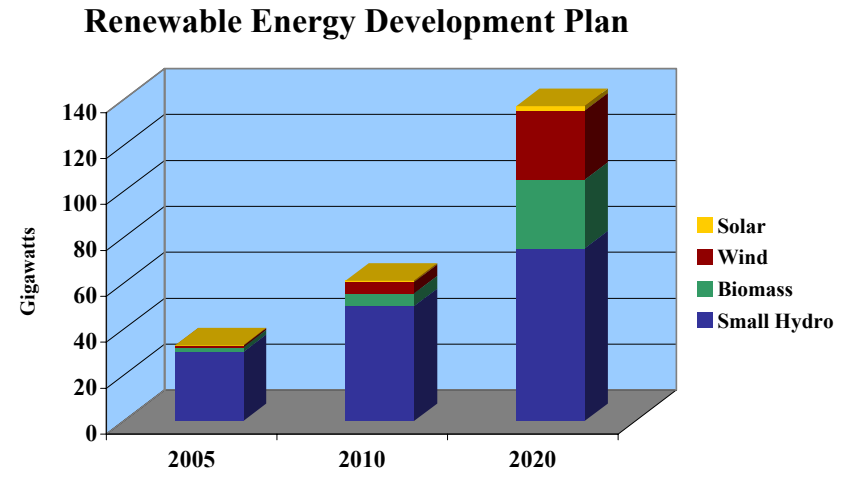
China needs to step up policies to encourage people to get out of their cars. Many in China want a car, but there use needs to become prohibitively expensive. City streets are quickly becoming congested parking lots. There has to be clean, effective and efficient mass transportation that's affordable to everyone, and this should be encouraged before allowing car infrastructure to be built. Affordability of building mass transit need not be a barrier, although many cities aspire to build expensive subway systems. It still costs on average US$100,000,000 or HK$800,000,000 per kilometre to build a subway. The more affordable solution is bus rapid transit systems, or BRT. These involve dedicated bus lanes that no other vehicles can encroach into. The buses travel station to station moving people with subway efficiency but at only 5-10 percent of subway costs.

Beijing now has China's first BRT corridor, from Tiananmen Square 16-kilometers out into the southeast suburbs, that moves about 100,000 passengers a day. Beijing has plans to introduce two more corridors ahead of the Olympic Games. Five other cities are now constructing BRT systems.

China's mayors are very interested in this. They are under pressure to solve the terrible traffic congestion that underlies mounting urban discontent. This is a great opportunity for the private sector to become involved in supporting investment in buses, including in advanced hybrid buses, and in all of the infrastructure and advanced electronics that are required to move buses more effectively and efficiently, particularly in BRT configurations.

Renewable Energy Law

Renewables to be 15% of all electricity in 2020



Source: National Development and Reform Commission, Medium and Long-term RE Targets

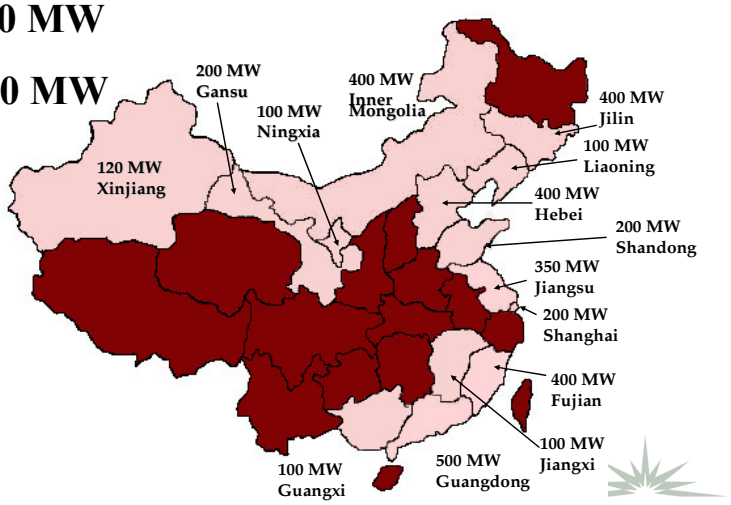
The new National Renewable Energy Law, adopted in early 2005, was an initiative that started with meetings held with the National People's Congress. Qu Geping, who was then the chairman of the NPC's Environment and Resources Committee, really embraced the initiative. His successor, Mao Rubai, who sits on our Senior Policy Advisory Council, then developed the law and moved it out of the People's Congress, as we understand it, faster than any previous law in the history of the PRC.

