Natural Resources Canada | Ressources naturelles Canada

Small-Scale Biomass Combined Heat and Power for Northern Rural and Remote Communities

2026 Update: Technologies, Suppliers, Lessons Learned

Arctic Bioenergy Summit & Tour

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CanmetENERGY-Ottawa

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Canada

NRCan’s Energy Efficiency & Technology Sector (EETS)

- Bioenergy
- Built Environment
- Carbon Management
- Industry
- Northern and Remote Community Energy
- Renewables, Electrification and Transportation

CanmetENERGY Devon

CanmetENERGY Ottawa

CanmetMATERIALS Hamilton

CanmetENERGY Varennes

Office of Energy Efficiency

Office of Energy R&D

CanmetENERGY Ottawa (CEO)

Bioenergy Domain :
Transformation of biomass residues to low-C products for industries and transportation

- Production and valorization of the solid, liquid and gaseous products
- Modular digital framework integrating geospatial intelligence, supply chain analysis, process modeling, TEA and LCA

Northern & Remote Communities Domain:

Improving Reliability and Accessibility of Renewable Energy Technologies in Northern & Remote Communities – bioenergy/solar/wind; thermal technologies, microgrid,

Net-zero Pathways for Northern & Remote Communities – Heat loads, energy efficiency


Renewable diesel


Biomass and Biocarbon pellets


CEO’s Upgrading pilot test facility

Bioenergy Plant #3
Teslin Tlingit FN

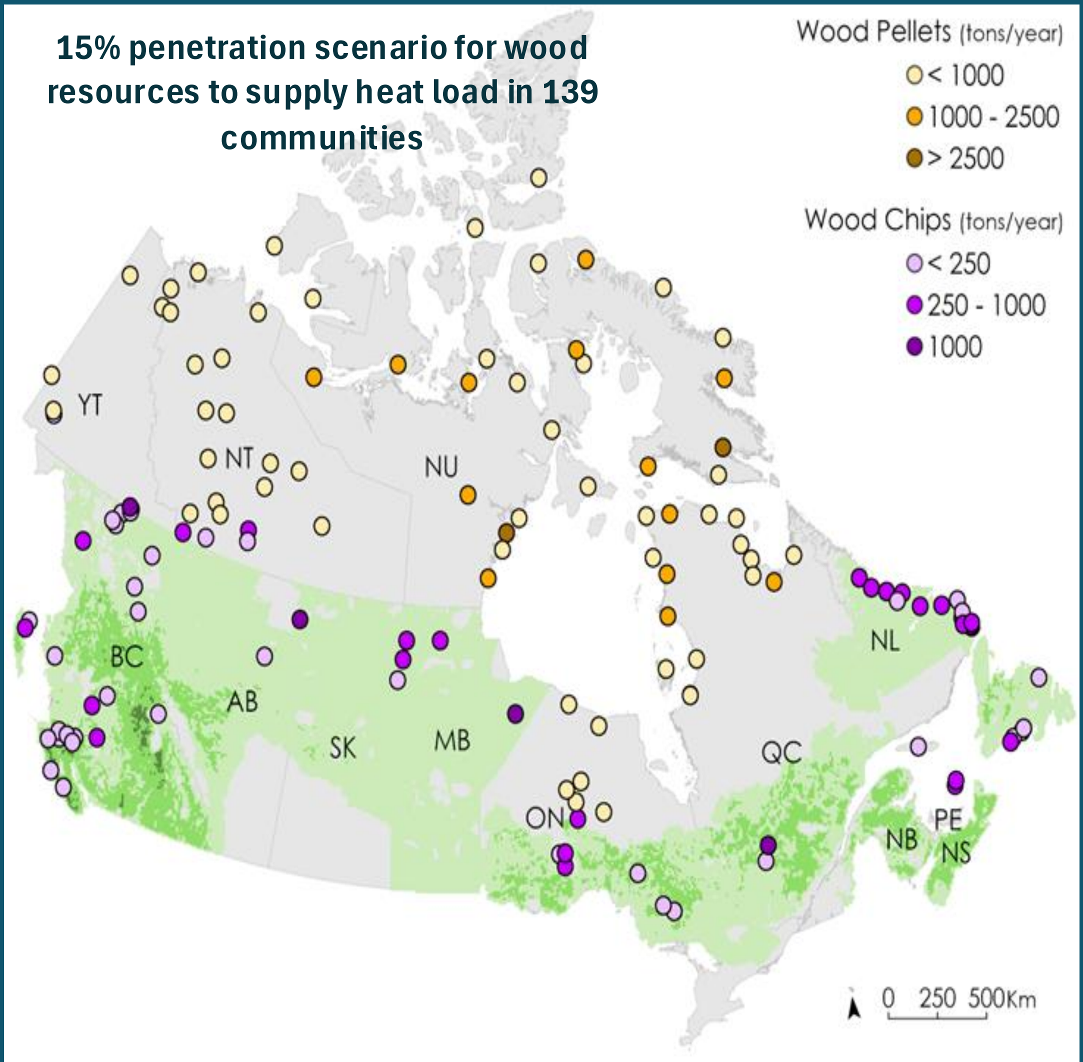
TEA: Techno-Economic Analysis
LCA: Life Cycle Assessment

