

Wood Heat Feasibility Study



SEPTEMBER 20, 2022



Introduction

- Nova Scotia Department of Public Works planning to eliminate use of furnace oil from all buildings
- More than **115 buildings** on furnace oil
- Nova Scotia's Environmental Goals and Climate Change Reduction Act requires a **decrease** in GHG emissions across Provincially-owned buildings by **75% by the year 2035**
- Heating and DHW accounts for 50% of total energy use in commercial and institutional buildings across Atlantic Canada (~58%)
- Roadmap

Building Categories

- Buildings were categorized based on their annual oil consumption

<7,000L

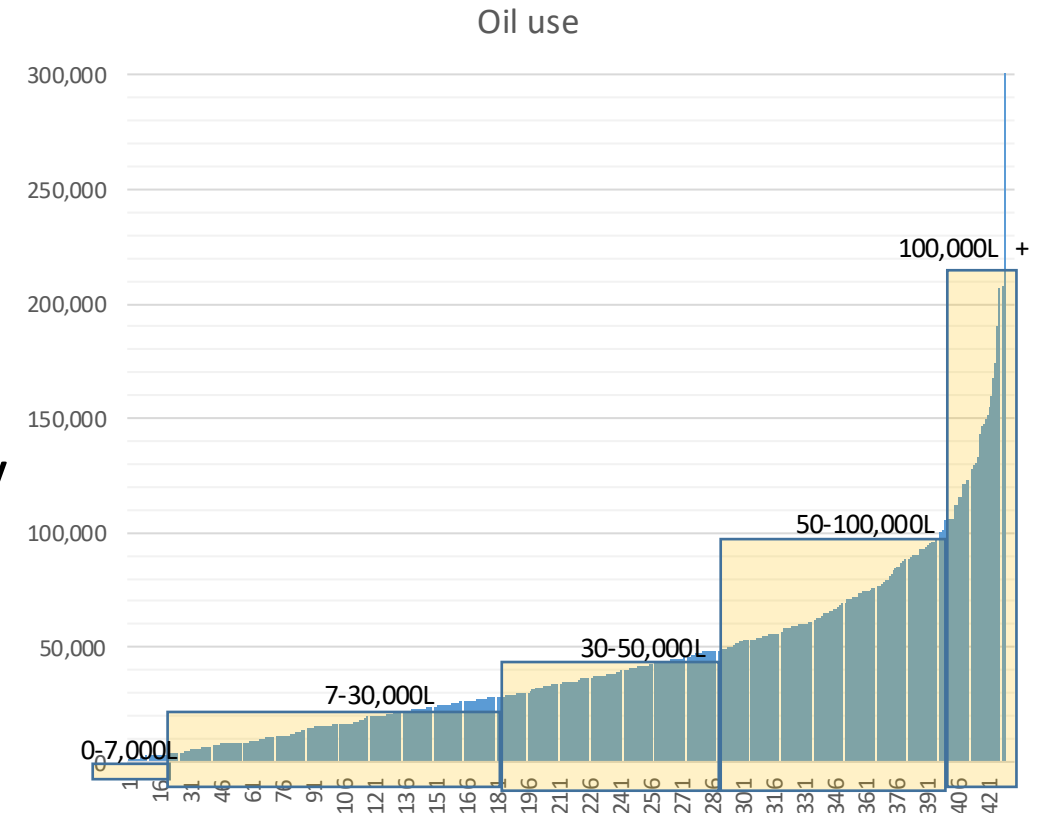
7,000-30,000L

30,000-50,000L

50,000-100,000L

100,000L+

- One building was selected from each category
- Mechanical and Electrical drawings and oil consumption records were received for each building and some site visits were conducted



Proposed Retrofit Systems

Wood Pellet System

Wood Chip System

Air to Water HP

Electric Boiler

Propane Boiler

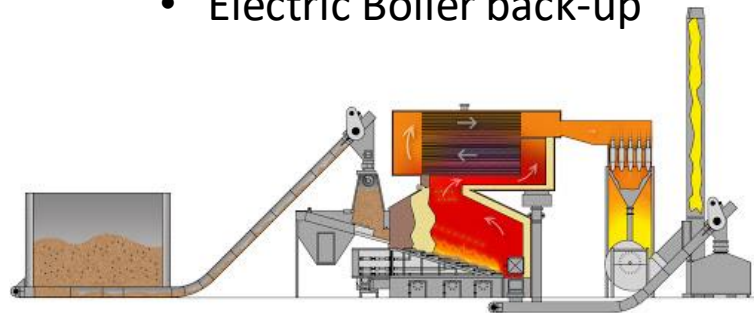
- Boiler
- Pellet storage and handling system
- Buffer tank
- Ash bin
- Electric Boiler back-up

- Boiler
- Underground Chips storage and handling system
- Buffer tank
- Ash bin
- Cyclone dust extractor
- Electric Boiler back-up

- Heat pump
- Heat exchanger
- Electric Boiler back-up

- Electric Boiler

- Propane Boiler
- Propane tank



Design Requirements & Limitations

Wood Pellet System

- Pellet silo to be close to boiler room
- Pellet silo accessible to delivery truck
- Boilers are larger in size and require more space than oil fired boilers
- Higher ceiling height compared to oil fired boilers



Wood Chip System

- Wood chips are stored underground and have to be close to the boiler
- To meet above requirement, new outdoor mechanical shed is required at our sites



Air to Water HP

- Can not provide required supply water temperature below 40° F (4.4° C) Outdoor Air Temperature and requires a backup system
- May require electrical service upgrade

Electric Boiler

- Normally requires electrical service upgrade

Propane Boiler

- Tanks to be stored outdoors

System Sizing Requirements

System	Digby lock-up	Noel 5-Bay garage	Port Hawkesbury Provincial Bldg.	Kentville Justice Centre	Port Hawkesbury Justice Centre
	<7,000L	7,000-30,000L	30,000-50,000L	50,000-100,000L	100,000L+
Wood Pellet/Chips	One boiler @ 100%	One boiler @ 100%	One boiler @ 100% & One backup Elec boiler @ 66%		
Elec Boiler	One boiler @ 100%	One boiler @ 100%	Two boilers @ 66%		
Air to Water HP	Heat Pump @ 100% & One backup Elec boiler @ 100%				
Propane Boiler	One boiler @ 100%	One boiler @ 100%	Two boilers @ 66%		
#2 Furnace Oil	One boiler @ 100%	One boiler @ 100%	Two boilers @ 66%		

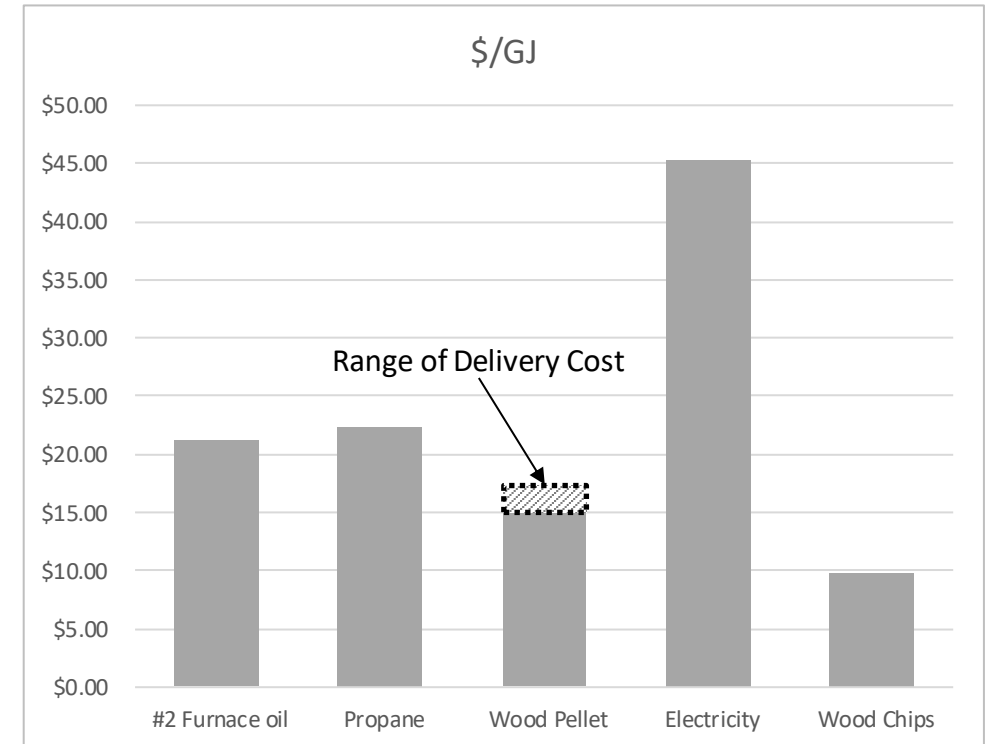
Due to site limitations (room size, electrical) boiler quantities needed to be adjusted

Life-Cycle Cost Explanation

- LCC performed in accordance with ASTM Standard E917-05
- Present value analysis, which includes:
 - Capital cost - from suppliers and RS Means
 - Maintenance & repair costs – from RS Means
 - Energy cost – calculated based upon existing oil use
 - Salvage value – based on capital cost
- Options requiring electrical upgrade assumed to be \$50,000
- Study period of 30 years
- Discount rate 5%

Fuel Costs

Fuel Type	\$/Tonne	\$/litr	\$/kWh	\$/GJ
#2 Furnace oil	-	\$0.82	\$0.076	\$21.13
Propane	-	\$0.57	\$0.081	\$22.36
Wood Pellet	\$258 - \$288	-	\$0.055 - 0.062	\$15.07 - \$16.84
Electricity	-	-	\$0.16	\$45.28
Wood Chips	\$110	-	\$0.04	\$9.82



Sources of information

- Propane & Oil – NS Government data shared for the month of Oct & Nov 2021
- Electricity – NS Power Integrated resource planning, Scenario 3.1C
- Wood Pellet – Shaw Resources, cost varies based on distance from Shaw Plant
- Wood Chips – Averaged price from several suppliers across the Maritimes

