OPG Biomass Experience

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Canadian Wood Pellet Industry Seminar

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ONTARIO POWER GENERATION

Overview

- OPG Profile

- Initial Biomass Test Burns
- Atikokan GS Conversion
- Advanced Biomass Fuels Evaluation
- Thunder Bay GS Conversion

- Current Advanced Fuels Evaluation

ONTARIO POWER GENERATION

Ontario Power Generation

Owned by the Province of Ontario.

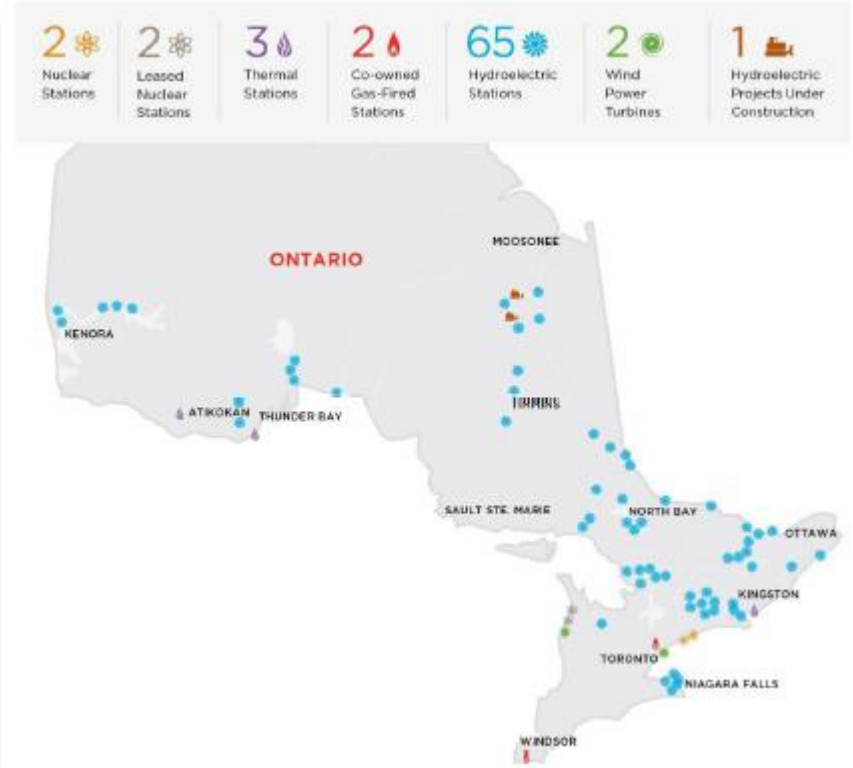
16,000+ MW of generating capacity.

Supplies >50% of Ontario demand.

9800 employees.

Over $37 billion in assets.

2013 Revenue: $4.863 billion.



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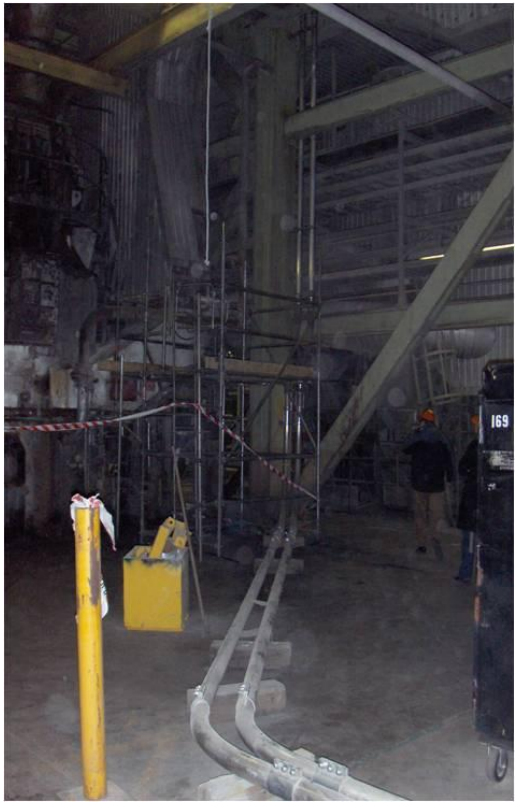
Initial Biomass Test Burns

- Biomass testing at all Thermal sites commencing in 2006
- Direct Injection and Dedicated Milling
- Wheat shorts and white wood pellets



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Atikokan GS

- 1 x 205 MWe
- Designed for Western Canadian lignite.
- Opposed wall fired
- 5 MPS 75G mills.
- July 24, 2014: commercial operation date on 100% biomass.