CEO Northern & Remote Communities Domain

Energy Usage Summary for 139 Communities across Canada

- Annual electricity generation is estimated to be ~753 GWh/yr (215 million litres of diesel oil equivalent)
- Annual heating loads are estimated to be ~1600 GWh/yr (153 million litres of fuel oil equivalent)
- For many of the 139 communities, heating loads are greater than electrical loads (~ 2 times).
    - On average, commercial, industrial and institutional (CII) heat loads are greater than residential heat loads

In the North, heat matters as much as power



Data from annual heating loads map and estimates for 139 communities by CanmetENERGY Ottawa – includes residential and commercial building heating loads

Introduction

Key Themes:

- Overview of CHP technologies
- Emerging trends
- Recent Canadian initiatives
- Considerations – ingredients for successful CHP implementation

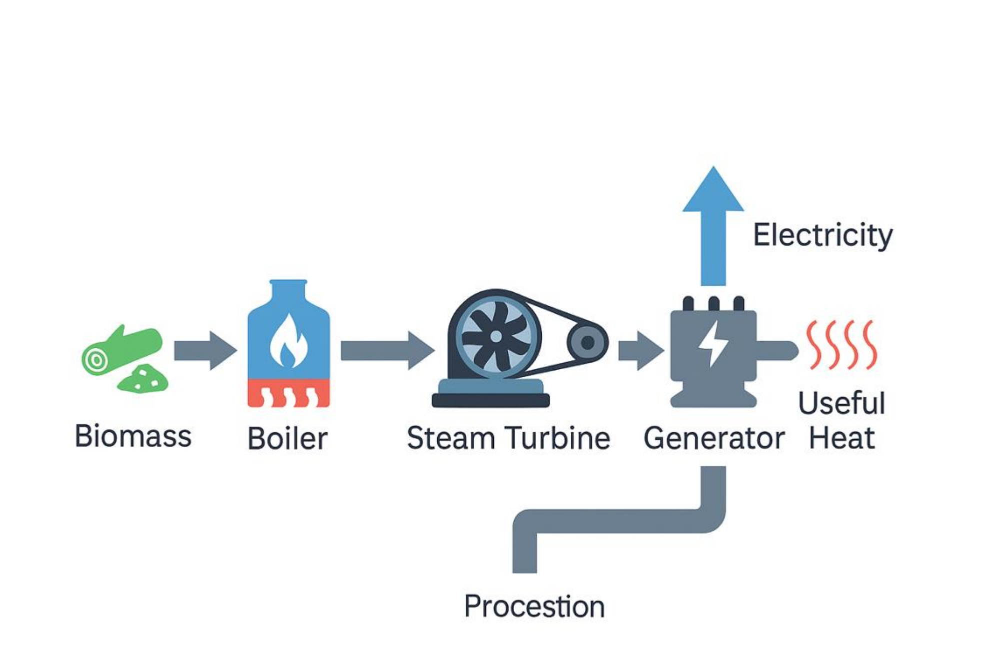
Why Revisit Biomass CHP?

- Recent advances in modular and automated technologies
- Maturing supplier landscape with new performance experiences and Canadian installations
- Growing Indigenous leadership roles in biomass supply chains and project ownership
- Improved remote connectivity and digital monitoring enabling OEM support in the North
- Opportunities to align FireSmart thinning with local energy production using excess woody biomass

Conventional Biomass Combined Heat & Power

Based on Steam Cycle:

- Proven, mature technology
- Widely used in Canadian kraft mills
- Higher efficiency when heat demand is sustained and sizeable
- Economically viable where low-cost biomass is available
- High capital cost and O&M requirements
- Requires 24/7 oversight by certified power engineers



Scope: Small Modular Biomass CHP

System Scale:

less than 5 MWe, typically at smaller for community scale

System Configuration:

delivered as pre-engineered, packaged modules

designed for simplified transportation, installation and on-site integration

Technology Pathways Considered:

combustion based - Organic Rankine Cycle (ORC)

