SCR

16

<TARGET><BILL>SCR 16</BILL><SUBJECT>SCR
16</SUBJECT><COMM>SRES28</COMM></TARGET>

SENATE COMMITTEE REPORT
First Committee of Referral

DATE: 2/24/14 FURTHER:

Date of 5-Day Notice: ____________________
(in accordance with Uniform Rule 23)

DATE TURNED
IN TO OFFICE: 3/6/14

Resources Committee considered SENATE CONCURRENT RESOLUTION NO. 16

SCR 16-REQ GOV TO INVESTIGATE COAL RESOURCES

Requesting the Governor to investigate and report to the legislature regarding the development of a large coal power plant and associated electric grid to provide energy to residents of the state.

and recommends:

[✓] be **replaced** with **CS** SCR 16 (RES) [✓] *Same Title* [ ] *New Title*

[ ] adopt **previous CS** ____________ (________) [ ] *Same Title* [ ] *New Title*

[ ] attached amendment(s)

[ ] adopt ____________ Letter of Intent

[ ] further referral to ____________ Committee

Dept Abbr.	
ADM	LWF
CED	LAW
COR	LEG
CRT	MVA
EED	DNR
DEC	DPS
DFG	REV
GOV	DOT
DHS	UA

NEW FISCAL NOTE(S)

Dept.	Fiscal	Indet.	Zero	FN #
CED	✓			1

PREVIOUS FISCAL NOTE(S)

Dept.	Fiscal	Indet.	Zero	FN #

[ ] **APPROPRIATION - no fiscal note**

SIGNATURES AND RECOMMENDATIONS:	PRINTED LAST NAME	DO PASS	DO NOT PASS	NO REC	AMEND
[signature]	French			✓	
[signature]	MICCICHE			✓	
[signature]	Bishop	✓			
[signature]	Dyson	✓			
[signature]	FAIRCLOUGH	✓			
CHAIR: [signature]	Giessel	✓			

CS FOR SENATE CONCURRENT RESOLUTION NO. 16(RES)

IN THE LEGISLATURE OF THE STATE OF ALASKA

TWENTY-EIGHTH LEGISLATURE - SECOND SESSION

BY THE SENATE RESOURCES COMMITTEE

Offered:
Referred:

Sponsor(s): SENATORS KELLY, Giessel, Bishop, McGuire, Dyson, Dunleavy

A RESOLUTION

Requesting the Governor to investigate and report to the legislature regarding the development of large coal power plants and associated electric grids to provide energy to residents of the state.

BE IT RESOLVED BY THE LEGISLATURE OF THE STATE OF ALASKA:

WHEREAS the quality of life of the residents of the state is threatened by high energy costs; and

WHEREAS many residents of the state are struggling to provide for their basic needs; and

WHEREAS federal actions consistently slow, impede, or stop the development of the energy resources of the state; and

WHEREAS the United States Environmental Protection Agency continues to disregard the science-based permitting process of the state; and

WHEREAS the United States Fish and Wildlife Service has closed the most productive portions of the coastal plain of the state, preventing the pipelines and existing infrastructure of the state from being wisely utilized; and

WHEREAS the development of a large coal power plant and associated electrical grid in the state would provide energy to residents of the state; and

WHEREAS the residents of the state need access to the resources of the state;

BE IT RESOLVED that the Alaska State Legislature respectfully requests the Governor to investigate, without regard to federal permits or restrictions, the development of large coal power plants and associated electric grids to provide energy to residents of the state to heat their homes and keep their lights on; and be it

FURTHER RESOLVED that the Alaska State Legislature requests the Governor to evaluate and report back to the legislature on the feasibility of locating a large coal power plant

(1) on state or university land adjacent to hundreds of years' worth of coal reserves in the Alaska Range;

(2) on state land adjacent to the vast coal resources of Cook Inlet; and

(3) on state or Alaska Native regional corporation land adjacent to many hundreds of years' worth of coal reserves in the western Brooks Range; and be it

FURTHER RESOLVED that the Alaska State Legislature requests the Governor to report back to the legislature on

(1) the potential costs of coal plants ranging in size from 200 megawatts to two gigawatts of electricity generation;

(2) the cost of a kilowatt of coal-generated energy in comparison to hydroelectric, natural gas, and other energy sources;

(3) the technological potential for transmission of coal-generated energy, including high-voltage direct current, and how that transmission might provide for the needs of residents of the state not part of the Railbelt power grid;

(4) how a large mine-mouth coal plant might help balance future needs of the state with hydroelectric and other types of power generation.

28-LS1519\A.2
Nauman
2/28/14

AMENDMENT

OFFERED IN THE SENATE

TO: SCR 16

passed

Page 2, line 5, following "investigate":

Insert ", without regard to federal permits or restrictions,"

passed

Conceptual amendment:
Fairclough

Page 2,
Line 5: after "development of"
~~Insert~~ "a"
delete

Page 2
Line 5: after "coal power plant"
Insert "s"

28-LS1519\A.2
Nauman
2/28/14

AMENDMENT

OFFERED IN THE SENATE

TO: SCR 16

Page 2, line 5, following "investigate":

Insert ", without regard to federal permits or restrictions,"

CRC
CAPITAL RESEARCH CENTER

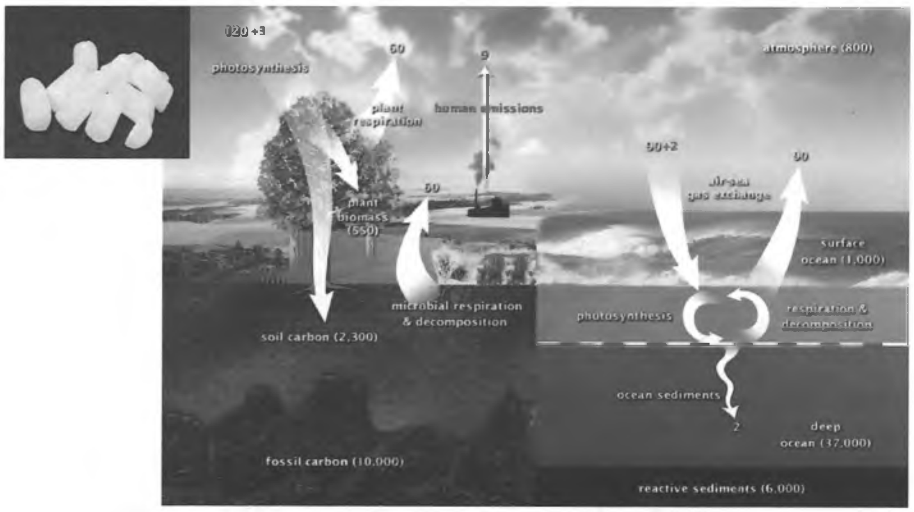
Green Watch

The Social Cost of Carbon

Pseudoscience, deception, and a grab for power—all in one magic number

By Marlo Lewis

Summary: *The Social Cost of Carbon is a number guesstimated by economists and then manipulated by bureaucrats and environmentalists to justify government activities ranging from the shutdown of coal-fired power plants to the regulation of microwave oven clocks. The problem is that it's a made-up number with no scientific validity, put out by flawed computer models using data from other flawed models and ignoring the huge cost of* not *using carbon-based energy.*



Carbon dioxide in solid form ("dry ice"), and an illustration of the carbon cycle (admittedly one that downplays the role of human-caused carbon emissions).

It's a number that underlies a wide range of government regulations. It's the foundation for taking away consumers' freedom of choice and for giving broad powers to politicians, judges, and bureaucrats. It has the potential to deprive the country of cheap and abundant energy and to do unimaginable harm to the U.S. economy. And when invoked to demand "action" on climate change, it's an utter con.

As a pretext for expanding political control of the economy and bilking the American people to the benefit of special interests, nothing beats the pseudoscience of the Social Cost of Carbon (SCC). Here's how it works: Government regulations are subject to cost-benefit analysis—that is, the executive branch of the federal government is required to establish that the benefits of a regulation will exceed the costs to society. That's a principle that, as Eric Posner of the University of Chicago Law School noted in *The New Republic*, was "brought to government by none other than Ronald Reagan, in Executive Order 12291 of 1981. Reagan was riding the wave of the deregulatory movement, which held that regulation of industry was excessive and stunted economic growth. His order stipulated that agencies should issue regulations only after finding that the benefits exceeded the costs." The principle became so well-established that Democratic presidents Bill Clinton and Barack Obama renewed the order, with modifications.

But anyone familiar with the operation of bureaucracies should be able to spot the weak links in cost-benefit analysis of regulation: Who determines the cost? Who determines the benefit? Simply by changing one part of the formula or the other, you can justify anything.

Carbon dioxide, in brief

Carbon dioxide (CO_2) is the basic building block of planetary food chains. Plants use CO_2 to construct their tissues, all animals depend (directly or indirectly) on plants for food, and countless animal species depend on vegetation for critical habitat. A colorless, odorless gas, CO_2 is non-toxic to humans at more than 20 times current atmospheric concentrations. It is unlike any substance traditionally regulated as an "air pollutant." So why is CO_2 said to have a social "cost"? In addition to being a plant nutrient, CO_2 is a "greenhouse" (heat-absorbing) gas. Like water vapor, the atmosphere's chief greenhouse gas, CO_2 helps keep the Earth habitably warm. But it is possible to have too much a good thing. Many experts and legions of activists contend that CO_2 emissions from the combustion of coal, oil, and natural gas—fuels vital to manufacturing, transportation, and electricity generation—will cause dangerous global warming.

Since the mid-19th century, CO_2 concentrations have increased from 280 parts per million (ppm) to 396 ppm. During that period global temperatures increased

February 2014

approximately 0.85°C. About half of that warming occurred between 1910 and 1940, before anthropogenic (human-caused) CO_2 emissions could have had much effect on planetary temperatures. Virtually all scientists agree that, other things being equal, a doubling of CO_2 concentrations above pre-industrial levels will warm the Earth by about 1°C. Most would also agree that a 1°C warming would likely have net benefits for human health and welfare. There is a reason, after all, that millions of retirees move from the cold north to the Sunbelt.

As discussed below, the theory that CO_2 emissions will cause dangerous warming is based on numerous speculative assumptions. Here's what we know for certain: The current warm period (roughly 1880 to the present) has been an era of unprecedented improvement in human health and welfare, natural variability remains the overwhelming cause of the strength and frequency of extreme weather events, and climate models increasingly project more warming than is actually observed. It's also a safe bet that future technologies for coping with drought, storms, and other adverse weather phenomena will surpass current technologies.

The Social Cost of Carbon is an estimate of how much climate change-related damage is supposedly done to society by an extra ton of CO_2 emissions. Because the SCC represents the supposed cost to society of carbon emissions, it's a critical factor in calculating the relative benefit-to-cost of any regulation that is supposed to affect these emissions. Raise the SCC estimate high enough and it can appear to justify almost any CO_2-reduction measure, no matter how expensive.

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SCC analyses can make uneconomic "renewable" energy look like a bargain at any price, and make traditional carbon-based fuels look unaffordable no matter how cheap. The political function of SCC analysis is to legitimize a wide range of anti-CO_2 measures—cap-and-trade, carbon taxes, wind power mandates, "green jobs" subsidies, and other schemes to rig energy markets.

Spot the externalities

All economic activities have "externalities"—costs or benefits not reflected in the prices people pay for the associated goods and services. Pollution is a common example of a "negative" (harmful) externality. Thus, it sounds plausible that CO_2 emissions have a social cost.

SCC analysts calculate carbon's social cost down to the penny, creating the impression that they are reporting an objective magnitude like the price of wheat futures at the end of a trading day. In fact, the social cost of carbon is an unknown quantity. For example, see if you can discern, from the following information, carbon's social cost via its supposed role in Global Warming:

• There has been no trend in the strength or frequency of land-falling hurricanes in the world's five main hurricane basins during the past 50-70 years.

• The U.S. is currently enjoying the longest period on record without a major (category 3-5) hurricane landfall.

• There has been no trend in the strength or frequency of tropical cyclones in the main Atlantic hurricane development region during the past 370 years.

• There has been no trend in U.S. hurricane-related damages since 1900, once economic losses are adjusted ("normalized") for changes in population, wealth, and the consumer price index.

• There has been no trend in global normalized weather-related losses since 1960, and as a proportion of GDP, global weather-related losses since 1900 have been declining.

• There has been no trend since 1950 in the strength or frequency of tornadoes in the U.S.

• There has been no trend since 1900 in U.S. soil moisture as measured by the Palmer Drought Severity Index.

• There has been no trend in U.S. flood magnitudes over the past 85 years.

• Since the 1920s, global deaths and death rates related to extreme weather declined by 93% and 98%, respectively.

• Twenty-First Century sea-level rise due to ice loss on Greenland and West Antarctica is likely to be measured in inches, not feet or meters.

• The greater-than-present warmth of the Holocene Optimum (roughly 7000 to 3000 B.C.), Roman Warm Period (250 B.C. to A.D. 400), and Medieval Warm Period (A.D. 950 to 1250) contributed to improvements in human health and welfare. Warming has historically been *beneficial* to mankind.

• Historically, rising CO_2 emissions and concentrations are strongly correlated with improvements in per capita income, per capita food production, average lifespan, and public health.

A staple of global warming advocacy is the claim that climate change is "worse than we thought." In reality, the 17-year pause in global warming, the growing divergence between climate model projections and observations (models on average overshoot the warming of the past 15 years by 300%), and more than a dozen recent papers on the critical issue of climate sensitivity (how much warming results from a doubling of CO_2 concentrations) all indicate that the state of the climate is *better* than they told us, even assuming that all such change is harmful.

Thus, if SCC analysis were an honest enterprise, the Obama administration's most recent SCC estimates (May 2013) would be lower than its initial (February 2010) estimates. Instead, the administration's 2013 SCC estimates for year 2020 ($12, $43, $65, and $129) were substantially higher than its 2010 SCC estimates for 2020 ($6.80, $26.30, $41.70, and $80.70).

The administration's revised SCC estimates are a product of political calculation, not science, argues Cato Institute climatologist Chip Knappenberger:

> In this way, all qualifying rules and regulations, including the EPA's promised emissions limits on new and existing power plants, appear less costly—a critical asset, as costs are often the greatest barrier to approval.

Since the war on global warming is a high priority within the Obama administration, finding ways to make the social cost of carbon appear to be as high as possible is the ongoing objective.

Back in May [2013], the administration increased its previous estimate by more than 50%, from $25 to $40, which means that all proposed carbon dioxide emissions cuts are now some 50% more valuable.

Putting out the trash

Just because a calculation is run through a computer doesn't mean that it makes any sense or has any relation to reality. Scientists call the processing of bad information to get bad results GIGO, "Garbage In, Garbage Out." This concept is so widely accepted that even Wikipedia notes—

> **Garbage in, garbage out (GIGO)** in the field of computer science or information and communications technology refers to the fact that computers will unquestioningly process unintended, even nonsensical, input data ("garbage in") and produce undesired, often nonsensical, output ("garbage out").

The computer programs used to estimate carbon's social cost are called "integrated assessment models" because they integrate a model of how CO_2 emissions supposedly change the climate with a model of how climate change supposedly damages the economy.

That creates two opportunities for GIGO. *If either of the two models is flawed, the final model which combines them is flawed, perhaps useless.*

Finding the integrated assessment models (IAMs) "so deeply flawed as to be close to useless as tools for policy analysis," Robert Pindyck, a professor at MIT, cautions that "their use suggests a level of knowledge and precision that is simply illusory, and can be highly misleading." By tweaking the assumptions, modelers can get almost any estimate they want. Pindyck explains:

> The modeler has a great deal of freedom in choosing functional forms, parameter values, and other inputs, and different choices can give wildly different estimates of the SCC and the optimal amount of abatement. You might think that some input choices are more reasonable or defensible than others, but no, "reasonable" is very much in the eye of the beholder. Thus these models can be used to obtain almost any result one desires.

Is that the commentary of a hard-core "climate skeptic"? No. Pindyck believes CO_2 emissions "will eventually result in unwanted climate change." He even favors adoption of a carbon tax.

Two speculative inputs in particular determine IAM outputs, Pindyck notes, are *climate sensitivity*, which "translates increases in CO_2e [carbon dioxide-equivalent] concentration to increases in temperature," and the *damage function*, which "translates higher temperatures into reductions in GDP and consumption."

The reader may be familiar with the Intergovernmental Panel on Climate Change, a body created by the United Nations to study the Global Warming issue (and, critics say, designed to promote alarm about manmade Global Warming regardless of what the evidence might show). The UN IPCC has long studied a key factor in Global Warming theory, how much carbon it takes to warm the atmosphere by a certain amount. This is usually calculated based on "doubling," a hypothetical 100% increase in atmospheric carbon.

The range of "likely" climate sensitivity estimates in the UN IPCC's first (1990) climate change assessment report was 1.5°C-4.5°C for a doubling of CO_2 concentrations. That's a wide range. Today, after more than two decades of research, the so-called likely range remains 1.5°C-4.5°C. Scientists have been unable to narrow the range, much less determine the actual value, Pindyck explains, because "the physical mechanisms that determine climate sensitivity involve crucial feedback loops, and the parameter values that determine the strength (and even the sign [i.e., positive or negative]) of those feedback loops are largely unknown, and for the foreseeable future may even be unknowable."

(A feedback loop is when Factor A causes Factor B, and Factor B in turn affects Factor A, back and forth in a cycle, or when 'A' causes 'B,' which causes 'C,' which causes 'A.' For example, imagine that rising temperatures cause water to evaporate, which creates clouds, which block sunlight, which cools things down. That is the sort of process that can make it difficult to make predictions with computer models.)

As for the damage function component of SCC analysis, the part that assesses the harm supposedly caused by Global Warming, it is guesswork and yarn-spinning:

> When assessing climate sensitivity, we at least have scientific results [e.g. temperature data] to rely on, and can argue coherently about the probability distribution that is most consistent with those results. When it comes to the damage function, however, we know almost nothing, so developers of IAMs can do little more than make up functional forms and corresponding parameter values. And that is pretty much what they have done.

None of the loss functions that modelers select are "based on any economic (or other) theory," Pindyck adds. "They are just *arbitrary functions*, made up to describe how GDP goes down when T [temperature] goes up."

Damage functions are speculative because no one knows how human adaptive capabilities will develop over time. Since technology is what enables humans to adapt to whatever climatic conditions they happen to live in, SCC analysts must make assumptions about technological change over the next 50-100 years and beyond. Good luck with that! (Imagine someone in 1914 predicting today's technology, from antibiotics and DNA testing to GPS, the Internet, and iPhones.)

In a study for the Reason Foundation, economist Indur Goklany finds that modelers often fail to account for reasonably anticipated changes in future adaptive capabilities, and thus "substantially overestimate future net damages from global warming." For example, an impact assessment used in the UK Government's *Stern Review of the Economics of Climate Change* assumed that farmers in 2025, 2050, and 2085 would adapt to climate change with 1990s technologies "rather than technologies available at the time for which impacts are estimated."

Of course, societies will adapt more easily to climate change if CO_2 emissions have benefits ("positive externalities") as well as costs. Carbon dioxide is the basic compound from which plants construct their tissues, and literally thousands of laboratory and field experiments demonstrate that plants raised in CO_2-enriched environments grow faster and larger, utilize water more efficiently, and are more resistant to drought, pests, pollution, and other stresses.

In a recent study based on a large database of such research, climate researcher Craig Idso estimates that rising CO_2 concentrations boosted global agricultural output by $3.2 trillion during the past 50 years and will increase yields by another $9.8 trillion between now and 2050. Incorporating "CO_2 fertilization" benefits of that magnitude in IAMs would significantly reduce most SCC estimates. (The IAMs, remember, are the computer models that combine speculation about both Global Warming's effects and the degree to which carbon dioxide in the air causes Global Warming.)

Two of the three IAMs the Obama administration uses to estimate the SCC, the Dynamic Integrated Climate Economy (DICE) and Policy Analysis of the Greenhouse Effect (PAGE) models *have no CO_2 fertilization benefit*.

That omission alone renders those two models unfit to guide policymakers. As Idso concludes:

> The very real positive externality of inadvertent atmospheric CO_2 enrichment must be considered in all studies examining the SCC; and its observationally-deduced effects must be given premier weighting over the speculative negative externalities presumed to occur in computer model projections of global warming. Until that time, little if any weight should be placed on current SCC calculations.

Accounting gimmicks

The idea of a "discount rate" may sound complicated, but the concept is simple. Just as a bird in the hand is worth two in the bush, $100 in your pocket today is worth more than a promise to pay you $100 a year from today. Lottery winners usually take the immediate lump-sum payment, even though it is much less than the amount that would be paid over time. Since the beginning of civilization, much of the economic activity in the world is based on this concept, and any business person is familiar with the math, the "discount rate," that's used to determine the *present* value of *future* sums of money.

That principle applies to any future harm, such as harm caused by Global Warming. One of the easiest ways to get big, scary-sounding SCC estimates is to select low discount rates when making the calculations.

Like the Social Cost of Carbon? You'll love the Drake Equation

by Steven J. Allen

The Social Cost of Carbon isn't the only instance in which scientists concoct a phony formula designed to fool the public, and sometimes fool themselves.

Perhaps the most famous such formula is the Drake Equation, which is used to estimate the chance that we will contact aliens from outer space. (I'm simplifying things slightly.) Proposed by astronomer Frank Drake at a 1961 conference on SETI (the search for extra-terrestrial intelligence), the formula multiplies estimates of the number of stars, times the number of planets around the average star, times the portion of those planets that might support life, and so forth, to come up with an estimate of the number of civilizations with whom we might someday communicate.

One parallel to SCC is that the Drake Equation is self-serving to scientists and reflects their wishful thinking. Remember: The equation was created at a conference on the search for aliens, then used to justify public interest in and funding for the search for aliens.

Another parallel is that each part of the formula is highly speculative. A tiny change in each factor is enough to create a huge difference in the final result, and the estimated range for some factors is so large that no reasonable guess can be made.

Some scientists believe that earthlike conditions are common in the universe. Others (correctly, in my view) believe that the earth has many characteristics necessary for intelligent life, from its dense, gravity-producing core to its binary, regulatory relationship with the moon, that are very rare among planets. But it's the SETI-believers who dominate the public discussion and the popular imagination, because, well, the universe would be a lot cooler if everything were like *Star Trek*. So the Drake Equation is often presented as if it were proof of the likelihood of intelligent aliens.

The person who did the most to popularize the equation was present at that 1961 SETI conference. His name: Carl Sagan. Sagan, as noted in the December *Green Watch*, often used pseudoscience to push his opinions. Like many scientists who happen to be atheists or agnostics, he saw SETI as a counterweight to religion. Critics of the equation see SETI itself as a sort of religion, one that, like environmentalism and unlike many traditional religions, is socially acceptable in the academic world.

The late Michael Crichton, a physician and the creator of *Jurassic Park* and the TV show *ER*, said of the Drake Equation:

> The problem, of course, is that none of the terms can be known, and most cannot even be estimated. The only way to work the equation is to fill in with guesses. . . . As a result, the Drake equation can have any value from "billions and billions" to zero. An expression that can mean anything, means nothing. Speaking precisely, the Drake equation is literally meaningless . . .

The Drake Equation is to astronomy what the Social Cost of Carbon is to public policy—nothing more than a magicians' trick performed with math.

Dr. Steven J. Allen (JD, PhD) is editor of Green Watch.

Most of the damage from a ton of CO_2 emitted today is assumed to occur in future decades, even centuries from now. Modelers use discount rates to calculate the present value of future costs and benefits. As noted, discounting reflects the fact that people tend to attach less value to costs and benefits in the future, especially the remote future, than they do to costs and benefits in the present. The lower the selected discount rate, the larger the present value of future CO_2-related damages, and the larger the estimated SCC.

In its guidance on regulatory analysis for the federal government, a document known as Circular A-4, the Office of Management and Budget (OMB) instructs agencies to use discount rates of both 7% (the "average before-tax rate of return to private capital" in the U.S. economy) and 3% (the average rate of return on long-term government bonds). But in both its 2010 and 2013 SCC analyses, the Obama administration used only discount rates of 2.5%, 3%, and 5%. The discrepancy may look like small potatoes, but through the miracle of compounding, small differences in the annual discount rate add up to big bottom-line differences.

For example, in the administration's 2013 assessment, the SCC for 2010 is $11 per ton at a 5% discount rate but $52 per ton at a 2.5% discount rate. "In other words," notes economist Robert Murphy of the Institute for Energy Research, "cutting the discount rate in half caused the reported SCC to more than quadruple."

What would happen to the administration's SCC estimates if the models were run with a 7% discount rate, in accordance with OMB best practices?

Heritage Foundation analysts Kevin Dayaratna and David Kreutzer found that the SCC estimates generated by one of the models "shift substantially"—that is, are much lower—when reasonable alternative inputs, such as a 7% discount rate, are substituted for just a few of the assumptions made by the modeler. Specifically:

• Using a 7% discount rate reduces the DICE model's 2020 SCC estimate by more than 80%.

• Using the climate sensitivity range indicated by recent studies reduces the 2020 SCC estimate by 40%.

• If, in addition to those substitutions, projections of future damages are limited to an almost plausible time span (through 2150 rather than all the way to 2300, as in the DICE model), the 2020 SCC estimate "falls by nearly 90%, from $37.79 to $4.03."

Dayaratna and Kreutzer conclude that the DICE model is "loaded" and unfit to guide policy decisions:

> Since moderate and defensible changes in assumptions lead to such large changes in the resulting estimates of the SCC, the entire process is susceptible to political gaming. This problem exacerbates the model's more fundamental and more serious shortcomings in estimating damages in the first place. While running the DICE model (and similar integrated assessment models) may be a useful academic exercise in anticipation of solving these very serious problems, the results at this time are nowhere near reliable enough to justify trillions of dollars of government policies and burdensome regulations.

Harm to the U.S.... or the world?

