U.S. Department of Commerce
International Trade Administration

Potential Exports of U.S. Clean Coal Technology through 2030

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Overview

The United States is a world leader in technology that allows coal to be burned for electricity production without excessive emissions of sulfur dioxide, nitrogen oxide, mercury, and particulate matter. To reduce overall emissions, the U.S. coal industry is developing specific technology that can be incorporated into coal-fired power plants. That technology will allow coal to be burned with lower emissions of carbon dioxide. The U.S. technological preeminence in this field presents an opportunity to export the equipment and to license the technology to countries such as China and India, where coal-fired electricity production is rising quickly. This paper estimates the potential for U.S. exports of existing clean coal technology (CCT) to a growing worldwide market. U.S. exports of CCT to Australia, Brazil, China, India, Mexico, New Zealand, South Africa, South Korea, and the European Union (EU) 25[1] could amount to US$36 billion between now and 2030.

The potential CCT exports are estimated using several assumptions about future demand for U.S. CCT in those countries. The first assumption is that all new coal-fired electricity-generation capacity will incorporate CCT. A total estimated demand for CCT is derived by using the projections of the Energy Information Administration (EIA) for increased coal-fired electricity-generating capacity, combined with an estimate of the value of CCT equipment needed for one gigawatt of capacity. If all required CCT equipment were imported and if the United States maintained its current share of each country's current CCT imports, the projected demand for U.S. CCT equipment in those countries from 2003 to 2030 would be $36 billion.

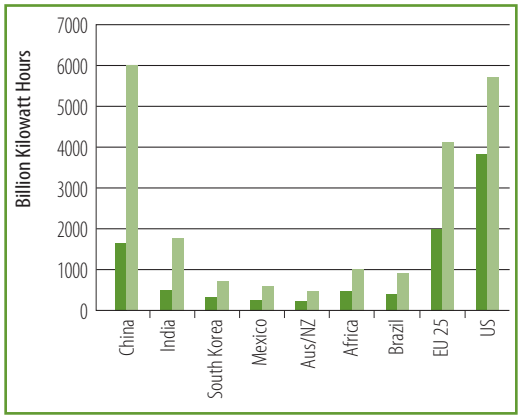
Specifically, China, India, and South Korea present the greatest value of U.S. CCT exports in this study, representing approximately $26 billion, $3.5 billion, and $3.2 billion, respectively. Australia, Brazil, Mexico, New Zealand, South Africa, and the EU 25 account for an additional $2.9 billion of growth.

Worldwide Clean Coal Technology Demand

There is a stark difference in the growth rates of electricity consumption between countries that are members of the Organization for Economic Cooperation and Development (OECD) and those that are not. According to the EIA,[2] growth in electricity consumption will be much lower in OECD countries, such as Australia, New Zealand, the EU 25, and the United States. In the non-OECD countries of China and India, electricity consumption will more than triple by 2030 (see Figure 1). China currently consumes 1,671 billion kilowatt hours of energy, which is anticipated to increase to 5,971 billion kilowatt hours by 2030. Overall electricity consumption in India will grow from 519 billion kilowatt hours in 2003 to 1,730 billion kilowatt hours by 2030.

INTERNATIONAL TRADE ADMINISTRATION

Figure 1. World Net Electricity Consumption, 2003 and 2030



Source: EIA, International Energy Outlook 2006 (Washington, DC: EIA, 2006), Appendix A, Table A9).

Coal-fired electricity-generating capacity is projected to increase by 546 gigawatts in China and 94 gigawatts in India, with those two countries representing 73 percent of projected worldwide electricity-generating capacity growth (see Figure 1). Because China's economy is expected to grow by 6 percent per year from 2003 to 2030 and India's by 5.4 percent per year, both of these coal-rich countries will greatly rely on their domestic energy resources to spur economic development.

With this anticipated growth, China and India will require increased investments in mining operations, power plants, and power distribution systems. Furthermore, Africa, Brazil, Mexico, and South Korea will more than double their electricity consumption from 2003 to 2030. The increased demand for CCT equipment provides an opportunity for U.S. exporters to supply this rapidly growing market.

