Power Generation and Transmission Task Force

Action Plan

Contents

Introduction

The six countries of the Asia-Pacific Partnership on Clean Development and Climate—Australia, China, India, Japan, the Republic of Korea, and the United States of America—are cooperating to meet both their increased energy needs and associated challenges, including those related to air pollution, energy security, and greenhouse gas intensities.

The Partnership has established public-private Task Forces in eight key sectors: (1) cleaner fossil energy; (2) renewable energy and distributed generation; (3) power generation and transmission; (4) steel; (5) aluminium; (6) cement; (7) coal mining; and (8) buildings and appliances. The Task Forces are designed to meet Partnership goals through international cooperation to facilitate the development, diffusion, deployment, and transfer of existing, emerging and longer term cost-effective, cleaner, more efficient technologies and practices among the Partners through concrete and substantial cooperation so as to achieve practical results.

As a product of its first stage of collaboration, each Task Force has created an Action Plan which has been endorsed by the Policy and Implementation Committee. The Action Plans contain an initial set of priority activities for implementation. Some projects contained within the Action Plans may need to be refined or elaborated. Financial resources are needed for the implementation of the Action Plans. Some initial funding from some government and industry sources has already been identified for the implementation of projects. Partner countries will continue to work to mobilize further funding from both public and private sectors in order to bring about full implementation of the practical projects identified in the Action Plans and will continually develop new projects and add them to this set of activities.

Sector Review

Reliable and affordable supply of electricity is a prerequisite for economic growth. Increasing electrification of developing countries around the globe is an essential development imperative. Today's energy need is to improve efficiency in generation, transmission, and distribution in the power sector. Potential areas for cooperation in the power sector include efficiency and environmental performance improvements at existing power plants of all types, fuel switching and/or multi-firing in thermal power systems, loss reduction in electricity transmission and distribution (T&D), improved demand side management, and electricity market reform.

Five general power generation and transmission subject areas were identified and agreed upon by the Task Force to be included in the Sector Review as self-reported information and data from each country. These subject areas are: electricity supply and demand, grid system, ownership, regulations, and emissions.

Supply and Demand Overview

The availability of electricity in most countries is determined by sustainable access to market-competitive power generation sources such as fossil, nuclear, and renewable energy. Demand typically drives capacity additions. The following paragraphs summarize key electricity supply and demand issues for each Partner country.

Australia

The Australian electricity sector has an installed generating capacity of more than 48,800 MW, serving an annual consumption of 240 terawatt-hours (TWh) and a peak demand of 35,350 MW. Coal and natural gas are the dominant primary fuel inputs, supplying around 90% of the total generation. The electricity industry's consumption by sector is dominated by industry, which used almost half (45%) of electricity consumed in 2003–04, followed by residential (27%), commercial (26%), agriculture (0.8%) and transport (1%). The overall increase in national electricity consumption from 2002–03 to 2003–04 was approximately 4.4%.

Consumption growth is expected to continue, with a growth rate of 1.2% for 2004–05, and a 2.2% annual growth increase from through 2019–20. The major factors contributing to the growth in electricity demand are population growth and growth in domestic production. Forecasts suggest that electricity demand in Australia will increase to 334 TWh in 2019-20. Projected electricity demand implies the need for an additional 8,410 MW of generation capacity by 2019–20.

China

National power growth has maintained an average two-digit growth rate for four years, higher than the gross domestic product (GDP) growth rate. At the end of 2004, China's installed capacity reached 442,000 MW, an annual increase of 51,000 MW. Installed capacity in 2005 exceeded 500,000 MW. In 2005, the total generated power reached 2474.7 TWh, up 12.3% from 2004.

Through continuous improvement in power technologies and equipment, domestically manufactured power generation units of 300 MW and 600 MW have become mainstream in China. Currently, domestically manufactured supercritical units of 600 MW and 900 MW have been put into service, and 1,000 MW domestically manufactured ultra-super critical units are about to begin operation. Nevertheless, China still lags behind international advanced levels in some aspects, such as in the manufacturing of equipment for 1,000 MW nuclear power stations.

India

Electricity is a critical infrastructure component for India's socio-economic development, and affordable, quality power is required for rapid economic growth. The Indian power sector is witnessing major changes, with rapid growth in generation, transmission and distribution.

The present generating capacity of India is around 124,000 MW, which is poised to increase to more than 200,000 MW by 2012, and is projected to double every ten years thereafter. Total electricity generation by utilities in fiscal year 2004–5 was 594.5 TWh, and increased by 4.84% in fiscal year 2005–6. Because India's economy is growing at a fast rate, there is a national energy shortage of about 7%, and a peaking shortage of about 12%. National electricity policy aims at fully meeting demand with spinning reserves of 5% by 2012. To meet this objective, huge investments in power generation, transmission and distribution are required, and a favorable environment has been created for the private sector to participate in the areas of power generation, transmission and distribution.

Presently, thermal generation constitutes 66.4%, hydroelectric 26%, nuclear 2.7% and renewable 4.9% of installed capacity. Coal-based power plants contribute 83.2% of thermal generation, with gas and diesel providing the balance. Industry is India's largest power consumer, using 35.6% of the total power produced, followed by agriculture (23%), domestic (25%), and commercial (8%), with the remaining being consumed by railroads, public water works and other miscellaneous consumers.

The coal-based power plants consist of a large number of nominal 200 MW and 500 MW units. For faster addition of generation capacity 660 MW units are under construction, and 800 MW units are being proposed. The increase in unit size has also led to an increase in overall efficiency of power generation. The performance of the coal-based power plants is improving, as characterized by an increase in plant load factor from 72.96% during 2003–04 to 74.82% in 2004–05. The operating availability has also increased from 81.93% during 2003-04 to 82.93% in 2004–05.

Japan

The Japanese electricity sector has an installed generating capacity of 216,803 MW, and a total annual generation of 877 TWh in fiscal year 2004. According to the Japan Electric Power Survey Committee, electric energy demand for fiscal year 2015 is estimated to reach 989 TWh, representing an average annual increase of 0.9% from 2004. Peak capacity through 2015 is expected to grow at an average rate of 1.0% per year from 2004.

Japan has a paucity of energy resources and has moved to diversify its energy supply since the oil crises of the 1970s. Japan has also worked to build an electricity industry with a balanced fuel composition that disperses fuel supply risk while utilizing the characteristics of various power generation methods, including nuclear power generation, thermal power generation (coal, gas, and oil) and hydroelectric power generation. As a result of these policies, Japan has succeeded in lowering the fraction of power generation dependent on oil, from 75% in 1973 to 12% in fiscal year 2002. At the same time, it has achieved a balanced power output sourced from nuclear power (30%), coal (22%), gas (26%), and hydroelectric power (9%) in fiscal year 2002. Future government policy aims to maintain the proportion of power output from nuclear power at between 30% and 40%.

Korea

Demand for electricity in Korea grew at a compounded average rate of 6.8% per annum for five years at the end of 2005, higher than the GDP growth rate. The Korean electricity sector had an installed generating capacity of 62,258 MW, and a total annual generation of 365 TWh in 2005.

Korea has tried to build an electricity industry with a balanced fuel composition to achieve efficient use of generating resources and diversification of generating capacity. Since the oil shock in 1974, Korea's power development plans have emphasized the construction of nuclear generating units. Korea tries to maintain nuclear power production capacity equal to baseload demand. With continuous improvements in power technologies and equipment, domestically manufactured supercritical coal-fired power generation units have also become mainstream in Korea. The proportion of power generating facilities is: nuclear power (28.5%), steam (38.2%), combined cycle (24.1%) and hydroelectric power (6.2%).

The average growth rate of electricity demand is expected to be 2.5% per annum from 2004 to 2017 (294 TWh in 2003 to 416 TWh in 2017). Cumulative generating capacity additions are estimated to be 38,200 MW by 2017.

United States

There are approximately 17,000 electric generators in the United States, representing about 1,000,000 MW of installed capacity. Coal is the predominant fuel source for power generation in the United States, accounting for 51% of power generated, followed by nuclear (20%), gas (17%), hydroelectric (7%), oil (3%), and renewables (2%). Generation by all fuel types totaled approximately 4,000 TWh in 2004. Along with an expected need to replace aging capacity, the projected electricity supply growth of 50% by 2030 will create many opportunities for installing more efficient and clean generating capacity in the near future.

Grid System

The evolution of grid systems over time through both public and private initiatives have developed inherent inefficiencies associated with collections of locally optimized solutions. Collaboration within the Partnership context should lead to real-world technology solutions to support transformed national electric systems that are replicable within Partner countries. These solutions will likely employ distributed technologies using advanced control approaches to create optimized grid systems. The following paragraphs summarize key electricity grid system issues for each Partner.

Australia

The Australian electric transmission grid system includes more than 27,000 kilometers (km) of high-voltage electric transmission lines. Transmission assets are predominantly greater than 30 years old, and line losses are estimated at 10%. Distribution line losses are only 5.7%. Australia has a number of different electricity grids. The Australian National Electricity Market (NEM) contains 92% of Australia’s electricity infrastructure. The NEM currently consists of the (interconnected) electricity grids of the eastern Australian States of New South Wales, Victoria, and Queensland, the central Australian State of South Australia, and the island State of Tasmania. The electricity grids of Australia’s Northern Territory and the State of Western Australia are not connected to the NEM.

China

The Chinese grid system includes more than 228,000 km of electric transmission lines, with average line losses of approximately 7.5%. Domestically produced 500 kV AC/DC transmission and transformation equipment has become the backbone of China’s power grids. A 750 kV AC transmission and transformation demonstration project in Northwest China, along with the Lingbao back-to-back HVDC (High Voltage DC) station project, located in Henan province, have been finished and put into operation.

India

Development of India’s transmission network has occurred in parallel with growth in generating capacity, and is characterized by the physical growth in transmission network as well as introduction of higher transmission voltages and new technologies for bulk power transmission. The growth is attributed to the introduction of 220 kV in 1960, 400 kV in 1977, HVDC back-to-back link in 1989, ±500 kV HVDC bi-pole line in 1990, and 765 kV transmission line (initially charged at 400 kV) in 2000. Future plans include operation of the 765 kV line in 2007 and ±600 kV, 4,000-MW HVDC bi-pole line in 2011. The 220 kV system has an installed network of 113,400 circuit km. The 400 kV system has an installed network of 64,506 circuit km. The 765 kV system will have a total of 2,031 circuit km installed by the end of 2007.

India’s power transmission is divided into five regions: Northern Region, Western Region, Eastern Region, Southern Region and North-Eastern Region. Over the years, transmission system planning exercises were based on regional self-sufficiency, resulting in strong regional grids. The generation capacity at the end of 2007 for each regional grid is projected to be: (1) Northern Region — 37,228 MW; (2) Western Region — 43,732 MW; (3) Eastern Region — 23,823 MW; (4) Southern Region — 32,226 MW; and (5) North-Eastern Region — 2,363 MW. Currently, the Eastern, Northeastern, Northern and Western Region grids are operating in synchronize mode. With the existing and planned high capacity AC and HVDC transmission links connecting various regions, India is progressing toward a strong national grid, which would allow operations of unevenly distributed generation resources in the country to reach their optimal potential. The inter-regional transmission capacity for all five regional grids is projected to be 16,450 MW by the end of 2007.

Japan

The Japanese grid system includes more than 94,000 km of electric transmission lines, with estimated line losses of 5.2%. Japan’s transmission territory carries geographical restrictions, being stretched long and thin from east to west. The majority of the transmission assets in Japan have been in constant use for more than 30 years. A further restriction is the existence of regional frequency differences (50 Hz, 60 Hz). Service areas covered by each company are linked only by connecting lines. As a result, unlike countries in Europe and North America, Japan’s power transition lines network does not form a mesh nor is it linked to neighboring countries. For the ten companies to fulfill their obligation to provide stable power supplies in these restricted circumstances, the Japanese government promotes a “Japanese-style liberalization model” that maintains integrated power generation and T&D services, while including a partial liberalization of the retail market.

Korea

The Korean electric transmission grid system consists of approximately 28,642 circuit km of high-voltage lines (up to 765 kV), including high-voltage direct current lines. The Korean distribution system is comprised of 83,352 megavolt-amperes of transformer capacity and 7.4 million units of support with a total line length of 385,419 circuit km. Korea reduced its transmission and distribution loss factor to 4.51% in 2005 by increasing transmission capability for existing transmission lines.

Transmission voltages in Korea are 345 kV for trunk lines and 154 kV or 66 kV for local networks. Most of the 66 kV lines have been phased out. To meet future demand, Korea is concentrating on voltage upgrades by expanding its 765 kV power lines.

United States

The electric transmission grid consists of more than 289,680 km of high-voltage (>180 kV) electric transmission lines. Annual investment in new transmission declined steadily in the 1980s and 1990s, while electricity demand increased. Due to grid congestion, average T&D losses grew from 5% in 1970 to 6.81% across all voltages in 2004. Issues with land use, siting, and permitting, and concerns over whose responsibility it is to build new lines have hampered new investment.

Ownership

Ownership of electric power generation infrastructure is determined by a number of issues — national security, government ideology, the strength of a nation’s private sector, the regulatory environment within a nation, etc. Across the Partners, there is a fair amount of divergence on the percentage of government vs. private ownership of electric power generation infrastructure. While centralized ownership remains common in certain countries, deregulation is increasing the level of private ownership. The following paragraphs summarize key electricity ownership issues for each Partner.

Australia

Electricity generation in the Australian National Electricity Market includes both public and private ownership. Public ownership dominates, with nearly 31,000 MW (approximately 67%) of total generating capacity owned by government. Private owners control nearly 15,000 MW (approximately 33%) of total generating capacity. Victoria is the only State to have fully privatized its generation assets. South Australia has effectively privatized its generating assets though 199 year leases to the private sector. All other states have retained government ownership.

The five largest generation companies supply around 52% of the market, with market shares of the largest three companies in each region (a standard measure of ownership concentration) ranging from between 60% and 100% of regional generation capacity.

China

Five major power generation groups in China own nearly 43% of the nation's total installed capacity. All of the power generation groups are state-owned. China also has many local power companies, most are state-owned, and some are private or foreign capital. The proportions of the private and foreign capital are increasing year by year.

India

Generation capacity ownership in India is divided as follows: 57% under the state sector, 32% under the central sector, and 11% under the private sector.

