IBM Energy & Utilities

2020: Transforming China's Electric Power Future

Enabling Low Carbon Energy and Empowering Customers for Sustainable Growth

IBM Energy & Utilities

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Affordable and reliable energy has fueled China's remarkable economic and social achievements over the past twenty years. But this success has come with significant costs and challenges, including worsening air pollution, rising CO2 emissions, structural inefficiencies and a growing reliance on energy imports. In response, China's government has set aggressive 2020 targets for cleaner and more efficient energy. China's continued economic growth and rising energy consumption through 2020 offers unique opportunities for power generators, grid companies and customers to leverage technology in new ways to meet and even exceed these targets, while also accelerating China's transition to sustainable economic development. Doing so will require electric power stakeholders to transform by becoming more customer oriented, integrated, asset performance focused, innovative and market responsive. While not easy, the transformation journey is a worthwhile one for China's utility companies, Chinese society and the world.

"Environmental protection is the weak link in China's economic development. Energy savings and emission reduction are serious issues"

- National Chinese Leader

Introduction

Over the past two decades, China's supply-driven energy policies have been instrumental in fueling economic growth and raising living standards. During the span of just twenty years ending in 2010, China's total annual energy production nearly tripled to 2.97 billion metric tons coal equivalent, supporting manufacturing industries responsible for 71% of China's total energy consumption. [1] In 2011, China surpassed the U.S. to become the largest producer and consumer of energy in the world, accounting for over 21% of energy use globally. [2]

During this period, China established some of the largest energy enterprises in the world – eleven of the 87 energy companies in the Global Fortune 500 are from China. Energy development has also improved the lives of the Chinese people – annual per capita energy consumption grew by 85% from 1990 to 2010. [3]

However, China's energy achievements have been accompanied by significant challenges. CO_2 emissions and air pollution levels (SO_X and NO_X) are now the largest in the world, and in the case of CO_2 emissions are expected to grow further by 2020, even if government targets are met.

Similarly, China's insatiable demand for energy has led it from being a net exporter to net importer of coal, oil and natural gas resources. These challenges are exacerbated by major energy inefficiencies, weak financial performance of energy companies, regional imbalances and sporadic power shortages.

There is growing recognition among government, industry and the general public that China's current development model is simply not sustainable. For example, China's 500 million Weibo users are increasingly vocal on topics ranging from air pollution to power shortages. [4]

China's growing economy and rising energy consumption through 2020 offers electric power stakeholders a unique opportunity to leverage technology to enable the use of low carbon energy while also empowering industrial, commercial and residential customers to achieve significant energy savings. Between 2010 and 2020, China's GDP is expected to double, while the urban population is estimated to grow by 30% to 850 million by 2020. Over the same time period, per capita energy consumption may increase by 33%. The need for low carbon energy and energy savings has never been greater.

Achieving and exceeding China's targets while also taking advantage of new commercial opportunities requires electric power stakeholders to transform across five areas: focusing on customer needs, integrating across energy value chains, improving asset performance, accelerating innovation, and creating more market-responsive government policies.

Methodology

IBM, in partnership with the China Greentech Initiative (CGTI), explored the challenges, trends and opportunities for energy and electric power in China, focusing on actions through 2020 to achieve a cleaner and more sustainable future. The study provides a strategic framework for electric power generators, grid companies and other energy-related companies to address China's energy and environmental challenges while also seizing new commercial opportunities.

Our study focused on the following questions:

- How can China balance economic growth with growing energy demand and the need to reduce emissions and air pollutants?
- What are the main drivers for change and how are China's government and industry stakeholders responding?
- How can stakeholders transform to meet and exceed China's 2020 targets while also creating new commercial opportunities for power generators and grid companies?
- How can technology and innovation help enable and accelerate the transformation?

This study drew on IBM's global energy and utilities expertise, IBM's experience serving companies in China and globally, CGTI's insights into China's energy industry, and interviews with more than twenty executives and policymakers in China – including experts from power generation companies, grid companies, research institutes, universities and global multinationals.

Remarkable energy development

Supply-driven energy policies have fueled China's economic growth and rising living standards over the past two decades, a remarkable achievement given the country's vast size and population.

China surpassed the U.S. as the largest power producer and consumer in the world by 2011, with an installed electricity generation capacity of 1,056 GW, a nearly six-fold expansion from only 180 GW in 1990. [5] Energy production and consumption both grew by more than 250% during the same period to 2,466 and 2,613 million tons oil equivalent (Mtoe) respectively by 2011. Today, China accounts for over 21% of the world's total energy production and consumption. [6]

"Energy efficiency improvement is the best way to address China's energy challenges"

- China Energy Expert from Leading Research Institute

China's annual per rural capita energy consumption increased from 83 to 204 kilograms of coal equivalent (kgce) between 1990 and 2010, when 370 million people relocated to urban areas. [7]

China's energy development has been enabled by supportive policies, availability of domestic energy resources, state-owned enterprises with the technology and management capabilities to scale rapidly, and subsidies to help ensure affordable energy for industry and consumers.