The estimate of potential U.S. CCT exports relies on the following assumptions:

• All new coal-fired facilities will incorporate clean coal technology and emissions abatement equipment.

• All coal-fired facilities will be on the scale of a supercritical 402 megawatt (0.4 gigawatt) plant.[3]

• The current market shares for CCT equipment for both the world and the United States will continue in their current proportions to 2030.

• Coal-fired electricity generation in 2030 will be equal to EIA forecasts.

In addition, the estimate is based on trade in equipment only. Therefore, sales of U.S. licenses of CCT equipment are not incorporated. Moreover, the estimate of U.S. market share of CCT is based on Harmonized Tariff Schedules (HTS) categories (listed in Table 3), although those categories cover equipment that is used both in CCT power plants and in other industrial applications.

Analysis of Potential CCT Equipment Exports Worldwide, 2003–2030

Potential CCT exports are estimated using several assumptions about future demand for U.S. CCT in Australia, Brazil, China, India, Mexico, New Zealand, South Africa, South Korea, and the EU 25. In those countries, coal is used primarily for coal-fired power generation. Estimating the potential market for CCT technology in those countries requires an estimate of the total world demand for imported CCT equipment and an estimate of the U.S. market share for those imports.

The potential market for CCT can be derived from the EIA's 2030 estimates of coal-fired electricity-generating capacity in those countries.[4] Assuming that all of this new capacity will use CCT equipment and that all the CCT equipment must be imported, an estimate of the costs of CCT equipment per gigawatt is multiplied by the projected increased capacity to derive a total CCT market estimate.

To estimate the U.S. market share of CCT equipment to each of those countries, assume that this future market share will be equal to the current market share. Current market share estimates are based on world trade data: Table 1 shows the EIA's projected increases in coal-fired electricity-generating capacity for the countries that were analyzed.

Table 1: Coal-Fired Generating Capacity in Gigawatts, 2003 and 2030

Country/Region	2003	2030
Africa	39	53
Australia and New Zealand	30	39
Brazil	1	6
China	239	785
EU 25	196	198
India	67	161
Mexico	5	9
South Korea	17	49
United States	310	457

Source: EIA, International Energy Outlook 2006 (Washington, DC: EIA, 20060, Appendix F, Table F$.

Estimated Cost of CCT Equipment: $300 Million per Gigawatt

The cost of CCT equipment can be derived from the Department of Energy's 1999 publication "Market-Based Advanced Coal Power Systems"[5], which is the most recent estimate of costs of supercritical pulverized coal plants. Table 2 shows the equipment costs for a 0.4 gigawatt supercritical coal-fired power plant in 1998 dollars.

Because the $100.2 million total cost refers to a 0.4 gigawatt facility, the cost of equipment per gigawatt in 1998 dollars totals $250 million, which is $298 million in 2005 dollars.[6]

Table 2: Costs of a 0.4 Gigawatt Supercritical Coal-Fired Power Plant (1998 dollars)

Equipment	Cost $ (millions)
Supercritical boiler	$60.7
Flue gas cleanup system	$33.6
Ash and spent sorbent handling system	$5.9
Total	$100.2

Source: U.S. Department of Energy. "Supercritical Pulverized Coal Plants.' in Market-Based Advanced Coal Power Systems. Appendex E, Page 22, May 1999.

Table 3: Selected HTS Codes

Code number	Description
HTS 840490	Auxiliary plant for use with boilers of heading 8402 or 8403 (for example, economizers, super-heaters, soot removerers, gas recoverers); condensers for steam or other vaper power units; parts thereof
HTS 841620	Furance burners for liquid fuel, pulverized solid fuel, or gas; mechanical stokers, including their mechanical grates, mechanical ash dischargers, and similar appliances
HTS 842139	Centrifuges, including centrifugal dryers; filtering or purifying machinery and apparatus for liquids or gases; parts thereof (including electrostatic precipitators and selective catalytic reductions systems)
HTS 842199	Centrifuges, including centrigugal dryers; filtering or purifying machinery and apparatus for liquids or gases; parts thereof

Source: U.S. Intetnational Trade Commission. http://hotdocs.usitc.gov/docs/tata/hts/bychapter/0612c84.pdf.