Japan

In the Japanese power industry, 10 private-sector general power utility companies maintain an integrated system for power generation, transmission, and distribution, with each of the companies fulfilling their responsibility to supply a specific area. Wholesale power utility companies supply electricity to the general power utility companies, while power producers and suppliers sell and distribute electricity to customers covered by deregulation legislation.

Korea

Of the total installed capacity in Korea 88.7% is owned by six major public utilities, which have spun off from KEPCO (Korea Electric Power Corp.) in 2002. State-owned KEPCO still hold whole shares of the six public utilities. As the single buyer in the Korea electric market, KEPCO operate transmission and distribution system. In 2005, the six major public utilities supplied 96% of the grid demand.

United States

The United States has more entities involved in the production, transmission and distribution of electricity than any other nation. Power is provided by more than 3,100 electric utilities owned by stockholder-owned companies (serving 73% of customers), state and local government agencies (serving 15% of customers), regional cooperatives (serving 12% of customers), and a few federal utilities. In addition, there are nearly 2,100 non-utility power producers, including independent power companies and customer-owned distributed energy facilities.

Regulation

The power sectors in most countries rely on a complex array of regulations to guide the production, sale, and distribution of electricity. Some countries have empowered a small number of agencies with oversight and control responsibilities, while others have divided these responsibilities among distributed entities. The following paragraphs describe regulation aspects concerning power generation in each Partner.

Australia

The National Electricity Market (NEM) is structured around a gross pool, or spot market, for trading wholesale electricity. A specially constituted company, the National Electricity Market Management Company Limited, manages the system's control functions and is responsible for the day-to-day operation and administration of both the power system and the wholesale spot electricity market. System control functions for Western Australia and the Northern Territory are performed by government organizations.

All electricity produced in NEM states by generators with a capacity greater than 30 MW must be traded through the NEM pool. The Australian Energy Regulator provides economic regulation of the wholesale electricity market and electricity transmission networks in the NEM. The Australian Energy Market Commission is responsible for market development and management of the market rules.

China

At the end of 2002, China completed the first phase of reform in the power sector, establishing the State Electricity Regulatory Commission, two major grid companies, five major power generation groups and four supporting companies. Through specific reforms aimed at "separating power generation from transmission" and "separating functions of the government and enterprises," China has created an orderly competition situation in the power sector.

India

In India power sales by generating companies to distribution licensees, including transmission, distribution, and trading of electricity are regulated by the Electricity Regulatory Commissions, which are independent and autonomous. The Central Electricity Regulatory Commission (CERC) regulates inter-state activities. The State Electricity Regulatory Commission (SERC) regulates distribution business and other activities within the state. CERC regulates tariffs with respect to Central Government owned companies and for Independent Power Producers (IPPs) selling power to more than one state. SERCs regulate tariffs with respect to state generating companies and independent power producers (IPPs). Generation tariffs are fixed based on capital costs and normative operating parameters. Currently, the tariff policy mandates a shift to developing projects through tariff based competitive bidding. Distribution licensees can also contract to purchase power through a transparent process of tariff-based bidding and tariff, so arrived, is adopted by the Regulatory Commissions.

The Electricity Act of 2003 has established open access in transmission, creating an all-India Electricity Market. Trading of power is a licensed activity, and there are many trading companies operating in India. Generating companies can also sell power directly to bulk consumers who have a connected load of more than 1 MW, on mutually agreed rates subject to open access in distribution by SERCs. Such open access is mandated by law, scheduled to be in place by January 2009.

Japan

Japan's retail power market was partially liberalized in March 2000, and has subsequently expanded in stages. By 2005, approximately 60% of the power sold occurred via retail electricity transactions. A wholesale power exchange has also been established, allowing active power trading, not only between general power utility companies, but also between other parties, including power producers and suppliers. Deliberations on a fully liberalized market are scheduled to start in April 2007.

Korea

Korea's electricity industry restructuring plan established a stand-alone generating sector and six generation groups. The Korea Power Exchange was established in April 2001 to deal with the sale of electricity and develop regulations for a competitive electricity distribution market. Power generating companies compete and large consumers purchase electricity in the market under a cost-based pool system. Korea has created orderly competition in the power sector.

United States

Interstate wholesale markets are regulated by the Federal Energy Regulatory Commission (FERC), while state and local agencies regulate the retail market, including distribution and retail pricing. The electricity sector has been slowly shifting from a federally- and state-regulated system of vertically integrated public utility monopolies toward a market system characterized by numerous market players, lower regulation, and competitive pricing. As of 2005, 17 states and the District of Columbia had enacted comprehensive restructuring legislation. The number of players in the market, in addition to the patchwork of regulations state-to-state, has created uncertainty about the future of the electricity sector, which has hindered investment in new plants, transmission and distribution.

Emissions

The production of electric power, particularly from fossil fuels, results in the emission of air pollutants. Many national governments have taken steps to reduce emissions from power generation systems, and further regulations to protect human health and the environment are anticipated. Many countries are also considering or implementing efforts to reduce emissions of CO_2 and other greenhouse gases due to growing concerns regarding global climate change.

Australia

Due to Australia's continuing strong economic and population growth, Australia's electricity demand continues to grow. However, while the economy is projected to approximately double over 20 years from 1990, overall emissions growth is projected to rise by only 8%. Energy emissions per dollar of GDP are similarly projected to fall by 25% between 1990 and 2010. The Australian Government has committed more than A$2 billion to tackling climate change, including through programs targeted at reducing emissions from electricity generation. These programs include a A$500 million Low Emissions Technology Demonstration Fund, more than A$700 million to support renewable energy, a Mandatory Renewable Energy Target and voluntary industry partnership programs such as Greenhouse Challenge Plus and the Generator Efficiency Standards.

China

The Chinese government decided to build up a resource saving society throughout the country. According to the 11th Five-year National Plan, the Energy intensity will drop by 20% in 2010.

India

With the increased power generation capacity from coal, larger size units with supercritical parameters are planned with better efficiencies. Work is being done to introduce new technologies such as IGCC, which are cost effective.

The Government of India has enacted emission legislation namely the "Energy Conservation Act, 2001." The Bureau of Energy Efficiency, envisaged under the act, has been put in place. Several lines of actions have been initiated by the Bureau of Energy Efficiency in the area of energy conservation in industry, domestic sector, commercial establishments and agriculture sector.

Japan

Although power demand has increased by about three times since the oil crises of the 1970s, CO_2 emissions from the electric power industry have increased by about two-fold. Under the difficult circumstance of continuous power demand increase, the electric power industry in Japan set a voluntary target to reduce CO_2 emissions intensity in 1996, and seeks to continue lowering CO_2 emissions intensity. Through promoting measures to improve fuel quality and to change plant facilities, sulfur oxide (SO_x) and nitrogen oxide (NO_x) emissions per kWh have been dramatically reduced recently, with levels significantly lower than those of OECD countries.

Korea

In order to ensure zero-tolerance implementation for the national emission regulation, the government legislated to install the real-time emission monitoring system named TMS (Tele-Monitoring System) in the smoke stacks with high emission volumes since February 2002. Based upon the data gathered from TMS, the government mandates improvements or imposes charges to those who exceed emission regulations. As of January 2004, TMS had been installed in 1,841 stacks at 317 industrial sites. The Korean government has established a green house gas (GHG) registration program similar to the Kyoto Protocol's Clean Development Mechanism (CDM).

United States

While emissions of SO_x, NO_x, mercury, and other local air pollutants from electricity generation are declining, CO_2 emissions continue to grow due to the increased demand for electricity. The federal government has made the reduction of greenhouse gas (GHG) emissions intensity a priority and has initiated several voluntary programs to reduce GHG emissions. It is also providing R&D and tax incentives for clean coal combustion and carbon capture and storage. Some states are introducing mandatory programs to cap CO_2 emissions from the energy sector.

Comparative Country Tables

The data in all of the tables were reported by each Partner country's Task Force representatives.

Table 1 Country Comparison: Total Installed Capacity by Fuel Type

<table>
<tr><th></th><th>Australia Installed Capacity (MW)</th><th>China Installed Capacity (MW)</th><th>India Installed Capacity (MW)</th><th>Japan Installed Capacity (MW)</th><th>Korea Installed Capacity (MW)</th><th>United States Installed Capacity (MW)</th></tr>
<tr><td>Coal</td><td>32,038</td><td rowspan="5">All fossil fuels 329,483</td><td></td><td></td><td>17,965</td><td>338,538</td></tr>
<tr><td>Black coal</td><td>24,466</td><td rowspan="2">67,790.87</td><td>30,230</td><td>16,840</td><td>323,419</td></tr>
<tr><td>Brown coal/ lignite</td><td>7572</td><td></td><td>1125</td><td>15,119</td></tr>
<tr><td>Oil</td><td>359</td><td>1201.75</td><td>39,335</td><td>6091</td><td>37,970</td></tr>
<tr><td>Gaseous fuel simple cycle</td><td>6358</td><td rowspan="2">11,909.82</td><td>35,295</td><td></td><td>241,725</td></tr>
<tr><td>Gaseous fuel combined cycle</td><td>2076</td><td></td><td>22,838</td><td>16,447</td><td>193,188</td></tr>
<tr><td>Nuclear</td><td></td><td>6,836</td><td>2770</td><td>47,122</td><td>17,716</td><td>105,560</td></tr>
<tr><td>Renewables</td><td>8005</td><td rowspan="3">105,242</td><td></td><td>33,543</td><td>4039</td><td>118,601</td></tr>
<tr><td>Hydroelectric</td><td>7609</td><td>30,942.24</td><td>33,042</td><td>3829</td><td>96,955</td></tr>
<tr><td>Other</td><td>396</td><td>3811</td><td>501</td><td>210</td><td>21,646</td></tr>
</table>

Table 2 Country Comparison: Average Heat Rate by Fuel

<table>
<tr><th></th><th>Australia Average Heat Rate</th><th>China Average Heat Rate</th><th>India Average Heat Rate</th><th>Japan Average Heat Rate</th><th>Korea Average Heat Rate</th><th>United States Average Heat Rate</th></tr>
<tr><td>Black coal</td><td>10,100</td><td rowspan="5">Average fossil fuel combustion: 10,164*</td><td>11,000</td><td>8937</td><td>9171</td><td>10,397</td></tr>
<tr><td>Brown coal/ lignite</td><td>13,600</td><td>12,550</td><td></td><td>10,305</td><td>11,131</td></tr>
<tr><td>Oil</td><td>12,000</td><td>N/A</td><td>9580</td><td>7640</td><td>11,024</td></tr>
<tr><td>Gaseous fuel simple cycle</td><td>11200</td><td>N/A</td><td>9577</td><td rowspan="2">9589</td><td>11,312</td></tr>
<tr><td>Gaseous fuel combined cycle</td><td>8100</td><td>9000</td><td>7804</td><td>10,753</td></tr>
<tr><td>Nuclear</td><td>N/A</td><td></td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Hydroelectric</td><td>N/A</td><td></td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

*The average heat rate was converted from a stated average efficiency of 35.42%

Table 3 Comparative Transmission and Distribution Data

	Australia			**China**			**India**		
	Transmission		**Distribution**	**Transmission**		**Distribution**	**Transmission**		**Distribution**
	AC	**DC**		**AC**	**DC**		**AC**	**DC**	
Voltage Levels and Distance Covered	500kV –2409 km	500 (Includes 290 km Basslink Interconnector)	44kV – 37 km	750 kV	500 kV	110 kV – 263,004 km	765kV – 563 km	+/- 500kV – 6841km	33/22 kV – 299,639km
	330kV – 6578 km	330 (Includes 65 km Directlink Interconnector)	33kV – 41,075 km	500 kV - 54252 km		35 kV – 405,276 km	400kV – 57,185 km		15/11kV – 1,971,722km
	275kV – 10026 km		22kV – 200,670 km	330 kV - 10773 km		10 kV	230/220kV – 104,758 km		6.6/3.3/2.2 kV – 6,431 km
	220kV – 8058 km	220 (Includes 180 km Murraylink Interconnector)	11kV & below-- 168,563km	220 kV - 163,835km			132/110/90kV – 124,344 km		up to 500 Volts – 3,953,456 km
	132kV – 25462 km	132	Single Wire Earth Return (SWER) – 154,211km				78/66kV – 45,884 km		
	110kV – 3542 km		Low Voltage (640 volts & below) – 226199 km						
	88kV – 73 km		44kV – 37 km						
	66kV – 27631 km		33kV – 41,075 km						

	Australia			China			India		
	Transmission		Distribution	Transmission		Distribution	Transmission		Distribution
	AC	DC		AC	DC		AC	DC	
Voltage Levels and Distance Covered	500 kV*	±250 kV	6600 (V) – 714,173 km	765 kV – 11,908 km			750 kV – 3,975 km	500 kV – 2,146 km	2.4 – 34.5 (primary distribution)
	275 kV		100/200 (V) – 554,824 km	345 kV – 82,800 km			500 kV – 44,933 km	450 kV	
	220 kV						345 kV – 84,011 km	400 kV – 1,372 km	
	187 kV				180 kV – 261,312 km		230 kV – 125,237 km	250 – 300 kV – 721 km	
	154 kV			154 kV– 79,816 km					
	132 kV								
	110 kV								
	77 kV								
	66 kV			66 kV – 1,702 km					
	33 kV								
	22 kV					22.9kV – 560,846 km			

*The total transmission distance in Japan is 94,124 km

Goals and Objectives

The long-term goal for the Power Generation and Transmission Task Force (the Task Force) under the Asia-Pacific Partnership on Clean Development and Climate (Partnership) is to improve the efficiency and environmental performance of power generation, transmission and distribution, and end use. This goal will be achieved through broad objectives that were agreed upon during the Inaugural Ministerial Meeting of the Partnership in Sydney, Australia, in January 2006. These broad Task Force objectives are to:

1. Assess opportunities for practical actions to develop and deploy power generation, transmission and demand-side management technologies that can aid development and mitigate climate concerns.

2. Facilitate demonstration and deployment of practices, technologies and processes to improve efficiency of power production and transmission within Partner countries.

3. Enhance collaboration between Partner countries on research and development (R&D) of such technologies and processes.

4. Enhance synergy with other Task Forces (i.e., Cleaner Fossil Energy, Renewable Energy and Distributed Generation, Buildings and Appliances, Cement, etc.).

5. Identify potential projects that would enable Partner countries to assess the applicability of energy feedstocks to their specific requirements.