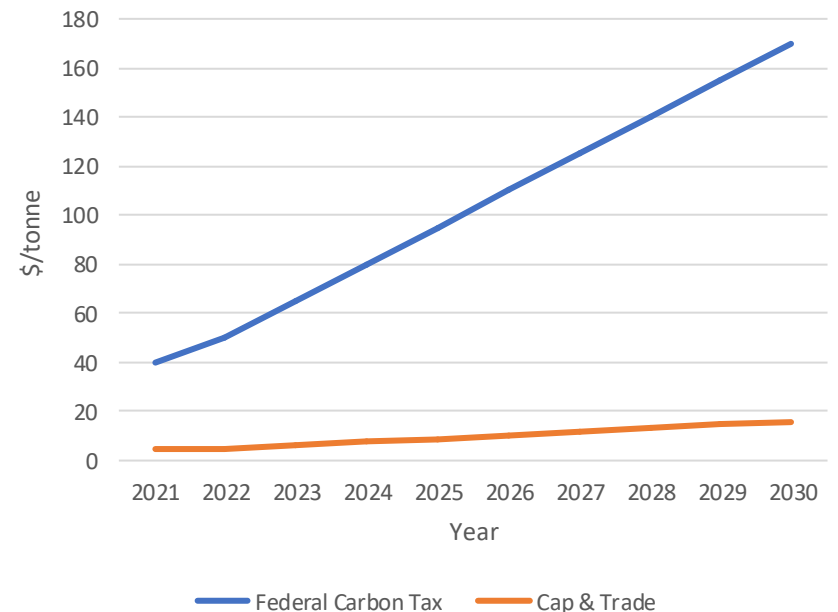
Carbon Cost

Cap & Trade Program

- Heating oil impacted by \$0.013/L starting year 2018 (\$4.71/ton)
- It is assumed to raise at the same rate as Federal carbon tax
- NSP's IRP grid decarbonization scenario 3.1C has emissions below the allowed cap
- CO₂ emissions from the combustion of biomass are exempt under Cap & Trade program

Federal Carbon Tax

- \$40/ton in year 2021 and will reach \$170/ton in year 2030
- Beyond 2030, it is assumed to raise \$6.5/year to reach \$300/ton in year 2050



<7,000L - Digby lock-up

Scenario 1

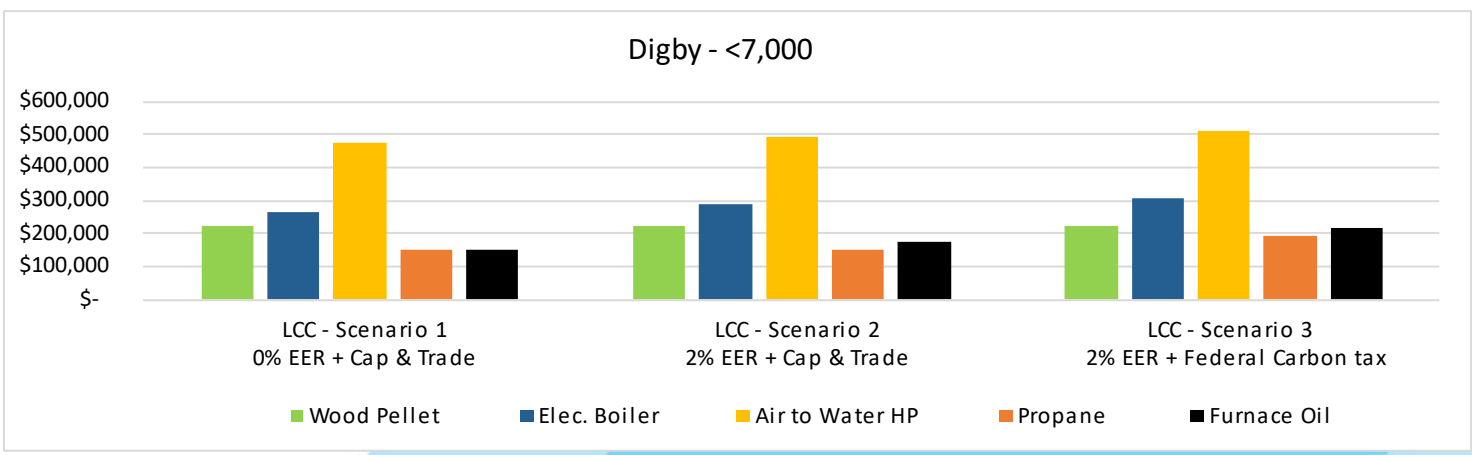
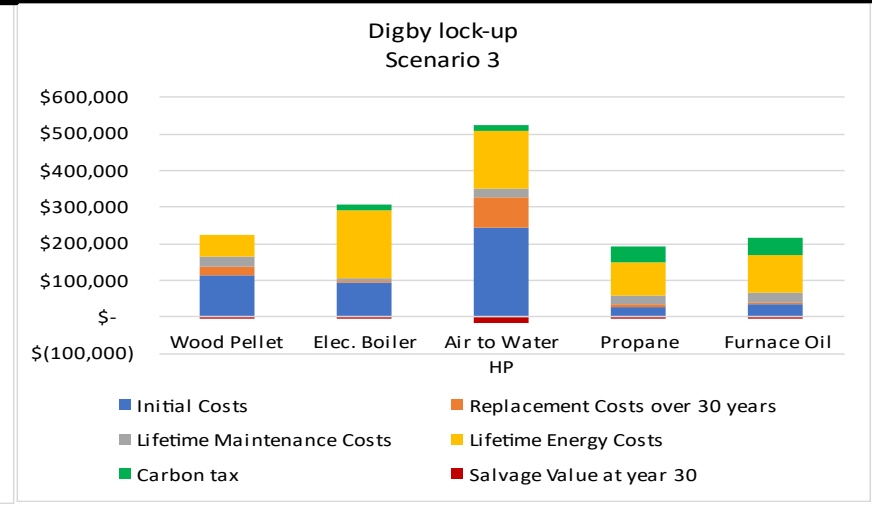
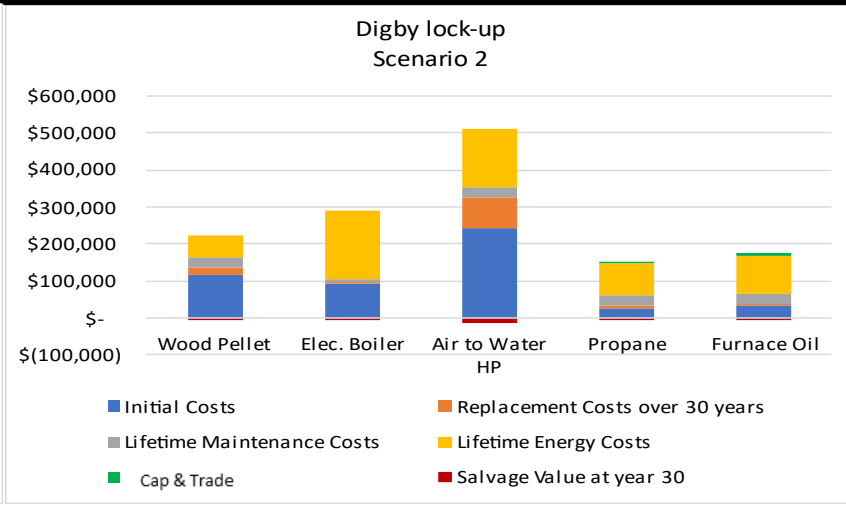
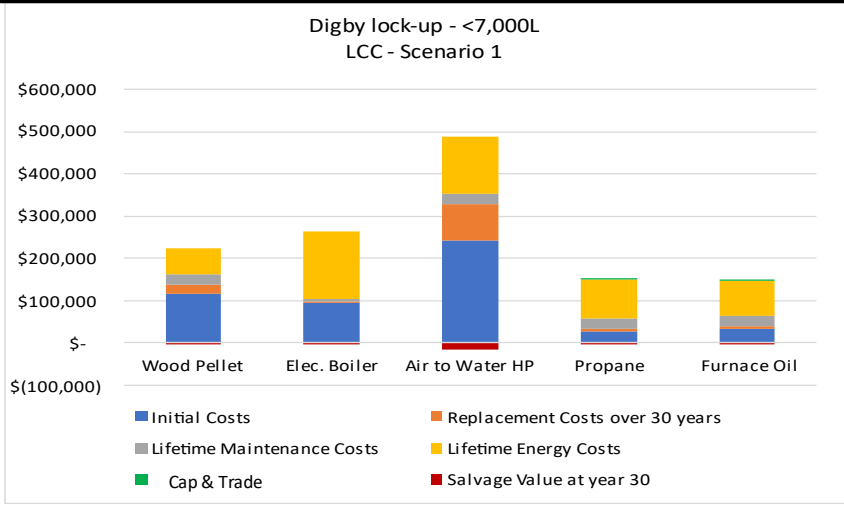
- 30 year lifecycle, 5% discount rate,
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 0.8% EER
- Oil 0% EER
- Cap & Trade

Scenario 2

- 30 year lifecycle, 5% discount rate,
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 2% EER
- Oil 2% EER
- Cap & Trade

Scenario 3

- 30 year lifecycle, 5% discount rate
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 2% EER
- Oil 2% EER
- Federal Carbon tax



Findings:

1. Due to ceiling height, two smaller capacity pellet boilers are required
2. Propane is the most economical alternative fuel source but it does not meet the GHG reduction criteria
3. Wood pellets are the most economical alternate fuel source which also meets the GHG reduction criteria