Murphy of the Institute for Energy Research calls attention to another accounting trick that inflates SCC estimates. It, too, flouts OMB's regulatory best practices. (A "best practice" is a method or technique that consistently shows superior results and that is used as a standard.) The administration's February 2010 SCC assessment acknowledges that, "Under current OMB guidance contained in Circular A-4, analysis of economically significant proposed and final regulations from the domestic perspective is required, while analysis from the international perspective is optional." Yet the May 2013 update reports only *global* SCC estimates. The effect is to make climate change appear to be a bigger problem for the U.S. than even the flawed underlying analysis indicates.

The global SCC incorporates SCC estimates for developing countries, which have fewer resources for adapting to climate change. According to the administration's 2010 SCC report, "a range of values from 7% to 23% should be used to adjust the global SCC to calculate domestic effects." Thus, when the administration estimates that the global SCC in 2010 is $33 per ton, the corresponding domestic impact is only $2-$8 per ton. Not publishing the lower domestic impact helps the EPA pretend that its climate regulations pass a cost-benefit test. Murphy explains:

> Suppose the EPA issues a new regulation that causes private industry to restrict carbon emissions, and that the compliance costs (in terms of forfeited economic output in the U.S. because of the new regulation) work out to $25/ton. Using the [administration's] recent headline SCC estimate of $33/ton, this regulation would apparently pass a cost/benefit test, because the $25 cost to American industry for every ton of restricted emissions would be counterbalanced by $33 in avoided future climate change damage. However, Americans would still on net be hurt by the regulation, as they would only receive $2 to $8 of the stipulated benefits (i.e. avoiding the domestic social cost of carbon on each ton no longer emitted), while suffering the full $25 in compliance costs.

Actually, all domestic carbon-reduction policies are bound to fail a cost-benefit test. Using the UN IPCC's mid-range warming scenario, Cato's Knappenberger calculates that the total U.S. contribution to the earth's warming will be less than 0.02°C by 2100. An aggressive carbon tax might cut that contribution in half. But a 0.01°C reduction in warming—one-*hundredth* of a degree—would have no discernible impact on sea-level rise, weather patterns, or any other climate variable potentially affecting public health and welfare. In contrast, carbon taxes could significantly increase household and business energy costs, reducing GDP growth and per capita income. The policy's very real costs would outweigh its hypothetical benefits.

Editor's note: Incredibly, some environmentalists demand that the SCC calculation must include such fantastically speculative notions as the cost of future wars caused by shortages or by people moving from one region to another due to Global Warming. The inclusion of this factor in their version of the SCC is particularly amusing, given that a common trope in left-wing science fiction, known as the Genghis Gambit, is the idea that an existential threat—one like Global Warming—would cause the world's nations to put aside their differences and unite in peace and brotherhood! Of course, a key difference between environmentalists and, say, *Star Trek* fans is that the latter insist on a certain degree of continuity in their science fiction stories.—***SJA***

Repackaging uneconomic energy as a bargain at any price

A recent study by economists Laurie Johnson, Starla Yeh, and Chris Hope, *The Social Cost of Carbon: Implications for Modernizing Our Electricity System*, has the unintentional virtue of exposing what a menace SCC analysis has become.

Johnson, Yeh, and Hope (known collectively as JYH) compute carbon's social cost using discount rates even lower than the low-end of the Obama administration's range. The administration, using 5%, 3%, and 2.5% discount rates, produced year-2010 SCC estimates of $11, $33, and $52 per ton. The JYH study, using discount rates of 2%, 1.5%, and 1%, produces SCC estimates of $62, $122, and $266 per ton. JYH's lowest SCC estimate is higher than the administration's highest SCC estimate.

Those big numbers could leverage a lot of mischief if adopted by federal agencies, which is a distinct possibility. Johnson and Yeh are analysts with the Natural Resources Defense Council (NRDC), a key ally of the Obama administration's climate policies. [For more on the NRDC, see the August 2003 *Organization Trends* and various other CRC publications.] Chris Hope is the creator of the PAGE model, one of the three principal IAMs underpinning the administration's SCC estimates.

JYH translate their SCC estimates into cents-per-kilowatt estimates, and then "compare the total social cost (generation plus environmental costs) of building new generation from traditional fossil [i.e., carbon-based] fuels versus cleaner technologies." They also "examine the cost of replacing existing coal generation with cleaner options, ranging from conventional natural gas to solar photovoltaic." Their results are exactly what Global Warming campaigners want to hear:

1. In a full accounting that incorporates environmental damages, renewable energies are always more "efficient" than new coal generation, and usually more efficient than new gas generation.

2. If the SCC is $266/ton or even $122/ton, switching from coal to solar or installing carbon capture and sequestration (CCS) is more "efficient" than maintaining an existing coal power plant.

In the authors' words:

> We find that for most SCC values, it is more economically efficient (from a social cost–benefit perspective) for the new generation to come from any of these cleaner sources rather than conventional coal, and in several instances, the cleanest sources are preferable to conventional natural gas. For existing generation, for five of the six SCC estimates we examined, replacing the average existing coal plant with conventional natural gas, natural gas with carbon capture and storage, or wind increases economic efficiency. At the two highest SCCs, solar photovoltaic and coal with carbon capture and storage are also more efficient than maintaining a typical coal plant.

An obvious objection is that the average cost of generating electric power from today's existing fleet of coal-fired power plants is 3.0 cents/kilowatt-hour, as JYH acknowledge. To all relevant economic actors—consumers, power producers, and shareholders—that is pretty darn efficient. At three cents, society is getting a whole lot of bang for very little electricity buck.

But, argue JYH, a $266/ton SCC makes the "real" cost of electric power from existing coal plants ten times greater:

Specifically, at $266/ton CO_2, the average coal plant costs 34.5 cents/kWh (more than ten times its direct generation costs) versus 15.1 and 13.3 cents/kWh, respectively, for new coal with CCS and solar. At $122/ton CO_2, the average coal plant costs 18.7 cents/kWh versus 13.8 and 13.3 cents/kWh, respectively.

So here is the madness to their method. Having selected very low discount rates to produce very high SCC estimates, JYH compare their make-believe price of coal- or gas-fired electricity with the actual market price of wind- or solar-generated electricity. They then deduce that wind and solar are cheaper than new gas, and that replacing existing coal power plants with renewable energy will make the overall economy more efficient. That is loopy.

Any serious attempt to repower America with wind turbines and solar panels would cause electric rates to skyrocket. The premature retirement of the existing U.S. coal fleet, which supplies 40% of U.S. electric power, would destroy hundreds of billions of dollars in shareholder value. In addition, regulating or taxing natural gas generation based on SCC estimates of $122-266/ton would trigger massive capital flight from the gas industry.

And if SCC estimates demand corrective taxes for coal and gas, why not for oil, too? Such measures would snuff out the entire shale revolution—the most important source of new jobs, investment, tax revenue, and U.S. competitive advantage of the past 20 years.

Even if those "transitional" costs could somehow be avoided, wind and solar energy are simply too costly, intermittent, and unreliable—in a word, too inefficient—to power a modern economy. In 2012, wind and solar technologies provided 3.46% and 0.11% of U.S. electric generation, respectively. Wind and solar would not make even those meager contributions if not for mandatory production quotas in 29 states and other policies that subsidize their use.

Swapping out existing coal with solar and installing wind turbines instead of new gas would compel America to spend lots more for a more costly, smaller, and less reliable electricity supply. How can that possibly be *economically efficient*?

JYH try to finesse renewable electricity's well-known deficiencies: "An ideal comparison of costs would be one that adjusted for the intermittency of renewable sources, which is not captured in a levelized cost comparison. Adjusting for this factor is beyond the scope of this analysis, so the estimates here should be viewed as a first approximation."

In other words, JYH place "beyond the scope" of their analysis the very thing that: (1) makes kilowatts from wind and solar power less valuable than kilowatts from coal, gas, or nuclear energy; (2) renders wind and solar energy unfit to provide base load electricity (power you can depend on 24/7); and (3) disqualifies wind as a source of peaking power on summer days when the heat is intense precisely because the wind is *not* blowing.

In a study of three interconnection regions that account for more than half of U.S. installed wind capacity, economist Jonathan Lesser found that during 2009-2012, over 84% of the installed wind generation failed to produce electricity when demand was greatest. During peak hours on high demand days, only 1.8% to 7.6% of wind infrastructure generated power in the Midwest (ISO) region, only 6.0% to 15.9% of installed wind generated power in the Texas (ERCOT) region, and only 8.2% to 14.6% of installed wind produced power in the East Coast (PJM) region.

An electric power station that fails to produce during a heat wave is like subway service that's available except during rush hour. Neither is of much value, regardless of how "competitive" the rates may seem to some SCC analysts.

As Lesser put it, forcing taxpayers and ratepayers to subsidize wind "is like asking someone to pay for a taxi that does not show up when it's raining." But armed with their SCC estimates, JYH can claim the no-show taxi is a bargain at any price!

Still, JYH are to be congratulated for clarifying the nature and purpose of SCC estimation. SCC analysts adjust computer model inputs to create the illusion that uneconomic energy is "more efficient" than economic energy. They do so for the purpose of advancing an agenda that could severely damage the economy.

Making carbon-based fuels look unaffordable

The same assessment can also be stated this way: SCC analysis is a political strategy for making carbon energy, especially coal-based power, look unaffordable no matter how cheap.

The administration's SCC estimates for the year 2020 range from \$12/ton CO_2 at the low end to \$129/ton CO_2 at the high end.

What this means, according to electric power industry analyst Bob Kapplemann, is that the administration implicitly attributes over \$210 million a year in social costs to a mid-sized (600 megawatt) pulverized coal power plant and over \$74 million a year to a natural gas combined cycle power plant. In the case of the coal plant, the CO_2 portion of the social cost is 75% (with 25% attributed to particulate matter and other contaminants). In the case of the gas plant, CO_2 accounts for 97% of the social cost.

Given those damage estimates, "even radical reductions" in existing coal-fired generation can look economically justified.

For example, assume the administration's central SCC estimate of \$43/ton CO_2 in 2020, and wind and solar power become cheaper than new coal generation. Assume the administration's high SCC estimate of \$129/ton CO2, and renewable energy becomes cheaper than new gas. By fiddling with discount rates, climate sensitivity estimates, or damage functions, the EPA could easily raise SCC estimates to the point where the numbers appear to justify regulations forcing the premature shutdown of existing coal-fired generation and even gas-fired generation.

The economic effects of such bogus efficiency would likely be devastating. The Social Cost of Carbon has truly become a menace to society.

Inherently biased

As noted, SCC estimates derive from speculations about climate sensitivity (how feedback mechanisms, positive or negative, will amplify or damp down the direct warming effect of rising CO_2 concentrations), climate impacts (how projected warming will affect weather patterns, ice-sheet dynamics, sea-level rise, and eco-system services), economic impacts (how projected changes in temperature, weather, and sea-levels will affect agriculture, forestry, tourism, and other climate-related activities), and technological change (how adaptive capacities will develop to limit climate change-related losses). Uncertainties accumulate through each stage of the analysis, as do opportunities to game the assumptions to arrive at predetermined conclusions.

But even if modelers used valid scientific, economic, and technological assumptions, appropriate discount rates, and domestic (as opposed to global) SCC estimates to calculate the costs and benefits of climate policies, the models they produce would still be one-sided and misleading because SCC analysis would still leave out the *social benefits* of affordable, reliable, carbon-based energy.

In a study for the Cato Institute, Indur Goklany shows that carbon-based fuels are the chief energy source of a "cycle of progress" in which economic growth, technological change, human capital formation, and freer trade co-evolve and mutually reinforce each other. The Earth today sustains some seven billion people who on average live longer, healthier, and more comfortably, with greater mobility and more access to information, than the privileged elites of earlier times. Absent plentiful, affordable, reliable carbon energy, life for the vast majority would be nasty, poor, brutish, and short, and most of us would not even exist.

Since the cycle of progress is the very context of modern life, it is a collective good. And since the vast majority of the energy necessary for progress still comes from coal, oil, and gas, that cycle is, to no small degree, a positive "externality" of carbon-based fuels. The social benefits of carbon energy are absent from the SCC ledger.

Consequently, and more importantly, SCC analysis is blind to the social costs—the adverse effects on public health and welfare—that result from the economic losses that carbon mitigation schemes impose. The links between livelihoods, living standards, and life expectancy are more than etymological. Poverty and unemployment significantly increase the risk of sickness and death—a common-sense intuition confirmed by numerous academic studies.

Given the continuing importance of carbon-based fuels to human flourishing and the health risks of economic hardship, carbon mitigation schemes undoubtedly have social costs. Unless paired with a serious assessment of such costs, SCC analysis even at its theoretical best would still present only one side of the relevant risks and costs; it would still be partisan advocacy posing as science.

An old saying tells us that prediction is difficult, especially about the future. That's not always true. The odds are overwhelming that the Obama administration will never produce a report on the social cost of carbon *regulation*.

The public health and welfare risks of anthropogenic global warming are speculative but those of central planning and energy poverty are real and substantial. Rules, regulations, restrictions, and prohibitions based on GIGO Social Cost of Carbon estimates are likely to do much more harm than good.

Marlo Lewis is a Senior Fellow at the Competitive Enterprise Institute

GW

GreenNotes

Global Warming expert **John Beale**, a top official at the **Environmental Protection Agency**, had another job as a **CIA** agent. Actually, it turns out he was lying about the CIA. Now he's pled guilty to theft of government property and agreed to pay almost $1.4 million in fines and restitution, and he's been sentenced to 32 months in prison. The ***Wall Street Journal*** commented on his relationship with **Gina McCarthy**, now the EPA administrator: "In 2009 Ms. McCarthy became the head of EPA's **Air and Radiation office**, where Beale was a senior adviser. In 2010 she [credited] him with developing EPA policies on climate change and air quality. In September 2011, Ms. McCarthy attended a retirement party for Beale and two other EPA colleagues aboard a yacht on the **Potomac River**. On March 29, 2012, Ms. McCarthy was informed via e-mail that although he had retired the previous year, Beale was still on the EPA payroll."

Yet it was "seven months after being told that the retired 'spy' was still getting paid" that McCarthy referred the matter to the EPA's general counsel. Two Inspector General reports concluded that EPA officials "enabled" Beale by failing to check out his stories, even when he took taxpayer-funded trips to London where he stayed at five-star hotels and rented limousines. Despite her (at least) seven-month delay in reporting Beale, Sen. **Barbara Boxer** (D-Calif.) praised McCarthy for "her actions [which] helped uncover his crimes."

Three years ago, **Christiana Figueres**, executive secretary of the **U.N. Framework Convention on Climate Change**, opened the international climate conference in **Cancun** with a prayer to **Ixchel**, the **Mayans**' jaguar goddess of midwifery and medicine. Figueres continues to express herself, telling **Bloomberg News** that **China** is "doing it right" on Global Warming because it's adopted strict codes for new buildings and transportation and brought solar panel prices down by 80% since 2008 (using subsidies).

China, she added, is able to implement policies efficiently because of its political system, in which the **National People's Congress** simply carries out the decisions of the **Communist Party**, while (as Figueres was paraphrased by Bloomberg) "The political divide in the **U.S. Congress** has slowed efforts to pass climate legislation and is 'very detrimental' to the fight against Global Warming."

How does the environment fare with the Far Left in charge? On December 6, the **Associated Press** reported that **Shanghai** ordered all schoolchildren indoors when pollution reduced visibility to a few dozen meters. The concentration of small particles in the air reached more than 24 times the level considered safe. On January 16 in **Beijing's Tiananmen Square**, where the sunrise was not otherwise visible, people could see it on a giant, panoramic LED display that was set up for a tourism commercial.

By the way, a recent study indicated China's "one child" policy led to 336 million abortions since 1971—more than the current population of the U.S. The brutal policy, which included infanticide and forced abortions, was adopted at the urging of environmentalists worried about the Population Bomb, a doomsday prediction that was later discredited.

Writing in ***FrontPage*** magazine, CRC's **Matthew Vadum** noted: "Although many Americans are convinced that global warming is real, they don't believe it is enough of a problem to justify spending cold, hard cash on a supposed solution, according to the **Pew Research Center for the People and the Press**. 'The American public routinely ranks dealing with global warming low on its list of priorities for the president and Congress.' In 2013 'it ranked at the bottom of the 21 [issues] tested.'"

Meanwhile, enough Americans are so well-informed on Global Warming that both the ***Los Angeles Times*** and **Reddit**, the online news aggregator, plan to censor them. The *Times* will no longer print letters from "deniers" and Reddit's science forum has banned comments from such people.

But lack of public support won't stop Sens. Barbara Boxer (D-Calif.) and **Sheldon Whitehouse** (D-R.I.). They've formed a **Climate Change Action Task Force**, reports the left-wing blog **Daily Kos**, to "bring more attention to the issue of climate change via hearings, legislative battles, internal briefings, among other means, and to build outside support (religious groups, businesses, etc.) in order to counteract the power of fossil fuel interests." Other members: **Blumenthal** and **Murphy** (Conn.), **Booker** and **Menendez** (N.J.), **Cantwell** (Wash.), **Cardin** (Md.), **Franken** and **Klobuchar** (Minn.), **Heinrich** and **Udall** (N.M), **King** (Me.), **Markey** (Mass.), **Merkley** (Ore.), **Sanders** (Vt.), **Schatz** (Ha.), and **Shaheen** (N.H.).

Blumenthal and Markey must have a lot of time on their hands; they're also in a group of Senators attacking the **Golden Globe** awards for showing **Leonardo DiCaprio** and **Julia Louis-Dreyfus** smoking e-cigarettes during the recent broadcast (Louis-Dreyfus as part of a comedy bit).

RESOURCE DEVELOPMENT COUNCIL

Growing Alaska Through Responsible Resource Development

March 3, 2014

Senator Cathy Giessel, Chair
Senate Resources Committee
Alaska State Senate
Juneau, AK 99801

Re: Support for SCR 16

Dear Chairwoman Giessel and members of the Senate Resources Committee:

The Resource Development Council for Alaska, Inc. (RDC) is writing in support of SCR 16: *Requesting the Governor to investigate and report to the legislature regarding the development of a large coal power plant and associated electric grid to provide energy to residents of the state.*

RDC is a statewide business association comprised of individuals and companies from Alaska's oil and gas, mining, forest products, tourism, and fisheries industries. Our membership includes all of the Alaska Native regional corporations, local communities, organized labor, and industry support firms. RDC's purpose is to expand the state's economic base through the responsible development of our natural resources.

It is a policy of RDC to support utilization of Alaska's coal resources for power generation, as well as to support efforts to diversify Alaska's energy sources. RDC believes it is imperative Alaskans and Alaskan businesses have access to reliable and affordable energy.

Alaska contains about half of our nation's coal resources, much of which is of higher value due to naturally lower sulfur contents. The low sulfur content makes Alaska's coal some of the cleanest burning in the world.

Coal can provide some of the lowest cost energy of alternatives available. As Alaska is disproportionately impacted by high costs of energy, coal should be among the diverse and cost-effective energy options.

Additionally, Alaska's one large operating mine, Usibelli Coal Mine, Inc. has demonstrated a commitment to maintaining and improving the environment. RDC believes these resources and values can help offer affordable energy to Alaskans.

RDC applauds the legislature for introducing this resolution, and urges the members of this committee to pass SCR 16.

Sincerely,

Marleanna Hall
Projects Coordinator

121 West Fireweed Lane, Suite 250, Anchorage, Alaska 99503
Phone: 907-276-0700 • Fax: 907-276-3887 • Email: resources@akrdc.org • Website: akrdc.org

Fiscal Note

State of Alaska
2014 Legislative Session

Bill Version: SCR 16
Fiscal Note Number:
() Publish Date:

Identifier: SCR016-DCCED-AEA-02-28-14
Title: REQ GOV TO INVESTIGATE COAL RESOURCES
Sponsor: KELLY
Requester: Senate Resources

Department: Department of Commerce, Community and Economic Development
Appropriation: Alaska Energy Authority
Allocation: Statewide Project Development, Alternative Energy and Efficiency
OMB Component Number: 2888

Expenditures/Revenues

Note: Amounts do not include inflation unless otherwise noted below. (Thousands of Dollars)

	FY2015 Appropriation Requested	Included in Governor's FY2015 Request	Out-Year Cost Estimates				
OPERATING EXPENDITURES	**FY 2015**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**
Personal Services							
Travel							
Services	75.0						
Commodities							
Capital Outlay							
Grants & Benefits							
Miscellaneous							
Total Operating	**75.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Fund Source (Operating Only)

1004 Gen Fund	75.0						
Total	**75.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Positions

Full-time							
Part-time							
Temporary							

Change in Revenues							

Estimated SUPPLEMENTAL (FY2014) cost: 0.0 *(separate supplemental appropriation required)*
(discuss reasons and fund source(s) in analysis section)

Estimated CAPITAL (FY2015) cost: 0.0 *(separate capital appropriation required)*
(discuss reasons and fund source(s) in analysis section)

ASSOCIATED REGULATIONS

Does the bill direct, or will the bill result in, regulation changes adopted by your agency? No
If yes, by what date are the regulations to be adopted, amended or repealed?

Why this fiscal note differs from previous version:

Not applicable, initial version.

Prepared By: Sara Fisher-Goad, Executive Director Phone: (907)771-3000
Division: Alaska Energy Authority Date: 02/28/2014 05:00 PM
Approved By: Jeanne Mungle, Director Date: 02/28/14
Agency: Administrative Services Director

FISCAL NOTE ANALYSIS

STATE OF ALASKA
2014 LEGISLATIVE SESSION

BILL NO. SCR16

Analysis

The resolution requests the Governor investigate the development of a large coal power plant and associated electric grid to provide energy to the state; and to evaluate and report back to the legislature on the feasibility of locating a large coal power plant near certain coal resources. The resolution requests the Governor to report back to the legislature on (1) the potential costs of coal plants ranging in size from 200 megawatts to two gigawatts of electricity generation; (2) the cost of a kilowatt of coal-generated energy in comparison to hydroelectric, natural gas, and other energy sources; (3) the technological potential for transmission of coal-generated energy, including high-voltage direct current, and how that transmission might provide for the needs of residents of the state not part of the Railbelt power grid; and (4) how a large mine-mouth coal plant might help balance future needs of the state with hydroelectric and other types of power generation.

Upon passage of the resolution, and if directed by the Governor, AEA's contractual costs to produce the requested report in FY2015 is estimated to be $75,000.

USIBELLI COAL MINE, INC.

PO Box 1000 Healy, Alaska 99743
Telephone (907) 683-2226 • Facsimile (907) 683-2253

Senator Cathy Giessel
Chair, Senate Resources
State Capitol
Juneau, Alaska 99801

RE: Support for SCR 16

Dear Senator Giessel:

Usibelli Coal Mine Inc. (UCM) supports Senate Concurrent Resolution 16 (SCR 16) which requests the governor to investigate and report to the legislature regarding the development of a large coal power plant and associated electric grid to provide energy to Alaskans.

Alaska's energy needs have long been debated in the policy arena. While our state is rich in natural resources like natural gas, oil, and coal, we still struggle with how to best transform that wealth into viable energy solutions. Providing reliable, affordable energy to the rural and urban areas of Alaska remains a challenge.

The State of Alaska is currently analyzing a menu of energy ideas. As we consider the many implications of each of the proposed projects, it is critical to also remember that coal has provided reliable, affordable energy to Alaska for 100 years.

Usibelli Coal Mine Inc. (UCM) contracted with the McDowell Group, an Alaska-based research firm, to study the role of coal in Interior Alaska's energy supply and evaluate the economic impact of coal in the region's economy. The report can be found online at www.usibelli.com.

This analysis has identified several key findings and it is no surprise that coal is the Interior's lowest-cost source of energy. On an energy basis, coal is half the cost of natural gas, one-third the cost of naphtha, and one-sixth the cost of diesel. Without coal on our grid, energy costs in Interior Alaska would be significantly higher, perhaps $200 million annually. We all know that the Interior already faces economic challenges and that a dramatic increase to residential, commercial, industrial, and military energy prices could cripple our region.

