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GPT and GHG Emissions from Coal Exports

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1 Summary

The proposed Gateway Pacific Terminal (GPT) project will include an annual export capacity of 48 million metric tons of coal; coal will be produced in the Powder River Basin (PRB), transported by rail to the terminal then exported by deep draft, ocean-going vessels to Pacific Rim countries. The end use of coal is most likely dominated by the power generation sector in China. At issue is the question of whether a new west coast export facility could cause increased consumption of coal and corresponding increased greenhouse gas (GHG) emissions, particularly CO_2.

Examination of the Asian coal market and power generation sector (particularly in China, the expected destination of GPT coal), including data and literature on the globally determined pricing of coal, the predominant role of the government in the Chinese electricity sector, and the rapidly growing demand for energy production regardless of fuel source, shows that the maximum availability of 48 million metric tons of PRB coal exported through the GPT Terminal will ***not create a net increase in GHG emissions***.

Net GHG emissions could only increase if PRB exports through the GPT result in a net increase in worldwide coal use. Net worldwide coal use would only increase as a result of the GPT if:

1) Global or regional coal use is constrained now or in the future by coal availability, meaning the total demand for coal exceeds the total potential supply and exports via GPT would increase the available supply, or

2) GPT exports reduce global or regional coal prices and energy generation cost, causing coal use to increase more than it otherwise would through:

    a) An increase in total power generation in response to a rise in demand associated with less expensive electricity rates.

    b) Substitution of coal for other, less GHG intensive sources of power generation, such as hydrologic, geothermal, nuclear, etc. (fuel switching).

Review of data and literature on the global coal market from such sources as the U.S. Energy Information Administration (EIA) and published economics literature shows that none of these conditions is expected to occur as a result of the operation of the proposed GPT and export of PRB coal to Asia, particularly China. Economically recoverable coal reserves are plentiful worldwide and in China itself, so PRB coal shipped through the GPT will simply displace coal from other sources, not increase total coal use. The amount of coal shipped via the GPT is so small relative to the total coal market that it will have little to no effect on worldwide or Chinese coal prices, with no consequent expected effects on coal use, consumption of electricity, or GHG emissions[1].

[1] GHG emissions from bulk coal transportation were not included in this analysis as they are associated with all sources of imports and while variable between source locations are not significant when viewed in the context of emissions from power generation.

2 Supporting Documentation

2.1 Point 1: Proved coal reserves exceed projected coal demand for the foreseeable future, even without PRB coal.

Global proved coal reserves[2] are estimated at nearly 861,000 million metric tons. These reserves, which are economically feasible to extract under current conditions, are distributed throughout the world, with a significant proportion located in countries currently serving the Asian market: Russia (18%), China (13%), United States (28%), and Australia (9%). In countries serving the Asian market, total proved reserves far exceed current rates of extraction. For example, at current rates of extraction, proved coal reserves would last 443 years in Russia, 257 years in the United States, 31 years in China, 31 years in Indonesia, and 177 years in Australia. Proved coal reserves within the Asia Pacific region would last for 51 years at 2012 extraction rates. Adding in Russian reserves and production, proved reserves in the Asia Pacific and Russia would last for 76 years at 2012 extraction rates. Globally, at current rates of extraction, proved coal reserves would last 109 years (Table 2-1).

Total global coal demand in 2012 was 7,151 million metric tons, of which China accounted for 51% (3,681 million metric tons) by itself. Global annual coal consumption is estimated to increase 43% from 7,151 million metric tons in 2012 to 10,196 million metric tons in 2040 (Table 2-2), with 89% of this increase occurring in the Asia Pacific region and 64% of this increase (1,960.6 million tons / 3,045.0 million tons) occurring in China alone. Growth in Chinese demand represents 72% of *Asia Pacific growth* (1,960.6 million tons / 2,709.0). Clearly the rise in Chinese demand dominates both the regional (Asia Pacific) and global increase in coal consumption over the period 2012 to 2040.

Other coal producing countries currently exporting to Asia, notably Australia and Russia have the proved reserves to meet Asia's growing demand. As shown in Tables 2-1 and 2-2, both Russia and Australia have very high reserve to production ratios (R/P) and low growth in domestic consumption. Even at 2040 extraction rates, proved reserves within Asia and in nearby coal exporting countries, notably Russia and Australia, could meet the Asia Pacific demand for coal for over 50 years (this is estimated by including Russian reserves and demand with the Asia Pacific region). Taking into account proved reserves in other countries currently exporting coal to Asia (including South Africa, Colombia, and the United States), proved reserves can meet Asia Pacific demand for the foreseeable future, even barring PRB exports.

