MILLENNIUM BULK TERMINALS—LONGVIEW SEPA ENVIRONMENTAL IMPACT STATEMENT

SEPA COAL MARKET ASSESSMENT TECHNICAL REPORT

PREPARED FOR:

Cowlitz County
207 4th Avenue North
Kelso, WA 98626
Contact: Elaine Placido, Director of Building and Planning
(360) 577-3052

IN COOPERATION WITH:
Washington State Department of Ecology, Southwest Region

PREPARED BY:

ICF International
710 Second Avenue, Suite 550
Seattle, WA 98104
Contact: Linda Amato, AICP
(206) 801-2800

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Acronyms and Abbreviations

$/MMBtu	dollars per million British thermal unit
Applicant	Millennium Bulk Terminals—Longview, LLC
BNSF	BNSF Railway Company
Btu/lb	British thermal units per pound
CAIR	Clean Air Interstate Rule
CFR	Code of Federal Regulations
CN	Canadian National
CO_2	carbon dioxide
CP	Canadian Pacific
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
FOB	Free on board
FPL	Florida Power and Light
GHG	greenhouse gas
IEA	International Energy Agency
IPM®	Integrated Planning Model
MMBtu	million British thermal unit
NOx	nitrogen oxides
SO_2	sulfur dioxide
TBtu	trillion British thermal unit

Chapter 1
Introduction

Millennium Bulk Terminals—Longview, LLC (Applicant) proposes to construct and operate a coal export terminal in Cowlitz County, Washington, along the Columbia River (Figure 1). The coal export terminal would receive coal from the Powder River Basin in Montana and Wyoming and the Uinta Basin in Utah and Colorado via rail, then load and transport the coal by ocean-going vessels via the Columbia River and Pacific Ocean to overseas markets in Asia. The coal export terminal would be capable of receiving, stockpiling, blending, and loading coal by conveyor onto ships for export. Construction of the coal export terminal would begin in 2018. For the purpose of this analysis, it is assumed the coal export terminal would operate at full capacity in 2028.

1.1 Project Description

Millennium Bulk Terminals—Longview, LLC (Applicant) proposes to construct and operate a coal export terminal in Cowlitz County, Washington, along the Columbia River (Figure 1). The coal export terminal would receive coal from the Powder River Basin in Montana and Wyoming and the Uinta Basin in Utah and Colorado via rail, then load and transport the coal by ocean-going ships via the Columbia River and Pacific Ocean to overseas markets in Asia. The coal export terminal would be capable of receiving, stockpiling, blending, and loading coal by conveyor onto ships for export. Construction of the coal export terminal would begin in 2018. For the purpose of this analysis, it is assumed the coal export terminal would operate at full capacity in 2028.

The following subsections present a summary of the Proposed Action and No-Action Alternative. For detailed information on these alternatives, see the Washington State Environmental Policy Act (SEPA) Alternatives Technical Report (ICF International 2016).

1.1.1 Proposed Action

The Proposed Action would develop a coal export terminal on 190 acres (project area). The project area is located within an existing 540-acre area currently leased by the Applicant at the former Reynolds Metals Company facility (Reynolds facility), and land currently owned by Bonneville Power Administration. The project area is adjacent to the Columbia River in unincorporated Cowlitz County, Washington near Longview city limits (Figure 2).

The Applicant currently and separately operates, and would continue to separately operate, a bulk product terminal on land leased by the Applicant. Industrial Way (State Route 432) provides vehicular access to the Applicant's leased land. The Reynolds Lead and the BNSF Spur, both operated by Longview Switching Company (LVSW),[1] provide rail access to the Applicant's leased area from a point on the BNSF Railway Company (BNSF) main line (Longview Junction, Washington) located to the east in Kelso, Washington. Ships access the Applicant's leased area via the Columbia River and berth at an existing dock (Dock 1) operated by the Applicant in the Columbia River.

[1] The Longview Switching Company (LVSW) is jointly owned by BNSF Railway Company (BNSF) and Union Pacific Railroad (UP).

Figure 1. Project Vicinity

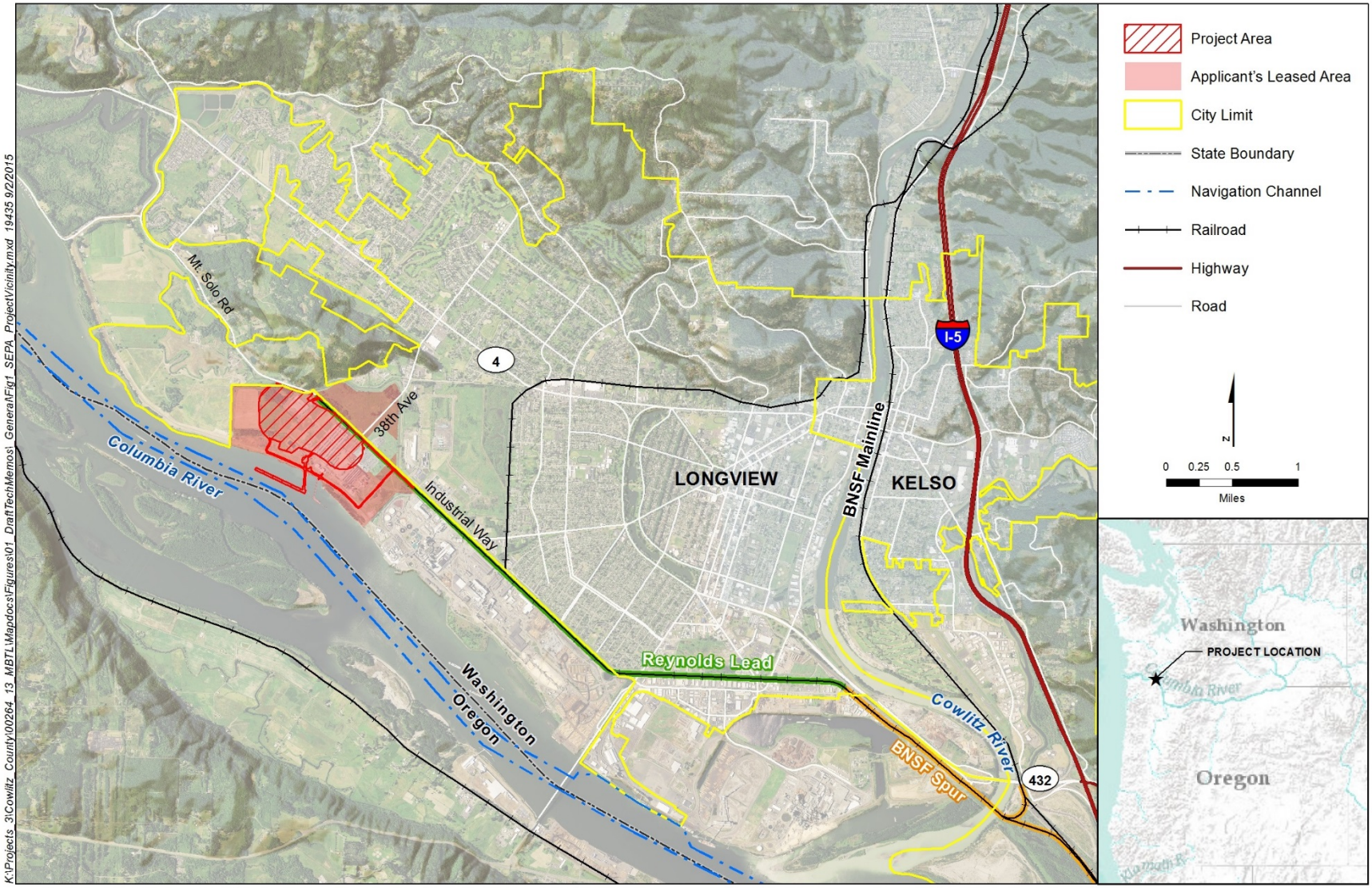
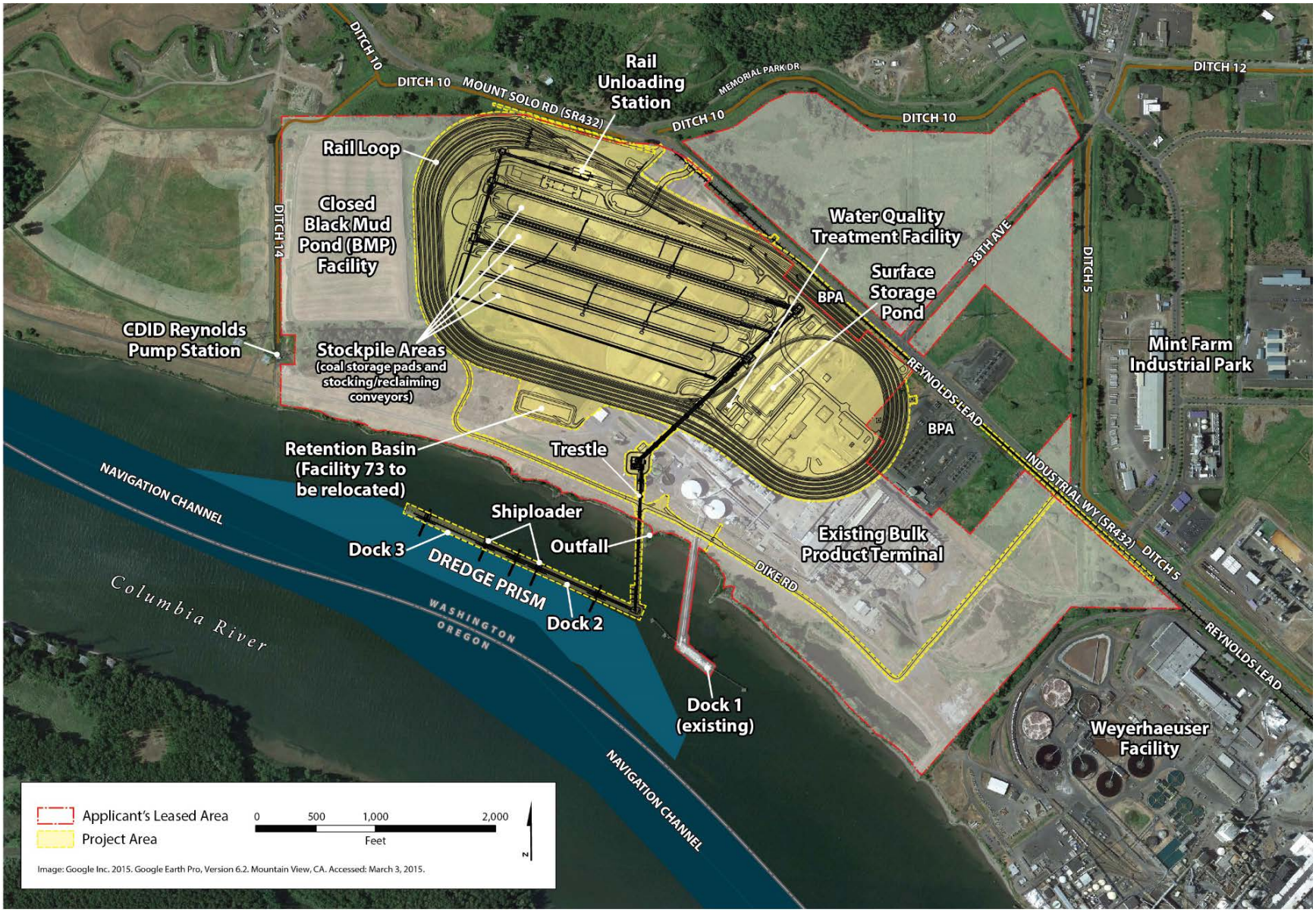


Figure 2. Proposed Action



Under the Proposed Action, BNSF or Union Pacific Railroad (UP) trains would transport coal in rail cars from the BNSF main line at Longview Junction, Washington, to the project area via the BNSF Spur and Reynolds Lead. Coal would be unloaded from rail cars, stockpiled and blended, and loaded by conveyor onto ocean-going ships at two new docks (Docks 2 and 3) on the Columbia River for export.

Once construction is complete, the Proposed Action would have an annual throughput capacity of up to 44 million metric tons.[2] The coal export terminal would consist of one operating rail track, eight rail tracks for the storage of rail cars, rail car unloading facilities, stockpile areas for coal storage, conveyor and reclaiming facilities, two new docks in the Columbia River (Docks 2 and 3), and ship-loading facilities on the two docks. Dredging of the Columbia River would be required to provide access to and from the Columbia River navigation channel and for berthing at the two new docks.

Vehicles would access the project area from Industrial Way (State Route 432). Ships would access the project area via the Columbia River and berth at one of the two new docks. Terminal operations would occur 24 hours per day, 7 days per week. The coal export terminal would be designed for a minimum 30-year period of operation.

1.2 Overview of Coal Market Analysis

This report presents the analysis of coal production, consumption, distribution, and CO_2 emissions from combustion of coal in relation to the U.S. and Pacific Basin markets. The analysis examines the Proposed Action and No-Action Alternative and documents the methods and data used to develop the results and conclusions.

This analysis examines the movement of coal from the Powder River Basin in Montana and Wyoming, and coal from the Uinta Basin in Colorado and Utah, through the proposed coal export terminal to China, Japan, South Korea, and Taiwan. Only coal from these coal basins were examined based on information provided by the Applicant. To examine the potential impact of the proposed coal export terminal on domestic and Pacific Basin coal markets, a least-cost, linear programming model was used to capture the dynamic interactions between the supply and demand regions within these markets.

Historically, approximately 2% of Powder River Basin coal has been exported.[3] There are four primary reasons that Powder River Basin coal has not been exported in larger quantities in the past.

- The Powder River Basin is far from large U.S. coal export facilities along the Atlantic coast and in the Gulf Coast.
- Canadian coal export facilities in the Pacific Northwest have had limited capacity for Powder River Basin coal or are too far to be economic.

[2] A metric ton is the U.S. equivalent to a tonne per the International System of Units, or 1,000 kilograms or approximately 2,204.6 pounds.

[3] Based on EIA U.S. Domestic and Foreign Coal Distribution by State of Origin.

- Powder River Basin coal has a lower heat content than eastern bituminous coals. Lower heat content increases transportation cost per unit of energy delivered.[4]
- Powder River Basin coal is subbituminous coal that is suitable for use in electric power plants, but is not suitable for coking coal, which limits the marketability of the coal.

The Proposed Action would address the first two reasons Powder River Basin coal has not been exported, and thus would reduce the distance to Pacific Basin markets and make Powder River Basin coal more competitive with other coal delivered to the Pacific Basin. Currently, the largest suppliers of coal in the Pacific Basin are Australia, China, India, and Indonesia. This analysis examines the U.S. and Pacific Basin coal market changes that would take place under the Proposed Action, under five different scenarios. The scenarios examine a wide range of possible future market states that would have an influence on how the proposed coal export terminal would affect these markets

1.2.1 Report Organization and Chapter Summary

The following sections describe the remaining chapters of this report.

1.2.1.1 Chapter 2, U.S. Coal Market and Pacific Northwest Export Terminals

This chapter provides a brief overview of the U.S. coal market and more in-depth information about the Powder River Basin and the Uinta Basin. Information on the type of coal mined in these coal basins is included, as well as the historical distribution of the coal. This chapter also discusses the existing and planned Pacific Northwest coal export terminals.

1.2.1.2 Chapter 3, International Coal Markets

Chapter 3 describes the international coal markets into which the coal exported from the proposed coal export terminal would enter. This chapter provides information on the major coal importing and exporting countries and provides a summary of each country that is a possible destination for coal exported from the terminal. Finally, this chapter provides a brief discussion on international coal prices.

1.2.1.3 Chapter 4, Model Framework, Methods, and Key Assumptions

Chapter 4 provides a summary of the model, methods, and assumptions used in this analysis to estimate coal production, consumption, distribution, and CO_2 emissions. This analysis uses ICF International's Integrated Planning Model (IPM®) to assess coal production, consumption, and distribution patterns that would be affected by the Proposed Action. This computer modeling platform is also used by the U.S. Environmental Protection Agency (EPA), other government entities, electric utilities, independent power producers, coal companies, and environmental groups. The assumptions used in this analysis are largely from publicly available sources.

[4] The cost per unit of energy delivered is proportional to the tons of coal transported and the heat content of the coal. If the energy or heat content per ton is low, then the transportation cost per unit of energy is higher.

1.2.1.4 Chapter 5, Scenarios

This chapter describes the five scenarios analyzed in this report. Under each scenario, both a No-Action Alternative and a Proposed Action were examined to determine the effect of the Proposed Action on the U.S. and Pacific Basin coal markets. The five scenarios analyzed in this report are as follows.

- Past Conditions (2014) Scenario, which represents the business as usual case in early 2015 but does not include the proposed or final Clean Power Plan.
- Lower Bound Scenario, which is designed to result in a reasonable lower bound of global CO_2 emissions from the power sector. The energy markets under the Lower Bound Scenario could be described as a high renewable energy penetration scenario, where international coal demand and prices are lower than in the Past Conditions (2014) Scenario.
- Upper Bound Scenario, which is designed to result in a reasonable upper bound of global CO_2 emissions from the power sector. The energy markets under the Upper Bound Scenario could be described as a high international coal demand scenario, where international coal demand and prices are higher than in the Past Conditions (2014) Scenario.
- 2015 Energy Policy Scenario, which differs from the Past Conditions (2014) Scenario in that it includes implementation of the U.S. Environmental Protection Agency (EPA)'s proposed Clean Power Plan and assumes greenhouse gas (GHG) policies are implemented in other countries, such as China. The Clean Power Plan was not enacted at the time of the model runs in mid-2015 but has since been adopted and there has been additional movement on international climate policies such that this scenario reflects the most probable scenario as of late 2015.
- Cumulative Scenario, which differs from the Past Conditions (2014) Scenario only in that it includes the capacity of other proposed Pacific Northwest coal export facilities.

1.2.1.5 Chapter 6, Modeling Results

Chapter 6 presents the modeling results of the five scenarios analyzed. The results are presented for the No-Action Alternative and Proposed Action and for the difference as calculated by subtracting the No-Action Alternative results from the Proposed Action results. Results are presented for coal production from the U.S. and non-U.S. producing regions; coal consumption in the U.S. and the Pacific Basin; the distribution of coal in the Pacific Basin; and CO_2 emissions from the combustion of coal. In addition, natural gas usage at electric power plants in the U.S. and the CO_2 emissions from natural gas combustion are reported as natural gas is a substitute fuel when coal consumption decreases.

1.2.1.6 Chapter 7, Conclusions

Chapter 7 provides a summary of the conclusions from the analysis.

Chapter 2

U.S. Coal Market and Pacific Northwest Export Terminals

2.1 General U.S. Coal Market

The United States is the world's second largest coal producer and consumer, with total coal production of 1 billion short tons in 2014. The largest coal producer and consumer is China, with total coal production of 4 billion short tons. This chapter discusses the U.S. coal market to provide context for the focus of this analysis, which is coal produced from the Powder River Basin and the Uinta Basin to be exported through the proposed terminal. The goal of this chapter is to provide a basic understanding of the U.S. coal markets, and Chapter 3, *International Coal Markets*, provides an overview of the international coal markets, both of which will help the reader to understand and interpret the modeling results

2.1.1 Total Production

Since 1990, total U.S. coal production has been over 1 billion tons, except for only 4 years. In this period, coal production has averaged 1.07 billion tons and peaked at 1.17 billion tons in 2008. Historically, about 90% of U.S. coal has been used domestically for power generation, with the remainder being used for industrial processes, steel production, or export. The Powder River Basin is the leading source of U.S. coal, at 40% of U.S. total coal production. The majority of Powder River Basin coal is used in domestic power plants, with only 1% to 2% being exported. Exports from the United States have been primarily to Europe.

Coal production and consumption have both decreased since 2011, when natural gas prices first fell below $3.5 per million British thermal unit (MMBtu). Natural gas is a competing fuel for electric generation and thus when natural gas prices are below $3.5/MMBtu the cost of generating electricity from natural gas is below the cost of generating electricity from some types of coal.

Coal is produced in four major coal basins within the United States, along with several smaller coal basins. The four major coal basins are the Powder River Basin, Rocky Mountains, Illinois Basin, and Appalachia. The Appalachian coal basin is further divided into a Northern, Central, and Southern section. The Rocky Mountain area includes the Uinta Basin, which includes Utah and the western part of Colorado, the Wyoming Green River area, and parts of Colorado not in the Uinta Basin.

2.1.2 Types of Coal

Coal has two primary uses: metallurgical and thermal. Coal used to produce coke (a hard porous residue used in steel manufacturing) is called metallurgical coal. Non-metallurgical coal is referred to as thermal or steam coal, because it is used to generate electricity through steam turbines. Metallurgical coal in the United States is found in the Appalachian basin. Thermal coal is produced in all regions.

Coal is also categorized by rank, with three ranks used in the United States. The coal ranks are, from hardest and highest heat content to softest and lowest heat content, bituminous, subbituminous, and

lignite. Bituminous coal is mined in the Appalachian and Illinois Basins as well as in the Rocky Mountains.[5] Subbituminous coal is primarily mined in the Powder River Basin. Lignite coal is primarily found in Texas and the Great Plains area of North Dakota and Montana.

Within each rank, coal is graded by the heat content as well as the trace elements found in the coal, such as sulfur, mercury, and chlorine. Generally, higher heat content coal sells at a higher price, and coal with lower concentrations of trace elements sells for a higher price, all else being equal.

2.1.3 Exports

The United States imports small amounts of thermal coal and exports both metallurgical and thermal coal. Appalachia is the focal point of U.S. coal exports. This is due to high coal quality, nearby infrastructure (i.e., ports), and locational proximity to Atlantic Basin markets. In the past, Appalachian coal demand has increased when international markets strengthened. However, there is large and growing energy demand and coal industry demand around the Pacific Basin. Delivered Pacific Basin coal prices were 2.1 times higher between 2010 and 2013 versus 2000 and 2006. The coal trade around the Pacific Basin is seaborne.

2.2 Powder River Basin

The Powder River Basin, located in Montana and Wyoming, is the largest source of coal production in the United States, accounting for 40% of national coal production (Figure 3). Powder River Basin coal is all subbituminous coal that is mined from large surface mines. Since 1970, Powder River Basin coal production has increased at an average annual rate of 10% per year (Figure 4). Between 1993 and 2008, production more than doubled, from 228 million tons per year to a record high of 496 million tons per year. Coal production in the Powder River Basin was able to expand so quickly because the coal seams are thick compared to all other coal-producing regions in the United States, and because the coal is close to the surface and can be mined using surface mining techniques. The largest Powder River Basin coal seams are 100 feet thick, while seams in other coal basins in the United States are typically less than 8 feet thick.

Between 2009 and 2011, coal production averaged 464 million tons per year, and ranged from 452 million tons in 2009 to 473 million tons in 2010 (U.S. Energy Information Administration 2013a). In 2012, production decreased to 425 million tons, driven down by the lowest natural gas prices in 15 years and lower electric power demand (Mine Safety and Health Administration 2014). This trend continued in 2013 with production decreasing to 416 million tons. The U.S. Energy Information Administration (EIA) expects total 2014 and 2015 production to meet or exceed 2013 production, but remain below 2012 production (U.S. Energy Information Administration 2014).

[5] The Uinta Basin is part of the Rocky Mountain coal production area.

Figure 3. Powder River Basin (Montana and Wyoming)

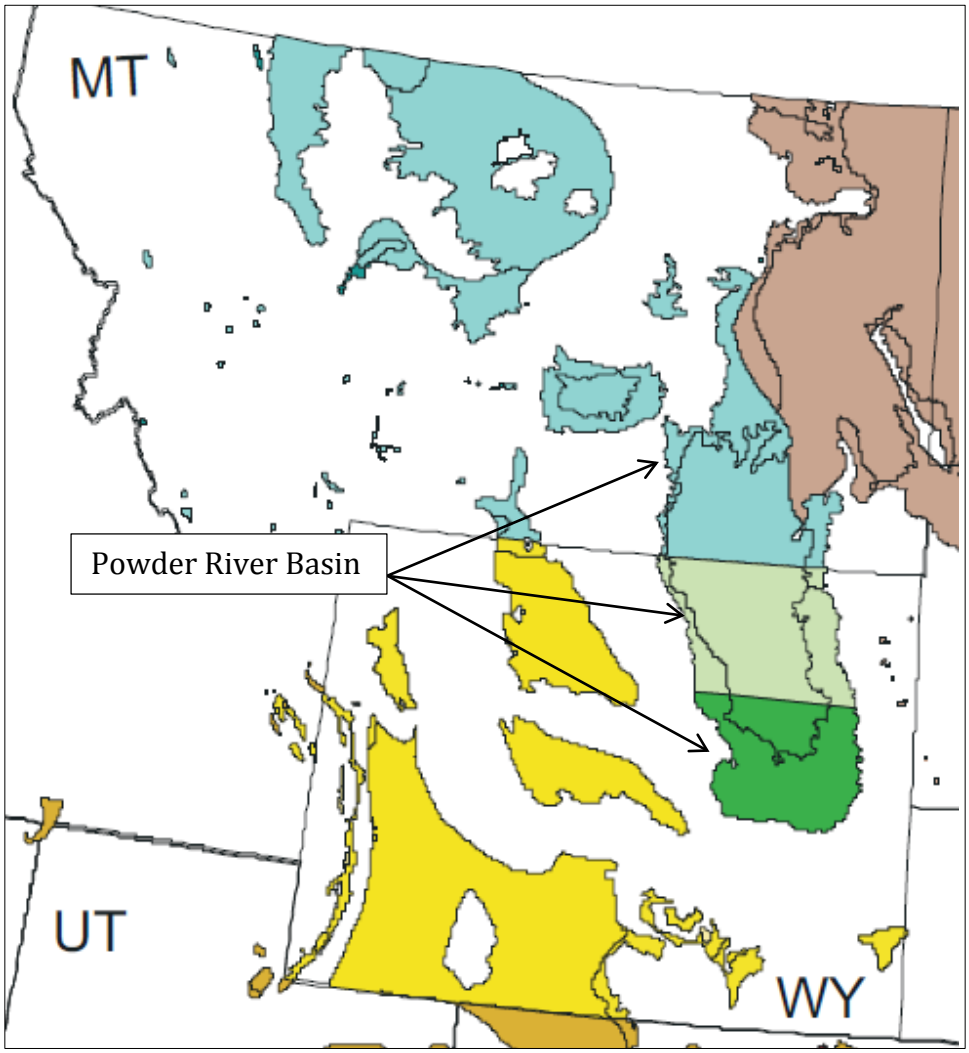
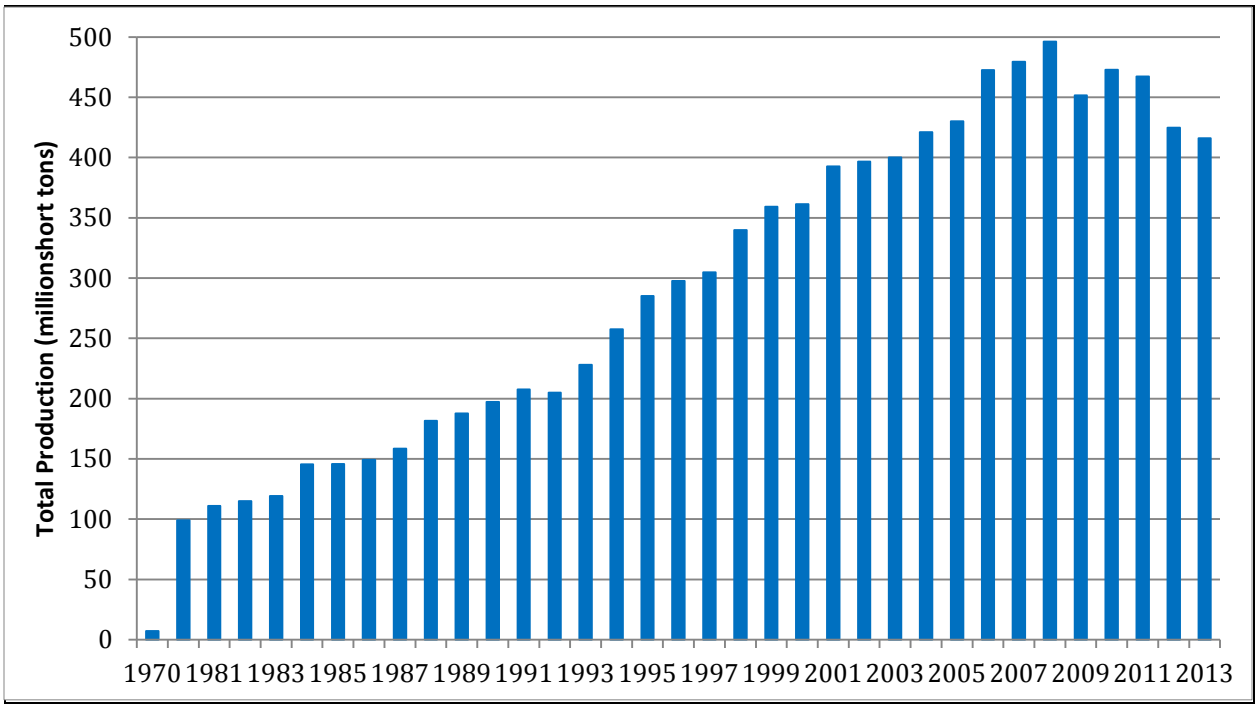


Figure 4. Historical Powder River Basin Coal Production (Montana and Wyoming)



Source: BXG Publications 1993 (1970–1982 data); Mine Safety and Health Administration 2014 (1983–2013 data).

This analysis considers the following three sources of Powder River Basin coal.

Montana coal: Coal produced in Montana with a heat content of 9,300 British thermal units per pound (Btu/lb).

Wyoming 8400 coal: Coal produced in Wyoming with a heat content of 8,400 Btu/lb.

Wyoming 8800 coal: Coal produced in Wyoming with a heat content of 8,800 Btu/lb.

Since 2008, Wyoming coalfields have produced about 91% of Powder River Basin coal, with the remaining 9% produced in Montana (Table 1). However, because Montana coal has a higher heat content, it is more likely to be exported. Higher heat content coals are more likely to be exported because they contain more heating potential per ton of coal, thus, users have to transport fewer tons of high heat content coal than they would have to import lower heat content coal. For example, a coal consumer would have to import 5.7% more Wyoming 8800 coal than they would the higher heat content Montana coal.

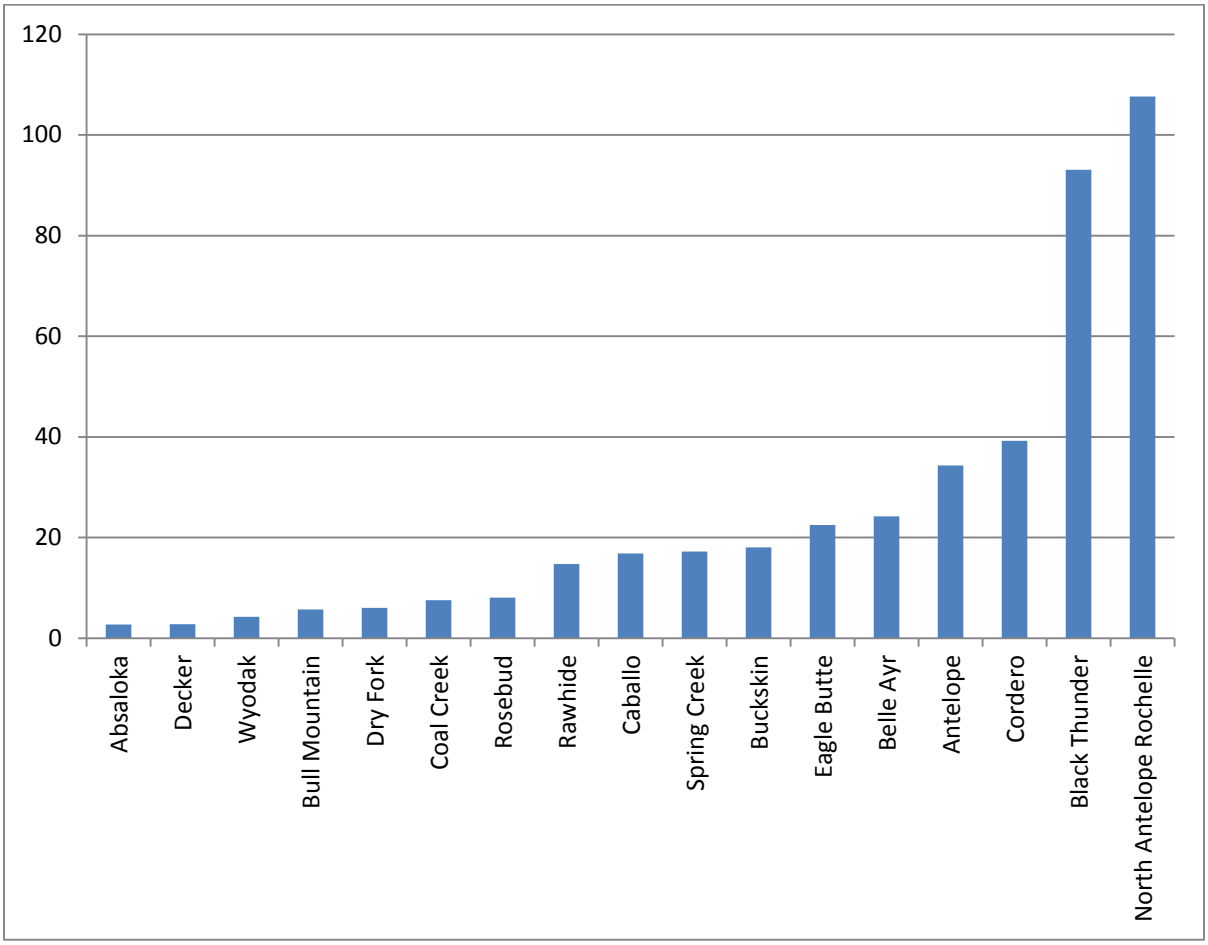
Table 1. Powder River Basin Coal Production by State (million short tons)

State	2008	2009	2010	2011	2012	2013	2014	2008–2014 Average
Montana	44	38	44	41	36	42	44	42
Wyoming	452	414	428	426	388	374	381	410
Total	496	452	473	467	425	416	425	451

Notes:
Source: Mine Safety and Health Administration 2014.

Figure 5 shows that only 17 mines contribute to coal production in the Powder River Basin, and all except one (Bull Mountain) are surface mines. Two mines (Black Thunder and North Antelope Rochelle) dominate production, accounting for approximately half of the region's coal production.

Figure 5. Powder River Basin 2012 Production by Mine (million short tons)



Source: Mine Safety and Health Administration 2014.

Powder River Basin coal mines are large compared to other U.S. coal mines. Most Powder River Basin mines produce at least 10 million tons per year, and two (the Black Thunder and the North Antelope Rochelle Mines in Wyoming) each produce 100 million tons per year. For comparison, mines in the eastern United States produce, on average, less than 1 million tons of coal per year, with very few mines producing over 4 million tons per year.

Mining conditions change over time. Initially coal reserves are mined that are the easiest to access and have the least amount of overburden.[6] However, as a mine ages, more overburden must be removed to access the coal, thus increasing the cost of production. Productivity gains have counteracted some of the increased cost of overburden removal. For example, the size of the shovels and trucks has increased, which allows more material to be moved in the same amount of time. The most significant contributor to the cost of surface mining coal production, however, remains the overburden ratio.[7]

2.3 Uinta Basin

The Uinta Basin coalfield is located in the western portion of Colorado and in Utah (Figure 6). Coal production in the Uinta Basin is from both underground and surface mines; however, over 80% of the coal is from underground mines (Mine Safety and Health Administration 2014). The coal produced from the Uinta Basin is both bituminous and subbituminous coal, with bituminous coal the predominant kind at 85% of annual production. The Uinta Basin bituminous coal has an average heat content of 11,345 Btu/lb and the subbituminous coal has an average heat content of 9,985 Btu/lb.[8]

Between 1983 and 2014, coal production in the Uinta Basin has ranged between 26.9 and 62.1 million short tons, with an average of 46.5 million short tons (Figure 7) (Mine Safety and Health Administration 2014). Uinta Basin coal production peaked in 2005 with 62.1 million short tons (Mine Safety and Health Administration 2014). Since 2005, Uinta Basin coal production steadily declined through 2010, and then picked up slightly in 2011 before declining again. Since 2011, Uinta Basin coal production has decreased from 45.6 million short tons to 38.5 million short tons in 2013.

This analysis considers two sources of Uinta Basin coal: coal produced in Colorado with a heat content of 11,780 Btu/lb, and coal produced in Utah. Two bituminous coal types are modeled in Utah, one with a heat content of 11,500 Btu/lb and low sulfur content and the second with a heat content of 11,950 Btu/lb and medium sulfur content.

[6] Overburden is the layers of soil and rock covering a coal seam. It is removed prior to surface mining and replaced after the coal has been taken from the seam.

[7] The overburden ratio refers to the ratio of the thickness of soil and rock that lies above a coal seam and the thickness of the coal seam itself. In surface mining, which is the predominant mining method in the Powder River Basin, the soil and rock above a coal seam must be removed before the coal can be mined. For example, a coal seam that is 30 feet thick and overlain by 120 feet of rock and soil would have an overburden ratio of 4.0 (=120/30)

[8] EIA 923 data, using a weighted average over 2010 through 2014.

Figure 6. Uinta Basin (Colorado and Utah)

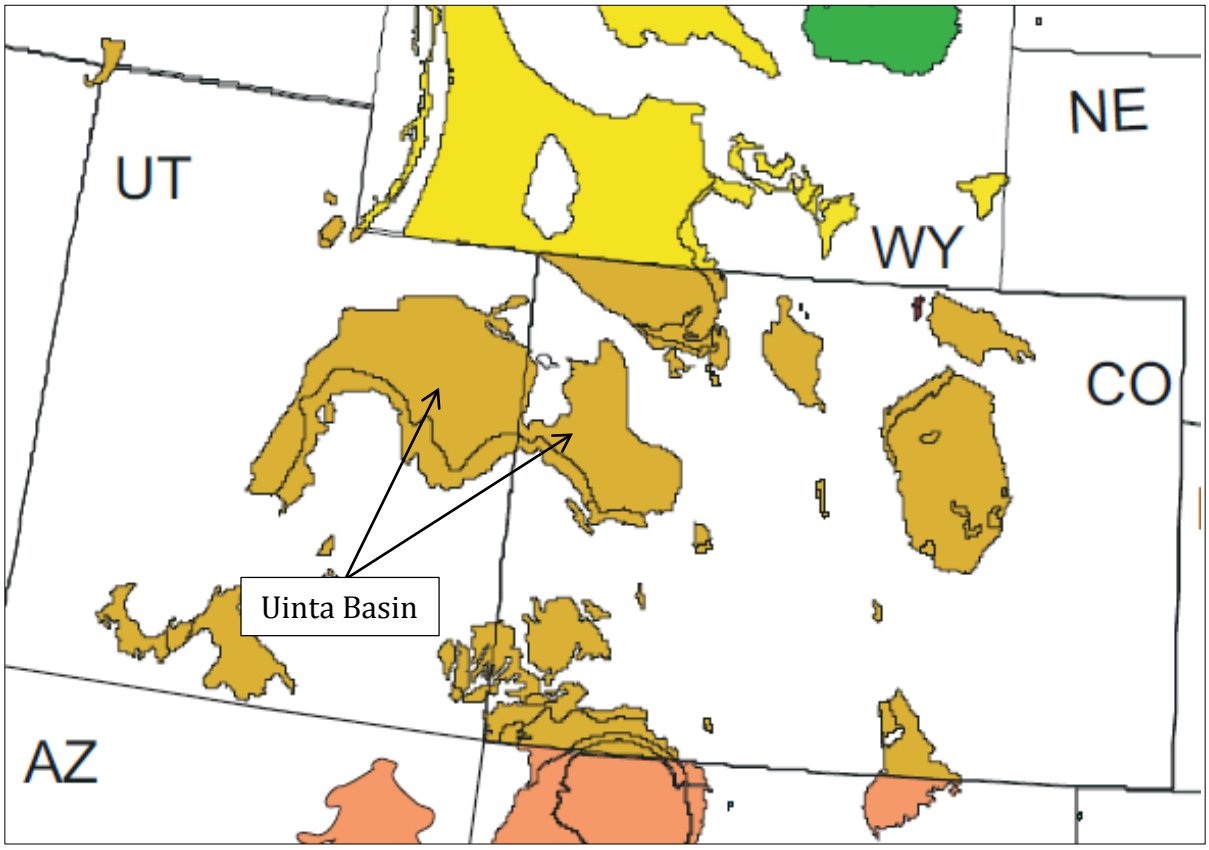
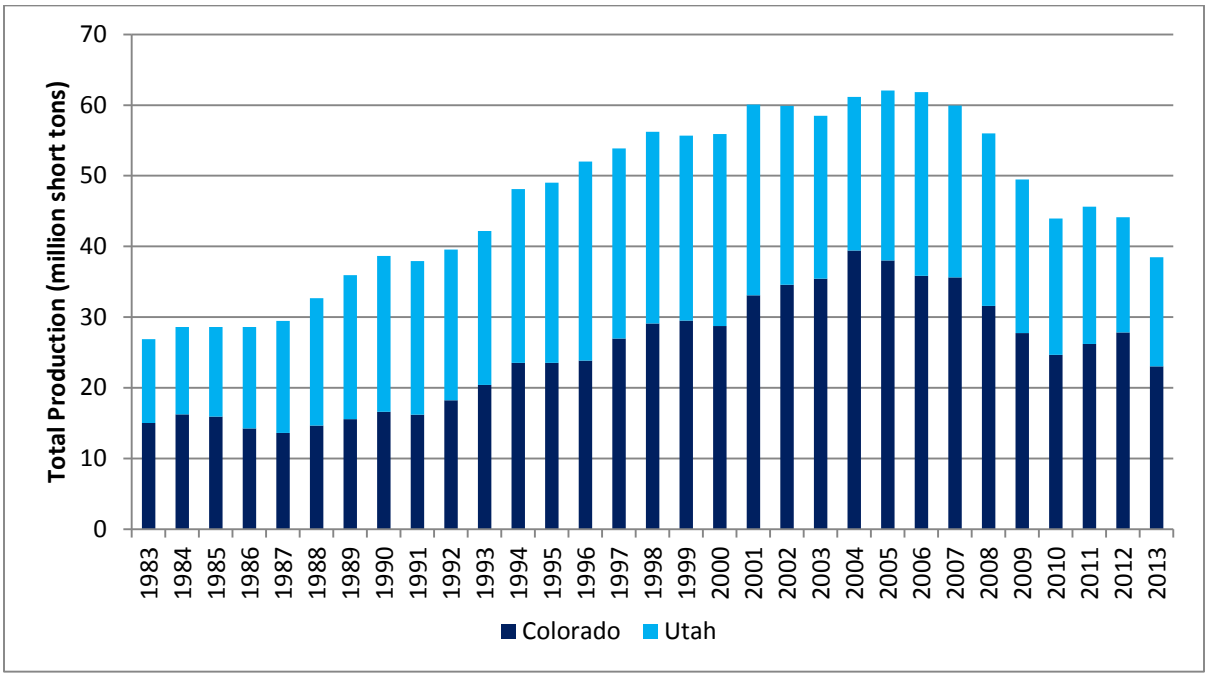


Figure 7. Historical Uinta Basin Coal Production (Colorado and Utah)



Source: Mine Safety and Health Administration 2014 (1983–2013 data).

