Hello my name is Haifa Iversen. I speak to you as a high school biology teacher. I am a former Assistant Project Manager in the habitat conservation division of the California Department of Fish and Game where I worked on large ROW projects ensuring compliance with CEQA and the NEPA.

I will refer to, *The Full Cost Accounting For the Life Cycle of Coal*, (Epstein et al). "Each stage in the life cycle of coal—extraction, transport, processing, and combustion—generates a waste stream and carries multiple hazards for health and the environment. These costs are external to the coal industry and are thus often considered "externalities." We estimate that the life cycle effects of coal and the waste stream generated are costing the U.S. public a third to over one-half of a trillion dollars annually. Many of these so-called externalities are, moreover, cumulative. Accounting for the damages conservatively doubles to triples the price of electricity from coal per kWh generated. The monetizable impacts found are damages due to nitrous oxide, sulfer dioxide, and mercury emissions, fatalities of members of public due to rail accidents during coal transport, the public health burden in Appalachia associated with the coal mining, and government subsidies, and lost value of abandoned land mines."

In 2005, coal accounted for 40% of electricity worldwide and 41% of CO2 emissions
In 2005, coal accounted for 50% of electricity in the United States and 81% of US CO2 emissions.

These figures do not include emissions from

- coal mining= methane
- coal transport
- carbon and nitrous oxide emissions from mountain top removal
- coal mining and combustion (nitrous oxide, sulfer dioxide and mercury)
- coal crushing, processing, and washing

I request a comprehensive study on the following:

1. Methane emissions from coal mining in The Powder River Basin and its effects on each state along the proposed route.
2. Impact of train generated diesel exhaust and its impact on cancer rates along potential train routes
3. Coal plants are the largest source of sulfur dioxide and mercury emissions and the second largest source of nitrous oxide. These pollutants combine to form ozone and particulate matter pollution. Coal combustion results in emissions of nitrous oxide, sulfer dioxide, and mercury. Please measure the impact of these emissions and particulates on water, ocean acidification, public health, ecological systems, and air quality.

These are significant impacts to our state, our country and the world. There are too many hidden costs to coal that will significantly impact our health, food, economy, and the environment. This is not simply the environment vs jobs. Permitting The Gateway Pacific Terminal is a national and global issue that cannot be mitigated for. I ask that you take the no action alternative do not approve the Gateway Pacific Terminal.

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Full cost accounting for the life cycle of coal

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Each stage in the life cycle of coal—extraction, transport, processing, and combustion—generates a waste stream and carries multiple hazards for health and the environment. These costs are external to the coal industry and are thus often considered "externalities." We estimate that the life cycle effects of coal and the waste stream generated are costing the U.S. public a third to over one-half of a trillion dollars annually. Many of these so-called externalities are, moreover, cumulative. Accounting for the damages conservatively doubles to triples the price of electricity from coal per kWh generated, making wind, solar, and other forms of nonfossil fuel power generation, along with investments in efficiency and electricity conservation methods, economically competitive. We focus on Appalachia, though coal is mined in other regions of the United States and is burned throughout the world.

Keywords: coal; environmental impacts; human and wildlife health consequences; carbon capture and storage; climate change

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Introduction

Coal is currently the predominant fuel for electricity generation worldwide. In 2005, coal use generated 7,334 TWh (1 terawatt hour = 1 trillion watt-hours, a measure of power) of electricity, which was then 40% of all electricity worldwide. In 2005, coal-derived electricity was responsible for 7.856 Gt of CO_2 emissions or 30% of all worldwide carbon dioxide (CO_2) emissions, and 72% of CO_2 emissions from power generation (one gigaton = one billion tons; one metric ton = 2,204 pounds.)[1] Non–power-generation uses of coal, including industry (e.g., steel, glass-blowing), transport, residential services, and agriculture, were responsible for another 3.124 Gt of CO_2, bringing coal's total burden of CO_2 emissions to 41% of worldwide CO_2 emissions in 2005.[1]

