Sealaska Plaza Wood Pellet Boiler

Benefit-Cost and Sensitivity Analysis

September 2013

Prepared by:

Sohrab Pathan

Institute of Social and Economic Research, University of Alaska Anchorage

Alaska Center for Energy and Power, University of Alaska Fairbanks

Prepared for

Denali Commission

Table of Contents

List of Tables

List of Graphs

Acknowledgements

Thanks to Nathan Soboleff of Haa Aaní, LLC (a subsidiary of Sealaska Corporation) for providing me with the necessary data for the analysis, and Alejandra Villalobos Meléndez of Institute of Social and Economic Research at UAA for providing necessary feedbacks to finalize the report.

Disclaimer

This report was prepared as a part of the Emerging Energy Technology Grant funded by the Denali Commission and any findings and conclusions of this paper are those of the authors. For any further inquiry please contact Sohrab Pathan at ahpathan@uaa.alaska.edu.

Suggested Citation

Pathan, S. 2013, Sealaska Plaza Wood Pellet Boiler: Benefit-Cost and Sensitivity Analysis, Technical Report, Institute of Social and Economic Research, University of Alaska Anchorage, Prepared for the Denali Commission, 12 pages.

Introduction

Executives at Sealaska Corporation's headquarters, Sealaska Plaza, in Juneau decided to replace existing oil fired boilers with a wood pellet boiler for heating as a part of the Corporation's green initiative.[1] By introducing green energy, the Corporation hopes to reduce its carbon footprint, encourage other business entities in Southeast Alaska to use green energy, help to establish a local wood pellet industry in Southeast Alaska, increase local employment, and reduce the impacts of oil price volatility. Currently there is no wood pellet industry in southeast Alaska and Sealaska Corporation is assuming the leading role to develop the demand for wood pellets by promoting this renewable technology and using the Corporation's building as a demonstration location. The wood pellet boiler that the Sealaska Plaza building is using to heat the building is a Viessmann PYROT boiler that is powered by KÖB biomass technology. The publicly visible silo in front of the Corporation's headquarters in downtown Juneau is an indication that this is a signature project to increase the public awareness about biomass technology.

This paper provides a technical summary of benefit-cost ratios and sensitivity analyses of the biomass project given different fuel price projections and estimates of the social costs of carbon. The costs driving the benefit-cost ratios of this 20-year project are calculated by using the data provided by the Sealaska Corporation. In order to conduct these analyses, some economic assumptions were made and are presented below.

Economic Assumptions

The analysis is based on one year (2011) of operation of the wood pellet boiler and it is assumed that with proper maintenance the boiler will last for 20 years. The real discount rate used in the net present value (NPV) calculation is 3%. Pellet cost is approximately $300 per short ton (or $330 per metric ton or long ton) and net operation and maintenance (O&M) cost[2] is $6,700 per year. The O&M cost is $100 per hour when an external contractor is utilized, although the same job could be tasked internally with a lower cost, around $20 per hour.[3] It is assumed that the *real* O&M cost and pellet cost will remain constant throughout the project lifetime and is presented in 2011 dollars. The old oil fired boilers and the new wood pellet boiler use the same amount of electricity for their operations and hence the saving

[1] The Corporation's website states that its headquarters in Juneau will be first commercial building in Alaska to convert to renewable bio-energy.

[2] Net O&M cost is O&M cost for the new system less O&M cost for the old system

[3] Phone Interview with Nathan Soboleff of Sealaska Corporation on February 21st, 2012. The decision to utilize an external contractor is related to the demonstration nature of this particular project.

or cost for net electricity usage is zero.[4] Fuel prices (low, medium, and high) are based on projections by the Institute of Social and Economic Research (ISER).[5] Social cost of carbon (SCC)[6] is assumed to be $5.42 per metric ton (low), $22.78 per metric ton (medium), $37.97 per metric ton (high), and $70.52 per metric ton (higher than expected assumption)[7] in 2011 dollars.