Since 2008, Colorado coalfields have produced about 58% of Uinta Basin coal, with the remaining 42% produced in Utah (Table 2). The coal from both regions has a similar heat content; however, the Utah coal is closer to the export terminals, and thus, is more likely to be exported.

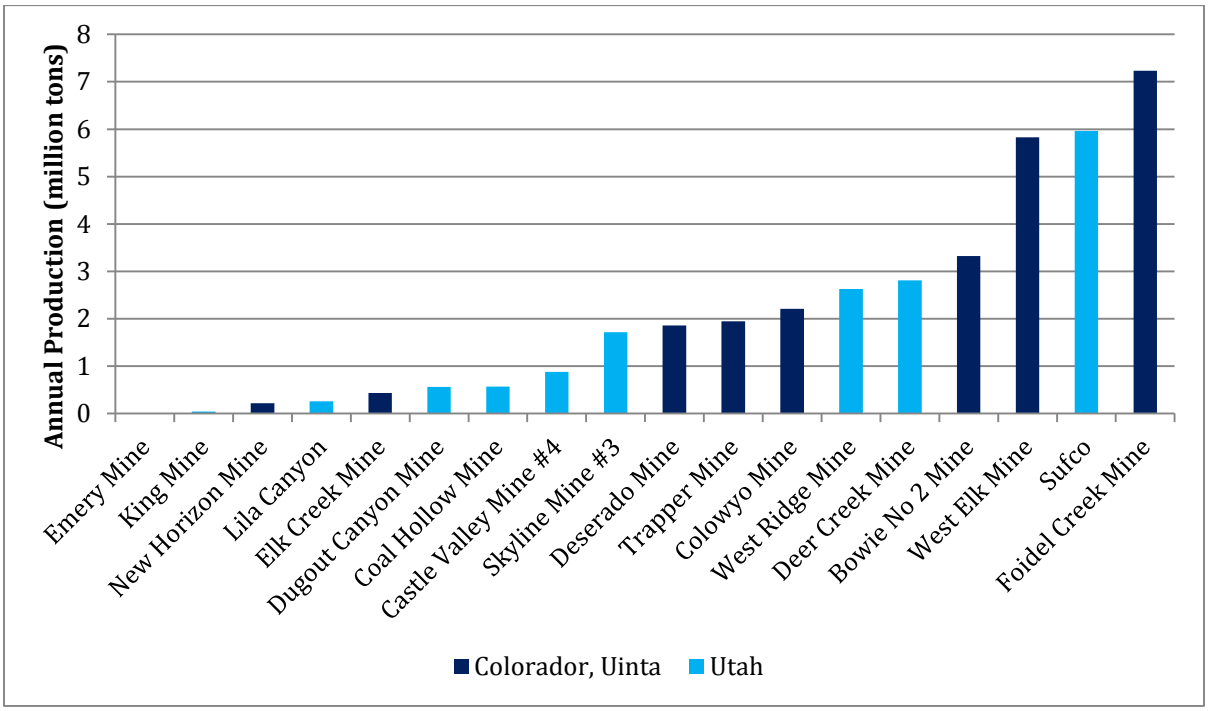
Table 2. Uinta Basin Coal Production by State (million tons)

State	2008	2009	2010	2011	2012	2013	2014	2008–2014 Average
Colorado, Uinta	31.6	27.8	24.6	26.2	27.8	23.5	23.0	26.4
Utah	24.4	21.7	19.3	19.4	16.3	16.4	17.9	19.3
Total	56.0	49.5	43.9	45.6	44.1	39.9	41.0	45.7

Notes:
Source: Mine Safety and Health Administration 2014.

Figure 8 shows that only 18 mines contribute to coal production in the Uinta Basin in 2013. Three mines (West Elk Mine, Sufco, and Foidel Creek Mine) produce over 5 million short tons per year, and account for approximately half of the region's coal production.

Figure 8. Uinta Basin 2013 Production by Mine (million short tons)



Source: Mine Safety and Health Administration 2014

2.4 Coal Distribution

2.4.1 Powder River Basin

Powder River Basin coal is subbituminous and has a lower heat content than the bituminous coal mined in the eastern United States. The lower heat content increases the transportation cost per unit of energy, and has effectively limited the historical distribution of Powder River Basin coal to domestic markets, although in recent years exports of Powder River Basin coal have been increasing.

Historically, 98% of Powder River Basin coal has been distributed to the domestic market. Powder River Basin coal generally reaches large markets in the Midwest, Texas, the southeast, and within the basin itself (U.S. Energy Information Administration 2013b). On average, from 2010 through 2014, Iowa, Illinois, Kansas, Michigan, Missouri, Oklahoma, and Wisconsin, consumed more than 48% (201 million tons per year) of Powder River Basin coal, while Texas consumed 14% (58 million tons per year) (Tables 3 and 4).

Table 3. Average Annual Deliveries of Powder River Basin Coal by Region[a]

Region	Montana Coal (million tons per year)	Wyoming Coal (million tons per year)	Total (million tons per year)	Montana Coal (%)	Wyoming Coal (%)
Central United States	15.1	269.7	284.8	41	68
Mid-Atlantic	0.2	1.0	1.1	0	0
Northeast		1.5	1.5	0	0
Powder River Basin	8.9	15.3	24.1	24	4
Rockies		9.8	9.8	0	2
Southeast		24.3	24.3	0	6
Southwest	0.6	6.1	6.8	2	2
Texas	0.0	58.4	58.4	0	15
West	2.6	4.2	6.8	7	1
Exports	9.4	4.2	13.6	26	1
Total	**36.8**	**394.5**	**431.2**	**100**	**100**

Notes:

[a] Domestic deliveries average 2010-2014 data from U.S. Energy Information Administration 923; International deliveries (exports) average 2009-2011 data from U.S. Energy Information Administration *Annual Coal Distribution Report* as 2012 data is not yet available.

Source: U.S. Energy Information Administration 2013a, 2013c.

Table 4. Historical Powder River Basin Coal Production by Source State and Destination (million tons)[a]

State	Historical Distribution	2009	2010	2011	2012	2013
Montana	Domestic Consumption[b]	36	38	33	25	30
	Exports[c,d]	2	6	8	11	12
	Total Production[e]	38	44	41	36	42
Wyoming	Domestic Consumption[b]	411	423	422	384	370
	Exports[c,d]	3	5	4	4	4
	Total Production[e]	414	428	426	388	374
Total	Domestic Consumption[b]	447	462	455	409	400
	Exports[c,d]	5	11	12	15	16
	Total Production[e]	452	473	467	425	416

Notes:
[a] Estimated exports from Montana have grown six-fold between 2009 and 2013, causing total Powder River Basin exports to more than triple. However, exports of Powder River Basin coal remain less than 4% of total Powder River Basin coal production.
[b] Total production less exports.
[c] U.S. Energy Information Administration 2013b. Export values estimated for 2012 and 2013.
[d] Thapa pers. comm.
[e] Mine Safety and Health Administration 2014.

The following factors have historically limited the economic viability of exporting Powder River Basin coal compared to higher heat content thermal coal.

- Long distances to export terminals
- Abundant international coal supply
- Relatively low international coal prices
- Relatively high shipping costs compared to international coal sources

Powder River Basin coal is exported primarily through the Pacific Northwest to Asia, with a small amount exported to Europe (Table 5).

Table 5. Powder River Basin Coal Exports by Terminal of Departure (2012)

Terminal	Destination	Coal Exports (million tons per year)
Westshore (Vancouver, BC)[a]	Asia	4.5
Ridley (Prince Rupert, BC)[b]	Asia	2.2
New Orleans and Texas Gulf Coast[c,d]	Asia	2.0
Duluth (Superior, WI)[c,d]	Europe	1.5
Total		**10.2**

Notes:
[a] Westshore Terminals Investment Corporation 2012
[b] IHS McCloskey 2013a
[c] U.S. Securities and Exchange Commission 2012a
[d] U.S. Securities and Exchange Commission 2012b

2.4.2 Uinta Basin

The Uinta Basin consists of coal deposits in Utah and northwestern Colorado, and is part of the broader Rocky Mountain coal production area. In total, the basin covers 14,450 square miles. Over the last 20 years, Utah has produced an average of 23.7 million tons of coal, although production in the last 3 years has fallen to between 19.4 and 15.4 million tons. The Colorado portion of the Uinta Basin has had average production over the last 20 years of 29.9 million tons, with production in the last 3 years ranging between 23.1 and 27.8 million tons (Mine Safety and Health Administration 2014).[9] The coal from this region is bituminous and ideal for energy production, and stays primarily within Colorado and Utah. On average between 2010 and 2014, 70% of Uinta basin coal has been consumed in Colorado and Utah. However, Uinta Basin Coal is also consumed in states to the east, including Alabama, Illinois, Kentucky, Mississippi, and Tennessee[10]. Table 6 shows the average annual deliveries of Uinta Basin coal by region.

Table 6. Average Annual Deliveries of Uinta Basin Coal by Region[a]

Region	Colorado Uinta Coal (million tons per year)	Utah Coal (million tons per year)	Total (million tons per year)	Colorado Uinta Coal (%)	Utah Coal (%)
Central United States	5.70	0.21	5.91	32	1
Mid-Atlantic	0.07	0	0.07	0	0
Rockies	9.96	12.37	22.34	56	84
Southeast	1.45	0.13	1.58	8	1
Southwest	0.13	0	0.13	1	0
West	0.41	2.06	2.47	2	14
Total	**17.73**	**14.77**	**32.50**	**100**	**100**

Notes:
[a] Domestic deliveries average 2010–2014 data from U.S. Energy Information Administration 923
Source: U.S. Energy Information Administration 2013a, 2013b.

2.5 Pacific Northwest Export Terminals

The main operating coal export terminals on the west coast are in Vancouver and Prince Rupert (British Columbia, Canada). These terminals have limited capacity for additional overseas export of U.S. coal in spite of recently completed and proposed capacity expansions. Existing coal traffic from Canadian mines already consumes most of the Canadian terminal capacity (Westshore Terminals 2013). Increased coal terminal capacity in the United States or Canada is foreseeable because several companies in addition to Millennium Bulk Terminals—Longview LLC, such as Teck Coal and SSA Marine, have recently proposed several new terminals for construction on the west coast and have begun environmental reviews or permitting processes.

[9] MSHA Part 50 data.
[10] EIA 923 data 2010 through 2014.

2.5.1 Existing Pacific Northwest Terminals

There are three existing terminals and four proposed terminals in the Pacific Northwest through which U.S. coal could be exported. The existing coal export terminals are in British Columbia, Canada, and include Westshore Terminal, Neptune Terminal, and Ridley Terminal. The Westshore and Neptune Terminals are located near Vancouver, while the Ridley Terminal is located at Prince Rupert, which is approximately 1,400 rail miles north of Vancouver.

2.5.1.1 Westshore Terminal

The Westshore Terminal is located at Roberts Bank, British Columbia, less than 1 mile north of the U.S. border. The BNSF Railway Company (BNSF), Canadian Pacific (CP), and Canadian National (CN) railroads serve this terminal. Westshore is one of the largest coal export terminals in North America and serves both Canadian and U.S. coal producers with a capacity of 36.3 million tons per year.

2.5.1.2 Neptune Terminal

The Neptune Terminal is owned by Canadian coal company Teck Coal and is served by the BNSF, CP, and CN railroads. Neptune's export capacity is 13.2 million tons per year. Teck Coal plans to expand the Neptune Terminal capacity by an additional 6.6 million tons per year, with an expected online date of 2015. Historically, Neptune Terminal has only shipped metallurgical coal.

2.5.1.3 Ridley Terminal

The Ridley Terminal, located in Prince Rupert, British Columbia, is served by the CN railroad, and has a capacity of 13.2 million tons per year. Ridley Terminal primarily handles coal from mines in northern British Columbia, although a few million tons of coal from the Powder River Basin have shipped through this terminal in the last 5 years. Several Powder River Basin coal producers, such as Arch Coal and Cloud Peak Energy, signed 5-year contracts to ship coal through Ridley Terminal. The contracts expire in 2015 and the government-owned terminal is expected to handle only Canadian coal from 2015 onward (Arch Coal 2011; de Place and MacRae 2012).[11] It is also significantly more expensive to ship Powder River Basin or other U.S. coal through Ridley Terminal compared to current or proposed terminals in Washington, Oregon, or Vancouver, British Columbia. Despite having 10% shorter shipping distance to the Pacific Basin, Ridley Terminal has a rail distance that is about 100% longer than other terminals.[12] At current rail and shipping costs, the overall transportation cost from the Powder River Basin to Asia is higher through Ridley Terminal than through the Westshore Terminal.

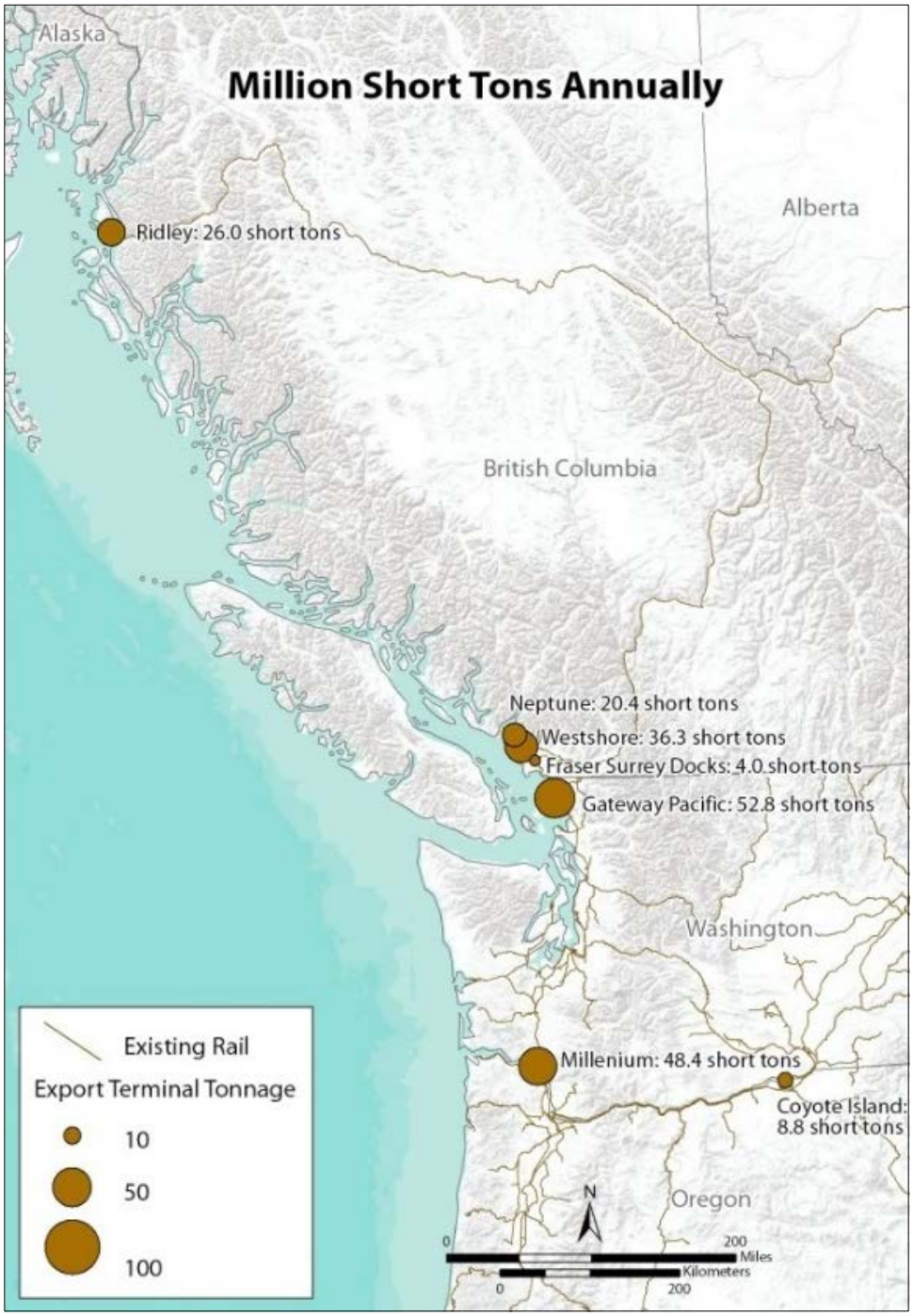
2.5.2 Planned Pacific Northwest Export Terminals

Four new coal export terminals are proposed in Washington, Oregon, and British Columbia that could provide additional capacity for Powder River Basin and other U.S. coal exports. Figure 9 shows the export capacities of these terminals. Three of the proposed terminal projects are in Washington and Oregon.

[11] Arch Coal's agreement with Ridley Terminal to export up to 2.5 million metric tons per year through 2015.

[12] Cloud Peak states that the rail distance from their Powder River Basin mines to Ridley is over 2,600 miles and can require up to three different rail carriers (Cloud Peak Energy 2013).

Figure 9. Existing and Planned Coal Export Terminals



2.5.2.1 Gateway Pacific Terminal

The proposed Gateway Pacific Terminal at Cherry Point, Washington, would handle bulk commodities such as coal. The terminal is served by BNSF and has a planned capacity of 52.8 million

tons of coal per year. One advantage of this terminal would be that it could load capesize vessels, which provide a cost advantage over smaller Panamax vessels.[13]

2.5.2.2 Millennium Bulk Terminals—Longview

This is the Proposed Action discussed in this technical report. The Millennium Bulk Terminal—Longview operates an existing bulk product terminal on the Columbia River in Cowlitz County. Plans include adding infrastructure to unload coal from trains and move it to storage and then to ships. The terminal is served by the BNSF and UP railroads. The terminal can load up to Panamax size vessels, with no plans to modify the port to handle larger vessels.

2.5.2.3 Coyote Island Terminal

The Coyote Island Terminal at Morrow, Boardman, Oregon, would be located on the Columbia River. This terminal would be served by the BNSF railroad and has a planned capacity of 8.8 million tons per year. Coal coming to this terminal would be barged by the shipper down the Columbia River to the Port Westward Industrial Park in Oregon and transloaded onto Panamax vessels. On August 18, 2014, the Oregon Department of State Lands denied the removal-fill permit for the Coyote Island Terminal at the Port of Morrow in Boardman, Oregon. The applicant, Ambre Energy, has appealed the decision, and a hearing is pending as of March 2015 (Oregon Department of State Lands 2014).

2.5.2.4 Fraser Surrey Docks

Fraser Surrey Docks, at Vancouver, British Columbia, has applied for a permit to construct a coal transfer facility of 4.4 million tons per year of capacity. BNSF would serve this facility. On August 21, 2014, Port Metro Vancouver granted a Project Permit for the terminal's Direct Coal Transfer Project, which is scheduled to begin operations late in 2015 (Port Metro Vancouver 2014).

2.5.3 Export Routing

The coal that would most likely be exported out of the Pacific Northwest terminals is from the Powder River Basin, as most other coal basins are farther away or have other export options, such as terminals on the Atlantic or Gulf coast. The one exception is the Uinta Basin that might be competitive through the proposed coal export terminal. The transportation costs were estimated for coal exports through the terminal and the other existing and planned Pacific Northwest terminals.

Tables 7 and 8 show the details of the cost calculations for transporting coal to Japan from the Powder River Basin through the two most economically viable options, which would be the Proposed Action and the Vancouver, British Columbia, area terminals. This analysis focuses on the Pacific Basin because it is the fastest growing market for steam coals, and Japan is an example of a Pacific Basin movement. Japan was selected for the model to illustrate the total transportation costs, because it has historically imported more coal than any other Pacific Basin country, and is one possible destination for coal exports through the terminal. Powder River Basin coal exports to other countries, such as China, South Korea, or Taiwan, would be similar, except that the shipping distances would be longer by 140 to 1,100 miles.

[13] *Capesize* vessels are cargo ships capable of carrying approximately 150,000 metric tons. *Panamax* vessels are smaller and can carry approximately 75,000 metric tons. The Gateway Pacific Terminal would be able to load the larger, capesize vessels because of its deeper waters.

Table 7. Estimated Powder River Basin Rail and Ship Export Costs—Pacific Northwest Exports

Powder River Basin Export Routes	Rail Distance (miles)	Rail Rate with fuel surcharge ($/ton)	Total Rail Cost (2012$/ton)[a]	Ship Distance (nautical miles)	Ship Rate ($/ton-nautical mile)	Total Ship Cost via Panamax ($/ton)[b]	Port Fee ($/ton)	Total Transportation Cost ($/ton)
Montana to Japan via MBTL	1,231	$0.0249	$30.65	4,402	$0.0027	$11.88	$11.00	$53.53
Montana to Japan via Vancouver	1,357	$0.0249	$33.79	4,328	$0.0027	$11.69	$11.00	$56.48
Wyoming 8800 Btu/lb to Japan via MBTL	1,360	$0.0249	$33.86	4,402	$0.0027	$11.88	$11.00	$56.74
Wyoming 8800 Btu/lb to Japan via Vancouver	1,483	$0.0249	$36.93	4,328	$0.0027	$11.69	$11.00	$59.62

Notes:
[a] Includes fixed rail cost of $1.50/ton.
[b] Includes transfer cost of $1.50/ton.
PNW = Pacific Northwest; Btu/lb = British thermal units per pound

Table 8. Estimated Powder River Basin Delivered Coal Costs—Pacific Northwest Exports

Powder River Basin Export Routes	Total Transportation Cost ($/ton)	Illustrative Minemouth Price ($/ton)[a]	Total Delivered Cost ($/ton)	Heat Content (MMBtu /ton)	Delivered Cost to Japan ($/MMBtu)
Montana to Japan via MBTL	$53.53	$15.00	$68.53	18.6[c]	$3.68
Montana to Japan via Vancouver	$56.48	$15.00	$71.48	18.6[c]	$3.84
Wyoming 8800 Btu/lb to Japan via MBTL	$56.74	$13.00	$69.74	17.6	$3.96
Wyoming 8800 Btu/lb to Japan via Vancouver	$59.62	$13.00	$72.62	17.6	$4.13

Notes:

[a] Actual minemouth prices will differ by year for the various Powder River Basin coals; $15/ton approximates the Montana Powder River Basin 9,300 Btu/lb coal prices expected in 2016, and $13/ton approximates Powder River Basin Wyoming 8,800 Btu/lb coal prices expected in 2016.

[c] Spring Creek heat content is 9,300 Btu/lb; this is taken as the illustrative existing Montana coal's heat content.

MMBtu = million British thermal units; Btu = British thermal units

The existing and proposed Pacific Northwest terminals, not including Ridley Terminal, have the following advantages and characteristics.

- **Shortest export route to Asia.** Shipping distances to Japan from the Pacific Northwest are approximately half the distance from the U.S. Gulf Coast.
- **Lowest-cost export.** There is an ocean freight cost advantage to Asia via the Pacific Northwest as compared to Gulf Coast or California originating exports.
- **Historically used for Powder River Basin shipments**. Historically, Powder River Basin exports have been shipped primarily via Pacific Northwest terminals, supporting the conclusion that this export route is most economical for Powder River Basin coal.

Lastly, as Table 8 shows, the delivered costs to Japan via the existing and proposed Pacific Northwest terminals are similar for all Powder River Basin coals. Relatively small changes in production costs or parts of the transportation cost could affect the export prospects of any of the Powder River Basin coals. It may be more economical to export certain Powder River Basin coals to the Pacific Basin and transport others to domestic locations, as determined by the variables of location, markets, transportation facilities, and heat content of the coal.

Chapter 3
International Coal Markets

3.1 International Coal Demand

As described in Chapter 2, Section 2.3, *Coal Distribution*, only about 2% of Powder River Basin coal is exported to international markets. This chapter discusses this market.

3.1.1 Major Importing and Exporting Countries

The top five global coal-importing countries (Japan, China, South Korea, India, and Taiwan) are located in Asia and together they account for 64% of total coal imports globally. In Europe, while total coal imports have not bounced back to pre-recession levels last seen in 2007, they grew by about 8% from 2009 to 2012. A greater percentage of European coal imports came from the United States over this time period, with U.S. coal exports to Europe approximately doubling in just four years. Table 9 provides the top coal countries for coal imports in 2012.

Some of the top importers rely heavily on coal imports to meet their consumption. For example, Japan, South Korea, and Taiwan import all of their coal, whereas China and India have significant domestic production and could reduce imports if coal prices increase.

Table 9. Top International Coal Importers in Million Short Tons (2012)

Rank	Country	Total Coal Import	Total Coal Consumption	Import (%) of Consumption
1	China	317.9	3,887.3	8
2	Japan	203.5	201.9	101
3	Korea, South	135.7	137.6	99
4	India	97.2	744.5	13
5	Taiwan	73.5	72.1	102
6	Germany	53.4	269.4	20
7	United Kingdom	49.6	69.8	71
8	Russia	34.8	274.2	13
9	Turkey	31.8	108.4	29
10	Italy	26.6	26.1	102
11	Malaysia	24.3	27.2	89
12	Brazil	19.9	27.3	73
13	Thailand	18.6	38.8	48
Total Coal Imports		**1,086.8**		

Notes:
Source: U.S. Energy Information Administration 2013c.

The top coal exporters are Indonesia and Australia, together accounting for nearly 54% of the total coal exports in 2012 (Table 10). In Australia, companies and port owners propose to construct and

expand export terminals, which would triple export capacity from 490 to 1,420 million tons per year (Yang and Cui 2012).

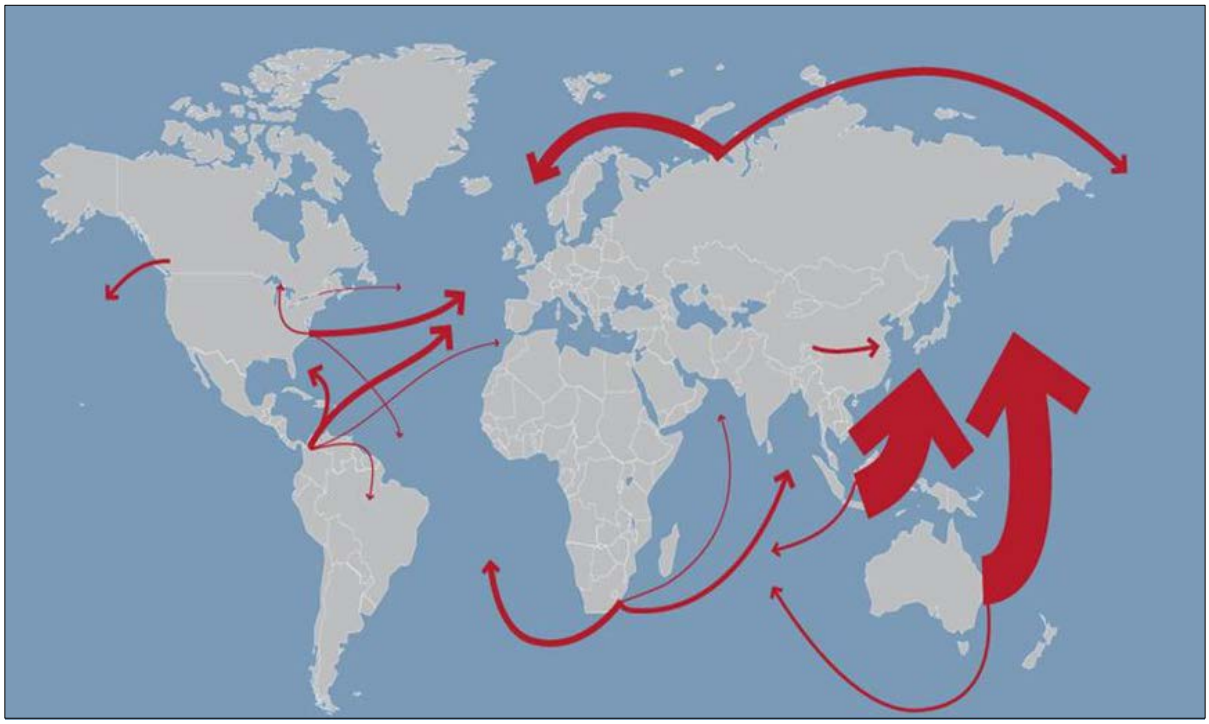
Table 10. Top International Coal Exporters in Million Tons (2012)

Rank	Country	Total Coal Export	Total Coal Production	Export (%) of Production
1	Indonesia	421.8	488.1	86
2	Australia	332.4	463.8	72
3	Russia	150.7	390.2	39
4	United States	126.7	1,016.5	12
5	Colombia	92.2	98.6	94
6	South Africa	82.0	285.8	29
7	Canada	38.8	73.3	53
8	Kazakhstan	35.2	138.9	25
9	Mongolia	24.3	47.0	52
10	Vietnam	21.2	46.4	46
11	Poland	14.9	158.2	9
12	North Korea	13.2	43.2	31
13	China	10.2	4,017.9	0.3
Total Coal Exports		**1,309.5**		

Notes:
Sources: Yang and Cui 2012;, U.S. Energy Information Administration 2010.

In summary, the largest markets in the Pacific Basin are served primarily by the largest exporters in the Pacific Basin, Australia and Indonesia (Figure 10). Recent Pacific Basin coal trade is comparable to the flows presented for 2009. While the Pacific Basin market is expected to grow, so is the competition between a few large suppliers.

Figure 10. Indonesia and Australia Dominate Pacific Basin Coal Markets



Source: Alpha Natural Resources 2010.

While Japan has historically been the largest importer of coal worldwide, the Indian and Chinese economies are projected to grow, adding to the demand for energy resources in the Indo-Pacific region. Coal continues to be the fuel of choice to meet burgeoning demand in these growing countries; however, planned coal additions and construction have slowed significantly since 2012. India and China currently have plans to increase coal capacity by nearly 800 gigawatts, down from 1,100 gigawatts in 2012 (Shearer et al. 2015). This proposed capacity is more than twice the total U.S. installed coal capacity of about 300 gigawatts (as of 2013). Japan, South Korea, and Taiwan lack significant domestic thermal coal reserves and have been key importers in the Pacific Basin steam coal import market. Both India and China will likely continue or increase their consumption of coal going forward. The following sections address market conditions in the top two coal-importing nations, which are expected to remain the top importing countries for the next 10 years: Japan and China. The next three top importers—South Korea, India, and Taiwan—are expected to have flat to increasing imports, with South Korea generally flat and Taiwan increasing slowly, while coal imports to India are expected to grow more rapidly as large amounts of new electrical generating capacity comes online.

3.1.2 Asian Focus

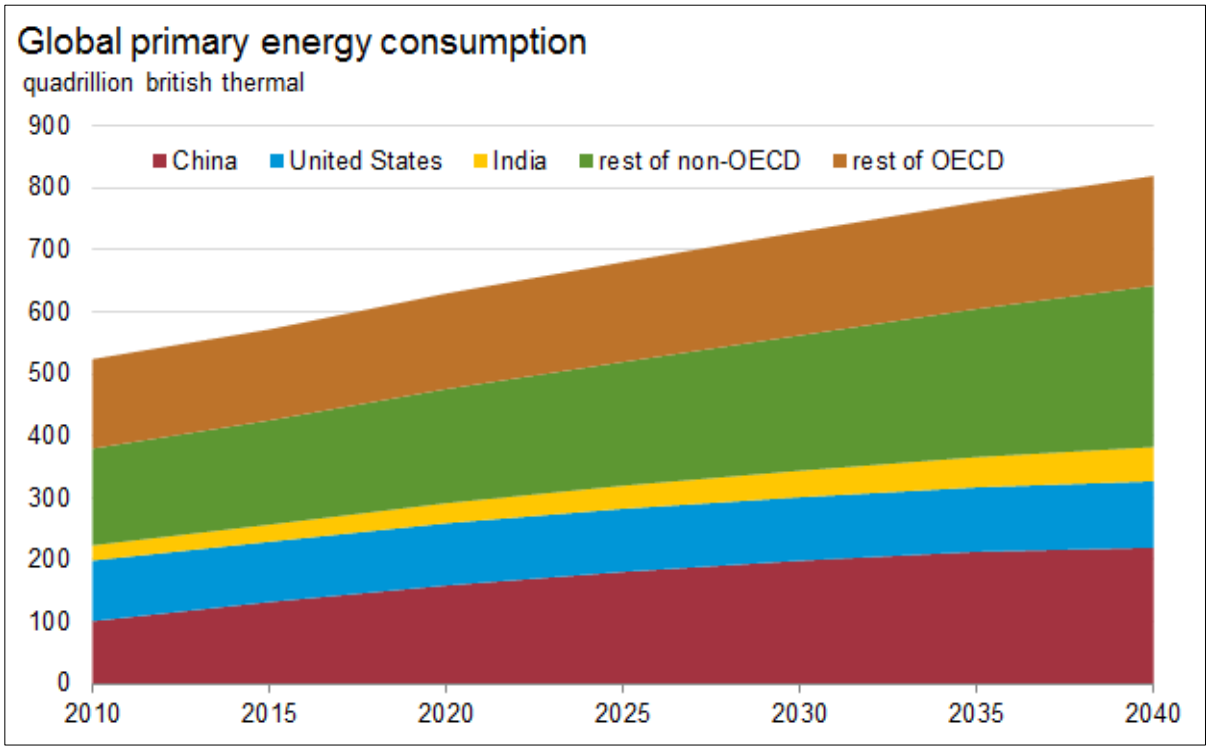
China, Japan, South Korea, and Taiwan have historically been the world's primary importers of coal. The following provides an overview of their coal consumption and recent import level trends.

3.1.2.1 China

China is the world's largest coal producer and consumer. China's coal demand, driven by power generation and industrial uses, increased by an average of 8.44% annually from 2001 to 2012. For

comparison, coal demand outside of China increased at an average of 3.8% per year (U.S. Energy Information Administration 2013b). However, coal consumption in China and across the globe actually slipped in 2012 by about 1.7% and 1.2%, respectively. As of 2012, China's coal consumption accounted for 47% of global coal consumption at about 3.9 billion tons annually—almost as much as the entire rest of the world combined (U.S. Energy Information Administration 2013d). China's demand for coal is expected to grow in the future. Although current policy changes in China will reduce the growth rate of coal consumption, the absolute amount of coal consumed is expected to continue to increase. EPA's projection of China's power generation shows that coal will produce 67% to 75% of the nation's electrical energy from 2012 to 2040 (Figure 11). Coal-fired electric power generation is expected to increase by 87% compared to current 2013 levels (U.S. Energy Information Administration 2013d). To meet growing demand, China is considering proposals for new installed coal capacity of 496 gigawatts (Shearer et al. 2015). For comparison, as of the end of 2014, the total capacity for all coal-fired power plants in the United States was 299 gigawatts, with nearly 18 additional gigawatts of retirements expected by the end of 2016 (SNL Energy 2015). With its vast domestic coal resources, China has historically been a coal exporter. However, China's coal imports exceeded exports for the first time in 2009 (Figure 12). In 2012, China imported 318 million tons of coal, or approximately 8% of total Chinese coal consumption.[14] The increase in imports has been rapid and dramatic, and suggests a strong market in the Pacific Basin.

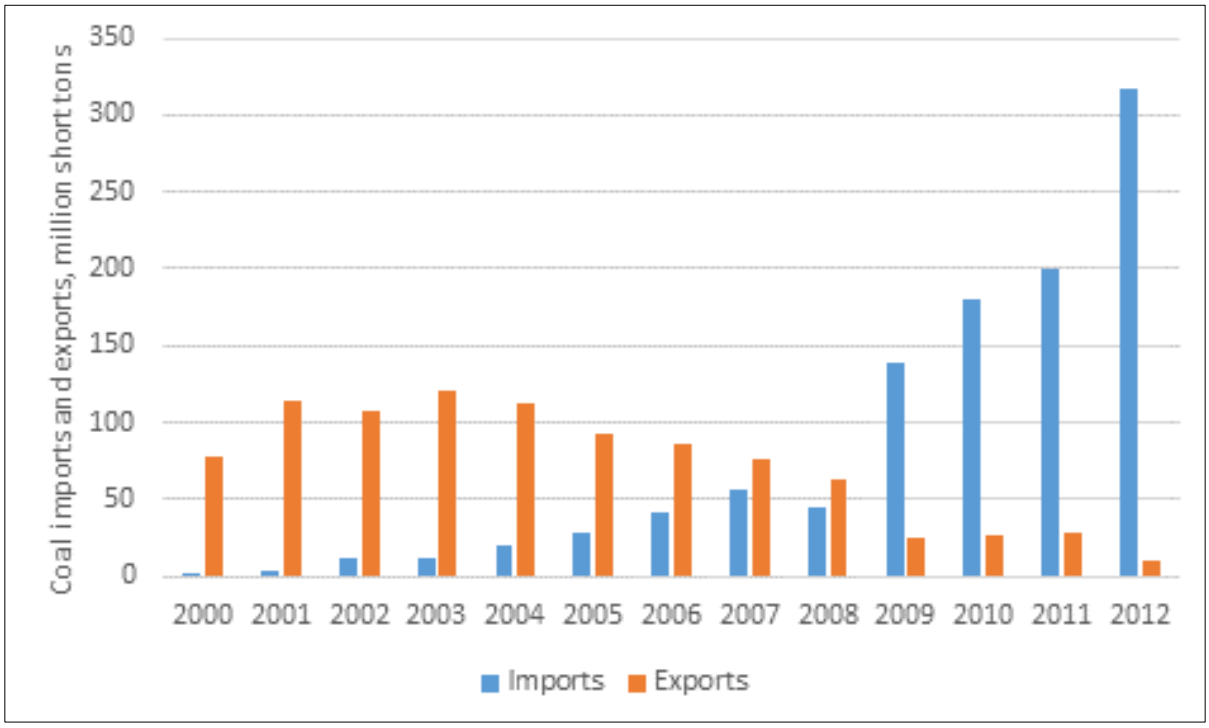
Figure 11. China's Projected Cumulative Power Generation by Type



Source: U.S. Energy Information Administration 2014.

[14] For reference, 200 million tons is about 45% of recent annual coal production from the Powder River Basin, and about 10 times the permitted annual production of 20 million tons from the Otter Creek Mine.

Figure 12. China's Coal Imports and Exports, 2000–2012 (million tons)



Source: U.S. Energy Information Administration 2012.

While analysts expected China's reliance on imports to increase through 2015, Chinese coal imports have actually fallen since peaking in 2013. Weaker economic growth has led to lower coal consumption, while a governmental emphasis on reducing the energy intensity of their economy and lowering air pollution are both compounding factors as well. In response, the government has protected domestic industry and prioritized domestic coal consumption. These measures resulted in a Chinese import tariff of 6% for thermal coal as of October 2014 (The Guardian 2015; Sustainable Enterprise Media 2014).

China has made progress in addressing a number of issues that might have required it to import more coal in the last year and going forwards (Hook 2011).

- **Transportation bottlenecks.** Mining activity in China has shifted farther north and west, away from the south and eastern coastal cities where many coal-fired power plants are located and the demand for electricity is greatest. The coal must be transported from remote northwest locations, where there is limited demand for electricity, to the northeast ports, where it is shipped to the southern ports for domestic consumption. China has made extensive progress in addressing transportation bottlenecks over the last 5 years, which has reduced the reliance on imported coal.

- **Mine safety.** China produces coal primarily from underground coal mines. The methane concentrations in China's underground mines are responsible for a high number of fatalities, relative to fatalities in U.S. underground mines on a per ton basis. In 2012, the overall death rate in China's coal mines was 0.374 deaths per million tons of coal production. In contrast, the death rate in the United States was around 0.035 deaths per million tons of coal production. By increasing coal imports, especially coal produced from surface mines, China expects to lower

overall mining fatalities per ton of coal consumed (China Labour Bulletin 2013; Mine Safety and Health Administration 2014).

- **Mine consolidation.** The Chinese government has been consolidating small, private mines into a few large state-owned mines. Initially, consolidation causes coal production to fall dramatically as mines are closed temporarily to retrofit them with additional safety measures (Hook 2011). This consolidation process is well under way and most mines are back to full production.