China has also established some of the world's largest energy enterprises – 11 of the 87 energy companies in the Global Fortune 500 are from China, five of which are utilities: State Grid, Southern Grid, Huaneng, Datang Group and Guodian. [8]

These utilities, having benefited from China's enormous scale, are now well positioned to capture new markets, develop and acquire new technologies, secure global resources and further develop their capabilities to become global leaders.

Unsustainable growth model

Along with China's remarkable achievements have come energy, environmental and industry challenges on a scale unique to China:

- Rapidly rising emissions and air pollution
- Growing dependence on fossil fuel imports
- Energy intensity and inefficiencies
- Regional power imbalances and shortages
- Weak industry financial performance

Rapidly rising emissions and air pollution

Heavy reliance on coal for power generation led to China surpassing the U.S. as the world's largest carbon dioxide (CO_2) emitter in 2009, accounting for nearly 24% of global emissions. [9] Given the rate of rising emissions, even if China achieves its CO_2 reduction targets for 2020, it will still be responsible for about 27% of global emissions. [10]

The situation is similar for nitrogen oxide (NO_X) and sulfur oxide (SO_X) emissions, which are major contributors to rising smog, acid rain and health problems across China. Although SO_X and NO_X emissions may continue to decline by 2020, China will likely still remain the world's largest emitter of these pollutants, accounting for approximately 25% of the global total. [11]

In January of 2013, Beijing and other northern cities in China experienced the most severe air pollution levels on record in recent history. In Beijing, official air pollution readings nearly reached 1,000 for PM2.5 (particulate matter smaller than 2.5 micrograms), far beyond the World Health Organization standard of 75 that is considered acceptable. [12]

Growing dependence on fossil fuel imports

China's insatiable energy demand is increasingly met by coal, natural gas and oil imports. Beginning in 2007, China shifted from being a net exporter to a net importer of coal and natural gas; by 2010, 4.6% of coal and 11.6% of gas consumption relied on imports. This trend is expected to continue and is rapidly reshaping China's energy and foreign policy agenda. [13]

Energy intensity and inefficiencies

Significant demand-side energy intensity and inefficiencies exacerbate China's energy supply challenges, especially in heavy industries like power generation. China requires 273 kilograms of oil equivalent per US$ 1,000 of GDP, compared with only 171 for the U.S., 184 for South Korea and 125 for Japan. While this is partly because energy intensive industries account for 47% of China's GDP, it also demonstrates inefficiency in the industrial sector. [14]

"We think solar can get close to grid parity by 2020. Solar could be a real game changer in China."

- China Oil and Gas Company Executive

China's cement, steel and fossil-fired power plants – which combined account for 57% of total energy consumption – are, respectively, 23%, 11% and 37% less energy efficient than those in Japan. [15]

Regional power imbalances and shortages

Regional differences, low utilization of power generation assets, and price distortions are leading to increasingly large supply-demand imbalances and power shortages. In 2011, 50% of China's surplus power was located in wind and coal-rich Inner Mongolia while 90% of power shortages were in the central and eastern provinces. [16] China suffered its most severe power shortfall since 2004; in 2012 there was a 30 to 40 GW shortfall, impacting both heavy and light industries. [17]

Weak industry financial performance

Despite revenue growth over 15% per year from 2007 to 2011, China's top five power generators (accounting for 50% of total installed capacity) suffered from declining profit margins, rising debt levels and difficulties in covering growing interest expenses. The combination of rising fuel costs, tightly regulated feed-in tariffs, aggressive asset expansion and higher costs of capital all contributed to weakened financial performance. [18]

Drivers of Change

China's rapid and unsustainable economic development is leading to widespread recognition of the need for change. Fortunately, policymakers and energy industry stakeholders are responding to these concerns. IBM expects the pace and

"Optimization related technologies will be very important to improve efficiency of the future energy value chain"

- China Policy Influencer

extent of change will be driven by a range of factors including social media, new and potentially disruptive technologies, and global developments.