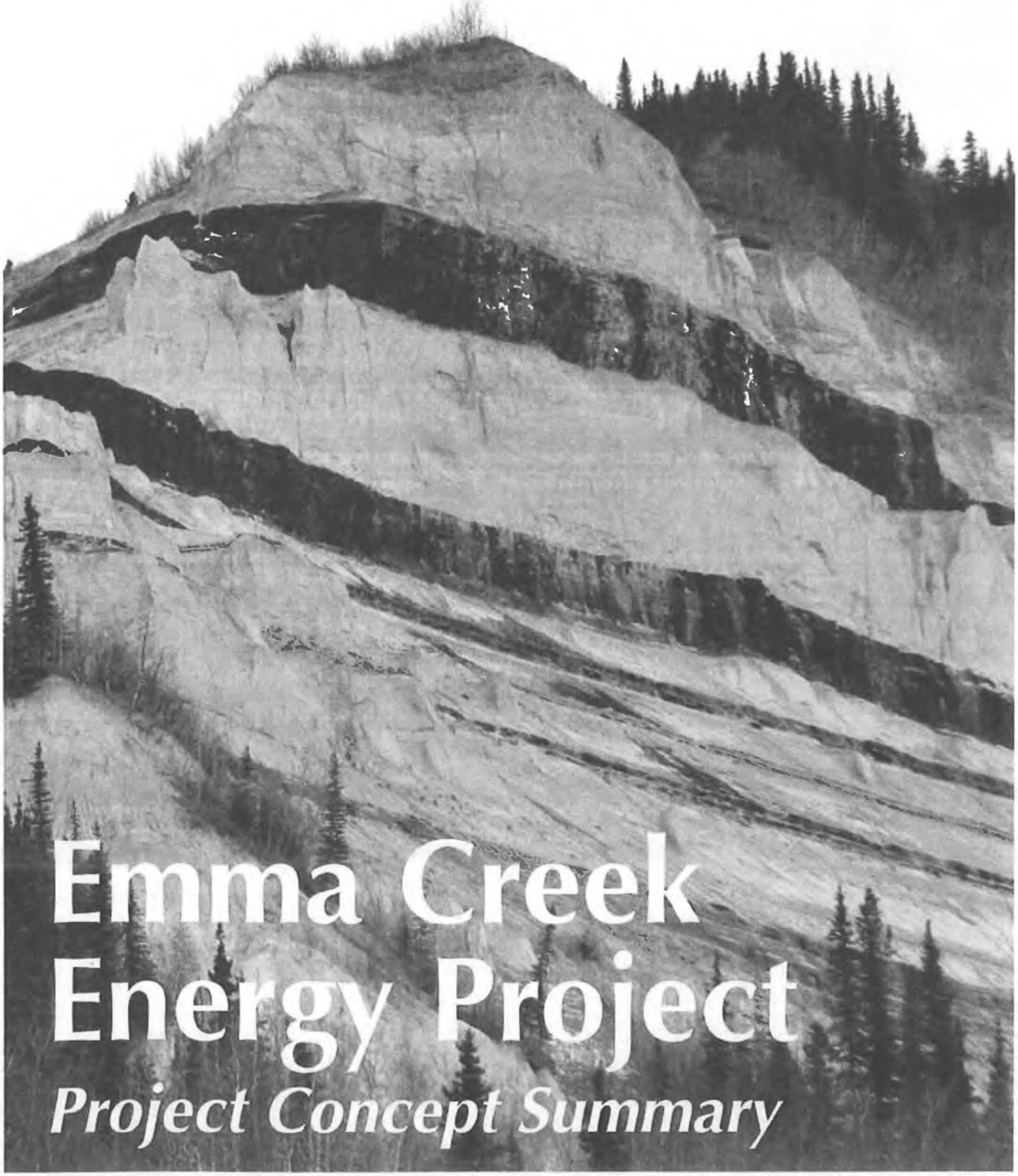
In addition to energy prices, the report highlights the impact that UCM has on the region's economy. In 2012, UCM spent $72 million with 400 different suppliers, service-providers, and organizations in Alaska. 577 Interior Alaska jobs and $44 million in annual payroll are connected with mining, distribution and consumption of Usibelli coal. Statewide, the impact is 692 jobs and $52 million in payroll.

While this report focuses on Interior Alaska, it is clear that more coal generation in Alaska would have statewide energy and economic benefits.

Usibelli Coal Mine celebrated our 70^{th} anniversary in 2013 and we still have a coal supply that will last more than another 100 years. Like my grandfather and father before me, I am proud of our company's role in building Alaska and I look forward to many more years providing solutions to Alaska's energy and economic challenges.

Sincerely,

Joseph E. Usibelli Jr.
President
Usibelli Coal Mine, Inc.



Emma Creek Energy Project

Project Concept Summary

Executive Summary

- Usibelli Coal Mine Inc. has performed a conceptual design and fatal flaw analysis for a coal fired power plant to be built near their coal leases about 16 miles northeast of Healy, Alaska, close to the new Healy to Fairbanks Intertie.
- The intended project will be a 200 megawatt (MW) net plant, fueled by Usibelli coal from their Emma Creek Mine. This is based on an analysis of the Alaskan power grid, comparison of the economics of this plant versus existing plants in Alaska and discussions with Usibelli regarding the capability of the coal mine.
- The unit will have two half-size fluidized bed boilers and a single steam turbine producing 232 MW gross. The emissions controls will include limestone addition to the fluidized bed boilers for SO_2 control, controlled NO_x production in the fluidized bed boiler via specific low NO_x combustion design and a baghouse for particulate control. Ash will be returned to the mine. There will be a new raw water reservoir constructed to provide a consistent flow of water to the plant.
- The technology chosen for the combustion of the fuel is a circulating fluidized bed (CFB) boiler. A sketch of the combustor is included with this summary. The choice of this technology is based specifically on its environmental and commercial characteristics . The emissions from a CFB meet and exceed the existing environmental regulations. CFB's are tried and proven technology with hundreds of units in operation, demonstrated reliability and competitive capital and operating costs.
- The permitting requirements for the project are outlined in Section 4. At the present time, there do not appear to be any permitting fatal flaws. There are also no technical fatal flaws associated with the project. There do not appear to be any economic fatal flaws based on today's economic conditions.
- The schedule for the project anticipates a permitting duration of 38-months and an engineer, procure, and construct (EPC) schedule of 52-months for a total duration of 7.5 years.
- The total Capital requirement is estimated at $421 million.
- Operating and Maintenance costs, exclusive of fuel are estimated at $10,197,000 or $0.00646/kWh on a yearly basis. Fuel costs are estimated at $22,066,000 or $0.0140 / kWh based on coal supplied at $1 per million BTU (mmBtu) delivered.
- The economic analysis shows power cost at $0.0411 / kWh, compared to current Railbelt firm cost of approximately $0.050/kWh. Based on a 30-year debt term at 6% interest, the cost components are:

Fuel	$0.0140/kWh
Labor	$0.0030/kWh
Fixed O&M	$0.0015/kWh
Variable O&M	$0.0020/kWh
Debt Service	$0.0205/kWh

- Emissions are expected to be less than:

SO_2	0.167 lb/mmBTU or	1842 tons/yr
NO_x	0.180 lb/mmBTU or	1986 tons/yr
CO	0.220 lb/mmBTU or	2427 tons/yr
Particulate	0.030 lb/mmBTU or	331 tons/yr

It is expected that these emission levels are permittable at the Emma Creek site.

Note

Harris Group Inc. provided the conceptual design and cost analysis and Steigers Corporation provided the environmental analysis.

USIBELLI COAL MINE, INC.

Emma Creek Energy Project Concept Summary prepared by
Harris Group Inc. & Steigers Corporation, April 2003

Project Opportunities

The proposed Emma Creek Energy Project provides unique benefits to the Railbelt utilities. 1200 MW of capacity is currently interconnected by the Railbelt transmission system, which distributes energy to the Railbelt utilities. Approximately 4.0 million megawatt-hours (MWH) of energy are currently sold by these Railbelt utilities. Oil and gas units over 25 years old produce over 70% of this capacity and energy. The Railbelt utilities are likely to experience decreasing reliability and unpredictable escalating retail energy prices due to aging units and dependence on oil and gas fuel.

Emma Creek will add 200 MW of new base loaded firm coal fired generation to the Railbelt, providing energy for future growth and retirement of aging oil and gas fired units. As a new unit with boiler redundancy, Emma Creek will be capable of a high capacity factor adding reliability to the Railbelt. Emma Creek can produce 1.6 million MWH of energy annually, while adding stability to energy prices for the Railbelt consumers.

Non-firm electricity on the Railbelt has varied between an average of 3.4 cents per kWh in 2000 to over 4.2 cents during oil and gas cost spikes in 2001. During this same period, firm electricity on the Railbelt averaged 4.7 cents per kWh. Emma Creek will produce firm wholesale electricity at approximately 4.11 cents per kWh or about 0.6 cents per kWh less than current firm electric rates on the Railbelt. If oil and gas prices are assumed to escalate 2% per year faster than coal, Emma Creek firm energy after five years of operation could provide approximately $15 million annual savings to Railbelt utilities.

Project Description

The intended project will be a 200 MW net atmospheric circulating fluid bed power plant, fueled by Usibelli coal from their Emma Creek Mine. The unit will have two half-size fluidized bed boilers and a single steam turbine producing 232 MW gross. The emissions controls will include limestone addition to the fluidized bed boilers for SO_2 control, controlled NO_x production in the fluidized bed boiler via specific low NO_x combustion design and a baghouse for particulate control. Ash will be returned to the mine.

General Plant Design Criteria

A 44.4 acre site is selected near new coal leases about 16 miles northeast of Healy, Alaska at 2,200 ft elevation. The site is located about 3 miles east of the Golden Valley Electric Association (GVEA) Northern Intertie transmission line. Coal is trucked via coal mine haul roads to the site. Cycle heat is rejected to atmosphere via a cooling tower. Both bed and fly ashes are trucked back to the coal mine and used as restoration material. Cooling tower and boiler makeup waters are supplied from a raw water reservoir to be built adjacent to the plant, located on Emma Creek.

Coal used by the plant has a BTU content of approximately 7,200 BTU/lb and an average sulfur content of 0.2%.

The plant generates nominally 200 MW net, 232 MW gross output with two circulating fluidized bed boilers. The steam turbine generator (STG) is designed for 250 MW gross, at valves wide open and throttle conditions of 1,250 psig and 950° F; however, expected output is 232 MW gross.

Crushed limestone from Alaska is trucked to the site and pneumatically unloaded into 60-day storage silos (5,400 tons).

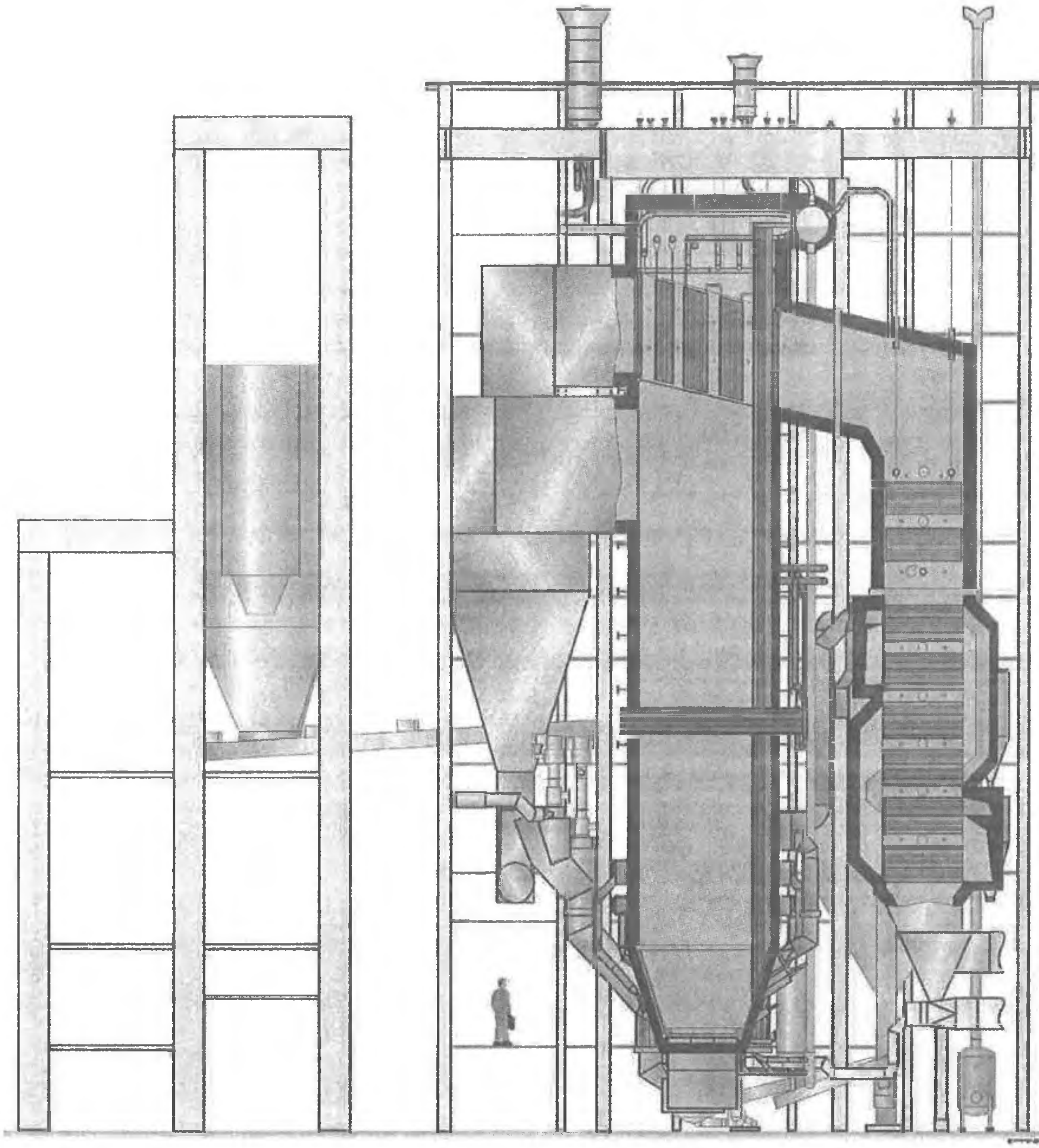
Process wastewater is used to condition ash to meet the landfill requirements or returned to the raw water reservoir.

Coal storage pile storm drainage is collected and treated before being routed to the raw water reservoir. A single, storm drainage point is formed by grading open channels that are routed to a low point and then pumped or routed by gravity to the raw water reservoir.

An earthen containment consisting of approximately 2 million cubic yards of mine overburden is planned to hold 5,855 acre-feet of water drained from Emma Creek during periods of high run-off flow and pumped from Marguerite Creek when Emma Creek can't supply the needs.

Permitting and Environmental Summary

Usibelli Coal Mine, Inc. (Usibelli) has had a permitting feasibility and fatal flaw analysis performed for construction of the 200 MW net circulating fluidized bed coal-fired power facility to be located near Healy, Alaska. The generating facility would be located near a proposed surface coal mine to be developed by Usibelli. This is a preliminary assessment of major issues based on limited data and as such provides only a basic review of these issues. Some of the information presented in this assessment was provided or corroborated through consultation with federal, state, and local agency staff, and we have relied on their representations in this assessment.



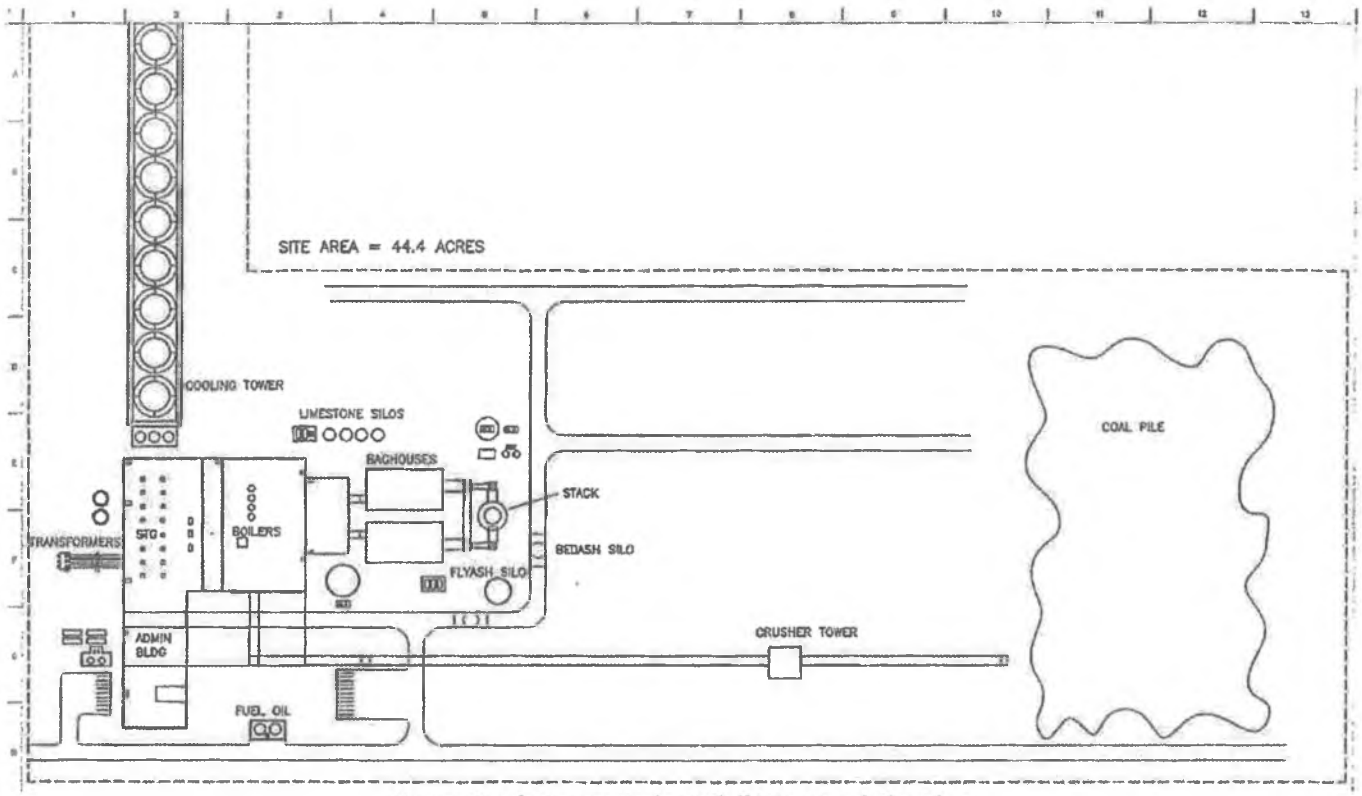
Circulating Fluidized Bed Boiler

A number of environmental issues were evaluated, and several major permits and investigations required for project development were identified. Project development will likely require a number of less significant permits, but these typically have a lesser effect on project feasibility and were not included here. A list of major permits and investigations that either would likely be required or could be required based on current project design alternatives includes:

- Air Quality Permitting
- Wetlands Permitting
- National Environmental Policy Act Compliance
- State Land Use Permitting
- Fish Habitat Permitting
- Dam Safety Permitting
- Transmission Line Construction Permitting.

Each of these permits and investigations was evaluated for any potential major issues that could complicate or impede project development. Our analysis did not identify any fatal flaws or exceptionally problematic issues associated with permitting the proposed facility.

The following is a summary of the permitting and environmental assessment results, including the estimated relative level of effort for permitting and the anticipated schedule.



Emma Creek Energy Project Civil/Structural Site Plan

Air Quality Permitting

As a new fossil-fuel-fired source of air pollutant emissions with a heat input rating of more than 250 mmBtu/hr and the potential to emit more than 100 tons per year (tpy) of nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (PM_{10}), the Emma Creek Energy Project will require a Prevention of Significant Deterioration (PSD) air quality construction permit from the Alaska Department of Environmental Conservation (ADEC).

Review of the air quality requirements did not identify any fatal flaws or exceptionally problematic issues associated with development of the PSD air quality construction permit. Because there are no existing meteorological data available that are representative of the project site, a 1-year pre- construction meteorological monitoring program would be required before dispersion modeling, which is an essential part of the PSD permit application process, could begin. Existing ambient air quality data are available that should be deemed by ADEC as representative of the project site; therefore, no pre-construction air quality monitoring should be necessary. The main air quality-related issue is expected to be the visibility impact to Denali National Park and Preserve (DNPP). The post-construction visibility monitoring for the Healy Clean Coal Project (HCCP) did not result in any concerns at DNPP and this is expected to be the case for the Emma Creek Project, which is located farther away from DNPP than the HCCP.

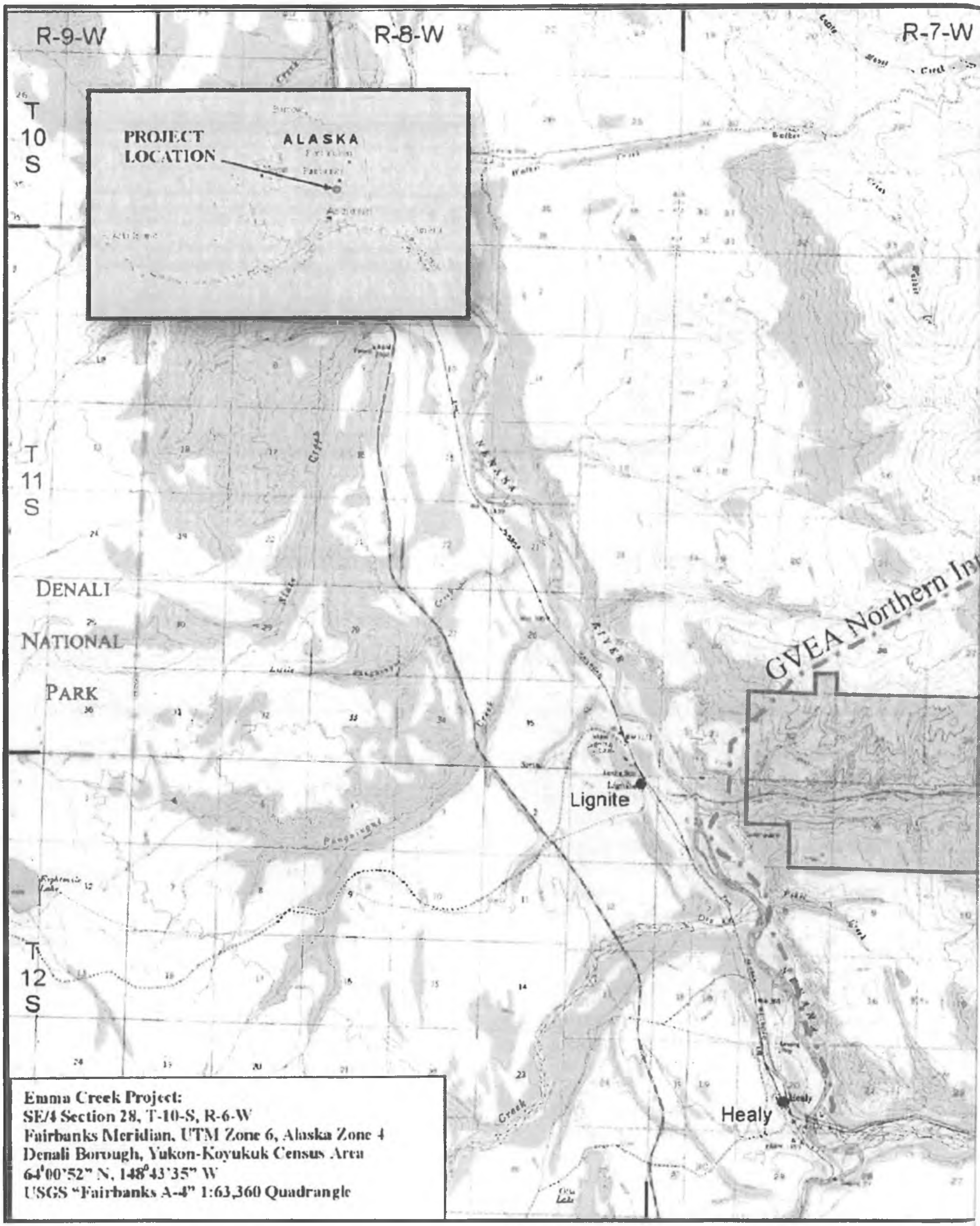
Air quality permitting for the project, including the 1-year pre-construction meteorological monitoring program, is estimated to take approximately 38 months to complete.

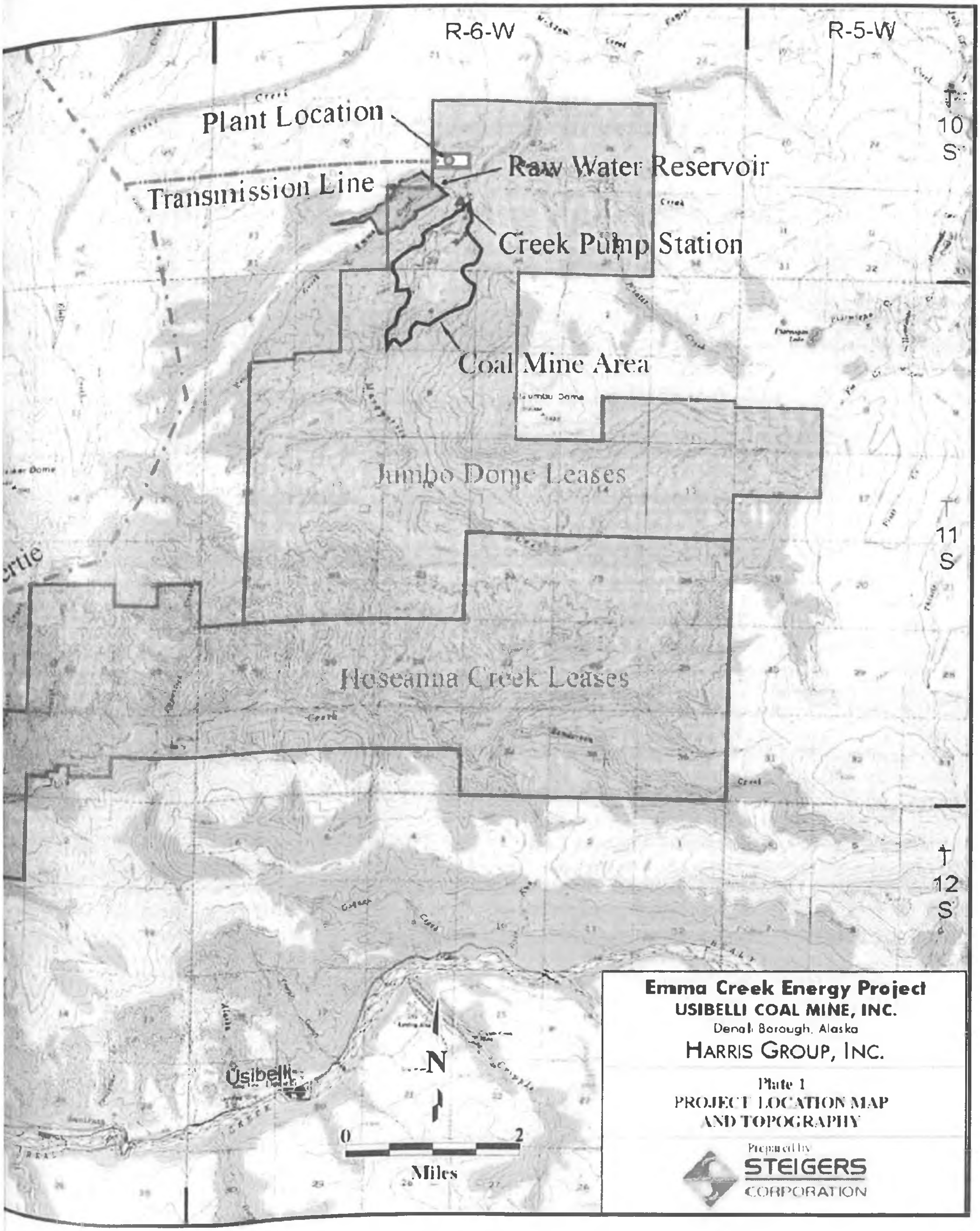
Wetlands Permitting

The United States Army Corps of Engineers (USACE) regulates impacts to wetlands and waters of the U.S. by enforcing the requirements of Section 404 of the Clean Water Act. It appears that development of the Emma Creek Project would result in permittable impacts to wetlands and/or waters of the U.S. It also appears that USACE Section 404 permitting for the project would likely be accomplished through securing an Individual permit. There is no indication that securing an Individual permit for the Emma Creek Project will require an unusually high level of effort or require an unusually long processing time for permit approval. It is expected that wetlands permitting could be accomplished in approximately 14 months.