3.1.2.2 Japan

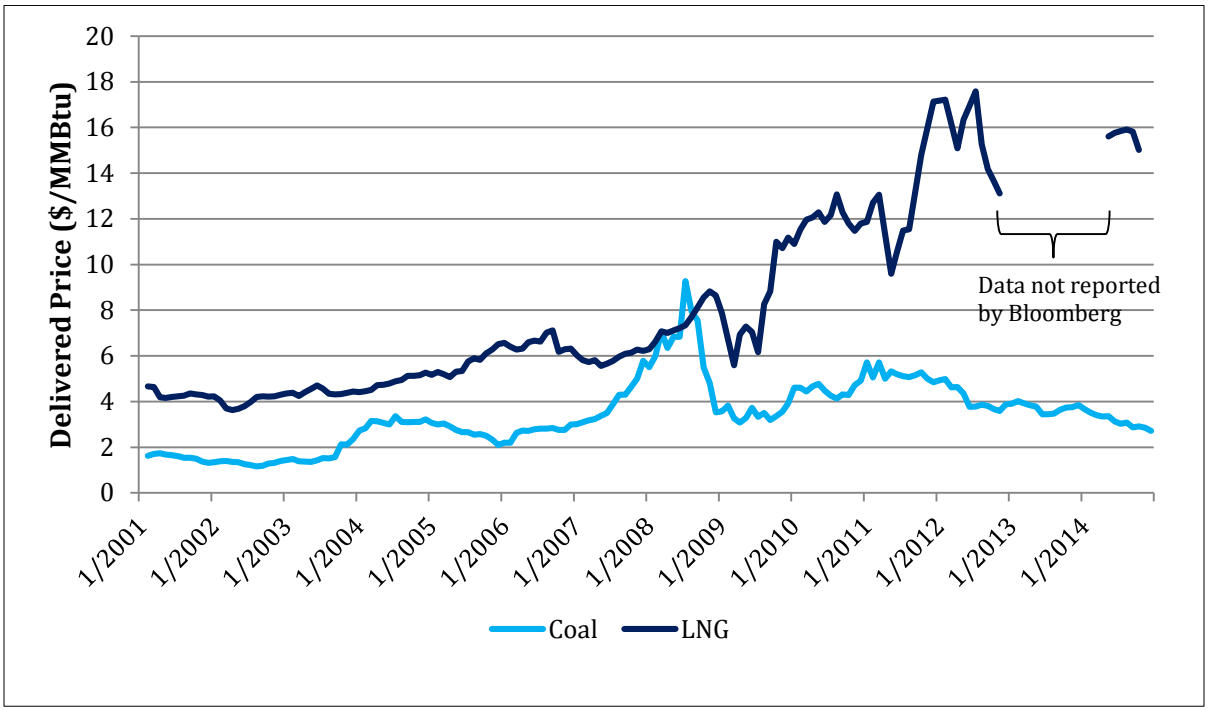
Japan was the world's largest coal importer through 2010; however, after 2010, China became the world's largest coal importer. Japan imported an average of 193.5 million short tons of coal per year between 2000 and 2012 (U.S. Energy Information Administration 2011). Without domestic steam coal resources, Japan relies heavily on imports to satisfy domestic coal demands. Several factors may drive an increase in Japan's coal consumption and imports in the future.

- **Uncertain future for nuclear energy.** The earthquake and tidal wave of March 2011 caused cataclysmic damage at the Fukushima nuclear power plant, precipitating the shutdown of 48 of Japan's 50 nuclear reactors, leaving only two reactors at the Oi nuclear plant in operation (Westlake 2012). Nuclear energy had previously supplied about 30% of the country's electricity needs, a percentage that, prior to the damage, had been expected to increase to 40% by 2017 and 50% by 2030 (World Nuclear Association 2013). The first two idled reactors may reopen in June 2015; however, nuclear reactor operations are still highly uncertain and coal and natural gas consumption are likely to remain higher than consumption prior to 2011.

- **Relative expense of liquefied natural gas.** Coal has historically been significantly cheaper than liquefied natural gas at generally about half price per unit of energy (Figure 13). Much of the recent rush to build U.S. liquefied natural gas export terminals is targeted at exporting gas to Asian countries such as Japan (the world's largest liquefied natural gas importer) to take advantage of the significantly higher natural gas prices in Asia.

- **Renewed government commitment to coal energy.** After withholding approval of all but two proposed coal-fired power plants since 2006, Japan's Ministry of Environment recently lifted a virtual ban on the construction of new coal plants, provided they are equipped with the cleanest and best technologies. This development is motivated by the economic need to diversify energy resources rather than by environmental or safety considerations (Iwata 2013).

Figure 13. Delivered Coal versus Natural Gas Prices to Japan ($/MMBtu)



Source: McCloskey and LNG Japan Corporation data from Bloomberg.

3.1.2.3 South Korea

South Korea is one of the top energy importers in the world, relying on fuel imports for about 97% of its energy demand due to lack of domestic fuel resources. In 2013, the country was the fourth-largest importer of coal. Australia and Indonesia account for the majority of South Korea's coal imports, followed by Russia. Between 2005 and 2012 coal consumption in South Korea increased by 55%. This rise was driven primarily by growing demand from the electric power sector. The electric power sector accounts for 62% of the country's coal consumption, while the industrial sector accounts for most of the remaining amount (U.S Energy Information Administration 2015).

3.1.2.4 Taiwan

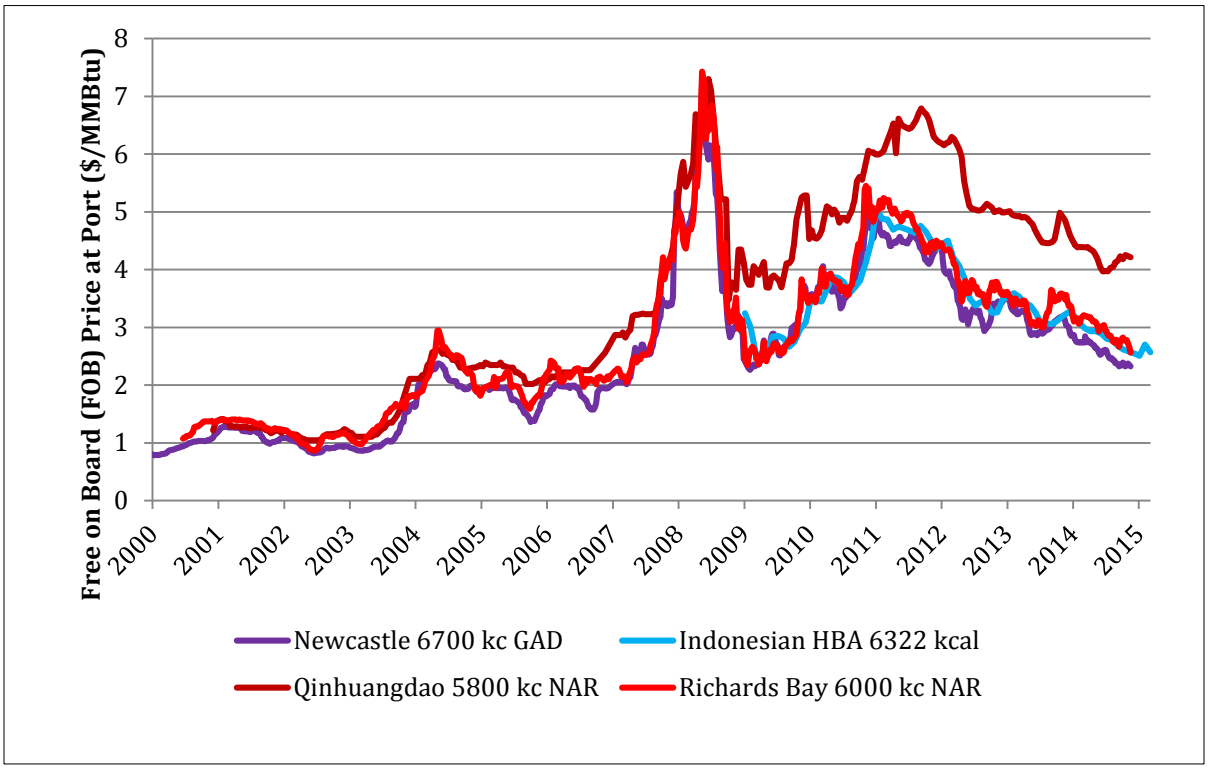
Oil and coal made up 41% and 34% of Taiwan's total primary energy consumption in 2013, respectively, while the remainder was mostly natural gas, nuclear, and smaller amounts of various renewable energy sources. Due to its very limited domestic energy resources, Taiwan imports a large percentage of coal and oil. Taiwan consumed about 72 million tons of coal in 2012, all of which was imported. Coal consumption steadily increased overall since the 1990s and slowed after 2007 as a result of natural gas and renewables substituting some coal supply in the power sector.

3.1.3 Coal Prices

3.1.3.1 Free On Board Prices

Free on board (FOB) terminal prices refer to the aggregate price of the coal, insurance, loading, transportation to the terminal, and documentation costs, typically paid by the seller. Figure 14 shows FOB prices at the supply country's terminal, expressed as price per energy unit ($/MMBtu) to account for coals with different heat content. Key players in the Pacific Basin steam coal export market shown in Figure 15 include Australia (Newcastle), Indonesia (HBA), China (Qinhuangdao), and South Africa (Richards Bay). The coal prices in Figure 15 are not adjusted for the coal moisture content because coals are reported as gross air-dried, gross as received, and net as received.[15]

Figure 14. Historical Pacific Basin Free On Board Steam Coal Prices

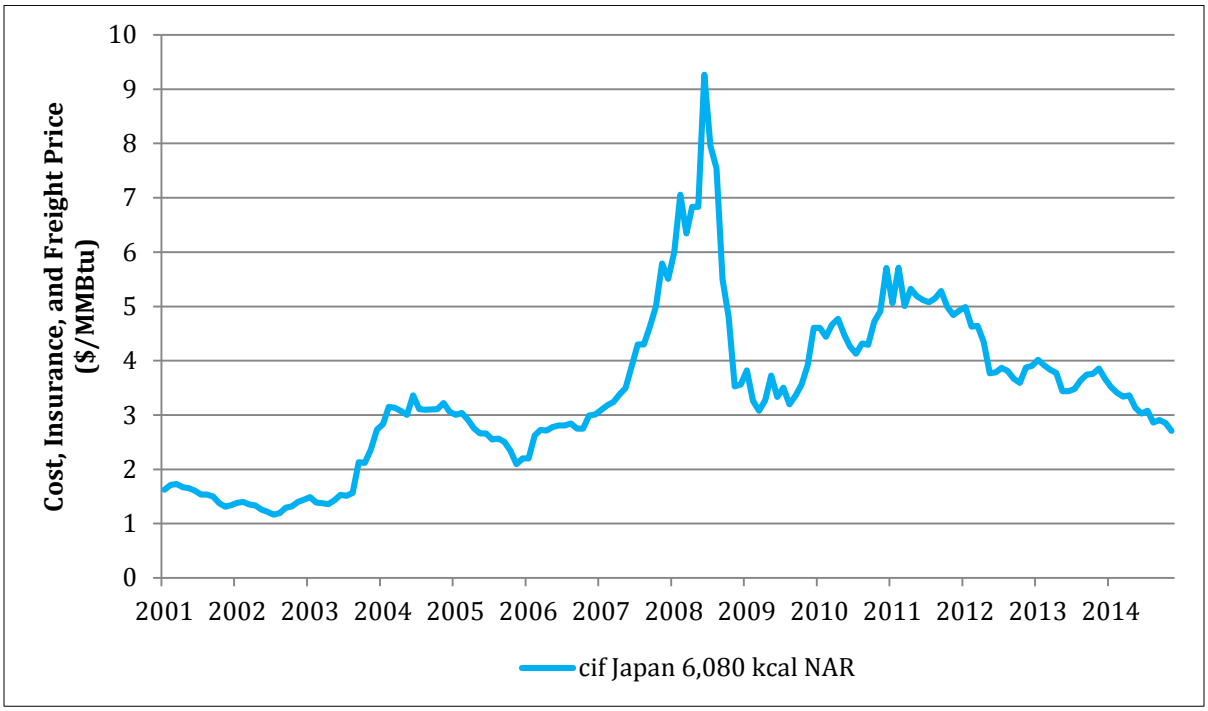


Source: McCloskey, Platts, Indonesia Coal Index, and Newcastle Export Index data from Bloomberg.

Trends in FOB costs are relatively consistent across supply ports, with the exception of China's Qinhuangdao prices, which were noticeably higher from late 2008 to 2014. This gap in prices further illustrates demand for lower-cost coal imports in China, although there are non-market effects impacting Chinese prices as well. The most recent peak in prices was in early 2011 at about $5/MMBtu. Since then international coal prices have dropped by 50% to around $2.5/MMBtu. Powder River Basin coal shipped through Vancouver, British Columbia or other Pacific Northwest ports would have an FOB cost of close to $2.9/MMBtu in 2015, making it somewhat higher than the Pacific Basin 2015 coal prices.

[15] Definitions and conversions can be found at World Coal Association, Coal Conversion Statistics (http://www.worldcoal.org/resources/coal-statistics/coal-conversion-statistics).

Figure 15. Pacific Basin Steam Coal Prices—Japan and Asia



Source: McCloskey data from Bloomberg.

3.1.3.2 Delivered Coal Prices to the Pacific Basin

Delivered coal prices to the Pacific Basin include the costs of coal, freight, and insurance. These prices are summarized using IHS McCloskey's Japan index benchmarks (IHS McCloskey 2013b), which show delivered prices at the terminal of delivery.[16] Prices ranged from $2.7 to $5.7/MMBtu from their peak in early 2011 to 2014 (Figure 15). Delivered prices to Japan in the range of $3.0/MMBtu suggest that Powder River Basin coal would have a difficult time being cost-competitive, if shipped through the Pacific Northwest to Japan or other Pacific Basin countries, until international coal prices increase.

[16] IHS McCloskey is a company that provides benchmark coal prices that can be accessed through Bloomberg.

Chapter 4
Model Framework, Methods, and Key Assumptions

IPM® was used to assess likely coal production, consumption, and distribution patterns resulting from development of the proposed terminal. The impacts of economic and regulatory uncertainties on these outcomes were also examined, through the analysis of three scenarios.

This chapter provides an overview of the IPM® framework, the key assumptions for running the model, and the specific methods used in its analysis.

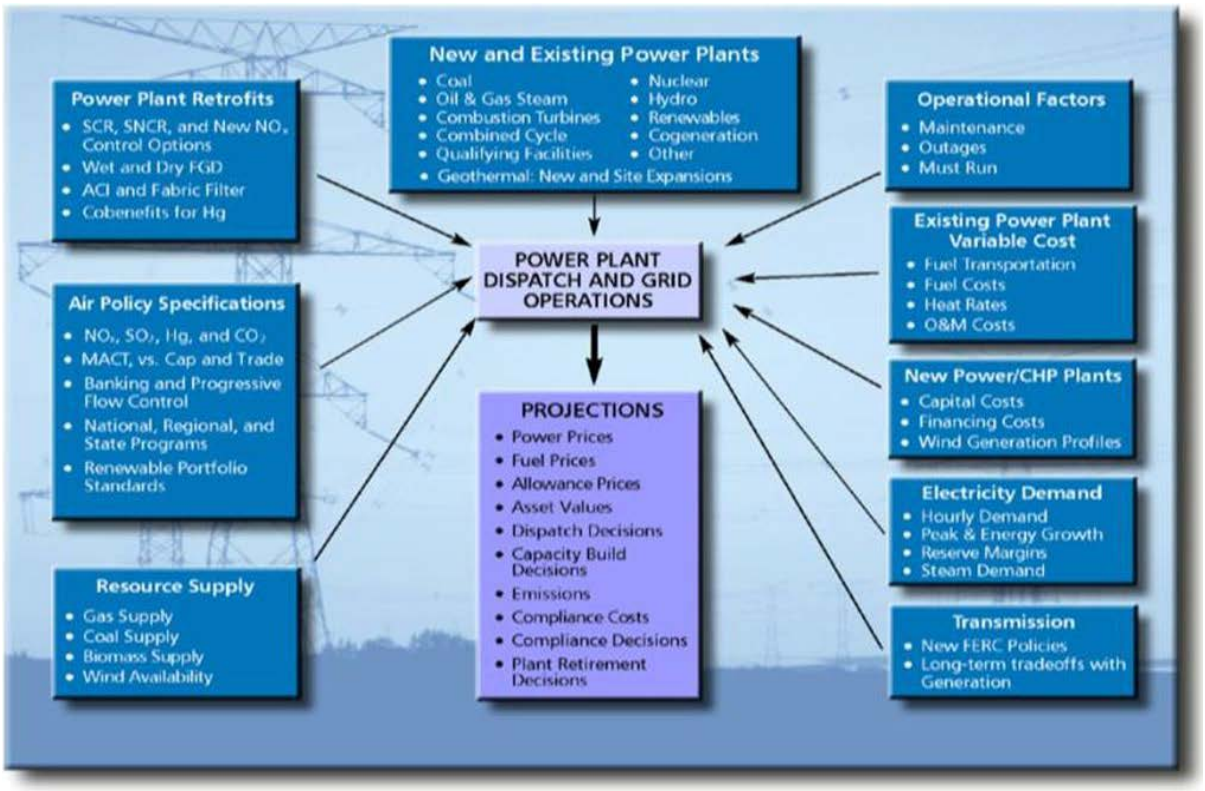
4.1 IPM® Overview and Model Framework

IPM® is an engineering and economic model of the coal and power sectors, supported by an extensive database of coal and power parameters. The model has the ability to add new electricity-generating capacity in response to demand growth and policies, such as renewable portfolio standards. It is widely used to assess domestic and international coal production, transportation, and consumption, and the operations and economics of the U.S. electric power industry. The model also characterizes the U.S. natural gas industry. IPM® is a multiregional model in terms of electricity demand regions, fuel demand regions, and coal supply regions that provides detailed results on a plant, regional, or national level. ICF International has maintained IPM® since the mid-1970s.

IPM® simultaneously analyzes the following energy sectors and the important interactions between them (Figure 16).

- The coal mining industry, including regional coal mine type and coal quality distinctions.
- Coal transportation sectors, such as rail, barge, and ship.
- The electric power generation sector, including regional and power-plant-type distinctions, and very detailed treatment of existing power plants, especially coal-fired units.
- The electricity consumption portion of the business, including hourly and seasonal variations in demand.
- The electricity transmission sectors and the alternatives available to local power production.
- Environmental regulations (national and state) affecting the power sector including CO_2 emissions limitations and renewable portfolio standards. The model also calculates emissions for each individual plant.
- Investment and long-term operational decisions such as coal power plant retirement, power plant mothballing, new power plant construction, existing coal mine operation, and new coal mine additions.
- Domestic and international coal deliveries and consumption.
- Interactions with the natural gas industry.

Figure 16. Integrated Planning Model (IPM®)



IPM® analyzes these markets and calculates competitive market prices based on supply and demand fundamentals. It forecasts the following wide range of parameters.

- Wholesale market power prices for each electricity demand region.
- Power plant dispatch.
- Fuel consumption and both delivered and coal minemouth or gas hub prices.
- Interregional transmission flows.
- Environmental emissions and associated costs.
- Capacity expansion and retirements.
- Retrofits based on an analysis of the engineering economic fundamentals.

The model does not extrapolate from historical conditions. Rather, it provides a least-cost forecast for a given set of current and future conditions that determine how the industry will function. The optimization routine that IPM® uses has dynamic effects—it looks ahead at future years and simultaneously evaluates decisions over an entire specified time horizon, typically 20 to 40 years.

IPM® uses a dynamic linear programming structure to model how electricity demand is met through a mix of generation and transmission in each region, as well as the transmission between

regions. The North American version[17] of IPM® is divided into roughly 110 power demand regions, including eight Canadian provinces. The North American version of the model also includes international coal demand and coal supply regions to forecast global coal production and movement.

4.1.1 IPM® Users and Documentation

IPM® is widely used, both in the United States and globally, by private sector companies such as electric utilities, coal power plant owners, coal companies, independent power producers, and financial institutions, and public sector entities, such as environmental groups and state public service commissions (Table 11).

Table 11. Private and Public Sector Entities Using IPM®

Private Sector Entities	Public Sector Entities
PEPCO	U.S. Environmental Protection Agency
Entergy	State public service commissions
Exelon	Environment Canada
Tucson Electric Power	European Union
Florida Power and Light (FPL)	Environmental groups (e.g., Natural Resources Defense Council)
Dominion	
NRG	
Delmarva Power	
Southwestern Electric Power Company	
Calpine	
APS	
Duke Energy	
American Electric Power	
Otter Tail Power Company	
Xcel Energy	
Dogwood Energy	
Peabody Energy	
Dynegy	

IPM® has been used in support of the following types of analyses.

- Coal price forecasts, including forecasts supporting litigation.
- Other coal industry forecasts, including production, transportation, and consumption.
- Air emissions compliance strategies for coal power plants and emissions allowance price forecasting.
- Impact assessments of alternate environmental regulatory standards including coal sector impacts.

[17] ICF International has completed IPM® systems for Europe, Australia, Japan, China, Korea and India, among other nations.

- Assessments of power plant retirement decisions, such as for existing coal power plants.
- Valuation studies for generation and transmission assets, including coal power plant valuations.
- Forecasting of regional forward energy and capacity prices.
- Forecasting of state and regional renewable energy credits.
- Impact assessments of changes in fuel pricing.
- Integrated Resource Planning analyses.
- Economic or electricity demand growth analyses.
- Pricing impacts of demand responsiveness.

EPA uses IPM® to analyze the impact of air emissions policies on the U.S. electric power sector. As part of this analysis, EPA publishes its assumptions and other information regarding its use of IPM® on its website (U.S. Environmental Protection Agency 2012). Although this documentation provides insight into EPA's assumptions, the data and assumptions used by ICF in this analysis are not necessarily the same as used by EPA. However, ICF did use many of the EPA assumptions as described in more detail in Section 4.2.

4.2 Key Assumptions

In this use of IPM®, key assumptions were made regarding fuel; air, waste, and water regulations; renewable energy regulations; reserve margin targets; mothballing and retirement of existing power plants; and transmission. To the extent possible, assumptions from publicly available sources, such as the EIA, IEA, and EPA were used. The majority of assumptions were obtained from EPA's v5.13 IPM Base Case (2013). The following subsections discuss the major assumptions used in this analysis.

4.2.1 Assumptions from Millennium Bulk Terminals—Longview

The following project-specific assumptions were provided by the Applicant.

- The proposed coal export terminal will export 44 million metric tons of coal per year.
- The proposed coal export terminal will start exporting 44 million metric tons of coal in 2025.
- Only Powder River Basin or Uinta Basin coal will be exported through the proposed coal export terminal.

4.2.2 Fuel

Fuel-related assumptions include those concerning coal and natural gas production and demand.

4.2.2.1 Coal Supply Curves

For this analysis, coal supply curves from EPA's v5.13 IPM® case were used. Because EPA only models the United States and does not include international representation beyond coal imports from Colombia and coal production from Canada, coal supply curves were developed for each of the international supply regions used in the model, except for Canada. These international coal supply curves were adjusted over time at the average rate that the EPA domestic supply curves were adjusted. On average, the domestic EPA supply curves increase in cost by 1.5% annually. Thus the international supply curve costs were also increased by 1.5% per year. The coal prices that the EPA coal supply curves produce in the Past Conditions (2014) Scenario are shown in Table 12 for Wyoming, Montana, Colorado, and Utah, which are regions from which coal might be exported through the terminal. Coal prices in 2016 for Wyoming Powder River Basin 17.6 MMBtu/ton coal are expected to be around $10.9/ton (2012$) and rising to $13.0/ton by 2018.[18] Thus, the EPA supply curves for Wyoming Powder River Basin coal result in prices somewhat higher than market expectations as of early 2015. Coal prices in 2016 for Utah coal are expected to be $40.8/ton (2012$) and rising to $41.2 by 2018. EPA's coal supply curves were most likely developed in 2013, at which time the Uinta Basin coal prices were in the $35/ton range. Thus, the EPA supply curves result in Uinta Basin coal prices that are below market expectations for the next few years. Since 2013, coal prices in general have declined by 10% to 20%, although some prices started declining in 2012 and others, such Powder River Basin coal fell 20% to 30% in 2012 and have been gradually increasing. Coal prices have decreased recently due to lower demand because of milder weather and because of being displaced by natural gas, which has been at historically low prices. In the mid- to long term, which is the focus of this analysis, coal prices are expected to increase above the low prices observed in 2015.

However, of equal importance is that a cohesive view of the coal markets and coal prices is used in the analysis. Such a cohesive approach is obtained by using the EPA coal supply curves in their entirety.

Table 12. Coal Prices in the Past Conditions (2014) Scenario—No-Action Alternative (2012$/short ton)

Year	Wyoming Powder River Basin, 17.6 MMBtu/ton	Montana Powder River Basin, 18.2 MMBtu/ton	Colorado Uinta, 23.58 MMBtu/ton	Utah Uinta, 23 MMBtu/ton
2016	12.69	11.99	29.42	27.00
2018	13.37	12.62	30.72	28.05
2020	14.16	13.37	32.61	29.43
2025	16.21	15.30	36.05	32.73
2030	18.70	17.64	40.44	36.95
2040	24.59	23.18	52.03	45.81

4.2.2.2 Natural Gas

This analysis incorporates the natural gas module that EPA used in its IPM® v5.13 Base Case. The assumptions and details of the natural gas module are fully documented in Chapter 10 of EPA's v5.13 documentation, which can be found at:

[18] SNL Coal Price Forecast as of May 18, 2015; SNL Financial; www.SNL.com.

http://www.epa.gov/airmarkets/programs/ipm/psmodel.html. Using the natural gas module allows natural gas prices to adjust to changes in demand. Table 13 shows the natural gas prices at Henry Hub, which is a major natural gas pricing point in Louisiana.

Table 13. Natural Gas Prices in the Past Conditions (2014) Scenario (2012$/MMBtu)

Year	Henry Hub (2012$/MMBtu)
2016	4.73
2018	5.39
2020	4.86
2025	5.34
2030	5.52
2040	6.12

4.2.3 Air, Waste, and Water Regulations

The regulatory assumptions used in this analysis reflect the assumptions used by EPA in its IPM® v5.13 Base Case. The Past Conditions (2014) Scenario for this analysis of the terminal does not include EPA's Clean Power Plan. However, the 2015 Energy Policy Scenario does include the proposed Clean Power Plan as modeled by EPA.

- The provisions of the Clean Air Interstate Rule (CAIR) are used in the analysis for sulfur dioxide (SO_2) and nitrogen oxides (NO_x) regulations. CAIR uses a cap and trade system to reduce SO_2 and NO_x for 27 eastern states and DC. CAIR uses Title IV SO_2 allowances as currency for the SO_2 trading program. The initial bank and allowance totals for CAIR are the same as for the Acid Rain Program established under Title IV of the Clean Air Act Amendments of 1990. For the Annual NO_x trading program, the total Annual NO_x allowances issued for 2016 was 1.2 million and the initial bank for 2016 was projected to be 1.5 million allowances. For the Ozone Season NO_x trading program, the total seasonal NO_x allowances was 0.48 million and the initial bank going into 2016 was projected to be 0.74 million.

- The EPA's Mercury and Air Toxics Standards final rule is used in the analysis and requires that all coal-fired generating units be controlled for air toxics, or be within 1 year of being controlled, by 2016, or the units must be retired (40 Code of Federal Regulations [CFR] Parts 60 and 63).

- EPA included the CO_2 cap in the Regional Greenhouse Gas Initiative for this analysis. The Regional Greenhouse Gas Initiative is a market-based regulatory program to reduce CO_2 emissions by setting a cap on emissions that decreases each year. Nine states in the northeast are part of the initiative (Regional Greenhouse Gas Initiative 2014).

- EPA also included the California Assembly Bill 32 cap-and-trade program in the v5.13 Base Case, which is expected to be more stringent than any likely federal CO_2 standards. The bill affects both in-state generation and power imported into California (Assembly Bill No. 32 Chapter 488).

- Other state SO_2 and NO_X regulations are included where final regulations exist.

4.2.4 Renewable Energy Regulations

- EPA's assumptions and regional structure regarding state specific renewable portfolio standards and solar carve-outs as described in Section 3.9.8 of Chapter 3 of EPA's documentation of its IPM® v5.13 Base Case were used.

4.2.5 Reserve Margin Targets

IPM's reliability-related assumptions reflect planning reserve margin requirements, which are targets for generating capacity that are used to ensure sufficient generating capacity is available at all times, such as when some plants are out of service for maintenance or equipment problems occur during peak demand periods.

- The reserve margin assumptions used in IPM® for this analysis are the planning reserve margins used by EPA in its IPM® v5.13 Base Case, as described in Section 3.6 of Chapter 3 of its v5.13 documentation.

4.2.6 Mothballing and Retirement

ICF's assumptions reflect the ability of electricity generating plants to mothball and return to service at a later date, or to retire. The capability to model plants entering a mothball state or retiring more realistically represents the actual energy market than a model that does not include this capability.

- To capture market exit behavior, IPM® included mothballing and retirement capabilities. Generating units with high fixed operations and maintenance costs become candidates for mothballing and retirement as more efficient generation capacity is constructed.

- The mothballing option is provided for all oil/natural gas steam facilities and is exercised if short-term annual fixed costs exceed annual revenues in a market with excess supply. The decision to mothball takes into consideration fixed costs, reserve requirements, and the costs of mothballing a unit and returning it to service at a later date.

- Retirement options are available to all existing coal, nuclear, and oil/natural gas steam units in IPM®. The modeling assumes that the retirement option would be exercised if projected discounted cash flows do not exceed projected costs (fixed, variable, and capital). Again, this decision takes long-term reserve requirements and revenues into consideration.

- The analysis assesses higher fixed operations and maintenance costs to uncontrolled coal units after 60 years in service to account for life-extension costs, potentially increasing the amount of coal retirements as the model chooses to retire units rather than pay the life-extension costs.

4.2.7 Transmission

IPM's assumptions took into account the capabilities of transmission lines. These assumptions are based on a thorough analysis of the transmission structure and constraints, and represent the most probable outlook at the time of the forecast.

- Joint capacity constraints were included to reflect limitations across groups of transmission links.

- Total transmission capability assumptions from public sources such as the North American Electric Reliability Corporation and regional reliability councils were used, as well as interface limits published by the International Organization for Standardization, where available.
- In regions where data were unavailable, the analysis used estimates derived from industry contacts and proprietary modeling exercises.
- The model assumed that power transported across power pools would incur a cost of $3.09 per megawatt hour (2011 U.S. dollars) to reflect charges assessed by one power pool to another.
- IPM® did not include regional through-and-out rates for any transactions terminating in the combined PJM-MISO footprint. Regional through-and-out rates are transmission rates for transactions where electricity originated in one transmission control area was transmitted to a point outside that control area.
- Transmission losses vary with line loading and line length, but estimating the exact loss factors for each interconnecting transmission path for the entire country would be impracticable. ICF's analysis, therefore, assumed transmission losses between 2% and 3%, based on industry practices. Note that these losses were intended to capture only bulk power transmission losses; distribution losses were not included.

4.2.8 International Coal Demand

International coal demand in the model is represented by a forecast of a region's or country's total thermal coal demand. Two sources were used as starting points for the international demand forecast. First, for the Past Conditions (2014) and Cumulative Scenarios, the most recent EIA forecast available was used, which was EIA's 2013 International Energy Outlook. The EIA data was used because it is a publicly available source and because it provides coal demand forecast data in sufficient detail for the countries of interest. Second, the International Energy Agency's 2014 World Energy Outlook was used. Tables 14 through 16 show the demand forecast for six Pacific Basin countries/regions. The Lower Bound and 2015 Energy Policy Scenarios used international demand forecasts based on IEA's 2014 World Energy Outlook, New Policy Scenario as a starting point. Under the New Policy Scenario major industrial countries are assumed to have policies in place to reduce the emissions of GHGs. These policies reduce the demand for coal. However, because of differences in assumptions, all but China's coal demand forecast uses the IEA New Policy Scenario, since the coal demand for other countries was higher than the EIA forecasts used in the Past Conditions (2014) Scenario. Thus, in the Lower Bound Scenario the EIA demand growth rates for all but China were reduced by 50% instead of using the higher IEA New Policy Scenario forecast for all other Pacific Basin countries. Without this assumption, the Lower Bound coal demand would have been the same as or higher than the Past Conditions (2014) Scenario coal demand, which would defeat the purpose of the Lower Bound Scenario. The IEA Current Policy Scenario was not used for the Past Conditions (2014) Scenario in this analysis as the IEA data is not provided at sufficient detail to populate the international demand regions used in the model.

Table 14. International Coal Demand—Past Conditions (2014) and Cumulative Scenarios (Trillion Btu)

	Country or Region					
Year	**China**	**Hong Kong**	**India**	**Japan**	**South Korea**	**Taiwan**
2016	76,248	336	11,841	3,190	2,013	1,633
2017	79,543	338	12,111	3,190	1,992	1,641
2018	81,449	339	12,325	3,182	1,977	1,650
2019	83,174	341	12,675	3,188	1,961	1,658
2020	84,961	343	13,109	3,190	1,945	1,666
2021	87,254	345	13,482	3,190	1,947	1,675
2022	89,458	346	13,821	3,184	1,939	1,683
2023	91,682	348	14,187	3,173	1,927	1,691
2024	94,198	350	14,592	3,164	1,919	1,700
2025	96,410	351	14,904	3,151	1,899	1,708
2026	97,989	353	15,251	3,142	1,873	1,717
2027	99,672	355	15,641	3,131	1,843	1,725
2028	101,448	357	15,965	3,119	1,814	1,734
2029	103,146	359	16,280	3,105	1,781	1,743
2030	104,764	360	16,591	3,089	1,751	1,751
2031	106,167	362	16,951	3,077	1,754	1,760
2032	107,315	364	17,306	3,063	1,757	1,769
2033	108,297	366	17,659	3,042	1,757	1,778
2034	109,033	368	18,010	3,022	1,760	1,787
2035	109,484	369	18,346	3,001	1,761	1,796
2036	109,703	371	18,670	2,972	1,747	1,805
2037	109,799	373	18,969	2,933	1,732	1,814
2038	109,662	375	19,280	2,902	1,722	1,823
2016–2019 CAGR	2.94%	0.50%	2.29%	-0.02%	-0.87%	0.50%
2020–2029 CAGR	2.18%	0.50%	2.44%	-0.30%	-0.97%	0.50%
2030–2038 CAGR	0.57%	0.50%	1.90%	-0.78%	-0.21%	0.50%
2016–2038 CAGR	1.67%	0.50%	2.24%	-0.43%	-0.71%	0.50%

Table 15. International Coal Demand—Lower Bound Scenario (Trillion Btu)

	Country or Region					
Year	**China**	**Hong Kong**	**India**	**Japan**	**South Korea**	**Taiwan**
2016	68,855	336	11,841	3,190	2,013	1,633
2017	69,742	338	11,977	3,189	1,987	1,637
2018	70,639	339	12,114	3,188	1,961	1,641
2019	71,549	341	12,253	3,187	1,936	1,646
2020	72,470	343	12,402	3,172	1,907	1,650
2021	72,713	345	12,553	3,158	1,880	1,654
2022	72,956	346	12,706	3,144	1,852	1,658
2023	73,200	348	12,861	3,130	1,825	1,662
2024	73,445	350	13,017	3,116	1,799	1,666
2025	73,691	351	13,176	3,102	1,772	1,670
2026	73,887	353	13,336	3,088	1,747	1,675
2027	74,083	355	13,499	3,074	1,721	1,679
2028	74,280	357	13,663	3,060	1,696	1,683
2029	74,477	359	13,830	3,046	1,671	1,687
2030	74,675	360	13,961	3,010	1,666	1,691
2031	74,545	362	14,093	2,975	1,661	1,696
2032	74,416	364	14,227	2,941	1,656	1,700
2033	74,288	366	14,361	2,906	1,651	1,704
2034	74,159	368	14,497	2,872	1,645	1,708
2035	74,031	369	14,635	2,839	1,640	1,713
2036	73,497	371	14,774	2,806	1,635	1,717
2037	72,968	373	14,914	2,773	1,630	1,721
2038	72,442	375	15,055	2,740	1,625	1,726
2039	71,922	375	15,198	2,708	1,620	1,730
2040	71,406	375	15,342	2,677	1,615	1,734

Notes:

Source: IEA World Energy Outlook 2014 for China demand. Due to differences in methodology, the IEA thermal coal demand for the other countries is above the EIA demand forecast. Thus, the demand estimate for the other countries was calculated by reducing the growth rates by 50%.

Table 16. International Coal Demand—Upper Bound Scenario (Trillion Btu)

	Country or Region					
Year	China	Hong Kong	India	Japan	South Korea	Taiwan
2016	76,248	336	11,841	3,190	2,013	1,633
2017	79,611	339	12,248	3,190	2,004	1,646
2018	83,122	341	12,670	3,190	1,996	1,658
2019	86,788	344	13,106	3,189	1,987	1,670
2020	89,624	346	13,585	3,184	1,977	1,683
2021	92,553	349	14,081	3,180	1,968	1,695
2022	95,577	351	14,595	3,175	1,958	1,708
2023	98,700	354	15,129	3,170	1,949	1,721
2024	101,925	357	15,681	3,165	1,939	1,734
2025	105,256	359	16,254	3,161	1,930	1,747
2026	108,695	362	16,848	3,156	1,921	1,760
2027	112,247	365	17,464	3,151	1,911	1,773
2028	115,915	368	18,102	3,146	1,902	1,786
2029	119,703	370	18,763	3,142	1,893	1,800
2030	120,731	373	19,296	3,129	1,891	1,813
2031	121,769	376	19,845	3,117	1,889	1,827
2032	122,815	379	20,409	3,105	1,887	1,841
2033	123,870	382	20,990	3,093	1,885	1,854
2034	124,934	384	21,586	3,081	1,883	1,868
2035	126,008	387	22,200	3,069	1,881	1,882
2036	127,090	390	22,831	3,057	1,879	1,897
2037	128,182	393	23,480	3,045	1,877	1,911
2038	129,283	396	24,148	3,033	1,875	1,925
2039	130,394	399	24,835	3,021	1,873	1,940
2040	131,514	402	25,541	3,010	1,871	1,954

Notes:
The EIA thermal coal demand estimate was calculated by increasing each country's growth rate by 50%.

4.2.9 Coal Demand Elasticity

Because the international coal demand is a forecast that is an input to the model, coal demand elasticity was used to adjust the demand based on the change in delivered coal prices. The demand elasticity is a measure of how much coal demand will change with a given change in the delivered coal price. As delivered coal prices change, the demand for coal changes in the opposite direction. ICF conducted a literature search to identify an energy-specific demand elasticity for this analysis. A total of eight sources were reviewed that provided demand elasticity for electricity, natural gas, and coal. The demand elasticity found in the sources ranged from a minimum of 0.11% to a maximum of 1.2%. Thus, for a 1.0% decrease in delivered coal prices there would be an increase in demand of between 0.11% and 1.2%. For the Past Conditions (2014) Scenario, the average of the eight sources, 0.4%, was used for the coal demand elasticity. The Lower and Upper Bound Scenarios used the minimum and maximum demand elasticity values from the literature search.

4.2.10 CO_2 Emissions from Coal Combustion

To estimate the CO_2 emissions from coal combustion, two main inputs are required. These inputs are (1) the amount of coal consumed in trillion Btu (TBtu) and (2) the carbon content, in pounds per million Btu, of the coal being consumed. The carbon content varies by coal rank (i.e., bituminous, subbituminous, and lignite) and by the source region of the coal; however, the data by region is incomplete. Since IPM® includes all U.S. coal plants, the model calculates the CO_2 emissions in the United States. However, IPM® does not calculate the CO_2 emissions for international coal consumption. The model solution does determine the amount of coal consumed and the type of coal consumed, which covers the two inputs required for calculating CO_2 emissions from international coal demand regions. IPM assumes that no coal plants have carbon capture and sequestration technology installed and that it will not be installed on new or existing plants during the timeframe of this analysis. Table 17 shows the CO_2 content of the three coal ranks.

Table 17. CO_2 Content in Coal by Type and Source Region

Source	Coal Type	CO_2 (lb/MMBtu)
Powder River Basin – WY	Subbituminous	214.3
Powder River Basin – MT	Subbituminous	215.5
Uinta – CO	Bituminous	209.6
Uinta – UT	Bituminous	209.6
Australia	Bituminous	205.3
Indonesia	Bituminous	205.3
Indonesia	Subbituminous	212.7
China	Bituminous	205.3
China	Lignite	215.4

Notes:
Source: Hong and Slatick 1994

4.2.11 Coal Distribution Limitations

Coal plants are typically designed to burn a specific type of coal and have limited ability to switch to a different type of coal. For example, coal plants designed to burn bituminous coal have boilers that are too small to burn 100% subbituminous coal. However, bituminous coal plants are typically able to mix some subbituminous coal along with the bituminous coal they consume. Coal plants in Japan, South Korea, Taiwan, and Hong Kong, consume higher heat content bituminous coal and thus would be limited in the amount of subbituminous coal that they could consume without needing costly plant retrofits. To ensure that the model does not send more subbituminous coal to these countries than they can use, constraints were added to limit the amount of subbituminous coal to no more than 30% of the country's total coal demand in TBtu.

4.2.12 Coal Reserves

Coal reserves both domestically and internationally are an important companion input to annual coal production capacity in the coal supply curves. Over time as the reserves on a step on the coal supply curve are exhausted the solved equilibrium price must solve higher on the coal supply curve, thus generally pushing prices higher over time, all else equal.

The domestic coal reserve estimates used in this analysis are included in the EPA coal supply curves adopted from EPA's v5.13 IPM documentation. International reserve data is generally of lower quality and can be inconsistent between sources. If multiple sources of reserve estimates were available, the analysis used the higher estimates, as technological improvements tend to make resources available that might have been un-economic previously.

4.3 Methods

This section provides an overview of the methods used in the analysis.

4.3.1 Model Run Years

Table 18 presents a map of calendar years and run years. Run years aggregate calendar years to limit model complexity. In other words, a run year is a calendar year chosen to represent a single year or a group of years in which prevailing electricity and fuel market conditions and environmental policies are expected to be most similar. The number of IPM® run years must be limited to decrease model complexity. The analysis period of 2016 to 2038 reflects the 23-year period of reasonably foreseeable coal export by the proposed terminal.

