

# Workshop: Opportunities for Wood Heat from Forest Residues in Alaskan Communities



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# Purpose

- Identify boiler systems that may be suitable for use in Rural Alaska.
- Understand criteria for selecting boiler systems for Rural Alaska.

Based on Assessments for Juneau  
Economic Development Council (2006)\*

\* Feasibility Assessment for Wood Heating

[www.jedc.org/forms/AWEDTG\\_WoodEnergyFeasibility.pdf](http://www.jedc.org/forms/AWEDTG_WoodEnergyFeasibility.pdf)

# Assessments

- Community Buildings
  - Thorne Bay City Hall and Shops
  - Craig Community Center
  - Venetie Airport and Washeteria
  - Craig Aquatic Center and Schools
- Schools
  - South East Island School District: Naukati and Coffman Cove
  - Thorne Bay Community School
  - Delta Greely Schools



# Main Factors

- Wood Supply
- Energy Demand
- Suitability of Wood Heat
- Investment (Cost/Benefit) of Using Wood
- Willingness to Implement Project

# Cordwood and Chips are Abundant



# Alaskan Wood Fuel Properties

Table 4-1. Wood Fuel Properties.

Species	HHV Btu/lb od <sup>a</sup>	GHV Btu/lb MC20 <sup>a</sup>	Lb/Cord <sup>b, c</sup>	Ton/Cord <sup>b, c</sup>	MMBtu/ cord <sup>c</sup>	GHV Btu/lb MC50 <sup>a</sup>
Western Red Cedar	8,620	6,896	1,860	0.93	12.8	4,310
Hemlock	8,338	6,670	2,512	1.26	13.9	4,169
Sitka Spruce	8,200	6,650	2,040	1.02	13.4	4,100
White (Englemann) Spruce	8,401	6,721	2,040	1.02	13.7	4,201

Source: Juneau Economic Development Council

Notes:

<sup>a</sup> Higher Heating Value (HHV) and Gross Heating Value (GHV) from JEDC.

GHV = HHV (1-MCwb/100)

<sup>b</sup> Specific Gravity: Cedar 0.31, Hemlock 0.42, Spruce 0.34

<sup>c</sup> 80 ft<sup>3</sup> per cord

# Wood Systems

80,000 Btuh-250,000 Btuh

- Prefabricated Clean, Efficient Boilers
- Alternate Heating Systems
- Tarm USA



500,000 -1 MM Btuh

Build to suit,  
Cordwood or chip

- Dectra (Garn),
- AHS
- Tarm USA
- Chiptek



2 million -8 million Btuh

Industrial wood chip systems

- Chiptek
- Messersmith
- Decton
- Biomass Conversion Associates





**1. 3 MMBtuh Boiler with Gasifier, MA**



**2. 3 MMBtuh Chiptek Gasifier, Athol, MA**



**3. 4.9 MMBtuh Boiler Building Victor, MT**



**4. Fuel Bin With Chip Reclaim Auger, Victor MT**



**5. Fuel Bin, Chip Reclaim and Boiler, Victor, MT**



**6. Low Fire, Victor MT**

# Wood Chip Boilers in Alaska

Table 4-3. Wood Chip Boilers in Alaska.				
Location	Boiler Horsepower	MMBtuh	Heating Degree Days	Supplier
Craig Aquatic Center, Craig, AK	120	4	7,487	Chiptek
Icy Straits Lumber & Milling, Hoonah, AK	72	2.4	8,217	Decton
Regal Enterprises, Copper Center, AK	N/A	N/A	13,797	Messersmith (Fuel bin only)
Notes:				
* Heat delivered as hot water or steam. 1 Boiler Horsepower = 33,475 Btuh or 34.5 pounds of water at a temperature of 100°C (212°F) into steam at 212°F				

# Cost of Wood Chip Boilers

Table 4-5. Darby Public Schools Wood Chip Boiler Costs.

Boiler Capacity	3 MMBtuh
Fuel Oil Displaced	47,000
Heating Degree Days	7,186
System Costs	
Building, Fuel Handling	\$ 230,500
Boiler and Stack	<u>\$ 285,500</u>
Boiler system	\$ 516,000
Piping, integration	\$ 95,000
Other repairs, improvements	<u>\$ 268,000</u>
Total direct Costs	\$ 885,000
Engineering, permits, indirect	<u>\$ 116,000</u>
Total Cost	\$1,001,000
Source: Biomass Energy Resource Center, 2005.	

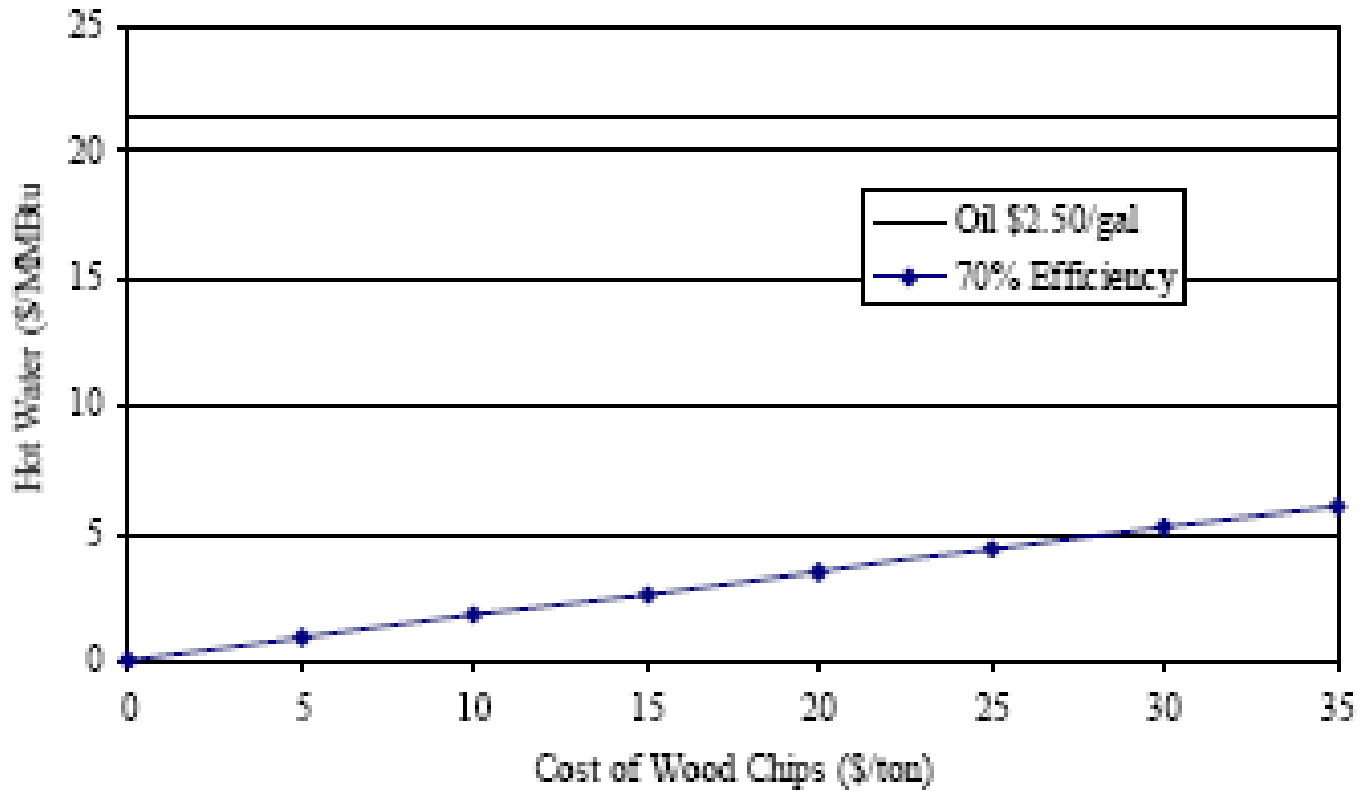


Figure 4-1. Effect of Wood Chip Costs on Cost of Delivered Heat.