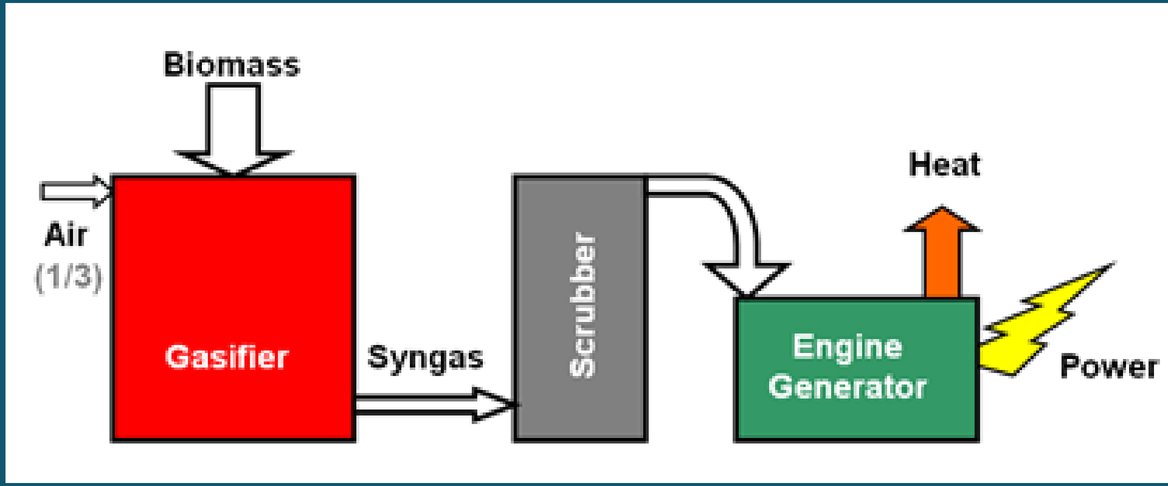
gasification based - Internal Combustion Engine (ICE)

Commercial Operating Experience:

10 + installations worldwide

systems with 3+ years of operational history

Gasification – Internal Combustion Engine CHP



- Fuel type: wood chips and wood pellets
- Wood pellets: Grade A1
- Wood chips: Grade A1
    - Moisture content < 20 % wet basis - most manufacturers require lower MC
    - Ash content <1 % dry basis
    - Particle Size:
        - P31S (60% wood chips 3.15 mm ≤ m < 31.5 mm)
        - Fines ≤ 10 % on mass basis
- Producing low tar syngas is critical
- Typical efficiencies, based on fuel input:
    - Electrical up to 30%
    - Thermal up to 60%

Gasification –ICE CHP

Supplier	Typical Outputs
Spanner Re² - Germany https://re2.energy/	30-70 kWe
Volter Oy & Heizomat– Finland https://volter.fi/en/	50 kWe / 130 kWth
Syncraft Engineering – Austria https://www.syncraft.at/en/frohe-weihnachten/	500 kWe / 740 kWth 1000kWe/1400kWth
GLOCK Ecotech – Austria http://www.glock-ecotech.com/	18 kWe / 44 kWth 50 kWe / 110 kWth

Most of the installations that are in operation in Scandinavia, Central and Eastern Europe, and Japan

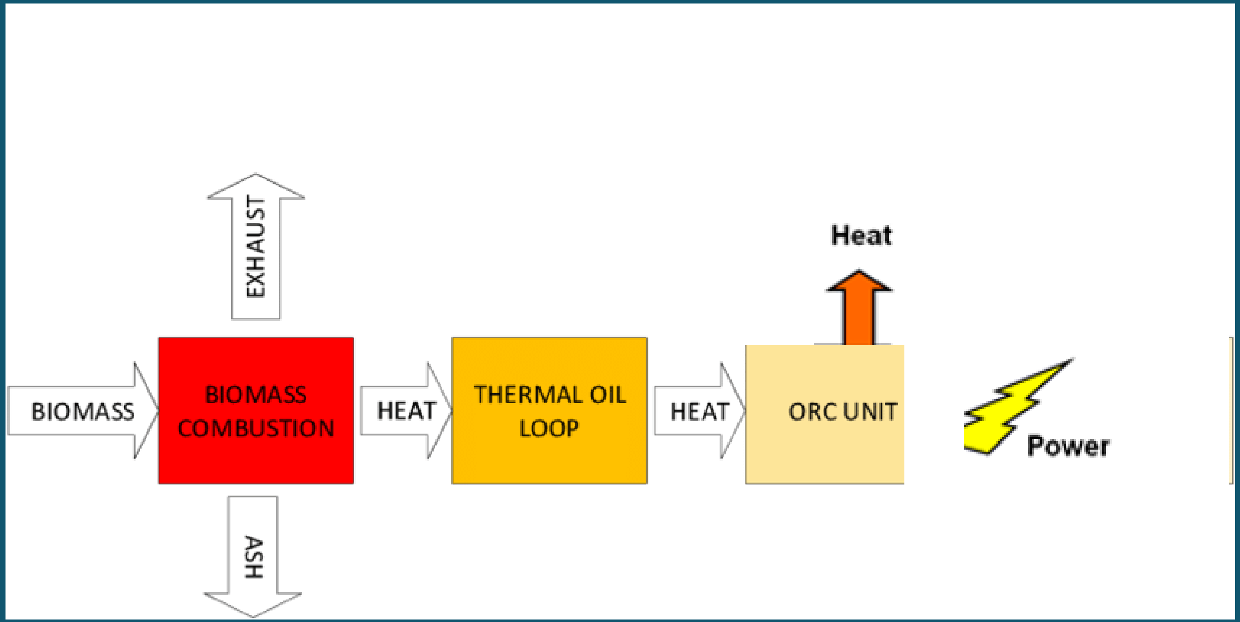
Gasification – Internal Combustion Engine CHP