National Environmental Policy Act Compliance

Major federal actions require compliance with the National Environmental Policy Act (NEPA), and NEPA compliance generally requires an analysis of the environmental effects of the action, typically through preparation of an Environmental Assessment (EA) and/or an Environmental Impact Statement (EIS). Assuming a USACE Section 404 Individual permit will be required for project development, then it is likely that issuance of this permit would


R-9-W
R-8-W
R-7-W
T 10 S
T 11 S
T 12 S
PROJECT LOCATION
ALASKA
DENALI NATIONAL PARK
GVEA Northern In
Lignite
Healy
NENANA
RIVER
Emma Creek Project:
SE/4 Section 28, T-10-S, R-6-W
Fairbanks Meridian, UTM Zone 6, Alaska Zone 4
Denali Borough, Yukon-Koyukuk Census Area
64°00'52" N, 148°43'35" W
USGS "Fairbanks A-4" 1:63,360 Quadrangle


R-6-W
R-5-W
T 10 S
T 11 S
T 12 S
Plant Location
Raw Water Reservoir
Transmission Line
Creek Pump Station
Coal Mine Area
Jumbo Dome Leases
Hoseanna Creek Leases
Usibelli
N
0
2
Miles
Emma Creek Energy Project
USIBELLI COAL MINE, INC.
Denali Borough, Alaska
HARRIS GROUP, INC.
Plate 1
PROJECT LOCATION MAP
AND TOPOGRAPHY
Prepared by
STEIGERS
CORPORATION

result in the application of NEPA to the project. However, for the purposes of this evaluation it is assumed that project development will require preparation of the less involved EA. This assumption is based on the project's ability to minimize its overall impacts and an evaluation of the conditions that typically result in the requirement for an EIS.

State Land Use Permitting

It has been determined that all project development will be located on state or University of Alaska (UA) owned lands. As a result it will be necessary to secure a right-of-way and/or a lease to meet the regulatory requirements under Alaska Department of Natural Resources (ADNR) jurisdiction. The final location, project configuration, and consultation with ADNR will determine which of the land acquisition requirements will apply to the project. A state and/or UA land lease will likely be required for the facility area, the reservoir, and possibly the water pipeline. A right-of-way will likely be required for the transmission line. There is no indication that any portion of the land acquisition process will be particularly difficult or costly or could result in significant project delays. It is anticipated that land use permitting could be accomplished in approximately 6 months.

Fish Habitat Permitting

The Alaska Department of Fish & Game (ADF&G) Fish Habitat permit is designed to guarantee efficient passage of fish and to protect and conserve fishery resources and fish habitat in waters designated as important for the spawning, rearing, and migration of resident and anadromous fish. Given the distance of dam/reservoir construction and water withdrawal from waters known to support anadromous fish species, the potential for impacts as a result of the project are very unlikely. It is anticipated that analysis of potential impacts will still be required by ADF&G while a Fish Habitat permit will not. A fish habitat assessment will be required to demonstrate that project related impacts will not impact downstream anadromous fisheries.

Resident fish species are most likely only seasonal occupants of these streams. Consultation with ADF&G staff indicates that regulatory requirements for impacts to these species is unlikely. ADF&G historically has not required a Fish Habitat permit for impacts to resident non-anadromous fish species and it is likely that this will also be the case for this project. It is anticipated that the habitat assessments and consultation with ADF&G to resolve fisheries issues will require approximately 27 months.

Dam Safety Permitting

ADNR Division of Mining, Land, and Water, Dam Safety Construction Unit (DSCU), regulates all dams in the State of Alaska that impound 50 acre-feet of water or more and are at least 10 feet high. The dam proposed for the Emma Creek Energy Project will impound 9500 acre-feet of water and will be approximately 120 feet high, which would require inclusion of the structure in the State Dam Safety Program. It is assumed that the project will be able to construct a dam that will meet DSCU approvable design criteria. Therefore, no difficulties are anticipated in securing the necessary dam safety permits. Due to the possibility of the dam receiving a Class II hazard rating, it is also anticipated that the project will require an Emergency Action Plan for dam operations. Dam Safety permitting is usually accomplished in approximately 1 month.

Transmission Line Construction Permitting

As an additional component of project development, the installation of an approximately 3-mile-long 230 kV transmission line from the substation located on site to the GVEA Northern Intertie will be required. Permitting for the transmission line is expected to require a number of relatively minor permits and clearances, assuming that no major resource complications are encountered. By locating the transmission line in a corridor without wetlands or potentially sensitive sites, additional permitting effort may be avoided. Approvals for construction of the transmission line should be completed in approximately 6 months.

Conclusion

As with any large development project there will be issues that arise during development that were not anticipated. However, our analysis did not identify any significant issues that would prevent or significantly complicate project development. Additional effort will be required to resolve issues associated with construction of the reservoir and the water collection structure as well as visibility issues but there is no indication that this level of effort will be excessive or resolutions to permitting issues will be unavailable. Considering the project as a whole, it is anticipated that the overall permitting effort, schedule, and cost would be moderate and consistent with a project of this size.

The overall permitting effort would likely be completed in 38 months and permitting costs are estimated at $1,850,000.

Project Costs

Capital Cost Estimate

The capital cost estimate or "Total Capital Requirement" for the project is $420.2 million. This equates to $2,101 per net kilowatt. This estimate is based on vendor budgetary quotes for major equipment, factored estimates for other equipment, construction cost estimates from the recently constructed Healy Clean Coal Project and information from other recent projects constructed in the lower 48 states.

Operating and Maintenance Cost Estimate

The O&M cost estimate shows yearly fuel costs of $22 million based on coal supplied at $1 per million BTU's and 10.2 million yearly for other fixed and variable O&M costs. This equates to a total of about $0.0205/kWh. The O&M estimate is based on utilizing 53 personnel, experience at Healy unit 1 and the Healy Clean Coal Project, historical data from other projects of similar size and commodities estimates from Usibelli personnel and local providers.

Capital Cost Estimate

Area	Total Installed Equipment Cost	$$10^6$	$/net kW
100	Coal Unloading and Handling	5.8	28.83
200	Sorbent Unloading and Handling	2.8	14.11
400	Combustion/Steam Generation	130.6	653.00
700	Power Generation	65.0	325.00
	Dam, Reservoir, Pumps and Condenser	10.0	50.00
1000	Particulate Removal	9.8	49.07
1400	Ash Collection and Removal	4.3	21.47
1500	Civil/Structural/Architectural	29.3	146.68
A	Total Process Capital	257.6	1,288.18
B	General Facilities (10% of A)	25.8	128.82
C	Engineering & Home Office (15% of A+B)	42.5	212.50
D	Total EPC Contract (A+B+C)	325.9	1,629.53
E	Development (Owners & Permits)	5.1	25.26
F	Project Contingency (10% of D)	32.6	162.95
G	Electrical Interconnect	1.7	8.50
H	Bank's Reserve Fund	6.8	34.00
I	Total Plant Cost (D+E+F+G+H)	372.1	1,860.50
J	Interest During Construction (14% of EPC)	45.6	228.00
K	Total Plant Investment (E+F)	417.7	2,088.50
L	Preproduction Costs (3 months of startup)	1.2	6.13
M	Inventory Capital	1.2	6.13
N	Initial Chemicals	0.1	0.50
O	Total Capital Requirement (J+K+L+M)	420.2	2,101.00

Operating and Maintenance Cost Estimate

	Units	Qty	$/Unit	$$10^6$/yr
Fixed O&M Costs				
Operating Labor	Man hr/hr	32	45.00	2.880
Maintenance Labor		21	45.00	1.890
Maintenance Material and Land Lease				2.100
Administration/ Support Labor				0.200
Subtotal Fixed Costs				7.070
Variable Operating Costs				
Fuels				
Coal	ton/hr	190.145	14.40	22.066
No. 2 Fuel Oil	gallons/hr	79.0	1.40	0.126
Sorbent				
Limestone	tons/hr	3.58	85.00	2.466
Utilities				
Raw Water	kgal/hr	4.7	0.60	0.023
Cooling Water	kgal/hr	included	0.60	0.000
Station Service Electric Power	kWh/hr	2,000.00	0.05	0.070
Waste Disposal Charges				
Ash Trucked and Landfilled	tons/hr	21.958	2.50	0.442
Subtotal Variable Cost				25.193
Total O&M Cost (Fixed + Variable)				32.263

Note: Non-Fuel O&M: Total O&M ($32,263,000) minus coal ($22,066,000) equals $10,197,000

Project Economic Analysis

Basis

The economic analysis for the project was developed on the basis that all of the capital required would be financed as debt. This $420.2 million is then paid at a 6% interest rate over a 30-year period. The analysis also assumes that the project will not generate a profit on its own, that is, all power will be sold at cost. This cost number is based on payment of the debt over 30-years and covering all operating costs.

We have assumed the following economic escalators:

Coal and ash disposal cost	2%
Power cost to the project	2%
Electric sales price	1%
All other O&M costs	3%

These estimated costs and economic assumptions derive an initial wholesale price requirement for power generated by the project to be $0.0411/kWh.

Sensitivity Discussion

Capital Cost

If the capital cost is actually 10% different than the estimate, plus or minus, the electric sales price required for a breakeven analysis would change by $0.0018 or about 4.3%, plus or minus. On a practical basis, assume that the project design is changed from a single 200 MW unit to two 100 MW units with independent boilers, steam turbine/generators and transformers, the net price increase in the capital cost is estimated to be about 12 million. This would result in an increase in the wholesale electric sales price of about 1% to $0.0415.

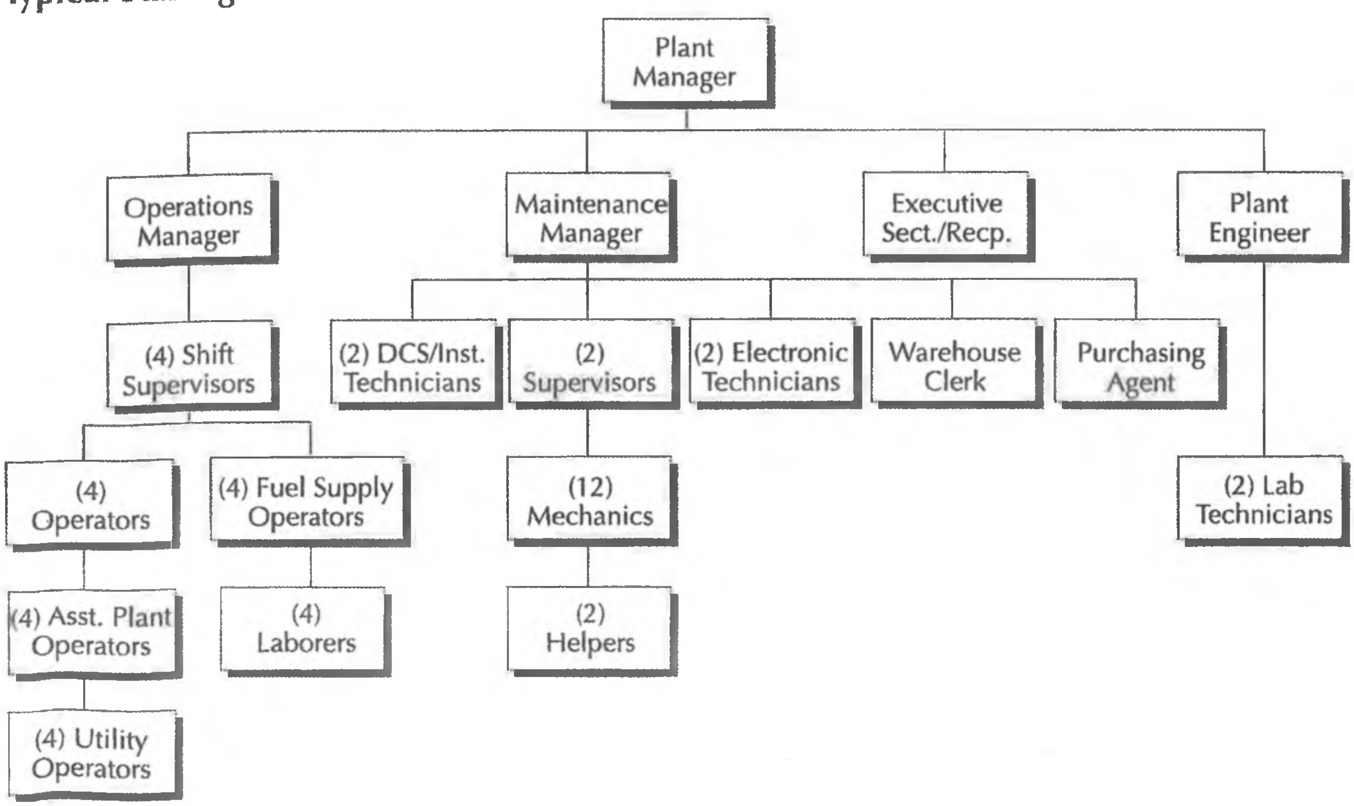
Or, if one assumes that Selective Non-Catalytic Reduction (SNCR) is required for further NOX reduction, the additional 1.2 million in capital costs and additional $500,000 in yearly operating costs would require adding $0.0006/kWh to the initial sales price.

Operating Costs

If the manpower requirements are 10 personnel higher or lower than projected in this analysis, or if rates were 20% higher or lower, the operating costs change by about $1,000,000 per year. The initial wholesale price of power would have change by $0.0011 to either $0.0422 for an increase or would drop to $0.040/kwh.

If the limestone requirements can be reduced by 20%, and Foster-Wheeler has proposed that this is possible by hydrating of ash and re-injection, the project would provide $35 million in added revenue over the 30-year life.

Typical Staffing



Economic Assumptions

If the actual escalation rate for O&M costs were only 2% over the life of the project, the project would provide about $73 million in added revenue over those 30 years.

If the actual escalation rate for O&M associated costs were 4%, the required wholesale price of power would have to increase by $0.0016 to $0.0427.

Interest Rates

The economic analysis for the project is based on an interest rate of 6%. A one percent decrease or increase in the interest rate will decrease or increase the required price of power by about $0.0018/kwh. This is, the price of power at a 5% interest rate will be $0.0393/kWh and conversely, at a 7% interest rate, the price of power would be $0.0429/kWh.

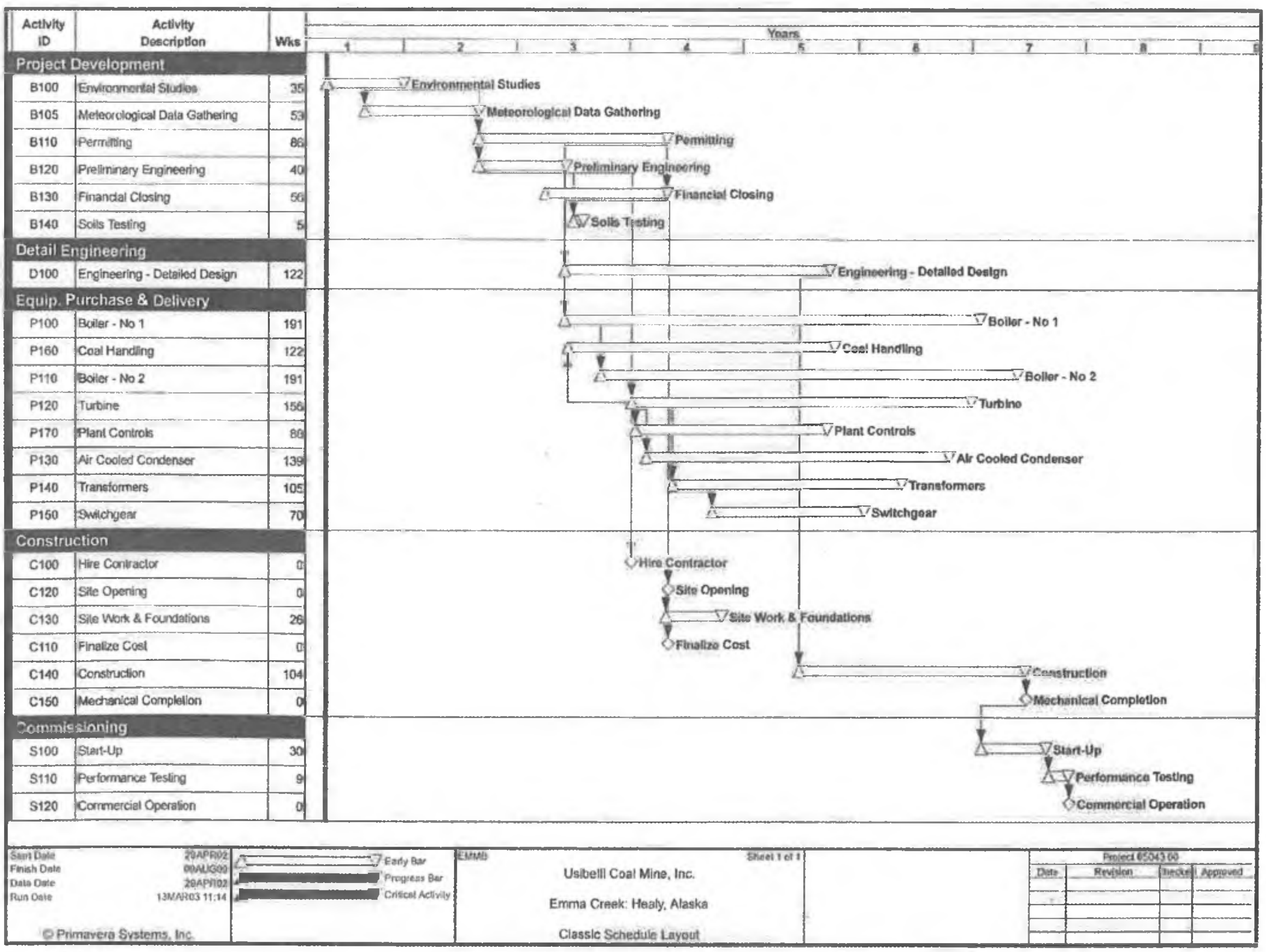
Conclusions

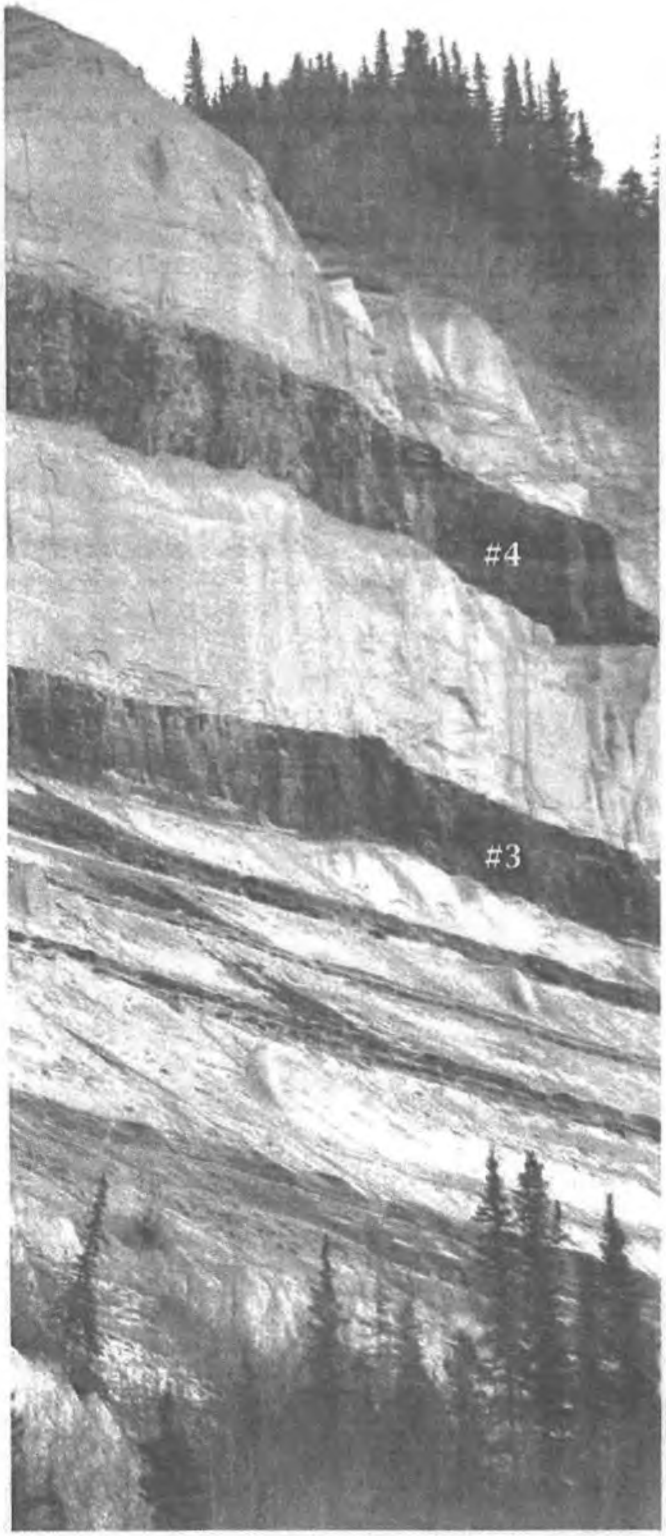
The project is not as sensitive to capital costs as it is to escalation factors and O&M costs. However, it is important to note that we believe the assumptions made and the estimates of capital costs and O&M costs are conservative.

Schedule

The schedule for the project shows a 7.5-year duration. This is comprised of 38 months of permitting and 52 months of engineering, procurement and construction. It is possible that the permitting cycle could be somewhat shorter; however, this schedule is based on other recently permitted projects in the lower 48 states and on input from project personnel knowledgeable of the Alaska permitting process.

Note that there is a break in the construction schedule in the first winter. This is consistent with the HCCP schedule and normal for major construction projects in Alaska.





Coal seams #3 and #4 are exposed in this spectacular natural outcropping of the coal-bearing rocks north of Hoseanna Creek. These two coal seams continue deep below the surface until they outcrop again near the mouth of Emma Creek, about 6 miles to the north. Near-surface coal from #3 and #4 seams southeast of Emma Creek contain enough reserves to feed the Emma Creek Energy Project for over 50 years. Seam #3 is approximately 25 feet thick and seam #4 is approximately 40 feet thick. The two coal seams are typical of the ultra-low sulfur coal found in the Nenana coal field and, using modern combustion equipment, can provide environmentally friendly heat for electricity generation to meet the needs of the Railbelt's growing economy.

science for a changing world

Mercury in U.S. Coal—Abundance, Distribution, and Modes of Occurrence

Introduction

In February 1998, The U.S. Environmental Protection Agency (EPA, 1998a,b) issued a report citing mercury emissions from electric utilities as the largest remaining anthropogenic source of mercury released to the air. EPA officials estimated that about 50 tons of elemental mercury are emitted each year from U.S. coal-burning powerplants, with lesser amounts coming from oil- and gas-burning units. According to EPA estimates, emissions from coal-fired utilities account for 13 to 26 percent of the total (natural plus anthropogenic) airborne emissions of mercury in the United States. On December 14, 2000, the EPA announced that it will require a reduction in mercury emissions from coal-fired powerplants, with regulations proposed by 2003 and final rules for implementation completed by 2004 (EPA, 2000).

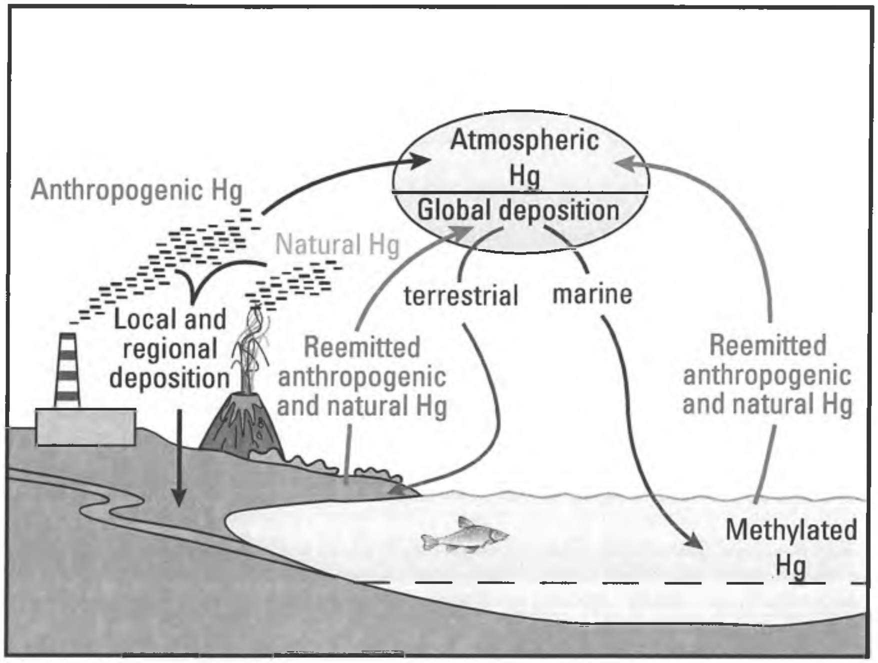


Figure 1. Simplified geochemical cycle of mercury (Hg).

