

Electric Thermal Storage in the North

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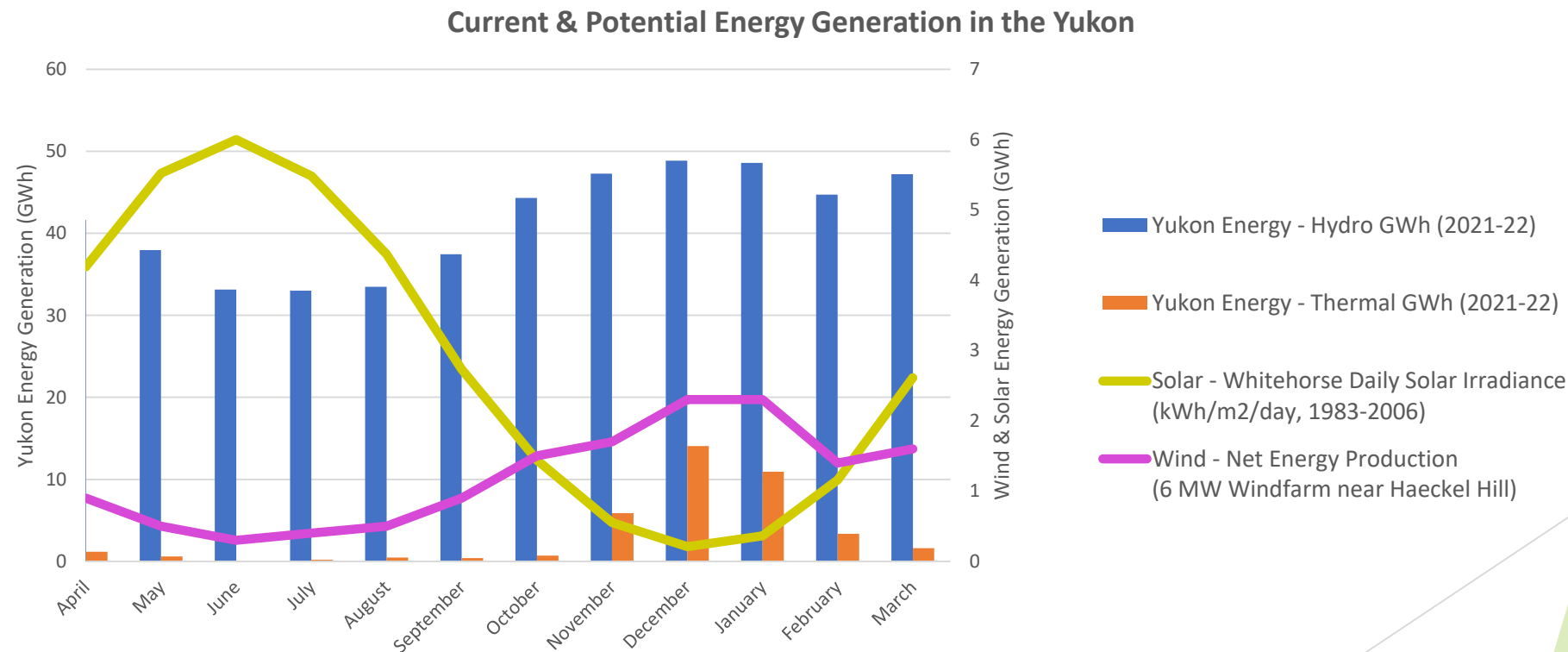
ETS Project Manager, Yukon Conservation Society

Outline

- ▶ Importance of energy storage in remote communities
- ▶ Common forms of energy storage
- ▶ Electric thermal storage (ETS)
- ▶ Yukon ETS Demonstration Project
 - ▶ Spin-off projects
 - ▶ Results to date
- ▶ Next steps for ETS in the Yukon

Why is energy storage important in remote communities?

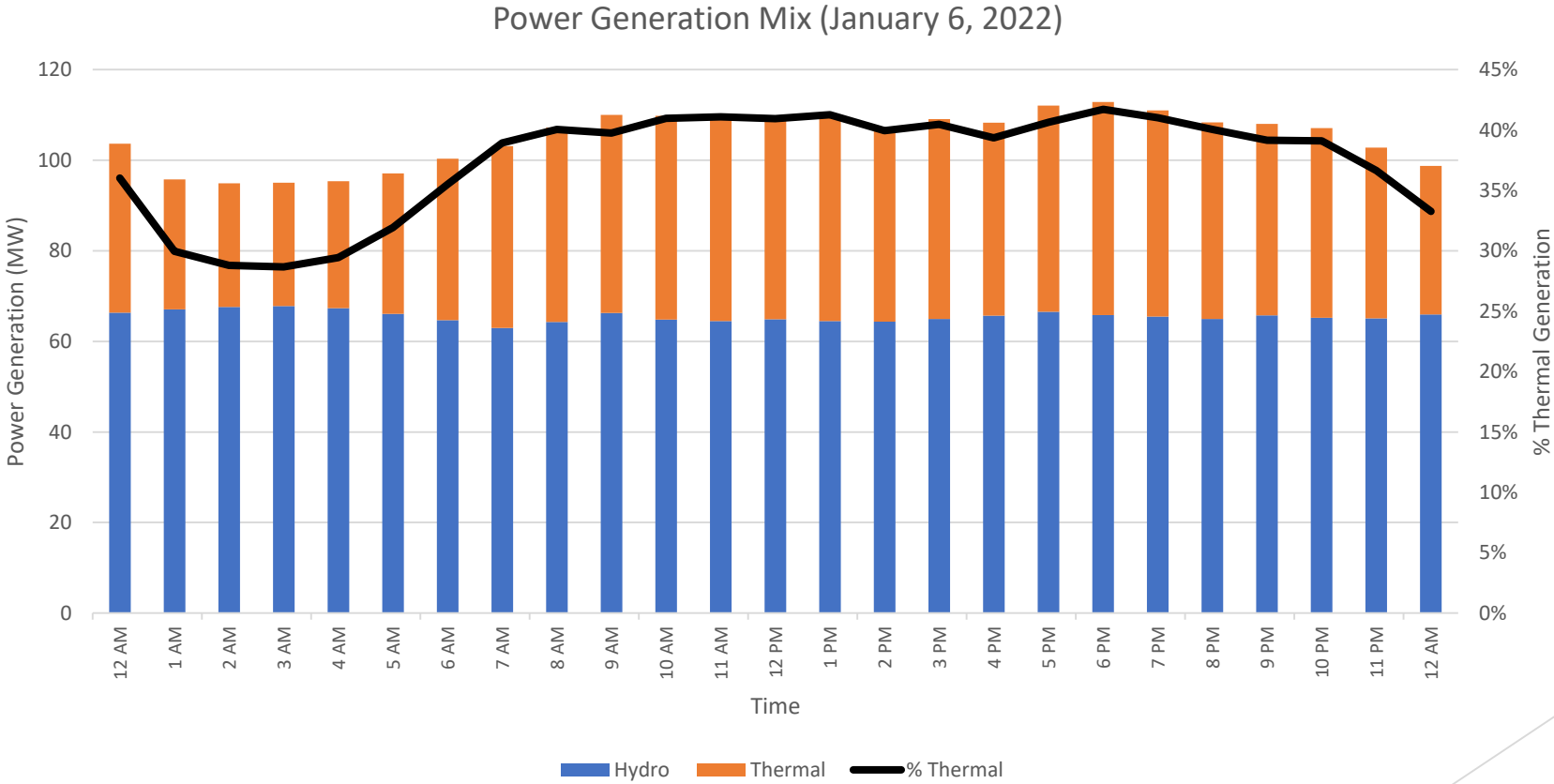
1. Seasonal variation of energy demand & renewable energy resources



