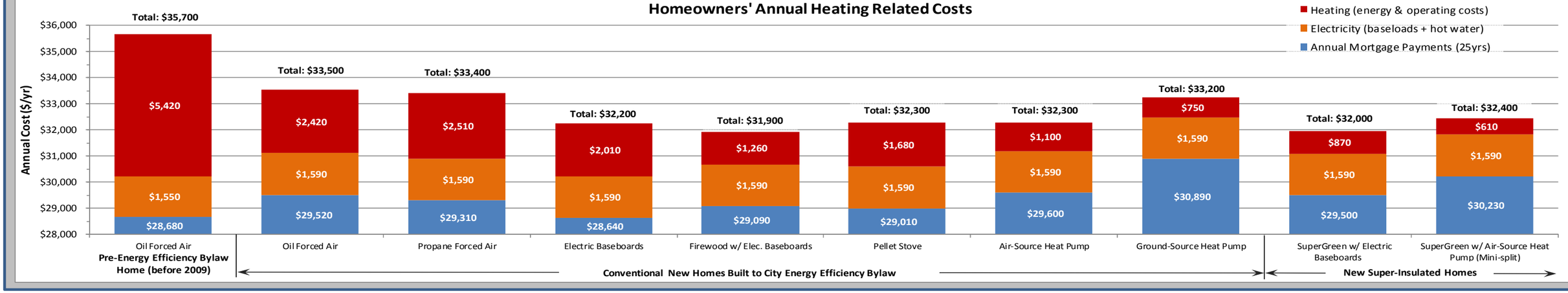
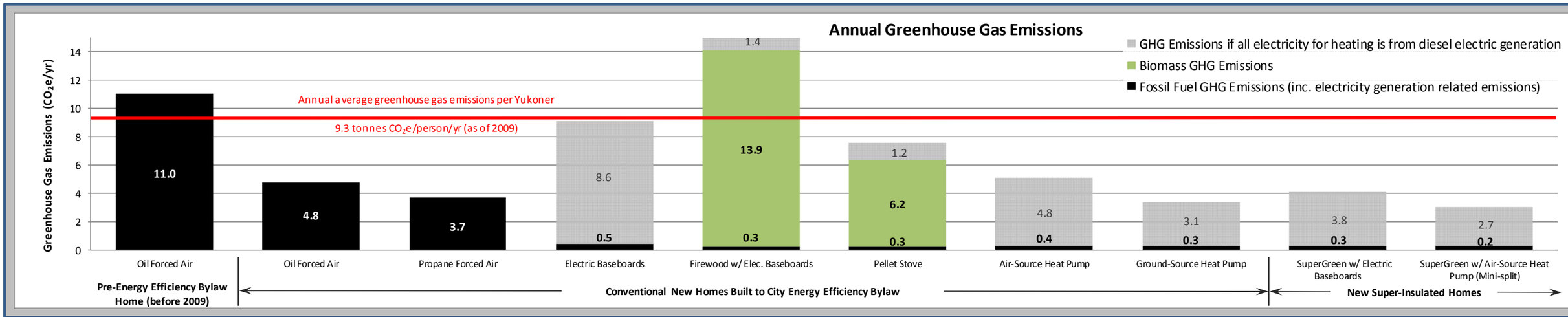
Overview of Heating Options for New Homes in Whitehorse

A Sustainability Based Review for 2011*

Financial



Environmental



Social (Comfort, health & resilience)