A summary of economic assumptions is presented below:

Table 1. Summary of Economic Assumptions

Full Year of Operation Began	2011
Project Lifetime	20 years
Discount Rate for Net Present Value (NPV)	3%
Fuel Price Projection for Juneau	Low, Medium, and High
Social Cost of Carbon (SCC) (2011$)[8]	
$5.42	low cost - per metric ton of CO_2 emissions
$22.78	medium cost - per metric ton of CO_2 emissions
$37.97	high cost - per metric ton of CO_2 emissions
$70.52	higher than expected cost - per metric ton of CO_2 emissions

Benefit-Cost Analysis and Sensitivity Analysis

The wood pellet boiler uses around 250 metric tons[9] of wood pellets per year to produce heat. The annual cost for the wood pellets is approximately $82,000. By removing the oil fired boilers and replacing them with wood pellet boiler, Sealaska Corporation is able to displace over 30,000 gallons of fuel oil each year which contributed to $1.3 million savings over the project's lifetime if one assumes the low fuel price projection, $2.2 million if one assumes the medium fuel price projection, or $3.0 million if one assumes the high fuel price projection.

30,000 gallons of fuel oil displacement also contributed to annual CO_2 reduction of around 290 metric tons.[10] If one considers the savings due to social cost of carbon as an added benefit to the project, then the additional savings for the project's lifetime is $23 thousand if one assumes the low social cost of carbon, $97 thousand if one assumes the medium social cost of carbon, $162 thousand if one assumes the high social cost of carbon, or $301 thousand if one assumes the higher than expected social cost of carbon.

[4] E-mail communication with Nathan Soboleff of Sealaska Corporation on February 21st, 2012.

[5] Fay, G. and Villalobos-Melendez, A. and Pathan, S. 2012. *Alaska Fuel Price Projections 2012-2035,* Technical Report, Institute of Social and Economic Research, University of Alaska Anchorage, prepared for the Alaska Energy Authority, 14 pages.

[6] Social cost of carbon (SCC) is an attempt to monetize the value of the damages caused by the CO_2 emissions in the environment. Heating oil or diesel emits CO_2 in the environment when it is used to generate heat. If the alternative energy source (e.g. wood pellet) is used to generate heat then CO_2 emission will go down which will be beneficial for the environment and SCC estimates the monetary value for that reduced CO_2.

[7] Greenstone, M., Kopits, E., and Wolverton, A. 2011. *Estimating the social cost of carbon for use in U.S. federal rulemakings: a summary and interpretation*. NBER Working Paper 16913, available at: http://www.nber.org/papers/w16913.

[8] SCC data has been converted to 2011 $ by using US National CPI-U (all urban consumers).

[9] Note that the pellet usage was calculated using the data for the cold months (November 2010 to April 2011) when the demand for heat is higher compare to warmer months. Data were not available for warmer months. If data for a full year were available, then the annual usage of pellets may have been lower than 250 metric tons.

[10] CO_2 Emission Factor (Coefficient): 73.15 kg CO_2/MMBtu; data is from U.S. Energy Information Administration.

The net present value (NPV) of the project depend on different fuel oil prices and different social costs of carbon and so this report shows the benefit-cost ratios once only based on three (low, medium, high) fuel oil price projections; and once based on three (low, medium, high) fuel oil price projections and four (low, medium, high, higher than expected) social costs of carbons. Both the old heating system (oil boilers) and new heating system (wood pellet boiler) create CO_2 emissions and so CO_2 emission coefficients were used to calculate the *net* CO_2 reduction. Fuel oil price projection for Juneau, displaced fuel cost, and social cost of carbon for displaced fuel are given in the appendix.

The net present value of the project is negative for low and medium fuel oil price projection, but positive for high fuel oil price projection. If one considers the social cost of carbon in the analysis, then the net present value is -$1.4 million for low fuel price projection and low social cost of carbon. Net present value of the project gets higher with higher fuel price projection and higher social cost of carbon. Net present value is -$507 thousand for medium fuel price projection and medium social cost of carbon, and it is $367 thousand for high fuel price projection and high social cost of carbon. If one does not consider the social cost of carbon as additional savings, then the net present value of the project is -$1.5 million for low fuel price projection, -$604 thousand for medium fuel price projection, and $205 thousand for high fuel price projection. Table below shows the net present value for different fuel price projections and different social costs of carbon.

