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measuring environmental values

Sustainability Analysis of Electricity Generation from Renewable Biomass

Mike Kennedy, CEO and President
Green Analytics

Green Analytics

- Who We Are
  - Green Analytics is an independent consulting firm focused on research, socio-economic analysis, and complex and systems modelling to support public and private decision-making that protects the environment and provides economic returns.
    - Our clients include:
      - Government, industrial, non-profit and charitable institutions who choose to seek progressive solutions towards advancing the green economy.

Recognition

- I want to recognize key contributors:
  - Dave Lovekin: Project Manager
  - Rich Wong: Lifecycle Analysis Lead
  - Andrew Vandenbroek: Forest Carbon Analysis Lead
  - Marlo Reynolds: Project Advisor
  - Rob Lyng: Client
  - Tammy Wong: Client
  - Technical Advisory Members
  - Staff of Ontario Ministry of Natural Resources

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Green Analytics

Strengths
and Expertise:

- Strategy development
- Business development
- Corporate leadership

Mike Kennedy
President/CEO

Strengths
and Expertise:

- Non-market valuation
- Cost-benefit analysis
- Analytics
- Technical communications

Jeff Wilson
Vice President – Analytics

Strengths
and Expertise:

- Project management
- Quality control
- Policy analysis

Amy Taylor
Vice President – Research

Strengths
and Expertise:

- Policy analysis
- Communicating economic ideas
- Systems model development
- Systems modelling

Eric Miller
Senior Resource Economist

Strengths
and Expertise:

- Economic impact assessment
- Econometric
- Academic publishing

Mike Patriquin
Senior Resource Economist

Strengths
and Expertise:

- Research
- Project management
- Communications

Amanda Young
Resource Analyst

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Project Objective and Outcome

To conduct a sustainability analysis of using renewable sources of biomass for electricity generation in four existing coal-fired generating stations in Ontario.*

*The outcome of the project will provide further direction to OPG on whether utilizing biomass in their generating stations using crown-land biomass can be done so in a sustainable way.

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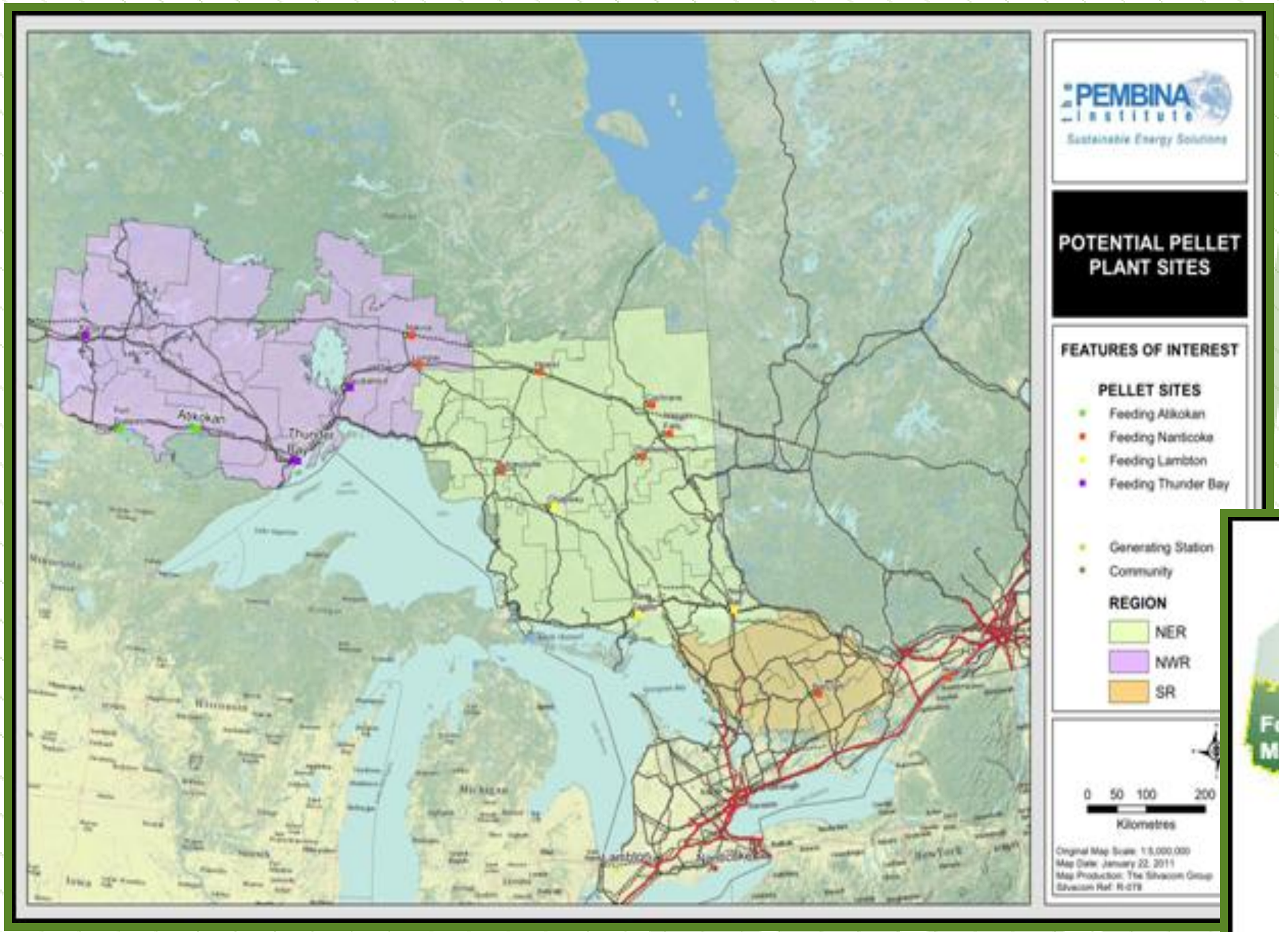
Project Scope: Ontario's Forest Management Units



