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APPENDIX D

The Impact of Otter Creek Coal Development on the Montana Economy

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Acknowledgements

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0. Executive Summary

This is a study of the effects on the Montana economy of the development of Otter Creek coal in southeastern Montana. As described below, the Bureau of Business and Economic Research at The University of Montana, using a state-of-the-art policy analysis model and publicly available data describing the timing and type of investments involved, produced a detailed assessment of the ultimate impact of coal development and operations -- including the construction and operations of the railroad -- on employment, income, output, and population in the Montana economy.

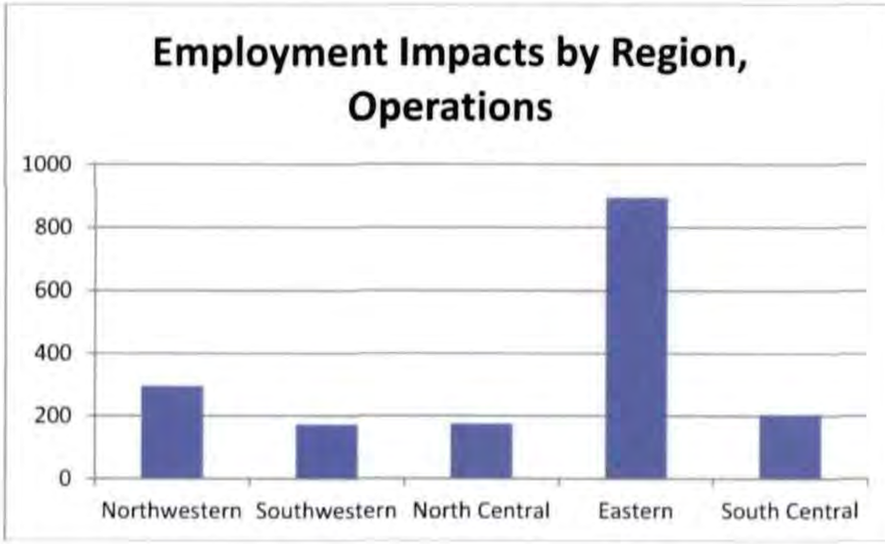
Impacts Summary

	Impacts by Phase	
Category	Construction	Operations
Total Employment	2,648 Jobs	1,740 Jobs
Private Sector	2,372 Jobs	1,338 Jobs
Personal Income	$103.5 million	$125.4 million
Disposable Personal Income	$87.7 million	$167.9 million
Population	1,025 people	2,843 people
State tax revenues	$23.5 million	$91.6 million

This study finds that with the Otter Creek coal development the state economy would be significantly larger, more prosperous, and more populous than would otherwise be the case. Specifically, we find that as a result of the development of the first of the three Otter Creek tracts, ultimately producing 20 million tons of coal, that:

- 2,648 jobs would be created during the peak year of the construction phase as the mine facilities and the railroad are built, with most new jobs created in eastern Montana;
- The impacts on income received by Montana households would be similarly substantial, with $103.5 million of new personal income and $87.7 million in after-tax income occuring during the peak construction year statewide. In eastern Montana, total household earnings would increase more than 8 percent;
- As a result of the continuing operations of the mine, 1,740 new permanent, year-round jobs would be created in the Montana economy, increasing household income by $125.4 million per year;
- Job increases would occur across a wide spectrum of industries, and, largely due to rail operations, in most regions of the state;
- Overall state population would be almost 2,850 higher and school-aged population more than 560 higher due to the operations of the mine.

- Mine operations would increase state and local tax revenue by more than $91 million per year due to both coal-specific taxes as well as growth in the overall base for Montana's other taxes.



Background and Overview

The University of Montana Bureau of Business and Economic Research at (BBER) was engaged by the Montana Contractors' Association to conduct an empirical study of how the development of the Otter Creek coal tracts in southeastern Montana would impact the economy of the state. Specifically, the BBER was tasked with (i) developing and detailing a scenario of coal development in Otter Creek, including land preparation, building, and other infrastructure preparation, and transportation improvements, including rail, (ii) developing a scenario of ongoing coal production from a new mine that reflected the capacity of the tracts, the likely limitations of a mining permit, and the conditions of the global coal marketplace, and (iii) incorporating these scenarios into an economic impact model which would fully describe how the state economy (and its subregions) would evolve should these events take place. This report presents the findings of this analysis.

This study asks and answers a simple question: How would be economies of Montana and it sub-regions react if Otter Creek coal development takes place? To address this question, we construct two future economic scenarios – a baseline, no development scenario and a coal development scenario. The difference between these two alternative futures – in the number of jobs, the dollars of income, and the number of people who live in Montana -- is the ultimate impact of the development of coal.

The coal development scenario incorporated into this study was independently developed by the BBER using publicly available information from public filings, historical data, and the information available on other mining projects. The scenario is broadly consistent with the expected scale of the project and what is economically and operationally feasible. Thus, the results reported here are representative of how the investments and operations associated with the coal (and railroad) development will affect statewide growth.

Research Overview

The core question posed by this study is: What would the Montana economy look like if Otter Creek coal development takes place? The question essentially involves analyzing two different futures for the Montana economy the status quo, no-investment scenario where development does not occur and a coal development scenario which includes mining, transportation, and other associated infrastructure. The latter represents a stimulus which can set off other actions and reactions in the economy.

There are three essential components to estimating the ultimate impact of new investment. These are:

- the *direct impact* (e g., spending) the investment itself represents,
- the *indirect impacts*, which are the spending of other entities (e.g., the railroad) which are carried out by others because of the original investments, and
- the *induced impacts* that occur as the spending represented by the direct and indirect impacts propagates through the economy

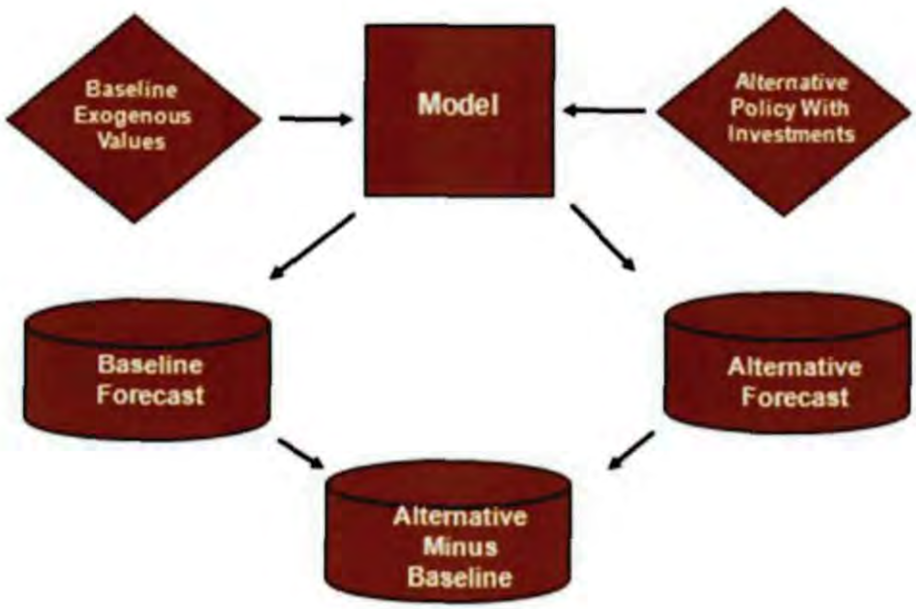
Likewise there are two different stages of any project involving significant infrastructure development.

- the *permitting and construction phase* - a one-time boost in spending and investment -- that occurs in the beginning of a project -- to plan and build infrastructure, facilities and, buildings, and
- the *operations phase* - commencing when construction is complete and ongoing operations can begin. The operations phase continues for the life of the project.

Although the precise timetable and scale of the investments that could take place as part of development of the Otter Creek coal tracts are not yet known, reasonable scenarios can be constructed based on development of similar coal seams elsewhere. This study has carefully constructed a development scenario that faithfully represents the major investments that would have to take place to develop and produce Otter Creek coal. The induced impacts, which take place as wage, vendor, and other payments are captured by Montana businesses and households and are spent again in the state and local economies, are estimated using BBER's five-region economic impact model.

To quantify the impacts of events that influence the Montana economy, the BBER uses a mathematical model of the regional economy leased from Regional Economic Models, Inc. (REMI). The fundamental premise of the REMI model is that regions compete for investment, jobs, and people. Thus, when new events occur which change the competitiveness of one particular region – such as construction and development of mining operations – investment, employment, and demographic flows in and out of the region can be affected, ultimately producing new levels of economic activities. The model thus produces impact estimates by examining the economy before and after these new events take place.

The total contribution of Otter Creek development to the economy is the difference between these two scenarios, as shown diagrammatically in the figure below. The model is a means of estimating the economy's new "resting point," which includes the changes in investment, employment, and spending that are induced by the project.



The Direct and Indirect Economic Contribution of Otter Creek Coal

The first step in the analysis is to specify the timing and the extent of spending by Arch Coal on developing the mine. Before a shovel full of Otter Creek coal can be mined, a number of regulatory, engineering, and logistical tasks must be carried out. The construction of all of the infrastructure of the mine, including land preparation, road, rail, and power distribution construction, equipment acquisition, construction of buildings and on-site processing facilities, and, finally, the excavation of the initial overburden, will take approximately two years at a cost of about $600 million.

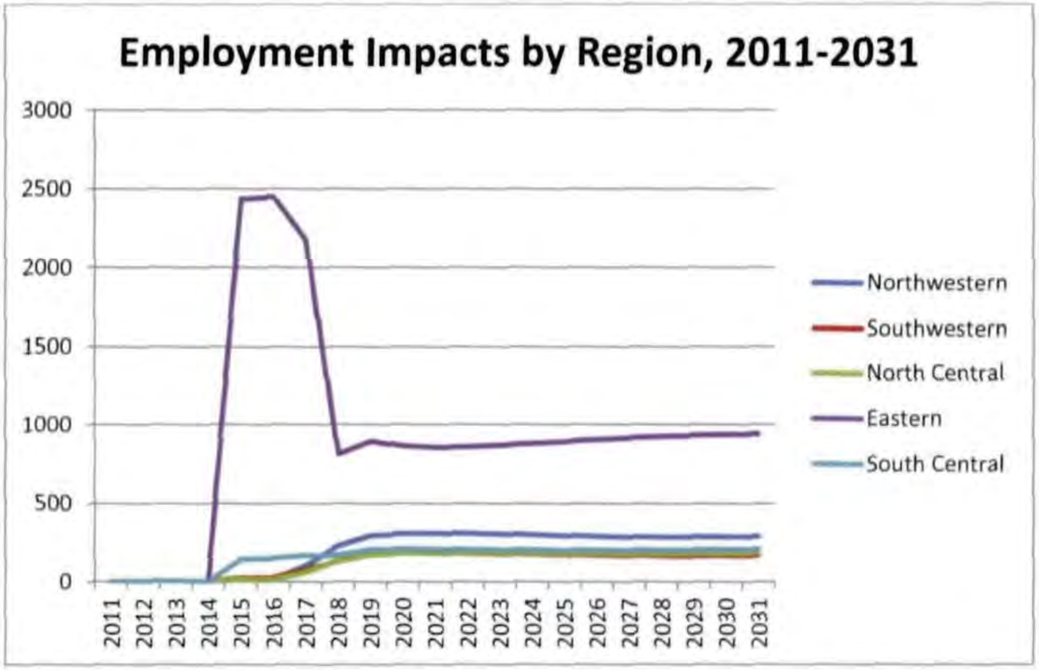
It is anticipated that when construction is completed that the Otter Creek mine will produce 20 million tons of coal annually, with approximately 300 full-time employees, plus an additional 50 contractors. We expect that the mine mouth value of this coal will be $14 per ton. We anticipate that the dominant market for this coal will be Asia, with coal shipped by rail to the (new and existing) Pacific northwest coal ports. Significant domestic customers are expected as well.

The development of the railroad represents by far the most significant indirect impact of mine development. While transporting coal by truck is possible, the economic competitiveness of the mine depends critically on access to the rail transportation network. Coincident with mine construction, we envision a new 89-mile rail spur north to connect to the main BNSF line near Miles City at a cost of about $472 million. When operational, new and existing rail links – including those owned by both BNSF and Montana Rail Link (MRL) – within Montana will see approximately $340 million in new demand for rail transportation services due to mining operations.

The Economic Impact of Otter Creek Coal

The substantial amount of spending and production occurring in both the construction and operations phases of this project represents a tremendous new injection of revenue and income for Montana businesses and households. This sets off new investment, employment, and demographic flows as secondary jobs and income are created. The investment ultimately produces a new level of economic activity, with jobs and incomes affected across the spectrum of the economy. The difference between this new level of activity and the status quo projection represents the total economic impact of Otter Creek coal.

We can measure how Otter Creek direct and indirect impacts propagate through the Montana economy with the REMI model. Comparing the trajectory of the economy with and without coal development yields an estimate of the impact of Otter Creek over the next 20 years. As can be seen from the employment impacts graphed below, with the tremendous activity in the construction phase of the project, the impacts of the project in the beginning of the project are outsized, especially in the eastern Montana region. When the construction is complete and mining operations commence, the job impacts remain significant, growing slightly over the span of the next two decades.



Since the investment and spending patterns in the construction and operations phases of the project are distinct, we present the findings of the analysis for the two phases separately. In the discussion that follows, we define the construction phase impacts as the total impacts that occur in year 2016, the peak year. The operations impacts are defined as the impacts occurring in year 2019, when all construction impacts are finished. All dollar figures are inflation-corrected, expressed in terms of 2012 dollars.

Employment Impacts

The wide footprint of the mine's economic impacts can be seen very clearly from the distribution of new jobs by industry, shown in the table below. As would be expected, the majority of jobs in the construction phase are construction industry jobs, and in the operations phase a large number of new mining jobs are created. But in each phase there are significant ripple effects on other sectors of the economy. These include retail trade, health care, accommodations and food, and local government. The increases come about through a variety of mechanisms – some industries benefit directly from worker spending, some are due to other businesses related through the supply chain, still others come about because of population increases as people migrate to the state because of the new jobs.

The analysis shows that mine and other associated construction supports almost 2,650 new jobs statewide, and that mine operations creates more than 1,700 new permanent jobs in the Montana economy.

Employment Impacts

Industry	Job Impacts by Phase	
	Construction	Operations
Forestry, Fishing, Related Activities, and Other	0	0
Mining	(3)	346
Utilities	0	6
Construction	1,948	79
Manufacturing	4	3
Wholesale Trade	41	66
Retail Trade	129	235
Transportation and Warehousing	0	51
Information	1	3
Finance and Insurance	2	7
Real Estate and Rental and Leasing	12	45
Professional and Technical Services	30	44
Management of Companies and Enterprises	0	0
Administrative and Waste Services	25	43
Educational Services	1	7
Health Care and Social Assistance	69	165
Arts, Entertainment, and Recreation	5	20
Accommodation and Food Services	54	116
Other Services, except Public Administration	54	103
State Government	37	71
Local Government	240	331
TOTAL	2,648	1,740

Income Impacts

The impacts on Montanan's personal income as a result of Otter Creek coal investment stem from three separate mechanisms. First, income is created – both wage and salary income, as well as business proprietor income – as the new jobs described above are created. Secondly, as population increases due to increased Montana job opportunities, the total income of the state increases. The final way in which Otter Creek coal impacts after-tax income of Montanans has to do with the substantial tax revenues paid by the mine. How these revenues would be dealt with by the Legislature is unknown. The conservative assumption made in this study is that the increased revenues allow the Legislature to fund the same amount of services with lower tax rates. These lower rates increase the after-tax income of Montana households.

As shown in the table below, the personal income impacts of Otter Creek development are substantial – amounting to $103.5 million in the construction phase and $125.4 million in permanent increases during mine operation. The increase in after-tax income during coal operations exceeds the pre-tax increase, amounting to a $167.9 million increase in Montana household purchasing power every year the mine is in operation.

Personal Income Impact, Millions of Dollars

Category	Income Impacts by Phase Construction	Operations
Total Earnings by Place of Work	$123.0	$119.4
Total Wage and Salary Disbursements	81.9	88.1
Supplements to Wages and Salaries	21.0	25.5
Employer contributions for employee pension and insurance funds	13.5	16.3
Employer contributions for government social insurance	7.5	9.2
Proprietors' income with inventory valuation and capital consumption adjustments	20.2	5.8
Less: Contributions for government social insurance	15.8	18.3
Employee and self-employed contributions for government social insurance	8.3	9.1
Employer contributions for government social insurance	7.5	9.2
Plus: Adjustment for residence*	-1.7	-1.2
Gross earnings flows into Montana	2.2	2.1
Gross earnings flows out of Montana	3.9	3.3
Equals: Net earnings by place of residence	105.6	99.9
Plus: Rent, interest, and dividends	5.8	19.0
Plus: Personal current transfer receipts	-7.8	6.6
Equals: Personal Income	103.5	125.4
Less: Personal current taxes	15.7	-42.4
Equals: Disposable personal income	87.7	167.9

* Total earnings data are derived from records of employers who are located in Montana. Since some Montana workers are employed by out-of-state firms, and some Montana firms employ workers from other states, the adjustment for residence nets out these two impacts to produce an estimate of Montana residents' income.

Other Impacts

Mine operations, as well as construction, also have other significant impacts on the Montana economy, including:

- significant increases in population, in both eastern Montana as well as the entire state, as workers migrate into the state and region in pursuit of economic opportunities;
- an increase in the school-aged population as younger workers bring their young (or yet to be born children) into the state;
- increases in local government, primarily in local public schools, in response to population changes caused by the mine development and operation;
- increases in state and local tax revenues due to both (i) severance and other special taxes levied on coal, and (ii) an increase in the base of Montana's other major taxes.

Summary and Conclusion

Through an analysis of the direct, indirect, and induced economic activity surrounding the development of Otter Creek coal, we find that the total economic contribution such an activity would make to the state economy to be substantial. The construction of the mine, the new railroad construction, and the other associated infrastructure represents a total investment approaching $1 billion and is expected to create more than 2,600 construction jobs in the peak building year. The operations of the mine are expected to create more than 1,700 permanent jobs in the Montana economy and add almost $168 million in after-tax income annually. Those jobs would benefit all regions of the state as well as a broad spectrum of public and private sector businesses.

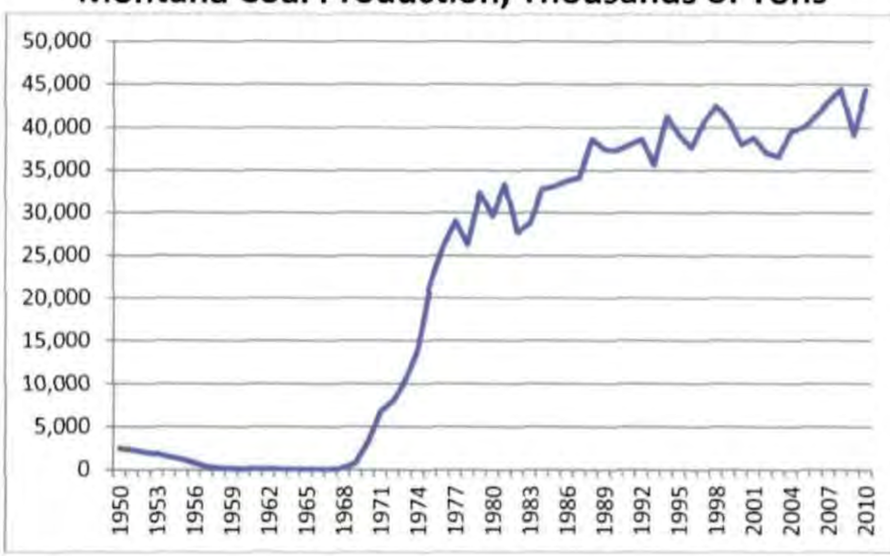
1. Background and Overview

1.1 Montana Coal: History and Prospects

Coal mining has a long history in Montana. In the age of steam, underground mines near Red Lodge, Roundup, and elsewhere supplied coal to railroads and the industrial facilities in the Butte-Anaconda area. In addition, numerous small underground and surface mines provided coal to local homes and businesses. By the 1960s, diesel locomotives and other energy sources reduced Montana coal production to practically zero.

Montana's current coal mining industry began with the Arab oil boycott of 1973 and the resulting energy crunch. There were numerous proposals to use Powder River Basin coal to produce synthetic natural gas and other fuels. In addition, the naturally low sulfur content of Powder River coal made it an attractive boiler fuel for electric utilities attempting to comply with newly formulated emission regulations. One federal study published in 1975 predicted that Montana coal production would be between 34 and 64 million tons in 1980 and from 39 to 153 million tons in 1985 (Northern Great Plains Resource Program, 1975, p. 40). A later federal-state study released in 1979 predicted Montana coal production would be 39.3 million tons in 1980 and 49.7 million tons in 1985 (U.S. Department of the Interior and Montana Department of State Lands, 1975, pp1-3).

Figure 1.1
Montana Coal Production, Thousands of Tons

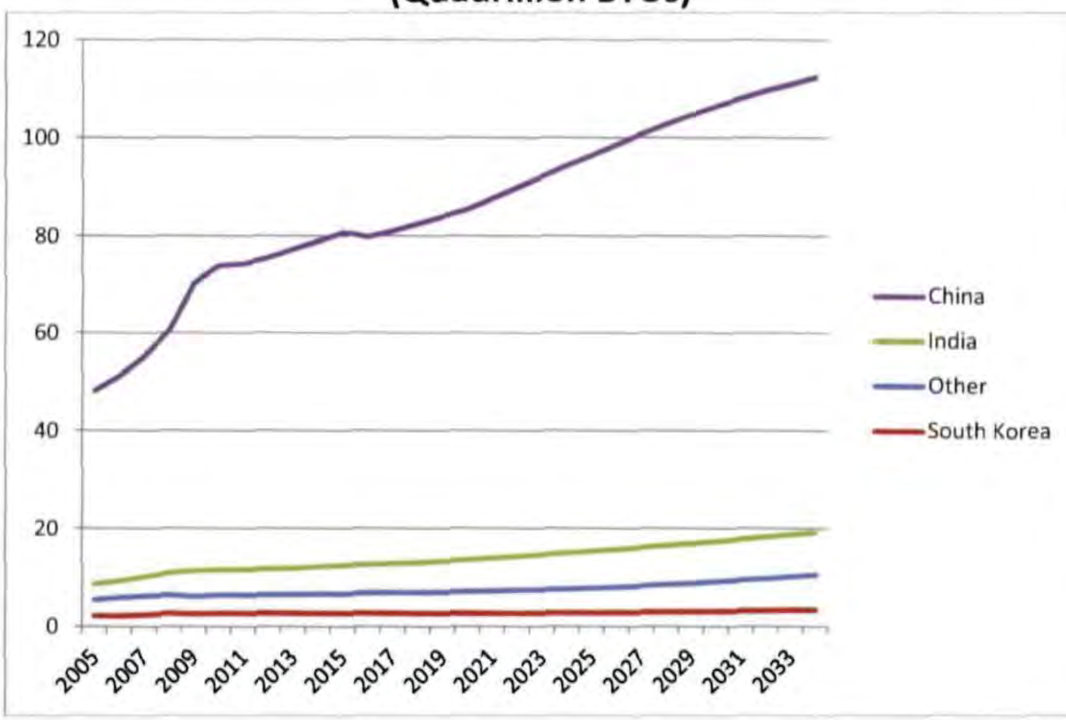


Source: Montana Coal Council.

The 1970s' forecasts for Montana production of the Powder River Basin were far too rosy. There were a number of reasons for this over-optimism. First, synthetic fuel production never materialized. Second, changes in federal emission regulations made low-sulfur coal less attractive. Third, Wyoming coal mines are closer via rail to large metro areas in the southeast and southern Midwest and they received the benefits of the fast urban growth. Finally, the nationwide demand for electricity moderated due to rising prices (Polzin, 1985).

Montana's coal production has been relatively stable over the last four decades. In 1981, about 33.3 million tons of coal was being produced at six large surface mines in eastern Montana. The more recent trends are pictured in Figure 1.1. Total Montana coal production has been between 40 and 45 million tons per year since 2000, with only a mild upward trend since the 1990s.

Figure 1.2
Actual and Predicted Asian Coal Demand
(Quadrillion BTUs)

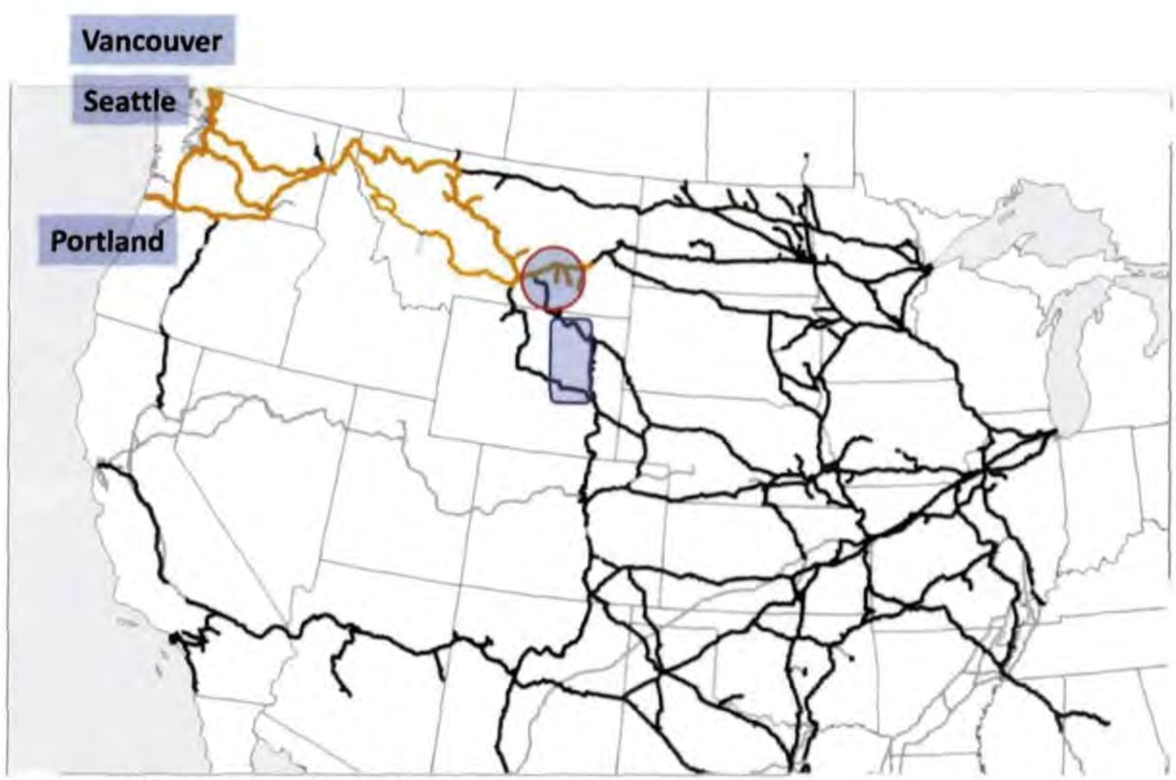


Source: U.S. Energy Information Administration (EIA), International Energy Statistics database (www.eia.gov/ies, accessed November, 2011).

Since the 1970s' renewal, Montana coal has been primarily used to fire electrical generating plants and most is transported by train to cities in the northern Midwest. In addition, significant amounts of coal are burned for electric generation near the mine site at Colstrip and small amounts are transported west toward the Pacific Northwest. Domestic markets are unlikely to provide significant growth for Montana coal. The overall production of U.S. coal has been stable or declining due increased environmental concerns about coal-fired electric generating plants.

The same is not true in Asia, especially Southeast Asia, where coal demand is mushrooming. As shown in Figure 1.2, the annual demand for coal in China and elsewhere in the region is projected to grow significantly between 2010 and 2035. The data in Figure 1.2 are measured in Btus rather than tons to correct for quality differences between different types of coal. To put this growth into perspective, the increase from 2010 to 2035 in China alone is more than twice the current U.S. production of coal. If this growth in Asian demand materializes, it would have some very favorable impacts on Montana. There is not sufficient capacity in Southeast Asia to satisfy this growth, so coal would have to be imported by boat from other places. There are currently only a couple of bulk loading facilities in the Northwest that can handle coal, and they are in British Columbia. But there are proposals for several more on the Washington and Oregon coast.

Figure 1.3
Major Rail Lines Serving Powder River Basin and Destination Markets



Source: BNSF Railway, System Map.

Figure 1.3 depicts the rail lines in the Northern Great Plains and Pacific Northwest along with Montana and Wyoming in the Powder River Basin. It takes only quick glance to see that the Montana coal fields are closer to Northwest ports than the Wyoming coal fields. The transportation situation may now be reversed. Just as Wyoming was in a favorable geographic position to serve the fast growth in the south and east, Montana is now better situated to serve these fast growing Asian markets.

1.2 Otter Creek Coal

In the mid-1990s the U.S. government bought property adjacent to Yellowstone National Park on which the mining company Noranda proposed to develop a gold mine, called the New World mine. Governor Marc Racicot, citing the revenue that would be lost to the state because the mine would not be developed, asked the federal government for compensation. The federal government offered Montana a choice: $10 million, or the Otter Creek coal tracts located near Ashland in Powder River County. The State of Montana chose the coal.

The Otter Creek coal tracts have not yet been developed because they have a checkerboard ownership pattern. Great Northern Properties owns slightly more than half of the 1.3 billion tons of coal and the State of Montana owns the remainder. Montana invited bids for its coal in 2009. Arch Coal was chosen as the successful bidder. Since Arch Coal already leased the coal owned by Great Northern Properties, the checkerboard ownership problem no longer inhibits the development of these deposits.

The development phase for these tracts is just beginning and few specifics have been developed. Some preliminary work has begun as the Montana Department of Environmental Quality has determined that the Arch Coal's application to begin prospecting is administratively complete.

The state's 2009 appraisal of the tracts envisioned two surface mines each producing roughly 35 million tons per year. Projects of this scale would roughly triple Montana's coal production. Very conservatively, there would be at least 500 new mining jobs, which would place them among the largest industrial employers in the state. In addition, a new railroad would have to be constructed connecting the mines with the BNSF mainline to the north.

The new mines would be subject to administrative review before they could begin production. The mine operator would have to submit detailed operating and reclamation plans to the Montana Departments of Natural Resources and Conservation (DNRC) and Environmental Quality (EQC) for permitting review pursuant to the Montana Environmental Policy Act (MEPA).

1.3 The Impact of Coal Operations and Development

It is difficult to compare the economic contribution to the state economies coal mining makes in different states. Mining technology, the quality, quantity, and placement of coal seams, access to markets, and the vintage of equipment can all play a major role in productivity, production and impacts. But some studies carried out for coal mines in the western United States can at least frame the analysis. Studies of new developments for surface mining of other minerals can be relevant as well.

- A 2010 study conducted by the University of Utah found that the 24.3 million tons of coal mined annually from Utah employed 1,888 people, and that the operations induced an additional 2,815 jobs to be created in the state economy.

- A study of the new development of a proposed surface copper mine in Arizona conducted by Arizona State University in 2010 found that the project would generate about 3,600 jobs and $152 million in personal income while under construction, with operations supporting about 2,100 jobs and $143 million per year.

- A 2005 study conducted by the University of Wyoming of different production scenarios for Powder River Basin coal and natural gas in Wyoming found that a "low" production ramp up scenario that increased coal production by about 145 million tons per year contributed to an increase of about 12,500 jobs in a six-county region of the state.

All of these studies made use of the REMI model -- which we also employ in this study -- to estimate economic impacts. These studies confirm that the development of coal and other surface mined mineral reserves represent large-scale projects with commensurate large economic impacts.

1.4 Report Overview

The remainder of this report proceeds as follows. In the next section we introduce the policy analysis model that is used in this study to estimate economic impacts of Otter Creek coal development, and describe the basic philosophy behind its construction. As we shall describe, the task of estimating economic impacts involves carefully assessing the direct investments and spending (direct impacts) of both the Otter Creek mine as well as the Tongue River railroad. This is carried out in the following two sections. Section 5 presents the results of the analysis, followed by conclusions in the last section.

2. Policy Analysis with the REMI Model

Economic impacts occur because of events or activities that create new expenditures. Spending which is new – which is over and above existing expenditures and does not simply displace spending elsewhere in the region – not only adds to economic activity in its own right, but it also induces further spending as the recipients of wages, sales and tax revenues spend a portion of their income in the local economy. Changes in the path of investment, migration, and prices and wages are possible as well.

The basic tool used in this study to assess the economic contribution of Otter Creek is an economic model, calibrated to represent the interactions in the Montana economy, leased from Regional Economic Models, Inc.. The REMI model is one of the best known and most respected analytical tools in the policy analysis arena and has been used in more than a hundred previous studies as well as dozens of peer-reviewed articles in scholarly journals. It is a state-of-the-art econometric forecasting model that incorporates dynamic feedbacks between economic and demographic variables. The REMI model forecasts employment, income, expenditures and populations for counties and regions based on a model containing over 100 stochastic and dynamic relationships as well as a number of identities. A full explanation of the design and operation of the model can be found in Treyz (1988).

The model used in this study disaggregated the state economy into five regions: Northwest, Southwest, North Central, South Central, and Eastern. It explicitly recognizes trade flows that exist between these regions, as well as between the regions and the rest of the world. The definition of the regions is shown in Figure 2.1 below.

Figure 2.1
Economic Regions

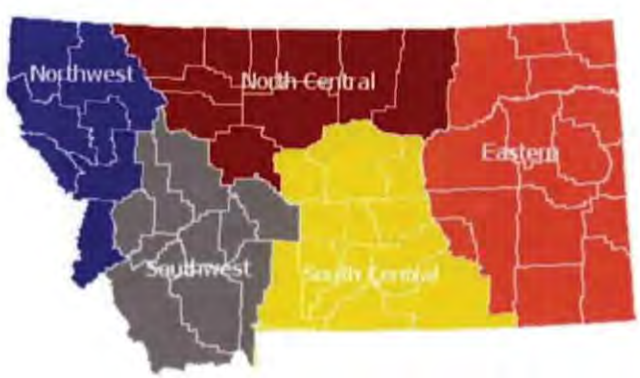
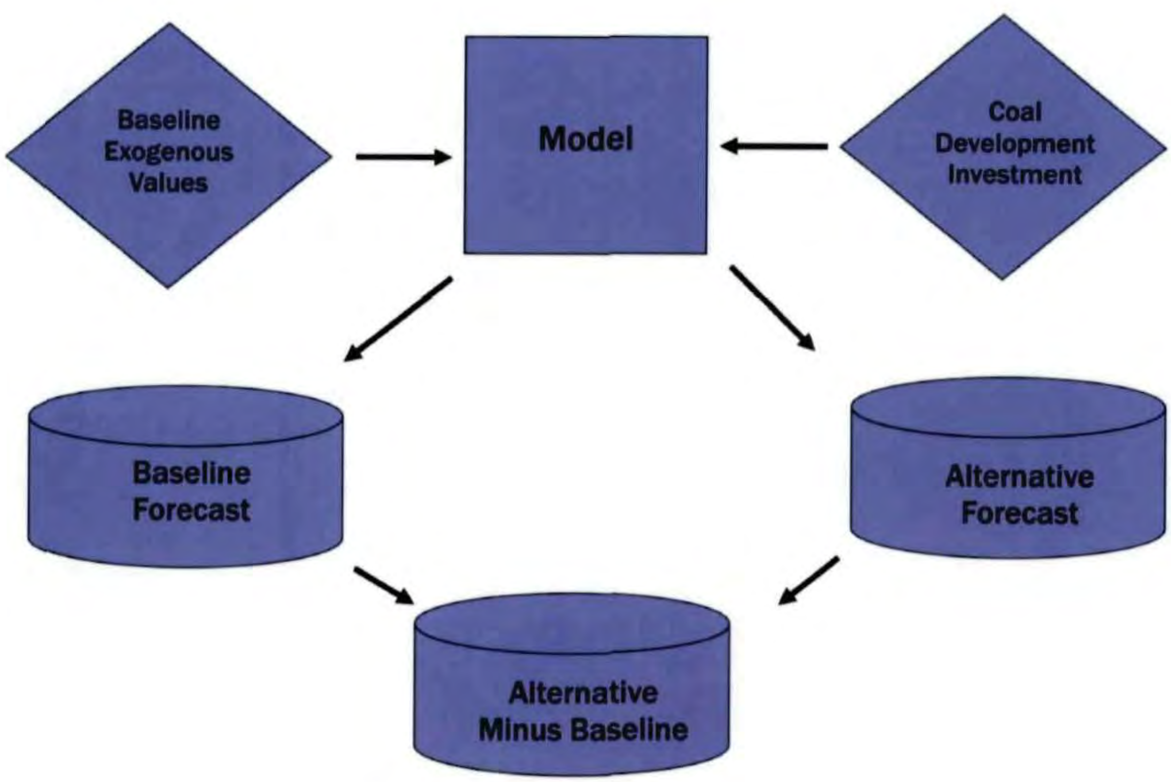


Table 2.1

Eastern Montana Counties

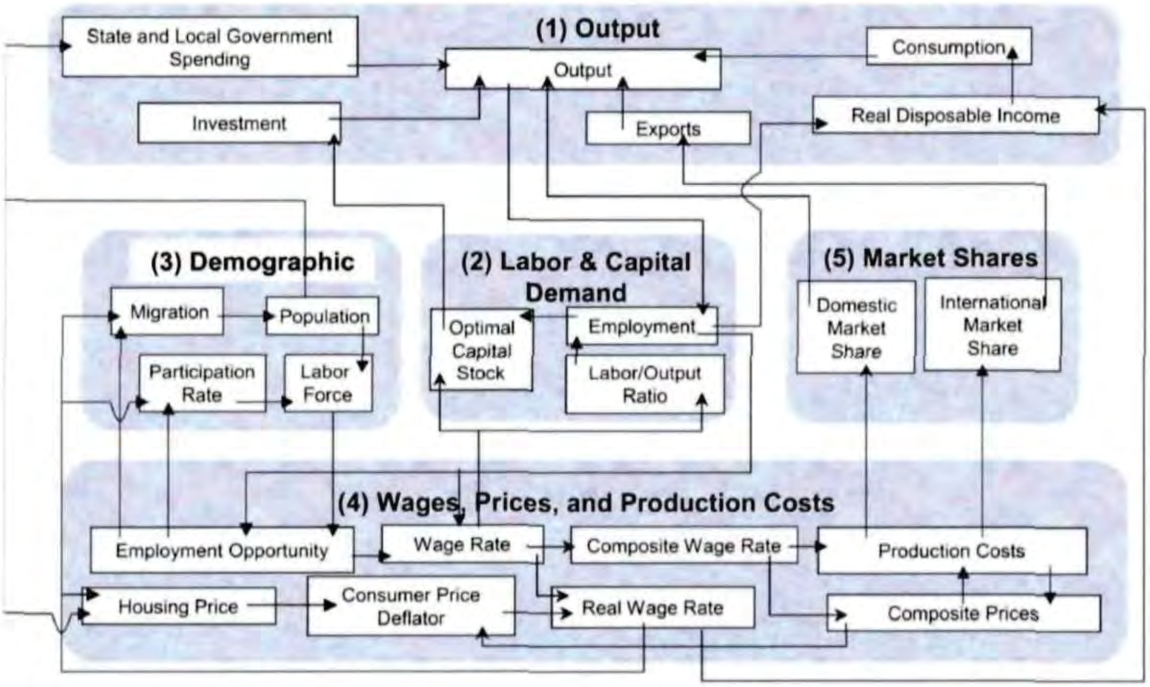
Carter	Powder River
Custer	Prairie
Daniels	Richland
Dawson	Roosevelt
Fallon	Rosebud
Garfield	Sheridan
McCone	Valley
Phillips	Wibaux

Figure 2.2
Policy Analysis with the REMI Model



The use of the model to derive the results of this study is illustrated graphically in Figure 2.2. First, a baseline projection of the economy is produced using the model, utilizing inputs and assumptions which extrapolate growth and conditions of recent history. The model is then used a second time, with identical inputs – except that in this alternative scenario, the activity associated with coal development (including rail) is added. Thus the Otter Creek development is an input that ultimately produces a different economy, reflecting not only the addition of the production, employment, and expenditures of the project, but how the rest of the economy reacts to those changes. The difference between the baseline and alternative scenarios of the economy represents the economic impact of Otter Creek coal development.

REMI Model Linkages (Excluding Economic Geography Linkages)



The model utilizes historical data on production, prices, trade flows, migration and technological change to calibrate the relationship between five basic blocks of the regional economy as depicted above: output, labor and capital demand, population and labor force, wages and prices, and market shares. The changes in production, labor demand and intermediate demand caused by the construction and operation of Otter Creek causes these blocks of the economy to react and adjust to a new equilibrium. As described above, the difference between the baseline and the alternate scenario is the ultimate impact of coal development.

The essential philosophy of the model is that regions throughout the country compete for investment, jobs, and people. When events occur in a region they set off a chain reaction of actions causing dollar flows toward better investment and production opportunities, followed over time by a flow of workers and households toward employment opportunities and higher wages The model embodies an 82-sector input-output matrix that describes the technological interdependence of production sectors of the economy, as well as extensive trade and capital flow data to determine the share of each sector's demand that can be met by local production.

The model is extremely well suited for the analysis described in this report. As seen in several of the energy studies listed in the references section, it has been used for similar analyses of energy-related investment and opportunities.

As powerful and flexible as the model is, the answers it provides are only as good as the questions posed to it. The majority of work in this study is carefully crafting the inputs used to construct a scenario of the Montana economy that faithfully represents all of the investments and production that encompass Otter Creek coal development. We now turn to this task.

3. The Direct Economic Contribution of Otter Creek Construction and Operations

A careful specification of the scale and timing of the investments and income flows that would occur if Otter Creek coal is developed is a critical first step in understanding how that development would ultimately impact economic activity in Montana Using publicly available information, we have assembled a scenario of coal investment and operations that is (i) operationally and financially feasible, (ii) consistent with the coal production potential of the Otter Creek tracts, and (iii) consistent with mining developments planned or conducted elsewhere. While the precise spending and timing of actual development that unfolds in the coming years will doubtless deviate from this scenario, it faithfully represents the scale of the investment that is under consideration.

The greenfield development of even a small portion of the estimated 1 3 billion ton Otter Creek coal reserves is a major undertaking In order to transform a single tract of the approximately 19,200 acres of public and private land in Powder River County from its current agricultural use into an operating coal mine facility, years of contractual, regulatory, engineering, and legal challenges must be addressed and hundreds of millions of dollars expended. Infrastructure to support the mine must also be planned, approved, and constructed, including significant new construction in the railroad network. The overall project would represent one of the largest industrial developments in Montana's modern history

In this section we detail a development scenario for mining permitting, construction, and operations In the next section we describe the investments and income flows associated with the rail transport of Otter Creek coal. Jointly these activities represent sizable one-time and continuing income flows to the economy of the state How those new flows ultimately impact jobs and income in Montana – the central research question of this report – is then assessed using the REMI model as a tool, and the development scenario developed here as the main input.

3.1 The Permitting Phase

Broadly speaking, the permitting, or pre-construction phase of coal development in Otter Creek has been underway since the Montana Land Board voted to support opening the land to coal development in 2009. Significant resources have been expended for land acquisition, engineering and testing, planning, and for legal and lobbying services Perhaps the most significant and visible of these is the $85.8 million lease payment made by Arch Coal to the state of Montana in 2010

Many of these expenditures represent net new income flows to the Montana economy that are attributable to coal development in Otter Creek. Thus it is appropriate to include them as part of the direct economic contributions of the mining development and operation

The lease payments from Arch Coal to Great Northern Properties, mineral rights owners of the privately held half of the Otter Creek properties, represent a significant investment in coal development From the standpoint of the Montana economy, however, those payments have largely been directed outside the state Thus there is no direct impact of this private lease arrangement

The $85.6 million payment to the state of Montana, on the other hand, was a (one-time) new income stream to the state. It enabled, among other things, a fiscally strapped Legislature to reduce cuts to programs in the 2011-12 biennium that might otherwise have been made. However, it occurred before the beginning of the study period of this project (2012). Its impacts are embedded in the baseline projection of the economy – but not in our estimates of the economic changes caused by development

The new income flows that were included in this analysis are the costs of the extensive engineering, environmental, and legal analyses and support services that have begun and are expected to continue as part of the preparation of the mining permit application. This creates a demand for approximately $4 million per year for professional and technical services in the state economy during the period 2012-2017.

3.2 The Construction Phase

It is assumed for purpose of this analysis that construction of the mine will commence in the year 2015 and will continue for two years While the actual date is dependent upon the outcomes of regulatory and/or legal proceedings whose timelines and outcomes are unknown in advance, this construction scenario is consistent with a careful and thorough review of all the relevant permit applications. Events that push back the start date for construction will alter the timing, but not the size, of the ultimate economic impacts.

Construction of the railroad (with the exception of the rail spur that serves the new mine's loading facilities) is considered in the next section. For the mine facility's construction phase there are two broad categories of expenditures equipment and facilities Equipment includes the dragline, shovels, haul trucks, water trucks, drills, dozers, and other equipment Facilities include an office, maintenance shop, warehouse, wash bay, power/water system, power station, road and site preparation, coal storage, coal processing plant, and rail spur and loading loop

This study had access to three categories of information which could be used to create a construction scenario for the Otter Creek mine. These were:

(i) The Montana Otter Creek Coal Valuation study prepared by Norwest Corporation in 2009 presented construction estimates for the development of two Otter Creek tracts as part of an "income approach" to estimate of the value of coal leases;

(ii) Construction estimates for other surface mining projects, most notably the Rosemont Copper project in Arizona;

(iii) Conversations with Mike Rowlands, director of Otter Creek Operations for Arch Coal.

This information can be summarized as follows.

Norwest Valuation Study. The Norwest study developed a detailed cost plan for development of two Otter Creek tracts as part of an income approach to lease valuation. Their estimates were based upon an independent engineering analysis and prevailing prices for materials and equipment. The model for one of their tracts, termed LMU5 (logical mining unit) in the report, is close in scale to what is studied in this report. The Norwest study estimates $591.2 million in equipment expenditures and $123.6 million in facilities spending

Rosemont Copper Project. The development of a 15,000 acre site in Pima County, Arizona, was studied by Arizona State University in 2009 based on a detailed feasibility study made available for the project While not a description of Otter Creek development, its estimate of $897 2 million in total construction costs for the greenfield development of a surface mine provide some support for the scale of this project

Arch Coal. Mike Rowlands, director of Otter Creek Operations for Arch Coal, was able to share his estimates of construction costs associated with Otter Creek coal development in several conversations. His estimates of equipment costs, in particular, were informed by the existence of draglines and other major equipment items that are available internally within the company

Priced in terms of the value of 2012 dollars, we have estimated the broad categories of construction phase expenditures associated with Otter Creek coal development as equipment expenditures, $400 million, and facilities expenditures, $200 million

3.3 The Operations Phase

It is projected that the development of Otter Creek coal resources envisioned in this study will create an operating mine that will ultimately produce 20 million tons of coal annually, using a year-round workforce of 300 employees with an additional 50 contractors. Production is assumed to commence in 2017, ramping up to full production levels by year 2009

New surface mining operations such as the projected Otter Creek mine are capital intensive, with very high levels of productivity per worker. Jobs are projected to pay in the neighborhood of $78,000 per year, not including sizable benefits

There are significant ongoing purchases from vendors of a wide range of items – from electricity to legal services – that have important ramifications for the Montana economy as a result of coal operations The subsequent impacts of these and other income flows due to coal operations are derived from the REMI model One purchase, however – rail transportation services – is large and important enough to be considered in its own right. We turn to that subject in the next section.

4. Construction and Operation of the Tongue River Railroad

4.1 Overview

A rail connection with the BNSF mainline in Miles City is an integral component of the Otter Creek Coal Project. This rail line would provide access to domestic and export markets for coal mined in the Ashland area and other nearby sites.

The Tongue River Railroad was first proposed in the 1970s but was never built. It began as a roughly 90-mile line from Miles City to Ashland. In the 1990s, the original project was expanded to extend the rail line south to connect with Decker (now Cloud Peak) mine at the Montana-Wyoming border. In mid-2011 a large landowner from the Birney area purchased one-third of the proposed railroad and said that the tracks would never cross his land. This effectively nullified the extension south of Ashland. Currently the railroad permits are owned in roughly equal parts by Mars, Inc , BNSF, and Arch Coal.

Then, in late 2011 the Ninth Circuit Court of Appeals in San Francisco ruled that the environmental impact statements were deficient in certain areas and construction could not proceed.

The following paragraphs describe features of the proposed Tongue River Railroad. They are based on the original environmental impact statement, the Ninth Circuit's ruling, and discussions with knowledgeable railroad experts

The proposed railroad would proceed southeast from Miles City and generally follow the Tongue River to Ashland. For the first 70 miles it would be west of the river on the opposite bank from Highway 332 About 10 miles north of Ashland the railroad would cross the Tongue River and proceed directly south An approximately 20-mile spur line would connect the Otter Creek mine with the terminus in Ashland The overall ruling grade of 0 2 percent makes this line very efficient in terms of fuel consumption.

The rail line would occupy an average right-of-way of 200 feet. There would be about four microwave towers linked to a centralized traffic control board in Miles City which would be the primary communication and signaling facilities. There would be either construction or rehabilitation of an interchange yard in Miles City and the construction of a maintenance facility in Ashland. The construction period would be about three years, with the actual construction season being seven or eight months of the year The rail line would require the construction of six sidings and 12 bridges.

The trains would require a three-person crew, and Miles City would be terminal location for these crews A 110 car train with each hopper car holding 100 tons of coal would have a capacity of 11,000 tons. The trains could operate 24 hours a day and 350 days per year. Extracting 20 million tons of coal a year would require about 1,800 round trips per year—or approximate 5.1 per day. Since each round trip requires two trains (one loaded, one empty), extracting 20 million tons per year would be associated with about ten trains per day. The maximum allowable speed on the Tongue River Railroad would be 40 miles per hour

Two maintenance crews would service the proposed railroad One crew would be headquartered in Miles City and the other in Ashland. These crews would perform daily maintenance chores as well as cleaning, oiling, and adjusting the switches.

The Tongue River Basin is sparsely populated and semiarid with a mostly agricultural base Livestock is the dominant agricultural product and most of the land is used for grazing. Only a small portion of the land is used for crops. Only a very small portion of the cropland is irrigated. Dry land farming and irrigated cropland are concentrated in the valley floor near the Tongue River.