Table 2-1 Global Proved Reserves and Export Volume (Million Metric Tons)

Region	Anthracite and Bituminous	Sub-bituminous and Lignite	Total	% Global Reserves	Reserves / Current Production	2011 Export Volume
North America	112,835	132,253	245,088	29%	244	132
United States	108,501	128,794	237,295	28%	257	98
Powder River Basin	---	22,680	22,680	3%	59	---
South / Central America	6,890	5,618	12,508	2%	129	83
Europe / Eurasia	92,990	211,613	304,603	35%	238	204
Russia	49,088	107,921	157,010	18%	443	126
Middle East / Africa	32,721	174	32,894	4%	124	73

2 Proved reserves are defined as following the BP Statistical Review of World Energy: "Generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known deposits under existing economic and operating conditions." (BP, 2013, page 30.)

Region	Anthracite and Bituminous	Sub-bituminous and Lignite	Total	% Global Reserves	Reserves / Current Production	2011 Export Volume
Asia Pacific	159,326	106,517	265,842	31%	51	675
Australia	37,100	39,300	76,399	9%	177	284
China	62,200	52,300	114,499	13%	31	17
India	56,100	4,500	60,600	7%	100	5
Indonesia	1,520	4,009	5,529	1%	14	309
Japan	340	10	350	---	265	1
Asia Pacific & Russia	192,047	106,691	298,737	35%	55	748
Global	**404,761**	**456,175**	**860,937**	**100%**	**109**	**1167**
Global, Without PRB	**404,761**	**433,495**	**838,257**	**---**	**106**	**---**

Source: Adapted from BP, 2013 and USGS, 2013. Export data from EIA, 2011. Export data converted from short tons to metric tons by factor of 0.907184 metric tons per short ton. See http://www.eia.gov/tools/faqs/faq.cfm?id=7&t=2.

Reserves-to-production (R/P) ratio – If the reserves remaining at the end of the year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate. PRB production (2012) source: http://www.platts.com/latest-news/coal/washington/power-river-basin-producers-finding-it-more-costly-21402408. Note that the R/P ratio without PRB reserves is estimated as global proven reserves (less PRB reserves) divided by total extraction (including PRB reserves).

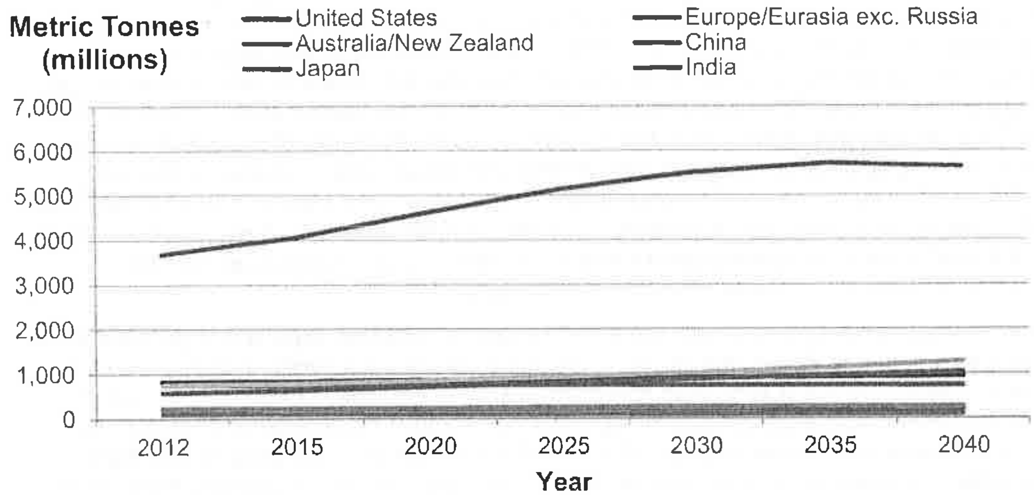
Table 2-2 Current and Projected Global Coal Consumption (Million Metric Tons)