Pre-Energy Efficiency Bylaw w/ Oil Forced Air	Oil Forced Air	Propane Forced Air	Electric Baseboards	Wood Stove	Pellet Stove	Air Source Heat Pump	Ground-Source Heat Pump	SuperGreen with Electric Baseboards	SuperGreen with Air-Source Heat Pump
✓ Uses least electricity	✓ Conventional, many contractors to install and maintain	✓ Conventional, many contractors to install and maintain	✓ Easy to install	✓ Simple & common	✓ Simple & common	✓ Reduced indoor air quality problems	✓ Reduced indoor air quality problems	✓ Easy to install	✓ Reduced indoor air quality problems
✗ Low insulation levels no longer permitted in City	✗ Indoor air quality risk	✗ Indoor air quality risk	✓ Reduced indoor air quality problems	✓ Comfortable radiant heat	✓ Comfortable radiant heat	✓ Low maintenance	✓ Very low to no maintenance	✓ Reduced indoor air quality problems	✓ Low maintenance
✗ Indoor air quality risk	✗ Annual maintenance	✗ Annual maintenance required	✓ No maintenance	✓ Local energy	✗ Indoor air quality risk	✓ Low & predictable heating costs (regulated)	✓ Very low & predictable heating costs (regulated)	✓ No maintenance	✓ Very quiet homes
✗ Annual maintenance	✗ High energy cost fluctuation = lack of financial certainty (i.e. fixed income households)	✗ High energy cost fluctuation = lack of financial certainty (vis. fixed income households)	✓ Comfortable and has individual room heating control	✓ Works during power outages	✗ Regular loading of pellets & storage space required	✓ Locally produced energy	✓ Locally produced energy	✓ Very quiet homes	✓ Comfortable and has individual room heating control
✗ Can be cold & uncomfortable	✗ Risk of fuel spills	✗ Furnace can be noisy	✓ Predictable heating costs (regulated)	✗ Indoor air quality risk	✗ Regular cleaning required	✓ "High-tech" - exciting	✓ "High-tech" – exciting	✓ Comfortable and has individual room heating control	✓ Low & predictable heating costs (regulated)
✗ High energy cost fluctuation = lack of financial certainty (vis. fixed income homes)	✗ Furnace can be noisy	✗ Does not work during power outages	✓ Locally produced energy	✗ Labour intensive & needs wood storage space	✗ Some local air pollution	✗ Few contractors and limited experience	✗ Very few contractors and limited experience in Yukon	✓ Low & predictable heating costs (regulated)	✓ Locally produced energy
✗ Risk of fuel spills	✗ Does not work during power outages	✗ Replacement after 20+years	✓ Last for life of home	✗ Regular cleaning required & messy	✗ Some stoves noisy	✗ Outside unit can be noisy	✗ Does not work during power outages	✓ Locally produced energy	✓ Home stays warmer during power outages
✗ Furnace can be noisy	✗ Replacement after 20+years		✗ Boring – low-tech	✗ Risk of house fires & burns	✗ Does not work during power outages	✗ Does not work during power outages	✗ Replacement after 20+years	✓ Home stays warmer during power outages	✓ "High-tech" – exciting
✗ Does not work during power outages			✗ Uses most electricity	✗ Local air pollution	✗ Replacement after 20+years	✗ Replacement after 20+years		✓ Last for life of home	✗ Outside unit can be noisy
✗ Replacement after 20+years				✗ Replacement after 20+years				✗ Boring – low-tech	✗ Replacement after 20+years

* Based on costs and opportunities as of September 2011. See reverse side for data sources and analysis basis.

Old Way of Seeing
Sustainable Building Services
705 Jarvis St. Whitehorse, Yukon
T: (867) 393-3301 e: fkpearson2002@yahoo.com

Overview of Heating Options for New Homes in Whitehorse

Data Sources and Cost Estimates

1. Pre-Energy Efficiency Bylaw Home (before 2009) with Oil-Forced Air Heating:

Insulation: 2x6 construction, dual pane glass, higher air leakage (3.2 ACH), no HRV, no foundation insulation (EnerGuide Rating ~61)
Heating System Efficiency: 80%
Total Annual Heating Requirement: 29,200 kWh/yr
Incremental Construction Costs:

• Reduced construction cost:	-$12,200
• Oil Furnace, Fuel Tank	$10,500
• Ductwork:	$6,500
• Total:	$4,800

Annual Operating Costs:

• Oil costs (3,966 L/yr):	$5,116
• Annual furnace maintenance:	$184
• Insurance premium (+5%)	$44
• Electricity (**13,500 kWh/yr**)	$1,623
• Total:	$6,967

Fossil Fuel Emission Factor: 2.7 tonnes CO_2e / 1000 L (GHG Protocol) + electricity emissions (see below)

2. Conventional New Construction with Oil-Forced Air Heating:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~80)
Heating System Efficiency: 83%
Total Annual Heating Requirement: 14,300 kWh/yr
Incremental Construction Costs:

• Oil Furnace, Fuel Tank	$10,500
• Ductwork:	$6,500
• Makeup air device:	$1,250
• Total:	$18,250