4.2 Construction Costs

The major components of railroad construction costs are:

- Acquisition of the right-of-way For the most part, the right-of way would be approximately 200-feet wide Sidings and signal devices might require greater width in certain locations.
- Materials and labor. These costs are usually computed as the cost per track foot multiplied by the length of the railroad.
- Construction grade The average grade of the entire railroad will be an important determinant of fuel costs The local topology will determine the amount of cut and fill needed to provide an evenly sloped surface between the starting and ending points of the proposed railroad.
- Road crossings. The costs of road crossings is determined by the number of road crossings, the material used at each crossing, the crossing length (i e. road width), and the type of protection needed (gates, lights, etc.).
- Stream crossings. Depending on the size of the stream, either culverts will be placed under the roadway, a short span bridge built (about 23 feet per span), or a long span bridge (less than 120 feet per span) built.

According to a technical railway website, "A single track freight line with a few locomotives and simple signaling, running across a flat, geologically sound, sparsely populated landscape in a developing country might be built for as little as US$ 2 million per kilometer." (www railway-technical com/finance/shtml) This converts to approximately $3.3 million per mile

A Texas railroad consultant estimated average construction costs to be about $4.0 million per mile including centralized traffic control and other communications equipment For the proposed 89-mile Tongue River Railroad, this yields total construction costs of about $356 million.

The engineering department of the BNSF railroad independently estimated construction costs of the Tongue River Railroad to be about $471 million, or approximately $5 3 million per mile We chose the BNSF calculation because the engineers are most familiar with the route and terrain associated with the Tongue River Railroad. Construction is assumed to commence in 2015 and continue for three years.

4.3 Railroad Operations

The operations of a coal mine in southeastern Montana will introduce significant new demand for rail transport From the point of view of the economy, demand for rail transport that originates from a customer in one location is ultimately met by a combination of the local network (self supply) and networks and facilities elsewhere. From the point of view of the Montana economy, supplies of rail services from elsewhere that meet demand originating locally are essentially imports.

Based on mileage calculations to west coast port facilities, and based on an industry average transportation charge of $ 03 per ton mile for coal transport, we project that Otter Creek coal production will generate just over a billion dollars of demand for rail transport annually That new demand results in new business and higher rail employment for all regions of the state.

5. The Economic Impact of Otter Creek Coal Development

5 1 Impacts Summary

The scenario of coal development, including additions to the railroad network, described in the previous two sections represents significant new income and expenditure streams for the Montana economy. As these projects are carried out, and as the facilities go into operation, the economy of the region, and the state as a whole, can be expected to change significantly. We have analyzed these changes using the REMI model, and we detail our findings in this section of the report

All of the economic impacts described below are total impacts – which include the spending, production, and income of coal miners, as well as those involved with coal transport, and any new jobs in other industries ultimately induced by their spending. As described in section 2 of this report, these impacts are the difference between a "coal" and "no coal" scenario for any given year.

As we describe below, the changes in the economy evolve over time, for two primary reasons First, the nature of the project changes significantly when facilities are completed and the operations of the mine commence. Specifically, the construction jobs associated with mine and railroad construction do not continue when capital improvements are complete. The second change in economic impacts over time is caused by population migration. The high wage jobs represent an attractive opportunity for non-residents to move to the region. This migration occurs gradually, and over time increases the population and the workforce.

For readability, we present tables in this section detailing impacts for two points in time. the peak construction year (2016) and the first year of the operations-only period (2019). These two time points are termed the "Construction" and "Operations" impacts, respectively. We also present several charts that describe the impacts visually for the entire project period. Detailed impacts for all years can be found in the Appendix.

Summary of Findings

This study finds that as a result of Otter Creek coal development, the state economy is significantly larger, more prosperous, and more populous than would otherwise be the case Specifically, we find that as a result of the development of the first of the three Otter Creek tracts, ultimately producing 20 million tons of coal, that.

- 2,648 jobs would be created during the peak year of the construction phase as the mine facilities and the railroad are built, with most new jobs created in eastern Montana;

- The impacts on income received by Montana households would be similarly substantial. $103.5 million of new personal income, and $87.7 million in after-tax income, would occur during the peak construction year statewide. In eastern Montana, total household earnings would increase more than 6 percent;
- As a result of the continuing operations of the mine, 1,740 new permanent, year-round jobs would be created in the Montana economy, increasing household income by $125.4 million per year;
- Job increases would occur across a wide spectrum of industries, and, largely due to rail operations, in most regions of the state;
- Overall state population would be more than 2,800 higher, and school-aged population more than 560 higher, due to the operations of the mine.
- Mine operations would increase state and local tax revenue by more than $91.6 million per year, due to both coal specific taxes as well as growth in the overall base for Montana's other taxes.

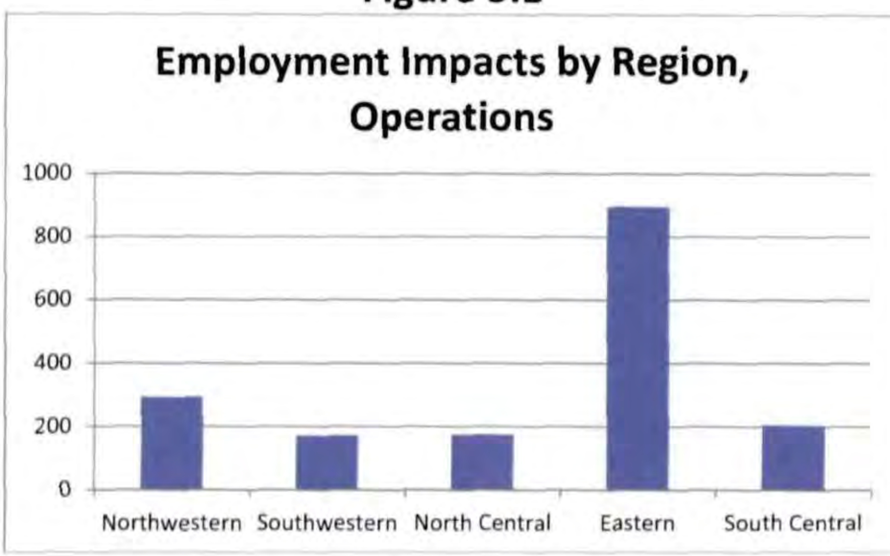
Table 5.1

Impacts Summary

	Impacts by Phase	
Category	Construction	Operations
Total Employment	2,648 Jobs	1,740 Jobs
Private Sector	2,372 Jobs	1,338 Jobs
Personal Income	$103.5 million	$125.4 million
Disposable Personal Income	$87.7 million	$167.9 million
Population	1,025 people	2,843 people
State tax revenues	$23.5 million	$91.6 million

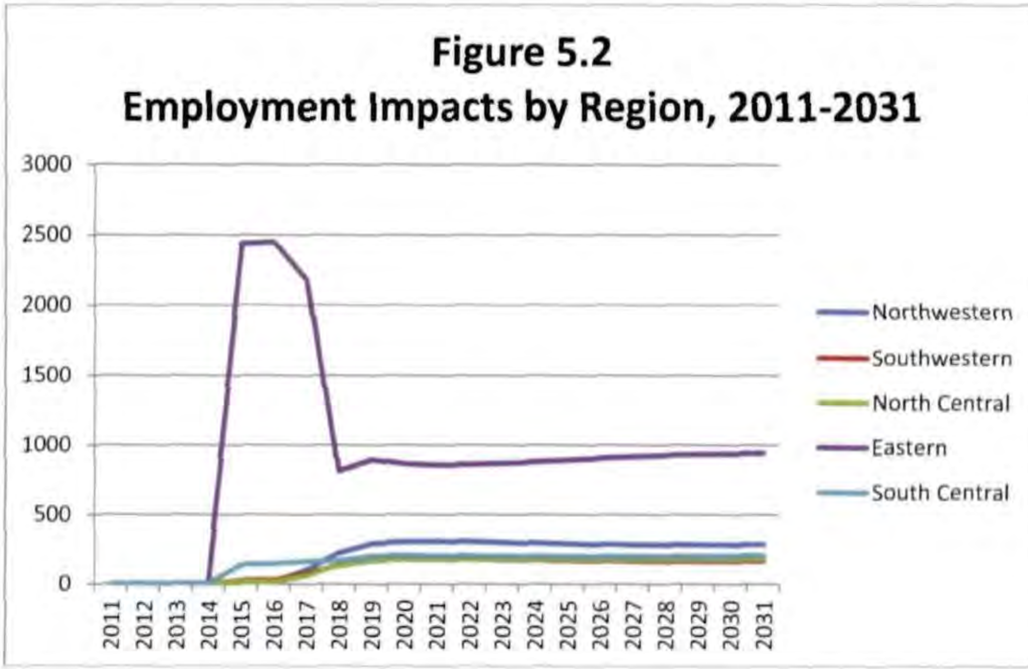
-

Figure 5.1



5.2 Employment Impacts

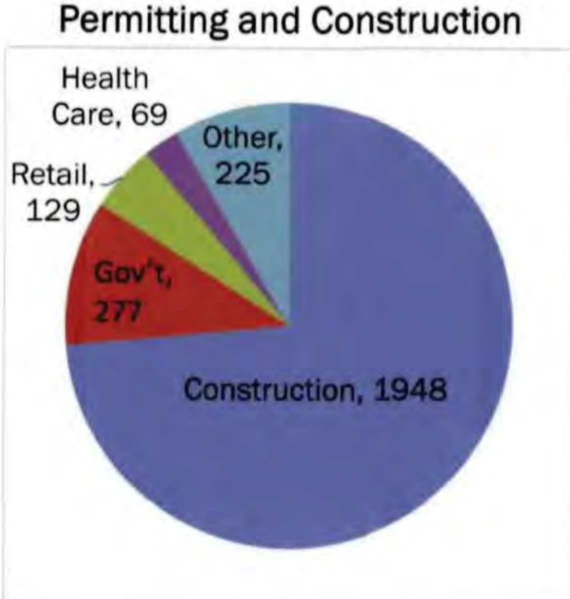
Coal development ultimately will result in a significantly higher number of jobs, both in the eastern Montana region as well as the state as a whole. The construction phase job totals peak at almost 2,650 jobs, with about 90 percent of those additional jobs created in the private sector. As shown in Figure 5.2, most of the construction phase jobs created are in eastern Montana. The next most impacted region of Montana in terms of new jobs is the south central portion of the state, which includes Billings.



As the figure shows, while the construction phase jobs only persist during the period when the mine facilities and rail lines are being built, the operations jobs are permanent additions to the Montana economy. The employment impacts drift up modestly over time as population and demographic dynamics unfold. At the first year of operations, 1,740 new permanent jobs are added to the state economy due to Otter Creek coal operations.

Some insights can be made on the nature of these jobs if we examine the different industries and occupations they represent. As shown in Figure 5.3, the composition of the job impacts changes significantly after the construction phase is over. Nearly three quarters of all of the jobs created by coal development during the construction phase of the project are in the construction industry itself. Smaller, yet significant, impacts are seen in Government, Retail Trade, Health Care, and other industries as the spending of construction and other workers propagates through the regional economy.

Figure 5.3
Employment Impacts by Industry



When the operations phase is underway, the composition of the jobs impacts changes. This reflects not only the addition of the mining jobs themselves, but also the population- related increases in local public school employment (included in Government), health care jobs and such businesses as retail and restaurants. These impacts demonstrate the importance of the induced jobs created as the direct impacts of mining and railroad jobs impact services and government in the state.

A second way to look at the job impacts of coal development is by examining the impacts by occupation. The U.S. Bureau of Labor Statistics classifies each job in the economy into 23 major categories, from white collar management to blue collar production occupations. Figure 5.4 again shows that the most profound job impacts of coal development in the construction phase of the project is in the construction and extraction occupations, comprising nearly half of all jobs created. When looking at occupations, however, the job impacts are more varied in all phases of the project. There are significant management jobs involved in construction and permitting, as well as jobs in sales and administrative support, maintenance jobs and jobs in other occupations. The full list of job impacts by occupations is shown in Table 5.2.

In the operations phase, job impacts spread out across a larger number of occupations. The largest impacts are on sales and administrative support positions, construction occupations, transportation occupations, and management.

Figure 5.4
Employment Impacts by Occupation

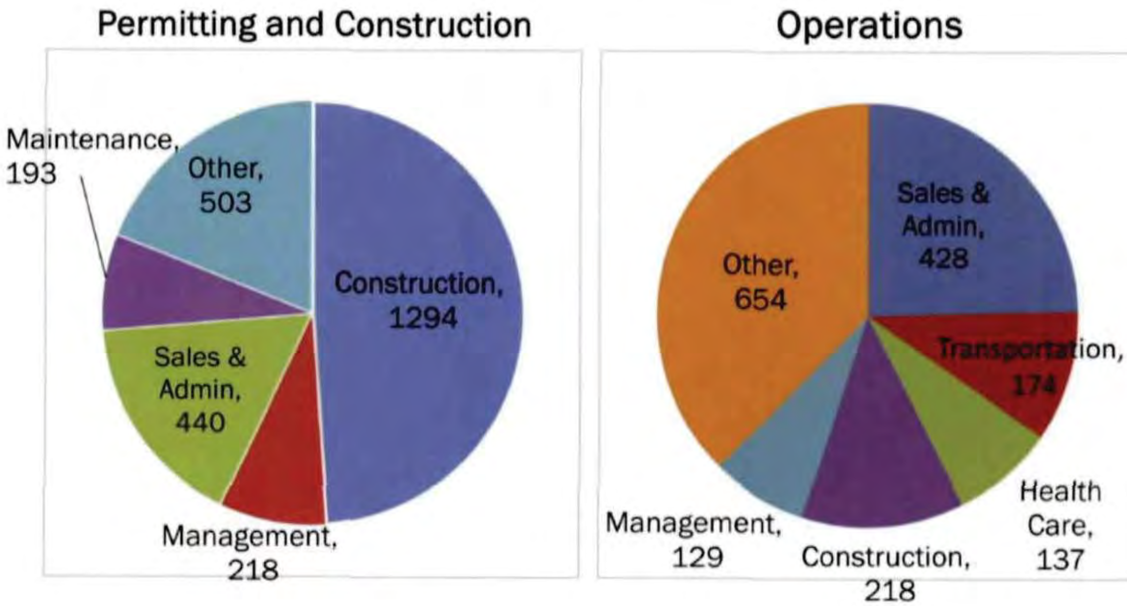


Table 5.2
Employment Impacts by Occupation

Occupation	Job Impacts by Phase: Construction	Job Impacts by Phase: Operations
Management, business, financial occupations	218	129
Computer, math, architect, engineer occupations	49	49
Life, physical, social science occupations	10	16
Community, social service occupations	4	10
Legal occupations	10	15
Education, training, library occupations	8	17
Arts, design, entertainment, sports, media occupations	7	13
Health care occupations	65	137
Protective service occupations	74	110
Food preparation, serving related-occupations	59	124
Building, grounds, personal care, service occupations	60	106
Sales, office, administrative occupations	440	428
Farm, fishing, forestry occupations	2	2
Construction, extraction occupations	1,294	218
Installation, maintenance, repair occupations	193	122
Production occupations	49	71
Transportation, material moving occupations	107	174
TOTAL	2,648	1,740

5.3 Income and Compensation Impacts

The income impacts attributable to the development of Otter Creek coal are substantial, whether measured against the income of the entire state, or against the much smaller income base of eastern Montana. Both mining and railroad jobs pay wages significantly above the state average, and even though every job created by coal development is not a high paying job, the increased income due to the project is substantial.

Since income is measured in dollars, and the impacts of coal development occur in the future, it is important to take into account the effect of wage and price inflation when reporting these results. All impacts measured in dollars in this report are calculated according to their purchasing power in year the 2012. Thus with inflation, a dollar amount of income realized in, say, year 2019 would yield a somewhat smaller amount

Table 5.3
Personal Income Impact, Millions of Dollars

Category	Income Impacts by Phase	
	Construction	Operations
Total Earnings by Place of Work	$123.0	$119.4
Total Wage and Salary Disbursements	81.9	88.1
Supplements to Wages and Salaries	21.0	25.5
Employer contributions for employee pension and insurance funds	13.5	16.3
Employer contributions for government social insurance	7.5	9.2
Proprietors' income with inventory valuation and capital consumption adjustments	20.2	5.8
Less: Contributions for government social insurance	15.8	18.3
Employee and self-employed contributions for government social insurance	8.3	9.1
Employer contributions for government social insurance	7.5	9.2
Plus: Adjustment for residence*	-1.7	-1.2
Gross earnings flows into Montana	2.2	2.1
Gross earnings flows out of Montana	3.9	3.3
Equals: Net earnings by place of residence	105.6	99.9
Plus: Rent, interest, and dividends	5.8	19.0
Plus: Personal current transfer receipts	-7.8	6.6
Equals: Personal Income	103.5	125.4
Less: Personal current taxes	15.7	-42.4
Equals: Disposable personal income	87.7	167.9

* Total earnings data are derived from records of employers who are located in Montana. Since some Montana workers are employed by out-of-state firms, and some Montana firms employ workers from other states, the adjustment for residence nets out these two impacts to produce an estimate of Montana residents' income.

of purchasing power in 2012, and the inflation correction (which reduces it) reflects that fact.

As shown in Table 5.3, there is considerably more to personal income – the income received by Montana households – than the wages and salaries workers receive from employment. Most – but not all – of the income impacts listed in the table for both the construction and operations phase of the project are connected to employment. Total earnings are $123 million higher during the construction phase of the project, including benefits and an additional $20.2 million earned by business owners during the same year due to coal development. Even some categories of so-called non-earned income, such as dividends, interest, and rent are positively impacted by coal development, largely through the population impacts of the project.

The U.S. Bureau of Economic Analysis defines personal income as wages and benefits net of social security contributions, but prior to paying personal income tax. The impact on personal income is $105.6 million during the peak year of the construction phase, and falls only slightly to just shy of $100 million per year during the operations phase. The very small decrease, despite the much fewer number of jobs when construction is over, reflects the high paying nature of the rail and mining jobs that commence with mine operation.

After tax, or disposable personal income, impacts actually are higher during the operations phase, at about $168 million per year. This is because of the treatment of the severance taxes paid to state government during mining operations. As described in section 3, these taxes are assumed to be used to finance state expenditures with a slightly lower personal tax rate. As shown in the table, the net effect of this tax decline with the increase base is a $42.4 million decrease in personal tax payments (to both the state and federal government).

The earnings and income impacts of coal development are significant. With the construction phase concentrated in less populous eastern Montana, the additional income attributable to coal development in the last year of construction (2017) for this single project represents more than 3.5 percent of total income for the entire region. In the operations phase of the project, the average earnings per new job added ($68,600) exceeds the state average by a sufficient margin to actually raise the total compensation per job in the entire state economy (Table 5.4). It is clear that in terms of income, coal development is an important event.

Table 5.4
Compensation Impacts

Category	Units	Compensation Impacts by Phase	
		Construction	Operations
Wage and Salary Disbursements	$ Millions	81.9	88.1
Compensation	$ Millions	102.9	113.6
Earnings by Place of Work	$ Millions	123.0	119.4
Average Annual Wage Rate	$ Thousands	0.003	0.054
Average Annual Compensation Rate	$ Thousands	0.001	0.071
Average Annual Earnings Rate	$ Thousands	0.010	0.060

Note: Compensation includes cash and non-cash employee benefits, including health, retirement, and other employer-funded programs. Earnings includes employee compensation and proprietor's income. All compensation is measured on a place-of-work basis.

5.4 Output Impacts

A third aspect of the impact of coal development on the Montana economy can be evaluated by examining the impacts on economic output. This is particularly relevant for capital-intensive industries whose employment impacts may understate their reaction to changes that occur as a result of new coal activity. Net output is measured in inflation-corrected dollars, using value added (revenues minus costs) by industry.

Table 5.5 reveals that the impact on economic output is almost 60 percent higher during mining operations than during the construction phase of the project, even as the total employment impact falls after construction. This occurs as the two most capital intensive industries – mining and rail transport – ramp up as mining operations commence. The table clearly reveals the outsized impact contribution of mining's value added during the operations phase.

These output gains are substantial, especially as measured against the comparatively smaller regional economy of eastern Montana. Whereas the overall output increase of $231.1 million per year during the operations phase only represents about 0.4 percent of total state output, $150.3 million of that change comes from producers located in eastern Montana. Mining operations at this single facility in Powder River County are thus responsible for more than 4 percent of total economic output of the entire region.

Table 5.5
Gross Domestic Product Impacts
(Private Sector, $ Millions)

Industry	GDP Impacts by Phase Construction	Operations
Forestry, Fishing, Related Activities, and Other	0.0	0.0
Mining	(0.3)	138.9
Utilities	0.1	2.4
Construction	110.7	6.4
Manufacturing	0.5	0.4
Wholesale Trade	5.0	9.1
Retail Trade	7.1	14.8
Transportation and Warehousing	(0.0)	10.1
Information	0.1	0.4
Finance and Insurance	0.4	1.4
Real Estate and Rental and Leasing	1.8	6.0
Professional and Technical Services	1.8	2.9
Management of Companies and Enterprises	(0.0)	(0.0)
Administrative and Waste Services	1.0	2.0
Educational Services	0.0	0.2
Health Care and Social Assistance	4.9	12.0
Arts, Entertainment, and Recreation	0.1	0.4
Accommodation and Food Services	1.4	3.1
Other Services, except Public Administration	1.7	2.8
Total	136.3	213.1

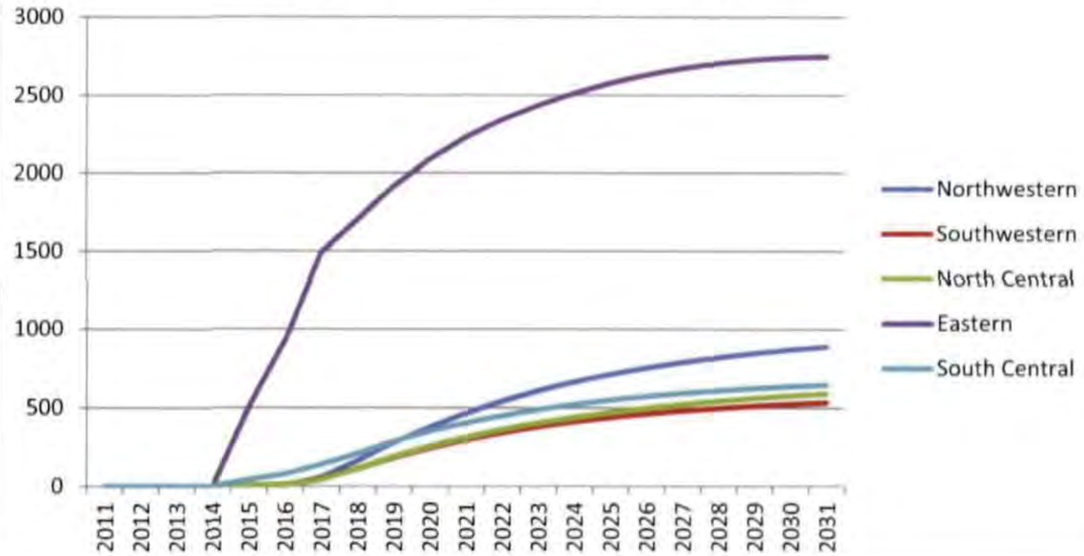
5.5 Population Impacts

The economic opportunity represented by a large scale energy investment paying compensation per job substantially in excess of the Montana average is attractive to potential workers. As has actually occurred in the wake of other significant capital investments that create high paying jobs – e.g., Colstrip in the 1980s – we can expect to see a significant increase in the population of southeastern Montana resulting from coal development. A second, less pronounced, draw for new migrants to the state could result from the ability of state government to meet its obligations with slightly lower personal taxes – making up the difference with severance taxes collected from the new mine. This effectively increases the after-tax wage of every Montana job, making state jobs slightly more attractive than the "no coal" scenario situation.

Population changes take time to develop, for two reasons. First, as an empirical matter, years typically pass before increased opportunity induces a nonresident household to relocate. This is due in part to the expense and complexity of moving families. A second reason is that children born to those who migrate may not show up until years after the move. This is especially prevalent since mobility is prominent for those in prime child-bearing ages groups.

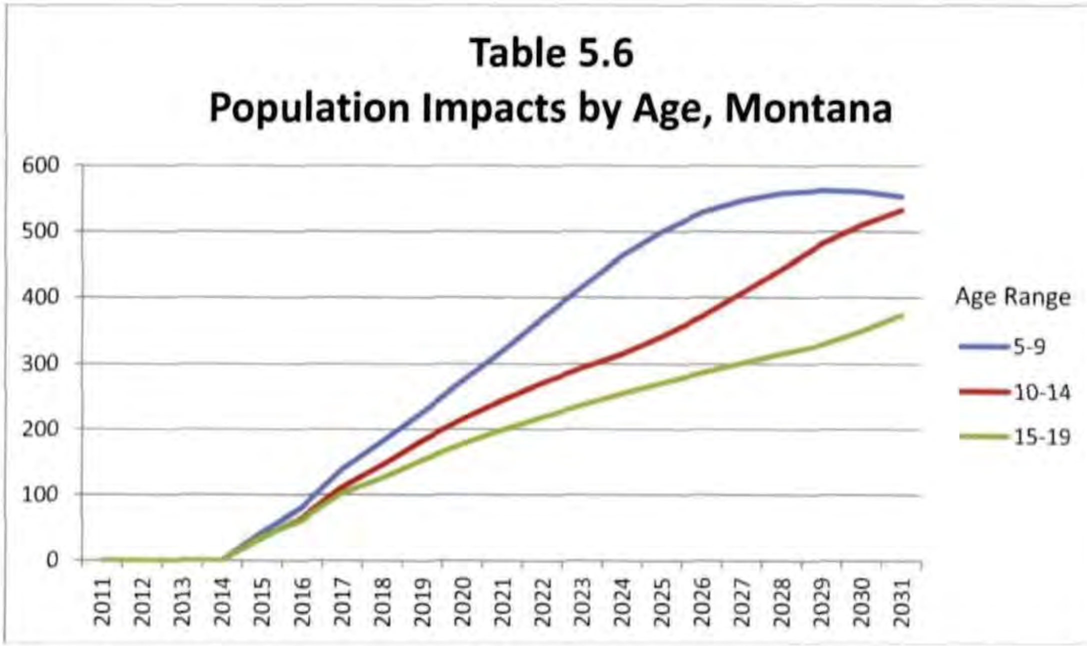
For these reasons, the population impacts of coal development in Otter Creek given in summary Table 5.1 at the beginning of this section significantly understate the changes in population that the development will eventually produce.

Figure 5.5
Population Impacts by Region



As is clear from Figure 5.5 above, the population impacts grow significantly beyond year 2019, which is the first year of full mine operation reported in the overall impacts summary. Indeed, by year 2031 mining operations will ultimately be responsible for the addition of almost 5,400 more people throughout the state, with roughly half living in eastern Montana. This gradual increase in population will create additional demand for housing, health care, consumer goods, and government services.

Since younger people are more mobile, population migration has particular impacts on the younger aged cohorts. Of particular interest to rural school districts in the slower growing areas of the state is the impact of coal development on the school-aged population.



The statewide impacts are shown in Figure 5.6 above for three five-year age cohorts. These correspond roughly to elementary, middle school, and high school populations. These population impacts build over time, such that in year 2031 we would expect the total increase to approach 1,500. This could stabilize or increase the demand for public schooling in the affected communities.

5.6 Summary

This section has examined in detail the changes that can be expected to occur in the Montana and the eastern Montana economies as a result of coal development in Powder River County. Not only is the development of the coal and rail infrastructure and facilities responsible for almost 2,700 jobs and more than $100 million in personal income in the peak construction year of the projects, but the operations of the mine will create 1,740 permanent, high-paying jobs across the state. By any measure, these are significant impacts that help create a more productive, prosperous, and populous state economy.

6. Conclusion

The research question posed by this study is "What would the economy of Montana look like if Otter Creek coal development takes place?" It is a hypothetical question – we have no special insight on the prospects for those investments, from either an economic or a political standpoint. Yet in a policy and political environment where the contributions of coal development to the state economy are poorly understood or perhaps taken for granted, it deserves to be carefully analyzed and answered.

Using a state-of-the-art policy analysis model of the Montana economy that has been peer-reviewed and used in dozens of other studies, we have carefully examined the contribution made to both the economy of eastern Montana as well as to the state economy as a whole by the proposed Otter Creek mine. Our study has revealed the footprint of this single facility in Powder River County to be substantial. Comparing the status quo economy to one that would exist if the construction and operations of the mine took place as envisioned, we find that:

- 2,648 jobs, including 2,372 private sector jobs,
- more than $103 million of personal income received by Montanans, and
- $136 million in net output produced in Montana

would be created and sustained annually throughout the construction period for both the mine and the railroad. Almost three-quarters of these new jobs would be in the state's hard-hit construction industries.

When the mine goes into operation and ramps up to the 20 million tons of annual production envisioned, there will be:

- 1,740 permanent jobs, including 1,338 private sector jobs,
- more than $125.4 million in annual personal income,
- 2,843 more people, and
- almost $92 million in additional annual state tax revenues

in the Montana economy that are attributable to Otter Creek operations. To state it another way, without Otter Creek, the Montana economy will be smaller, less prosperous, and less populous by these amounts.

There are several aspects of Otter Creek coal development that lead directly to this impressive result. First, the facility will pay wages and benefits to its workforce that are substantially above the state and regional average. When employees spend part of their money in the local and state economy, many other jobs are supported. Second, the operation of the facility is a boon to another high-paying industry with a significant presence in Montana, namely, the railroad. Finally, the project involves a huge capital investment – well in excess of $1 billion – to be committed to the equipment, facilities, rail, and other support infrastructure in the state.

Finally, the product produced by Otter Creek – high quality coal delivered to domestic and overseas markets – does not displace or crowd out other Montana producers. Thus it's activities add to, rather than supplant or replace, other activities in the economy. The uses and demand for electricity worldwide continue to grow, and the prospects for the state with the nation's largest coal reserves to take advantage of the opportunity are very good.

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APPENDIX

REMI Tables

Otter Creek Summary

Economic Summary

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Economic Summary

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Employment	Individuals (Jobs)	+6	+6	+6	+2,626	+2,648	+2,585	+1,481	+1,740	+1,740	+1,739
Total Employment as % of Nation	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Private Non-Farm Employment	Individuals (Jobs)	+5	+5	+5	+2,364	+2,372	+2,246	+1,175	+1,338	+1,337	+1,333
Private Non-Farm Employment as % of N	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Gross Domestic Product	Millions of Fixed (2005) I	+0	+0	+0	+121	+123	+149	+134	+180	+179	+179
Gross Domestic Product (GDP) as % of N	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Output	Millions of Fixed (2005) I	+0	+0	+0	+212	+214	+267	+251	+342	+343	+343
Value Added	Millions of Fixed (2005) I	+0	+0	+0	+121	+123	+149	+134	+180	+179	+179
Personal Income	Millions of Current Dollar	+0	+0	+0	+96	+112	+152	+125	+144	+151	+157
Personal Income as % of Nation	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Disposable Personal Income	Millions of Current Dollar	+0	+0	+0	+82	+95	+156	+161	+193	+201	+208
Disposable Personal Income as % of Nati	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
PCE-Price Index	2005=100 (Nation)	0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Real Disposable Personal Income	Millions of Fixed (2005) I	+0	+0	+0	+64	+71	+115	+116	+136	+139	+140
Real Disposable Personal Income as % of	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Population	Individuals	+0	+1	+1	+559	+1,025	+1,770	+2,289	+2,843	+3,308	+3,701
Population as % of Nation	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0

Otter Creek Summary

Economic Summary

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Economic Summary

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
+1,736	+1,735	+1,736	+1,738	+1,743	+1,750	+1,758	+1,768	+1,776	+1,787	+1,795	+1,805	+1,810	+1,813	+1,813
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+1,327	+1,325	+1,324	+1,325	+1,330	+1,336	+1,344	+1,353	+1,361	+1,371	+1,380	+1,390	+1,396	+1,400	+1,402
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+178	+178	+179	+179	+180	+180	+181	+182	+184	+185	+186	+188	+190	+191	+192
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+343	+344	+345	+345	+347	+348	+349	+351	+353	+355	+357	+359	+361	+363	+364
+178	+178	+179	+179	+180	+180	+181	+182	+184	+185	+186	+188	+190	+191	+192
+162	+168	+175	+181	+188	+196	+204	+213	+223	+234	+245	+258	+271	+283	+297
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+215	+223	+231	+239	+247	+256	+266	+277	+288	+301	+314	+328	+342	+356	+372
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+142	+143	+144	+146	+147	+148	+150	+151	+153	+155	+158	+160	+162	+164	+167
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+4,031	+4,310	+4,546	+4,745	+4,913	+5,054	+5,171	+5,266	+5,341	+5,398	+5,437	+5,462	+5,472	+5,468	+5,453
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0

Otter Creek Summary

Personal Income

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Personal Income

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Earnings by Place of Work	Millions of Fixed (2012) [	+0	+0	+0	+114	+123	+154	+109	+119	+116	+112
Total Wage and Salary Disbursements	Millions of Fixed (2012) [	+0	+0	+0	+74	+82	+108	+81	+88	+86	+83
Supplements to Wages and Salaries	Millions of Fixed (2012) [	+0	+0	+0	+19	+21	+28	+22	+25	+26	+26
Employer contributions for employee pe	Millions of Fixed (2012) [	+0	+0	+0	+12	+13	+18	+14	+16	+16	+16
Employer contributions for government	Millions of Fixed (2012) [	+0	+0	+0	+7	+8	+10	+8	+9	+9	+9
Proprietors' income with inventory valua	Millions of Fixed (2012) [	+0	+0	+0	+21	+20	+17	+6	+6	+4	+3
Less: Contributions for Government Socia	Millions of Fixed (2012) [	+0	+0	+0	+14	+16	+21	+16	+18	+18	+18
Employee and Self-Employed Contributio	Millions of Fixed (2012) [	+0	+0	+0	+7	+8	+11	+8	+9	+9	+9
Employer contributions for government s	Millions of Fixed (2012) [	+0	+0	+0	+7	+8	+10	+8	+9	+9	+9
Plus: Adjustment for Residence	Millions of Fixed (2012) [	0	0	0	-2	-2	-2	-1	-1	-1	-1
Gross In	Millions of Fixed (2012) [	+0	+0	+0	+2	+2	+3	+2	+2	+2	+2
Gross Out	Millions of Fixed (2012) [	+0	+0	+0	+4	+4	+5	+3	+3	+3	+3
Equals: Net Earnings by Place of Residenc	Millions of Fixed (2012) [	+0	+0	+0	+98	+106	+131	+92	+100	+96	+93
Plus: Rental, Personal Interest, and Persor	Millions of Fixed (2012) [	+0	+0	+0	+3	+6	+11	+15	+19	+22	+25
Plus: Personal Current Transfer Receipts	Millions of Fixed (2012) [	0	0	0	-10	-8	-4	+5	+7	+9	+12
Equals: Personal Income	Millions of Fixed (2012) [	+0	+0	+0	+91	+103	+138	+111	+125	+128	+130
Less: Personal current taxes	Millions of Fixed (2012) [	+0	+0	+0	+14	+16	-4	-32	-42	-42	-43
Equals: Disposable personal income	Millions of Fixed (2012) [	+0	+0	+0	+77	+88	+141	+144	+168	+171	+173

Otter Creek Summary

Personal Income

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Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Personal Income

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
+108	+105	+103	+101	+99	+98	+97	+97	+97	+97	+98	+99	+99	+100	+100
+81	+79	+77	+76	+75	+74	+73	+73	+73	+74	+74	+74	+75	+75	+76
+26	+26	+26	+26	+26	+26	+27	+27	+27	+27	+28	+28	+28	+28	+29
+17	+17	+17	+17	+17	+17	+17	+17	+17	+17	+18	+18	+18	+18	+18
+9	+9	+9	+9	+9	+10	+10	+10	+10	+10	+10	+10	+10	+10	+10
+2	+1	0	-1	-2	-3	-3	-3	-3	-4	-4	-4	-4	-4	-4
+18	+17	+17	+17	+17	+17	+17	+17	+17	+17	+18	+18	+18	+18	+18
+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8
+9	+9	+9	+9	+9	+10	+10	+10	+10	+10	+10	+10	+10	+10	+10
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3	+3
+90	+87	+84	+82	+81	+80	+79	+79	+79	+79	+79	+80	+80	+81	+81
+28	+30	+32	+34	+36	+37	+39	+40	+42	+43	+44	+46	+47	+48	+50
+14	+16	+17	+19	+20	+21	+22	+23	+24	+25	+27	+28	+29	+30	+31
+132	+133	+134	+135	+137	+138	+140	+142	+144	+147	+150	+153	+156	+159	+162
-43	-43	-43	-43	-43	-43	-43	-42	-42	-42	-42	-41	-41	-41	-41
+174	+176	+177	+178	+179	+181	+182	+185	+187	+189	+192	+195	+198	+200	+203

Otter Creek Summary

Employment | Industry | Private Non-Farm | Private Non-Farm Employment | Sector Level

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Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Sector Level

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Forestry, Fishing, Related Activities, and (	Individuals (Jobs)	+0	0	0	+0	+0	+0	+0	+0	+0	+0
Mining	Individuals (Jobs)	0	0	0	-1	-3	+346	+345	+346	+335	+326
Utilities	Individuals (Jobs)	+0	+0	0	+1	+0	+2	+4	+6	+5	+5
Construction	Individuals (Jobs)	+0	+0	+0	+1,978	+1,948	+1,218	+50	+79	+89	+94
Manufacturing	Individuals (Jobs)	+0	+0	+0	+5	+4	+3	+2	+3	+3	+3
Wholesale Trade	Individuals (Jobs)	+0	+0	+0	+31	+41	+60	+60	+66	+63	+60
Retail Trade	Individuals (Jobs)	+0	+0	+0	+106	+129	+208	+213	+235	+230	+226
Transportation and Warehousing	Individuals (Jobs)	+0	0	0	+0	0	0	+47	+51	+50	+48
Information	Individuals (Jobs)	+0	+0	+0	+1	+1	+1	+2	+3	+2	+2
Finance and Insurance	Individuals (Jobs)	+0	+0	0	+2	+2	+4	+6	+7	+7	+7
Real Estate and Rental and Leasing	Individuals (Jobs)	+0	+0	+0	+14	+12	+26	+35	+45	+45	+43
Professional and Technical Services	Individuals (Jobs)	+4	+4	+4	+27	+30	+34	+37	+44	+43	+42
Management of Companies and Enterprise	Individuals (Jobs)	0	0	0	0	0	0	0	0	0	0
Administrative and Waste Services	Individuals (Jobs)	+0	+0	+0	+25	+25	+33	+34	+43	+43	+43
Educational Services	Individuals (Jobs)	+0	+0	+0	+1	+1	+3	+5	+7	+8	+8
Health Care and Social Assistance	Individuals (Jobs)	+0	+0	+0	+67	+69	+125	+137	+165	+167	+171
Arts, Entertainment, and Recreation	Individuals (Jobs)	+0	+0	+0	+5	+5	+11	+16	+20	+20	+21
Accommodation and Food Services	Individuals (Jobs)	+0	+0	+0	+47	+54	+87	+95	+116	+125	+134
Other Services, except Public Administrati	Individuals (Jobs)	+0	+0	+0	+55	+54	+84	+87	+103	+101	+99

Otter Creek Summary

Employment | Industry | Private Non-Farm | Private Non-Farm Employment | Sector Level

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Sector Level

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
0	0	0	+0	+0	+0	+0	+0	+0	+0	+0	+1	+1	+1	+1
+317	+309	+301	+293	+286	+279	+273	+266	+259	+254	+247	+242	+236	+230	+224
+5	+5	+5	+6	+6	+6	+6	+6	+6	+6	+6	+6	+6	+6	+5
+95	+96	+95	+96	+97	+98	+101	+103	+105	+108	+110	+114	+117	+119	+121
+3	+3	+3	+3	+3	+4	+4	+4	+4	+4	+4	+5	+5	+5	+5
+58	+55	+54	+52	+51	+50	+49	+48	+47	+46	+45	+45	+44	+43	+43
+222	+220	+217	+216	+215	+214	+213	+213	+213	+214	+215	+215	+215	+215	+214
+47	+46	+45	+45	+44	+43	+43	+42	+42	+41	+41	+40	+39	+39	+38
+3	+3	+3	+3	+3	+4	+4	+4	+4	+5	+5	+5	+5	+5	+5
+7	+7	+8	+8	+9	+9	+10	+11	+11	+12	+12	+13	+13	+14	+14
+42	+40	+39	+38	+37	+37	+37	+37	+37	+37	+37	+38	+38	+38	+38
+41	+41	+40	+41	+41	+42	+43	+44	+45	+46	+47	+48	+49	+50	+51
0	0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+43	+43	+43	+43	+43	+44	+44	+45	+45	+46	+47	+47	+48	+48	+48
+9	+9	+9	+10	+10	+10	+10	+10	+11	+11	+11	+11	+11	+11	+12
+175	+180	+186	+192	+198	+205	+211	+218	+225	+231	+238	+244	+250	+255	+259
+22	+23	+24	+25	+25	+26	+27	+28	+29	+30	+31	+32	+32	+33	+34
+141	+148	+154	+160	+165	+169	+173	+176	+179	+182	+184	+186	+187	+188	+189
+98	+97	+97	+96	+96	+97	+97	+98	+98	+99	+99	+100	+100	+100	+100

Otter Creek Summary

Employment | Industry | Government | State and Local

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
State and Local

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
State Government	Individuals (Jobs)	+0	+0	+0	+35	+37	+50	+54	+71	+73	+73
Local Government	Individuals (Jobs)	+0	+0	+0	+228	+240	+289	+251	+331	+331	+334

Otter Creek Summary

Employment | Industry | Government | State and Local

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Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
State and Local

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
+73	+73	+73	+73	+73	+72	+72	+72	+72	+73	+73	+73	+73	+73	+73
+335	+337	+339	+340	+341	+342	+342	+343	+343	+343	+342	+342	+341	+340	+338

Otter Creek Summary

Employment | Occupation | Summary Level

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Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Summary Level

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Management, business, financial occupatic	Individuals (Jobs)	+1	+1	+1	+217	+218	+196	+105	+129	+129	+129
Computer, math, architect, engineer occu	Individuals (Jobs)	+1	+1	+1	+48	+49	+55	+40	+49	+48	+48
Life, physical, social science occupations	Individuals (Jobs)	+0	+0	+0	+9	+10	+14	+13	+16	+16	+16
Community, social service occupations	Individuals (Jobs)	+0	+0	+0	+4	+4	+7	+8	+10	+11	+11
Legal occupations	Individuals (Jobs)	+0	+0	+0	+10	+10	+12	+12	+15	+15	+15
Education, training, library occupations	Individuals (Jobs)	+0	+0	+0	+8	+8	+12	+13	+17	+17	+18
Arts, design, entertainment, sports, medi	Individuals (Jobs)	+0	+0	+0	+7	+7	+10	+10	+13	+13	+13
Healthcare occupations	Individuals (Jobs)	+0	+0	+0	+62	+65	+107	+113	+137	+138	+140
Protective service occupations	Individuals (Jobs)	+0	+0	+0	+70	+74	+92	+84	+110	+110	+111
Food preparation, serving related occupati	Individuals (Jobs)	+0	+0	+0	+51	+59	+94	+102	+124	+133	+141
Building, grounds, personal care, service c	Individuals (Jobs)	+0	+0	+0	+60	+60	+88	+88	+106	+105	+104
Sales, office, administrative occupations	Individuals (Jobs)	+2	+2	+2	+421	+440	+489	+366	+428	+421	+416
Farm, fishing, forestry occupations	Individuals (Jobs)	+0	+0	+0	+2	+2	+2	+2	+2	+2	+2
Construction, extraction occupations	Individuals (Jobs)	+0	+0	+0	+1,314	+1,294	+955	+192	+218	+220	+220
Installation, maintenance, repair occupatic	Individuals (Jobs)	+0	+0	+0	+193	+193	+197	+108	+122	+121	+119
Production occupations	Individuals (Jobs)	+0	+0	+0	+48	+49	+80	+65	+71	+69	+68
Transportation, material moving occupatic	Individuals (Jobs)	+0	+0	+0	+105	+107	+174	+160	+174	+170	+167

Otter Creek Summary

Employment | Occupation | Summary Level

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Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Summary Level

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
+129	+129	+129	+129	+129	+130	+131	+132	+133	+134	+135	+136	+136	+137	+137
+47	+47	+47	+47	+47	+47	+48	+48	+48	+49	+49	+49	+50	+50	+50
+16	+16	+16	+16	+16	+16	+16	+17	+17	+17	+17	+17	+17	+17	+17
+12	+12	+13	+13	+14	+14	+15	+15	+16	+16	+16	+17	+17	+17	+18
+15	+15	+15	+15	+15	+15	+15	+16	+16	+16	+16	+16	+16	+16	+16
+18	+19	+19	+19	+20	+20	+20	+21	+21	+21	+21	+22	+22	+22	+22
+13	+13	+14	+14	+14	+14	+14	+15	+15	+15	+16	+16	+16	+16	+16
+143	+147	+150	+154	+158	+162	+166	+171	+175	+180	+184	+188	+192	+195	+198
+112	+112	+113	+113	+114	+114	+114	+115	+115	+115	+115	+115	+115	+115	+115
+149	+155	+161	+166	+171	+175	+179	+182	+185	+188	+190	+192	+193	+194	+194
+103	+102	+102	+103	+103	+104	+104	+105	+106	+107	+108	+109	+109	+110	+110
+411	+408	+405	+404	+403	+404	+405	+406	+408	+410	+412	+414	+416	+416	+416
+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
+217	+214	+211	+208	+206	+204	+204	+202	+201	+201	+200	+200	+199	+199	+198
+118	+117	+115	+114	+114	+113	+113	+112	+112	+112	+111	+111	+111	+110	+110
+67	+66	+65	+64	+63	+63	+62	+62	+61	+61	+61	+60	+60	+59	+59
+163	+161	+158	+155	+153	+151	+149	+147	+146	+144	+143	+141	+140	+138	+136

Otter Creek Summary

Gross Domestic Product | Real Gross Value Added by Sector, Fixed Dollars | Private Non-Farm | Sector Level

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Sector Level

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Forestry, Fishing, Related Activities, and (	Thousands of Fixed (201	0	0	0	+4	+4	+5	+3	0	-5	-10
Mining	Thousands of Fixed (201	0	-1	-1	-85	-337	+56,511	+95,945	+138,913	+137,041	+136,750
Utilities	Thousands of Fixed (201	+1	+1	+0	+436	+115	+1,069	+1,520	+2,357	+2,249	+2,170
Construction	Thousands of Fixed (201	+12	+17	+20	+110,853	+110,725	+70,549	+4,410	+6,409	+7,243	+7,645
Manufacturing	Thousands of Fixed (201	+0	+1	+0	+467	+450	+365	+290	+367	+361	+347
Wholesale Trade	Thousands of Fixed (201	+6	+6	+6	+3,658	+5,032	+7,675	+8,107	+9,135	+8,955	+8,773
Retail Trade	Thousands of Fixed (201	+12	+13	+14	+5,701	+7,131	+12,010	+12,957	+14,772	+14,677	+14,603
Transportation and Warehousing	Thousands of Fixed (201	+0	0	0	+41	-30	-32	+9,022	+10,099	+10,078	+10,058
Information	Thousands of Fixed (201	+1	+1	+1	+157	+106	+236	+318	+386	+330	+283
Finance and Insurance	Thousands of Fixed (201	+2	+2	+2	+454	+374	+771	+1,115	+1,351	+1,250	+1,157
Real Estate and Rental and Leasing	Thousands of Fixed (201	+8	+8	+8	+2,078	+1,809	+3,639	+4,745	+6,001	+5,858	+5,611
Professional and Technical Services	Thousands of Fixed (201	+232	+232	+233	+1,620	+1,847	+2,139	+2,369	+2,869	+2,841	+2,794
Management of Companies and Enterprise	Thousands of Fixed (201	+0	0	0	-2	-20	-16	-13	-3	-8	-9
Administrative and Waste Services	Thousands of Fixed (201	+5	+5	+5	+980	+1,012	+1,408	+1,608	+2,049	+2,075	+2,087
Educational Services	Thousands of Fixed (201	+0	+0	+0	+25	+30	+75	+118	+155	+170	+182
Health Care and Social Assistance	Thousands of Fixed (201	+12	+11	+12	+4,797	+4,924	+8,963	+9,952	+12,031	+12,168	+12,412
Arts, Entertainment, and Recreation	Thousands of Fixed (201	+0	+0	+0	+94	+89	+205	+289	+363	+372	+379
Accommodation and Food Services	Thousands of Fixed (201	+4	+4	+4	+1,193	+1,353	+2,235	+2,513	+3,118	+3,351	+3,564
Other Services, except Public Administrati	Thousands of Fixed (201	+4	+4	+4	+1,749	+1,718	+2,409	+2,311	+2,752	+2,688	+2,640

Otter Creek Summary

Gross Domestic Product | Real Gross Value Added by Sector, Fixed Dollars | Private Non-Farm | Sector Level

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Sector Level

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
-15	-19	-22	-25	-28	-30	-32	-33	-34	-36	-37	-38	-39	-41	-42
+136,466	+136,338	+136,162	+136,064	+136,055	+135,990	+136,094	+136,099	+136,230	+136,430	+136,577	+136,820	+137,094	+137,394	+137,717
+2,117	+2,085	+2,063	+2,050	+2,041	+2,031	+2,024	+2,014	+2,003	+1,990	+1,973	+1,956	+1,936	+1,914	+1,889
+7,801	+7,848	+7,862	+7,885	+7,970	+8,110	+8,305	+8,468	+8,661	+8,901	+9,168	+9,494	+9,813	+10,112	+10,405
+333	+320	+310	+304	+301	+301	+303	+306	+310	+314	+319	+325	+330	+334	+338
+8,615	+8,490	+8,390	+8,311	+8,257	+8,221	+8,204	+8,201	+8,216	+8,253	+8,294	+8,358	+8,412	+8,461	+8,508
+14,556	+14,544	+14,558	+14,598	+14,670	+14,766	+14,889	+15,049	+15,249	+15,481	+15,709	+15,970	+16,199	+16,403	+16,597
+10,048	+10,047	+10,053	+10,063	+10,077	+10,094	+10,112	+10,132	+10,153	+10,175	+10,199	+10,224	+10,251	+10,278	+10,308
+246	+219	+201	+189	+184	+182	+184	+189	+194	+201	+206	+215	+220	+224	+226
+1,076	+1,012	+963	+927	+902	+887	+880	+881	+884	+893	+904	+921	+935	+946	+958
+5,311	+5,001	+4,711	+4,447	+4,218	+4,028	+3,869	+3,745	+3,633	+3,539	+3,447	+3,374	+3,283	+3,181	+3,057
+2,749	+2,720	+2,708	+2,713	+2,734	+2,769	+2,814	+2,869	+2,927	+2,991	+3,058	+3,131	+3,200	+3,265	+3,329
-7	-2	+6	+15	+25	+35	+46	+56	+66	+76	+85	+93	+100	+107	+113
+2,097	+2,112	+2,133	+2,158	+2,188	+2,223	+2,263	+2,308	+2,354	+2,405	+2,455	+2,509	+2,558	+2,603	+2,646
+191	+200	+207	+213	+219	+225	+230	+235	+240	+244	+249	+253	+257	+261	+265
+12,731	+13,123	+13,571	+14,041	+14,544	+15,079	+15,647	+16,257	+16,850	+17,476	+18,093	+18,743	+19,351	+19,906	+20,442
+387	+395	+403	+412	+421	+431	+442	+453	+464	+475	+486	+497	+507	+514	+521
+3,755	+3,929	+4,085	+4,225	+4,351	+4,462	+4,565	+4,663	+4,748	+4,823	+4,889	+4,951	+4,998	+5,032	+5,057
+2,601	+2,574	+2,558	+2,548	+2,547	+2,553	+2,566	+2,588	+2,609	+2,638	+2,667	+2,705	+2,734	+2,757	+2,778

Otter Creek Summary

Industries

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Industries

Category	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Employment	Individuals (Jobs)	+6	+6	+6	+2,626	+2,648	+2,585	+1,481	+1,740	+1,740	+1,739
Employment as % of Nation	Percent	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Regional Purchase Coefficient	Proportion	0	0	0	0	0	0	0	0	0	0
Average Annual Wage Rate	Thousands of Current Dc	0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Average Annual Compensation Rate	Thousands of Current Dc	0	0	+0	0	+0	+0	+0	+0	+0	+0
Average Annual Earnings Rate	Thousands of Current Dc	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
Demand	Millions of Fixed (2012) [	+4	+4	+4	+673	+730	+559	+1,292	+1,466	+1,465	+1,461
Imports of Goods and Services	Millions of Fixed (2012) [	+4	+4	+4	+444	+496	+357	+1,177	+1,326	+1,322	+1,318
Self Supply	Millions of Fixed (2012) [	+0	+0	+0	+229	+234	+202	+115	+140	+142	+144
Exports of Goods and Services	Millions of Fixed (2012) [	+0	+0	+0	+19	+17	+111	+179	+261	+259	+258
Output	Millions of Fixed (2012) [	+0	+0	+0	+248	+251	+313	+294	+400	+402	+402
Value Added	Millions of Fixed (2012) [	+0	+0	+0	+141	+144	+175	+157	+210	+209	+209
Wage and Salary Disbursements	Millions of Fixed (2012) [	+0	+0	+0	+74	+82	+108	+81	+88	+86	+83
Compensation	Millions of Fixed (2012) [	+0	+0	+0	+94	+103	+137	+104	+114	+111	+109
Earnings by Place of Work	Millions of Fixed (2012) [	+0	+0	+0	+114	+123	+154	+109	+119	+116	+112
Labor Productivity	Thousands of Fixed (200	0	0	0	0	0	+0	+0	+0	+0	+0
National Deflator	2005=1 (Nation)	0	0	0	0	0	0	0	0	0	0

Otter Creek Summary

Industries

C:\Users\Pat.Barkey\Documents\REMI\PI+ Montana Regions v1.3.5 (Build 2599)\Workbooks\Otter Creek with RR and taxes.rwb
Regional Simulation 1 compared to Standard Regional Control — Difference
Region = All Regions
Industries

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
+1,736	+1,735	+1,736	+1,738	+1,743	+1,750	+1,758	+1,768	+1,776	+1,787	+1,795	+1,805	+1,810	+1,813	+1,813
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
+1,458	+1,456	+1,454	+1,453	+1,452	+1,452	+1,453	+1,455	+1,457	+1,460	+1,463	+1,467	+1,470	+1,472	+1,475
+1,313	+1,310	+1,308	+1,305	+1,304	+1,303	+1,302	+1,302	+1,303	+1,304	+1,304	+1,306	+1,307	+1,308	+1,308
+145	+146	+146	+147	+148	+150	+151	+153	+155	+157	+159	+161	+163	+165	+166
+258	+257	+257	+258	+258	+258	+258	+259	+259	+260	+260	+260	+260	+260	+260
+402	+403	+404	+405	+406	+408	+410	+411	+414	+416	+418	+421	+423	+425	+427
+209	+209	+209	+210	+210	+211	+212	+214	+215	+217	+219	+220	+222	+224	+225
+81	+79	+77	+76	+75	+74	+73	+73	+73	+74	+74	+74	+75	+75	+76
+107	+105	+103	+102	+101	+100	+100	+100	+100	+101	+101	+102	+103	+104	+104
+108	+105	+103	+101	+99	+98	+97	+97	+97	+97	+98	+99	+99	+100	+100
+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 54

‹ ALL ENERGY IN BRIEF ARTICLES

ENERGY IN BRIEF

ARTICLES | EMAIL THIS PAGE | PRINT

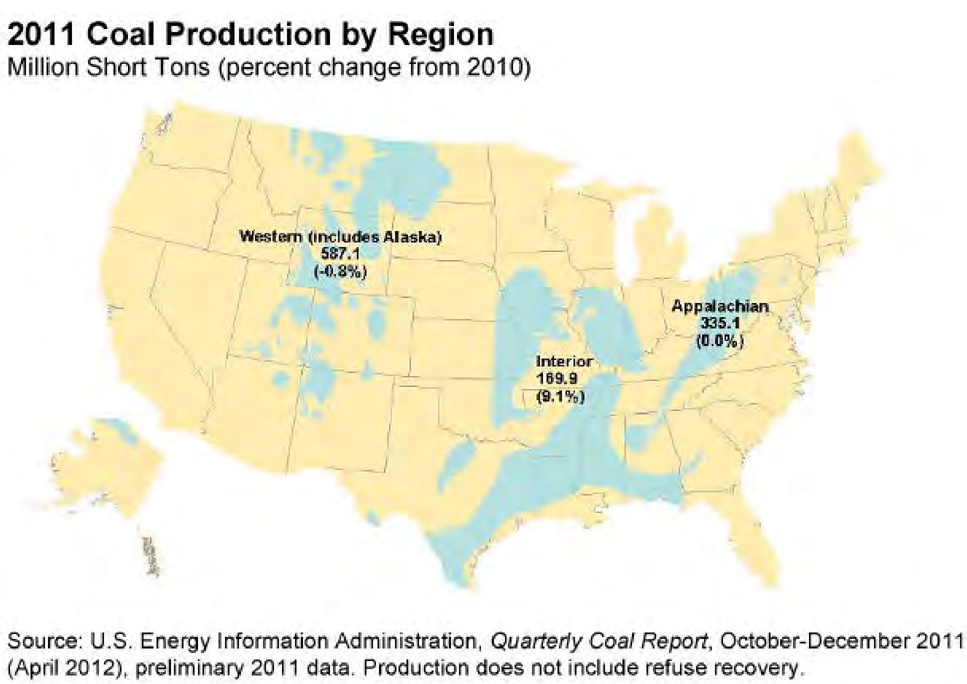
What is the role of coal in the United States?