Rising social awareness

The power of social media is taking China by storm. Common citizens, media dignitaries, business tycoons, government officials and others are using on-line forums to express their views on some of China's most imminent and controversial social and economic issues. Internet company Sina's popular social media site Weibo, for example, grew from just 1 million registered users in 2010 to an estimated 500 million users by 2012, evidence of the potential for social media to influence change. [19]

In addition to providing a platform for citizens to voice their opinions, Weibo and other social media platforms are being used as tools to seek organized public feedback on environmental issues, many of which relate to energy. A recent example was in January 2013 when Mr. Pan Shiyi, Chairman of SOHO China (one of China's top real estate companies), asked Weibo users if they support a Clean Air Act legislation for China. Within days, 98% of over 56,000 Weibo users voted for Clean Air Act legislation during one week when record air pollution levels struck Beijing and other cities in North China. [20]

Our interviews suggest utilities, in particular State Grid and Southern Grid, which interact with customers every day, recognize the importance of social media to better understand and engage with customers.

Disruptive potential of new technologies

The emergence of potentially disruptive technologies is a major driver and enabler for change. When adopted across the value chain, these technologies have the potential to expand cleaner energy production and reduce energy demand, more than many may expect. Similar to the internet, when integrated together and enabled by intelligent networks, new technologies have the potential to change how energy is supplied and consumed across value chains.

As for power generation, large scale adoption of wind, solar, distributed energy and demand side management can significantly expand a diverse energy supply and reduce emissions and pollutions over the next decade. For transmission and distribution, smart grid technologies ranging from energy storage to renewable energy integration can enable the efficient, reliable delivery of cleaner power to end-users. End-users of electric power can also adopt technologies such as smarter buildings, distributed energy solutions, energy reporting systems and energy storage to help reduce energy costs while also managing demand.

The pace and scale of adoption will naturally depend on costs and value relative to today's technologies. For example, as shown in Figure 1, while coal and hydro currently cost much less than solar, wind, nuclear and gas, cleaner energy sources may be more cost competitive by 2020.

Figure 1. Forecasted cost trends for coal and cleaner energy

Energy Sources	2010 RMB/KWh	2020 RMB/KWh
Coal	0.34	0.68
Hydro	0.20 - 0.35	0.45 - 0.60
Nuclear	0.43	0. 60 - 1.20
Wind	0.57	0.51
Gas	0.66	0.40 - 1.20
Solar	1.50	0.60 - 0.80

Source: IBM analysis [21]

Global developments are impacting China

Global energy supply constraints, climate change concerns and the energy strategies of other countries are also shaping China's energy agenda. As reliance on energy imports increases, risk of supply disruptions grows. As the CEO of State Grid commented, "some important energy export countries and regions have political and social issues; it will affect China's energy supply if there is unrest."

Climate change is also influencing China's energy strategy. Although the economic downturn across Europe and other countries has the potential to overshadow climate change concerns, there is continued discussion of links between natural disasters and climate change. As the largest greenhouse gas emitter in the world, China will likely experience increasing international pressure to reduce its emissions in years to come.

Finally, energy strategies of other major economies are also shaping China's agenda. The U.S., for example, due to major shale oil and gas discoveries, has the potential to lower its energy costs considerably and in turn improve its economic competitiveness. In fact, the International Energy Agency (IEA) predicts that the U.S. will overtake Saudi Arabia as the largest oil supplier in the world by 2020. As a result, China must develop an energy strategy that simultaneously lowers long-term energy costs, secures cleaner energy supplies and ensures national competitiveness.

In 2011, China's average cost of electricity was almost 13% lower than the U.S. However, China's average cost of gas was nearly twice as much as the U.S, and this gap may widen in the short-term as production of U.S. shale gas expands. [22]

Government and industry response

In response to these drivers of change – growing social awareness, potential disruptive technologies and global developments – China's government and energy industry players are taking steps to ensure a competitive, low-carbon energy future.

For example, the government has established various national policies to develop clean energy technologies, reduce emissions, save energy, foster innovation and promote global expansion. Specific targets for cleaner fuels have been set which, if fully implemented, will increase gas from 4% of the 2010 energy mix to 10% by 2020, and non-fossil fuels from 8% to 15%.

Aggressive 2015 reduction targets for CO_2, NO_X and SO_X emissions have also been established which – combined with cleaner fuel targets – can help slow the growth of emissions. [23] Nevertheless, due to continued reliance on coal, CO_2 is expected to still increase in absolute terms and SO_2 and NOx will be reduced by only 17% and 20% respectively from 2010 levels by 2020. [24]

The Chinese government encourages energy companies, especially state-owned enterprises, to achieve reduction targets through the use of subsidies, incentives and key performance indicators (KPIs). While helpful, some experts we interviewed questioned if these methods alone can ensure China's cleaner energy and emission reduction targets are met.