Glock's Ecotech - Wood chips (18 kWe/ 44 kWth)

Volter - Wood Chips (50 kWe/ 130 kWth)

Spanner Re2 - Wood Pellets (50 kWe/ 100 kWth)

Combustion – Organic Rankine Cycle CHP



- Works like a traditional steam engine but uses an organic fluid with a low boiling point and a higher vapor pressure than water
- Can generate power from low to medium grade heat
- Biomass combustion can be a heat source
- Boiler dictates fuel specs
- Typically requires thermal oil loop
- Heat to power ratio is commonly 5:1, meaning lower electrical efficiencies compared to gasification – ICE

Combustion – Organic Rankine Cycle CHP

Againity AT200 (200-355kWe)

ElectraTherm Power Module75

Turboden

Combustion - ORC CHP

Supplier	Typical Electrical Output
ElectraTherm (BITZER) - USA	Up to 75 kWe
Turboden -Italy	Multiple models ≥200 kWe
Againity AB - Sweden	Multiple models from 50kWe to 900 kWe

Most of the small-scale biomass installations that are in operation are concentrated in Europe (Central, Eastern, southern and Scandinavia)

Emerging Trends and Entrants

Trends:

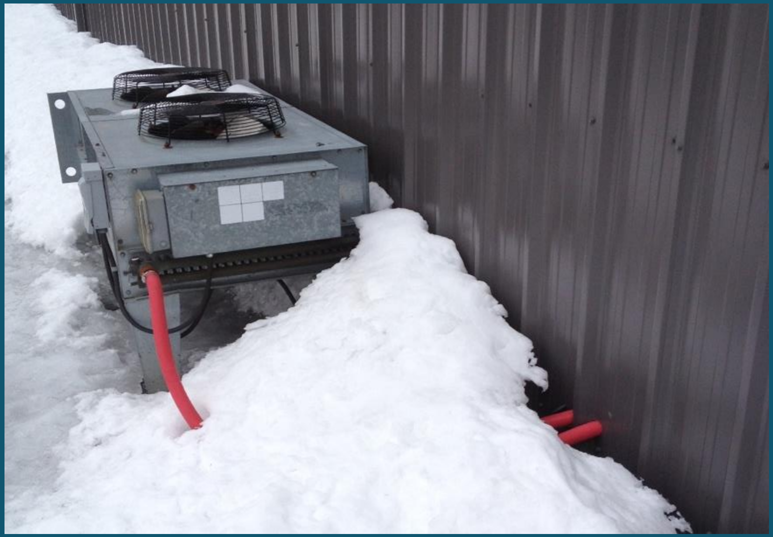
- Operations & Controls
  - Advanced PLC controls
  - Remote diagnostics and predictive maintenance
  - Some companies offer low NOx control (selective non catalytic reduction)
- Heat Integration
  - Integrating drying units - using the waste heat
- Carbon & biochar pathways
  - Emerging biochar production

Entrants to Monitor:

Gasification-ICE : Fröling, Entrenco/WE Bioenergy, Burkhardt (pellet), CMD Energy, ESPE, Reset-Energy, Hargassner

