Quebec pathways for climate change mitigation
Results from Quebec’s Working Group on Forestry and Climate Change (WGFCC)

Patrick Lavoie, FPInnovations
WGFCC partners and collaborators
1. Quebec’s Working Group on Forestry and Climate Change (WGFCC)
   • Overview of the WGFCC
   • Mandate
   • Scenarios and analyses
   • Results
     • Biophysical
     • Economic
   • Conclusions and recommendations

2. Discussion
FPInnovations

FPInnovations is a private not-for-profit organization that specializes in the creation of solutions in support of the Canadian forest sector’s global competitiveness.

- Innovation catalyst for the Canadian forest industry sector.
- Over 300 experts across Canada, spans industry value chain from forest operations to markets.
- Unique partnership with industry and governments.
- 180 industry members and FPAC.
- Partnering with universities and institutions in Canada and abroad.
Working Group on Forestry and Climate Change

• Develop and implement a robust modeling approach to evaluate the role of forest management and forest products in climate change mitigation in Quebec.
• Propose measures and strategic guidelines to make the forest sector a part of climate change action plans based on the best available science.

Scientific advisory committee: *Quebec Ministry of Forests (MFFP), *Ministry of Environment (MELCC), Quebec Ministry of Energy and Natural Resources, Quebec Chief Forester, Transition Énergétique Québec, Natural Resources Canada, Environment and Climate Change Canada (E3C).
An integrated approach to look at the forest sector

«In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit. » IPCC, 2007. AR4 WG3.

Forest carbon sequestration and storage  Carbon storage in products  Substitution of carbon intensive products

Forest sector mitigation = Forest + Products + Substitution

*Based on IPCC AR4 and CBM-CFS3 model.*
Methods

- Scope of analysis: commercial forests both public and private
- Forest management modeled using CBM-CFS3
- Harvested biomass converted into products using adapted framework for harvested wood products (FHWP)
- Application of the MEA approach to obtain mitigation costs ($/t CO$_2$ eq.)
- Socio-economic benefits estimated in collaboration with BMMB

Source: Kurz, 2009.
**Mitigation scenarios**

### INT

**Intensive forest management**

- Afforestation: 50,000 ha/year 2021-2030
  - Increased carbon storage, increased wood supply.
- Planting: 17,000 ha/year more than business as usual (BAU)
  - Increased carbon storage, increased wood supply.
- Increased harvest: 1.6 to 4.5 Mm³/year more than BAU
  - Reduced forest carbon stocks.
  - Product and energy substitution.
- Increased long-lived wood product (LLWP) yield: 2-4% more logs to sawmill, 5-20% chips sent to derived products category.
  - Product substitution: steel and concrete replaced by forest products.

### BIO

**Bioenergy development**

- Increased bioenergy: increased extraction of forest residual harvest by 0.8 to 2.0 M odt/year 2020-2089
  - Reduced forest carbon storage.
  - Energy substitution: coal and HFO/LFO in industry and buildings replaced by biomass heat.

### INT + BIO + HLVS

**Harvest of low-value stands**

- Increased harvest of low-value stands (HLVS) and commercial thinning
  - Reduced forest carbon storage
  - Product substitution: steel and concrete replaced by forest products.
  - Energy substitution: coal and HFO/LFO in industry and buildings replaced by biomass heat. Also, replacement of fossil fuels by biofuels.
## Business as usual (BAU) scenario