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Parameters of the Sustainability Analysis

- Forest carbon stocks, flux over time (100 years)
- Lifecycle GHG emissions from the biomass pathway
- Inventory of forest biomass resource
- Comparison with natural gas pathway
- Social well-being impact assessment (not presented today)

Sources: Peer-reviewed, post 1999 data and publications

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OPG's Four Scenarios

Scenario Definitions:

- **NH (No harvest)**: no harvesting takes place in the forest
- **BAU (Business-as-usual)**: Harvesting takes place at a rate that is equal to a chosen historical rate.
  - 15 M m3 for 2015 to 2020
  - 20 M m3 for 2020 to 2115
- **CO-FIRE *(BAU + 2M ODT)***:
  - 15 M m3/period for 2015 to 2020
  - 20 M m3/period for 2020 to 2115
  - Harvest forest residues as priority
- **MAX CO-FIRE (MSH):**
  - Maximize the sustainable harvest level
  - 21 Mm3/period for the entire planning horizon

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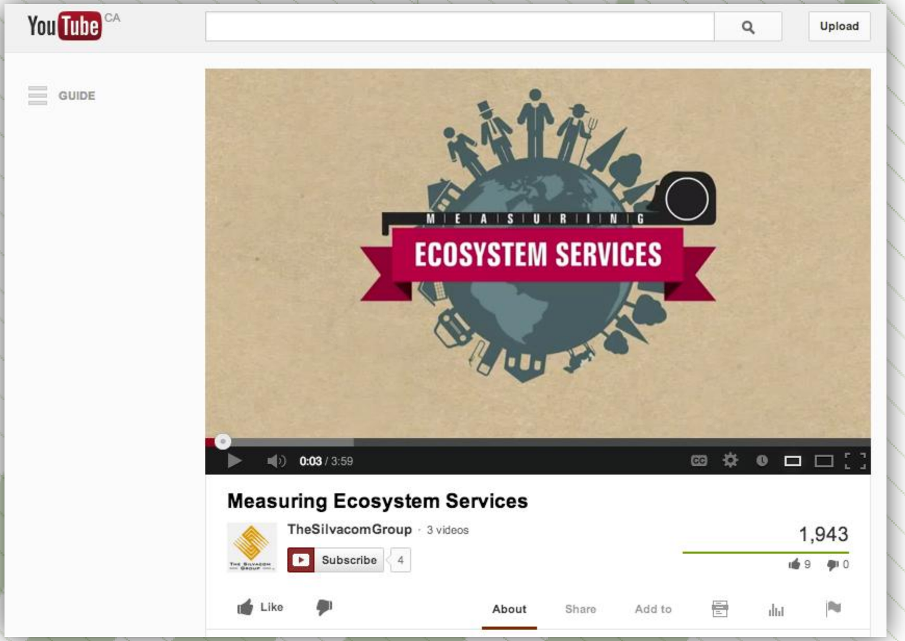
Caveat

- Ecosystem service impacts were out of scope for this analysis.
- We don't know what the implications of the scenarios presented might mean for fauna, flora and fin.
- This work is advancing quickly…



http://www.youtube.com/watch?v=-Jw9dPYVT_Y

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General Project Approach

- Develop a modelling framework
- Gather input from Technical Advisory Committee
- Define modelling scenarios
- Define modelling assumptions
- Present and discuss results

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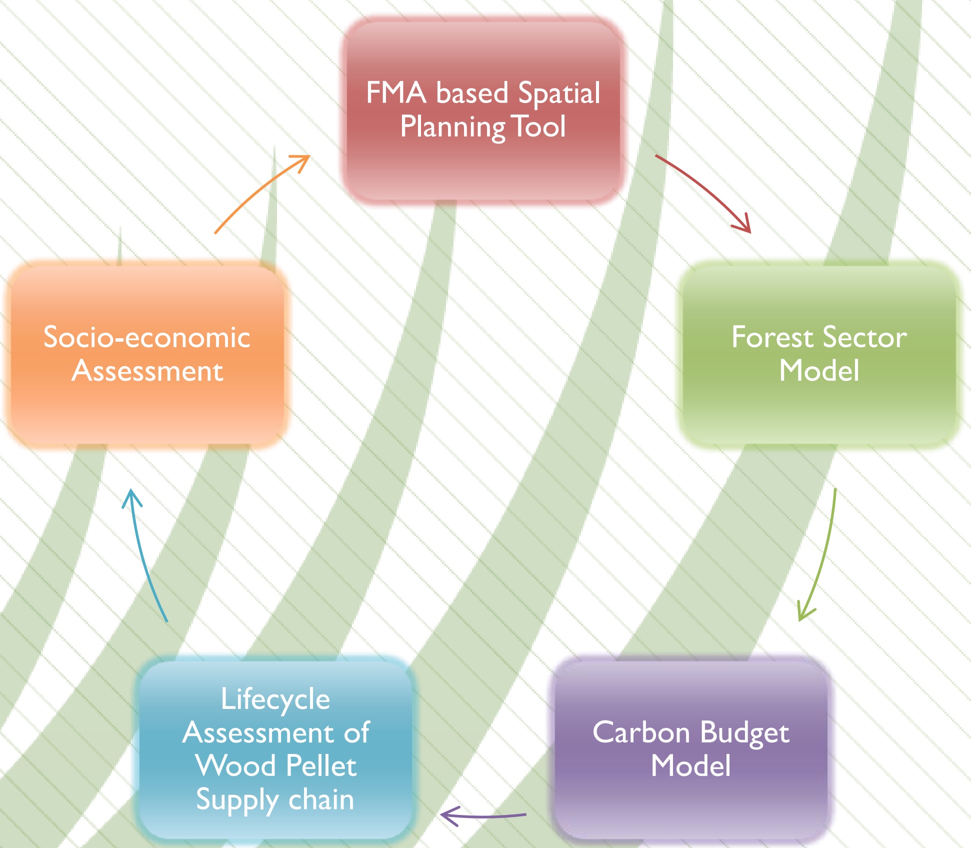
Modelling Framework