Table 2. Net Present Value

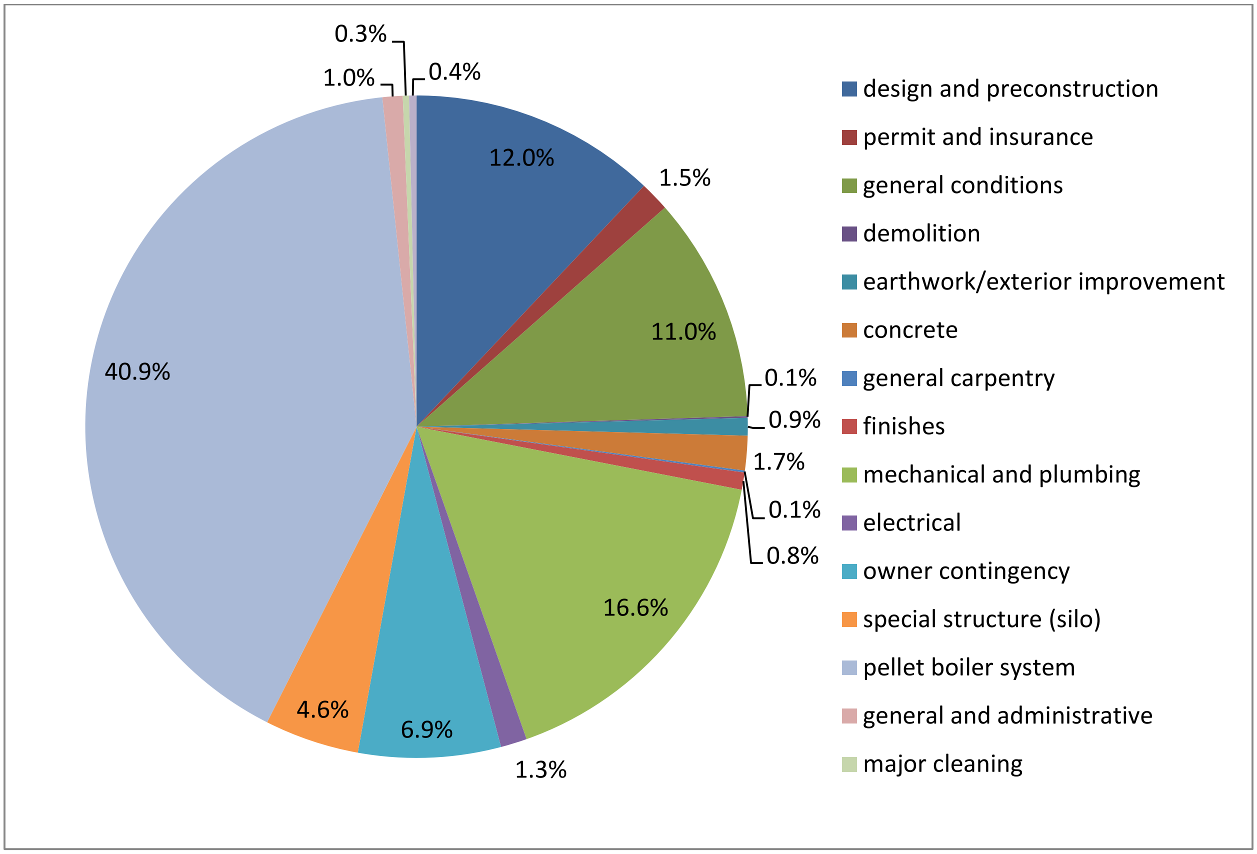
Net Present Value with Social Cost of Carbon ($000)[11]		
Fuel - low projection	SCC - low cost	($1,432)
	SCC - medium cost	($1,358)
	SCC - high cost	($1,293)
	SCC - higher than expected cost	($1,154)
Fuel - medium projection	SCC - low cost	($581)
	SCC - medium cost	($507)
	SCC - high cost	($442)
	SCC - higher than expected cost	($303)
Fuel - high projection	SCC - low cost	$228
	SCC - medium cost	$302
	SCC - high cost	$367
	SCC - higher than expected cost	$506
Net Present Value without Social Cost of Carbon		
Fuel - low projection		($1,455)
Fuel - medium projection		($604)
Fuel - high projection		$205

[11] In thousand dollars.

Factors Driving Benefit-Cost Ratios

98% of the *initial* project cost (excluding pellet cost) is due to the capital cost; the remaining 2% of the total initial project cost is due to the general & administrating (G&A) expense, and operation & maintenance (O&M) cost.[12] 47% of the total capital cost is due to the high cost of the pellet boiler system and silo. The remaining 53% of capital cost is due to permit & insurance, design & pre-construction, and construction cost to convert the building to a biomass heating system. Below is a graph that shows the breakdown of various initial costs.