6. Identify opportunities to enhance investment in efficient power supply by improving energy markets and investment climate.

Specific goals will be embodied in specific projects.

It is important for the Task Force to develop meaningful activities and performance metrics for each activity it conducts. The Task Force envisions setting two sets of activities: near-term activities to be completed in 2007, and follow-on activities to be determined in 2007 after more information on specific needs and Task Force project opportunities has been gathered and analyzed. Near-term goals will focus on the number of Task Force actions completed, and are shown in Table 4 (page 18). From analysis of data obtained by near-term activities, follow-on activities will be developed. Performance metrics will apply to a Partner country as agreed to by that Partner country specifically.

Partnership Actions

Numerous multilateral and bilateral activities will be conducted under the Task Force to meet the objectives listed above. Although individual activities may not meet all objectives, the set of activities as a whole will strive to do so. Where applicable, Task Force actions should leverage and extend existing activities and efforts and involve as much private sector participation as practicable.

Four major task statements were developed and agreed upon during the first Task Force meeting in Berkeley, California, in April 2006:

1. Information sharing consistent with Clean Development and Climate Change.

2. Identification and implementation of applicable best practices for power generation.

3. Identification and implementation of applicable best practices for transmission and distribution.

4. Identification and implementation of applicable best practices for demand side management.

The following paragraphs briefly describe the intent of these four major task statements.

Information Sharing Consistent with Clean Development and Climate Change: To facilitate collaboration between Partner countries, information detailing key issues concerning the power generation and transmission sectors in Partner countries' needs to be effectively communicated and shared within the Task Force. Information sharing will allow a better understanding of specific key issues facing each Partner country's power sector and will educate all Partners on the similarities and differences between Partners' power systems. This better understanding will allow the Task Force to more efficiently achieve its objectives. Topics to be covered should include power generation and transmission systems, R&D efforts and initiatives, and energy markets. It is envisioned that major project opportunities would be identified and Task Force projects would be established based on the results of the information sharing and workshops.

Identification and Implementation of Applicable Best Practices for Power Generation: Many commonalities exist among the Partner countries' power generation sectors, and key issues faced by one Partner may have already been addressed by other Partners. Identification of best practices achieved in Partners will build a knowledge base that can be applied as appropriate to increase power generation efficiency, reduce emissions, improve operation and maintenance, and facilitate life extension and/or retrofits. A comprehensive program, beginning with site and plant visits and broad reviews, will progress through more specific workshops and expert reviews, studies, and capacity building to facilitate project demonstration and deployment of applicable cost effective best practices and technology.

Identification and Implementation of Applicable Best Practices for Transmission & Distribution: Many commonalities exist between Partner countries in the transmission and distribution (T&D) of electric power, and key issues faced by one Partner may have already been faced by other Partners. Identification of best practices achieved in Partners will build a knowledge base that can be applied as appropriate to improve T&D, including reducing technical losses, connection standards and equipment, system upgrades, and grid planning and operation (including power quality). A comprehensive program, beginning with site and plant visits and broad reviews, will progress through more specific workshops and expert reviews, studies, and capacity building to facilitate project demonstration and deployment of applicable cost effective best practices and technology.

Identification and Implementation of Applicable Best Practices for Demand Side Management: Many commonalities exist between Partner countries in Demand Side Management (DSM) practices, and key issues faced by one Partner may have already been faced by other Partners. Identification of best practices achieved in member countries will build a knowledge base that can be applied as appropriate to improve DSM practices, such as smart metering and end user energy efficiency. A comprehensive program, beginning with site and plant visits and broad reviews, will progress through more specific workshops and expert reviews, studies, and capacity building to facilitate project demonstration and deployment of applicable cost effective best practices and technology. It is expected that projects involving end user energy efficiency will be coordinated with other Partnership Task Forces, as appropriate.

The Task Force has developed goals and performance metrics for each project activity. These goals will focus on the number of Task Force actions completed, and are shown in the action plan milestones (see Table 4 below). Table 4 was constructed based on the needs identified by the Task Force in areas such as increased power generation and transmission efficiency. A more detailed description of each individual project plan is located in Appendix A. The major tasks will be accomplished through implementing a portfolio of complementary projects. Additional projects will be added over time.

The Task Force will be establishing processes/procedures to ensure that site visits, workshops, etc. generate improvement/change projects and activities back in the visitor's countries, and will be monitoring the outcomes from these activities.

Table 4 Action Plan Milestones: Near-Term Goals

Project No	Project Title	2006	2007	2008
PGT-06-01	Best Practices for Power Generation Activity Plan	Q4: One country visit (3 sites)	Four country visits (3 sites/country)	Q1: One country visit (3 sites) Note: Up to 12 site visits will occur by 2008
PGT-06-02	Best Practices for Transmission and Distribution Activity Plan	Q4 : One country visit (2 sites)	Four country visits (2 sites/country)	Q1: One country visit (2 sites) Note: Up to 12 site visits will occur by 2008
PGT-06-03	Best Practices for Demand Side Management Activity Plan	Q4 : One country visit (2 sites)	Q4: Four country visits (2 sites/country) Workshops will take place starting 2007	Q1: One country visit (2 sites) Note: Up to 12 site visits will occur by 2008
PGT-06-04	Energy Regulatory & Market Development Forum		Q1: First meeting of forum First report due by end of 2007	
PGT-06-05	Trade Exhibitions/Conferences and Trade Missions	Recruit firms from Partner countries to U.S.-based trade shows, overseas trade shows, and trade missions. Facilitate pre-arranged one-on-one appointments. Facilitate business-to-business matchmaking and the scheduling of one-on-one appointments.		
PGT-06-06	Hydroelectric Generation Best Practices	Q4 2006: Host site visit or Q1 2007		
PGT-06-07	Combustion Optimization in Coal Based Power Plants	Q4: Finalization of project itinerary	Q2 & Q4: Visit to plants in the United States & Japan and discussions (5 days each)	Q1: Study report finalization Q2-3: Detailed scheme and specification Q4:Implementation in pilot project thru Q4 2009
PGT-06-08	Implementation of Artificial Intelligent Soot Blowing System for Improving the Steam Generator Efficiency by Increasing the Effectiveness of Soot Blowers.	Q4: Finalization of project itinerary	Q2 & Q4: Visit to plants in the United States & Japan and discussions (5 days each)	Q1: Preparation of study report & technical specifications Q3-4: Implementation in pilot project thru Q4 2009
PGT-06-09	SOx Reduction Technologies in Flue Gas	Q4: Finalization of project itinerary	Q2 & Q4: Visit to plants in the United States & Japan and discussions (5 days each)	Q1: Study report finalization & selection of technology Q2-3: Detailed scheme and specification
PGT-06-10	Risk Evaluation and Prioritization (REAP) for Maintenance and Renovation & Modernization (R&M) of Power Plants	Q4: Finalization of project itinerary	Q2 & Q4: Visit to plants in the United States and discussions (5 days each)	Q1: Preparation of study report & technical specifications Q3-4: Implementation in pilot project & validation thru Q4 2009

Project No	**Project Title**	**2006**	**2007**	**2008**
PGT-06-11	Life Extension & Remaining Life Assessment of Power Plants	Q4: Finalization of project itinerary	Q2 & Q4: Visit to plants in the United States and discussions (5 days each)	Q1: Preparation of study report & technical specifications Q3–4: Implementation in pilot project & validation thru Q4 2009
PGT-06-12	Site Visit of Energy Conservation and Environment Protection Technology—Application of Plasma Ignition Technology in Power Generation	Q4: Site visit in China	Q1–Q4: Site visits in China quarterly	
PGT-06-13	Generator Transformer Programs (Inspection Procedure, Diagnostic Tools and Maintenance)	Q4: Finalization of project itinerary	Q2 & Q4: Visit to plants in the United States and discussions (5 days each)	Q1: Preparation of study report & technical specifications Q2–4: Implementation in pilot project through Q4 2009

Appendix A contains a brief description of each individual project that is listed and considered to be implemented under the Power Generation and Transmission Task Force. Material in Appendix A will document Task Force activities and will be kept current as new activities develop.

The Task Force will be establishing processes/procedures to ensure that site visits, workshops, etc. generate improvement/change projects and activities back in the visitor's countries, and that we will be monitoring the outcomes from these activities.

The Task Force will also endeavor to explore integrating relevant activities that can be incorporated in other activities from the viewpoint of efficient project implementation, for example, to conduct multiple activities during one site visit.

Appendix A: Individual Project Plans

PGT-06-01 Best Practices for Power Generation Activity Plan

Project

This project will consist of several activities: site visits and related follow-up, workshops, and capacity building.

Site Visits: Partnership power generators will host Partner country representatives, including plant engineers, at site visits to highlight good and best practices they employ that the visiting engineers can employ at their power plants to improve operating efficiency, and to share appropriate knowledge and practices to control air pollutants, e.g. SO_2, from power plants. Site visit topics will include combustion optimization methods for coal-fired power plants, SO_2 reduction technologies in power plant flue gas, and intelligent soot blowing system for steam generator efficiency improvement. The goal of the program is to help power generators learn from each other how to improve generating efficiency and how to control and reduce air pollutants, and to implement those practices, technologies, etc. in their own power plants as applicable. Each site visit will include follow-up reports that document the practices and technologies demonstrated, whether or not the practices or technologies that the participants have learned have been implemented at the visiting generator facility; and efficiency improvements resulting from that implementation. Themes to be addressed include operations, maintenance, education and training.

Peer Review Visits: One element of the site visits activity will be a peer review of coal-fired power plants. The peer review activities should be implemented during the site visits and its aim is to learn "best-of-kind" operation, maintenance, and management practices of each Partner countrie's same-generation coal-fired plants, which can be considered as a "best practice" in the power plants' generation. This activity will include frank discussion by participants consequently being summarized into a set of recommendations, the creation of a database of items to be reviewed (e.g., thermal efficiency, date of start of operations, steam conditions and specifications, etc.), creation of a checklist of items that contribute to improved thermal efficiency, sequential peer review visits to coal-fired plants (desirably that have been operated for some years or so as to effectively clarify both strong points and challenges in their operation) in each country, and development of a best practices handbook to collate the outcomes of the peer reviews. Further project opportunities are to be sought and discussed based on the result of the peer review activities.

Workshops: The workshops will start in 2007 addressing the three thematic areas of the Task Force's work: generation, transmission and end-use efficiency in one workshop. The frequency and venue of the workshops should be based on the content to be covered. The goal of the workshops is to serve as a forum for information exchange on improving efficiency across the whole power system and as a platform for identifying new project opportunities, R&D efforts and Task Force initiatives. Some workshops should aim to share interim results of the peer reviews among the Partners. Links with related Task Forces (e.g., Cleaner Fossil Fuels, Buildings and Appliances, etc.) will be considered to produce greater synergies.

Capacity Building: Partner countries, utilizing existing personnel development programs, will accept students for training and send experts to other Partners in an effort to promote efficiency practices consistent with the three thematic areas of the Task Force's work: generation, transmission and end-use efficiency. Partner countries will also explore the possibility of collaboration with existing official and/or private programs that also hold energy efficiency related capacity building programs. (ex. AusAID, ADB, JICA, NEDO, USAID, World Bank, etc.) In addition, Partners will make an effort to use the best practices shared through site visits, peer reviews and workshops to help develop energy conservation technology engineers to accelerate adoption of and improvements in energy conservation technologies and practices.

Participation

Management: The Task Force and participating electric utilities will oversee and manage this activity.

Participation: Participants will primarily be plant engineers and representatives from power generators in the Partner countries, although it may be possible that government and other industry representatives will also attend the site visits case by case. The peer review activity will primarily target personnel responsible for the daily monitoring, operation maintenance, and plant efficiency-management of coal-fired power plants. The capacity building activity will include organizations that implement personnel development programs.

Objectives

The goal of this activity is for Partner power generators to improve their overall coal-fired power plant thermal efficiency, which will result in a significant mitigation of greenhouse gas emissions and air pollutants, by implementing the good and best practices and technologies that are demonstrated at the site visits and contained in the handbook, and by training personnel to further stimulate deployment of those practices and technologies.

Performance indicators should include the number of site visits and workshops held, implementation by visiting generators of good and best practices shared (via follow-up reports), development of a best practices handbook and improvements in national generating thermal efficiency.

Milestones

It is anticipated that up to 18 site visits (= 2-3 sites * 6 countries) will occur by 2008, which will consist of visits to more than one facility/generator per trip. Site visits may also include workshops and training programs. Each site visit will include the follow-up reports noted above. For one Partner country, up to 2–3 site visits are expected and at least one of them will contain a peer review program. The peer review program will generally be carried out in coal power plants. It is envisioned that one country visit (maximum 3 sites) will take place during Q4 of 2006, four country visits (max. 3 sites/country) will take place during 2007, and one country visit (max. 3 sites) will take place during Q1 of 2008. Interim results will be appropriately summarized after each peer review activity and the handbook will be produced during the remainder of 2008.

The workshops and capacity building activities will take place starting in 2007.

Location

Sites to be visited include:

- American Electric Power, Tampa Electric and Southern Company facilities in the United States. (October/November 2006) — Best practices in power generation, IGCC, etc.

- Duke Energy facilities in the United States (time TBD) — Hydro/pumped storage

- Wisconsin Electric/We Energies facilities in the United States. (time TBD) — Coal combustion byproduct use

- Other facilities in the United States (time TBD) — Additional site visits to U.S. facilities will be organized during 2006, possibly on a thematic basis (e.g., combustion optimization method in coal-fired power plants, SO_2 reduction technologies in power plant flue gas, intelligent soot blowing system for steam generator efficiency improvement, coal combustion product use, IGCC, etc.).

- Facilities in Japan (Q1 of 2007) for peer review and site visit activity for best O&M Practices including combustion optimization method in coal-fired power plants, SO_2 reduction technologies in power plant flue gas, intelligent soot blowing system for steam generator efficiency improvement. Coal fired power plants, which are old, but well maintained and managed in its thermal efficiency, are to be selected including a site visit for a latest technology power plant.

- Facilities in Korea (2007) — Site visits to Korean facilities will be organized during 2006, possibly on a thematic basis (e.g., ultra-supercritical plants, voluntary energy savings, etc.).

- Facilities in India.

- Facilities in China.

- Workshops will be held in each Partner country (sites and timing TBD).

Resources

In-kind financial resources will be used for site visits (visitors will pay travel expenses and accommodation fees, hosts will cover on-site costs).