Table 18. Mapping of Calendar Years and Model Run Years

Calendar Year	Run Year
2016	2016
2017	
2018	2018
2019	2020
2020	
2021	
2022	
2023	2025
2024	
2025	
2026	
2027	
2028	2030
2029	
2030	
2031	
2032	
2033	
2034	2040
2035	
2036	
2037	
2038	

Calendar Year	Run Year
2039	
2040	
2041	
2042	
2043	
2044	
2045	

4.3.2 Coal

4.3.2.1 Modeling U.S. Coal Production

IPM® optimizes coal production, transportation, and consumption. For this purpose, the model uses coal supply curves developed for EPA, which provide supply curves for 34 different domestic coal supply basins. The international coal supply curves for 25 international supply basins were developed by ICF and added to the domestic supply curves to allow for global coal modeling. Coal supply curves are developed for 15 coal types distinguished by rank and sulfur content. There are multiple coal supply curves for each supply basin corresponding to the major coal quality types in that region. The supply curves consist of a series of supply "steps" that consist of a production cost, annual production capacity, and a coal resource limit. These supply curves are then incorporated into IPM®. Each coal power plant in IPM® is assigned to its own coal demand region in the model.

Coal varies by heat content, SO_2 content, hydrogen chloride content, and mercury content among other characteristics. To capture differences in the sulfur and heat content of coal, a two letter "coal grade" nomenclature is used. The first letter indicates the "coal rank" (bituminous, subbituminous, or lignite) with their associated heat content ranges (as shown in Table 19). The second letter indicates their "sulfur grade," i.e., the SO_2 ranges associated with a given type of coal. (The sulfur grades and associated SO_2 ranges are shown in Table 20).

Table 19. Coal Rank Heat Content Ranges

Coal Type	Heat Content (Btu/lb)	Classification
Bituminous	>10,260–13,000	B
Subbituminous	>7,500–10,260	S
Lignite	Less than 7,500	L

Notes:
Btu/lb = British thermal units per pound

Table 20. Coal Grade SO_2 Content Ranges

SO_2 Grade	SO_2 Content Range (lbs/MMBtu)
A	0.00–0.80
B	0.81–1.20
D	1.21–1.66
E	1.67–3.34
G	3.35–5.00
H	> 5.00

Notes:
SO_2 = sulfur dioxide; lbs/MMBtu = pounds per million metric British thermal unit

IPM® includes integrated U.S. and international coal market modeling. Figures 17 and 18 show the domestic and international coal supply regions. The modeling platform captures terminal capacity limits, international shipping costs, steam coal supply, and demand from both electricity and non-electricity sectors.

Figure 17. Domestic Coal Supply Regions

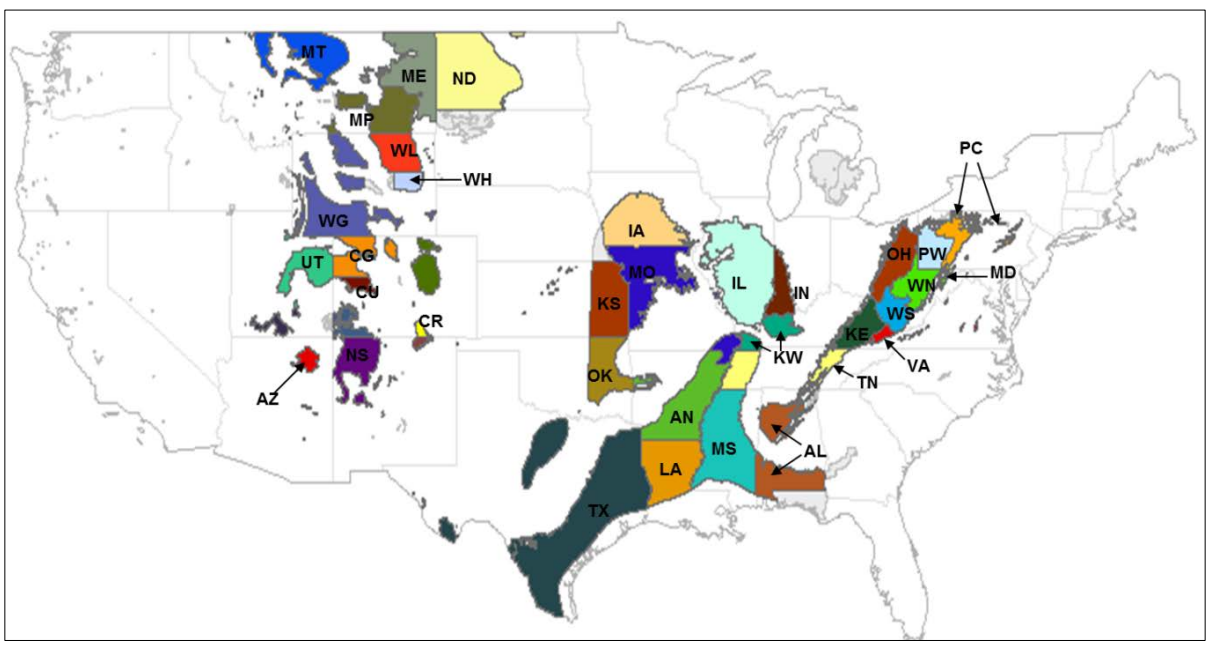
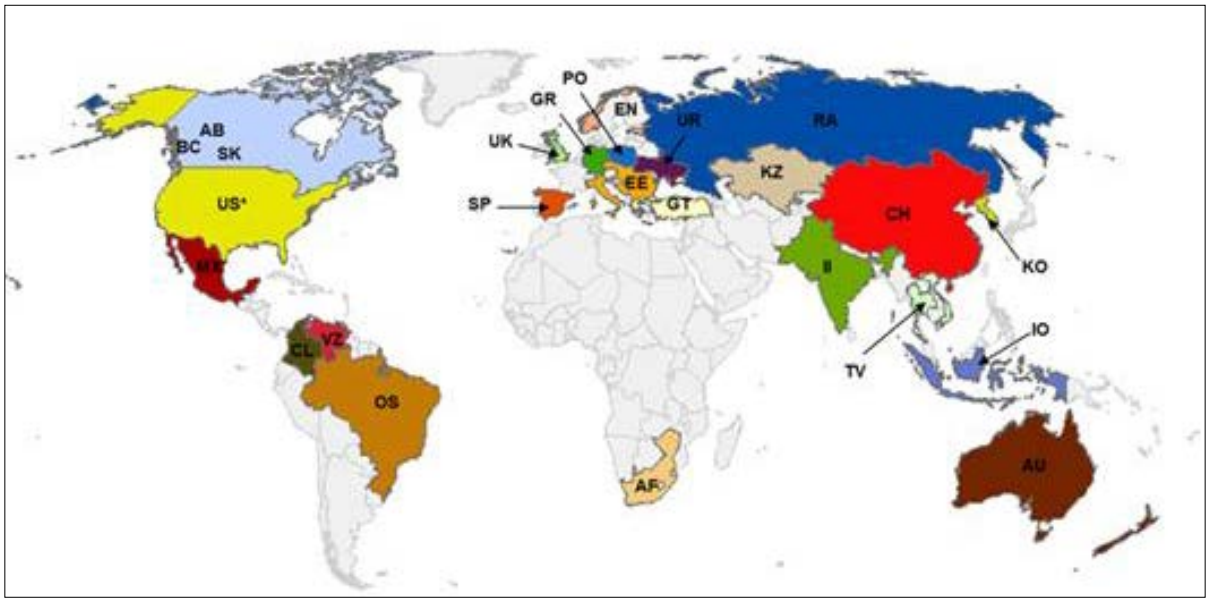


Figure 18. International Coal Supply Regions



4.3.2.2 Coal Demand

Using IPM®, coal demand is determined in the United States and Canada by the operation of existing coal-fired power plants, and elsewhere by projections of coal demand by country. Within a model run, IPM® calculates thermal coal consumption for each coal-fired electricity generation plant in the United States and Canada. Thermal coal consumption and coal prices are determined by the supply and demand economics of meeting the electricity demand. The plant specific coal consumption and coal supply region price projections result in an integrated and consistent analysis in IPM® of the electricity demand; natural gas supply and prices; air emissions regulations for NO_X, SO_2, hydrogen chloride, and mercury; CO_2 policy alternatives, and renewable portfolio standards and explicit modeling of renewable generation options.

If the future electricity demand cannot be met by existing power plants, IPM® will determine the type and amount of new generating capacity required to meet the electricity demand on a least cost basis. The different types of capacity that can be added consist of combustion turbines, combined cycles, nuclear units, wind plants, coal-fired units, solar PV and thermal, geothermal, biomass, landfill gas, and hydro. Thus, if IPM® determines that new coal plants in the United States and Canada are necessary, it will increase coal demand. IPM® can also determine that it is most economical to retire existing coal plants, which would decrease coal demand. This is only applicable in the United States and Canada, as coal plants are modeled explicitly in only these countries. Using this structure, IPM® is able to model explicitly the shifts in coal demand related to environmental mandates, natural gas prices, and coal production and transportation costs. For example, if natural gas prices are low, more electricity will be generated by natural gas-fired combined cycles, and coal consumption will be lower than in a case with higher natural gas prices. Outside of the United States and Canada, coal demand is estimated using historical coal consumption data, expected coal plant construction, and economic and population trends.

Table 21 shows the coal demand forecast for China, the rest of the Pacific Basin, and the United States. As the forecast shows, China is expected to continue to be the largest thermal coal consumer through 2038.

Table 21. Global Thermal Coal Demand (million tons)

Year	China[a]	Hong Kong[a]	India[a]	Japan[a]	South Korea[a]	Taiwan[a]	United States[b]
2018	4,548	14.6	712	136	83.8	66.6	907
2025	5,383	15.1	820	135	80.5	69.0	863
2030	5,849	15.5	958	132	74.2	70.7	852
2038	6,123	16.1	1,096	124	73.0	73.6	865

Notes:
[a] International total coal demand obtained from EIA International Energy Outlook 2013. Metallurgical coal demand was subtracted to obtain the thermal coal demand.
[b] The U.S. demand is from the Past Conditions (2014) Scenario of this analysis.

In terms of non-electricity sector demand for thermal coal, IPM® includes domestic and international forecasts that serve as the demand for this coal. IPM® has an international coal supply and demand representation that enables it to project coal exports out of and imports into the United States and other countries. Table 22 summarizes the overall U.S. electricity demand forecast.

Table 22. U.S. Energy Demand Forecast

Year	Energy Demand (TWh)
2016	4,048.7
2018	4,134.6
2025	4,390.0
2030	4,535.1
2040	4,887

Notes:
Source: EPA IPM V5.13 documentation
TWh = terawatt hours

4.3.2.3 Coal Transportation

The model also connects the 34 U.S. coal supply regions and the 25 international supply regions with the plant specific coal demand regions in the United States and Canada, and 26 international coal demand regions. The transportation costs between supply and demand regions are based on the transportation mode, such as rail, barge, and truck, and the mileage between each region by mode. Each coal demand region has on average 9 supply regions connected to it, using one or more transportation modes. For international shipments, shipping rates are estimated based on published shipping cost data and are adjusted going forward based on projections of the global shipping index, the Baltic Dry Index.

During each run, IPM® determines the least cost means to meet power sector demand for coal as part of an integrated optimal solution for power, fuel, and emissions markets. Thus, IPM® is able to determine the optimal sourcing of coal for each power plant based on the estimated coal prices and transportation costs. Additional information on the coal transportation inputs and methodology used can be found in Chapter 9 of EPA's documentation on the IPM v5.13 Base Case.

4.3.3 Environmental Compliance

4.3.3.1 Plant-by-Plant Compliance Overview

For explicitly modeled coal plant in the United States and Canada, IPM® incorporates constraints on emissions of NO_X, SO_2, hydrogen chloride, mercury, CO_2, and potentially other pollutants into its optimization process. Since coal demand in other countries is done through a forecast and not explicitly modeling coal plants, this is only applicable to U.S. and Canadian coal plants. Constraints are specified on the basis of target emissions rates, cap-and-trade policies, dollars per ton emitted tariffs, or command-and-control policies, and applied to individual generating units or groups of units. Power-generating units subject to environmental regulations have the following compliance options, with any combination or individual use of the first four options as a viable compliance mechanism.

- **Reduce running regime**. To comply with non-command-and-control policies, such as target emissions rates or an emissions cap, a unit can reduce the number of hours in a year it operates and shift when it operates to hours that are more lucrative, which would be during peak demand periods of a day or year. For example, a plant might run only during the peak hours of 6:00 a.m. and 10:00 p.m., or only during the peak summer season.

- **Fuel switch**. Coal-fired units can choose from a variety of coals of different sulfur and mercury contents to minimize emissions and allowance cost impacts. The demand for these lower content coals results in premiums for those coals, over coals with higher pollutant contents. This premium may shrink if, for example, control becomes the dominant compliance option and higher pollutant content coals can be burned by controlled units. Oil units are generally offered fuels with different sulfur contents as well. The system may also fuel switch, from new coal builds to new natural gas builds, for example, to address CO_2 emissions requirements.

- **Retrofit**. For the four pollutants NO_X, SO_2, hydrogen chloride, and mercury, a variety of retrofit technologies is available to reduce emissions. In the case of CO_2, IPM® includes potential carbon capture-and-sequestration technology retrofits that can be applied to both new and existing units.

- **Purchase allowances**. By calculating an allowance price, IPM® is implicitly assuming that some units are sellers of allowances and others are buyers.

- **Retire.** A unit can be forced to retire or be given the economic option to retire if it cannot cover its operating costs going forward.

4.3.3.2 CO_2 Emissions

IPM® has the capability to model carbon policies as a cap-and-trade program or as a strict limit on CO_2 emissions from the power sector or the economy as a whole. In the 2015 Energy Policy Scenario, which is the scenario that includes a CO_2 policy, IPM models EPA's proposed Clean Power Plan through state level emissions constraints in the same way that EPA modeled the Clean Power Plan. The modeled CO_2 program reflects the proposed regulations that covers CO_2 emissions only from the power sector. As of mid-2015, a policy that goes beyond the power sector seems unlikely, based on public and Congressional sentiment. The New Source Performance Standards for CO_2 for new and modified sources are reflected in the model by requirements that any new coal units, other

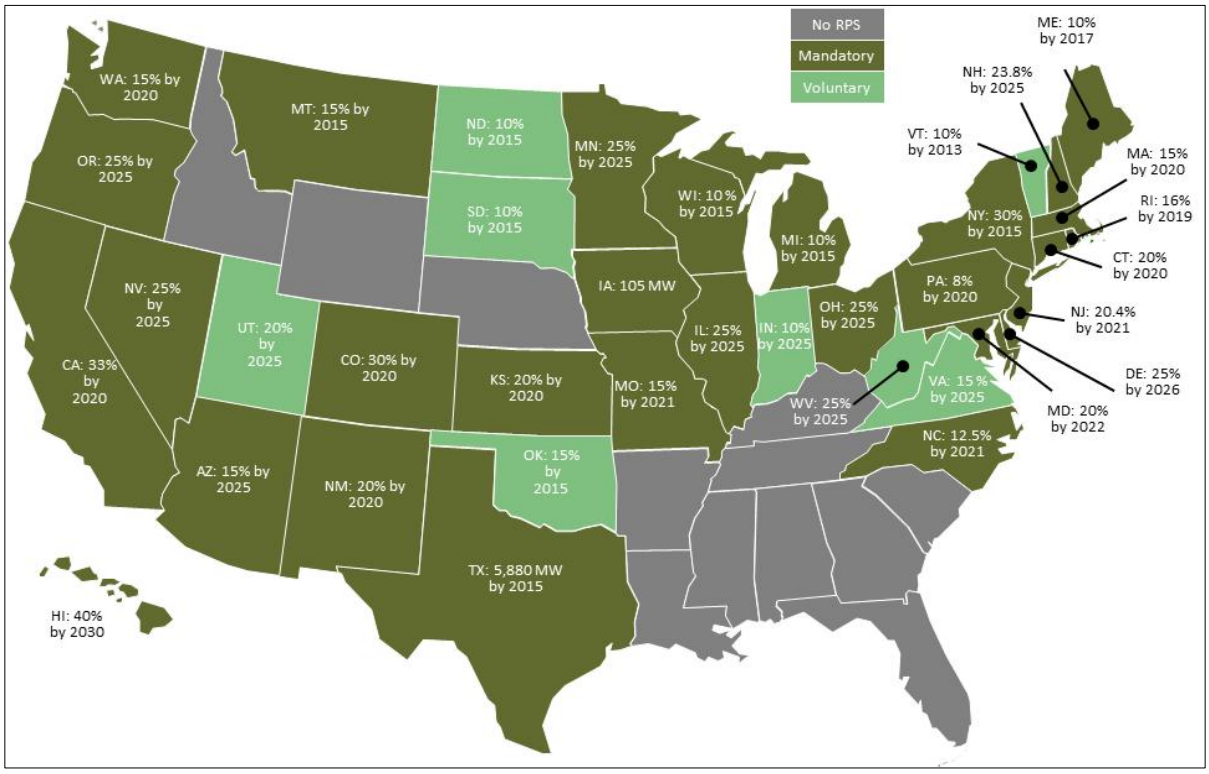
than those named by EPA as exceptions, would have to be constructed with carbon capture and sequestration.

4.3.3.3 Renewable Portfolio Standards

IPM® treats renewable portfolio standards as follows.

- Twenty-nine states and the District of Columbia have passed mandatory renewable energy requirements; eight more have enacted voluntary standards or goals (Figure 19).
- The design of each renewable portfolio standard varies by target and timing, the types of renewable generation allowed, the geographic scope within which a generator might be eligible to meet the standard, and the types of enforcement mechanisms and escape clauses included.

Figure 19. Renewable Portfolio Standards



Renewable generation capacity tends to have a higher-levelized cost than fossil-fuel generation. To encourage the development of renewable capacity, many states allow generators to commoditize the green attributes of renewable power in renewable energy credits.[19] The sale of such credits can provide supplemental revenue.

4.3.3.4 Other State and Regional Requirements

The modeling also addresses the following state and regional programs.

[19] Alternative terms used for such instruments include *green tags* and *renewable energy certificates*.

- IPM® included the CO_2 cap currently specified in the Regional Greenhouse Gas Initiative.
- IPM® includes California Assembly Bill 32 cap-and-trade program, which affects both in-state generation, as well as power imported into California.
- IPM® includes other state SO_2 and NO_X regulations where final regulations exist.

4.3.4 Natural Gas

This analysis uses the natural gas mode from EPA's IPM v5.13 Base Case. A thorough description of the natural gas modeling and assumption is contained in Chapter 10 of EPA's documentation for v5.13, and thus, is not duplicated here.

Chapter 5
Scenarios

Four main scenarios and a cumulative scenario were modeled using IPM®. The four main scenarios are the Past Conditions (2014) Scenario, Lower Bound Scenario, Upper Bound Scenario, and 2015 Energy Policy Scenario. The Cumulative Scenario takes into account the addition of other reasonably foreseeable planned export terminals in the Pacific Northwest. The Lower and Upper Bound Scenarios are designed to provide reasonable bounds on GHG emissions from the implementing the Proposed Action. The four main scenarios differ regarding the following six parameters.

- International coal prices
- International thermal coal demand growth rate
- Coal demand elasticity
- Powder River Basin and Uinta Basin coal prices
- U.S. rail transportation prices
- U.S. and International Climate Policy

5.1 Scenarios Analyzed

A No-Action Alternative and a Proposed Action case were created for each scenario analyzed, except for the Cumulative Scenario, where the Proposed Action is compared to the Past Conditions (2014) Scenario No-Action Alternative. This was done to isolate the Proposed Action as the only change between the No-Action Alternative and Proposed Action in each scenario. Table 23 summarizes the Past Conditions (2014), Lower Bound, Upper Bound, and 2015 Energy Policy Scenarios and the following sections provide additional details on the differences between each scenario.

Table 23. Scenario Definitions

Parameter	Scenario			
	Past Conditions (2014) No-Action and Proposed Action	**Lower Bound No-Action and Proposed Action**	**Upper Bound No-Action and Proposed Action**	**2015 Energy Policy No-Action and Proposed Action**
International Coal prices	$60 to 70/ton	Decrease by 10%	Increase by 50%	No change from Past Conditions (2014)
International thermal coal demand growth rate	2016 to 2038 CAGR China: 1.7% India: 2.2% Korea: -0.7% Japan: -0.4% Taiwan: 0.5%	Use IEA World Energy Outlook demand forecast from the New Policy Scenario, unless the IEA demand is greater than the EIA demand. In these cases the EIA demand growth rates were reduced by 50%.	Increase coal demand growth rates by 50%. For countries with negative growth rates, the growth rate would be set to zero.	Use IEA World Energy Outlook demand forecast from the New Policy Scenario unless the IEA demand is greater than the EIA demand. In these cases the EIA demand growth rates were reduced by 50%.
Coal demand elasticity	1.0% change in delivered coal cost results in 0.4% change in demand in opposite direction	1.0% change in delivered coal cost results in 0.11% change in demand in opposite direction	1.0% change in delivered coal cost results in 1.2% change in demand in opposite direction	No change from Past Conditions (2014)
Powder River Basin and Uinta Basin coal prices	Powder River Basin 8800 Btu/lb: $12/ton Uinta Basin 11,700 Btu/lb: $40/ton	Increase Powder River Basin by 25% and Uinta Basin by 10%	Decrease by 10%	No change from Past Conditions (2014)
U.S. Rail transportation costs	Between $30 to 36/ton	Increase by 20%	Decrease by 20%	No change from Past Conditions (2014)
U.S. Climate Policy	No National Climate Policy	No National Climate Policy	No National Climate Policy	Clean Power Plan as proposed

Notes:
CAGR = compound annual growth rate; IEA = International Energy Agency; EIA = Energy Information Administration; Btu/lb = British thermal units; lb = pound; MMBtu = million metric British thermal units

5.1.1 Past Conditions (2014) Scenario

The Past Conditions (2014) Scenario is defined by a set of assumptions that are intended to represent the state of the energy markets as of mid-2015 when the model was run. The assumptions that are presented in Chapter 4, *Model Framework, Methods, and Key Assumptions*, are the Past Conditions (2014) Scenario assumptions. For the six parameters that are changed to define the four main scenarios, the Past Conditions (2014) Scenario is defined as described in the following bullets.

- International coal prices would be between $60 to $70 per short ton.
- The international thermal coal demand growth rate would vary by country, with China operating at the highest rate at 1.7%, and South Korea with a negative growth rate of -0.7%.
- Coal demand elasticity would be moderate, with every 1.0% change in delivered coal cost resulting in 0.4% change in demand in the opposite direction.
- Powder River Basin coal prices would be $12/ton for Powder River Basin 8800 Btu/lb coal, and Uinta Basin prices would be $40/ton for 11,700 Btu/lb coal.
- Rail transportation costs would be $30 to $36 per ton for coal transported from the Powder River Basin and Uinta Basin to the proposed coal export terminal.
- Coal would emit 205 to 215 pounds of CO_2 per MMBtu when combusted, with the lower value for bituminous coal and the upper value for lignite.
- This scenario operates under an assumption of no national climate policy.

5.1.2 Lower Bound Scenario

The Lower Bound Scenario is designed to result in a reasonable lower bound estimate of global CO_2 emissions from the power sector and to evaluate the likelihood of a smaller CO_2 emissions impact with the construction and operation of the proposed coal export terminal. This scenario is designed to be a plausible and reasonable lower bound, and does not attempt to model an absolute lowest bound of CO_2 emissions or CO_2 emissions due to the Proposed Action. The energy market under the Lower Bound Scenario could be described as a high renewable energy penetration scenario. If renewable energy penetration is higher than expected, international coal consumption and prices would both decline. For the seven parameters that are changed to define the four main scenarios, the Lower Bound Scenario for both the No-Action Alternative and Proposed Action is defined as described in the following bullets.

- International coal prices were decreased from the Past Conditions (2014) Scenario by 10%. This change would cause a smaller amount of induced demand because it would reduce the differential in prices between international coal and the coal exported through the terminal. Thus, there would be lower CO_2 emissions than the Past Conditions (2014) Scenario, because the export of coal from the terminal would cause a smaller reduction, or no reduction, in international delivered coal prices, and thus, would induce less new coal demand than the Past Conditions (2014) Scenario.
- Powder River Basin and Uinta Basin coal prices would increase by 25% and 10%, respectively.
- Transportation costs would increase by 20% for Powder River Basin and Uinta Basin coal movements to the terminal.
- Coal demand would be less elastic than the Past Conditions (2014) Scenario. In the Lower Bound Scenario a 1.0% change in delivered coal cost would result in a 0.11% change in coal demand in the opposite direction. To the extent that there would be a decrease in delivered coal costs, this assumption would cause the amount of induced demand to be less than it would be under the Past Conditions (2014) Scenario.

- International thermal coal demand in the Lower Bound Scenario was obtained from the International Energy Agency (IEA) World Energy Outlook demand forecast for its New Policy Scenario, except if the IEA demand was greater than the EIA demand forecast used for the Past Conditions (2014) Scenario, then the EIA demand growth rates were reduced by 50% and the resulting demand forecast used in the analysis.
- The Lower Bound Scenario does not include a national or international climate policy.

5.1.3 Upper Bound Scenario

The Upper Bound Scenario is designed to result in a reasonable upper bound estimate of global CO_2 emissions and to evaluate the likelihood of greater CO_2 emissions impact with the construction and operation of the terminal. This scenario is designed to be a plausible and reasonable upper bound, and does not attempt to model an absolute highest bound of global CO_2 emissions or CO_2 emissions due to the Proposed Action. The world energy outlook under the Upper Bound Scenario could be described as a high coal demand scenario, where coal plant construction, and thus, coal demand, is higher than expected in the Past Conditions (2014) Scenario. Thus, both international coal consumption and prices would increase. The coal prices would increase because the higher demand would drive the prices higher. For the seven parameters that change to define the four main scenarios, the Upper Bound Scenario for both the No-Action Alternative and Proposed Action is described in the following bullets.

- International coal prices were increased from the Past Conditions (2014) Scenario by 50%. This change would cause a larger amount of induced demand because it would increase the differential between the international coal prices and the coal exported though the terminal. Thus, there would be higher CO_2 emissions than the Past Conditions (2014) Scenario, because the export of coal from the terminal would cause a larger reduction in international delivered coal prices, and thus, would induce more new coal demand than the Past Conditions (2014) Scenario.
- Powder River Basin and Uinta Basin coal prices would decrease by 10%.
- Transportation costs were decreased by 20% for Powder River Basin and Uinta Basin coal movements to the terminal.
- Coal demand would be more elastic than the Past Conditions (2014) Scenario. In the Upper Bound Scenario, a 1.0% change in delivered coal cost would result in a 1.2% change in coal demand in the opposite direction. To the extent that there would be a change in delivered coal costs, this assumption would cause the amount of induced demand to be greater than it would be under the Past Conditions (2014) Scenario.
- International thermal coal demand in the Upper Bound Scenario was obtained by increasing the Past Conditions (2014) Scenario coal demand growth rates by 50%, unless the country had a negative growth rate. In this case, the negative growth rate was set to zero, to obtain a flat demand.
- The Upper Bound Scenario does not include a national or international climate policy.

5.1.4 2015 Energy Policy Scenario

The 2015 Energy Policy Scenario was created to evaluate how recent international climate negotiations and perspectives on future climate policies might affect GHG emissions under the Proposed Action. In particular, this scenario evaluates the November 2014 U.S.-China announcement on climate change action goals and implementation of the proposed U.S. EPA Clean Power Plan. This scenario represents the energy market as of late 2014 and is the most probable of the four scenarios.

The 2015 Energy Policy Scenario is the same as the Past Conditions (2014) Scenario except for two parameter changes. First, the international thermal coal demand was taken from the IEA World Energy Outlook, New Policy Scenario demand forecast. The New Policies Scenario takes into account the policies and implementing measures affecting energy markets that have been adopted as of mid-2014, together with relevant policy proposals, even if specific measures needed to put them into effect have yet to be fully developed. The New Policies Scenario assumed only cautious implementation of these proposed commitments and plans.

Second, this scenario includes the Clean Power Plan as proposed by EPA, which is intended to reduce CO_2 emissions in the United States that are a start to achieving the November 2014 commitments. The Clean Power Plan would also likely reduce the amount of coal consumed in the United States. This analysis uses the proposed Clean Power Plan in the modeling because the final Clean Power Plan was not released until August, 2015, which was after the modeling was completed. See the side bar below for the key differences between the proposed and final Clean Power Plan.

Differences between the proposed and final Clean Power Plan:

CPP Component	Proposed Rule	Final Rule
Implementation	2020	2022
Interim standards	1 step 2020-2029	3 steps, 2022-2024, 2025-2027, 2028-2029
Best System of Emission Reduction (BSER) application	State-specific	Interconnection, to develop national technology specific standards
BSER Building Blocks	Four	Three (removed nuclear and existing RE from BB3 and all of BB4-EE)
State Standard derivation	BSER applied to 2012 baseline	National technology-specific rates applied to 2012 adjusted baseline
Standard types	Rate-based	Rate- and mass-based
Potential for trading	Allowed with joint plan	Allowed with joint plan or trading-ready option

5.1.5 Cumulative Scenario

The Cumulative Scenario include the addition of other planned export terminals in the Pacific Northwest in both the United States and Canada. The export terminals, and their capacities included in this scenario are shown in Table 24. Each terminal is assumed to operate at full capacity, for a total export tonnage of 183 million metric tons, which would include both thermal and metallurgical coal. Because the Canadian export terminals primarily export Canadian coal and are expected to continue this practice, only a portion of these terminals are available to export U.S. coal, as shown in

the last column of Table 24. All other assumptions are the same as in the Past Conditions (2014) Scenario.

Table 24. Planned and Existing Pacific Northwest Export Terminals

Terminal	State/Province	Online Year	Capacity (MMTons/year)	Capacity Available for U.S. Coal (MMTons/year)
Planned				
Millennium Bulk Terminal—Longview	Washington	2025	44	44
Gateway Pacific Terminal	Washington	2030	48	48
Coyote Island/Morrow	Oregon	2030	8	8
Fraser Surrey Docks	British Columbia	2018	4	4
Westshore Expansion	British Columbia	2017	3	3
Ridley Expansion	British Columbia	2016	13	9
Neptune Expansion	British Columbia	2018	6	0
Total Planned			126	116
Existing				
Westshore	British Columbia	N/A	33	8
Neptune (metallurgical coal only)	British Columbia	N/A	12	0
Ridley	British Columbia	N/A	12	5
Total Existing			57	13
Total Planned and Existing			**183**	**129**

Notes:
MMTons/year = million metric tons per year

Chapter 6
Modeling Results

6.1 Overview of Results

This chapter presents the coal production, consumption, distribution, and emissions modeling results. Coal production results are presented for both U.S. and non-U.S. production, with a focus on Powder River Basin and Uinta Basin coal production. Emissions of CO_2 are presented for the consumption of coal only in the Pacific Basin, and for coal and natural gas in the United States. Emissions from other sources, such as the transportation of coal, are presented in the air quality and greenhouse gas sections of the EIS. Emissions of CO_2 from natural gas are included in this chapter, because natural gas generation is a replacement for coal-fired electric generation that will have CO_2 emissions. Results are presented for the full modeling time horizon of 2016 through 2040 to provide additional context for the changes that would occur under the Proposed Action. However, the averages presented in the tables are only for the period 2025 to 2040, to focus the changes in results on the period when the proposed coal export terminal is operational in the model. Construction of the coal export terminal is expected to begin in 2018 and continue through 2024, when full operation of the coal export terminal begins.

The proposed coal export terminal may cause changes in coal production at the following scales of production.

- Powder River Basin or Uinta Basin coal production
- U.S. coal production
- Non-U.S. coal production, such as in Indonesia or Australia

This section provides an overview of the Past Conditions (2014) Scenario, No-Action Alternative and Proposed Action results, as well as results from the four scenarios analyzed.

- Lower Bound Scenario
- Upper Bound Scenario
- 2015 Energy Policy Scenario

  The Cumulative Scenario is discussed in section 6.6, *Cumulative Scenario*.

All coal production and consumption results in this analysis are presented in million metric tons.

6.1.1 Past Conditions (2014) Scenario Results

Under the Past Conditions (2014) Scenario total U.S. coal production for the No-Action Alternative would have an average of 791 million metric tons per year over 2025 to 2040. U.S. coal production would remain relatively flat over this period. Total non-U.S. coal production in this period would have an average of 8,634 million metric tons per year and increases during the period analyzed to meet the expected growth in coal demand, which is primarily in China and India. For the Proposed

Action, the U.S. average coal production over 2025 to 2040 would be 819 million metric tons, which would be an increase of 28 million metric tons per year. The non-U.S. average coal production would decrease by 26.8 million metric tons per year. The reason that the U.S. coal production would only increase by 28 million metric tons per year is primarily because exported Powder River Basin coal under the No-Action Alternative would shift from the Canadian export terminals to the new terminal under the Proposed Action. Specifically, 13.6 million metric tons of Powder River Basin coal that is exported through the Canadian terminals in 2025 in the No-Action Alternative is no longer exported through the Canadian terminals in the Proposed Action Alternative. Instead this coal from the Powder River Basin is exported through the terminal in the Proposed Action because it is expected that due to lower transportation costs, the coal will shift to the coal export terminal. Therefore there would be a smaller change in total Powder River Basin exports, and thus, total U.S. production, than if the exports through the Canadian terminals continued under the Proposed Action Alternative. Non-U.S. coal production would decrease in response to the increase in exports, and would be less than the change in U.S. production because the lower heat content Powder River Basin coal would be displacing a smaller amount of higher-heat content coal from Asia.

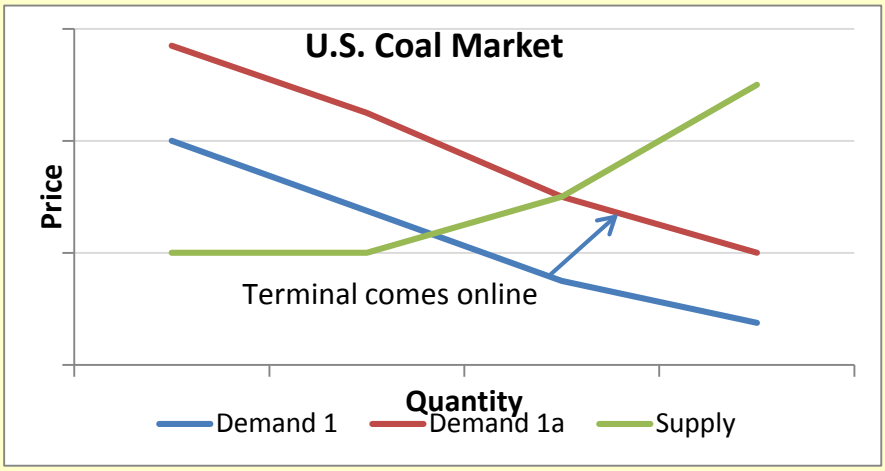
The total average U.S. thermal coal consumption for 2025 to 2040 under the No-Action Alternative would be 785 million metric tons per year, while Pacific Basin average thermal coal consumption would be 7,068 million metric tons per year. Average annual Pacific Basin coal consumption for the period 2025 to 2040 under the Proposed Action would be within 6.5 million metric tons of consumption under the No-Action Alternative. The change would be due to a small amount of induced demand (about 1 million metric tons), which is due to lower delivered coal prices in the Pacific Basin, and due to the greater consumption of lower heat content coal that replaces some higher heat content coal.

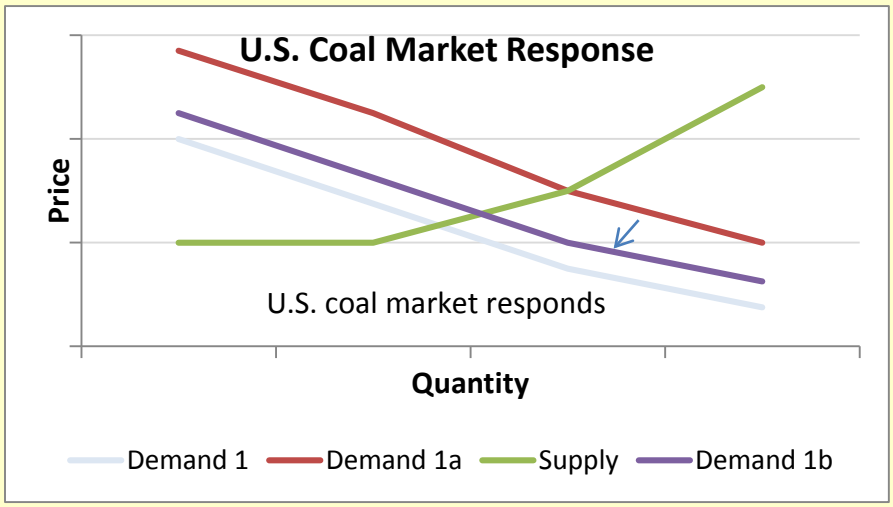
Seaborne thermal coal distribution in the Pacific Basin would average 902 million metric tons per year during 2025 to 2040 under the No-Action Alternative, and would only change by 0.7 million metric tons under the Proposed Action because the exported coal would replace coal produced in Asia. Under the Proposed Action, coal from the Montana portion of the Powder River Basin and from Utah would be exported to Japan. While the total tons of coal transported by ship in the Pacific Basin would only increases by 0.7 million metric tons per year on average, the distance that the coal travels would be greater under the Proposed Action than under the No-Action Alternative. Under the Proposed Action, the change in the distance coal would be transported would average 42,322 nautical miles more than under the No-Action Alternative.

CO_2 emissions in the United States under the No-Action Alternative from the combustion of coal would average 1,505 million metric tons per year over 2025 to 2040, while emissions from natural gas consumption would average 470 million metric tons per year. In the Pacific Basin, CO_2 emissions under the No-Action Alternative from the combustion of coal would average 13,407 million metric tons per year over 2025 to 2040. Under the Proposed Action, CO_2 emissions would increase by 2.6 million metric tons per year in the Pacific Basin, and decrease by 6.9 million metric tons per year in the United States. Since natural gas emissions in the United States would also increase, the total net change in CO_2 emissions under the Proposed Action would be a decrease of 2.55 million metric tons per year on average over 2025 to 2040.

Operation of the Proposed Action would further integrate the U.S. and Asian coal markets. However, to the extent that Asian coal prices would be higher than U.S. prices, operation of the Proposed Action would cause Asian coal prices to decline, while U.S. prices would increase. These changes in prices would cause Asian coal demand to increase and U.S. demand to decrease. The reason U.S. coal prices would increase is because the Applicant would act as a "buyer" of coal, and thus, would shift the demand curve to the right, setting a new, higher equilibrium coal price. In response, utilities would choose to use less coal and more natural gas, so the coal demand curve shifts back to the left, but still to the right of the original curve.

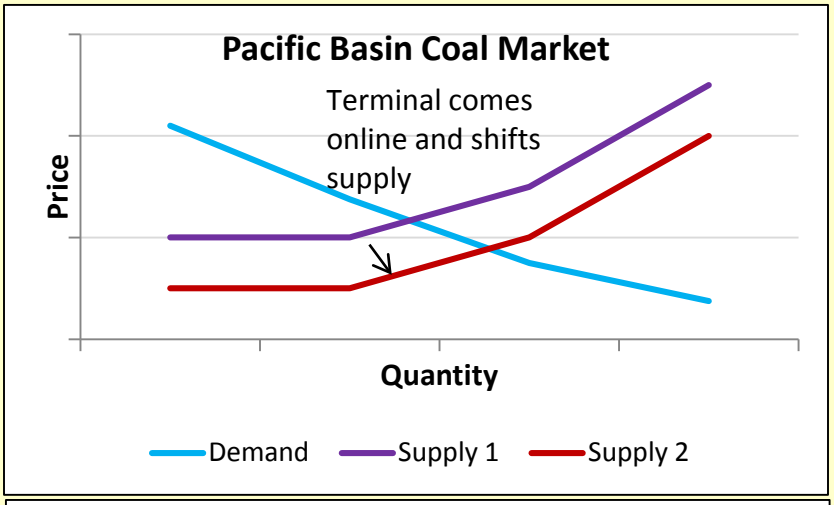
Impact of Proposed Action Alternative on Domestic Coal Supply and Demand at Full Capacity

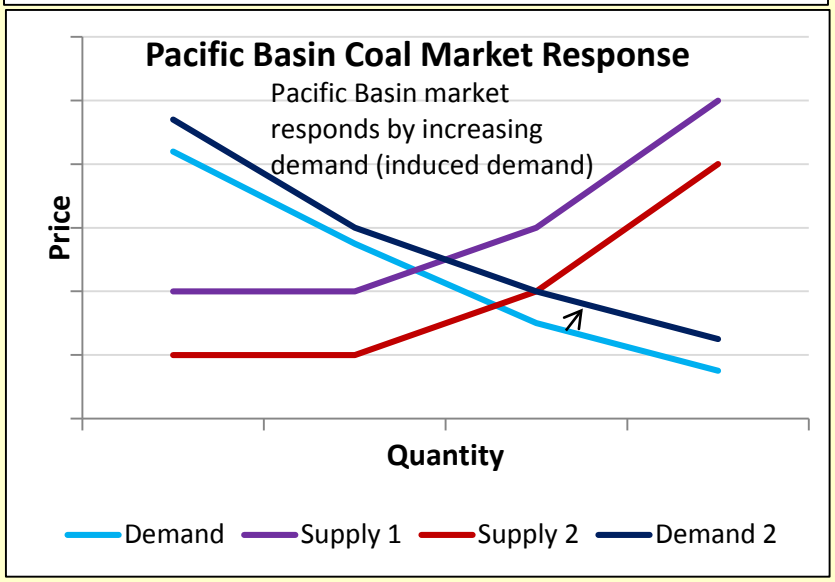




The Proposed Action would cause Asian coal demand to increase because the proposed coal export terminal would act as a new source of coal, and thus, would shift the supply curve to the right, setting a new, lower equilibrium coal price. In response, Asian countries would choose to use more coal, so the coal demand curve would shift to the right.