**Table 3-1. Examples of Efficient Cordwood Boilers.**

Model	MBtuh	Location	Supplier
Garn	900,000	Dot Lake, AK	Dectra
Tarm	140,000	Palmer, AK	Tarm USA

**Table 3-2. Emissions from Wood Heating Appliances**

Appliance	Emissions Gm/1000 Btu Delivered
EPA Certified Non Catalytic Stove	0.50
EPA Certified Catalytic Stove	0.25
EPA Industrial Boiler (many states)	0.225
GARN WHS 1350 Boiler*	0.179

Source: Intertek Testing Services, Michigan, March 2006.

Note:

\*Average efficiency of 75.4% based upon the higher heating value of wood.



**Garn 350,000  
Btuh WHS 1500  
Ready to Ship**



**Tarm USA,  
House in  
Palmer, AK**

# Cost of Cordwood Systems

Table 4-9. Cost Estimates for Cordwood Systems.

Facility	Thorne Bay School	Craig Community Center	Thorne Bay Shop + Duplexes	Thorne Bay Solid Waste
Fuel Oil, gallons per year	11,501	6,605	3,050	2,000
Calculated required capacity*	347,000	207,000	90,000	60,000
Wood Boiler, Btuh	425,000	350,000	350,000	100,000
Building and Equipment Costs				
Building	\$ 21,600	\$ 14,500	\$ 6,500	\$ 1,900
Boilers	\$ 19,500	\$ 15,540	\$ 15,540	\$ 9,200
Piping	\$ 38,300	\$ 3,500	\$ 8,000	\$ 3,200
Installation	\$ 3,500	\$ 1,200	\$ 1,300	\$ 2,100
Total Direct Costs	\$ 81,700	\$ 34,700	\$ 31,340	\$ 16,400
Engineering +Contingency**	\$ 22,000	\$ 2,000	\$ 560	\$ 600
Total	\$ 104,300	\$ 37,000	\$ 31,900	\$ 17,000
Notes:				
* Table 4-6 Estimate of heat required in Coldest 24 Hr period.				
** This larger project may require more allowance for indirect costs such as engineering, approvals, etc.				

# Effect of Cordwood Cost on Delivered Heat

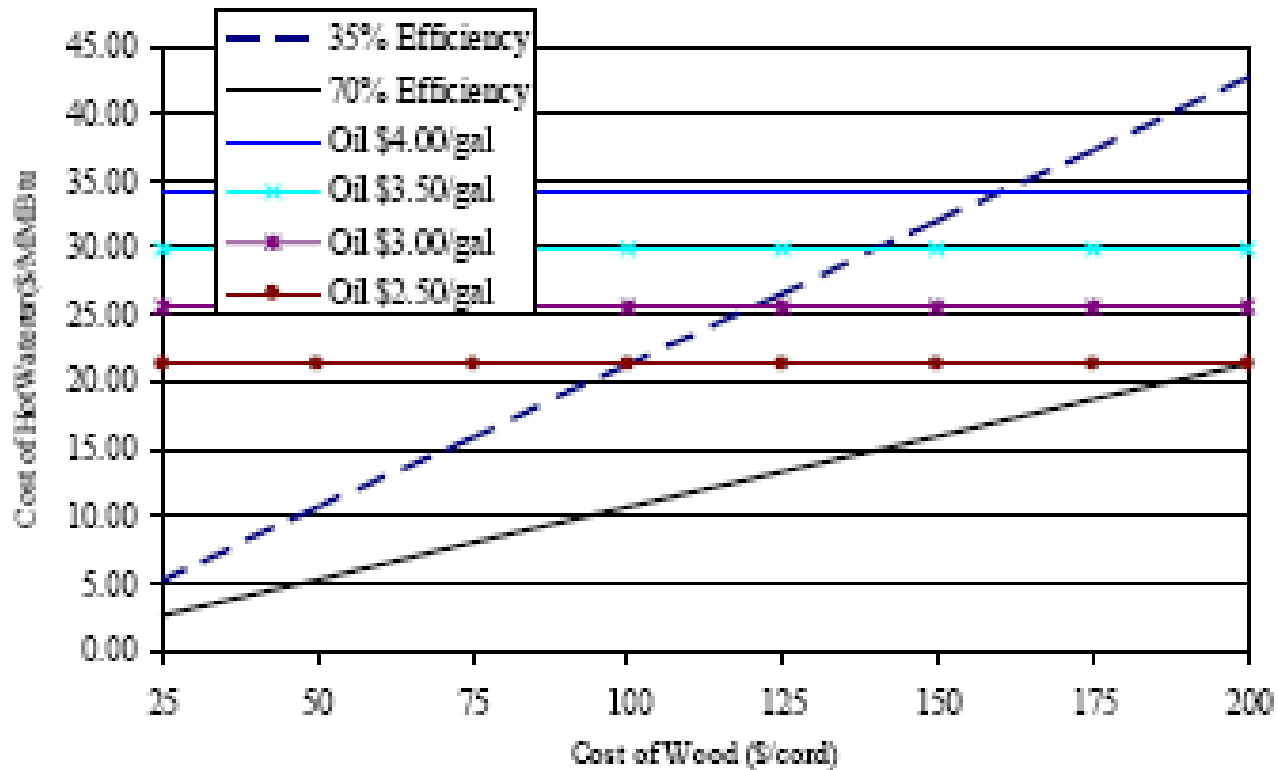


Figure 4-2. Effect of Cordwood Cost on Cost of Delivered Heat.

# Wood Pellet Boiler



TARM 140,000 BTUH



HEARTH AND ASH BIN

# Fuel Oil Replacement

Table 4-2. Fuel Oil Replaced by Wood Boilers

Fuel, boiler	Conversion Efficiency CE	Energy in Fuel HHV	Btu Delivered RHV	Gal Fuel Oil
Fuel Oil, Btu/gal	85%	138,500	117,300	1
<sup>a</sup> Wood chip boiler, 50% MC, MMBtu/ton, gal/ton	70%	8.2	5.8	49
<sup>b</sup> Efficient Cordwood Boiler 20% MC, MMBtu/cd, gal/cord	70%	11.1	7.8	66
<sup>c</sup> Low efficiency wood boiler, 20% MC, MMBtu/cd, gal/cord	35%	11.1	3.9	33

Notes:

- <sup>a</sup> Typical conversion efficiency 70%. Recovered Heating Value (RHV) = Gross Heating Value (GHV) x % Conversion Efficiency (CE).
- <sup>b</sup> Based on references cited in Section 3.0
- <sup>c</sup> Typical efficiency 35% to 40%

**Table 4-6. Estimate of Heat Required in Coldest 24 Hr Period.**

Facility	Fuel Oil Used gal/year <sup>a</sup>	Heating Degree Days <sup>b</sup>	Btu/DD <sup>c</sup>	Design Temp <sup>b</sup> F	Capacity MMBtu/h <sup>c</sup>	Installed MMBtu/h <sup>a</sup>
Delta-Greely Schools (Estimated)	102,000	13,549	866,261	-43	3.988	~10,000
2004 Fuel Oil	69,000	13,549	599,529		2.698	4.200
High School and Admin(former elementary)	33,000 <sup>d</sup>		286,731		1.290	4.200
VoTec, Career Advancement and Cyber Center, (est ea)	9,300 <sup>d</sup>		80,806		0.363	~.500
New Elementary	33,000 <sup>d</sup>		286,731		1.290	4.500
Thorne Bay School	11,501	7,802	173,540	17	0.347	1.800
Craig Community Assn	6,605	7,487	103,857	17	0.207	0.704
City of Thorne Bay						
Maintenance Garage and Duplexes	3,050	7,802	46,022	17	0.092	
Maintenance Garage	1,800		18,861	17	0.054	0.140
City Duplexes	1,250					
Solid Waste Building	2,000		30,178		0.060	0.080
City Hall, VPSO	1,250		18,861		0.038	0.190
Emergency Services, Water Treatment	600		9,053		0.018	0.080
Wastewater Treatment	600		9,053		0.018	0.120
Venetie Airport Maintenance	1,688	16,465	12,069	-57	0.061	0.500