7,000-30,000L - TPW Noel 5-Bay garage

Scenario 1

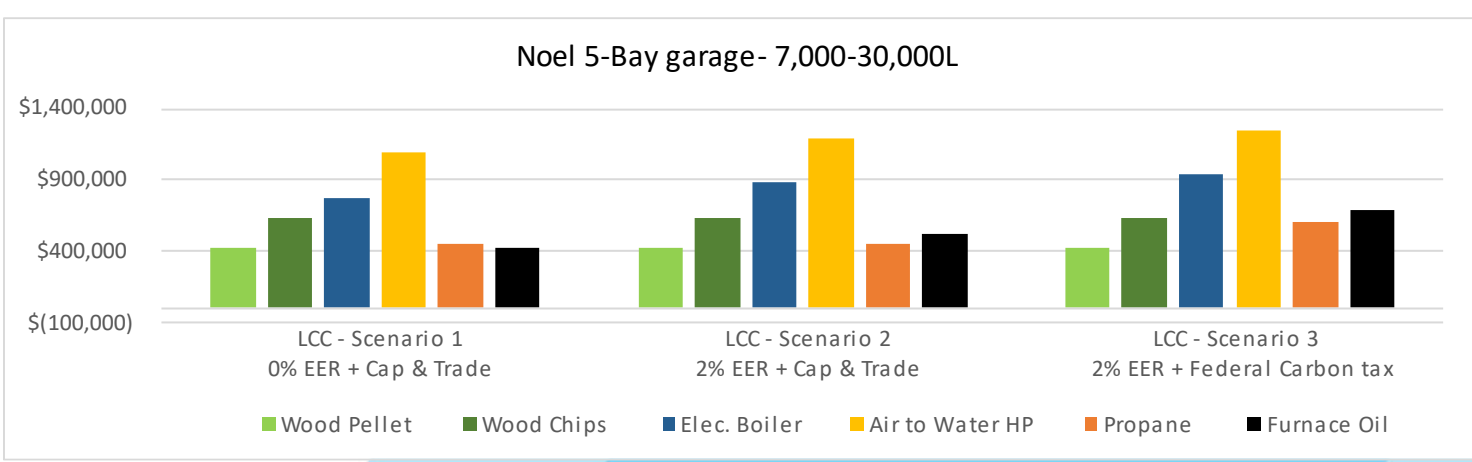
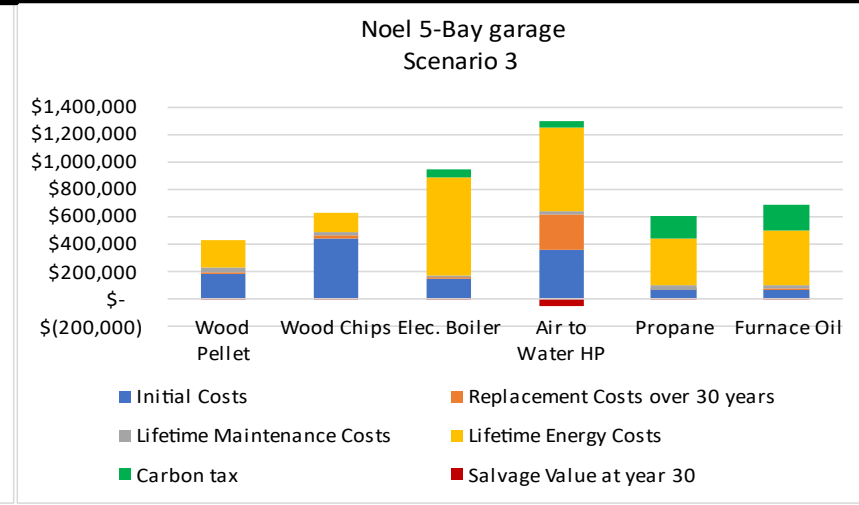
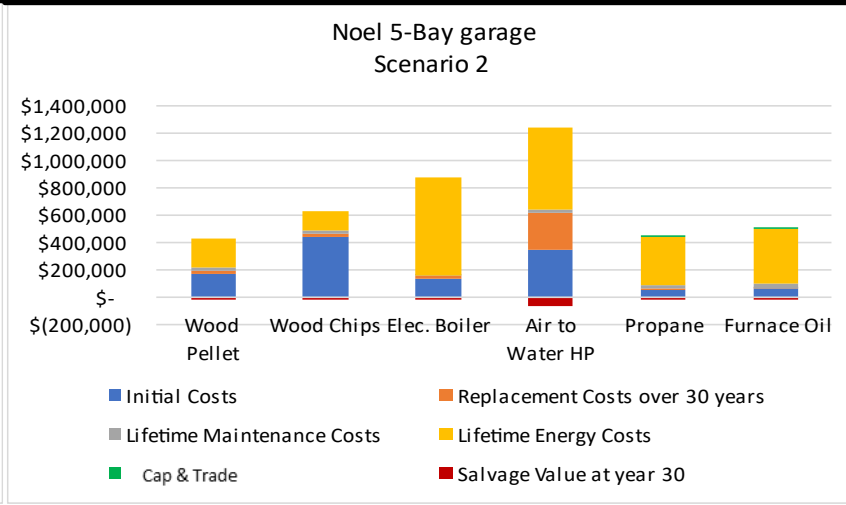
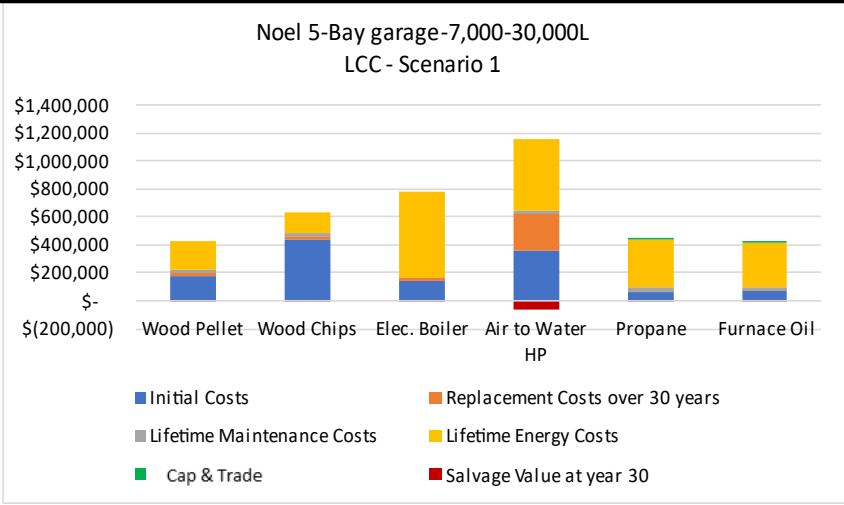
- 30 year lifecycle, 5% discount rate,
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 0.8% EER
- Oil 0% EER
- Cap & Trade

Scenario 2

- 30 year lifecycle, 5% discount rate,
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 2% EER
- Oil 2% EER
- Cap & Trade

Scenario 3

- 30 year lifecycle, 5% discount rate
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 2% EER
- Oil 2% EER
- Federal Carbon tax



Findings:

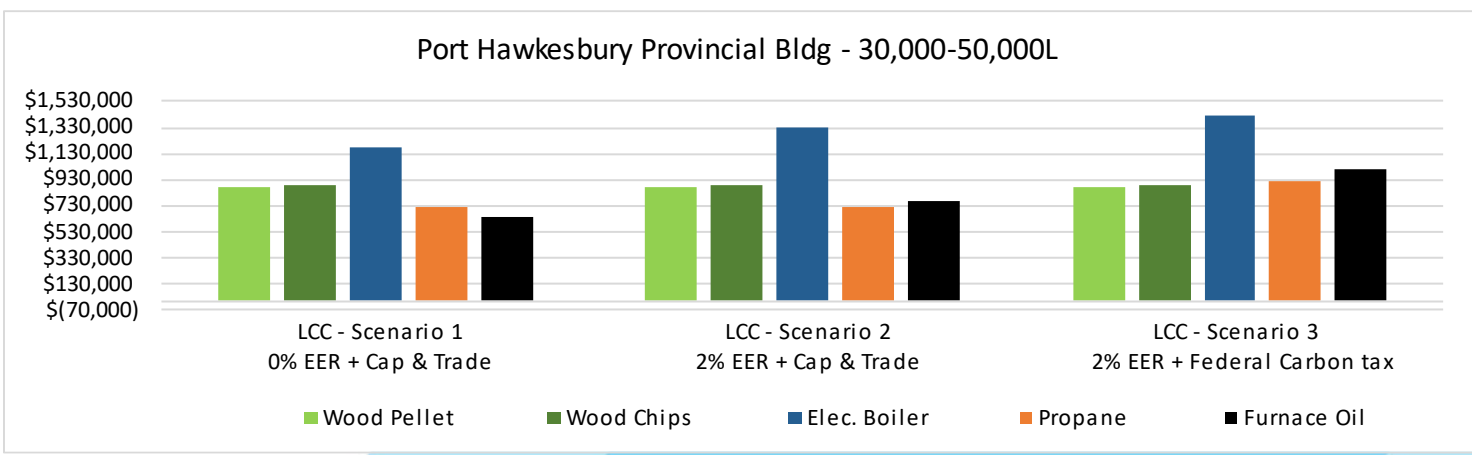
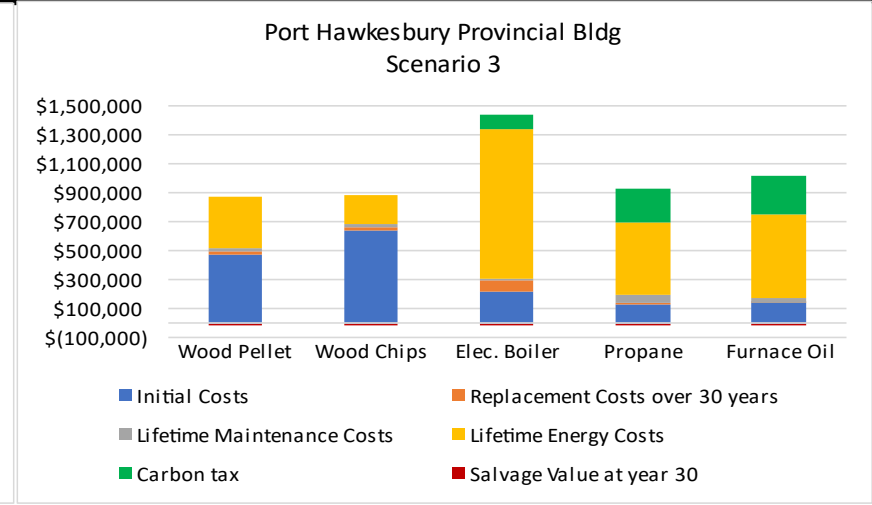
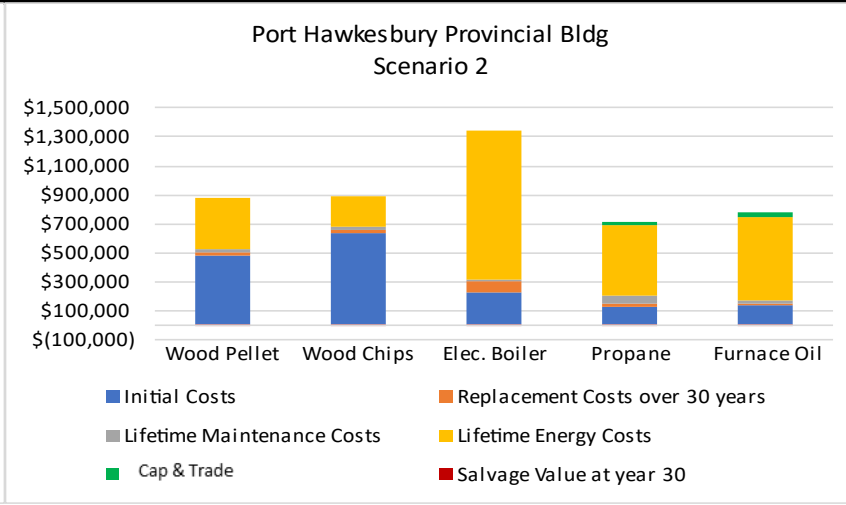
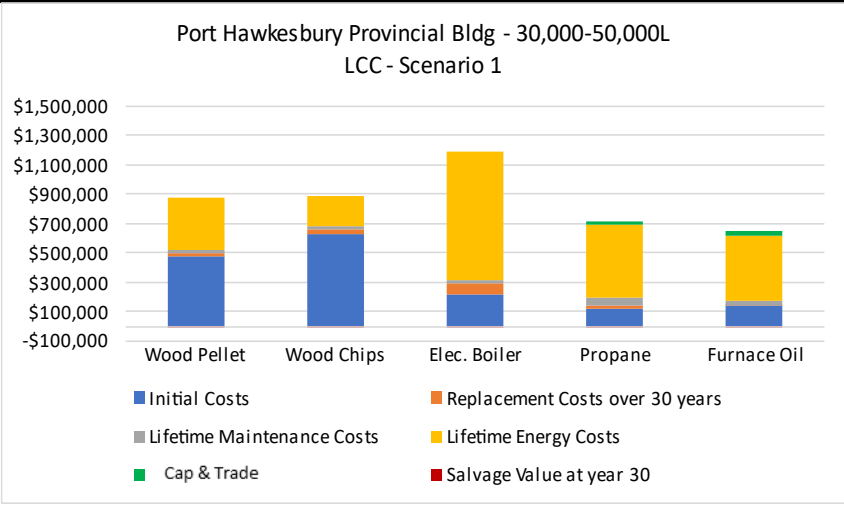
1. Wood pellet is the most economical and green alternative system
2. Pellet boiler can be located indoors
3. Wood chip storage requires the construction of a new mechanical shed increasing the initial cost