Data Sources: Yukon Energy Corporation (Hydro & Thermal Data)
“Yukon Government Solar Energy Pilot: Performance Monitoring”, February 2014 (Solar Data)
“Yukon Wind Site Inventory - Final Report”, Prepared for Yukon Energy, August 2016

Why is energy storage important in remote communities?

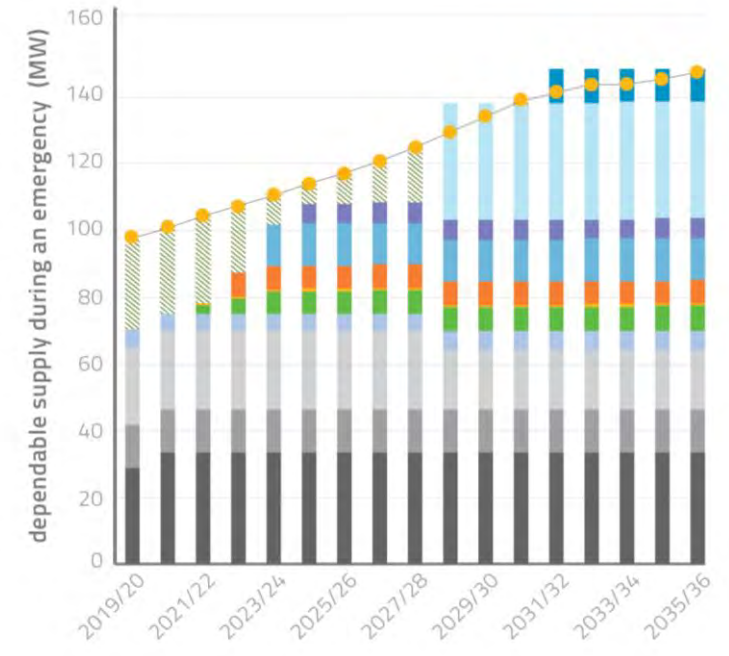
2. Daily variation of energy demand & renewable energy resources



Why is energy storage important in remote communities?

3. Rapidly Rising Peak Demand

- Peak Demand
 - 2018: 93.0 MW
 - 2019: 90.0 MW (-3%)
 - 2020: 103.8 MW (+15%)
 - 2021: 112.7 MW (+8.5%)
- Rented Diesels
 - 2017/18: 4 units (7.2 MW, ~\$700k)
 - 2018/19: 6 units (10.8 MW, \$1.72M)
 - 2019/20: 9 units (16.2 MW, \$4.37M)
 - 2020/21: 17 units (27 MW, \$6.65M)



Yukoners' power usage was sizzling

By Whitehorse Star on January 7, 2022

Yukon Energy hit a record this week for power generation as the territory remained in the grips of frigid temperatures.

President Andrew Hall said this morning generation peaked at 111 megawatts, smashing the previous record of 104 MW.

Hydro generation contributed between 65 and 67 MW of generation with the remaining 50-plus MW generated by LNG and diesel.

The previous record was set Dec. 16, and in January 2020 before that.