Region	2012	2040	Change	% Change	% Global Change
North America	908.9	1,032.5	123.6	14%	4%
South / Central America	42.0	73.8	31.8	76%	1%
Middle East / Africa	203.8	352.8	149.0	73%	5%
Europe / Eurasia	968.4	1,000.0	31.6	3%	1%
Asia Pacific	5,028.3	7,737.3	2,709.0	54%	89%
*Australia**	105.7	90.6	-15.1	-14%	0%
China	3,681.0	5,641.6	1,960.6	53%	64%
India	584.6	1,040.0	455.4	78%	15%
Japan	227.4	200.0	-27.4	-12%	-1%
Global	**7151.4**	**10,196.4**	3,045.0	43%	--

Source: EIA, 2013a. Consumption data converted from quadrillion BTU to short tons by factor of 19,530,000 BTU/short ton and from short tons to metric tons by factor of 0.907184 metric tons per short ton. See http://www.eia.gov/tools/faqs/faq.cfm?id=667&t=2 and http://www.eia.gov/tools/faqs/faq.cfm?id=7&t=2.

* Consumption data for Australia also includes New Zealand. New Zealand accounts for 0.1% of global proved reserves.

Figure 2-1 Demand Growth in Major Coal Markets



Source: EIA, 2013a. Consumption data converted from quadrillion BTU to short tons by factor of 19,530,000 BTU/short ton and from short tons to metric tonnes by factor of 0.907184 metric tons per short ton. See http://www.eia.gov/tools/faqs/faq.cfm?id=667&t=2 and http://www.eia.gov/tools/faqs/faq.cfm?id=7&t=2.

2.2 Point 2: Proposed coal exports through GPT have limited potential to affect global or Asian coal prices

As estimated in a briefing paper for the Western Interstate Energy Board, due to its very low cost of extraction, PRB coal has an expected supply cost (cost and freight, or CFR) below that of Australian (and presumably) other exporters to Asia (McAllister, Undated). However, PRB exports through GPT are not likely to measurably affect coal price in Asia. This is due to two factors: 1) the integrated, global nature of the coal market, where global coal price is increasingly determined by the Chinese domestic price, and 2) the relatively low volume of PRB coal potentially available from GPT.

PRB is one of many coal sources supplying an integrated global coal market. All coal suppliers sell at the prevailing market price for coal of similar quality. (Coal quality is primarily determined by the heating value of the coal, but also influenced by other factors such as moisture, ash content, and SO_2 content.) Coal market price is reported as a combination of cost and freight (CFR) for coal of similar heat content. For example, the CFR spot price in South China on August 5, 2013 for coal with heating content of 5,500 kcal/kg NAR (net as received), was reported as $77.30 per metric ton. Regardless of supply cost, this is the market price of coal transacted in South China in early August.

The price of coal, after adjusting for transport cost and coal quality, is consistent across different geographic regions. Although coal is a bulky commodity that is costly to transport, there are coal suppliers in South Africa, Australia, and the United States that, through seaborne shipping, link geographic disparate markets and integrate price globally. The globally integrated nature of the steam coal market has been borne out in several academic studies. For example, Li (2008) examined whether there is a single economic market for the international coal industry. He concludes that, "Using three different tests, we obtained a consistent conclusion – the international steam coal market is generally integrated" (Li, 2008). Because the coal market is integrated globally, for a coal supplier to affect price, the volume it supplies has to be a sizable share of the global coal market. On this global market, lower supply costs (including extraction and freight) enjoyed by individual producers accrue in the form or higher profits relative to other, higher cost producers.

China is the largest producer and consumer of coal in the world. Global coal prices are determined largely by China's domestic price, not the cost of international supplies such as PRB. Given its size, small changes in China's domestic production can have substantial influence on international prices. As noted by Morse and He (2010), "China's role as the world's largest coal arbitrageur has a hugely significant implication for the global coal market: it links the international price of coal to China's domestic price. China's buying and selling activity on the margins of its massive domestic coal market bring domestic and global prices closer to parity (though at present not to complete parity)." This finding, that China significantly influences international coal market price, is also supported by Lin and Liu (2010), who find that: "The transformation of China from being a coal exporter to a significant coal importer will be inevitable and will have a great impact on the international coal markets, especially Asian markets.... If this is the case, a slight change in China's coal market would have a great impact on international coal markets, especially on international coal prices."

In this global market dominated by China, the small volume of PRB coal exported to Asia will have limited impacts on global or Asian coal price. GPT's maximum annual capacity of 48 million metric tons accounts for small volumes of both Asian and global coal trade volumes. Operating at maximum capacity, the maximum annual supply of coal through GPT represents 0.7% of global coal consumption and just 1.3% of Chinese coal consumption in 2012 (EIA, 2013a). Even as a proportion of total Asian imports, GPT coal is a small portion of the market: GPT would represent 8.5% of projected Asian steam import demand in 2020 and 6.4% of projected Asian steam import demand in 2040 (EIA, 2013b).