Impact of Proposed Action on International Coal Supply and Demand at Full Capacity



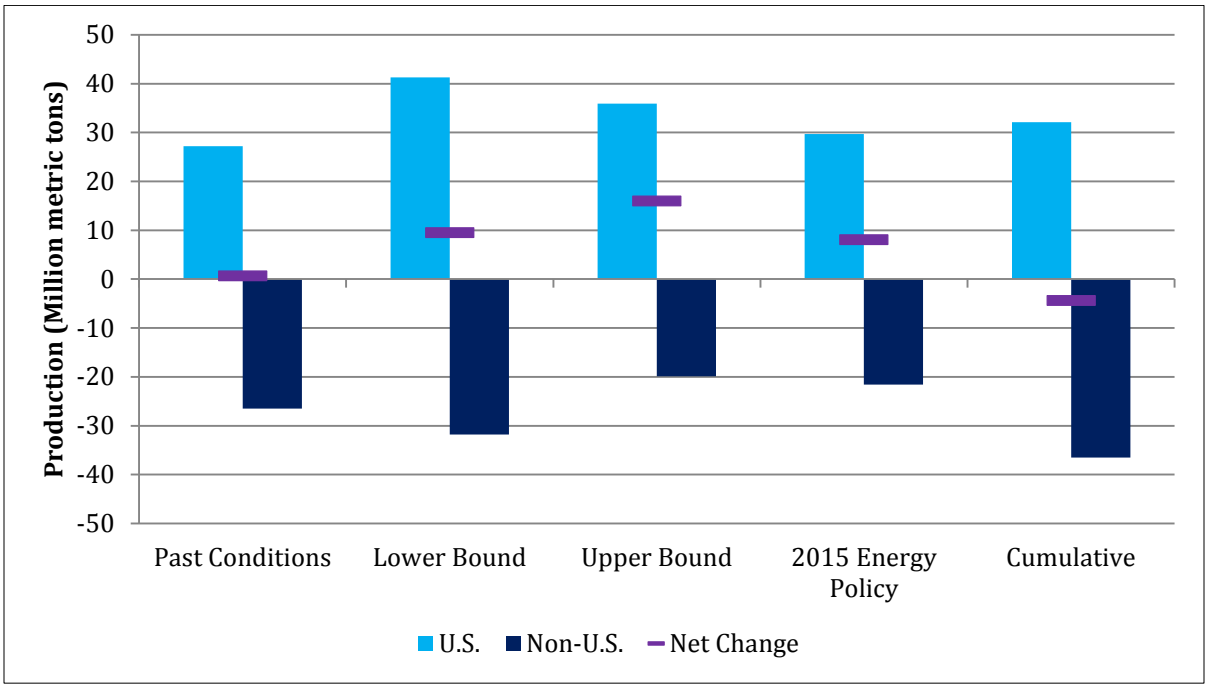


6.1.2 Scenario Results

The four scenarios that were analyzed in addition to the Past Conditions (2014) Scenario are used to explore how CO_2 emissions from the Proposed Action would change under different sets of assumptions. Figure 20 shows the change in production under each scenario for 2025, where the change is calculated by subtracting the No-Action Alternative production from the Proposed Action Alternative production. The change in the 2025 U.S. thermal coal production in the Past Conditions (2014) and the 2015 Energy Policy Scenarios would be less than the other scenarios because in these scenarios coal that is exported through Canadian export terminals under the No-Action Alternative would move to be exported through the proposed coal export terminal. Specifically,

13.6 million metric tons of Powder River Basin coal that is exported through the Canadian terminals in 2025 in the No-Action Alternative is no longer exported through the Canadian terminals in the Proposed Action Alternative. Instead this coal from the Powder River Basin is exported through the terminal in the Proposed Action. Therefore there would be a smaller change in total Powder River Basin exports, and thus, total U.S. production, than if the exports through the Canadian terminals continued under the Proposed Action Alternative.

Figure 20. Change in Production for 2025—Proposed Action minus No-Action Alternative (million metric tons)



In the Lower Bound Scenario, U.S. coal production increases nearly the full 44 million metric tons of the terminal capacity because under the Proposed Action, nearly the full amount of coal exported is incremental production. Unlike the Past Conditions (2014) Scenario, in the Lower Bound Scenario there are no exports of Powder River Basin coal out of Canadian export terminals in the No-Action Alternative. The change in U.S. coal production in the Lower Bound Scenario Proposed Action Alternative is not equal to the full 44 million metric ton capacity of the terminal because there is some reduction in U.S. coal demand due to higher U.S. coal prices.

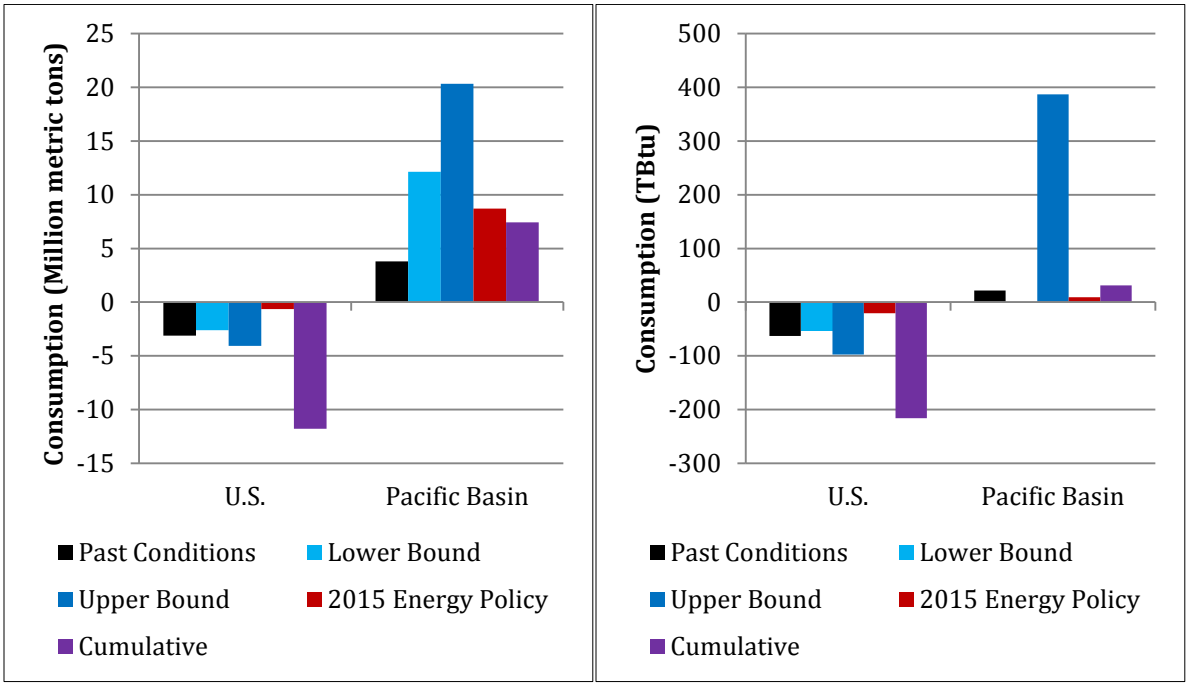
In the Upper Bound Scenario, U.S. coal production increases under the Proposed Action because all of the coal exported out of the terminal is incremental, since global coal demand is higher in this scenario. However, the increase in U.S. production is less than the terminal capacity because coal production in the Appalachias declines as exports from this region would decline. Finally, in the Cumulative Scenario, the U.S. production increase is less than the Lower and Upper Bound Scenarios because there is a decrease in U.S. Powder River Basin coal demand due to higher coal prices driven by the large amounts of Powder River Basin exports under this scenario.

Non-U.S. coal production declines in each scenario in proportion to the increase in U.S. production, as there is some induced demand in all but the Lower Bound scenario. Also, the exported Powder River Basin coal would have a lower heat content than some of the coal that it would displace, thus,

less total tons would be displaced than exported, while the same amount of total heating value would be replaced. For example, if 10 million metric tons of a 9,000 Btu/lb coal is exported and displaces a 12,000 Btu/lb coal, then the total heat content exported would be 198 TBtu (*=10,000,000 metric tons x 1.1 short tons/metric ton x 2,000 lbs/ short ton x 9,000 Btu/lb x 1 TBtu/10^12 Btu*). The equivalent tons of the 12,000 Btu/lb coal is then 7.5 million metric tons (*=198 TBtu x 10^12 Btu/1 TBtu x 1/12,000 Btu/lb x 1/2000 lb/short ton x 1/1.1 short ton/metric ton x 1 million metric ton/10^6 metric tons*). Thus, for every 10 million metric tons of 9,000 Btu/lb coal exported, only 7.5 million metric tons of 12,000 Btu/lb coal would be displaced.

Coal consumption in the United States would be lower under the Proposed Action because higher Powder River Basin coal prices, due to the export of Powder River Basin coal through the proposed coal export terminal, would depress the U.S. demand for Powder River Basin coal (Figure 21). The depressive effect on U.S. coal consumption would be the largest in the Cumulative Scenario at 11.8 million metric tons, because 100 million metric tons of coal would be exported through all of the proposed terminals, causing a relatively larger increase in coal prices and an attendant depressive effect on coal demand. The EPA IPM v5.13 coal supply curves for the Powder River Basin used in this analysis have a relatively steep right hand section that results in higher coal prices when the demand curve shifts to the right. This is particularly evident in the Cumulative Scenario, which has the largest increase in demand for Powder River Basin coal, due to the model exporting 100 million metric tons of Powder River Basin coal. In this scenario Powder River Basin coal prices would increase by 16.6% in the Proposed Action Alternative compared to the No-Action Alternative.

Figure 21. Change in Consumption for 2025—Proposed Action minus No-Action Alternative (million metric tons and trillion Btu (TBtu))



Coal consumption in the Pacific Basin would be higher under the Proposed Action for two reasons. First, in all but the Lower Bound Scenario, some new demand would be induced due to lower delivered coal prices in the Pacific Basin due to the export of lower cost Powder River Basin coal through the terminal. Second, lower heat content coal would be displacing higher heat content coal.

Therefore, to maintain the same level of electric generation, more tons of the lower heat content coal must be consumed than the amount of the higher heat content coal that was displaced. The change in coal consumption due to the mix of coals is evident by comparing the two charts in Figure 21. The left hand chart shows the change in tons of coal consumed, while the right hand chart shows the change in total heating value of the coal consumed. For example, in the Lower Bound Scenario there is no change in the heating value of the coal consumed in the Pacific Basin; however, there is an increase of 12.1 million metric tons due to switching to consuming more coal that has a lower heat content.

The change in the amount of coal imported in the Pacific Basin in 2025 would be positive in all scenarios and would be highest in the Upper Bound Scenario (Figure 22). This scenario has the highest amount of induced demand, and the change in imports reflects that increase in demand. Also, the exported coal would be displacing the delivery of coal from other countries, and since the coal exported through the terminal would be displacing higher heat content coal there would be a net increase in the tons of coal imported and consumed.

Since CO_2 emissions from the transportation of coal depend on how far the coal is shipped, Figure 23 shows the change in the tons of coal multiplied by the distance the coal is shipped for 2025. Including the distance the coal is shipped shows that the Upper Bound Scenario would have the largest change and the 2015 Energy Policy Scenario would have the smallest change in the ton-miles that the coal is shipped. The Upper Bound Scenario would have the largest change in coal imports because of the larger amount of induced demand compared to the other scenarios. The Lower Bound Scenario would have a larger change in imports than the Past Conditions (2014) Scenario when the source of the coal is included because the shift among sources of the coal in the Past Conditions (2014) Scenario would be between coal supply regions with more similar distances, whereas in the Lower Bound Scenario the change would be due primarily to the export of coal through the terminal.

Figure 22. Change in Imports of Coal in the Pacific Basin via Ship for 2025—Proposed Action minus No-Action Alternative (million metric tons)

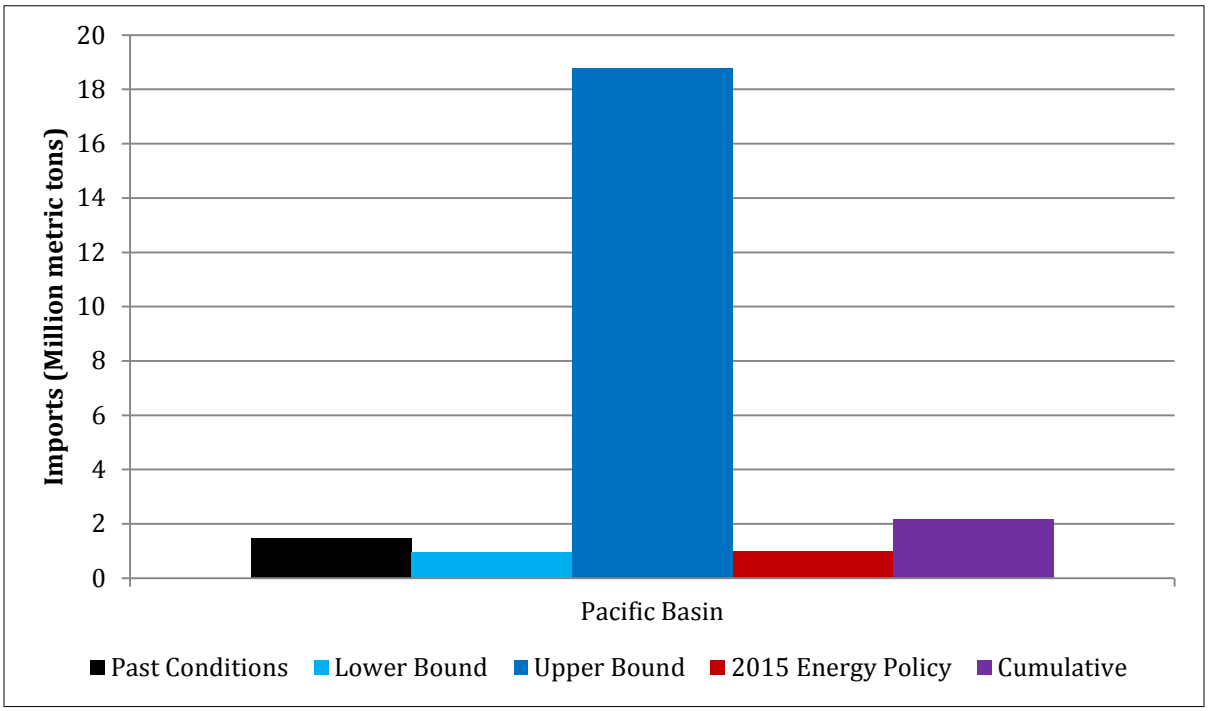
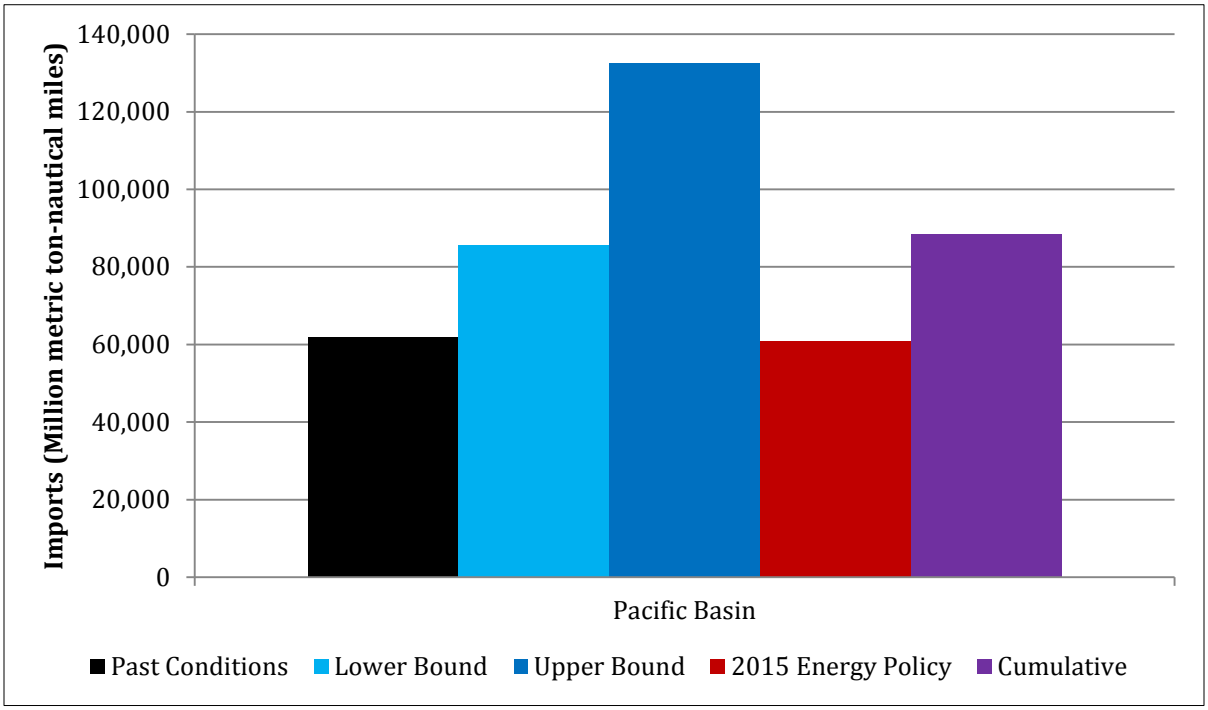


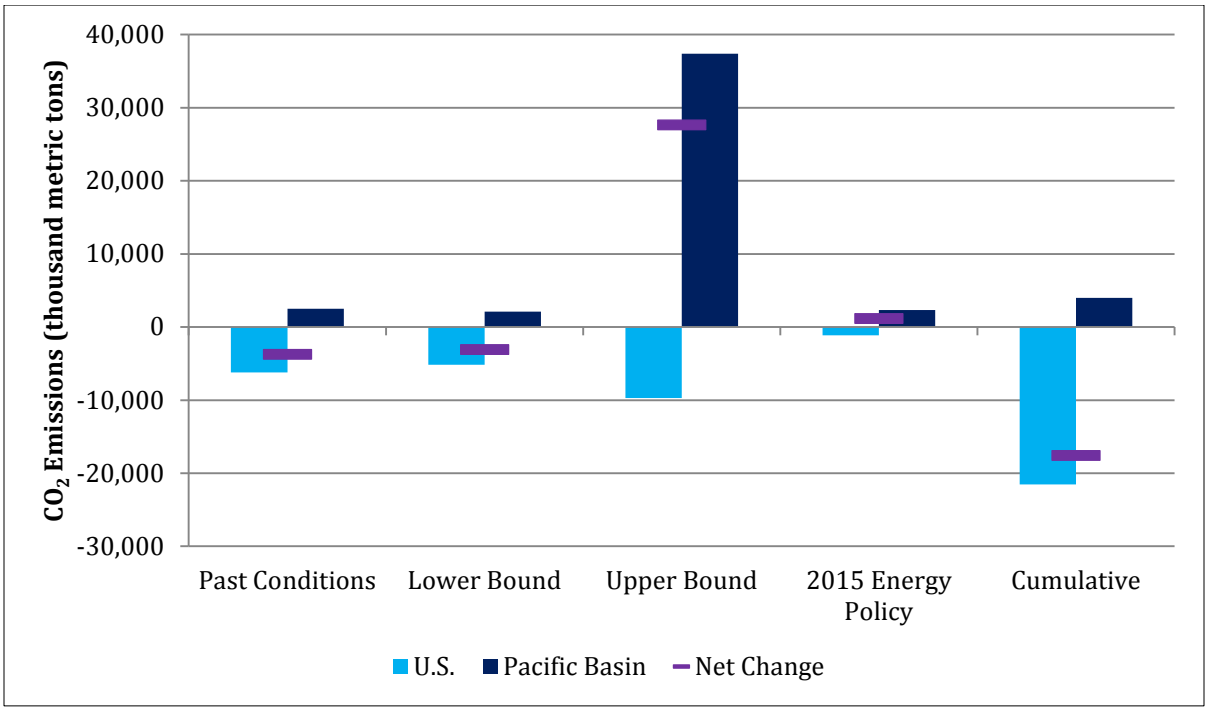
Figure 23. Change in Imports of Coal in the Pacific Basin via Ship for 2025—Proposed Action minus No-Action Alternative (million metric tons – nautical miles)



CO_2 emissions from the combustion of coal in the United States and Pacific Basin are estimated for all five scenarios. Figure 24 shows the change in CO_2 emissions from the combustion of coal for the

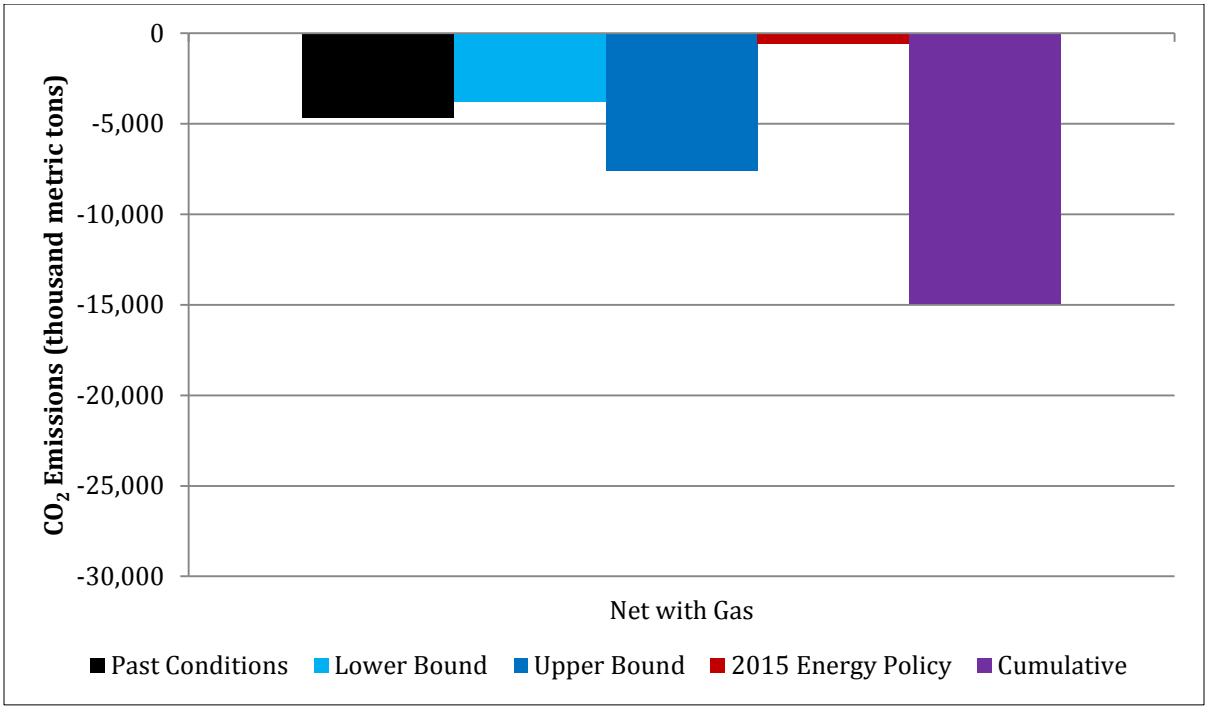
year 2025, when the proposed coal export terminal is modeled to come online. The CO_2 emissions reflect the changes in consumption with U.S. emissions declining while Pacific Basin emissions are increasing. Due to the mix of coals consumed and their respective CO_2 emissions rates, the emissions do not exactly reflect the change in consumption seen in Figure 21.

Figure 24. Change in CO_2 Emissions from the Consumption of Coal for 2025—Proposed Action minus No-Action Alternative (thousand metric tons CO_2)



When the change in CO_2 emissions from the combustion of natural gas are included with the change from the combustion of coal, the net CO_2 emissions in 2025 in the U.S. move closer to zero, but are still a net decrease (Figure 25).

Figure 25. Change in CO_2 Emissions from the Consumption of Coal and the Consumption of Natural Gas in the United States for 2025—Proposed Action minus No-Action Alternative (thousand metric tons CO_2)



6.2 Past Conditions (2014) Scenario

The Past Conditions (2014) Scenario uses the assumptions presented in Chapter 4, *Model Framework, Methods, and Key Assumptions*, and represents the expected energy market outcome. This section presents the modeling results for the Past Conditions (2014) Scenario No-Action Alternative and Proposed Action for coal production, consumption, distribution, and CO_2 emissions.

6.2.1 Coal Production

Under the No-Action Alternative, U.S. thermal coal production would average 791 million metric tons per year for the 2025 to 2040 period. U.S. coal production would be fairly flat between 2020 and 2040 as electric demand growth is primarily met with natural gas and renewable generation. Over the 2016 to 2040 period, non-U.S. coal production grows at an average annual rate of 1.6% per year from 6.4 to 9.4 billion metric tons. Powder River Basin coal production under the No-Action Alternative would average 337 million metric tons per year over 2025 to 2040. Uinta Basin coal production under the No-Action Alternative would average 15.6 million metric tons per year, with production gradually declining over the 2025 to 2040 period. Table 25 shows the No-Action Alternative coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 25. Past Conditions (2014) Scenario Coal Production—No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,448	6,786	7,048	7,805	8,463	9,373	8,634
Total U.S. Thermal Coal	799	838	785	797	788	789	791
Powder River Basin Coal	334	366	329	336	331	344	337
Uinta Basin Coal	18.8	18.4	17.1	16.5	16.3	14.3	15.6

Under the Proposed Action U.S. thermal coal production would average 819 million metric tons per year for the 2025 to 2040 period. As with the No-Action Alternative, U.S. coal production would be relatively flat, although it would be somewhat higher under the Proposed Action after 2025, which is when the terminal is online in the model. Non-U.S. coal production follows the same growth rate under the Proposed Action as the No-Action Alternative, except non-U.S. production declines by 26 to 28 million metric tons per year once the terminal comes online. The non-U.S. production declines because the coal exported through the terminal displaces some of the coal produced in other countries.

Powder River Basin coal production under the Proposed Action would average 359 million metric tons per year with production fluctuating around this average with no clear upward or downward trend. Uinta Basin coal production would average 19.2 million metric tons per year for 2025 to 2040, with production declining until 2040, when additional Uinta Basin coal is exported and production increases. Table 26 shows the Proposed Action coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 26. Past Conditions (2014) Scenario Coal Production—Proposed Action (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,449	6,786	7,048	7,779	8,437	9,346	8,608
Total U.S. Thermal Coal	796	835	782	825	818	815	819
Powder River Basin Coal	332	362	325	363	361	353	359
Uinta Basin Coal	18.5	18.1	16.7	16.2	16.0	24.0	19.2

Table 27 shows the estimated change in coal production between the Proposed Action and the No-Action Alternative by model run year to be close to zero in the years before 2025 when the terminal was assumed to come online. Once the terminal is online and exporting coal, total modeled U.S. coal production would be higher under the Proposed Action, primarily due to increases in Powder River Basin and Uinta Basin coal production, and coal production in Colorado that is outside the Uinta Basin. There are small changes in coal production prior to the terminal coming online because the IPM model is forward-looking and makes adjustments in the near term to optimize the whole time period being analyzed. The IPM® model calculates that the terminal comes online in 2025 and that coal prices will change, and thus it makes adjustments throughout the analytical period to minimize

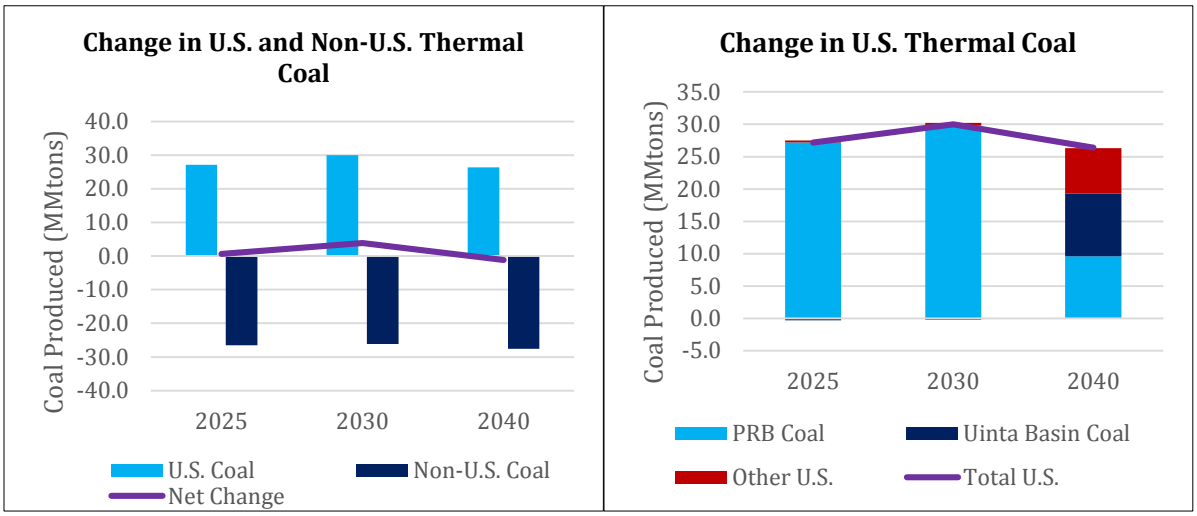
overall costs. The decrease in non-U.S. coal production is due to coal shipped through the proposed coal export terminal displacing coal from other countries.

Table 27. Past Conditions (2014) Scenario Change in Coal Production—Proposed Action minus No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	0.1	0	0	-26.5	-26.1	-27.6	-26.8
Total U.S. Thermal Coal	-2.3	-3.2	-2.8	27.2	30.0	26.4	27.8
Powder River Basin Coal	-2.4	-3.9	-3.5	27.2	29.8	9.6	21.2
Uinta Basin Coal	-0.3	-0.3	-0.3	-0.3	-0.2	9.7	3.6

Figure 26 shows that total non-U.S. thermal coal production would decrease in similar amounts to the increase in U.S. coal production under the Proposed Action. This indicates that U.S. thermal coal exports would mostly replace internationally produced coal, instead of the full exported amount adding to overall global coal demand. In 2025 and 2030 the increase in U.S. thermal coal production is due entirely to the increase in Powder River Basin coal production. However, in 2040 the Powder River Basin and Uinta Basin production is only a portion of the total U.S. coal production increase. For example, in 2040 total U.S. thermal coal production increases by 26.4 million metric tons, while Powder River Basin coal production increases by 9.6 million metric tons and Uinta Basin production increases by 9.7 million metric tons. Most of the remaining difference of 7.0 million metric tons is due to a production increase (5.6 million metric tons) in the Colorado Green River area, which is outside of the Uinta Basin in the northwest corner of Colorado. Most of the coal produced in Colorado and Utah is consumed locally. Some of the 9.7 million metric tons of Uinta Basin coal was being consumed locally under the No-Action Alternative and thus is being replaced with other coal from the Rocky Mountain region.

Figure 26. Past Conditions (2014) Scenario Change in Coal Production—Proposed Action minus No-Action Alternative



6.2.2 Coal Consumption

Under the No-Action Alternative U.S. thermal coal consumption averages 785 million metric tons per year for the 2025 to 2040 period. U.S. coal consumption is fairly flat between 2020 and 2040 as electric demand growth is primarily met with natural gas and renewable generation. Over the 2016 to 2040 period, Pacific Basin coal consumption grows at an average rate of 1.9% per year from 4.9 to 7.8 billion metric tons. The growth in consumption is driven by increasing coal consumption in China and India. Table 28 shows the No-Action Alternative coal consumption values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

China is responsible for the largest share of global thermal coal consumption, burning 3,550 million metric tons of coal in 2016. This amount is projected to grow under the No-Action Alternative to 5,431 million metric tons by 2040 and average 5,047 million metric tons over the 2025 to 2040 period. Total U.S. coal consumption remains relatively stable across the projection, fluctuating around 785 million metric tons.

Table 28. Past Conditions (2014) Scenario Coal Consumption—No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	119	165	133
Australia	158	168	176	193	212	253	223
China	3,550	3,802	3,975	4,548	5,013	5,431	5,047
Hong Kong	14	14	14	15	15	17	16
India	691	732	783	900	1,010	1,249	1,072
Indonesia	165	181	195	228	264	357	290
Japan	139	133	132	131	128	128	129
South Korea	90	88	87	83	74	82	80
Taiwan	68	72	69	71	81	85	79
Total Pacific Basin Coal Consumption	4,950	5,272	5,526	6,273	6,916	7,767	7,068
Total U.S. Coal Consumption	792	826	772	787	777	790	785

Coal consumption under the Proposed Action follows similar patterns as the No-Action Alternative, with U.S. thermal coal consumption averaging 781 million metric tons per year for the 2025 to 2040 period. As it would be under the No-Action Alternative, U.S. coal consumption would be fairly flat between 2020 and 2040 as electric demand growth is primarily met with natural gas and renewable generation.

Over the 2016 to 2040 period, Pacific Basin coal consumption follows the same pattern as it would be under the No-Action Alternative as it grows from 4.95 to 7.76 billion metric tons. However, under the Proposed Action there is a 0.1%, or about 1 million metric ton total increase in demand in four regions that is induced due to lower delivered coal prices to the Pacific Basin. Demand is induced in Hong Kong, Japan, South Korea, and Taiwan.

Table 29 shows the Proposed Action coal consumption values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 29. Past Conditions (2014) Scenario Coal Consumption—Proposed Action (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	119	165	133
Australia	158	168	176	193	212	253	223
China	3,550	3,802	3,975	4,550	5,018	5,431	5,049
Hong Kong	14	14	14	15	15	17	16
India	691	732	783	900	1,010	1,248	1,072
Indonesia	165	181	195	228	264	357	290
Japan	139	133	132	132	129	126	129
South Korea	90	88	87	83	74	82	80
Taiwan	68	72	69	71	81	85	80
Total Pacific Basin Coal Consumption	4,950	5,272	5,526	6,276	6,922	7,764	7,070
Total U.S. Coal Consumption	790	823	769	784	775	785	781

Table 30 shows the estimated change in coal consumption between the Proposed Action and the No-Action Alternative by model run year to be close to zero in the years before 2025 when the terminal was assumed to come online. Once the terminal is online and exporting coal, total U.S. coal consumption is lower by an average of 3.4 million metric tons per year under the Proposed Action for 2025 to 2040. Thermal U.S. coal consumption at electric power plants is lower because once the terminal comes online and is exporting coal the U.S. coal prices increase slightly, which causes a downward shift in U.S. coal demand.

Table 30. Past Conditions (2014) Scenario Change in Coal Consumption—Proposed Action minus No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	2.3	4.5	0	2.1
Hong Kong	0	0	0	0	0	0	0
India	0	0	0	0	0	-1.3	-0.5
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	1.0	1.5	-1.5	0.2
South Korea	0	0	0	0.2	0.2	0.2	0.2
Taiwan	0	0	0	0.2	0.2	0.2	0.2
Total Pacific Basin Coal Consumption	0	0	0	3.8	6.5	-2.4	2.3
Total U.S. Coal Consumption	-2.3	-3.2	-2.8	-3.1	-2.6	-4.2	-3.4

In the Pacific Basin, coal consumption is higher on average by 2.3 million metric tons per year for 2025 to 2040, which is 0.03% higher than the average Pacific Basin coal consumption shown in Table 28. The reason that the Pacific Basin coal consumption increase is higher than the increase in induced demand due to lower coal prices is because a larger quantity of lower heat content subbituminous coal is being consumed, while the total change in the heating value of coal demand is equal to the amount of induced demand. For example, in China under the Proposed Action, coal consumption increases by 2.3 million metric tons in 2025 over the No-Action Alternative; however, the total heat content of the coal consumed remains the same, as does the amount of coal imported (350 million metric tons). This is possible because Indonesia shifts the type of coal exported to China to include 10 million metric tons more subbituminous coal, which has a lower heat content, and 10 million metric tons less bituminous coal, which has a higher heat content under the Proposed Action compared to the No-Action Alternative. Thus, Indonesia is exporting a lower amount of total coal energy to China while still exporting the same total tons of coal (350 million metric tons). China is compensating for the lower delivered heat content by consuming more domestic coal.

6.2.3 Coal Distribution

Coal from the Powder River Basin and the Uinta Basin are distributed primarily in the United States. These distribution patterns are expected to remain largely unchanged under the Proposed Action. Thus, this section focuses on the distribution of coal in the Pacific Basin and how that distribution would be expected to change with the construction of the terminal. Under the No-Action Alternative, no coal would be exported through the terminal; however, 615 million metric tons of coal would be distributed in the Pacific Basin by ship in the seaborne coal market in 2016. Table 31 shows the tons of coal that are imported by each country in the Pacific Basin under the No-Action Alternative. By 2040, a total of 1,194 million metric tons of coal are expected to be distributed in the Pacific Basin seaborne coal market.

Table 31. Past Conditions (2014) Scenario Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	119	165	133
Australia	0	0	0	0	0	0	0
China	227	227	227	318	318	726	476
Hong Kong	14	14	14	15	15	17	16
India	44	24	12	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	139	133	132	131	128	128	129
South Korea	49	46	43	66	67	74	69
Taiwan	68	72	69	71	81	85	79
Total Pacific Basin Coal sent via ship	615	598	591	704	726	1,194	902

To understand how coal distribution is changing in more detail than the tons of coal imported by each country, the tons of coal shipped to each country were multiplied by the distance in nautical miles that the coal is shipped. This is important because the change in tons imported might not

change significantly; however, where the coal is sourced might change, which might have a significant impact on the emissions associated with shipping. Table 32 shows the result of multiplying the tons of coal by the nautical miles that the coal was shipped for coal shipped to each country for the No-Action Alternative. Thus the values in Table 32 are in units of million metric ton-nautical miles.

Table 32. Past Conditions (2014) Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	123,074	176,042	532,288	299,869
Australia	0	0	0	0	0	0	0
China	386,461	386,461	386,461	541,045	541,045	1,236,674	811,567
Hong Kong	27,007	27,278	27,552	28,247	28,961	65,231	42,868
India	135,789	73,478	38,193	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	535,267	378,469	355,049	352,952	345,299	568,913	434,385
South Korea	128,027	120,235	112,984	173,889	123,473	371,891	234,084
Taiwan	267,987	234,316	103,192	105,797	342,100	359,595	283,264
Total Pacific Basin Coal sent via ship	**1,485,335**	**1,252,527**	**1,130,299**	**1,325,005**	**1,556,918**	**3,134,591**	**2,106,037**

Under the Proposed Action coal would be exported through the terminal to destinations in the Pacific Basin. Table 33 shows how the coal exported from the terminal is distributed by the model. All of the coal would be going to Japan, which would be the closest destination and thus would allow for the greatest reduction in system costs when the model calculates a solution.

Table 33. Past Conditions (2014) Scenario Distribution of Coal Exported—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040
China	0	0	0	0	0	0
Hong Kong	0	0	0	0	0	0
Japan	0	0	0	44.0	44.0	44.0
South Korea	0	0	0	0	0	0
Taiwan	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship through MBTL	**0**	**0**	**0**	**44.0**	**44.0**	**44.0**

Under the Proposed Action, a similar number of tons is distributed in the Pacific Basin seaborne coal market as the No-Action Alternative, as can be seen in Table 34. Meanwhile, Table 35 shows the ton-mile values for coal distributed in the Pacific Basin seaborne coal market under the Proposed Action.

Table 34. Past Conditions (2014) Scenario Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	75	82	94	104	119	165	133
Australia	0	0	0	0	0	0	0
China	227	227	227	318	318	726	476
Hong Kong	14	14	14	15	15	17	16
India	44	24	12	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	139	133	132	132	129	126	129
South Korea	49	46	43	67	67	74	70
Taiwan	68	72	69	71	81	85	80
Total Pacific Basin Coal sent via ship	615	598	591	706	728	1,193	903

Table 35. Past Conditions (2014) Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	123,074	176,042	532,288	299,869
Australia	0	0	0	0	0	0	0
China	386,461	386,461	386,461	541,045	541,045	1,236,674	811,567
Hong Kong	27,007	27,278	27,552	28,329	29,042	65,416	42,989
India	135,789	73,478	38,193	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	535,267	378,469	355,049	413,869	411,800	573,343	475,197
South Korea	128,027	120,235	112,984	174,470	124,053	373,049	234,889
Taiwan	267,987	234,316	103,192	106,097	342,552	360,494	283,847
Total Pacific Basin Coal sent via ship	1,485,335	1,252,527	1,130,299	1,386,883	1,624,533	3,141,264	2,148,359

As can be seen in Table 36, which shows the estimated change in tons of coal imported by each of the regions, the largest change in coal imports between the No-Action Alternative and the Proposed Action is in coal exported to Japan in 2030 with an increase of 1.5 million metric tons.

Table 36. Past Conditions (2014) Scenario Change in Seaborne Coal Imports in Pacific Basin—Proposed Action minus No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	0	0	0	0
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	1.0	1.5	-1.5	0.2
South Korea	0	0	0	0.2	0.2	0.2	0.2
Taiwan	0	0	0	0.2	0.2	0.2	0.2
Total Pacific Basin Coal sent via ship	0	0	0	1.5	2.0	-1.0	0.7

Despite the small changes in the total tons of coal imported to each region, there are some relatively large changes in the ton-mile values, as shown in Table 37. For example, in Japan in 2030 coal imports increase by 1.2% while the ton-miles increased by 19%. This change is due to Japan importing Powder River Basin coal through the proposed coal export terminal, which is farther than either Indonesia or Australia.