The target is for 15 per cent of all energy to come from renewables, not just electricity but all energy, by 2020. This presents an enormous opportunity, not only for wind energy, biomass energy and solar electric, but also for biofuels. China is now moving aggressively toward ethanol, following the same corn-based approach as in the West, which has low net energy benefits. Moving to cellulosic ethanol is where there is compelling future potential: Distilling for example China's enormous volume of rice stocks into grain alcohol could become an enormous growth industry propelled by this law over the next 15 years, if a cost-effective distillation catalyst and other technical hurtles can be overcome.

Wind Concessions

Goal: Encourage bulk purchases to drive down costs and speed commercialization.

- **To Date: 2,000 MW**
- **By 2010: 3,570 MW**

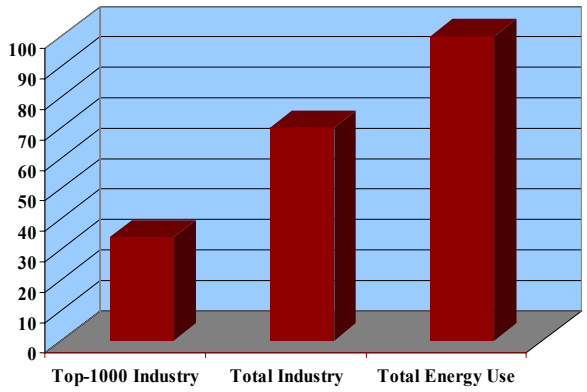


China is ramping up for the 30,000 megawatts of wind power that the Renewable Energy Law calls for by 2020. Competitive bidding via wind concessions is the current most-used approach. To date, investments of approximately US$2 billion have been made in wind energy. There will be a lot more wind plants built in China which will require both capital and know-how. There are 70 percent local content requirements, but for those foreign companies willing to manufacture or source components in China, this is a promising market. Gamesa of Spain, for example, has 35 percent market share in China.

The centrepiece of the Eleventh Five-Year Plan is to target heavy industries for efficiency technology upgrades. There are 1,000 enterprises in China that consume a third of all primary energy in China - a staggering number. China's Central Government is looking at how the weak can be weeded out from the strong and how the most modern manufacturing processes can be invested in for the winning enterprises.

Top-1000 Enterprise Program

China 2004 Energy Consumption



Target by 2010:

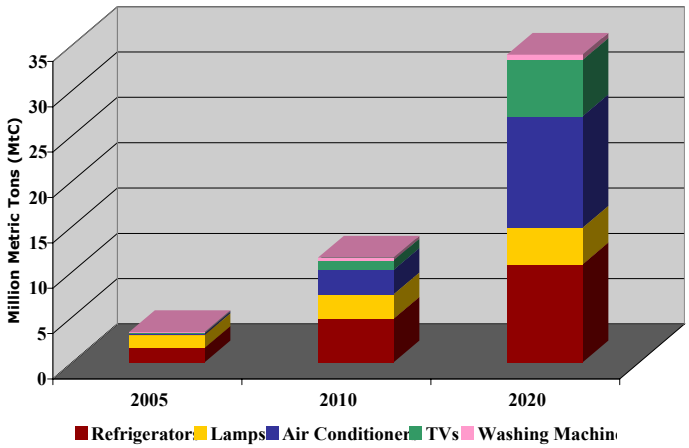
- **Save 100 million tons of coal**
- **Reduce 242 million tons of CO2**

The Top-1000 Enterprise Program started with a pilot amongst two steel enterprises in Shandong province that then morphed into a 100 enterprise program just for Shandong. It has now become the Top-1,000 Program. There are enormous opportunities in every one of the heavy industrial sectors for investing in energy efficiency upgrades.

Appliance Efficiency Standards

Efficient appliances could save:

- **12% of residential electricity in 2020**
- **34 large (1,000 MW) coal-fired plants**