- Parameterized a collection of models to form a biomass sustainability analysis modeling framework
- Gathered input from provincial experts (Technical Advisory Committee)



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Technical Advisory Committee

Organization	Name	Expertise
Canadian Forest Service	Werner Kurz/ Eric Nielsen	Carbon Budget Model
Queen's University	Warren Mabee	Wood Chemistry and Energy
Lakehead University	Peggy Smith	Community Participation and Aboriginal Issues
Ontario Forest Industry Association	Scott Jackson	Forest Industry
Former OMNR	Bill Kissick	Wood competitiveness in Ontario
Eastern Ontario Model Forest	Mark Richardson	Private lands
Wolf Lake First Nation	Rosanne Van Schie	Aboriginal Issues & Economic Development
Canadian Forest Service	Bill White	Socio-economic Analysis
Ontario Ministry of Natural Resources	Dan Rouillard	Wood supply modelling

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Scenario Assumptions

- **Scenario planning objectives**:
  - max timber harvest, even flow harvest rate (+/- 10% of swd/hwd vol), non-declining total forest carbon.
- **Baseline Harvest activities for Crown Land**
  - Boreal: full-tree clearcut harvesting, burn slash at roadside.
  - GLSL: cut-to-length, mixed harvesting system (clearcut shelterwood and selection), no burning of slash at roadside, roadside chipping.
- **Silviculture levels** are maintained within limits of the existing forest management unit plans.
- **Landscape Guide objectives are met:** incorporated as modelling constraints.

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Economic/Resource Use Assumptions

- **Determining Pellet Plant Size/ Location**:
  - Mill site clustering, fixed scale (120,000 MT for CO-FIRE and 193,000 tonne for Max CO-FIRE), 15% feedstock consumption for drying.
  - Minimize logging trucking costs
  - Minimize pellet transportation costs (truck, rail and shipping).
- **Generating Station feedstock consumption:**
  - Nanticoke: 1,125 K ODT
  - Atikokan: 200 K ODT
  - Thunder Bay: 300 K ODT
  - Lambton: 375 K ODT

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Biomass Resource Assumptions

- Sawmill waste: bark, chips and sawdust
- Forest residues (road-side slash)
- Low-grade wood volumes
  - White Birch in the Boreal (50%)
  - Poplar in the GLSL (70%)
  - Tolerant HWD volumes in GLSL Region (50%)
- Salvage logging from post-fire sites

*No account is taken for non-carbon environmental benefits of using these biomass resource types.

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Biomass-Energy Indicator Results

- Total Forest Carbon stored (Megatonnes)
- Biomass Resource Inventory/ Harvested (ODT)
- Biomass Pathway Lifecycle GHG Emissions (tonnes CO2e)
- Comparison between biomass and baseline (NGCC) pathways

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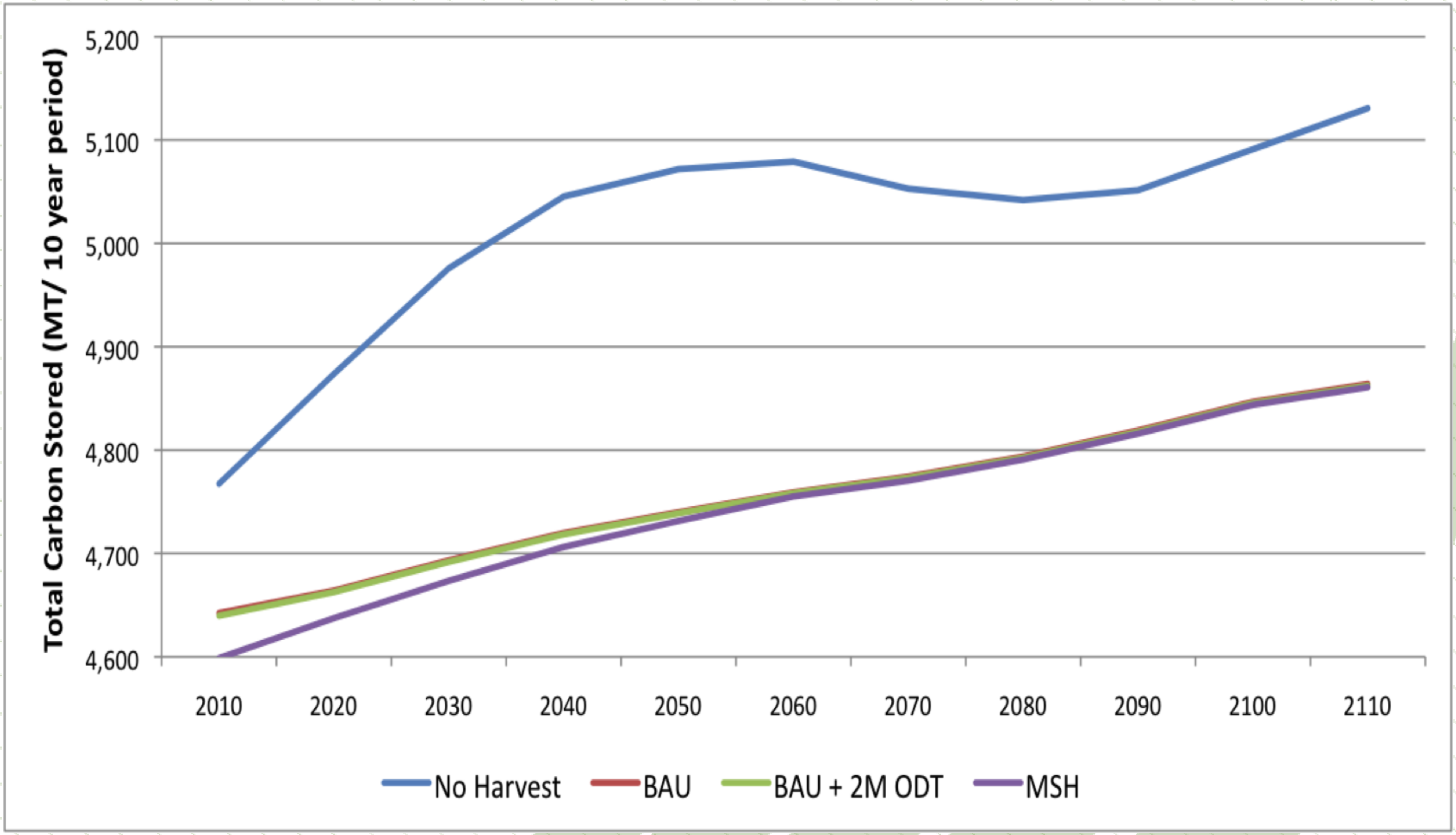
Total Forest Carbon Stored