Policymakers are focusing on seven strategic emerging industries that may account for 15% of GDP by 2020. Three are energy-related: energy savings and environmental protection, cleaner energy and new energy vehicles. [25]

Preparing for 2020: Five Transformation Areas

China's policies and targets provide a strong foundation to ensure a cleaner and more sustainable energy future by 2020. Achieving and exceeding China's targets challenges electric power stakeholders to transform across five areas with significant implications for power generators, grid companies, customers and government organizations.

Figure 2. What might happen if targets are met but nothing else changes by 2020?

9.7 billion tons
annual CO_2 emissions;
Would still be world's largest CO_2 emitter

19 million tons
annual SO_2 emissions
Would still be world's largest SO_2 emitter

18 million tons
annual NOx emissions
Would still be world's largest NO_X emitter

73%
percentage of China's oil
imports by 2020, compared to 55% in 2010

23%
percentage of China's gas
imports by 2020, compared 11% in 2010

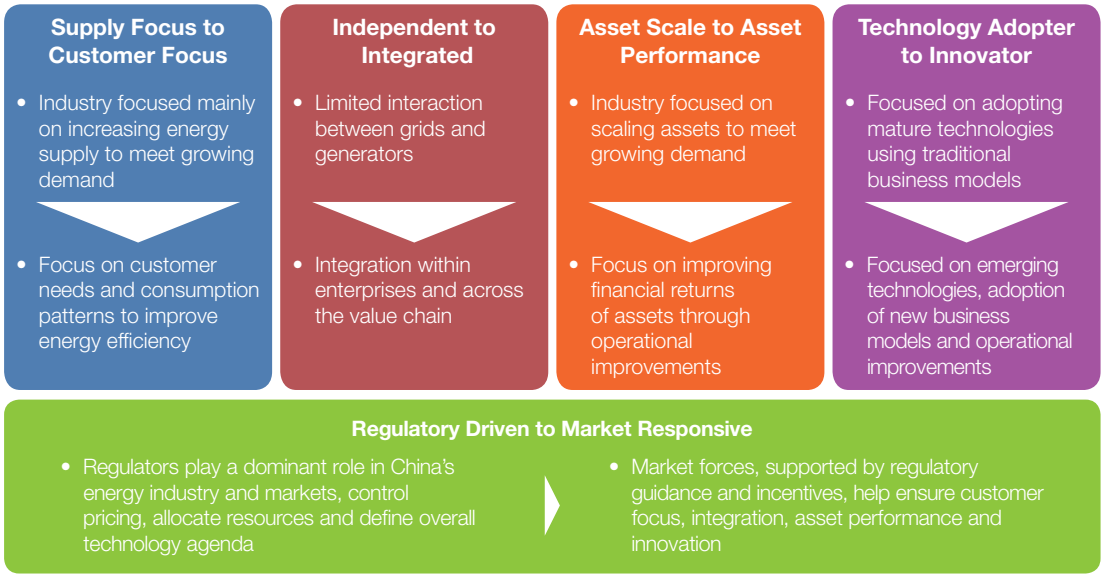
Source: IBM analysis based on projections from IEA, Energy Research Institute of NDRC and UK Embassy

Figure 3 highlights the five transformation areas which, considered together, will help China achieve a cleaner, more sustainable energy future.

From Supply Focus to Customer Focus

A top priority for China's energy stakeholders is to become more customer-focused. While China has historically prioritized energy supply expansion, energy systems are now at a critical inflection point that requires not only resource development and delivery, but also the achievement of energy savings – especially for industrial and commercial customers who are pursuing their own low-carbon agendas and face steadily growing cost and policy pressures.

Figure 3. Five strategic transformation areas to achieve and exceed China's targets by 2020



Source: IBM

For example, China's steel and cement sectors, which are respectively 23% and 11% less energy efficient than Japan's, consumed over 24% of total energy in 2010. [26] Light manufacturing and electronics industries also have growing pressures to become more energy efficient. For example, export-oriented Chinese companies supplying companies such as Wal-Mart, IKEA, Nike, Apple and others, are under pressure to reduce their energy consumption and carbon footprints as part of their customers' global sustainability initiatives.

Similarly, new and older buildings in China account for approximately 20% of primary energy consumption but are far less energy efficient than in developed countries. [27] While some policies and subsidies are in place to encourage building energy efficiency, developers and owners need innovative, cost-effective solutions to capture energy savings, especially in large public spaces like shopping malls, hotels, schools, commercial office buildings and hospitals.

Finally, although residential customers only account for 12% of China's total electricity consumption in 2010, technology-savvy consumers are increasingly aware of the economic and environmental benefits of using less energy and are interested in ways to save on their electricity bills, especially in prosperous regions of the country with higher electricity prices. [28]

How can China's utility companies become more customer-focused? Power generators can partner with large industrial users to co-generate power at acceptable prices for both parties. Grid companies can create customized solution offerings for industrial, commercial and residential customers that both achieve energy savings and offer new forms of revenue.