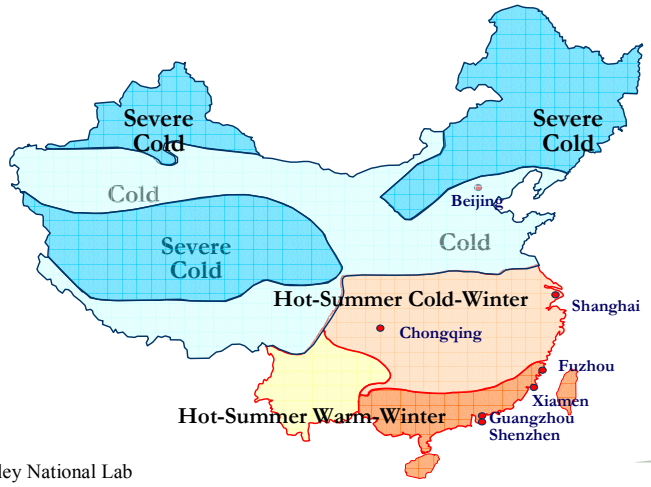


Grantees of our programs have worked with the Central Government's NDRC to develop standards for efficient lighting, refrigeration, air-conditioning, washing machines, and so on. Internationally, the best efficiencies for all of these consumer appliances have set a bar in China and the Central Government is requiring its manufacturers to reach the equivalent of these international standards. Most of China's appliances for export now incorporate these standards. The challenge will be to get domestic manufacturers retrofitted to produce the most efficient products for China's domestic market. More efficient appliances, spurred by required efficiency standards, are a crucial way to cut down on the number of polluting coal-fired electricity plants. Standards adopted to date could save 12 per cent of all residential electricity in 2020 and eliminate the need for 34 huge (1000-MW) coal-fired power plants.

Building Codes

National Commercial & Residential Codes Adopted

Six pilot cities demonstrating implementation



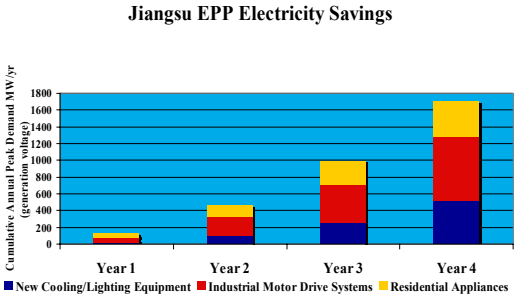
Source: Lawrence Berkeley National Lab

China now has some of the world's most advanced commercial and residential building codes. These call for energy efficient windows, insulation, wallboard, and various other building materials. The codes call for high material standards that currently require a lot of these products to be imported, which makes the buildings less affordable, a major problem. A great deal of investment is needed in order to produce efficient building materials locally that meet these new building codes.

Energy Efficiency Power Plants

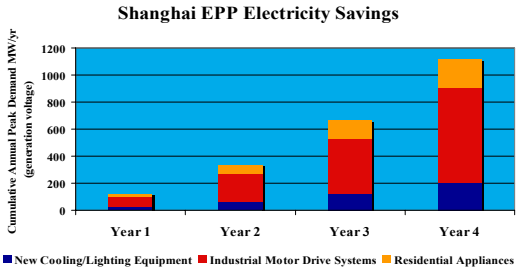
Jiangsu:

- **Save 17,000 MW in 10 years**
- **1/4 the cost of a coal-fired power plant (average cost: US 1.6 cents/kWh)**



Shanghai:

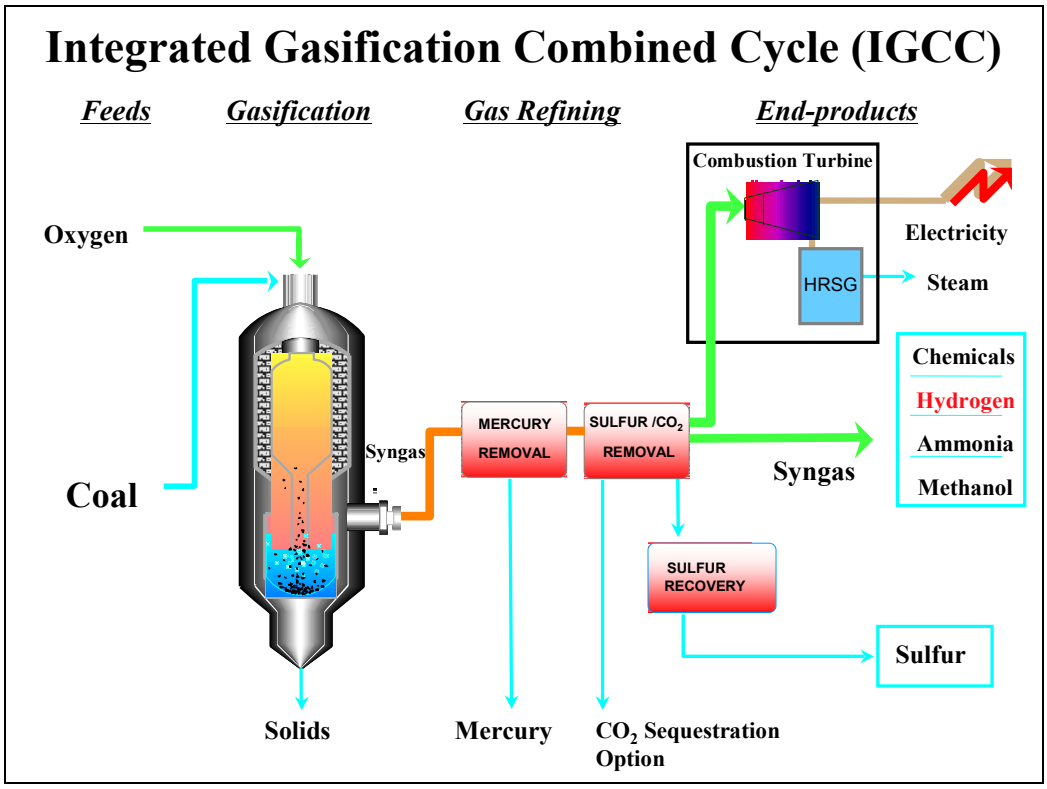
- **Saves 198 MW in 2 years**
- **Saves US $69 million**
- **Average cost: US 1.6 cents/kWh**