# Thorne Bay City Hall



# Thorne Bay Garage + Duplexes



# Thorne Bay City Buildings





**1. Thorne Bay City Hall**



**2. Boiler Room and Fuel Tank**



**3. City Hall Boiler**



**4. VPSO and Emergency Service Buildings**



**5. VPSO Heater Fuel Tank**



**6. Emergency Services Building**



**7. Fuel and Exhaust Emergency Services**



**8. Air Heater Exhaust Emergency Services**



**9. City Garage (Former Gym)**



**10. Air Heated Garage**



**11. Adjacent City Duplexes for Teachers**



**12. Access to Garage Air heater**



**13. Fuel Oil Tank Near Heater**



**14. Air Heater**



**15. Maintenance Shop**



**16. Water Treatment**



**17. Water Treatment South Heater**



**18. Typical Heater**



**19. Sanitary Plant**



**20. Sanitary Boiler**



**21. Air Heater in Sanitary Plant**



**22. Municipal Waste Building**



**23. Fuel Tank Municipal Waste**



**24. Waste Baler and Office**

# Thorne Bay City Buildings

- Clusters of small demand: City Hall, Shop, Water Treatment, Wastewater, Solid Waste
- Suitable for cord wood systems
- Low equipment and building cost
- Share small shop with High School
- Modular systems
- Good demonstration site

# Potential Savings at City of Thorne Bay Facilities

Table 8-1. Potential Savings from Wood at City of Thorne Bay Facilities.

Facility	Oil Gal/yr <sup>a</sup>	Wood Cord/yr <sup>b</sup>	Oil \$/yr <sup>c</sup>	Wood \$/yr <sup>d</sup>	Potential Savings \$/yr
City Shop and Duplexes	3,050	46	\$ 7,625	\$ 4,600	\$ 3,025
City shop	1,800	27	\$ 4,500	\$ 2,700	\$ 1,800
City Owned Duplexes	1,250	19	\$ 3,125	\$ 1,900	\$ 1,225
Solid Waste Building	2,000	30	\$ 5,000	\$ 3,000	\$ 2,000
City Hall + VPSO	600	9	\$ 1,500	900	\$ 600
Emergency Services	600	9	\$ 1,500	900	\$ 600
Water Treatment	600	9	\$ 1,500	900	\$ 600
Wastewater Treatment	600	9	\$ 1,500	900	\$ 600

Notes:

- <sup>a</sup> 2004 use from SOI
- <sup>b</sup> 66 gallons per cord Table 4-2
- <sup>c</sup> \$2.50/gal
- <sup>d</sup> \$100/cord

# Potential Savings at Maintenance Facilities

Table 8-3. Savings from Cordwood at Thorne Bay Maintenance and Duplexes.

Table Header	Cost	Quantity	\$	Total
Fuel Oil Used, gallons <sup>a</sup>	\$2.50/gal	3,050		\$ 7,625
Cordwood <sup>b</sup>	\$100/cord	46	\$ 4,600	
Electricity	\$0.17/kWh	3,520	600	
Labor <sup>c</sup>	Incl.	Incl.		
				\$ 4,500
Annual Savings from Wood				\$ 3,125

Notes:

<sup>a</sup> 2004 Maintenance 1800 gal, Duplexes, 1250 gal at \$2.00/gal

<sup>b</sup> 66 gallons fuel oil per cord at 70% efficiency, Table 4-2.

<sup>c</sup> Labor by school personnel

**Table 8-2. Estimated Wood Boiler Costs for Thorne Bay Maintenance Facility.**

<b>Facility</b>	<b>Full Capacity</b>	<b>Smaller Boiler</b>	<b>Duplex, or City Hall and VPSO</b>
Capacity, Btuh	350,000	100,000	100,000
Fuel Oil, gallons per year	3,050	3,050	1,250
Buildings, 20ft x 14ft, 160 ft <sup>2</sup>	\$ 6,500	\$ 1,900	\$ 1,900
Boilers, Fuel System, Stack	\$15,500	\$ 9,200	\$ 9,200
Pumps, Piping, Integration	\$8,000	\$ 3,200	\$ 3,200
Other Installation, Electrical	\$1,300	\$ 2,100	\$ 1,100
Total Direct Costs	\$31,300	\$16,400	\$15,400
Engineering +Contingency	\$600	\$ 600	\$ 600
Total	\$31,900	\$17,000	\$16,000
Present Value of Savings from Wood compared with Fuel Oil, 20 year			
Wood \$60/cord	\$21,000	\$ 40,800	\$ 6,400
Wood \$100/cord	(\$ 2,300)	\$ 17,500	( \$ 3,200)

Notes:

\* Garn WHS 1500 350,00 Btuh

\*\* Alternate Heating Systems or Tarm 100,000 Btuh

# Wood Boiler Costs at Solid Waste Facility

Table 8-4. Estimated Wood Boiler Costs for Thorne Bay Solid Waste Facility	
Facility	Solid Waste Facility
Capacity, Btuh	100,000
Fuel Oil, gallons per year	2,000
Buildings, 50 ft <sup>2</sup>	\$ 1,900
Boiler	\$ 9,200
Pumps, Piping, Integration	\$ 3,200
Other Installation, Electrical	\$ 2,100
Total Direct Costs	\$16,400
Engineering +Contingency	\$ 600
Total	\$17,000
Present Value Savings compared with Fuel Oil, 20 year	
Wood \$60/cord	\$ 19,600
Wood \$100/cord	\$ 4,300

# Thorne Bay Community School





**1. Thomas Bay High School Entry approach**



**2. TB School Upper and Lower Buildings**



**3. TB School Upper Entry**



**4. TB School Utility Entry**



**5. Possible Location for Wood Boiler**



**6. Back Wall to Upper Boiler Room**



7. Boilers in Upper Building



8. Water Heater Upper Building



9. Upper and Lower Building



10. Boiler Room Lower Building



11. Road Past Lower Building



12. Lower Building Water Heater and Boilers



**13. Duct Heat Exchanger**



**14. Duct Ex changer and Unit Heater**

# Thorne Bay Community School

- Good demand
- Potential for cord wood system
- Need low cost modular system
- Use part of demand
- Share demand with city

**Table 6-2. Savings from Wood Chips at Thorne Bay School.**

<b>Table Header</b>	<b>Cost</b>	<b>Quantity</b>	<b>\$</b>	<b>Total</b>
Fuel Oil Used, gallons <sup>a</sup>	\$2.50/gal	11,500		\$ 28,750
Wood chips used, tons green <sup>b</sup>	\$30/ton	236	\$ 7,080	
Electricity	\$0.17/kWh	10,170	\$ 1,730	
Labor	Inc	Inc	-	
				\$ 8,810
<b>Gross Savings from Wood</b>				<b>\$ 19,940</b>

Notes:  
<sup>a</sup> 2004 11,500 gal at \$2.00/gal  
<sup>b</sup> 49 gallons of fuel oil/ton wood chips, Table 4-2.

**Table 6-3. Savings from Cordwood at Thorne Bay School.**

<b>Table Header</b>	<b>Cost</b>	<b>Quantity</b>	<b>\$</b>	<b>Total</b>
Fuel Oil Used, gallons <sup>a</sup>	\$2.50/gal	11,500		\$ 28,750
Cordwood <sup>b c</sup>	\$100/cord	147	\$ 14,700	
Electricity	\$0.17/kWh	13794	\$ 2,345	
Labor <sup>d</sup>	Inc.	Inc		
				\$ 17,045
<b>Annual Savings from Wood</b>				<b>\$ 11,705</b>

Notes:  
<sup>a</sup> 2004 11,500 gal at \$2.00/gal  
<sup>b</sup> 66 gallons fuel oil per cord at 70% efficiency, Table 4-2.  
<sup>c</sup> Slabs and edgings available from Goose Creek or Klawock  
<sup>d</sup> Labor by school personnel

**Table 6-1. Estimated Wood Boiler Costs for Thorne Bay School.**

<b>Facility</b>	<b>Wood Chips</b>	<b>Cordwood (1) boiler*</b>	<b>Cordwood (1) boiler**</b>
Capacity, Btuh	1,000,000	425,000	425,000
Fuel Oil, gallons per year	11,500	11,500	11,500
Buildings, 1500 ft <sup>2</sup> ; 600 ft <sup>2</sup>	\$ 158,000	\$ 21,600	**
Boilers, Fuel System, Stack	\$ 280,000	\$ 19,500	\$ 19,500
Pumps, Piping, Integration	\$ 52,500	\$ 38,300	\$ 38,300
Other Installation, Electrical	\$ 48,100	\$ 2,300	\$ 3,500
Total Direct Costs	\$ 538,600	\$ 81,700	\$ 61,260
Engineering +Contingency	\$ 161,000	\$ 22,600	\$ 17,20
Total	\$ 699,000	\$ 104,300	\$ 78,500
NPV \$ 15/ton, \$60/cord	(\$455,000)	\$ 93,700	\$ 119,500
NPV \$30/ton, \$100/cord	(\$510,400)	\$ 6,000	\$ 31,800

**Notes:**

\* Building sufficient for two boilers. Install one (Garn WHS 2000) since estimated load is less than 425,000 Btuh. Table 4-6.

