Biomass for Residential and Commercial Heating in Off-Grid Communities

*A Case Study of Bella Coola, British Columbia*

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Overview

• **Background** – Remote Communities & Bella Coola

• Heating Oil, Propane, Firewood, and Electric **Alternatives**

• **District** Energy vs. **Decentralized** Boilers

• Heat **Economics and Risks**

• **Co-generation** of Electricity

• Integration with **Wood Products** in a cluster approach

• **Conclusion**
Remote Communities in Canada

- Not connected to North American electrical grid
  - 200 communities
  - Population of ~200,000
  - Range from 10 to ~25,000 people
  - Energy cost up to 10x average in Canada
  - Many First Nations (aboriginal) communities
  - A large number in NT, YK, QC, ON, and BC

- Micro-grid generation
  - Diesel dominates
  - Small hydro common
  - Several have integrated wind and/or solar

- Firewood heating common

- Remote location impacts cost of heating alternatives
Background

Bella Coola, BC

- Bella Coola Valley
  - Village and Four Mile; Hagensborg
  - Traditional territory of the Nuxalk Nation
  - Connected to Williams Lake by gravel road
  - Docking facilities
  - 1900 people in the valley; 850 on-reserve
  - Reserve average income <40% BC average
  - Reserve estimates of unemployed: 70-80%

- Research support: Nuxalk Development Corp. & MITACS
  - UBC lead academic institution
  - Bioheat one of nine projects on economic opportunities from the forest
  - Projects on biopower, briquetting, CNC products
  - Support tenure of 20,000 m³/yr, harvest of 12,500 m³/yr, and milling of 4,000 m³/yr
### Bioheat in Remote Communities

#### Nuxalk Reserve, BC

<table>
<thead>
<tr>
<th></th>
<th>Heating Oil</th>
<th>Propane</th>
<th>Electricity</th>
<th>Firewood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>435,000 L</td>
<td>110,000 L</td>
<td>4,484,000 kWh</td>
<td>900 cords</td>
</tr>
<tr>
<td>Cost of Heat ($/MWh)</td>
<td>163</td>
<td>141</td>
<td>130 (410*)</td>
<td>46</td>
</tr>
</tbody>
</table>

- 275 residences, 30 commercial buildings
  - Most residences use firewood, back-up heating oil, and electric hot water
  - Commercial buildings usually propane
  - Electricity cost subsidized by BC Hydro
  - Band office and school use ground-source heat pump and hydronic heating systems

- Yearly consumption of ~12,000 MWh (41,000 MMBTU)
  - Average cost of heat = $100 MWh ($29/MMBTU)
**DES vs. Decentralized**

*Local and Imported Fuel*

### District Energy System
- Surveyed community and used GIS analysis
- Four different layouts; energy centre in 4 Mile (flood)
- Heat load dictates pipe diameter
- Space and hot water heating
- Assumed harvest residue feedstock, covered storage
- RetScreen used for costing and climate

### Decentralized Boilers
- Boilers scaled, including buffer, for each building
- Bulk purchase of Fröling boilers (Evergreen pricing)
- Pellet fuel assumed – trucked from Williams Lake
- Space and hot water heating
- Retain forced-air systems (heating coil)
District Energy System
Bioheat in Remote Communities

Overview
Background
Alternatives
**DES/Decentralized**
Economics & Risks
Co-generation
Wood Products
Conclusion
Bella Coola Village
Economics & Risks

Summary Results

District Energy System

- Four scenarios
- 2.1-5.2 MW capacity (relatively flat load curve)
- $7.8-18.2 M
- Smallest and largest most economical
- $128-154/MWh ($38-45/MMBTU)
- Control of fuel supply

Decentralized Boilers

- Three scenarios
- $2.8-7.2 M
- $110-127/MWh ($32-37/MMBTU)
- Still dependent upon fuel imports
Economics & Risks

Policy and Community Considerations

- **Electricity is subsidized**
  - Pay $0.13-0.17/kWh; diesel cost = $0.41/kWh
  - BC Hydro has incentive to reduce electrical space and hot water heating

- **Low cost firewood**
  - Pellet boilers/DES higher cost
  - Isolated community, little travel
  - Stay at home
  - Firewood boilers may be best option

- **No sewage system**
  - DES installation more economically competitive if installed at same time
  - Flooding in Bella Coola – septic problems
Co-generation

• Sister study compared ORC & gasification/ICE
  - 300 kW ORC could fit load profile of community
  - Need heat revenue (DES) – match e-/heat load
  - Competitive with BAU (assuming no subsidy)

• TorchLight and QIEEP completed study on small-scale (<3 MWe) biomass CHP technologies for NRCan
  - 40 companies/technologies assessed
Wood Products Cluster

Examining the Role of Bioheat

- Integration of bioheat with other forest products
  - Community-scale sawmill
  - CHP, briquettes, pellets
  - Solid wood products – digital technologies, CNC
Conclusion

• High cost of energy in remote communities
• BAU fuel will impact viability of DES and pellets
• Heat load density critical for DES
• Co-generation can be possible at small-scale if displacing diesel/heating oil and regulations are supportive
• Bulk purchase of boilers can improve economics
• Integration with solid wood products cluster
• Solid wood products create jobs and increases income, bioheat reduces operating costs
• Community priorities determine best option
Thank you!

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