Source: Asian Development Bank

Energy Efficiency Power Plants (EPPs) are a new concept for China. Instead of building a new coal-fired power plant, the same capital is invested (in the same service territory) in efficient demand-side technology such as more efficient electric motors, more efficient lighting, refrigeration, air-conditioning and so on. The result is saving the same (or more) energy than could be produced by a new generation plant. These EPPs can be built at a quarter of the cost of a conventional coal plant, have zero emissions, and are faster to deploy. China should require these instead of issuing permits for any more power plants.

China's first EPP is being developed in Jiangsu. Another is being developed in Guangzhou for which the Asian Development Bank has put up US$120,000,000.



China has so much coal. And China will use its coal. When coal is burned (combusted), it creates carbon dioxide and other pollutants. A clean advanced technology alternative exists, involving cracking coal into syngas. Gasifying coal creates not only electricity but also numerous additional industrial products - marketable products such as hydrogen, ammonia for fertilizer, and methanol that can be used as a vehicle fuel. It's a very promising future for coal and produces a pure stream of carbon dioxide that can be buried. There are various demonstrations around the world, most of which focus on using the isolated stream of carbon dioxide such as for enhanced oil recovery. China is beginning to examine this technology. GE owns 14 gasifiers in the fertilizer industry. The chemical industry is likely to drive the market in coal gasification; linking coal gasifiers to the electricity grid will require favorable incentives, such as a tariff subsidy. Helpful will be to require environmental penalties on coal combustion facilities so that the economics of gasification technology with carbon capture and sequestration becomes attractive. If China adopts such policies there will be strong opportunities to help China move toward gasification technology.

China could move off in the wrong direction on using coal for vehicle fuels, however. China has attracted several large investments in coal liquefaction for vehicle fuels. These facilities use an environmentally horrible "direct liquefaction" approach that involves filthy combustion, an intense amount of coal volume and thus severe CO2 emissions, and uses an enormous amount of water. This approach to coal liquefaction is incredibly polluting and yet investment has been moving towards this technology due to a lack of regulation. Investment needs to move toward gasification – an "indirect" route to developing liquid fuels from gasifying coal, where carbon capture and sequestration can be achieved.

In summary, China is moving toward a sustainable energy future by implementing energy efficiency, and ramping up renewable energy. Public policy is the driver. In our program, we have focused on high-level access with bottom-up demonstrations. The hardest thing now is getting those demonstrations replicated throughout the provinces. Provincial governors' leadership will be crucial.

Private investment in advanced energy efficiency and renewable energy technologies in China needs to recognize that the competition is cheap coal. If substitution is to occur, companies should get active upstream, supporting the development and implementation of regulations and incentive policies that shape markets for clean technology. Those of you with philanthropic inclinations are urged to participate in the China Sustainable Energy Program in order to help catalyze clean energy markets in China, clean up the air, improve public health, and help address the serious challenges of energy for generations to come.

Please see next page for Q&A

Q&A

Q: Does nuclear technology also represent a good alternative to clean up the environment?

Ogden: The environmental community is split on nuclear. It is a zero carbon technology. There has not been any commitment, however, to building new nuclear plants in developed countries because the electricity is expensive, there are safety issues, and there are perhaps insurmountable nuclear proliferation challenges.