\*\* Install boiler under existing building cover.

# Capital and Non Fuel Costs of Cordwood Boilers: 425,000 Btuh (11,500 gpy)

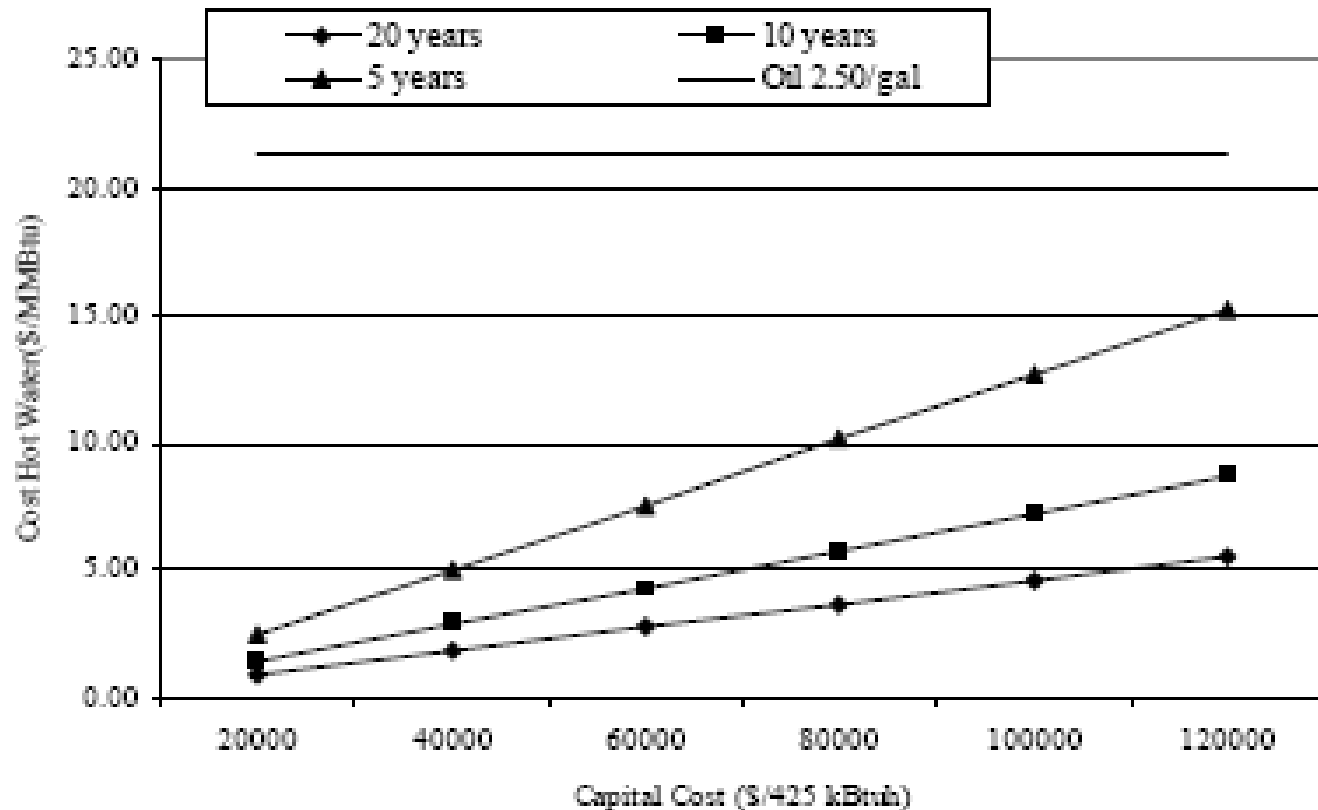


Figure 4-7. Impact of Capital and Non Fuel Cost on Cost of Heat for a 425,000 Btuh Cordwood Boiler to Replace 11,500 gpy Fuel Oil. Does not include wood cost.

# Capital and Non Fuel Costs of Cordwood Boilers: 425,000 Btuh (6,000 gpy)

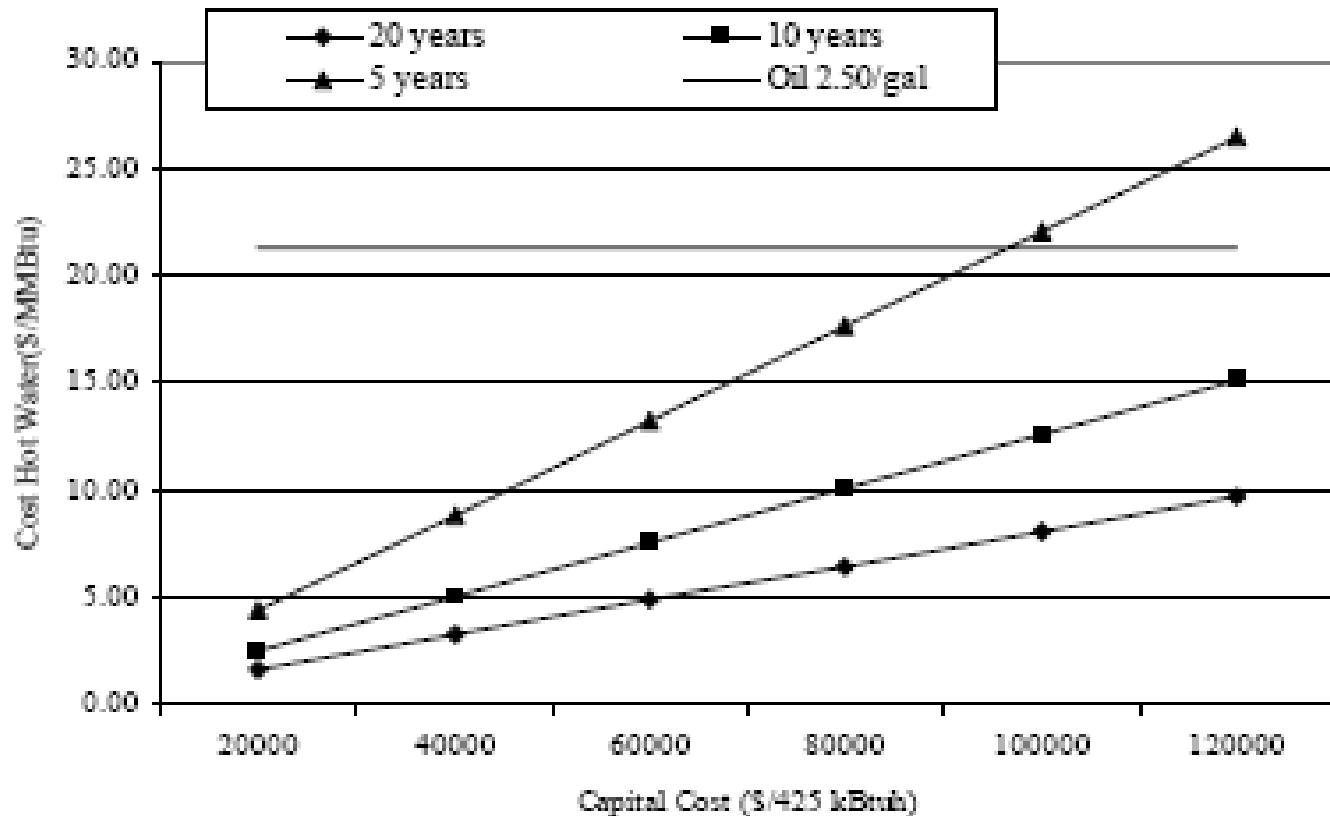


Figure 4-8. Impact of Capital and Non Fuel Cost on Cost of Heat for a 425,000 Btuh Cordwood Boiler to Replace 6,600 gpy Fuel Oil. Does not include wood cost.

