BIOENERGY IN ELECTRICITY GENERATION

Capital Power Perspectives & Initiatives

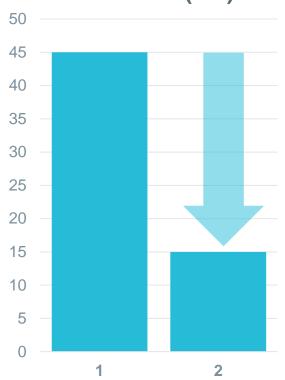


THE CHALLENGE: Transitioning Away From Coal

Canada is working to significantly reduce coal emissions by 2030:

- Under the Climate Leadership Plan, Alberta will completely phase out coal emissions by 2030, affecting 2,500 MW of coal-fired generation that would have otherwise operated after 2030
- All other provinces will be required to reduce emissions from coal to a standard of 0.42 tonnes/MWh CO₂e by 2030 (a reduction of more than half from current emissions)
- All fossil fuel electricity generators are subject to a carbon price targeted to be \$50/tonne by 2022 for emissions above a performance threshold

Alberta Electricity Sector GHG Emissions (MT)



THE CHALLENGE:

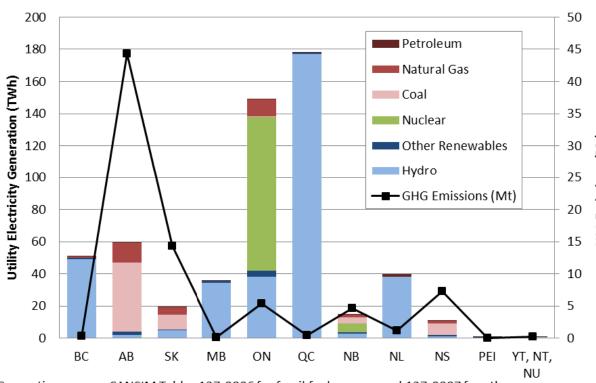
Transitioning Away From Coal

Provinces with Coal Generation

- Alberta
- Saskatchewan
- New Brunswick
- Nova Scotia

Emissions from coalfired electricity account for 8% of Canada's GHG emissions.

Provincial GHG Emissions and Electricity Generation by Energy Source (2014)

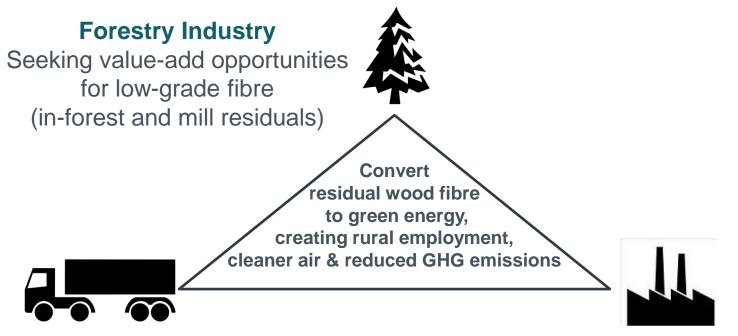


Generation source: CANSIM Tables 127-0006 for fossil fuel sources and 127-0007 for other sources. Emissions source: National Inventory Report 1990-2014.

A strategy to utilize bioenergy in place of coal at existing electrical generation facilities represents a significant opportunity to lower GHG emissions.

Defining the Opportunity

Woody biomass residuals from existing forestry operations are a significant potential renewable energy resource that can enable transformation of the electricity generation sector, while helping to sustain a strong forestry sector



Rural & Indigenous Communities

Seeking value-added industries that create local jobs

Coal-Fired Electricity Generators

Seeking pre-2030 emission reductions and medium to long-term fuel conversion opportunities

Why Bioenergy?