By 2030, electricity demand worldwide is projected to double (from a 2005 baseline) to 35,384 TWh, an annual increase of 2.7%, with the quantity of electricity generated from coal growing 3.1% per annum to 15,796 TWh.[1] In this same time period, worldwide CO_2 emissions are projected to grow 1.8% per year, to 41.905 Gt, with emissions from the coal-power electricity sector projected to grow 2.3% per year to 13.884 Gt.[1]

In the United States, coal has produced approximately half of the nation's electricity since 1995,[2] and demand for electricity in the United States is projected to grow 1.3% per year from 2005 to 2030, to 5,947 TWh.[1] In this same time period, coal-derived electricity is projected to grow 1.5% per year to 3,148 TWh (assuming no policy changes from the present).[1] Other agencies show similar projections; the U.S. Energy Information Administration (EIA)

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projects that U.S. demand for coal power will grow from 1,934 TWh in 2006 to 2,334 TWh in 2030, or 0.8% growth per year.[3]

To address the impact of coal on the global climate, carbon capture and storage (CCS) has been proposed. The costs of plant construction and the "energy penalty" from CCS, whereby 25–40% more coal would be needed to produce the same amount of energy, would increase the amount of coal mined, transported, processed, and combusted, as well as the waste generated, to produce the same amount of electricity.[1,4] Construction costs, compression, liquefaction and injection technology, new infrastructure, and the energy penalty would nearly double the costs of electricity generation from coal plants using current combustion technology (see Table 2).[5]

Adequate energy planning requires an accurate assessment of coal reserves. The total recoverable reserves of coal worldwide have been estimated to be approximately 929 billion short tons (one short ton = 2,000 pounds).[2] Two-thirds of this is found in four countries: U.S. 28%; Russia 19%; China 14%, and India 7%.[6] In the United States, coal is mined in 25 states.[2] Much of the new mining in Appalachia is projected to come from mountaintop removal (MTR).[2]

Box 1.

Peak Coal?

With 268 billion tons of estimated recoverable reserves (ERR) reported by the U.S. Energy Information Administration (EIA), it is often estimated that the United States has "200 years of coal" supply.[7] However, the EIA has acknowledged that what the EIA terms ERR cannot technically be called "reserves" because they have not been analyzed for profitability of extraction.[7] As a result, the oft-repeated claim of a "200 year supply" of U.S. coal does not appear to be grounded on thorough analysis of economically recoverable coal supplies.

Reviews of existing coal mine lifespan and economic recoverability reveal serious constraints on existing coal production and numerous constraints facing future coal mine expansion. Depending on the resolution of the geologic, economic, legal, and transportation constraints facing future coal mine expansion, the planning horizon for moving beyond coal may be as short as 20–30 years.[8–11]

Recent multi-Hubbert cycle analysis estimates global peak coal production for 2011 and U.S. peak coal production for 2015.[12] The potential of "peak coal" thus raises questions for investments in coal-fired plants and CCS.

Worldwide, China is the chief consumer of coal, burning more than the United States, the European Union, and Japan combined. With worldwide demand for electricity, and oil and natural gas insecurities growing, the price of coal on global markets doubled from March 2007 to March 2008: from \$41 to \$85 per ton.[13] In 2010, it remained in the \$70+/ton range.

Coal burning produces one and a half times the CO_2 emissions of oil combustion and twice that from burning natural gas (for an equal amount of energy produced). The process of converting coal-to-liquid (not addressed in this study) and burning that liquid fuel produces especially high levels of CO_2 emissions.[13] The waste of energy due to inefficiencies is also enormous. Energy specialist Amory Lovins estimates that after mining, processing, transporting and burning coal, and transmitting the electricity, only about 3% of the energy in the coal is used in incandescent light bulbs.[14]

Thus, in the United States in 2005, coal produced 50% of the nation's electricity but 81% of the CO_2 emissions.[1] For 2030, coal is projected to produce 53% of U.S. power and 85% of the U.S. CO_2 emissions from electricity generation. None of these figures includes the additional life cycle greenhouse gas (GHG) emissions from coal, including methane from coal mines, emissions from coal transport, other GHG emissions (e.g., particulates or black carbon), and carbon and nitrous oxide (N_2O) emissions from land transformation in the case of MTR coal mining.