Table 37. Past Conditions (2014) Scenario Change in Distance Weighted Seaborne Coal Distribution in Pacific Basin—Proposed Action minus No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	Annual Average
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	81	81	185	122
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	60,917	66,501	4,430	40,811
South Korea	0	0	0	580	580	1,158	805
Taiwan	0	0	0	300	452	899	584
Total Pacific Basin Coal sent via ship	0	0	0	61,879	67,615	6,672	42,322

6.2.4 CO_2 Emissions

This section presents the CO_2 estimated emissions from coal combusted in the United States and the Pacific Basin under the Past Conditions (2014) Scenario No-Action Alternative and Proposed Action. In addition, CO_2 emissions from natural gas consumption in the United States are included because decreases in coal consumption may be offset by increases in natural gas consumption. No other emissions are included in this section.

Table 38 presents the CO_2 emissions under the No-Action Alternative. Total U.S. CO_2 emissions remain fairly flat at an average of 1,505 million metric tons for 2025 to 2040, which reflects the flat coal consumption in the U.S. Pacific Basin CO_2 emissions from coal average 13,407 million metric tons per year between 2025 and 2040, which is 8.9 times the total coal CO_2 emissions from the United States.

Table 39 presents the CO_2 emissions under the Proposed Action. Total CO_2 emissions from coal under the Proposed Action average 0.5% lower than the coal CO_2 emissions under the No-Action Alternative.

Table 38. Past Conditions (2014) Scenario CO_2 Emissions—No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	196,125	220,325	269,361	232,672
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	7,260,862	7,757,297	8,092,857	9,192,572	10,001,116	10,625,911	10,019,496
Hong Kong	32,192	32,514	32,840	33,670	34,520	36,086	34,893
India	1,136,069	1,182,859	1,257,877	1,430,059	1,592,500	1,923,614	1,676,144
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	305,620	304,862	305,584	301,809	294,803	273,014	288,276
South Korea	193,262	189,802	186,751	182,342	167,305	163,906	170,160
Taiwan	155,582	158,027	159,611	163,642	166,852	175,385	169,279
Pacific Basin - Coal	9,752,941	10,352,077	10,813,357	12,182,110	13,245,137	14,420,611	13,406,980
U.S. - Coal	1,538,695	1,606,196	1,490,678	1,515,506	1,495,512	1,506,365	1,505,286
U.S. - Natural Gas	449,418	417,456	421,240	392,499	400,710	585,198	470,174

Table 39. Past Conditions (2014) Scenario CO_2 Emissions—Proposed Action (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	196,125	220,325	269,361	232,672
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	7,260,862	7,757,297	8,092,857	9,193,009	10,001,969	10,625,911	10,019,902
Hong Kong	32,192	32,514	32,840	33,774	34,624	36,190	34,997
India	1,136,069	1,182,859	1,257,877	1,430,059	1,592,500	1,923,521	1,676,108
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	305,620	304,862	305,584	302,717	296,857	273,261	289,308
South Korea	193,262	189,802	186,751	182,892	167,855	164,456	170,710
Taiwan	155,582	158,027	159,611	164,140	167,350	175,883	169,777
Pacific Basin - Coal	9,752,941	10,352,077	10,813,357	12,184,607	13,249,196	14,421,916	13,409,535
U.S. - Coal	1,535,939	1,602,368	1,487,223	1,509,276	1,490,688	1,497,083	1,498,339
U.S.- Natural Gas	449,998	418,357	421,870	394,094	401,689	587,959	472,017

Table 40 shows the estimated change in CO_2 emissions for each region, as well as the total net change across all regions. Total Pacific Basin CO_2 emissions from coal consumption would increase between 1,305 and 4,059 thousand metric tons starting in 2025 due to induced demand from the reduction in delivered coal prices under the Proposed Action. The change in CO_2 emissions from individual countries would be between a decrease of 93 thousand metric tons to an increase of 2,054 thousand metric tons.

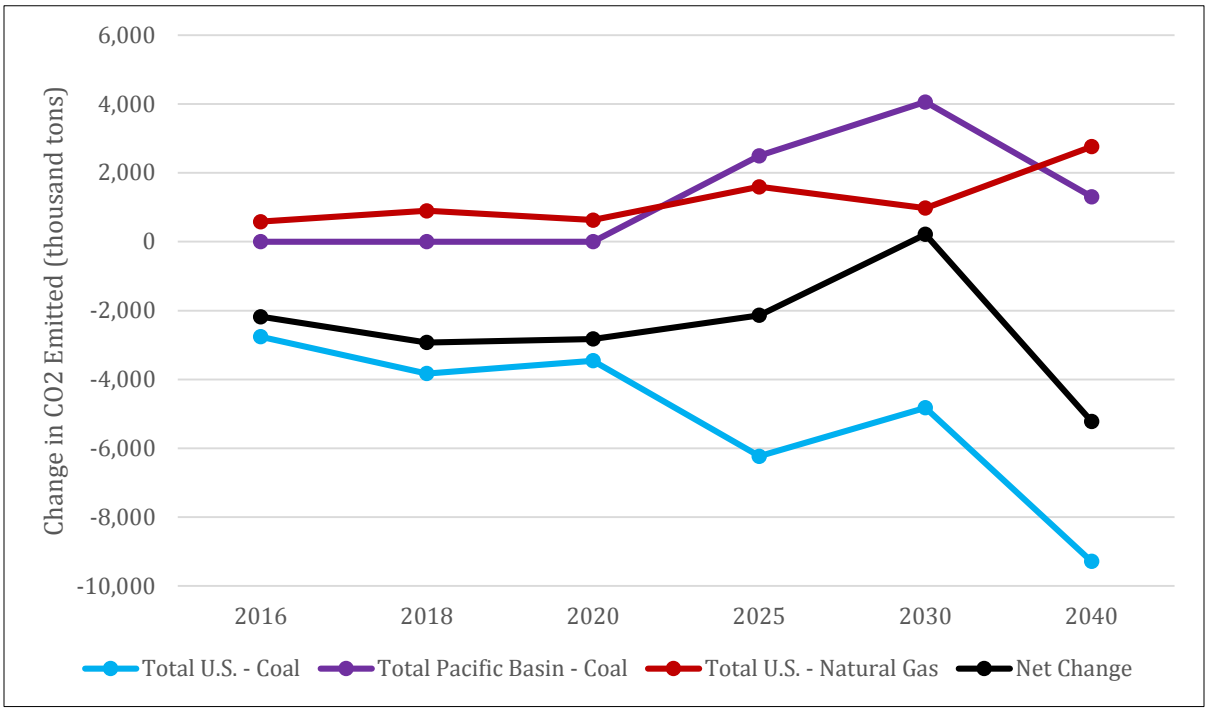
Table 40. Past Conditions (2014) Scenario Change in CO_2 Emissions—Proposed Action minus No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	438	853	0	406
Hong Kong	0	0	0	104	104	104	104
India	0	0	0	0	0	-93	-36
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	907	2,054	247	1,033
South Korea	0	0	0	550	550	550	550
Taiwan	0	0	0	498	498	498	498
Pacific Basin - Coal	0	0	0	2,497	4,059	1,305	2,554
U.S. - Coal	-2,757	-3,828	-3,454	-6,229	-4,823	-9,282	-6,948
U.S. - Natural Gas	580	900	630	1,595	979	2,761	1,843
Total Change	-2,177	-2,928	-2,824	-2,137	215	-5,216	-2,551

In contrast, U.S. coal CO_2 emissions would decrease in every year due to slightly higher coal prices that would depress coal demand under the Proposed Action. The slightly higher coal prices would result from the fact that an additional 44 million metric tons of coal is mined and exported under the Proposed Action, which would shift the demand curve up and yield higher coal prices in the United States. The decrease in coal consumption would be offset by an increase in natural gas consumption, as is seen by the increase in CO_2 emissions from natural gas, which would average 1,843 thousand metric tons per year. The total net change in CO_2 emissions, including both coal and natural gas emissions, would decrease by an average of 2,551 thousand metric tons per year for 2025 to 2040.

U.S. CO_2 emissions from natural gas are expected to increase as electric generation from natural gas-fired plants increases to meet increasing demand and as generation from coal-fired plants decreases. Figure 27 shows the net change in CO_2 emissions between the No-Action Alternative and Proposed Action. The decrease in U.S.coal emissions would drive the net change to be a net decrease in CO_2 emissions, under the Proposed Action.

Figure 27. Past Conditions (2014) Scenario Change in CO_2 Emissions—Proposed Action minus No-Action Alternative[a,b,c]



a Total U.S. CO_2 emissions from the combustion of coal would decrease because the terminal would be a new demand sink for U.S. coal, and thus, would cause coal prices to rise, and thus, U.S. coal consumption would decrease in response to the higher prices.

b Pacific Basin CO_2 emissions from the combustion of coal would increase due to new demand induced by lower coal prices and because more tons of lower heat content coal would be consumed.

c Total U.S. natural gas combustion CO_2 emissions would increase because when coal consumption for electric generation declines, natural gas usage for electric generation would increase to fill the gap.

6.3 Lower Bound Scenario

The Lower Bound Scenario uses the assumptions presented in Chapter 5, *Scenarios*, and represents the lower bound of global GHG emissions that could be reasonably expected if the assumptions are realized. This scenario is designed to model the lowest potential GHG emissions under the Proposed Action, and to provide a low GHG emissions world into which the terminal is constructed and operated. This section presents the modeling results for the Lower Bound Scenario No-Action Alternative and Proposed Action for coal production, consumption, distribution, and CO_2 emissions.

6.3.1 Coal Production

The Lower Bound Scenario is designed to reduce coal consumption, and thus, coal production. Therefore, coal production in the Lower Bound Scenario would be less than the Past Conditions (2014) Scenario. Under the No-Action Alternative U.S. thermal coal production would average 703 million metric tons per year for the 2025 to 2040 period, and would decline by 56 million metric tons between 2016 and 2040 because the higher Powder River Basin coal prices assumed in this scenario would dampen coal demand. Over the 2016 to 2040 period, non-U.S. coal production would grow at an average annual rate of 0.8% per year from 6.1 to 7.4 billion metric tons. Powder River

Basin coal production under the No-Action Alternative would average 258 million metric tons per year over 2025 to 2040, with production declining by less than 1%. Uinta Basin coal production under the No-Action Alternative would average 13.1 million metric tons per year over 2025 to 2040, with production gradually declining over the 2016 to 2040 period. Table 41 shows the No-Action Alternative coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 41. Lower Bound Scenario Coal Production—No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,135	6,297	6,451	6,695	6,958	7,359	7,041
Total U.S. Thermal Coal	748	768	713	716	704	692	703
Powder River Basin Coal	275	295	259	261	253	259	258
Uinta Basin Coal	18.7	18.0	16.0	12.5	14.2	12.6	13.1

Under the Proposed Action, U.S. thermal coal production would average 745 million metric tons per year for the 2025 to 2040 period. When the terminal comes online in 2025, total U.S. coal production would increase by 46 million metric tons over 2020 production, before gradually declining. The decline in production between 2025 and 2030 would be due to declining domestic coal demand. The decline in coal production between 2030 and 2040 is due to an increase in imports of coal into the United States, and thus, less domestic coal is required to meet demand.

Non-U.S. coal production would follow the same growth rate under the Proposed Action as it would under the No-Action Alternative, except production would decline by 32 to 43 million metric tons per year, once the terminal comes online in 2025 in the model. Thus, the coal exported from the terminal would displace coal production in other countries. Powder River Basin coal production under the Proposed Action would average 295 million metric tons per year for 2025 to 2040, with production gradually declining. Uinta Basin coal production would average 15.3 million metric tons per year for 2025 to 2040, with production following the same downward decline as it would under the No-Action Alternative, except in 2040 when production would jump to 20.2 million metric tons due to the export of Uinta Basin coal to Japan.

Table 42 shows the Proposed Action coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 42. Lower Bound Scenario Coal Production—Proposed Action (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,135	6,297	6,451	6,664	6,917	7,317	7,002
Total U.S. Thermal Coal	746	767	711	757	746	734	745
Powder River Basin Coal	273	292	256	302	295	290	295
Uinta Basin Coal	18.5	17.8	14.6	12.9	11.6	20.2	15.3

For the United States, Table 43 shows the estimated change in coal production between the Proposed Action and the No-Action Alternative by model run year to be a decrease of 2.0 million

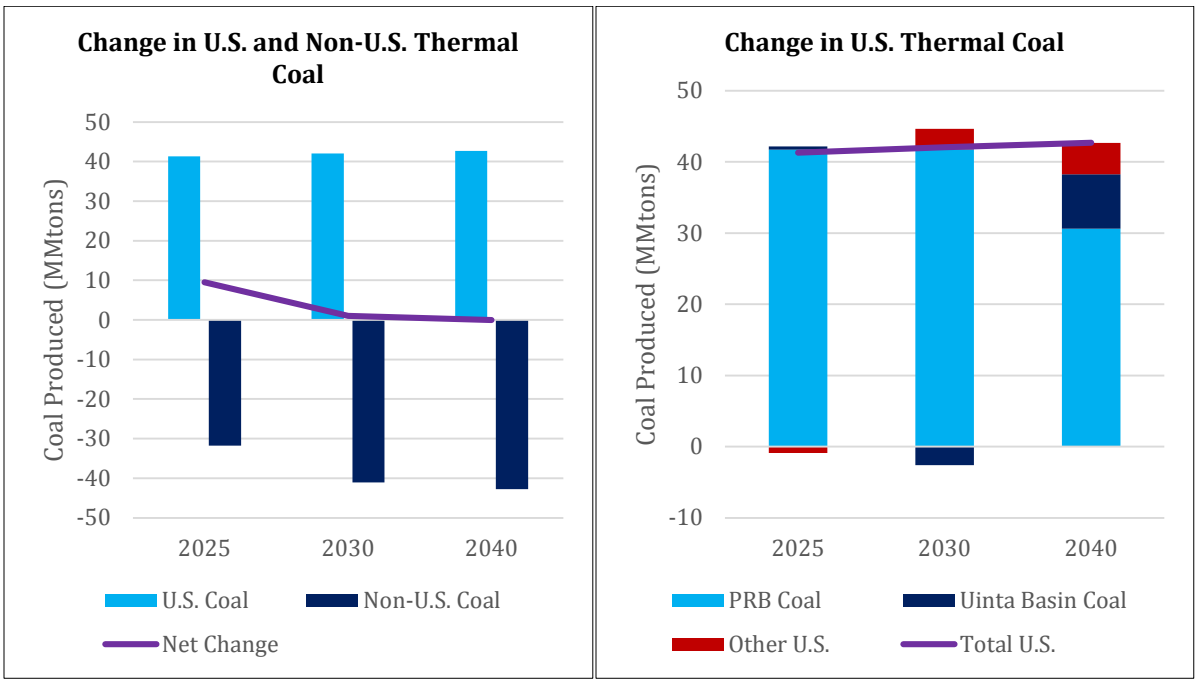
metric tons or less in the years before 2025 when the terminal would come online. Once the terminal is online and exporting coal, total modeled U.S. coal production would be higher by an average of 42.1 million metric tons under the Proposed Action, primarily due to increases in Powder River Basin and Uinta Basin production.

Table 43. Lower Bound Senario Change in Coal Production—Proposed Action minus No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	0	0	0	-31.8	-41.0	-42.7	-39.1
Total U.S. Thermal Coal	-1.8	-1.1	-2.0	41.3	42.1	42.7	42.1
Powder River Basin Coal	-2.2	-3.1	-3.2	41.7	41.8	30.6	37.4
Uinta Basin Coal	-0.2	-0.2	-1.4	0.5	-2.6	7.6	2.2

The left-hand chart in Figure 28 shows that total non-U.S. thermal coal production would decrease in similar amounts to the increase in U.S. coal production when comparing the Proposed Action to the No-Action Alternative. This would indicate that U.S. thermal coal exports would take the place of some internationally produced coal, instead of adding to overall global coal demand. The right-hand chart in Figure 28 shows that the changes in Powder River Basin coal production would make up most of the changes in overall U.S. coal production.

Figure 28. Lower Bound Scenario Change in Coal Production—Proposed Action minus No-Action Alternative



In the Lower Bound Scenario, the average increase in U.S. coal production (42.1 million metric tons) under the Proposed Action would be close to the 44 million metric tons of coal being exported through the terminal, while the Past Conditions (2014) Scenario increase would only average 27.8 million metric tons. The difference would be due primarily to changes in coal exports through

Canadian export terminals. In the Past Conditions (2014) Scenario, 13.6 million metric tons of Powder River Basin coal would be exported through Canadian export terminals under the No-Action Alternative. Under the Past Conditions (2014) Scenario Proposed Action, all of the coal being exported through the Canadian terminals would be exported through the terminal . For the Lower Bound Scenario Powder River Basin coal would not be exported through the Canadian export terminals under the No-Action Alternative. Thus, when the terminal comes online, the full amount of exports would be new incremental production, and explains most of the difference in the change in production (42.1 million metric tons – 13.6 million metric tons = 28.5 million metric tons).

6.3.2 Coal Consumption

Under the No-Action Alternative U.S. thermal coal consumption would average 715 million metric tons per year for the 2025 to 2040 period. U.S. coal consumption would be fairly flat between 2020 and 2040, as electric demand growth would be primarily met with natural gas and renewable generation. Over the 2016 to 2040 period, Pacific Basin coal consumption would grow at an average rate of 0.9% per year from 4.6 to 5.6 billion metric tons. The growth in consumption would be driven by increasing coal consumption in China and India. Table 44 shows the No-Action Alternative coal consumption values for each model run year.

China is responsible for the largest share of global thermal coal consumption, burning 3,260 million metric tons of coal in 2016. This amount is projected to grow in the Lower Bound Scenario under the No-Action Alternative to 3,602 million metric tons by 2040. Total U.S. coal consumption would remain relatively stable, hovering in the low 700 million metric ton range. In the Lower Bound Scenario the growth in coal demand in Asia would be only 0.9% and, with the lower international coal prices, would be a challenging market environment for coal transported through the terminal.

Table 44. Lower Bound Scenario Coal Consumption—No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	114	134	165	140
Australia	158	168	176	193	212	253	223
China	3,260	3,337	3,397	3,515	3,625	3,602	3,586
Hong Kong	14	14	14	15	16	17	16
India	686	719	745	801	859	982	891
Indonesia	165	181	195	228	264	357	290
Japan	122	122	131	129	125	121	124
South Korea	83	81	86	78	74	78	77
Taiwan	63	63	68	74	75	80	77
Total Pacific Basin Coal Consumption	4,626	4,768	4,906	5,146	5,384	5,654	5,423
Total U.S. Coal Consumption	749	769	713	719	707	718	715

Coal consumption under the Proposed Action would follow similar patterns as the No-Action Alternative, with U.S. thermal coal consumption averaging 713 million metric tons per year for the 2025 to 2040 period. As with the No-Action Alternative, U.S. coal consumption would be fairly flat between 2020 and 2040 as electric demand growth would be met primarily with natural gas and renewable generation.

Over the 2016 to 2040 period, Pacific Basin coal consumption would follow the same pattern as it grows from 4.6 to 5.6 billion metric tons. Table 45 shows the Proposed Action coal consumption values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 45. Lower Bound Scenario Coal Consumption—Proposed Action (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	114	134	165	140
Australia	158	168	176	193	212	253	223
China	3,260	3,337	3,397	3,526	3,625	3,602	3,589
Hong Kong	14	14	14	15	15	17	16
India	686	719	745	801	859	982	891
Indonesia	165	181	195	228	264	357	290
Japan	122	122	131	130	126	117	123
South Korea	83	81	86	78	73	75	75
Taiwan	63	63	68	74	75	80	77
Total Pacific Basin Coal Consumption	4,626	4,768	4,906	5,158	5,384	5,647	5,423
Total U.S. Coal Consumption	747	768	711	716	705	717	713

Table 46 shows the estimated change in coal consumption between the Proposed Action and the No-Action Alternative by model run year to be zero in the Pacific Basin before 2025 when the terminal was assumed to come online. Once the terminal is online and exporting coal, total Pacific Basin coal consumption would increase by an average of 0.4 million metric tons between 2025 and 2040, with Pacific Basin consumption increasing in 2025 and then decreasing in subsequent years. The increase in consumption in 2025 would be due to the consumption of a greater quantity of lower heat content coal. U.S. coal consumption would be slightly lower at an average of 1.8 million metric tons per year over the 2025 to 2040 period under the Proposed Action due primarily to a decrease in the demand for Powder River Basin coal. Powder River Basin coal demand in the United States would decrease slightly due to higher coal prices caused by higher production when the Powder River Basin coal is exported through the terminal.

In the Pacific Basin, coal consumption would be lower on average by 0.4 million metric tons per year between 2025 and 2040, with only China, Japan, and South Korea having changes above 2 million metric tons. The changes in consumption would be due to changes in the mix of coal consumed and the differences in heat content of the coal being consumed. Under the Proposed Action, a larger quantity of lower heat content coal would be consumed than under the No-Action Alternative in 2025. This makes it appear that total coal consumption is increasing. In 2030, Japan, and in 2040, Japan and South Korea, would be importing a greater quantity of higher heat content coal from Australia, Indonesia, and Utah, so the overall tons of coal consumed falls in these years.

Table 46. Lower Bound Scenario Change in Coal Consumption—Proposed Action minus No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	11.2	0	0	3.1
Hong Kong	0	0	0	0	-0.4	0	-0.1
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	0.9	0.9	-4.1	-1.0
South Korea	0	0	0	0	-1.4	-2.9	-1.6
Taiwan	0	0	0	0	0	0	0
Total Pacific Basin Coal Consumption	0	0	0	12.1	-0.8	-7.0	0.4
Total U.S. Coal Consumption	-1.8	-1.1	-2.0	-2.6	-1.9	-1.2	-1.8

6.3.3 Coal Distribution

Similar to the Past Conditions (2014) Scenario, the Lower Bound Scenario distribution patterns for Powder River Basin and Uinta Basin coal are expected to remain largely unchanged under the Proposed Action. Thus, this section focuses on the distribution of coal in the Pacific Basin and how that distribution would be expected to change with the construction of the terminal. Under the No-Action Alternative, there is no coal exported through the terminal; however, there would be 454 million metric tons of coal distributed in the Pacific Basin by ship in the seaborne coal market in 2016. Table 47 shows the tons of coal that would be imported by each country in the Pacific Basin under the No-Action Alternative. By 2040, a total of 1,178 million metric tons of coal are expected to be imported in the seaborne coal market in the Pacific Basin.

Table 47. Lower Bound Scenario Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	114	134	165	140
Australia	0	0	0	0	0	0	0
China	99	195	227	318	318	726	476
Hong Kong	14	14	14	15	16	17	16
India	38	11	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	122	122	131	129	125	121	124
South Korea	42	39	42	61	67	70	66
Taiwan	63	63	68	74	75	80	77
Total Pacific Basin Coal sent via ship	454	526	576	710	734	1,178	900

To understand how coal distribution is changing in more detail than the tons of coal imported by each country, the tons of coal shipped to each country were multiplied by the distance in nautical miles that the coal would be shipped. The change in tons imported might not change significantly; however, where the coal is sourced might change, which might have a significant impact on the emissions associated with shipping. Table 48 shows the ton-nautical miles for coal shipped to each country under the No-Action Alternative.

Table 48. Lower Bound Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	272,493	418,998	532,288	422,360
Australia	0	0	0	0	0	0	0
China	169,404	331,634	386,461	541,045	541,045	1,236,674	811,567
Hong Kong	27,007	27,278	27,552	28,247	44,581	46,582	40,822
India	117,868	32,724	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	306,401	306,172	329,879	322,761	313,527	526,326	398,847
South Korea	111,406	102,324	109,207	161,205	200,656	341,389	244,427
Taiwan	94,325	93,933	102,246	194,663	198,365	341,257	252,906
Total Pacific Basin Coal sent via ship	831,211	926,354	1,062,215	1,520,415	1,717,172	3,024,517	2,170,929

Under the Proposed Action coal would be exported through the terminal to destinations in the Pacific Basin. Table 49 shows that the coal exported from the terminal would be distributed by the model to Japan, because this would be the closest destination, thus, it allows for the greatest reduction in system costs when the model calculates a solution. The distribution of coal shipped through the terminal in the Lower Bound Scenario would be the same as the Past Conditions (2014) Scenario.

Table 49. Lower Bound Scenario Distribution of Coal Exported through the Proposed Coal Export Terminal—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040
China	0	0	0	0	0	0
Hong Kong	0	0	0	0	0	0
Japan	0	0	0	44.0	44.0	44.0
South Korea	0	0	0	0	0	0
Taiwan	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship through Terminal	0	0	0	44.0	44.0	44.0

Under the Proposed Action, a similar number of tons would be distributed in the seaborne coal market as for the No-Action Alternative, as can be seen in Table 50. The distance weighted coal distribution in the Pacific Basin is presented in Table 51 for the Proposed Action.

Table 50. Lower Bound Scenario Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	75	82	94	114	134	165	140
Australia	0	0	0	0	0	0	0
China	99	195	227	318	318	726	476
Hong Kong	14	14	14	15	15	17	16
India	38	11	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	122	122	131	130	126	117	123
South Korea	42	39	42	61	65	67	65
Taiwan	63	63	68	74	75	80	77
Total Pacific Basin Coal sent via ship	454	526	576	710	733	1,171	897

Table 51. Lower Bound Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	272,493	418,998	532,288	422,360
Australia	0	0	0	0	0	0	0
China	169,404	331,634	386,461	541,045	541,045	1,236,674	811,567
Hong Kong	27,007	27,278	27,552	28,247	38,457	46,582	38,781
India	117,868	32,724	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	306,401	306,172	329,879	408,243	399,008	494,484	438,703
South Korea	111,406	102,324	109,207	161,205	171,009	262,896	204,019
Taiwan	94,325	93,933	102,246	194,663	198,365	341,257	252,906
Total Pacific Basin Coal sent via ship	831,211	926,354	1,062,215	1,605,896	1,766,883	2,914,181	2,168,336

As can be seen in Table 52, which shows the estimated change in tons of coal imported by each of the regions, the changes in coal imports between the No-Action Alternative and the Proposed Action mirror the changes in consumption, except for China because the total amount of coal imported does not change. As mentioned in the previous section, the changes in consumption are due to changes in the mix of coal being consumed and not a change in overall coal demand.

Table 52. Lower Bound Scenario Change in Seaborne Coal Distribution in Pacific Basin—Proposed Action minus No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	0	-0.4	0	-0.1
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	0.9	0.9	-4.1	-1.0
South Korea	0	0	0	0	-1.4	-2.9	-1.6
Taiwan	0	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship	0	0	0	0.9	-0.8	-7.0	-2.8

The changes in the total tons of coal imported to each region would be magnified or diminished depending on how the sources of the coal shifted. There would be some relatively large changes in the ton-mile values, as shown in Table 53. For example, in Japan in 2025 coal imports would increase by less than 1%, while the ton-miles would increase by over 26%.

Table 53. Lower Bound Scenario Change in Distance Weighted Seaborne Coal Distribution in Pacific Basin—Proposed Action minus No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	Annual Average
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	0	-6,124	0	-2,041
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	85,482	85,482	-31,843	39,856
South Korea	0	0	0	0	-29,647	-78,493	-40,407
Taiwan	0	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship	0	0	0	85,482	49,711	-110,336	-2,593

6.3.4 CO_2 Emissions

This section presents the estimated CO_2 emissions from coal combusted in the United States and the Pacific Basin in the Lower Bound Scenario. In addition, CO_2 emissions from natural gas consumption in the United States are included because decreases in coal consumption may be offset by increases in natural gas consumption. Table 54 presents the CO_2 emissions under the No-Action Alternative. Total U.S. CO_2 emissions from coal would gradually decline and average 1,372 million metric tons between 2025 and 2040, which reflects the gradually declining coal consumption in the U.S. Pacific Basin CO_2 emissions would average 10,061 million metric tons per year between 2025 and 2040, which is 7.3 times the total CO_2 emissions from the U.S. coal combustion emissions. Natural gas CO_2 emissions would average 514 million metric tons per year between 2025 and 2040, which is 44 million metric tons higher than the Past Conditions (2014) Scenario. The higher natural gas emissions under the Lower Bound Scenario would be due to the higher assumed coal prices in this scenario, which would cause a shift away from coal and toward natural gas consumption. Between 2030 and 2040, CO_2 emissions from natural gas would increase by 180 million metric tons. This increase would be due to nuclear units retiring in this period and natural gas-fired generation replacing the retired nuclear generation.

Table 55 presents the CO_2 emissions under the Proposed Action. Total CO_2 emissions under the Proposed Action would follow the same trends as under the No-Action Alternative.

Table 54. Lower Bound Scenario CO_2 Emissions—No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	194,165	217,138	269,361	231,066
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	6,562,859	6,735,018	6,905,308	7,036,113	7,141,291	6,869,080	7,006,215
Hong Kong	32,192	32,514	32,840	33,670	34,330	35,728	34,690
India	1,134,742	1,161,652	1,189,727	1,264,655	1,340,727	1,475,993	1,372,199
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	303,319	303,092	303,914	297,147	288,440	255,726	278,137
South Korea	191,810	186,871	183,174	170,327	159,831	154,367	160,622
Taiwan	155,413	156,058	158,041	159,143	161,146	165,230	162,178
Pacific Basin - Coal	9,049,688	9,301,922	9,550,840	9,837,111	10,110,619	10,178,818	10,061,166
U.S. - Coal	1,460,162	1,500,110	1,377,345	1,386,257	1,358,466	1,373,259	1,371,938
U.S. - Natural Gas	477,173	455,573	463,820	436,317	446,673	626,705	513,809

Table 55. Lower Bound Scenario CO_2 Emissions—Proposed Action (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	194,165	217,138	269,361	231,066
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	6,562,859	6,735,018	6,905,308	7,038,230	7,141,291	6,869,080	7,006,803
Hong Kong	32,192	32,514	32,840	33,670	34,405	35,728	34,715
India	1,134,742	1,161,652	1,189,727	1,264,655	1,340,727	1,475,993	1,372,199
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	303,319	303,092	303,914	297,147	288,440	256,071	278,271
South Korea	191,810	186,871	183,174	170,327	160,131	154,690	160,847
Taiwan	155,413	156,058	158,041	159,143	161,146	165,230	162,178
Pacific Basin - Coal	9,049,688	9,301,922	9,550,840	9,839,229	10,110,994	10,179,485	10,062,139
U.S. - Coal	1,458,006	1,498,426	1,373,883	1,381,092	1,354,117	1,370,285	1,367,897
U.S.- Natural Gas	477,969	456,026	465,155	437,730	447,149	627,368	514,618

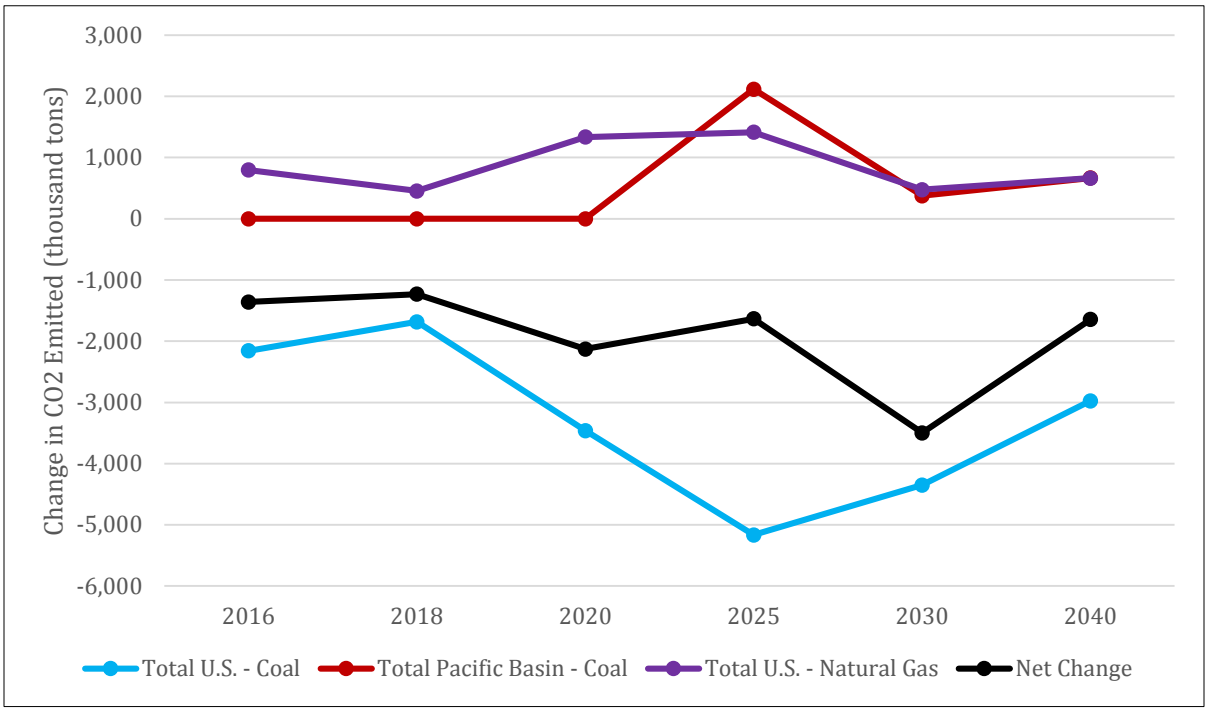
Table 56 shows the estimated change in CO_2 emissions for each region and the total net change across all regions. Total Pacific Basin CO_2 emissions from coal consumption would increase between 375 and 2,118 thousand metric tons starting in 2025 due to shifts in the type of coal consumed in China, Hong Kong, Japan, and South Korea, where the different coal types would have different CO_2 emissions rates. In contrast, U.S. coal CO_2 emissions would decrease in every year due to slightly higher coal prices that would depress U.S. coal demand. The slightly higher coal prices would result from the fact that an additional 44 million metric tons of coal would be mined and exported under the Proposed Action, which would shift the demand curve up and yield higher coal prices in the United States. The decrease in coal consumption would be offset by an increase in natural gas consumption, as is seen by the increase in CO_2 emissions from natural gas, which would average 809 thousand metric tons per year between 2025 and 2040. The total net change in CO_2 emissions would be a decrease of an average of 2,259 thousand metric tons per year between 2025 and 2040.

Table 56. Lower Bound Scenario Changes in CO_2 Emissions—Proposed Action minus No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	2,118	0	0	588
Hong Kong	0	0	0	0	74	0	25
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	0	0	344	134
South Korea	0	0	0	0	301	323	226
Taiwan	0	0	0	0	0	0	0
Pacific Basin - Coal	0	0	0	2,118	375	667	973
U.S. - Coal	-2,156	-1,684	-3,462	-5,165	-4,349	-2,974	-4,041
U.S. - Natural Gas	795	453	1,334	1,413	476	663	809
Total Change	-1,360	-1,231	-2,128	-1,634	-3,498	-1,643	-2,259

In the Lower Bound Scenario, coal combustion emissions of CO_2 would be higher under the Proposed Action in the Pacific Basin than under the No-Action Alternative. U.S. emissions would generally decline. Figure 29 shows the net change in CO_2 emissions between the No-Action Alternative and Proposed Action. The decrease in U.S. coal emissions would override the increase in Pacific Basin coal emissions and U.S. natural gas emissions and would drive the net change to be a net decrease in CO_2 emissions under the Proposed Action.

Figure 29. Lower Bound Scenario Changes in CO_2 Emissions by Region—Proposed Action minus No-Action Alternative



a. Total U.S. CO_2 emissions from the combustion of coal decrease because the proposed coal export terminal would be a new demand sink for U.S. coal, and thus, would cause coal prices to rise, and U.S. coal consumption to decrease in response to the higher prices.

b. Pacific Basin CO_2 emissions from the combustion of coal increase due to a larger quantity of lower heat content coal being consumed.

c. Total U.S. natural gas combustion CO_2 emissions increase because when coal consumption for electric generation declines, natural gas usage for electric generation increases to fill the gap.

6.4 Upper Bound Scenario

The Upper Bound Scenario uses the assumptions presented in Chapter 5, *Scenarios*, and represents the upper bound of global GHG emissions that could be reasonably expected if the scenario assumptions are realized. This scenario is designed to model the highest potential GHG emissions under the Proposed Action, and to provide a high GHG emissions environment into which the terminal is constructed and operated. This section presents the modeling results for the Upper Bound Scenario No-Action Alternative and Proposed Action for coal production, consumption, distribution, and CO_2 emissions.

6.4.1 Coal Production

The Upper Bound Scenario is designed to model high levels of coal consumption, and thus, increased CO_2 emissions. Therefore, coal production in the Upper Bound Scenario would be greater than the Past Conditions (2014) Scenario. Under the No-Action Alternative U.S. thermal coal production would average 979 million metric tons per year for the 2025 to 2040 period. In contrast, the average U.S. coal production over 2025 to 2040 under the Past Conditions (2014) Scenario would be 188 million metric tons lower at 791 million metric tons. The higher production under the Upper Bound

Scenario would be due to two factors. First, the assumed lower Powder River Basin coal prices in the Upper Bound Scenario would cause about 39 million metric tons more of Powder River Basin coal to be consumed. Second, exports out of the east coast and Canadian Pacific Northwest ports would be 100 to 185 million metric tons higher for the Upper Bound Scenario. U.S. coal production would fluctuate over the 2016 to 2040 period in response to both domestic demand and exports, and would end up being 33 million metric tons higher in 2040 than in 2016. Over the 2016 to 2040 period, non-U.S. coal production would grow at an average annual rate of 2.2% per year from 6.3 to 10.3 billion metric tons.

Powder River Basin coal production under the No-Action Alternative would average 405 million metric tons per year over 2025 to 2040. The modeled Powder River Basin average production in the Upper Bound Scenario, No-Action Alternative, would be 14% below the 2006 to 2011 historical production average of 473 million metric tons. After 2011 natural gas prices dropped to below $3/MMBtu, which significantly reduced coal demand and drove Powder River Basin production to around 435 million metric tons. Uinta Basin coal production under the No-Action Alternative would average 18.4 million metric tons per year over 2025 to 2040, with production gradually declining over the 2016 to 2040 period. Table 57 shows the No-Action Alternative coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 57. Upper Bound Coal Production—No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,266	6,678	7,119	8,122	9,175	10,342	9,337
Total U.S. Thermal Coal	986	1,047	962	960	947	1,019	979
Powder River Basin Coal	404	436	403	410	409	398	405
Uinta Basin Coal	27.6	24.5	22.8	22.0	20.0	14.4	18.4

Under the Proposed Action, U.S. thermal coal production would average 1,018 million metric tons per year for the 2025 to 2040 period. As with the No-Action Alternative, U.S. coal production would fluctuate and end at 66 million metric tons higher by 2040. The higher production by 2040 would be due to the additional exports through the terminal and higher domestic Powder River Basin coal consumption. Non-U.S. coal production would follow the same growth rate under the Proposed Action as it would under the No-Action Alternative, except production would decline by 16.8 to 34.4 million metric tons per year, once the terminal comes online. Thus, the coal exported from the terminal would displace some coal production in other countries. Powder River Basin coal production under the Proposed Action would average 435 million metric tons per year between 2025 and 2040 with production gradually increasing over time. Uinta Basin coal production would average 24.7 million metric tons per year between 2025 and 2040, with production declining through 2020 and then increasing to 35.2 million metric tons in 2025 because coal from the Uinta Basin would be exported through the terminal. After 2025, Uinta Basin production would decline as less coal from this basin is exported in each subsequent run year. Table 58 shows the Proposed Action coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 58. Upper Bound Scenario Coal Production—Proposed Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,259	6,660	7,119	8,102	9,141	10,325	9,313
Total U.S. Thermal Coal	989	1,059	958	996	994	1,055	1018
Powder River Basin Coal	398	434	400	427	438	438	435
Uinta Basin Coal	18.9	18.5	14.2	35.2	23.0	18.6	24.7

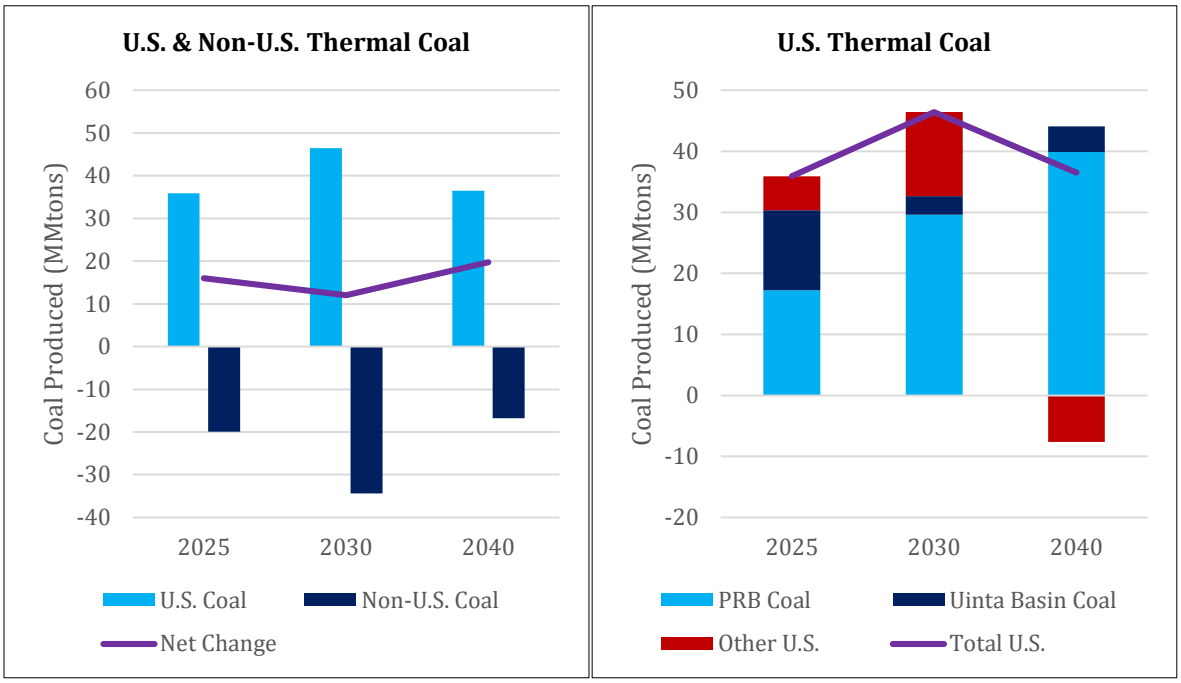
Table 59 shows the estimated change in coal production between the Proposed Action and the No-Action Alternative by model run year to generally be a decrease of less than 18 million metric tons for non-U.S. coal in the years before 2025 when the terminal was assumed to come online. The increase in U.S. coal production prior to 2025 is due to an increase in exports from the Appalachian basin. Once the terminal is online and exporting coal, total modeled U.S. coal production would be higher under the Proposed Action, primarily due to increases in the Powder River Basin and the Uinta Basin. In response to the increase in exports from the terminal, non-U.S. coal production would decrease by 16.8 to 34.4 million metric tons per year.