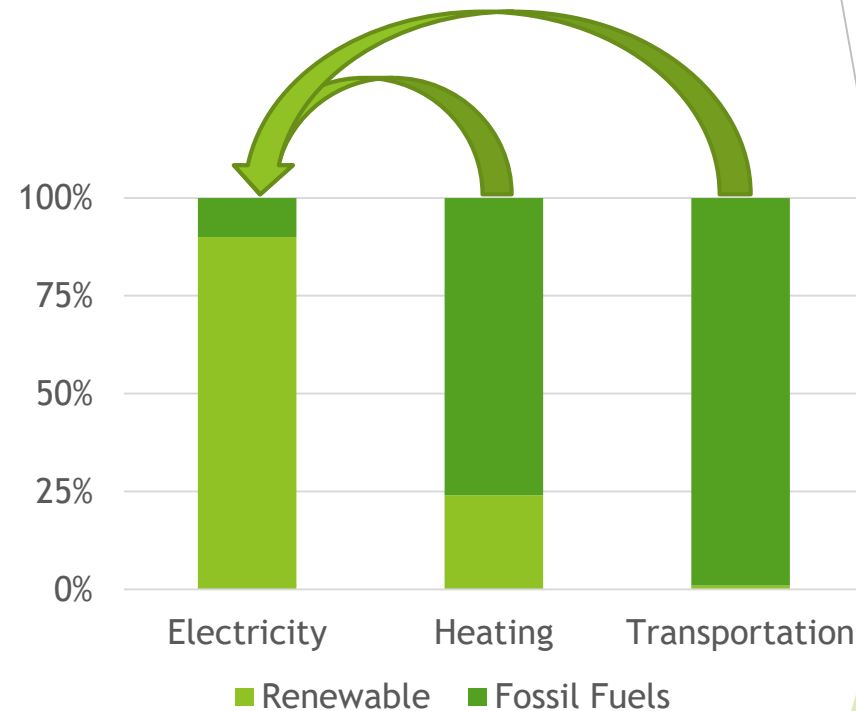
Photo Credit: Yukon News, Whitehorse Star (modified)

Data Sources: Our Clean Future (September 2020), 2021 Confidence and Supply Agreement (April 2021), 2021 GRA Evidence - Russ Bell (Sept. 2021), Legislative Return RE:: Diesel Energy generation costs (October 2021), Yukon Energy Corporation 2021 General Rate Application (Nov. 2020)

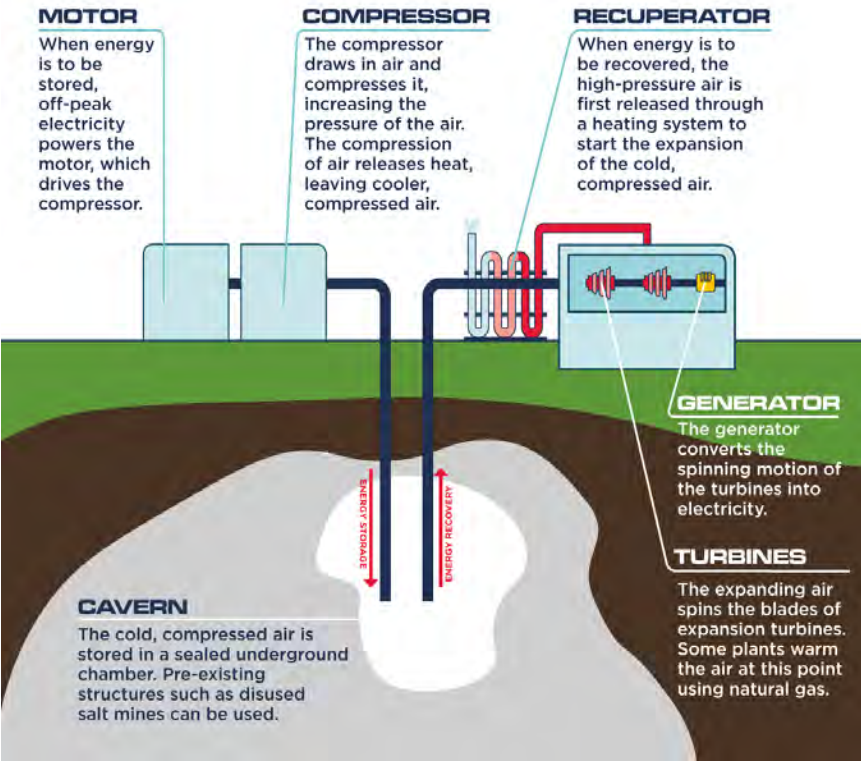
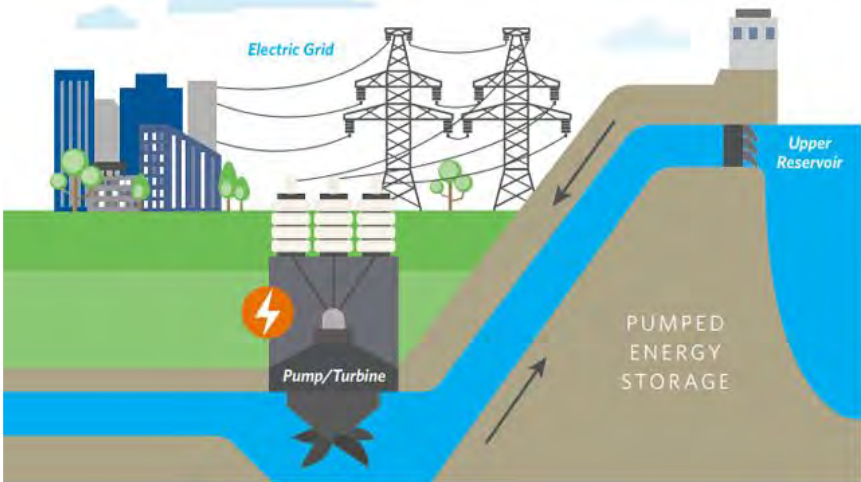
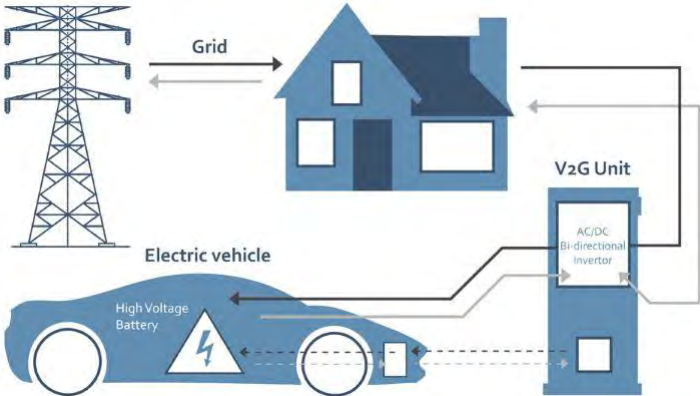
Why is energy storage important in remote communities?