Coal mining and combustion releases many more chemicals than those responsible for climate forcing. Coal also contains mercury, lead, cadmium, arsenic, manganese, beryllium, chromium, and other toxic, and carcinogenic substances. Coal crushing, processing, and washing releases tons of particulate matter and chemicals on an annual basis and contaminates water, harming community public health and ecological systems.[15–19] Coal combustion also results in emissions of NO_x, sulfur dioxide (SO_2), the particulates PM_{10} and $PM_{2.5}$, and mercury; all of which negatively affect air quality and public health.[20–23]

In addition, 70% of rail traffic in the United States is dedicated to shipping coal, and rail transport is associated with accidents and deaths.[20] If coal use were to be expanded, land and transport infrastructure would be further stressed.

Summary of methods

Life cycle analysis, examining all stages in using a resource, is central to the full cost accounting needed to guide public policy and private investment. A previous study examined the life cycle stages of oil, but without systematic quantification.[24] This paper is intended to advance understanding of the measurable, quantifiable, and qualitative costs of coal.

In order to rigorously examine these different damage endpoints, we examined the many stages in the life cycle of coal, using a framework of environmental externalities, or "hidden costs." Externalities occur when the activity of one agent affects the well-being of another agent outside of any type of market mechanism—these are often not taken into account in decision making and when they are not accounted for, they can distort the decision-making process and reduce the welfare of society.[20] This work strives to derive monetary values for these externalities so that they can be used to inform policy making.

This paper tabulates a wide range of costs associated with the full life cycle of coal, separating those that are quantifiable and monetizable; those that are quantifiable, but difficult to monetize; and those that are qualitative.

A literature review was conducted to consolidate all impacts of coal-generated electricity over its life cycle, monetize and tabulate those that are monetizable, quantify those that are quantifiable, and describe the qualitative impacts. Since there is some uncertainty in the monetization of the damages, low, best, and high estimates are presented. The monetizable impacts found are damages due to climate change; public health damages from NO_x, SO_2, $PM_{2.5}$, and mercury emissions; fatalities of members of the public due to rail accidents during coal transport; the public health burden in Appalachia associated with coal mining; government subsidies; and lost value of abandoned mine lands. All values are presented in 2008 US$. Much of the research we draw upon represented uncertainty by presenting low and/or high estimates in addition to best estimates. Low and high values can indicate both uncertainty in parameters and different assumptions about the parameters that others used to calculate their estimates. Best estimates are not weighted averages, and are derived differently for each category, as explained below.

Climate impacts were monetized using estimates of the social cost of carbon—the valuation of the damages due to emissions of one metric ton of carbon, of \$30/ton of CO_2equivalent (CO_2e),[20] with low and high estimates of \$10/ton and \$100/ton. There is uncertainty around the total cost of climate change and its present value, thus uncertainty concerning the social cost of carbon derived from the total costs. To test for sensitivity to the assumptions about the total costs, low and high estimates of the social cost of carbon were used to produce low and high estimates for climate damage, as was done in the 2009 National Research Council (NRC) report on the "Hidden Costs of Energy."[20] To be consistent with the NRC report, this work uses a low value of \$10/ton CO_2e and a high value of \$100/ton CO_2e.

All public health impacts due to mortality were valued using the value of statistical life (VSL). The value most commonly used by the U.S. Environmental Protection Agency (EPA), and used in this paper, is the central estimate of \$6 million 2000 US$, or \$7.5 million in 2008 US$.[20]

Two values for mortality risk from exposure to air pollutants were found and differed due to different concentration-response functions—increases in mortality risk associated with exposure to air pollutants. The values derived using the lower of the two concentration-response functions is our low estimate, and the higher of the two concentration-response functions is our best and high estimate, for reasons explained below. The impacts on cognitive development and cardiovascular disease due to mercury exposure provided low, best, and high estimates, and these are presented here.