Table 59. Upper Bound Scenario Change in Coal Production—Proposed Action minus No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	-7.3	-17.7	0.0	-19.9	-34.4	-16.8	-23.5
Total U.S. Thermal Coal	3.2	12.1	-4.3	35.9	46.4	36.5	39.7
Powder River Basin Coal	-5.4	-1.4	-3.1	17.2	29.6	39.9	30.2
Uinta Basin Coal	-8.7	-5.9	-8.6	13.1	3.0	4.2	6.3

Figure 30 shows that total non-U.S. thermal coal production would decrease in proportion to the increase in U.S. coal production under the Proposed Action. The difference in the changes of U.S. and non-U.S. coal production are due to the 15 to 20 million metric ton increase in international coal demand due to induced demand caused by the lower coal prices of exported coal. This would indicate that U.S. thermal coal exports would take the place of some internationally produced coal.

Figure 30. Upper Bound Scenario Change in Coal Production—Proposed Action minus No-Action Alternative



6.4.2 Coal Consumption

In the Upper Bound Scenario, under the No-Action Alternative U.S. thermal coal consumption would average 809 million metric tons per year for the 2025 to 2040 period. U.S. coal consumption would be fairly flat between 2020 and 2040 as electric demand growth would be primarily met with natural gas and renewable generation. Over the 2016 to 2040 period, Pacific Basin coal consumption would grow at an average rate of 2.5% per year from about 5.0 to almost 9.0 billion metric tons. The growth in consumption would be driven by increasing coal consumption in China and India. Table 60 shows the No-Action Alternative coal consumption values for each model run year.

China is responsible for the largest share of global thermal coal consumption, burning 3,550 million metric tons of coal in 2016. This amount is projected to grow in the Upper Bound Scenario, No-Action Alternative to 6,350 million metric tons by 2040. Total U.S. coal consumption would remain relatively stable, fluctuating between 803 and 857 million metric tons. In the Upper Bound Scenario the growth in coal demand for countries in Asia is 2.5%, which would provide for a robust market environment for coal transported through the terminal.

Coal consumption under the Proposed Action follows similar patterns as the No-Action Alternative, with U.S. thermal coal consumption averaging 807 million metric tons per year for the 2025 to 2040 period. As under the No-Action Alternative, U.S. coal consumption is fairly flat between 2020 and 2040.

Table 60. Upper Bound Scenario Coal Consumption—No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	116	143	123
Australia	158	168	176	193	212	253	223
China	3,550	3,879	4,190	4,952	5,729	6,346	5,753
Hong Kong	14	14	14	15	15	17	16
India	691	749	806	971	1,158	1,565	1,264
Indonesia	165	181	195	228	264	357	290
Japan	138	132	132	131	136	130	132
South Korea	89	89	88	84	83	83	83
Taiwan	70	71	70	72	79	85	79
Total Pacific Basin Coal Consumption	4,950	5,364	5,765	6,750	7,793	8,978	7,964
Total U.S. Coal Consumption	821	857	803	817	805	808	809

Over the 2016 to 2040 period, Pacific Basin coal consumption under the Proposed Action grows from 4.9 to about 9.0 billion metric tons, similar to the No-Action Alternative. However, under the Proposed Action there is an average 1.65% increase in demand in Hong Kong, India, Japan, South Korea, and Taiwan that is induced due to lower delivered coal prices. Table 61 shows the Proposed Action coal consumption values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 61. Upper Bound Scenario Coal Consumption—Proposed Action (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	116	143	123
Australia	158	168	176	193	212	253	223
China	3,550	3,879	4,190	4,953	5,725	6,347	5,753
Hong Kong	14	14	14	15	16	18	16
India	691	749	806	985	1,170	1,581	1,279
Indonesia	165	181	195	228	264	357	290
Japan	137	131	132	134	137	133	135
South Korea	89	89	88	85	85	85	85
Taiwan	70	70	70	73	80	86	80
Total Pacific Basin Coal Consumption	4,949	5,362	5,765	6,771	7,806	9,002	7,984
Total U.S. Coal Consumption	818	853	799	813	802	807	807

Table 62 shows the estimated change in coal consumption between the Proposed Action and the No-Action Alternative by model run year to be close to zero in the Pacific Basin before 2025 when the terminal was assumed to come online. Once the terminal is online and exporting coal, total Pacific Basin coal consumption would be higher by an average of 19.3 million metric tons between 2025

and 2040, while U.S. coal consumption would be slightly down by an average of 2.5 million metric tons per year over the 2025 to 2040 period under the Proposed Action.

In the Pacific Basin, coal consumption would be higher on average by 19.3 million metric tons per year between 2025 and 2040, with the increase driven by the induced demand from the lower coal prices when the terminal comes online in 2025. India's consumption would have the largest increase with an average of 14.6 million metric tons per year between 2025 and 2040. Some of the changes in consumption would be due to changes in the mix of coal, such as in China, where there was no induced demand due to lower delivered coal prices.

Table 62. Upper Bound Scenario Change in Coal Consumption—Proposed Action minus No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia – Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	1.5	-3.6	0.6	-0.5
Hong Kong	0	0	0	0.2	0.2	0.2	0.2
India	0	0	0	14.2	12.5	16.6	14.6
Indonesia	0	0	0	0	0	0	0
Japan	-0.9	-0.7	0	2.5	0.8	3.2	2.2
South Korea	0	0	0	1.0	2.0	2.6	2.0
Taiwan	0	-1.3	0	0.9	1.0	1.0	0.9
Total Pacific Basin Coal Consumption	-0.9	-1.9	0.0	20.3	12.9	24.1	19.3
Total U.S. Coal Consumption	-3.4	-3.5	-4.4	-4.1	-3.4	-0.5	-2.5

6.4.3 Coal Distribution

As with the Past Conditions (2014) Scenario, distribution patterns for Powder River Basin and Uinta Basin coal are expected to remain largely unchanged under the Proposed Action. This section focuses on the distribution of coal in the Pacific Basin and how that distribution would be expected to change with the construction of the terminal. Under the No-Action Alternative, there would be no coal exported through the terminal; however, there would be 615 million metric tons of coal distributed in the Pacific Basin by ship in the seaborne coal market in 2016. Table 63 shows the tons of coal that would be imported by each country in the Pacific Basin under the No-Action Alternative. By 2040, 1,175 million metric tons of coal are expected to be distributed in the seaborne coal market in the Pacific Basin.

Table 63. Upper Bound Scenario Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	116	143	123
Australia	0	0	0	0	0	0	0
China	227	227	227	318	318	726	476
Hong Kong	14	14	14	15	15	17	16
India	43	41	36	38	37	0	23
Indonesia	0	0	0	0	0	0	0
Japan	138	132	132	131	136	130	132
South Korea	48	47	44	68	76	74	73
Taiwan	70	71	70	72	79	85	79
Total Pacific Basin Coal sent via ship	615	613	616	746	777	1,175	923

To understand how coal distribution is changing in more detail than the tons of coal imported by each country, the tons of coal shipped to each country were multiplied by the distance in nautical miles that the coal is shipped. The change in tons imported might not change significantly; however, where the coal is sourced might change, which would have a significant impact on the emissions associated with shipping. Table 64 shows the ton-nautical miles for coal shipped to each country under the No-Action Alternative.

Table 64. Upper Bound Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	123,074	140,747	178,803	150,637
Australia	0	0	0	0	0	0	0
China	386,461	386,461	386,461	541,045	555,523	1,602,575	958,688
Hong Kong	27,007	27,404	27,806	28,838	29,908	59,514	41,124
India	141,530	125,520	109,856	116,765	114,231	0	70,512
Indonesia	0	0	0	0	0	0	0
Japan	531,038	415,489	380,241	377,452	541,404	512,386	484,577
South Korea	112,335	122,121	99,830	177,011	263,975	260,019	238,280
Taiwan	241,300	189,341	104,144	108,008	259,410	280,908	225,714
Total Pacific Basin Coal sent via ship	1,444,470	1,298,624	1,215,208	1,472,192	1,905,197	2,894,204	2,169,532

Under the Proposed Action, coal would be exported through the terminal to destinations in the Pacific Basin. Table 65 shows that the coal exported from the terminal would be distributed by the model to China, Japan, and South Korea. In the Past Conditions (2014) Scenario, all of the exported coal goes to Japan. In the Upper Bound Scenario, coal would be exported to China because at the higher coal consumption levels in this scenario, the Indonesian bituminous coal that would be sent

to China would become depleted and coal from the Uinta basin would replace some of the coal that was being delivered from Indonesia. The situation would be similar in South Korea, except that it would be South Korean bituminous coal reserves that become depleted in the 2025 run year, and thus additional coal must be imported in 2030 and 2040. Imports to South Korea through the terminal would increase from 11.1 to 17.1 million metric tons between 2030 and 2040 because less coal from Russia would be imported in 2040.

Table 65. Upper Bound Scenario Distribution of Coal Exported through the Proposed Coal Export Terminal—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040
China	0	0	0	0	0	10.5
Hong Kong	0	0	0	0	0	0
Japan	0	0	0	44.0	32.9	16.5
South Korea	0.0	0	0	0	11.1	17.1
Taiwan	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship through MBTL	0	0	0	44.0	44.0	44.0

Under the Proposed Action, a similar number of tons would be distributed in the seaborne coal market as the No-Action Alternative, except for an increase in imports to India in 2025 and 2030 (Table 66). The distance weighted coal distribution in the Pacific Basin is presented in Table 67 for the Proposed Action.

Table 66. Upper Bound Scenario Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	75	82	94	104	116	143	123
Australia	0	0	0	0	0	0	0
China	227	227	227	318	318	726	476
Hong Kong	14	14	14	15	16	18	16
India	43	41	36	52	62	0	35
Indonesia	0	0	0	0	0	0	0
Japan	137	131	132	134	137	133	135
South Korea	48	47	44	68	78	77	75
Taiwan	70	70	70	73	80	86	80
Total Pacific Basin Coal sent via ship	614	611	616	764	806	1,182	941

Table 67. Upper Bound Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	123,074	140,747	178,803	150,637
Australia	0	0	0	0	0	0	0
China	386,461	386,461	386,461	541,045	546,450	1,607,131	957,436
Hong Kong	27,007	27,404	27,806	29,196	30,266	60,330	41,660
India	141,530	125,520	109,856	160,813	191,943	0	108,651
Indonesia	0	0	0	0	0	0	0
Japan	524,301	436,271	380,241	461,622	590,289	578,555	549,985
South Korea	112,562	122,121	99,830	179,568	313,560	334,087	284,323
Taiwan	241,300	140,231	104,144	109,334	263,388	284,886	228,956
Total Pacific Basin Coal sent via ship	1,437,960	1,270,297	1,215,208	1,604,652	2,076,644	3,043,793	2,321,648

As can be seen in Table 68, which shows the estimated change in tons of coal imported by each of the regions, the changes in coal imports between the No-Action Alternative and the Proposed Action generally mirror the changes in consumption, except for China and India. The change in coal imports between the Proposed Action and the No Action differ from the change in consumption for China because the mix of coal consumed by China changes in the two alternatives. For India, the change in seaborne imports in 2040 is not similar to the change in consumption because in 2040 13.3 million metric tons of coal is imported via overland routes and not via seaborne routes.

Table 68. Upper Bound Scenario Change in Seaborne Coal Imports in Pacific Basin—Proposed Action minus No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	0.2	0.2	0.2	0.2
India	0	0	0	14.2	25.1	0	12.3
Indonesia	0	0	0	0	0	0	0
Japan	-0.9	-0.7	0	2.5	0.8	3.2	2.2
South Korea	0	0	0	1.0	2.0	2.6	2.0
Taiwan	0	-1.3	0	0.9	1.0	1.0	0.9
Total Pacific Basin Coal sent via ship	-0.9	-1.9	0	18.8	29.1	6.9	17.6

The changes in the total tons of coal imported to each region are magnified or diminished depending on how the sources of the coal are shifting. There are some relatively large changes in the ton-mile values, as shown in Table 69. For example, in Japan in 2025, coal imports increase by 1.9% while the ton-miles increase by 22.3%.

Table 69. Upper Bound Scenario Change in Distance Weighted Seaborne Coal Imports in Pacific Basin—Proposed Action minus No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	Annual Average
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	0	-9,073	4,557	-1,252
Hong Kong	0	0	0	358	358	816	536
India	0	0	0	44,048	77,712	0	38,140
Indonesia	0	0	0	0	0	0	0
Japan	-6,737	20,783	0	84,170	48,885	66,169	65,408
South Korea	227	0	0	2,557	49,586	74,069	46,043
Taiwan	0	-49,109	0	1,326	3,978	3,978	3,242
Total Pacific Basin Coal sent via ship	-6,510	-28,327	0	132,460	171,447	149,589	152,117

6.4.4 CO_2 Emissions

This section presents the CO_2 estimated emissions from coal combusted in the United States and the Pacific Basin in the Upper Bound Scenario. In addition, CO_2 emissions from natural gas consumption in the United States are included because decreases in coal consumption may be offset by increases in natural gas consumption. Table 70 presents the CO_2 emissions under the No-Action Alternative. Total U.S. CO_2 emissions from coal gradually decline and average 1,525 million metric tons between 2025 and 2040, which reflects the gradually declining coal consumption in the U.S. Pacific Basin CO_2 emissions average 15,260 million metric tons per year between 2025 and 2040, which is 10 times the total coal CO_2 emissions from the United States. Natural gas CO_2 emissions average 466 million metric tons per year, or about one third of U.S. coal CO_2 emissions. Between 2030 and 2040, CO_2 emissions from natural gas increase by 188 million metric tons. This increase is due to nuclear units retiring in this period and natural gas-fired generation replacing the retired nuclear generation.

Table 71 presents the CO_2 emissions under the Proposed Action. Total CO_2 emissions under the Proposed Action follow the same trends as under the No-Action Alternative, and are within 2% of the coal CO_2 emissions under the No-Action Alternative.

Table 70. Upper Bound Scenario CO_2 Emissions—No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	196,125	220,787	273,997	234,629
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	7,260,862	7,916,147	8,536,087	10,032,545	11,514,543	12,571,160	11,513,784
Hong Kong	32,192	32,675	33,166	34,425	35,732	38,498	36,445
India	1,135,920	1,216,497	1,304,198	1,560,679	1,852,812	2,452,270	2,004,787
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	305,003	303,770	304,841	302,552	299,415	287,620	295,700
South Korea	193,004	191,589	189,564	185,299	180,563	178,736	181,168
Taiwan	156,232	158,808	161,194	167,314	173,668	187,108	177,129
Pacific Basin - Coal	9,752,567	10,546,203	11,306,885	13,160,831	15,045,236	16,942,721	15,259,701
U.S. - Coal	1,564,980	1,633,641	1,524,593	1,546,138	1,516,225	1,516,980	1,524,828
U.S. - Natural Gas	442,260	409,224	409,458	383,544	396,159	584,167	465,769

Table 71. Upper Bound Scenario CO_2 Emissions—Proposed Action (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	196,125	220,787	273,997	234,629
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	7,260,862	7,916,147	8,536,087	10,032,838	11,513,995	12,571,286	11,513,731
Hong Kong	32,192	32,675	33,166	34,884	36,191	38,956	36,903
India	1,135,920	1,216,497	1,304,198	1,589,150	1,881,675	2,480,229	2,033,189
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	304,679	302,953	304,841	306,096	302,555	292,150	299,492
South Korea	193,004	191,589	189,564	187,721	183,374	181,758	183,953
Taiwan	156,232	158,808	161,194	169,518	175,871	189,311	179,333
Pacific Basin - Coal	9,752,243	10,545,385	11,306,885	13,198,223	15,082,165	16,981,019	15,297,291
U.S. - Coal	1,560,176	1,625,710	1,516,370	1,536,424	1,505,925	1,507,002	1,514,816
U.S.- Natural Gas	442,892	411,246	411,755	385,646	397,726	587,015	467,983

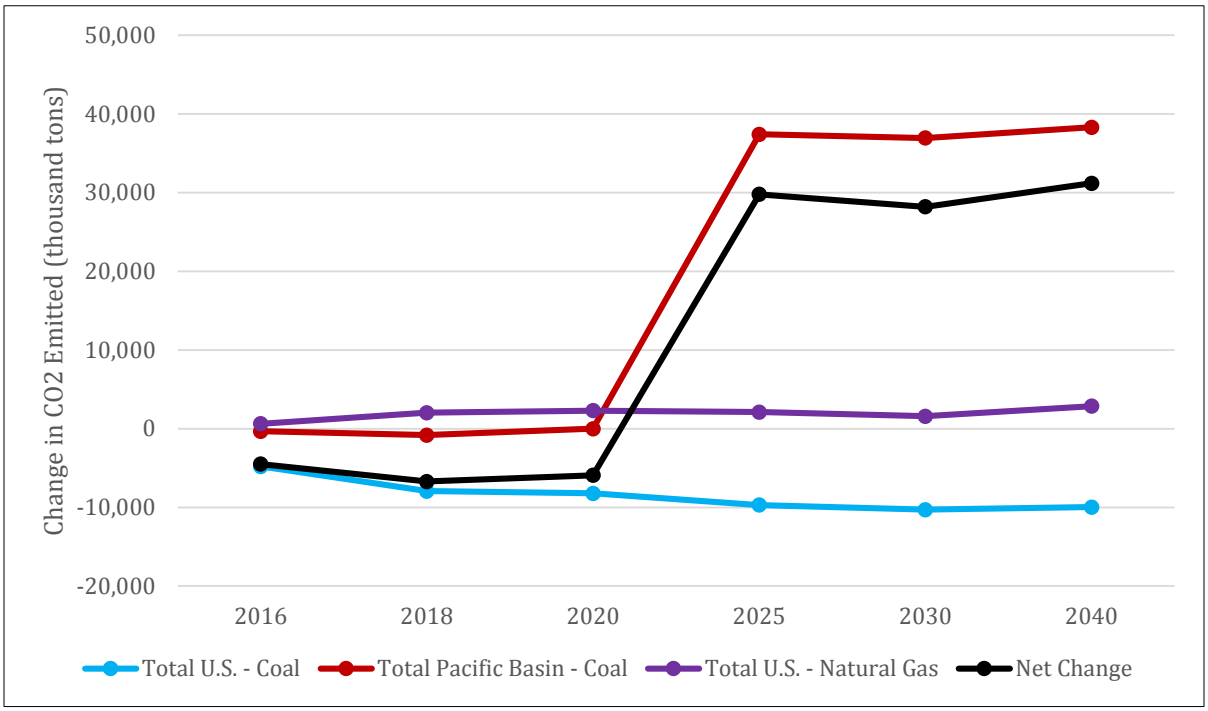
Table 72 shows the estimated change in CO_2 emissions for each region, as well as the total net change across all regions. Total Pacific Basin CO_2 emissions from coal consumption would increase between 36,928 and 38,298 thousand metric tons starting in 2025, due to induced demand from the reduction in delivered coal prices under the Proposed Action and because of shifts in the type of coal consumed. In contrast, U.S. coal CO_2 emissions would decrease in every year due to slightly higher coal prices that would depress coal demand by about 2.5 million metric tons per year. The slightly higher coal prices would result from the fact that an additional 44 million metric tons of coal would be mined and exported under the Proposed Action, which would shift the demand curve up and yield higher coal prices in the United States. The shift would be to the coal demand curve because from the perspective of the U.S. coal market the terminal would be a new source of demand. The decrease in coal consumption would be offset by an increase in natural gas consumption, as is seen by the increase in CO_2 emissions from natural gas, which would average an increase of 2,214 thousand metric tons per year between 2025 and 2040. The total net change in CO_2 emissions would be an average increase of 29,792 thousand metric tons per year.

Table 72. Upper Bound Scenario Changes in CO_2 Emissions—Proposed Action minus No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0
China	0	0	0	293	-547	126	-52
Hong Kong	0	0	0	459	459	459	459
India	0	0	0	28,471	28,863	27,959	28,402
Indonesia	0	0	0	0	0	0	0
Japan	-324	-818	0	3,544	3,140	4,529	3,792
South Korea	0	0	0	2,422	2,811	3,022	2,785
Taiwan	0	0	0	2,203	2,203	2,203	2,203
Pacific Basin - Coal	-324	-818	0	37,392	36,928	38,298	37,590
U.S. - Coal	-4,804	-7,931	-8,223	-9,714	-10,300	-9,978	-10,012
U.S. - Natural Gas	632	2,023	2,297	2,102	1,567	2,848	2,214
Total Change	-4,496	-6,726	-5,926	29,780	28,195	31,168	29,792

In the Upper Bound Scenario the change in coal combustion emissions between the No-Action Alternative and Proposed Action would fluctuate for both the Pacific Basin and the U.S. The change in U.S. CO_2 emissions from natural gas are expected to grow from 2016 to 2018 and fluctuate from 2018 to 2040 while remaining relatively flat overall. Figure 31 shows the net change in CO_2 emissions between the No-Action Alternative and Proposed Action. In the long term, the increase in Pacific Basin coal emissions would drive the net change to be a net increase in CO_2 emissions under the Proposed Action.

Figure 31. Upper Bound Scenario Changes in CO_2 Emissions by Region—Proposed Action minus No-Action Alternative[a,b,c]



a Total U.S. CO_2 emissions from the combustion of coal decrease because the proposed coal export terminal would be a new demand sink for U.S. coal, and thus, would cause coal prices to rise and U.S. coal consumption to decrease in response to the higher prices.

b Pacific Basin CO_2 emissions from the combustion of coal increase due to a larger quantity of lower heat content coal being consumed and due to induced demand from the lower delivered coal prices when the terminal comes online in 2025.

c Total U.S. natural gas combustion CO_2 emissions increase because when coal consumption for electric generation declines, natural gas usage for electric generation increases to fill the gap.

6.5 2015 Energy Policy Scenario

The 2015 Energy Policy Scenario uses the assumptions presented in Chapter 5, *Scenarios*, and is intended to represent a scenario in which the United States and China have implemented policies to reduce GHG emissions. These policies would also reduce coal consumption, and thus production, especially in the long term. This section presents the modeling results for the 2015 Energy Policy Scenario No-Action Alternative and Proposed Action for coal production, consumption, distribution, and CO_2 emissions.

6.5.1 Coal Production

Under the No-Action Alternative U.S. thermal coal production would average 615 million metric tons per year for the 2025 to 2040 period. Annual U.S. coal production would decline by 158 million metric tons between 2016 and 2040 because the climate policies would drive down coal demand. Over the 2016 to 2040 period, non-U.S. coal production would grow at an average annual rate of 0.7% per year from 6.1 to 7.2 billion metric tons. Powder River Basin coal production under the No-Action Alternative would average 236 million metric tons per year over 2025 to 2040. Uinta Basin coal production under the No-Action Alternative would average 14.3 million metric tons per year,

with production gradually declining to a low of 13.7 million metric tons in 2020 and then gradually increasing to 14.5 million metric tons by 2040. Uinta Basin coal production would increase between 2020 and 2040 because several coal plants in Utah would increase their coal consumption and electrical output in this period. Table 73 shows the No-Action Alternative coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 73. 2015 Energy Policy Scenario Coal Production—No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,127	6,279	6,441	6,689	6,932	7,244	6,986
Total U.S. Thermal Coal	783	767	622	619	601	625	615
Powder River Basin Coal	321	323	241	241	225	242	236
Uinta Basin Coal	17.0	16.2	13.7	13.9	14.4	14.5	14.3

Under the Proposed Action, U.S. thermal coal production would average 654 million metric tons per year for the 2025 to 2040 period. As with the No-Action Alternative, U.S. coal production would decline. Non-U.S. coal production would follow the same growth rate under the Proposed Action as it would under the No-Action Alternative, except production would decline by 22 to 44 million metric tons per year once the terminal comes online. Thus, the coal exported from the terminal would displace some coal production in other countries. Powder River Basin coal production under the Proposed Action would average 268 million metric tons per year with production declining to 241 million metric tons by 2020 and then staying below 275 million metric tons. Uinta Basin coal production would average 18.7 million metric tons per year, with production declining through 2030 to 11.8 million metric tons and then spiking in 2040 when production jumps to 28.7 million metric tons due to exports of Uinta Basin coal to Japan. Table 74 shows the Proposed Action coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 74. 2015 Energy Policy Scenario Coal Production—Proposed Action (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,127	6,279	6,441	6,668	6,898	7,200	6,951
Total U.S. Thermal Coal	782	766	621	648	643	668	654
Powder River Basin Coal	320	323	241	272	267	266	268
Uinta Basin Coal	17.0	16.2	12.8	13.1	11.8	28.7	18.7

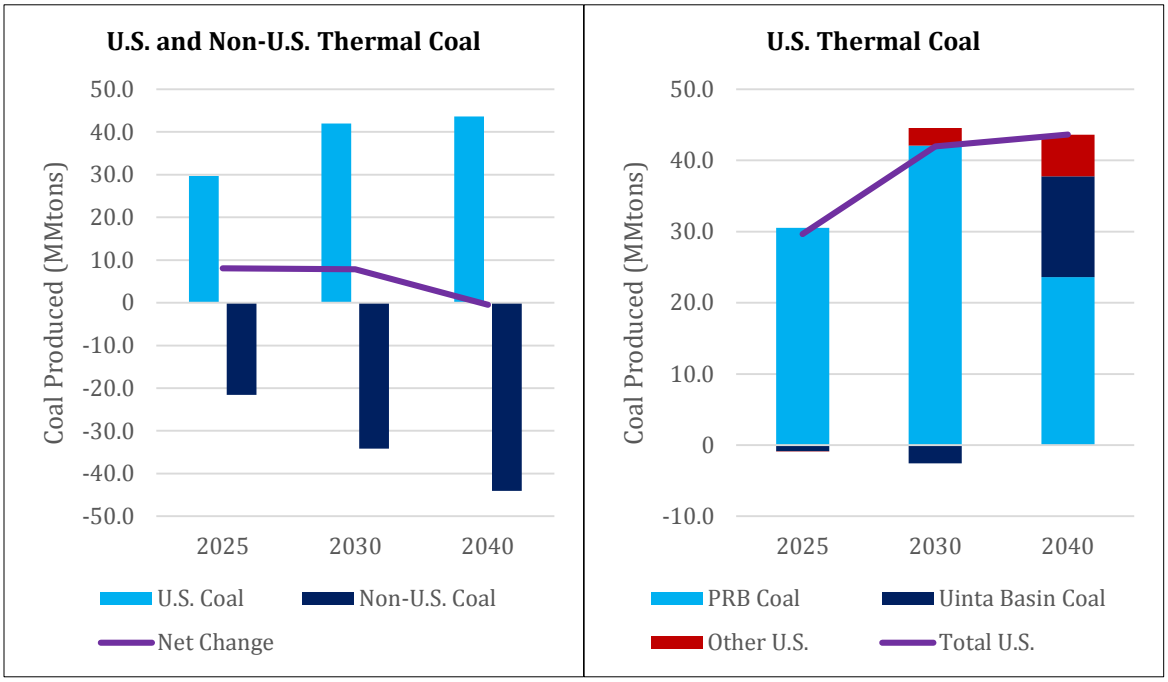
Table 75 shows the estimated change in coal production between the Proposed Action and the No-Action Alternative by model run year. Assuming the terminal is online and exporting coal, total modeled U.S. coal production would be higher under the Proposed Action, primarily due to increases in Powder River Basin and the Uinta Basin.

Table 75. 2015 Energy Policy Scenario Change in Coal Production—Proposed Action minus No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	0	0	0	-21.6	-34.2	-44.1	-34.5
Total U.S. Thermal Coal	-1.0	-1.1	-1.0	29.7	42.0	43.6	39.2
Powder River Basin Coal	-1.1	-0.5	-0.2	30.5	42.1	23.6	31.7
Uinta Basin Coal	0	0	-0.9	-0.8	-2.6	14.2	4.4

Figure 32 shows that total non-U.S. thermal coal production would decrease in proportion to the increase in U.S. coal production under the Proposed Action. The difference in the changes of U.S. and non-U.S. coal production are due to the fact that the increase in U.S. coal production would be lower heat content subbituminous coal and the decrease in non-U.S. coal production would be higher heat content bituminous coal.

Figure 32. 2015 Energy Policy Scenario Change in Coal Production—Proposed Action minus No-Action Alternative



6.5.2 Coal Consumption

In the 2015 Energy Policy Scenario, under the No-Action Alternative U.S. thermal coal consumption would average 615 million metric tons per year for the 2025 to 2040 period. U.S. coal consumption would decline steeply between 2016 and 2020, and then would be fairly flat between 2020 and 2040, as electric demand growth is primarily met with natural gas and renewable generation. The steep decline through 2020 would be due to the implementation of EPA's Clean Power Plan in the model. Over the 2016 to 2040 period, Pacific Basin coal consumption would grow at an average rate of 0.8% per year from 4.6 to 5.6 billion metric tons. The growth in consumption would be driven by

increasing coal consumption in Australia, China, India, and Indonesia. Table 76 shows the No-Action Alternative coal consumption values for each model run year.

Table 76. 2015 Energy Policy Scenario Coal Consumption—No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	108	126	143	127
Australia	158	168	176	193	212	253	223
China	3,260	3,331	3,400	3,529	3,623	3,581	3,581
Hong Kong	14	14	14	15	15	16	15
India	686	719	745	801	859	982	891
Indonesia	165	181	195	228	264	357	290
Japan	124	125	132	129	125	116	123
South Korea	83	81	86	78	72	71	73
Taiwan	63	65	68	73	74	75	74
Total Pacific Basin Coal Consumption	4,627	4,766	4,910	5,153	5,371	5,593	5,397
Total U.S. Coal Consumption	776	754	607	607	601	631	615

China is responsible for the largest share of global thermal coal consumption, burning 3,260 million metric tons of coal in 2016. This amount is projected to grow in the 2015 Energy Policy Scenario No-Action Alternative to 3,581 million metric tons by 2040. Under the 2015 Energy Policy Scenario the growth in coal demand in countries in Asia would be only 0.8%, which would be a challenging market environment for coal transported through the terminal.

Coal consumption under the Proposed Action would follow similar patterns as the No-Action Alternative, with U.S. thermal coal consumption averaging 614 million metric tons per year for the 2025 to 2040 period. As under the No-Action Alternative, U.S. coal consumption would decline steeply through 2020, and then would be fairly flat between 2020 and 2040.

Over the 2016 to 2040 period, Pacific Basin coal consumption would follow the same pattern as it would grow from 4.6 to 5.6 billion metric tons. However, under the Proposed Action there would be a 0.13% increase in demand that would be induced due to lower delivered coal prices to Hong Kong, Japan, South Korea, and Taiwan. Table 77 shows the Proposed Action coal consumption values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 77. 2015 Energy Policy Scenario Coal Consumption—Proposed Action (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	108	121	143	126
Australia	158	168	176	193	212	253	223
China	3,260	3,331	3,400	3,536	3,623	3,581	3,583
Hong Kong	14	14	14	15	15	16	15
India	686	719	745	801	859	982	891
Indonesia	165	181	195	228	264	357	290
Japan	124	125	132	130	126	115	123
South Korea	83	81	86	78	72	71	73
Taiwan	63	65	68	73	74	76	75
Total Pacific Basin Coal Consumption	4,627	4,766	4,910	5,162	5,367	5,592	5,398
Total U.S. Coal Consumption	775	753	606	607	601	631	614

Table 78 shows the estimated change in coal consumption between the Proposed Action and the No-Action Alternative by model run year. Assuming the terminal is online and exporting coal, total Pacific Basin coal consumption would be higher with an average of 0.6 million metric tons between 2025 and 2040, while U.S. coal consumption would be slightly down at an average of 0.3 million metric tons per year over the 2025 to 2040 period under the Proposed Action. However, Pacific Basin coal consumption, on a tonnage basis, would only be higher in 2025, because in 2030 and 2040 there is a shift in the mix of coal being consumed to higher heat content coal.

Table 78. 2015 Energy Policy Scenario Change in Coal Consumption—Proposed Action minus No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia – Other	0	0	0	0	-4.8	0	-1.6
Australia	0	0	0	0	0	0	0
China	0	0	0	7.7	0	0	2.1
Hong Kong	0	0	0	0	0	0	0
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	0.8	1.1	-1.6	-0.03
South Korea	0	0	0	0.1	0.1	-0.1	0.01
Taiwan	0	0	0	0.1	0.1	0.1	0.1
Total Pacific Basin Coal Consumption	0	0	0	8.7	-3.6	-1.6	0.6
Total U.S. Coal Consumption	-1.2	-1.1	-1.0	-0.6	0.0	-0.3	-0.3

In the Pacific Basin, coal consumption would be higher on average by 0.6 million metric tons per year between 2025 and 2040. The changes in consumption would be primarily due to changes in the mix of coal consumed and the differences in heat content of the coal being consumed, as the amount of induced demand is only about 0.45 million metric tons. Under the Proposed Action, a larger quantity of lower heat content coal would be being consumed than under the No-Action Alternative

in 2025. This makes it appear that total coal consumption would increase in 2025, and then decrease in 2030 and 2040.

6.5.3 Coal Distribution

In the 2015 Energy Policy Scenario, as with the Past Conditions (2014) Scenario, distribution patterns for Powder River Basin and Uinta Basin coal are expected to remain largely unchanged under the Proposed Action. Thus, this section focuses on the distribution of coal in the Pacific Basin and how that distribution would be expected to change with the construction of the terminal. Under the No-Action Alternative, no coal would be exported through the terminal; however, there would be 461 million metric tons of coal distributed in the Pacific Basin by ship in the seaborne coal market in 2016. Table 79 shows the tons of coal that would be imported by each country in the Pacific Basin under the No-Action Alternative. By 2040, 730 million metric tons of coal are estimated to be distributed in the seaborne coal market in the Pacific Basin.

Table 79. 2015 Energy Policy Scenario Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	108	126	143	127
Australia	0	0	0	0	0	0	0
China	106	227	227	227	272	318	277
Hong Kong	14	14	14	15	15	16	15
India	38	11	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	124	125	132	129	125	116	123
South Korea	42	39	42	61	65	63	63
Taiwan	63	65	68	73	74	75	74
Total Pacific Basin Coal sent via ship	461	563	576	612	677	730	680

To understand how coal distribution is changing in more detail than the tons of coal imported by each country, the tons of coal shipped to each country were multiplied by the distance in nautical miles that the coal is shipped. The change in tons imported might not change significantly; however, where the coal is sourced might change, which might have a significant impact on the emissions associated with shipping. Table 80 shows the ton-nautical miles for coal shipped to each country for the No-Action Alternative.

Table 80. 2015 Energy Policy Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	178,116	289,700	178,803	215,578
Australia	0	0	0	0	0	0	0
China	179,881	386,461	386,461	386,461	463,753	541,045	472,341
Hong Kong	27,007	27,278	27,552	28,247	28,961	30,140	29,221
India	117,868	32,724	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	323,825	338,842	355,221	347,855	316,547	437,700	372,359
South Korea	111,406	102,324	108,897	160,162	170,306	170,514	167,569
Taiwan	93,465	158,886	102,169	192,467	194,885	246,318	214,215
Total Pacific Basin Coal sent via ship	858,252	1,078,804	1,087,169	1,293,308	1,464,151	1,604,519	1,471,282

Under the Proposed Action, coal would be exported through the terminal to destinations in the Pacific Basin. Table 81 shows that the coal exported from the terminal would be distributed by the model to Japan, because this is the closest destination, and thus, allows for the greatest reduction in system costs when the model calculates a solution.

Table 81. 2015 Energy Policy Scenario Distribution of Coal Exported through the Proposed Coal Export Terminal—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040
China	0	0	0	0	0	0
Hong Kong	0	0	0	0	0	0
Japan	0	0	0	44.0	44.0	44.0
South Korea	0	0	0	0	0	0
Taiwan	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship through the Terminal	0	0	0	44.0	44.0	44.0

Under the Proposed Action, a similar number of tons would be distributed in the seaborne coal market as it would under the No-Action Alternative (Table 82). The distance weighted coal distribution in the Pacific Basin is presented in Table 83 for the Proposed Action.

Table 82. 2015 Energy Policy Scenario Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	75	82	94	108	121	143	126
Australia	0	0	0	0	0	0	0
China	106	227	227	227	272	318	277
Hong Kong	14	14	14	15	15	16	15
India	38	11	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	124	125	132	130	126	115	123
South Korea	42	39	42	61	65	63	63
Taiwan	63	65	68	73	74	76	75
Total Pacific Basin Coal sent via ship	461	563	576	613	673	729	678

Table 83. 2015 Energy Policy Scenario Distance Weighted Seaborne Coal Imports in Pacific Basin—Proposed Action (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Avg.
Asia - Other	4,798	32,290	106,870	178,116	213,186	178,803	190,073
Australia	0	0	0	0	0	0	0
China	179,881	386,461	386,461	386,461	463,753	541,045	472,341
Hong Kong	27,007	27,278	27,552	28,282	28,995	30,174	29,256
India	117,868	32,724	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	323,825	338,842	355,221	408,241	398,770	457,402	424,202
South Korea	111,406	102,324	108,897	160,393	170,537	163,982	165,170
Taiwan	93,465	158,886	102,169	192,592	195,010	246,693	214,437
Total Pacific Basin Coal sent via ship	858,252	1,078,804	1,087,169	1,354,085	1,470,251	1,618,100	1,495,480

As seen in Table 84, which shows the estimated change in tons of coal imported by each of the regions, the changes in coal imports between the No-Action Alternative and the Proposed Action would mirror the changes in consumption, except for China. The change in consumption in China would be due to changes in the mix of coal; however, the same total tons of coal would be imported into China and the change in the tons consumed would be met with coal supplies from within China.

Table 84. 2015 Energy Policy Scenario Change in Seaborne Coal Imports in Pacific Basin—Proposed Action minus No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	-4.8	0	-1.6
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	0	0	0	0
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	0.8	1.1	-1.6	-0.03
South Korea	0	0	0	0.1	0.1	-0.1	0.01
Taiwan	0	0	0	0.1	0.1	0.1	0.1
Total Pacific Basin Coal sent via ship	0	0	0	1.0	-3.6	-1.6	-1.5

The changes in the total tons of coal imported to each region would be magnified or diminished depending on how the sources of the coal shift. There would be some relatively large changes in the ton-mile values, as shown in Table 85. For example, in Japan in 2030, coal imports would increase by 0.9% while the ton-miles would increase by 26.0%

Table 85. 2015 Energy Policy Scenario Change in Distance Weighted Seaborne Coal Imports in Pacific Basin—Proposed Action minus No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	Annual Average
Asia - Other	0	0	0	0	-76,513	0	-25,504
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	35	35	35	35
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	60,386	82,223	19,702	51,843
South Korea	0	0	0	231	231	-6,532	-2,399
Taiwan	0	0	0	125	125	376	223
Total Pacific Basin Coal sent via ship	0	0	0	60,777	6,101	13,581	24,198

6.5.4 CO_2 Emissions

This section presents the CO_2 estimated emissions from coal combusted in the United States and the Pacific Basin in the 2015 Energy Policy Scenario. In addition, CO_2 emissions from natural gas consumption in the United States are included because decreases in coal consumption may be offset by increases in natural gas consumption.

Table 86 presents the CO_2 emissions under the No-Action Alternative. Total U.S. CO_2 emissions from coal would decline gradually through 2030, before increasing slightly in 2040, and would average 1,138 million metric tons per year between 2025 and 2040. Coal emissions would increase post 2030, as greater renewable energy resource implementation in 2040 would allow for more coal consumption without exceeding the Clean Power Plan emissions rate limits, which remain flat after 2030. This increase in coal consumption post 2030, was identified in EPA's own modeling of the Clean Power Plan in its Rate Based case results. Pacific Basin CO_2 emissions would average 10,056 million metric tons per year between 2025 and 2040, which would be 8.8 times the total coal CO_2 emissions from the U.S. Natural gas CO_2 emissions average 591 million metric tons per year, or about one-half of coal CO_2 emissions. Between 2030 and 2040, CO_2 emissions from natural gas would increase by 172 million metric tons. This increase would be due to nuclear units retiring in this period and natural gas-fired generation replacing the retired nuclear generation.

Table 87 presents the CO_2 emission sunder the Proposed Action. Total CO_2 emissions under the Proposed Action would follow the same trends as under the No-Action Alternative, and would be within 0.5% of the coal CO_2 emissions under the No-Action Alternative.