Environmental Significance of Mercury

The mercury (Hg) directly emitted from powerplants generally is not considered harmful; however, in the natural environment, mercury can go through a series of chemical transformations that convert elemental mercury to a highly toxic form that is concentrated in fish and birds (fig. 1). The most toxic form of mercury is methylmercury, an organic form created by a complex bacterial conversion of inorganic mercury. Methylation rates (creation of methylmercury) in ecosystems are a function of mercury availability, bacterial population, nutrient load, acidity and oxidizing conditions, sediment load, and sedimentation rates (National Research Council, 1978).

Methylmercury enters the food chain, particularly in aquatic organisms, and bioaccumulates. Bioaccumulation is the enrichment of a substance in an organism and includes bioconcentration from environmental concentrations and additional uptake via the food chain. Cases of mercury poisoning have been documented in people who eat contaminated fish for prolonged periods, both in the United States and abroad. Pregnant women and subsistence fishermen are particularly vulnerable. Because high levels of mercury have been detected in fish, many U.S. States have issued advisories that restrict fishing.

Reduction in mercury emissions from U.S. coal-fired powerplants may help minimize or avoid health problems caused by exposure to excess mercury. There are several ways in which this reduction can be accomplished. One option to reduce the quantity of mercury in the atmosphere is to use high-rank coals. Generally, moisture in coal decreases and calorific value (thermal energy) increases as coal rank (degree of maturation) increases. Therefore, powerplants that burn high-rank coal in their boilers require less coal for a given thermal output. Thus, for coals having similar mercury concentrations, the higher rank coals will contribute less mercury to the environment. Additional options include selective mining of coal (avoiding parts of a coal bed that are higher in mercury content), coal washing (to reduce the amount of mercury in the coal delivered to the powerplants), switching from coal to natural gas, and postcombustion removal of mercury from the powerplant stack emissions. Information on the abundance, distribution, and forms of mercury in coal may be helpful in selecting the most efficient and cost-effective options for mercury reduction.

Abundance and Distribution of Mercury in Coal

The U.S. Geological Survey (USGS) has compiled a nationwide coal information database over the last 25 years. A subset of the data, called COALQUAL (Bragg and others, 1998) contains analyses of over 7,000 coal samples that have been collected or calculated to represent the entire thickness of a coal bed in the ground.

Figure 2 is a histogram of the mercury values in the COALQUAL database for conterminous U.S. coal. Statistics for all analyses indicate a mean of 0.17 part per million (ppm), with a median and standard deviation of 0.11 ppm and 0.17, respectively. About 80 percent of the mercury concentrations in the database are less than 0.25 ppm. The maximum mercury database value for coal in the ground is 1.8 ppm, after deleting one higher value as a statistical outlier.

Table 1 shows the median and mean values for mercury concentrations (in ppm) and calorific values (British thermal units per pound (Btu/lb)), as well as the number of analyses, for selected coal-producing regions in the United States, using the COALQUAL database. The mercury data in table 1 have been calculated back to an as-received basis, approximately the mercury concentration of the coal in the ground.

Northern Appalachian area coal has the highest mean and median values for mercury, with coal from the southern Appalachian area having the second highest value and coal from the central Appalachian area slightly lower. Coal from these three areas has extremely high calorific values. Coal from the Uinta region has the lowest mean and median mercury values of all indicated areas. Some western U.S. coals are low in mercury but are also low in calorific value, because they are low in rank.

The concentration of mercury can also be presented on an equal-energy basis (input load) in pounds (lb) per trillion (10^{12}) Btu to provide a convenient unit of comparison between coal from different areas (fig. 3). This is a simple calculation, dividing as-received mercury ppm values by Btu/lb and expressing the value on a 10^{12} Btu basis. The data from COALQUAL used in this analysis yield a mean U.S. input load of 14 lb Hg/10^{12} Btu (with a median of 9.7 and a standard deviation of 15). The calculated input loads from individual samples were used to calculate a mean value for each of the selected coal-producing regions listed in table 1. Mean mercury input loads were divided into arbitrary 5-unit intervals and are color-coded in figure 3. According to the Energy Information Administration (EIA, 2001), U.S. coal production, which can be roughly correlated with usage, is similar between coal regions east and west of the Mississippi River (38 and 48 percent, respectively). About 14 percent of U.S. production comes from coal in the Interior areas.

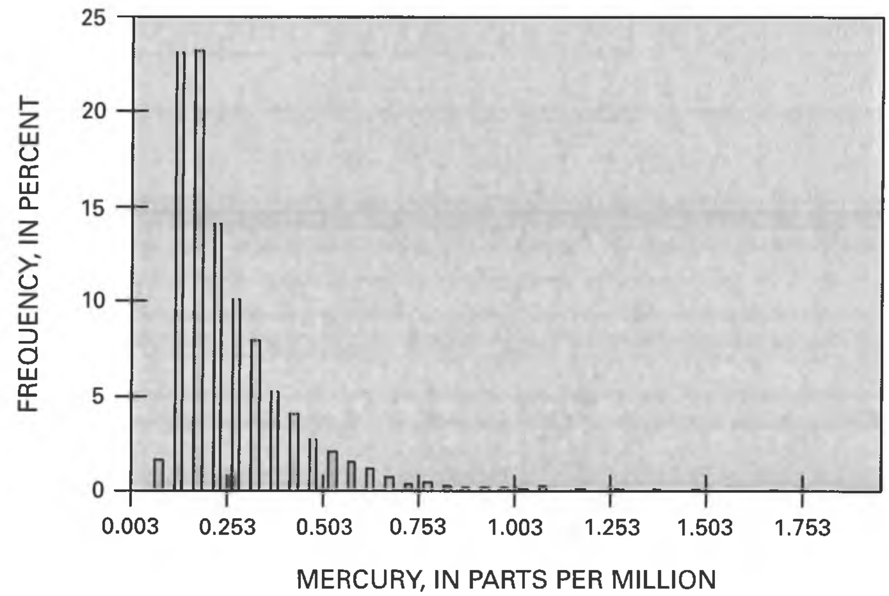


Figure 2. Histogram of mercury concentrations (remnant moisture, whole coal basis) for conterminous U.S. coal from the COALQUAL database.

On the basis of the information shown in figure 3, the Gulf Coast lignite may have the highest potential for mercury emissions, and the Green River coal from western Wyoming may have the lowest mercury emissions on an equal-energy basis. Of the two major bituminous coal-producing regions, samples from the Appalachian region contain higher mercury levels than those from the Eastern Interior. Samples from the Powder River Basin are slightly higher in mercury levels than the subbituminous coals of the San Juan River Basin.

Modes of Occurrence and Reduction of Mercury

The COALQUAL data set does not take into account the potentially substantial reduction of mercury by physical coal cleaning, because the analyses represent coal as it exists in the ground. The modes of occurrence of an element in coal can affect the way the element behaves during coal cleaning, combustion, and leaching.

Table 1. Median and mean values for mercury concentrations (in parts per million (ppm)) and calorific values (in British thermal units per pound (Btu/lb) on an as-received, whole coal basis for selected coal-producing regions in the United States.

[No. = number of analyses]

Coal-producing region	Mercury (ppm)			Calorific value (Btu/lb)		
	Median	Mean	No.	Median	Mean	No.
Appalachian, northern	0.19	0.24	1,613	12,570	12,440	1,506
Appalachian, central	.10	.15	1,747	13,360	13,210	1,648
Appalachian, southern	.18	.21	975	12,850	12,760	969
Eastern Interior	.07	.10	289	11,510	11,450	255
Fort Union	.08	.10	300	6,280	6,360	277
Green River	.06	.09	388	9,940	9,560	264
Gulf Coast	.13	.16	141	6,440	6,470	110
Pennsylvania Anthracite	.10	.10	51	12,860	12,520	39
Powder River	.06	.08	612	8,050	8,090	489
Raton Mesa	.05	.09	40	12,500	12,300	34
San Juan River	.04	.08	192	9,340	9,610	173
Uinta	.04	.07	253	11,280	10,810	226
Western Interior	.14	.18	286	11,320	11,420	261
Wind River	.08	.15	42	9,580	9,560	42

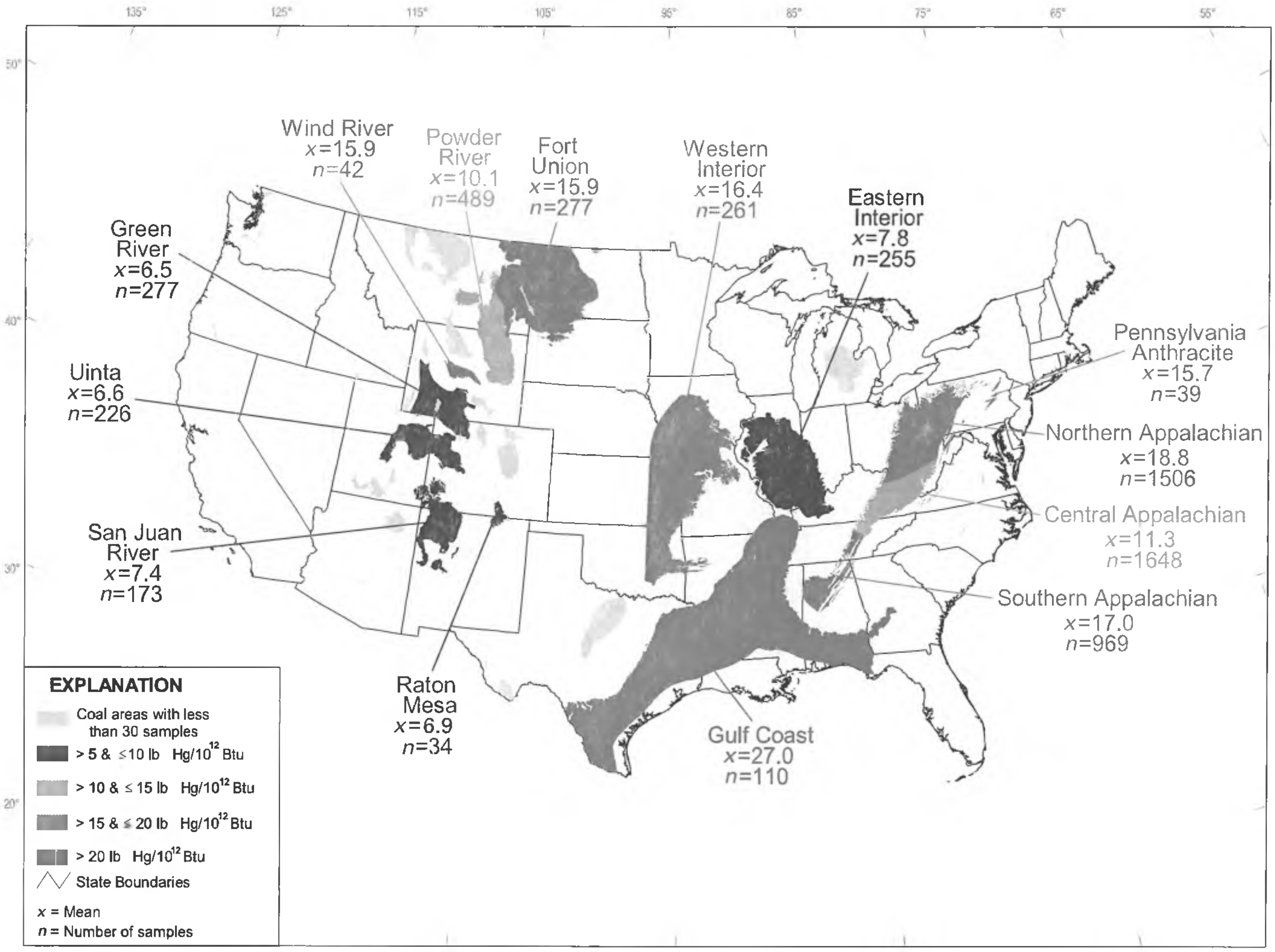


Figure 3. Mercury input loadings (in pounds of mercury per 10^{12} British thermal units (lb Hg/10^{12} Btu)) of in-ground coal for selected U.S. coal-producing regions.

Thus, the element's mode of occurrence has an important influence on its environmental and technological impacts. Because of the low concentrations (commonly less than 0.2 ppm) of mercury and its volatility, it is particularly difficult to determine the modes of mercury occurrence in coal. USGS research indicates that much of the mercury in coal is associated with pyrite, which generally forms after the coal is compacted (fig. 4). Other forms of mercury that have been reported in coal are organically bound, elemental, and in sulfide and selenide minerals (fig. 5).

The U.S. Geological Survey is collaborating on research to determine if the modes of occurrence of mercury in coal influence the formation of mercury species during the combustion process and thus the likelihood of mercury capture from the gas. The USGS has also collaborated with industry on research to assess the removability of mercury from coal by conventional physical coal-cleaning techniques. The results of these studies indicate that, on the average, 37 percent of the mercury is removed by coal cleaning (Toole-O'Neil and others, 1999). The information that the USGS is generating on mercury distribution and modes of occurrence is also relevant to mercury reduction by fuel switching, selective mining, and chemical coal cleaning. Flue gas controls on mercury (sorbent injection and hydrothermal treatment technologies) are also being evaluated by research organizations as possible economic solutions for mercury reduction.

Summary

The concentration of mercury in coal samples from the U.S. Geological Survey's COALQUAL database averages 0.17 ppm for in-ground coal in the conterminous United States. Mean values range from 0.07 ppm for coal samples from the Uinta region to 0.24 ppm for samples from the northern Appalachian coal-producing region. On an equal-energy basis, Gulf Coast coal samples have the highest input load values (27.0 lb Hg/10^{12} Btu), and the Green River region samples have the lowest values (6.5 lb Hg/10^{12} Btu).

The COALQUAL database is an extremely valuable source of information for raw or in-ground trace-element concentrations in U.S. coals and, if adjusted for the effect of coal cleaning in appropriate coals, can provide a first estimate of as-shipped mercury concentration in coal where data are not available. Physical coal cleaning is a viable method of reducing mercury that enters the combustion system and, therefore, reducing mercury that enters the atmosphere. The mean mercury concentration of eastern U.S. coals may be less than reported, if the impact of physical coal cleaning is considered.

—By Susan J. Tewalt, Linda J. Bragg, and Robert B. Finkelman

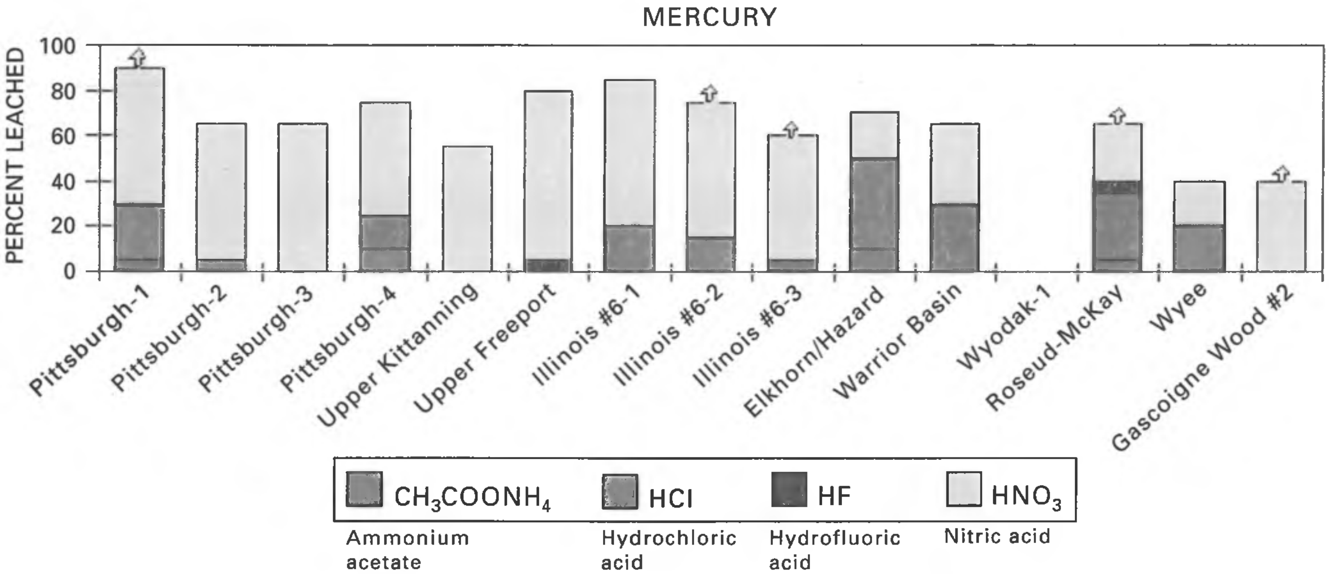


Figure 4. Selective leaching results for 15 coal samples (12 from the United States) (Palmer and others, 1998). The yellow bars indicate the proportion of mercury leached by nitric acid. This mercury is believed to be associated with the sulfide minerals, such as pyrite. Direct analysis of pyrite grains by a laser ablation mass analyzer indicated mercury concentrations consistent with selective leaching data. The green bars indicate the mercury leached by hydrochloric acid; much of this mercury may have come from oxidized pyrite. Arrows indicate minimum values.

Figure 5. Scanning electron photomicrograph of a polished block of lignite from California. The minute (less than 1 micrometer) bright spots are rare grains of mercury selenide.

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Energy and Economic Impacts of Coal in Interior Alaska





PREPARED BY

McDowell GROUP

PREPARED FOR

UCM USIBELLI COAL MINE, INC.

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Juneau • Anchorage

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Executive Summary

Usibelli Coal Mine (UCM) contracted with McDowell Group, an Alaska-based research firm, to profile the role of coal in Interior Alaska's energy supply infrastructure and assess the economic impact of coal in the region's economy. UCM is the state's only operating coal mine, producing approximately 2 million tons of coal annually. Roughly half of the mine's coal production is used in Interior Alaska to generate electricity and space heat while the other half is exported to overseas markets. The mine is located near Healy, Alaska, approximately 115 miles south of Fairbanks. This analysis has identified several key findings, including:

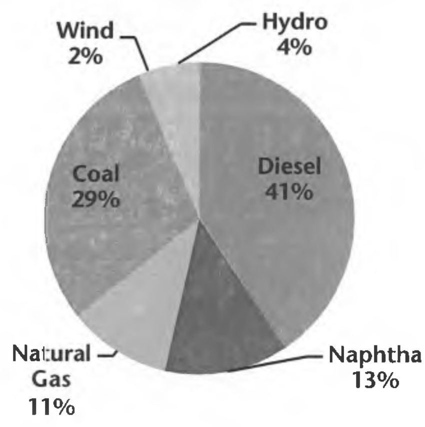
- *Coal is Interior Alaska's lowest-cost source of energy. On a per Btu basis, coal is half the cost of natural gas, one-third the cost of naphtha, and one-sixth the cost of diesel.*
- *Coal is a critical source of Interior Alaska energy. Coal accounts for over one-quarter of Interior Alaska's electrical energy capacity and nearly one-third of electrical energy generation.*
- *In the absence of Usibelli coal, energy costs in Interior Alaska would be much higher, perhaps 25 percent higher than they are today (a cost of $200 million annually depending on other fuels used).*
- *Bringing Healy Unit 2 online will double the amount of coal-fired power capacity available to Golden Valley Electric Association (GVEA), which will stabilize rates and have potential future savings of as much as $30 million annually, because of coal's much lower cost relative to other fuels.*
- *The economic impact of Usibelli Coal Mine is broad and diverse. In 2012, UCM spent $72 million with 400 different suppliers, service-providers, and organizations in Alaska.*
- *577 Interior Alaska jobs and $44 million in annual payroll are connected with mining, distribution and consumption of Usibelli coal. Statewide, the impact is 692 jobs and $52 million in payroll.*

A more detailed summary of study findings is provided below.

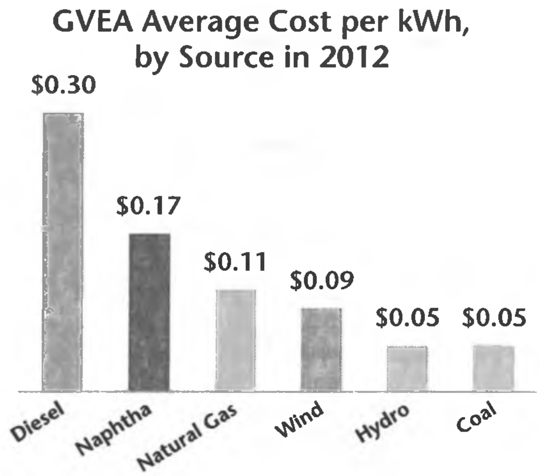
The Role of Coal in Interior Alaska Energy Generation

- Coal accounts for 29 percent of the electric power capacity in the Interior. Six coal-fired plants have a combined total of 136 megawatts (MW) of capacity. Five of the region's coal-fired plants are cogeneration plants that produce heat and electricity.
- Among the different fuel sources that can be used to generate electricity, coal is by a substantial margin the lowest cost source (excluding hydro). Based on Golden Valley Electric Association (GVEA) data, coal-generated electricity is one-sixth the cost of diesel and half the cost of natural gas-fired electricity transported over the Intertie from Southcentral Alaska.

Interior Energy Capacity, by Source



- In 2012, diesel-generated electricity cost GVEA an average of $0.30 per kilowatt-hour (kWh) to produce. The cost to generate power with naphtha (a relatively clean crude distillate) was $0.17/kWh and natural gas-fired electricity purchased over the Intertie from Southcentral Alaska averaged $0.11/kWh, according to GVEA data. Meanwhile the cost to generate electricity with coal averaged $0.05/kWh. Hydroelectric power from Bradley Lake costs $0.05/kWh, but accounted for just 4 percent of total generation. Wind-generated power from Eva Creek Wind Farm cost $0.09/kWh and accounted for 2 percent of total generation.



- If coal use was discontinued in Alaska, electricity costs would rise an estimated 25 percent in Interior Alaska, depending on what alternative fuel sources were available. Including GVEA, UAF and the military bases, the absence of coal as a fuel source would have a cost of $200 million or more annually.

- Increasing the use of coal to generate electricity will reduce the region's dependence on expensive and price-volatile petroleum products. Though the effect on consumer rates of bringing on line the coal-fired Healy Unit 2 Plant has not been determined, the project will at least stabilize rates in the near term and provide for lower costs in the future than would otherwise be the case in the absence of Healy Unit 2. Hypothetical modeling conducted for purposes of this study suggest that, with Healy Unit 2, overall generation cost savings of more than 10 percent could result, equating to $30 million a year in savings for Interior consumers, compared to what they would pay in the absence of Healy Unit 2.

- Heat generated at the five coal-fired cogeneration plants in Interior Alaska is the lowest cost heat in the region. Coal is an important, low-cost source of heat for the University of Alaska Fairbanks (UAF), the region's military bases, and most of the large buildings in downtown Fairbanks near the Aurora Energy LLC cogeneration plant.

- If the military bases in the Interior switched to natural gas, their heat and electricity costs would rise 250 percent assuming the lowest cost near-term delivery option. There is currently no natural gas available for use by the military.

UAF Case Study

- The energy cost and supply situation at UAF typifies the Interior region overall. To meet its energy needs, UAF relies on a mix of sources: coal, oil, electricity purchased from GVEA, and a small amount of natural gas. Coal accounts for 85 percent of annual energy generation but only 44 percent of the University's annual expenditures on energy. Oil accounts for 11 percent of generation and 36 percent of annual costs, and purchases from GVEA account for 3 percent of UAF's needs but 18 percent of annual spending on electricity.

- Among the energy sources available to UAF, the difference in cost is dramatic. For UAF, burning diesel is six times more costly than coal while natural gas is four times more expensive per Btu.
- UAF's 10 MW coal power plant is at the end of its useful life and will be replaced with a new, more efficient, lower-emission plant with 17 MW of production capacity. With this additional capacity, UAF does not expect to supplement its energy supply with oil, gas, or purchases from GVEA. The result will be an overall reduction in the cost of energy for UAF.
- UAF examined 13 different design options to replace their existing power plant. Weighing the factors of cost, reliability, and environmental stewardship, coal emerged as the preferred design option given new cleaner burning technology, supply stability, and lower cost than alternatives. The selected design reduces emissions (relative to the existing plant) and provides flexibility to use a blend of biomass fuel sources.
- If the new coal plant had been operating in 2012, UAF's energy cost would have been 40 to 50 percent lower.

The Economic Impact of Usibelli Coal Mine

Direct Employment and Payroll

- UCM directly employed an average of just over 140 workers in 2012. These workers earned $20.9 million in total labor income, including $15.0 million in payroll and $5.9 million in benefits.
- Average UCM wages are among the highest in the Interior and more than twice the statewide average.
- UCM jobs are a particularly important part of the Healy economy, a small community of approximately 1,100 residents. UCM directly accounts for 30 percent of all Healy employment and 60 percent of all wages paid in the community.

Workforce Residency

- The UCM workforce is 100 percent Alaska resident. This compares to a mining industry average of 65 percent Alaska resident hire and an economy-wide average of 80 percent Alaska hire. UCM's entirely resident workforce is in contrast to the Denali Borough's average of 41 percent Alaska resident workers.
- The high rate of local employment at the coal mine, along with a high level of in-region spending in support of mine operations, plus in-state downstream consumption of coal at Interior power plants, means that the economic benefits tend to stay in the Interior region.

Spending in Support of Mine Operations

- UCM has substantial indirect economic impacts. The mine's multiplier effects stem from $72 million in annual spending in Alaska in support of mine operations. This includes $51 million in spending on supplies and services, and $21 million in personnel-related expenditures.