Last Updated: July 18, 2012

The United States holds the world's largest estimated recoverable reserves of coal and is a net exporter of coal. In 2011, our nation's coal mines produced more than a billion short tons of coal, and more than 90% of this coal was used by U.S. power plants to generate electricity. While coal has been the largest source of electricity generation for over 60 years, its annual share of generation declined from 49% in 2007 to 42% in 2011 as some power producers switched to lower-priced natural gas.

Coal is an Abundant U.S. Resource

The United States is home to the largest estimated recoverable reserves of coal in the world. In fact, we have enough coal to last more than 200 years, based on current production levels. Coal is produced in 25 states spread across three coal-producing regions. In 2011, approximately 72% of production originated in five states: Wyoming, West Virginia, Kentucky, Pennsylvania, and Texas.



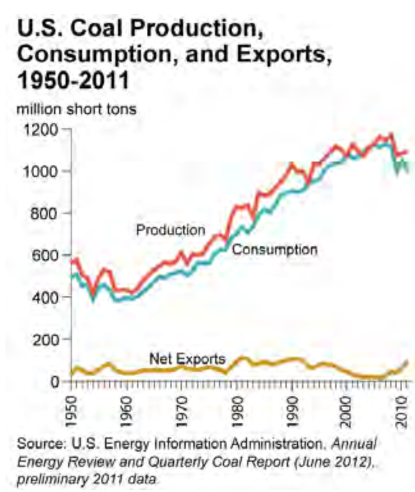
Most of Our Coal is Used to Generate Electricity

Over 90% of U.S. coal consumption is in the electric power sector. The United States has more than 1,400 coal-fired electricity generating units in operation at more than 600 plants across the country. Together, these power plants generate over 40% of the electricity produced in the United States and consume more than 900 million short tons of coal per year.

Did You Know?

In 2011, Wyoming produced 438 million short tons of coal, or 40% of the coal mined in the United States. West Virginia was the second largest producer, with 135 million short tons (12%).

U.S. coal mines produce more coal than the nation consumes.



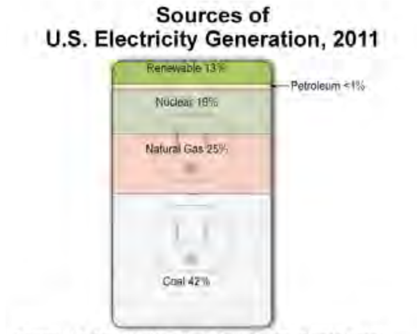
Download Figure Data

Coal is the largest source of U.S. electricity generation.

Although coal-fired generation still holds the largest share among all sources of electricity, its use has declined since 2007 due to a combination of slow growth in electricity demand, strong price competition with natural gas, and increased use of renewable technologies. See related article — *Today in Energy*, July 6, 2012

While the share of our electricity generated from coal is expected to decrease by 2035, the amount of coal used to meet growing demand for power is expected to increase in the absence of new policies to limit or reduce emissions of carbon dioxide and other greenhouse gases. Revised emissions policies could significantly change the outlook for domestic coal use. See related article — *Today in Energy*, May 4, 2012

Besides its role in generating electricity, coal also has industrial applications in cement making and conversion to coke for the smelting of iron ore at blast furnaces to make steel. A small amount of coal is also burned to heat commercial, military, and institutional facilities, and an even smaller amount is used to heat homes.



Source: U.S. Energy Information Administration, *Electric Power Monthly* (March 2012). Percentages based on Table 1.1, preliminary 2011 data.

The United States Exports Coal to Other Countries

Between 2000 and 2010, about 5% of the coal produced in the United States, on average, was exported to other countries. Coal exports come in two forms: metallurgical coal, which can be used for steel production, and steam coal, which can be used for electricity generation. In 2011, U.S. coal exports climbed to 10% (the highest level in two decades), partly because flooding disrupted coal mining in Australia, which is normally the world's largest coal exporter. Metallurgical coal dominated U.S. coal exports in 2011 with Europe the largest importer, followed by Asia. See related article — *Today in Energy*, June 19, 2012

The United States also imports a small amount of coal; some power plants along the Gulf Coast and the Atlantic Coast find it cheaper to import coal by sea from South America than to have it transported from domestic coal mines.

Did You Know?

Different types of coal have different characteristics including sulfur content, mercury content, and heat energy content. Heat content is used to group coal into four distinct categories, known as ranks: anthracite, bituminous, subbituminous, and lignite (generally in decreasing order of heat content).

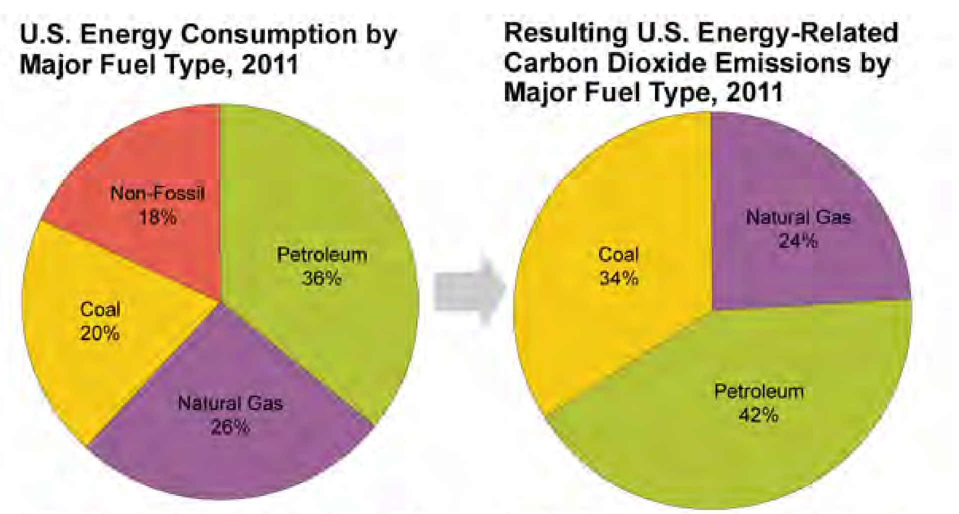
There are far more bituminous coal mines in the United States than the other ranks (over 90% of total mines), but subbituminous mines (located predominantly in Wyoming and Montana) produce more coal because their average size is much larger.

Coal Is a Relatively Inexpensive Fuel

Although some natural gas plants are more efficient than coal plants at generating electricity, in the past the fuel cost of generating one kilowatthour of electricity from natural gas had typically been higher than that of coal. In 2009, coal began losing its price advantage over natural gas for electricity generation in some parts of the country, particularly in the eastern United States as a surge in natural gas production from domestic shale deposits (made possible by advances in drilling technologies) substantially reduced the price of natural gas. See related article — *Today in Energy*, July 13, 2012

Environmental Effects from Using Coal

Coal is plentiful and fairly cheap relative to the cost of other sources of electricity, but its use produces several types of emissions that adversely affect the environment. Coal emits sulfur dioxide, nitrogen oxide, and heavy metals (such as mercury and arsenic) and acid gases (such as hydrogen chloride), which have been linked to acid rain, smog, and health issues. Coal also emits carbon dioxide, a greenhouse gas. In 2011, coal accounted for 34% of the energy-related carbon dioxide emissions in the United States. On the production-side, coal mining can have a negative impact on ecosystems and water quality, and alter landscapes and scenic views.



Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 (May 2012), preliminary 2011 data.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 12.1 (May 2012), preliminary 2011 data.

Outlook for Future Coal Use

The economics of burning coal may change if the U.S. adopts policies that restrict or otherwise control carbon dioxide emissions. For example, a cap-and-trade program to regulate carbon dioxide emissions would likely increase the cost of burning coal because of its carbon content, and thereby cause power companies to consider using less carbon-intensive generating technologies such as nuclear, renewables, and natural gas. In March 2012, the U.S. Environmental Protection Agency proposed a new source performance standard for emissions of carbon dioxide (CO_2) that would establish an output-based emission limit of 1,000 pounds of CO_2 per megawatthour for new fossil-fuel-fired power plants. This emission limit would effectively require that new coal-fired generating units employ carbon capture and sequestration (CCS) technologies to reduce uncontrolled emissions of CO_2 by approximately 50%.

Researchers are working on ways to lower the costs and improve the efficiency of various CCS technologies with a goal of capturing approximately 90% of the carbon dioxide from coal plants before it is emitted into the atmosphere and then storing it below the Earth's surface. CCS would theoretically address much of coal's carbon dioxide emissions; however, substantial economic and technological hurdles remain.

LEARN MORE

- Animated global map - coal consumption growth
- Recent coal articles
- Fuel Competition in Power Generation
- Quarterly Coal Report
- Coal Projections Through 2035
- Energy Explained: Coal
- Energy Explained: Electricity in the United States
- Clean Coal Technology Compendium (NETL)

APPENDIX 55

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Regional Adaptation
Sectoral Adaptation

Supporting Materials
An Agenda for Climate Impacts Science
Federal Advisory Committee Authors
Report Credits

Global Climate Change

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Key Messages:

- Human activities have led to large increases in heat-trapping gases over the past century.
- Global average temperature and sea level have increased, and precipitation patterns have changed.
- The global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases. Human “fingerprints” also have been identified in many other aspects of the climate system, including changes in ocean heat content, precipitation, atmospheric moisture, and Arctic sea ice.
- Global temperatures are projected to continue to rise over this century; by how much and for how long depends on a number of factors, including the amount of heat-trapping gas emissions and how sensitive the climate is to those emissions.

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1. Influences on Climate
   - Heat-trapping gases
   - Other human influences
   - Natural influences
   - Carbon release and uptake
   - Ocean acidification
2. Observed Climate Change
   - Temperatures are rising
   - Precipitation patterns are changing
   - Sea level is rising
3. Human "Fingerprint" on Climate
4. Projected Climate Change
   - Emissions scenarios
   - Rising global temperature
   - Changing precipitation patterns
   - Currently rare extreme events are becoming more common
   - Sea level will continue to rise
   - Abrupt climate change
5. Primary Sources
6. References

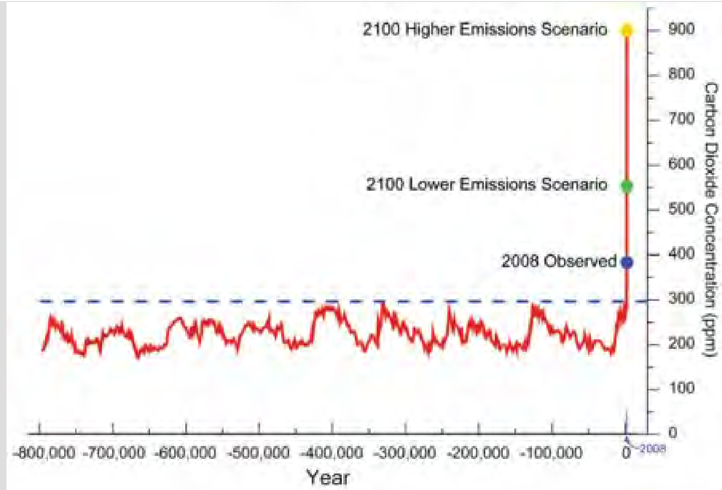
This introduction to global climate change explains very briefly what has been happening to the world’s climate and why, and what is projected to happen in the future. While this report focuses on climate change impacts in the United

800,000 Year record of CO2 Concentration

- Primary Sources of Information
- Data Sets
- Image Gallery
- References

States, understanding these changes and their impacts requires an understanding of the global climate system.

Many changes have been observed in global climate over the past century. The nature and causes of these changes have been comprehensively chronicled in a variety of recent reports, such as those by the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Climate Change Science Program (CCSP). This section does not intend to duplicate these comprehensive efforts, but rather to provide a brief synthesis, and to integrate more recent work with the assessments of the IPCC, CCSP, and others.



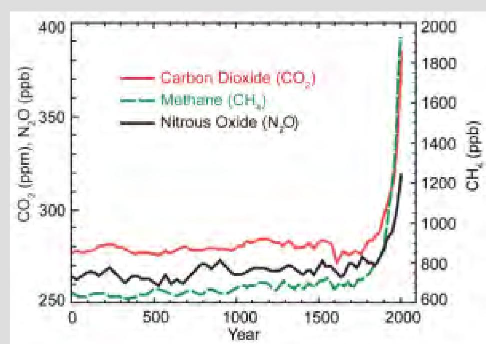
Analysis of air bubbles trapped in an Antarctic ice core extending back 800,000 years documents the Earth's changing carbon dioxide concentration. Over this long period, natural factors have caused the atmospheric carbon dioxide concentration to vary within a range of about 170 to 300 parts per million (ppm). Temperature-related data make clear that these variations have played a central role in determining the global climate. As a result of human activities, the present carbon dioxide concentration of about 385 ppm is about 30 percent above its highest level over at least the last 800,000 years. In the absence of strong control measures, emissions projected for this century would result in the carbon dioxide concentration increasing to a level that is roughly 2 to 3 times the highest level occurring over the glacial-interglacial era that spans the last 800,000 or more years. Image References: Luthi et al.; Tans; IIASA[1]

Influences on Climate

Human activities have led to large increases in heat-trapping gases over the past century.

The Earth's climate depends on the functioning of a natural "greenhouse effect." This effect is the result of heat-trapping gases (also known as greenhouse gases) like water vapor, carbon dioxide, ozone, methane, and nitrous oxide, which absorb heat radiated from the Earth's surface and lower atmosphere and then radiate much of the energy back toward the surface. Without this natural greenhouse effect, the average surface temperature of the Earth would be about 60°F colder. However, human activities have been releasing additional heat-trapping gases, intensifying the natural greenhouse effect, thereby changing the Earth's climate.

2000 Years of Greenhouse Gas Concentrations



Increases in concentrations of these gases since 1750 are due to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion molecules of air. Image References: Forster et al.[2]; Blasing[3]

Climate is influenced by a variety of factors, both human-induced and natural. The increase in the carbon dioxide concentration has been the principal factor causing warming over the past 50 years. Its concentration has been building up in the Earth's atmosphere since the beginning of the industrial era in the mid-1700s, primarily due to the burning of fossil fuels (coal, oil, and natural gas) and the clearing of forests. Human activities have also increased the emissions of other greenhouse gases, such as methane, nitrous oxide, and halocarbons.[2] These emissions are thickening the blanket of heat-trapping gases in Earth's atmosphere, causing surface temperatures to rise.

Heat-trapping gases

Carbon dioxide concentration has increased due to the use of fossil fuels in electricity generation, transportation, and industrial and household uses. It is also produced as a by-product during the manufacturing of cement. Deforestation provides a source of carbon dioxide and reduces its uptake by trees and other plants. Globally, over the past several decades, about 80 percent of human-induced carbon dioxide emissions came from the burning of fossil fuels, while about 20 percent resulted from deforestation and associated agricultural practices. The concentration of carbon dioxide in the atmosphere has increased by roughly 35 percent since the start of the industrial revolution.[2]

Methane concentration has increased mainly as a result of agriculture; raising livestock (which produce methane in their digestive tracts); mining, transportation, and use of certain fossil fuels; sewage; and decomposing garbage in landfills. About 70 percent of the emissions of atmospheric methane are now related to human activities.[4]

Nitrous oxide concentration is increasing as a result of fertilizer use and fossil fuel burning.

Halocarbon emissions come from the release of certain manufactured chemicals to the atmosphere. Examples include chlorofluorocarbons (CFCs), which were used extensively in refrigeration and for other industrial processes before their presence in the atmosphere was found to cause stratospheric ozone depletion. The abundance of these gases in the atmosphere is now decreasing as a result of international regulations designed to protect the ozone layer. Continued decreases in ozone-depleting halocarbon emissions are expected to reduce their relative influence on climate change in the future.[2,5] Many halocarbon replacements, however, are potent greenhouse gases, and their concentrations are increasing.[6]

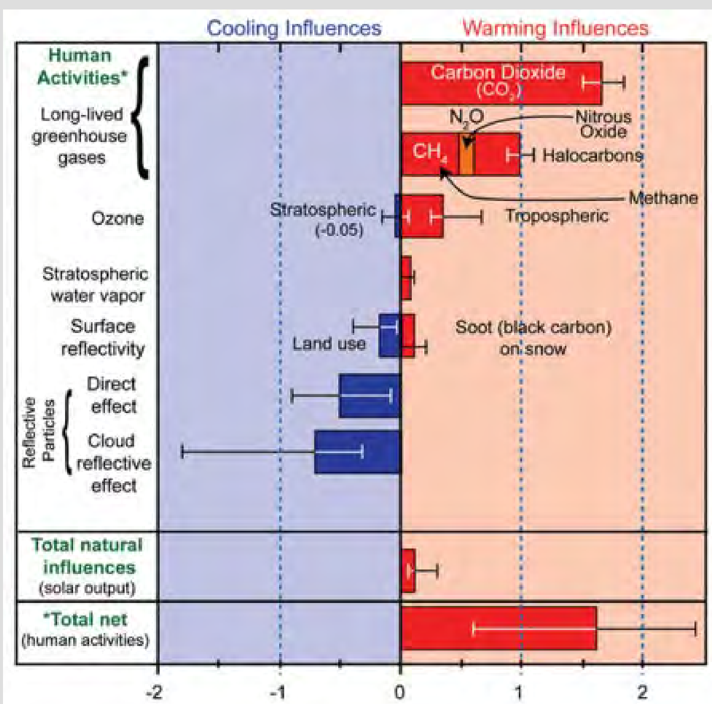
Ozone is a greenhouse gas, and is continually produced and destroyed in the atmosphere by chemical reactions. In the troposphere, the lowest 5 to 10 miles of the atmosphere near the surface, human activities have increased the ozone concentration through the release of gases such as carbon monoxide, hydrocarbons, and nitrogen oxides. These gases undergo chemical reactions to produce ozone in the presence of sunlight. In addition to trapping heat, excess ozone in the troposphere causes respiratory illnesses and other human health problems.

In the stratosphere, the layer above the troposphere, ozone exists naturally and protects life on Earth from exposure to excessive ultraviolet radiation from the Sun. As mentioned previously, halocarbons released by human activities destroy ozone in the stratosphere and have caused the ozone hole over Antarctica.[7] Changes in the stratospheric ozone layer have contributed to changes in wind patterns and regional climates in Antarctica.[8]

Water vapor is the most important and abundant greenhouse gas in the atmosphere. Human activities produce only a very small increase in water vapor through irrigation and combustion processes.[2] However, the surface warming caused by human-produced increases in other greenhouse gases leads to an increase in atmospheric water vapor, since a warmer climate increases evaporation and allows the atmosphere to hold more moisture. This creates an amplifying "feedback loop," leading to more warming.

Other human influences

Major Warming and Cooling Influences on Climate



The figure above shows the amount of warming influence (red bars) or cooling influence

In addition to the global-scale climate effects of heat-trapping gases, human activities also produce additional local and regional effects. Some of these activities partially offset the warming caused by greenhouse gases, while others increase the warming. One such influence on climate is caused by tiny particles called "aerosols" (not to be confused with aerosol spray cans). For example, the burning of coal produces emissions of sulfur-containing compounds. These compounds form "sulfate aerosol" particles, which reflect some of the incoming sunlight away from the Earth, causing a cooling influence at the surface. Sulfate aerosols also tend to make clouds more efficient at reflecting sunlight, causing an additional indirect cooling effect. Another type of aerosol, often referred to as soot or black carbon, absorbs incoming sunlight and traps heat in the atmosphere. Thus, depending on their type, aerosols can either mask or increase the warming caused by increased levels of greenhouse gases.[9]

(blue bars) that different factors have had on Earth's climate over the industrial age (from about 1750 to the present). Results are in watts per square meter. The longer the bar, the greater the influence on climate. The top part of the box includes all the major human-induced factors, while the second part of the box includes the Sun, the only major natural factor with a long-term effect on climate. The cooling effect of individual volcanoes is also natural, but is relatively short-lived (2 to 3 years), thus their influence is not included in this figure. The bottom part of the box shows that the total net effect (warming influences minus cooling influences) of human activities is a strong warming influence. The thin lines on each bar provide an estimate of the range of uncertainty. Image Reference: Forster et al.[2]

On a globally averaged basis, the sum of these aerosol effects offsets some of the warming caused by heat-trapping gases.[10]

The effects of various greenhouse gases and aerosol particles on Earth's climate depend in part on how long these gases and particles remain in the atmosphere. After emission, the atmospheric concentration of carbon dioxide remains elevated for thousands of years, and that of methane for decades, while the elevated concentrations of aerosols only persist for days to weeks.[11,12] The climate effects of reductions in emissions of carbon dioxide and other long-lived gases do not become apparent for at least several decades. In contrast, reductions in emissions of short-lived compounds can have a rapid, but complex effect since the geographic patterns of their climatic influence and the resulting surface temperature responses are quite different. One modeling study found that while the greatest emissions of short-lived pollutants in summertime by late this century are projected to come from Asia, the strongest climate response is projected to be over the central United States.[9]

Human activities have also changed the land surface in ways that alter how much heat is reflected or absorbed by the surface. Such changes include the cutting and burning of forests, the replacement of other areas of natural vegetation with agriculture and cities, and large-scale irrigation. These transformations of the land surface can cause local (and even regional) warming or cooling. Globally, the net effect of these changes has probably been a slight cooling of the Earth's surface over the past 100 years.[13,14]

Natural influences

Two important natural factors also influence climate: the Sun and volcanic eruptions. Over the past three decades, human influences on climate have become increasingly obvious, and global temperatures have risen sharply. During the same period, the Sun's energy output (as measured by satellites since 1979) has followed its historical 11-year cycle of small ups and downs, but with no net increase (see *Measurements of Surface Temperature and Sun's Energy* figure below).[15] The two major volcanic eruptions of the past 30 years have had short-term cooling effects on climate, lasting 2 to 3 years.[16] Thus, these natural factors cannot explain the warming of recent decades; in fact, their net effect on climate has probably been a slight cooling influence over this period. Slow changes in Earth's orbit around the Sun and its tilt toward or away from the Sun are also a purely natural influence on climate, but are only important on timescales from thousands to many tens of thousands of years.

The climate changes that have occurred over the last century are not solely caused by the human and natural factors described above. In addition to these influences, there are also fluctuations in climate that occur even in the absence of changes in human activities, the Sun, or volcanoes. One example is the El Niño phenomenon, which has important influences on many aspects of regional and global climate. Many other modes of variability have been identified by climate scientists and their effects on climate occur at the same time as the effects of human activities, the Sun, and volcanoes.

Carbon release and uptake

Once carbon dioxide is emitted to the atmosphere, some of it is absorbed by the oceans and taken up by vegetation, although this storage may be temporary. About 45 percent of the carbon dioxide emitted by human activities in the last 50 years is now stored in the oceans and vegetation. The rest has remained in the air, increasing the atmospheric concentration.[1,2,17] It is thus important to understand not only how much carbon dioxide is emitted, but also how much is taken up, over what time scales, and how these sources and "sinks" of carbon dioxide might change as climate continues to warm. For example, it is known from long records of Earth's climate history that under warmer conditions, carbon tends to be released, for instance, from thawing permafrost, initiating a feedback loop in which more carbon release leads to more warming which leads to further release, and so on.[18,19]

Global emissions of carbon dioxide have been accelerating. The growth rate increased from 1.3 percent per year in the 1990s to 3.3 percent per year between 2000 and 2006.[20] The increasing emissions of carbon dioxide are the primary cause of the increased concentration of carbon dioxide observed in the atmosphere. There is also evidence that a smaller fraction of the annual human-induced emissions is now being taken up than in the past, leading to a greater fraction remaining in the atmosphere and an accelerating rate of increase in the carbon dioxide concentration.[20]

Ocean acidification

As the ocean absorbs carbon dioxide from the atmosphere, seawater is becoming less alkaline (its pH is decreasing) through a process generally referred to as ocean acidification. The pH of seawater has decreased significantly since 1750,[21,22] and is projected to drop much more dramatically by the end of the century if carbon dioxide concentrations continue to increase.[23] Such ocean acidification is essentially irreversible over a time scale of centuries. As discussed in the *Ecosystems* sector and *Coasts* region, ocean acidification affects the process of calcification by which living things create shells and skeletons, with substantial negative consequences for coral reefs, mollusks, and some plankton species important to ocean food chains.[24]

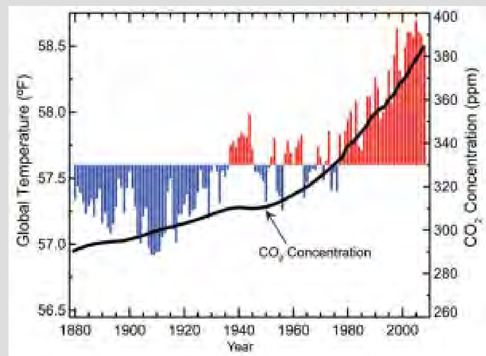
Observed Climate Change

Global average temperature and sea level have increased, and precipitation patterns have changed

Temperatures are rising

Global average surface air temperature has increased substantially since 1970.[27] The estimated change in the average temperature of Earth's surface is based on measurements from thousands of weather stations, ships, and buoys around the world, as well as from satellites. These measurements are independently compiled, analyzed, and processed by different research groups. There are a number of important steps in the data processing. These include identifying and adjusting for the effects of changes in the instruments used to measure temperature, the measurement times and locations, the local environment around the measuring site, and such factors as satellite orbital drift. For instance, the growth of cities can cause localized "urban heat island" effects.

Global Temperature and Carbon Dioxide



Global annual average temperature (as measured over both land and oceans). Red bars indicate temperatures above and blue bars indicate temperatures below the average temperature for the period 1901-2000. The black line shows atmospheric carbon dioxide (CO_2) concentration in parts per million (ppm). While there is a clear long-term global warming trend, each individual year does not show a temperature increase relative to the previous year, and some years show greater changes than others.[25] These year-to-year fluctuations in temperature are due to natural processes, such as the effects of El Niños, La Niñas, and the eruption of large volcanoes. Image Reference: NOAA/NCDC[26]

A number of research groups around the world have produced estimates of global-scale changes in surface temperature. The warming trend that is apparent in all of these temperature records is confirmed by other independent observations, such as the melting of Arctic sea ice, the retreat of mountain glaciers on every continent,[28] reductions in the extent of snow cover, earlier blooming of plants in spring, and increased melting of the Greenland and Antarctic ice sheets.[29,30] Because snow and ice reflect the Sun's heat, this melting causes more heat to be absorbed, which causes more melting, resulting in another feedback loop.[19]

Additionally, temperature measurements above the surface have been made by weather balloons since the late 1940s, and from satellites since 1979. These measurements show warming of the troposphere, consistent with the surface warming.[31,32] They also reveal cooling in the stratosphere.[31] This pattern of tropospheric warming and stratospheric cooling agrees with our understanding of how atmospheric temperature would be expected to change in response to increasing greenhouse gas concentrations and the observed depletion of stratospheric ozone.[13]

Precipitation patterns are changing

Precipitation is not distributed evenly over the globe. Its average distribution is governed primarily by atmospheric circulation patterns, the availability of moisture, and surface terrain effects. The first two of these factors are influenced by temperature. Thus, human-caused changes in temperature are expected to alter precipitation patterns.

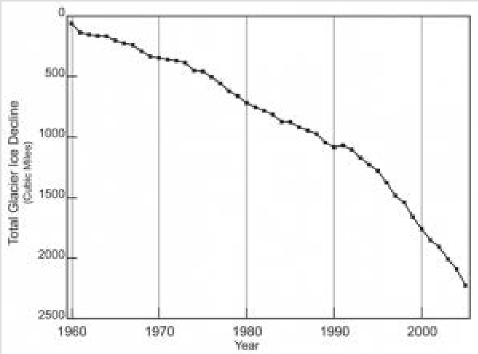
Observations show that such shifts are occurring. Changes have been observed in the amount, intensity, frequency, and type of precipitation. Pronounced increases in precipitation over the past 100 years have been observed in eastern North America, southern South America, and northern Europe. Decreases have been seen in the Mediterranean, most of Africa, and southern Asia. Changes in the geographical distribution of droughts and flooding have been complex. In some regions, there have been increases in the occurrences of both droughts and floods.[29] As the world warms, northern regions and mountainous areas are experiencing more precipitation falling as rain rather than snow.[33] Widespread increases in heavy precipitation events have occurred, even in places where total rain amounts have decreased. These changes are associated with the fact that warmer air holds more water vapor evaporating from the world's oceans and land surface.[32] This increase in atmospheric water vapor has been observed from satellites, and is primarily due to human influences.[34,35]

Sea level is rising

After at least 2,000 years of little change, sea level rose by roughly 8 inches over the past century. Satellite data available over the past 15 years show sea level rising at a rate roughly double the rate observed over the past century.[36]

There are two principal ways in which global warming causes sea level to rise. First, ocean water expands as it warms, and therefore takes up more space. Warming has been observed in each of the world's major ocean basins, and has been directly linked to human influences.[37,38]

Cumulative Decrease in Global Glacier Ice



As temperatures have risen, glaciers around the world have shrunk. The graph shows the cumulative decline in glacier ice worldwide. Image Reference: Meier et al.[28]

Second, warming leads to the melting of glaciers and ice sheets, which raises sea level by adding water to the oceans. Glaciers have been retreating worldwide for at least the last century, and the rate of retreat has increased in the past decade.[30,39] Only a few glaciers are actually advancing (in locations that were well below freezing, and where increased precipitation has outpaced melting). The total volume of glaciers on Earth is declining sharply. The progressive disappearance of glaciers has implications not only for the rise in global sea level, but also for water supplies in certain densely populated regions of Asia and South America.

The Earth has major ice sheets on Greenland and Antarctica. These ice sheets are currently losing ice volume by increased melting and calving of icebergs, contributing to sea-level rise. The Greenland Ice Sheet has also been experiencing record amounts of surface melting, and a large increase in the rate of mass loss in the past decade.[40] If the entire Greenland Ice Sheet melted, it would raise sea level by about 20 feet. The Antarctic Ice Sheet consists of two portions, the West Antarctic Ice Sheet and the East Antarctic Ice Sheet. The West Antarctic Ice Sheet, the more vulnerable to melting of the two, contains enough water to raise global sea levels by about 16 to 20 feet.[30] If the East Antarctic Ice Sheet melted entirely, it would raise global sea level by about 200 feet. Complete melting of these ice sheets over this century or the next is thought to be virtually impossible, although past climate records provide precedent for very significant decreases in ice volume, and therefore increases in sea level.[41,42]

Human "Fingerprint" on Climate

The global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases. Human "fingerprints" also have been identified in many other aspects of the climate system, including changes in ocean heat content, precipitation, atmospheric moisture, and Arctic sea ice.

In 1996, the IPCC Second Assessment Report[43] cautiously concluded that "the balance of evidence suggests a discernible human influence on global climate." Since then, a number of national and international assessments have come to much stronger conclusions about the reality of human effects on climate. Recent scientific assessments find that most of the warming of the Earth's surface over the past 50 years has been caused by human activities.[44,45]

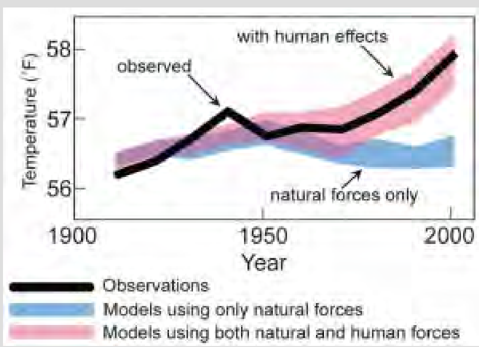
This conclusion rests on multiple lines of evidence. Like the warming "signal" that has gradually emerged from the "noise" of natural climate variability, the scientific evidence for a human influence on global climate has accumulated over the past several decades, from many hundreds of studies. No single study is a "smoking gun." Nor has any single study or combination of studies undermined the large body of evidence supporting the conclusion that human activity is the primary driver of recent warming.

The first line of evidence is our basic physical understanding of how greenhouse gases trap heat, how the climate system responds to increases in greenhouse gases, and how other human and natural factors influence climate. The second line of evidence is from indirect estimates of climate changes over the last 1,000 to 2,000 years. These records are obtained from living things and their remains (like tree rings and corals) and from physical quantities (like the ratio between lighter and heavier isotopes of oxygen in ice cores) which change in measurable ways as climate changes. The lesson from these data is that global surface temperatures over the last several decades are clearly unusual, in that they were higher than at any time during at least the past 400 years.[46] For the Northern Hemisphere, the recent temperature rise is clearly unusual in at least the last 1,000 years.[46,47]

The third line of evidence is based on the broad, qualitative consistency between observed changes in climate and the computer model simulations of how climate would be expected to change in response to human activities. For example, when climate models are run with historical increases in greenhouse gases, they show gradual warming of the Earth and ocean surface, increases in ocean heat content and the temperature of the lower atmosphere, a rise in global sea level, retreat of sea ice and snow cover, cooling of the stratosphere, an increase in the amount of atmospheric water vapor, and changes in large-scale precipitation and pressure patterns. These and other aspects of modeled climate change are in agreement with observations.[13,48]

Finally, there is extensive statistical evidence from so-called "fingerprint" studies. Each factor that affects climate produces a unique pattern of climate response, much as each person has a unique fingerprint. Fingerprint studies exploit these unique signatures, and allow detailed comparisons of modeled and observed climate change patterns.[43] Scientists rely on such studies to attribute observed changes in climate to a particular cause or set of causes. In the real world, the climate changes that have occurred since the start of the Industrial Revolution are due to a complex mixture of human and natural causes. The importance of each individual influence in this mixture changes over time. Of course, there are not multiple Earths, which would allow an experimenter to change one factor at a time on each Earth, thus helping to isolate different fingerprints. Therefore, climate models are used to study how individual factors affect climate. For example, a single factor (like greenhouse gases) or a set of factors can be varied, and the response of the modeled climate system to these individual or combined changes can thus be studied.[49]

Separating Human and Natural Influences on Climate



The blue band shows how global average temperatures would have changed due to natural forces only, as simulated by climate models. The red band shows model projections of the effects of human and natural forces combined. The black line shows actual observed global average temperatures. As the blue band indicates, without human influences, temperature over the past century would actually have first warmed and then cooled slightly over recent decades.[50] Image Reference: Hegerl et al.[48]

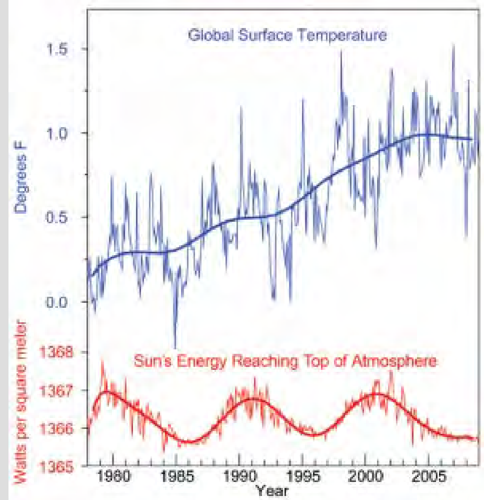
For example, when climate model simulations of the last century include all of the major influences on climate, both human-induced and natural, they can reproduce many important features of observed climate change patterns. When human influences are removed from the model experiments, results suggest that the surface of the Earth would actually have cooled slightly over the last 50 years. The clear message from fingerprint studies is that the observed warming over the last half-century cannot be explained by natural factors, and is instead caused primarily by human factors.[13,49]

Another fingerprint of human effects on climate has been identified by looking at a slice through the layers of the atmosphere, and studying the pattern of temperature changes from the surface up through the stratosphere. In all climate models, increases in carbon dioxide cause warming at the surface and in the troposphere, but lead to cooling of the stratosphere. For straightforward physical reasons, models also calculate that the human-caused depletion of stratospheric ozone has had a strong cooling effect in the stratosphere. There is a good match between the model fingerprint in response to combined carbon dioxide and ozone changes and the observed pattern of tropospheric warming and stratospheric cooling (see *Patterns of Temperature Change* figure below).[13]

In contrast, if most of the observed temperature change had been due to an increase in solar output rather than an increase in greenhouse gases, Earth's atmosphere would have warmed throughout its full vertical extent, including the stratosphere.[8] The observed pattern of atmospheric temperature changes, with its pronounced cooling in the stratosphere, is therefore inconsistent with the hypothesis that changes in the Sun can explain the warming of recent decades. Moreover, direct satellite measurements of solar output show slight decreases during the recent period of warming.

Measurements of Surface Temperature and Sun's Energy

The earliest fingerprint work[53] focused on changes in surface and atmospheric temperature. Scientists then applied fingerprint methods to a whole range of climate variables,[49,54] identifying human-caused climate signals in the heat content of the oceans,[37,38] the height of the tropopause[55] (the boundary between the troposphere and stratosphere, which has shifted



The Sun's energy received at the top of Earth's atmosphere has been measured by satellites since 1978. It has followed its natural 11-year cycle of small ups and downs, but with no net increase (bottom). Over the same period, global temperature has risen markedly (top).[51] Image References: NOAA/NCDC; Frolich and Lean; Willson and Mordvinov; Dewitte et al.[52]

upward by hundreds of feet in recent decades), the geographical patterns of precipitation,[56] drought,[57] surface pressure,[58] and the runoff from major river basins.[59]

Studies published after the appearance of the IPCC Fourth Assessment Report in 2007 have also found human fingerprints in the increased levels of atmospheric moisture[34],[35] (both close to the surface and over the full extent of the atmosphere), in the decline of Arctic sea ice extent,[60] and in the patterns of changes in Arctic and Antarctic surface temperatures.[61]

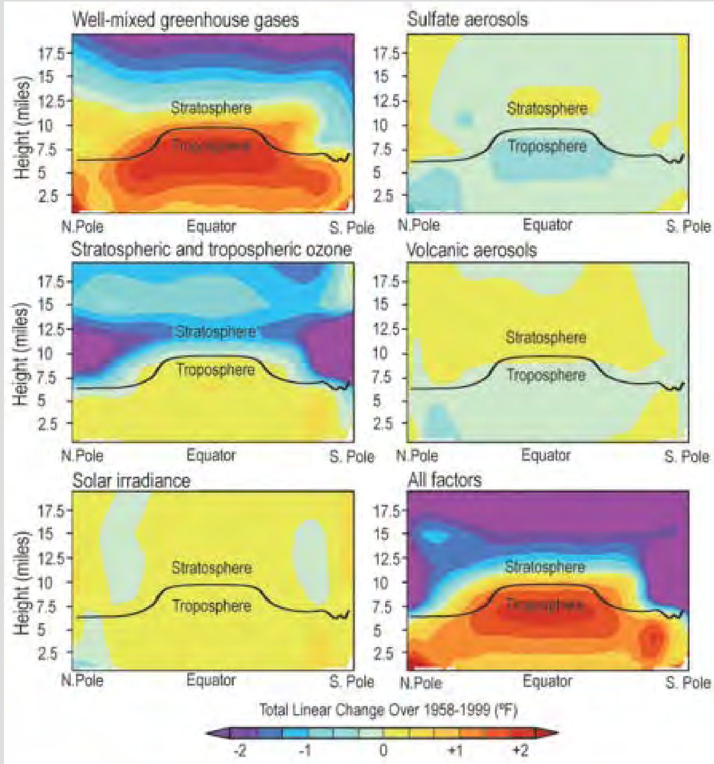
The message from this entire body of work is that the climate system is telling a consistent story of increasingly dominant human influence – the changes in temperature, ice extent, moisture, and circulation patterns fit together in a physically consistent way, like pieces in a complex puzzle.

Increasingly, this type of fingerprint work is shifting its emphasis. As noted, clear and compelling scientific evidence supports the case for a pronounced human influence on global climate. Much of the recent attention is now on climate changes at continental and regional scales,[62],[63] and on variables that can have large impacts on societies. For example, scientists have established causal links between human activities and the changes in snowpack, maximum and minimum temperature, and the seasonal timing of runoff over mountainous regions of the western United States.[33] Human activity is likely to have made a substantial contribution to ocean surface temperature changes in hurricane formation regions.[64],[65],[66] Researchers are also looking beyond the physical climate system, and are beginning to tie changes in the distribution and seasonal behavior of plant and animal species to human-caused changes in temperature and precipitation.[67],[68]

Patterns of Temperature Change Produced by Various Atmospheric Factors, 1958-1999

For over a decade, one aspect of the climate change story seemed to show a significant difference between models and observations.[13] In the tropics, all models predicted that with a rise in greenhouse gases, the troposphere would be expected to warm more rapidly than the surface. Observations from weather balloons, satellites, and surface thermometers seemed to show the opposite behavior (more rapid warming of the surface than the troposphere). This issue was a stumbling block in our understanding of the causes of climate change. It is now largely resolved.[70] Research showed that there were large uncertainties in the satellite and weather balloon data. When uncertainties in models and observations are properly accounted for, newer observational data sets (with better treatment of known problems) are in agreement with climate model results.[32],[71],[72],[73],[74]

This does not mean, however, that all



Climate simulations of the vertical profile of temperature change due to various factors, and the effect due to all factors taken together. The panels above represent a cross-section of the atmosphere from the north pole to the south pole, and from the surface up into the stratosphere. The black lines show the location of the tropopause, the boundary between the lower atmosphere (troposphere) and the stratosphere. Image Source: Modified from CCSP SAP 1.1[69]

remaining differences between models and observations have been resolved. The observed changes in some climate variables, such as Arctic sea ice,[60],[75] some aspects of precipitation,[56],[76] and patterns of surface pressure,[58] appear to be proceeding much more rapidly than models have projected. The reasons for these differences are not well understood. Nevertheless, the bottom-line conclusion from climate fingerprinting is that most of the observed changes studied to date are consistent with each other, and are also consistent with our scientific understanding of how the climate system would be expected to respond to the increase in heat-trapping gases resulting from human activities.[13],[48]

Scientists are sometimes asked whether extreme weather events can be linked to human activities.[23] Scientific research has concluded that human influences on climate are indeed changing the likelihood of certain types of extreme events. For example, an analysis of the European summer heat wave of 2003 found that the risk of such a heat wave is now roughly four times greater than it would have been in the absence of human-induced climate change.[66],[77]

Like fingerprint work, such analyses of human-caused changes in the risks of extreme events rely on information from climate models, and on our understanding of the physics of the climate system. All of the models used in this work have imperfections in their representation of the complexities of the “real world” climate system.[78],[79] These are due to both limits in our understanding of the climate system, and in our ability to represent its complex behavior with available computer resources. Despite this, models are extremely useful, for a number of reasons.

First, despite remaining imperfections, the current generation of climate models accurately portrays many important aspects of today’s weather patterns and climate.[78],[79] Models are constantly being improved, and are routinely tested against many observations of Earth’s climate system. Second, the fingerprint work shows that models capture not only our present-day climate, but also key features of the observed climate changes over the past century.[46] Third, many of the large-scale observed climate changes (such as the warming of the surface and troposphere, and the increase in the amount of moisture in the atmosphere) are driven by very basic physics, which is well-represented in models.[34] Fourth, climate models can be used to predict changes in climate that can be verified in the real world. Examples include the short-term global cooling subsequent to the eruption of Mount Pinatubo and the stratospheric cooling with increasing carbon dioxide. Finally, models are the only tools that exist for trying to understand the climate changes likely to be experienced over the course of this century. No period in Earth’s geological history provides an exact analogue for the climate conditions that will unfold in the coming decades.[19]

Projected Climate Change

Global temperatures are projected to continue to rise over this century; by how much and for how long depends on a number of factors, including the amount of heat-trapping gas emissions and how sensitive the climate is to those emissions.

Some continued warming of the planet is projected over the next few decades due to past emissions. Choices made now will influence the amount of future warming. Lower levels of heat-trapping emissions will yield less future warming, while higher levels will result in more warming, and more severe impacts on society and the natural world.

Emissions scenarios

The IPCC developed a set of scenarios in a Special Report on Emissions Scenarios (SRES).[80] These have been extensively used to explore the potential for future climate change. None of these scenarios, not even the one called "lower", includes implementation of policies to limit climate change or to stabilize atmospheric concentrations of heat-trapping gases. Rather, differences among these scenarios are due to different assumptions about changes in population, rate of adoption of new technologies, economic growth, and other factors.