2.3 Point 3: Even if coal exports through GPT reduce the price of coal in China, price reductions are unlikely to increase Chinese coal use.

Any change in coal price due to PRB coal is unlikely to affect Chinese coal use and associated GHG, for three reasons: 1) government participation in the electric sector disconnects the link between coal price and demand (steam coal use in China is predominantly by the power generation sector), 2) price has a weak influence on power demand in China (inelastic demand), as demand is determined more by other factors than price, including income growth and population growth, and 3) Infrastructure capacity limitations, in both generation and transmission, limits growth in both coal use and overall energy use.

Government policy and participation in the energy sector profoundly limits the effect on coal use of any change in coal price. China's electricity sector is "fundamentally government owned and operated," with a lack of a "robust link between prices and costs." (Kahrl et al, 2011). Government intervention in the power market starts with its ability to influence the price received by domestic coal suppliers, to the dispatching of power plants, to setting of electricity rates, to the level of investment in different types of generation technologies (renewable, coal, hydropower, etc.).

Government policy limits the effects of price signals on the supply side of Chinese electricity generation. The level of coal use by existing generation facilities does not fluctuate with energy prices (i.e. use of existing capacity doesn't vary based on relative fuel prices). Even if coal plants have a (greater) cost advantage over other power sources due to cheaper coal, they cannot increase production and sell more because electricity production is allocated through a quota system. "Dispatching of power plants (i.e., turning generators on and off as the requirement for power changes) is also not done with an eye toward costs. Rather than being dispatched in order of lowest marginal cost, as in the United States, in China power plants are assigned roughly the same number of operating hours, which means that the least efficient power plants may run just as much as the most efficient ones." (Kahrl et al, 2011).

Government regulation of Chinese electricity rates also limits the effect of price signals to influence demand for electricity. Retail electricity rates in China are set by the National Development and Reform Commission (NRDC), and are subsidized, limiting any effect of PRB on energy demand. As noted by the EPA (2011), "China's electricity prices are complex and still mostly regulated by the government. The NDRC determines both the price at which generating companies can sell power to the grid and what prices the grid operators can charge different categories of users." Cost savings from energy production are thus likely not passed on to end users. (Even if coal prices drop, electricity prices may not change, limiting effects on energy demand.)

Energy policy in China is also aimed at increasing energy security and achieving environmental goals, both of which limit the influence of fuel prices and the role of coal imports in national energy production. China is aiming to reduce its carbon intensity (carbon emissions per unit of GDP), which will limit total coal use as a percentage of energy production. As part of its 12th Five Year Plan, the Chinese government has set a target to raise non-fossil fuel energy consumption to 11.4 percent of the energy mix by 2015. The EIA (2013c) projects that coal's share of the total Chinese energy mix will fall to 59 percent by 2035, due to anticipated higher energy efficiencies and China's goal to reduce its carbon intensity.

China may also encourage energy efficiency and environmental sustainability by maintaining (not reducing) retail electricity rates, even with reductions in energy production costs (such as would result from reductions in coal price). Although maintaining low electricity prices supports economic growth and social stability, it decreases energy supply security and energy use efficiency. As noted by Hang and Tu (2007), "China has a long way to go in terms of future energy price reform, because policy makers face a trade-off among economic growth, social stability, energy supply security, and energy efficiency. Since the beginning of 2006, the state government has raised energy prices several times."

Finally, energy security concerns also limit total imports of coal. Coal is differentiated by heating value, moisture, ash content, SO2 content, CO2 content, etc. Power facilities have specific requirements for the types of coal that can be used, and Chinese power plant generators are designed to burn domestic coal. This acts as a technical constraint on the amount of coal that can be imported and used by domestic generators. As noted by Morse and He (2010), "Coal powered plants limit total imports of coal. Power plants boilers are designed to burn specific specification of coal, which is almost always domestic for energy security reasons. Power generators can blend imports and domestic supplies, but there is a technical limitation on the amount of blending that can occur."