Annual Operating Costs:

• Oil costs (1,670 L/yr):	$2,150
• Annual furnace maintenance:	$184
• Insurance premium (+5%)	$44
• Electricity (**13,600 kWh/yr**)	$1,628
• Total:	$4,006

Fossil Fuel Emission Factor: 2.7 tonnes CO_2e / 1000 L (GHG Protocol) + electricity emissions (see below)

3. Conventional New Construction with Propane-Forced Air Heating:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~80)
Heating System Efficiency: 87%
Total Annual Heating Requirement: 14,200 kWh/yr
Incremental Construction Costs:

• Propane Furnace, installed	$7,000
• Ductwork:	$6,500
• Makeup air device:	$1,250
• Total:	$14,750

Annual Operating Costs:

• Propane costs (2,260 L/yr):	$2,333
• Propane tank rental:	$100
• Insurance premium (+5%)	$44
• Electricity (**13,600 kWh/yr**)	$1,628
• Total:	$4,165

Fossil Fuel Emission Factor: 1.5 tonnes CO_2e / 1000 L (Environment Canada National GHG Inventory) + electricity emissions (see below)

4. Conventional New Construction with Electric Baseboards:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~80)
Heating System Efficiency: 100%
Total Annual Heating Requirement: 14,200 kWh/yr
Incremental Construction Costs:

• Electric baseboards:	$4,000
• Total:	$4,000

Annual Operating Costs:

• Electricity (**27,500 kWh/yr**)	$3,599
• Total:	$3,599

Electricity Emission Factor: 0.01 tonnes CO_2e / 1000 kWh (based on 2011 Yukon electrical grid generation, Yukon Energy Corp. 2011 Business Plan), see details below.

5. Conventional New Construction with Firewood Heating:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~70)
Heating System Efficiency: 60%
Total Annual Heating Requirement: 16,000 kWh/yr
Incremental Construction Costs:

• Wood stove, chimney & labour:	$6,000
• Electric baseboard backup:	$4,000
• Makeup air device:	$1,250
• Total:	$11,250

Annual Operating Costs:

• Firewood costs (3.3 cords /yr):	$797
• Insurance Premium (+10%)	$88
• Electricity (**16,000 kWh/yr**)	$1,966
• Total:	$2,851

GHG Emission Factors: 1.86 tonnes CO_2e / tonne (GHG Protocol) + electricity emissions (see below)

6. Conventional New Construction with Pellet Stove Heating:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~76)
Heating System Efficiency: 78%
Total Annual Heating Requirement: 15,200 kWh/yr
Incremental Construction Costs:

• Pellet stove, chimney & labour:	$4,750
• Electric baseboard backup:	$4,000
• Makeup air device:	$1,250
• Total:	$10,000

Annual Operating Costs:

• Pellet costs (3.4 tonnes/yr):	$1303
• Insurance Premium (+10%)	$88
• Electricity (**15,700 kWh/yr**)	$1,920
• Total:	$3,311

GHG Emission Factors: 1.86 tonnes CO_2e / tonne (GHG Protocol) + electricity emissions (see below)

7. Conventional New Construction with Air-Source Heat Pump – Forced Air:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~87)
Annual Heating System Efficiency: 180% with rated COP of 2.75 (Mitsubishi Zuba)
Total Annual Heating Requirement: 14,200 kWh/yr
Incremental Construction Costs:

• Heat Pump, installed:	$14,300
• Ductwork:	$6,500
• Total:	$20,800

Annual Operating Costs:

• Electricity (**21,200 kWh/yr**)	$2,690
• Total:	$2,690

Electricity Emission Factor: 0.017 tonnes CO_2e / 1000 kWh (estimated 2011 Yukon electrical grid generation, Yukon Energy Corp. 2011 Business Plan)

8. Conventional New Construction with Ground-Source Heat Pump – Forced Air:

Insulation: Energy Conservation Bylaw prescriptive approach (Enhanced 2x6 construction, EnerGuide Rating ~89)
Annual Heating System Efficiency : 250% with rated COP of 4.2 (WaterFurnace Envision in partial load)
Total Annual Heating Requirement: 14,200 kWh/yr
Incremental Construction Costs:

• Heat Pump, installed, inc. 4 boreholes:	$35,000
• Ductwork:	$6,500
• Total:	$41,500