The IPCC emission scenarios also do not encompass the full range of possible futures: emissions can change less than those scenarios imply, or they can change more. Recent carbon dioxide emissions are, in fact, above the highest emissions scenario developed by the IPCC[81] (see figure below). Whether this will continue is uncertain.

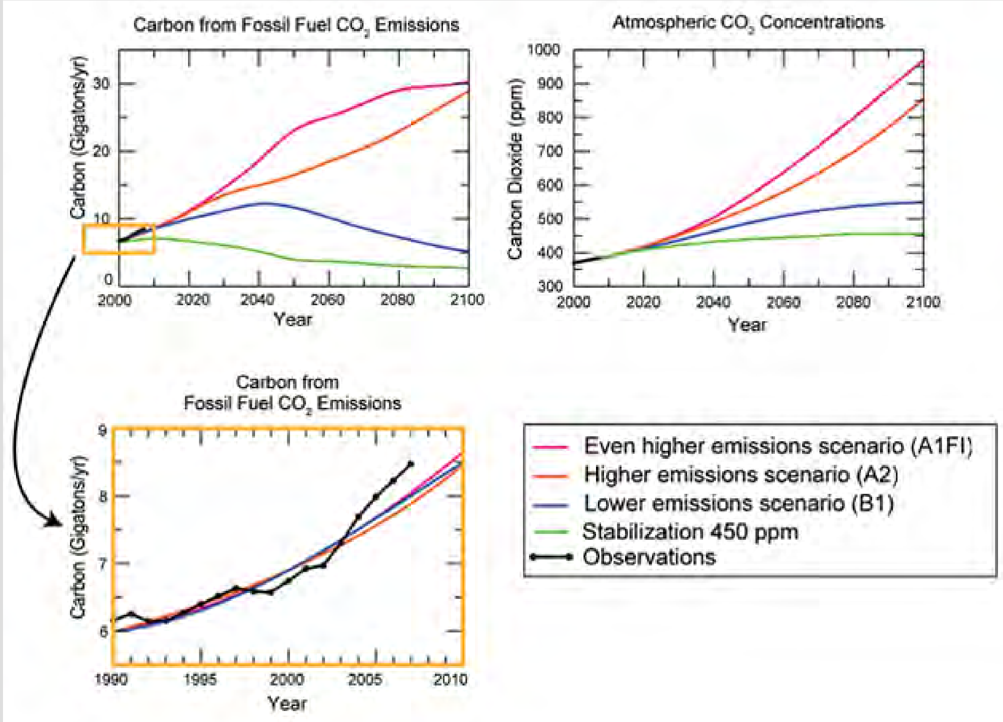
There are also lower possible emissions paths than those put forth by the IPCC. The Framework Convention on Climate Change, to which the United States and 191 other countries are signatories, calls for stabilizing concentrations of greenhouse gases in the atmosphere at a level that would avoid dangerous human interference with the climate system. What exactly constitutes such interference is subject to interpretation.

A variety of research studies suggest that a further 2°F increase (relative to the 1980-1999 period) would lead to severe, widespread, and irreversible impacts.[82,83,84] To have a good chance (but not a guarantee) of avoiding temperatures above those levels, it has been estimated that atmospheric concentration of carbon dioxide would need to stabilize in the long term at around today's levels.[85,86,87,88]

Reducing emissions of carbon dioxide would reduce warming over this century and beyond. Implementing sizable and sustained reductions in carbon dioxide emissions as soon as possible would significantly reduce the pace and the overall amount of climate change, and would be more effective than reductions of the same size initiated later. Reducing emissions of some shorter-lived greenhouse gases, such as methane, and some types of particles, such as soot, would begin to reduce the warming influence within weeks to decades.[9]

The graphs below show emissions scenarios and resulting carbon dioxide concentrations for three IPCC scenarios[89,90] and one stabilization scenario.[24]

Scenarios of Future CO2 Global Emissions and Concentrations



The graphs show recent and projected global emissions of carbon dioxide in gigatons of carbon, on the left, and atmospheric concentrations on the right under five emissions scenarios. The top three in the key are IPCC scenarios that assume no explicit climate policies (these are used in model projections that appear throughout this report). The bottom line is a "stabilization scenario," designed to stabilize atmospheric carbon dioxide concentration at 450 parts per million. The inset expanded below these charts shows emissions for 1990-2010 under the three IPCC scenarios along with actual emissions to 2007 (in black). Image References: Nakicenovic and Swart; Clarke et al.; Marland et al.; Tans[91]

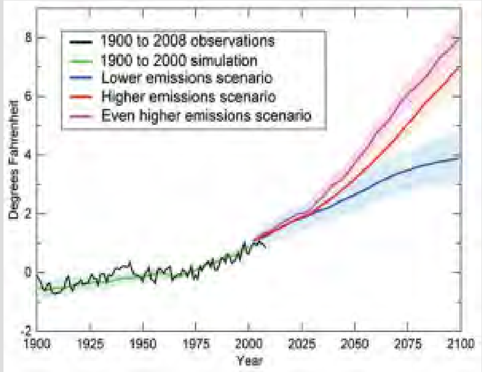
The stabilization scenario is aimed at stabilizing the atmospheric carbon dioxide concentration at roughly 450 parts per million (ppm); this is 70 ppm above the 2008 concentration of 385 ppm. Resulting temperature changes depend on atmospheric concentrations of greenhouse gases and particles and the climate's sensitivity to those concentrations.[86] Of those shown in the figure above, only the 450 ppm stabilization target has the potential to keep the global temperature rise at or below about 3.5°F from pre-industrial levels and 2°F above the current average temperature, a level beyond which many concerns have been raised about dangerous human interference with the climate system.[87,88] Scenarios that stabilize carbon dioxide below 450 ppm (not shown in the figure) offer an increased chance of avoiding dangerous climate change.[87,88]

Carbon dioxide is not the only greenhouse gas of concern. Concentrations of other heat-trapping gases like methane and nitrous oxide and particles like soot will also have to be stabilized at low enough levels to prevent global temperatures from rising higher than the level mentioned above. When these other gases are added, including the offsetting cooling effects of sulfate aerosol particles, analyses suggest that stabilizing concentrations around 400 parts per million of "equivalent carbon dioxide" would yield about an 80 percent chance of avoiding exceeding the 2°F above present temperature threshold. This would be true even if concentrations temporarily peaked as high as 475 parts per million and then stabilized at 400 parts per million roughly a century later.[71,87,88,92,93,94] Reductions in sulfate aerosol particles would necessitate lower equivalent carbon dioxide targets.

Rising global temperature

All climate models project that human-caused emissions of heat-trapping gases will cause further warming in the future. Based on scenarios that do not assume explicit climate policies to reduce greenhouse gas emissions, global average temperature is projected to rise by 2 to 11.5°F by the end of this century[89] (relative to the 1980-1999 time period). Whether the actual warming in 2100 will be closer to the low or the high end of this range depends primarily on two factors: first, the future level of emissions of heat-trapping gases, and second, how sensitive climate is to past and future emissions. The range of possible outcomes has been explored using a range of different emissions scenarios, and a variety of climate models that encompass the known range of climate sensitivity.

Global Average Temperature 1900 to 2100



Observed and projected changes in the global average temperature under three IPCC no-policy emissions scenarios. The shaded areas show the likely ranges while the lines show the central projections from a set of climate models. A wider range of model types shows outcomes from 2 to 11.5ºF.90 Changes are relative to the 1960-1979 average. Image References: Smith et al.[71]; CMIP3-A[92]

Changing precipitation patterns

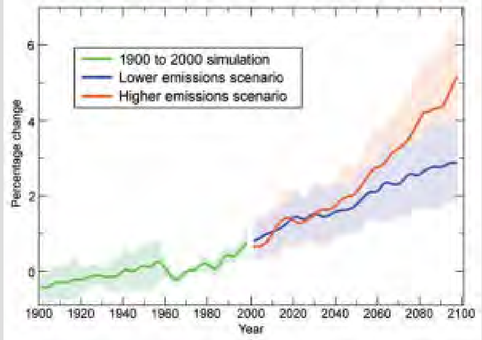
Projections of changes in precipitation largely follow recently observed patterns of change, with overall increases in the global average but substantial shifts in where and how precipitation falls.[89] Generally, higher latitudes are projected to receive more precipitation, while the dry belt that lies just outside the tropics expands further poleward,[95],[96] and also receives less rain. Increases in tropical precipitation are projected during rainy seasons (such as monsoons), and especially over the tropical Pacific. Certain regions, including the U.S. West (especially the Southwest) and the Mediterranean, are expected to become drier. The widespread trend toward more heavy downpours is expected to continue, with precipitation becoming less frequent but more intense.[89] More precipitation is expected to fall as rain rather than snow.

Currently rare extreme events are becoming more common

In a warmer future climate, models project there will be an increased risk of more intense, more frequent, and longer-lasting heat waves.[89] The European heat wave of 2003 is an example of the type of extreme heat event that is likely to become much more common.[89] If greenhouse gas emissions continue to increase, by the 2040s more than half of European summers will be hotter than the summer of 2003, and by the end of this century, a summer as hot as that of 2003 will be considered unusually cool.[77]

Increased extremes of summer dryness and winter wetness are projected for much of the globe, meaning a generally greater risk of droughts and floods. This has already been observed,[57] and is projected to continue. In a warmer world, precipitation tends to be concentrated into heavier events, with longer dry periods in between.[89]

Global Increase in Heavy Precipitation 1900-2100



Simulated and projected changes in the amount of precipitation falling in the heaviest 5 percent of daily events. The shaded areas show the likely ranges while the lines show the central projections from a set of climate models. Changes are relative to the 1960-1979 average. Image Reference: CMIP3-A[92]

Models project a general tendency for more intense but fewer storms overall outside the tropics, with more extreme wind events and higher ocean waves in a number of regions in association with those storms. Models also project a shift of storm tracks toward the poles in both hemispheres.[89]

Changes in hurricanes are difficult to project because there are countervailing forces. Higher ocean temperatures lead to stronger storms with higher wind speeds and more rainfall.[97] But changes in wind speed and direction with height are also projected to increase in some regions, and this tends to work against storm formation and growth.[98],[99],[100] It currently appears that stronger, more rain-producing tropical storms and hurricanes are generally more likely, though more research is required on these issues.[66] More discussion of Atlantic hurricanes, which most affect the United States, appears in the *National Climate Change* section.

Sea level will continue to rise

Projecting future sea-level rise presents special challenges. Scientists have a well-developed understanding of the contributions of thermal expansion and melting glaciers to sea-level rise, so the models used to project sea-level rise include these processes. However, the contributions to past and future sea-level rise from ice sheets are less well understood. Recent observations of the polar ice sheets show that a number of complex processes control the movement of ice to the sea, and thus affect the contributions of ice sheets to sea-level rise.[30] Some of these processes are already producing substantial loss of ice mass. Because these processes are not well understood it is difficult to predict their future contributions to sea-level rise.[101]

Because of this uncertainty, the 2007 assessment by the IPCC could not quantify the contributions to sea-level rise due to changes in ice sheet dynamics, and thus projected a rise of the world's oceans from 8 inches to 2 feet by the end of this century.[89]

More recent research has attempted to quantify the potential contribution to sea-level rise from the accelerated flow of ice sheets to the sea[28],[41] or to estimate future sea level based on its observed relationship to temperature.[102] The resulting estimates exceed those of the IPCC, and the average estimates under higher emissions scenarios are for sea-level rise between 3 and 4 feet by the end of this century. An important question that is often asked is, what is the upper bound of sea-level rise expected over this century? Few analyses have focused on this question. There is some evidence to suggest that it would be virtually impossible to have a rise of sea level higher than about 6.5 feet by the end of this century.[41]

The changes in sea level experienced at any particular location along the coast depend not only on the increase in the global average sea level, but also on changes in regional currents and winds, proximity to the mass of melting ice sheets, and on the vertical movements of the land due to geological forces.[103] The consequences of sea-level rise at any particular location depend on the amount of sea-level rise relative to the adjoining land. Although some parts of the U.S. coast are undergoing uplift (rising), most shorelines are subsiding (sinking) to various degrees – from a few inches to over 2 feet per century.

Abrupt climate change

There is also the possibility of even larger changes in climate than current scenarios and models project. Not all changes in the climate are gradual. The long record of climate found in ice cores, tree rings, and other natural records show that Earth's climate patterns have undergone rapid shifts from one stable state to another within as short a period as a decade. The occurrence of abrupt changes in climate becomes increasingly likely as the human disturbance of the climate system grows.[89] Such changes can occur so rapidly that they would challenge the ability of human and natural systems to adapt.[104] Examples of such changes are abrupt shifts in drought frequency and duration. Ancient climate records suggest that in the United States, the Southwest may be at greatest risk for this kind of change, but that other regions including the Midwest and Great Plains have also had these kinds of abrupt shifts in the past and could experience them again in the future.

Rapid ice sheet collapse with related sea-level rise is another type of abrupt change that is not well understood or modeled and that poses a risk for the future. Recent observations show that melting on the surface of an ice sheet produces water that flows down through large cracks that create conduits through the ice to the base of the ice sheet where it lubricates ice previously frozen to the rock below.[30] Further, the interaction with warm ocean water, where ice meets the sea, can lead to sudden losses in ice mass and accompanying rapid global sea-level rise. Observations indicate that ice loss has increased dramatically over the last decade, though scientists are not yet confident that they can project how the ice sheets will respond in the future.

There are also concerns regarding the potential for abrupt release of methane from thawing of frozen soils, from the sea floor, and from wetlands in the tropics and the Arctic. While analyses suggest that an abrupt release of methane is very unlikely to occur within 100 years, it is very likely that warming will accelerate the pace of chronic methane emissions from these sources, potentially increasing the rate of global temperature rise.[105]

A third major area of concern regarding possible abrupt change involves the operation of the ocean currents that transport vast quantities of heat around the globe. One branch of the ocean circulation is in the North Atlantic. In this region, warm water flows northward from the tropics to the North Atlantic in the upper layer of the ocean, while cold water flows back from the North Atlantic to the tropics in the ocean's deep layers, creating a "conveyor belt" for heat. Changes in this circulation have profound impacts on the global climate system, from changes in African and Indian monsoon rainfall, to atmospheric circulation relevant to hurricanes, to changes in climate over North America and Western Europe.

Recent findings indicate that it is very likely that the strength of this North Atlantic circulation will decrease over the course of this century in response to increasing greenhouse gases. This is expected because warming increases the melting of glaciers and ice sheets and the resulting runoff of freshwater to the sea. This additional water is virtually salt-free, which makes it less dense than sea water. Increased precipitation also contributes fresh, less-dense water to the ocean. As a result, less surface water is dense enough to sink, thereby reducing the conveyor belt's transport of heat. The best estimate is that the strength of this circulation will decrease 25 to 30 percent in this century, leading to a reduction in heat transfer to the North Atlantic. It is considered very unlikely that this circulation would collapse entirely during the next 100 years or so, though it cannot be ruled out. While very unlikely, the potential consequences of such an abrupt event would be severe. Impacts would likely include sea-level rise around the North Atlantic of up to 2.5 feet (in addition to the rise expected from thermal expansion and melting glaciers and ice sheets), changes in atmospheric circulation conditions that influence hurricane activity, a southward shift of tropical rainfall belts with resulting agricultural impacts, and disruptions to marine ecosystems.[75]

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APPENDIX 56

U.S. Energy Information Administration

COAL

OVERVIEW DATA ANALYSIS & PROJECTIONS GLOSSARY › FAQS ›

Home > Coal> Carbon Dioxide Emission Factors for Coal

Carbon Dioxide Emission Factors for Coal

by

B.D. Hong and E. R. Slatick

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Introduction

Coal is an important source of energy in the United States, and the Nation's reliance on this fossil fuel for electricity generation is growing. The combustion of coal, however, adds a significant amount of carbon dioxide to the atmosphere per unit of heat energy, more than does the combustion of other fossil fuels.(1) Because of a growing concern over the possible consequences of global warming, which may be caused in part by increases in atmospheric carbon dioxide (a major greenhouse gas), and also because of the need for accurate estimates of carbon dioxide emissions, the Energy Information Administration (EIA) has developed factors for estimating the amount of carbon dioxide emitted as a result of U.S. coal consumption.

Carbon dioxide emission factors for U.S. coals have previously been available from several sources. However, those emission factors have shortcomings because they are based on analyses of only a few coal samples. Most are single factors applied to all coals, regardless of rank (i.e., whether anthracite, bituminous, subbituminous, or lignite) or geographic origin. Because single factors do not account for differences among coals, they fail to reflect the changing "mix" of coal in U.S. coal consumption that has occurred in the past and will occur in the future. Lacking standardization, the factors previously available also differ widely from each other.(2)

EIA's emission factors will improve the accuracy of estimates of carbon dioxide emissions, especially at State and regional levels, because they reflect the difference in the ratio of carbon to heat content by rank of coal and State of origin. EIA's emission factors are derived from the EIA Coal Analysis File, a large database of coal sample analyses. The emission factors vary significantly by coal rank, confirming a long-recognized finding, and also within each rank by State of origin. These findings were verified statistically.

Two types of carbon dioxide emission factors have been developed. First are basic emission factors covering the various coal ranks by State of origin. These basic emission factors are considered as "fixed" for the foreseeable future until better data become available. Second are emission factors for use in estimating carbon dioxide emissions from coal consumption by State, with consuming-sector detail. These emission factors are based on the mix of coal consumed and the basic emission factors by coal rank and State of origin. These emission factors are subject to change over time, reflecting changes in the mix of coal consumed.

EIA's emission factors will not only enable coal-generated carbon dioxide emissions to be estimated more accurately than before, but they will also provide consistency in estimates. Energy and environmental analysts will find EIA's emission factors useful for analyzing and monitoring carbon dioxide emissions from coal combustion, whether they are estimated by the State of origin of the coal, consuming State, or consuming sector.

Coal Combustion and Carbon Dioxide Emissions

The amount of heat emitted during coal combustion depends largely on the amounts of carbon, hydrogen, and oxygen present in the coal and, to a lesser extent, on the sulfur content. Hence, the ratio of carbon to heat content depends on these heat-producing components of coal, and these components vary by coal rank.

Carbon, by far the major component of coal, is the principal source of heat, generating about 14,500 British thermal units (Btu) per pound. The typical carbon content for coal (dry basis) ranges from more than 60 percent for lignite to more than 80 percent for anthracite. Although hydrogen generates about 62,000 Btu per pound, it accounts for only 5 percent or less of coal and not all of this is available for heat because part of the hydrogen combines with oxygen to form water vapor. The higher the oxygen content of coal, the lower its heating value.(3) This inverse relationship occurs because oxygen in the coal is bound to the carbon and has, therefore, already partially oxidized the carbon, decreasing its ability to generate heat. The amount of heat contributed by the combustion of sulfur in coal is relatively small, because the heating value of sulfur is only about 4,000 Btu per pound, and the sulfur content of coal generally averages 1 to 2 percent by weight.(4) Consequently, variations in the ratios of carbon to heat content of coal are due primarily to variations in the hydrogen content.

The carbon dioxide emission factors in this article are expressed in terms of the energy content of coal as pounds of carbon dioxide per million Btu. Carbon dioxide (CO_2) forms during coal combustion when one atom of carbon (C) unites with two atoms of oxygen (O) from the air. Because the atomic weight of carbon is 12 and that of oxygen is 16, the atomic weight of carbon dioxide is 44. Based on that ratio, and assuming complete combustion, 1 pound of carbon combines with 2.667 pounds of oxygen to produce 3.667 pounds of carbon dioxide. For example, coal with a carbon content of 78 percent and a heating value of 14,000 Btu per pound emits about 204.3 pounds of carbon dioxide per million Btu when completely burned.(5) Complete combustion of 1 short ton (2,000 pounds) of this coal will generate about 5,720 pounds (2.86 short tons) of carbon dioxide.

Methodology and Statistical Checks

EIA's carbon dioxide emission factors were derived from data in the EIA Coal Analysis File, one of the most comprehensive data sources on U.S. coal quality by coalbed and coal-producing county. Most of the samples in the file were taken from coal shipments to U.S. Government facilities, from tipples and from mines. From the more than 60,000 coal samples in the File, 5,426 were identified as containing data on heat value and the ultimate analysis[(6)] needed for developing the relationship between carbon and heat content of the coal, that is, the carbon dioxide emission factors. Coal rank was assigned to each sample according to the standard classification method developed by the American Society for Testing and Materials. These data observations (samples) covered all of the major and most of the minor coal-producing States (Table FE1). Except for Arizona, North Dakota, and Texas, all of the major coal-producing States were considered to have a sufficiently large number of data observations to yield reliable emission factors.

The ratio of carbon to heat content was computed for each of the 5,426 selected coal samples by coal rank and State of origin under the assumption that all of the carbon in the coal is converted to carbon dioxide during combustion.[(7)] Variations in the ratios were observed across both coal rank and State of origin. Analysis was performed to determine whether these variations were statistically significant and to ensure that other factors pertaining to the samples (that is, the year the sample was collected and the degree of cleaning the sample received) were not significantly responsible for the observed variations.

Table FE1. Number of Observations by Coal Rank and State of Origin

State of Origin	Anthracite	Bituminous	Sub-bituminous	Lignite
Alabama	--	224	--	--
Alaska	--	--	--	--
Arizona	--	8	--	--
Arkansas	--	8	--	--
California	--	--	--	--
Colorado	--	164	18	--
Georgia	--	1	--	--
Idaho	--	2	--	--
Illinois	--	332	--	--
Indiana	--	51	--	--
Iowa	--	67	1	--
Kansas	--	19	--	--
Kentucky: East	--	486	--	--
Kentucky: West	--	151	--	--
Louisiana	--	--	--	--
Maryland	--	13	--	--
Missouri	--	86	--	--
Montana	--	6	23	2
Nevada	--	4	--	--
New Mexico	--	50	--	--
North Dakota	--	--	--	16
Ohio	--	228	--	--
Oklahoma	--	155	--	--
Oregon	--	--	2	--
Pennsylvania	523	679	--	--
South Dakota	--	--	--	3
Tennessee	--	271	--	--
Texas	--	--	--	11
Utah	--	104	2	--
Virginia	--	169	--	--
Washington	--	181	36	4
West Virginia	--	1,071	--	--
Wyoming	--	133	121	1
Total.	**523**	**4,663**	**203**	**37**

Source: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, "Analysis of the Relationship Between the Heat and Carbon Content of U.S. Coals," September 1992.

Distributions of the data observations by year of collection and degree of cleaning were compiled (Table FE2). Because the dates of the samples range from 1900 through 1986, it was thought that changes in laboratory analysis techniques over the years might have influenced the resultant carbon-to-heat-content ratios. A regression analysis found that, with a R^2 value of only 0.01 (Table FE3), the year the sample was collected was not a useful factor in explaining the variation in the ratio, although there were small changes in the ratio over time.[(8)] This finding indicated that samples from earlier time periods could be combined with more recent samples to derive carbon dioxide emission factors.

Table FE2. Distribution of Observations by Year and Degree of Cleaning

Year	Number of Observations	Percent of Total
1900-1909	217	4.0
1910-1919	679	12.5
1920-1929	657	12.1
1930-1939	772	14.2

1940-1949	744	13.7
1950-1959	1,043	19.2
1960-1969	557	10.3
1970-1979	339	6.2
1980-1986	418	7.7
Total	5,426	100.0
Degree of Cleaning		
Raw	4,519	83.3
Washed	847	15.6
Partially washed	60	1.1

Note: Total may not equal sum of components due to independent rounding.
Source: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, "Analysis of the Relationship Between the Heat and Carbon Content of U.S. Coals," September 1992.

Of the total samples, 83 percent were raw coal, with the remainder either washed or partially washed. Cleaning should not materially affect the ratio of a coal's heat-to-carbon content because the process removes primarily non-combustible impurities. This was confirmed by an analysis of variance. There were differences in the carbon-to-heat-content ratios between washed or partially washed and raw coal, but with a R^2 value of 0.06, the differences did little to explain the variation in the ratios. Therefore, no data correction was warranted to account for the small effect that coal cleaning had on emission factors.

Analysis of variance was used to test the statistical significance of differences in the carbon-to-heat-content ratios across coal rank and across State of origin within coal rank. The continuous response variable (the carbon dioxide emission factor) was related to classification variables of rank and State of origin. The carbon dioxide emission factor was assumed to be a linear function of the parameters associated with the coal rank and State of origin.[(9)]

The statistical analyses (Table FE3) indicated that: (1) there are statistically significant differences in carbon dioxide emission factors across both coal rank and State of origin; (2) coal rank and State of origin each explain approximately 80 percent of the variation in carbon dioxide emission factors; and (3) State of origin combined with coal rank is a slightly more powerful explanatory variable than either coal rank or State of origin alone.

Table FE3. Summary of Statistical Analyses Carbon Dioxide Emission Factors by Coal Rank and State of Origin

Variable	F Test	R^2	MSE	Root MSE
Year Collected	***	0.01	55.18	7.43
Degree of Cleaning	***	0.06	52.07	7.22
Coal Rank	***	0.78	12.24	3.50
State of Origin	***	0.81	10.78	3.28
State of Origin Combined				
with Coal Rank	***	0.82	9.98	3.16

Notes: The F test indicates the statistical significance of differences in the emission factors across levels of the explanatory variable; *** indicates significance at the 0.001 level. R^2 (coefficient of determination) indicates the proportion of total variation in the emission factors explained by the model. MSE (mean square error) is the variance of the emission factors, and root MSE is the corresponding standard deviation.
Source: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, "Analysis of the Relationship Between the Heat and Carbon Content of U.S. Coals," September 1992.

Carbon Dioxide Emission Factors by Coal Rank and State of Origin

The (arithmetic) average emission factors obtained from the individual samples (assuming complete combustion) (Table FE4)[(10)] confirm the long-recognized finding that anthracite emits the largest amount of carbon dioxide per million Btu, followed by lignite, subbituminous coal, and bituminous coal. The high carbon dioxide emission factor for anthracite reflects the coal's relatively small hydrogen content, which lowers its heating value.[(11)] In pounds of carbon dioxide per million Btu, U.S. average factors are 227.4 for anthracite, 216.3 for lignite, 211.9 for subbituminous coal, and 205.3 for bituminous coal.

Table FE4. Average Carbon Dioxide Emission Factors for Coal by Rank and State of Origin

State of Origin	Anthracite	Bituminous	Sub-bituminous	Lignite
Alabama	--	205.5	--	--
Alaska	--	--	[a]214.0	--
Arizona	--	209.7	--	--
Arkansas	--	211.6	--	[b]213.5
California	--	--	--	[c]216.3
Colorado	--	206.2	212.7	--
Georgia	--	206.1	--	--
Idaho	--	205.9	--	--
Illinois	--	203.5	--	--
Indiana	--	203.6	--	--
Iowa	--	201.6	[d]207.2	--
Kansas	--	202.8	--	--
Kentucky: East	--	204.8	--	--
Kentucky: West	--	203.2	--	--
Louisiana	--	--	--	[b]213.5
Maryland	--	210.2	--	--

Missouri	--	201.3	--	--
Montana	--	209.6	213.4	220.6
Nevada	--	201.8	--	--
New Mexico	--	205.7	[e]208.8	--
North Dakota	--	--	--	218.8
Ohio	--	202.8	--	--
Oklahoma	--	205.9	--	--
Oregon	--	--	210.4	--
Pennsylvania	227.4	205.7	--	--
South Dakota	--	--	--	217.0
Tennessee	--	204.8	--	--
Texas	--	[f]204.4	--	213.5
Utah	--	204.1	207.1	--
Virginia	--	206.2	--	--
Washington	--	203.6	208.7	211.7
West Virginia	--	207.1	--	--
Wyoming	--	206.5	212.7	215.6
U.S. Average	**227.4**	**205.3**	**211.9**	**216.3**

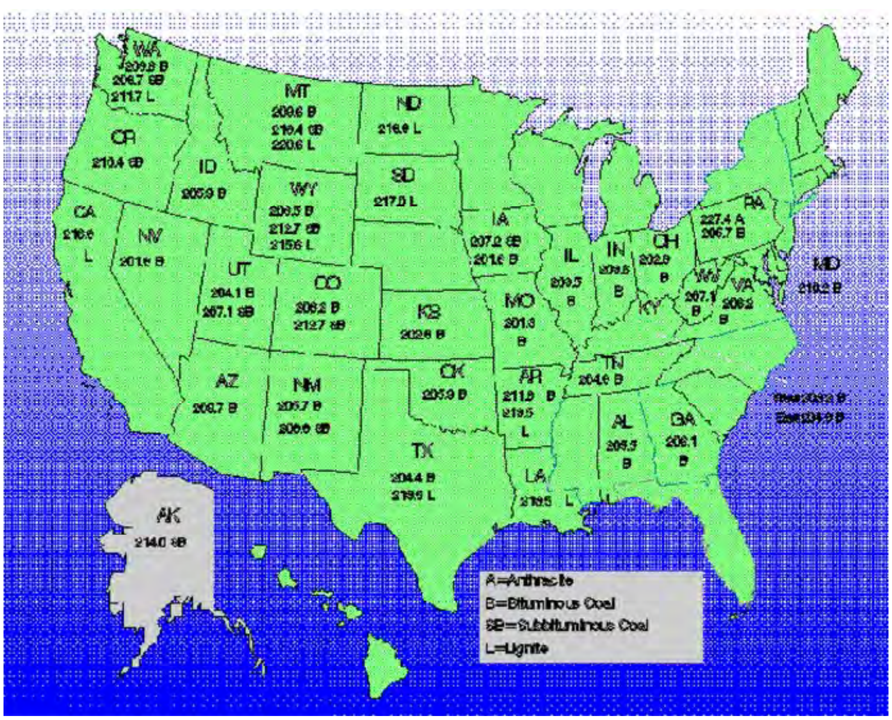
[a]Based on carbon and heat content data supplied by Usibelli Coal Mining Company for the subbituminous C coal currently being produced in the State.
[b]Based on the CO_2 emission factor for Texas lignite.
[c]Based on the CO_2 emission factor for U.S. lignite.
[d]Derived from “Element Geochemistry of Cherokee Group Coals (Middle Pennsylvanian) from South-Central and Southeastern Iowa,” *Technical Paper No. 5*, Iowa Geological Survey (Iowa City, IA, 1984), pp. 15, 48, and 49.
[e]Based on the CO_2 emission factor for subbituminous A coal.
[f]Based on the CO_2 ratio for U.S. high-volatile bituminous coal.
Source: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, “Analysis of the Relationship Between the Heat and Carbon Content of U.S. Coals,” September 1992.

In general, the carbon dioxide emission factors are lowest for coal produced in States east of the Mississippi River (Figure FE1), where the predominant coals are bituminous in rank and therefore have relatively low emission factors. By comparison, the coal deposits in the West are largely subbituminous coals, which have relatively high emission factors. In a broad sense, the geographic differences reflect the greater degree of coalification--the process that transformed plant material into coal under the influence of heat and pressure--in the coal-bearing areas in the East.

In the Appalachian Coal Basin, the emission factors for bituminous coal range from a low of 202.8 pounds of carbon dioxide per million Btu in Ohio to a high of 210.2 in Maryland.(12) Pennsylvania anthracite, which is produced in small amounts, has the highest emission factor among all coal ranks (227.4). For Illinois Basin coal, all bituminous in rank, the emission factors are relatively uniform, ranging from 203.2 in western Kentucky to 203.6 in Indiana.

Figure FE1: Average Carbon Dioxide Emission Factors for Coal by Rank and State of Origin

Pounds of Carbon Dioxide per Million Btu



West of the Mississippi River, the emission factors for bituminous coal range from more than 201 pounds of carbon dioxide per million Btu in Missouri, Iowa, and Nevada to more than 209 in Arizona, Arkansas, and Montana. About 16 percent of the 1992 coal output west of the Mississippi was bituminous coal, with production chiefly from Utah, Arizona, Colorado, and New Mexico.

Subbituminous coal is the predominant rank of coal produced west of the Mississippi River, accounting for 62 percent of the region's total coal output in 1992. Subbituminous coal in Wyoming's Powder River Basin, the principal source of this rank of coal, has an emission factor of 212.7 pounds of carbon dioxide per million Btu. This is the same as for subbituminous coal in Colorado, but slightly below that in Montana. The lowest emission factor for subbituminous coal is in Utah (207.1) and the highest is in Alaska (214.0).

The emission factor for lignite from the Gulf Coast Coal Region in Texas, Louisiana, and Arkansas is 213.5 pounds of carbon dioxide per million Btu. This is 1 to 3 percent lower than the emission factors for lignite in the Fort Union Coal Region in North Dakota, South Dakota, and Montana and for lignite in the Powder River Basin in Wyoming. The 1992 output of lignite accounted for 22 percent of coal production west of the Mississippi River, with two-thirds from Texas and most of the balance from North Dakota.

All of EIA's carbon dioxide emission factors for coal by rank and State of origin should be considered as "fixed" for the foreseeable future. This is because detailed coal analysis data are not widely available annually, and because the EIA emission factors, as developed from the EIA Coal Analysis File, are considered to effectively represent the relationship between the carbon and heat content of the various U.S. coals. However, the basic emission factors will be reviewed when sufficient additional coal analysis data are accumulated.

Carbon Dioxide Emission Factors by Coal-Consuming Sector and State

Coal use among the consuming sectors and States varies in quantity as well as in rank and State of origin. Therefore, emission factors by consuming sector in each State were derived by weighting the emission factors by coal rank and State of origin by the respective amounts received by sector.[(13)],[(14)] For comparison, emission factors for 1980 and 1992 are reported in this article (Table FE5). It should be noted that the amount of coal received in a certain year may not equal the amount consumed during that year because of stock additions or withdrawals. Furthermore, because data on the origin and destination of coal are available only for coal distribution, EIA's emission factors for coal consumption by sector assume that the mix of coal received during a certain year was the same as that consumed in that year.

The emission factors for coal consumption involving combustion are based on the assumption that all of the carbon in coal is converted to carbon dioxide during combustion. Actually, a very small percentage of the carbon in coal is not oxidized during combustion. The emission factors in Table FE5 can be adjusted to reflect incomplete combustion.[(15)]

In coke plants, coal is carbonized, not combusted, to make coke, which is used in the manufacture of pig iron by the iron and steel industry. Although most of the carbon in the coal carbonized remains in the coke, a small amount is retained in byproducts, some of which are consumed as energy sources and others as non-energy raw materials.[(16)] Examination of historical data for coke plant operations indicates that about 10 percent of the carbon in coking coal remains in non- energy byproducts.[(17)] However, no allowances have been made in the emission factors for coke plants (Table FE5) for carbon retained in non-energy byproducts, leaving any adjustments to the user's stipulations.

Table FE5. Average Carbon Dioxide Emission Factors for Coal-Consuming Sector and State, 1980 and 1992

State	Sector									
	Electric Utilities		Industrial				Residential/Commercial		State Average[b]	
			Coking Coal[a]		Other Coal					
	1980	1992	1980	1992	1980	1992	1980	1992	1980	1992
Alabama	205.0	205.3	205.5	206.1	205.5	205.7	205.4	205.5	205.1	205.4
Alaska	214.0	214.0	--	--	--	--	--	214.0	214.0	214.0
Arizona	208.0	207.7	--	--	209.2	206.7	--	208.6	208.1	207.6
Arkansas	212.7	212.7	--	--	201.4	205.2	205.3	222.3	210.7	212.5
California	--	--	208.7	--	205.6	204.2	204.5	204.1	207.5	204.1
Colorado	211.5	209.8	212.6	--	212.6	212.5	212.6	211.0	211.7	209.9
Connecticut	--	204.9	--	--	--	204.7	226.1	220.2	226.1	205.2
Delaware	206.0	206.9	--	--	205.9	207.4	221.8	221.1	206.0	207.0
District of Columbia	--	--	--	--	205.0	--	205.5	206.3	205.4	206.3
Florida	204.0	204.4	--	--	204.2	205.1	205.0	205.7	204.0	204.5
Georgia	204.3	204.8	--	--	204.9	204.9	204.7	204.9	204.3	204.8
Hawaii	--	--	--	--	--	204.4	--	--	--	204.4
Idaho	--	--	--	--	212.6	212.2	205.4	205.0	210.7	211.3
Illinois	207.1	206.2	205.2	206.5	204.2	203.7	203.9	203.9	206.7	205.9
Indiana	204.0	205.6	205.0	206.0	203.7	204.5	203.7	203.8	204.3	205.5
Iowa	207.2	211.1	--	--	205.7	208.3	205.1	204.2	207.0	210.7
Kansas	209.2	210.9	--	--	201.9	205.3	202.2	202.9	209.0	210.8
Kentucky	204.0	204.1	204.6	206.3	205.4	205.4	204.6	204.6	204.1	204.2
Louisiana	212.7	212.9	--	--	203.9	210.9	201.3	--	212.1	212.8
Maine	--	--	--	--	206.0	204.9	216.2	213.0	207.9	205.3
Maryland	206.6	207.0	205.9	--	206.1	208.4	210.6	211.7	206.3	207.1
Massachusetts	206.4	206.8	--	--	206.3	207.0	218.2	214.1	207.6	206.9
Michigan	206.0	208.9	205.5	--	204.8	205.3	205.0	205.0	205.7	208.5
Minnesota	212.9	213.0	--	--	211.6	211.8	208.6	212.3	212.7	212.9
Mississippi	204.7	204.5	--	--	204.0	204.6	202.6	227.4	204.7	204.5
Missouri	204.5	206.2	205.2	--	203.6	204.5	202.1	203.4	204.5	206.1
Montana	213.9	213.5	--	--	211.2	211.4	205.6	213.3	213.7	213.5
Nebraska	211.7	212.7	--	--	212.3	213.1	212.6	219.2	211.7	212.7
Nevada	208.2	208.4	--	--	204.5	204.1	208.4	204.1	208.1	208.3
New Hampshire	206.9	206.3	--	--	207.0	207.1	227.2	225.4	207.0	206.5
New Jersey	206.6	206.6	--	--	218.3	207.3	227.2	227.1	207.1	206.8

New Mexico	205.7	205.7	--	--	212.0	212.7	209.8	206.3	205.7	205.7
New York	205.7	206.1	205.5	206.1	206.9	207.0	218.9	218.0	206.3	206.5
North Carolina	205.6	205.8	--	--	204.8	205.7	204.9	206.2	205.6	205.8
North Dakota	218.8	218.8	--	--	218.8	218.3	218.5	216.8	218.8	218.6
Ohio	204.4	204.4	205.4	206.4	204.0	204.5	203.8	205.5	204.5	204.6
Oklahoma	210.5	212.6	--	--	202.2	207.5	205.7	207.0	210.0	212.3
Oregon	212.7	212.9	--	--	212.7	211.5	205.6	204.1	212.5	212.8
Pennsylvania	206.1	206.2	205.7	206.1	207.9	208.5	221.2	219.7	206.4	206.7
Rhode Island	--	--	--	--	210.0	--	223.9	227.4	217.2	227.4
South Carolina	204.9	205.0	--	--	205.0	205.3	204.8	205.3	204.9	205.0
South Dakota	218.1	218.8	--	--	210.5	212.7	212.0	212.8	217.6	217.9
Tennessee	204.0	204.0	210.2	--	204.8	205.5	204.5	204.6	204.1	204.2
Texas	213.0	212.9	209.8	--	212.3	212.3	213.7	211.0	212.8	212.9
Utah	204.1	204.3	210.8	205.6	205.2	204.1	204.1	204.1	205.7	204.4
Vermont	205.7	--	--	--	207.8	212.2	227.4	227.4	216.0	216.8
Virginia	205.9	206.0	206.2	206.2	205.1	206.2	205.0	206.3	205.7	206.1
Washington	208.7	209.3	--	--	206.3	205.8	204.3	206.9	208.3	209.1
West Virginia	206.9	207.0	205.3	206.7	205.4	206.6	205.0	210.2	206.6	207.0
Wisconsin	207.0	209.9	205.4	--	205.5	206.1	205.8	204.9	206.8	209.5
Wyoming	212.7	212.0	--	--	212.0	212.5	212.3	212.7	212.6	212.1
U.S. Average[b]	**206.7**	**207.7**	**205.8**	**206.2**	**205.9**	**207.1**	**210.6**	**211.2**	**206.5**	**207.6**

[a]No allowances have been made for carbon retained in non-energy coal chemical byproducts from the coal carbonization process.
[b]Weighted average. The weights used are consumption values by sector.
Source: Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels.

The mix of rank and origin of coal consumed in the United States has changed substantially in the past two decades, reflecting shifts to Western low-sulfur subbituminous coal and lignite, predominantly for electricity generation. Further changes are expected in the coming years, especially due to the Clean Air Act Amendments of 1990, which will encourage switches from high-sulfur Eastern bituminous coal to low-sulfur Western subbituminous coal.

The shift in the mix of coal ranks consumed becomes apparent when production by coal rank in 1980 is compared with that in 1992, as most production was for domestic consumption.[(18)] In 1980, bituminous coal comprised 76 percent of the total, but by 1992 its share dropped to 65 percent. By contrast, the share for subbituminous coal rose from 18 percent in 1980 to 25 percent in 1992, while the share for lignite grew from 6 percent to 9 percent. Anthracite's share was about 1 percent in both years. Because lower rank coals have relatively high carbon dioxide emission factors, increased use of these coals caused the national average carbon dioxide emission factor to rise from 206.5 pounds per million Btu in 1980 to 207.6 pounds per million Btu in 1992.

The change in mix of coal ranks produced reflects the large sectorial and regional shifts in coal consumption that have occurred in the past two decades. The electric utility sector dominates coal consumption, and its share has grown substantially. Of total coal consumption in 1992, electric utilities accounted for 87 percent, up from 81 percent in 1980, due mostly to increases in utility coal consumption west of the Mississippi River.[(19)] The share held by low-rank coals in the electric utility sector increased substantially.[(20)] Subbituminous coal rose from 24 percent in 1980 to 31 percent in 1992, and lignite grew from 7 to 10 percent during the period. In contrast, bituminous coal fell from 69 percent in 1980 to 58 percent in 1992. The share held by anthracite (about 1 percent) did not change.

Coal used to produce coke is virtually all bituminous in rank; less than 1 percent is anthracite. Only a few States, mostly in Appalachia, supply coking coal. The coke industry, which has been declining, accounted for only 4 percent of total coal consumption in 1992, down from 9 percent in 1980.

All ranks of coal are used by the other industrial and the residential/commercial sectors.[(21)] The other industrial sector accounted for 8 percent of total coal consumption in 1992, slightly less than in 1980. However, the emission factor for this sector increased sizably during the period, due mainly to the rising use of low-rank coals in the West, and contributed to the increase in emission factors for the overall national average. The residential/commercial sector is a relatively minor component of coal consumption, with about 1 percent of the total in 1980 and 1992.

As with coal consumption by sector, the amount of carbon dioxide emitted from total coal combustion in a particular State--and hence the carbon dioxide emission factor for that State--depends on the mix of coal consumed by various consuming sectors in that State during a particular year. When the total energy in Btu from coal consumption by State is known (with no breakdown by coal-consuming sector), the State average emission factors can be used to estimate the total amount of carbon dioxide emissions by State.

Publication of Carbon Dioxide Emission Factors

EIA's carbon dioxide emission factors by consuming sector and State will be updated periodically to reflect changes in the mix of U.S. coal consumption. EIA plans to report these updates in the *Quarterly Coal Report*, the *State Energy Data Report*, and the annual issue of *Emissions of Greenhouse Gases in the United States*.

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[1]Coal combustion emits almost twice as much carbon dioxide per unit of energy as does the combustion of natural gas, whereas the amount from crude oil combustion falls between coal and natural gas, according to Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1985-1990*, DOE/EIA-0573 (Washington, DC, September 1993), p. 16.

[2]Examples of previously published emission factors include, in pounds of carbon dioxide per million Btu, single emission factors of 205.7 in "United States Emissions of Carbon Dioxide to the Earth's Atmosphere," *Energy Systems Policy*, Vol. 14, 1990, p. 323; 210.2 in *Changing by Degrees*, U.S. Congress, Office of Technology Assessment, February 1991, p. 333; 205.6 for bituminous coal in *Greenhouse Gases, Abatement and Control*, IEA Coal Research, June 1991, p. 24; and 183.4 in *Limiting Net Greenhouse Gas Emissions in the United States (Executive Summary)*, U.S. Department of Energy, Office of Environmental Analysis, September 1991, p. 37. EIA's first reported emission factors by coal rank, published in *Electric Power Annual 1990*, DOE/EIA-0348(90) (Washington, DC, January 1992), p. 124, were as follows: anthracite, 209; bituminous coal, 209; subbituminous coal, 219; and lignite, 213.

[3]U.S. Department of Energy, Pittsburgh Energy Technology Center, "A Coal Combustion Primer," *PETC Review*, Issue 2 (Pittsburgh, PA, September 1990), p. 17.

[4]The relationships of the various heat-producing components of coal are given in Dulong's formula, which provides a method for calculating the heating value of solid fuels. Dulong's formula is as follows: Btu per pound = 14,544C + 62,028(H - O ÷ 8) + 4,050S. C is carbon, H is hydrogen, O is oxygen, and S is sulfur, all expressed in percent by weight. The coefficients represent the approximate heating values of the respective components in Btu per pound. The term O ÷ 8 for hydrogen is a correction applied to account for the portion of hydrogen combined with oxygen to form water. For a further discussion of Dulong's formula, see Babcock and Wilcox Co., *Steam/Its Generation and Use*, 40th edition, 1992, p. 9-9.

[5]Potential carbon dioxide emissions can be calculated by use of the following formula: percent carbon ÷ Btu per pound x 36,670 = pounds (lbs) of carbon dioxide per million (10^6) Btu. Multiply pounds of carbon dioxide per million Btu by 0.123706 to get million metric tons (MMT) of carbon per quadrillion (10^{15}) Btu.

[6]Ultimate analysis refers to the determination of carbon, hydrogen, sulfur, nitrogen, oxygen, and ash. By comparison, proximate analysis determines fixed carbon, volatile matter, moisture, and ash. Fixed carbon is principally carbon, but it may contain appreciable amounts of sulfur, hydrogen, nitrogen, and oxygen. Volatile matter comprises hydrogen, carbon dioxide, carbon monoxide, and various compounds of carbon and hydrogen.

[7]Modification of the emission factors for incomplete combustion is described on page 6 of this article under "Carbon Dioxide Emission Factors by Coal-Consuming Sector and State."

[8]For details, see "Analysis of the Relationship Between the Heat and Carbon Content of U.S. Coals," prepared for the Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, by Science Applications International Corp., September 1992.

[9]Because of the unbalanced nature of the data being analyzed (i.e., unequal numbers of observations for the different levels of the classification variables), the General Linear Models procedure in the Statistical Analysis System was used to perform the analyses.

[10]The EIA Coal Analysis File did not contain data for bituminous coal in Texas, subbituminous coal in Alaska and New Mexico, or lignite in Arkansas, California, and Louisiana. The emission factor for Alaska subbituminous coal was derived from information obtained from the sole producer of coal in Alaska. The others were assigned appropriate average factors for their coal ranks, as noted in Table FE4.

[11]For the coal analyzed in the EIA Coal Analysis File, the average hydrogen content was as follows, by weight (dry basis): anthracite, 2.5 percent; bituminous coal, 5.0 percent; subbituminous coal, 4.8 percent; and lignite, 4.4 percent.

[12]For information on States that produce coal, see Energy Information Administration, *Coal Production 1992*, DOE/EIA-0118(92) (Washington, DC, October 1993), and *State Coal Profiles*, DOE/EIA-0576 (Washington, DC, January 1994).

[13]The amount of coal distributed by State of origin and State of destination is reported on Form EIA-6, "Coal Distribution Report," for consuming sectors other than electric utilities, and on Federal Energy Regulatory Commission (FERC) Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants," for utility coal by rank. The amount and energy content of coal consumption by State and sector are detailed in Energy Information Administration, *State Energy Data Report*, DOE/EIA-0214, published annually.

[14]Acknowledgement is due Albert D. Gerard, Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, for assistance in developing Table FE5.

[15]Adjustments can be made by multiplying the factors by the estimated percentage of carbon converted to carbon dioxide. This has been estimated as 99 percent by G. Marland and A. Pippin, "United States Emissions of Carbon Dioxide to the Earth's Atmosphere by Economic Activity," *Energy Systems and Policy*, Vol. 14, (1990), p. 323. EIA's *Emissions of Greenhouse Gases in the United States 1985-1990* (DOE/EIA-0573, September 1993) also assumed 99 percent combustion for carbon emission estimates.

[16]Byproducts include coke oven gas, benzene, creosote, and other hydrocarbons. See, for example, Energy Information Administration, *Coke and Coal Chemicals in 1980*, DOE/EIA-012(80) (Washington, DC, May 1981), for production and disposition of coal chemical materials.

[17]Another source, *Greenhouse Gas Inventory Reference Manual--IPCC Draft Guideline for National Greenhouse Gas Inventories* (IPCC/OECD Joint Programme, 1993), Volume 3, part 2, 1.29, states that on average 5.91 percent of coal going to coke plants ends up as light oil and crude tar, with 75 percent of the carbon in these products remaining unoxidized for long periods.

[18]Energy Information Administration, *Coal Production 1980*, DOE/EIA-0118(80) (Washington, DC, May 1982), p. 20; and *Coal Production 1992*, DOE/EIA-0118(92) (Washington, DC, October 1993), p. 30.

[19]Energy Information Administration, *Quarterly Coal Report July-September 1993*, DOE/EIA-0121(93/3Q) (Washington, DC, February 1994), p. 77; and *Quarterly Coal Report October-December 1987*, DOE/EIA-0121 (87/4Q) (Washington, DC, May 1988), p. 46.

[20]Energy Information Administration, *Cost and Quality of Fuels for Electric Utility Plants 1992*, DOE/EIA-019(92) (Washington, DC, August 1993), and *Cost and Quality of Fuels for Electric Utility Plants 1980 Annual*, DOE/EIA-0191(80) (Washington, DC, June 1981).

[21]Information on the rank of coal distributed to the other industrial and residential/commercial sectors from States producing more than one rank is not available. Therefore, based on available EIA data, the following coal ranks were assigned to distributions of nonutility coal from the following coal-producing States: Arkansas, bituminous; Colorado, Montana, Washington, and Wyoming, subbituminous; Texas, lignite.