30,000-50,000L - Port Hawkesbury Provincial Bldg

- Scenario 1**
- 30 year lifecycle, 5% discount rate,
 - Wood Pellets 0% EER
 - Wood Chips 0% EER
 - Electricity 0.8% EER
 - Oil 0% EER
 - Cap & Trade

- Scenario 2**
- 30 year lifecycle, 5% discount rate,
 - Wood Pellets 0% EER
 - Wood Chips 0% EER
 - Electricity 2% EER
 - Oil 2% EER
 - Cap & Trade

- Scenario 3**
- 30 year lifecycle, 5% discount rate
 - Wood Pellets 0% EER
 - Wood Chips 0% EER
 - Electricity 2% EER
 - Oil 2% EER
 - Federal Carbon tax



Findings:

1. **Outdoor mechanical shed is required to accommodate Pellet boiler**
2. Pellet heating system would be most economical option if boiler could be accommodated in the existing mechanical room

50,000-100,000L - Kentville Justice Centre

Scenario 1

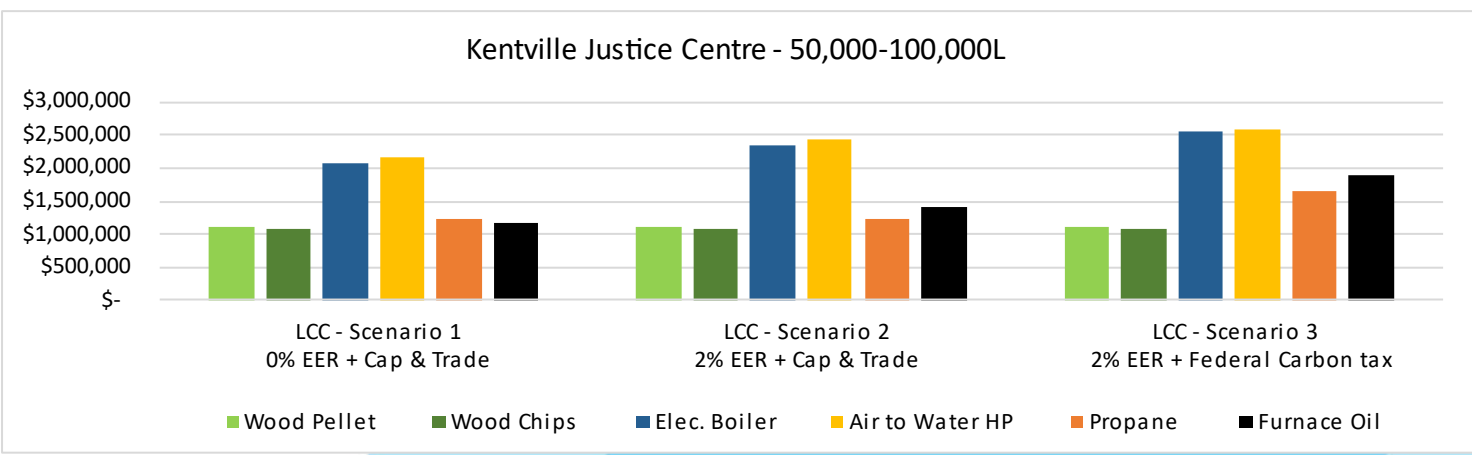
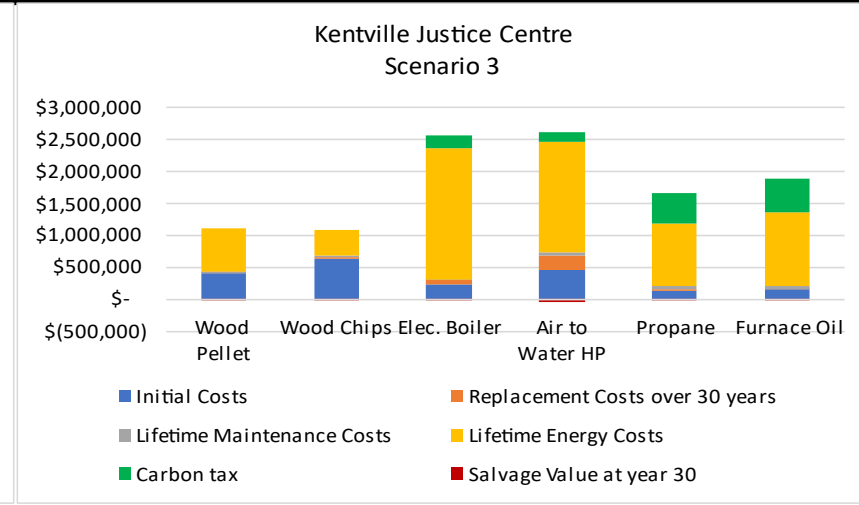
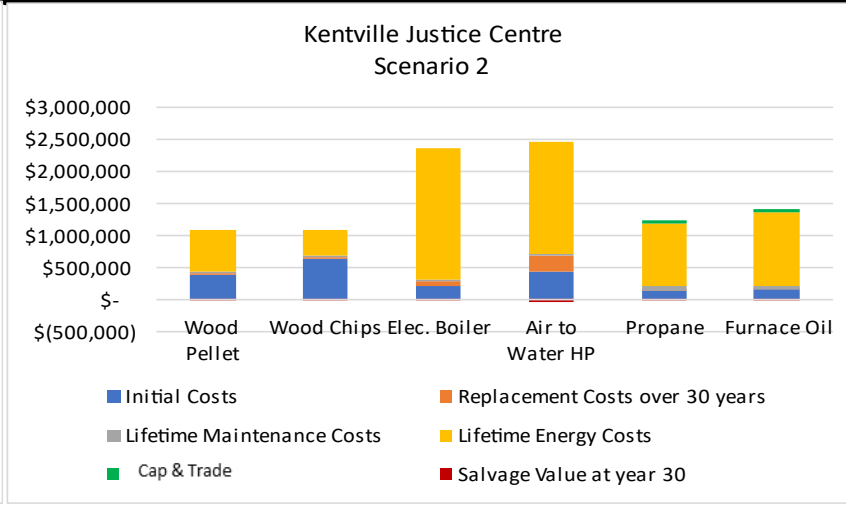
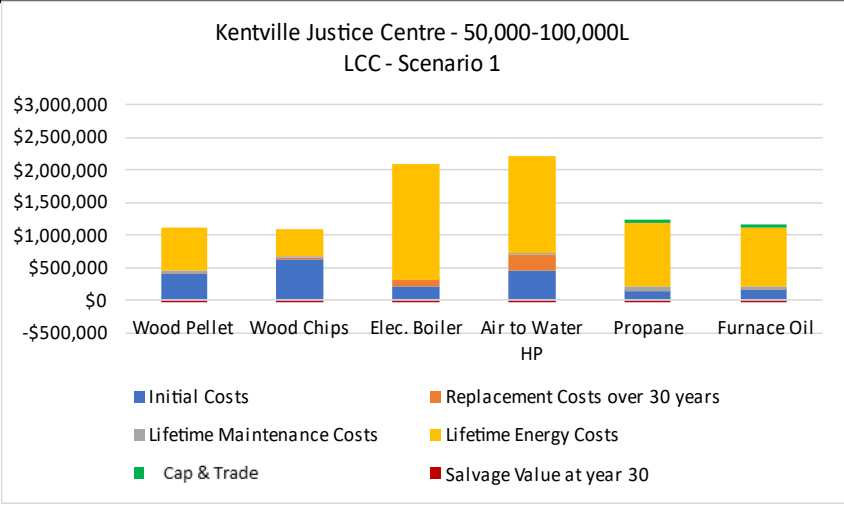
- 30 year lifecycle, 5% discount rate,
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 0.8% EER
- Oil 0% EER
- Cap & Trade