Annual Operating Costs:

• Electricity (**18,800 kWh/yr**)	$2,343
• Total:	$2,343

Electricity Emission Factor: 0.017 tonnes CO_2e / 1000 kWh (estimated 2011 Yukon electrical grid generation, Yukon Energy Corp. 2011 Business Plan)

9. SuperGreen Construction with Electric Baseboards:

Insulation: Super Insulated-R60 walls, R100 ceiling, R30 under-slab, air-tight (0.8 ACH), double doors (EnerGuide Rating ~88)
Heating System Efficiency: 100%
Total Annual Heating Requirement: 6,300 kWh/yr
Incremental Construction Costs:

• Extra materials, insulation & labour:	$16,600
• Electric baseboards:	$2,500
• Total:	$19,100

Annual Operating Costs:

• Electricity (**19,600 kWh/yr**)	$2,456
• Total:	$2,456

Electricity Emission Factor: 0.017 tonnes CO_2e / 1000 kWh (estimated 2011 Yukon electrical grid generation, Yukon Energy Corp. 2011 Business Plan)

10. SuperGreen Construction with Mini-Split Air-Source Heat Pump

Insulation: Super Insulated-R60 walls, R100 ceiling, R30 under-slab, air-tight (0.8 ACH), double doors (EnerGuide Rating ~90)
Annual Heating System Efficiency: 170% with rated COP of 2.78 (Fujitsu 30RLX)
Total Annual Heating Requirement: 6,300 kWh/yr
Incremental Construction Costs:

• Extra materials, insulation & labour:	$16,600
• Mini-split Heat Pump, installed:	$11,750
• Electric baseboards:	$2,500
• Total:	$30,900

Annual Operating Costs:

• Electricity (**17,700 kWh/yr**)	$2,199
• Total:	$2,199

Electricity Emission Factor: 0.017 tonnes CO_2e / 1000 kWh (estimated 2011 Yukon electrical grid generation, Yukon Energy Corp. 2011 Business Plan)

Common Elements:

Home Size: 1,800 sq. ft. (average Yukon home size) + full ICF basement, no garage.
Base Building Cost: $457,000 (inc. land). All costs based on actual construction costs experienced in Whitehorse, 2010.
Mortgage Terms: 25 year amortization, 5yr fixed @ 4.09%, 5% down-payment. CHMC loan insurance cost of 2.75% added (less 10% discount for energy efficient homes (EGH Rating 80 or higher)).
Energy Costs:

- Arctic Stove Oil - $1.29 / L; Propane - $1.03 / L (source: Yukon Retail Fuel Prices)
- Pellets - $365 / ton ($7.30 / bag based on average Whitehorse retail price in November 2011); Firewood: $240 / cord.
- Electricity: $15.27 + $0.102 for 0-1000kWh +$0.137/kWh for 1000-2500kWh + $0.149 for >2500kWh / month.
- All operating costs include GST.

Heat Energy Requirements: from the Yukon's home energy audit database (http://www.housing.yk.ca/pdf/SpaceHeatingCost1800sqfthome08-09-10.pdf)
Base electrical usage: from HOT2000 with baseload from Yukon Conservation Potential Review (Marbek 2011 in prep.) = 8,350 kWh/yr for baseload + 4,580 kWh/yr for hot water and BC Recommended Standard Operating Conditions (Innes Hood 2011) =2.5 people / home, 160 L/day of hot water, weather data for Whitehorse, 19°C average house temperature. Average house temperature reduced by 1°C for heating systems that provide zone or individual room heating to reflect practice of reducing temperature in rooms when unoccupied.

GHG emission factor for electricity from Yukon's electrical grid in 2011 is approximately 0.017 tonnes CO_2e / 1000 kWh. This is based on a total estimated generation on the grid of 399 GWh in 2011, of which 9 GWh is produced by diesel electric generation (see Yukon Energy Corp. 2011 Business Plan).
If it is assumed that electricity used for heating comes from diesel electric generation, then the GHG emission factor for that electricity is 0.71 tonnes CO_2e / 1000 kWh.

All costing contractor supplied as of Sept 1, 2011 or actual construction costs from 2010 building season

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705 Jarvis St. Whitehorse, Yukon
T: (867) 393-3301 e: fkpearson2002@yahoo.com