- In 2012, approximately 400 Alaska businesses and organizations were in UCM's service and supply chain, including 195 in the Fairbanks area, 105 in Anchorage, 28 in the Mat-Su Borough, and 27 in the Denali Borough (primarily in the Healy economy). The remaining 45 businesses and organizations are scattered elsewhere in Alaska.

Indirect and Induced Employment and Payroll

- UCM's economic impact includes a large number of jobs and payroll associated with purchases of goods and services in support of mine operations (indirect effects) and associated with mine employees spending their payroll dollars (induced effects).

- Alaska Railroad (ARRC) is one of UCM's vendors, moving 1.8 million tons of coal in 2012 from the mine to Interior power plants or to the Seward coal export facility. Another 200,000 tons is transported from the mine in trucks to the Healy 1 plant.

- Other important sources of support activity include trucking large volumes of liquid motor fuel from Fairbanks and from Seward to the mine (to fuel the mine's heavy equipment). UCM is also an important customer for Alaska's heavy equipment dealers and service providers.

- Based on modeling conducted for purposes of this study, UCM accounts for approximately 212 indirect and induced jobs in the Interior region and $11.5 million in payroll. Statewide, UCM accounts for approximately 327 indirect and induced jobs and $18.9 million in annual payroll. This is an estimate of the total number of "upstream" jobs associated with UCM operations. It does not include "downstream" impacts, i.e., those jobs and income at power plants that rely on UCM coal.

Regional and Statewide Employment and Payroll Impacts

- Including all direct, indirect and induced employment, in 2012 UCM accounted for approximately 355 jobs in Interior Alaska and $26.5 million in total annual payroll. Statewide, the mine's impact included a total of 470 jobs and $33.9 million in payroll.

- UCM's economic impact includes financial support of non-profit organizations, through the Usibelli Foundation. The Foundation contributes to over 100 nonprofit organizations statewide, with total annual contribution averaging $112,000 over the past few years. Grants are made in the areas of education, health and social services, the arts, youth programs, and civic organizations and activities. The Usibelli Foundation also matches employee donations to United Way and several other community organizations in Healy.

Other Coal-Related Economic Impacts

- The economic impact of UCM includes significant in-state "downstream" effects. Downstream economic impacts occur when buyers of coal add value by converting it to electricity and space heat. The process of converting coal to energy has its own set of economic impacts as power plants employ workers and purchase goods and services in support of their operations.

- Downstream jobs associated with UCM include the power plants that buy and use UCM coal, namely the plants operated by GVEA, UAF, Aurora Energy LLC, and the military facilities at Clear Air Force Station, Ft. Wainwright, and Eielson Air Force Base. Employment at these facilities totaled 222 workers in 2012.

- More difficult to quantify, but perhaps more important (from an economic impact perspective) than the jobs at coal-fired power plants, is the role coal has played in keeping Interior energy costs well below what they would be in the absence of coal. Because energy costs are an important cost of doing business, the Fairbanks economy would likely be smaller if not for the low-cost energy provided by coal.

- Looking forward, the high cost of energy in Interior Alaska will continue to act as a constraint on economic development. Without the reliable and low-cost energy made possible by UCM, the Interior economy would be facing much stronger energy cost-related headwinds.

Summary of UCM Economic Impacts, 2012

	Impacts
Direct Impacts	
Annual average employment	143 jobs
UCM employee payroll	$15.0 million
UCM employee labor income (payroll plus benefits)	$20.9 million
Spending on goods and services with Alaska-based vendors	$50.7 million
Number of Alaska-based vendors	400 vendors
Upstream Multiplier Effects (related to UCM spending on goods and services)	
Indirect and induced employment in Interior Alaska only	212 jobs
Indirect and induced employment statewide	327 jobs
Indirect and induced payroll in Interior Alaska only	$11.5 million
Indirect and induced payroll statewide	$18.9 million
Downstream Impacts	
Interior Alaska coal-fired power plant employment	222 jobs
Interior Alaska coal-fired power plant payroll	$17.8 million
Total Employment and Payroll Impacts	
Total employment (direct, indirect, induced and downstream) in Interior Alaska	577 jobs
Total employment (direct, indirect, and induced) statewide	692 jobs
Total payroll (direct, indirect, and induced) in Interior Alaska only	$44.3 million
Total payroll (direct, indirect, and induced) statewide	$51.7 million

Source: Direct impact figures from UCM. All others are McDowell Group estimates.

Introduction

The purpose of this study is to profile the economics of coal in Interior Alaska, including the role of coal in the region's energy infrastructure and the economic impact of coal mining, in terms of jobs and income. The study will also explore the potential economic impact of conversion of the Interior's five cogeneration heat and power plants from coal to natural gas.

The Interior of Alaska, a region stretching from Cantwell to Delta and including the Fairbanks North Star Borough, faces a paradoxical energy situation. While an average of 500,000 barrels of crude oil run through the nearby Trans-Alaska Pipeline System every day, businesses and residents struggle with some of the highest costs of energy in the nation as a result of heavy reliance on costly petroleum products.

As petroleum prices have risen, the Interior finds itself in a difficult situation, with high and unpredictable energy costs eating into household budgets and constraining economic growth. In recent years residential rates for electricity have been as high as $0.22/ kWh (kilowatt hour) and heating oil as high as $4.30 a gallon. Heating oil, a fuel that has increased 180 percent in price in the last 10 years, warms 86 percent of residential homes. Golden Valley Electricity Association (GVEA), the utility that provides electricity to the area, relies on diesel and naphtha for 43 percent of its electric generation. Meantime, coal has provided a steady and low-cost source of energy for the region.

Currently the only active coal mine in Alaska, Usibelli Coal Mine supplies 100 percent of the coal used to generate electricity and heat in the Interior. The mine, in operation since 1943, is located 115 miles south of Fairbanks in Healy, in close proximity to the large population center of Fairbanks and military bases (Eielson Air Force Base (AFB)), Ft. Wainwright, and Clear Air Force Station (AFS)) within Interior Alaska. The mine produces an average of 2,000,000 tons of coal per year with roughly half used in the Interior for heat and electric generation and the remainder exported to overseas markets from a facility in Seward.

Understanding the role of coal in Interior Alaska requires an understanding of the entire energy landscape in the region. This report begins with a profile of Interior Alaska's existing energy supply and infrastructure. Chapter 2 provides information on the cost of various sources of energy in the region. In Chapter 3, various efforts to develop new sources of energy are profiled. Chapter 4 examines coal's place in the region's future energy supply. Finally, in Chapter 5, the economic impact of Usibelli Coal Mine is profiled, including an assessment of direct economic impacts as well as mine-related multiplier effects.

Methods and Sources

A variety of data sources were used for this study. Usibelli Coal Mine provided McDowell Group with data on direct employment, payroll, benefits, vendor spending, and tax payments. McDowell Group also relied on data from the Alaska Department of Labor and Workforce Development and the federal Bureau of Economic Analysis. IMPLAN, a model for estimating economic impacts of industry activity, was used to assess the mine's multiplier effect on Alaska and the local economy. McDowell Group also conducted interviews with a number of stakeholders knowledgeable about Interior Alaska energy production and consumption.

Chapter 1: Interior Alaska's Existing Energy Infrastructure and Supply

Overview

The purpose of this chapter is to provide a profile of Interior Alaska's energy infrastructure, and coal's place within that infrastructure. Interior Alaska relies on a complex blend of fuel sources and energy products. The majority of electricity comes from diesel, naphtha, and coal while heating is provided primarily from coal and heating oil. A few very large energy users in the Interior (military bases and UAF, for example) produce heat and electricity with coal cogeneration plants. Cogeneration technology allows a single power plant to provide both electricity and heat.

Other energy consumers purchase large amounts of electricity from GVEA for industrial purposes (Fort Knox gold mine, for example) and use heating oil for heating purposes. For all other consumers except the military bases and UAF, electricity is purchased from GVEA. Heating oil sold by a network of local dealers is the primary source of fuel for heat. A small, but growing, amount of coal, natural gas, propane, firewood, and pellets are used for heating residences and small commercial businesses as well.

Utilities

Four utilities serve the Interior and provide electricity and heating services: Golden Valley Electric Association (GVEA), Doyon Utilities, LLC, Fairbanks Natural Gas, LLC (FNG), and Aurora Energy, LLC.[1]

- GVEA is the largest utility in the Interior, providing electricity to residential and commercial/industrial customers. Serving an area from Cantwell to Delta, the utility has 37,270 residential meters and 501 commercial/industrial meters.
- Aurora Energy, LLC operates a coal-fired cogeneration plant that sells wholesale electricity to GVEA, and markets steam-heat and hot water heat to 192 residential and commercial customers in the downtown Fairbanks area.
- Doyon Utilities, LLC (DU) owns and operates a coal-fired cogeneration plant that produces electricity and steam for use at Ft. Wainwright. DU also owns and operates a diesel-fired steam generator that fulfills the heating needs of Ft. Greely. DU has a 50-year contract with the Department of Defense for three army posts (Fort Wainwright, Fort Greely, and JBER Richardson located in Anchorage).
- Fairbanks Natural Gas, LLC (FNG) sells natural gas for heating and domestic use to approximately 1,100 customers in Fairbanks. FNG trucks the natural gas from Cook Inlet and distributes it in the Fairbanks area. The utility plans to expand its service area and is an active player in the proposed plan to truck natural gas from the North Slope.

[1] Interior Gas Utility (IGU) is a public corporation formed in 2012 by the Fairbanks North Star Borough. IGU plans to provide sections of Fairbanks with natural gas and propane. At this time IGU has no ratepayers.

Virtually all Interior energy users rely on GVEA for electricity, and based on where they are located usually choose the lowest-cost source of heating available to them.

Fuels for Electricity Generation

Electricity used in the Interior is produced mainly from fossil fuels. Diesel, naphtha, natural gas, and coal provide approximately 90 percent of the fuel necessary to produce this electricity. Hydroelectric, wind, and a very small amount of solar complete the portfolio.

The Interior's electricity infrastructure is unique for the population that is served. Despite having just over 100,000 residents, the region has 12 major facilities that produce heat and/or electricity. Compared to other population centers, this ratio is unusually high. While a diverse energy supply base can have its benefits, the high number of facilities hampers economies of scale for electricity generation that might otherwise be possible with a more consolidated infrastructure.

Utilization of various sources of fuel for electrical energy generation is described below.

Coal

- Eielson AFB's cogeneration plant has a capacity of 25 MW (megawatts). Constructed in 1952, the plant burns approximately 180,000 tons of coal annually.
- Doyon Utilities' 20 MW cogeneration plant produces electricity for Ft. Wainwright. The facility was built in the 1940s with major additions in the mid-1950s. The plant uses 280,000 tons of coal per year and completed major refurbishments in 2003 and 2005.
- Clear AFS operates a 23 MW cogeneration plant that was built in 1961 and uses about 55,000 tons of coal per year.
- University of Alaska Fairbanks' 10 MW plant burns approximately 70,000 tons of coal per year and was built in 1964. A replacement coal plant is being permitted and the current plant will operate as back-up.
- The privately owned Aurora Energy cogeneration plant, located in Fairbanks, is a 32 MW plant that sells wholesale electricity generated to GVEA. The plant was built in 1952 and uses 210,000 tons of coal a year.
- The 25 MW Healy Unit 1 plant is operated by GVEA and uses 200,000 tons of coal per year. Located close to UCM, the plant has produced power since 1967.

Diesel

- GVEA's 40 MW Zehnder Power Plant is located in downtown Fairbanks and burns diesel.
- The GVEA North Pole Power Plant has a capacity to generate 120 MW. The plant was built in 1976 and uses two 60 MW diesel turbines to produce electricity.
- GVEA's Delta Power Plant was built in 1976 and uses diesel to generate a maximum of 27 MW. This plant is used primarily as a back-up generator.
- In total, GVEA burned 16 million gallons of diesel in 2012.

Naphtha

- GVEA's North Pole Expansion Power Plant uses naphtha and can generate 60 MW. Built in 2006, the plant can add another turbine to double its power generation capability. The power plant can be retrofitted relatively easily to burn natural gas. The plant used 26 million gallons of naphtha in 2012.

Natural Gas

- The electricity that comes through the Intertie from Southcentral Alaska is produced mainly from Cook Inlet natural gas. The Railbelt Intertie from Wasilla to Healy was completed in the 1980s and provides 70MW of transmission capacity between Southcentral and Interior Alaska. That is, Interior access to the combination of natural gas and Bradley Lake hydroelectricity is limited to 70MW. The Northern Intertie was completed in 2003 and provides a second transmission route from Healy to Fairbanks and the two transmission lines provide approximately 140MW of combined capacity between Healy and Fairbanks.

Hydroelectric

- Located 27 miles southeast of Homer, the 120 MW Bradley Lake hydroelectric dam is owned by six Alaska utilities. Completed in 1991, GVEA owns 17 percent (20 MW) of the dam's output. Bradley Lake power feeds into the Intertie that connects the Southcentral generation to the Interior.

Renewable Energy

- The 25 MW Eva Creek Wind farm is owned and operated by GVEA. Located north of Healy, the 12-turbine wind farm was completed in 2012. The plant is forecasted to operate at 36 percent capacity due to wind speed fluctuations, which means that the facility will operate at 9 MW on an annual average basis.

- A small amount of electricity comes from GVEA members who own solar panels or wind turbines. Known as the Sustainable Natural Alternative Power Program (SNAP), members are reimbursed for electricity that is fed into the grid.

Summary of Interior Electricity Generation Infrastructure, 2012

Fuel	Number of Plants*	Capacity (MW)	Percent of Total Capacity	Percent of Total 2012 Generation
Diesel	3	187	41%	13%
Coal	6	133	29	31
Intertie**	1	70	15	25
Naphtha	1	60	13	30
Wind	1	9	2	2
Total	**12**	**459**	**100%**	**100%**

Source: GVEA 2012, RCA 2012, and McDowell Group estimates. *Only plants larger than 1 MW are included.
**The Intertie includes hydroelectric and natural gas purchases from Southcentral.

Fuels for Generating Heat

Heating oil is the main source of fuel for residential space heat in the Interior. The amount of heat required in a region can be expressed in terms of heating degree days (HDD). This is a measurement of the amount of energy required to maintain a comfortable temperature (65°F) inside a building relative to outside temperatures. A region like Hawaii requires 0 HDD, because the average daily temperature is above 65°F, while Seattle requires 5,000 HDD.[2] With Interior Alaska at 14,000 HDD, a building in Fairbanks that is similar to a building in Seattle will require almost three times the heat to maintain a temperature of 65°F.

Heating Oil

A 2009 housing assessment estimated that 86 percent of residential homes in Fairbanks use heating oil as a primary fuel source for home heating.[3] This study, though limited to Fairbanks, is representative of the rest of the Interior. While many commercial buildings, such as schools, stores, and office buildings, rely on heating oil, more options are available for this type of energy user. A significant number of commercial buildings are clustered in areas that have alternative sources of heat available, such as natural gas or steam from coal cogeneration facilities. Additionally, because the average commercial building requires more heat than the average residential structure, the economics of accessing and using alternative fuel sources can be more favorable.

Natural Gas

Approximately 1,100 homes and several commercial buildings use natural gas in Fairbanks. Access to natural gas is limited at this time and only available in a small portion of Fairbanks.

Coal

Coal cogeneration technology provides heat for a number of large Interior energy consumers. Steam from electrical generation is piped to buildings to be utilized for heating purposes. Used at Eielson AFB, Clear AFS, Ft. Wainwright, and UAF, this steam is the cheapest source of heat available in the Interior. In addition to these large institutional users, the Aurora plant sells steam or hot water for heating 192 homes and commercial establishments in the core of Fairbanks.

All but one (Healy 1) of the Interior's coal-fired plants are cogeneration plants, which provide heat for area buildings as well as electricity. As coal is burned, water is heated into steam. This steam is used to either turn a turbine (making electricity) or sent in underground pipes as either steam or hot water (to provide heat to buildings in close proximity – two to three miles – to the plant). This approach to heating is very common in colder areas. While opportunities for district heat are limited by the amount of steam a plant is capable of making, and by the distance from the plant, it is efficient, clean compared to alternatives, maintenance free, and cost-effective. In Interior Alaska, it is less expensive than all other options, primarily due to the attractive price of coal compared to other fuel choices.

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[2] http://www.ncdc.noaa.gov/img/documentlibrary/clim81supp3/annualheatingDD_hires.jpg

[3] http://www.cchrc.org/docs/reports/TR_2009_02_2009_AK_Housing_Assessment_Final.pdf

Other Sources

The recent rise in heating oil cost has increased interest in alternative sources of fuel for heating. Many residential buildings are augmenting oil use with wood or pellets. A small number of residential and light commercial customers are using outdoor boilers that burn coal and wood. Other fuel sources, such as electricity, solar thermal, and propane, complete the types of fuel that are used for heating in the Interior.

Chapter 2: The Cost of Energy in Interior Alaska Today

Overview

Residents of Interior Alaska pay some of the highest electric and heating costs in the United States. The combination of a sub-arctic climate and a reliance on oil for residential heating and electricity generation results in the region's high costs. Because the average home requires 1,086 gallons of heating oil per year, annual average heating costs are roughly $5,000.[4] Combined with an average annual electricity usage of 8,000 kWh, the average home in the Interior spends more than $6,000 a year for electricity and heat.[5] According to the Council for Community and Economic Research, utility costs in Fairbanks are 220 percent of the national average.[6,7] By comparison, Anchorage is 104 percent of the national average and Juneau is at 172 percent.

Electricity Costs

GVEA electricity rates have regularly exceeded 180 percent of the national average. With 43 percent of the electricity produced by GVEA in 2012 coming from diesel or naphtha, any increase in oil prices raises the cost of electricity for ratepayers. In 2012, electrical rates peaked at $0.22/kWh before settling at the current price of $0.19/kWh.

Comparison of Average Residential Electricity Rates per kWh

Location	Cost per kWh
Hawaii	$0.37
Interior Alaska	**0.19**
California	0.16
Anchorage	0.13
U.S. Average	0.12
Washington State	0.09

Source: EIA 2013, GVEA 2013, Chugach Electric 2013.

The relationship between oil prices and the cost per kWh is strong but may weaken as non-oil sources of electricity generation are brought online. The newly constructed Eva Creek Wind Farm is an example of a project that has the potential to displace expensive diesel power generation. However, any effect is expected to be small as the wind farm currently produces a relatively small amount of electricity and is not considered as reliable as electricity generated from a diesel or naphtha turbine. Whenever electricity from wind is being

[4] http://www.cchrc.org/docs/reports/TR_2009_02_2009_AK_Housing_Assessment_Final.pdf
[5] http://www.gvea.com/rates/billexplained
[6] http://labor.alaska.gov/trends/jul13.pdf
[7] Utility costs include other services such as sewer, trash, and water.

used, diesel, coal, or natural gas fired generation must still be available as back-up generation in case the wind dies.

GVEA actively manages various fuel sources for power generation to meet demand while minimizing costs. Cheaper fuel sources such as coal and the Intertie are used first and more expensive fuel sources such as diesel are brought online as demand increases. As demand for electricity has risen, the more expensive fuel sources of electricity have been used more frequently. At the same time, these sources have increased in cost with the rise of oil prices.

In contrast to oil prices, coal prices have been relatively steady over the last ten years. Purchasing 1 million British thermal unit (MMBtu) for electricity generation in the form of diesel currently costs $21 while the same amount of energy from coal costs less than $4. The availability of coal as a relatively low cost and stable source of energy has helped soften the effect of the dramatic increase in oil prices.

As illustrated in the following table, coal is a substantially lower-cost source of electrical energy; one-sixth the cost of diesel and less than half the cost of electric power provided by natural gas.

Average GVEA Production Costs per kWh in 2012 and Percent of Total Generation by Fuel Type

Energy Source	Cost per kWh	Percent of Generation
Diesel	$0.30	13%
Naphtha	$0.17	30%
Natural Gas	$0.11	18%
Wind	$0.09	2%
Coal	**$0.05**	**31%**
Hydro	$0.05	6%

Source: GVEA 2013, RCA 2013.

Heating Costs

With 86 percent of residential homes using heating oil as the primary source of heating, any increase in the price of oil raises the cost of warming a home.[8] Most commercial buildings in the Interior are in the same position.

The cost of heating oil per gallon peaked in Fairbanks at $4.30/gallon in 2008 before settling at a current price of $3.78/gallon (12-month average). With the average home in Fairbanks requiring 150 MMBtu annually, the current annual cost to heat a home is estimated to be approximately $5,000.

Some residential and commercial buildings are able to access natural gas or district heat. While less expensive than heating oil, access is limited and a relatively small number of the Interior's buildings are connected to

[8] http://www.cchrc.org/docs/reports/TR_2009_02_2009_AK_Housing_Assessment_Final.pdf

these services. As heating oil has become more expensive, wood, coal, and pellets have all increased in use. This substitution away from heating oil is occurring mainly in residential homes. A common strategy for reducing home heating costs is to continue using heating oil but augmenting its use with cheaper sources, such as wood or pellets. A 2010 survey of Fairbanks households estimated that heating oil use per household has fallen 20 percent compared to 2007.[9] An increase in the use of other fuel sources, as consumers react to expensive heating oil, is credited for this reduction.

Fairbanks Residential Heating Costs, 2013

Type of Fuel (Delivered)	Cost per Unit	Heat Content per Unit (Btu)	Cost per MMBtu ($)	Approximate Efficiency (Percent)	Annual Cost to Heat Average Home ($)
Electricity	$0.19/kWh	3,412	$55.69	100%	$8,353
Propane	$3.78/gallon	91,000	41.65	78	8,009
Heating Oil	$3.78/gallon	138,000	27.39	78	5,268
Natural Gas	$23.33/MCF	1,000,000	23.33	82	4,268
Pellets	$320/short ton	16,500,000	19.39	78	3,730
Birch Firewood	$325/cord	20,000,000	16.25	72	3,385
Coal	$143/short ton	15,000,000	9.53	75	1,907
District Steam	$10.50/1,000lbs	1,000,000	10.50	100	1,575
District Hot Water	$27.03/MMBtu	1,000,000	27.03	100	4,055

Notes: The average home uses 150 MMBtu/year. Cost per unit data was obtained from various fuel vendors in Fairbanks (July, October 2013).

[9] http://www.dec.state.ak.us/air/doc/Fbks_2010_HHSurvey.pdf

Chapter 3: Interior Energy in the Future

Overview

Concerns about energy supplies and rising energy prices in the Interior have spurred interest in developing cheaper sources of electricity and heating. As the future of coal in Interior Alaska's infrastructure is considered, it is useful to describe the energy development projects now underway or in various stages of planning. The projects detailed below have been, or most likely will be, funded mainly from government sources.

Healy Unit 2

Originally completed in 1998, the Healy Clean Coal Project (now being called Healy Unit 2) showcased the latest in coal burning power generation technology. Funded in part by the U.S. Department of Energy, the power plant was engineered to use coal that traditionally was discarded because of being too low in energy content. The 50 MW plant is located adjacent to the Healy Unit 1 coal plant in Healy. Disputes between shareholders caused the plant to be shut down in 1999. While the plant is currently idle, GVEA plans to start generating electricity at the facility in 2015.[10]

Negotiations with the Environmental Protection Agency (EPA) resulted in GVEA agreeing to install further emission controls on the plant at a cost of $45 million. The plant will employ 40 people. Coal-fired electrical generation capacity within the Interior will rise from 136 MW to 185 MW when the plant is brought on-line.

Susitna-Watana Hydroelectric Project

The proposed Susitna-Watana Hydroelectric Project would create a 600 MW dam across the Susitna River. Estimated to cost $5.2 billion, the dam would provide approximately 50 percent of the Railbelt's electrical needs. While difficult to project, the wholesale rate of electricity coming from the dam is estimated to start at $0.12/ kWh and after 50 years be $0.05/kWh (in 2012 dollars).[11] This initial rate falls roughly in the middle of wholesale cost paid by utilities, with coal the cheapest and diesel the most costly.

Interior Energy Project (trucking North Slope gas)

In 2013, Governor Parnell signed legislation that provides $362.5 million to build the necessary infrastructure to truck natural gas to Fairbanks from the North Slope. The Alaska Industrial Development and Export Authority (AIDEA) will provide a large portion of this funding ($275 million) in low interest financing to build a liquefaction plant and distribution system in Fairbanks. The remaining funding will be disbursed in the form of tax credits for the construction of storage capacity and capital funding. Private investors are expected to partner with AIDEA and eventually own part of the project.

[10] http://www.gvea.com/news/65-hccp-air-permit
[11] http://www.susitna-watanahydro.org/alaska-energy-authority-confident-susitna-watana-hydro-will-provide-long-term-stable-and-affordable-energy/

Known as the Interior Energy Project, a liquefaction plant will be built on the North Slope to convert natural gas into liquefied natural gas (LNG). The LNG will then be transported to Fairbanks with 30 trucks making 48 trips a day.[12] A plant in Fairbanks will warm the LNG, converting it from liquid back to gaseous state, to be distributed to customers through an underground piping system. AIDEA is projecting that natural gas will be available to customers by the end of 2015 at a rate of $14.09 to $17.09 per MCF (thousand cubic feet). At those rates, on a per Btu basis natural gas will cost approximately half the cost of diesel and 4 to 5 times the cost of coal. While natural gas is planned to be available for moderate and highly populated portions of Fairbanks, it is difficult to predict with any certainty when natural gas could supply the majority of the Fairbanks population.

Natural Gas Pipelines

For the past 50 years, many different pipelines that would transport natural gas to the Interior have been proposed. The impact on energy costs within the Interior is difficult to forecast but delivered natural gas to the Interior will likely be cheaper than diesel or naphtha, but more expensive than coal or district heat.

Pipeline to Lower 48

The proposed Alaska Pipeline Project would transport natural gas 1,700 miles from the North Slope to the Alberta/British Columbia border.[13] Connecting to the existing North American natural gas distribution system would mean that natural gas produced on the North Slope could be used in almost all major urban regions in Canada and the United States. The main issue slowing construction of this project is the precipitous fall in natural gas prices in markets where North Slope natural gas would be sold. A gas pipeline to the Lower 48 would include take-off points to provide natural gas for consumption in Alaska.

