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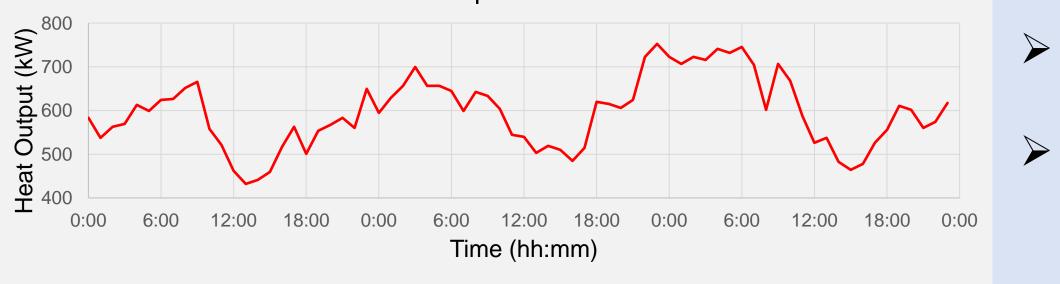


Figure 3: Transient Heat Output of TESS

Feasibility of a Thermal Energy Storage System for District Heating in Calgary

Nian He, Mah Noor Imtiaz, Chase Lamoureux, Connor Layton, Kyle Lutes

BENEFITS OF A TESS

Cost savings via peak-

Reduce carbon footprint by enabling district heating to consistently use excess

TYPES OF TESS	COST FEASIBILITY			
Table 1: Comparison of TESS Architectures	-Heat Pump -Electric Furnace -TESS			
Category Sensible Latent Chemical	\$8.00			
Simplicity 🗸	\$6.00 \$6.00			
Low Costs Versatility of Image: A state of the st	State Off-peak hours Off-peak hours			
Storage Mediums	Image: Second			
Verification Verification 	\$2.00 Our TESS:			
	\$1.00 \$35.47/day			
DESIGN	\$0.00 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 Time (hours)			
	Figure 4. Transient Analysis of Variable Electricity Charges (Average Winter Day).			
neter)				
	Figure 4 shows that a TESS will decrease variable electricity costs. However, due to the			
	\$35,432 D310 electricity cost structure, the monthly			
of NK	\$11,614 \$9,196 \$12,767 electricity bill is not the smallest (as seen in Figure 5).			
	Our TESS Heat Pump Electric Natural Gas			
nger	Figure 5. Monthly Electricity Cost Comparison (December).			
or	Table 4: Cost Comparison of Energy Storage Devices for Large-Scale Peak Shavings			
	System Capital Cost Maintenance Cost NPV over 20 yr TESS \$ 352,594 \$ 950,600 \$ 90,641			
	TEOD # 002,001 # 000,000 # 00,011 TESLA Megapack \$ 5,569,663 \$ 410,353 -\$ 6,726,142			
ump -	Battery (2x, 3.9 MWh)			
Figure 1: Cross Section of TESS	CONCLUSIONS			
	1. TESSs are not currently economically feasible in Calgary due to the electricity cost structure.			
COST ESTIMATES	2. In an ideal system where the TESS is offset from the original peak demand such that it			
Table 2: General Construction Estimates	does not increase the overall demand peak, the system would have a payback period of 10 years.			
ItemEstimated CostTank (Steel)\$ 134,479	3. TESSs offer a means to store an abundance of renewable energy for use during periods			
Heat Pump \$ 50,000	when these sources are scarce, but are cost prohibitive for peak shavings applications.			
Variable Blower\$5,704Copper Tubing\$17,422				
Insulation \$ 4,746	REFERENCES Thank you to ENMAX for providing			
Construction \$ 140,241 Total \$ 352,593	Distribution tariff. ENMAX Power Distribution Tariff. (2023, January 1). Retrieved March 21, 2023, from https://www.enmax.com/business/electricity-natural- gas/tariffs/distribution-tariff			
	Government of Alberta. (n.d.). Current and Historical Alberta Weather Station Data Viewer. Current and historical Alberta Weather Station Data Viewer. Retrieved March 22, 2023, from https://acis.alberta.ca/weather-data-viewer.jsp			
Table 3: Value Added Over Electric Furnace Parameter Value	Government of Canada. (2021). Survey of energy consumption of multi-unit residential buildings (secmurbs) 2018 – data tables. Natural Resources Canada. Retrieved March 21, 2023, from			
NPV \$ 108,246	https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/murb/2018/tables.cfm Order megapack. Electric Cars, Solar & amp; Clean Energy. (n.d.). Retrieved from			
IRR23.1%Payback Period10 years	https://www.tesla.com/megapack/design Wexford Developments LP. (2023). The Arch - Calgary. The Arch Rental Tower. Retrieved from http://wexforddevelopments.com/location/the-arch-rental-tower/.			
	* All \$ are in \$CAD			