ORC: Zuccato Energia

Testing of Volter CHP System (40 kWe) at CEO



Fuel Supply & Specs

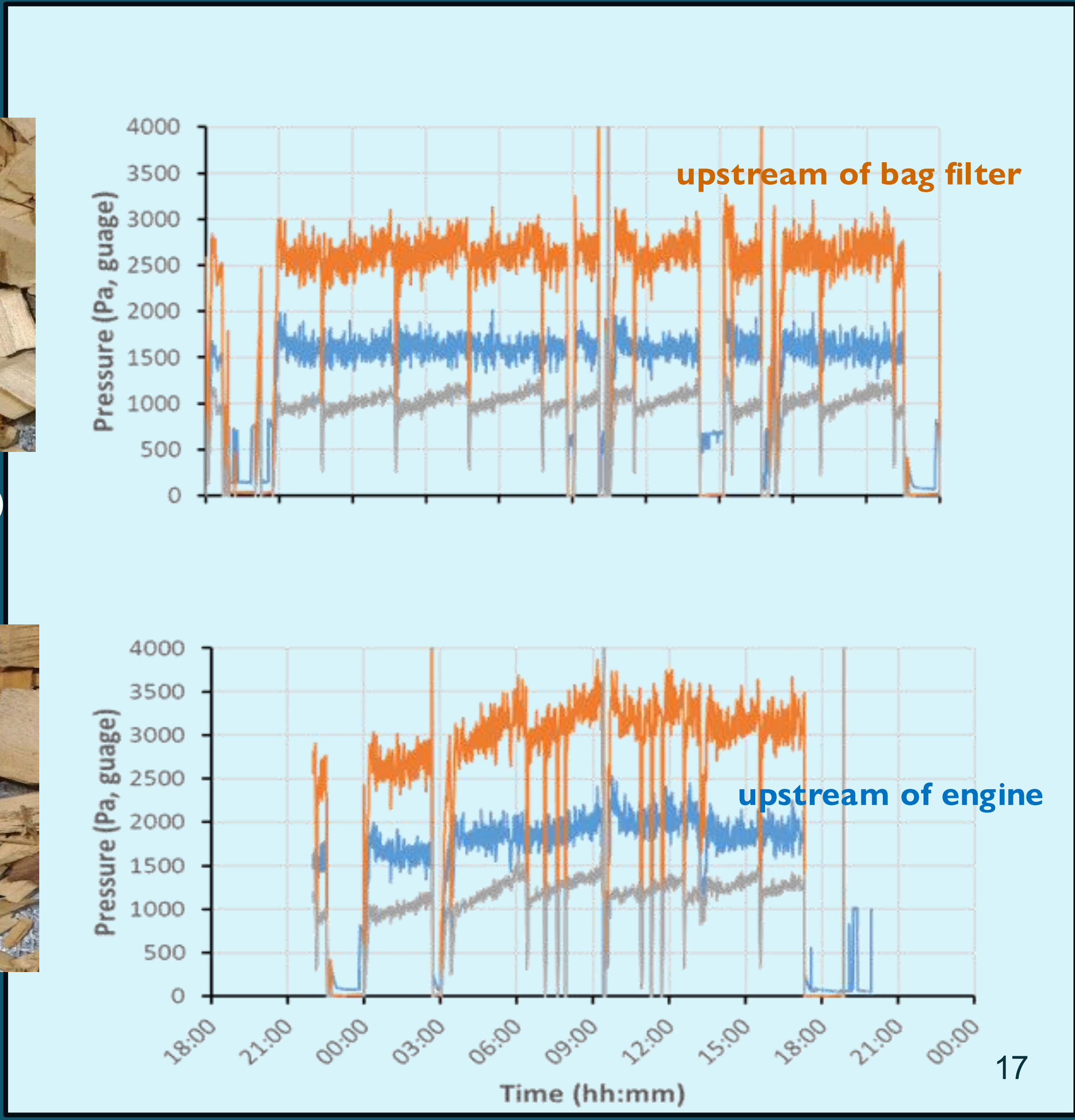
Sourcing fuel meeting particle size and moisture content specification is critical

For the fuel sourced in this testing, HW chips conformed to size spec more so than SW chips

Fuel spec conformance enables operation within expected ranges.

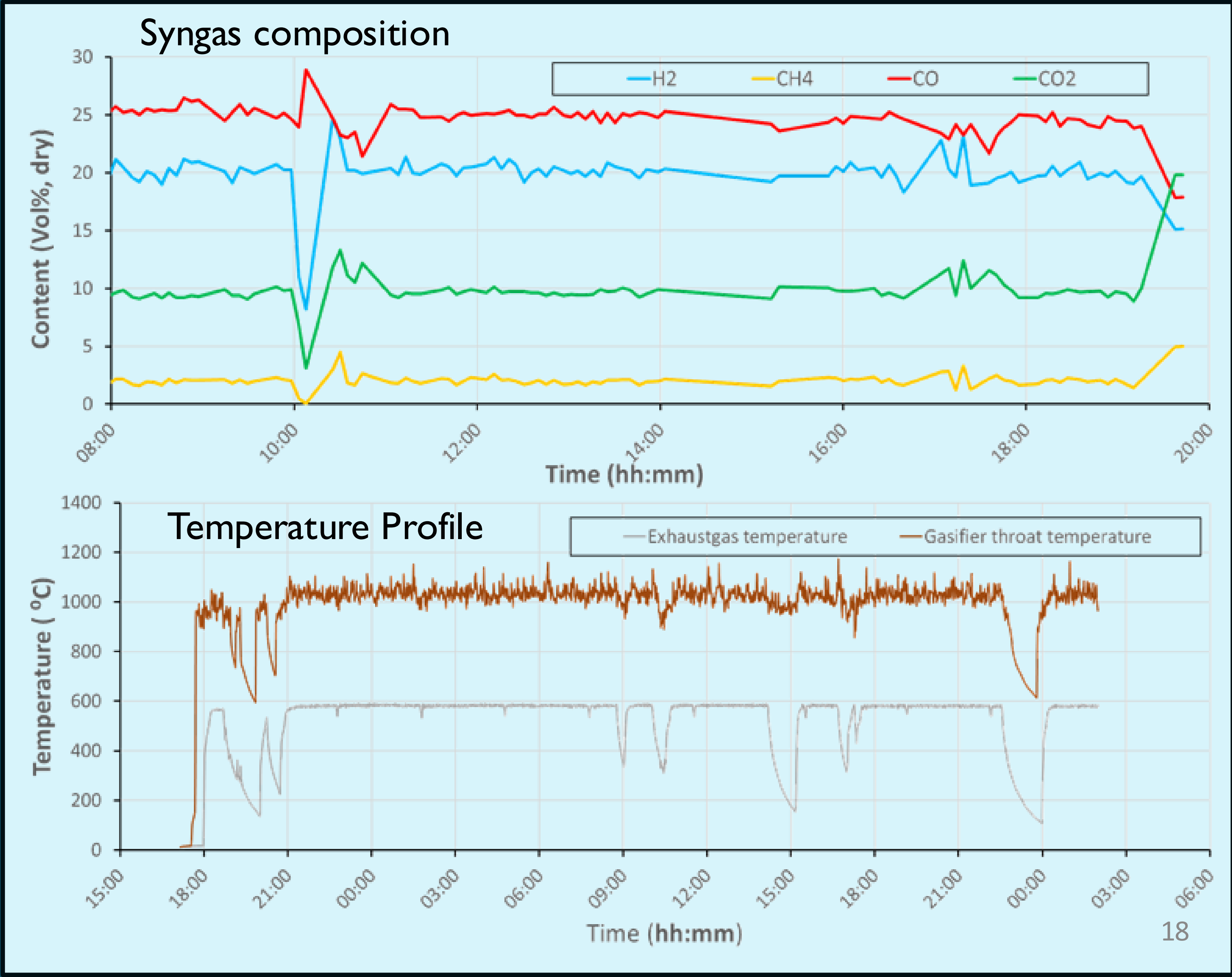
Ontario, Hardwood (HW)