4. Electrifying Transportation & Heating

- 2030 Our Clean Future Targets:
 - 45% reduction in GHG emissions vs. 2010
 - 30% of light-duty vehicle sales are EVs
 - 4,800 EVs registered
 - Replace 1,300 residential fossil fuel heating systems in residential homes w/ ETS & ASHP
 - Reduce YG building GHGs by 30%
 - 50% of heating from renewable energy
 - 97% of electricity from renewable energy
- Electrification w/o Storage = Higher Peak Demand



What are the most common forms of energy storage?



What is Electric Thermal Storage?

Separates heat production from heat delivery

- Produce heat from electricity, typically during off-peak periods
- Store heat, such as in bricks or PCM
- Release heat as appropriate
- Variety of forms available for central and room-based heating
- Systems available for residential, commercial, or institutional settings
- Benefits: Peak reduction/shifting, ancillary services (frequency, black start), integration of intermittent renewables (dispatchable storage)...
- Challenges: Higher maximum power demand, weight, size, lack of local capacity & awareness, not 100% of capacity “dispatchable”



What is Electric Thermal Storage?

ETS Manufacturers & Suppliers in North America:

- Steffes
- Elnur (ECOMBI)*
- Dimplex†

Noteworthy Canadian ETS start-ups:

- Stash Energy (ETS + ASHP)
- Neothermal (supplemental ETS)

* Distributed by Coldbrook Electric Supply

† Pending CSA Approval



What is the Yukon Electric Thermal Storage Demonstration Project?

First ETS Project in the Canadian North

- Installing ETS systems in 40+ Yukon homes as their primary heating system
- Installing the first commercial/institutional ETS system in northern Canada
- Studying system performance, including peak shifting and thermal comfort
- Evaluating charging control options
- Supporting community energy literacy efforts
- ...and so much more!!



What is the Yukon Electric Thermal Storage Demonstration Project?

Research-Intensive Demonstration Project

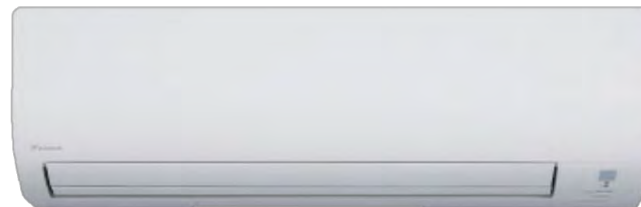
- How effective are ETS units at reducing the Yukon's winter peak?
- What regulatory or infrastructure changes would need to be made for adoption and wide implementation in the Yukon?
- How effective are ETS units as controllable, predictable, dispatchable resources?
- What is the best ETS control approach for peak reduction without producing a secondary peak?
- Other topics: Black starts, occupant comfort, diesel-powered communities, thermal comfort during power outages, rooftop solar integration



What is the Yukon Electric Thermal Storage Demonstration Project?

Air Source Heat Pump & Smart Heating Market Development Pilot (ETS + ASHP)

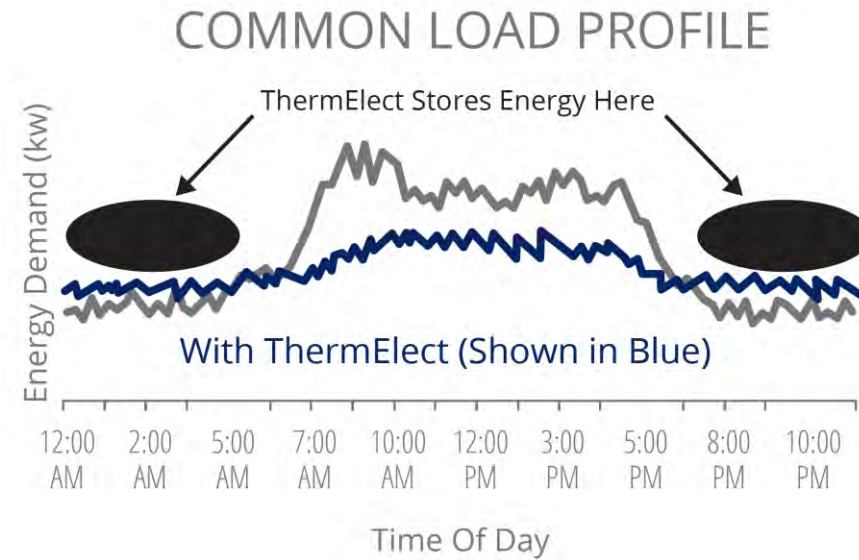
- Partnership with the Yukon Government
- Installing ETS as cold weather back-up to ccASHP, both room-based and central heating
- Above ASHP cut-off: Low energy & cost heat (ASHP)
- Below ASHP cut-off: Off-peak clean energy heat (ETS)
- Combined: Low energy/cost, clean energy heating!



What is the Yukon Electric Thermal Storage Demonstration Project?

Institutional & Commercial ETS @ Yukon U

- Partnership with the Yukon Government
 - Sustainable Infrastructure Branch (HPW)
 - Green Infrastructure Program
- Steffes ThermElect 9180 (installed Fall 2022)
 - Charging Input: ~80 kW
 - Storage Capacity: 440 kWh
- Reducing heating oil consumption and boiler runtime without increasing demand charge
- Developing best practices, local capacity



What is the Yukon Electric Thermal Storage Demonstration Project?

Project Statistics

- Number of participants: 44 (37 installed, 2 pending)
 - Spread across the territory from Mount Lorne to Dawson City
- Original heating system sources:
 - 19 fossil fuel, 19 electric, 6 mix
- Original heating system types:
 - 19 central (furnace/hydronic)
 - 25 room-based (baseboard / Toyo)
- 6+ ETS+ASHP participants
- Storage capacity: 4 MWh (4.4 MWh w/ YukonU ETS)
- Rated power: 680 kW (733 kW w/ YukonU ETS)
- ~15 contractors trained in ETS (more in 2023)
- 100+ energy assessments!



