Oral Statement of Mike Burnett, President, Hot Sky Consulting Opposing the Millennium Bulk Terminal Longview

September 17, 2013; Longview WA

My name is Mike Burnett. I am currently President of Hot Sky Consulting, a climate change and clean energy consulting firm. For ten years, I was Executive Director of The Climate Trust in Oregon, where I administered the Carbon Dioxide Standard, the first legislative limit on greenhouse gas emissions (GHGs).

I advise you to reject the application of the coal terminal for the following reasons:

1. **The coal terminal represents a massive increase in Washington State GHG emissions**.

   The coal terminal's annual capacity represents 79.5 million metric tons of CO_2, which is equivalent to 83% of Washington's current GHG inventory.

2. **Carbon dioxide is a rare gas and a potent atmospheric heating agent**.

   Before the Industrial Revolution, CO_2 comprised 1 in 3600 molecules in the atmosphere. Remove this rare atmospheric component, and our beautiful green Earth would be like Antarctica. Humanity is in the process of injecting at least this amount of excess CO_2 into the atmosphere, taking temperatures in the opposite direction.

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3. **Carbon dioxide is a long lived gas in the atmosphere**.

   A reasonable average lifetime for policy purposes is 300 years.

4. **CO_2 is so potent that the atmospheric heating effect is greater than the energy content of the coal**.

   Using measured atmospheric data, one can compute that the atmospheric heating effect is nearly 3 times as great as the energy content of the coal, and this is just in the year in which combustion occurs.

5. **Since CO_2 remains in the atmosphere for 300 years, the atmospheric heating effect is over 800 times as great as the energy content of the coal**.

6. **When the atmospheric heating effect is considered, the efficiency of new coal burning power plants is less than 1%**.

   A new coal power plant operates at 40% efficiency, but when the atmospheric heating effect is considered as well, efficiency drops to 0.05%.

   Thank you for the opportunity to testify.

Written Statement of Mike Burnett, President, Hot Sky Consulting Opposing the Millennium Bulk Terminal Longview

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My name is Mike Burnett. I am currently President of Hot Sky Consulting, a climate change and clean energy consulting firm. For ten years, I was Executive Director of The Climate Trust in Oregon, where I administered the Carbon Dioxide Standard, the first legislative limit on greenhouse gas emissions (GHGs). I also provided testimony to the Washington State Energy Facility Site Evaluation Council. Previously, I was Managing Director of Conservation and Renewable Energy System, a joint operating agency of Washington consumer-owned utilities.

I apply my thirty years as a pioneer in renewable energy, energy efficiency, and climate change in advising you to reject the application of the Millennium Bulk Terminal Longview (the "coal terminal"), for the following reasons:

1. **The coal terminal represents a massive increase in Washington State GHG emissions.**

   Burning a metric ton of Powder River coal releases 1.8 metric tons of carbon dioxide (CO_2). The coal terminal's annual 44 million metric ton capacity represents 79.5 million metric tons of CO_2. Contrast this to Washington's 2010 GHG Inventory of 96.1 million metric tons of CO_2. The coal terminal is equivalent to 83% of Washington's current GHG footprint.

2. **Carbon dioxide is a rare gas and a potent atmospheric heating agent.**

   Before the Industrial Revolution, CO_2 represented 1 in 3600 molecules in the atmosphere. That's one week in a lifetime or one mile in a trip from Seattle to Key West. Yet without this rare atmospheric component, the Earth's average temperature would be 0° F. Our beautiful green world would be a frigid icy ball. In the Ice Ages, CO_2 levels dropped by 30%, dropping temperatures by 9° F. Due largely to fossil fuel combustion, humanity is on a track to more than double levels of this potent atmospheric heating agent, taking temperatures in the opposite direction. The coal terminal would be a significant contributor to this trend.

3. **Carbon dioxide is a long lived gas in the atmosphere.**

   The CO_2 that we humans release is not merely a brief transitory pulse, but rather has a very long lifetime in the atmosphere. A reasonable average lifetime for policy purposes is 300 years, and this ignores the one-fifth of CO_2 additions that remains in the atmosphere for over a millennium.

4. **CO_2 is so potent that the atmospheric heating effect is greater than the energy content of coal.**

   Burning fossil fuels releases energy, and burning fossil fuels is the largest cause of climate change. One can compare the atmospheric heating effect of the CO_2 by-product to the energy content of the fuel by using changes in measured atmospheric data: 1) the change in CO_2 concentration and 2) the change in the atmospheric heating effect caused by this CO_2 increase (radiative forcing). The result speaks to the great potency of CO_2. A kilogram of bituminous coal contains 16.4 megajoules of energy, while the atmospheric heating effect of the CO_2 by-product is 45.9 megajoules. The atmospheric heating effect is nearly 3 times (2.8) as great as the energy content of the fossil fuel, and this is just in the year in which combustion occurs.