<table>
<thead>
<tr>
<th>Activities</th>
<th>Business-as-Usual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afforestation/reforestation of unproductive/non-forest sites</td>
<td>No afforestation/reforestation of unproductive/non-forest sites.</td>
</tr>
<tr>
<td>Reforestation of areas harvested by clear-cutting by planting seedlings</td>
<td>Reforested area of 56,000 ha/year from 2020 to 2089.</td>
</tr>
<tr>
<td>Merchable wood harvesting</td>
<td>Gradual increase in harvesting from 31 to 34 Mm³/year between 2020 and 2089.</td>
</tr>
<tr>
<td></td>
<td>2020-2030: 31 Mm³/year</td>
</tr>
<tr>
<td></td>
<td>2031-2050: 32 Mm³/year</td>
</tr>
<tr>
<td></td>
<td>2051-2089: 34 Mm³/year</td>
</tr>
<tr>
<td>Recovery of clear-cutting residues in the form of branches and crowns</td>
<td>Recovery ranging from 200,000 to 296,000 amt/year between 2020 and 2089. Biomass is mainly intended for heat production.</td>
</tr>
<tr>
<td></td>
<td>2020-2030: 211,000 amt/year</td>
</tr>
<tr>
<td></td>
<td>2031-2050: 259,000 amt/year</td>
</tr>
<tr>
<td></td>
<td>2051-2089: 296,000 amt/year</td>
</tr>
<tr>
<td>Commercial thinning</td>
<td>Gradual increase in harvesting from 6,000 to 8,500 ha/year between 2020 and 2089.</td>
</tr>
<tr>
<td></td>
<td>2020-2030: 6,400 ha/year</td>
</tr>
<tr>
<td></td>
<td>2031-2050: 7,800 ha/year</td>
</tr>
<tr>
<td></td>
<td>2051-2089: 8,500 ha/year</td>
</tr>
<tr>
<td>Production and yield in long-lived products</td>
<td>84% of the merchantable timber volumes harvested are intended for the sawmill industry. The long-lived sawmill product yield is 48%. These values remain constant from 2020 to 2089.</td>
</tr>
<tr>
<td>Substitution</td>
<td>No substitution. The carbon footprint of the materials is constant from 2020 to 2089.</td>
</tr>
</tbody>
</table>

Note: The values presented for the time intervals (e.g., 2051-2089) are the average for the years concerned.
Scenarios and analyses

A note on terminology

- 4 «forest» scenarios: INT, BIO, INT+BIO and INT+BIO+HLVS
  - Scenarios are kept constant for both analyses (see below)

- 2 analyses altering only harvested wood products
  - Base analysis (conservative)
  - Sensitivity analysis, which includes two elements:
    - Targeted substitutions: policy
    - Industry modernization: LLWP yield and innovative forest products

- All mitigation scenarios are compared to the BAU scenario

<table>
<thead>
<tr>
<th></th>
<th>INT</th>
<th>BIO</th>
<th>INT+BIO</th>
<th>INT+BIO+HLVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>Min</td>
<td>Min</td>
<td>Min</td>
<td>Min</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Max</td>
<td>Max</td>
<td>Max</td>
<td>Max</td>
</tr>
</tbody>
</table>
Substitution

• What is it? **Emission reductions** stemming from replacement of non-renewables products or energy sources by forest products or bioenergy.
  • Displacement factors (DFs) represent embodied emissions reductions stemming from the use of a given amount of biogenic carbon. Based on life cycle assessment (LCA) data.

• Substitution only relative to BAU, i.e. no substitution in BAU.

<table>
<thead>
<tr>
<th>Products</th>
<th>Base analysis</th>
<th>Sensitivity analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>0.91 tCO₂/tCO₂</td>
<td>1.2 tCO₂/tCO₂</td>
</tr>
<tr>
<td>Panels and derived products</td>
<td>0.77 tCO₂/tCO₂</td>
<td>1.2 tCO₂/tCO₂</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>0.43 tCO₂/tCO₂</td>
<td>1.2 tCO₂/tCO₂</td>
</tr>
</tbody>
</table>

• Substitution factors are kept constant over 2020-2089 period.
Harvested wood products

Key differences between scenarios and analyses

1. Sawmilling logs

2. Lumber yield

3. Chips going to derived products category

4. Shavings going to derived products category

Note: BAU and INT are the same.