# Total Cost to Replace 11,500 gpy

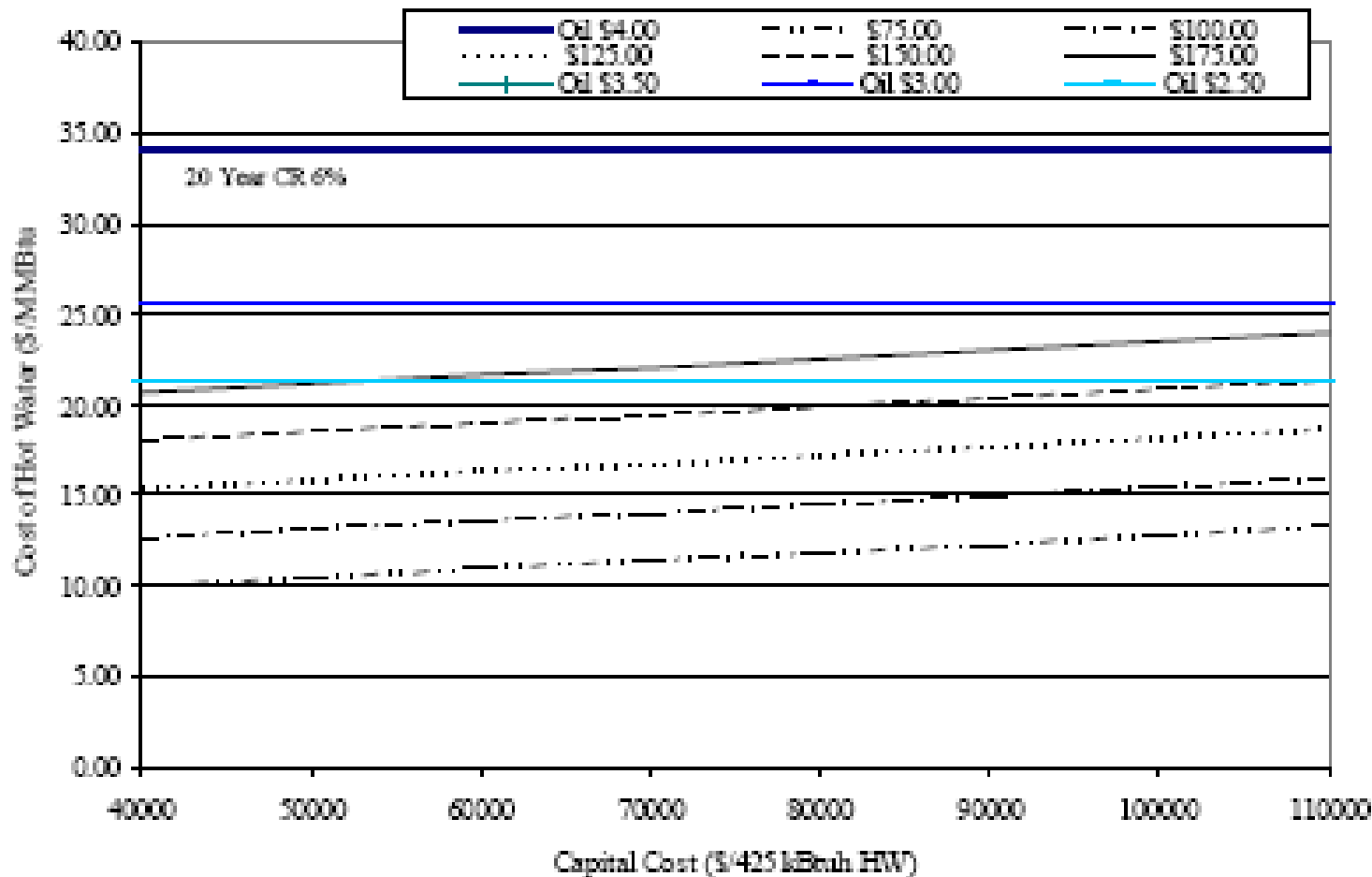


Figure 4-9. Total Cost of Heat to Replace 11,500 gpy Fuel Oil At Various Wood Costs (\$/Cord).

# Cost to Replace 6,600 gpy Fuel oil

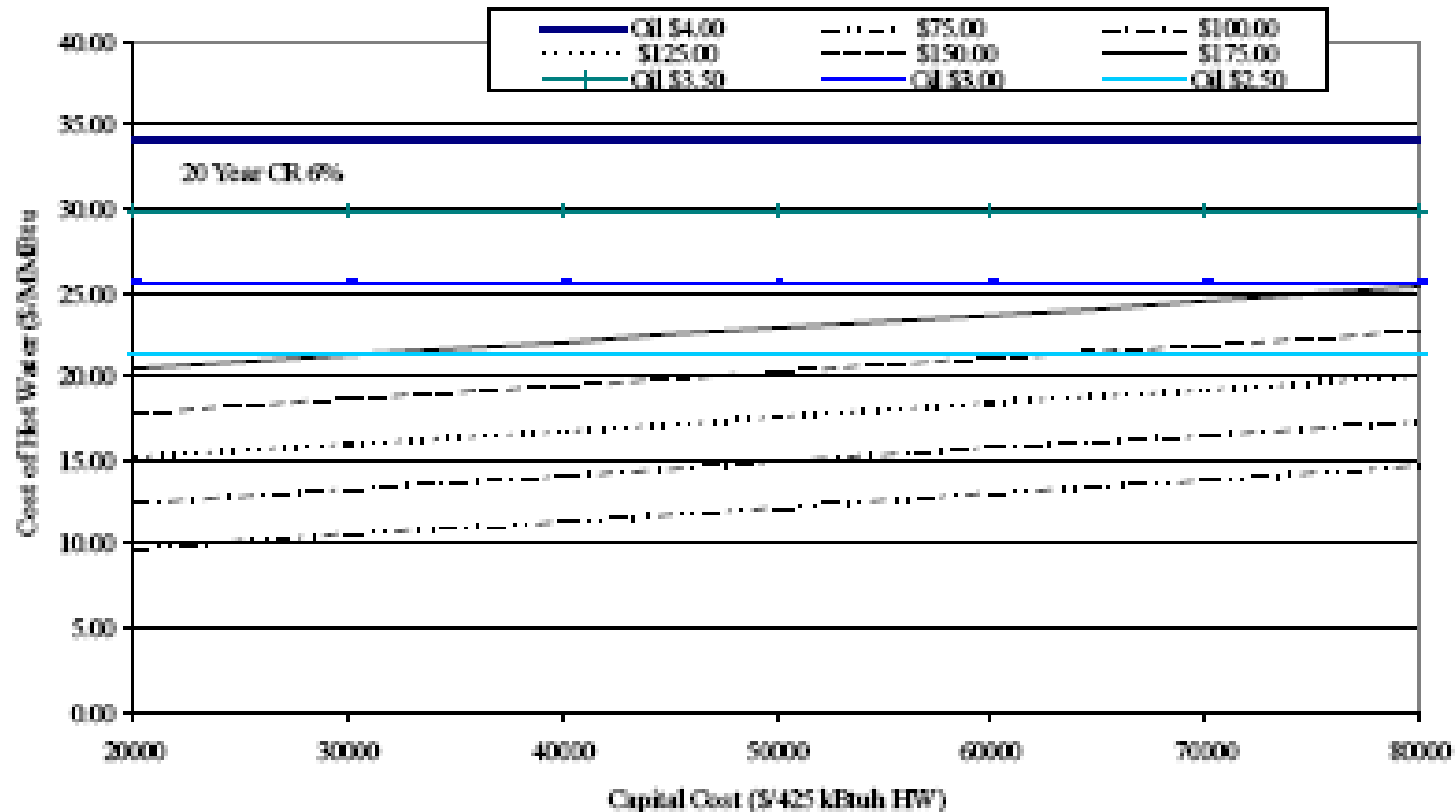


Figure 4-10. Total Cost of Heat to replace 6,605 gal Fuel Oil at Various Wood Costs (\$/Cord).