5. **Since CO_2 remains in the atmosphere for over 300 years, the atmospheric heating effect is over 800 times as great as the energy content of the coal.**

   The CO_2 released from burning coal continues to heat the atmosphere for an average of 300 years. Thus, the atmospheric heating effect of the CO_2 over its lifetime is 840 times (300 times 2.8) as great as the energy content of the coal.

6. **When the atmospheric heating effect is considered, the efficiency of new coal burning power plants is less than 1%.**

   A state-of-the-art coal power plant operates at 40% thermal efficiency when the heat content of the fuel is considered. However, when viewed from a holistic environmental perspective that considers the atmospheric heating effect as well, efficiency drops to 0.05%. (40% divided by 840.)

Compare MBTL Emissions to Statewide Emissions

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1. Calculate Annual CO2 Emissions from MBTL

	44	million metric tons of coal/year	http://www.ecy.wa.gov/geographic/millennium/
x	2204.6	pounds per metric ton	
=	97,003	million pounds of coal/year	
*	8500	BTU per pound	http://en.wikipedia.org/wiki/Powder_River_Basin
=	8.25E+08	million BTU/year	
*	212.7	pounds CO2 per million BTU	http://www.eia.gov/coal/production/quarterly/co2_article/co2.html
=	1.75E+11	million pounds CO2/year	
/	2204.6	pounds/metric ton	
=	7.95E+07	metric tons CO2/year	
/	1,000,000	metric tons/million metric tons	
=	79.5	million metric tons of CO2/year	

2. Compare Annual MTBL CO2 Emissions to Washington Statewide GHG Inventory

	79.5	million metric tons of CO2/year	
/	96.1	million metric tons CO2 statewide 2010	https://fortress.wa.gov/ecy/publications/publications/1202034.pdf
=	**83%**	**AS LARGE AS STATEWIDE CO2 EMISSIONS FROM THIS ONE FACILITY**	

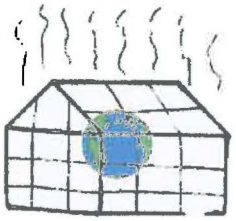
3. Compare Annual MTBL CO2 Emissions to Keystone Pipeline CO2 Emissions

	79.5	million metric tons of CO2/year	
/	144.0	million tons CO2/year Keystone	http://daily.sightline.org/2011/11/16/coal-exports-are-bigger-threat-than-tar-sands-pipeline/
=	**31%**	**AS LARGE AS KEYSTONE FROM THIS ONE FACILITY**	

Potent

CO_2: A Potent Gas

- Burning fossil fuels releases energy



- Burning fossil fuels is the most important cause of climate change

Potent

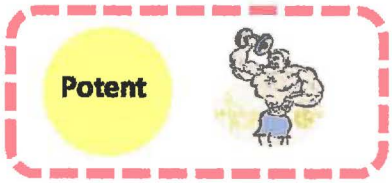
CO_2: A Potent Gas

Let us now compare these two effects:

- Energy content of fossil fuel
- Atmospheric heating effect of the CO_2 by-product
  - First in the year of combustion
  - Then over the lifetime of CO_2 in the atmosphere.

Energy Content of Fossil Fuel

Atmospheric Heating Effect of CO_2



Atmospheric Heating Effect of CO_2

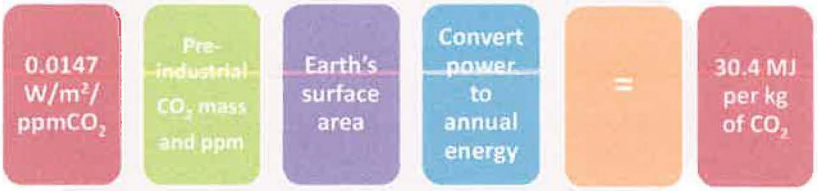
Between 1998 and 2005…	
Atmospheric Heating Effect increased by … *0.19 watts per square meter (W/m^2)*	**Amount of CO_2 in Atmosphere** increased by … *13 parts per million ($ppmCO_2$)*

Now divide these two numbers:

The average increase in atmospheric heating per part per million increase in CO_2 concentration is **0.0147 $W/m^2/ppmCO_2$**

Atmospheric Heating Effect of CO_2

Use this to calculate the annual heating energy from one kilogram of CO_2



Factors used in computation

This spreadsheet provides the calculations used in the following document:

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Calculation of Atmospheric Heating Energy from Carbon Dioxide Emissions

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STEP 1: Radiative Forcing Per Part Per Million of CO2

	379	ppm			<1>	2005 CO2 concentration
-	366	ppm			<1>	1998 CO2 concentration
=	13	ppm				Difference between 2005 and 1998 CO2 concentrations
	1.66	watts	per	m2	<1>	2005 CO2 radiative forcing
-	1.47	watts	per	m2	<1>	1998 CO2 radiative forcing
=	0.19	watts	per	m2		Difference in radiative forcing between 2005 and 1998
	0.19	watts	per	m2		Difference in radiative forcing between 2005 and 1998
/	13	ppm				Difference between 2005 and 1998 CO2 concentrations
=	**0.0147**	**watts/m2**	**per**	**ppm**		**Radiative forcing per ppm of CO2**