Liquefied Natural Gas Export Project

This type of project would involve the construction of an approximately 800 mile pipeline from the North Slope to Southcentral with the goal of exporting LNG. Natural gas would be liquefied at tidewater and transported by ship to the global market. Spurs along the main pipeline would provide natural gas for in-state consumption. Two private companies and one government group are examining this project. Pipeline construction costs are estimated at $45 to $65 billion. Legal issues surrounding the export of LNG and the high development cost have slowed this project.

North to South Pipeline

A 730-mile pipeline, stretching from the North Slope to Big Lake, has been examined as a way to bring natural gas to Southcentral Alaska. A 35-mile spur off the main line would provide natural gas to Fairbanks. With Southcentral Alaska facing natural gas shortages just a few years ago, this pipeline was seen as a way to alleviate the shortfall. Recent investments in Cook Inlet natural gas production have reduced the pressure to bring natural gas from the North Slope but the project is still moving forward.

[12] http://www.interiorenergyproject.com/Project%20Overview/index.html
[13] http://www.arcticgas.gov/guide-alaska-natural-gas-projects#southcentral

Chapter 4: Coal's Role in Present and Future Interior Energy Production

Examination of Interior Alaska's energy infrastructure reveals that coal is a vital fuel for stationary heat and power generation. Coal is inexpensive and abundant. Without coal in the Interior, energy costs would be substantially higher and, further, in the absence of coal, the economy of the Interior likely would not be what it is today. When considering the future of energy infrastructure in the Interior, and the various projects to reduce or slow the increase in cost, three important points are important to recognize:

- Coal is well situated to continue meeting the near term electrical generation needs of the Interior and provide cost-effective electricity and heat at stable, affordable, rates. The Healy Unit 2 project will at least stabilize if not reduce electricity rates and diversify GVEA's energy portfolio away from oil. As evidenced by the proposed UAF coal power plant, new coal burning facilities can provide both electricity and heat while balancing cost and emissions.

- Coal is increasingly clean. Coal technology has improved in the last 30 years and now offers more efficient and cost effective ways to utilize coal. Technologies such as integrated gasification combined cycle and fluidized bed combustion offer improved performance of coal burning plants.

- Coal is price-stable relative to gas or oil. This stability is an asset to GVEA and the military bases as price certainty resulting from long-term contracts lowers risk. With hundreds of years of coal resources available at current production levels and established infrastructure (both mining and transportation), coal prices in the Interior are likely to remain stable into the future.

As public debate about energy-related development occurs, especially around the role of coal, it is critical to consider the financial implications of an increase or decrease in the use of coal. UAF's replacement coal-fired cogeneration plant offers insight into the future of coal in the Interior.

UAF Case Study

UAF examined 13 different design options to replace their existing power plant. Traditional options, such as natural gas, coal, and diesel turbines, were considered along with much less traditional technologies, such as nuclear and solid waste gasification. Of these 13 options coal emerged as the best balance between cost, reliability and emissions. UAF estimates that if the plant were operating in 2012 energy cost would be 40 to 50 percent lower. [14]

While the majority of the energy used at the university comes from coal, other sources such as natural gas and diesel play a role. Electricity from GVEA is also purchased when the plant is down for maintenance or demand is beyond production capacity.

[14] Charles Ward, UAF Director of Utilities, personal communication, August 2013.

UAF's 10 MW power plant was built in 1964 and was estimated to have a 50-year operating life. As the plant approaches the end of its expected operating life, it has become increasingly expensive to maintain. A permit to build a new 17 MW coal plant has been filed with the EPA and a ruling on the permit is expected by the end of 2013.

The new plant will be a fluidized bed boiler that is much more technologically advanced than the current facility. UAF will be able to use biomass such as pellets, woodchips, paper, or grain to fuel approximately 10 percent of output. Natural gas could provide 30 percent of the required energy with a relatively easy retrofit. Compared to the current facility, emissions from the new plant will be cut drastically, as illustrated in the following table.

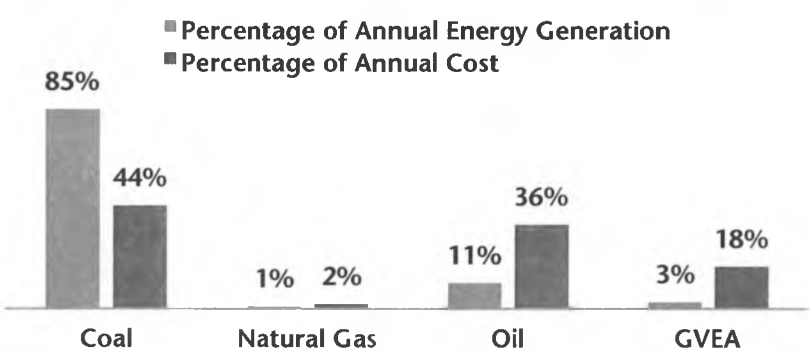
Emissions Reduction with UAF's New Coal Power Plant

Type of emission	Reduction (%)
Nitrogen Oxide (NOx)	65%
Carbon Monoxide	40
Particulates	60
Fine Particulates (PM2.5)	38
Sulfur	71

Note: Reductions are in relation to the existing UAF coal-fired power plant. Source: UAF

Within the current portfolio of energy sources that UAF can choose from, the difference in cost is dramatic. Burning diesel costs 6 to 7 times the cost of coal while natural gas is 4 to 5 times higher. The new power plant will substantially reduce the cost of energy for UAF as more coal will be used in place of the more costly sources that now fill out UAF's energy needs.[15] UAF burns an average of $3.6 million worth of coal annually. Providing an equivalent amount of energy using natural gas or diesel would cost roughly $17 million and $25 million, respectively. By continuing to use coal UAF will save $13 million to $21 million annually over alternative sources. Building a new power plant will take advantage of coal as a lower cost fuel while at the same time providing a cleaner source of energy relative to the existing plant.

Energy Generation Versus Cost for UAF, 2012



Source: UAF

[15] Charles Ward, UAF Director of Utilities, personal communication, July 2013.

Impact of Coal on Military Energy Costs

Ft. Wainwright, Eielson AFB, and Clear AFS use an estimated 515,000 tons of coal annually for cogeneration purposes. Data was not available for an in-depth analysis of energy costs for the military but examining the annual consumption of energy, in the form of coal, allows for some basic understanding. Knowing the bases require approximately 7.7 million MMBtu annually and the cost of various sources of energy, financial implications of a switch to another source of energy can be explored.

With an estimated cost of $60/ton for coal, the bases currently spend approximately $31 million annually on coal purchases. If trucked natural gas from the North Slope becomes available, the bases could switch from coal to natural gas but energy costs would more than triple. The proposed Interior Energy Project is forecasted to deliver natural gas at a cost of $14-17/MCF. Using $14/MCF, a switch to natural gas would increase annual costs from $31 million to more than $108 million, or an increase of $77 million annually.

Another way to understand the cost-saving nature of coal is to examine a scenario where the bases relied upon diesel generators for their electrical energy and heating needs. Assuming diesel costs $3 per gallon (the current market rate for large scale consumers), purchasing 7.7 million MMBtu would increase energy costs from $31 million to approximately $169 million, an increase of $138 million.

Military spending is estimated to support 30 percent of the Fairbanks economy.[16] Large increases in energy costs could risk maintaining the military's presence in the Interior.

Impact of Coal on GVEA

McDowell Group modeled GVEA's short-term generation costs to understand how the electricity rates would vary with different levels of coal use. This analysis showed that use of coal for electrical generation and GVEA generation costs are inversely related. That is, as GVEA uses more coal, electricity costs less. Two main scenarios were examined; GVEA using zero coal and the impact of Healy Unit 2.

Scenario-Zero Coal

A loss of all coal-fired electrical generation would mean that Healy Unit 1 and the Aurora power plant would be idled. A reduction of this magnitude would represent roughly one third of 2012 electrical sales. Assuming consumers require the same amount of electricity, generation would be shifted to other available capacity, mainly the North Pole Expansion Plant and the North Pole Power Plant; facilities that generate electricity at $0.17 and $0.26 per kWh, respectively.[17] This switch to fuel sources 3 to 6 times more expensive than coal would likely result in a 20-30 percent increase in GVEA's cost per kWh. Assuming this cost is passed on to consumers, GVEA ratepayers would collectively pay approximately $80 million more annually for electricity.

[16] Jim Dodson, CEO Fairbanks Economic Development Corporation, personal communication, July 2013.

[17] GVEA annual filing with the Regulatory Commission of Alaska, 2012.

SCENARIO- HEALY 2

Bringing the Healy Unit 2 online would double the amount of coal-fired power capacity available to GVEA. The availability of this cheaper electricity would displace the use of diesel and naphtha at the North Pole Power Plant and the North Pole Extension Plant, as well as reduce reliance on Intertie purchases from Chugach Electric Association. Estimates of the fully loaded generation costs (capital recovery and operating cost) for Healy Unit 2 are not available and, further, it is not clear how GVEA might use Healy Unit 2 production to offset dependence on diesel, naphtha or purchases from Southcentral. Therefore it is not possible to predict with any certainty how rates paid by consumers will be affected by commissioning of Healy Unit 2.

Nevertheless, the significantly lower fuel costs associated with coal will translate into savings for consumers, either in the near-term or in the future as the region's energy demands grow. At a minimum, Healy Unit 2 will stabilize electricity rates (as suggested by GVEA) and serve to insulate consumers from future rate uncertainty. And lower rates are also a possibility. McDowell Group modeling indicates that if the cost of Healy Unit 2 electricity averages $0.10 per kWh, this doubling of coal-fueled generation could hypothetically result in overall generation cost savings of more than 10 percent, equating to perhaps $30 million a year. Again, it is important to note the hypothetical nature of these calculations. The actual affect of Healy Unit 2 on rates paid by consumers will ultimately depend on a numbers of factors too speculative to predict at this stage of GVEA's efforts to re-commission the facility.

Environmental Considerations

Environmental issues regarding coal utilization are an important part of the discussion about the future of Interior Alaska energy supply. As discussed in the UAF case study, current coal technology offers far cleaner, more efficient, and more cost effective coal-burning equipment and processes than in the recent past. Just as today's cars are cleaner and more fuel efficient, new coal plants are cleaner and more efficient.

Interior Alaska has the advantage of access to clean coal. Coal can be classified into four ranks that are separated based on the amount of energy within the fuel. Lignite has the lowest amount of energy per unit, followed by, sub-bituminous, bituminous, and anthracite with the highest energy content. The composition of coal ranges as well; the amount of compounds such as sulfur and mercury change depending on where the coal is mined. Healy coal used in Interior Alaska is sub-bituminous with ultra low sulfur content of 0.2 percent.[18,19] Other coal used elsewhere has a sulfur content of 5-6 percent or more. Mercury content of Alaska coal at 0.07 ppm is also much less than the national average of 0.17 ppm. [20,21]

[18] http://pubs.usgs.gov/dds/dds-077/dds77text.html#heading128041696

[19] http://pubs.usgs.gov/of/1998/of98-763/ofr98-763.pdf

[20] http://pubs.usgs.gov/fs/fs095-01/fs095-01.html

[21]http://webcache.googleusercontent.com/search?q=cache:38TSEZsRbv0J:www2.bren.ucsb.edu/~keller/courses/esm595F/EmissionRedElecIndustry/Appendix%2520A.doc+&cd=26&hl=en&ct=clnk&gl=us&client=firefox-a

Chapter 5: Economic Impact of Coal in Interior Alaska

This chapter examines the employment and payroll impacts of Usibelli Coal Mine (UCM). In addition to jobs at the mine, there is a range of multiplier effects associated with mine operations. Jobs are created throughout the economy, the mine purchases supplies and services in support of its operations and mine employees spend their payroll dollars on supplies and services.

UCM Employment and Payroll

Jobs

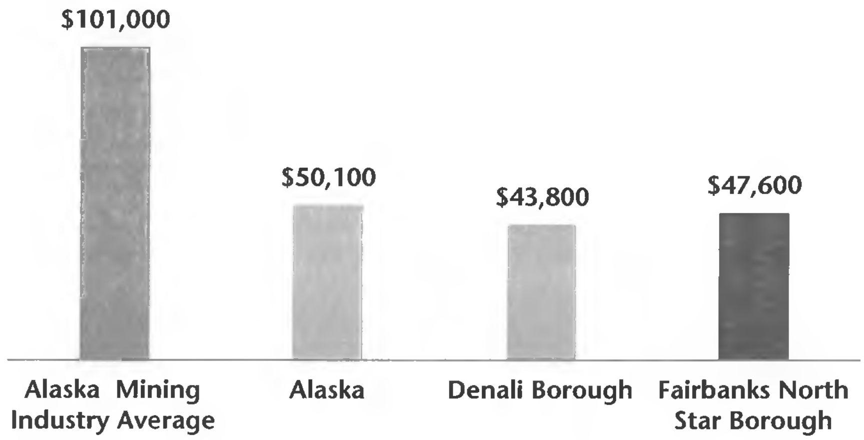
UCM employed an average of just over 140 workers in 2012. Jobs at the mine include equipment operators, along with a variety of professional, technical, mechanical, and administrative staff. Employment is consistent throughout the year, ranging from a July peak of 149 to a December low of 129. More than 90 percent of UCM employment is in Healy; seven positions are based in Fairbanks and two positions are based in Palmer. UCM's steady employment is particularly important in a local (Denali Borough) economy that is characterized by high seasonal employment fluctuations. In the visitor industry-dominated Denali Borough, overall 2012 employment ranged between a high of 3,636 in July and a low of 832 in January. For the months November through March, UCM directly accounts for one in six jobs in the Denali Borough.[22]

Payroll and Average Wages

UCM wages are on par with pay levels in the mining industry throughout Alaska. Mining wages are among the highest in the state, averaging $101,100 in 2012. In fact mining is second only to the oil and gas industry, where annual wages averaged $127,200 in 2012. Mining wages are more than double the 2012 average annual wages for all workers in Alaska overall and in the Interior (Fairbanks North Star Borough and Denali Borough combined). According to the Alaska Department of Labor and Workforce Development (ADOLWD), the average annual wage in Alaska was $50,100 in 2012, while the average annual wage in the Denali Borough was $43,800.[23] In the Fairbanks North Star Borough, the average annual wage was $47,600 in 2012. These wage comparisons are important because they illustrate the role of UCM in providing family-wage jobs when many of the new jobs being added to the Interior economy are relatively lower-paying, seasonal, service sector jobs.

22 Based on November through March employment.
23. *http://laborstats.alaska.gov/qcew/qcew.htm*

Comparison of Annual Average Wages, 2012



Workforce Residency

All UCM employees are Alaska residents. In comparison, the statewide metal mining industry average is 65 percent Alaska resident employment, a statewide private sector average of 77 percent, and the Alaska economy-wide (all-industry) average of 80 percent, according to 2011 ADOLWD data.[24] UCM's entirely resident workforce is in sharp contrast to the Denali Borough's average of only 41 percent Alaska resident workers.

Other Employment Related to UCM

The employment and payroll impacts of UCM go substantially beyond the direct jobs at the mine. UCM-related employment also includes:

- Indirect impacts, including jobs and income in businesses providing goods and services to the mine in support of its operations. These impacts are some sometimes termed "upstream" economic impacts and are measured using multipliers derived from econometric models.[25]
- Induced impacts, including the jobs and income created as a result of UCM employees spending their payroll dollars in the local and regional economies. Induced impacts are also part of the upstream economic impact and are measured with model-generated multipliers.
- Employment and payroll in operations that consume UCM coal, particularly the region's power plants. These are "downstream" economic impact effects. Downstream impacts are not captured in multipliers and therefore must be considered separately from upstream effects.[26]

[24] *Residency of Alaska Workers, 2011*, Alaska Department of Labor and Workforce Development, January 2013.

[25] While from an operational perspective transporting coal from the mine to power plants is a downstream activity, for purpose of this study the economic impact of rail shipment of coal is included in the analysis of upstream (indirect) impacts. ARRC is UCM's single largest vendor.

Indirect and Induced Employment and Payroll (Upstream Effects)

Indirect jobs are those jobs supported by UCM's spending on the wide variety of goods and services that are required to operate the mine and move coal to customers. In 2012, UCM spent $61 million with approximately 600 businesses and organizations in Alaska and elsewhere. Approximately 400 of those businesses and organizations are based in Alaska or otherwise have a physical presence in Alaska. In-state spending by UCM totaled $50.7 million. Anchorage ($27.0 million) and Fairbanks ($21.6 million) capture the majority share of this spending. The greatest amount is reported in Anchorage because all UCM spending with the Alaska Railroad Corporation (ARRC) is reported in Anchorage, where ARRC is headquartered.

ARRC is the single largest provider of services to UCM, in terms of annual spending in support of mine operations. ARRC hauls UCM coal to the mine's primary in-state customers and to the Seward Coal Loading Facility for shipment to overseas customers. The Alaska Railroad has approximately 614 year-round employees and 114 seasonal employees (as of spring 2013). Though specific data is not publically available, ARRC likely accounts for over $40 million in annual payroll.

Usibelli Coal Mine Spending in Alaska, 2012, by Community

Location	Number of Vendors	Spending ($millions)
Anchorage	105	$27.0
Fairbanks North Star Borough	195	21.6
Denali Borough	27	0.5
Mat-Su Borough	28	0.4
All Other Alaska	45	1.2
Total Spending in Alaska	**400**	**$50.7**

Source: UCM.

Movement of coal is an important part of the railroad's overall viability. Coal accounted for about 20 percent of all freight revenue earned by ARRC in 2012 and approximately one in six of all operating revenue dollars earned by ARRC. As a very important customer for ARRC, UCM plays a key role in supporting the more than 700 Alaskan's employed by the railroad.

Though a detailed accounting of all operational, maintenance, and administrative personnel that are in some way dependent on coal (from an operational or revenue perspective) is not available, it is estimated that between 30 and 40 ARRC employees are directly or indirectly related to the movement of coal. This is a conservative estimate of the number of ARRC personnel who would not be employed if UCM and its coal were entirely absent from ARRC's mix of customers. However, the employment implications of a railroad without coal may be much greater than just the jobs directly or indirectly connected to coal. Coal plays a critical role in generating revenue for ARRC, and, therefore, in the railroad's continuing economic

[26] Upstream effects are also known as "backward linkages." That is, they capture only jobs associated with purchases of goods and services by a mine (for example) and its employees. Downstream effects are also known as "forward linkages," or those jobs associated with adding value to a mine's product (such as generating energy or heat from burning coal).

sustainability in general. This has broad regional implications. ARRC is a critical part of Alaska's transportation infrastructure, with 685 miles of track and serving Anchorage, Fairbanks, Denali National Park, the ports of Anchorage, Whittier and Seward (and soon Pt. MacKenzie), and military bases along Alaska's Railbelt.

There are similar linkages between UCM and many other businesses in Alaska, including trucking companies, fuel suppliers, heavy equipment dealers and service providers, tire dealers, insurance companies, GVEA (for electric power needed for mine operations), professional and technical services firms, and many others.

It is not practical to determine the employment and payroll effects of UCM purchases for each of the hundreds of businesses that provide equipment, materials, supplies, and services to the mine. However, it is possible to use models, such as IMPLAN, to estimate the total combined employment and payroll effects of UCM spending.[27]

IMPLAN is a predictive input-output model of local and state economies, and is widely used across the country to measure the economic impact of industries and industrial/commercial development. IMPLAN uses borough and statewide level employment and payroll data to define linkages between industries in the local economy and multipliers that predict the total impact of an economic stimulus. For Alaska, IMPLAN typically requires modification to account for non-resident labor and/or supply constraints. As noted above, IMPLAN only captures upstream economic impacts, that is, jobs and income related to purchases made by UCM and its employees. It does not capture the jobs and income at power plants that rely on UCM coal.

IMPLAN can also be used to guide the assessment of induced effects, i.e., jobs and income connected with UCM employees spending their payroll dollars. Mine workers and their families spend money throughout the local and regional economies, in stores, gas stations, auto repair shops, recreational facilities, doctor's offices, and a range of other places. The mine related population also creates jobs for school teachers, local government administrators, public safety personnel, and other public service providers.

Based on vendor data provided by UCM and multipliers derived from the IMPLAN model, UCM spending on goods and services generated 355 jobs in Interior Alaska and 470 jobs statewide in 2012. Indirect annual payroll totaled an estimated $26.5 million in the Interior and $33.9 statewide.

[27]The IMPLAN® (IMpact analysis for PLANning) economic impact modeling system is provided by IMPLAN Group LLC, Inc.

Direct and Upstream Employment and Payroll Impacts of Usibelli Coal Mine, 2012, including Direct, Indirect, and Induced Employment

	Interior Alaska	Statewide
Employment	**355**	**470**
Direct	143	143
Indirect/Induced	212	327
Payroll (dollars in millions)	**$26.5**	**$33.9**
Direct	$15.0	$15.0
Indirect/Induced	11.5	18.9

Source: Direct employment and payroll from UCM. Indirect/Induced are McDowell Group estimates. Does not include downstream employment at power plants that burn UCM coal.

UCM has a remarkably large multiplier effect. Based on this analysis, UCM's regional employment multiplier is 2.5 (for every job at the mine, there are 1.5 jobs indirect and induced jobs created elsewhere in the economy, for a total multiplier of 2.5). The statewide UCM employment multiplier is approximately 3.3. These employment multipliers do not include jobs at power plants that burn UCM coal (these jobs are described in the next section of this report).

In Alaska, employment multipliers are rarely above 2.0, meaning that, for example, 100 direct jobs would be linked to no more than 100 indirect and induced jobs, for a total employment impact of 200. UCM's multiplier is high for several reasons, but mainly it is the result of a very high level of in-state spending on goods and services ($51 million annually) relative to the number of direct jobs at the mine. The mine's much higher-than-average wages also place more money into the support sector than lower wage jobs. In addition, UCM is the foundation of the Healy economy, a community of about 1,100 residents. Without the jobs provided by UCM (which directly accounts for 30 percent of all jobs in Healy and 60 percent of all wages paid in the community), the local economy would be much smaller than would be indicated by the customary model-driven analysis of multiplier effects.[28]

Downstream Employment and Payroll

Another unique aspect of the economic impact of UCM is that coal production in Alaska has significant in-state downstream effects. Downstream economic impacts occur when buyers of a product (such as crude oil, coal, fish, or mineral-rich ore concentrates) add value to a product through some form of processing. However, the vast majority of the oil, seafood, and metallic mineral resources mined in Alaska are sold to out-of-state buyers and, therefore, do not create downstream economic activity in Alaska. In contrast, about half of all UCM coal production is sold and consumed in Alaska.

[28] According to ADOLWD data, employment averaged 454 jobs in 2012 in Healy. Those jobs accounted for wages totaling $24.5 million.

Downstream jobs (forward linkages) associated with UCM include the power plants that buy and use Usibelli coal (including the power and steam plants operated by GVEA, University of Alaska Fairbanks, Aurora Energy LLC, and military facilities at Clear AFS, Ft. Wainwright, and Eielson AFB). Employment at these facilities totaled 222 workers in 2012.[29]

Coal-Fired Power Plant Employment in Alaska, 2012
(UCM-Related Downstream Employment)

Facility	Estimated Employment
GVEA Healy Unit 1	30
UAF	38
Aurora Energy	20
Clear Air Force Station	31
Fort Wainwright (operated by Doyon)	47
Eielson Air Force Base	56
Total	**222**

Though payroll data is not available for these facilities, based on statewide average wages in the power generation sector, these jobs likely account for approximately $17.8 million in annual payroll. According to ADOLWD, workers employed in power generation-related jobs earned an average $80,300 in 2012.

Unlike the jobs connected with UCM through backward linkages, not all of these power plant jobs would be foregone in the absence of an in-state coal supply. Alternative sources of energy would have been developed. However, alternative sources of energy, such as oil and natural gas, in addition to being more expensive on a per Btu basis, are less labor intensive and, therefore, would account for far fewer jobs in the Interior.

Total UCM-Related Employment and Payroll

UCM spent approximately $82 million in support of its operations in 2012, including personnel and non-personnel related expenditures. All but about $10 million, was spent within Alaska. This spending had a total annual employment impact in Alaska of approximately 470 jobs and $34 million in total annual payroll. Approximately three-quarters of those jobs and income are in the Interior Alaska economy: 355 jobs and $27 million in annual payroll. In addition, Alaska's coal-fired power plants directly accounted for an estimated 222 jobs and $17.8 million in annual payroll, all in the Interior.

Finally, it is important to note that UCM's economic impact includes support of non-profit organizations. The Usibelli Foundation's mission is to provide funds to facilitate learning by supporting education, preserve Alaska's uniqueness by supporting its heritage, and strengthen communities. The Foundation contributes to over 100 nonprofit organizations statewide. The average pay-out over the past few years has been approximately $112,000 annually. Grants are made in the areas of education, health and social services, the arts, youth programs, and civic organizations and activities. The Usibelli Foundation also matches employee donations to United Way and several other community organizations in Healy.

[29] Based on interviews conducted with plant managers.

ALASKA STATE LEGISLATURE

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Senator Pete Kelly

Senate District B

Senate Concurrent Resolution 16 – Requesting the Governor to Investigate Coal Resources

Sponsor Statement

Senate Concurrent Resolution 16 requests the Governor investigate the development of a large coal power plant and associated electric grid and to evaluate the costs and benefits of coal-generated energy with respect to other energy sources.

Today, it is unfashionable to talk about our most abundant energy source, Coal. Alaska has enough coal to provide for peoples' needs for hundreds of years. It is a plentiful and inexpensive source of energy. Coal power plants are more efficient than ever. Some proposed and experimental plants even remove carbon dioxide. Coal is far more abundant globally than either oil or natural gas.