Table 86. 2015 Energy Policy Scenario CO_2 Emissions—No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	195,403	218,834	273,997	233,778
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	6,562,991	6,735,018	6,906,016	7,035,199	7,139,055	6,848,958	6,997,391
Hong Kong	32,192	32,514	32,840	33,670	34,520	35,925	34,830
India	1,134,742	1,161,652	1,189,727	1,264,655	1,340,727	1,475,993	1,372,199
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	303,669	303,749	303,901	297,112	288,383	256,423	278,379
South Korea	191,810	186,871	183,147	170,235	160,070	155,197	160,999
Taiwan	155,281	156,058	158,029	159,136	161,135	166,121	162,519
Pacific Basin - Coal	9,050,038	9,302,578	9,551,496	9,837,301	10,110,439	10,165,947	10,056,154
U.S. - Coal	1,500,666	1,455,861	1,142,218	1,134,297	1,113,549	1,161,957	1,138,138
U.S. - Natural Gas	464,255	466,711	548,527	524,814	523,079	695,232	590,509

Table 87. 2015 Energy Policy Scenario CO_2 Emissions—Proposed Action (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	195,403	219,837	273,997	234,112
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	6,562,991	6,735,018	6,906,016	7,036,660	7,139,055	6,848,958	6,997,797
Hong Kong	32,192	32,514	32,840	33,714	34,564	35,969	34,875
India	1,134,742	1,161,652	1,189,727	1,264,655	1,340,727	1,475,993	1,372,199
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	303,669	303,749	303,901	297,493	288,764	255,937	278,423
South Korea	191,810	186,871	183,147	170,455	160,289	155,417	161,218
Taiwan	155,281	156,058	158,029	159,344	161,343	166,329	162,727
Pacific Basin - Coal	9,050,038	9,302,578	9,551,496	9,839,616	10,112,295	10,165,933	10,057,410
U.S. - Coal	1,498,671	1,453,918	1,141,076	1,133,145	1,113,873	1,162,272	1,138,048
U.S.- Natural Gas	464,842	467,245	549,124	525,365	522,996	695,057	590,567

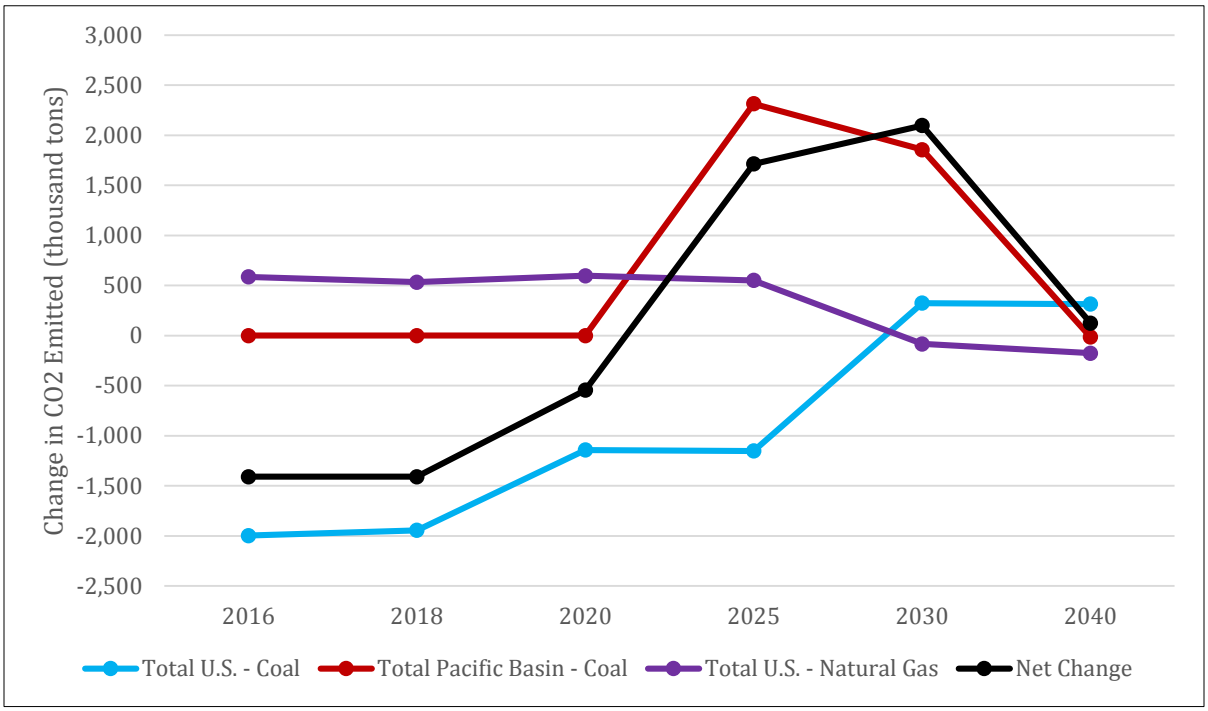
Table 88 shows the estimated change in CO_2 emissions for each region, as well as the total net change across all regions. Total Pacific Basin CO_2 emissions from coal consumption would range from a decrease of 14 thousand metric tons to an increase of 2,315 thousand metric tons starting in 2025, due to shifts in the type of coal consumed, where the different coal types have different CO_2 emissions rates, and the induced demand of about 0.45 million metric tons of coal. In contrast, U.S. coal CO_2 emissions would decrease in every year, except for 2030 and 2040. In these years, the higher penetration of renewable energy resources would make room for more coal consumption, while still meeting the emissions rate targets under the Clean Power Plan. The decrease in coal consumption through 2025 would be offset by an increase in natural gas consumption, as is seen by the increase in CO_2 emissions from natural gas, which would average 57 thousand metric tons per year between 2025 and 2040. The total net change in CO_2 emissions would be an increase of an average of 1,224 thousand metric tons per year between 2025 and 2040.

Table 88. 2015 Energy Policy Scenario Changes in CO_2 Emissions—Proposed Action minus No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	0	0	0	0	1,003	0	334
Australia	0	0	0	0	0	0	0
China	0	0	0	1,461	0	0	406
Hong Kong	0	0	0	45	45	45	45
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	381	381	-486	44
South Korea	0	0	0	219	219	219	219
Taiwan	0	0	0	208	208	208	208
Pacific Basin - Coal	0	0	0	2,315	1,857	-14	1,256
U.S. - Coal	-1,996	-1,943	-1,141	-1,152	324	315	-89
U.S. - Natural Gas	587	534	597	551	-83	-175	57
Total Change	-1,409	-1,409	-544	1,714	2,098	126	1,224

In the 2015 Energy Policy Scenario the change in coal combustion emissions between the No-Action Alternative and the Proposed Action in the Pacific Basin would decline between 2025 and 2040. The changes in Pacific Basin CO_2 emissions would be due to changes in the mix of coal consumed and the differing CO_2 emissions rates of the different coal types. Emissions of CO_2 from coal combustion in the United States would decline through 2030, and then increase slightly as greater renewable energy resource implementation in 2030 would allow for more coal consumption without exceeding the Clean Power Plan emissions rate limits. This increase in coal consumption post 2030 was identified in EPA's own modeling of the Clean Power Plan in its Rate Based case results. The change in U.S. CO_2 emissions from natural gas are estimated to remain relatively flat over the 2016 to 2025 period and then decline as coal consumption increases. Figure 33 shows the net change in CO_2 emissions between the No-Action Alternative and Proposed Action. In the long term, the increase in Pacific Basin coal emissions would drive the net change to be a net increase in CO_2 emissions under the Proposed Action.

Figure 33. 2015 Energy Policy Scenario Changes in CO_2 Emissions by Region—Proposed Action minus No-Action Alternative



[a] Total U.S. CO_2 emissions from the combustion of coal decrease through 2025 because the proposed coal export terminal would be a new demand sink for U.S. coal, and thus, would cause coal prices to rise and U.S. coal consumption to decrease in response to the higher prices. In 2030 and 2040, U.S. coal combustion emissions of CO_2 would increase as greater renewable energy generation would allow for increased coal consumption without exceeding the emissions rates under the Clean Power Plan.

[b] Pacific Basin CO_2 emissions from the combustion of coal would increase due to a larger quantity of lower heat content coal being consumed and due to induced demand from the lower delivered coal prices when the terminal comes online in 2025.

[c] Total U.S. natural gas combustion CO2 emissions would increase and then decrease in response to the changes in coal consumption.

6.6 Cumulative Scenario

The Cumulative Scenario is the same as the Past Conditions (2014) Scenario, except that all of the proposed export terminals in the Pacific Northwest would be constructed and online by 2030, and operating at full capacity. This section presents the modeling results for the Cumulative Scenario No-Action Alternative and Proposed Action for coal production, consumption, distribution, and CO_2 emissions. Note that the Cumulative Scenario No-Action Alternative is the same as the Past Conditions (2014) Scenario No-Action Alternative.

6.6.1 Coal Production

Under the No-Action Alternative U.S. thermal coal production would average 791 million metric tons per year for the 2025 to 2040 period. Over the 2016 to 2040 period, non-U.S. coal production would grow at an average annual rate of 1.57% per year from 6.4 to 9.4 billion metric tons. Powder River Basin coal production under the No-Action Alternative would average 337 million metric tons per year over 2016 to 2040, with production remaining relatively flat. Uinta Basin coal production

under the No-Action Alternative would average 15.6 million metric tons per year, with production gradually declining over the 2016 to 2040 period.

Table 89 shows the No-Action Alternative coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 89. Cumulative Scenario Coal Production—No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,448	6,786	7,048	7,805	8,463	9,373	8,634
Total U.S. Thermal Coal	799	838	785	797	788	789	791
Powder River Basin Coal	334	366	329	336	331	344	337
Uinta Basin Coal	18.8	18.4	17.1	16.5	16.3	14.3	15.6

Under the Proposed Action, U.S. thermal coal production would average 859 million metric tons per year for the 2025 to 2040 period. U.S. coal production would have an upward trend as production increases to meet the increased exports. Non-U.S. coal production would have a slightly lower annual growth rate of 1.54% under the Proposed Action than the No-Action Alternative, because some of the exported coal displaces some international coal production. Powder River Basin coal production under the Proposed Action would average 390 million metric tons per year with production generally increasing over time. Uinta Basin coal production would average 19.0 million metric tons per year, with production declining through 2025 and then increasing as Uinta Basin coal is exported in larger quantities. Table 90 shows the Proposed Action coal production values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 90. Cumulative Scenario Coal Production—Proposed Action (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	6,449	6,786	7,047	7,769	8,415	9,303	8,581
Total U.S. Thermal Coal	790	828	773	830	872	870	859
Powder River Basin Coal	319	351	311	361	407	396	390
Uinta Basin Coal	18.2	17.5	14.9	12.9	14.2	27.4	19.0

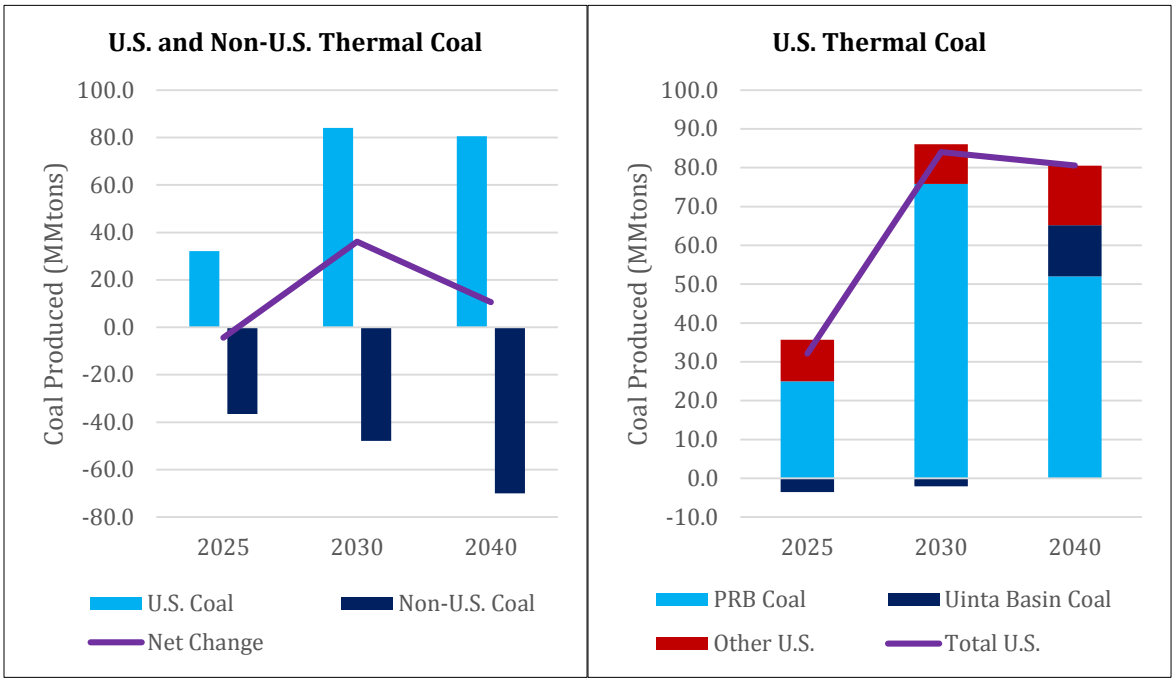
Table 91 shows the estimated change in coal production between the Proposed Action and the No-Action Alternative by model run year. Since IPM® is forward–looking and solves all years simultaneously, the model shows that there would be changes to production under the Proposed Action before the terminal is modeled to come online in 2025. The changes in coal production prior to 2025 reflect the model optimizing the overall solution based on what it calculates will be happening in the future. Once the terminal is online and exporting coal, total average modeled U.S. coal production would be higher under the Proposed Action by 68.2 million metric tons per year, primarily due to increases in Powder River Basin and the Uinta Basin coal production.

Table 91. Cumulative Scenario Change in Coal Production—Proposed Action minus No-Action Alternative (million metric tons)

Producing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Total Non-U.S. Thermal Coal	0.1	0.0	-0.6	-36.5	-47.9	-69.9	-53.3
Total U.S. Thermal Coal	-8.7	-10.3	-11.7	32.1	84.0	80.6	68.2
Powder River Basin Coal	-15.2	-15.1	-17.7	25.0	75.8	52.0	52.4
Uinta Basin Coal	-0.7	-0.9	-2.2	-3.6	-2.0	13.1	3.4

Figure 34 shows that total non-U.S. thermal coal production would decrease as U.S. coal production increases under the Proposed Action. This indicates that U.S. thermal coal exports would take the place of some internationally produced coal, instead of just adding to overall global coal demand.

Figure 34. Cumulative Scenario Change in Coal Production—Proposed Action minus No-Action Alternative



6.6.2 Coal Consumption

Under the No-Action Alternative U.S. thermal coal consumption would average 785 million metric tons per year for the 2025 to 2040 period. U.S. coal consumption would be fairly flat between 2020 and 2040, as electric demand growth would be primarily met with natural gas and renewable generation. Over the 2016 to 2040 period, Pacific Basin coal consumption would grow at an average rate of 1.89% per year from 4.95 to 7.77 billion metric tons. The growth in consumption would be driven primarily by increasing coal consumption in China and India. Table 92 shows the No-Action Alternative coal consumption values for each model run year.

China is responsible for the largest share of global thermal coal consumption, burning 3,550 million metric tons of coal in 2016. This amount is projected to grow in the Cumulative Scenario No-Action

Alternative to 5,431 million metric tons by 2040. Total U.S. coal consumption would remain relatively stable, hovering in the high 700 to low 800 million metric tons.

Table 92. Cumulative Scenario Coal Consumption—No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	75	82	94	104	119	165	133
Australia	158	168	176	193	212	253	223
China	3,550	3,802	3,975	4,548	5,013	5,431	5,047
Hong Kong	14	14	14	15	15	17	16
India	691	732	783	900	1,010	1,249	1,072
Indonesia	165	181	195	228	264	357	290
Japan	139	133	132	131	128	128	129
South Korea	90	88	87	83	74	82	80
Taiwan	68	72	69	71	81	85	79
Total Pacific Basin Coal Consumption	4,950	5,272	5,526	6,273	6,916	7,767	7,068
Total U.S. Coal Consumption	792	826	772	787	777	790	785

Coal consumption under the Proposed Action would follow similar patterns as the No-Action Alternative, although the U.S. thermal coal consumption, averaging 768 million metric tons per year for the 2025 to 2040 period, would average 17 million metric tons less due to lower demand in the U.S. Coal demand in the U.S. would be lower under the Proposed Action Alternative due to Powder River Basin coal prices that are on average 16.6% higher due to the greater export demand for this coal. As under the No-Action Alternative, U.S. coal consumption would be fairly flat between 2020 and 2040, as electric demand growth would be primarily met with natural gas and renewable generation.

Over the 2016 to 2040 period, Pacific Basin coal consumption would follow the same pattern as it grows from 4.95 to 7.80 billion metric tons. However, under the Proposed Action there would be a 0.44% increase in demand in 2025 and a 3.8% increase in demand in 2030 that would be induced due to lower delivered coal prices from the terminal and the other proposed terminals that are modeled to come online in 2030.

Table 93 shows the Proposed Action coal consumption values for each model run year. The average values in the last column of the table were derived by weighting the modeled values based on the number of calendar years mapped to each model run year.

Table 93. Cumulative Scenario Coal Consumption—Proposed Action (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	75	82	94	104	116	160	130
Australia	158	168	176	193	212	253	223
China	3,550	3,802	3,975	4,553	5,018	5,431	5,050
Hong Kong	14	14	14	15	15	16	15
India	691	732	783	900	1,058	1,297	1,107
Indonesia	165	181	195	228	264	357	290
Japan	139	133	132	132	131	128	130
South Korea	90	88	87	83	77	79	80
Taiwan	68	72	69	71	76	82	77
Total Pacific Basin Coal Consumption	4,950	5,272	5,526	6,280	6,968	7,804	7,102
Total U.S. Coal Consumption	784	815	759	775	762	770	768

Table 94 shows the estimated change in coal consumption between the Proposed Action and the No-Action Alternative by model run year to be zero, or near zero, in the Pacific Basin before 2025 when the terminal was assumed to come online. Once the terminal is online and exporting coal, total Pacific Basin coal consumption would be higher with an average change of 34.1 million metric tons per year between 2025 and 2040, while U.S. coal consumption would decrease by an average of 16.3 million metric tons per year under the Proposed Action. The increase in Pacific Basin demand is due to the induced demand from the lower-priced coal being exported through the terminal.

In the Pacific Basin, coal consumption would be higher on average by 34.1 million metric tons per year between 2025 and 2040, with China and India having the largest increases. India's consumption would increase because of induced demand from the lower coal prices when the other proposed terminals come online in 2030. The changes in Chinese consumption would be due to changes in the mix of coal consumed and the differences in heat content of the coal being consumed. Under the Proposed Action, a larger quantity of lower heat content coal would be consumed than under the No-Action Alternative, making it appear that total coal consumption would increase, while the total heating value of the China coal demand does not change between the alternatives.

Table 94. Cumulative Scenario Change in Coal Consumption—Proposed Action minus No-Action Alternative (million metric tons)

Consuming Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	-2.2	-4.3	-2.4
Australia	0	0	0	0	0	0	0
China	0	0	0.3	5.3	4.7	0	3.0
Hong Kong	0	0	0	0.1	0.1	-0.9	-0.3
India	0	0	0	0	48.2	48.2	34.8
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	1.3	3.3	0.2	1.5
South Korea	0	0	0	0.5	2.9	-3.2	-0.1
Taiwan	0	0	0	0.3	-4.2	-2.9	-2.4
Total Pacific Basin Coal Consumption	0	0	0.3	7.4	52.8	37.2	34.1
Total U.S. Coal Consumption	-8.7	-10.3	-12.7	-11.8	-15.8	-19.8	-16.3

6.6.3 Coal Distribution

As with the Past Conditions (2014) Scenario, distribution patterns for Powder River Basin and Uinta Basin coal are expected to remain largely unchanged under the Proposed Action in the Cumulative Scenario. Thus, this section focuses on the distribution of coal in the Pacific Basin and how that distribution would be expected to change with the construction of the terminal. Under the No-Action Alternative, there would be no coal exported through the terminal; however, there would be 615 million metric tons of coal distributed in the Pacific Basin by ship in the seaborne coal market in 2016. Table 95 shows the tons of coal that would be imported by each country in the Pacific Basin under the No-Action Alternative. By 2040, a total of 1,194 million metric tons of coal are expected to be distributed in the seaborne coal market in the Pacific Basin.

Table 95. Cumulative Scenario Seaborne Coal Distribution in Pacific Basin—No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	119	165	133
Australia	0	0	0	0	0	0	0
China	227	227	227	318	318	726	476
Hong Kong	14	14	14	15	15	17	16
India	44	24	12	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	139	133	132	131	128	128	129
South Korea	49	46	43	66	67	74	69
Taiwan	68	72	69	71	81	85	79
Total Pacific Basin Coal sent via ship	615	598	591	704	726	1,194	902

To understand how coal distribution is changing in more detail than the tons of coal imported by each country, ICF multiplied the tons of coal shipped to each country by the distance in nautical miles that the coal is shipped. The change in tons imported might not change significantly; however, where the coal is sourced might change, which might have a significant impact on the emissions associated with shipping. Table 96 shows the ton-nautical miles for coal shipped to each country for the No-Action Alternative.

Table 96. Cumulative Scenario Distance Weighted Seaborne Coal Distribution in Pacific Basin—No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	4,798	32,290	106,870	123,074	176,042	532,288	299,869
Australia	0	0	0	0	0	0	0
China	386,461	386,461	386,461	541,045	541,045	1,236,674	811,567
Hong Kong	27,007	27,278	27,552	28,247	28,961	65,231	42,868
India	135,789	73,478	38,193	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	535,267	378,469	355,049	352,952	345,299	568,913	434,385
South Korea	128,027	120,235	112,984	173,889	123,473	371,891	234,084
Taiwan	267,987	234,316	103,192	105,797	342,100	359,595	283,264
Total Pacific Basin Coal sent via ship	1,485,335	1,252,527	1,130,299	1,325,005	1,556,918	3,134,591	2,106,037

Under the Proposed Action, coal would be exported through the terminal to destinations in the Pacific Basin. Table 97 shows that the coal exported from the terminal would be distributed by the model to Japan, South Korea, and China.

Table 97. Cumulative Scenario Distribution of Coal Exported through the Proposed Coal Export Terminal—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040
China	0	0	0	0	11.3	0
Hong Kong	0	0	0	0	0	0
Japan	0	0	0	33.6	6.5	19.3
South Korea	0	0	0	10.4	26.2	24.7
Taiwan	0	0	0	0	0	0
Total Pacific Basin Coal sent via ship through MBTL	0	0	0	44.0	44.0	44.0

Under the Proposed Action, a similar number of tons would be distributed in the seaborne coal market as it would under the No-Action Alternative, as seen in Table 98. The distance weighted coal distribution in the Pacific Basin is presented in Table 99 for the Proposed Action.

Table 98. Cumulative Scenario Seaborne Coal Distribution in Pacific Basin—Proposed Action (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	75	82	94	104	116	160	130
Australia	0	0	0	0	0	0	0
China	227	227	227	318	318	726	476
Hong Kong	14	14	14	15	15	16	15
India	44	24	12	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	139	133	132	132	131	128	130
South Korea	49	46	43	67	70	71	69
Taiwan	68	72	69	71	76	82	77
Total Pacific Basin Coal sent via ship	615	598	591	706	726	1,183	898

Table 99. Cumulative Scenario Distance Weighted Seaborne Coal Distribution in Pacific Basin—Proposed Action (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	4,798	32,290	106,870	123,074	140,747	463,478	261,344
Australia	0	0	0	0	0	0	0
China	386,461	386,461	386,461	541,045	582,144	1,236,674	825,267
Hong Kong	27,007	27,278	27,552	28,366	29,176	48,439	36,442
India	135,789	73,478	38,193	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	535,267	378,469	357,047	419,513	419,980	559,682	474,179
South Korea	128,027	120,235	112,984	195,053	232,175	335,929	262,212
Taiwan	267,987	234,316	103,192	106,233	322,604	370,504	281,129
Total Pacific Basin Coal sent via ship	1,485,335	1,252,527	1,132,297	1,413,283	1,726,826	3,014,706	2,140,573

As seen in Table 100, which shows the estimated change in tons of coal imported by each of the regions, the changes in coal imports between the No-Action Alternative and the Proposed Action would mirror the changes in consumption, except for China and India. This indicates that the changes in consumption for China and India would be due to shifts in the coal types consumed or that domestic production in these countries would increase to meet the higher demand.

Table 100. Cumulative Scenario Change in Seaborne Coal Distribution in Pacific Basin—Proposed Action minus No-Action Alternative (million metric tons)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia – Other	0	0	0	0	-2.2	-4.3	-2.4
Australia	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0
Hong Kong	0	0	0	0.1	0.1	-0.9	-0.3
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	1.3	3.3	0.2	1.5
South Korea	0	0	0	0.5	2.9	-3.2	-0.1
Taiwan	0	0	0	0.3	-4.2	-2.9	-2.4
Total Pacific Basin Coal sent via ship	0	0	0	2.1	-0.1	-11.0	-3.7

The changes in the total tons of coal imported to each region would be magnified or diminished depending on how the sources of the coal shift, and there would be some relatively large changes in the ton-mile values, as shown in Table 101. For example, in Japan in 2025, coal imports would increase by 1.0% while the ton-miles would increase by 18.9%.

Table 101. Cumulative Scenario Change in Distance Weighted Seaborne Coal Distribution in Pacific Basin—Proposed Action minus No-Action Alternative (million metric ton-nautical miles)

Importing Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	0	0	0	0	-35,294	-68,810	-38,524
Australia	0	0	0	0	0	0	0
China	0	0	0	0	41,099	0	13,700
Hong Kong	0	0	0	118	215	-16,792	-6,426
India	0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	0	0
Japan	0	0	1,998	66,561	74,681	-9,230	39,793
South Korea	0	0	0	21,164	108,702	-35,962	28,128
Taiwan	0	0	0	435	-19,495	10,909	-2,135
Total Pacific Basin Coal sent via ship	0	0	1,998	88,278	169,908	-119,885	34,536

6.6.4 CO_2 Emissions

This section presents the CO_2 estimated emissions from coal combusted in the United States and the Pacific Basin in the Cumulative Scenario. In addition, CO_2 emissions from natural gas consumption in the United States are included because decreases in coal consumption may be offset by increases in natural gas consumption. Table 118 presents the CO_2 emissions under the No-Action Alternative. Total U.S. CO_2 emissions from coal would be relatively flat and average 1,505 million metric tons per

year over 2025 to 2040. Pacific Basin CO_2 emissions would average 13,407 million metric tons per year between 2025 and 2040, which would be 8.9 times the total coal CO_2 emissions from the U.S. Natural gas CO_2 emissions average 470 million metric tons per year, or about one-third of U.S. coal CO_2 emissions. Between 2030 and 2040, CO_2 emissions from natural gas would increase by 184 million metric tons. This increase would be due to nuclear units retiring in this period and natural gas-fired generation replacing the retired nuclear generation.

Table 103 presents the CO_2 emissions under the Proposed Action. Total CO_2 emissions under the Proposed Action for this scenario would follow the same trends as the No-Action Alternative, and would be within 5.1% of the coal CO_2 emissions under the No-Action Alternative. The higher emissions in this scenario are due to the higher induced demand compared to the other scenarios.

Table 102. Cumulative Scenario CO_2 Emissions—No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	196,125	220,325	269,361	232,672
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	7,260,862	7,757,297	8,092,857	9,192,572	10,001,116	10,625,911	10,019,496
Hong Kong	32,192	32,514	32,840	33,670	34,520	36,086	34,893
India	1,136,069	1,182,859	1,257,877	1,430,059	1,592,500	1,923,614	1,676,144
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	305,620	304,862	305,584	301,809	294,803	273,014	288,276
South Korea	193,262	189,802	186,751	182,342	167,305	163,906	170,160
Taiwan	155,582	158,027	159,611	163,642	166,852	175,385	169,279
Pacific Basin - Coal	9,752,941	10,352,077	10,813,357	12,182,110	13,245,137	14,420,611	13,406,980
U.S. - Coal	1,538,695	1,606,196	1,490,678	1,515,506	1,495,512	1,506,365	1,505,286
U.S. - Natural Gas	449,418	417,456	421,240	392,499	400,710	585,198	470,174

Table 103. Cumulative Scenario CO_2 Emissions—Proposed Action (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	147,182	160,511	173,771	196,125	220,787	270,264	233,177
Australia	246,894	267,557	285,312	321,771	361,963	448,680	384,522
China	7,260,862	7,757,297	8,092,909	9,193,571	10,001,957	10,625,911	10,020,054
Hong Kong	32,192	32,514	32,840	33,821	34,795	36,561	35,211
India	1,136,069	1,182,859	1,257,877	1,430,059	1,673,183	2,004,297	1,734,415
Indonesia	275,278	298,648	318,752	360,120	405,754	504,652	431,538
Japan	305,620	304,862	305,584	303,128	298,168	273,798	290,069
South Korea	193,262	189,802	186,751	183,141	169,616	166,198	172,043
Taiwan	155,582	158,027	159,611	164,365	168,770	177,170	170,813
Pacific Basin - Coal	9,752,941	10,352,077	10,813,408	12,186,102	13,334,994	14,507,532	13,471,844
U.S. - Coal	1,525,873	1,590,003	1,469,797	1,493,962	1,464,483	1,468,715	1,474,318
U.S. - Natural Gas	453,457	423,086	427,952	399,133	411,164	595,999	479,702

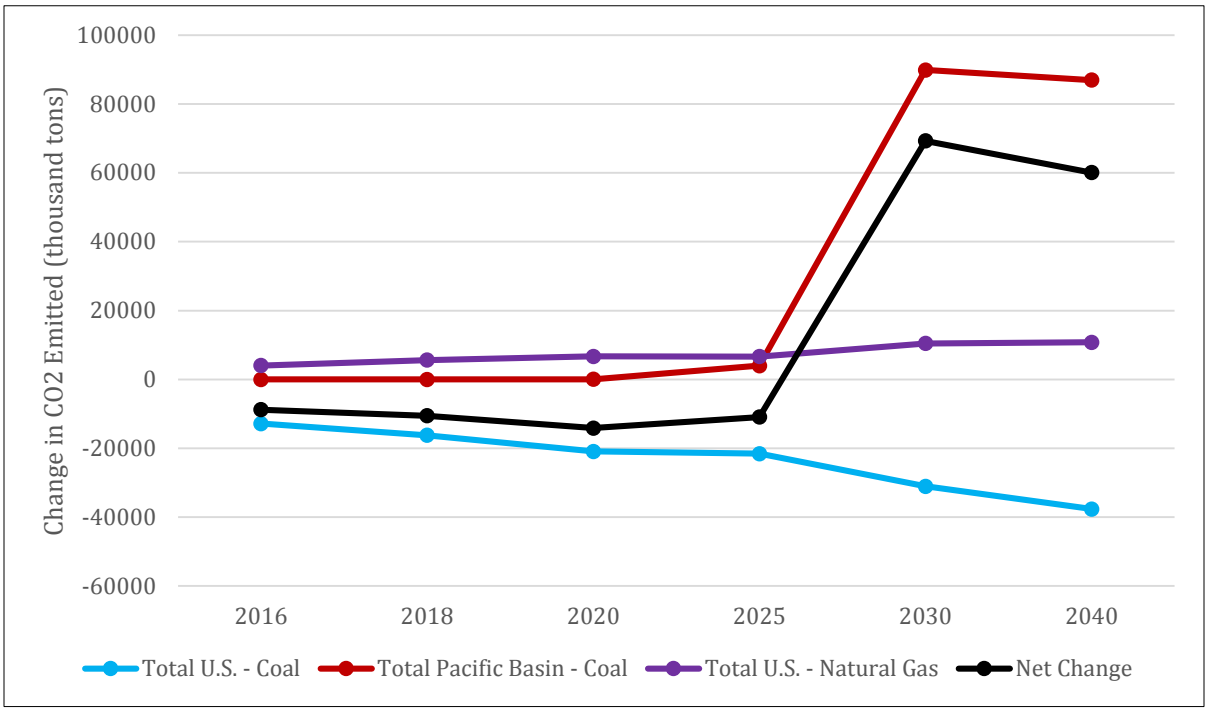
Table 104 shows the estimated change in CO_2 emissions for each region, as well as the total net change across all regions. Total Pacific Basin CO_2 emissions from coal consumption would increase between 3,992 and 89,857 thousand metric tons starting in 2025 due to induced demand from the reduction in delivered coal prices under the Proposed Action, and because of shifts in the type of coal consumed. In contrast, U.S. coal CO_2 emissions would decrease in every year due to higher coal prices that depress domestic coal demand. The higher coal prices result from the fact that an additional 44 million metric tons of coal is mined and exported starting in 2025, and another 56 million metric tons of coal is mined and exported starting in 2030 under the Proposed Action, which shifts the demand curve up and yields higher coal prices in the United States. The decrease in coal consumption is offset by an increase in natural gas consumption, as is seen by the increase in CO_2 emissions from natural gas, which would average 9,528 thousand metric tons per year over 2025 to 2040. The total net change in CO_2 emissions would be an increaseof an average of 43,423 thousand metric tons per year over 2025 to 2040.

Table 104. Cumulative Scenario Changes in CO_2 Emissions—Proposed Action minus No-Action Alternative (thousand metric tons)

Region	2016	2018	2020	2025	2030	2040	2025–2040 Average
Asia - Other	0	0	0	0	463	902	505
Australia	0	0	0	0	0	0	0
China	0	0	51	1,000	841	0	558
Hong Kong	0	0	0	151	276	475	319
India	0	0	0	0	80,683	80,683	58,271
Indonesia	0	0	0	0	0	0	0
Japan	0	0	0	1,318	3,366	784	1,793
South Korea	0	0	0	799	2,311	2,292	1,883
Taiwan	0	0	0	724	1,918	1,785	1,535
Pacific Basin - Coal	0	0	51	3,992	89,857	86,921	64,864
U.S. - Coal	-12,822	-16,193	-20,880	-21,543	-31,028	-37,651	-30,969
U.S. - Natural Gas	4,039	5,630	6,712	6,634	10,454	10,801	9,528
Net Change	-8,783	-10,563	-14,117	-10,918	69,283	60,072	43,423

In the Cumulative Scenario, the change in coal combustion emissions between the No-Action Alternative and the Proposed Action in the Pacific Basin would grow over time, while the change in U.S. emissions would generally decline. U.S. CO_2 emissions from natural gas are estimated to increase over the 2016 to 2040 period. Figure 35 shows the net change in CO_2 emissions between the No-Action Alternative and Proposed Action. In the long term, the increase in Pacific Basin coal emissions would drive the net change to be a net increase in CO_2 emissions under the Proposed Action.

Figure 35. Cumulative Scenario Changes in CO_2 Emissions by Region—Proposed Action minus No-Action Alternative



[a] Total U.S. CO_2 emissions from the combustion of coal would decrease because the proposed coal export terminal would be a new demand sink for U.S. coal, and thus, would cause coal prices to rise and U.S. coal consumption to decrease in response to the higher prices.

[b] Pacific Basin CO_2 emissions from the combustion of coal would increase due to a larger quantity of lower heat content coal being consumed and due to induced demand from the lower delivered coal prices when the terminal comes online in 2025.

[c] Total U.S. natural gas combustion CO_2 emissions would increase because when coal consumption for electric generation declines, natural gas usage for electric generation increases to fill the gap.

Chapter 7
Conclusions

This analysis examined the coal production, consumption, distribution, and CO_2 emissions associated with the operation of the terminal under five scenarios. The results of the analysis show that the operation of the terminal would likely cause changes in the production, consumption, and distribution of coal in the United States and the Pacific Basin. These changes would cause a change in CO_2 emissions as well, with the net average annual emissions ranging from a decrease of 2.551 and 2.259 million metric tons CO_2 in the in the Past Conditions (2014) and Lower Bound Scenarios to an increase of 29.792 and 43.423 million metric tons CO_2 in the Upper Bound and Cumulative Scenarios, when averaged over 2025 to 2040.

7.1 Summary of Key Results

The Co-Lead Agencies defined the study area for the coal market analysis as the United States and the Pacific Basin coal markets. Within the United States, results for the CO_2 emissions from the combustion of coal and natural gas are the primary results from this analysis that are used in the GHG analysis report. Additionally, the GHG analysis uses the change in the distribution of coal in the Pacific Basin to estimate the CO_2 emissions from the change in the transportation of coal.

7.1.1 Coal Production

This analysis shows that coal production in the United States would increase in all five scenarios under the Proposed Action as the export of coal through the terminal would cause additional coal to be mined in the United States, beyond that which is produced for domestic consumption under the No-Action Alternative. If production did not increase under each scenario, it would imply either that there is a decrease in the consumption of Powder River Basin and Uinta Basin coal in the United States, or that exports of other coal are decreasing. The results also show that coal production in the Pacific Basin would decrease in all five scenarios, as the exported coal displaces some coal production from Pacific Basin coal producing countries.

The amount of increase in production varies by scenario and by year in each scenario. The Past Conditions (2014) Scenario has the lowest change in U.S. coal production at an average of 27.8 million metric tons, because the coal that was being exported through Canadian coal export terminals under the No-Action Alternative shifts to the terminal under the Proposed Action. Thus, the amount of U.S. coal being exported through Pacific Northwest ports does not increase by the full 44 million metric tons of the proposed coal export terminal's annual capacity. In the Lower Bound Scenario, there are no exports of Powder River Basin or Uinta Basin coal under the No-Action Alternative, thus, when the terminal comes online, U.S. coal production increases by an average of 42.1 million metric tons per year. There is a small decrease in U.S. consumption of these coals, which accounts for the increase not being the full 44 million metric tons.

In the Upper Bound Scenario, international demand for coal is higher than under the Past Conditions (2014) Scenario, and thus, the coal exported through the terminal helps meet that growing demand and results in 39.7 million metric tons of increased U.S. coal production. There are changes in both

domestic consumption of coal and exports of non-Powder River Basin coal, which keep the increase in production below the 44 million metric tons of export terminal capacity.

The 2015 Energy Policy Scenario is similar to the Past Conditions (2014) Scenario in that U.S. coal production increases, but not as much as the full terminal capacity, as coal exported from Canadian terminals under the No-Action Alternative is shifted to the terminal under the Proposed Action. Coal production in the United States increases an average 39.2 million metric tons per year under the 2015 Energy Policy Scenario. The increase is higher than under the Past Conditions (2014) Scenario because there is a larger change in production in 2030 and later.

Finally, the Cumulative Scenario has an average annual increase in U.S. coal production of 68.2 million metric tons. In this scenario Powder River Basin coal demand in the United States declines by 28.5 million metric tons in the long term as the higher export demand on Powder River Basin coal increases the prices, which in turn, suppresses domestic demand for Powder River Basin coal.

7.1.2 Coal Consumption

This analysis shows that coal consumption in the United States would decrease in all five scenarios under the Proposed Action as the export of coal through the terminal would cause additional demand for U.S. coal, which causes coal prices to rise. In response to the higher coal prices, U.S. coal plants consume between 0.3 and 16.3 million metric tons per year less coal. If flatter coal supply curves were used in this analysis, then the decrease in U.S. coal consumption would be less. Similarly, if steeper coal supply curves were used in this analysis, then the decrease in U.S. coal consumption would be greater.

The results also show that coal consumption in the Pacific Basin would increase in all scenarios. The exported coal has a lower heat content than the coal that it displaces, and thus, more coal must be consumed to achieve the same electric power output. Another factor causing higher coal consumption in the Pacific Basin is induced demand from lower delivered coal prices in the Past Conditions (2014), Upper Bound, 2015 Energy Policy, and Cumulative Scenarios. In all but the Cumulative Scenario, the amount of induced demand is less than 15.0 million metric tons per year. In fact, in all but the Upper Bound and Cumulative Scenarios, the amount of induced demand is less than 1.5 million metric tons. One of the factors causing greater induced demand in the Upper Bound and Cumulative Scenarios is the change in prices in India caused by a change in exports of coal from India, which is caused by the export of coal from the terminal.

7.1.3 Coal Distribution

Coal distribution in the Pacific Basin changes when the terminal comes online in the model in 2025 because the coal exported through the terminal displaces coal from other sources. Primarily the exported coal displaces coal from Australia, China, and Indonesia. The change in coal distribution under the Proposed Action is less than 4.9 million metric tons in all years and under all scenarios, except for the Upper Bound Scenario. In the Upper Bound Scenario the change in coal distribution is less than 25.2 million metric tons in all years. The average annual change in coal distribution is 2.0 million metric tons across all five scenarios under the Proposed Action.

7.1.4 CO_2 Emissions from Coal Consumption

The CO_2 emissions from the combustion of coal follow the same pattern as the changes in consumption under the Proposed Action. Thus, in the United States, CO_2 emissions from coal would decrease, while CO_2 emissions from the Pacific Basin would increase. The Past Conditions (2014) Scenario would result in an average decrease in U.S. CO_2 emissions from the combustion of coal of 6.9 million metric tons under the Proposed Action. The largest changes would be in the Upper Bound and Cumulative Scenarios, where U.S. CO_2 emissions from the combustion of coal would decrease under the Proposed Action by 10.0 and 16.7 million metric tons, respectively. These two scenarios would have the largest changes in U.S. CO_2 emissions because they would have the largest increase in Powder River Basin coal prices, and thus, the largest response in the decrease of U.S. demand. The scenario with the smallest average decrease in U.S. CO_2 emissions from the combustion of coal would be the 2015 Energy Policy Scenario at 0.1 million metric tons per year. Table 105 shows the CO_2 emissions results by scenario and region of origin.

Table 105. Average Change in CO_2 Emissions by Scenario and Region—Proposed Action minus No-Action Alternative (million metric tons)

Scenario	Pacific Basin Coal	U.S. Coal	U.S. Natural Gas	Total
Past Conditions (2014)	2.554	-6.948	1.843	-2.551
Lower Bound	0.972	-4.041	0.809	-2.259
Upper Bound	37.590	-10.012	2.214	29.792
2015 Energy Policy	1.256	0.089	0.057	1.224
Cumulative	64.864	-30.969	9.528	43.423

The results show that the net change in average CO_2 emissions from the combustion of coal would be a net positive for the Upper Bound 2015 Energy Policy, and Cumulative Scenarios. The other two scenarios have a net decrease in the average CO_2 emissions from the combustion of coal.

This analysis also estimated the change in CO_2 emissions from the combustion of natural gas in the United States for use in electric power generation. When the emissions from the consumption of natural gas are included, the net change in CO_2 emissions under the Proposed Action shift higher, but none of the values change sign.

Chapter 8
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