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APPENDIX 57

Heavy Traffic Ahead

Rail Impacts of Powder River Basin Coal to Asia By Way of Pacific Northwest Terminals

Report Prepared For

Western Organization of Resource Councils

July 2012

Heavy Traffic Ahead

Rail Impacts of Powder River Basin Coal to Asia

By Way of Pacific Northwest Terminals

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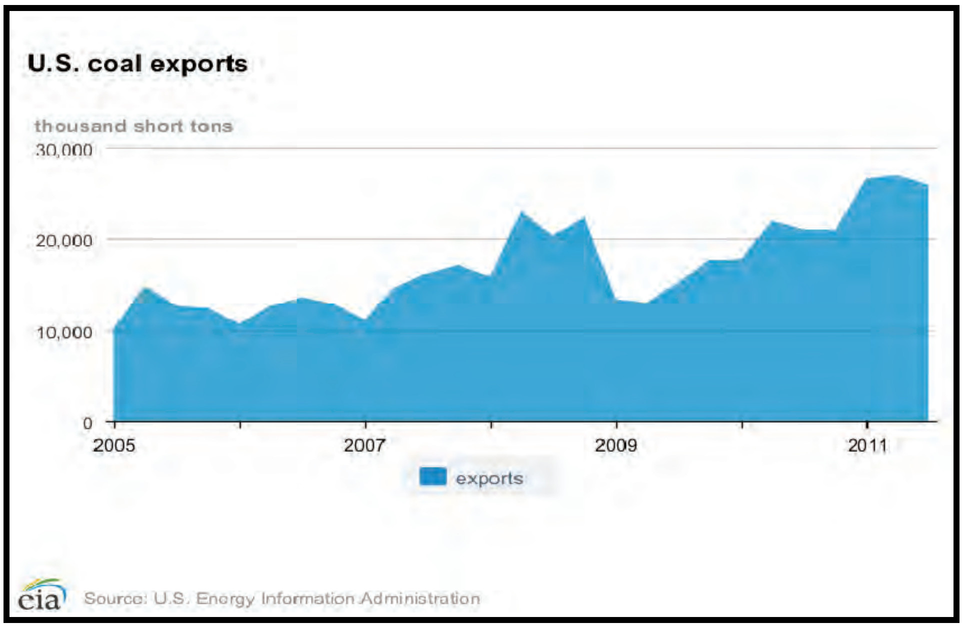
Introduction

Western Organization of Resource Councils (WORC) is a regional network of seven (7) grassroots community organizations that include 10,000 members and 38 local chapters. WORC's member organizations are: Dakota Rural Action; Dakota Resource Council; Idaho Rural Council; Northern Plains Resource Council; Oregon Rural Action; Powder River Basin Resource Council; and Western Colorado Congress. WORC's mission is to advance the vision of a democratic, sustainable and just society through community action. WORC is committed to building sustainable environmental and economic communities that balance economic growth with the health of people and stewardship of their land, water and air resources.

WORC is concerned about the potential impacts associated with the recent and projected significant increase in U.S. coal exports and related railroad shipments. Total U.S. export coal shipments increased from approximately 81.7 million tons in 2010 to 107.3 million in 2011.[1] This increase in U.S. coal exports is illustrated in the following chart:

Figure 1

U.S. Export Coal Tonnage Since 2005



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1 U.S. Energy Information Administration (EIA), U.S. Coal Exports, Table 7. Export coal tons are often expressed in metric tons (2,204.6 lbs.), whereas U.S. mine production and railroad coal tons are normally expressed in U.S. short tons (2,000 lbs.). Unless otherwise noted, the tons referenced herein, such as the referenced 82 and 107 million U.S. export coal tons, are listed in short tons.

The increase in U.S. coal exports can be attributed, in part, to the significant growth in export coal shipments to Asian markets, such as China, Japan, and South Korea, which increased from approximately 17.9 million in 2010 to 27.5 million in 2011. Total steam coal exports to Asia have increased from approximately 4.9 million in 2010 to over 7.8 million in 2011 and will likely exceed 12 million in 2012.[2]

U.S. coal producers and suppliers are actively looking to expand steam coal production from mines and origins in the Powder River Basin (PRB) in Montana and Wyoming and shift significant coal volumes away from domestic destinations to existing and proposed Pacific Northwest (PNW) export coal terminals, in order to compensate for a recent and projected decline in domestic steam coal-fired power production and take advantage of the growing Asian steam coal market. Currently, there are only three (3) PNW export coal terminals in British Columbia (BC), which handle approximately 5 million tons of PRB coal per year. In order to meet large export tonnage goals and reduce transportations costs, at least six (6) U.S. PNW export terminals are being considered in Washington and Oregon. The nine (9) existing and planned PNW export coal terminals are listed in the following table and described in more detail herein:

Figure 2

<u>Existing and Proposed PNW Export Coal Terminals</u>

British Columbia
Roberts Bank, BC (Westshore) N. Vancouver, BC (Neptune) Prince Rupert, BC (Ridley)
Washington
Cherry Point, WA (Bellingham) Longview, WA Grays Harbor,WA (Hoquiam)
Oregon
Coos Bay, OR St. Helens, OR (Westward) Boardman, OR (Morrow)

[2] In the past, most U.S. export coal shipments have been metallurgical coal (approximately 69.5 million tons in 2011). Europe, which received over 53.9 million tons of U.S. coal exports in 2011, has historically been the largest destination market for U.S coal exports. Consequently, the largest U.S. export coal ports are currently East coast ports such as Norfolk, Virginia and Baltimore, Maryland and Gulf coast ports such as New Orleans, Louisiana and Mobile, Alabama.

State and local governments have expressed concerns about the proposed expansion of PNW export coal terminals. For example, in a recent letter from Oregon Governor John A. Kitzhaber to U.S. Secretary of Interior Ken Salazar and others, the Governor requested a programmatic and comprehensive environmental impact statement (EIS) under the National Environmental Policy Act to look at the "unprecedented number of export coal proposals."[3] The Seattle City Council also recently unanimously passed a resolution in opposition to the transportation of coal through Seattle, which highlights the negative impacts from the significant increase in coal trains that would run through Seattle.[4]

Based on announced and proposed expansion plans associated with these existing and proposed PNW export coal terminals, PRB to PNW export coal shipments, which amounted to only a few million tons five years ago, could very well exceed 75 million tons per year by 2017 and 170 million tons by 2022. The projected annual volumes are shown in the following table:

Figure 3

Projected Annual PRB to PNW Export Coal Tons

(Millions of Short Tons)

PNW Export Coal Terminals	2012	2017	2022
Roberts Bank, BC (Westshore)	5.0	8.0	15.0
N. Vancouver, BC (Neptune)	0.0	2.0	5.0
Prince Rupert, BC (Ridley)	0.0	1.5	5.0
Existing British Columbia Coal	**5.0**	**11.5**	**25.0**
Cherry Point, WA (Bellingham)	0.0	27.5	52.5
Longview, WA	0.0	27.5	48.0
Grays Harbor, WA (Hoquiam)	0.0	0.0	5.0
Proposed Washington Coal Terminals	**0.0**	**55.0**	**105.5**
Coos Bay, OR	0.0	0.0	10.0
St. Helens, OR (Westward)	0.0	5.0	21.0
Boardman, OR (Morrow)	0.0	3.5	8.5
Proposed Oregon Coal Terminals	**0.0**	**8.5**	**39.5**
Total to PRB to PNW Export Coal Tons	**5.0**	**75.0**	**170.0**

3 Letter from Governor John A. Kitzhaber dated April 25, 2012.
4 http://www.seattle.gov/council/newsdetail.asp?id=12809&dept=28

The proposed expansion of PNW export coal terminal capacity will likely result in an explosion in PRB to PNW coal exports and railroad export coal movements. Two major U.S. Class I railroads dominate the PNW region as well as the PRB coal transportation market: BNSF Railway Company (BNSF) and Union Pacific Corporation (UP).[5] BNSF serves PRB origins in Montana and Wyoming. UP serves PRB origins in Wyoming, which are jointly served by BNSF. There are currently six railroad PRB coal lines in Montana and Wyoming and one proposed new coal line in Montana, which serve approximately twenty coal mines and would feed PRB export coal trains onto railroad mainlines for movement to the nine existing and proposed PNW terminals. The coal mines served by BNSF and UP are owned and operated by a few major coal companies, such as Peabody Energy, Arch Coal and Cloud Peak, which would work with the railroads and PNW export terminals in regard to export coal shipments. These PRB coal mines, railroad coal lines and railroad routes are described in more detail herein.

Repetitive and voluminous PRB to PNW export coal movements will obviously benefit the coal companies, railroads and terminal companies by generating billions of dollars in annual revenues and profits, but these coal movements will have a wide-range of adverse environmental, economic, transportation, public safety and other impacts. As described herein, the rail routes potentially impacted by the increase in PRB to PNW export coal cover an extremely broad impact area covering a total rail distance of over 4,000 miles. The impacted railroad routes traverse through many major populated areas, such as Spokane and Seattle, Washington, Billings, Montana and Portland, Oregon, as well as many environmentally sensitive areas, such as Glacier National Park in Montana.

WORC is concerned about the environmental, economic, transportation and other impacts associated with the expected increase in rail tonnage from the PRB coal mines to PNW export terminals and prepared this report to study the possible impacts associated with the expected increase in railroad export coal movements from PNW origins to PNW export terminals. WORC retained the consulting firms of Whiteside & Associates (TCW), a transportation and marketing consulting firm located in Billings, Montana, and G. W. Fauth & Associates, Inc. (GWF), an economic consulting firm specializing in transportation issues located in Alexandria, Virginia, to study the possible environmental, economic and transportation impacts associated with the expected increase in railroad export coal movements from PNW origins to PNW export terminals. Richard H. Streeter, an attorney in Washington, DC specializing in transportation issues, also contributed to this report.

[5] On Feb. 12, 2010, Burlington Northern Santa Fe, LLC, (formerly known as Burlington Northern Santa Fe Corporation) and BNSF Railway Company became subsidiaries of Berkshire Hathaway Inc.

Executive Summary

The U.S. coal export market is headed for explosive growth of coal movements from the PRB region in Montana and Wyoming to nine existing and proposed PNW export terminals in Oregon, Washington and British Columbia.

The projected movement of 75 million tons per year by 2017 to 170 million tons per year by 2022 will generate billions of dollars in annual revenues for railroad, coal and terminal companies.

Although BNSF, UP and other railroads will be involved in the PRB to PNW export coal transportation market to some extent, BNSF's routes are significantly shorter than UP's routes and BNSF has a lower cost structure. Thus, BNSF can provide transportation rates which are significantly lower than UP and will likely capture the lion's share and dominate the expanding and lucrative PRB to PNW export coal market.

The total rail route miles potentially impacted cover an extremely broad impact area covering a total rail distance of over 4,000 miles. The impacted railroad route miles would directly impact over 48,977 acres based on a 100 ft. right-of-way (ROW).

The projected movement of 75 million tons per year by 2017 to 170 million tons per year by 2022 will equate to the movements of 27.86 to 63.15 loaded and empty coal trains per day. These repetitive 1¼-mile long loaded and empty coal trains will be going through numerous populated cities, towns, communities (such as Spokane, Washington, Seattle, Washington, Billings, Montana and Portland, Oregon), parks, forests, historical areas and other environmentally sensitive areas (such as Glacier National Park in Montana).

In addition to the obvious environmental and traffic concerns, the expected large coal volumes will result in several major choke points and bottlenecks and will likely cause rail congestion problems for the entire route. Many of the impacted railroad line segments, such as the line known as "The Funnel" from Sandpoint, ID to Spokane, WA, already have significant rail capacity and congestion issues.

Current railroad traffic, such as PNW import and export intermodal container traffic and export grain railroad traffic, would be adversely impacted by the reduction of rail capacity and would likely experience a deterioration of rail service, such as higher transit and cycle times and would likely incur higher costs in the form of higher freight rates and equipment costs.

The west bound movement of coal is likely to disrupt the frequency and reliability of inbound and outbound shipments of containerized traffic and that traffic would likely experience a diversion to California and Canadian ports where it will not be impacted by the congestion associated with the increased PRB to PNW coal shipments.

The two major cities that would be the most adversely impacted in terms of the expected export coal trains per day are: Spokane, Washington (pop. 208,916) and Billings, Montana (pop. 104,170). Nearly every PRB to PNW loaded and empty coal train would move through these two cities (up to 63.2 trains per day through Spokane and 57.6 trains per day through Billings).

There are many areas along the railroad routes which would require major upgrading and expansion of existing railroad tracks and related infrastructure which could cost billions of dollars. State and local governments would likely bear the brunt and burden of the related infrastructure costs in their localities and would likely be required to spend hundreds of millions of dollars in related mitigation, litigation, debt and other costs associated with the necessary improvements to accommodate export coal traffic levels.

The following table shows the projected annual tons for 2017 and 2022 and estimated loaded and empty coal trains per day for 38 indentified and studied railroad line segments covering 4,054.1 route miles:

Figure 4

Impacted Railroad Line Segments

(Sorted By Projected 2022 Export Coal Trains Per Day)

Railroad Line Segment	Railroad	Miles	Coal Tons/Year (Millions)		Coal Trains/Day (Loaded & Empty)	
			2017	2022	2017	2022
Sandpoint, ID to Spokane, WA (Latah Jct.) (The Funnel)	BNSF	70.5	75.0	170.0	27.9	63.2
Huntley, MT to Mossmain, MT (Billings)	BNSF/MRL	24.8	60.0	155.0	22.3	57.6
W. Dutch, WY to Huntley, MT	BNSF	138.9	60.0	105.0	22.3	39.0
Mossmain, MT to Sandpoint, ID (Helena, Missoula)	MRL	564.2	35.0	90.0	13.0	33.4
Spokane, WA (Latah Jct.) to Pasco, WA (SP&S Jct.)	BNSF	149.4	40.5	88.0	15.0	32.7
Campbell, WY to W. Dutch, WY	BNSF	100.5	45.0	80.0	16.7	29.7
Broadview, MT to Great Falls, MT	BNSF	188.0	40.0	80.0	14.9	29.7
Great Falls, MT to Shelby, MT	BNSF	99.1	40.0	80.0	14.9	29.7
Shelby, MT to Sandpoint, ID (Hi-Line)	BNSF	337.9	40.0	80.0	14.9	29.7
Everett, WA (PA Jct.) to Intalco, WA (Bellingham)	BNSF	78.3	38.0	77.5	14.1	28.8
Mossmain, MT to Broadview, MT	BNSF	35.8	25.0	65.0	9.3	24.1
Pasco, WA to Vancouver, WA (Columbia River Gorge)	BNSF	219.8	28.5	58.5	10.6	21.7
Spokane, WA (Latah Jct.) to Everett, WA (Stevens Pass)	BNSF	301.1	28.5	58.0	10.6	21.5
Intalco, WA to Cherry Point, WA	BNSF	8.9	27.5	52.5	10.2	19.5
Sarpy Jct., MT to Huntley, MT	BNSF	66.1	0.0	50.0	0.0	18.6
Eagle Butte Jct., WY to Campbell, WY	BNSF	25.6	25.0	45.0	9.3	16.7
Nichols, MT to Sarpy, Jct., MT	BNSF	16.4	0.0	45.0	0.0	16.7
Vancouver, WA to Longview, WA	BNSF	35.4	25.0	43.0	9.3	16.0
Ashland, MT to Miles City, MT	TRRC	89.0	0.0	40.0	0.0	14.9
Miles City, MT to Nichols, MT	BNSF	51.6	0.0	40.0	0.0	14.9
Shawnee Jct., WY to Campbell, WY (Joint Line)	BNSF/UP	140.2	20.0	35.0	7.4	13.0
Pasco, WA to Auburn, WA (Yakima) (Stampede Pass)	BNSF	227.5	12.0	29.5	4.5	11.0
Spring Creek, MT to W. Dutch, WY	BNSF	22.8	15.0	25.0	5.6	9.3
Intalco, WA to British Columbia Terminals	BNSF/CN	49.7	11.5	25.0	4.3	9.3
Spokane, WA to Hinkle, OR	UP	171.0	6.0	24.0	2.2	8.9
Hinkle, OR to Boardman, OR (Morrow)	UP	20.0	6.0	24.0	2.2	8.9
Portland, OR to St. Helens, OR (Port Westward)	PNWR	56.0	5.0	21.0	1.9	7.8
Auburn, WA to Everett, WA (PA Jct.) (Seattle)	BNSF	55.6	9.5	19.5	3.5	7.2
Vancouver, WA to Portland, OR	BNSF	9.9	2.5	15.5	0.9	5.8
Portland, OR to Boardman, OR (Morrow)	UP	164.0	2.5	15.5	0.9	5.8
Signal Peak, MT to Broadview, MT	BNSF	35.0	15.0	15.0	5.6	5.6
Auburn, WA to Centralia, WA (Tacoma)	BNSF	72.6	2.5	10.0	0.9	3.7
Portland, OR to Eugene, OR	UP	124.0	0.0	10.0	0.0	3.7
Eugene, WA to Coos Bay, OR	CORP	122.0	0.0	10.0	0.0	3.7
Centralia, WA to Longview, WA	BNSF	47.1	2.5	5.0	0.9	1.9
Big Sky, MT to Nichols, MT	BNSF	39.0	0.0	5.0	0.0	1.9
Kuehn, MT to Sarpy Jct., MT	BNSF	37.4	0.0	5.0	0.0	1.9
Centralia, WA to Port of Grays Harbor, WA	PSAP	59.0	0.0	5.0	0.0	1.9
Total / Average		**4.054.**	**24.8**	**57.1**	**9.2**	**21.2**

Study Assumptions

For the purpose of this report, it was assumed that PRB to PNW export coal shipments, which amounted to only a few million tons five years ago, will reach 75 million tons per year by 2017 and 170 million tons by 2022. The 170 million ton level assumes that all nine existing and proposed export coal terminals will be fully operational at projected capacity by 2022 and PRB coal would originate from all PRB coal lines.

It was necessary to make certain assumptions for this report in terms of export coal origin and destination annual tonnage levels and railroad route utilization. Since relatively very little PRB coal currently moves to PNW destinations and the projected annual volumes to the proposed PNW terminals may change based on the ongoing environment review process and other unforeseen factors, the PRB to PNW export coal tonnage levels included herein will obviously change and fluctuate as events transpire and as that market changes and expands over time.

BNSF can originate coal from several PRB origins. The economics may favor BNSF's PRB coal origins which involve the shortest rail distances to the various PNW export terminals, but the large projected annual coal volumes and PRB origin capacity constraints will likely result in coal being originated from nearly *all* PRB coal origins to some extent.

In addition, BNSF has several routing options in Montana and Washington which could be utilized for PRB to PNW export coal movements. Again, the economics may favor the shortest available route, however, the large projected annual coal volumes, current railroad traffic levels and current capacity constraints will likely result in BNSF's utilization of *all* of the BNSF available routing options to some extent. The tonnages assigned to each origin, destination and route were estimated by attempting to take these and other factors into account.

For the purpose of this report, it has been assumed that BNSF would originate 100% of the PRB coal, but UP would terminate approximately 14% of the tonnage by 2022 via its interchange with BNSF at Spokane, Washington[6]. UP could originate PRB coal and obtain a larger market share by the utilization of its longer, but less congested, southern routes. However, an evaluation of these UP routes was not included as part of this study.

[6] It has been assumed that UP would terminate 100% of the Boardman tonnage (8.5 million tons in 2022) and 50% of the Coos Bay tons (5 million tons by 2022) and 50% of the St. Helens tons (10.5 million tons by 2022), for a total of 24 million tons or approximately 14% of the 170 million total tons.

Longview is jointly served by BNSF and UP, however, this report assumes that BNSF would terminate 100% of the Longview traffic. Initially, Ambre Energy projected that 60 million metric tons (66 million short tons) would move via Longview, but subsequently lowered the projection to 44 million metric tons (48.5 million short tons)[7]. UP had been interested in capturing a share of the large Longview market, but recently expressed wariness of the controversies surrounding the PNW export terminals.[8] UP currently carries high-BTU, low-sulfur coal from Colorado and Utah for export to Mexico.

It is doubtful that UP will abandon the profitable and voluminous PNW export coal market, however. UP's role may be limited to more of that of a *congestion reliever* for BNSF (by delivering coal via the Spokane interchange) rather than a vigorous competitor to BNSF by originating PRB coal and the utilization of its southern routes. Although the use of UP for coal movements from Spokane could help alleviate some congestion of BNSF's lines in Washington, any Longview coal traffic handled by UP would result in more coal traffic moving through Portland, Oregon. Moreover, the use of UP's expansive southern routes would significantly broaden the adverse impacts.

There are several cases in which the allocated PRB to PNW export coal traffic may exceed the existing capacity of line segment. For example, MRL currently handles approximately five (5) loaded and empty coal trains per day and projects that it has the capacity to handle up to 10 loaded and empty coal trains per day in the next ten years. MRL's President Tom Walsh MRL indicates that it has capacity problems with two tunnels: "Probably, our biggest pinch points really are the two mountain passes when it comes down to it, especially the Continental Divide."[9] This analysis assumes that MRL would handle 13 loaded and empty coal trains by 2017 and 33 loaded and empty coal trains by 2022. Therefore, in these cases, the study assumes that the capacity issues would be resolved by either the diversion of other traffic or by increasing capacity. In the MRL case, if the projected traffic levels are lowered, traffic levels would increase on other lines segments, namely BNSF's line through Great Falls, Montana.

7 http://seattletimes.nwsource.com/html/localnews/2017582357_coalterminal24m.html
8 http://www.platts.com/RSSFeedDetailedNews/RSSFeed/Coal/6202450.
9 http://missoulian.com/news/local/booming-asia-demands-more-energy-and-montana-has-it-by/article_ee425fa2-86b3-11e1-bb17-001a4bcf887a.html?cid=print

BNSF's unit coal trains average approximately 125 cars per train and carry approximately 14,750 loaded tons per train.[10] Each loaded and empty train is over 1¼ miles long.[11] These coal train characteristics were utilized in this report. Based on these characteristics (125 cars per train and 14,750 loaded tons per train), the following table shows the number of loaded and empty trains at various annual tonnage levels:[12]

Figure 5

Loaded & Empty Trains
Per Day at Various Tonnage Levels

Annual Tons	Trains Per Day (L&E)
1,000,000	0.37
5,000,000	1.86
10,000,000	3.71
25,000,000	9.29
50,000,000	18.57
75,000,000	27.86
100,000,000	37.15
150,000,000	55.72
170,000,000	63.15

In 2006, BNSF began using 150-car unit coal trains for a limited number of domestic unit train coal movements. The ultimate train size utilized for PRB to PNW export coal movements will depend on several factors, including the origin and destination car capacity and weight and train size restrictions along the utilized routes. Whether 125 or 150 cars per train are utilized, the same number of cars per day will be moving over the impacted railroad routes. There may be fewer trains with the use of 150-car unit trains, but the trains will be longer (i.e., approximately 1½ miles versus 1¼ miles long).

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10 Testimony of Matthew K. Rose, Chairman, BNSF President and CEO, April 26, 2006, before the U. S. House of Representatives Transportation and Infrastructure Committee and 2010 Railroad Carload Waybill Sample data.

11 Each railroad car is approximately 53.1 ft. long and each locomotive is approximately 70 ft. long. A unit coal train with 4 locomotives and 125 cars would be approximately 6,917.5 ft. long or 1.31 miles long.

12 Tons per year / 14,750 tons per train / 365 days x 2.0 empty return ratio.

Pacific Northwest Export Coal Terminals

Plans, discussions and permitting are already in progress concerning several PNW export coal terminals. The following describes nine (9) current and proposed PNW export coal terminals:

1. Roberts Bank, BC (Westshore)

Westshore Terminals in Roberts Bank, BC is in the Vancouver Port Metro area. It is currently the largest PNW export coal terminal, with an annual capacity of approximately 32 million tons.[13] Westshore indicates that it currently moves U.S. coal from the PRB, but the majority of the coal exported from Roberts Bank is from Canada. U.S. PRB coal was first shipped through Westshore in 1988. Since then PRB coal shipments have gradually increased. In 2009, Westshore shipped a record 2 million tons of US coal, including several shipments from Utah mines.[14] Cloud Peak, which has PRB coal operations in Antelope, WY, Cordero Rojo, WY and Spring Creek, MT, exported approximately 3.3 million tons to Asian customers in 2010 through Westshore and indicated that it would ship 4 million tons in 2011. Gunvor Group, which recently acquired Signal Peak mine, also has an agreement with Westshore Terminals to ship export coal.[15]

2. North Vancouver, BC (Neptune)

Neptune Bulk Terminals (Canada) Ltd. in the Vancouver Port Metro area handles potash, steelmaking coal, bulk vegetable oils, fertilizers and agricultural products. The coal handled at Neptune Terminals is predominantly metallurgical grade, which is primarily used in steel production. Currently, Neptune has a total coal capacity of approximately 8 million tons, but is expanding its capacity to over 10 million tons to meet the growing demand from Asia.[16]

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[13] http://www.westshore.com/background.html (29 million metric tonnes)
[14] http://www.westshore.com/milestones.html
[15] http://www.businessweek.com/ap/financialnews/D9QEVCBO4.htm
[16] http://www.em.gov.bc.ca/Mining/investors/Documents/Coal15Feb2010web.pdf

3. Prince Rupert, BC (Ridley)

The Prince Rupert coal export facility is operated by Ridley Terminals, Inc. (Ridley), a Federal Crown Corporation owned by Canada. The coal terminal is in a remote location in the northwestern part of the province near Alaska, which is a long distance away from the PRB mines in Wyoming and Montana, but closer in nautical miles to the Asian market. Currently, Prince Rupert has an annual capacity of approximately 13 million tons, but plans are underway to double the capacity to over 26 million tons.[17] Ridley Terminals indicates that it began to receive U.S. PRB coal shipments in 2011.[18] In its 2010 Annual Report, Ridley stated: "Commencing in 2011 the Terminal will be receiving coal from customers based in the United States, their throughput volume combined with our Canadian producers have helped the Terminal realize a goal that has been 28 years in the making, to double the Terminal's capacity from 12 million tonnes per annum to 24 million tonnes." In its most recent report (Third Quarter 2011), Ridley indicated that its multi-year "Modification Project" will bring its total throughput capacity to 24-25 million tonnes by the end of 2014." (26.5 to 27.6 million short tons). In January 2011, Arch Coal announced that it had reached agreement with Ridley to export approximately 2.75 million tons from Prince Rupert.[19] CP and CN rail are also examining increased Canadian coal movements to Prince Rupert.

4. Cherry Point, WA (Bellingham)

In June 2010, SSA Marine began the environmental review process for a $500 million Gateway Pacific Terminal project at near Bellingham, WA.[20] The project, known as Cherry Point, could export up to 60 million tons per year.[21] On March 19, 2012, SSA Marine, through its subsidiary Pacific International Terminals, Inc. (PIT) submitted additional information to Whatcom County, Washington concerning the Cherry Point project. The submission indicates that the project will be completed in two stages. The first stage is planned to commence in 2014 and the second stage is expected to be completed by 2017.

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17 http://www.rti.ca/en_terminalprofile.html

18 According to Ridley Terminals, Inc. 2010 Annual Report, in early 2011 Ridley Terminals Inc. signed an amended long-term terminal services agreement with Western Coal Corp. and entered into a multi-year terminal service agreement with Arch Coal Sales Company, Inc. The Arch Coal agreement is for coal exports which originate from the PRB (page 26).

19 http://news.archcoal.com/phoenix.zhtml?c=107109&p=irol-newsArticle&ID=1517028&highlight

20 http://gatewaypacificterminal.com/gateway-pacific-terminal-at-cherry-point-starts-permit-process/

21 An economic analysis prepared by Martin Associates for Gateway Pacific Terminals dated October 27, 2011 states "In the first phase, the terminal is projected to handle 25 million metric tons per year (27.6 million short tons). The second phase will take the terminal capacity up to 54 million metric tons per year" (59.5 million short tons), 6 million slated to be potash and coke.

BNSF would provide rail service to Cherry Point via the 6.2 mile Custer Spur, which branches out west from BNSF's line near Custer, Washington, which is north of Bellingham. The rail line was originally built in 1965 to serve the Intalco aluminum smelter, and later a series of petroleum-related industries were constructed on the line.[22] The following map shows the BNSF line serving Cherry Point:

Figure 6

<u>Map of BNSF's Line Serving Cherry Point</u>

Although BNSF currently provides service to Cherry Point, significant railroad improvements will be required to achieve the projected capacity. BNSF expects to acquire an additional 43 acres of contiguous adjacent to its current right-of-way in order to double track the line. In addition, up to three receiving and departure or "R&D" tracks are planned near the Custer connection and two independent loop tracks (the "East" and "West" loops) and rail unloading stations are planned at Cherry Point.[23]

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[22] Washington State <u>Statewide Rail Capacity and System Needs Study</u> dated May 2006, page 12.
[23] March 19, 2012, Pacific International Terminals, Inc. additional information submitted to Whatcom County, Washington (see pages 4-33 and 4-34).

Initially, 7,000 ft. long trains (approximately 125 cars per train) are expected, but the facilities are being planned to accommodate 8,500 ft. long coal trains (approximately 150 cars per train). SSA Marine has already signed a contract with Peabody Energy, an investor in the project, agreeing to export 26.5 million tons of coal from its proposed terminal.[24] The following tonnage and train projections were included in PIT's March 2012 application:[25]

Figure 7

<u>MIT's Tonnage and Train Projections For Cherry Point</u>

Item	2016 East Loop	2016 West Loop	2016 Total	2018 East Loop	2018 West Loop	2018 Total	2021 East Loop	2021 West Loop	2021 Total	2026 East Loop	2026 West Loop	2026 Total
Metric Tons / Year (millions)	25.0	0.0	25.0	25.0	6.0	31.0	39.0	6.0	45.0	48.0	6.0	54.0
Short Tons / Year (millions)	27.6	0.0	27.6	27.6	6.6	34.2	43.0	6.6	49.6	52.9	6.6	59.5
Metric Tons / Train	13,625	0	---	13,625	17,272	---	16,350	17,272	---	16,350	17,272	---
Short Tons / Train	15,019	0	---	15,019	19,039	---	18,023	19,039	---	18,023	19,039	---
Cars / Train	125	0	---	125	170	---	150	170	---	150	170	---
Loaded Trains / Year	1,835	0	1,835	1,835	347	2,182	2,385	347	2,733	2,936	347	3,283
Loaded Trains / Day	5.0	0.0	5.0	5.0	1.0	6.0	6.5	1.0	7.5	8.0	1.0	9.0
Loaded & Empty Trains/Day	10.1	0.0	10.1	10.1	1.9	12.0	13.1	1.9	15.0	16.1	1.9	18.0

The proposed export coal movements would move from the East Loop, whereas export petroleum coke and potash trains would be unloaded at the West Loop. PIT's analysis assumes that by 2021 all export coal trains moving from Cherry Point would consist of 150 cars per train and carry 18,023 short tons per train. This 150-car per train assumption could result in an understatement in the expected number of trains per day. Although Cherry Point may be able to accommodate 150 cars per train, the ultimate train size will depend on several factors, including the origin car capacity and weight restrictions along the utilized route. Moreover, whether 125 or 150 cars per train are utilized, the same number of cars per day will be moving over the impacted railroad routes. There may be fewer trains, but the trains will be longer (i.e., approximately 1½ miles versus 1¼ miles long).

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24 Cascadia Weekly, March 2, 2011, *Cherry Point Shipping Terminal Signs its First Customer – A Coal Exporter.* (24 Million Metric Tonnes).

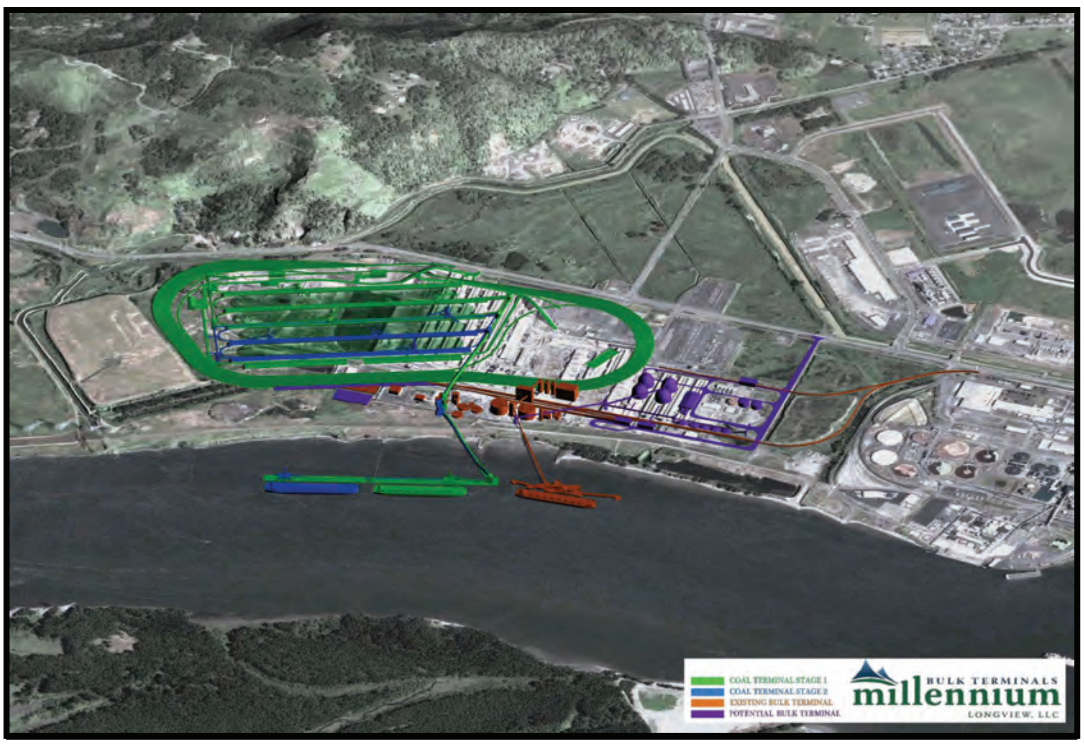
25 PIT March 2012 Application, Chapter 4.5 Terminal Operations, Tables 4-2 and 4-5.

5. Longview, WA

In February 2012, Millennium Bulk Terminals Longview, LLC (MBTL), submitted several permit applications in order to seek permission to build a $643 million coal terminal on a 416 acre site on the Columbia River near Longview, Washington, which, by 2018, would handle 48.5 million tons per year.[26] MBTL is a Limited Liability Company (LLC) with two shareholders. Ambre Energy owns 62 percent of the shares and Arch Coal, Inc., the second largest U.S. coal producer, owns the remaining 38 percent.[27] Longview is served by both BNSF and UP. The Longview Switching Company (LSC) is a jointly owned subsidiary of BNSF and UP that performs terminal switching duties at the Port of Longview.[28] The following is a site rendering of the proposed Longview terminal:

Figure 8

<u>Site Rendering of Longview Terminal</u>



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[26] See study prepared by Berk titled: *Economic & Fiscal Impacts of Millennium Bulk Terminals Longview*, dated April 12, 2012 (44 million metric tonnes).

[27] http://ambreenergy.com/projects/millennium

[28] Washington State <u>Statewide Rail Capacity and System Needs Study</u> dated May 2006, page 15.

6. Grays Harbor, WA (Hoquiam)

RailAmerica, which owns the Puget Sound and Pacific Railroad (PSAP) that serves the Port of Grays Harbor, near Hoquiam, Washington, has been actively exploring an export coal terminal. RailAmerica states that the Port of Grays Harbor "is the only deep-draft shipping port on Washington's coast, only 2 hours from open sea."[29] RailAmerica states that this would be a "relatively small project" ($45 Million) with a capacity of 5 million metric tons (5.5 million short tons).[30] PSAP connects with UP at Blakeslee Jct., Washington and with BNSF at Centralia, Washington.

7. Coos Bay, OR

The Port of Coos Bay, Oregon is considering an international shipping terminal. Coos Bay is served by Coos Bay Rail Link (CORP). The Oregon International Port of Coos Bay bought the 126-mile railroad in 2009, which interchanges with BNSF (via PNWR) and UP at Eugene, OR. The line is currently in serious disrepair. The line was embargoed in 2007 and abandonment was filed in 2008. CORP plans to resume freight service, but requires significant funding to repair and upgrade 110 bridges (70 of which are in poor condition) and 9 tunnels.[31] The port has been actively negotiating with investors. David Koch, the port's CEO, states that three companies are drawing up plans for a coal terminal that could export up to 10 million tons per year. Mitsui, an international trading firm headquartered in Japan, and Metro Ports, a company that specializes in terminals, are reportedly involved in the negotiations with Coos Bay.[32]

8. St. Helens, OR (Westward)

In January 2012, Kinder Morgan Terminals and Pacific Transloading, a subsidiary of Ambre Energy, submitted a proposal to export coal from St. Helens, Oregon, Port of Westward. Ambre Energy expects to ship as much as 30 million tons from St. Helens.[33] The proposed terminal is estimated to require $150 to $200 million in capital investment for construction and development. Port of Westward is served by PNWR, which connects with both BNSF and UP at Portland, Oregon.[34]

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29 http://www.railamerica.com/RailServices/PSAP.aspx

30 http://www.washingtonports.org/washington_ports/pgh%20newsletter%202011-08.pdf

31 See, e.g., Coos Bay Rail Link Infrastructure Evaluation Report, Revised August 20, 2010

32 See KLCC Public Radio story by Amelia Templeton titled: *International Investors Plan Coal Terminal at Coos Bay*, dated April 19, 2012. http://klcc.org/Feature.asp?FeatureID=3324

33 To date, Kinder Morgan has not released specific tonnage levels. Estimates of 15 to 30 million tons have appeared in various press reports.

34 http://portwestwardproject.com/PortWestwardFactSheet.pdf

9. Boardman, OR (Morrow)

The Port of St. Helens plans also call for a water transloading facility, which is part of the "The Morrow Pacific Project" under which PRB would be shipped by train to Morrow and from there by barge to Port Westward Industrial Park at the Port of St. Helens and then transferred directly from the barges to oceangoing vessels bound for Japan, South Korea or Taiwan.[35] Port of Morrow, near Boardman, OR, recently signed a one-year lease option with a subsidiary of Australian coal giant Ambre Energy (Coyote Island Terminal LLC of Salt Lake City) to shift Montana and Wyoming coal from trains to river barges. The company wants to build a rail off-loading terminal use the area to transfer the coal onto barges for shipment to St. Helens.[36] Initially, Ambre anticipates shipping 3.5 million metric tons (3.85 short tons) of coal per year to trade allies such as Japan, South Korea and Taiwan beginning as soon as mid-2013. Full operational and permitted capacity is expected to be 8 million metric tons (8.82 short tons) annually, subject to approval.[37] Port of Morrow is served by UP.

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[35] http://morrowpacific.com/
[36] *Ibid.*
[37] http://morrowpacific.com/wp-content/uploads/2012/04/Morrow_Pacific_Project-Packet.pdf

Powder River Basin Coal

Steam coal can originate from many areas in the U.S., but it is expected and probable that the vast majority of the PNW export coal shipments will originate from the PRB coal mines and origins in Montana and Wyoming, which is the largest coal mining region in the United States.[38] As a result of the economics associated with mining the large seams of PRB coal, the price of PRB coal is the lowest in the United States. The following table compares the price of PRB coal with coal prices from other western coal origins. As can be seen, the low-cost PRB coal dominates the western coal market:

Figure 9

Western Coal Price Comparison[39]

Origin	Tons (Millions)	Average Sale Price
PRB Coal Origins		
Campbell County, WY	392.6	$12.05
Montana	44.5	$15.20
Other Western Coal Origins		
Sweetwater, WY	8.8	$32.09
Colorado	24.9	$40.00
Utah	19.0	$29.15

1. PRB Coal Mines and Origins

The PRB area in Montana and Wyoming, is dominated by several large coal companies. The current and proposed PRB coal mines and coal companies are listed below:

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38 There are also other western coal origins in southwestern Wyoming, Colorado and Utah which also could be utilized for PNW exports, but this report focuses on the PRB coal origins in Montana and Wyoming.

39 Source: U.S. Energy Information Administration, Table 30, Average Sales Price of Coal by State, County, and Number of Mines, 2010.

Figure 10

Current and Proposed PRB Coal Mines and Origins

Railroad	Mine	Station	Coal Company
Montana PRB Coal Mines and Origins			
BNSF	Absaloka	Kuehn, MT	Westmoreland Coal Co.
BNSF	Decker	Decker, MT	Kiewit Mining Group
BNSF	Rosebud	Colstrip, MT	Westmoreland Coal Co.
BNSF	Signal Peak[40]	Roundup, MT	Signal Peak Energy
BNSF	Spring Creek	Nerco Jct., MT	Cloud Peak Energy
TRRC/BNSF	Otter Creek[41]	Ashland, MT	Arch Coal
Wyoming PRB Coal Mines and Origins			
BNSF	Buckskin	Buckskin, WY	Kiewit Mining Group
BNSF	Clovis Point	Clovis Point., WY	Wyodak Resources
BNSF	Dry Fork	Dry Fork Jct., WY	Western Fuels
BNSF	Eagle Butte	Eagle Jct., WY	Alpha Natural Resources
BNSF	Rawhide	Rawhide, WY	Peabody Energy
BNSF/UP	Antelope	Converse Jct., WY	Cloud Peak Energy
BNSF/UP	Belle Ayr	Belle Ayr, WY	Alpha Natural Resources
BNSF/UP	Black Thunder	Black Thunder, WY	Arch Coal
BNSF/UP	Caballo	Caballo Jct., WY	Peabody Energy
BNSF/UP	Cordero Rojo	Cordero/Rojo, WY	Cloud Peak Energy
BNSF/UP	Coal Creek	Coal Creek, WY	Arch Coal
BNSF/UP	North Antelope Rochelle	Nacco Jct., WY	Peabody Energy
BNSF/UP	School Creek	Thunder Jct., WY	Peabody Energy
BNSF	Youngs Creek[42]	Decker, MT	Consol Energy

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[40] Signal Peak is not technically in the PRB. The bituminous coal from Signal Peak is considered high-quality, producing higher heat and lower mercury than PRB coal. However, it is being marketed for the Pacific Rim and lies within the scope of the rail system being studied.

[41] The Otter Creek property near Ashland, Montana contains significant (731 million tons) coal reserves, which were recently obtained by Arch Coal. The Otter Creek mine would be served by the Tongue River Railroad Company (TRRC), a proposed 89-mile new coal line in Montana which would connect with BNSF's mainline at Miles City, Montana. Arch has not yet filed an application for a mine permit with the Montana Dept. of Environmental Quality.

[42] CONSOL of Wyoming LLC, and Chevron NPRB, LLC, have formed a new company, Youngs Creek Mining Company, LLC. to develop and operate the proposed Youngs Creek mine north of Sheridan, Wyoming. Youngs Creek mine has coal reserves of approximately 315 million tons. Based on initial feasibility studies, the mine has the potential to reach 15 million tons per year when at full production. This would require building a short spur line which would connect to BNSF's line near Decker, Montana. Youngs Creek is already permitted by the Wyoming Department of Environmental Quality.

2. PRB Railroad Coal Lines

The PRB coal mines are located on six (6) current lines and one (1) proposed line in Montana and Wyoming:

Figure 11

PRB Railroad Coal Lines

From	To	Railroad	Miles	Mines
Shawnee Jct. WY	Campbell, WY	BNSF/UP	140.2	10
Eagle Butte Jct., WY	Campbell, WY	BNSF	25.6	5
Spring Creek, MT	Dutch, WY	BNSF	22.8	2
Kuehn, MT	Sarpy Jct.	BNSF	37.4	1
Big Sky, MT	Nichols, MT	BNSF	39.0	1
Signal Peak, MT	Broadview, MT	BNSF	35.0	1
Ashland, MT	Miles City, MT	TRRC/BNSF	89.0	1

The largest PRB coal volumes currently originate from the so-called "Joint Line" from Shawnee Jct., to Campbell, WY, which is served by both BNSF and UP.[43] In 2011, the PRB coal mines in Wyoming originated 422 million tons whereas the mines in Montana originated 22 million tons.[44]

3. Current PRB Coal Market & Destinations

PRB coal movements are voluminous and repetitive. PRB coal production was approximately 444 million tons in 2011 and could exceed 500 million in a few years.[45] Currently, approximately 80 loaded coal trains move out of the PRB each day.

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43 Under a Joint Line Agreement between BNSF and UP, the two railroads jointly serve the large coal mining operations on the line, which mine the "Wyodak" PRB coal seam. The BNSF's Orin Subdivision Line runs from Donkey Creek Jct., WY (MP 0.4) to Bridger Jct., WY (MP 127.3), which is approximately 127 miles (126.9). The portion of the line which is jointly owned and maintained by BNSF and UP (i.e., the Joint Line) actually runs 103 miles from MP 14.7 near Caballo Jct. to the interchange with UP at Shawnee Jct., WY (MP 117.7) . This study looks at the characteristics of the line from Campbell, WY (which is 3.5 miles before Donkey Creek Jct.) to the UP interchange at Shawnee Jct., which is a total of 120.8 miles.

44 Source EIA-423 Monthly Non Utility Fuel Receipts and Fuel Quality Data for 2011.

45 Source EIA-423 Monthly Non Utility Fuel Receipts and Fuel Quality Data for 2011.

The majority of these PRB coal trains move *south* from the BNSF/UP Joint Line in Wyoming and then either: south, east or west to numerous domestic destinations (168 destinations in 2011) stretching from Arizona to New York.[46] In comparison, very little coal traffic currently moves *northwest* from the PRB to PNW destinations. For example, only 6 million of the 444 million 2011 PRB coal tons, or 1.3%, moved to destinations in Washington and Oregon.

As a result of the expected increase in demand for export coal and a gradual decrease in demand from domestic users, a significant *shift* in PRB railroad coal traffic from current domestic destinations (e.g., less economical in eastern destinations such as New York and New Jersey) to the PNW export terminals will likely take place.[47] The following table shows the wide-distribution of PRB domestic coal tons to electric generating stations in 2011:

46 *Ibid.*

47 There are several other factors which have resulted in a decrease in demand for domestic coal, such as: the boom in availability of low cost natural gas; proposed new rules by the U.S. Environmental Protection Agency (EPA) to bring new coal-fired electric power plants in compliance with the Federal Clean Air Act and Clean Water Act.; increasing competitiveness of renewable energy sources; investments in energy efficiency, and the economic downturn - all of which have combined to affect a drop in domestic demand for coal.

Figure 12

2011 Distribution of PRB Coal Tons

Destination States	PRB Tons From: Montana	PRB Tons From: Wyoming
2011 PRB to PNW Coal Tons		
Oregon	108,462	2,243,208
Washington	2,436,289	1,180,782
Total to OR and WA	**2,544,751**	**3,423,990**
2011 PRB Coal Tons to Other Destination States		
Alabama	0	12,315,605
Arizona	761,439	5,818,897
Arkansas	0	17,497,425
Colorado	0	9,516,900
Georgia	0	13,619,370
Illinois	237,701	61,291,247
Indiana	0	9,836,466
Iowa	0	23,799,910
Kansas	0	19,962,502
Kentucky	0	2,638,466
Louisiana	0	11,452,691
Maryland	0	582,606
Michigan	2,109,260	17,142,197
Minnesota	6,709,385	9,321,579
Mississippi	0	986,649
Missouri	0	44,227,641
Montana	8,405,469	0
Nebraska	0	13,732,077
Nevada	0	1,361,874
New Jersey	0	14,308
New York	0	2,020,463
North Dakota	0	301,381
Ohio	369,947	4,967,528
Oklahoma	13,967	18,884,374
Pennsylvania	0	378,352
South Dakota	0	1,676,078
Tennessee	0	9,409,077
Texas	0	62,096,767
Wisconsin	394,779	20,097,511
West Virginia	0	487,784
Wyoming	0	23,106,731
Total to Other States	**19,001,947**	**418,544,456**
Total 2011 PRB Coal Tons		
Total PRB Coal	**21,546,698**	**421,968,446**

4. Current PRB to PNW Coal Movements

Currently, approximately 10 to 12 million tons of coal per year move in railroad trains through the impacted PNW area, which is a significant volume, but small in comparison to the expected 75 to 175 million tons of PNW export coal traffic. There are only two (2) active coal fired generating stations which currently receive coal in unit trains from PRB mines:

> **Centralia, WA -** In 2011, 3.5 million tons of coal moved via BNSF from PRB mines in Montana and Wyoming to Transalta's coal-fired Centralia generating station, which is Washington State's largest base-load power source with a capacity of 1,376 megawatts. The Centralia plant provides 10 percent of Washington State's power. In April 2011, legislation was passed which will close the plant by 2025.[48]

> **Boardman, OR -** In 2011, 2.3 million tons of coal moved via BNSF and UP from PRB mines in Montana and Wyoming to Portland General Electric's (PGE) coal-fired Boardman generating station, which has a 585-megawatt capacity. In 2010, PGE announced plans to close Boardman by 2020.[49]

In addition to the domestic PRB coal traffic to these PNW plants, there is also current export coal (approximately 3 to 5 million tons), which currently moves through the PNW to the British Columbia export terminals (primarily Roberts Bank, BC). The current PRB to PNW coal traffic utilizes many of the same railroad line segments which will be used to haul the export coal traffic.

5. Projected PRB Export Coal Tons

As a result of the expected dramatic increase in demand for export coal, PRB coal production is likely to increase, but, because of the decrease in demand from domestic users, a significant *shift* in PRB traffic can also be expected. PRB coal production was approximately 445 million tons in 2011. PRB coal production could exceed 500 million, but the estimated demand for 75 to 170 million tons will likely result in shifting traffic from current destinations (e.g., less economical movements to New York and New Jersey) to the PNW. The following projections of the annual coal volumes from these railroad coal lines were used in this report:

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[48] On April 29, 2011, Gov. Chris Gregoire signed Senate Bill 5769 into law a collaborative agreement to close Centralia's two coal boilers – the first in 2020 and the second in 2025.

[49] On December 29, 2010, Oregon's Environmental Quality Commission unanimously approved Portland General Electric plan to close the state's only coal-fired power plant by Dec. 31, 2020 in exchange for a far smaller investment in pollution controls.

Figure 13

Projected Annual PRB to PNW Coal Tons

(Millions of Short Tons)

Railroad Coal Lines	2017	2022
Shawnee Jct. ("Joint Line")	20.0	35.0
Eagle Butte Jct., WY	25.0	45.0
Total From Wyoming Origins	**45.0**	**80.0**
Spring Creek, MT [50]	15.0	25.0
Big Sky, MT	0.0	5.0
Kuehn, MT	0.0	5.0
Signal Peak, MT	15.0	15.0
Ashland, MT (TRRC)	0.0	40.0
Total From Montana Origins	**30.0**	**90.0**
Total to PRB to PNW Export Coal Tons	**75.0**	**170.0**

[50] Includes projected tonnage from Youngs Creek Mine in Wyoming.

Impacted Railroad Routes

Currently, two Class I railroads dominate the western coal market as well as all rail shipments from the PRB to the PNW - BNSF and UP. Although UP also has access to the PRB coal origins, as a result of geographical and other advantages enjoyed by BNSF, it is reasonable and logical to assume that BNSF will dominate the PRB to PNW export coal market.

1. BNSF Market Domination

UP has access to Longview, but does not serve Cherry Point. BNSF's routes associated with its longest PRB movements to Longview are at least 200 miles shorter than UP's routes from the PRB.[51] BNSF's unit costs are also lower than UP's cost. BNSF's expected domination of the PRB to PNW export coal market can be seen by the current coal movements to PGE's Boardman generating station. Although Boardman is served by UP and has in years past received coal directly from UP via the PRB Joint Line and UP's routes, BNSF currently originates all the coal movements to Boardman (2.1 million tons) and interchanges the traffic with UP at Spokane, WA for delivery to Boardman.