Yukon pilot project aims to shift energy demand away from peak times, reduce diesel use

Yukon Conservation Society plans to install electric thermal storage units in 40 homes

[Karen McColi](#) · CBC News · Posted: Apr 14, 2020 8:52 AM CT | Last Updated: April 14, 2020

The Narwhal NEWS

Whitehorse pilot project will cut reliance on fossil fuels for heating

Electric thermal storage units help smooth out peaks in demand, reducing the need for diesel and LNG generators



By Julien Gignac (Local Journalism Initiative reporter)

April 21, 2020 · 3 min. read

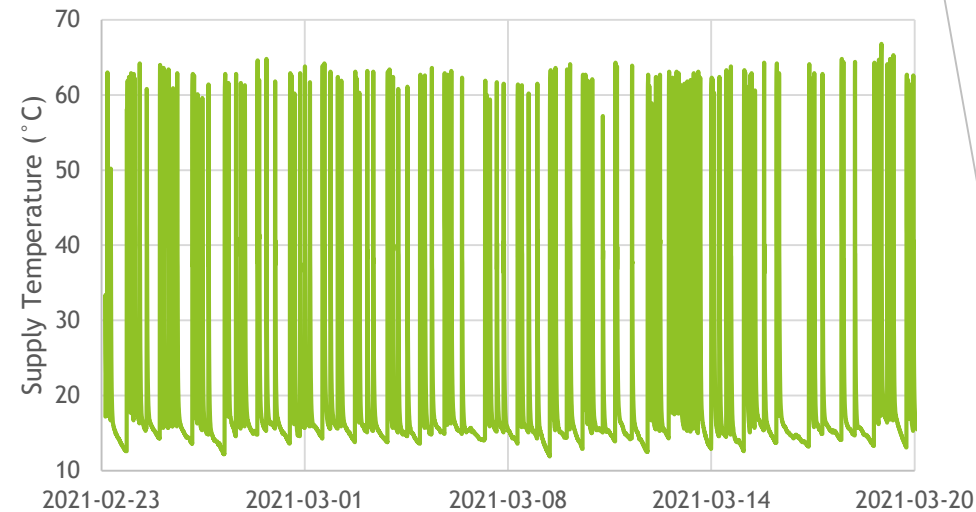
What is the Yukon Electric Thermal Storage Demonstration Project?

Occupant Comfort - Results to Date

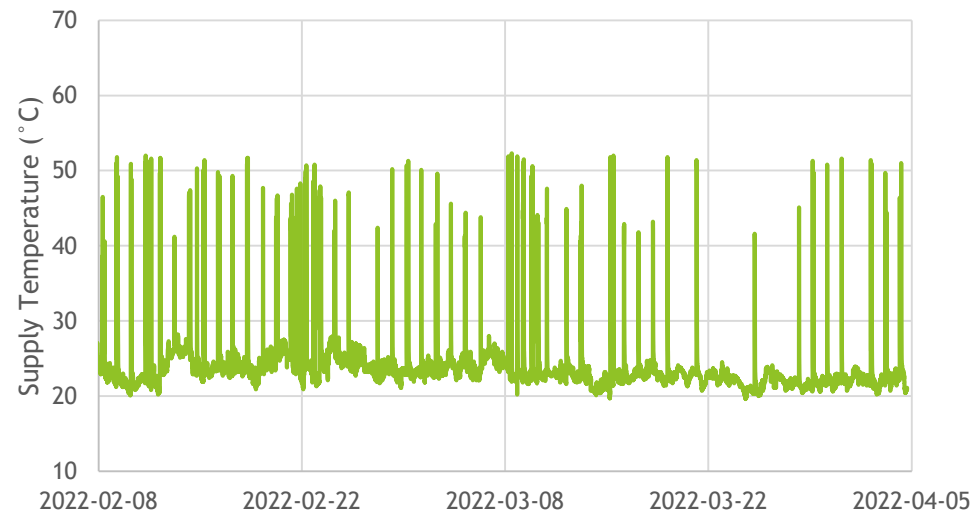
- 85% of participants satisfied with ETS heating
- 94% of participants found ETS worked well with secondary heating system(s)
- 96% of participants would recommend ETS
- 97% of participants' expectations met by their ETS systems and experience with the project



Supply Temp - Pre-Install (Spring 2021)



Supply Temp - Post-Install (Spring 2022)



What is the Yukon Electric Thermal Storage Demonstration Project?

Regulatory & Infrastructure - Results to Date

- Encountered several ~\$50,000 estimates for service upgrades from ATCO Electric Yukon
- Aging power grid designed for fossil fuel based heating and transportation
- Sparked the “Electric Vehicle & Smart Heating Project”, led by Yukon University
 - Identifying neighbourhoods most in need of distribution upgrades
- Working with utilities across Canada to develop policy recommendations to boost ETS adoption
 - Rebates for upfront costs
 - Time-of-use rates for on-going costs



What is the Yukon Electric Thermal Storage Demonstration Project?