The forces that are developing nuclear in the Mainland are within the national security circles. This is not a technology out in the open where you can examine the costs and benefits next to other alternatives and perform integrated resource planning, costing out supply versus demand options. If you could, you'd find that the economics are far from favorable. This is why truly competitive, market economies are not moving toward nuclear.

I wrote a recent editorial in Newsweek stating that China doesn't need more electric power. The issue is how to use China's existing power more efficiently. China may not need another power plant for another 60 years according to a recent analysis, because of so much current energy waste. Better than developing nuclear power would be to upgrade and update the antiquated technologies and inefficient energy practices of heavy industries, commercial enterprises, and buildings.

In China, even though they have ambitious plans, I would be surprised if they build even half the number of nuclear plants that are currently being discussed. Usually a high-cost provider does not win without policy support, and nuclear must have a lot of policy support if it is to survive in a competitive market. And China's energy markets are trending toward, not away from, market competition.

Conventional nuclear technology is expensive. But there are interesting new technologies such as pebble bed nuclear technology, particularly if the fuel cycle can be decoupled from the threat of nuclear proliferation. Using the current technology, however, it is crucial to recognize that everywhere nuclear fission technology has been developed, nuclear weapons capability has followed. To put a lid on nuclear proliferation, the building of new nuclear power plants must cease.

And efficiency is so much cheaper anyways. So its very unlikely that we need to move toward nuclear when the main zero carbon technologies, efficiency and renewables, are readily available with only policy barriers in their way.

Q: What are the costs of renewables versus coal?

Ogden: Coal is cheap, renewables are not, at least when considering construction costs. But the operating costs of renewables – particularly wind, biomass, and solar – are significantly lower than coal. So within a payback time frame that is increasingly attractive, renewables are cheaper. And they're always cheaper on a social cost basis. Wind resources in wind-rich areas already out competes coal head-to-head on a kilowatt-hour production basis.

In the U.S. Midwest, from the Dakotas down through West Texas, there are strong winds and farmers are stepping up to wind as a cash crop. Out in Iowa, our staff recently visited a soy bean farm. The farmer makes about US$300 from each acre planted in soy. By putting up a wind turbine on that same acre, he still gets his US$300 for soy but he's also getting US$3,500 for his wind output. If a wind-rich area can be coupled with economic development incentives it is a win-win that can really drive the technology.

Q: Are we going to see wind farms all along China's countryside?

Ogden: Wind is the low-hanging fruit in China. The challenge is in obtaining a transparent tariff that's favorable for wind. China's very interested in developing advanced technologies locally and in promoting its Renewable Energy Law, so the pricing bureaus are beginning to award favorable wind tariffs. It requires negotiation, and grantees are working hard on trying to standardize these tariffs. The central government, in the Renewable Energy Law, adopted a national fund that provides kilowatt-hour subsidies from wind and other renewable energy facilities, thus lifting the higher marginal construction costs off of local consumers and averaging those additional costs nationwide, which creates a very favorable investment climate.

Q: What is the potential for impacting tariffs and making them favorable for these new technologies?

Ogden: That is the crucial issue. The pricing bureaus have the authority to award favorable tariffs but need approval from NDRC. There needs to be a national pricing policy including a favorable "feed-in" tariff for renewables. This exists for renewables other than wind, currently; wind still faces a competitive bidding structure, but we hope this shifts toward a higher feed-in tariff in order to encourage China's nascent wind industry.

Tariffs are one of the hardest things our grantees are up against. In three to five years I think we will see a very different, more favorable tariff climate for these technologies.

Q: How do you ensure that targets can be reached and met?

Ogden: That's a great question. What's been instructive is watching how the 2010 targets have been allocated among industrial enterprises.

We had an analytically rigorous approach to entering energy efficiency agreements with the two steel plants in Shandong province. We assumed that this experience was being used to make the Top 1,000 Enterprise Program. Then all of these 1,000 enterprises signed energy efficiency agreements with the central government that simply stipulated that each enterprise is to reduce their energy consumption by 20 per cent by 2010, without taking into account the differences between enterprises, or the differences between sectors. Some enterprises can achieve a reduction of more than 20% but for others it's going to be very hard. We are trying to help with introducing a more rational basis to this, focusing on a bottom-up, enterprise-by-enterprise demand-side management, advanced technology investment approach.