Note: INT and rapid modernization are the same.
Biophysical results

Base analysis

- All mitigation is calculated relative to the business-as-usual (BAU) scenario.
- Between 127-160 Mt CO$_2$ eq. for intensive forest management (INT) and low-value stand harvest scenarios (INT+BIO+HLVS).
- Bioenergy scenario does not mitigate climate change unless energy substitution targets carbon intensive energy sources.
Biophysical results

Sensitivity analysis

- All mitigation is calculated relative to the business-as-usual (BAU) scenario.
- Significant increase (4x) in mitigation in the 460-730 Mt CO₂ eq. range for INT and INT+BIO+HLVS scenarios when substitution is targeted and industry modernization happens at a more rapid pace (↑LLWP).
- Bioenergy scenario mitigates CC when it targets carbon intensive energy sources in industry, buildings and transportation.
Economic analysis

• Net revenue calculated from:
  • Forest management revenues: timber and biomass sales to mills (stumpage)
  • Forest management costs: forest operations, fire/insect protection, road construction, etc.
  • Profits from the sale of forest products
• Excludes employment and carbon revenues
• Financial fluxes actualized using a 3% discount rate; carbon fluxes discounted at 1%/yr.

Equation 1: Net revenue (NR)

\[ NR = (Rfm - Cfm) + (Rp - Cp) \]

Equation 2: Marginal net revenue (MNR)

\[ MNR = NR\ mitigation - NR\ business\ as\ usual \]

Where:

Rfm/Cfm: forest management revenue or cost
Rp/Cp: product revenue or cost
Economic results - Mitigation costs

* Mitigation costs calculated with marginal net revenue based on avg mitigation for base and sensitivity analysis.
Mitigation costs from other sectors and technologies

Graphique 1-30 - Courbe de coûts marginaux sectoriels, horizon 2050

<table>
<thead>
<tr>
<th>Scenario C</th>
<th>2030 objective</th>
<th>2050 objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average costs</td>
<td>87$/t</td>
<td>220$/t</td>
</tr>
<tr>
<td>Marginal costs</td>
<td>175-300$/t</td>
<td>400-1200$/t</td>
</tr>
<tr>
<td>Investment</td>
<td>1.7G$</td>
<td>9.8G$</td>
</tr>
</tbody>
</table>

Conclusions

• The forest sector can provide short-term climate change mitigation by 2030 in the range of 0.5 to 6.7 Mt CO₂/year. About 50% of cumulative mitigation is explained by substitution.

• Policy measures, market development and standard development efforts needed to achieve this potential mitigation.

• Over the long-term, 10 Mt CO₂/year is within reach.

• Substitution benefits can be increased by improving carbon footprint of resource extraction (e.g. harvesting).

• Afforestation acts as a long-term «buffer», its role is mainly to help increase supply (36 Mt CO₂ between 2020-2089).

• Bioenergy use in industry, buildings, etc. makes sense if it is part of a larger intensive forest management strategy and if substitution is targeted.

• Mitigation costs (10-87$/t) low compared to other sectors.
Policy roadmap

Priorities

• Increase yield of long-lived wood products (LLWP) which store carbon for a longer time. Role for R&D.

• Implement mechanisms / methods to identify the largest emission reductions from substitution of non-renewables (i.e. fossil). Implement policies and regulations that create markets for these products.

• Activate the «forest-products-substitution» system through afforestation. Select species and origin of seedlings in context of climate change adaptation.

• Given the low cost of intensive forest management, consider generating carbon offsets on public lands.

• Facilitate the harvest and use of low-quality stands given economic, social and environmental constraints.
Study limitations

- Results based on state of forest C dynamics knowledge in CBM-CFS3 / GCBM.
- ~70 years is a relatively short-term modeling horizon for forestry activities.
- Natural disturbances and climate change adaptation excluded from results.
- Scenarios are neither maximal, nor optimal.
- Over time, regulations will be introduced and will change the BAU.
- Limited number of products accounted for in HWP modeling at a time where there is strong focus on innovation, bioeconomy, etc.
- Inter-industry dynamics difficult to capture in regards to substitution. Displacement factors likely will change over time.
- Mitigation is based CO$_2$ emissions, not radiative forcing.
  - Temporality of emissions and other GHGs and climate forcers (e.g. albedo, air moisture content) not accounted for.
- CBM and Quebec GHG inventory have different scopes.
Next steps

Forest

Product basket – ICC1

Circular economy – ICC2

Market demand – ICC3

Emission reductions from substitution – ICC4

*ICC is a research initiative underway with Quebec’s MFFP/MELCC/Finance Ministry.

ICC financial partners:
Thank you!

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Natural Resources Canada
Ressources naturelles Canada
Canada
UQAC
Université Laval