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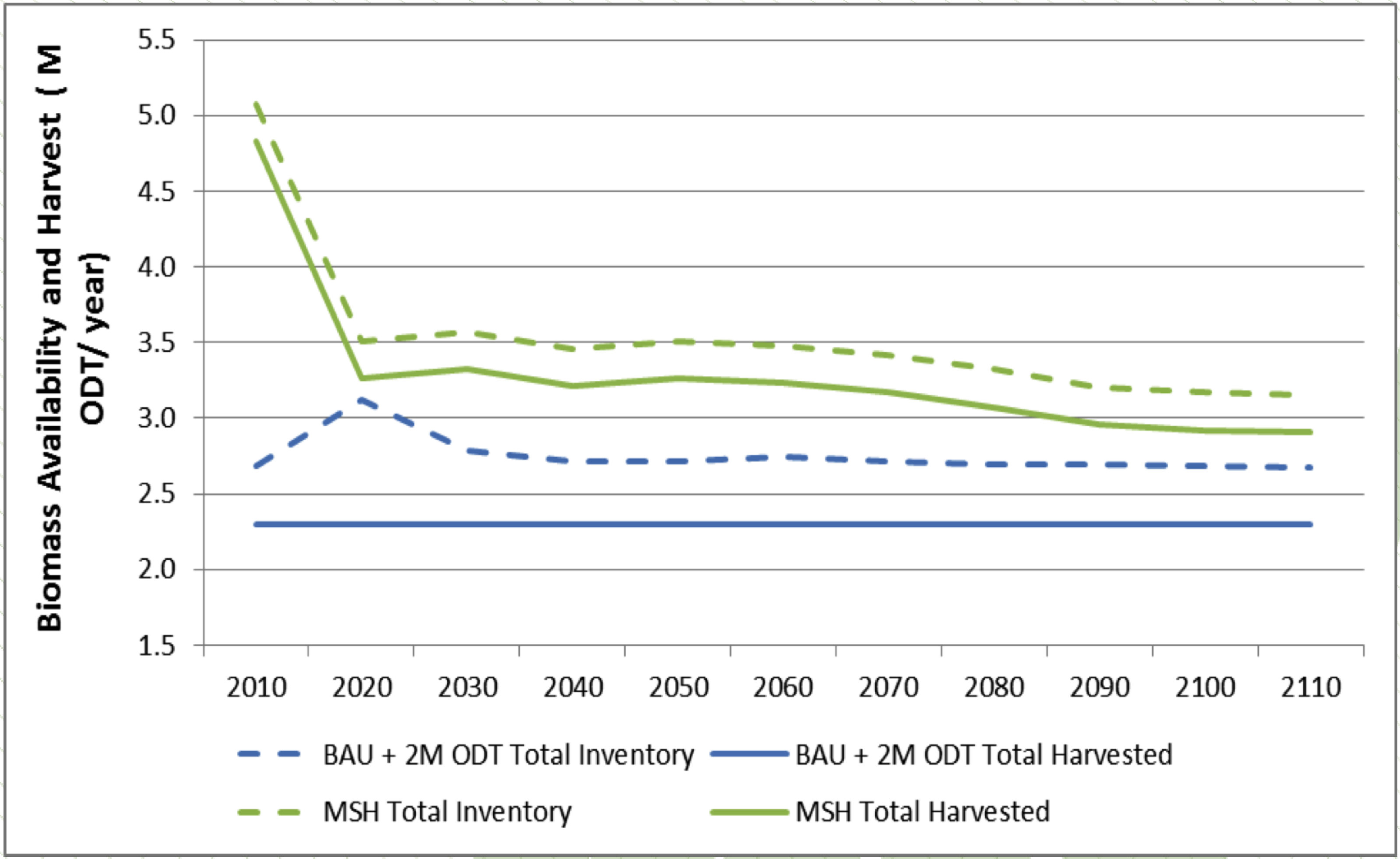
Forest Carbon Stored: Findings

Harvesting of forest biomass for electricity production can be done in such a way as to not systematically decrease forest carbon stores over time.