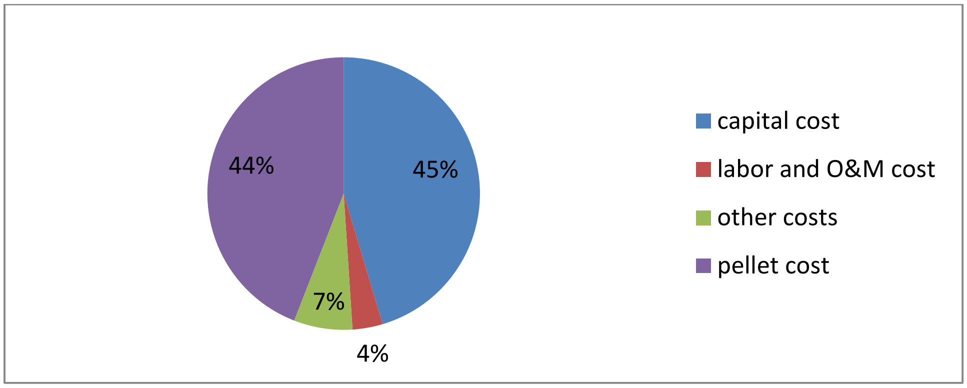
Figure 1. Initial Project Costs



The total cost for the project's lifetime shows a different picture. Pellet cost (44%) is almost equal to capital cost (45%) and is a large portion of the total cost. Labor and O&M cost equal 4% of the total cost, and administrative expense (mentioned as 'other cost') is 7% of the total cost. Graph below shows the chart for the total cost of the project.

[12] Capital costs include design and pre-construction, permit and insurance, general condition assessment, demolition, earthwork/exterior improvement, concrete remodeling, general carpentry, electrical, mechanical, plumbing, silo, and pellet boiler cost. O&M cost includes major and minor cleaning.

Figure 2. Total Cost of the Project



The benefit-cost ratio of the project is below 1 for low and medium fuel price projection, but greater than 1 for high fuel price projection. If one considers the social cost of carbon in the analysis, then the benefit-cost ratio is 0.50 for low fuel price projection and low social cost of carbon. Benefit-cost ratio of the project gets higher with higher fuel price projection and higher social cost of carbon. It is 0.83 for medium fuel price projection and medium social cost of carbon, and 1.10 for high fuel price projection and high social cost of carbon. If one does not consider the social cost of carbon as additional savings, then the benefit-cost ratio of the project is 0.49 for low fuel price projection, 0.80 for medium fuel price projection, and 1.09 for high fuel price projection. Table below shows the benefit-cost ratios for different fuel price projections and different social costs of carbon.

Table 3. Benefit-Cost Ratio

Benefit-Cost ratio with Social Cost of Carbon		
Fuel - low projection	SCC - low cost	0.50
	SCC - medium cost	0.53
	SCC - high cost	0.55
	SCC - higher than expected cost	0.60
Fuel - medium projection	SCC - low cost	0.80
	SCC - medium cost	0.83
	SCC - high cost	0.85
	SCC - higher than expected cost	0.90
Fuel - high projection	SCC - low cost	1.10
	SCC - medium cost	1.12
	SCC - high cost	1.15
	SCC - higher than expected cost	1.20
Benefit-Cost ratio without Social Cost of Carbon		
Fuel - low projection		0.49
Fuel - medium projection		0.80
Fuel - high projection		1.09

Payback Period

Payback period[13] is high compared to the project lifetime mainly because of high capital cost and high pellet cost. It is more than 20 years (which is the project lifetime) for low and medium fuel price projections. For high fuel price projection and low social cost of carbon the payback period is 16.6 years and it gets lower as the social cost of carbon gets higher. For high fuel price projection and medium social cost of carbon the payback period is 15.7 years, and for high fuel price projection and high social cost of carbon the payback period is 15.0 years. If one does not consider the social cost of carbon as additional savings, then the payback period of the project is more than 20 years for low fuel price projection, more than 20 years for medium fuel price projection, and 16.8 years for high fuel price projection. Table below shows different payback periods for different fuel price projections and different social costs of carbon.

Table 4. Payback Period

Payback Period (Years) with Social Cost of Carbon		
Fuel - low projection	SCC - low cost	>20
	SCC - medium cost	>20
	SCC - high cost	>20
	SCC - higher than expected cost	>20
Fuel - medium projection	SCC - low cost	>20
	SCC - medium cost	>20
	SCC - high cost	>20
	SCC - higher than expected cost	>20
Fuel - high projection	SCC - low cost	16.6
	SCC - medium cost	15.7
	SCC - high cost	15.0
	SCC - higher than expected cost	13.6
Payback Period (Years) without Social Cost of Carbon		
Fuel - low projection		>20
Fuel - medium projection		>20
Fuel - high projection		16.8

Conclusion

The wood pellet boiler system installed by Sealaska was intended as a technology demonstration. The goal of the project was not solely cost savings through fuel displacement; the demonstration of the technology in a corporate, visible, and publicly-accessible setting was also a critical component. As such, certain capital and system costs (for both a signature project and premium wood pellet system) would not normally be incurred by future projects in typical commercial installations.