Alberta Softwood (SW)

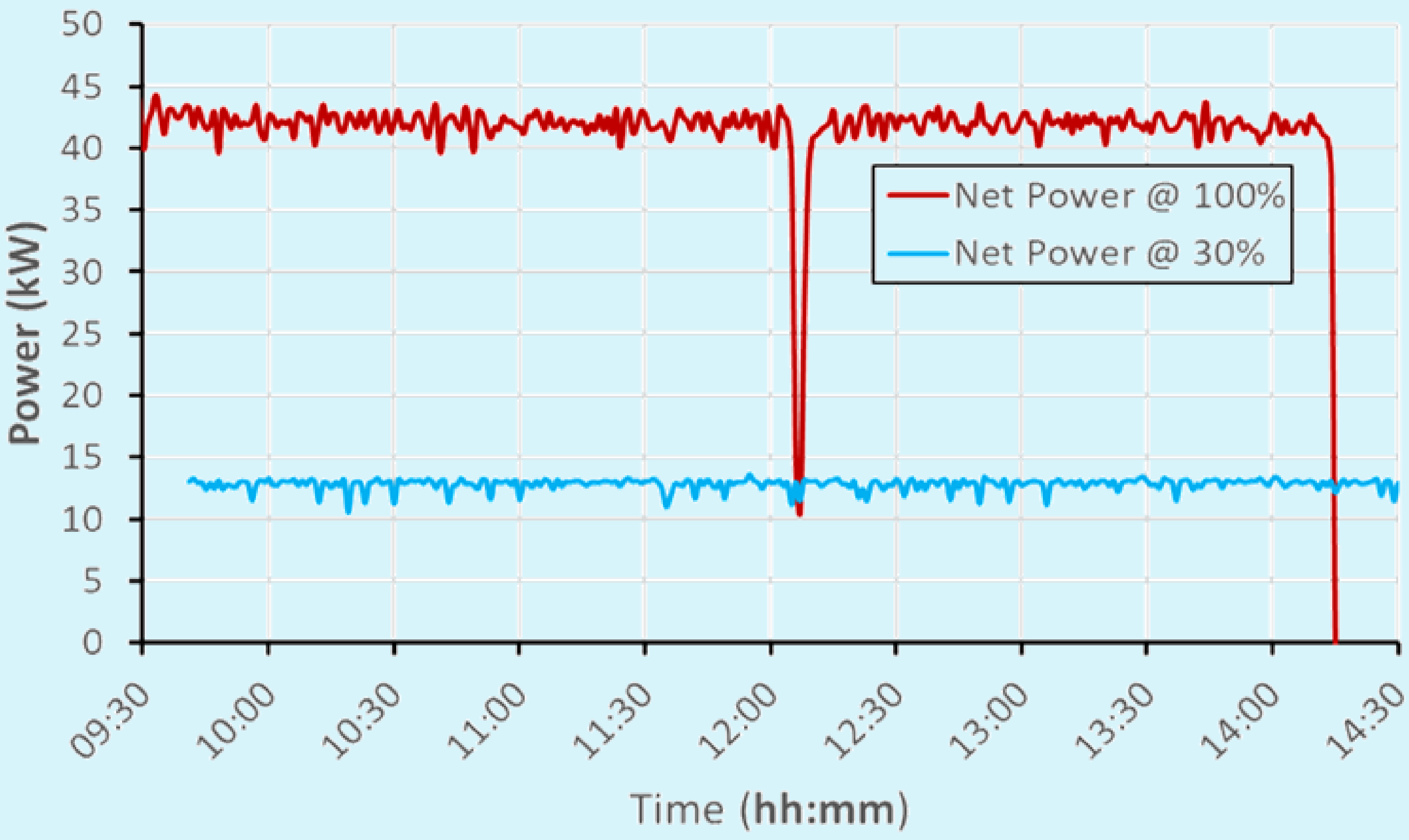


Autonomous Operation & Safety

- 24-hour operation with very minimal intervention
- Major hazards include handling of hazardous gases, explosive gas mixtures, dust explosions and fire.
- Important that engineering designs and procedures reviewed to ensure compliance to relevant codes/standards
    - such as electrical safety, grid connection, pressure vessel, fuel & fire safety etc.

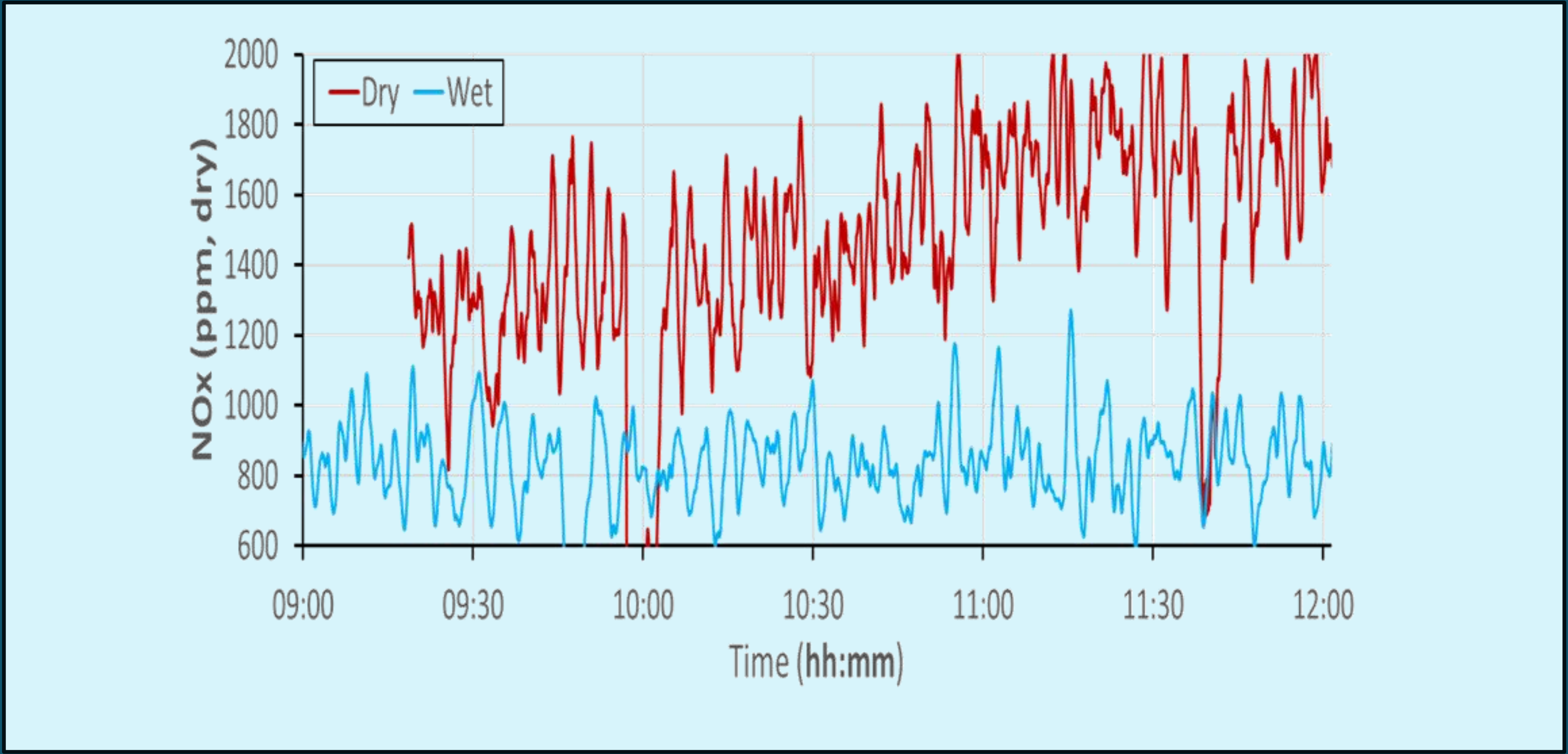


Performance Characteristics



Output (%)	Elect. (kW_{el})	Heat (kW_{th})	Elect. (%)	Heat (%)	Total Eff. (%)
100	41	92	26	57	83
30	12	56	15	66	81

Engine Emission Data



Summary of Key Findings of Testing Volter CHP at CEO

- Conforming to fuel specifications enables operation within expected ranges and allows for essentially autonomous and unmanned operation
- Access to supply of fuel meeting specifications is critical or necessitates independent fuel processing (chipping, sieving and drying)
- Fuel quality impacts emissions performance. Regulatory framework should consider impacts of fuel moisture and N content on NO_x
- Following best practices for installation, design and operation to ensure safe and reliable operation

Are CHP systems suitable for remote installations?