Regarding federal subsidies, two different estimates were found. To provide a conservative best estimate, the lower of the two values represents our low and best estimate, and the higher represents our high estimate. For the remaining costs, one point estimate was found in each instance, representing our low, best, and high estimates.

The monetizable impacts were normalized to per kWh of electricity produced, based on EIA estimates of electricity produced from coal, as was done in the NRC report tabulating externalities due to coal.[2,20] Some values were for all coal mining, not just for the portion emitted due to coal-derived electricity. To correct for this, the derived values were multiplied by the proportion of coal that was used for electrical power, which was approximately 90% in all years analyzed. The additional impacts from nonpower uses of coal, however, are not included in this analysis but do add to the assessment of the complete costs of coal.

To validate the findings, a life cycle assessment of coal-derived electricity was also performed using the Ecoinvent database in SimaPro v 7.1.[25] Health-related impact pathways were monetized using the value of disability-adjusted life-years from ExternE,[26] and the social costs of carbon.[20] Due to data limitations, this method could only be used to validate damages due to a subset of endpoints.

Box 2.

Summary Stats

1. Coal accounted for 25% of global energy consumption in 2005, but generated 41% of the CO_2 emissions that year.
2. In the United States, coal produces just over 50% of the electricity, but generates over 80% of the CO_2 emissions from the utility sector.[2]
3. Coal burning produces one and a half times more CO_2 emissions than does burning oil and twice that from burning natural gas (to produce an equal amount of energy).
4. The energy penalty from CCS (25–40%) would increase the amount of coal mined, transported, processed, and combusted, and the waste generated.[4]
5. Today, 70% of rail traffic in the United States is dedicated to shipping coal.[20] Land and transport would be further stressed with greater dependence on coal.

Life cycle impacts of coal

The health and environmental hazards associated with coal stem from extraction, processing, transportation and combustion of coal; the aerosolized, solid, and liquid waste stream associated with mining, processing, and combustion; and the health, environmental, and economic impacts of climate change (Table 1).

Underground mining and occupational health

The U.S. Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) track occupational injuries and disabilities, chronic illnesses, and mortality in miners in the United States. From 1973 to 2006 the incidence rate of all nonfatal injuries decreased from 1973 to 1987, then increased dramatically in 1988, then decreased from 1988 to 2006.[27] Major accidents still occur. In January 2006, 17 miners died in Appalachian coal mines, including 12 at the Sago mine in West Virginia, and 29 miners died at the Upper Big Branch Mine in West VA on April 5, 2010. Since 1900 over 100,000 have been killed in coal mining accidents in the United States.[14]

In China, underground mining accidents cause 3,800–6,000 deaths annually,[28] though the number of mining-related deaths has decreased by half over the past decade. In 2009, 2,631 coal miners were killed by gas leaks, explosions, or flooded tunnels, according to the Chinese State Administration of Work Safety.[29]

Black lung disease (or pneumoconiosis), leading to chronic obstructive pulmonary disease, is the primary illness in underground coal miners. In the 1990s, over 10,000 former U.S. miners died from coal workers' pneumoconiosis and the prevalence has more than doubled since 1995.[30] Since 1900 coal workers' pneumoconiosis has killed over 200,000 in the United States.[14] These deaths and illnesses are reflected in wages and workers' comp, costs considered internal to the coal industry, but long-term support often depends on state and federal funds.

Again, the use of "coking" coal used in industry is also omitted from this analysis: a study performed in Pittsburgh demonstrated that rates of lung cancer for those working on a coke oven went up two and one-half times, and those working on the top level had the highest (10-fold) risk.[31]

Mountaintop removal

MTR is widespread in eastern Kentucky, West Virginia, and southwestern Virginia. To expose coal seams, mining companies remove forests and fragment rock with explosives. The rubble or "spoil"