PGT-06-02 Best Practices for Transmission and Distribution Activity Plan

Project

This project will consist of site visits, related follow-up and workshops.

Site visits: Power generators will host Partner country representatives, including plant engineers, at site visits to highlight good and best practices they employ that the visiting engineers can employ at their power plants to improve transmission and distribution efficiency. The goal of the program is to help power generators learn how to improve T&D efficiency and to implement those practices, technologies, etc. in their own systems. Each site visit will include follow-up reports that document: the practices and technologies demonstrated, whether or not the practices or technologies have been implemented, and efficiency improvements resulting from that implementation. Themes to be addressed include system maintenance and upgrades.

Peer Review Visits: As part of the peer review of coal-fired power plants activity, study tours of T&D facilities will be included in each country site visit. The T&D best practices shared during the site visits will be included in the best practices handbook that will be created as part of the best practices in power generation activity.

Workshops: Workshops will be held in each Partner starting in 2007 that will address the three general areas of the Task Force's work: generation, transmission and end-use efficiency. The goal of the workshops is to serve as a forum for information exchange on improving efficiency across the whole power system. Links with related Task Forces (e.g., Cleaner Fossil Fuels, Buildings and Appliances, etc.) will be considered to produce greater synergies.

Participation

Management: The Task Force and participating electric utilities will oversee and manage this activity.

Participation: Participants will primarily be plant engineers and representatives from power generators in the Partner countries, although it is possible that government and other industry representatives will also attend the site visits.

Objectives

The overall goal of this activity is for power generators to improve their overall T&D efficiency—which will result in a significant mitigation of greenhouse gas emissions and air pollutants—by implementing the practices and technologies that are demonstrated at the site visits and workshops, and contained in the handbook. Electrification of non-urban areas can promote development, reduce poverty and provide environmental benefits. Improvements in distribution systems can minimize line loses (possibly to less than 10%), increase the amount of electricity delivered, and create a better investment climate in rural areas. One specific goal is the development and implementation of a standardized village distribution system as part of a demonstration project.

Performance indicators should include the number of site visits and workshops held, implementation by visiting generators of good and best practices shared (via follow-up reports), development of a best practices handbook and improvements in national T&D efficiency.

Milestones

List of key intermediate outputs or deliverables, and their target date: It is anticipated that up to 12 site visits will occur by 2008, which may consist of visits to more than one facility/generator per trip. Site visits may also include workshops and training programs. Each site visit will include the follow-up reports noted above.

Under the peer review program, it is envisioned that one country visit (2 sites) will take place during Q4 of 2006, four country visits (2 sites/country) will take place during 2007, and one country visit (2 sites) will take place during Q1 of 2008. The handbook will be produced during the remainder of 2008.

Workshops will take place starting in 2007.

Location

Site visits and workshops may be held in each country (sites and timing TBD).

Resources

In-kind financial resources will be used for site visits (visitors will pay travel expenses, hosts will cover on-site costs). Multilateral financing may be necessary to fund equipment/technology upgrades.

PGT-06-03 Best Practices for Demand Side Management Activity Plan

Project

This project will consist of site visits and related follow-up, workshops, and a specific activity in India.

Site Visits: Partner power generators will host other Partner representatives, including plant engineers, at site visits to highlight good and best practices that can be employed to improve end-use efficiency. The goal of the program is to help power generators learn from each other how to improve end-use efficiency and to implement those practices, technologies, etc. in their own country. Each site visit will include follow-up reports that document: the practices and technologies demonstrated, whether or not the practices or technologies have been implemented, and efficiency improvements resulting from that implementation. Themes to be addressed include appliance duty cycling and curtailable service for commercial and industrial consumers, real time pricing, and distributed generation.

India Project: This project will expand demand side management (DSM) programs that are being initiated in two states in India, Maharashtra and Karnataka, where regulatory commissions and utility companies are beginning implementation of lighting programs. The project will expand these activities to other end-use technologies, and to other states in the country and more broadly to other Partners.

Peer Review Visits: Study tours of DSM related facilities will be included as part of the peer review of coal-fired power plants activity. The DSM best practices shared during the site visits will be included in the best practices handbook that will be created as part of the best practices in power generation activity.

Workshops: Workshops will be held in each Partner country starting in 2007 that will address the three general areas of the Task Force's work: generation, transmission and end-use efficiency. The goal of the workshops is to serve as a forum for information exchange on improving efficiency across the whole power system. Links with related Task Forces (e.g., Cleaner Fossil Fuels, Buildings and Appliances, etc.) will be considered to produce greater synergies.

Participation

Management: The Task Force and participating electric utilities will oversee and manage this activity.

Participation: Utility companies, regulatory commissions, technology suppliers, and other relevant entities.

Objectives

Electrification of non-urban areas can promote development, reduce poverty and provide environmental benefits. The overall goal of this activity is to raise awareness in utilities of the potential contributions of DSM in managing available capacity, reducing the need for additional capacity, and controlling energy costs. The focus is to institutionalize DSM in energy planning and operations through sharing the experiences of utilities in the valuation and administration of various DSM programs and build management capacity to administer or contract for such programs. Specific goals include:

- Development and implementation of a standardized village distribution system as part of a demonstration project.

- Obtaining commitment from legislature, utility commission, or other body for a DSM program (in consultation with stakeholders, utility companies, regulatory commissions, consumer representatives, and environmental organizations).

- Inventory of current DSM technologies, practices and potential applications. Potential areas for focus include energy audits for large industrial and commercial consumers with consideration of buy-back and demand bidding programs; and residential, light commercial, and agricultural (e.g., irrigation pumping) applications for utility-dispatched load management and curtailable service programs.

- Assess the barriers, costs, and benefits of DSM programs in representative circumstances such as large and small utilities, urban vs. rural, various consumer profiles, etc.

- Develop the institutional capacity of the utilities to administer DSM programs through educational exchanges and establishment of model DSM programs at utilities in states/provinces.

- Introduce load management suppliers and outsourcers to utilities.

- Develop capacity for monitoring and evaluation of program benefits.

- Set up resource centers at utility companies to provide technical and other advice on the implementation of DSM programs.

Performance indicators should include the number of site visits and workshops held, implementation of good and best practices shared (via follow-up reports), and development of a best practices handbook. The India project will be measured, monitored, and evaluated on the basis of number of technologies distributed, customers served, energy and power savings, and program and technology costs.

Milestones

It is anticipated that up to 12 site visits will occur by 2008, which may consist of visits to more than one facility/generator per trip. Site visits may also include workshops and training programs. Each site visit will include the follow-up reports noted above. Under the peer review program, it is envisioned that one country visit (2 sites) will take place during Q4 of 2006, four country visits (2 sites/country) will take place during 2007, and one country visit (2 sites) will take place during Q1 of 2008. The handbook will be produced during the remainder of 2008.

Workshops will take place starting in 2007.

The India project activity will produce:

- A DSM design plan for the two states (4-6 months).

- Implementation of the least expensive, and easiest to implement end-use technology(ies) (6-9 months).

- Outreach and technical assistance to other states and Asia Pacific Partnership country participants (6 months +).
- Monitoring and evaluation plan to be used during program implementation (4-12 months).
- Setting up a DSM resource center at a utility company to provide appropriate resources for program design and implementation in consultation with other Partners (4 months).

Location

Site visits and workshops will be held in each Partner country (sites and timing TBD). The India project will involve one or more states in India.

Resources

In-kind financial resources will be used for site visits (visitors will pay travel expenses, hosts will cover on-site costs). Multilateral financing may be necessary to fund equipment/technology upgrades.

PGT-06-04 Energy Regulatory and Market Development Forum

Project

Efficient investment, operation and use of power generation and transmission systems is fundamentally affected by regulatory and market arrangements. Market and regulatory frameworks that create and support incentives for efficient and innovative behavior have the potential to substantially improve efficient investment, operation and use of power systems, leading to more reliable, affordable and environmentally sustainable outcomes.

This project proposes the establishment of an energy regulatory and market development forum to provide an ongoing mechanism for information sharing, capacity building and cooperative development of the regulatory arrangements conducive to efficient energy market development.

Participation

Participation would be open to all Partnership countries. It is envisaged that participants would include energy policy makers, economic and technical regulators, system operators, market operators, institutions responsible for market development, and other stakeholders by agreement.

Objectives

The forum's initial objective would be to establish a shared understanding of the regulatory framework and market arrangements governing the operation of power generation and transmission in participating Partnership countries, with a view to developing a work program to support effective sharing of information and experience, and to facilitate capacity building. Longer-term objectives will be developed by forum members. It is envisaged that these may include ongoing engagement to facilitate continued information sharing and capacity building, and cooperation to support implementation of best practice regulatory principles and practices.

Milestones

First meeting of forum during first quarter 2007—focus on identifying potential areas for cooperation and information exchange and the development of a work program.

Subsequent meetings, and specific goals, to be determined by the forum.

Annual report through Power Generation & Transmission Task Force to the Policy and Implementation Committee. First report due by end 2007.

Location

Various—meeting location could rotate among participating Partner countries.

Resources

As agreed by forum members. Australia is willing to host the first meeting, and to provide the forum secretariat.

PGT-06-05 Trade Exhibitions/Conferences and Trade Missions

Project

Promote trade in power generation and transmission sector among the six Partner countries. The U.S. Department of Commerce (DOC) Partnership team, consisting of trade specialists throughout the United States and in each of the Partner countries, will utilize its worldwide network to attract companies to participate in DOC-led trade shows, trade missions, business-to-business matchmaking, and client counseling programs that will facilitate trade in the power generation and transmission sector among the six Partner countries. Specific events where the DOC Partnership team will lead delegations and provide business-to-business matchmaking, and client counseling programs include:

- Trade Mission to China and India, February 2007.
- Electric Power, May 2007, Atlanta, GA.
- Coal-Gen, August 2007, Las Vegas, NV.
- China Power, September 2007, Hong Kong.

Participation

Manager
U.S. Department of Commerce
East Asia/Pacific Region
1401 Constitution Ave, NW, Room 3122
Washington, DC 20230

Partners

- Trade agencies of the five other Partner countries.
- American Chambers of Commerce in each Partner country.
- Trade event organizers for events in this sector.
- Multipliers such as state trade development organizations, industry associations, and District Export Councils.

Objectives

Make technology available to foster clean energy and development in power generation and transmission sector.

Increase the level of trade within the power generation and transmission sector among the six Partner countries.

Assist companies from each country find buyers, sellers, and partners in the power generation and transmission sector.

Milestones

Recruit firms from Partner countries to U.S.-based trade shows, overseas trade shows, and trade missions to the United States focused on the power generation and transmission sector.

Facilitate pre-arranged one-on-one appointments for U.S. and foreign companies and U.S. government industry specialists.

Facilitate business-to-business matchmaking and the scheduling of one-on-one appointments for U.S. company representatives with their foreign counterparts.

Location
This will take place at trade events in the United States and other Partner countries.

Resources
The Department of Commerce will seek approximately $200,000 of funding to make these programs possible. The funds will be used for:

- Expenses for three domestic and five overseas experts from each U.S. Embassy in Partner countries to travel to each trade event. These specialists will be involved with the recruitment, preparation, and execution of the event.

- Booth space.

- Counseling program expenses.

- Matchmaking materials.

- Spin-off visits for foreign visitors.

- Recruitment, planning, logistical support, and execution of a trade mission to China and India.

PGT-06-06 Hydroelectric Generation Best Practices

Project

Lead U.S. utilities (Duke Energy Corporation and other potential partners) will develop a technical information program on hydroelectric generation efficiency improvement practices that can be shared with and replicated by participating utilities. In the near term the lead utility will share with Partner countries its experiences concerning maintaining and improving the operation of hydroelectric facilities. In the long term, relationships that are established by these initial interfaces will facilitate further information exchange regarding engineering concepts/technologies, hydroelectric upgrade approaches, outage planning techniques and grid interfaces to avoid CO_2 emissions.

Participation

Management: This project is proposed by utilities of the United States (Duke Energy Corporation and other potential partners).

Participants: Participants from the Partner countries will participate in an information sharing session concerning processes for improving hydro efficiency and capacity and will conduct an associated site visit to proposed and other facilities.

Objectives

Duke Energy will invite Partner countries to participate in an information sharing session concerning processes for improving hydro efficiency and capacity and will conduct an associated site visit at Jocassee Hydroelectric Pump Storage Facility (4 unit, 610 MW), which is in the process of being upgraded. Also, Duke Energy will provide background discuss actions a utility can undertake to improve hydro efficiency and capacity for conventional hydroelectric facilities. The following is a list of topics to be covered:

- Turbine runner replacement.
- Wicket gate, operating mechanism, and bearing refurbishments.
- Generator stator rewinds.
- Generator rotor rewinds.
- Monitoring and control upgrades including electronic governor.
- Breaker and switch gear replacements.
- Lube oil and auxiliary system replacements.
- Generator air filtration and powerhouse ventilation systems.
- Head gate, trash rack, and drain valve refurbishments.

Duke Energy will also discuss items such as outage planning, equipment procurement and delivery processes and project execution. Pumped storage interface with the grid will be a topic of discussion.

Milestones

Host Site Visit 4th Quarter 2006 or 1st half 2007 (approximately 3–4 day visit):

- Day 1 — Meet at Duke Energy Headquarters in Charlotte, North Carolina in AM:
  - meet hydroelectric engineering staff and discuss process of evaluation of upgrades.
  - overview of HydroVision program and replacement / refurbishment activities undertaken.
- Day 2 — Travel to Jocassee Pumped Storage Station in AM:
  - meet staff and host engineer.
  - safety training and equipment briefing.
  - overview of plant and surrounding operations.
  - discuss of outage planning, equipment procurement activities and overall project execution.
  - review of project implementation utilizing a site tour.
- Day 3 — Travel back to Charlotte, North Carolina:
  - debrief on visit
  - discuss hydroelectric interfaces with grid operation .
  - discuss follow-up actions/information sharing opportunities.
- Day 4 — Potential visit to conventional hydro facilities in the Charlotte vicinity.

Note: Other facility site visits will be considered and incorporated into the milestones.

Location

This will take place at a site visit at Jocassee Hydroelectric Pump Storage Facility and other facilities will be considered for participation.

Resources

In-kind financial resources will be used for site visits (visitors will pay travel expenses and accommodation fees, hosts will cover on-site costs).