Estimated U.S. Share of International CCT Exports: 24.6 Percent[7]

The HTS code is used to derive the potential exports of clean coal equipment used in supercritical coal-fired power plants (see Table 3).[8]

The HTS codes in Table 3 include (a) parts of coal-fired power plants that are used with boilers; (b) furnace burners for pulverized solid fuels; (c) filters and purifying machinery, including electrostatic precipitators and selective catalytic reduction units; and (d) other filter purifying machinery.

The nine countries that were analyzed (according to their high current and projected coal usage rates for power production) are listed in Table 1. The *World Trade Atlas* and the HTS codes noted in Table 3 were used to derive the U.S. imports and worldwide imports of CCT equipment for 2005, the most recent year for which data for all countries analyzed is available. Notably, the majority of Mexico's imported boilers, furnace burners, filters, and purifying systems for coal-fired power plants came from the United States. For the EU

Table 4. Clean Coal Technology Equipment Imports in 2005 (Based on HTS Number, US$ Millions)

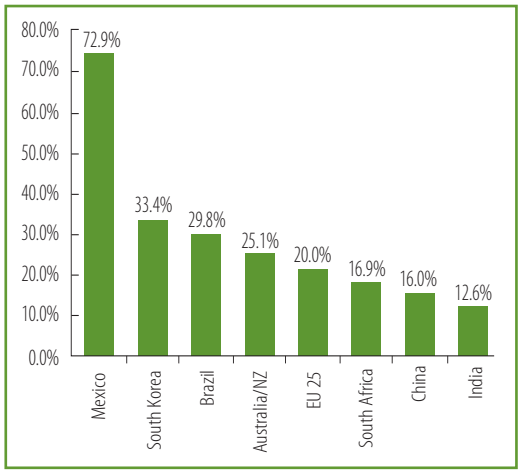
Country	U.S. rank	Imports from the United States	Imports from the world
Australia and New Zealand	1	52.33	208.77
Brazil	1	34.93	117.34
China	3	168.68	1,054.31
EU 25	2	470.54	2,351.59
India	3	20.50	162.62
Mexico	1	290.35	398.22
South Africa	2	15.87	93.79
South Korea	1	90.17	269.60
Total		1,143.37	4,656.24

Source: ITA derived these numbers using the HTS codes and the World Trade Atlas database.

25, the majority of its imported equipment came from South Africa, while South Africa's imported equipment came from Germany. China's primary trade partners for imported CCT equipment were Japan and Germany, while India imported the majority of its CCT equipment from Thailand and Germany (see Table 4).

The percentage of CCT equipment imports from the United States to each of those countries in 2005 was derived by dividing the dollar amount of imports from the United States by the dollar amount of imports from the world. Of note, Mexico imported 72.9 percent of its CCT equipment from the United States, followed by South Korea, which imported 33.4 percent of its equipment from the United States (see Figure 2).

Figure 2: Percentage of CCT Equipment Imports Sourced from the United States in 2005



Source: World Trade Atlas.

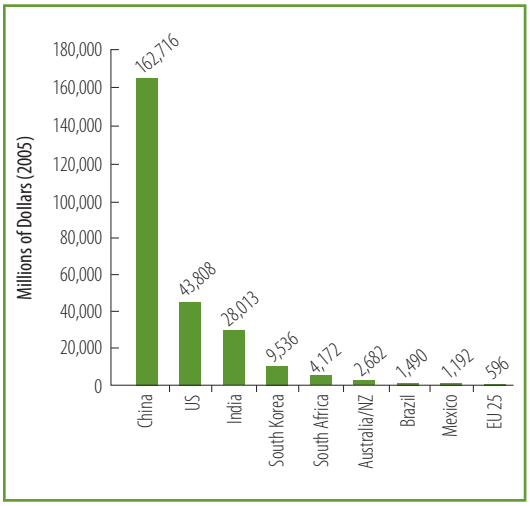
Total Worldwide Demand for CCT Equipment from 2003 to 2030: $254 billion

The potential world market for CCT equipment for the countries analyzed was deduced by multiplying the projected increase in coal-fired gigawatts from 2003 to 2030 (as noted in Figure 1) by the cost of one gigawatt of CCT equipment in 2005 dollars ($298 million). The resulting amount is a cumulative total of CCT equipment imports from 2003 to 2030 in millions of 2005 dollars. According to those assumptions, China would import $163 billion in CCT equipment worldwide from 2003 to 2030, and India's imports would total $28 billion from worldwide sources (see Figure 3).