Peak Reduction / Shifting - Charging Periods

- “Preferred Charging Periods” & “Ramped Charging”
- Steffes (Non-Solar Participant):
 - Overnight: 9 pm to 6 am
 - Mid-Day: 10 am to 4 pm
- Steffes (Solar Participant):
 - Overnight: 7 pm to 6 am
 - Mid-day charging eliminated to maximize net-metering revenue

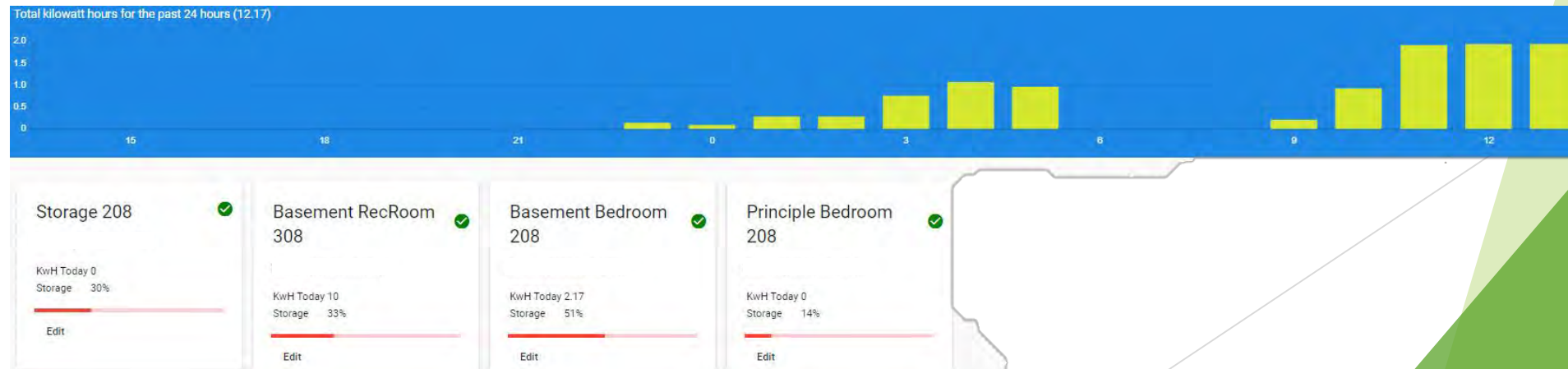


What is the Yukon Electric Thermal Storage Demonstration Project?

Peak Reduction / Shifting - Charging Periods

- ECOMBI:
 - Overnight: 10 pm to 6 am
 - Mid-Day: 11 am to 3 pm
 - Deferred Charging
- ECOMBI units on-peak draw higher than Steffes
 - Due limited control options (no schedule)

Mode Auto	Off Peak * 10:00 PM - 6:00 AM
Emitter Set Temp (C) 23	Off Peak 2 * 11:00 AM - 3:00 PM
Manual Set Temp (C) 20	Eco * 12:00 AM - 12:00 AM
Auto Set Temp (C) 19	Excess of Temp Prot 2
Storage Charge (0 to 5) * 5	Limit Factor * 0.1
Room Compensation (C) 0	Auto Charge Regulation 10
Convection Compensation (C) 0	
<input checked="" type="checkbox"/> Deferred Charge	

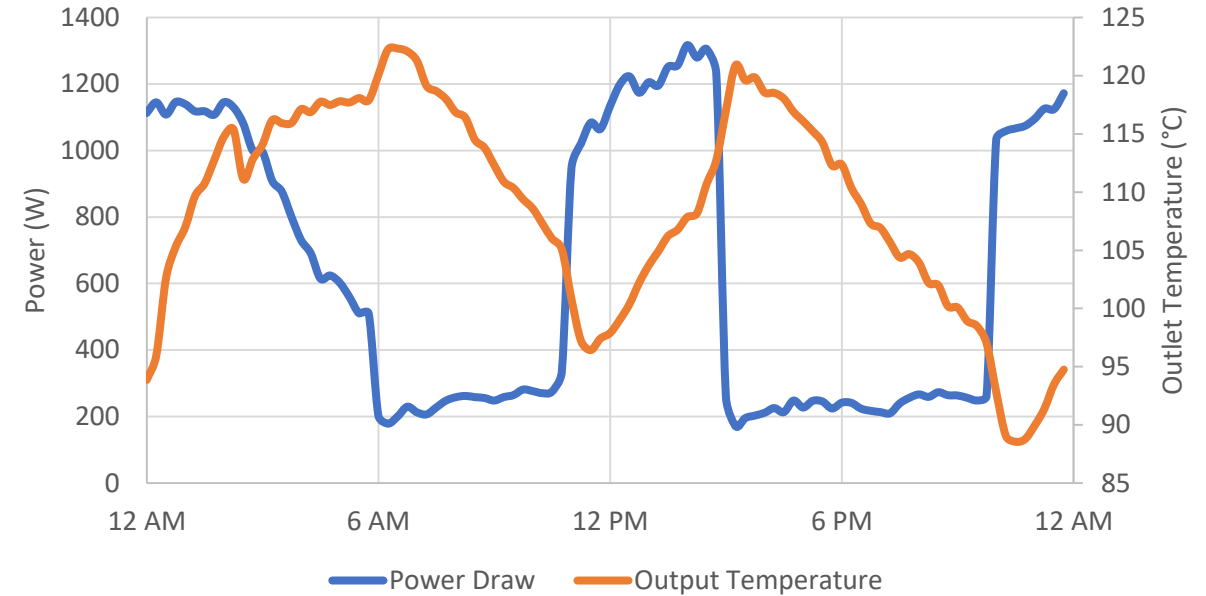


What is the Yukon Electric Thermal Storage Demonstration Project?