Due to the expected large coal volumes, it is likely that all of BNSF's PRB coal origins, including the Joint Line origins, will be involved at some point in export coal movements to the PNW. However, the BNSF/UP Joint Line is already near capacity (primarily from existing coal traffic moving south on the line and then east and south to coal-fired generating stations) and there are several closer BNSF-served Montana origins (such as Signal Peak, MT), which will likely originate more of the export PNW coal as a result of the shorter distances.[52]

The following table compares the estimated total delivered cost for BNSF and UP PRB to PNW export coal movements and illustrates the economic advantages enjoyed by BNSF:

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51 UP shipped 1.5 million tons of export coal in 2010, but expects exports to increase. Morrow, Coos Bay or St. Helens would be the most likely PNW destinations for UP. It is possible that UP could more effectively compete with BNSF for the Asia export market with non-PRB coal shipments from southern WY (Green River coal area) or UT (Uinta coal area). For example, the mileage from Hanna, WY to Longview, WA is approximately 200 miles shorter than BNSF's miles from Antelope, WY (which is on the Joint Line) to Longview, WA. However, this study concentrates on potential export coal movements from the PRB to the PNW and these potentially alternative western coal movements (which would have substantially different characteristics, e.g., cost, sulfur content, btu., etc, and rail routings) have not been studied here.

52 Russian energy trader, Gunvor, recently invested $400 million to take a 33% stake in the Signal Peak coal mine in Montana and expects to increase production from 9 million to 15 million tons by exporting coal to Asia through Westport, BC.

Figure 14

BNSF & UP PRB to PNW Export Coal
Estimated Delivered Cost Comparison [53]

Item	Amount
Shortest BNSF Joint Line Movement (Caballo Jct.) to Longview, WA	
Coal Price Per Ton (Campbell County, WY)	$12.05
Route Miles	1,318
BNSF 2010 URCS Variable Cost Per Ton (120 Cars)	$18.65
Rate Per Ton (at 180% R/VC)	$33.57
Total Delivered Cost	$45.62
Shortest BNSF PRB Movement (Signal Peak) to Longview, WA	
Coal Price Per Ton (Montana)	$15.20
Route Miles	1,135
BNSF 2010 URCS Variable Cost Per Ton (120 Cars)	$16.18
Rate Per Ton (at 180% R/VC)	$29.12
Total Delivered Cost	$44.32
Shortest UP Joint Line Movement (Antelope) to Longview, WA	
Coal Price Per Ton (Campbell County, WY)	$12.05
Route Miles	1,582
UP 2010 URCS Variable Cost Per Ton (120 Cars)	$20.96
Rate Per Ton (at 180% R/VC)	$37.73
Total Delivered Cost	$49.78

As can be seen, the added distance associated with UP's route places UP in significant economic disadvantage with BNSF (i.e., UP $49.78 versus BNSF $44.32 to $45.62 per ton).

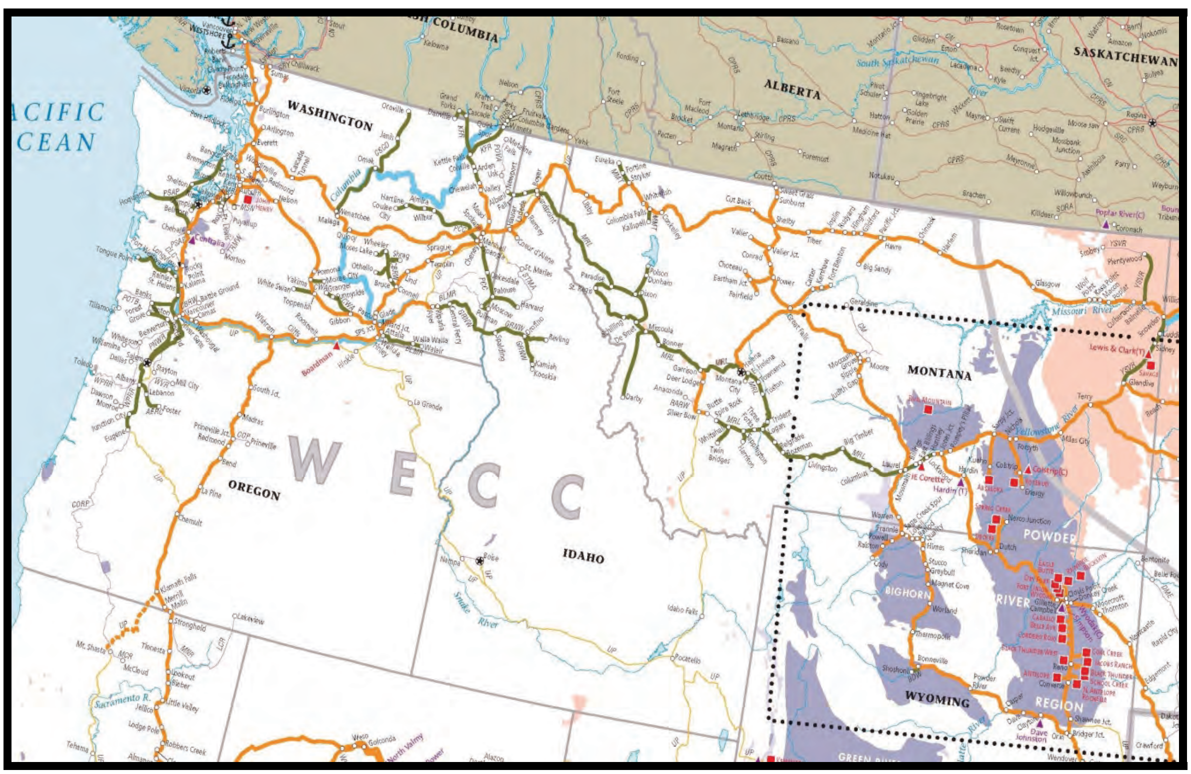
[53] Costs are based on STB's Uniform Railroad Costing System (URCS) 2010 unadjusted unit cost data for BNSF and UP. Rail rates are based on a 180% revenue-to-variable cost ratio, which is the STB's jurisdictional threshold level.

2. BNSF Railroad Routes Impacted

The possible railroad routes of movement and the individual railroad line segments which would likely be involved in coal movements from PRB coal mines to PNW export coal terminals have been carefully evaluated and studied for this report. These routes are expansive and cover a total distance of over 4,000 miles.[54] The vast majority of PRB export coal traffic would likely move north via BNSF from PRB mines in Wyoming and Montana, through Montana, Idaho and Washington to the PNW export coal terminals in Washington and Oregon.[55] The following is a portion of BNSF's system map which shows an overview of BNSF's routes from the PRB to the PNW:

Figure 15

<u>BNSF's PRB to PNW Routes</u>



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[54] The over 4,000 route miles which will be potentially impacted excludes potential coal movements via UP's southern routes through Wyoming, Colorado, Utah , Idaho and Oregon and the miles in British Columbia to Prince Rupert, which were not part of this study.

[55] There are other BNSF routing options, such as the movement south from the PRB mines and then west with the utilization of UP's routes west though Colorado, Utah and then north through Idaho and Oregon (BNSF has trackage rights over a portion of the UP's Central Corridor route), but these other routing options are more circuitous.

As can be seen from Figure 14, BNSF's PRB to PNW routes are expansive, stretching from eastern Wyoming to the Pacific coast. These rail routes traverse many environmentally sensitive areas, such as Glacier National Park in Montana, as well as many major populated areas, such as Billings, Montana and Spokane, Washington. Most export coal movements from Montana and Wyoming would move north and connect with and utilize most of the western portion of BNSF's heavily utilized Great Northern Corridor, which runs from the PNW to Chicago, IL. Most of the freight moving along BNSF's Great Northern Corridor is consumer, industrial and agricultural products, such as double-stack intermodal container traffic and export grain traffic. Passenger trains such as Amtrak's Empire Builder and Cascades in the Northwest; and commuter trains, including Sound Transit in Washington, use the Great Northern Corridor. In addition, there are a growing number of unit-train tank car movements of oil from the Bakken shale formation in North Dakota and Montana to PNW destinations which are and will be increasing using this important corridor.[56]

3. BNSF's Routing Options

BNSF does have the benefit of have several viable routing options, which may lessen the impact on certain areas, but also significantly broadens the impact area. For example, the shortest rail distance is from Eagle Butte Jct., WY to Longview, WA which is 1,313 miles, but BNSF's viable routing options cover a distance of 2,321 miles. BNSF has two viable routing options in Montana and three routing options in Washington from Spokane:[57]

a. **BNSF/MRL Helena Route -** Montana Rail Link's (MRL) 564.2 mile line from Mossmain, MT (near Billings) to Sandpoint, ID runs through Helena and Missoula, MT and reconnects with BNSF at Sandpoint, ID. MRL, which is owned by Washington Companies, assumed control of the western portion of BNSF's mainline in Montana in 1987. MRL is considered a "bridge carrier" for BNSF as it only connects with BNSF at Huntley, MT and Sandpoint, ID and BNSF retains ownership of the MRL lines. BNSF and MRL have a long-term lease purchase plan for MRL to acquire the line. The MRL route is approximately 100 miles shorter than the BNSF route. BNSF currently uses MRL route to move the current PRB to PNW coal traffic to Centralia and Boardman, as well as grain traffic to the PNW and other traffic.

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56 For example, in July, 2011, Tesoro Corp. announced that it intends to move 30,000 barrels per day (or approximately 50 loaded cars per day) of Bakken oil by rail in a dedicated unit trains to the Anacortes, Washington refinery and expects to spend $50 million on the project.

57 BNSF has other available routing options, such as moving east or south and then west, but these routes are significantly more circuitous and thus not economically viable.

b. **BNSF Great Falls Route -** BNSF's northbound line from Mossmain, MT through Great Falls, which connects to BNSF's main east-west "Hi-Line" at Shelby, MT. Although the BNSF/MRL Helena route is approximately 100 miles shorter, as a result of the expected high volumes, it is likely that both of these routes will be heavily utilized by BNSF for export coal shipments.

c. **Stevens Pass / Cascade Tunnel -** BNSF's northern line from Spokane through Wenatchee, WA connecting with BNSF's north-south line along the coast at Everett, WA. This mainline, which passes through the Cascade Tunnel, is BNSF's major transcontinental route for double-stack intermodal container trains. Currently, this line has a capacity of 24 to 28 trains per day and is operating at 57 percent to 75 percent capacity.[58]

d. **Columbia River Gorge -** The BNSF's Vancouver-Pasco line, which follows the Columbia River along the north side of the Columbia River Gorge, is used by double-stack intermodal container trains moving east, grain trains moving west to the PNW ports, and other carload traffic. The line is operating today at about 80 percent of practical capacity with an estimated capacity of 40 trains per day.[59]

e. **Stampede Pass & Tunnel -** The Stampede Pass route moves south from Spokane and then west through Yakima, connecting with BNSF's north-south line along the coast south of Seattle, WA (Auburn). The line passes through the Stampede Tunnel and operates at a lower capacity because the ceiling of the Stampede Tunnel is too low to accommodate double-stack intermodal container trains and the grades over the Stampede Pass also make it difficult to haul heavily-loaded unit trains. As a result, BNSF could use the Columbia River Gorge or Steven Pass / Cascade Tunnel routes for loaded trains and the Stampede Pass route for empty trains.[60]

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58 Washington State 2010-2030 Freight Rail Plan, page 3-28.

59 *Ibid.*

60 *Ibid.* It should be noted that these three (3) alternative routes in Washington have some common line segments. For example, both the Stampede Pass and Columbia River Gorge routes would use the line segment from Spokane to Pasco, WA and the Stevens Pass/Cascade Tunnel and Stampede Pass routes would use the line from Auburn to Longview, WA.

4. Mileage Differences For BNSF Routing Options

The following table shows the mileage differences for the six different viable routing options available to BNSF for export coal movements from Antelope, WY to Longview, WA:

Figure 16

BNSF Routing Options For Export Coal Movements
From Antelope, Wyoming to Longview, Washington

Route	Miles
From Antelope, WY to Spokane, WA	
Via BNSF/MRL Helena Route	966
Via BNSF Great Falls Route	1,064
From Spokane, WA to Longview, WA	
Via Columbia River Gorge Route	403
Via Stevens Pass / Cascade Tunnel Route	479
Via Stampede Pass Route	493
From Antelope, WY to Longview, WA	
Via BNSF/MRL Helena & Columbia River Gorge Routes	1,368
Via BNSF/MRL Helena & Stevens Pass/Cascade Tunnel Routes	1,445
Via BNSF/MRL Helena & Stampede Pass Routes	1,459
Via BNSF Great Falls & Columbia River Gorge Routes	1,467
Via BNSF Great Falls & Stevens Pass/Cascade Tunnel Routes	1,543
Via BNSF Great Falls & Stampede Pass Routes	1,558

As can be seen, the shortest route to Longview would involve the utilization of the MRL line in Montana and the Columbia River Gorge line in Washington (1,368 miles) whereas the longest route would involve BNSF's line through Great Falls and its Stampede Pass route in Washington (1,558 miles).[61] The economics would generally favor the shortest routes, however, because of the massive volumes expected, it is likely that all of the routing options will be utilized to a certain extent which will likely result in congestion problems for all the routes.

[61] For Cherry Point, which is in northern Washington, the shortest route would involve the BNSF/MRL Helena and Stevens Pass/Cascade Tunnel routes.

5. Impacted Railroad Line Segments

The characteristics of the identified railroad line segments will be described in more detail herein. The following is a list of the major railroad line segments in Wyoming, Montana, Idaho, Washington and Oregon which could be impacted by various degrees by the expected increase in export coal movements from PRB to PNW:

Figure 17

Railroad Line Segments Impacted

Section	Line Segment	Railroad	Miles[62]
1.	Shawnee Jct., WY to Campbell, WY ("Joint Line")	BNSF/UP	140.2
2.	Eagle Butte Jct., WY to Campbell, WY	BNSF	25.6
3.	Campbell, WY to W. Dutch, WY	BNSF	100.5
4.	Spring Creek, MT to W. Dutch, WY	BNSF	22.8
5.	W. Dutch, WY to Huntley, MT	BNSF	138.9
6.	Big Sky, MT to Nichols, MT	BNSF	39.0
7.	Ashland, MT to Miles City, MT	TRRC	89.0
8.	Miles City, MT to Nichols, MT	BNSF	51.6
9.	Nichols, MT to Sarpy, Jct., MT	BNSF	16.4
10.	Kuehn, MT to Sarpy Jct., MT	BNSF	37.4
11.	Sarpy Jct., MT to Huntley, MT	BNSF	66.1
12.	Huntley, MT to Mossmain, MT	BNSF/MRL	24.8
13.	Mossmain, MT to Broadview, MT	BNSF	35.8
14.	Signal Peak, MT to Broadview, MT	BNSF	35.0
15.	Broadview, MT to Great Falls, MT	BNSF	188.0
16.	Great Falls, MT to Shelby, MT	BNSF	99.1
17.	Shelby, MT to Sandpoint, ID	BNSF	337.9
18.	Mossmain, MT to Sandpoint, ID	MRL	564.2
19.	Sandpoint, ID to Spokane, WA (Latah Jct.)	BNSF	70.5
20.	Spokane, WA (Latah Jct.) to Everett, WA (PA Jct.)	BNSF	301.1
21.	Spokane, WA (Latah Jct.) to Pasco, WA (SP&S Jct.)	BNSF	149.4
22.	Pasco, WA (SP&S Jct.) to Vancouver, WA	BNSF	219.8
23.	Vancouver, WA to Longview, WA	BNSF	35.4
24.	Vancouver, WA to Portland, OR	BNSF	9.9
25.	Pasco, WA (SP&S Jct.) to Auburn, WA	BNSF	227.5
26.	Auburn, WA to Centralia, WA	BNSF	72.6
27.	Centralia, WA to Longview, WA	BNSF	47.1
28.	Auburn, WA to Everett, WA (PA Jct.)	BNSF	55.6
29.	Everett, WA (PA Jct.) to Intalco, WA	BNSF	78.3
30.	Intalco, WA to Cherry Point, WA	BNSF	8.9
31.	Intalco, WA to British Columbia Terminals	BNSF/CN	49.7
32.	Centralia, WA to Port of Grays Harbor, WA	PSAP	59.0
33.	Spokane, WA to Hinkle, OR	UP	171.0
34.	Hinkle, OR to Boardman, OR	UP	20.0
35.	Portland, OR to Boardman, OR	UP	164.0
36.	Portland, OR to St. Helens, OR (Port Westward)	PNWR	56.0
37.	Portland, OR to Eugene, OR	UP	124.0
38.	Eugene, WA to Coos Bay, OR	CORP	122.0
	Total Railroad Route Miles		**4,054.1**

62 Includes route miles and mileage of connecting lines.

Projected Traffic Flow

The following charts show the impacted line segments and the potential the routing options and choke points:

Figure 18

Projected Traffic Flow From PRB Coal Mines to Spokane, WA

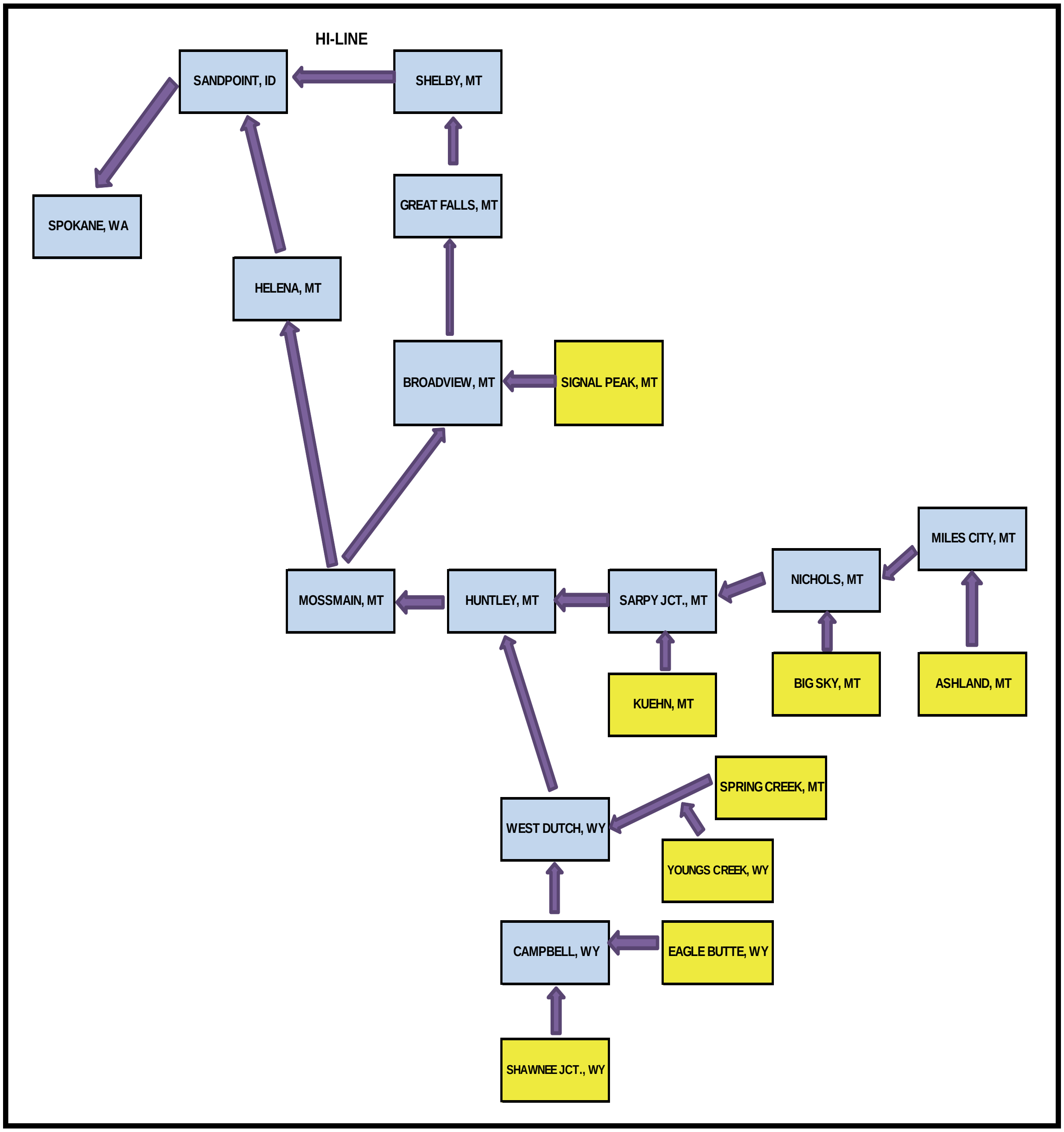
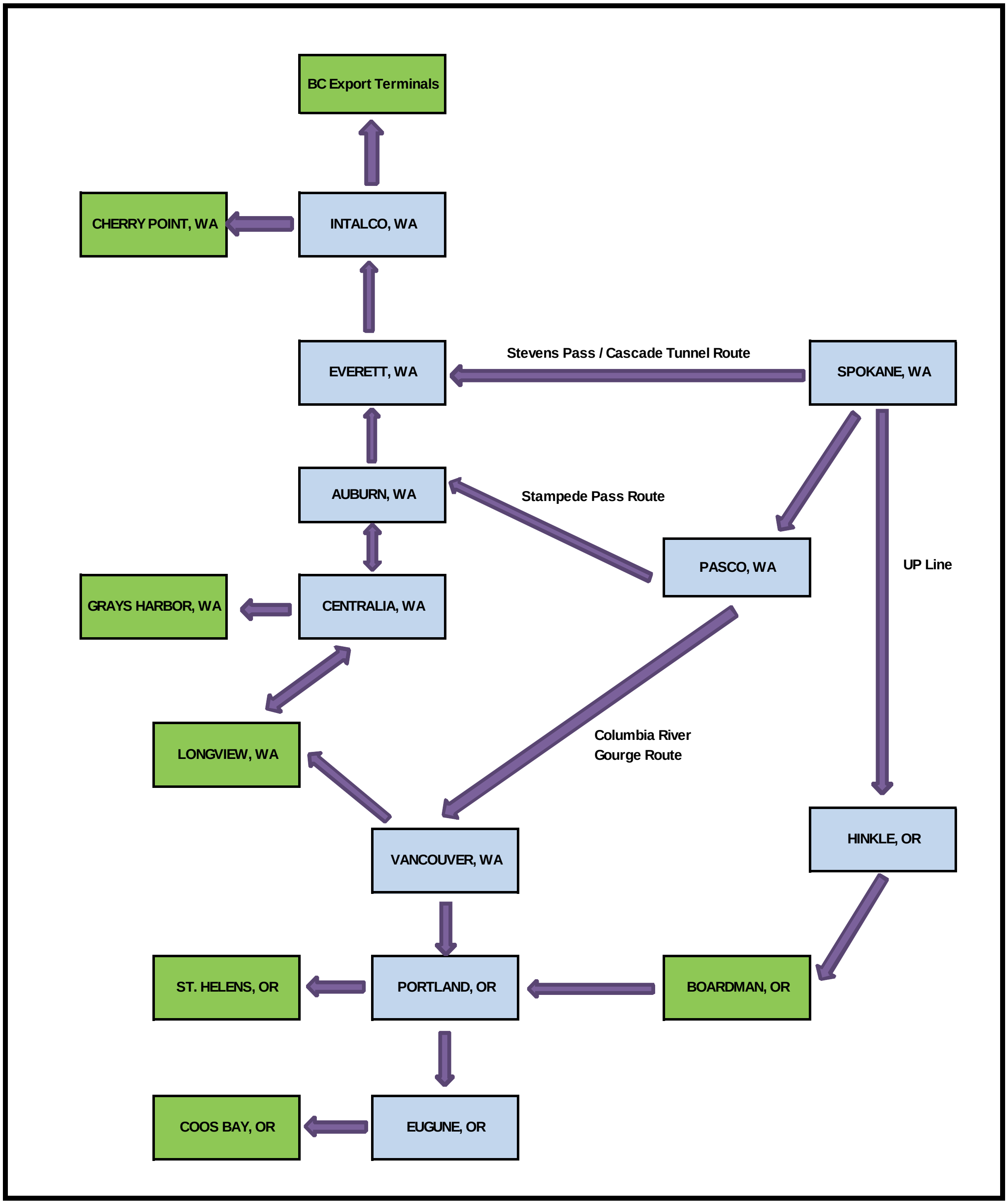


Figure 19

Projected Traffic Flow From Spokane, Washington
<u>To PNW Export Coal Terminals</u>



Major Choke Points & Bottlenecks

As indicated by Figures 17 and 18, the majority of the PRB coal shipments (all but Signal Peak) will converge at Huntley, MT and move to Mossmain, MT, where there is the routing option of either the shorter MRL route through Helena or the longer BNSF route through Great Falls, MT. All PRB coal shipments would then meet again at Sandpoint, ID and converge at Spokane, WA. Although BNSF has routing options from Spokane, WA, there are problems associated with each option, such as existing congestion on the Stevens Pass/Cascade Tunnel and Columbia River Gorge routes and the restrictions associated with the Stampede Pass route.

BNSF's internal routing options will help distribute the tonnage and could help lessen the impact in certain areas, however, the expected large coal volumes will likely result in congestion problems for the entire route. As illustrated by previous flowcharts (Figures 17 and 18), there are two key line segments which will carry nearly *all* the coal traffic and represent major choke points and bottlenecks:

Huntley, MT to Mossmain, MT (Billings) (BNSF/MRL - 24.8 Miles) - Coal shipments from the BNSF/UP Joint Line coal origins or the BNSF served origins would converge at Huntley, MT (Jones Jct.).[63] From Huntley the coal would move 24.8 miles on the MRL line to Mossmain, where it could then move on BNSF's direct route or via the shorter MRL route. It is projected that 22.3 to 57.6 PRB to PNW export coal trains per day will move over this line segments through Billings.

Sandpoint, ID to Spokane, WA (BNSF - 78.3 Miles) - The MRL route from Mossmain would converge with BNSF-direct coal from Shelby at Sandpoint, ID and move on the BNSF line to Spokane, WA. *All* (100%) BNSF export coal to the PNW would likely move over this 78.3 mile line segment. This line is commonly known as the "*Funnel*," and is the second-busiest rail corridor in Washington. It is projected that 27.9 to 63.2 PRB to PNW export coal trains per day will move through Spokane.

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[63] The only exception would be Signal Peak, which is served by a new 35-mile spur, which connects to BNSF's line north of Mossmain near Broadview, MT, thus avoiding the bottleneck from Huntley to Mossmain.

Major Traffic Congestion Areas

In addition to these major choke points, there are also several sections in the routings which are already congested and may not be able to adequately handle the expected large volumes of export coal:

BNSF/UP Joint Line - Currently, the majority of PRB coal (357.1 million tons in 2010) originates on the high-density BNSF/UP Joint Line or Orin Subdivision Line, which runs 120.8 miles from an interchange with UP at Shawnee Jct., WY north to Campbell, WY. This line is already near capacity. In addition, most of the coal from the Joint Line moves south whereas as most PRB to PNW coal traffic would move north, which could cause operational problems on the Joint Line.

BNSF "Hi-Line" - BNSF export coal shipments would connect to its mainline, (known as the "Hi-Line") at Shelby, MT and move west to Sandpoint, ID and beyond. This is one of BNSF's heaviest used mainline, carrying intermodal container trains and west-bound grain shipments. The additional PRB to PNW export coal trains will add 14.9 to 29.7 trains per day to the already congested Hi-Line.

Stevens Pass / Cascade Tunnel - BNSF's Everett-Spokane line, which passes through the Cascade Tunnel at Stevens Pass, is the BNSF's major northern transcontinental route for double-stack intermodal container trains. It is heavily used, operated at about 70 percent of practical capacity in 2008.

Columbia River Gorge - The BNSF's Vancouver-Pasco line, which follows the Columbia River along the north side of the Columbia River Gorge, is used by double-stack intermodal container trains moving east and grain trains moving west to PNW export grain terminals. The line is operating today at about 80 percent of practical capacity.

North-South I-5 Corridor - BNSF's line connecting Seattle with Portland, OR, is the most heavily trafficked rail line in Washington State, conveying BNSF and UP trains (the latter via trackage rights) to and from the major PNW ports. The corridor hosts an average of 58 freight trains each day. PRB to PNW export coal tons will move over this route from Vancouver, WA to Longview and between Longview, WA and Seattle, WA.

Rail Capacity Issues

This report carefully examines and describes these 38 impacted railroad line segments covering over 4,000 route miles in more detail herein. In addition to the obvious environmental and traffic concerns, the expected large coal volumes will result in several major choke points and bottlenecks and will likely cause congestion problems for the entire route. These choke points and congestion areas will be described in more detail herein. The two major cities that will be the most adversely impacted in terms of the expected export coal trains per day are: Spokane, Washington (pop. 208,916) and Billings, Montana (pop. 104,170). Nearly every PNW to PRB loaded and empty coal train will move through these two cities (63.2 trains per day through Spokane and 57.6 trains per day through Billings).[64]

Many of the impacted railroad line segments already have significant rail capacity and congestion issues associated with the current rail traffic, such as PNW import and export intermodal container traffic and grain railroad traffic. For example, for many years there have been rail traffic congestion problems and capacity issues associated with the rail lines between Sandpoint, ID to Spokane, WA, which is appropriately named "*The Funnel*" as four rail lines converge at Spokane and any east/west shipments must travel through the Funnel. It is the second-busiest rail corridor in the state of Washington and hosts an average of 46 freight trains each day, along with daily operation of Amtrak's Empire Builder service connecting Seattle and Portland to Chicago.[65]

Over a decade ago, State, regional and local agencies in Washington and Idaho worked with BNSF, UP and others in developing an infrastructure and capital spending plan called "*Bridging the Valley*," which involved the separation of railroad and roadway grades and increasing the capacity of the line from Spokane, Washington to Athol, Idaho.[66] The improvements were originally designed to handle a gradual growth in intermodal and grain traffic of up to a total of 70 trains per day. However, the expected rapid growth in PRB to PNW export coal traffic was not envisioned or considered when these improvements were first designed (2000) and approved (2006). Now, in few short years, instead of the expected 70 trains per day, Spokane could see more than 130 trains per day, or 5.42 trains per hour moving through the city.

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64 It is projected that all PRB to PNW export coal trains would move over the line from Sandpoint, ID to Spokane, WA, which is known as the "Funnel." With the exception of coal from the Signal Peak, MT mine, all other PRB to PNW coal trains would move over the Huntley, MT to Mossmain, MT line, which runs through Billings, MT.

65 Washington State 2010-2030 Freight Rail Plan, December 2009, Appendix 3-B32 Appendix 3-B: Railroad History, Profiles, Service Corridors, & Safety Regulatory History.

66 See, for example, Spokane Regional Transportation Council site: http://www.srtc.org/btv.html

Clearly, the Bridging the Valley plans and other similar infrastructure improvement plans are obsolete and will have to be reconsidered and significantly revised based on the expected growth in PRB to PNW export coal traffic.

The railroad traffic and associated problems in Billings, the largest city in Montana, have been the issue of many studies over the years. In 2004, the City of Billings, with Federal funding, conducted a Railroad Crossing Feasibility Study.[67] The 2004 report stated that the growth of rail traffic "has resulted in traffic slowdowns, safety hazards and air pollution." The report also concluded that the rail lines through Billings have "created a barrier" and "have played a role in the development and continuation of a social divider between downtown Billings and surrounding neighborhoods." The report looked at various alternatives to improving railroad traffic problems and made recommendations and recommended improved signage, signal controls and other low-cost improvements, as well as an underpass under the railroad tracks crossing 27th street combined with a small track shift appeared, to be the best alternative. It estimated that the cost would be approximately $20 million.

The 2004 Billings report was based on an estimated 30 trains per day through Billings. This traffic level, however, excluded the unexpected rapid growth in PRB to PNW export coal traffic, which could result in an additional 22.3 to 57.6 loaded and empty coal trains per day through Billings. The report also failed to reflect the significant increase in Bakken oil shipments, many of which move to three refineries around Billings or through Billings to Cushing, Oklahoma and other destinations, and the related rail shipments of tubulars, fracturing sand and other supplies into the Bakken, which have resulted in additional loaded and empty trains moving through Billings. With the added export coal trains and the existing coal, grain, intermodal, Bakken oil and other rail traffic already moving from, to and through Billings, there could be as many as 60 to 90 trains per day moving through the city in the near future.

In addition to potential improvements to downtown railroad crossings, the 2004 Billings report considered several options which involved major track relocations, which it estimated would cost between $60 and $150 million. These track relocation options involved possible by-passes around Billings (south of I-90, north of I-90 and north of Billings) and the relocation of MRL's switching yard in Billings. The report concluded that there would be major impacts associated with the track relocation options and they were too costly. Undoubtedly, Billings transportation planners will have to reevaluate these track relocation and by-pass options.

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67 See: http://ci.billings.mt.us/DocumentView.aspx?DID=8159

Several other cities along the route have examined their railroad traffic and congestion issues in the past and will be impacted by the increased movements. Helena, Missoula, Great Falls and other cities in Montana have task forces that have studied the problems associated with increased rail movements. These cities have rail yards and main rail routes that traverse through the heart of their towns. Additionally, the Montana and Washington Departments of Transportation have had continued involvement in studying rail movements, traffic densities, congestion and capacity issues.

As a result of these capacity and congestion problems, there are many areas which will require major upgrading and expansion of existing railroad tracks. In some cases (such as Spokane and Billings) new rail by-passes may be required around populated areas. It is likely that hundreds of miles of railroad lines will require expansion from single to double or even triple track. Other railroad infrastructure, such as bridges, tunnels, high-way crossings, will also need to be replaced or upgraded in order to adequately, efficiently and safely handle the expected traffic levels.

The required upgrading and expansion of railroad tracks and related infrastructure could well cost billions of dollars. State and local governments will likely be called upon to bear the brunt and burden of these related costs local costs and will likely be required to spend hundreds of millions of dollars in related mitigation, litigation, debt and other costs associated with the necessary improvements to accommodate export coal traffic levels.

Impacted Railroad Traffic

Many of the impacted rail lines are already at or near capacity. Even with substantial infrastructure improvements, such a significant increase in export coal rail tonnage and coal trains (as well as related construction projects) will likely significantly interrupt and disrupt other railroad traffic lanes. Existing rail traffic, such as export grain traffic and import and export intermodal container traffic, will likely experience a deterioration of rail service, such as higher transit and cycle times, and will likely incur higher costs in the form of higher freight rates and equipment costs.

PRB to PNW export coal traffic (which will move in efficient unit trains and, in most cases, involve shorter distances) will likely be significantly more profitable than the existing PNW import/export intermodal container traffic and as or more profitable than PNW export grain traffic. As a result of the economics (high volume and revenues), PRB to PNW export coal movements will likely be favored by the railroads over other types of existing railroad traffic. The remaining capacity available to other railroad shippers will be limited, constrained and more expensive. As a result, railroad freight rates for other traffic will increase, which will be an additional benefit for the railroads.

The increase in export coal traffic will likely create numerous railroad shipping and logistic problems and result in increased costs and railroad rates for other shippers as a result of rail congestion and the limitations on available rail capacity. Railroad transit times will likely increase for other railroad traffic as a result of congestion and it may be forced to move over more circuitous routes, which will increase private railroad equipment utilization and related costs.

1. PNW Import and Export Intermodal Container Traffic

Although the Port of Los Angeles and Long Beach, CA handles the largest number of import and export containers (approximately 33% of the total U.S. container traffic), a significant amount of container traffic moves inbound and outbound from the PNW Ports of Seattle, Tacoma and Portland. In 2009, over 3 million containers or TEU's (twenty-foot equivalent units) were handled by these PNW Ports. BNSF also dominates this PNW intermodal container traffic, which will also likely be adversely impacted by the increase in congestion on BNSF's Hi-Line and the impacted lines in Washington and Oregon. PNW container volumes recently increased after cargoes were shifted from Southern California to PNW due to continuing congestion problems in Southern California and the search for new gateways by shippers and carriers.

As export coal trains consume the remaining rail capacity, intermodal transit times to and from PNW ports will be adversely impacted which will reduce the ability of the PNW container ports to compete with the Southern California ports. The following table shows and compares BNSF's current service goal hours for intermodal traffic from S. Seattle, WA and Los Angeles, CA to Chicago, IL:

Figure 20

Comparison of BNSF Intermodal
Service Goal Hours For Movements To Chicago, IL

From	To	BNSF Service Goal Hours [68]		
		Premium COFC	Expedited COFC	Expedited TOFC
S. Seattle, WA	Chicago, IL	85	79	79
Los Angeles, CA	Chicago, IL	84-92	78	78

As can be seen, BNSF's service goal hours for movements of intermodal containers and trailers on flat cars from S. Seattle, WA to Chicago, IL are currently approximately the same as the hours from Los Angeles, CA. This transit time from S. Seattle will be adversely impacted by the added rail congestion resulting from the increased export coal movements, which will reduce the ability to compete with the Southern California ports.

The ability of PNW intermodal container ports to compete with the expanding Canadian Port of Prince Rupert, B.C. will also be hurt. As a review of various comments filed in response to the Federal Maritime Commission's (FMC) Notice of Inquiry, U.S. Inland Containerized Cargo Moving Through Canadian and Mexican Seaports, demonstrates, the recent growth of Trans-Pacific services through Prince Rupert is due "in substantial part to the transportation advantages of that service, especially the shorter ocean transit time from Asia, and the excellent rail connection and service from the railroad(s) providing service from that port into the U.S. Midwest."[69] As was also repeatedly stressed, the primary considerations affecting the ports used for cargo imported to the U.S. are market-driven.

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[68] Source: BNSF. COFC = Container on Flat Car. TOFC = Trailer on Flat Car

[69] Joint Comments Submitted by World Shipping Council, The National Industrial Transportation League, and National Retail Federation, at p. 2.

Hence, the "business requirements of U.S. importers for timely, efficient and cost-effective service that will satisfy their delivery requirements are paramount considerations."[70] In other words, speed to market will increasingly play a major role in causing shippers to route cargo through maritime gateways in Canada.

Given the need for fast, reliable supply chains for container shipments, of which the railroads are a major component, a substantial increase in the number of coal trains will further clog BNSF's congested lines and will provide an economic incentive to shippers to divert containerized traffic to the Port at Prince Rupert and to Canadian National Railway Company (CN). As CN observed in its Comments, once its recent acquisition of the Elgin, Joliet and Eastern Railway Company (EJ&E) has been fully integrated, it "will allow CN to move trains from the congested downtown Chicago area onto the EJ&E line circling the city" and enable it to provide seamless service from Prince Rupert to customers located throughout the eastern part of the U.S.[71]

In his response to the FMC's inquiry into possible cargo diversion, Tay Yoshitani, Chief Executive Officer of the Port of Seattle, pointed out that "Washington is the most trade-dependent state in the nation" and that the Port of Seattle is "a primary economic engine for Washington State, generating nearly 200,000 jobs and $867 million in state and local tax revenue."[72] He also observed that "foreign cargo is crucial to the state's future competitiveness, because cargo creates jobs, and because farmers and other manufacturers across Washington need the robust infrastructure a strong import trade creates – without it, they cannot get their goods to markets across the globe."

Plainly, if the west-bound movement of coal disrupts the frequency and reliability of inbound and outbound shipments of containerized traffic, that traffic likely will be diverted to Canadian ports where it will not be impacted by the congestion caused by the increased coal shipments. Unfortunately, no similar relief will be accorded outbound movements of agricultural products and other goods manufactured in Washington. As a result, the warehousing, distribution and transloading centers, third party logistics companies and brokers at the Port of Seattle who offer services and facilities to shippers will also be harmed. Therefore, it is imperative that the total consequences of moving coal to PNW export terminals must be carefully explored.

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[70] Id.at 6.
[71] CN Comments at 4.
[72] Letter to Secretary Gregory dated January 9, 2012

2. PNW Export Grain Traffic

In 2011, U.S exports of corn, wheat and soybeans to Asia exceeded 60 million tons. The majority of this export grain traffic moved from PNW export terminals, primarily located in and around Vancouver, WA, Kalama, WA, Tacoma, WA, Portland, Oregon and other PNW destinations. BNSF dominates this transportation market with significant railroad grain movements, such as wheat movements from Montana, soybean movements from North Dakota and corn movements from Iowa.

The following table shows the total railroad agricultural shipments (Farm Products - STCC 01) moving to PNW destinations in 2010:[73]

Figure 21

2010 Railroad Shipments of
Farm Products (STCC 01) to PNW Destinations

Commodity	STCC	Carloads	Tons	Railroad Revenue
Soy Beans	01-144	129,580	14,152,756	$631,053,156
Corn	01-132	128,257	14,051,553	$597,014,673
Wheat	01-137	84,334	9,040,273	$300,406,569
Grain, NEC	01-139	13,240	427,024	$17,050,356
Peas, Dry Ripe	01-342	3,260	327,040	$14,496,108
Barley	01-131	4,616	240,272	$8,986,304
Beans, Dry Ripe	01-341	2,120	79,588	$3,563,960
Cottonseeds	01-141	516	29,484	$2,354,356
Total	**01**	**365,923**	**38,347,990**	**$1,574,925,482**

This railroad export grain traffic will likely be adversely impacted by the increase in congestion on BNSF's Hi-Line and the impacted lines in Washington and Oregon. In addition to the large volumes of grain moving to the PNW, the traffic also fluctuates seasonally with increased volumes taking place after the fall harvests. As a result, the traffic congestion would likely be greater during these post-harvest periods.

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[73] Based on the STB's 2010 Public Waybill Sample for (BEA's 167, 168, 169 and 170)

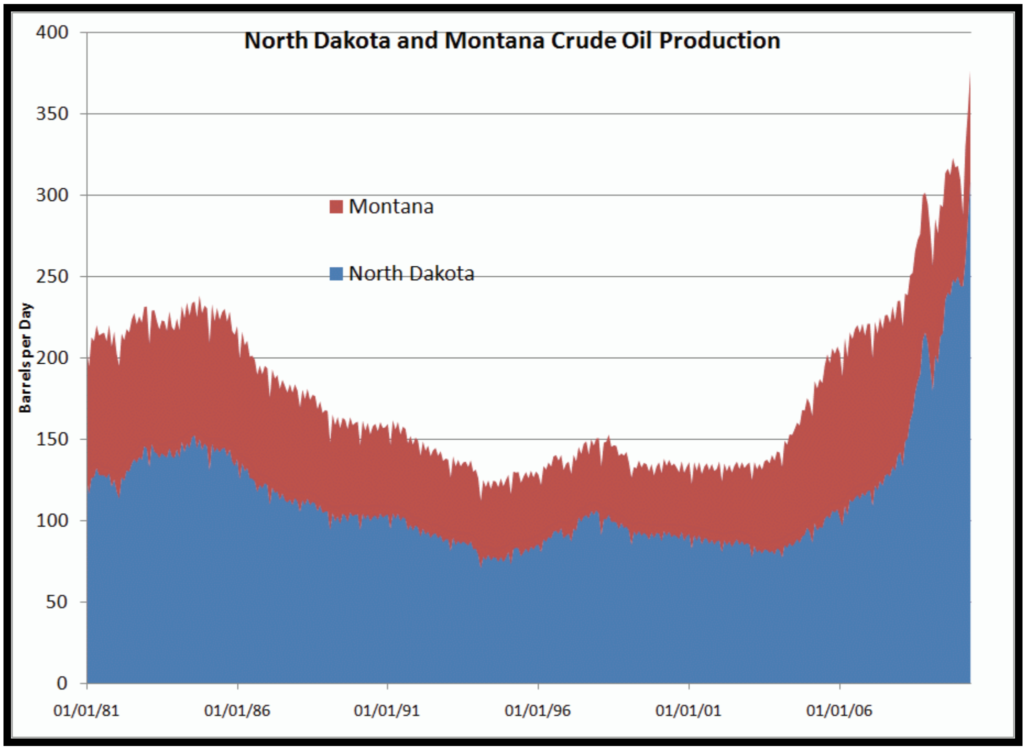
During the past decade, BNSF has increasingly promoted the use of 110-car shuttle trains for PNW export grain shipments. These shuttle trains will have to compete for capacity with the export coal unit trains, which will result in higher rates. Grain movements use a combination of privately-owned and railroad-owned covered hoppers. Transit times are likely to increase, which will increase equipment costs. Grain traffic from smaller elevators (non-shuttle elevators), such as 52-car elevators in Montana, will likely be hurt the most as BNSF will continue to favor the large shuttle facilities.

3. Bakken Oil Shipments

The Bakken Oil formation on North Dakota and Montana has been producing oil since its initial discovery in 1953, however, new discoveries coupled with the success of horizontal drilling in 1987 and the use of a new technique known as multi-stage fracturing or "fracking" in the early 2000's has resulted in an explosion of oil production from this area. The following chart shows this dramatic increase in North Dakota and Montana oil production in the last few years:

Figure 22

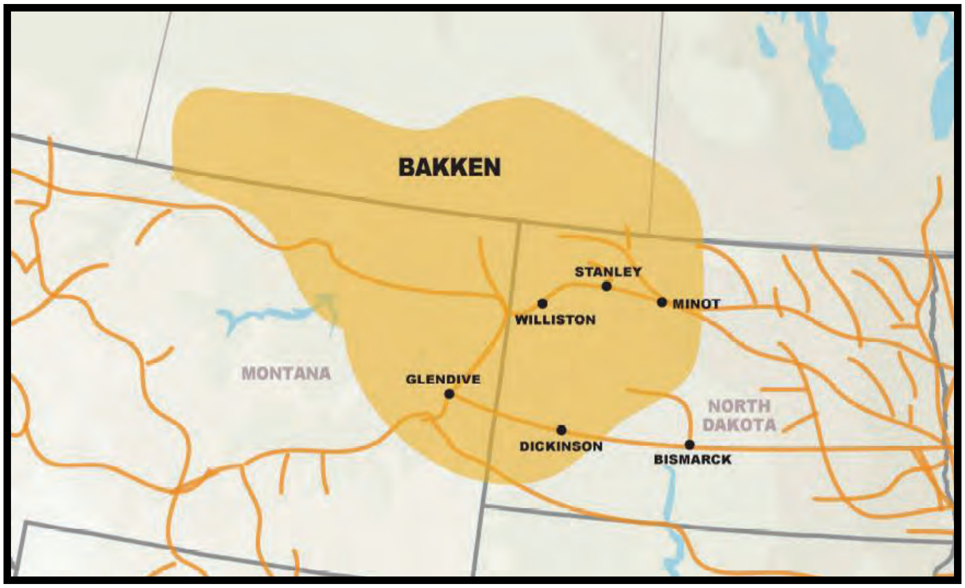
<u>North Dakota and Montana Crude Oil Production</u>



The railroads, especially BNSF, see this as a major growth area. BNSF estimates that nine (9) unit train loading facilities will be located in the area by 2013.[74] These facilities include: Trenton, ND, Tioga, ND, Epping, ND, and Dickinson, ND. BNSF estimates that it is positioned to transport 730,000 barrels of crude per day and that it directly serves 30% of U.S. refineries in 14 states.[75] The following map shows the Bakken area and BNSF's routes through the area:

Figure 23

<u>BNSF's Bakken Oil Formation Service Area</u>



A significant amount of the Bakken oil traffic will move over many of the lines that are also impacted by the increase in export coal shipments to the PNW. Bakken oil will move to refineries through-out the U.S, including the three refineries in the Billings area. Plans are also underway to move dedicated BNSF unit trains of Bakken crude oil to refineries to PNW.[76]

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74 Presentation titled "Bakken Shale Overview" by Denis Smith, BNSF Vice President, Industrial Products Marketing, dated July 12, 2011.

75 One 100-car unit train carries approximately 60,000 barrels. As a result, 730,000 barrels would equate to over 12 unit trains per day.

76 In July, 2011, Tesoro Corp. announced that it intends to move 30,000 barrels per day (or approximately 50 loaded cars per day) of Bakken oil by rail in a dedicated unit trains to its 120,000 barrels per day refinery in Anacortes, WA and expects to spend $50 million on the project. Shell Oil also has a large refinery in Anacortes (147,500 barrels per day). In addition, to the two refineries in Anacortes, there are two large refineries in Ferndale, WA (i.e., BP Oil – 232,000 barrels per day and ConocoPhillips – 101,000 barrels per day), which is close to Cherry Point, WA. In addition, there is a small refinery in Tacoma, WA (US Oil & Refining Co. – 36,250 barrels per day).

Bakken oil will also move to Gulf coast refineries, such as those located in Houston, TX, Beaumont, TX, Port Arthur, TX, Lake Charles, LA and St. James, LA. One major BNSF destination is Cushing, OK, which is a crude-oil epicenter that is connected to a pipeline network tied to many major U.S. markets. Bakken oil shipments to Cushing would move through Billings. In fact, MRL's Billings yard has become a staging yard for Bakken oil tank cars over the last 24 months. This trend should continue as one of BNSF's major routes for getting Bakken oil to distribution points such as Cushing is through Billings and Laurel and down the west side of the Big Horn Mountains.

4. Passenger & Commuter Traffic

Passenger and commuter rail traffic will also be disrupted by the increased rail congestion caused by the increase in export coal trains. Amtrak's Empire Builder travels daily along BNSF's routes between Chicago, Illinois and Seattle, Washington and Portland, Oregon. Amtrak serves many stations along the impact route, including: Shelby, MT, Cut Bank, MT; Browning, MT; East Glacier Park, MT; Essex, MT; West Glacier, MT; Whitefish, MT; Libby, MT, Sandpoint, ID; Spokane, WA; Pasco, WA; Wishram, WA; Bingen, WA; Vancouver, WA; Portland, OR; Ephrata, WA; Wenatchee, WA; Leavenworth, WA; Everett, WA; Edmonds, WA and Seattle, WA. This Amtrak service is likely to be disrupted and impacted by the increase in congestion.

Amtrak also operates Amtrak Cascades Intercity Passenger Rail, which is sponsored by ticket-buying passengers, the states of Washington and Oregon, and Amtrak. Amtrak Cascades service operates on the same railroad tracks as freight trains, makes a limited number of stops, and connects central cities between Vancouver, B.C. and Eugene, OR.

Sound Transit's Sounder Commuter offers commuter rail service between Tacoma and downtown Seattle with stops in Puyallup, Sumner, Auburn, Kent, and Tukwila, and between Everett and downtown Seattle with stops in Edmonds and Mukilteo. It shares the same railroad tracks as freight trains and Amtrak. In contrast to Amtrak, Sounder commuter rail makes frequent stops along the 70-mile corridor between Everett and Tacoma, with service currently provided only during the weekday morning and evening commute hours. Sounder commuter trains make additional stops along the route at Mukilteo, Auburn, Kent, Sumner, Puyallup, and Tacoma's Tacoma Dome station.