# Cost Estimate for Wood Chip Boilers

Table 4-7. Cost Estimates for Wood Chip Boiler Systems.		
Facility	Delta Greely Schools*	Thorne Bay School**
Capacity, Btuh	4,500,000	1,000,000
Fuel Oil Replaced, gallons per year	102,000***	11,501
Estimated costs		
Buildings	\$ 228,000	\$ 158,000
Boilers, Fuel System, Stack	\$ 397,000	\$ 280,000
Piping, Integration	\$ 231,000	\$ 52,500
Other Installation	\$ 80,000	\$ 48,100
Total Direct Costs	\$ 936,000	\$ 538,600
Engineering, permits	\$ 120,000	\$ 70,000
Contingency 15%	\$ 158,000	\$ 91,000
Total	\$ 1,214,000	\$ 699,000
Notes:		
* Section 5 Table 5-1		
** Section 6 Table 6-1		
*** 69,000 gpy at old school plus estimated 33,000 gpy at new elementary= 102,000 gpy		

# Cost to Replace 11,500 gpy Fuel Oil with Wood Chip Boiler

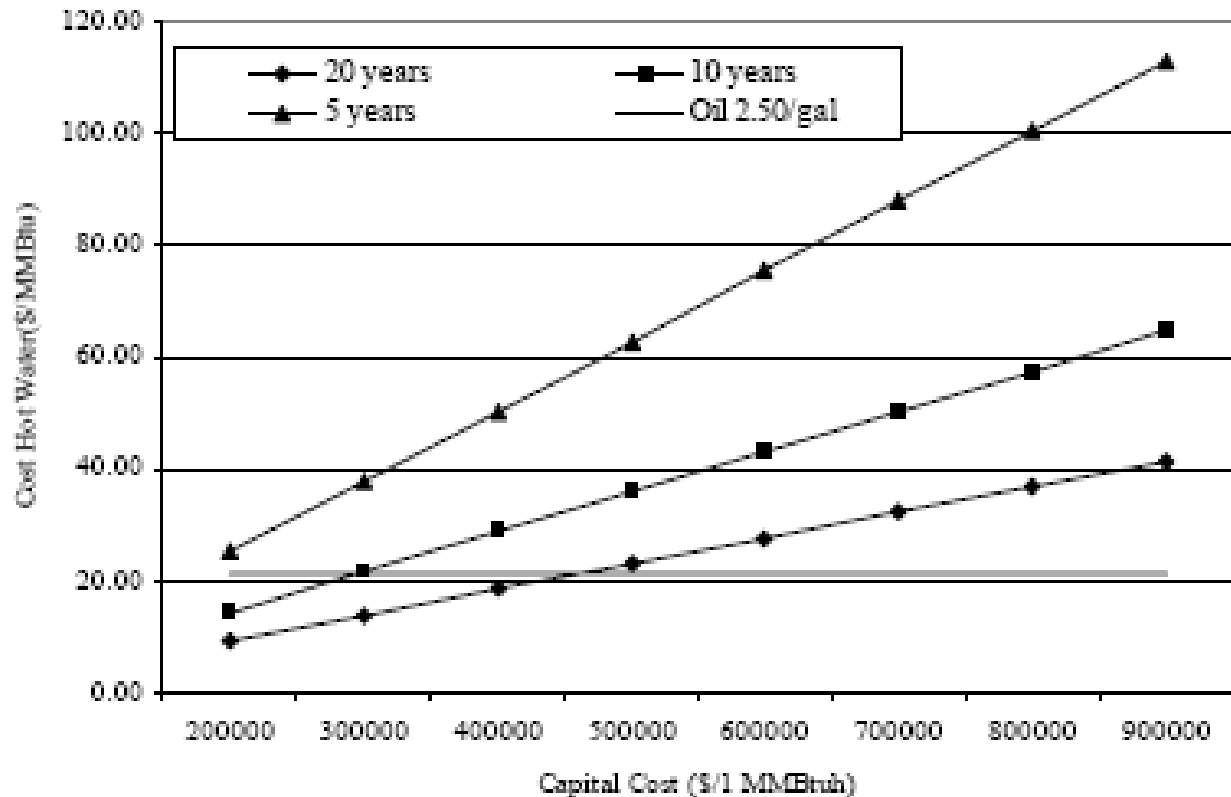


Figure 4-4. Impact of Capital and Non Fuel Cost on Cost of Heat for a 1 MMBtuh Boiler to replace 11,500 Gallons of Fuel Oil Per Year. Does not include wood cost.

# Cost to replace 11,500 gpy Fuel Oil with Wood Chip Boiler

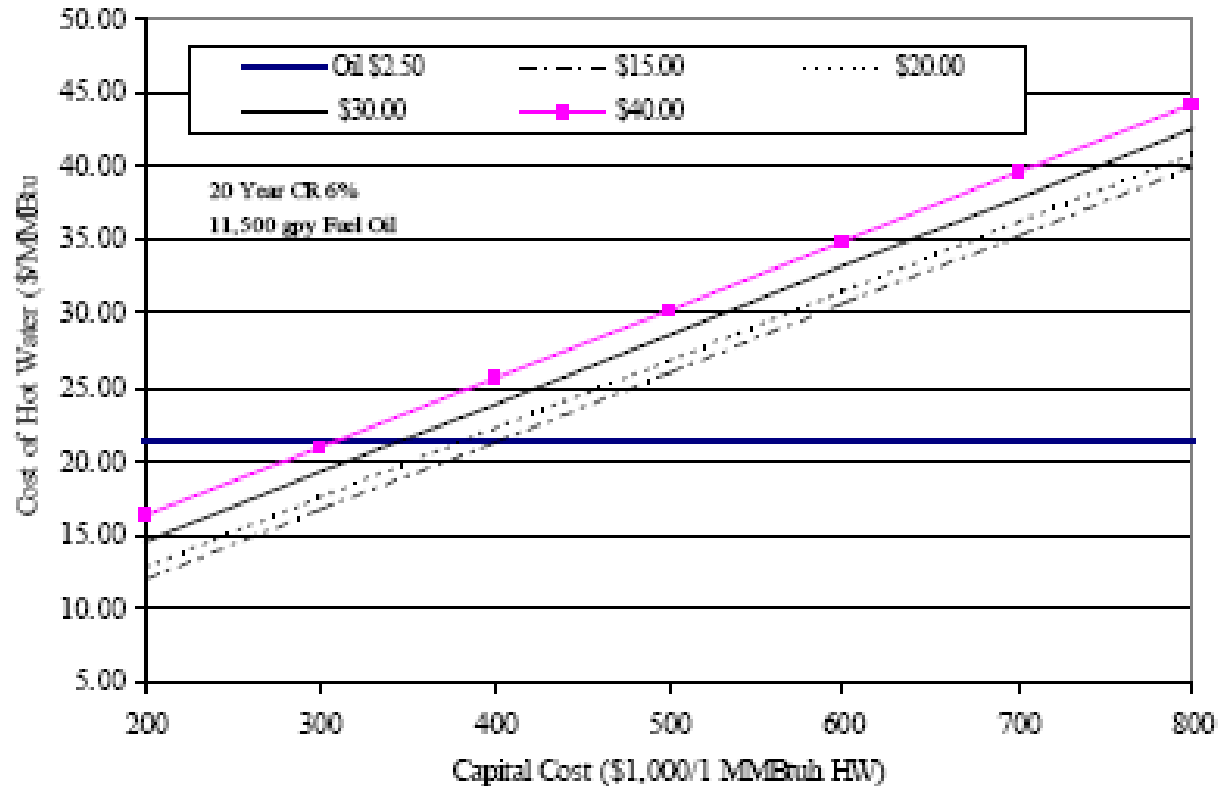


Figure 4-6. Total Cost of Heat to Replace 11,500 Gallons At Various Wood Chip Costs (\$/ton).