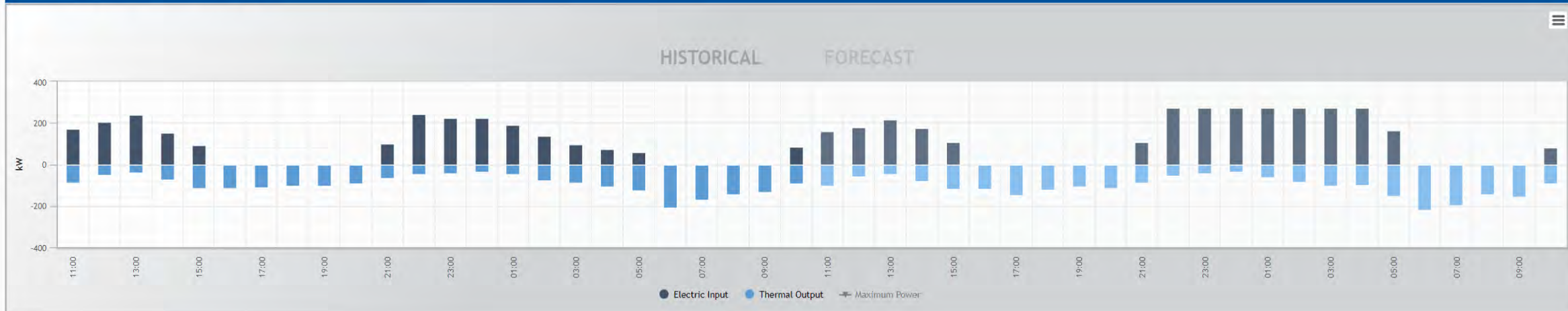
Peak Reduction / Shifting - Results to Date

- 86% of all ETS power draw during off-peak times in January
- ECOMBI: 75% off-peak draw
- Steffes: 92% off-peak draw
- Solar: 86% off-peak draw vs. 92% for non-solar

ECOMBI Performance - January 6, 2022 (Avg. Temp: -40°C)



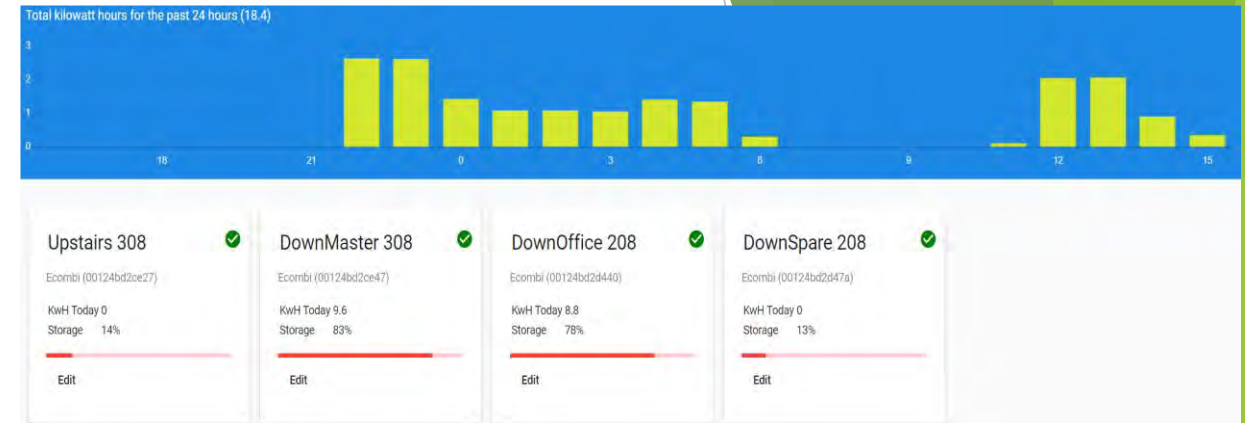
Electric Input vs Thermal Output



What is the Yukon Electric Thermal Storage Demonstration Project?

Other Successes & Observations

- Accelerating development of suppliers' hardware & software
 - System control & monitoring, data exporting, configurations
- Blackout heating: Passive ECOMBI units
- Residential ETS:
 - ~\$265k / MWh, \$1.5M / MW installed capacity
 - LCOC, 25 year life: \$75 / kW-year**
 - * % of installed capacity for dependable capacity: ~85%?
 - * O&M costs to utility: Unknown... Incentives? System monitoring?
- Grid Battery:
 - ~\$875k / MWh, \$5M / MW installed capacity
 - LCOC, 20 year life: \$235 / kW-year
- Rented Diesels:
 - LCOC, 20 year life: \$211 / kW-year



What is the Yukon Electric Thermal Storage Demonstration Project?



Barriers & Challenges Encountered

- Aging distribution infrastructure
 - YukonU's EV & Smart Heating Project
- ETS furnace size & weight
 - Steffes Serenity, Dimplex ETS
- Local capacity
 - ETS + ASHP contractor training
 - ETS Project Assistant + internships
 - Fireweed Market + literacy video



ECOMBI NORTH AMERICA

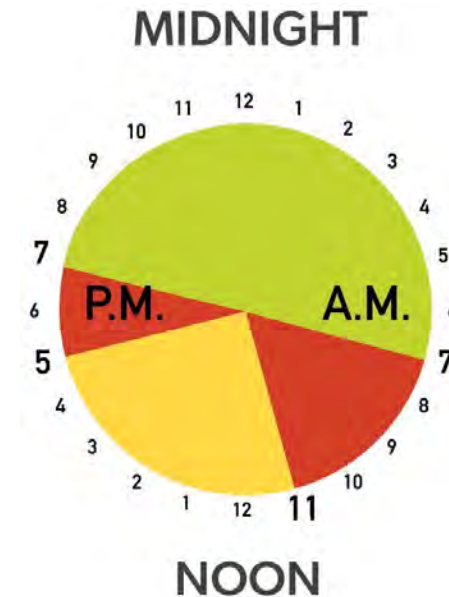


Certificate of Training

What is the Yukon Electric Thermal Storage Demonstration Project?

What's next for ETS in the Yukon?

- YukonU: Technical report to be released in Summer 2023
 - Addressing research questions through data analysis
- YCS: Advocacy-oriented report to be released in Summer 2023
 - Presenting actionable recommendations, backed by YukonU's technical report
 - Prepared in collaboration with partners and collaborators across the country, including governments, utilities, suppliers, and consultants
 - Yukon-focused, but as applicable in other northern Canadian jurisdictions as possible
- Hopeful outcomes:
 - ETS rebate offered by the Yukon Government
 - Time-of-use rates available for Yukoners
 - Modernized power grid - ready for electrification
 - Strong local capacity and public support for ETS
 - Opt-in ETS utility control program



What is the Yukon Electric Thermal Storage Demonstration Project?