[13] Payback period is the length of time it takes to recover the cost of investment in the project.

In order for a similar project in Juneau to be cost effective, the initial capital cost needs to be lower or the local cost of fossil fuel needs to be higher than demonstrated. The high cost of converting the existing building to make it suitable for use of wood pellets, the low cost of fossil fuel in Juneau, and high pellet cost all have contributed to a low benefit-cost ratio and high payback period.

It is believed that future wood pellet projects in typical commercial installations in SE Alaska could potentially realize cost savings. In this scenario, the project would incur standard project costs and wood pellet cost would be the major contributor to the total cost. This scenario has yet to be demonstrated. There are several commercial-scale projects moving forward in SE Alaska, most notably in Sitka, which could inform this conclusion.

References

Department of Labor and Workforce Development, State of Alaska. (2012, January 19). *Consumer price index for anchorage municipality & u.s.*. Retrieved from http://www.labor.state.ak.us/research/cpi/cpi.htm

Fay, G. and Villalobos-Melendez, A. and Pathan, S. 2011. *Alaska Fuel Price Projections 2011-2035,* Technical Report, Institute of Social and Economic Research, University of Alaska Anchorage, prepared for the Alaska Energy Authority, 14 pages.

Greenstone, M., Kopits, E., & Wolverton, A. (2011). Estimating the social cost of carbon for use in u.s. federal rulemakings: A summary and interpretation. *The National Bureau of Economic Research*, *NBER Working Paper No. 16913*, Retrieved from http://www.nber.org/papers/w16913

Sealaska Corporation. (2012). *Sealaska to convert plaza to biomass fuel*. Retrieved from http://www.sealaska.com/object/io_1259970973175.html

U.S. Energy Information Administration. (2011, January 31). *Voluntary reporting of greenhouse gases program: fuel emission coefficients* . Retrieved from http://www.eia.gov/oiaf/1605/coefficients.html

APPENDIX

Fuel Price Projection for Juneau ($/gallon) (2011 $)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Diesel ($ per gallon) - low projection	4.41	3.33	3.23	3.10	3.00	2.89	2.81	2.80	2.79	2.78
Diesel ($ per gallon) - medium projection	4.41	4.39	4.62	4.76	4.86	4.78	4.83	4.85	4.88	4.91
Diesel ($ per gallon) - high projection	4.41	5.50	6.83	6.92	6.93	6.79	6.78	6.81	6.83	6.85

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Diesel ($ per gallon) - low projection	2.78	2.79	2.79	2.80	2.79	2.82	2.83	2.83	2.84	2.84
Diesel ($ per gallon) - medium projection	4.95	4.99	5.03	5.06	5.09	5.11	5.13	5.16	5.21	5.26
Diesel ($ per gallon) - high projection	6.89	6.91	6.93	6.94	6.96	6.98	7.02	7.03	7.07	7.11

Displaced Fuel Cost ($) (round to thousand) (2011$)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Diesel - low projection	135,000	102,000	99,000	95,000	92,000	88,000	86,000	86,000	85,000	85,000
Diesel - medium projection	135,000	134,000	141,000	145,000	148,000	146,000	148,000	148,000	149,000	150,000
Diesel - high projection	135,000	168,000	208,000	211,000	212,000	207,000	207,000	208,000	209,000	209,000

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Diesel - low projection	85,000	85,000	85,000	86,000	85,000	86,000	86,000	86,000	87,000	87,000
Diesel - medium projection	151,000	152,000	153,000	154,000	155,000	156,000	157,000	158,000	159,000	160,000
Diesel - high projection	210,000	211,000	212,000	212,000	213,000	213,000	214,000	215,000	216,000	217,000

Social Cost of Carbon for Displaced Fuel Oil ($) (round to thousand) (2011 $)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SCC - low cost	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
SCC - medium cost	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
SCC - high cost	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000
SCC - higher than expected cost	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SCC - low cost	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
SCC - medium cost	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
SCC - high cost	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000
SCC - higher than expected cost	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000