Major Track and Infrastructure Improvements are Required

Many of the impacted railroad tracks are already at, near or exceed capacity and the existing infrastructure needs significant upgrades and improvements in order to handle the existing traffic and relieve existing congestions.[77] For example, BNSF's Stevens Pass / Cascade Tunnel route across Washington is already nearing capacity and BNSF has been forced to route intermodal trains south via the circuitous I-5 rail corridor to Vancouver (WA) and then east, which has added considerable volume to the Vancouver-Pasco line along the Columbia River Gorge, and made the scheduling of trains moving through the Gorge and along the I-5 rail corridor more complex. BNSF's rail routes will require major upgrading and expansion of existing railroad tracks, bridges, tunnels, high-way crossings and other infrastructure in order to adequately and safely handle such high annual volumes. Most of the infrastructure improvements related to coal movements made by BNSF and UP in recent years have focused on the east bound coal traffic lanes. As a result of the expected increase in PRB coal traffic to the PNW, many of the north-west bound line segments will require substantial infrastructure improvements and modifications in order to adequately handle the expected export coal volumes.

In 2007, the Association of American Railroads (AAR) released the National Rail Freight Infrastructure Capacity and Investment Study, which was an assessment of the long-term capacity expansion needs of the continental U.S. freight railroads and provided an approximation of the rail freight infrastructure improvements and investments needed to meet the U.S. Department of Transportation's (U.S. DOT) projected demand for rail freight transportation in 2035. The report included the following approximation of the capacity associated with various track configurations:

[77] e.g., see, December 2009, Washington State 2010-2030 Freight Rail Plan, which identified numerous existing rail bottlenecks and over 100 required capital improvement projects throughout the state.

Figure 24

Practical Track Capacity (Trains Per Day)

Number of Tracks	Train Control	Trains Per Day Lower Bound	Upper Bound
1	No Signal and Track Warrant Control (NS-TWC)	16	20
1	Automatic Block Signaling (ABS)	18	25
2	No Signal and Track Warrant Control (NS-TWC)	28	35
1	Centralized Traffic Control (CTC)	30	48
2	Automatic Block Signaling (ABS)	53	80
2	Centralized Traffic Control (CTC)	75	100
3	Centralized Traffic Control (CTC)	133	163
4	Centralized Traffic Control (CTC)	173	230
5	Centralized Traffic Control (CTC)	248	340
6	Centralized Traffic Control (CTC)	360	415

These AAR standards were used in the evaluation of the capacity of the studied line segments associated with the potential PRB to PNW export coal movements. In numerous instances, the existing traffic levels fall within (and in some cases already exceed) these capacity ranges and the addition of the expected PRB to PNW export coal trains per day will exceed the existing capacity.

Railroad by-passes and track relocations in and around major populated areas, such as Spokane and Billings, may also be required. For example, in 2004, a by-pass around Billings was estimated to cost between $60 and $150 million. The majority of the impacted line segments are single track, which has a capacity ranging from 16 to 48 trains per day depending on the type of train control. Based on AAR's capacity standards, over 800 route miles (or approximately 20% of the route miles) will need to be expanded to double track in order to expand the capacity to efficiently and safely handle the expected volumes. Based on AAR's estimate of cost $3.8 million per mile, it would cost over $3 billion to double track 800 miles.

For example, most of the 149.4-mile line segment from Spokane, WA to Pasco, WA is single track with CTC.[78] According to Washington State, this line segment has an average utilization of 32 trains per day, which is within the 30 to 48 trains per day range for single track with CTC. However, the expected PRB to PNW export coal will add an additional 15.0 to 32.7 loaded and empty coal trains per day, which will likely exceed the 48 trains per day capacity. As a result, it is likely that this entire 149.4-mile segment will likely require double track with CTC.

There are also over 800 miles of road which have not been upgraded to Centralized Traffic Control (CTC), which would probably be required for many of these lines. The largest of these non-CTC line segments are the key line segments from Mossmain, MT to Shelby, MT, which runs 322.9 miles through Great Falls, MT. AAR estimates that the conversion of a line to CTC can cost up to $700,000 per mile, which would equate to over $500 million. In addition to installing double tracks and CTC, there are numerous bridges, tunnels, grade crossings and other railroad-related infrastructure which will need to be expanded, upgraded or rebuilt to efficiently and effectively move the expected coal volumes from the PRB to PNW.

The costs associated with the required infrastructure improvements will certainly be in the billions. In 2009, the State of Washington identified over 100 capital improvement projects and other initiatives and estimated the cost to exceed $2 billion, but Washington's estimate did not reflect the potential impact associated with a significant increase in railroad shipments of export coal. The total required improvements in Washington, Oregon, Montana, Wyoming and Idaho could well exceed $5 billion. This report includes a separate evaluation of the identified 38 individual line segments, which generally describe the required improvements associated with each line segment.

78 The line includes approximately 10.9 miles of double track.

Environmental Impacts

The movement of 75 to 170 million tons per year would equate to the movements of 27.86 to 63.15 loaded and empty coal trains per day. These repetitive 1¼-mile long loaded and empty coal trains will be going through numerous populated cities, towns, communities (such as Spokane, Washington, Seattle, Washington, and Billings, Montana and Portland, Oregon), parks, forests, historical areas and other environmentally sensitive areas (such as Glacier National Park in Montana). As indicated Governor Kitzhaber's recent letter requesting a full EIS of the proposals, there are environmental concerns associated with: protection of water quality, including risk of spills; impacts to listed protected fish species; coal dust emissions at the facilities and during product transport; emissions of other air pollutants, including diesel particulate, ozone, mercury and greenhouse gases; and increased rail traffic, noise and delay times for communities along the proposed lines, including emergency vehicles at rail crossings.[79]

Although BNSF's shortest PRB to PNW railroad route (Signal Peak, MT to Longview, WA) covers a distance of 1,135 miles, there are 7 PRB existing and proposed coal lines in Wyoming and Montana which will likely be used and 9 existing and proposed PNW export coal terminals stretching from Prince Rupert, British Columbia to Coos Bay, Oregon. In addition, BNSF has several available routing options in Montana and Washington, which could lessen the impact on certain areas, but also significantly broadens the total impact area. As a result, the total rail route miles potentially impacted cover an extremely broad impact area covering a total rail distance of over 4,000 miles. The impacted railroad route miles would directly impact over 48,977 acres based on a 100 ft. right-of-way (ROW), as well as the adjoining and surrounding areas. These routes and impacted areas are described in more detail herein.

The PNW destination areas and communities in Washington, Oregon and British Columbia will obviously be adversely impacted by the increase in coal trains and pollution from coal dust and diesel fumes. Meeting these PNW export coal goals will also likely require coal companies to open brand new areas of mining and expand existing PRB coal mining operations in Montana and Wyoming, which could further increase air pollution, jeopardize water quality and require the industrialization of thousands of acres of agricultural land and wildlife habitat. The impacted areas will experience blocked vehicular traffic crossings and related traffic congestion, as well as an increase in related traffic accidents, injuries and deaths. The increase in export coal traffic could also adversely impact wildlife, pollute the air and ground, create noise and result in numerous other environmental problems along the entire route.

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[79] Letter from Governor John A. Kitzhaber dated April 25, 2012. Evaluating and quantifying the environmental impacts while they exist, is beyond the scope of this analysis.

Economic Impacts

In addition to the related environmental problems, however, there will be significant economic impacts. The railroads, terminals companies and coal companies plan to spend millions in expanding and upgrading the PNW export terminals. For example, Millennium Bulk Terminals is proposing to spend $600 million terminal for the proposed Longview export coal terminal.[80]

However, there are many areas along the railroad routes which will require major upgrading and expansion of existing railroad tracks and related infrastructure which could well cost billions of dollars. In some cases new rail by-passes may be required around major populated areas. Hundreds of miles of railroad lines will likely require expansion from single to double or even triple track. Other railroad infrastructure, such as bridges, tunnels, high-way crossings, will also need to be replaced or upgraded in order to adequately, efficiently and safely handle the expected increase in traffic levels.

State and local governments will likely bear the brunt and burden of these related local infrastructure costs and will likely be required to spend hundreds of millions of dollars in related mitigation, litigation, debt and other costs associated with the necessary improvements to accommodate export coal traffic levels.

Railroad shippers will also likely experience higher costs in terms and railroad rates, charges and related expenses. Many of the impacted rail lines are already at or near capacity. Even with substantial infrastructure improvements, such a significant increase in export coal rail tonnage and coal trains (as well as related construction projects) will likely significantly interrupt and disrupt other railroad traffic lanes and consume the majority of the existing rail capacity. Existing rail traffic, such as export grain traffic and import and export intermodal container traffic, will likely experience a deterioration of rail service, such as higher transit and cycle times, and will likely incur higher costs in the form of higher freight rates and equipment costs.

[80] http://millenniumbulk.com/wp-content/uploads/pdfs/BerkStudy.pdf

Regulatory Review & Mitigation

There are many areas along the impacted railroad routes which would require significant mitigation in order to alleviate the adverse impacts associated with the significant increase in coal traffic. State and local governments and other impacted and interested parties may have little input into related rail infrastructure requirements and needs.

The new PNW export coal terminals, such as Cherry Point and Longview, will have Environmental Impact Statements (EIS) associated with the local improvements and installations. U.S. Army Corps of Engineers (USACE) will serve as the lead federal agency in the preparation of these EIS reviews. USACE may look at the cumulative impacts as required by National Environmental Policy Act (NEPA), however, USACE has no authority over interstate railroad movements.[81]

The U.S. Surface Transportation Board (STB) is an economic regulatory agency that Congress has charged with resolving railroad rate and service disputes and reviewing proposed railroad mergers. The STB has often been involved in cases which involved mitigation resulting from increased railroad traffic levels and has been involved in several cases involving the proposed expansion of PRB coal movements.

For example, in the 1995 railroad merger between UP and Southern Pacific (UP/SP), the city of Reno, Nevada, along with many other cities and impacted parties, protested the merger, which required STB approval, because of the predicted 40 to 50 trains per day which would run through town as a result of the merger. Mitigation for Reno was a very expensive undertaking because the railroad tracks run through the heart of Reno's casino district. Several alternatives were considered and discarded, including track relocation or by-pass and a tunnel. After a decade of litigation and negotiations, an agreement was finally reached to excavate a 2.25-mile long, 33-feet-deep, and 54-foot-wide trench through the city, which was not completed until 2005. The Reno trench cost an estimated $265 million (excluding debt), of which the railroad contributed only $17 million.[82]

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[81] Recently, the EPA requested that USACE conduct a "thorough and broadly scoped cumulative impacts analysis" of a project at Port of Morrow in Oregon which has "the potential to significantly impact human health and the environment." The EPA stated that the Corps should address overall impacts, including increases in greenhouse gas emissions, rail traffic and mining activity on public lands.

[82] See *Railway Age* article by Willie Albright: We told you so - Predictions of calamity was not enough to derail Reno's runaway train trench. Now what ?, published July 11, 2011.

Although Reno was forced to spend millions in order to mitigate the adverse impact resulting from the UP/SP merger and the railroad's portion of the total cost was relatively small, Reno did obtain the benefit of STB-ordered mitigation. STB ordered relief which was intended to preserve the "environmental status quo." As a result, UP was forced to negotiate and Reno had some leverage in its subsequent negotiations.

Previous other potential expansions of railroad PRB coal movements have also been under the jurisdiction of, and the subject of approval by, the STB, namely:

- **DM&E -** The application filed by the Dakota, Minnesota & Eastern Railroad Corporation (DM&E) to construct and operate 280 miles of new rail line and the rehabilitation of approximately 600 miles of existing rail line in Wyoming, South Dakota, and Minnesota;[83] and

- **TRRC** - The Tongue River Railroad Company (TRRC), which involves the construction of an 89-mile coal line from Ashland, MT to Miles City, MT.[84]

In both the DM&E and TRRC cases, the railroads projected the movement of million tons of coal through either populated or environmentally sensitive areas, or both. As a result, STB identified and examined potential environmental and economic impacts associated with the project and ordered hundreds of environmental conditions.

For example, in the DM&E case, the STB prepared a Draft and a Final Environmental Impact Statement (EIS). The STB conducted biological surveys for threatened and endangered species and cultural resource surveys for archaeological sites and historic structures. Additionally, the STB gathered extensive data on air quality, crossing safety and potential

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83 DM&E filed an application for the expansion with the STB) on February 20, 1998. The STB subsequently approved DM&E's application in 2001. In 2007, the Canadian Pacific (CP) acquired DM&E. To date, no action has been taken on the construction of the line since CP's acquisition of DM&E.

84 A new coal line in Montana, which would be operated by the Tongue River Railroad Company (TRRC), has been proposed and approved for construction by the STB which would connect with BNSF's mainline at Miles City, MT. TRRC was first applied for regulatory approval in 1983 and has been the subject of numerous STB decisions and modifications. A recent agreement between one of the major opponents, billionaire Forrest Mars, and BNSF and Arch Coal, appears to have limited the proposed rail route to the 89-mile line from Ashland, MT to Miles City, MT. After a recent ruling in the 9th Circuit Court of Appeals, the STB in June reopened the Ashland to Miles City segment permit to require a revised application that reflects current plans to ship coal west to ports and the agency will conduct an environmental review of the revised project.

delays, railroad and vehicular traffic volumes, wetlands and aquatic resources, noise receptors, wildlife migration, and potential impacts to ranching operations.

There was extensive public involvement in the development of the original EIS. STB worked with five cooperating Federal agencies, conducted dozens of meetings and received approximately nearly 10,000 comments from agencies, elected officials, tribes, organizations, businesses, affected communities, landowners, and other members of the public. As a result, STB identified and examined potential environmental impacts associated with the project and ordered 147 environmental conditions.

The DM&E and TRRC proposals involved the construction of new rail lines in order to access PRB coal, whereas, the rail construction associated with the proposed PNW export terminals primarily involves the construction of railroad track, storage areas and unloading facilities. The required new construction may be smaller, but the size, scope and problems associated with DM&E's proposed PRB coal project are similar in many respects to the proposals to move PRB export coal tonnage to the PNW (i.e., same commodity (coal), same origin area (PRB), similar distances, similar congestion and environmental problems, etc.). Indeed, the traffic levels and adverse impacts associated with expansion of PRB to PNW export coal movements are likely bigger than the TRRC and DM&E cases combined:

Figure 25

Comparison of Projected PRB to PNW
<u>Export Coal Volumes With DM&E and TRRC</u>

Item	Low	High
Projected PRB to PNW Export Coal Volumes		
PRB to PNW Export Coal Tons Per Year (Millions)	75	170
PRB to PNW Export Coal Trains Per Day (L&E)	28	63
Projected DM&E PRB to U.S. Coal Volumes		
DM&E Proposed PRB Coal Tons Per Year (Millions)	20	100
DM&E Proposed PRB Coal Trains Per Day (L&E)	8	34
Projected TRRC PRB to U.S. Coal Volumes		
TRRC Proposed PRB Coal Tons Per Year (Millions)	33	44
TRRC Proposed PRB Coal Trains Per Day (L&E)	19	25

In the previous STB cases involving the expansion of PRB coal movements, i.e., DM&E and TRRC, the STB considered the "*downline*" and overall impacts associated with the proposed construction projects. Here, the size of the railroad track construction and expansion of the PNW export terminals may be smaller in comparison to the DM&E and TRRC PRB build-in proposals, but the "*upline*" and overall impacts will be much broader and more adverse to the areas along the impacted over 4,000 plus route miles.

However, the railroads, coal companies and other interested parties may resist an STB review of the cumulative impacts associated with the proposed expansion of PRB to PNW export coal movements - even though the proposed PRB to PNW export coal movements are much larger than any previous case that have been decided by the STB. Consequently, impacted and interested parties may be required to advocate and promote Federal legislation which would require a thorough STB review of the proposed cumulative impacts associated with the projected increase in PRB to PNW export coal movements.

Given the vast increase in the number of trains per day that are anticipated, it is imperative that State and local governments must be made aware that they will likely bear the brunt and burden of the local impacts. Without question, the increase will have substantial adverse environmental and economic consequences as it will increase the number of emissions, particulates, and delays in vehicular traffic. In order to address the adverse consequences, State and local governments must be prepared to seek relief from the STB and/or Congress.

The railroads, coal companies and PNW terminal companies may resist STB jurisdiction in regard to the proposed increase in PRB to PNW export coal movements and maintain that little or no mitigation is required because the railroads are not constructing a new line or merging with another railroad, but are instead constructing new facilities within existing rail corridors. However, in the event that new construction is required to reach new export terminals, that construction would likely entail an extension of a line of railroad into new territory, which would require STB approval.

In addition, the reopened TRRC proceeding opens the door for further environmental impact studies. As the Ninth Circuit recently recognized, "[t]he propose of TRRC II was to bring coal from Wyoming's PRB to the BNSF main line in Miles City, and then on to other destinations in the Midwest." (Slip Op. at 7, emphasis added). Given the absence of any prior focus on potential PNW movements, the argument can be made that the Board must perform a new cumulative impact analysis and that the shift in market destinations is a material change. (The STB ruled on June 18, 2012, to reopen the TRRC application to review the revised plans to ship the coal west.)

There are at least two STB precedents that provide some guidance regarding the STB's jurisdiction to consider the entirety of a project that is composed of both new construction and the rehabilitation and expansion of an existing line. In the DM&E case, the Board specifically rejected DM&E's argument that it lacked "jurisdiction to impose conditions related to the existing line."[85] As the Board explained, while it may not have jurisdiction over proposed improvements and upgrades of an existing line, it has jurisdiction to examine the potential environmental impacts resulting from increased rail operations over the portion of the rebuilt line as well as the impacts from the construction of the new line. As the Board further explained in slightly different terms:

> [W]e have broad power to impose conditions, so long as they are supported by the record and there is a sufficient nexus between the condition imposed and the transaction before us. Accordingly, we plainly have authority to impose mitigation to address the effects of increased operations on the existing line that would not occur but for the expansion of [the railroad's] system authorized here.
> (DM&E, 6 STB at 36).

It can also be anticipated that the railroad may argue that little or no mitigation is necessary and that the Board, as part of its conditioning authority, may not require the railroad to fund other than a small percentage of the cost of grade separations and other mitigation. Once again, there are two recent proceedings in which the Board required a railroad applicant to assume more than the minimal 5% of costs generally associated with the construction of grade crossing separation projects initiated at the request of a community and funded with federal highway grants.

When the Board approved the Canadian National Railroad Company's (CN) acquisition of EJ&E West Company, a wholly owned, non-carrier subsidiary of Elgin, Joliet and Eastern Railway Company (EJ&E), it reasoned that because the applicants were receiving the substantial benefit of the Board's approval of the transaction, they would be responsible for a higher share of the cost of grade-separation costs than would be the case if local governments were seeking to impose a grade-separation project on the railroad. As the STB realized in its approval of the transaction:

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[85] Dakota, MN & Eastern RR—Construction—Powder River Basin, 6 STB 8, 36 (2002) (DM&E). In so ruling, the STB relied on prior reasoning in Burlington Northern Santa Fe Corporation, BNSF Acquisition Corp., and Burlington Northern Railroad Company—Control—Washington Central Railroad Company, 1 STB 792 (1996), aff'd City of Auburn v. STB, 154 F.3d 1025 (9th Cir. 1998), cert. denied, 527 U.S. 1022 (1999) (City of Auburn).

> . . . will change the character of the EJ&E line from a line serving local traffic that also facilitates longer-haul movements through haulage and trackage rights into a line that will be integrated into CN's North American rail network at the very heart of the system. As the Final EIS shows, this transaction would have a substantial adverse effect on vehicular traffic delays and, in some areas, regional and local mobility and safety at grade crossings. (Slip op. at 46) Thus, CN's "share of the cost should be more than the traditional railroad share for grade-separation projects." (Id.)

Although CN appealed the Board's decision, the D.C. Circuit upheld the Board's decision when it found that "the higher proportion of costs the Board imposed on Canadian National is not unusual where, as here, the railroad, as opposed to the government, proposes the action that creates the need from grade separation and where no federal funds are involved."[86] The court also found that the Board's decision to require CN to pay as much as 78.5% of the cost of one grade separation and 67% of the cost of a second grade separation was "entirely consistent with [the Board's] policy of 'requiring {railroads} to mitigate transaction-related impacts, but not pre-existing conditions." Id.

In the DM&E case, the Board also required the railroad applicant to fund more than the minimal 5% of the cost of crossing-protection upgrades on the existing line and not only on the new line. See DM&E, 6 STB at 32. Plainly, the foregoing rationale is applicable to the situation involved herein where the overall adverse impacts will be much broader and more adverse than was the case in either the EJ&E, DM&E or TRRC proceedings.

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[86] Village of Barrington, Illinois v. Surface Transportation Board, D.C. Cir. No. 09-1002 (March 15, 2011), slip op. at 42.

Potential Legislation

Impacted and interested parties may want to consider seeking or promoting Federal legislation which would require STB approval for such increases in traffic levels or extensive infrastructure improvements.

For example, impacted and interested parties could seek and promote Federal legislation which would amend the Interstate Commerce Act to would require railroads, prior to engaging in extensive improvements and upgrades of an existing line that would increase the number of trains by more than a certain percentage (perhaps 25% to 50%), to notify the Board of such improvements so that the Board may determine whether such improvements and upgrades might have a significant impact on the human environment. Should it determine that the planned improvements might have a likely adverse impact, the Board shall be required to hold public hearings on the proposed project to determine the safety and environmental effects of the proposed project, including the effects on local communities, such as public safety, grade crossing safety, hazardous materials transportation safety, emergency response time, noise, and socioeconomic impacts. Should it determine after such hearings that the proposed improvements and upgrades would have an adverse impact, the Board would have jurisdiction to impose conditions that would mitigate the adverse impacts.

As an alternative approach, any increase in the number of trains above a specified percentage would establish a presumption that the project would have an adverse impact that the Board would be required to address. As noted earlier, the expected rapid growth in PRB to PNW export coal traffic was not envisioned or considered when the Bridging the Valley plan was first designed (2000) and approved (2005). Now, in a few short years, instead of the expected 70 trains per day, Spokane could see as many as 140 trains per day, or 5.83 trains per hour moving through the city. As a result, if the STB has no oversight jurisdiction to impose mitigation conditions, the State of Washington and the local communities will bear the burden of responding to the adverse environmental impacts even though they will not share in the resulting economic gains that will flow only to the railroads and the coal mines.

Conclusion & Recommendations

The movement of 75 to 170 million tons per year would equate to the movements of 27.9 to 63.2 loaded and empty coal trains per day. These repetitive 1¼-mile long loaded and empty coal trains will be going through numerous populated cities, towns, communities, parks, forests and other environmentally sensitive areas - blocking traffic, causing vehicular and railroad traffic congestion, creating logistics problems, adversely impacting wildlife, polluting the air and ground, creating noise and resulting in numerous other problems.

BNSF will likely dominate this large and expanding PRB to PNW export coal market. BNSF's routes from the PRB to the PNW are significantly shorter than UP's routes and BNSF has a lower cost structure. As a result, BNSF can provide transportation rates which are significantly lower than UP and thus will likely capture the lion's share of the expanding and lucrative PRB to PNW export coal market. BNSF's shortest PRB to PNW railroad route covers a distance of 1,135 miles, however, the potentially impacted area is extremely broad covering a total rail distance of over 4,000 miles. These railroad routes traverse many environmentally sensitive areas, such as Glacier National Park in Montana, as well as many major populated areas, such as Spokane, Washington, Seattle, Washington, and Billings, Montana and Portland, Oregon.

Many of the impacted railroad line segments already have significant rail capacity and congestion issues associated with the current rail traffic, such as PNW import and export intermodal container traffic and grain railroad traffic. As a result of these capacity and congestion problems, there are many areas which will require major upgrading and expansion of existing railroad tracks. In some cases (such as Spokane and Billings) new rail by-passes may be required around populated areas. It is likely that hundreds of miles of railroad lines will require expansion from single to double or even triple track. Other railroad infrastructure, such as bridges, tunnels, high-way crossings, will also need to be replaced or upgraded in order to adequately, efficiently and safely handle the expected traffic levels.

There are many areas along the impacted railroad routes which would require significant mitigation in order to alleviate the adverse impacts associated with the significant increase in coal traffic. The required upgrading and expansion of railroad tracks and related infrastructure could well cost billions of dollars. State and local governments will likely bear the brunt and burden of these related local costs and will likely be required to spend hundreds of millions of dollars in related mitigation, litigation, debt and other costs associated with the necessary improvements to accommodate export coal traffic levels.

The STB is an economic regulatory agency that Congress charged with resolving railroad rate and service disputes and reviewing proposed railroad mergers. The STB has often been involved in cases which involved mitigation resulting from increased railroad traffic levels. In the previous STB cases involving the expansion of PRB coal movements, i.e., DM&E and TRRC, the STB considered the overall impacts associated with the proposed construction projects. Here, the size of the railroad track construction and expansion of the PNW export terminals may be smaller in comparison to the DM&E and TRRC PRB build-in proposals, but the overall impacts will be much broader and more adverse to the areas along the over 4,000 miles of impacted rail route.

Impacted and interested parties may want to consider seeking or promoting an STB full environmental review of the effects of exporting PRB coal via PNW ports or Federal legislation which would require STB approval for such increases in traffic levels or extensive infrastructure improvements.

APPENDIX 58

United Nations

FCCC/CP/2010/7/Add.2

Framework Convention on Climate Change

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Conference of the Parties

Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010

Addendum

Part Two: Action taken by the Conference of the Parties at its sixteenth session

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Decision 2/CP.16

Fourth review of the financial mechanism

The Conference of the Parties,

Recalling Article 4, paragraphs 3, 4, 5, 8, and 9, of the Convention,

Taking fully into account Article 11 of the Convention, in particular its paragraph 1,

Also recalling decisions 11/CP.1, 12/CP.2, 3/CP.4, 7/CP.7, 6/CP.13 and 3/CP.14,

Pursuant to Article 7, paragraph 2(h), of the Convention,

Noting that multilateral and bilateral agencies have scaled up financial resources related to the implementation of the Convention,

Also noting the annual report of the Global Environment Facility to the Conference of the Parties,

Taking note of the completion of the fifth replenishment of the Global Environment Facility that took place in Punta Del Este from 24 to 28 May 2010,

Further noting the report[1] on the Fourth Overall Performance Study of the Global Environment Facility,

1. *Takes note* of the findings of the Fourth Overall Performance Study, which was completed prior to the fifth replenishment, that:

(a) The Global Environment Facility support continues to be in line with guidance from the Conference of the Parties;

(b) Although developed country donors have provided new and additional funding for global environmental benefits to developing countries, this has been insufficient to cover the increasing agenda of the Global Environment Facility as agreed upon in the conventions;

(c) The Global Environment Facility support has been crucial in enabling countries to integrate climate change into their national development agendas;

(d) The Global Environment Facility support has assisted developing countries in introducing policies to address climate change and reduce and avoid greenhouse gas emissions;

(e) The Resource Allocation Framework has hindered the access of group countries to the Global Environment Facility, particularly in relation to climate change, which may explain some of the discontent of the climate change community with the Global Environment Facility;

(f) The Global Environment Facility reporting requirements to the conventions have generally been met, yet certain aspects require improvement;

(g) The move of the Global Environment Facility towards country-level programming has increased country ownership to some extent, but the current modalities for resource allocation require improvement;

[1] Global Environment Facility Evaluation Office. 2009. *Fourth Overall Performance Study of the GEF: Progress Toward Impact*. Full report.

(h) There is scope to further simplify and streamline the Global Environment Facility procedures, particularly the project identification phase, and improve timeliness throughout the project cycle;

(i) The Global Environment Facility needs a knowledge management strategy to improve learning and the sharing of best practices;

(j) The Global Environment Facility has played an important role in scaling up resources to address climate change;

2. *Welcomes* the successful negotiations of the fifth replenishment of the Global Environment Facility and notes that this is the largest increase in the climate change focal area since the Global Environment Facility was established, noting the increasing mitigation and adaptation needs of developing countries to be taken into account within the context of the Global Environment Facility;

3. *Decides* that the Global Environment Facility has provided and should continue to enhance its support to developing countries in:

(a) Meeting their commitments under the Convention;

(b) Strengthening national capacity-building;

(c) Applying and diffusing technologies, practices and processes for mitigation;

4. *Requests* the Global Environment Facility to continue improving its modalities to increase the responsiveness, effectiveness and efficiency of its support, including:

(a) Being responsive to new guidance from the Conference of the Parties;

(b) Including in its reporting to the Conference of the Parties a critical assessment of its experience with implementation of projects, as well as its experience with incorporating guidance from the Conference of the Parties into its strategies and programme priorities;

(c) Enhancing modalities which reinforce country ownership and improve the allocation of resources;

(d) Further simplifying and improving its procedures, particularly those for the identification, preparation and approval of activities;

(e) Ensuring that access to resources is expeditious and timely;

(f) Enabling country-level programming, where appropriate;

(g) Ensuring consistency and complementarity with other financing activities;

(h) Promoting private-sector financing and investment to address climate change activities;

(i) Strengthening its knowledge management approach to share best practices;

5. *Decides* that the Global Environment Facility should continue to provide and enhance support for the implementation of adaptation activities, including the implementation of national adaptation programmes of action, through the Least Developed Countries Fund and the Special Climate Change Fund;

6. *Requests* the Global Environment Facility, in its regular report to the Conference of the Parties, to include information on the steps it has taken to implement the guidance provided in paragraphs 3, 4 and 5 above;

7. *Invites* Parties to submit to the secretariat annually, no later than 10 weeks prior to the subsequent session of the Conference of the Parties, their views and recommendations

in writing on elements to be taken into account in developing guidance to the Global Environment Facility;

8. *Requests* the Subsidiary Body for Implementation to initiate the fifth review of the financial mechanism at its thirty-seventh session in accordance with the criteria contained in the guidelines annexed to decisions 3/CP.4 and 6/CP.13, or as these guidelines may be subsequently amended, and to report on the outcome to the Conference of the Parties at its nineteenth session.

9th plenary meeting
10–11 December 2010

Decision 3/CP.16

Additional guidance to the Global Environment Facility

The Conference of the Parties,

Noting the reports of the Global Environment Facility to the Conference of the Parties,[1]

Recalling decision 12/CP.2,

Further noting the reform of the Global Environment Facility designed to improve its modalities to increase the responsiveness, effectiveness and efficiency of the support given to all developing countries, including the System for Transparent Allocation of Resources,

1. *Calls on* the Global Environment Facility to complete its reforms as early as possible in order to facilitate the successful implementation of the fifth replenishment cycle of the Global Environment Facility;

2. *Requests* the Global Environment Facility in the implementation of these reforms to give full information to countries, in particular in relation to the implications of these reforms on the activities conducted by the Global Environment Facility;

3. *Urges* the Global Environment Facility, as an operating entity of the financial mechanism of the Convention, to increase access to funding for activities related to Article 6 of the Convention;

4. *Requests* the Global Environment Facility:

(a) To continue to provide funds for technical support for the preparation of national communications of Parties not included in Annex I to the Convention (non-Annex I Parties), similar to that provided by the National Communications Support Programme, recognizing that the costs of such technical support are not deducted from the funds provided to non-Annex I Parties for the preparation of their national communications;

(b) To ensure that the expedited process under the operational procedures continues to provide timely disbursement of funds to non-Annex I Parties for the preparation of their national communications;

(c) To work with its implementing agencies to further simplify its procedures and improve the effectiveness and efficiency of the process through which non-Annex I Parties receive funding to meet their obligations under Article 12, paragraph 1, of the Convention, with the aim of ensuring the timely disbursement of funds to meet the agreed full costs incurred by developing country Parties in complying with these obligations, and to avoid gaps between enabling activities of current and subsequent national communications, recognizing that the process of preparation of national communications is a continuous cycle;

(d) To finalize any remaining operational procedures to ensure the timely disbursement of funds for those Parties that decide to access resources for the preparation of their national communications through direct access;

[1] FCCC/CP/2009/9 and FCCC/CP/2010/5.

(e) To provide detailed information on funding for projects that have been identified in the national communications of non-Annex I Parties in accordance with Article 12, paragraph 4, of the Convention and subsequently submitted and approved.

9th plenary meeting
10–11 December 2010

Decision 4/CP.16

Assessment of the Special Climate Change Fund

The Conference of the Parties,

Recalling the relevant provisions of Articles 4 and 11 of the Convention,

Also recalling decisions 4/CP.7, 5/CP.7, 7/CP.7, 7/CP.8 and 5/CP.9,

Expressing its appreciation to Parties included in Annex II to the Convention that contributed to the Special Climate Change Fund to support the activities relating to adaptation and technology transfer,

Noting the information on the Special Climate Change Fund provided through the annual reports of the Global Environment Facility to the Conference of the Parties,

Decides to conclude the assessment of the status of implementation of paragraph 2 of decision 1/CP.12 and to request the entity entrusted with the operation of the Special Climate Change Fund to include in its report to the Conference of the Parties at its seventeenth session information on the implementation of paragraph 2 (a–d) of decision 7/CP.7.

9th plenary meeting
10–11 December 2010

Decision 5/CP.16

Further guidance for the operation of the Least Developed Countries Fund

The Conference of the Parties,

Recalling Article 4, paragraph 9, of the Convention,

Also recalling decisions 6/CP.9, 3/CP.11 and 5/CP.14,

Further recalling the least developed countries work programme, as defined in decision 5/CP.7,

Noting the importance of updating and revising the national adaptation programme of action process over time,

Further noting with appreciation the contributions of some Parties to the Least Developed Countries Fund,

Noting the positive efforts made by the Global Environment Facility and its agencies to facilitate access to funding under the Least Developed Countries Fund,

Also noting the increasing need of least developed country Parties to implement the urgent and immediate adaptation activities identified in their national adaptation programmes of action,

Reiterating the need to implement national adaptation programmes of action as soon as possible after completion,

1. *Reiterates* its request to the Global Environment Facility, as an operating entity of the financial mechanism of the Convention operating the Least Developed Countries Fund, in parallel to supporting the ongoing implementation of national adaptation programmes of action, to facilitate the implementation of the remaining elements of the least developed countries work programme;

2. *Also reiterates* its request to the Global Environment Facility to work with its agencies to improve communication with least developed country Parties and to speed up the process by, for instance, establishing a time frame within which least developed country Parties can access funding and other support for the preparation and implementation of projects identified in their national adaptation programmes of action;

3. *Requests* the Global Environment Facility to provide funding from the Least Developed Countries Fund to least developed country Parties, upon request, to enable the update of their national adaptation programmes of action with a view to further improving their quality, to facilitate the integration of least developed countries adaptation actions into development planning and to reflect increased adaptation knowledge and changed priorities in the countries;

4. *Invites* Parties included in Annex II to the Convention to continue contributing, and other Parties in a position to do so to contribute, to the Least Developed Countries Fund for the implementation of the least developed countries work programme;

5. *Also invites* Parties and relevant organizations to submit to the secretariat, by 1 August 2012, information on their experience with the implementation of the least developed countries work programme, including the updating and implementation of national adaptation programmes of action, and in accessing funds from the Least Developed

Countries Fund, for compilation by the secretariat into a miscellaneous document for consideration by the Subsidiary Body for Implementation at its thirty-seventh session;

6. *Requests* the secretariat to prepare a synthesis report on the progress made in the implementation of the least developed countries work programme, including the updating and implementation of national adaptation programmes of action, taking into account information from the Global Environment Facility and its agencies, the submissions referred to in paragraph 5 above, reports of the Least Developed Countries Expert Group and other relevant sources of information, for consideration by the Subsidiary Body for Implementation at its thirty-seventh session;

7. *Also requests* the Subsidiary Body for Implementation to review, at its thirty-seventh session, the experiences of the least developed countries with the implementation of the least developed countries work programme, including the updating and implementation of national adaptation programmes of action, and in accessing funds from the Least Developed Countries Fund, on the basis of the submissions referred to in paragraph 5 above and the synthesis report referred to in paragraph 6 above;

8. *Further requests* the Global Environment Facility to include, in its reports to the Conference of the Parties, information on specific steps it has taken to implement this decision, for consideration by the Conference of Parties at its subsequent sessions;

9. *Decides* to assess progress made in the implementation of this decision and to consider the adoption of further guidance, as appropriate, at its eighteenth session.

9th plenary meeting
10–11 December 2010

Decision 6/CP.16

Extension of the mandate of the Least Developed Countries Expert Group

The Conference of the Parties,

Recalling decisions 5/CP.7, 29/CP.7, 7/CP.9, 4/CP.10, 4/CP.11 and 8/CP.13,

Recognizing the specific needs and special situation of the least developed countries under Article 4, paragraph 9, of the Convention,

Having considered the reports on the seventeenth and eighteenth meetings of the Least Developed Countries Expert Group, the report on possible elements for a future mandate for the group and the report on the training workshops on the implementation of national adaptation programmes of action,[1]

Expressing its appreciation to the Least Developed Countries Expert Group for its good work in implementing its work programme for 2008–2010, supporting the preparation and implementation of national adaptation programmes of action and conducting regional training workshops on the implementation of national adaptation programmes of action,

Noting that the least developed country Parties continue to require technical support for the preparation, update and implementation of their national adaptation programmes of action,

1. *Decides* to extend the mandate of the Least Developed Countries Expert Group under its current terms of reference;[2]

2. *Also decides* that the Least Developed Countries Expert Group should be mandated to provide technical guidance and advice on:

(a) The revision and update of national adaptation programmes of action, to further improve their quality, to facilitate the integration of adaptation actions of least developed country Parties into development planning and to reflect increased adaptation knowledge and changed priorities in the countries, upon request by least developed country Parties;

(b) The identification of medium- and long-term adaptation needs, their integration into development planning and the implementation of identified adaptation activities;

(c) Strengthening gender-related considerations and considerations regarding vulnerable communities within least developed country Parties;

(d) The implementation of the elements of the least developed countries work programme other than the preparation and implementation of national adaptation programmes of action that are relevant to the expertise of the Least Developed Countries Expert Group;

3. *Requests* the Least Developed Countries Expert Group to develop a two-year rolling programme of work for consideration by the Subsidiary Body for Implementation at its first sessional meeting of each year, and to report on its work to the Subsidiary Body for Implementation at each of its sessions;

[1] FCCC/SBI/2010/5, FCCC/SBI/2010/26, FCCC/SBI/2010/12 and FCCC/SBI/2010/15.

[2] Decisions 29/CP.7, 7/CP.9, 4/CP.11 and 8/CP.13.

4. *Decides* that the membership of the Least Developed Countries Expert Group should be expanded from 12 to 13 members in order to include one additional member from a least developed country Party;

5. *Requests* the Least Developed Countries Expert Group to engage a wide range of organizations to support the implementation of its work programme;

6. *Decides* that, consistent with decision 7/CP.9, paragraph 2, new experts may be nominated to the Least Developed Countries Expert Group, or existing members of the group may continue in office, as determined by the respective regions or groups;

7. *Requests* the secretariat to continue to facilitate the work of the Least Developed Countries Expert Group;

8. *Decides* to review, at its twenty-first session, the progress, need for continuation and terms of reference of the Least Developed Countries Expert Group, and to adopt a decision thereon;

9. *Also decides* on the following actions and steps necessary for the Subsidiary Body for Implementation to initiate the review at its forty-second session, with a view to complete the review referred to in paragraph 8 above at its twenty-first session:

(a) To request the Least Developed Countries Expert Group to convene a meeting, including Parties, the Global Environment Facility and its agencies, and other relevant organizations, with the assistance of the secretariat, to take stock of its work, before June 2015;

(b) To invite Parties to submit to the secretariat, by 1 February 2015, their views on the work of the Least Developed Countries Expert Group, for compilation by the secretariat into a miscellaneous document for consideration by the Subsidiary Body for Implementation at its forty-second session;

(c) To request the secretariat to prepare a report on the stocktaking meeting for consideration by the Subsidiary Body for Implementation at its forty-second session, as input to the review;

(d) To request the secretariat to prepare a synthesis report on the progress, need for continuation and terms of reference of the Least Developed Countries Expert Group, based on the submissions from Parties, reports of the Least Developed Countries Expert Group, the report on the stocktaking meeting and other relevant information, for consideration by the Subsidiary Body for Implementation at its forty-second session, as input to the review.

9th plenary meeting
10–11 December 2010

Decision 7/CP.16

Progress in, and ways to enhance, the implementation of the amended New Delhi work programme on Article 6 of the Convention

The Conference of the Parties,

Recalling Article 6 of the Convention,

Also recalling decision 9/CP.13,

Reaffirming the importance of Article 6 of the Convention and the continued relevance of the amended New Delhi work programme on Article 6 of the Convention,

Acknowledging the progress made by Parties in planning, coordinating and implementing education, training and public awareness activities,

Recognizing that ensuring the availability of sufficient financial and technical resources continues to be a challenge for the adequate implementation of Article 6 of the Convention for all Parties, in particular developing countries,

Reaffirming that national, regional and subregional workshops are valuable forums for sharing experiences and lessons learned and for advancing the implementation of Article 6 of the Convention,

Welcoming the contributions of the Governments of Australia, Belgium, New Zealand, Norway, Spain, Sweden, Switzerland and the United States of America in support of the regional and subregional workshops organized by the secretariat in 2009 and 2010,[1]

Reaffirming that the information network clearing house CC:iNet is a useful tool for promoting the implementation of Article 6 of the Convention,

Having considered submissions from Parties and relevant intergovernmental and non-governmental organizations[2] and documents prepared by the secretariat to support the intermediate review of the amended New Delhi work programme,[3]

1. *Recognizes* that:

(a) Parties have continued to progress and gain experience in implementing Article 6 of the Convention, including through the wide range of educational and outreach activities that they have undertaken;

(b) Article 6 related activities have been a component of a significant number of projects developed by intergovernmental, non-governmental and community-based organizations, and private- and public-sector actors;

[1] The European regional workshop on Article 6 of the Convention, 18–20 May 2009, Stockholm, Sweden; the regional workshop on the implementation of Article 6 in Asia and the Pacific, 14–16 October 2009, Bali, Indonesia; the regional workshop on the implementation of Article 6 in Latin America and the Caribbean, 27–30 April 2010, Bavaro, the Dominican Republic; the regional workshop on the implementation of Article 6 in Africa, 13–16 September 2010, Banjul, the Gambia; and the regional workshop on the implementation of Article 6 in small island developing States, 2–4 November 2010, Mahé, Seychelles.

[2] FCCC/SBI/2010/MISC.7.

[3] FCCC/SBI/2010/2, FCCC/SBI/2010/3, FCCC/SBI/2010/19, FCCC/SBI/2010/22, FCCC/SBI/2010/23 and FCCC/SBI/2010/24.

(c) Notwithstanding the progress made with respect to the implementation of the amended New Delhi work programme on Article 6 of the Convention, many challenges remain;

2. *Invites* Parties, with a view to enhancing the implementation of the amended New Delhi work programme:

(a) To designate a national focal point on Article 6, if Parties have not already done so, and to inform the secretariat accordingly;

(b) To foster networking, coordination and exchange of information between relevant stakeholders at the national, regional and international levels;

(c) To enhance efforts to elaborate national strategies and action plans on Article 6 of the Convention, including climate change communication strategies, taking into account, inter alia, the gender perspective;

(d) To enhance the involvement of, and create training opportunities for, groups with a key role in climate change communication and education, including journalists, teachers, youth, children and community leaders;

(e) To foster the participation of women, youth, indigenous peoples, civil society groups and relevant stakeholders in decision-making on climate change at the national level and their attendance at intergovernmental meetings, including sessions of the Conference of the Parties, the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol and the subsidiary bodies;

(f) To improve reporting on education, training and public awareness activities through national communications;

(g) To improve public access to information on, and public awareness of, adaptation and mitigation;

(h) To support formal education in schools and institutions at all levels, non-formal and informal education on climate change and the development of educational and public awareness materials according to national circumstances and cultural context;

3. *Also invites* all Parties and international organizations to enhance support to the national focal points on Article 6 of developing countries, in particular the least developed countries and small island developing States, through the provision of information, materials, training of trainers programmes and regional and national projects on topics relating to education, training and public awareness;

4. *Further invites* Parties in a position to do so and international organizations and bilateral and multilateral agencies to continue to support the convening of regional, subregional and national workshops focusing on specific elements of Article 6 of the Convention, and the maintenance and further development of the information network clearing house CC:iNet;

5. *Urges* the Global Environment Facility, as an operating entity of the financial mechanism of the Convention, to increase access to funding for Article 6 related activities;

6. *Encourages* intergovernmental and non-governmental organizations to enhance their efforts to respond to the amended New Delhi work programme and to share information on their respective activities through the information network clearing house CC:iNet and other information sources;

7. *Requests* the secretariat:

(a) To initiate and facilitate networking and exchange of information and good practices between national focal points on Article 6, including through the information network clearing house CC:iNet;

(b) To continue collaborating with international organizations, convention secretariats and the private sector with a view to catalysing action on education, information exchange, training and public awareness;

(c) To continue, subject to the availability of financial resources, its work on maintaining, developing and promoting the information network clearing house CC:iNet, by improving its functionality and accessibility and increasing the content in the official languages of the United Nations;

8. *Also requests* the Subsidiary Body for Implementation to develop, at its thirty-fourth session, terms of reference for a review of the implementation of the amended New Delhi work programme, with a view to launching the review at its thirty-sixth session.

9th plenary meeting
10–11 December 2010

Decision 8/CP.16

Continuation of activities implemented jointly under the pilot phase

The Conference of the Parties,

Recalling decisions 5/CP.1, 10/CP.3, 13/CP.5, 8/CP.7, 14/CP.8, 10/CP.10, 6/CP.12, and 7/CP.14,

Having considered the conclusions of the Subsidiary Body for Scientific and Technological Advice at its thirty-third session,

Acknowledging that activities implemented jointly under the pilot phase have been providing an opportunity for learning-by-doing and that a number of Parties are maintaining programmes on activities implemented jointly under the pilot phase,

Noting that reports on activities implemented jointly under the pilot phase may be submitted at any time and are available on the UNFCCC website,

1. *Decides* to continue the pilot phase for activities implemented jointly;

2. *Also decides* that the deadline for the submission of reports on activities implemented jointly under the pilot phase to be considered in the eighth synthesis report on such activities shall be 1 June 2012.

9th plenary meeting
10–11 December 2010

Decision 9/CP.16

National communications from Parties included in Annex I to the Convention

The Conference of the Parties,

Recalling Article 4, paragraph 2(a) and (b), Article 12 and other relevant provisions of the Convention,

Also recalling decisions 2/CP.1, 3/CP.1, 6/CP.3, 11/CP.4, 4/CP.5, 26/CP.7, 33/CP.7, 4/CP.8, 1/CP.9, 7/CP.11 and 10/CP.13,

Emphasizing that the national communications and annual greenhouse gas inventories submitted by Parties included in Annex I to the Convention are the main source of information for reviewing the implementation of the Convention by these Parties, and that the reports of the in-depth reviews of these national communications provide important additional information for this purpose,

1. *Acknowledges* the considerable improvement in timeliness of the submission of national communications from Parties included in Annex I to the Convention (Annex I Parties), with 16 Annex I Parties submitting their fifth national communications before the due date of submission in accordance with decision 10/CP.13, although 23 Annex I Parties submitted after that date and two Annex I Parties have yet to submit their fifth national communications;

2. *Urges* Annex I Parties that have not yet submitted their national communications in accordance with decision 10/CP.13 to do so as a matter of priority;

3. *Requests* the secretariat to prepare the compilation and synthesis of fifth national communications for consideration by the Conference of the Parties at its seventeenth session;

4. *Concludes* that the review of national communications and the consideration of the outcomes of this review have proved useful and should continue in accordance with decisions 2/CP.1, 6/CP.3 and 11/CP.4;

5. *Requests* Annex I Parties to submit to the secretariat, by 1 January 2014, a sixth national communication, in accordance with Article 12, paragraphs 1 and 2, of the Convention, with a view to submitting a seventh national communication no later than four years after this date.

9th plenary meeting
10–11 December 2010

Decision 10/CP.16

Capacity-building under the Convention for developing countries

The Conference of the Parties,

Recalling decision 8/CP.15,

1. *Requests* the Subsidiary Body for Implementation to continue its consideration of the second comprehensive review of the implementation of the framework for capacity-building in developing countries at its thirty-fourth session on the basis of the draft text contained in the annex to this decision, with a view to preparing a draft decision on the outcome of this review for adoption by the Conference of Parties at its seventeenth session;

2. *Decides* to complete the consideration of the second comprehensive review at its seventeenth session.

Annex

[English only]

Draft decision -/CP.16

Capacity-building under the Convention for developing countries

[The Conference of the Parties,

Recalling decisions 2/CP.7, 2/CP.10, 4/CP.12, 6/CP.14 and 8/CP.15,

Acknowledging that capacity-building for developing countries is essential to enable them to participate fully in, and implement effectively their commitments under, the Convention,

Reaffirming that decision 2/CP.7 remains effective and should continue to guide the implementation of capacity-building activities in developing countries,

Noting that a range of the priority issues identified in the framework for capacity-building in developing countries is being supported by Parties included in Annex II of the Convention, the Global Environment Facility and other multilateral, bilateral and international agencies, [the private sector] and intergovernmental and non-governmental organizations,

[*Also noting* that gaps still remain and the availability of and access to financial and technical resources is still an issue to be addressed, in order to progress qualitatively and quantitatively on the capacity-building implementation,]

[*Acknowledging* that capacity-building is a country-driven and learning-by-doing process that responds to the specific needs and priorities of the countries concerned,

Having considered the information in documents prepared by the secretariat in support of the second comprehensive review of the implementation of the framework for capacity-building in developing countries and submissions by Parties on the issue,[1]]

1. *Decides* that the scope of needs and priority areas identified in the framework for capacity-building in developing countries, as contained in decision 2/CP.7, and the key factors identified in decision 2/CP.10 are still relevant;

2. *Further decides* that new capacity-building needs and priorities in developing countries emerging from the processes and initiatives launched after the completion of the first comprehensive review as well as from the negotiations under the Ad Hoc Working Group on Long-term Cooperative Action under the Convention will need to be taken into account in the further implementation of the framework for capacity-building in developing countries;

3. *Also decides* that further implementation of the framework for capacity-building in developing countries should be improved at the systemic, institutional and individual levels as appropriate, by:

(a) Ensuring consultations with stakeholders throughout the entire process of activities, from the design of activities to their implementation and monitoring and evaluation;

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[1] FCCC/SBI/2009/MISC.1, FCCC/SBI/2009/MISC.2, FCCC/SBI/2009/MISC.8, FCCC/SBI/2009/MISC.12/Rev.1, FCCC/SBI/2009/4, FCCC/SBI/2009/5 and FCCC/SBI/2009/10.