# Craig Community Center



**6600 gpy**





**1. Craig Community Center Parking Area**



**2. Upper Level Meeting Hall**



**3. Lower Side-road Access Left**



**4. Upper Parking Above Boiler**



**5. Rear Used For Playground**



**6. Road Access Possible Boiler Location**



7. Bridge Entry, Fuel Oil Tank Near Boiler



8. West Side Fence Line



9. Boiler



10. Hot Water

# Craig Community Center

- Small load, low potential savings
- Limited space for wood system – parking lot
- DOT prevents use of Aquatic system
- No clear labor available
- Possible use of wood pellets in future

**Table 7-1. Estimated Wood Boiler Costs for Craig Community Center.**

Facility	Cordwood
Capacity, Btuh	350,000
Fuel Oil, gallons per year	6,605
Buildings, 20ft x 14ft, 280 ft <sup>2</sup>	\$ 14,500
Boilers, Fuel System, Stack Gam WHS 1500	\$ 15,500
Pumps, Piping, Integration	\$ 3,500
Other Installation, Electrical	\$ 1,200
Total Direct Costs	\$ 34,700
Engineering +Contingency	\$ 2,300
Total	\$ 37,000
Present Value Savings compared with Fuel Oil, 20 year	
Wood \$60/cord	\$ 90,800
Wood \$100/cord	\$ 40,400

**Table 7-2. Savings from Wood at Craig Community Center.**

Table Header	Cost	Quantity	\$	Total
Fuel Oil Used, gallons <sup>a</sup>	\$2.50/gal	6,605		\$16,513
Wood chips used, tons green <sup>b</sup>	\$100/cord	89	\$8,900	
Electricity	\$0.17/kWh	2,347	\$ 450	
Labor	Inc	Inc	-	
				\$ 9,350
Gross Savings from Wood				\$ 7,163

Notes:

<sup>a</sup> 2004 6,605 gal at \$2.45/gal, 10,000 ft<sup>2</sup> in use

<sup>b</sup> 66 gallons of fuel oil/cord, Table 4-2.

# Southeast Island School District: Naukati and Coffman Cove

- Naukati
  - Small school low demand – 8,000 gpy
  - Best opportunity: waste heat from generator
  - No area for heating unit
  - Early in the design phase
- Coffman Cove
  - Delayed construction
  - Similar demand – 7,000 gpy
  - Opportunity for adjacent buildings



# Venetie Airport and Washeteria



CLINIC	1500 gpy
COUNCIL	1500 gpy
TRIBAL OFF	1500 gpy
ELDERS ASSN	600 gpy



**1. Venetie Village, School Washer to Left**



**2. Lance Whitell and Council President**



**3. Hauling Firewood**



**4. Airport Garage and Waiting Room**



**5. Unit Heater Stack, Rear Side**



**6. Diesel Fuel and Engine Exhaust**



**7. Diesel storage, Engine Exhaust**



**8. Heat Vent and Engine Exhaust**



**9. Oil Unit Heater (45,000 Btu/h)**



**10. Heater and Stack (1 of 2)**



**11. Heated Equipment Room**



**12. Generator Room**



**13. Engine Exhaust, Radiator and Vent**



**14. Waiting Room**



**15. Waiting Room**



**16. Washeteria**



**17. Washing Machines**



**18. Showers**

# Venetie Community Buildings

- Good demand in airport and washeteria
- Demand is for future buildings
- Not clear who would provide the wood and maintain the system

# Savings from Wood at Venetie

Table 9-2. Savings from Wood at Venetie Airport Maintenance Facility

Table Header	Cost	Quantity	\$	Total
Fuel Oil Used, gallons <sup>a</sup>	\$4.20/gal	1,688		\$ 7,090
Wood chips used, tons green <sup>b</sup>	\$100/cord	26	\$2,600	
Electricity	\$0.25/kWh	2,347	\$ 590	
Labor	Inc	Inc	-	
				\$ 3,190
Gross Savings from Wood				\$ 3,900

Notes:

<sup>a</sup> 2004 1688 gal at \$4.20/gal

<sup>b</sup> 66 gallons of fuel oil/cord, Table 4-2.

# Wood Boiler Costs at Venetie

Table 9-1. Estimated Wood Boiler Costs for Venetie Airport Maintenance Facility.

Facility	Excess Capacity	Small Boiler
Capacity, Btuh	350,000	100,000
Fuel Oil, gallons per year	1,688	1,688
Buildings, 20ft x 14ft, 160 ft <sup>2</sup>	\$ 10,100	
Boilers, Fuel System, Stack	\$14,000	\$ 9,200
Pumps, Piping, Integration	\$4,000	\$ 2,300
Other Installation, Electrical, Freight	\$6,300	\$ 4,200
Total Direct Costs	\$34,400	\$15,700
Engineering +Contingency	\$600	\$ 2,300
Total	\$35,000	\$18,000
Present Value of Savings from Wood compared with Fuel Oil, 20 year		
Wood \$60/cord	\$ 26,800	\$ 46,700
Wood \$100/cord	\$ 13,900	\$ 33,800
Notes:		
* Gam WHS 1500 350,000 Btuh		
** Alternate Heating Systems or Tarm 100,000 Btuh		

# Craig Aquatic Center + (2) Schools



# Craig Aquatic Center

- Good demand with pool and two schools
- Target part of demand 1 MMBtuh
- Minimize capital investment
- Solve problem of wet fuel
- Center of community: noise and emissions  
Acceptable to city maintenance personnel
- In construction (2007)

# Delta Greely





**1. Delta Elementary School, New Admin**



**2. Delta Junction School**



**3. Delta Junction School**



**4. Delta High School**



**5. Shop Area of High School**



**6. Existing Stacks and Vents**



7. Typical Oil Boiler



8. Typical Hot Water Air Heater



11. Boiler at High School



12. Boiler at High School



9. Hot Water Heater



10. Oil fired Air Heater



13. Vocational Tech and Buildings



14. Separately Heated Votech Building



15. Modular Classrooms



16. Front of New Elementary



17. View New Elementary to Old Campus



18. Front Entry New Elementary



19. Side of New Elementary



20. New Elementary Fuel Tank



21. New Elementary Boiler Room



22. 4 MMBtu/h (3 Boilers) + Hot Water

# Delta Greely Schools

- Large demand – several buildings
- Possible wood chip system
- New school and space
- Evaluate further potential
- Issues: Location of wood boiler, chip supply, heat distribution

# Savings from Wood Fuel at Delta Greely Schools

Table 5-2. Savings from Wood Fuel at Delta Greely Schools

Table Header	Cost	Quantity	\$	Total
Fuel Oil Used, gallons	\$2.50/gal	102,000		\$ 255,000
Wood chips used, tons green <sup>*</sup>	\$30/ton	2,084	\$ 62,520	
Electricity, kWh	\$0.17/kWh	66,500	\$ 11,305	
Labor, hr	\$20/hr	500	\$ 10,000	
				\$ 83,825
Gross Savings from Wood <sup>**</sup>				\$ 171,175

Notes:

- \* 66 gallons of fuel oil per tons of wood chips Table 4-2
- \*\* Does not include maintenance, financing or other costs not listed above

Table 5-1. Estimated Wood Boiler Costs for Delta-Greely Schools.

Facility	A 4.5 MM Btuh Old School	B* 4.5 MMBtuh New+ Old	Difference
Fuel Oil Replaced, gallons per year	69,000	102,000	33,000
Building, 50 x 40	\$ 228,000	\$ 228,000	
Boilers, Fuel System	\$ 397,000	\$ 397,000	
Piping, Integration	\$ 106,000	\$ 231,000	\$ 125,000
Other Installation	\$ 66,000	\$ 80,000	\$ 14,000
Total Direct Costs	\$ 797,000	\$ 936,000	\$ 139,000
Indirect Costs: Engineering, Permits	\$ 102,000	\$ 120,000	\$ 18,000
Contingency, unlisted items 15%	\$ 135,000	\$ 158,000	\$ 23,000
Total	\$1,034,000	\$ 1,214,000	\$ 180,000
Savings Compared With Fuel Oil**			
PV Wood at \$15/ton	\$ 580,000	\$ 1,236,800	
PV Wood at \$30/ton	\$ 265,000	\$ 770,400	

Notes:

\* Wood system sized to supply actual consumption from schools. Table 4-6.