Biomass Resource Inventory/ Harvest



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Biomass Supply Chain Lifecycle Assessment

- The biomass pathway examined the following activity types:
  - Upstream fossil fuel production
  - Biomass harvesting
  - Biomass resource to pellet plant transportation
  - Pellet production
  - Pellet shipping
  - Generating Station-handling and plant conversion

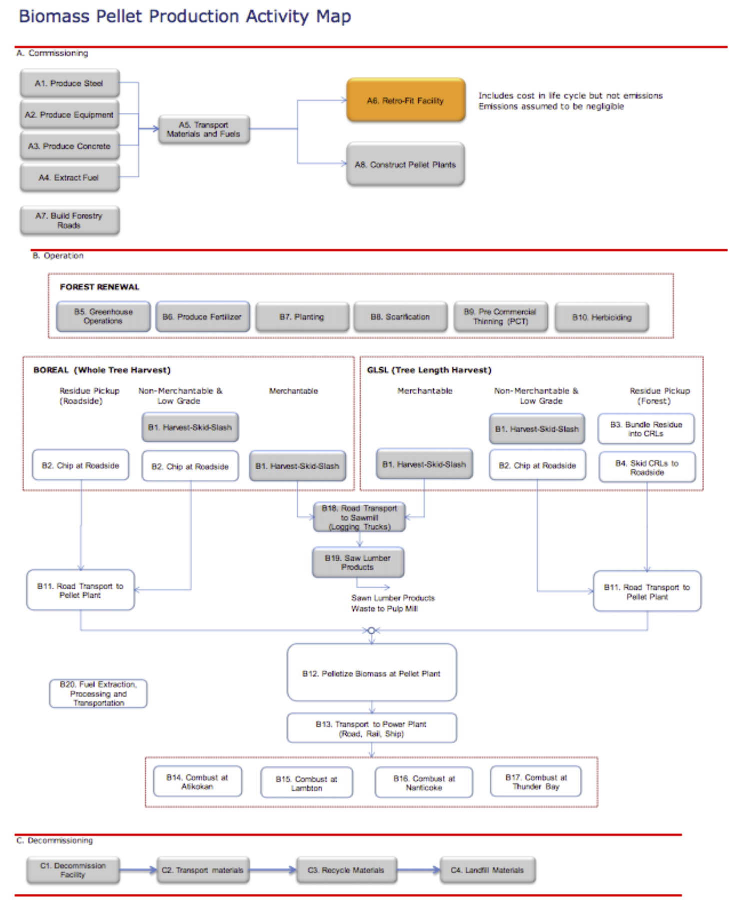

Figure 6. Biomass pellet life cycle activity map

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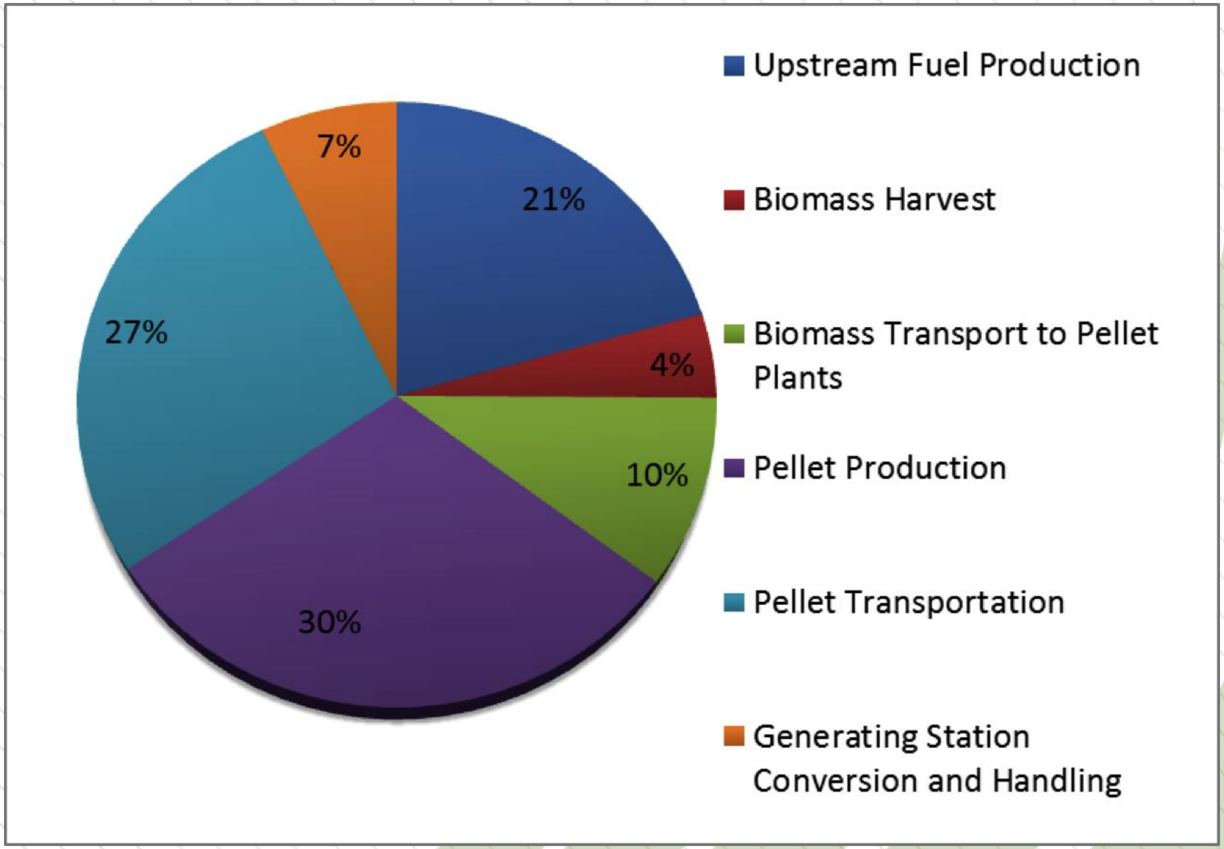
Biomass Pathway: CO-FIRE