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Atikokan GS Biomass Conversion

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Thunder Bay GS

- 2 x 160 MWe
- Designed for Western Canadian lignite.
- Converted to NPRB coal in 1996.
- 4 corner, tangentially fired.
- 5 RP 783 mills.
- April 2014: final generation of coal-fired electricity in Ontario.

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Coal to Biomass Conversion

- Repowering PC-fired boilers with white wood pellets
  - Receiving and storage
  - Material handling
  - Mills
  - Firing system
  - BOP

Advanced wood pellets must possess specific characteristics similar to coal to enable a low capital cost option.

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Advanced Fuel Evaluation

Internal program to evaluate upgraded biomass pellets since 2010.

Information exchange with utility peers with refined pellet experience.

Round robin bench scale testing of all major beneficiated pellet types.

Selected steam treated wood pellets based on safety and milling characteristics.

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Project Summary

The conversion of Thunder Bay Unit 3 from coal to 100% advanced wood pellet firing is the first such project worldwide.

All plant systems – from the fuel yard to the stack – were evaluated and process/equipment modifications were made where necessary to improve safety and performance.

The modified unit is capable of firing 100% biomass through the normal operating range (40-160 MWe).

The total project duration was ~7 months, including a construction outage of <3 months.

The capital cost of the project was approximately $3M CDN or 1700 JPY/kW.

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Key Points

- **Complete conversion of a PC utility unit to 100% advanced wood pellet fuel has been proven at scale.**

- **Leveraging the excellent handling properties of the selected pellets has enabled a low capital cost solution for a total coal-biomass conversion.**

- **Cooperation between suppliers, researchers and utilities is encouraged to further develop this new opportunity for our industry.**

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Advanced Fuels Ranking Program

"OPG will be a leading participant in a collaborative project with Natural Resources Canada (NRCan) that will aim to evaluate advanced biomass fuels for use in power generation and other industrial sectors. "

- Program kickoff in March 2017
- 17 Responses to date:
  - Canada, USA, Netherlands, Belgium, Sweden, Norway, Spain
- 12 samples received
- Woody and agricultural feedstocks
- Various processing techniques and conditions

Natural Resources Canada | Ressources naturelles Canada

CanmetENERGY

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Scope of Advanced Fuels Evaluation

- Fuel Selection
  - weatherability
  - material handling safety
  - milling and combustion
- Safety
  - explosion and fire risks
  - dust generation during handling
  - dust control via suppressants
  - electrostatic ignition
  - coal handling system modifications
- Mill Performance
  - pilot scale mill testing to identify performance limitations
  - evaluation of operational and physical modifications
- Full Scale Observations
  - outdoor storage
  - handling observations
  - airborne dust measurements
  - effectiveness of wetting agents and dust collection systems
  - Pulverizer performance including start-up / shutdown, load-fineness-power relationship
  - mill drying analysis
  - unit start on biomass
  - burner stability and combustion performance
  - boiler thermal performance including steam temperatures and back end observations
  - emissions