Furthermore, given the unique position of grid companies as the primary channels for electric power, State Grid and Southern Grid can develop platforms to provide innovative products and services to industrial, commercial and residential customers – ranging from basic information services that allow consumers to monitor and manage energy consumption more effectively, to sophisticated energy savings solutions targeted at specific industrial and commercial segments.

Figure 4 highlights some of the offerings IBM believes are particularly promising by 2020.

Figure 4. Promising energy savings offering for industrial, commercial and residential customers

Potential offering for industrial and commercial customers

- Insights into consumption patterns, predicted usage, savings potential and carbon impact
- Users set goals, receive alerts and track savings progress
- Flexible price incentives for large energy users to save more energy
- Industry-specific energy products, services and solutions (such as ESCOs)

Potential offerings for residential customers

- Insights into historical consumption and predicted usage patterns
- Tools to make smart decisions about energy use and saving money
- Mobile apps to set goals, receive alerts and track savings progress
- Social networking to learn and share how to save energy

"Asset management is becoming increasingly important to ensure overall performance"

- China Energy Industry Regulator

From Independent to Integrated

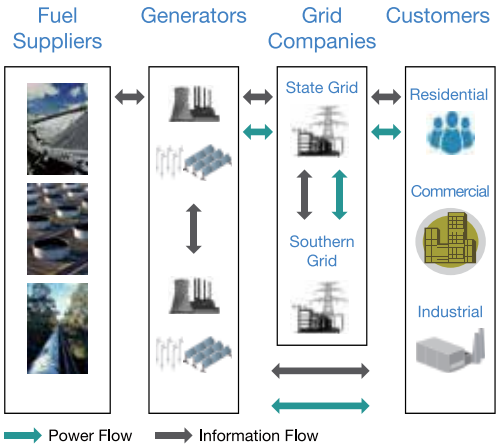
Today's power generators and grid companies operate relatively independently with limited collaboration in areas such as investment planning, demand forecasting and asset operations.

Currently, the flow of power is predominately unidirectional: power generated is transmitted by the grid and then dispatched and distributed to customers. At the same time, State Grid and Southern Grid gather information from customers, while information related to power generation (such as production forecasts) is sent from power generators directly to grid companies. This unidirectional flow of power and information contributes to a wide range of inefficiencies, including the inability of utilities to plan accurately, optimize generation and grid assets, and make timely management decisions.

Integration, on the other hand, leads to multidirectional information and power flows between power generators, grid companies and end users. Figure 5 provides a conceptual view of the new integration possibilities across the value chain.

Integration across companies introduces exciting new opportunities that can create value for power generators, grid companies and customers. For example, industrial customers can partner with grid power generators and grid companies to invest in distributed energy, micro-grids or storage to better manage energy supply. Integration between grid companies and customers through the use of technologies like smart meters can produce meaningful energy savings: smart appliances allow residents to track electricity usage in real time, automatically shut devices off, and adjust the temperature of homes automatically and remotely.

Figure 5. New integration possibilities across the value chain



Source: IBM

Integration is enabled and empowered by "systems of systems" intelligent networks that allow grid companies to optimize operations, manage power flows, integrate renewable energy and improve overall reliability. Technologies such as advanced metering infrastructure (AMI), energy storage, vehicle-to-grid (V2G), and renewable integration solutions – along with sensing, automation, measurement and control technologies – can also help grid companies drive efficiencies that increase revenues, lower costs and save energy.

At the same time, integration within individual enterprises can allow for better investment decisions, greater transparency, higher grid reliability, optimized asset performance, and greater energy savings for power generators.

"Innovation will be a critical pillar in our strategy."

- President of a U.S. utility, IBM 2012 CEO Study.

For China's utility companies, integration of business processes and management systems within their enterprises is important as they diversify business portfolios with operations across China and in other countries. Increasingly, companies are moving into new business areas such as coal mining, engineering and construction as well as making international investments. At the same time, company executives need to manage an increasingly diverse portfolio of technologies and assets. Generators are upgrading coal-fired plants, expanding renewable energy capacity and piloting new technologies such as alternative fuels, coal-to-gas, and carbon capture and storage (CCS).

From Asset Scale to Asset Performance

Asset optimization allows China's capital-intensive power generators and grid companies to improve their financial and operating performance.