STEP 2: Global Radiative Forcing Per Part Per Million of CO2

	0.0147	watts/m2	per	ppm	Radiative forcing per ppm of CO2
*	5.10E+14	m2			Earth's surface area in square kilometers
=	**7.49E+12**	**watts**	**per**	**ppm**	**Global radiative forcing per ppm of CO2**

STEP 3: Tons of CO2 Per Part Per Million

	2.163E+12	metric tons of CO2			<2>	Pre-industrial CO2 mass
/	278	ppm			<3>	Pre-industrial CO2 concentration
=	**7.78E+09**	**metric tons of CO2**	**per**	**ppm**		**Metric tons of CO2 per part per million**

STEP 4: Radiative Forcing (Atmospheric Heating) Instantaneous Power Per Metric Ton of CO2

	7.49E+12	watts	per	ppm	Global radiative forcing per ppm of CO2
/	7.78E+09	metric tons of CO2	per	ppm	Metric tons of CO2 per part per million
=	**963**	**watts**	**per**	**metric ton of CO2**	**Radiative forcing instantaneous power per metric ton of CO2**

STEP 5: Radiative Forcing (Atmospheric Heating) Annual Energy Per Metric Ton of CO2

	963	watts	per	metric ton of CO2	Radiative forcing instantaneous power per metric ton of CO2
*	8,760	hours	per	year	Conversion factor
=	8,436,223	watt-hours	per	metric ton of CO2	Radiative forcing annual energy per metric ton of CO2
/	1,000	watt-hours	per	kWh	Conversion factor
=	8,436	kWh	per	metric ton of CO2	Radiative forcing annual energy per metric ton of CO2
*	3.6	MJ	per	kWh	Conversion factor
=	**30,370**	**MJ**	**per**	**metric ton of CO2**	**Radiative forcing annual energy per metric ton of CO2**

STEP 6: Average Lifetime of CO2 in the Atmosphere

300	**years**	<4>	**Average lifetime of CO2 in atmosphere**

STEP 7: Radiative Forcing (Atmospheric Heating) Lifetime Energy Per Metric Ton of CO2

	30,370	MJ	per	metric ton of CO2	Radiative forcing annual energy per metric ton of CO2
*	300	years			Average lifetime of CO2 in atmosphere
	9,111,121	**MJ**	**per**	**metric ton of CO2**	**Radiative forcing lifetime energy per metric ton of CO2**

References Cited

<1> P. Forster and V. Ramaswamy et al. "Changes in Atmospheric Constituents and in Radiative Forcing." Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press. Page 141, Table 2.1.

<2> Energy Information Administration, 2008. International Energy Outlook 2008. DOE/EIA-0484(2008). Page 90.

<3> P. Forster and V. Ramaswamy et al. "Changes in Atmospheric Constituents and in Radiative Forcing." Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press. Page 141, Table 2.1, footnote c.

<4> See related paper: Fossil Fuels: The Fire That Burns Six Hundred Times.

<5> U. S. Inventory of Greenhouse Gas Emissions and Sinks: Fast Facts, Reference Tables, and Conversions. EPA 430-F-07-004. Heat Contents and Carbon Content Coefficients of Various Fuel Types.

<6> International Energy Agency. Key World Energy Statistics 2007. Page 6

Atmospheric Heating Effect from Sub-Bituminous Coal

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1. Data Inputs

15.55	million BTU	per	metric ton of sub-bituminous coal
1509.7	kg CO2	per	metric ton of sub-bituminous coal

Source: The U.S. Inventory of Greenhouse Gas Emissions and Sinks: Reference Tables and Conversions
U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2005 (EPA 2007)
http://www.epa.gov/cleanenergy/documents/sources/2007GHGFastFacts.pdf

2. Convert Energy Content of Sub-Bituminous Coal to Megajoules

	15.55	million BTU	per metric ton of sub-bituminous coal
x	1,055	MJ	per million BTU
=	**16,405**	**MJ**	**per metric ton of sub-bituminous coal**

3. Convert CO2 Emissions from Sub-Bituminous Coal to Megajoules of Annual Atmospheric Heating

	1509.7	kg CO2	per metric ton of sub-bituminous coal
x	30.4	MJ annual atmospheric heating	per kg CO2
=	**45,895**	**MJ annual atmospheric heating**	**per metric ton of sub-bituminous coal**

4. Divide Megajoules of Annual Atmospheric Heating by Energy Content of Sub-Bituminous Coal

	45,895	MJ annual atmospheric heating	per metric ton of sub-bituminous coal
/	16,405	MJ	per metric ton of sub-bituminous coal
=	**2.80**	**MJ annual atmospheric heating**	**per MJ of sub-bituminous coal**

5. Convert Annual Atmospheric Heating to Lifetime Atmospheric Heating

	2.80	MJ annual atmospheric heating	per MJ of sub-bituminous coal
x	300	MJ lifetime atmospheric heating	per MJ of annual atmospheric heating
=	**839**	**MJ lifetime atmospheric heating**	**per MJ of sub-bituminous coal**