PGT-06-07 Combustion Optimization in Coal-Based Power Plants

Project

Combustion optimization in coal-fired steam generators is one of the most important processes which helps steam generators to operate at maximum efficiency. Un-optimized combustion affects many performance parameters such as increased unburned carbon in the fly ash, distorted oxygen profile at steam generator outlet, uneven steam temperature profiles, etc. Japanese and U.S. systems will be studied to determine potential applicability to Indian coals.

Participation

Management: This project is proposed by India in association with utilities of the United States and Japan.

Participants: Participants from India will be design and operating engineers from utilities and the Central Electricity Authority.

Objectives

Identifying the necessary upgrades required in the combustion process to have a system, with state-of-the-art measurement techniques for air and fuel, and supported by intelligent software, which can process these parameters online for determining the steam generator control settings needed for optimizing the cycle heat rate.

Performance Indicators:

- Fuel savings.
- Optimum zone operation.

Milestones

Visit to utilities in the United States and Japan to study:

- Development of software for optimized operation, using data collected through sensors.
- Selection of appropriate instrumentation for sensing & collection of real time data of air and fuel.
- Selection of appropriate hardware.
- A study report to be made with detailed actions, as applicable to Indian coal.

The major milestones are presented below:

Year	**2006**				**2007**				**2008**				**2009**			
Activities	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Finalization of Project Itinerary				■												
Visit to Plants in the United States & Japan and Discussions (5 days each)						■		■								
Study Report Finalization									■							
Detailed Scheme and Specification										■	■					
Implementation in Pilot Project												■	■	■	■	■

Location

Activity Location: Power plant utilities in the United States and Japan, where combustion optimization packages have been used and benefited from.

Project Location: One pilot plant of an Indian utility will be selected for implementation of combustion optimization. Based on feedback of this pilot plant, other utilities may adopt similar methods.

Resources

For the on-site study visits and discussions, the visitors will bear the travel expenses and hosts will cover the on-site costs.

The cost required for this activity is to be borne by the beneficiary utility.

PGT-06-08 Implementation of Artificial Intelligent Soot Blowing System for Improving the Steam Generator Efficiency by Increasing the Effectiveness of Soot Blowers

Project

The existing conventional soot blowing system in a coal fired steam generator based on time and operator experience causes (1) lack of cleaning in one area but over cleaning in another area and (2) excessive use of steam, air and water. The objective of the project is to implement best practices/new technologies that offer "Efficient Heat Transfer" for steam generators.

Participation

Management: This project is proposed by India in association with utilities of Japan and the United States.

Participants: Participants from India will be power plant operation engineers and designers from utilities**.**

Objectives

The goal of this project is study of direct and indirect method and selection of appropriate software tool to implement artificial intelligence soot blowing system for optimizing the heat transfer rate and addressing local slagging conditions.

Performance Indicators:

- Local slagging conditions of steam generator are addressed.
- Reduction in tube leakages.
- Improvement in steam generator efficiency and availability.

Milestones

Visit to utilities in Japan and USA to study:

- System of measurement of heat flux of water walls.
- Thermodynamic model which analyses the temperature of steam generator sections.
- A study report will be made.

The major milestones are as below:

Year	**2006**				**2007**				**2008**				**2009**			
Activities	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Finalization of Project Itinerary				■												
Visit to Plants in the United States & Japan and Discussions (5 days each)						■		■								
Preparation of Study Report & Technical Specifications									■							
Implementation in Pilot Project											■	■	■	■	■	■

Location

Activity Location: The activity will include visits to power plants in the United States and Japan.

Project Location: Based on the study, artificial intelligence soot blowing optimization technology will be implemented in one of the Indian power plants as a pilot project. The information learned from this project will be put together in a handbook for use in the power sector.

Resources

For the on-site study visits and discussions, the visitors will bear the travel expenses and hosts will cover the on-site costs.

The equipment and technology upgrades cost will be borne by the beneficiary participant utility implementing the project.

PGT-06-09 SOx Reduction Technologies in Flue Gas

Project

SO_x emissions from combustion gases can be reduced by cleaning the flue gas before exiting the stack using various flue gas desulphurization technologies. The goal of the project is to study the suitability of these technologies for implementation in India, where high sulfur coal is used.

Participation

Management: This project is proposed by India in association with utilities of the United States and Japan.

Participants: Participants will be design engineers from Indian utilities.

Objectives

The objective of the project is to select the most appropriate technology for control of SO_x emission as suited to high sulfur Indian coals. Further, the project will make it possible to use high sulfur coal available in India for power plants by selection and implementation of appropriate technology for SO_x reduction.

Performance Indicators:

- Suitability of technology and SO_x removal efficiency.
- Capital and operational cost.

Milestones

Visit to utilities in the United States and Japan to study:

- Maturity and market proven status of technology.
- Removal efficiency of SO_2, use of by-products.
- Operational experience.
- Economic factors.
- A study report of the technology to be adopted using materials available in India and suitable for Indian coal.

The major milestones are presented below:

Year	**2006**				**2007**				**2008**			
Activities	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Finalization of Project Itinerary				■								
Visit to Plants in the United States & Japan and Discussions (5 days each)						■		■				
Study Report Finalization & Selection of Technology									■			
Detailed Scheme and Specification										■	■	

Location

Activity Location: The activity will include visits to identified utilities in the United States and Japan, etc., where SO_x reduction technologies have been implemented.

Project Location: Based on the study, technical specifications will be made for SO_x reduction technology to be implemented in one of the Indian power plants where high sulfur coal is required to be used.

Resources

For the on-site study visits and discussions, the visitors will bear the travel expenses and hosts will cover the on-site costs.

The technology cost will be borne by the beneficiary participant utility implementing the project.

PGT-06-10 Risk Evaluation and Prioritization (REAP) for Maintenance and Renovation and Modernization (R&M) of Power Plants

Project

In any power plant, various pieces of equipment work together to generate power. Failure of a single link can lead to a loss in generation. The frequency of these failures varies, and depends on equipment, location, operational parameters, constructional features, etc. The cost of the equipment or part thereof also varies. Hence, it will be our endeavor to prioritize the replacement of the equipment based on cost, down time cost, frequency of occurrence of such failures, etc., to improve plant availability, reduce forced outages, and facilitate implementation of renovation and modernization of power plants.

Participation

Management: This project is proposed by India in association with utilities of the United States, and the Department of Industries, Tourism and Resources of Australia.

Participants: Participants from India will be design engineers and specialists from the utilities.

Objectives

To study the best practices of REAP in such utilities and acquire the know how of implementation of REAP with a view to implementing the same in power utilities in India.

Performance Indicators:

- Improvement in availability.
- Reduction in maintenance cost.
- Increase in maintenance interval for a particular plant.

Milestones

Visit to Utilities in the United States and Australia to study:

- Diagnostic tools for evaluating, classifying and prioritizing the risks.
- Best practices in maintenance.
- Cost benefits due to implementation of REAP.

The major milestones are as below:

Year	2006				2007				2008				2009			
Activities	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**
Finalization of Project Itinerary																
Visit to Plants in the United States & Australia and Discussions (5 days each)																
Preparation of Study Report & Technical Specifications																
Implementation in Pilot Project & Validation																

Location

Activity Location: The activity will include visits to power plants in the United States and Australia and discussions with experts.

Project Location: Based on the study, REAP will be implemented in one of the Indian power plants as a pilot project. The information learned from this project will be put together in a handbook for use in the power sector.

Resources

For the on-site study visits and discussions, the visitors will bear the travel expenses and hosts will cover the on-site costs.

The implementation cost including equipment and technology upgrades if any, will be borne by the beneficiary participant utility implementing the project.

PGT-06-11 Life Extension and Remaining Life Assessment of Power Plants

Project

Life extension for aging power plant steam/gas driven turbines usually includes reconstructive measures intended not only to prolong their service time and raise their reliability but also to improve their efficiency.

Participation

Management: This project is proposed by India in association with utilities of the United States and the Department of Industries, Tourism and Resources of Australia.

Participants: Participants from India will be design engineers and specialists from the utilities and the Central Electricity Authority.

Objectives

To study the best practices of life extension (LE) and remaining life assessment (RLA) of power plants and acquire the know-how of implementation of LE & RLA technology with a view to implementing the same in power utilities in India.

Performance Indicators:

- Recapture of lost capacity at minimum cost.
- Operate the plant near to its design efficiency.

Milestones

Visit to utilities in Australia and the United States to study:

- Equipment life optimization program.
- Re-powering engineering techniques.
- RLA studies.

The major milestones are as below:

Year	**2006**				**2007**				**2008**				**2009**			
Activities	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**
Finalization of Project Itinerary				■												
Visit to Plants in the United States & Australia and Discussions (5 days each)						■		■								
Preparation of Study Report & Technical Specifications									■	■						
Implementation in Pilot Project & Validation											■	■	■	■	■	■

Location

Activity Location: The activity will include visits to power plants in the United States and Australia and discussions with experts.

Project Location: The information learned from this project will be put together in a handbook for use in the power sector. A pilot project (to be identified), will be taken up for implementation.

Resources

For the on-site study visits and discussions, the visitors will bear the travel expenses and hosts will cover the on-site costs.

The equipment and technology upgrades cost will be borne by the beneficiary participant utility implementing the project.

PGT-06-12 Site visit of Energy Conservation and Environment Protection Technology—Application of Plasma Ignition Technology in Power Generation

Project

China Guodian will host a series of site visits regarding the plasma ignition technology to highlight reliable energy conservation and environment protection technology and its application in China. The goal of the project is to help power generators learn the benefit of the plasma technology.

Plasma Ignition and Combustion Stabilization System: Directly igniting pulverized coal, the system can replace fuel oil and ensure ignition and stable combustion for pulverized-coal boilers. This system has found successful application in 270 of pulverized-coal boilers, with coals covering lean coal, bituminous coal and lignite; unit capacity of 50MW–1000MW, both tangential-fired and wall-fired types; milling systems including indirect-fired and direct-fired types; mills including spheroidal roller mill, ring-roller mill, ball race mill with double inlets and outlets, roller pulverizer, and fan mill, etc.

Participation

Participants will primarily be plant engineers and representatives from power generators and some government representatives may also attend the site visits.

Objectives

The goal of this activity is for power generators to learn the technologies that are demonstrated at the site visits on oil free ignition and stable operation that will result in energy saving.

Performance Indicators:

- Economy, the operation cost for the plasma system (oil free) is only 10–20% of the conventional ignition system (ignition with oil). For a newly built boiler 5,000 tons of oil can be saved during test run.
- Safety: avoid the possible fire and accidents caused by the ignition of oil.
- Environment protection: avoid the smoke from the stack because ESP cannot be used during the oil ignition.

Milestones

It is anticipated that up to five site visits will occur during 2006 and 2008. The first visit is anticipated to be near the end of this year depending on the interests of the other Partner countries. Site visits may include more than one site and also include technical presentations and discussions. Each trip will include follow-up reports.

Location

The company and the workshop are in Beijing and Yantai, Shandong province respectively, and the reference plants are in China.

Resources

Visitors will pay air flight and hotel costs, hosts will cover on-site costs. Multilateral financing may be necessary to fund equipment/technology upgrades.

PGT-06-13 Generator Transformer Programs (Inspection Procedures, Diagnostic Tools and Maintenance

Project

The reliability and availability of generator transformers needs to be improved by studying and adopting methods and techniques in manufacturing, on-line condition monitoring, and failure diagnostic tools.

Participation

Management: This project is proposed by India in association with utilities in the United States.

Participants: Participants from India will be design and quality engineers from utilities, transformer manufacturers and the Central Electricity Authority.

Objectives

To improve the reliability of generator transformers by necessary improvements in design, manufacturing techniques, selection of materials, and use of state-of-the-art on-line condition monitoring and maintenance and failure diagnostic tools.

Performance Indicators:

- Specification improvements.
- Quality improvements in manufacturing.
- Detection of fault inside the transformer at an early stage.

Milestones

Visit to utilities and transformer manufacturing shops in the United States to study:

- Manufacturing techniques.
- Condition monitoring systems and practices.
- Maintenance and failure diagnostic tools.
- Visit will also include meetings with experts.
- A study report to be made with detailed actions.

The major milestones are as below:

Year	2006				2007				2008				2009			
Activities	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 1**	**Q 2**	**Q 3**	**Q 4**
Finalization of Project Itinerary				■												
Visit to Plants in the United States and Discussions (5 days each)						■		■								
Preparation of Study Report & Technical Specifications									■							
Implementation in Pilot Project										■	■	■	■	■	■	■

Location

Activity Location: Utilities/power stations and manufacturing/workshop facilities in the United States and India.

Project Location: Utilities in India in association with transformer manufacturers.

Resources

For the on-site study visits and discussions, the visitors will bear the travel expenses and hosts will cover the on-site costs.

The cost required for equipment and technology upgrades will be borne by the beneficiary utilities and manufacturers implementing the project.

Appendix B: Electricity Generation, Transmission, and Distribution Data

Australia

Supply and Demand Overview

The Australian electricity sector has an installed generating capacity of more than 48,800 MW, serving an annual consumption of 240 terawatt-hours (TWh) and a peak demand of 35,350 MW. Coal and natural gas are the dominant primary fuel inputs, supplying around 90% of the total generation. The electricity industry's consumption by sector is dominated by industry, which used almost half (45%) of electricity consumed in 2003-04, followed by residential (27%), commercial (26%), agriculture (0.8%) and transport (1%). The overall increase in national electricity consumption from 2002-03 to 2003-04 was approximately 4.4%.

Consumption growth is expected to continue, with a growth rate of 1.2% for 2004-05, and a 2.2% annual growth increase from through 2019-20. The major factors contributing to the growth in electricity demand are population growth and growth in domestic production. Forecasts suggest that electricity demand in Australia will increase to 334 TWh in 2019-20. Projected electricity demand implies the need for an additional 8,410 MW of generation capacity by 2019-20.

Grid Systems

The Australian electric transmission grid system includes more than 27,000 kilometers (km) of high-voltage electric transmission lines. Transmission assets are predominantly greater than 30 years old, and line losses are estimated at 10%. Distribution line losses are only 5.7%. Australia has a number of different electricity grids. The Australian National Electricity Market (NEM) contains 92% of Australia's electricity infrastructure. The NEM currently consists of the (interconnected) electricity grids of the eastern Australian States of New South Wales, Victoria, and Queensland, the central Australian State of South Australia, and the island State of Tasmania. The electricity grids of Australia's Northern Territory and the State of Western Australia are not connected to the NEM.