Cumulative U.S. CCT Exports from 2003 to 2030: $36 Billion

The potential total U.S. market share for CCT equipment imports from 2003 to 2030 for each of the countries, was calculated by multiplying the potential world market for CCT equipment (as noted in Figure 3) by the current U.S. market share (as noted in Figure 2). The result was $36 billion. The analysis indicates that China could potentially import $26 billion from the United States in CCT equipment from 2003 to 2030 (see

Figure 3: Total World Market for CCT Equipment, Cumulative, 2003–2030



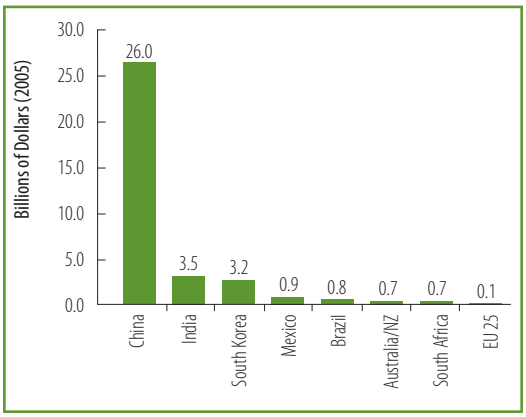
Source: International Trade Administration, U.S. Department of Energy, and World Trade Atlas.

Figure 4). India and South Korea may each take in approximately $3 billion in U.S. CCT equipment. A similar methodology can be used to determine the cumulative U.S. CCT exports by 2015, which would be $15 billion.

Conclusion

In light of predicted increases in coal use for electricity production worldwide between 2003 and 2030, as well as overall U.S. competitiveness in emissions abatement equipment and advanced coal-fired power plants, China, India, and South Korea present the greatest value of U.S. exports of CCT in this study, representing approximately $26 billion, $3.5 billion, and $3.2 billion, respectively.[9] Additional markets for growth in U.S. CCT exports include Australia, Brazil, Mexico, New Zealand, South Africa, and the EU 25, for a total of $2.9 billion.

Figure 4: Total U.S. Market for CCT Equipment, Cumulative, 2003–2030



Source: International Trade Administration, U.S. Department of Energy, and World Trade Atlas.

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Endnotes

1. The countries of the EU 25 are those that were members as of May 1, 2004: Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Malta, Poland, Portugal, Slovakia, Spain, Sweden, and the United Kingdom. Currently the EU has 27 members.

2. Department of Energy, Energy Information Administration, *2006 International Energy Outlook*, available on the Internet at http://tonto.eia.doe.gov/FTPROOT/forecasting/0484(2006).

3. Supercritical plants allow for higher pressures and temperatures, thereby enabling higher combustion efficiencies compared with standard pulverized coal power plants.

4. The most recent data available for analysis are noted in EIA's *International Energy Outlook 2006.*

5. See Department of Energy, "Natural Gas Combined Cycle "H" Class Gas Turbine" in *Market-Based Advanced Coal Power Systems* Appendix E, Page 22, May 1999, *www.fe.doe.gov/programs/powersystems/publications/MarketBasedPowerSystems/appe.pdf.*

6. The most recent data available for analysis is from 2005 and can be found in the World Trade Atlas database http://*www.gtis.com/product.cfm?level=1&type=W.*

7. This figure is derived from data obtained from the World Trade Atlas database.

8. Details of the HTS codes are found at http://*hotdocs.usitc.gov/docs/tata/hts/bychapter/0612c84.pdf.*

9. For assumptions, refer to the section titled "Worldwide Clean Coal Technology Demand."

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