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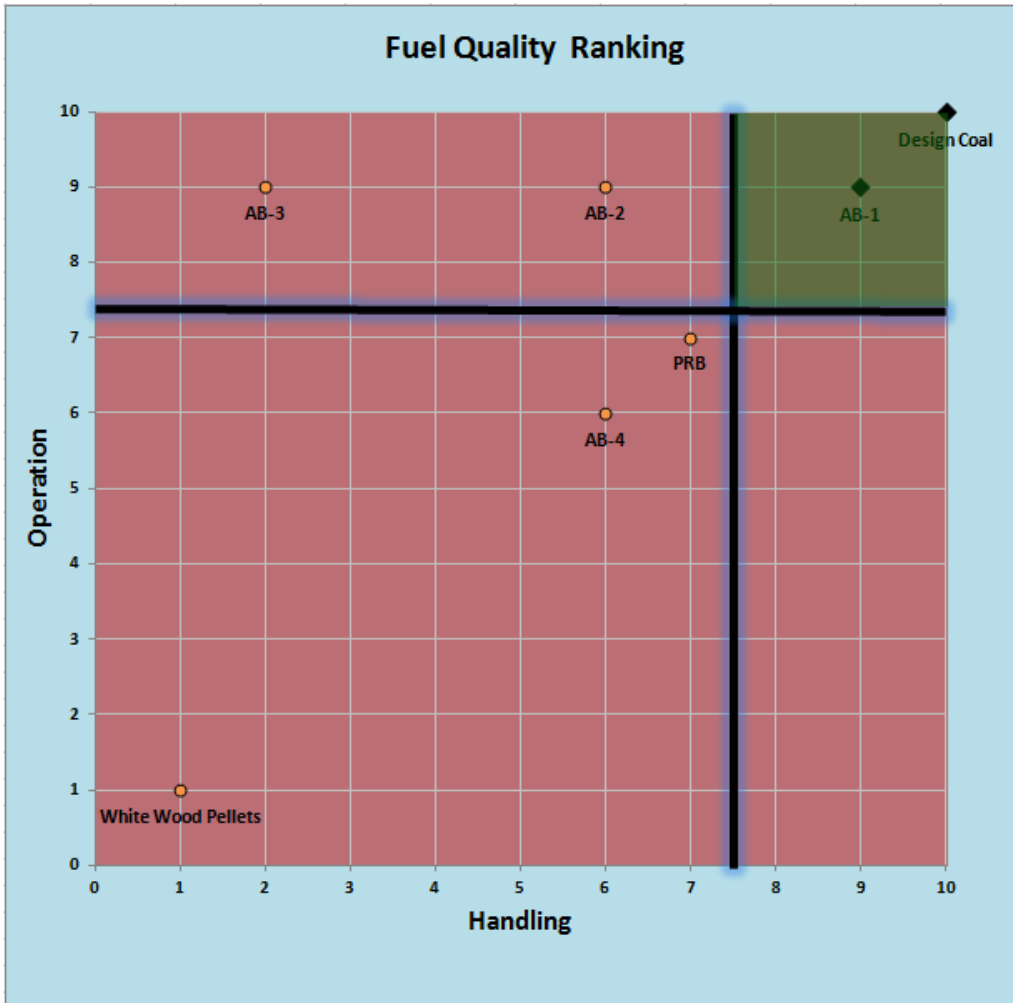
Fuels Evaluation Matrix

The key for each utility considering conversion is to match the fuel quality and price to their specific situation and level of capital investment.

Our goal is to help the information exchange to accelerate adoption of this energy option



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Pellet Weatherability

- Long term storage pile established in September 2013
  - Monitoring of actual impact of winter on pellet integrity
- Durability results

September 2013	**99.3**
October 2013	98.2
November 2013	98.0
December 2013	98.4
January 2014	98.2
February 2014	98.8

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Full Scale Results – Fuel Handling

- Visible dust only during loading of reclaim hopper
- Clean conditions downstream
- Personal breathing zone particulate measurements below OEL
- Airborne dust monitoring also well below OEL
- **Dust levels for Arbaflame pellets lower than for coal**

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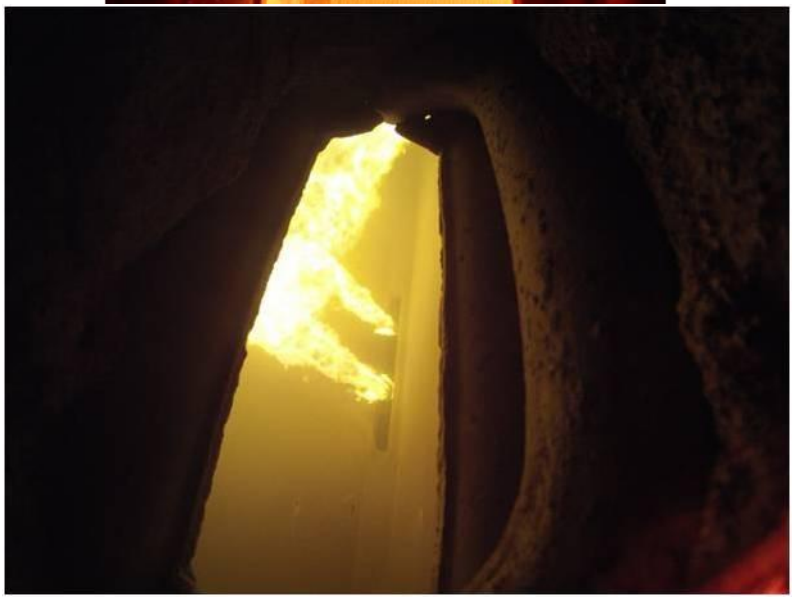
Full Scale Results – Combustion

- Operation up to original unit MCR on 100% Arbaflame pellets
- Stable 100% wood fires
- No significant fuel drop out or burning carryover
- LOI generally well less than 5%
- Testing included start up on wood
- Steam temperatures similar to coal performance
- CO concentration ~ 20 ppmv
- NOx emissions 45% lower than sub-bituminous coal



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Thank You

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