Ownership

Electricity generation in the Australian National Electricity Market includes both public and private ownership. Public ownership dominates, with nearly 31,000 MW (approximately 67%) of total generating capacity owned by government. Private owners control nearly 15,000 MW (approximately 33%) of total generating capacity. Victoria is the only State to have fully privatized its generation assets. South Australia has effectively privatized its generating assets though 199 year leases to the private sector. All other states have retained government ownership.

The five largest generation companies supply around 52% of the market, with the market shares of the largest three companies in each region (a standard measure of ownership concentration) ranging from between 60% and 100% of regional generation capacity.

Regulations

The National Electricity Market (NEM) is structured around a gross pool, or spot market, for trading wholesale electricity. A specially constituted company, the National Electricity

Market Management Company Limited, manages the system's control functions and is responsible for the day-to-day operation and administration of both the power system and the wholesale spot electricity market. System control functions for Western Australia and the Northern Territory are performed by government organizations.

All electricity produced in NEM states by generators with a capacity greater than 30 MW must be traded through the NEM pool. The Australian Energy Regulator provides economic regulation of the wholesale electricity market and electricity transmission networks in the NEM. The Australian Energy Market Commission is responsible for market development and management of the market rules.

Emissions

Due to Australia's continuing strong economic and population growth, Australia's electricity demand continues to grow. However, while the economy is projected to approximately double over 20 years from 1990, overall emissions growth is projected to rise by only 8%. Energy emissions per dollar of GDP are similarly projected to fall by 25% between 1990 and 2010. The Australian Government has committed more than A$2 billion to tackling climate change, including through programs targeted at reducing emissions from electricity generation. These programs include a A$500 million Low Emissions Technology Demonstration Fund, more than A$700 million to support renewable energy, a Mandatory Renewable Energy Target and voluntary industry partnership programs such as Greenhouse Challenge Plus and the Generator Efficiency Standards.

Table B-1 Australia: Summary Data 2005

Parameter	Total Installed Capacity by Fuel Type – Number of Plants or units	Total Installed Capacity by Fuel Type – MW	Total Generation by Fuel Type – MWh
Coal	107	32,038	182,251,800
Black coal	72	24,466	130,330,000
Brown coal/lignite	35	7,572	51,921,800
Oil	19	359	3,095,000
Natural gas	148	8,434	35,628,600
Nuclear			
Renewables	139	8,005	19,130,000
Hydroelectric	122	7,609	16,105,800
Other	17	396	3,024,200
Total SO_2 Emissions (tonne/year) *	636,000		
Total NOx Emissions (tonne/year) *	510,000		
Total CO_2 Emissions (tonne/year) *	203,501,000		
Total Particulate Emissions (tonne/year) *	45,000		
Per Capita Energy Consumption (kJ/person) **	260,100,000		
Per Capita Electricity Generation (annual kWh/person) *	11,830		
Energy Intensity (kJ/$GDP) **	6780		

*Calculated using 2004-05 generation data

** Calculated using 2003-04 energy data

Table B-2 Australia: Electricity Generation, Transmission, and Distribution Data 2005

Parameter	Transmission AC	Transmission DC	Distribution
Voltage Levels (kV)	500 kV	500 kV (Basslink Interconnector)	44 kV
	330 kV	330 kV (Directlink Interconnector)	33 kV
	275 kV		22 kV
	220 kV	220 kV (Basslink and Murraylink Interconnector	11kV & below
	132 kV	132 kV (Murraylink & Directlink Interconnector)	Single Wire Earth Return (SWER)
	110 kV		Low voltage (640 volts & below)
	88 kV		
	66 kV		
Total Distance Covered (km, for each voltage level)	500kV – 2,409 km	Includes 290-km Basslink Interconnector	44 kV – 37 km
	330kV – 6,578 km	Includes 65-km Directlink Interconnector	33 kV – 41,075 km
	275kV – 10,026 km		22 kV – 200,670 km
	220kV – 8,058 km	Includes 180-km Murraylink Interconnector	11 kV & below – 168,563 km
	132kV – 25,462 km		Single Wire Earth Return (SWER) – 154,211 km
	110kV – 3,542 km		Low Voltage (640 volts & below) – 226,199 km
	88kV - 73km		
	66kV – 27,631km		
Average Age (years, for each voltage level)	The average age of transmission assets in Australia is 30 years. Distribution assets are upgraded or installed on a regular basis.		
Average Line Losses (as percent of generation, for each voltage level)	Average line loss estimated by National Energy Market Managing Company at approximately 10%		5.70%
Total Generation (TWh)	240 TWh		
Auxiliary Consumption (TWh)[1]	20 TWh		
Net Generation (TWh)	220 TWh		
Imports (TWh)	No international energy trading currently exists in Australia.		
Exports (TWh)			

[1]Auxiliary consumption refers to parasitic consumption at power plants.

Table B-3 Australia: Generating Capacity Data 2005

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	Brown or Lignite	Simple Cycle	Combined Cycle			Hydro	Other
Number of Units	72	35	122	26	19	N/A	122	17
5-50 MW	10	4	87	20	18	N/A	68	0
50-100 MW	5	6	17	1	1	N/A	35	0
100-300 MW	17	15	17	4	0	N/A	19	0
300-500 MW	20	10	0	1	0	N/A	0	0
Greater than 500 MW	20	0	1	0	0	N/A	0	0
Total Capacity (MW)	24,466	7572	6358	2076	359	N/A	7609	396
5-50 MW	258	67	2453	694	309	N/A	1387	396
50-100 MW	306	405	993	53	50	N/A	2715	0
100-300 MW	3650	2620	2402	944	0	N/A	3507	0
300-500 MW	7252	4480	0	385	0	N/A	0	0
Greater than 500 MW	13,000	0	510	0	0	N/A	0	0
Capacity by Unit Age (MW)	24,466	7572	6358	2076	359	N/A	7609	396
Less than ten Years	2897	0	2219	1849	90	N/A	63	270
10-20 years	3120	1000	768	227	20	N/A	488	0
20-30 years	13,644	2760	2269	0	56	N/A	1632	0
Greater than 30 Years	4805	3812	1102	0	193	N/A	5426	126
Average Capacity/Unit Load Factor (%) *	60	78	48	45	98	N/A	18	86
Best-In-Country Capacity/Unit Load Factor (%) *	90	93	82	73	100	N/A	50	unavailable
Average Availability (%)**	Between 81.2% and 90.1% nationally. 89.2%/89.5% in NSW/Queensland & 89.3% in Victoria (1)					N/A	as per non-nuclear entry	
Best-In-Country Availability (%)	unavailable	unavailable	unavailable	unavailable	unavailable	N/A	unavailable	unavailable
Average Heat Rate (kJ/kWh)	10,100	13,600	11,200	8100	12,000 (2)	N/A	N/A	N/A
Best-In-Country Heat Rate (kJ/kWh)	9100	11,400	8000	7200	12,000 (2)	N/A	N/A	N/A
Average Emissions Levels (Where Applicable)								
SO_2 (ng/J)*	372	227	1.3	0.2	128	N/A	N/A	unavailable

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	**Brown or Lignite**	**Simple Cycle**	**Combined Cycle**			**Hydro**	**Other**
NOx (ng/J)*	286	178	201	33	1.5	N/A	N/A	unavailable
PM (ng/J)*	14	14	5.7	3.1	unavailable	N/A	N/A	unavailable
CO_2 (kg/MWh)*	914	1284	576	314	Nil	N/A	N/A	unavailable

*Calculated using 2004-05 generation data
** Calculated using 2003-04 generation data
(1) Generation in NSW and Queensland provides a good proxy for average availability of black coal-fired plants, while generation in Victoria provides a good proxy for average availability of brown coal-fired plants.
(2) Based on limited sample only.
N/A = Not Applicable

China

Supply and Demand Overview

National power growth has maintained an average two-digit growth rate for four years, higher than the gross domestic product (GDP) growth rate. At the end of 2004, China's installed capacity reached 442,000 MW, an annual increase of 51,000 MW. Installed capacity in 2005 exceeded 500,000 MW. In 2005, the total generated power reached 2474.7 TWh, up 12.3% from 2004.

Through continuous improvement in power technologies and equipment, domestically manufactured power generation units of 300 MW and 600 MW have become mainstream in China. Currently, domestically manufactured supercritical units of 600 MW and 900 MW have been put into service, and 1,000-MW domestically manufactured ultra-super critical units are about to begin operation. Nevertheless, China still lags behind international advanced levels in some aspects, such as in the manufacturing of equipment for 1,000-MW nuclear power stations.

Grid System

The Chinese grid system includes more than 228,000 km of electric transmission lines, with average line losses of approximately 7.5%. Domestically produced 500 kV AC/DC transmission and transformation equipment has become the backbone of China's power grids. A 750 kV AC transmission and transformation demonstration project in Northwest China, along with the Lingbao back-to-back HVDC (High Voltage DC) station project, located in Henan province, have been finished and put into operation.

Ownership

Five major power generation groups in China own nearly 43% of the nation's total installed capacity. All of the power generation groups are state-owned. China also has many local power companies, most are state-owned, and some are private or foreign capital. The proportions of the private and foreign capital are increasing year by year.

Regulations

At the end of 2002, China completed the first phase of reform in the power sector, establishing the State Electricity Regulatory Commission, two major grid companies, five major power generation groups and four supporting companies. Through specific reforms aimed at "separating power generation from transmission" and "separating functions of the government and enterprises," China has created an orderly competition situation in the power sector.

Emissions

The Chinese government decided to build up a resource saving society throughout the country. According to the 11th Five-year National Plan, the Energy intensity will drop 20% in 2010.

Table B-4 China: Summary Data 2004

Parameter	Total Installed Capacity by Fuel Type - Number of Plants	Total Installed Capacity by Fuel Type - MW	Total Generation by Fuel Type - MWh
Coal	5295	329,483 MW	1,810,380,000 MWh
Black Coal			
Brown coal / lignite			
Oil			
Natural gas			
Nuclear	9	6,836 MW	50,469,000 MWh
Renewables	1607	105,242 MW	330,990,000 MWh
Hydroelectric			
Other			
Total SO_2 Emissions (tonne/year)			
Total NOx Emissions (tonne/year)			
Total CO_2 Emissions (tonne/year)			
Total Particulate Emissions (tonne/year)			
Per Capita Energy Consumption (kJ/person)	45,879,680 kJ/person		
Per Capita Electricity Generation (annual kWh/person)	190 kWh/person		
Energy Intensity (kJ/$GDP)	28,558kJ/1 USD (year 2005 data, 1USD=8RMB)		

Table B-5 China: Generation, Transportation, and Distribution Data 2004

Parameter	Transmission		Distribution
	AC	DC	
Voltage Levels (kV)	750, 500, 330, 220 kV	500 kV	110 kV, 35 kV, 10 kV
Total Distance Covered (km, for each voltage level)	500, 5425 2km, 330, 10773 km, 220, 163835 km		110, 263004 km, 35, 405276 km
Average Age (years, for each voltage level)	500, 209210 kVA, 330, 20640 kVA, 220, 460260 kVA		110, 471390 kVA, 35, 193160 kVA
Average Line Losses (as percent of generation, for each voltage level)	7.55%		
Total Generation (TWh)	2.19		
Auxiliary Consumption (TWh)[1]	0.13		
Net Generation (TWh)	2.06		
Imports (TWh)	0.0034		
Exports (TWh)	0.0095		

Table B-6 China: Generating Capacity Data 2004

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	Brown or Lignite	Simple Cycle	Combined Cycle			Hydro	Other
Number of Units	5295					9	1607	
5-50 MW								
50-100 MW								
100-300 MW								
300-500 MW								
Greater than 500 MW								
Total Capacity (MW)	308,161Mkw					6836	77,702	
5-50 MW								
50-100 MW								
100-300 MW								
300-500 MW								
Greater than 500 MW								
Capacity by Unit Age (MW)								
Less than Ten Years								
10-20 years								
20-30 years								
Greater than 30 Years								
Average Capacity/Unit Load Factor (%)	68.40%					79.90%	39.50%	
Best-In-Country Capacity/Unit Load Factor (%)								
Average Availability (%)								
Best-In-Country availability (%)								
Average Heat Rate (kJ/kWh)	35.42%							
Best-In-Country Heat Rate (kJ/kWh)								
Average Emissions Levels (where applicable)								
SO_2 (ng/J) NOx (ng/J)								
PM (ng/J)								

CO_2 (kg/MWh)								

Note: Information not available at time of publication.

India

Supply and Demand Overview

Electricity is a critical infrastructure component for India's socio-economic development, and affordable, quality power is required for rapid economic growth. The Indian power sector is witnessing major changes, with rapid growth in generation, transmission and distribution.

The present generating capacity of India is around 124,000 MW, which is poised to increase to more than 200,000 MW by 2012, and is projected to double every ten years thereafter. Total electricity generation by utilities in fiscal year 2004-5 was 594.5 TWh, and increased by 4.84% in fiscal year 2005-6. Because India's economy is growing at a fast rate, there is a national energy shortage of about 7%, and a peaking shortage of about 12%. National electricity policy aims at fully meeting demand with spinning reserves of 5% by 2012. To meet this objective, huge investments in power generation, transmission and distribution are required, and a favorable environment has been created for the private sector to participate in the areas of power generation, transmission and distribution.

Presently, thermal generation constitutes 66.4%, hydroelectric 26%, nuclear 2.7% and renewable 4.9% of installed capacity. Coal-based power plants contribute 83.2% of thermal generation, with gas and diesel providing the balance. Industry is India's largest power consumer, using 35.6% of the total power produced, followed by agriculture (23%), domestic (25%), and commercial (8%), with the remaining being consumed by railroads, public water works and other miscellaneous consumers.

The coal-based power plants consist of a large number of nominal 200-MW and 500-MW units. To increase generation capacity 660-MW units are under construction, and 800-MW units are being proposed. The increase in unit size has also led to an increase in overall efficiency of power generation. The performance of the coal-based power plants is improving, as characterized by an increase in plant load factor from 72.96% during 2003-04 to 74.82% in 2004-05. The operating availability has also increased from 81.93% during 2003-04 to 82.93% in 2004-05.