Scenario 2

- 30 year lifecycle, 5% discount rate,
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 2% EER
- Oil 2% EER
- Cap & Trade

Scenario 3

- 30 year lifecycle, 5% discount rate
- Wood Pellets 0% EER
- Wood Chips 0% EER
- Electricity 2% EER
- Oil 2% EER
- Federal Carbon tax



Findings:

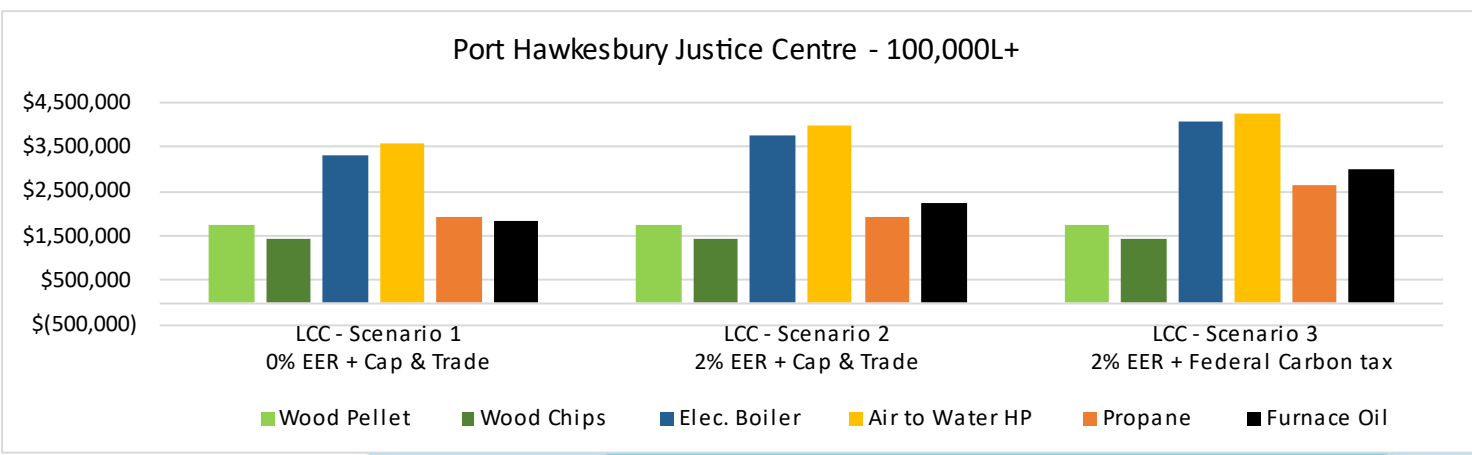
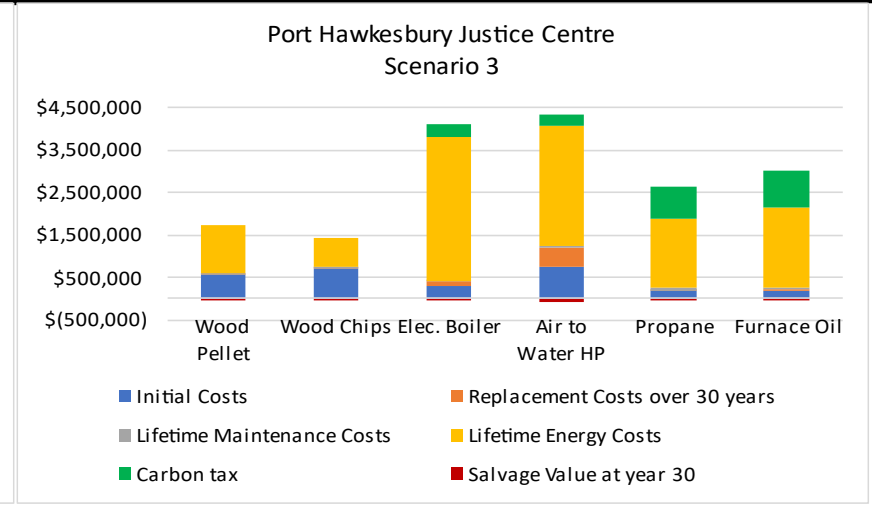
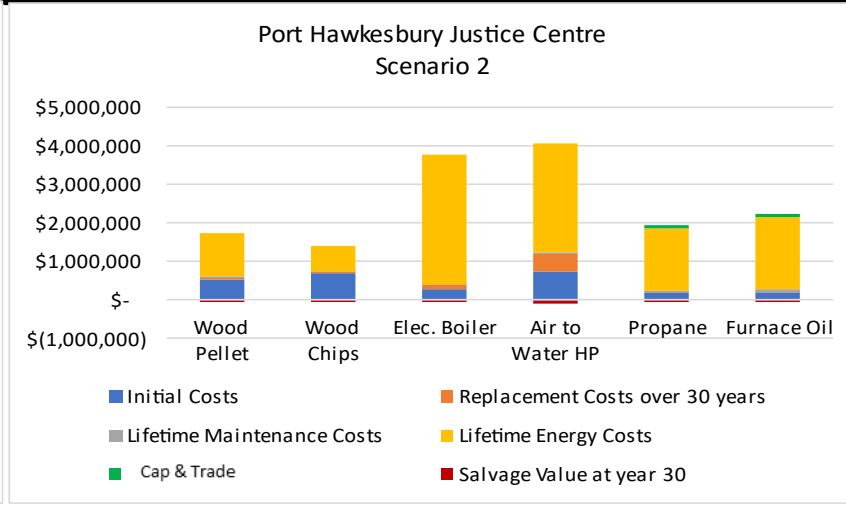
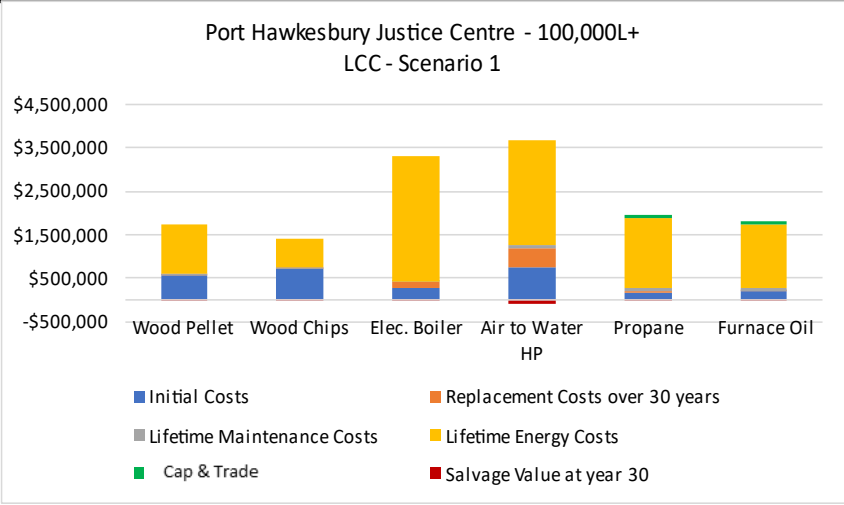
- Existing boiler room can accommodate pellet boiler
- Wood chip storage requires the construction of a new mechanical shed increasing the initial cost**
- Wood chips and wood pellet options have equal life-cycle costs

100,000L+ - Port Hawkesbury Justice Centre

- Scenario 1**
- 30 year lifecycle, 5% discount rate,
 - Wood Pellets 0% EER
 - Wood Chips 0% EER
 - Electricity 0.8% EER
 - Oil 0% EER
 - Cap & Trade

- Scenario 2**
- 30 year lifecycle, 5% discount rate,
 - Wood Pellets 0% EER
 - Wood Chips 0% EER
 - Electricity 2% EER
 - Oil 2% EER
 - Cap & Trade

- Scenario 3**
- 30 year lifecycle, 5% discount rate
 - Wood Pellets 0% EER
 - Wood Chips 0% EER
 - Electricity 2% EER
 - Oil 2% EER
 - Federal Carbon tax