Over the past twenty years, China's utilities have focused their efforts on scaling assets to support expansion of energy supply. Driven primarily by key performance indicators (KPIs) established by regulators, power generators expanded capacity from only 180 GW in 1990 to 1,056 GW in 2011. Similarly, grid companies increased transmission lines from only 90,000KM in 1990 to 480,000KM in 2011. [29]

Between 2007 and 2011, China's grid and power generation companies invested RMB 3.4 trillion in infrastructure to meet rising demand. [30] However, the average return on assets for China's top five power generators declined from 2.7% to only 0.7% over the same time period. [31]

A range of operational inefficiencies contribute to the low utilization of assets. In 2011, the average capacity factor of thermal power generation assets was only 60% due to rising fuel prices, overcapacity and underutilization of assets. Similarly, the average capacity factor of wind farms was only 23% in 2011, significantly lower than their estimated 28 to 30% potential due to challenges with grid connectivity and turbine availability. [32]

Focusing on the performance of existing and future assets can deliver significant operational and financial benefits to power generators and grid companies alike. For example, an estimated US$ 16 billion in global capital expenditures and operating expenses can be saved by improving the interoperability of assets during design, construction and operation. Moreover, ineffective maintenance costs US$ 60 billion per year globally. Globally, power generators estimate there is a 30 to 40% reduction in asset efficiency due to poor information management .[33]

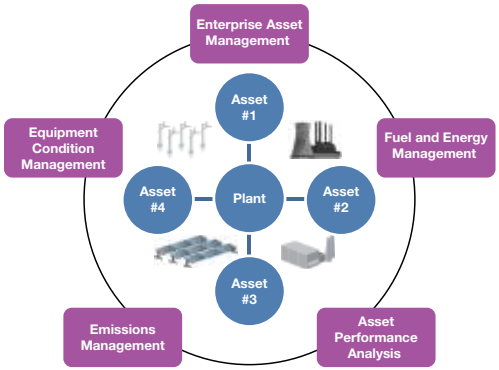
A wide range of initiatives are necessary to improve overall asset performance – including minimizing equipment downtime, maintaining long-term performance using sophisticated predictive maintenance systems, and establishing metrics that clearly link the operating and financial performance of assets.

The complexity and range of assets requires utilities to use robust performance management systems that provide a combined view of asset health and performance, easy access to equipment work and maintenance history, offer advanced visualization and analytics capabilities, and support complex decision-making by suggesting ways to optimize operations and maintenance processes.

As shown in Figure 6, asset performance management capabilities for power generators include:

- **Enterprise Asset Management** to organize and track assets, maintenance, work orders, materials and workflows
- **Fuel and Energy Management** to select, purchase, contract and manage supply chains for fuels and energy used by plants
- **Asset Performance Analysis** to support complex decision-making and prioritization of activities
- **Emissions Management** to measure, track and report CO_2, NO_X and SO_X emissions
- **Equipment Conditions Management** to assess the health of plant equipment and predict outages

Figure 6. Scope of asset performance management for power generators



Source: IBM

From Technology Adopter to Innovator

Innovation creates new sources of value in all industries – energy and utilities are no exception. To embrace this potential, China's utilities will need to shift their focus from the adoption of mature, proven technologies using traditional business models to investments in emerging technologies and innovative business models that challenge today's status quo but offer the potential to help solve China's energy and environmental challenges.

The Chinese government's focus on innovation places energy and the environment at the center of its efforts to not only solve challenges but foster the development of strategic emerging industries such as renewable energy, nuclear, energy savings and electric vehicles that can be global leaders and drive economic growth.

IBM has defined three types of innovation: product and service innovation to capture new growth opportunities; business model innovation to evolve the structure of businesses; and operational innovation to improve the effectiveness and efficiency of core processes and functions.

All three forms of innovation play a key role in shifting utilities' focus to customers, improving value chain integration and boosting asset performance.

For example, grid companies can create new energy savings products and services that address the needs of customers. They can also develop new physical and on-line channels for energy-related consumer products.

Similarly, power generators can co-research and develop emerging technologies with

"If a consumer knows how much energy they consume per day, we estimate 5 to 10% of their energy consumption can be saved by simply changing their behavior."

- Leading international appliance manufacturer

international companies that are eager to pilot and commercialize new cost-effective technologies in China and globally. Power generators can also become energy service providers and partner with third parties to offer new solutions to end-users such as distributed solar or co-generation of power for industry.

From Regulatory Driven to Market Responsive

Regulators play an important role supporting the transformation of China's utilities. China's regulators – which currently play a dominant role in the energy industry and markets by managing pricing, allocating resources and shaping the technology agenda – need to consider how market forces and incentives can be used to promote customer focus, value chain integration and asset optimization.