Power demand in China is determined more by other factors than price (i.e. demand is inelastic), including income growth and population growth. As noted by Mark Thurber (2013), Associate Director of the Program on Energy and Sustainable Development at Stanford University," if coal is exported to China, and China's demand is inelastic because of the country's rapid growth and limited available substitutes, exporting PRB coal could actually lead to a net reduction in greenhouse gases. China would simply be substituting imports for domestic coal and burning the same quantity of coal, while the increased coal price in the United States from higher PRB exports would lead to even more U.S. coal-to-gas switching. This logic probably holds to the extent that exports go to China and the mere existence of available PRB coal does not encourage China to build more coal power plants (Thurber, 2013). Also, as found in research by Hang and Tu (2007), "the positive own-price elasticity of electricity after 1995 probably indicates that the price effect was weaker than other factors such as income effect and population effect."

Finally, growth in energy consumption due to any price decrease is limited by available infrastructure capacity, including both generation and transmission capacity. Regarding generation capacity, in 2011, a publication by the World Bank noted that the Chinese "increase in economic output has spurred a corresponding increase in electricity consumption. In 2004–5, the industrial sectors, especially in the east coastal provinces, suffered from significant electricity shortages. Even with the major capacity additions since then, shortfalls continue to occur, particularly during the summer months. In short, the growth of capacity, extraordinary as it has been, is still struggling to meet the continuing surge of demand" (Nan and Mosely, 2011).

As generation capacity increases, growth in Chinese energy use may be limited by transmission capacity. As noted by the EPA (2011), "China has long struggled with the problem of most of its power generation facilities, both coal fired and hydroelectric, being located in the north and west of the country, while greater than 75 percent of energy demand comes from the heavily industrialized and densely populated central and eastern regions. A lack of reliable transmission capability has led to frequent supply disruptions in the major energy consuming regions."

2.4 Conclusion

Based on consideration of both availability and price, it is unlikely that export of PRB coal through the proposed Gateway Pacific Terminal will cause or contribute to an increase in annual coal consumption or GHG emissions.

3 References

BP, 2013. "BP Statistical Review of World Energy, June 2013." http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf. Accessed 8/19/2013.

Hang, L and Tu, M. 2007. "The impacts of energy prices on energy intensity: Evidence from China". Energy Policy 35. p2978–2988.

Kahrl, Fredrich; Jim Williams, and Ding Jianhua. 2011. "Four Things You Should Know about China's Electricity System." China Environmental Forum, Woodrow Wilson International Center for Scholars.

Li, Raymond. 2008. "International steam coal market integration." Department of Economics, Macquarie University, Australia.

Lin, Bo-qiang and Jiang-hua Liu. 2010. "Estimating coal production peak and trends of coal imports in China," Energy *Policy* 38. p512–519.

McCallister, Richard. Undated. "Coal Exporting Terminals." Briefing Paper prepared for the Western Interstate Energy Board. http://www.westgov.org/wieb/coalports/cpBP.pdf. Accessed 8/19/2013.

Morse, Richard and Gang He. 2010. "The World's Greatest Coal Arbitrage: China's Coal Import Behavior and Implications for the Global Coal Market." Stanford University Program on Energy and Sustainable Development, Working Paper #94, August 2010. http://pesd.stanford.edu/publications/the_worlds_greatest_coal_arbitrage_chinas_coal_import_behavior_and_implications_for_the_global_coal_market. Accessed 8/15/2013.

Thurber, Mark. 2013. "Coal in Asian and the Impact of the Shale Gas Revolution. An Interview with Mark Thurber, March 21, 2013 by the National Bureau of Economic Research." http://www.nbr.org/research/activity.aspx?id=325. Accessed 8/19/2013.

U.S. Energy Information Administration (EIA). 2011. "International Energy Statistics: Total Coal Exports (Thousand Short Tons)." http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=1&aid=4. Accessed 8/19/2013.

U.S. Energy Information Administration (EIA). 2013a. "International Energy Outlook 2013, Table A7: World coal consumption by region, Reference case, 2009-2040." http://www.eia.gov/forecasts/ieo/. Accessed 8/14/2013.

U.S. Energy Information Administration (EIA). 2013b. "Assumptions to the Annual Energy Outlook 2013: Coal Market Module. Table 12.3. World steam coal import demand by import region." http://www.eia.gov/forecasts/aeo/assumptions/pdf/coal.pdf. Accessed 8/14/2013.

U.S. Energy Information Administration (EIA). 2013c. "Country Analysis: China." http://www.eia.gov/countries/cab.cfm?fips=CH. Accessed 8/14/2013.

U.S. Environmental Protection Agency (EPA). 2011. "China's Energy Markets: Anhui, Chongqing, Henan, and Guizhou Provinces." U.S. EPA Coalbed Methane Outreach Program. November 2011.