(b) Enhancing integration of climate change issues and capacity-building needs into national development strategies, plans and budgets;

(c) Increased country-driven coordination of capacity-building activities;

(d) Strengthened networking and information sharing among developing countries, especially through South-South and triangular cooperation;

(e) [Building on existing skills and capacities [, where available,] [, as appropriate,] related to development [and implementation of capacity-building activities] [and delivery of reporting, including national communications [and inventories]];

(e bis) Developing and/or strengthening skills and capacities related to the implementation of climate change related activities;]

(f) [Strengthening local, national and regional research institutions;]

[4. Decides to establish an expert group on capacity-building with the terms of reference contained in the annex to this decision;]

[5. *Further decides* that the next and subsequent comprehensive reviews of the framework for capacity-building in developing countries will be undertaken using simple[, practical and cost-effective] [and effective] performance indicators developed by the expert group referred to in paragraph 7 above;]

[6. *Requests* the secretariat to improve the process for regularly gathering and disseminating information on capacity-building activities in developing countries, recognizing the usefulness of information on capacity-building deriving from the compilation and synthesis of national communications, annual submissions by Parties and other documents relevant to this effort, in collaboration with the Global Environment Facility and its agencies and bilateral and multilateral agencies, as appropriate;]

7. *Invites* Parties to enhance reporting on best practices related to capacity-building in their national communications, submissions and other relevant documents, with a view to furthering learning and broadening the impact of capacity-building activities;

8. [*Requests*] [Reiterates the request to] the Global Environment Facility, as an operating entity of the financial mechanism, to [increase] [continue to provide financial] [its] support to capacity-building activities in developing countries in accordance with decisions 2/CP.7 and 4/CP.9;

9. *Urges* Parties included in Annex II to the Convention and other Parties that are in a position to do so, multilateral, bilateral and international agencies and the private sector to continue providing financial resources to support capacity-building action in developing countries;

10. *Invites* relevant United Nations agencies and intergovernmental organizations to continue providing support for capacity-building efforts in developing countries, emphasizing and stressing the need for full involvement of developing countries in the conception and development of such activities;

11. *Requests* the Subsidiary Body of Implementation, at its fortieth session, to initiate a third comprehensive review of the implementation of the framework for capacity-building in developing countries, with a view to completing the review at the twenty-first session of the Conference of the Parties.]

9th plenary meeting
10–11 December 2010

Decision 11/CP.16

Administrative, financial and institutional matters

The Conference of the Parties,

Recalling decision 12/CP.15, which approved the programme budget for the biennium 2010–2011 and requested the Executive Secretary to report to the Conference of the Parties at its sixteenth session on income and budget performance, and to propose any adjustments that might be needed in the programme budget for the biennium 2010–2011,

Also recalling paragraph 11 of the financial procedures of the Conference of the Parties,[1]

Having considered the information in the documents prepared by the secretariat on administrative, financial and institutional matters,[2]

I. Audited financial statements for the biennium 2008–2009

1. *Takes note* of the audited financial statements for the biennium 2008–2009, the audit report of the United Nations Board of Auditors, which includes recommendations, and the comments of the secretariat thereon;

2. *Expresses its appreciation* to the United Nations for arranging the audits of the accounts of the Convention and for the valuable observations and recommendations of the auditors;

3. *Urges* the Executive Secretary to implement the recommendations of the auditors, as appropriate;

II. Budget performance for the biennium 2010–2011

4. *Takes note* of the reporting on budget performance for the biennium 2010–2011 as at 30 June 2010 and of the updated status of contributions as at 15 November 2010 to the trust funds administered by the secretariat;

5. *Expresses its appreciation* to Parties that have paid their contributions to the core budget in a timely manner;

6. *Calls upon* Parties that have not paid their contributions to the core budget to do so without delay, bearing in mind that contributions are due on 1 January of each year in accordance with the financial procedures of the Conference of the Parties;

7. *Expresses its appreciation* for the contributions received from Parties to the Trust Fund for Participation in the UNFCCC Process and to the Trust Fund for Supplementary Activities, especially for the generous contributions for the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention;

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[1] Decision 15/CP.1, annex I.

[2] FCCC/SBI/2010/13, FCCC/SBI/2010/14 and Add.1 and 2, FCCC/SBI/2010/INF.5/Rev.1 and FCCC/SBI/2010/INF.9.

8. *Urges* Parties to further contribute to the Trust Fund for Participation in the UNFCCC Process to ensure the widest possible participation in the negotiations in 2011, and to the Trust Fund for Supplementary Activities;

9. *Reiterates its appreciation* to the Government of Germany for its annual voluntary contribution to the core budget of EUR 766,938 and its special contribution of EUR 1,789,522 as Host Government to the secretariat in Bonn;

III. Continuing review of the functions and operations of the secretariat

10. *Notes* the information relating to the functions and operations of the secretariat as contained in relevant documents, particularly that contained in document FCCC/SBI/2009/11;

11. *Agrees* that the Subsidiary Body for Implementation should consider this matter at its thirty-fifth session, in keeping with its decision taken at its twenty-first session to continue to consider this matter annually;[3]

IV. Programme budget for the biennium 2012–2013

12. *Requests* the Executive Secretary to submit, for consideration by the Subsidiary Body for Implementation at its thirty-fourth session, a proposed programme budget for the biennium 2012–2013;

13. *Also requests* the Executive Secretary, when preparing the programme budget for the biennium 2012–2013, to prepare a contingency for funding conference services, should this prove necessary in the light of decisions taken by the General Assembly at its sixty-sixth session;

14. *Requests* the Subsidiary Body for Implementation to recommend, at its thirty-fourth session, a programme budget for adoption by the Conference of the Parties at its seventeenth session and by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its seventh session;

15. *Also requests* the Subsidiary Body for Implementation to authorize the Executive Secretary to notify Parties of their indicative contributions for 2012 on the basis of the recommended budget.

9th plenary meeting
10–11 December 2010

[3] FCCC/SBI/2004/19, paragraph 105.

Decision 12/CP.16

Dates and venues of future sessions

The Conference of the Parties,

Recalling Article 7, paragraph 4, of the Convention,

Also recalling decision 9/CP.14,

Further recalling United Nations General Assembly resolution 40/243 of 18 December 1985 on the pattern of conferences,

Recalling rule 22, paragraph 1, of the draft rules of procedure being applied, regarding the rotation of the office of President among the five regional groups,

Noting that in keeping with the principle of rotation among regional groups, and in the light of recent consultations among the groups, the President of the seventeenth session of the Conference of the Parties would come from the African Group, the President of the eighteenth session would come from the Asian Group and the President of the nineteenth session would come from the Eastern European Group,

A. Date and venue of the seventeenth session of the Conference of the Parties and the seventh session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol

1. *Recalls* that the seventeenth session of the Conference of the Parties and the seventh session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol shall be held in Durban, South Africa, from 28 November to 9 December 2011;

2. *Reiterates* its request to the Executive Secretary to continue consultations with the Government of South Africa and to negotiate a Host Country Agreement for convening the sessions, with a view to concluding and signing the Host Country Agreement not later than the thirty-fourth sessions of the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation;

B. Date and venue of the eighteenth session of the Conference of the Parties and the eighth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol

3. *Takes note* of the offers of the Governments of Qatar and the Republic of Korea to host the eighteenth session of the Conference of the Parties and the eighth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol;

4. *Invites* Parties to consult further on the host of the eighteenth session of the Conference of the Parties and the eighth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, with a view to concluding these consultations not later than the thirty-fourth session of the Subsidiary Body for Implementation;

5. *Requests* the Subsidiary Body for Implementation, at its thirty-fourth session, to consider the issue of the host of the eighteenth session of the Conference of the Parties and the eighth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, taking into account the offers and consultations referred to in paragraphs 3 and 4 above, and to recommend a draft decision on this matter for adoption by the Conference of the Parties at its seventeenth session;

C. Date and venue of the nineteenth session of the Conference of the Parties and the ninth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol

6. *Invites* Parties to come forward with offers to host the nineteenth session of the Conference of the Parties and the ninth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

9th plenary meeting
10–11 December 2010

Resolution 1/CP.16

Expression of gratitude to the Government of the United Mexican States, the State of Quintana Roo and the people of the city of Cancun

The Conference of the Parties and the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol,

Having met in Cancun from 29 November to 10 December 2010 at the invitation of the Government of the United Mexican States,

1. *Express their profound gratitude* to the Government of the United Mexican States for having made it possible for the sixteenth session of the Conference of the Parties and the sixth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol to be held in Cancun;

2. *Request* the Government of the United Mexican States to convey to the State of Quintana Roo and the people of Cancun the gratitude of the Conference of the Parties and the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol for the hospitality and warmth extended to the participants.

9th plenary meeting
10–11 December 2010

APPENDIX 59

International Energy Agency

WORLD ENERGY OUTLOOK 2012

EXECUTIVE SUMMARY

WORLD **ENERGY** OUTLOOK 2012

Industry and government decision makers and others with a stake in the energy sector all need *WEO-2012*. It presents authoritative projections of energy trends through to 2035 and insights into what they mean for energy security, environmental sustainability and economic development.

Oil, coal, natural gas, renewables and nuclear power are all covered, together with an update on climate change issues. Global energy demand, production, trade, investment and carbon-dioxide emissions are broken down by region or country, by fuel and by sector.

Special strategic analyses cover:

- What **unlocking the purely economic potential for energy efficiency** could do, country-by-country and sector-by-sector, for energy markets, the economy and the environment.
- The **Iraqi energy sector**, examining both its importance in satisfying the country's own needs and its crucial role in meeting global oil and gas demand.
- The **water-energy nexus**, as water resources become increasingly stressed and access more contentious.
- Measures of progress towards providing **universal access to modern energy services**.

There are many uncertainties; but many decisions cannot wait. The insights of *WEO-2012* are invaluable to those who must shape our energy future.

www.worldenergyoutlook.org

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea (Republic of)
Luxembourg
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA.

International Energy Agency

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9 rue de la Fédération
75739 Paris Cedex 15, France

www.iea.org

A new global energy landscape is emerging

The global energy map is changing, with potentially far-reaching consequences for energy markets and trade. It is being redrawn by the resurgence in oil and gas production in the United States and could be further reshaped by a retreat from nuclear power in some countries, continued rapid growth in the use of wind and solar technologies and by the global spread of unconventional gas production. Perspectives for international oil markets hinge on Iraq's success in revitalising its oil sector. If new policy initiatives are broadened and implemented in a concerted effort to improve global energy efficiency, this could likewise be a game-changer. On the basis of global scenarios and multiple case studies, this *World Energy Outlook* assesses how these new developments might affect global energy and climate trends over the coming decades. It examines their impact on the critical challenges facing the energy system: to meet the world's ever-growing energy needs, led by rising incomes and populations in emerging economies; to provide energy access to the world's poorest; and to bring the world towards meeting its climate change objectives.

Taking all new developments and policies into account, the world is still failing to put the global energy system onto a more sustainable path. Global energy demand grows by more than one-third over the period to 2035 in the New Policies Scenario (our central scenario), with China, India and the Middle East accounting for 60% of the increase. Energy demand barely rises in OECD countries, although there is a pronounced shift away from oil, coal (and, in some countries, nuclear) towards natural gas and renewables. Despite the growth in low-carbon sources of energy, fossil fuels remain dominant in the global energy mix, supported by subsidies that amounted to $523 billion in 2011, up almost 30% on 2010 and six times more than subsidies to renewables. The cost of fossil-fuel subsidies has been driven up by higher oil prices; they remain most prevalent in the Middle East and North Africa, where momentum towards their reform appears to have been lost. Emissions in the New Policies Scenario correspond to a long-term average global temperature increase of 3.6 °C.

The tide turns for US energy flows

Energy developments in the United States are profound and their effect will be felt well beyond North America – and the energy sector. The recent rebound in US oil and gas production, driven by upstream technologies that are unlocking light tight oil and shale gas resources, is spurring economic activity – with less expensive gas and electricity prices giving industry a competitive edge – and steadily changing the role of North America in global energy trade. By around 2020, the United States is projected to become the largest global oil producer (overtaking Saudi Arabia until the mid-2020s) and starts to see the impact of new fuel-efficiency measures in transport. The result is a continued fall in US oil imports, to the extent that North America becomes a net oil exporter around 2030. This accelerates the switch in direction of international oil trade towards Asia, putting a focus on the security of the strategic routes that bring Middle East oil to Asian markets. The

United States, which currently imports around 20% of its total energy needs, becomes all but self-sufficient in net terms – a dramatic reversal of the trend seen in most other energy-importing countries.

But there is no immunity from global markets

No country is an energy "island" and the interactions between different fuels, markets and prices are intensifying. Most oil consumers are used to the effects of worldwide fluctuations in price (reducing its oil imports will not insulate the United States from developments in international markets), but consumers can expect to see growing linkages in other areas. A current example is how low-priced natural gas is reducing coal use in the United States, freeing up coal for export to Europe (where, in turn, it has displaced higher-priced gas). At its lowest level in 2012, natural gas in the United States traded at around one-fifth of import prices in Europe and one-eighth of those in Japan. Going forward, price relationships between regional gas markets are set to strengthen as liquefied natural gas trade becomes more flexible and contract terms evolve, meaning that changes in one part of the world are more quickly felt elsewhere. Within individual countries and regions, competitive power markets are creating stronger links between gas and coal markets, while these markets also need to adapt to the increasing role of renewables and, in some cases, to the reduced role of nuclear power. Policy makers looking for simultaneous progress towards energy security, economic and environmental objectives are facing increasingly complex – and sometimes contradictory – choices.

A blueprint for an energy-efficient world

Energy efficiency is widely recognised as a key option in the hands of policy makers but current efforts fall well short of tapping its full economic potential. In the last year, major energy-consuming countries have announced new measures: China is targeting a 16% reduction in energy intensity by 2015; the United States has adopted new fuel-economy standards; the European Union has committed to a cut of 20% in its 2020 energy demand; and Japan aims to cut 10% from electricity consumption by 2030. In the New Policies Scenario, these help to speed up the disappointingly slow progress in global energy efficiency seen over the last decade. But even with these and other new policies in place, a significant share of the potential to improve energy efficiency – four-fifths of the potential in the buildings sector and more than half in industry – still remains untapped.

Our Efficient World Scenario shows how tackling the barriers to energy efficiency investment can unleash this potential and realise huge gains for energy security, economic growth and the environment. These gains are not based on achieving any major or unexpected technological breakthroughs, but just on taking actions to remove the barriers obstructing the implementation of energy efficiency measures that are economically viable. Successful action to this effect would have a major impact on global energy and climate trends, compared with the New Policies Scenario. The growth in global primary energy demand to 2035 would be halved. Oil demand would peak just before 2020 and would be almost 13 mb/d lower by 2035, a reduction equal to the current production of Russia and

Norway combined, easing the pressure for new discoveries and development. Additional investment of $11.8 trillion (in year-2011 dollars) in more energy-efficient technologies would be more than offset by reduced fuel expenditures. The accrued resources would facilitate a gradual reorientation of the global economy, boosting cumulative economic output to 2035 by $18 trillion, with the biggest gross domestic product (GDP) gains in India, China, the United States and Europe. Universal access to modern energy would be easier to achieve and air quality improved, as emissions of local pollutants fall sharply. Energy-related carbon-dioxide (CO_2) emissions would peak before 2020, with a decline thereafter consistent with a long-term temperature increase of 3 °C.

We propose policy principles that can turn the Efficient World Scenario into reality. Although the specific steps will vary by country and by sector, there are six broad areas that need to be addressed. Energy efficiency needs to be made clearly visible, by strengthening the measurement and disclosure of its economic gains. The profile of energy efficiency needs to be raised, so that efficiency concerns are integrated into decision making throughout government, industry and society. Policy makers need to improve the affordability of energy efficiency, by creating and supporting business models, financing vehicles and incentives to ensure that investors reap an appropriate share of the rewards. By deploying a mix of regulations to discourage the least-efficient approaches and incentives to deploy the most efficient, governments can help push energy-efficient technologies into the mainstream. Monitoring, verification and enforcement activities are essential to realise expected energy savings. These steps would need to be underpinned by greater investment in energy efficiency governance and administrative capacity at all levels.

Energy efficiency can keep the door to 2 °C open for just a bit longer

Successive editions of this report have shown that the climate goal of limiting warming to 2 °C is becoming more difficult and more costly with each year that passes. Our 450 Scenario examines the actions necessary to achieve this goal and finds that almost four-fifths of the CO_2 emissions allowable by 2035 are already locked-in by existing power plants, factories, buildings, etc. If action to reduce CO_2 emissions is not taken before 2017, all the allowable CO_2 emissions would be locked-in by energy infrastructure existing at that time. Rapid deployment of energy-efficient technologies – as in our Efficient World Scenario – would postpone this complete lock-in to 2022, buying time to secure a much-needed global agreement to cut greenhouse-gas emissions.

No more than one-third of proven reserves of fossil fuels can be consumed prior to 2050 if the world is to achieve the 2 °C goal, unless carbon capture and storage (CCS) technology is widely deployed. This finding is based on our assessment of global “carbon reserves”, measured as the potential CO_2 emissions from proven fossil-fuel reserves. Almost two-thirds of these carbon reserves are related to coal, 22% to oil and 15% to gas. Geographically, two-thirds are held by North America, the Middle East, China and Russia. These findings underline the importance of CCS as a key option to mitigate CO_2 emissions, but its pace of deployment remains highly uncertain, with only a handful of commercial-scale projects currently in operation.

Trucks deliver a large share of oil demand growth

Growth in oil consumption in emerging economies, particularly for transport in China, India and the Middle East, more than outweighs reduced demand in the OECD, pushing oil use steadily higher in the New Policies Scenario. Oil demand reaches 99.7 mb/d in 2035, up from 87.4 mb/d in 2011, and the average IEA crude oil import price rises to $125/barrel (in year-2011 dollars) in 2035 (over $215/barrel in nominal terms). The transport sector already accounts for over half of global oil consumption, and this share increases as the number of passenger cars doubles to 1.7 billion and demand for road freight rises quickly. The latter is responsible for almost 40% of the increase in global oil demand: oil use for trucks – predominantly diesel – increases much faster than that for passenger vehicles, in part because fuel-economy standards for trucks are much less widely adopted.

Non-OPEC oil output steps up over the current decade, but supply after 2020 depends increasingly on OPEC. A surge in unconventional supplies, mainly from light tight oil in the United States and oil sands in Canada, natural gas liquids, and a jump in deepwater production in Brazil, push non-OPEC production up after 2015 to a plateau above 53 mb/d, from under 49 mb/d in 2011. This is maintained until the mid-2020s, before falling back to 50 mb/d in 2035. Output from OPEC countries rises, particularly after 2020, bringing the OPEC share in global production from its current 42% up towards 50% by 2035. The net increase in global oil production is driven entirely by unconventional oil, including a contribution from light tight oil that exceeds 4 mb/d for much of the 2020s, and by natural gas liquids. Of the $15 trillion in upstream oil and gas investment that is required over the period to 2035, almost 30% is in North America.

Much is riding on Iraq's success

Iraq makes the largest contribution by far to global oil supply growth. Iraq's ambition to expand output after decades of conflict and instability is not limited by the size of its resources or by the costs of producing them, but will require co-ordinated progress all along the energy supply chain, clarity on how Iraq plans to derive long-term value from its hydrocarbon wealth and successful consolidation of a domestic consensus on oil policy. In our projections, oil output in Iraq exceeds 6 mb/d in 2020 and rises to more than 8 mb/d in 2035. Iraq becomes a key supplier to fast-growing Asian markets, mainly China, and the second-largest global exporter by the 2030s, overtaking Russia. Without this supply growth from Iraq, oil markets would be set for difficult times, characterised by prices that are almost $15/barrel higher than the level in the New Policies Scenario by 2035.

Iraq stands to gain almost $5 trillion in revenue from oil exports over the period to 2035, an annual average of $200 billion, and an opportunity to transform the country's prospects. The energy sector competes with a host of other spending needs in Iraq, but one urgent priority is to catch up and keep pace with rising electricity demand: if planned new capacity is delivered on time, grid-based electricity generation will be sufficient to meet peak demand by around 2015. Gathering and processing associated gas – much of which is currently flared – and developing non-associated gas offers the promise of a more efficient gas-fuelled power sector and, once domestic demand is satisfied, of gas exports. Translating oil export receipts into greater prosperity will require strengthened institutions, both to ensure efficient, transparent management of revenues and spending, and to set the course necessary to encourage more diverse economic activity.

Different shades of gold for natural gas

Natural gas is the only fossil fuel for which global demand grows in all scenarios, showing that it fares well under different policy conditions; but the outlook varies by region. Demand growth in China, India and the Middle East is strong: active policy support and regulatory reforms push China's consumption up from around 130 billion cubic metres (bcm) in 2011 to 545 bcm in 2035. In the United States, low prices and abundant supply see gas overtake oil around 2030 to become the largest fuel in the energy mix. Europe takes almost a decade to get back to 2010 levels of gas demand: the growth in Japan is similarly limited by higher gas prices and a policy emphasis on renewables and energy efficiency.

Unconventional gas accounts for nearly half of the increase in global gas production to 2035, with most of the increase coming from China, the United States and Australia. But the unconventional gas business is still in its formative years, with uncertainty in many countries about the extent and quality of the resource base. As analysed in a *World Energy Outlook Special Report* released in May 2012, there are also concerns about the environmental impact of producing unconventional gas that, if not properly addressed, could halt the unconventional gas revolution in its tracks. Public confidence can be underpinned by robust regulatory frameworks and exemplary industry performance. By bolstering and diversifying sources of supply, tempering demand for imports (as in China) and fostering the emergence of new exporting countries (as in the United States), unconventional gas can accelerate movement towards more diversified trade flows, putting pressure on conventional gas suppliers and on traditional oil-linked pricing mechanisms for gas.

Will coal remain a fuel of choice?

Coal has met nearly half of the rise in global energy demand over the last decade, growing faster even than total renewables. Whether coal demand carries on rising strongly or changes course will depend on the strength of policy measures that favour lower-emissions energy sources, the deployment of more efficient coal-burning technologies and, especially important in the longer term, CCS. The policy decisions carrying the most weight for the global coal balance will be taken in Beijing and New Delhi – China and India account for almost three-quarters of projected non-OECD coal demand growth (OECD coal use declines). China's demand peaks around 2020 and is then steady to 2035; coal use in India continues to rise and, by 2025, it overtakes the United States as the world's second-largest user of coal. Coal trade continues to grow to 2020, at which point India becomes the largest net importer of coal, but then levels off as China's imports decline. The sensitivity of these trajectories to changes in policy, the development of alternative fuels (*e.g.* unconventional gas in China) and the timely availability of infrastructure, create much uncertainty for international steam coal markets and prices.

If nuclear falls back, what takes its place?

The world's demand for electricity grows almost twice as fast as its total energy consumption, and the challenge to meet this demand is heightened by the investment needed to replace ageing power sector infrastructure. Of the new generation capacity that is built to 2035, around one-third is needed to replace plants that are retired. Half of all new capacity is based on renewable sources of energy, although coal remains the leading global fuel for power generation. The growth in China's electricity demand over the period to 2035 is greater than total current electricity demand in the United States and Japan. China's coal-fired output increases almost as much as its generation from nuclear, wind and hydropower combined. Average global electricity prices increase by 15% to 2035 in real terms, driven higher by increased fuel input costs, a shift to more capital-intensive generating capacity, subsidies to renewables and CO_2 pricing in some countries. There are significant regional price variations, with the highest prices persisting in the European Union and Japan, well above those in the United States and China.

The anticipated role of nuclear power has been scaled back as countries have reviewed policies in the wake of the 2011 accident at the Fukushima Daiichi nuclear power station. Japan and France have recently joined the countries with intentions to reduce their use of nuclear power, while its competitiveness in the United States and Canada is being challenged by relatively cheap natural gas. Our projections for growth in installed nuclear capacity are lower than in last year's *Outlook* and, while nuclear output still grows in absolute terms (driven by expanded generation in China, Korea, India and Russia), its share in the global electricity mix falls slightly over time. Shifting away from nuclear power can have significant implications for a country's spending on imports of fossil fuels, for electricity prices and for the level of effort needed to meet climate targets.

Renewables take their place in the sun

A steady increase in hydropower and the rapid expansion of wind and solar power has cemented the position of renewables as an indispensable part of the global energy mix; by 2035, renewables account for almost one-third of total electricity output. Solar grows more rapidly than any other renewable technology. Renewables become the world's second-largest source of power generation by 2015 (roughly half that of coal) and, by 2035, they approach coal as the primary source of global electricity. Consumption of biomass (for power generation) and biofuels grows four-fold, with increasing volumes being traded internationally. Global bioenergy resources are more than sufficient to meet our projected biofuels and biomass supply without competing with food production, although the land-use implications have to be managed carefully. The rapid increase in renewable energy is underpinned by falling technology costs, rising fossil-fuel prices and carbon pricing, but mainly by continued subsidies: from $88 billion globally in 2011, they rise to nearly $240 billion in 2035. Subsidy measures to support new renewable energy projects need to be adjusted over time as capacity increases and as the costs of renewable technologies fall, to avoid excessive burdens on governments and consumers.

A continuing focus on the goal of universal energy access

Despite progress in the past year, nearly 1.3 billion people remain without access to electricity and 2.6 billion do not have access to clean cooking facilities. Ten countries – four in developing Asia and six in sub-Saharan Africa – account for two-thirds of those people without electricity and just three countries – India, China and Bangladesh – account for more than half of those without clean cooking facilities. While the Rio+20 Summit did not result in a binding commitment towards universal modern energy access by 2030, the UN Year of Sustainable Energy for All has generated welcome new commitments towards this goal. But much more is required. In the absence of further action, we project that nearly one billion people will be without electricity and 2.6 billion people will still be without clean cooking facilities in 2030. We estimate that nearly $1 trillion in cumulative investment is needed to achieve universal energy access by 2030.

We present an Energy Development Index (EDI) for 80 countries, to aid policy makers in tracking progress towards providing modern energy access. The EDI is a composite index that measures a country's energy development at the household and community level. It reveals a broad improvement in recent years, with China, Thailand, El Salvador, Argentina, Uruguay, Vietnam and Algeria showing the greatest progress. There are also a number of countries whose EDI scores remain low, such as Ethiopia, Liberia, Rwanda, Guinea, Uganda and Burkina Faso. The sub-Saharan Africa region scores least well, dominating the lower half of the rankings.

Energy is becoming a thirstier resource

Water needs for energy production are set to grow at twice the rate of energy demand. Water is essential to energy production: in power generation; in the extraction, transport and processing of oil, gas and coal; and, increasingly, in irrigation for crops used to produce biofuels. We estimate that water withdrawals for energy production in 2010 were 583 billion cubic metres (bcm). Of that, water consumption – the volume withdrawn but not returned to its source – was 66 bcm. The projected rise in water consumption of 85% over the period to 2035 reflects a move towards more water-intensive power generation and expanding output of biofuels.

Water is growing in importance as a criterion for assessing the viability of energy projects, as population and economic growth intensify competition for water resources. In some regions, water constraints are already affecting the reliability of existing operations and they will increasingly impose additional costs. In some cases, they could threaten the viability of projects. The vulnerability of the energy sector to water constraints is widely spread geographically, affecting, among others, shale gas development and power generation in parts of China and the United States, the operation of India's highly water-intensive fleet of power plants, Canadian oil sands production and the maintenance of oil-field pressures in Iraq. Managing the energy sector's water vulnerabilities will require deployment of better technology and greater integration of energy and water policies.

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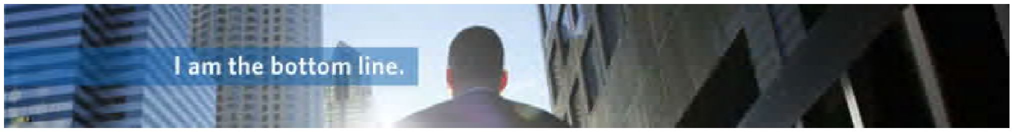
PEFC/10-31-1510

APPENDIX 60

MARKET SNAPSHOT

U.S. | EUROPE | ASIA

DJIA	14,517.90	+5.83	0.04%
S&P 500	1,564.10	+7.21	0.46%
NASDAQ	3,252.08	+7.08	0.22%




Falcone Follows Michael Jackson Path Taking Loan
Q


Shilling: Growth Could End Fed's War on Deflation
Q


BlackBerry's Disappointing Z10 Launch
Q

Obama Will Use Nixon-Era Law to Fight Climate Change

By Mark Drajem - Mar 15, 2013 11:50 AM ET

1019 COMMENTS Q QUEUE

Daniel Acker/Bloomberg

Similar analyses could be made for the oil sands that would be transported in TransCanada Corp.'s Keystone XL pipeline, and leases to drill for oil, gas and coal on federal lands, such as those for Arch Coal Inc. and Peabody Energy Corp.

President Barack Obama is preparing to tell all federal agencies for the first time that they should consider the impact on global warming before approving major projects, from pipelines to highways.

The result could be significant delays for natural gas- export facilities, ports for coal sales to Asia, and even new forest roads, industry lobbyists warn.

"It's got us very freaked out," said Ross Eisenberg, vice president of the National Association of Manufacturers, a Washington-based group that represents 11,000 companies such as Exxon Mobil Corp. (XOM) and Southern Co. (SO) The standards, which constitute guidance for agencies and not new regulations, are set to be issued in the coming weeks, according to lawyers briefed by administration officials.

In taking the step, Obama would be fulfilling a vow to act alone in the face of a Republican-run House of Representatives unwilling to pass measures limiting greenhouse gases. He'd expand the scope of a Nixon-era law that was first intended to force agencies to assess the effect of projects on air, water and soil pollution.

"If Congress won't act soon to protect future generations, I will," Obama said last month during his State of the Union address. He pledged executive actions "to reduce pollution, prepare our communities for the consequences of climate change, and speed the transition to more sustainable sources of energy."

Illinois Speech

The president is scheduled to deliver a speech on energy today at the Argonne National Laboratory in Lemont, Illinois. He is pressing Congress to create a $2 billion clean-energy research fund with fees paid by oil and gas producers.

While some U.S. agencies already take climate change into account when assessing projects, the new guidelines would apply across-the-board to all federal reviews. Industry lobbyists say they worry that projects could be tied up in lawsuits or administrative delays.

For example, Ambre Energy Ltd. is seeking a permit from the Army Corps of Engineers to build a coal-export facility at the Port of Morrow in Oregon. Under existing rules, officials weighing approval would consider whether ships in the port would foul the water or generate air pollution locally. The Environmental Protection Agency and activist groups say that review should be broadened to account for the greenhouse gases emitted when exported coal is burned in power plants in Asia.

Keystone Pipeline

Similar analyses could be made for the oil sands that would be transported in TransCanada Corp. (TRP)'s Keystone XL pipeline, and leases to drill for oil, gas and coal on federal lands, such as those for Arch Coal Inc. (ACI) and Peabody Energy Corp. (BTU)

If the new White House guidance is structured correctly, it will require just those kinds of lifecycle reviews, said Bill Snape, senior counsel at the Center for Biological Diversity in Washington. The environmental group has sued to press for this approach, and Snape says lawsuits along this line are certain if the administration approves the Keystone pipeline, which would transport oil from Canada's tar sands to the U.S. Gulf Coast.

"The real danger is the delays," said Eisenberg of the manufacturers' group. "I don't think the answer is ever going to be 'no,' but it can confound things."

Lawyers and lobbyists are now waiting for the White House's Council on Environmental Quality to issue the long bottled-up standards for how agencies should address climate change under the National Environmental Policy Act, signed into law by President Richard Nixon in 1970.

Environmental Impact

NEPA requires federal agencies to consider and publish the environmental impact of their actions before making decisions. Those reviews don't mandate a specific course of action. They do provide a chance for citizens and environmentalists to weigh in before regulators decide on an action -- and to challenge those reviews in court if it's cleared.

"Each agency currently differs in how their NEPA reviews consider the climate change impacts of projects, as well as how climate change impacts such as extreme weather will affect projects," Taryn Tuss, a Council on Environmental Quality spokeswoman, said in an e-mail. "CEQ is working to incorporate the public input we received on the draft guidance, and will release updated guidance when it is completed."

'Major Shakeup'

The new standards will be "a major shakeup in how agencies conduct NEPA" reviews, said Brendan Cummings, senior counsel for the Center for Biological Diversity in San Francisco.

The White House is looking at requiring consideration of both the increase in greenhouse gases and a project's vulnerability to flooding, drought or other extreme weather that might result from global warming, according to an initial proposal it issued in 2010. Those full reports would be required for projects with 25,000 metric tons of carbon dioxide equivalent emissions or more per year, the equivalent of burning about 100 rail cars of coal.

The initial draft exempted federal land and resource decisions from the guidance, although CEQ said it was assessing how to handle those cases. Federal lands could be included in the final standards.

The White House guidance itself won't force any projects to be stopped outright. Instead, it's likely to prompt lawsuits against federal projects on these grounds, and increase the probability that courts will step in and order extensive reviews as part of the "adequate analysis" required in the law, said George Mannina, an attorney at Nossaman LLP in Washington.

Next Administration

"The question is: Where does this analysis take us?" he said. "Adequate analysis may be much broader than the agency and applicant might consider."

While the Obama administration's guidance could be easily rescinded by the next administration, the court rulings that stem from these cases will live on as precedents, Mannina said.

Lobbying groups such as the U.S. Chamber of Commerce, American Petroleum Institute and the National Mining Association weighed in with the White House against including climate in NEPA, a law initially aimed at chemical leaks or air pollution.

"Not only will this result in additional delay of the NEPA process, but will result in speculative and inaccurate modeling that will have direct impacts on approval of specific projects," the National Mining Association in Washington wrote in comments to the White House in 2010.

Leases Challenged

The group represents Arch Coal (ACI) and Peabody, both based in St. Louis. Leases that the Department of Interior issued for those companies to mine for coal in Wyoming are facing lawsuits from environmental groups, arguing that the agency didn't adequately tally up the effect on global warming from burning that coal.

Given Obama's pledge to address global warming, "this is a massive contradiction," said Jeremy Nichols, director of climate at WildEarth Guardians in Denver, which filed lawsuits against the leases.

Arch Coal referred questions to the mining group.

Beth Sutton, a Peabody spokeswoman, said in an e-mail, "We believe the current regulatory approach to surface mine permits is appropriate and protects the environment."

Since CEQ first announced its proposal, more than three dozen federal approvals were challenged on climate grounds, including a highway project in North Carolina, a methane-venting plan for a coal mine in Colorado, and a research facility in California, according to a chart compiled by the Center for Climate Change Law at Columbia University.

Next Target

The next target is TransCanada (TRP)'s application to build the 1,661-mile (2,673-kilometer) Keystone pipeline. The Sierra Club and 350.org drew 35,000 people to Washington last month to urge Obama to reject the pipeline. Meanwhile, the NEPA review by the State Department included an initial analysis of carbon released when the tar sands are refined into gasoline and used in vehicles.

It stopped short, however, of saying the project would result in an increase in greenhouse gas emissions. With or without the pipeline, the oil sands will be mined and used as fuel, the report said. That finding is likely to be disputed in court if the Obama administration clears the project.

"Keystone is ground zero," said Snape, of the Center for Biological Diversity. "Clearly this will come into play, and it will be litigated."

Any actions by the administration now on global warming would pick up on a mixed record over the past four years.

Cap-and-Trade

While Obama failed to get Congress to pass cap-and-trade legislation, the EPA reversed course from the previous administration and ruled that carbon-dioxide emissions endanger public health, opening the way for the agency to regulate it.

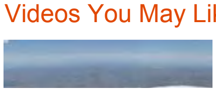
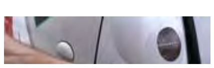
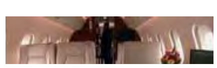
Using that finding, the agency raised mileage standards for automobiles and proposed rules for new power plants that would essentially outlaw the construction of new coal-fired power plants that don't have expensive carbon-capture technology.

Environmentalists such as the Natural Resources Defense Council say the most important action next will be the EPA's rules for existing power plants, the single biggest source of carbon-dioxide emissions. The NEPA standards are separate from those rules, and will affect how the federal government itself is furthering global warming.

"Agencies do a pretty poor job of looking at climate change impacts," Rebecca Judd, a legislative counsel at the environmental legal group Earthjustice in Washington. "A thorough guidance would help alleviate that."

To contact the reporter on this story: Mark Drajem in Washington at mdrajem@bloomberg.net

To contact the editor responsible for this story: Jon Morgan at jmorgan97@bloomberg.net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"Climate Change" Dictionary quoter: A science cynic who chooses to remain uneducated about science itself and the reality of how the industrial age has altered the atmospheric composition to the extent that it affects climate on a global scale.

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The Merriam-Webster "Climate Change" Dictionary:

PEER REVIEW: The act of banding together a group of like-minded academics with a funding conflict of interest, for the purpose of squeezing out any research voices that threaten the multi-million dollar government grant gravy train.

SETTLED SCIENCE: Betrayal of the scientific method for politics or money or both.

DENIER: Anyone who suspects the truth.

CLIMATE CHANGE: What has been happening for billions of years, but should now be flogged to produce ‘panic for profit.’

NOBEL PEACE PRIZE: Leftist Nutcase Prize, unrelated to “Peace” in any meaningful way.

DATA, EVIDENCE: Unnecessary details. If anyone asks for this, see “DENIER,” above.

CLIMATE SCIENTIST: A person skilled in spouting obscure, scientific-sounding jargon that has the effect of deflecting requests for “DATA” by “DENIERS.” Also skilled at affecting an aura of “Smartest Person in the Room” to buffalo gullible legislators and journalists.

JUNK SCIENCE: The use of invalid scientific evidence resulting in findings of causation which simply cannot be justified or understood from the standpoint of the current state of credible scientific or medical knowledge.

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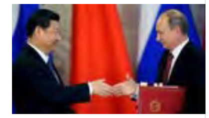

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APPENDIX 61

STATE OF OREGON STATE OF WASHINGTON

March 25, 2013

The Honorable Nancy Sutley, Chair
Council on Environmental Quality
Executive Office of the President
722 Jackson Place NW
Washington, DC 20503

Dear Chairwoman Sutley:

The U.S. Army Corps of Engineers is reviewing several permit applications for coal export shipping terminals in Oregon and Washington under Section 404 of the federal Clean Water Act, and Section 10 of the federal Rivers and Harbors Act. The permit applications include the Gateway Pacific terminal north of Bellingham, Washington (Peabody Energy - up to 48 million tons per year); the Millennium Bulk Terminals proposal in Longview, Washington (Ambre Energy - up to 44 million tons per year); and the Morrow Pacific Terminal at the Port of Morrow in Boardman, Oregon with a downstream barging component to Port Westward, also in Oregon (Ambre Energy - up to 8 million tons per year). Collectively, these proposals could result in the export of up to 100 million tons of coal per year. The expected end use of this coal is for energy production in Asia. No final decisions have been made on the related applications for state permits for these facilities. Our agencies are committed to a rigorous, fair and objective process to review these applications, within the scope of our respective authorities.

As you know, while coal consumption is declining in the United States, consumption in Asia is driving a substantial increase in global coal use. Although China and India are working to increase their use of other fuels and renewables, coal consumption in Asia has more than doubled in the last ten years. According to the International Energy Agency (IEA), global coal demand will grow by 16.9 percent over the next five years, or 2.6 percent per year. To date, coal exports from the United States have not been a major source of supply for foreign markets, but that is beginning to change. U.S. coal exports already have grown from 50 million tons in 2006 to just under 100 million tons in 2012 according to the U.S. Energy Information Agency (EIA). The U.S. holds the world's largest recoverable coal reserves, according to the EIA, much of which are found on federal lands in the western U.S. The recent interest in coal export shipping terminals along the west coast, along with decreasing domestic demand, is a clear indication that the U.S. could become a significant supplier of coal to Asia.

Coal will inevitably play an important part in the global energy supply in the short term. However, before the United States and our trading partners make substantial new investments in coal generation and the infrastructure to transport coal, extending the world's reliance on this fuel for decades, we need a full public airing of the consequences of such a path. Coal is the major source of global greenhouse gas emissions, and its share is increasing rapidly. Increasing levels of greenhouse gases and other pollutants resulting from the burning of coal, including pollutants other than CO_2, are imposing direct costs on people, businesses and communities in the U.S. and around the world. These costs include the public health costs of increased atmospheric deposition of mercury in drinking water sources, as well as costs resulting from ocean acidification, rising sea levels, wildfires, and shrinking snow packs that are key sources of water for the western U.S.

As the major owner of coal reserves in the western U.S., the federal government must consider whether it has appropriately priced the coal leases that it continues to grant, including the practice of granting non-competitive leases. Senators Ron Wyden and Lisa Murkowski recently asked the U.S. Department of the Interior for information concerning alleged industry practices using in-house trading affiliates to avoid paying royalties that reflect actual export sales. These issues raise significant concerns that we are subsidizing the export of coal at the same time we are winding down domestic consumption due to serious environmental and health concerns.

We believe the federal government must examine the true costs of long-term commitments to supply coal from federal lands for energy production, whether that production occurs domestically or in Asia. We cannot seriously take the position in international and national policymaking that we are a leader in controlling greenhouse gas emissions without also examining how we will use and price the world's largest proven coal reserves.

The Council on Environmental Quality (CEQ) has issued draft guidance for agencies concerning when and how they need to consider the climate change effects of their actions. Given that the cumulative total of coal exports from Oregon and Washington could result in CO_2 emissions on the order of 240 *million* tons per year, well above the significance level described in the draft guidance – it is hard to conceive that the federal government would ignore the inevitable consequences of coal leasing and coal export. We believe the decisions to continue and expand coal leasing from federal lands and authorize the export of that coal are likely to lead to long-term investments in coal generation in Asia, with air quality and climate impacts in the United States that dwarf those of almost any other action the federal government could take in the foreseeable future.

For these reasons, we urge the CEQ in the strongest possible terms to undertake and complete a thorough examination of the greenhouse gas and other air quality effects of continued coal leasing and export *before* the U.S. and its partners make irretrievable long-term investments in expanding this trade. We understand that the draft CEQ guidance under the National Environmental Policy Act (NEPA) that is referenced above is likely to be finalized in the near future, and applaud that step and urge that the new policy be applied to coal export terminal proposals now pending as well as to all future decisions concerning coal leases. We also ask that you evaluate and determine the proper policies for pricing coal leases from federal lands, both as a matter of securing a fair return for this resource, and to account for the direct costs of the resulting emissions to U.S. businesses and communities. These steps are needed for the U.S. to make sound decisions as the international demand for the coal resources in the U.S. continues to grow, and to ensure that we do not simply pass these tough issues on to future generations.

Thank you in advance for your careful consideration of this matter. We would welcome the opportunity to discuss these concerns in more detail.

Sincerely,

John A. Kitzhaber, M.D.
Governor of Oregon

Jay Inslee
Governor of Washington

cc: The Honorable Ken Salazar, Secretary of the Interior
The Honorable Bob Perciasepe, Acting Administrator, Environmental Protection Agency
The Honorable John McHugh, Secretary of the Army
The Honorable Jo-Ellen Darcy, Assistant Secretary of the Army for Civil Works
The Honorable Lisa Murkowski, United States Senate
Oregon State Congressional Delegation
Washington State Congressional Delegation

APPENDIX 62

Highlighted Statements of Concerns/Opposition to Coal Export

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U.S. Senators Ron Wyden & Jeff Merkley (OR)
U.S. Senator John Tester (MT)
U.S. Representative Suzan DelBene (WA)
U.S. Representative Jim McDermott (WA)
U. S. Representative Adam Smith (WA)
U.S. Representative Earl Blumenauer (OR)
EPA Region 10
Oregon Governor John Kitzhaber
Washington Governor Jay Inslee
U.S. Department of Housing and Urban Dev.
National Marine Fisheries Service
National Park Service, Pacific West Region
WA Dept. of Ecology
WA Dept. of Fish and Wildlife
WA Dept. of Health
WA Dept. of Agriculture
WA Utilities and Transportation Commission
Puget Sound Clean Air Agency
King County Executive Dow Constantine
Spokane Regional Clean Air Agency
Multnomah County Chair Jeff Cogen
Pierce County Executive Pat McCarthy
Clark County Commissioners
Skagit County Board of Commissioners
San Juan County Council
King County Council member Larry Phillips
Thurston County: Romero, Wolfe, Valenzuela
San Juan Island National Historical Park (NPS)
Lynn Burditt the Area Manager of the USFS, Columbia River Gorge National Scenic Area
WA State Representatives: Carlyle, Dunshee, Farrell, Fitzgibbon, Hudgins, Jinkins, Kagi, Lytton, Maxwell, Moeller, Morris, Pollett, Reykdal, Ryu, Takko, Tarleton, Tharinger
WA State Senators: Billig, Chase, Conway, Darneille, Fraser, Frockt, Harper, Keiser, Kline, Murray, Nelson, Ranker, Regala, Shin, Swecker

City Resolutions Passed

Bainbridge Island, WA
Bellingham, WA
Camas, WA
Edmonds, WA
Longview, WA
Marysville, WA
North Bonneville, WA
Puyallup, WA
Seattle, WA
Spokane, WA
Stevenson, WA
Thurston County, WA
Vancouver, WA
Washougal, WA
Eugene, OR
Hood River, OR
Milawaukie, OR
OR Metro Regional Council
Portland, OR
Salem, OR
The Dalles, OR
Missoula, MT

City Statements, additional letters

Bellevue, WA - Steven R. Sarkozy, City Manager
Bellingham, WA – Mayor Linville, Council members
Blaine, WA
Burlington, WA – Mayor Brunz
Cheney, WA – Mayor Tom Trulove
Dallesport, WA – Community Council
Elma, WA – Mayor David Osgood
Everett, WA
Ferndale, WA
Friday Harbor, WA – Mayor Carrie Lacher, Council
Kent, WA - Mayor Suzette Cooke, Council
Lacey, WA – Mayor Clarkson, CM Pratt, Lawson
Marysville – Mayor Jon Nehring
Monroe, WA – Mayor Zimmerman
Mount Vernon, WA –City Council Members
Mukilteo, WA – Mayor Marine, CC President
Olympia, WA – Mayor Buxbaum, CM Hawkins
Seattle – Mayor McGinn and City Council members
Sedro-Woolley – City Attorney Eron Berg
Shoreline, WA – Julie Thuy Underwood, City Mgr.
Snohomish . WA – City Manager
Stanwood, WA – Mayor White
Sumner, WA – Mayor Enslow
Tumwater, WA – Councilor Joan Cathey
La Connor, WA – Mayor Ramon Hayes
Washougal, WA – Mayor Guard
Woodway, WA – Mayor Carla Nichols
Eugene, OR – Mayor Piercy, Councilor Alan Zelenka

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Metro Councilor Rex Burhholder (OR)
Mosier, OR – Mayor Rogers and City Council
Roseburg, OR – Councilmember Tuchscherer
Livingston, MT – Steve Caldwell, City Comm. Chair
Milwaukie, OR – Mayor Jeffrey Ferguson
Portland – Councilmember Amanda Fritz
Helena, MT – City Council
Vancouver, BC – Councilor Geoff Meggs

Economic Entities

Port of Edmonds
Port of Skamania County
Burlington Chamber of Commerce
Snohomish County Tomorrow
Stanwood (WA) Area Merchants Association
Port of Skagit
Vancouver Downtown Association (Vancouver, WA)
Edmonds Chamber of Commerce
Washington Transportation Commission
Leslie Smith, E.D., The Alliance for Pioneer Square
Kyle Griffith, owner and operator, Seattle Great Wheel
Gibson Traffic Consultants have analyzed traffic impacts in the cities of Burlington, Marysville, Mt. Vernon, Seattle and Edmonds
Portland General Electric, opposed coal lease over concerns of coal dust on their operations in St. Helens, OR
Columbia Gorge Windsurfing Association

Health Entities

San Juan Island Board of Health
Skagit Regional Health, Skagit Valley Hospital
Spokane Regional Health District Board of Health
Bozeman City-County Health Board
Gallatin City-County Board of Health (MT)
Washington Academy of Family Physicians, King County Academy of Family Physicians
Washington Association of Naturopathic Physicians
Bob Elliott, Executive Director of the Southwest Clean Air Agency
Whatcom Docs – 160 physicians in Whatcom County + more than 400 health care professionals in Oregon
Robert Blake, M.D., Chief of Staff, Bozeman Deaconess Hospital
Arthur Winer, PhD, Professor Emeritus, Environmental Health Sciences Dept., UCLA School of Public Health

Northwest Tribes and tribal organizations

National Council of American Indians (566 Tribes)
Affiliated Tribes of Northwest Indians (57 Tribes)
Swinomish Indian Tribe
Confederated Tribes and Bands of the Yakama Nation
Columbia River Inter-Tribal Fish Commission
The Lummi Nation
Nez Perce Tribe
The Tulalip Tribes
Confederated Tribes of Umatilla
EPA Region 10 Tribal Operations Committee

Religious Leaders

Bishop Greg Rickel, Episcopal Diocese of Olympia (Western Washington)
Bishop Jim Waggoner, Episcopal Diocese of Spokane (Eastern Washington)
Bishop Chris Boerger, Evangelical Lutheran Church in America, Northwest Washington Synod
Rev. Mike Denton, Conference Minister, United Church of Christ Pacific Northwest Conference
Rev. Dr. Marcia Patton, Executive Minister, Evergreen Association of American Baptist Churches
Bishop Martin D. Wells, Evangelical Lutheran Church in America (E. WA/Idaho Synod)

Community Leaders Statements

Robert F. Kennedy Jr
San Juan Marine Resources Committee
Whatcom County Marine Resources Committee
Bellingham, WA – former Mayor Pike (2011)
Northwest Straits Commission
Puget Sound Partnership

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Washington State Democrats
Will Reichardt, Skagit County Sherriff
Cheney Public Schools
Ferndale School District
Bob Apple, former Spokane City Council member
Univ. of Washington Student Body Resolution
John Nelson, fmr City Planning Comm'r, The Dalles
Columbia County Democratic Central Committee (OR)
Seattle Parks Board
Mount Vernon School District
Fmr. Seattle Port Commissioner Gael Tarleton
Associated Students of Western WA Univ.
Portland, OR – former Mayor Sam Adams
Cliff Mass, PhD, Professor, Department of Atmospheric Sciences, University of Washington

Editorials

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Everett Herald, "Why coal royalties matter," January 2013
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Heather Acheson, *Camas-Washougal Post Record*, "Potential local impacts of coal trains need to be taken seriously," March 2012
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Marysville Globe, "The trains are coming," 2011

OpEds

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"Climate change poses a public-health threat," Dr. Howard Frumkin, Dean, UW School of Public Health, *Seattle Times*, January 2013

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"Salem should worry about risks from coal trains," Jim Scheppke, *The Statesman Journal*, July 2012

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"Are coal-carrying trains a sign of progress?" Kurt Waldenberg is owner of North Sound Energy & Remodel, of Bellingham. Mike Smith is a Realtor/broker with John L. Scott in Longview, *The Puget Sound Business Journal*, December 2011

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