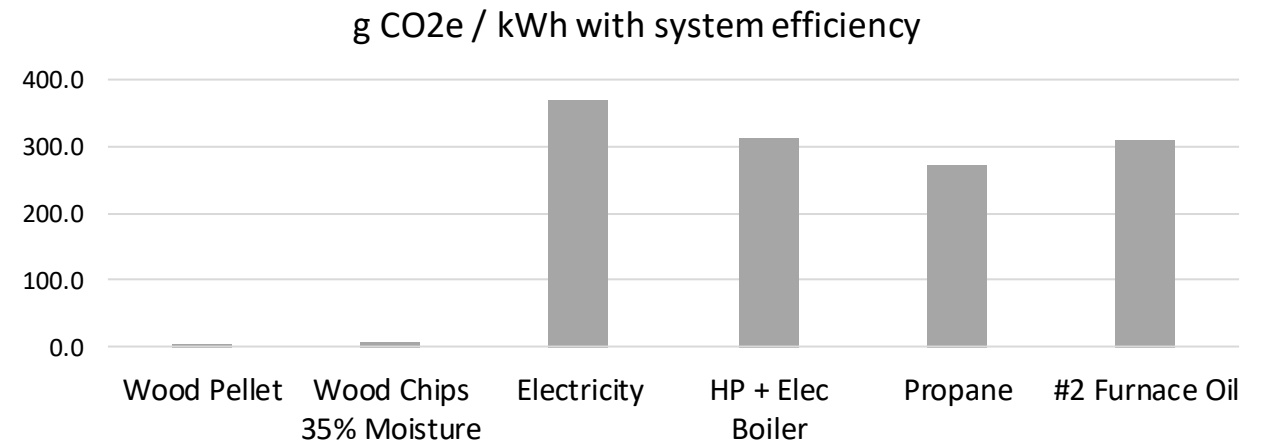
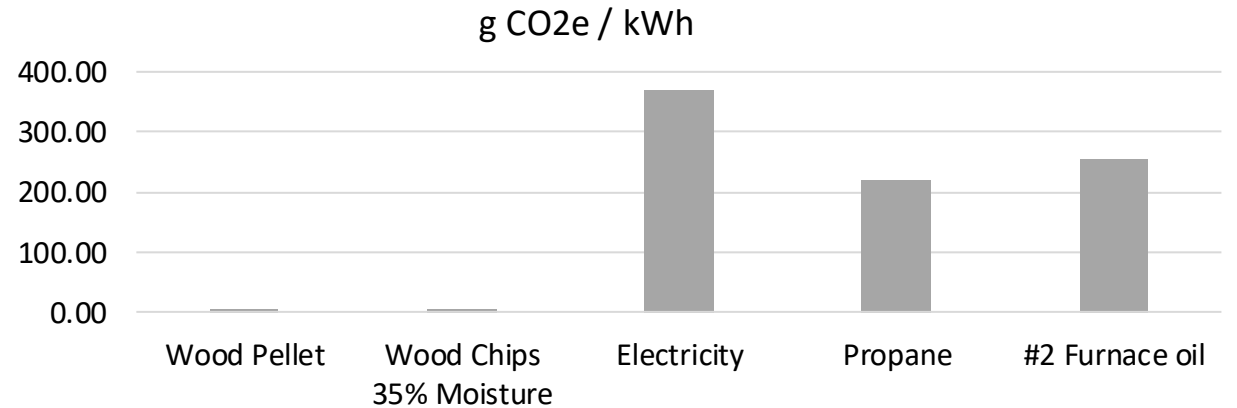
Findings:

1. The lower fuel cost of wood chips results in a lower life-cycle cost with this larger fuel consumption

GHG emissions - projected 2022

Fuel	g CO ₂ e/kWh
Wood Pellet	4.9
Wood Chips	7.5
Electric boiler	369.7
Propane	218.6
#2 Furnace oil	256.4

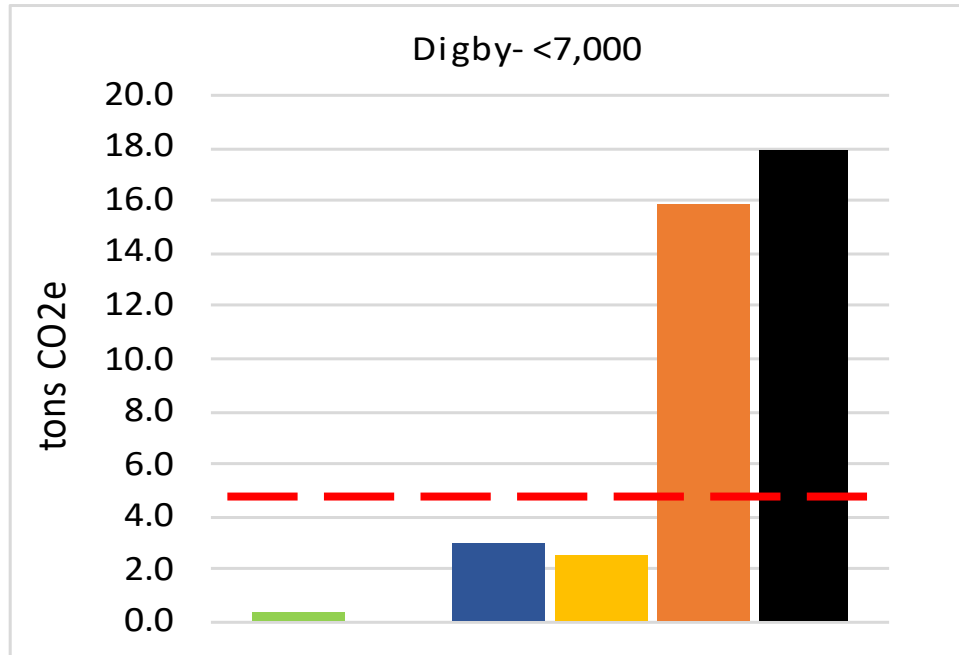
System	Eff/COP	g CO ₂ e/kWh with system efficiency
Wood Pellet	85%	5.8
Wood Chips	85%	8.8
Electric boiler	100%	369.7
HP + Elec. boiler	2.3	312.3
Propane	80%	273.3
#2 Furnace oil	83%	308.9



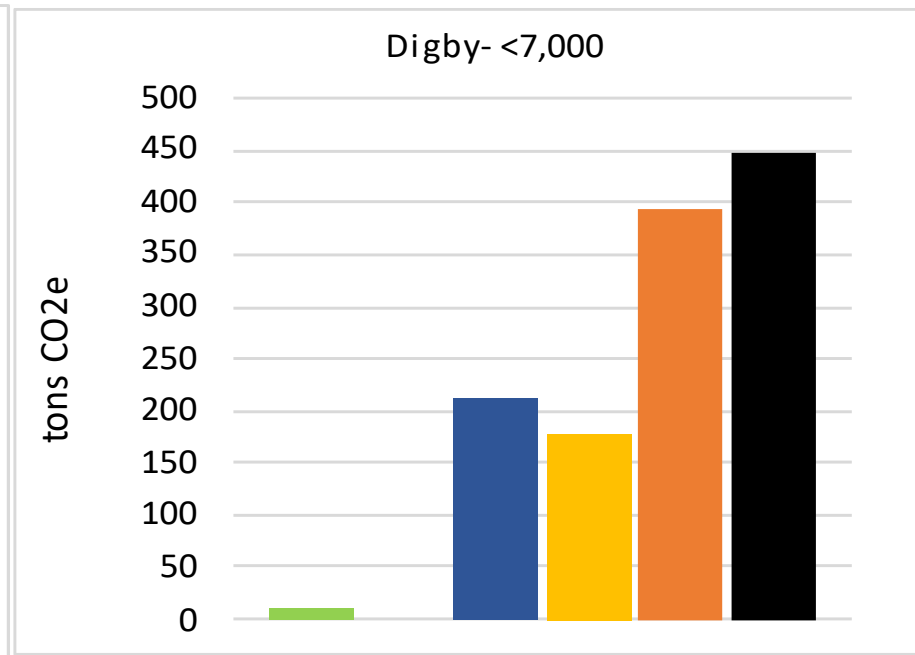
Sources of information

- Electricity emission were taken from NS Power IRP 3.1C scenario
- Other fuel types emissions taken from Emission Factors Sheet, used to estimate Canada's annual GHG inventory








GHG emissions - Digby



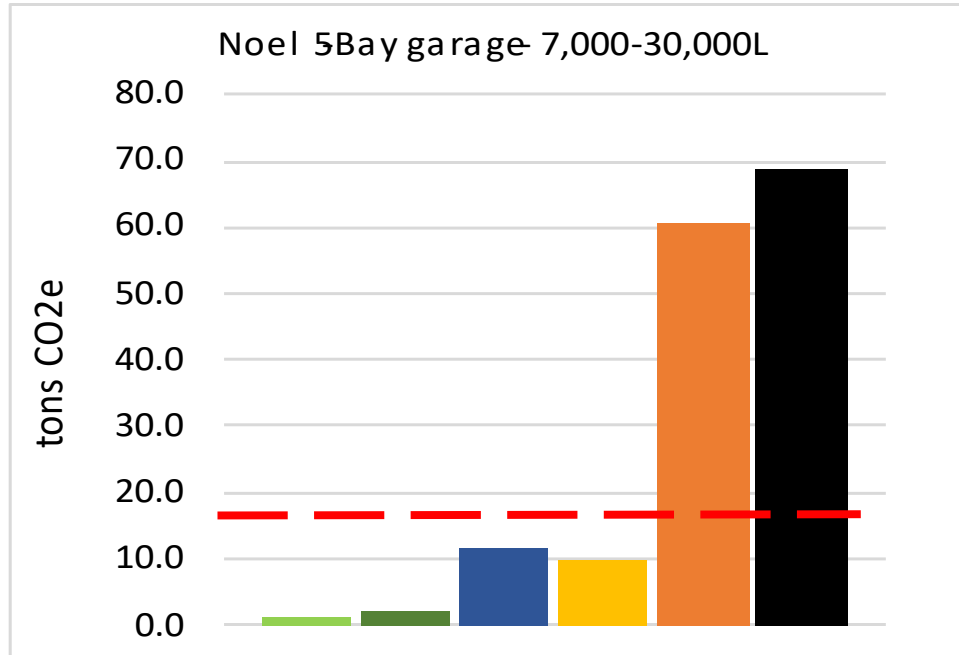
Emissions - 2035



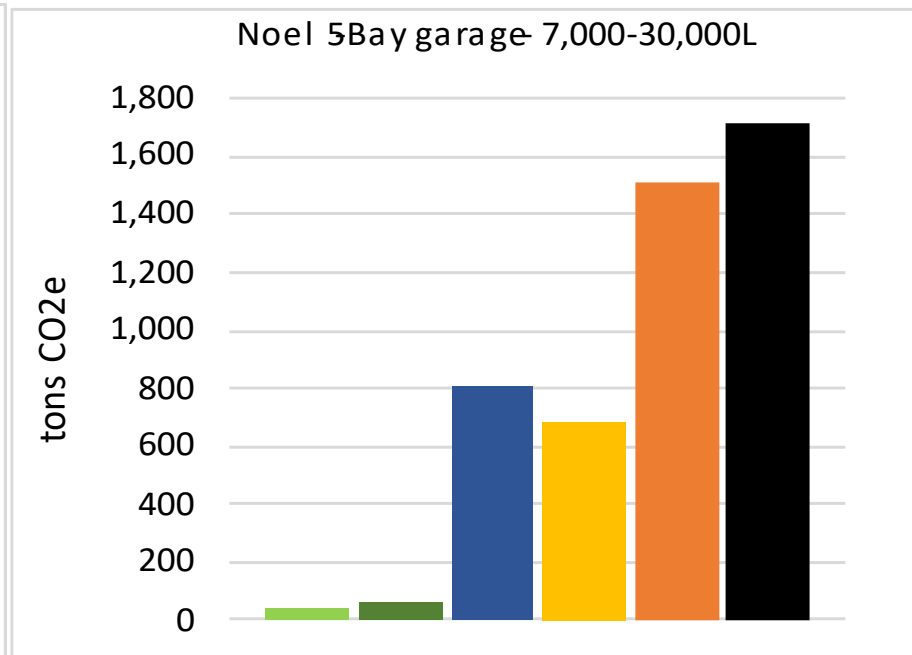
Emissions over 30 years

-  75% reduction from furnace oil
-  Wood Pellet
-  Wood Chips
-  Elec. Boiler
-  Air to Water HP
-  Propane
-  Furnace Oil