Compared to Natural Gas Conversions or Carbon Capture and Storage:

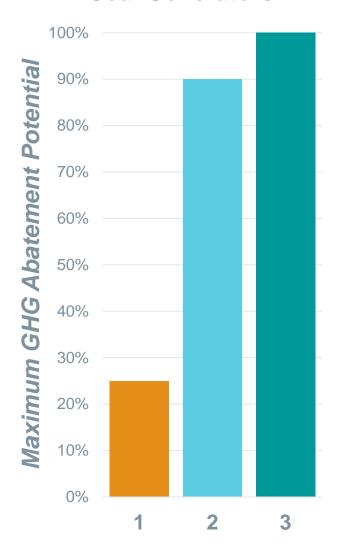
CO₂ abatement potential for replaced portion of fuel in an existing boiler:

- 100% abatement using biofuel
- ~25% abatement using gas

Compared to New Nuclear or Hydro:

- Deployable within short to medium time frames (2-5 years instead of 15-20 years)
- No requirement for new generation or transmission facilities; therefore no new impacts to traditional land uses and no need for new host communities
- Significant ongoing rural and Indigenous employment opportunities for biofuel processing and logistics

GHG Abatement Options for Existing Coal Generators



Environmental Benefits of Utilizing Residual Wood Fibre In Place of Coal

Reduction in Emissions from Electricity Generation

•Every dry tonne of wood fibre replacing coal eliminates \sim 2 tonnes of CO_2 , and reduces SO_x and mercury emissions

Reduction in Methane Emissions from Stockpiling

•Every tonne of residual mill fibre reduces methane emissions by 0.5 tonnes CO₂e



Reduction in Black Carbon Emissions from Slash Piles

•Significant reduction in black carbon emissions, a priority identified in *Canada's Mid-Century Long-Term Greenhouse Gas Development Strategy*

Reduction in Particulate Emissions from Slash Piles

•Significant reduction in particulate emissions from slash pile burning, resulting in health benefits



Leveraging Canadian BioCleantech



Ontario Power Generation

- Atikokan and Thunder Bay 100% Biomass Conversions
- Advanced Fuel Analysis & Testing Program



Capital Power

- Genesee Generating Station 2016-2017 Biomass Test Program
- · Alberta-wide Woody Biomass Feedstock Inventory Development
- Active development of a 15% co-firing project using forestry mill residual fibre

Canadian Advanced Biofuel Technology Developers:











Next Step: Make Effective use of Readily

Available Residual Fibre

Starting with 15% Co-firing At Genesee Generating Station Unit 1

- There is a unique opportunity to make use of residual mill fibre, currently being stockpiled at certain facilities
- This fuel represents the lowest cost fibre available because it is already concentrated in central locations and on major highways
- By utilizing this material, methane emissions are avoided and materials that would otherwise be wasted can be used to displace coal-fired emissions
- Processing and co-firing these materials at Genesee represents the lowest cost solution for many forestry mills
- Subject to receiving policy support, the project could be up and running by early 2019







Potential Canadian Pathway for Renewable Bioenergy Electricity Development

Starting with Co-firing to Enable Transformational Technologies by 2030



years

2-10

years

 Using Direct Combustion technology, co-fire up to 15-30% of wood mill residuals in one or more select facilities.

• Enabling Action:

- Government support to close cost gap for transportation of residual fibre potentially through support of Rural and Indigenous transportation initiatives
- Expanded use of biofuel within certain existing coal generation facilities, using commercial
 wood pellet technology and/or advanced solid biofuels, leveraging Canadian BioCleantech
 to further optimize the biomass supply chain. Implement new potential bioenergy streams
 such as bioenergy recovered from municipal refuse, and begin use of renewable natural
 gas (RNG) technologies, where economically viable.

Extended Biofuel Use

• Enabling Actions:

- Government support for Rural and Indigenous biofuel processing & transportation initiatives
- Government support of BioCleantech firms developing advanced biofuels & RNG
- Stable and predictable carbon pricing regime and/or strategic publicly funded capital transition investments at generation facilities

Where technically and economically feasible, expand biomass use at coal generators, using BioCleantech maximizing the use of bioenergy from forestry and all other viable sources, including municipal refuse and agriculture. Renewable Natural Gas is fully commercialized and deployed for use in existing and new gas-fired generation facilities.

Large Scale Biofuel Use

• Enabling Action:

- Continued government support of BioCleantech firms developing Renewable Natural Gas
- Stable and predictable carbon pricing regime