QUALIFIED YES

Key Aspects of Technology and Operation

- Electrical load-following and peaking capability remains limited compared to natural gas or diesel engines
- Most systems require auxiliary power for start up and parasitic loads (e.g., grid or diesel generator)
- Systems typically operate at atmospheric pressure, avoiding regulatory requirements for a power engineer
- Operational complexity remains higher than conventional generators due to fuel quality requirements, multiple subsystems and ongoing maintenance
- Comparable cold-climate installations remain limited, though accumulated operating hours are increasing globally, including in northern countries

Recent Biomass CHP Deployments

1. **Dalhousie University (NS)**
   5.4 MWth Biomass boiler + 1 Mwe Turboden ORC
2. **Meadow Lake Tribal Council (SK)**
   Large Indigenous-owned 6.6–8.4 MWe ORC
3. **UBC Alex Fraser Research Forest (BC)**
   Volter gasifier-ICE (40–50 kWe), commissioning
4. **GLOCK Micro-CHP (QC)**
   18 kWe gasifier-ICE + biochar; commissioning
5. **Opitciwan (QC)**
   4.8 MWe ORC CHP—major Indigenous-led development (2026 target)
6. **Kwadacha FN (BC)**
   Spanner RE2 gasifier –ICE (3X 45 kWe), decommissioned

Dalhousie University biomass CHP plant

The Technologies are Ready!

CHP becomes viable

- when heat loads are high to monetize thermal energy
- biomass is local and available at affordable cost
- supportive financial incentives – such as renewable incentives, power purchase agreements, heat sale agreements, feed in tariffs

Experience is building up in Canada – UBC, Meadow Lake, Dalhousie University

What Determines CHP Success in Northern Communities

Establish experience with wood fuel supply infrastructure

- fuel quality management is critical

Build and maintain local skills

- from project planning, to financing to operating

Establish grid connection strategies early on

- integrate with diesel / boiler back up for resilience
- engage power utilities early on

Sizing of the facility appropriately scaled to the energy needs of the community

Implement monitoring / performance protocols

Key Factors for Success

Success depends on fuel readiness, training, strong O&M support, Indigenous leadership, and a phased, evidence-based deployment strategy.

NRCan–CEO stands ready to support northern partners in delivering Canada’s first wave of modern biomass CHP demonstrations – through data-based evidence, derisking technology, demonstrations.

Acknowledgement

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CEO Team - Leslie Nguyen, Dr. Fernando Preto, Todd McDonald, Dillon Mazerolle, Kyle Sturgess-Smart, David Shawn, Frank Leclair.

THANK YOU

For more information, visit CanmetENERGY website:

Bioenergy - https://natural-resources.canada.ca/science-data/science-research/research-centres/bioenergy

Northern, Indigenous, Rural and Remote Communities - https://natural-resources.canada.ca/science-data/science-research/research-centres/northern-indigenous-rural-remote-communities

Canada

Supporting Slides

Dalhousie University Biomass CHP

5.4 MWth Biomass boiler (thermal oil): 1.0 MWe of electricity (gross) and 4.4 MWt of hot water

Power is exported to the local electrical grid year-round; hot water (85 deg C) for space heating and domestic hot water.

Sustainable biomass, 20,000 tonnes/year, mostly sawmill residue and yard residues (85%),

In operation since 2020.

Receives Community Feed-In Tariff at a rate of 175 per MWh

Photo credit: University of Dalhousie

Meadow Land Tribal Bioenergy Centre (MLTC)

- 100% Indigenous-owned; located near Meadow Lake, Saskatchewan
- Grate combustion + thermal oil system + ORC (8.3 MWe)
  - 6.6 MWe exported via PPA with SaskPower;
  - 5 MWth heat to a nearby sawmill & dry kilns
- Fuel: ~56,000 t/yr bark, sawdust, planer shavings
- In operation since October 2022
- Strong integration of forest management, harvesting, sawmill & energy operations reducing fuel risk and supports long-term reliability
- Fuel quality management is the single most important determinant of system performance and availability
  - Seasonal fuel moisture variability and frozen fuel is a challenge

Photo credit: MLTC

Kwadacha FN CHP

- CHP energy center:

  3 x 45 kW_{el} gasification CHP units,
  Integrated shed, fuel dryer and an energy distribution center

  supplied heat to school, greenhouse and wood chip drying operation

- Operating period: 2017 to 2021

- Key barriers to long-term viability
  - Operating costs exceeded expectations
  - Maintenance demands
  - Limited availability of trained operators constrained sustained operation

Photo credit: Kwadacha FN