Regulators rightfully recognize that pricing is an important driver that influences market behavior and encourages the effective allocation of resources. However, concerns over the affordability of energy, inflation and vulnerability to global price swings have naturally led China's government to adopt a more cautious, gradual approach to adopt market-based prices for energy.

There are a variety of actions regulators can take using market-based mechanisms to enable the transformation of utilities. For example, tax rebates and financial incentives can be used to encourage utilities to offer end-user energy efficiency and savings programs (such as tiered-pricing and distributed power generation solutions). To promote value chain integration, regulators can create or mandate electricity and emission trading platforms or can promote industry-wide systems that offer transparent pricing, supply and demand information. To improve asset performance, key performance indicators (KPIs) can be designed to measure and incentivize state-owned companies to improve the financial performance of their assets.

California regulatory incentives increase energy savings and customer satisfaction

In 2002, the California Public Utilities Commission set aggressive energy savings and GHG emissions reduction targets for 2020. [34] *In response, PG&E, a large utility in California, has created several customer programs to help achieve these targets while increasing revenues.* [35]

- *PG&E's Self-Generation Incentive Program provides financial incentives to customers for the installation of wind or fuel-cell generation equipment over 30KW.*
- *Demand response programs (such as the Schedule Load Reduction Program and Base Interruptible Program) provide incentives for businesses that curtail energy use during peak demand.*
- *SmartAC installs free devices to help avoid power interruptions during summer months and the California Solar Initiative provides cash incentives and tax credits for installing on-site PV systems 1KW to 1MW in capacity.* [36]

Combined, these programs have saved US$ 262 million in energy costs, 1,519 GWh of energy and avoided 840,000 metric tons of CO_2.

Implications for Grid Companies

Today's grid companies have the unique role of delivering reliable electric power to fuel China's growth and raise living standards. With this role comes important social responsibilities, including addressing China's increasing environmental challenges, driving innovation and making sound investments for the future.

In the context of the five transformation areas developed by IBM, delivering on these commitments requires grid companies to execute initiatives across numerous areas:

From Supply Focus to Customer Focus

- Develop a customer engagement strategy to understand customer segments and how they use electric power
- Develop interactive and compelling customer programs that engage customers to manage power use and become a network participant
- Integrate and analyze information, including data on real-time conditions, and act on insights to balance supply with demand

From Independent to Integrated

- Effectively manage electricity supply and demand while optimizing utility operations through "systems of systems" integration efforts
- Deepen integration and collaboration with power suppliers and customers to lower emissions, increase energy efficiency, network reliability and asset performance
- Strengthen coordination with power generators and customers during investment planning, design and construction phases for electric power infrastructure

From Asset Scale to Asset Performance

- Prioritize condition-based maintenance of assets and optimize future investments that can deliver OPEX and CAPEX benefits through higher asset utilization
- Invest in condition-based assed management techniques, mobile workforce capabilities and technologies to improve asset performance throughout life cycle
- Implement asset performance improvement initiatives in phases, using the benefits to fund future investments

Implications for Power Generators

Power generation companies play a crucial role in meeting China's rapidly growing energy demand while employing emerging and mature technologies to significantly lower emissions and reduce air pollution. Achieving these dual objectives is particularly challenging given the extent of change necessary and the financial pressures facing power generators.

Power generators can manage these competing objectives and challenges by capturing additional revenues and cost savings that help fund required investments:

From Supply Focus to Customer Focus

- Collaborate with grid companies to share data and analytics to integrate renewables, strengthen grid reliability and improve asset performance
- Partner with third parties to offer low-carbon electric power and electric power savings solutions to industrial customers
- Partner with industrial and commercial customers to supply or purchase on-site generated electric power

From Independent to Integrated

- Integrate information management systems and processes to standardize the design, build and operations across all phases of the plant lifecyle
- Integrate operations and maintenance, including applying fuel management and emissions controls, and ensuring integration of renewables with conventional sources
- Partner with regulators to create platforms for emissions trading and sharing of pricing, supply, demand information to optimize investments in existing and future assets

From Asset Scale to Asset Performance

- Prioritize existing and future assets that benefit most from asset performance improvements
- Reduce equipment downtime, minimize failures and lower maintenance costs through asset performance management initiatives
- Improve capacity utilization of power plants and wind farms to delay capital investments and increase revenues

Conclusion

China's challenge through 2020 is to build on past successes to meet its future energy needs in a sustainable manner. Awareness of this fundamental challenge is rising quickly and innovative technologies are available that provide viable solutions. China's government has set clear targets to transition the country to a more sustainable future; however, even if the targets are achieved, the scale of China's challenges will remain significant. IBM intends to partner with China to not only achieve these targets but to also exceed them and accelerate China's transformation to sustainable economic development. Doing so will require transformation on a scale few countries or companies can fully appreciate.