Grid System

Development of India's transmission network has occurred in parallel with growth in generating capacity, and is characterized by the physical growth in transmission network as well as introduction of higher transmission voltages and new technologies for bulk power transmission. The growth is attributed to the introduction of 220 kV in 1960, 400 kV in 1977, HVDC back-to-back link in 1989, ±500 kV HVDC bi-pole line in 1990, and 765 kV transmission line (initially charged at 400 kV) in 2000. Future plans include operation of the 765 kV line in 2007 and ±600 kV, 4000-MW HVDC bi-pole line in 2011. The 220 kV system has an installed network of 113,400 circuit km. The 400 kV system has an installed network of 64,506 circuit km. The 765 kV system will have a total of 2031 circuit km installed by the end of 2007.

India's power transmission is divided into five regions: Northern Region, Western Region, Eastern Region, Southern Region and North-Eastern Region. Over the years, transmission system planning exercises were based on regional self-sufficiency, resulting in strong regional grids. The generation capacity at the end of 2007 for each regional grid is projected to be: (1) Northern Region — 37,228 MW; (2) Western Region — 43,732 MW; (3) Eastern Region — 23,823 MW; (4) Southern Region — 32,226 MW; and (5) North-Eastern Region — 2,363 MW. Currently, the Eastern, Northeastern, Northern and Western Region grids are operating in synchronize mode. With the existing and planned high capacity AC and HVDC transmission links connecting various regions, India is progressing toward a strong national grid, which would allow operations of unevenly distributed generation resources in the country to reach their optimal potential. The inter-regional transmission capacity for all five regional grids is projected to be 16,450 MW by the end of 2007.

Ownership

Generation capacity ownership in India is divided as follows: 57% under the state sector, 32% under the central sector, and 11% under the private sector.

Regulation

In India power sales by generating companies to distribution licensees, including transmission, distribution, and trading of electricity are regulated by the Electricity Regulatory Commissions, which are independent and autonomous. The Central Electricity Regulatory Commission (CERC) regulates inter-state activities. The State Electricity Regulatory Commission (SERC) regulates distribution business and other activities within the state. CERC regulates tariffs with respect to Central Government owned companies and for Independent Power Producers (IPPs) selling power to more than one state. SERCs regulate tariffs with respect to state generating companies and independent power producers (IPPs). Generation tariffs are fixed based on capital costs and normative operating parameters. Currently, the tariff policy mandates a shift to developing projects through tariff based competitive bidding. Distribution licensees can also contract to purchase power through a transparent process of tariff-based bidding and tariff, so arrived, is adopted by the Regulatory Commissions.

The Electricity Act of 2003 has established open access in transmission, creating an all-India Electricity Market. Trading of power is a licensed activity, and there are many trading companies operating in India. Generating companies can also sell power directly to bulk consumers who have a connected load of more than 1 MW, on mutually agreed rates subject to open access in distribution by SERCs. Such open access is mandated by law, scheduled to be in place by January 2009.

Emissions

With the increased power generation capacity from coal, larger size units with supercritical parameters are planned with better efficiencies. Work is being done to introduce new technologies such as IGCC that are cost effective.

The Government of India has enacted emission legislation namely the “Energy Conservation Act, 2001”. The Bureau of Energy Efficiency, envisaged under the act, has been put in place. Several lines of actions have been initiated by the Bureau of Energy Efficiency in the area of energy conservation in industry, domestic sector, commercial establishments and agriculture sector.

Table B-7 India: Summary Data 2005

	Total Installed Capacity by Fuel Type - Number of Plants	Total Installed Capacity by Fuel Type - MW	Total Generation by Fuel Type - MWh
Coal			
Black Coal	96	67,790.87	424,244,060
Brown Coal/Lignite			
Oil	151	1201.75	2,559,620
Natural gas	52	11,909.82	61,524,660
Nuclear	6	2770	17,011,000
Renewables			
Hydroelectric	266	30,942.24	84,610,380
Other	Small Wind, Biomass, Urban & Industrial Waste	3811	4,506,480
Total SO_2 Emissions (tonne/year)	In general, the sulfur content in Indian coal is low. However, SO_2 in ambient air near power station is generally <50-60 microgram/ M3		
Total NOx Emissions (tonne/year)	Latest coal-fired boilers designed for NOx emission of 360 ppm and latest gas based stations designed for NOx emission of 50 ppm.		
Total CO_2 Emissions (tonne/year)	Coal-based station, CO2 produced is about 1098 gm/kWhr. In gas station, CO_2 produced is about 460 gm/kWhr.		
Total Particulate Emissions (tonne/year)	For 200 MW and 500 MW, the particulate emission is 100-150 mg/NM3. Latest boilers are designed for further lower value.		
Per Capita Energy Consumption (kJ/person)	21,771,360 (year 2003)		
Per Capita Electricity Generation (annual kWh/person)	612.5		
Energy Intensity (kJ/$GDP)	7,955 PPP wrt US Dollars (year 2003)		

Note: Filled up data is for period April 2004-March 2005

Table B-8 India: Generation, Transportation, and Distribution Data 2005

Parameter	Transmission		Distribution
	AC	DC	
Voltage Levels (kV)*	765 kV, 400 kV, 230/220 kV, 132/110/90 kV, 78/66 kV	+/- 500kV	33/22 kV, 15/11 kV,6.6/3.3/2.2 kV & up to 500 Volts
Total Distance Covered (km, for each voltage level)*	765 kV—563 km	+/- 500 kV— 6841 km	33/22 kV— 299,639km
	400 kV—57185 km		15/11 kV—1971722km
	230/220 kV—104,758 km		6.6/3.3/2.2 kV—6431
	132/110/90 kV---124,344 km		Up to 500 Volts—3,953,456 km
	78/66 kV—45,884 km		
Average Age (years, for each voltage level)	220 kV introduced in 1960, 400 kV in 1977, 765 kV installation anticipated in 2007	In operation since 1989	Have been in constant use for many years
Average Line Losses (as percent of generation, for each voltage level)	4–5% (Technical loss depends upon length of transmission lines)	less than 1.5%	15-18% (Technical Losses)
Total Generation (TWh)	594.45620 TWh		
Auxiliary Consumption (TWh)[1]	41.59021 TWh		
Net Generation (TWh)	552.86599 TWh		
Imports (TWh)	1.73505 TWh		
Exports (TWh)	0.04016 TWh		

Note: Filled up data is for period April 2004–March 2005

Table B-9 India: Generating Capacity Data 2005

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	**Brown or Lignite**	**Simple cycle**	**Combined Cycle**			**Hydro**	**Other**
Number of Units								
5-50 MW	51		100		54	Nil	429	Small wind, biomass, U&I waste
50-100 MW	65		23		Nil	Nil	91	
100-300 MW	254		58		Nil	14	103	
300-500 MW	31		Nil		Nil	Nil	Nil	
Greater than 500 MW	Nil		Nil		Nil	Nil	Nil	
Total Capacity (MW)								
5-50 MW	1874.5		2731		922.2	Nil	9476.5	3811
50-100 MW	4399		1484.5		Nil	Nil	6640.2	
100-300 MW	46,000		7651		Nil	2770	14,728	
300-500 MW	15,500		Nil		Nil	Nil	Nil	
Greater than 500 MW	Nil				Nil	Nil	Nil	
Capacity by Unit Age (MW)								
Less than Ten years	Coal-based stations first 200 MW unit commissioned in 1976 and first 500 MW unit commissioned in 1983. Smaller units are in constant use for many years		Gas first 80 MW and 108 MW gas turbines commissioned in 1982 and 1985 respectively. Smaller units are in constant use for many years		In use for many years.	First 160 MW commissioned in 1969	First 250 MW commissioned in 2000 at Koyna.	
10-20 years								
20-30 years								
Greater than 30 Years								
Average Capacity/Unit Load Factor (%)	74.80%			61.95%		70.70%		
Best-In-Country Capacity/Unit Load Factor (%)	103.87 %	89.68		96.83%		92.30%		
Average Availability (%)	82.93%			94.00%				
Best-In-Country Availability (%)	99.98%			97.04%				
Average Heat	11,000	12,550		9000			N/A	N/A

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	**Brown or Lignite**	**Simple cycle**	**Combined Cycle**			**Hydro**	**Other**
Rate (kJ/kWh)								
Best-In-Country Heat Rate (kJ/kWh)	9580	10,500		7511			N/A	N/A
Note: Filled up data is for period April 2004-March 2005								
Average Emissions Levels (where applicable)								
SO_2 (ng/J)	See page 1				N/A	N/A	N/A	
NOx (ng/J)					N/A	N/A	N/A	
PM (ng/J)					N/A	N/A	N/A	
CO_2 (kg/MWh)					N/A	N/A	N/A	

Japan

Supply and Demand Overview

The Japanese electricity sector has an installed generating capacity of 216,803 MW, and a total annual generation of 877 TWh in fiscal year 2004. According to the Japan Electric Power Survey Committee, electric energy demand for fiscal year 2015 is estimated to reach 989 TWh, representing an average annual increase of 0.9% from 2004. Peak capacity through 2015 is expected to grow at an average rate of 1.0% per year from 2004.

Japan has a paucity of energy resources and has moved to diversify its energy supply since the oil crises of the 1970s. Japan has also worked to build an electricity industry with a balanced fuel composition that disperses fuel supply risk while utilizing the characteristics of various power generation methods, including nuclear power generation, thermal power generation (coal, gas, and oil) and hydroelectric power generation. As a result of these policies, Japan has succeeded in lowering the fraction of power generation dependent on oil, from 75% in 1973 to 12% in fiscal year 2002. At the same time, it has achieved a balanced power output sourced from nuclear power (30%), coal (22%), gas (26%), and hydroelectric power (9%) in fiscal year 2002. Future government policy aims to maintain the proportion of power output from nuclear power at between 30% and 40%.

Grid System

The Japanese grid system includes more than 94,000 km of electric transmission lines, with estimated line losses of 5.2%. Japan’s transmission territory carries geographical restrictions, being stretched long and thin from east to west. The majority of the transmission assets in Japan have been in constant use for more than 30 years. A further restriction is the existence of regional frequency differences (50 Hz, 60 Hz). Service areas covered by each company are linked only by connecting lines. As a result, unlike countries in Europe and North America, Japan’s power transition lines network does not form a mesh nor is it linked to neighboring countries. For the ten companies to fulfill their obligation to provide stable power supplies in these restricted circumstances, the Japanese government promotes a “Japanese-style liberalization model” that maintains integrated power generation, T&D services, while including a partial liberalization of the retail market.

Ownership

In the Japanese power industry, ten private-sector general power utility companies maintain an integrated system for power generation, transmission, and distribution, with each of the companies fulfilling their responsibility to supply a specific area. Wholesale power utility companies supply electricity to the general power utility companies, while power producers and suppliers sell and distribute electricity to customers covered by deregulation legislation.

Regulation

Japan’s retail power market was partially liberalized in March 2000, and has subsequently expanded in stages. By 2005, approximately 60% of the power sold occurred via retail electricity transactions. A wholesale power exchange has also been established, allowing active power trading, not only between general power utility companies, but also between other parties, including power producers and suppliers. Deliberations on a fully liberalized market are scheduled to start in April 2007.

Emissions

Although power demand has increased by about three times since the oil crises of the 1970s, CO_2 emissions from the electric power industry have increased by about two-fold. Under the difficult circumstance of continuous power demand increase, the electric power industry in Japan set a voluntary target to reduce CO_2 emissions intensity in 1996, and seeks to continue lowering CO_2 emissions intensity. Through promoting measures to improve fuel quality and to change plant facilities, sulfur oxide (SO_x) and nitrogen oxide (NO_x) emissions per kWh have been dramatically reduced recently, with levels significantly lower than those of OECD countries.

Table B-10 Japan: Summary Data 2004

Parameter	Total Installed Capacity by Fuel Type - Number of Plants	Total Installed Capacity by Fuel Type - MW	Total Generation by Fuel Type - MWh
Coal			
Black Coal	60	30,230	193,318,000
Brown Coal/Lignite			0
Oil	97	39,335	68,621,000
Natural Gas	93	58,133	245,398,000
Nuclear	53	47,122	282,442,000
Renewables			
Hydroelectric	127	33,042	83,773,000
Other	19	501	3,141,000
Total SO_2 Emissions (tonne/year)	96,866		
Total NOx Emissions (tonne/year)	128,928		
Total CO_2 Emissions (tonne/year)	30,800,000		
Total Particulate Emissions (tonne/year)	N/A		
Per Capita Energy Consumption (kJ/person)	1,700,000,000		
Per Capita Electricity Generation (annual kWh/person)	6778		
Energy intensity (kJ/$GDP)	4440		

Table B-11 Japan: Electricity Generation, Transportation and Distribution Data 2004

Parameter	Transmission		Distribution
	AC	DC	
Voltage Levels (kV)	500 275 220 187 154 132 110 77 66 33 22	±250	6600 (V) 100/200 (V)
Total Distance Covered (km, for each voltage level)	94,124		High volt: 714,173 Low volt: 554,824
Average Age (years, for each voltage level)	over 30	N/A	N/A
Average Line Losses (as percent of generation, for each voltage level)	5.2		
Total Generation (TWh)	876,693		
Auxiliary Consumption (TWh)[1]	38,089		
Net Generation (TWh)	838,604		
Imports (TWh)			
Exports (TWh)			

[1]Auxiliary consumption refers to parasitic consumption at power plants.

Table B-12 Japan: Generating Capacity Data 2005

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	Brown or Lignite	Simple Cycle	Combined Cycle			Hydro	Other
Number of Units								
5-50 MW							5	13
50-100 MW	1				4		65	6
100-300 MW	23		25		16		26	
300-500 MW	9		11		45	4	9	
Greater than 500 MW	27		36	21	32	49	22	
Total Capacity (MW)								
5-50 MW							109	176
50-100 MW	85				340		4,234	325
100-300 MW	4,385		5,695		3,370		4,354	
300-500 MW	4,060		4,126		16,525	1,617	3,299	
Greater than 500 MW	21,700		25,474	22,838	19,100	45,505	21,046	
Capacity by Unit Age (MW)								
Less than Ten Years	15,844			10,260		4,741	860	7
10-20 Years	7,012		6,200	10,488	1,850	14,866	6,470	314
20-30 Years	3,175		9,016	2,090	10,750	19,363	9,427	100
Greater than 30 Years	4,199		20,079		26,735	8,152	16,285	80
Average Capacity/ Unit Load Factor (%)	72.4		37.3	62.5	15.3	66.9	N/A	N/A
Best-In-Country Capacity/Unit Load Factor (%)	96.5		64.1	76.3	46.1	97.8	N/A	N/A
Average Availability (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Best-In-Country availability (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average Heat Rate (kj/kwh)	8937		9577	7804	9580	N/A	N/A	N/A
Best-In-Country Heat Rate (kj/kwh)	8394		8953	7156	9086	N/A	N/A	N/A
Average Emissions Levels (where applicable)								
SO_2 (ng/J)								
NOx (ng/J)								
PM (ng/J)								
CO_2 (kg/MWh)								

Korea

Supply and Demand Overview

Demand for electricity in Korea grew at a compounded average rate of 6.8% per annum for five years at the end of 2005, higher than the GDP growth rate. The Korean electricity sector had an installed generating capacity of 62,258 MW, and a total annual generation of 365 TWh in 2005.