I do not believe China will reach its 2010 energy intensity target. But it's possible that they might by 2015. To achieve this, and earlier is obviously better, we will have to work with governors and each of the industry associations, and encourage stepped up advanced technology investment not only in industry but buildings and transportation as well. Needed are demand-side management experts to work with each enterprise and with the banks to get the right financing for improving the technology. All of that ground-up work has to happen together with the top down targets.

Q: Do you have any further information on gasification and liquefaction technologies?

Ogden: Because China is importing so much oil, they are very interested in using their domestic resources, their coal, to drive their vehicle fleet. There are two ways to turn coal into a liquid - direct liquefaction and indirect liquefaction. Direct liquefaction is a combustion process that is filthy, adds enormous global warming pollution, and uses a lot of water. This is where most of the investment has been going so far and it's worrisome.

Indirect liquefaction is where there is future potential. It's based on gasification technology: high pressure, high temperature, cracking of coal into its constituent gases and creating a number of

chemicals from this. It allows for carbon dioxide capture and sequestration, and thus can be a sustainable technology.

The electricity industry is not likely to drive this but the chemical industry cold. There's an interesting company in the town of Dongguang in Guangdong, the Dongguang City Power & Chemical Industry, Ltd., which aims to develop gasification facilities both for the electricity output and for the various chemical products that result, including 'Fischer-Tropsch Liquids' for transportation fuel. These are liquid fuel byproducts of gasifying coal, and with carbon capture and sequestration can offer China a clean domestic fuel supply. But the capture and sequestration will be crucial and we need to work hard on getting incentive policies in place soon.

Q: Would indirect liquefaction technology qualify as a Clean Development Mechanism (CDM)?

Ogden: Yes it would. Indirect liquefaction with carbon capture and sequestration costs more than direct combustion which just vents the carbon dioxide to the atmosphere, so the incremental costs could likely qualify for CDM credits.

CDM was set up under the Kyoto Protocol and involves companies earning credits for investing in cleaner technologies. For example, if coal is selling in China at three cents per kilowatt-hour and if wind costs seven cents, then the company could get CDM credits for that additional margin. The company could then sell the credits to cover the added risk of investment.

CDM is really in its nascence in China. China's Central Government has not yet finalized whether it should bank its credits for itself or whether it should allow foreign companies to earn the credits. There have been 137 CDM projects approved to date, all have involved arduous negotiations, and it continues to be difficult to have the certainty needed in order to make a bold investment in these technologies based on CDM alone.

Q: What levels of energy are expended on coal gasification?

Ogden: This relates to energy conversion efficiency. The conversion efficiencies of traditional coal plants in China, percentage-wise, are somewhere in the mid-thirties. However, you can combust more efficiently by moving to what is called 'super critical' and 'ultra-super critical'. These are ways of combusting coal that are more efficient and move up toward 42 or 44 per cent efficiencies. Gasification can achieve closer to 50 percent efficiencies. The conversion efficiency is higher meaning it uses less coal volume per kilowatt-hour of production.

Q: Which companies are involved in wind technology, aside from Longyuan and Goldwind?

Ogden: I think Longyuan and Goldwind are the main domestic companies at this stage. There are likely to be more, as 70 per cent local content is required of the wind concession projects, so the policy was designed by NDRC to encourage local manufacturing. Still, foreign companies that have localized manufacturing are doing well; Spain's Gamesa has 35 percent market share.

Working upstream in the public policy arena, it is important to develop policies that do not select particular technologies or particular companies. We will see who emerges but I think the companies that perform best are the ones with access to the best wind sites and low-cost capital. It's going to be expensive at first but then costs will come down with greater production volume and experience.

A lot of Chinese companies that have been winning the low bids in the wind concession program are untested companies that don't know if they can deliver at the aggressive bid prices they have committed to. It is a concern that they may have underbid and will fail to deliver, which could hamper the entire market. This is a real risk so teaming up with the most experienced players in China's wind markets can help mitigate that risk.

Overall, the challenge for investing in China's energy sector is coal: Coal is artificially cheap, and crowds out the ability of innovative companies, those that provide energy efficiency and renewable energy technologies, to compete on a fair, level playing field. To win in China, companies must be involved upstream in developing policies that (1) regulate the pollution from coal and oil to make these comparatively expensive, and (2) provide incentives to clean, sustainable energy substitutes, such as energy efficiency and renewable energy. The China Sustainable Energy Program works in this upstream policy space. I encourage individuals with philanthropic foresight to consider joining our partnership in order to shape China's market for a clean energy future.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