GHG emissions - Noel



Emissions - 2035

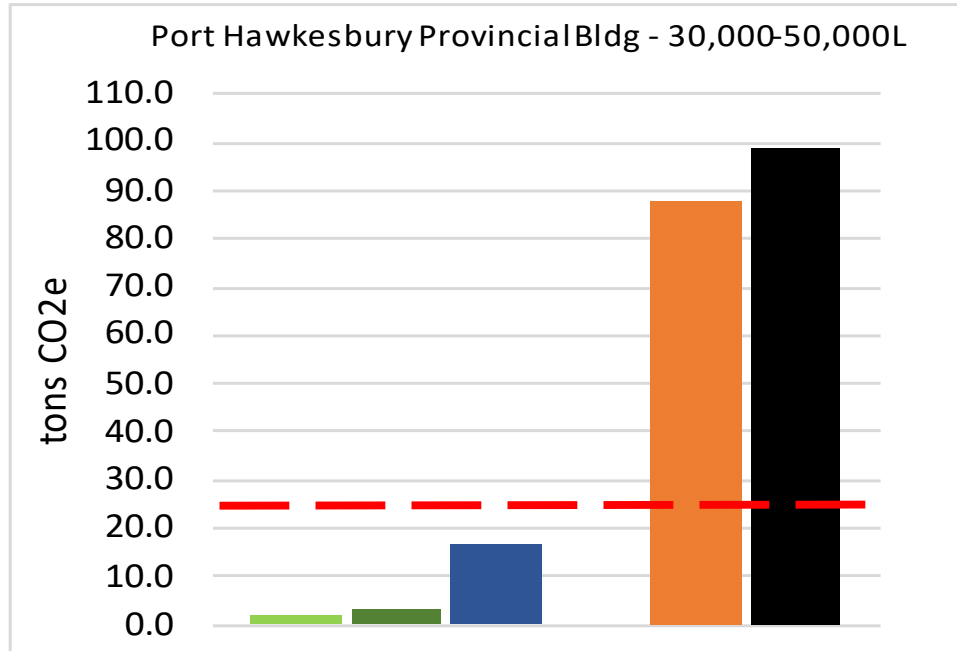


Emissions over 30 years

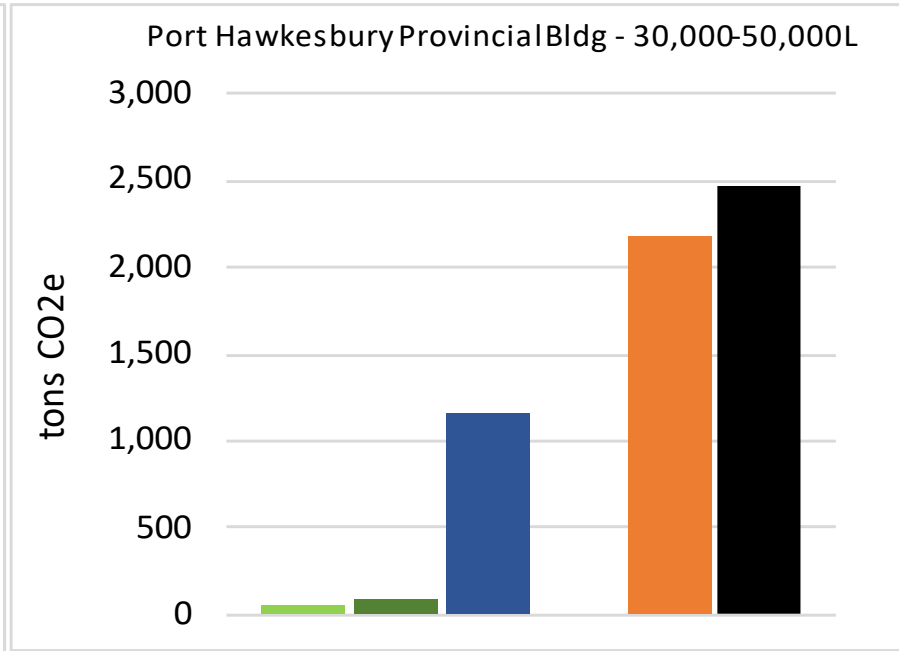
-  75% reduction from furnace oil
-  Wood Pellet
-  Wood Chips
-  Elec. Boiler
-  Air to Water HP
-  Propane
-  Furnace Oil










GHG emissions - Port Hawkesbury Provincial Bldg



Emissions - 2035

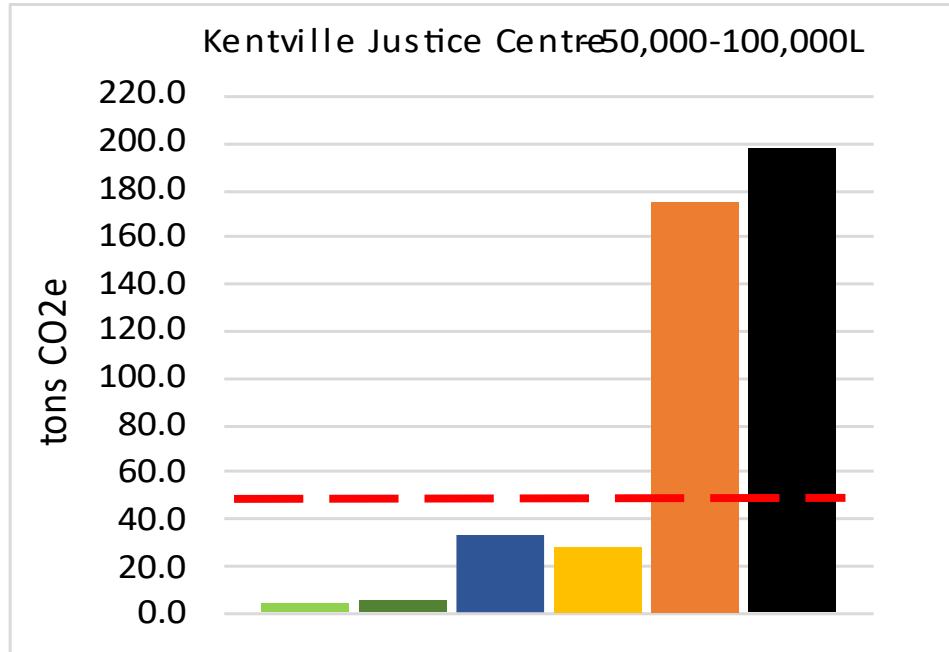


Emissions over 30 years

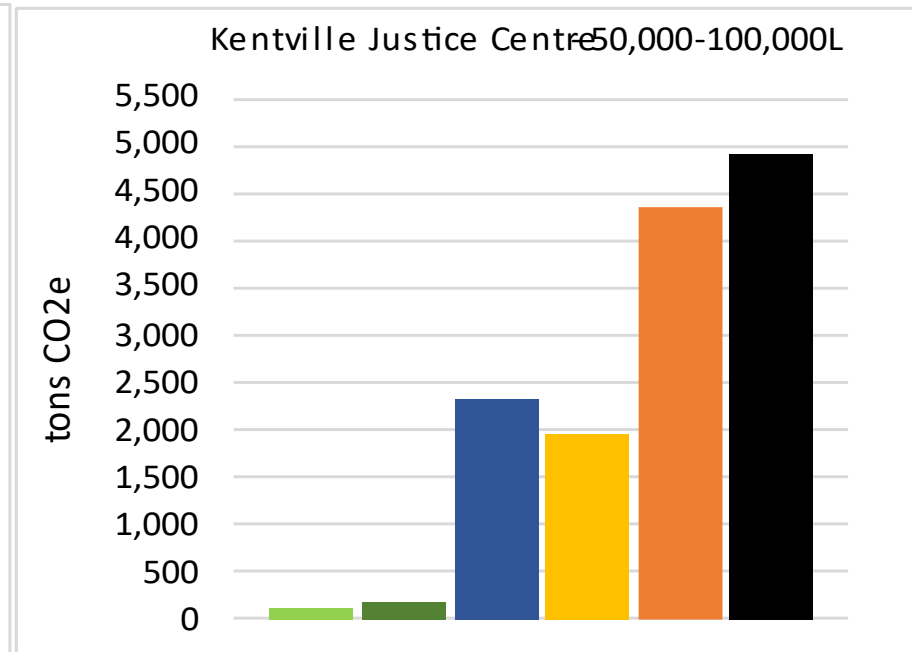
-  75% reduction from furnace oil
-  Wood Pellet
-  Wood Chips
-  Elec. Boiler
-  Air to Water HP
-  Propane
-  Furnace Oil