Right Cylinder (Exterior: 7.39m Tall x 7.39m Diamet

- Water Storage Medium
- Insulation: 1 x 11" Layer of Fiberglass NEXTGEN PIN (R40)
- Coiled Tube Heat Exchange with Variable Blower Motor
- Stored Underground
- Ground-Sourced Heat Pur COP 4.0 (Industrial Line Goliath 6900)

TYPES OF TESS		COST FEASIBILITY			
	Hoot Pump				
Table 1: Comparison of TESS Architectures	\$8.00	-Heat Pump -Electric Furnace -TESS			
Category Sensible Latent Chemical	\$7.00				
Simplicity ✓ Low Costs ✓	\$6.00		Electric Furnace:		
Versatility of	Solution 55.00 Off-peak hours	On-peak hours	\$149.45/day		
torage Mediums	Aug Off-peak hours \$4.00 \$0.009023/kWh \$3.00 \$0.009023/kWh	\$0.011933/kWh	Only Heat Pump: \$37.36/day		
Verification Verification 	\$2.00 \$2.00		Our TESS:		
	\$1.00		\$35.47/day		
	\$0.00	10 11 12 12 14 15 14 17 19 10 20	21 22 22 24		
DESIGN	0 1 2 3 4 5 6 7 8 9	Time (hours)	21 22 23 24		
	Figure 4. Transient Analy	sis of Variable Electricity Charges (Ave	erage Winter Day).		
		•	a TESS will decrease		
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	Furnace Figure 5. Monthly Electricity Cost	Ask us a	about this!		
	Comparison (December).				
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		al Cost Maintenance C			
	TESS \$	352,594 \$ 950,	600 \$ 90,641		
	Battery (2x, 3.9 MWh)	5,569,663 \$ 410,	353 -\$ 6,726,142		
		CONCLUSIONS			
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Total \$ 352,593	Government of Alberta. (n.d.). Current and Historical Alberta Weather S	tation Data Thank you t	o Najmus Saltanat and		
Table 3: Value Added Over Electric Furnace	Viewer. Current and historical Alberta Weather Station Data Viewer. R March 22, 2023, from https://acis.alberta.ca/weather-data-viewer.jsp	Sam Amiri fro	om ENMAX for providing		
Parameter Value	Government of Canada. (2021). Survey of energy consumption of multi residential buildings (secmurbs) 2018 – data tables. Natural Resource Retrieved March 21, 2023, from	s Canada. EXCEIIENT SU	pport and information.		
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IRR23.1%Payback Period10 years	https://www.tesla.com/megapack/design Wexford Developments LP. (2023). <i>The Arch - Calgary</i> . The Arch Renta		ghdad Ghias for their		
	Retrieved from http://wexforddevelopments.com/location/the-arch-rent	al-tower/.	ance and advice.		
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	* All \$ are in \$CAD			

Y 515	
1000kW Input from heat	
Cycles vary between 50°C and 95°C	
14 hour cycle charge time, 8 hour discharge	
System is always in use	

Daily heat output based on public government data