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Biomass Pathway- Annual Emissions (CO_2e)

CO-FIRE

Biomass Pathway Activity	GHG emissions (kg CO_2e / ODT)		
	2010	**2050**	**2110**
Fuel production	15.4	14.9	14.8
Biomass harvest	5.1	4.6	4.7
Biomass transport to pellet plants	11.7	10.0	9.5
Pellet production	34.6	34.6	34.6
Pellet transportation to GS	31.4	31.4	31.4
Generating station conversion and handling	8.1	8.1	8.1
Total Annual GHG emissions (tonnes/yr)	**106.4**	**103.5**	**103.1**

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Biomass Activity Pathway: CO-FIRE

- On average the emissions produced in preparing bio-energy feedstock is, on average, equivalent to:
  - 27,380 *additional* **automobiles** on the road each year.
  - 300,000 additional **barrels of oil** consumed every year.

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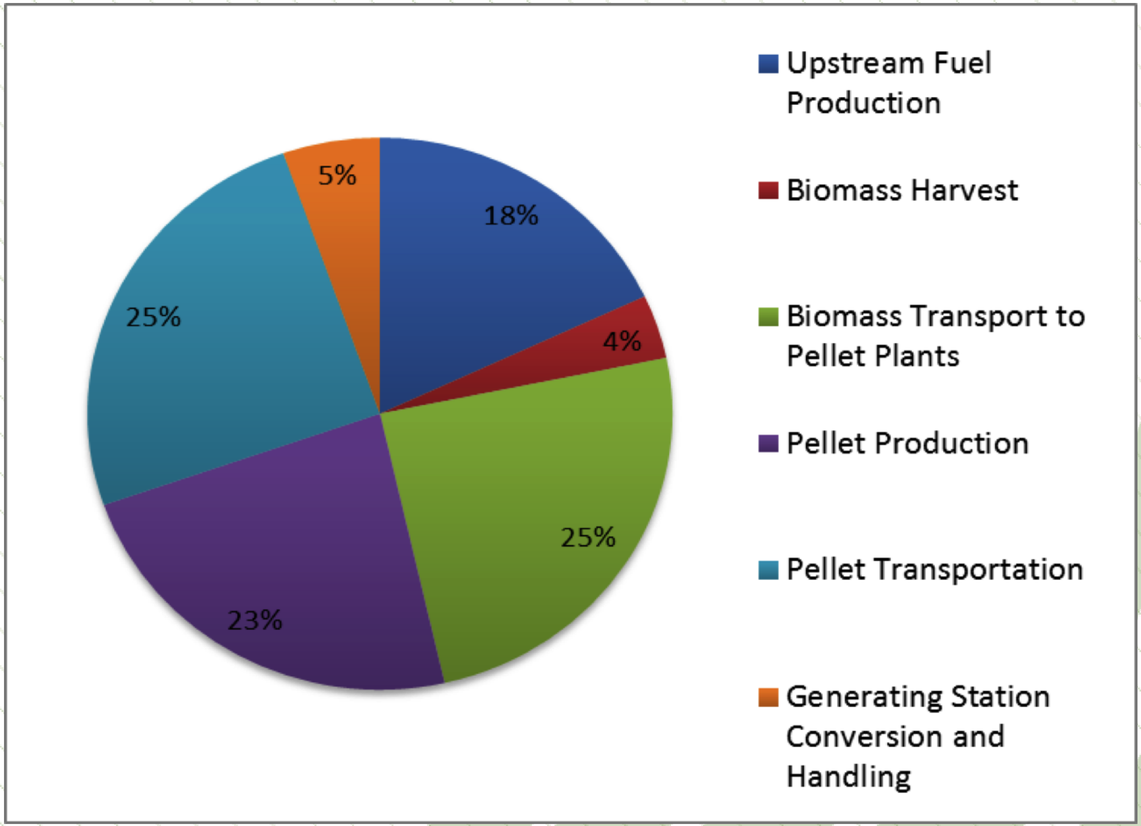
Biomass Pathway Emissions Breakdown (CO_2e), MAX-COFIRE



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Biomass Pathway- Annual Emissions (CO_2e): MAX CO-FIRE

Biomass Pathway Activity	GHG Emissions (kg CO_2e / ODT)		
	2010	**2050**	**2110**
Upstream fuel production	30.9	22.3	21.7
Biomass harvest	9.7	6.0	5.6
Biomass transport to pellet plants	44.7	30.5	30.9
Pellet production	65.9	44.6	39.7
Pellet transportation	62.0	38.2	36.3
Generating station conversion and handling	15.2	10.4	9.3
Total Annual GHG emissions	**228.4**	**152.0**	**143.5**