Korea has tried to build an electricity industry with a balanced fuel composition to achieve efficient use of generating resources and diversification of generating capacity. Since the oil shock in 1974, Korea's power development plans have emphasized the construction of nuclear generating units. Korea tries to maintain nuclear power production capacity equal to baseload demand. With continuous improvements in power technologies and equipment, domestically manufactured supercritical coal-fired power generation units have also become mainstream in Korea. The proportion of power generating facilities is: nuclear power (28.5%), steam (38.2%), combined cycle (24.1%) and hydroelectric power (6.2%).

The average growth rate of electricity demand is expected to be 2.5% per annum from 2004 to 2017 (294 TWh in 2003 to 416 TWh in 2017). Cumulative generating capacity additions are estimated to be 38,200 MW by 2017.

Grid System

The Korean electric transmission grid system consists of approximately 28,642 circuit kilometers of high-voltage lines (up to 765 kV), including high-voltage direct current lines. The Korean distribution system is comprised of 83,352 megavolt-amperes of transformer capacity and 7.4 million units of support with a total line length of 385,419 circuit kilometers. Korea reduced its transmission and distribution loss factor to 4.51% in 2005 by increasing transmission capability for existing transmission lines.

Transmission voltages in Korea are 345 kV for trunk lines and 154 kV or 66 kV for local networks. Most of the 66 kV lines have been phased out. To sufficiently meet future demand, Korea is concentrating on voltage upgrades by expanding its 765 kV power lines.

Ownership

Of the total installed capacity in Korea 88.7% is owned by six major public utilities, which have spun off from KEPCO (Korea Electric Power Corp.) in 2002. State-owned KEPCO still hold whole shares of the six public utilities. As the single buyer in the Korea electric market, KEPCO operate transmission and distribution system. In 2005, the six major public utilities supplied 96% of the grid demand.

Regulation

Korea's electricity industry restructuring plan established a stand-alone generating sector and six generation groups. The Korea Power Exchange was established in April 2001 to deal with the sale of electricity and develop regulations for a competitive electricity distribution market. Power generating companies compete and large consumers purchase electricity in the market under a cost-based pool system. Korea has created orderly competition in the power sector.

Emissions

In order to ensure zero-tolerance implementation for the national emission regulation, the government legislated to install the real-time emission monitoring system named TMS (Tele-Monitoring System) in the smoke stacks with high emission volumes since February 2002. Based upon the data gathered from TMS, the government mandates improvements or imposes charges to those who exceed emission regulations. As of January 2004, TMS had been installed in 1,841 stacks at 317 industrial sites. The Korean government has established a green house gas (GHG) registration program similar to the Kyoto Protocol's Clean Development Mechanism (CDM).

Table B-13 Korea: Summary Data 2005

Parameter	**Total Installed Capacity by Fuel Type - Number of Plants**	**Total Installed Capacity by Fuel Type - MW**	**Total Generation by Fuel Type - MWh**
Coal	39	17,965	133,658,000
Black Coal	33	16,840	129,174,000
Brown Coal/Lignite	6	1125	4,484,000
Oil	124	6091	20,486,000
Natural Gas	120	16,447	58,118,000
Nuclear	18	17,716	146,779,000
Renewables	190	4039	5,598,000
Hydroelectric	49	3829	5,015,000
Other	141	210	583,000
	491	62,258	364,639,000
Total SO_2 Emissions (tonne/year)	100,947		
Total NOx Emissions (tonne/year)	158,151		
Total CO_2 Emissions (tonne/year)	141,789,000		
Total Particulate Emissions (tonne/year)	4,287		
Per Capita Energy Consumption (kJ/person)	24,783,260 (6,883 kWh/person)		
Per Capita Electricity Generation (annual kWh/person)	7,550		
Energy Intensity (kJ/$GDP)	15,043.62		

Table B-14 Korea: Electricity Generation, Transmission, and Distribution Data 2005

Parameter	Transmission		Distribution
	AC	DC	
Voltage Levels (kV) Total Distance Covered (km, for each voltage level)	765 kV 11.908km		
	345 kV 82,800 km		
	154 kV 79,816 km	180 kV 261,312 km	
	66 kV 1,702 km		22.9 560,846 km
Average Age (years, for each voltage level)	19	8	
Average Line Losses (as percent of generation, for each voltage level)	4.51% (including transformer loss)		
Total Generation (TWh)	365TWh		
Auxiliary Consumption (TWh)[1]	16 TWh		
Net Generation (TWh)	349 TWh		
Imports (TWh)	No international energy trading currently exists in Korea.		
Exports (TWh)			

Table B-15 Korea: Generating Capacity Data 2005

Parameter	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	Brown or Lignite	Simple Cycle	Combined Cycle			Hydro	Other
Number of Units	33	6		120	124	18	49	141
5-50 MW					105		34	141
50–100 MW				24	5		1	
100–300 MW	2	6		94	6		8	
300–500 MW	25			2	8		6	
Greater than 500 MW	6					18		
Total Capacity (MW)	16,840	1,125		16,447	6,091	17,716	3,829	210
5–50 MW					1,676		879	210
50–100 MW				1,820	315		50	
100–300 MW	500	1,125		13,977	1,200		1,000	
300–500 MW	12,500			650	2,900		1,900	
Greater than 500 MW	3,840					17,716		
Capacity by Unit Age (MW)	16,840	1,125		16,447	6,091	17,716	3,829	210
Less than Ten Years	10,100	400		10,295	271	4,400	736	154
10–20 years	4,120			4,515	1,100	12,729	856	51
20–30 years	2,120	600		750	3,520	587	1,598	1
Greater than 30 Years	500	125		887	1,200		639	4
Average Capacity/Unit Load Factor (%)	85.69		30.17		48.89	85.30		
Best-In-Country Capacity/Unit Load Factor (%)	It is impossible to calculate by energy sources.							
Average Availability (%)	83.23	53.06		35.18	42.10	90.45	14.86	3.54
Best-In-Country Availability (%)	unavaila ble	unavaila ble		unavailable	unavailable	unavailable	unavaila ble	unavaila ble
Average Heat Rate (kJ/kWh)	9,171	10,305	7,640		9,589	N/A	N/A	–

United States

Supply and Demand Overview

There are approximately 17,000 electric generators in the United States, representing about 1,000,000 MW of installed capacity.[1] Coal is the predominant fuel source for power generation in the United States, accounting for 51% of power generated, followed by nuclear (20%), gas (17%), hydroelectric (7%), oil (3%), and renewables (2%). Generation by all fuel types totaled approximately 4,000 TWh in 2004. Along with an expected need to replace aging capacity, the projected electricity supply growth of 50% by 2030[2] will create many opportunities for installing more efficient and clean generating capacity in the near future.

Grid System

The electric transmission grid consists of more than 289,680 km of high-voltage (>180 kV) electric transmission lines. Annual investment in new transmission declined steadily in the 1980s and 1990s, while electricity demand increased. Due to grid congestion, average T&D losses grew from 5% in 1970 to 6.81% across all voltages in 2004.[3] Issues with land use, siting, and permitting, and concerns over whose responsibility it is to build new lines have hampered new investment.

Ownership

The United States has more entities involved in the production, transmission and distribution of electricity than any other nation. Power is provided by more than 3,100 electric utilities owned by stockholder-owned companies (serving 73% of customers), state and local government agencies (serving 15% of customers), regional cooperatives (serving 12% of customers), and a few federal utilities. In addition, there are nearly 2,100 non-utility power producers, including independent power companies and customer-owned distributed energy facilities.[4]

Regulation

Interstate wholesale markets are regulated by the Federal Energy Regulatory Commission (FERC), while state and local agencies regulate the retail market, including distribution and retail pricing. The electricity sector has been slowly shifting from a federally and state-regulated system of vertically integrated public utility monopolies toward a market system characterized by numerous market players, lowered regulation, and competitive pricing.[5] As of 2005, 17 states and the District of Columbia had enacted comprehensive restructuring legislation. The number of players in the market, in addition to the patchwork of regulations state-to-state, has created uncertainty about the future of the electricity sector, which has hindered investment in new plants, transmission and distribution.

Emissions

While emissions of SO_x, NO_x, mercury, and other local air pollutants from electricity generation are declining, CO_2 emissions continue to grow due to the increased demand for

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[1] Energy Information Administration, " Table 2.2, Existing Capacity by Energy Source, 2004" http://www.eia.doe.gov/cneaf/electricity/epa/epat2p2.html
[2] Energy Information Administration, Annual Energy Outlook 2006
[3] The United States Energy Information Administration, EIA-861, Annual Electric Industry Survey, 2004 data.
[4] The United States Department of Energy's Office of Electric Transmission and Distribution. Grid 2030: A national vision for electricity's second 100 years. July 2003.
[5] Amy Abel and Larry Parker. Electricity: the road toward restructuring. CRS Report IB 10006, 2001.

electricity. The federal government has made the reduction of greenhouse gas (GHG) emissions intensity a priority and has initiated several voluntary programs to reduce GHG emissions. It is also providing R&D and tax incentives for clean coal combustion and carbon capture and storage. Some states are introducing mandatory programs to cap CO_2 emissions from the energy sector.

Table B-16   United States: Summary Data 2004

Parameter ***All Data 2004 Unless Otherwise Noted***	**Total Installed Capacity by Fuel Type - Number of Units**	**Total Installed Capacity by Fuel Type - MW**	**Total Generation by Fuel Type - MWh**
Coal	1,511	338,538	1,978,620,000
Black Coal	1,478	323,419	1,830,224,000
Brown Coal/Lignite	33	15,119	148,397,000
Oil	3,175	37,970	120,646,000
Natural Gas	3,048	256,627	708,979,000
Nuclear	104	105,560	788,528,000
Renewables	2,589	118,601	358,825,000
Hydroelectric	1,907	96,955	268,417,000
Other	682	21,646	90,408,000
Total SO_2 Emissions (tonne/year)	10,307,000		
Total NOx Emissions (tonne/year)	3,951,000		
Total CO_2 Emissions (tonne/year)	2,444,443,000		
Total Particulate Emissions (tonne/year)	630,500 (2002 data)		
Per Capita Energy Consumption (kJ/person)	339,600,000		
Per Capita Electricity Generation (annual kWh/person)	13,505		
Energy Intensity (kJ/$GDP)	8,903 (2004 energy data, 2006 $)		

Table B-17 United States: Generation, Transmission, and Distribution Data 2004

Parameter All Data 2004 unless otherwise noted	**Transmission**		**Distribution**
	AC	**DC**	
Voltage Levels (kV) – NERC Electricity Supply & Demand Database (2004)	750	500	2.4–34.5 (primary distribution)
	500	450	
	345	400	
	230	250–300	
Total Distance Covered (km, for each voltage level) – NERC Electricity Supply & Demand Database (2004)	3,975	2,146	
	44,933		
	84,011	1,372	
	125,237	721	
Average Age (years, for each voltage level)			
Average Line Losses (as percent of generation, for each voltage level, T&D) – EIA-861, Annual Electric Industry Survey, 2004 data	6.81% across all voltages (2004 data)		
Total Generation (TWh)	3794		
Auxiliary Consumption (TWh)[1]	26		
Net Generation (TWh)	3768		
Imports (TWh)	34.2		
Exports (TWh)	22.9		

Table B-18 United States: Generation Capacity Data 2004

Parameter *All Data 2004 Unless Otherwise Noted*	Coal		Gaseous Fuels		Liquid Fuels	Nuclear	Renewables	
	Black	Brown or Lignite	Simple Cycle	Combined Cycle			Hydro	Other
Number of Units								
5-50 MW	471	1	1594	401	680		1321	574
50-100 MW	214	2	766	281	247		342	84
100-300 MW	414	8	562	780	64		217	23
300-500 MW	128	6	68	54	23		21	1
Greater than 500 MW	251	16	52		20	104	6	
Total Capacity (MW)								
5-50 MW	8982	40	36,564	10,718	13,403		26,128	11,248
50-100 MW	15,229	125	55,961	20,801	15,546		24,108	5404
100-300 MW	72,899	1375	88,454	143,395	10,136		31,622	3231
300-500 MW	50,295	2647	26,922	18,274	9155		7262	333
Greater than 500 MW	175,741	10,929	33,824		14,727	105,560	4215	
Capacity by Unit Age (MW)								
Less than Ten Years	1990	514	87,189	148,810	4298		882	6245
10-20 Years	22,756	1598	21,334	28,518	2931	25,345	5068	7523
20-30 Years	97,604	9000	15,390	6819	11,575	46,364	17,973	4894
Greater than 30 Years	201,069	4007	120,449	9206	48,920	33,851	73,032	2984
Average Capacity/Unit Load Factor (%)	55.40	71.40	18.40	35.60	5.30	86.10	39.10	48.30
Best-in-country Capacity/Unit Load Factor (%)	96.40	91.8	98.8	95.4	97.3	97.5	N/A	N/A
Average Availability (%)	87	88	85	N/A	93	82	89	N/A
Best-In-Country Availability (%)								
Average Heat Rate (kJ/kWh)	10,397	11,131	11,312	10,753	11,024	N/A	N/A	15,316
Best-In-Country Heat Rate (kJ/kWh)	8758	9982	8235	5980	1579	N/A	N/A	2138
SO_2 (ng/J)	413.7	346.3	17.9	0.39	324.7	N/A	N/A	
NOx (ng/J)	146.6	114.5	46.8	12.8	120.7	N/A	N/A	
PM (ng/J)	14.48		0.688	0.688	20.0	N/A	N/A	N/A
CO_2 (kg/MWh)	921.7	1,003.1	593.2	547.4	756.3	N/A	N/A	