Natural Resources
Canada

Ressources naturelles
Canada

Canada

Partnerships & Collaborators

- Primary Funder: NRCan (CERRC)
- Official Partners:
 - Yukon Energy Corporation
 - Yukon Government - Energy Branch*
 - Yukon University - Northern Energy Innovation
- Key Collaborators:
 - ATCO Electric Yukon
 - Solvest & Certified Heating
 - Steffes Corporation
 - Coldbrook Electric Supply
 - Hydro Quebec

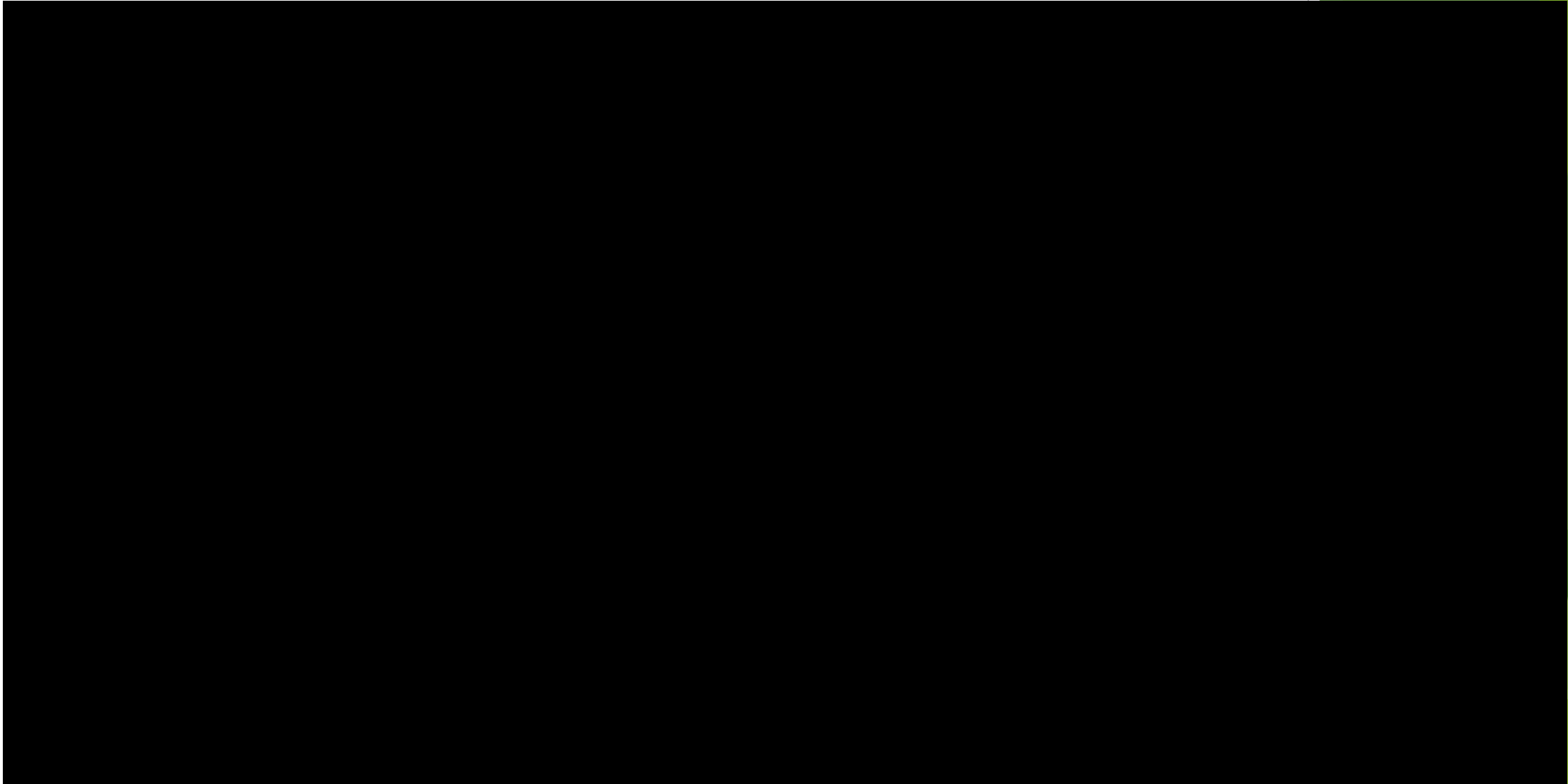


* Also providing project funding

Thank you for your time!

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Why not just use batteries?

ETS is more cost-effective, especially in areas with significant heat loads.

	Tesla Powerwall 2	Steffes Furnace	Steffes Space Heater	ECOMBI (Baseboard)
Storage Capacity	13.5 kWh	180 kWh	40 kWh	21 kWh
Power Draw	5 kW	28.8 kW (w/ 200 A panel)	10.8 kW	2.62 kW
Energy Delivery	5 kW	18.5 kW (12 hrs charge)	4.3 kW (12 hr charge)	1.3 kW (12 hr charge)
Unit Volume	0.13 m ³	3.3 m ³	0.28 m ³	0.15 m ³
Equipment Cost	~\$10,000	~\$10,500	~\$3,500	~\$2,000
Cycling Degradation	Yes	No	No	No

Source	\$ / kWh	kg CO ₂ eq / kWh
Hydro	0.005	0 (excl. embodied)
LNG	0.1814	0.688
Diesel	0.2051	0.884

GHG Data: “LNG for Yukon Energy Power Generation - A Life Cycle Emissions Inventory”, July 2013.
Prepared for Yukon Energy by the Pembina Institute.

Cost Data: Yukon Energy Corporation Application to the Yukon Utility Board re: Battery Energy Storage System Project, January 2021