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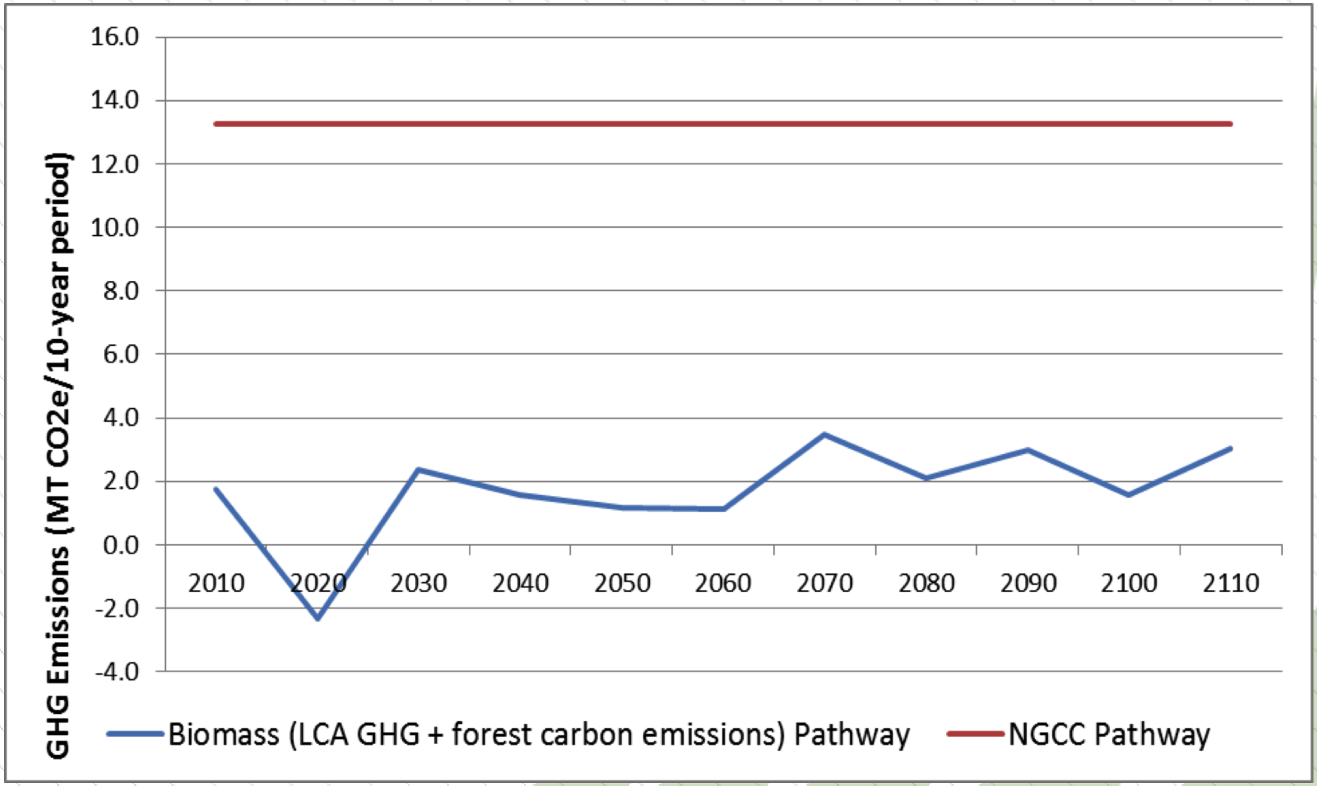
Biomass Pathway vs. NGCC Pathway: CO-FIRE



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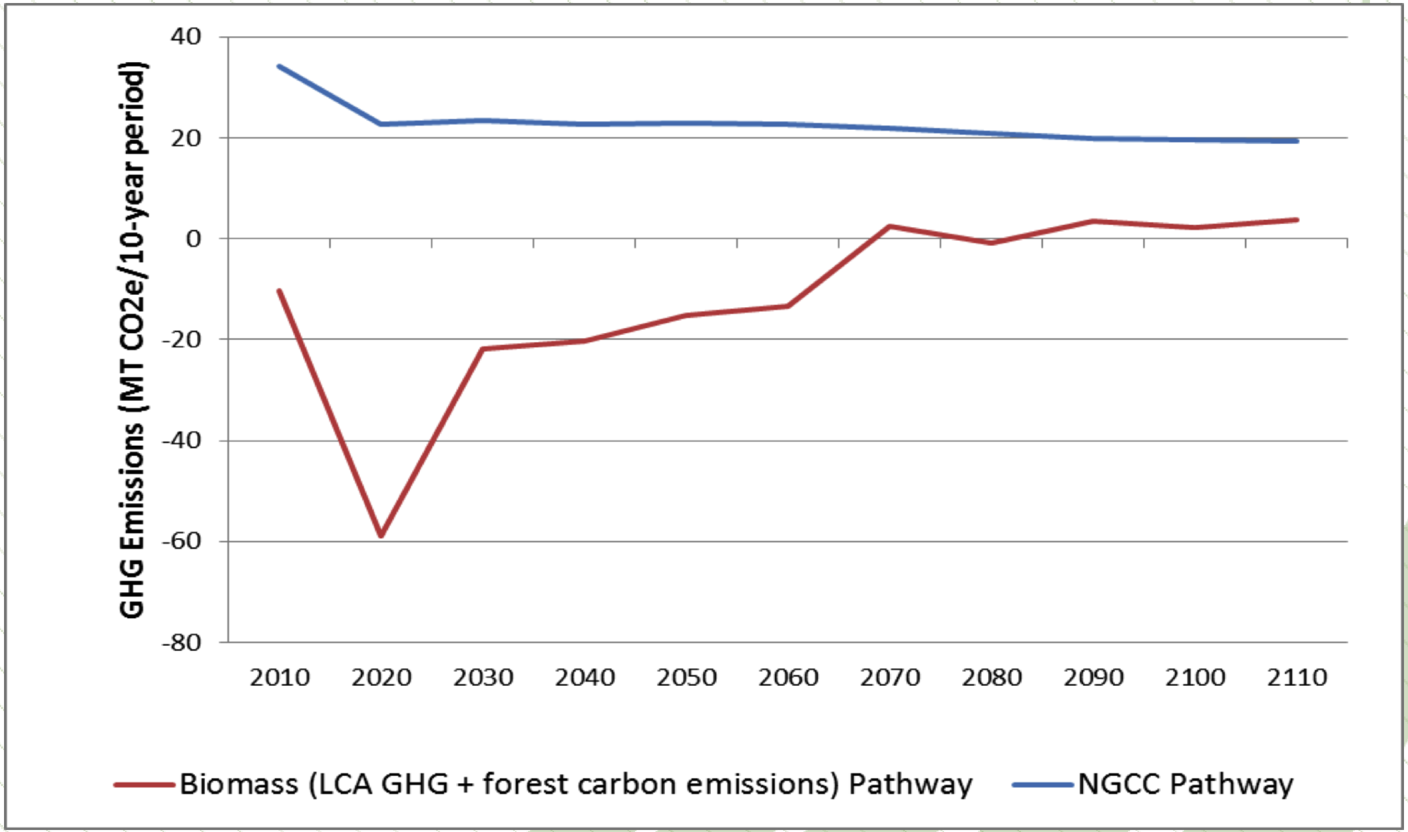
Comparing GHG Emissions Reductions: CO-FIRE