Fashions change, but if we fail to have this conversation today, we will have failed to keep this option open for future generations of Alaskans. This is that day, and we need to advance the conversation on coal today so it remains in our vernacular for tomorrow.

Yes, coal requires mining, and there are individuals and corporate entities that attack any effort to disturb the earth so as to provide for mankind. They are part of the conversation, but often shout too loudly about issues of possible relevance outside, that do not apply to Alaska's coal.

Coal can be used to heat homes, it can power communities. Alaska has 40 percent more coal than the Lower 48 and Alaskan coal is lower in sulfur (0.3 percent average) than most coal found in the rest of the United States. It falls within or below the minimum sulfur value mandated by the 1990 Clean Air Act amendments.

Coal is not just our past, but is also part of our future. We have the ability to secure Alaska's energy independence with a resource that is abundant in our soil. SCR 16 will help keep coal in our consciousness as a solution to our energy needs.

Please join me in supporting SCR 16

Senator.Pete.Kelly@akleg.gov

Fiscal Note

State of Alaska
2014 Legislative Session

Bill Version: SCR 16
Fiscal Note Number:
() Publish Date:

Identifier: SCR016-DCCED-AEA-02-28-14
Title: REQ GOV TO INVESTIGATE COAL RESOURCES
Sponsor: KELLY
Requester: Senate Resources

Department: Department of Commerce, Community and Economic Development
Appropriation: Alaska Energy Authority
Allocation: Statewide Project Development, Alternative Energy and Efficiency
OMB Component Number: 2888

Expenditures/Revenues

Note: Amounts do not include inflation unless otherwise noted below. (Thousands of Dollars)

	FY2015 Appropriation Requested	Included in Governor's FY2015 Request	Out-Year Cost Estimates				
OPERATING EXPENDITURES	**FY 2015**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**
Personal Services							
Travel							
Services	75.0						
Commodities							
Capital Outlay							
Grants & Benefits							
Miscellaneous							
Total Operating	**75.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Fund Source (Operating Only)

1004 Gen Fund	75.0						
Total	**75.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Positions

Full-time							
Part-time							
Temporary							

Change in Revenues							

Estimated SUPPLEMENTAL (FY2014) cost: 0.0 *(separate supplemental appropriation required)*
(discuss reasons and fund source(s) in analysis section)

Estimated CAPITAL (FY2015) cost: 0.0 *(separate capital appropriation required)*
(discuss reasons and fund source(s) in analysis section)

ASSOCIATED REGULATIONS

Does the bill direct, or will the bill result in, regulation changes adopted by your agency? No
If yes, by what date are the regulations to be adopted, amended or repealed?

Why this fiscal note differs from previous version:

Not applicable, initial version.

Prepared By: Sara Fisher-Goad, Executive Director — Phone: (907)771-3000
Division: Alaska Energy Authority — Date: 02/28/2014 05:00 PM
Approved By: Jeanne Mungle, Director — Date: 02/28/14
Agency: Administrative Services Director

FISCAL NOTE ANALYSIS

STATE OF ALASKA
2014 LEGISLATIVE SESSION

BILL NO. SCR16

Analysis

The resolution requests the Governor investigate the development of a large coal power plant and associated electric grid to provide energy to the state; and to evaluate and report back to the legislature on the feasibility of locating a large coal power plant near certain coal resources. The resolution requests the Governor to report back to the legislature on (1) the potential costs of coal plants ranging in size from 200 megawatts to two gigawatts of electricity generation; (2) the cost of a kilowatt of coal-generated energy in comparison to hydroelectric, natural gas, and other energy sources; (3) the technological potential for transmission of coal-generated energy, including high-voltage direct current, and how that transmission might provide for the needs of residents of the state not part of the Railbelt power grid; and (4) how a large mine-mouth coal plant might help balance future needs of the state with hydroelectric and other types of power generation.

Upon passage of the resolution, and if directed by the Governor, AEA's contractual costs to produce the requested report in FY2015 is estimated to be $75,000.

Guide to Eating Fish Safely for Alaska Women and Children

Mix and match your fish meals* for up to:

12 POINTS PER WEEK

* A ***meal size*** is 6 ounces (uncooked weight) for adults and 3 ounces for children age 12 years and under.

Alaska fish is good for you. State health officials recommend that everyone eat fish at least twice a week. All fish contain some level of mercury, a toxic metal that can harm the developing nervous systems of unborn babies and young children.

Women who are or can become pregnant, nursing mothers and children 12 and under should follow these guidelines to limit their mercury intake. Everyone else can eat as much seafood as they like.

PER MEAL 0 Points

[redacted]

Eat a variety of fish and other seafood as part of a balanced diet.

PER MEAL 3 Points

AK halibut 20–39 pounds
All store-bought AK halibut
AK rougheye rockfish
AK lingcod 30–39 inches
AK black cod (sablefish)

PER MEAL 4 Points

AK halibut 40–49 pounds
Canned albacore tuna

PER MEAL 6 Points

AK halibut 50–89 pounds
AK lingcod 40–44 inches
AK yelloweye rockfish

PER MEAL 12 Points

AK halibut 90 pounds or more
AK lingcod 45 inches or more
AK salmon shark
AK spiny dogfish

Avoid these fish: tilefish, king mackerel, swordfish, and shark

Good afternoon, my name is Sue Mauger.

I'd like to comment on SCR #16 and the apparent interest by the sponsors to investigate the value of coal-powered energy for Alaskans. In my position as Science Director for Cook Inletkeeper, I've worked in salmon streams around Southcentral Alaska for the last 14 years. My focus in recent years has been on stream temperatures; specifically, how current stream temperature patterns in Cook Inlet might change in the future and how these changes might impact salmon.

Based on compelling evidence from the climate scientists of the world (see "evidence" attachment) and from Alaskan researchers (see "SNAP" attachment), we understand that future climate change will result in not just warmer summer temperatures in Southcentral Alaska but also warmer winter temperatures, resulting in more rain-on-snow events, and a reduced snowpack. With less water stored in our hills during the winter, our summer water levels will be lower. And since a little bit of water warms faster that lots of water, our summer water temperatures in non-glacial streams will rise that much faster in the years ahead. Based on our 5 years of research in Cook Inlet salmon streams, many Kenai Peninsula and Mat-Su streams are already at temperatures known to be stressful to salmon (see "Executive Summary" attachment).

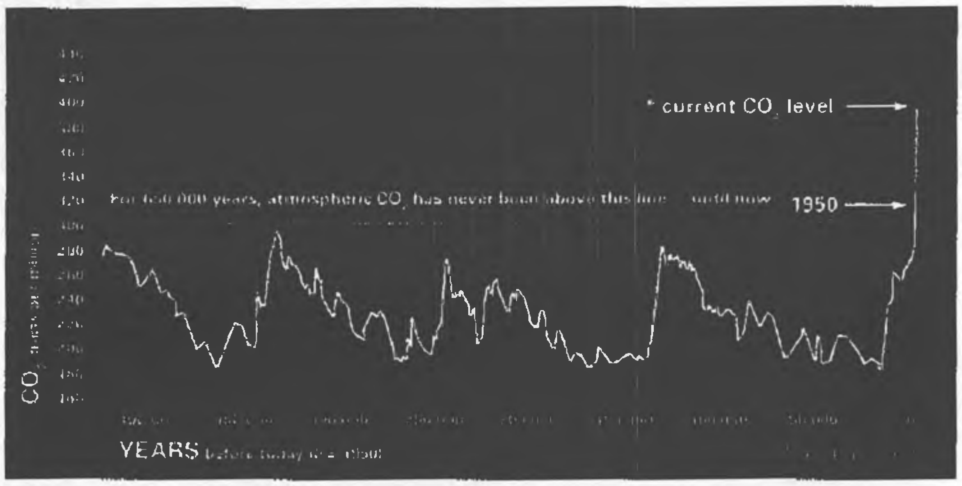
When I've talked about these climate change outcomes in the past, they have seemed a bit abstract, an eventuality for some future date. But as we sit here experiencing a remarkably warm winter, with record high temperatures, rain, ski races cancelled due to a lack of snow, the vagueness of climate change impacts are more tangible. As a scientific community, we know we have much to learn still about basic ocean dynamics and freshwater habitat requirements for salmon. And we must now add ocean acidification, and changing ocean and river temperatures into the challenge of attaining sustainable fisheries. But one thing is certain. The release of more carbon dioxide which will occur with new coal development will fast forward the timeline for the most drastic of climate change impacts. For Alaskans, living in the state disproportionately impacted by climate change, coal is a loser.

Please don't waste your time and Alaskans time exploring new fossil fuel development which will exacerbate climate change impacts in our salmon streams and salmon-based economies.

Sue Mauger

EVIDENCE

Climate change: How do we know?



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Source: NOAA)

The Earth's climate has changed throughout history. Just in the last 650,000 years there have been seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 7,000 years ago marking the beginning of the modern climate era — and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.

"Scientific evidence for warming of the climate system is unequivocal."

- Intergovernmental Panel on Climate Change

The current warming trend is of particular significance because most of it is very likely human-induced and proceeding at a rate that is unprecedented in the past 1,300 years.[1]

Earth-orbiting satellites and other technological advances have enabled scientists to see the big picture, collecting many different types of information about our planet and its climate on a global scale. Studying these climate data collected over many years reveal the signals of a changing climate.

Certain facts about Earth's climate are not in dispute:

- The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century.[2] Their ability to affect the transfer of infrared energy through the atmosphere is the scientific basis of many instruments flown by NASA. Increased levels of greenhouse gases must cause the Earth to warm in response.
- Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that the Earth's climate responds to changes in solar output, in the Earth's orbit, and in greenhouse gas levels. They also show that in the past, large changes in climate have happened very quickly, geologically-speaking: in tens of years, not in millions or even thousands.[3]

Scientific Consensus

Ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities, and most of the leading scientific organizations worldwide have issued public statements endorsing this position.

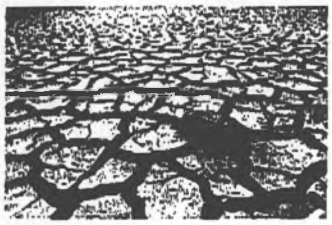
Click here for a partial list of these public statements and related resources.

The evidence for rapid climate change is compelling:

Sea level rise

Global sea level rose about 17 centimeters (6.7 inches) in the last century. The rate in the last decade, however, is nearly double that of the last century.[4]

Republic of Maldives: Vulnerable to sea level rise



Global temperature rise

All three major global surface temperature reconstructions show that Earth has warmed since 1880.[5] Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years.[6] Even though the 2000s witnessed a solar output decline resulting in an unusually deep solar minimum in 2007-2009, surface temperatures continue to increase.[7]

Warming oceans

The oceans have absorbed much of this increased heat, with the top 700 meters (about 2,300 feet) of ocean showing warming of 0.302 degrees Fahrenheit since 1969.[8]

Flowing meltwater from the Greenland ice sheet

Shrinking ice sheets

The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost 150 to 250 cubic kilometers (36 to 60 cubic miles) of ice per year between 2002 and 2006, while Antarctica lost about 152 cubic kilometers (36 cubic miles) of ice between 2002 and 2005.

Visualization of the 2007 Arctic sea ice minimum

Declining Arctic sea ice

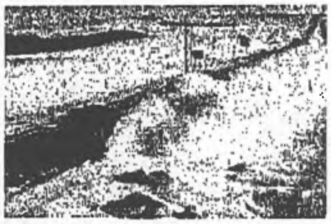
Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.[9]

The disappearing snowcap of Mount

Glacial retreat

Glaciers are retreating almost everywhere around the world — including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.[10]

Kilimanjaro, from space.



Extreme events

The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.[11]

Ocean acidification

Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent.[12, 13] This increase is the result of humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the oceans. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year.[14, 15]

This resource has been selected for inclusion in the CLEAN collection

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World Glacier Monitoring Service

11 http://lwf.ncdc.noaa.gov/extremes/cei.html

12 http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F

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SNAP Scenarios Network for Alaska & Arctic Planning

About Tools and Data Methods Projects Resources

Downscaling **Modeling** **Planning** **Uncertainty**

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Methods

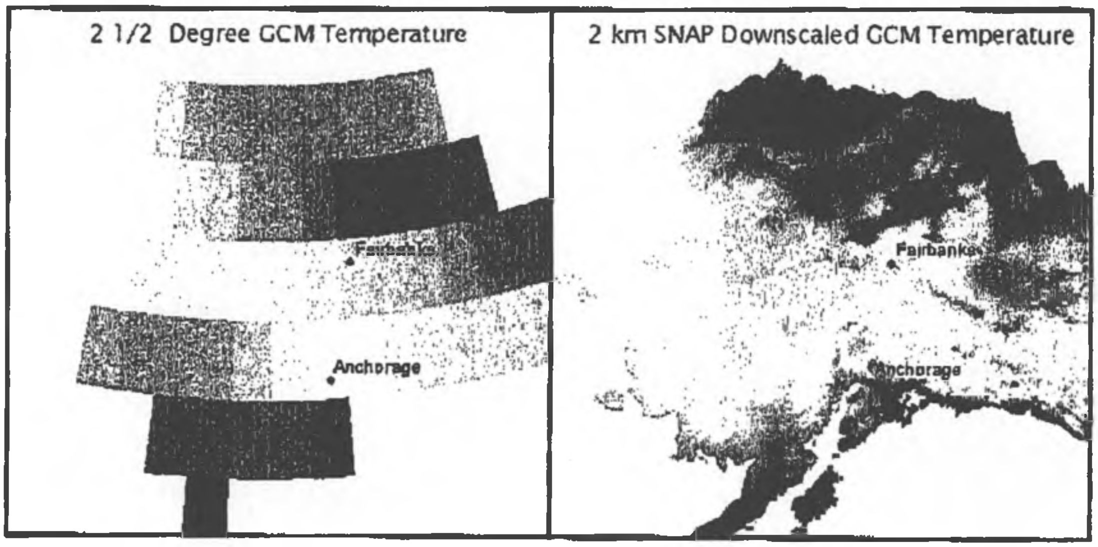
SNAP employs a variety of modeling and research methods that have been approved by the scientific community through large-scale research programs and peer-reviewed publications. In order to make global climate data useful for planning, SNAP downscales global model outputs to the local level.

SNAP selects the 5 Global Climate Models (GCM) that perform best in Alaska and the Arctic. Outputs from these models are then downscaled using PRISM data—which accounts for land features such as slope, elevation, and proximity to coastlines—as baseline climate data. This same downscaling procedure is applied to historical Climate Research Unit (CRU) data. The final products are high resolution monthly climate data for ~1901-2100 for Alaska and large regions of Canada. Where PRISM data are not available, GCM and historical data are downscaled to other baseline climate datasets such as CRU data products. Outputs are available for individual models and for a 5 model average, which reduces some types of errors associated with dependence on a single model. As new data become available, we continually update the SNAP climate datasets, applying these same methods to other areas of the Arctic and the world.

Our principal products are downscaled historical and projected monthly climate data, primarily temperature and precipitation. Projected data are produced for three emission scenarios (B1, A1B, A2). Additionally, SNAP produces derived data from the above base datasets through various modeling efforts. Derived data products include potential evapotranspiration, vegetation, fire, permafrost, day of freeze, day of thaw, the subsequent length of growing season, as well as decadal, seasonal and annual averages. For a full list of our available data, please visit the SNAP Data page. To explore the data with an interactive map, please visit the map tool.

As with any data, analysis or interpretation, multiple sources of uncertainty are always present. Understanding the uncertainty inherent in the input and output data can help in determining how these climate projections are best utilized and interpreted.

For additional details on SNAP Methods, please explore our Downscaling, Modeling, Planning, and Uncertainty sections.



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STREAM TEMPERATURE MONITORING NETWORK FOR COOK INLET SALMON STREAMS 2008-2012

EXECUTIVE SUMMARY

Despite the importance of salmon resources to Alaska's economy and links between warm water temperature and reduced salmonid survivorship in other regions, long-term stream temperature datasets in Alaska are limited. We implemented a Stream Temperature Monitoring Network for Cook Inlet salmon streams to describe current water temperature profiles and identify watershed characteristics that make specific streams more sensitive to climate change impacts. Beginning in the summer of 2008, we collected continuous water and air temperatures in 48 non-glacial salmon streams during open-water periods. This report presents a summary of five years of data (2008-2012) from this collaborative project.

Maximum stream temperatures varied broadly among sites: 11.9 – 24.5°C, with average summer temperatures across all five years ranging from 6.9 – 16.2°C. The vast majority of streams exceeded Alaska's water temperature criteria set for the protection of fish especially in 2009, the warmest year, when stream temperatures exceeded the criteria of 13°C at 47 sites, 15°C at 39 sites, and 20°C at 17 sites. We recorded frequent exceedances (> 30 days/year) of the 13°C criteria at 27 sites (56%) and of the 15°C criteria at 13 sites (27%). Thirty sites (63%) had maximum weekly averages above 15°C over the five year period. Our modeling efforts indicate that large watersheds with low slope and low elevation are inclined to have the warmest temperature profiles and are the most sensitive to increasing air temperature.

Based on our assessment of current stream temperature profiles and sensitivities in Cook Inlet streams, average July water temperature in 27% of the streams will increase by at least 2°C and may result in a greater incidence of disease, poor egg and fry incubation survival, low juvenile growth rates, and more pre-spawning mortality for salmon by 2099. Thermal impacts will be more moderate in 23% of the streams, with no significant impacts to salmon health for 50% of the streams.

The Stream Temperature Monitoring Network has proven to be a successful collaborative regional monitoring effort coordinated by Cook Inletkeeper, with fifteen different partnering entities involved. Project challenges over the five year study period included: 1) coordination of partner schedules and turnover; 2) loss of data from high flow events; 3) management of 6.8 million data points; and 4) lack of available high resolution GIS layers (land cover, NHD+, stream flow) for data analysis. This regional network can be a template for coordination, data management and analysis to facilitate expanded water temperature monitoring throughout Alaska.

To read the entire report, please go to:
http://inletkeeper.org/resources/contents/stream-temperature-synthesis-report/view

TESTIMONY ON SCR 16 – COAL FIRED POWER PLANTS
MARGO REVIEL – JAKOLOF BAY OYSTER COMPANY

My husband and I are small business owners who own an oyster farm in Kachemak Bay.

We are deeply concerned about changes due to Ocean Acidification. Ocean acidification is directly linked to increased carbon pollution in our atmosphere; as more carbon enters our atmosphere, our oceans absorb more carbon, which then forms acids that eat away at shellfish. Our spat - the early life stage of oysters – are especially vulnerable to increased acidity levels.

Spending money to study more coal fired power plants strikes me as a very bad idea, because coal is a leading source of carbon pollution. Even developing countries, suffocating from pollution, are backing away from coal.

The greatest threat to me and my family is not energy costs; shaving a few dollars off our energy bill will not vastly improve our quality of life. But ocean acidification directly threatens our livelihood.

For example, upwelling of acidic water off the coast of the Pacific Northwest is having a direct negative impact on the growth of small oysters, making it incredibly difficult for Alaska farmers to acquire enough spat to get shellfish farming going in Alaska. As recently as last week, ocean acidification has been implicated in a die-off of 90% of the mature stock of scallops at a BC shellfish farm.

What keeps me up at night, what hurts my quality of life, is the real and present danger that these risks are unfolding in Alaska's waters. We are fortunate to have one of the world's leading researchers on ocean acidification – Dr. Jeremy Mathis – in our state, and I am attaching a short paper he wrote on the issue.

The State of Alaska has been incredibly supportive of shellfish farming and ~~aquaculture~~ mariculture, and we are truly appreciative. The ability to grow oysters in Alaska hatcheries where acidity levels can be controlled during those delicate early life stages, is critical to the future of our industry. But oysters and other shellfish are the canaries in our ocean coal mine, and they are showing strong indications that it's past time to back away from coal.

I can think of a long list of resolutions that would improve our quality of life, this is not one of them.

Attached article: http://www.arcus.org/witness-the-arctic/2014/1/article/20438

Margo Reviel

Ocean Acidification Along the Rapidly Changing Alaskan Coast

By: Jeremy T. Mathis, Supervisor of Oceanography at NOAA Pacific Marine Environmental Laboratory

Jeremy T. Mathis, PhD, is also the Director of the Ocean Acidification Research Center at University of Alaska Fairbanks. Photo courtesy of Jeremy Mathis.

Since the pre-industrial era, human activities have increased atmospheric carbon dioxide (CO_2) concentrations by about 40% to values near 400 ppm, which is higher than at any point during the last 800,000 years. During this rapid loading of the atmosphere, the ocean has absorbed more than 25% of the total emitted anthropogenic CO_2, helping to offset atmospheric warming, but fundamentally changing ocean chemistry. The uptake of CO_2 triggers a series of well-understood reactions in the surface ocean called ocean acidification (OA) that has already reduced the global surface ocean pH by about 0.1 units, making the ocean 30% more acidic than in pre-industrial times. During this process, biologically important carbonate minerals are diminished, which makes it more difficult for organisms like mollusks to create and maintain their shells, especially during early life stages.

High-latitude oceans, like those around Alaska, have naturally low carbonate ion concentrations due to low sea surface temperatures and increased solubility of CO_2 and are thus considered to be more vulnerable to the impacts of OA on shorter timescales. Accordingly, the uptake of anthropogenic CO_2 further reduces carbonate ion concentrations, pushing the high-latitude waters closer to the threshold where shell dissolution can occur.

Waters that are potentially corrosive to carbonate shells in the western Arctic Ocean and the Bering Sea are found in the central Canada basin, on the Chukchi and Beaufort Sea shelves, in outflow waters on the Canadian Arctic Archipelago shelf, and across the expansive northern and southern Bering Sea

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began to fund the development of an ocean acidification-monitoring network (see Figure 2) in key regions around the state. Data from each location can be found at http://www.pmel.noaa.gov/CO (http://www.pmel.noaa.gov/CO)$_2$/story/Coastal+Moorings.

This network is made up of fixed buoys, oceanography research cruises, and unmanned vehicles; along with a citizen-monitoring program where fisherman, school children and concerned citizens collect water in their own regions for scientific analysis. By monitoring sensitive areas and the keystone species that inhabit these environments it will be possible to detect the detrimental consequences brought on by OA before a complete collapse of a fishery occurs.

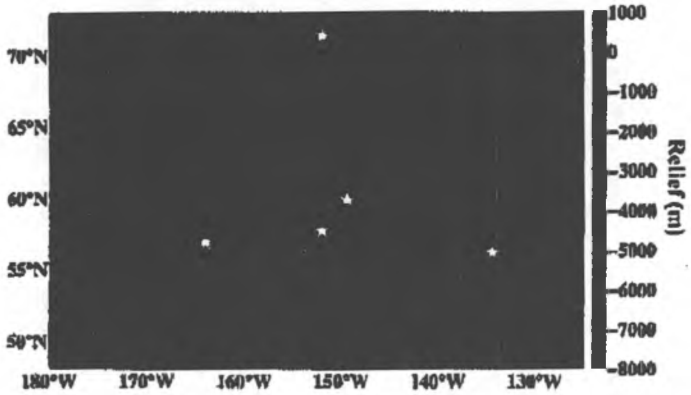

Figure 2. Map showing the location (yellow stars) of the buoys around Alaska that are measuring ocean acidification parameters in real-time. Image courtesy of Jeremy Mathis.

In the meantime, Alaskans, particularly those in the most vulnerable areas must work to diversify their regional economies so that they are not solely dependent on a few commercially important marine species. Alaskan commercial fisheries have a long history of opportunistically switching to different species based on availability and marketability. This suggests that the socio-economic system may have some ability to adapt to future conditions. However, every effort should be made to develop other industries and resources (e.g., fur seals, gold, timber) so that if a worse case OA scenario occurs, the consequences can be managed in a way that leaves both coastal communities and the state on sound financial footing.

For further information contact Jeremy Mathis (jeremy.mathis@noaa.gov (mailto:jeremy.mathis%40noaa.gov)).

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(/)

shelf. In the Chukchi Sea and Bering Seas, waters that are potentially corrosive to carbonate shells occur seasonally near the bottom due to the combination of natural respiration of large quantities of organic matter transported from the surface and the intrusion of anthropogenic CO_2 from the atmosphere. These processes are creating an ever-expanding environment where the intensity, duration, and extent of low-pH events are increasing in one of the most productive and diverse ecosystems on Earth (see Figure 1).

Figure 1 – Benthic grab from the bottom of the Bering Sea showing the diversity of organisms, many of which are calcifiers that could be impacted by ocean acidification. Photo courtesy of Jeremy Mathis.

While there have been few comprehensive studies, OA appears to act more strongly on certain species, but lower pH environments can fundamentally alter ecosystem composition toward dominance by non-calcifying organisms. Mollusks, such as oysters and clams, appear to be the calcifying group most negatively affected by OA. However, crustaceans such as the red king crab and tanner crab species exhibit negative responses that included slower growth and lower survival rates when they are exposed to high-CO_2, lower-pH water.

Alaska's heavy dependence on marine organisms for both commercial and subsistence activities implies that ecosystem services based on these species could change as OA continues to progress. As this happens over the next 50 to 100 years, the region could be impacted through changes in food security or shifts in livelihoods. In many communities around the State, large portions of the economy are tied directly to the extraction of living marine resources. Alaska's western and southern rural areas are likely at the highest risk from OA due to a confluence of factors, including: subsistence fishing for near-shore species like clams and crabs, more rapid projected OA, lower industry diversity, economic dependence on fishery harvests, lower income, and higher food prices.

While the only way to mitigate the impacts of OA is through the reduction of CO_2 emissions to the atmosphere, there are some adaptive strategies that can be implemented in the near-term to help managers and policymakers deal with any disruptions in marine ecosystem services. Careful monitoring of coastal marine environments, particularly in regions of societal and economic importance is a critical first step in addressing the challenges of OA. Beginning in 2012, a number of Federal and private agencies as well as the state of Alaska