GHG emissions – Kentville Justice Centre



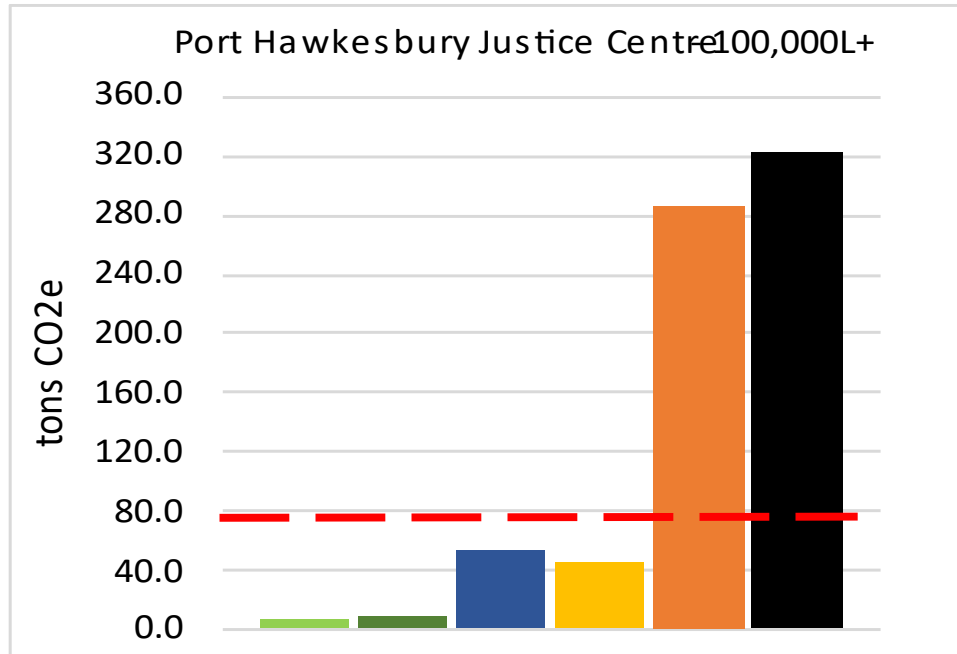
Emissions - 2035



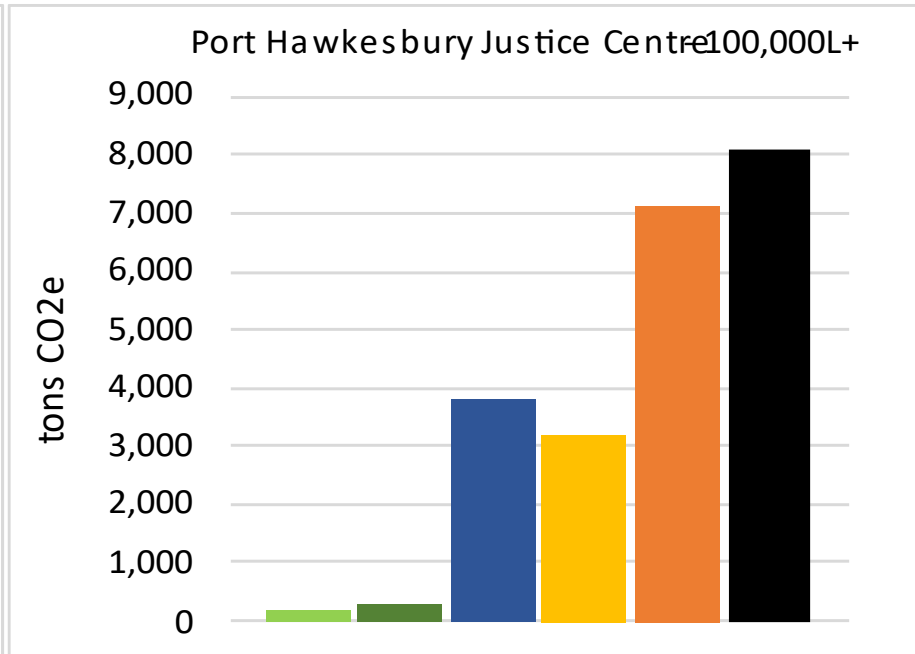
Emissions over 30 years

-  75% reduction from furnace oil
-  Wood Pellet
-  Wood Chips
-  Elec. Boiler
-  Air to Water HP
-  Propane
-  Furnace Oil








GHG emissions - Port Hawkesbury Justice Centre



Emissions - 2035



Emissions over 30 years

-  75% reduction from furnace oil
-  Wood Pellet
-  Wood Chips
-  Elec. Boiler
-  Air to Water HP
-  Propane
-  Furnace Oil

Financial Conclusions

Pellet Boiler Location Site	<7,000L		7,000-30,000L		30,000-50,000L		50,000-100,000L		100,000L+	
	New mech. shed	Existing boiler room	New mech. shed	Existing boiler room	New mech. Shed	Existing boiler room	New mech. shed	Existing boiler room	New mech. shed	Existing boiler room
Digby 255km	Elec. Boiler	Wood pellet	Wood pellet	Wood pellet	Wood Pellet Wood chips	Wood chips	Wood Chips	Wood Pellet Wood chips	Wood Chips	Wood Chips
Noel 50km	Elec. Boiler	Wood pellet	Wood pellet	Wood pellet	Wood pellet	Wood pellet	Wood pellet	Wood chips	Wood Chips	Wood Chips
Kentville 130km	Elec. Boiler	Wood pellet	Wood pellet	Wood pellet	Wood pellet Wood chips	Wood pellet	Wood pellet	Wood chips	Wood Chips	Wood Chips
Port Hawkesbury 220km	Elec. Boiler	Wood pellet	Wood pellet	Wood pellet	Wood pellet Wood chips	Wood chips	Wood Chips	Wood Pellet Wood chips	Wood Chips	Wood Chips

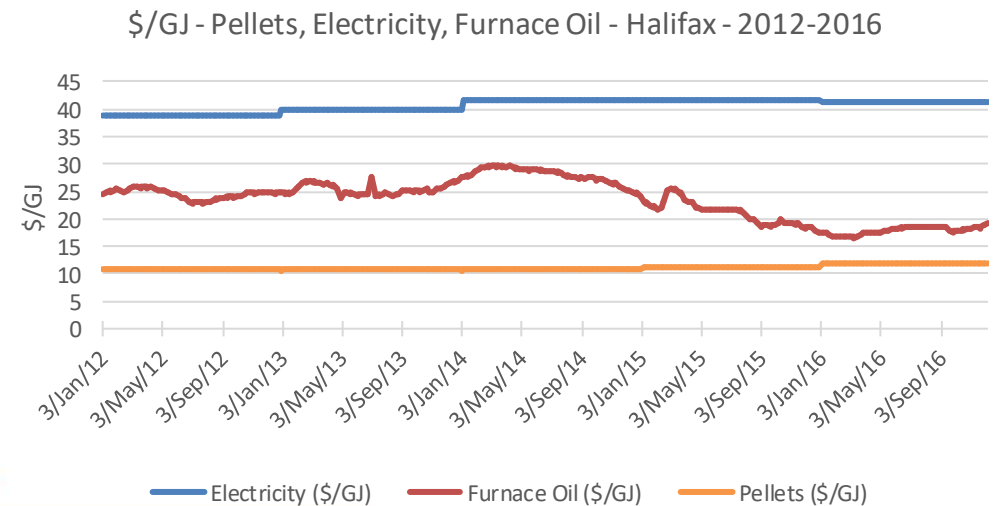
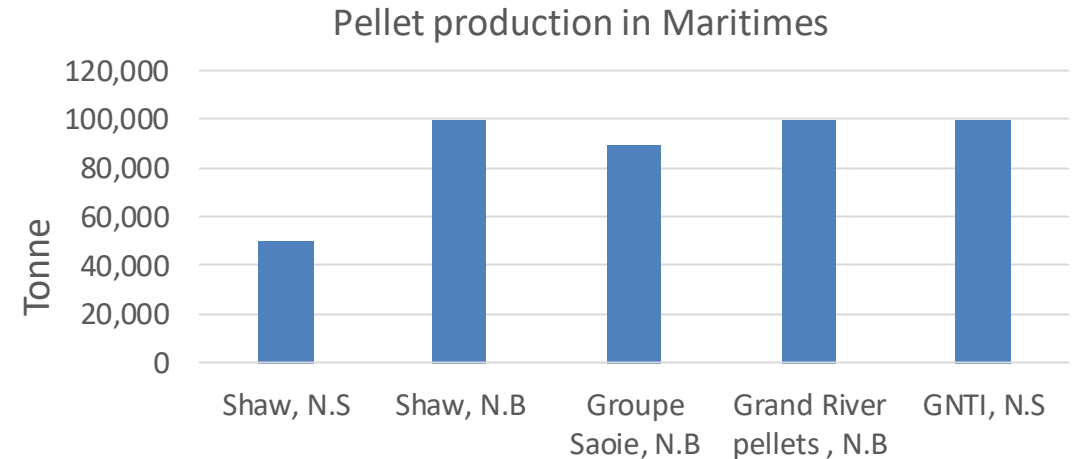
Note:
Wood pellet delivery costs vary depending on the distance from the delivery location and therefore affect the results.

Conclusions

- Wood heat meets the 75% GHG emissions reduction target, today
- The most economical alternative systems for each category is:
 - <7,000L - Wood pellets
 - 7,000-30,000L - Wood pellets
 - 30,000-50,000L - Wood pellets or Chips
 - 50,000-100,000L - Wood pellets or Chips
 - 100,000L+ - Wood chips
- Wood pellets have the least GHG emissions
- Wood pellet and chip prices are not affected by the current Carbon Pricing systems

Additional Benefits of Wood Heat

- Pellets are certified for guaranteed length & diameter, bulk density, ash & moisture content, calorific values and quality, which is not available for wood chips
- Shaw Resources, NS plant has the capacity to serve pellets to all DPW sites
- Fuel costs are stabilized which leads to budget predictability
- Supports local economy and forestry industry
- Eliminates fuel oil leaks and associated clean up costs and liabilities



Thank You!

Reach out with questions or request a copy of the Wood Heat Feasibility Study and/or Presentation:

paula.cook@novascotia.ca