- 168.6 million cars *off* the road over 100 years.
  - 1.7 million cars off the road every year.
- 159.6 million *fewer* barrels of oil consumed over 100 years.
  - 1.6 million fewer barrels of oil consumed every year.

Biomass Pathway vs. NGCC Pathway: MAX CO-FIRE



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Comparing GHG Emissions Reductions: MAX CO-FIRE

- 491.5 million cars *off* the road over 100 years.
  - 4.9 million cars off the road every year.
- 465.4 million *fewer* barrels of oil consumed over 100 years.
  - 4.6 million fewer barrels of oil consumed every year.

Summary of Findings

- Harvesting of forest biomass for electricity production can be done in such a way as to not systematically decrease forest carbon stores over time (Figure 8).
- This analysis validated that the availability of renewable biomass for pellet production is directly tied to harvesting activities on Crown land.
- The future supply of renewable biomass for pellet production is constrained by a total forest industry sustainable harvest level of 21 Mm^3/year.

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Summary of Findings

- In Ontario, there is a sustainable long-term flow of 2.9M ODT at existing harvest rates in the Boreal and GLSL forest regions (Figure 45).
- An additional but declining tonnage of biomass is available in the short term (2015 to 2060), at harvest rates of 21 Mm^3/year (Figure 60).
- There are a variety of biomass resource types available for pellet production in the province and these resource types have unique impacts on forest carbon, GHG emissions and costs.

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Findings: Biomass Resource

- Based on sensitivity analysis performed in this study, the following sources of biomass are prioritized for costs and GHG impacts:
  - Sawmill waste from existing mill facilities- was only sufficient to meet existing demands from pulp and paper plants.
  - The Boreal forest provides the largest tonnage of available forest residues from existing clearcut operations (1.85M ODT annually).
  - The GLSL region provides a declining tonnage of forest residues over time due to the focus in this region on shelterwood and selection harvesting regimes.

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Findings: Biomass Resource

- Low-grade wood volumes from standing timber volumes are a large source of biomass tonnage in the GLSL (312,000 ODT/year). Care must be taken to adequately balance habitat, biodiversity, timber productivity and economic benefits.
- Salvage wood volumes from fires and other natural disturbances are expected to be available over time; however in reality these volumes will be unpredictable and costly to obtain.

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Findings: GHG Emissions

- Biomass for electricity generation at a level of 2M ODT/170,000 TCO_2e/year
- For the CO-FIRE scenario, biomass for electricity generation is renewable, but on a life-cycle basis does contribute additional GHG emissions to the atmosphere.
- Relative to the NGCC pathway, using biomass for electricity generation at a level of 2M ODT/year (CO-FIRE) reduces emissions by 127 MT CO_2e over the 100-year planning horizon.

Findings: GHG Emissions

- Biomass for electricity generation at 3.3 M ODT/year (Max CO-FIRE) / -11.7 MT CO_2e/year
- Under the assumptions laid out in the Max CO-FIRE scenario, biomass for electricity generation is renewable and results in additional carbon sequestered, in the short and medium term (70 years).
- Relative to the NGCC pathway, using biomass for electricity generation at an average annual consumption rate of 3.3 M ODT/year (Max CO-FIRE) reduces emissions by 311 MT CO_2e over the 100-year planning horizon.

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For More Information

- You can download a copy of the **full report** at:
  - Ontario Power Generation's website:
    www.opg.com/power/thermal/repowering
  - IEA Bioenergy Task 32 website: www.ieabcc.nl/
  - Canadian Bioenergy Association
    www.canbio.ca/canbio.php

- You can download a copy of the **factsheet** at:
  www.opg.com/power/thermal/pembina%20biomass%20sustainability%20analysis%20summary%20report.pdf

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Recommendations to OPG

- Using biomass for wood pellet production is a good strategy to reduce GHG emissions in Ontario.
- If OPG chooses to proceed consideration should be given to sourcing some volumes of biomass from sustainably-managed private lands and agriculture resources to ensure the long-term viability of biomass supplies
- OPG should encourage pellet providers to locate their pellet plants in communities that would benefit the most from new employment opportunities.
- Consideration should be given to placing new generating plants next to pellet plants.

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Recommendations to the Ontario Governments

- Consideration should be given to exploring harvesting techniques and/or silviculture practices that might ensure that the use of biomass for electricity production does not lead to any additional GHG emissions in the atmosphere.
- Efforts should be made to integrate pellet product with wood products manufacturing into forest industry clusters.
- In the short term there are gains to forest carbon from harvesting forest stands in the GLSL that mature, with high volumes of low-grade