IBM believes the journey is a worthwhile one for China's energy companies, Chinese society and the world.

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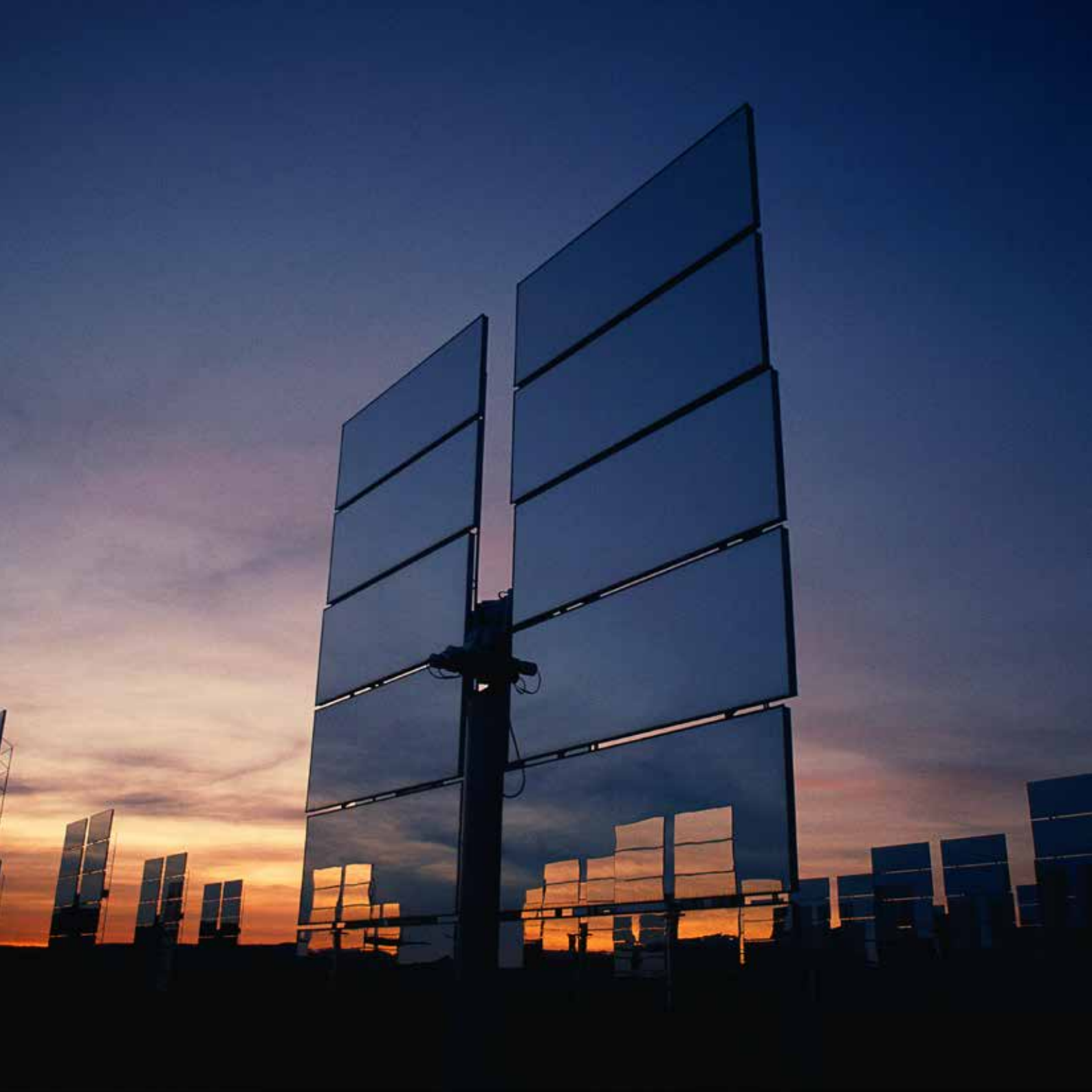
The China Greentech Initiative

The China Greentech Initiative (CGTI) is the only collaboration platform that creates and connects strategic insights with a community of over 100 companies and governments. CGTI builds upon the expertise of thousands of decision-makers to identify, develop and promote greentech solutions and projects. Through CGTI's Partner Program and Advisory Services, Partners gain market insights, relationships, project intelligence and thought leadership to accelerate their commercial success and China's green growth.

The China Greentech Report is published annually and established CGTI as the authority on China's greentech markets when it was first launched at the World Economic Forum in 2009. CGTI has also garnered recognition from the Harvard Business School through a case study examining how CGTI's open-source collaboration model combines its knowledgebase and network to define and accelerate the market.



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