\*\* Present Value Life Cycle Cost, 20 Year, 3% discount rate, constant dollars

# Impact of Capital and Non fuels Costs: 4.5 MMBtuh Boiler

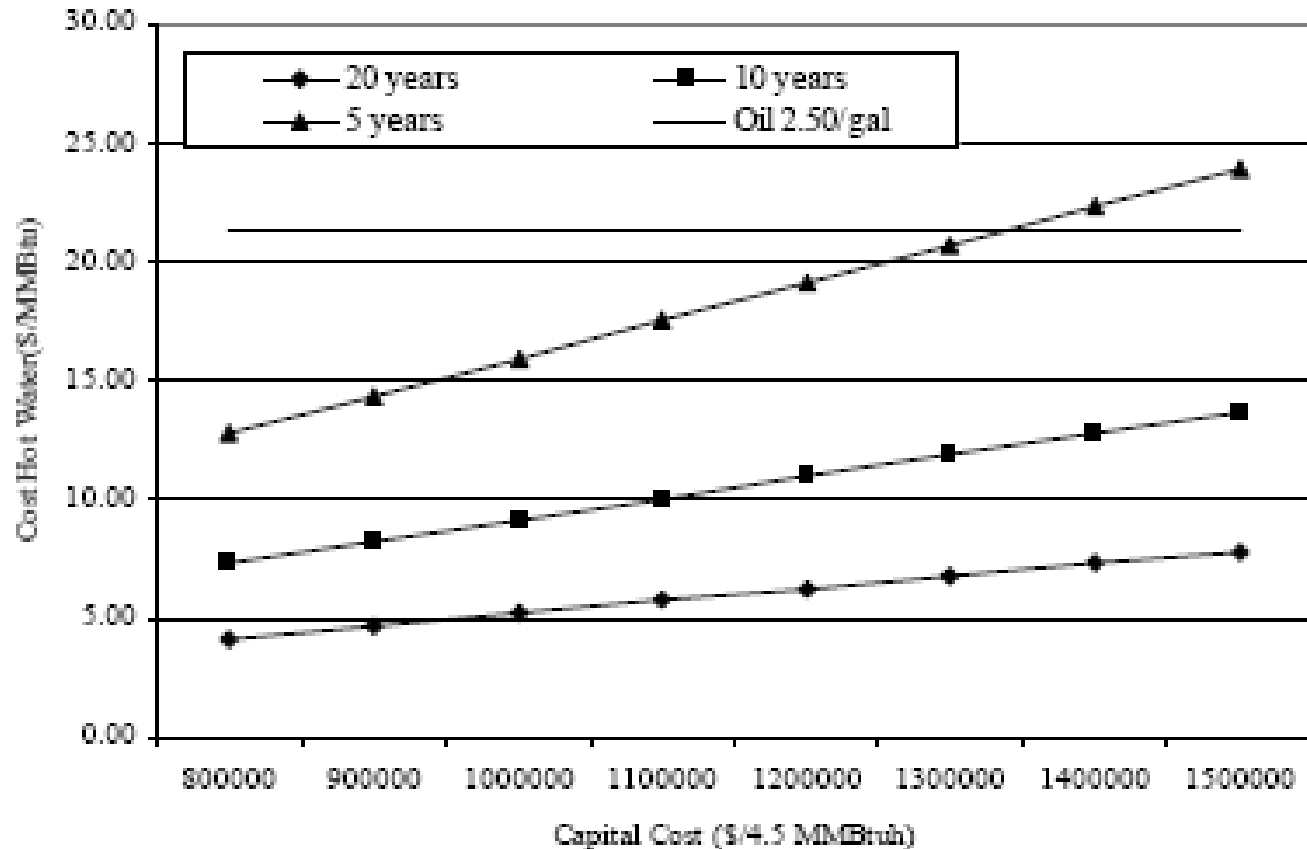


Figure 4-3. Impact of Capital and Non Fuel Cost on Cost of Heat for a 4.5 MMBtuh Boiler to replace 102,000 Gallons of Fuel Oil Per Year. Does not include wood cost.

# Total Cost to Replace 102,000 gpy Fuel Oil

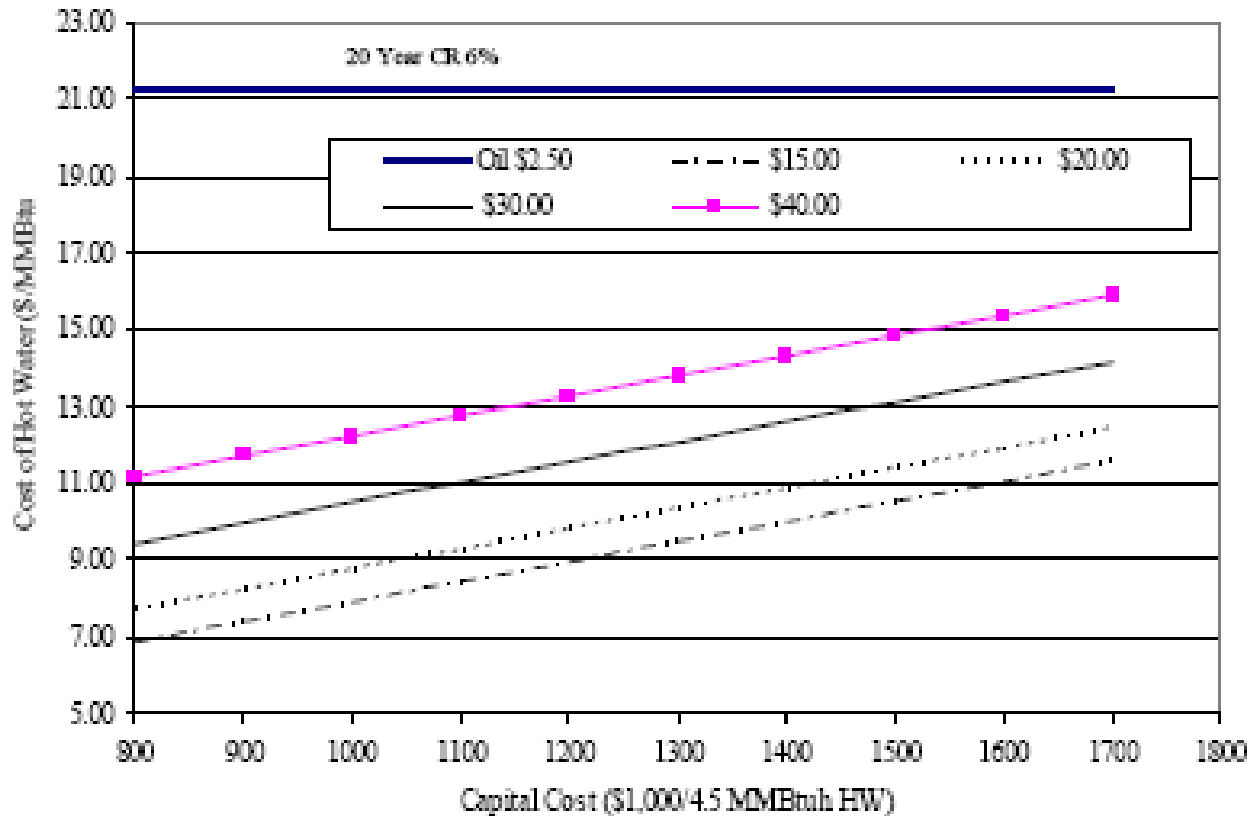


Figure 4-5. Total Cost of Heat to Replace 102,000 Gallons at Various Wood Chip Costs (\$/ton).

# Challenges

- Small Scale
- High Building Costs
- High costs for trenching, piping and heat exchangers

# Recommendations

- Start with Good Examples: Craig, Delta Greely, Thorne Bay School
- Build on success of Dot Lake
- Avoid over expectations
- Design for low quality fuels
- Investigate Lower Cost Alternatives for Buildings and Heat Distribution

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