Evaluation of the Green Construction through Wood (GCWood) Program

Audit and Evaluation Branch
Natural Resources Canada
February 16, 2023

Table of Contents

List of Acronyms

AEB	Audit and Evaluation Branch
CCBFC	Canadian Commission on Building and Fire Codes
CFS	Canadian Forest Service
EDI	Equity, diversity, and inclusion

FTE	Full-time equivalent
GCWood	Green Construction Through Wood
GBA	Gender-based analysis
GDP	Gross domestic product
GHG	Greenhouse Gas
MBF	Million board feet (of timber)
NRC	National Research Council
NRCan	Natural Resources Canada
PBC	Performance-based code
PCF	Pan-Canadian Framework on Clean Growth and Climate Change
PMRS	Performance Measurement and Risk Strategy
R&D	Research and development
TB	Treasury Board
TWBDI	Tall Wood Building Demonstration Initiative

Executive Summary

About the Evaluation

This report presents the findings, conclusions, and recommendations from the evaluation of the Green Construction through Wood program (GCWood). The GCWood program is housed under the Canadian Forest Service (CFS) Trade, Economics, and Industry Branch. CFS created the

GCWood program to showcase new construction technologies using mass timber and engineered wood products. The program is meant to help advance and promote market access, inclusiveness, and competitiveness for Canada's natural resource sectors. Transfer payments are used to support external funding recipients to complete technology transfer and education, wood and hybrid demonstration projects, and research and development (R&D) activities for building codes and standards revisions. The total program funding envelope was $55 million (M) over five years starting in 2018-19. The GCWood program funding will end by March 2023.

The evaluation assessed the relevance and performance (i.e., effectiveness and efficiency) of the GCWood, with considerations also given to the lessons learned with respect to the design and implementation of the program. The evaluations findings are intended to inform similar future NRCan programing, particularly in the CFS.

NRCan's Audit and Evaluation Branch (AEB) conducted this evaluation in accordance with the Treasury Board (TB) *Policy on Results* (2016).

What the Evaluation Found

Overall, the evaluation found that the GCWood program is relevant. It had significant support from industry upon its creation and it aligns with the needs of the sector for ongoing research, technology transfer and education surrounding mass timber and hybrid construction designs (particularly through demonstration, testing and building code change). The program is consistent with the federal government's roles and responsibilities to enable innovation by de-risking investment, and it aligns with NRCan's mandate to support the use of wood and the creation of value-added products as well as its targeted efforts towards Canada's climate change commitments.

The GCWood program was delivered as intended and in an efficient manner within its available funding envelope. With its governance structure and program processes clearly defined and effective, the program delivery model is sound. Design strengths of the program included the engagement of a variety of stakeholders during program planning and the implementation of balanced coverage across the different components included under the program (i.e., different categories of demonstration projects, education initiatives, R&D, and work on code changes) has proven to fill identified gaps.

However, the program did not have enough resources to initially deliver on its commitments and had to engage additional staff (students, part-time staff, and other personnel); in part due to permanent staff having to support other programs. The number of FTEs initially assigned to the program turned out to be insufficient. The COVID-19 pandemic did cause challenges for the program, in particular delays to the demonstration projects, but the program was able to accommodate proponents through amendments to contribution agreements.

The program has met and is on track to achieve its planned immediate outcomes. Planned activities and outputs have been completed or are reasonably forecasted to be completed by target dates. The program has succeeded in its production and provision of information and tools for wood use in construction projected to those directly involved in the sector, but there is room to expand the reach of its engagement to a wider audience including public sector decision-makers, practitioners, and entities that commission construction projects, in addition to other adjacent sectors, such as the insurance and finance industries.

Demonstration projects have also progressed, and the program will have more examples of tall-wood and commercial low-rise buildings, and bridges to contribute to further adoption and commercialization of wood in construction in Canada. The GCWood projects are attracting strong public interest and are receiving awards for mass wood construction, increasing visibility which will contribute to enhancing the uptake of wood innovations. However, there were external factors outside the control of the program, impacting the ability of the program to fully achieve its long-term outcomes, including supply chain issues and the effect of increasing materials cost. To continue making an impact, there is opportunity for an expansion in the types of demonstration projects the program funds, as well as developing better strategies to mitigate the barriers and manage limitations to building with modern mass timber and engineered wood products.

There is strong evidence that the program has made significant contributions towards revisions to the NBCC including new provisions to allow tall-wood buildings up to 12 storeys and the program played a key role in having more than 20 other Canadian jurisdictions adopt these code changes. But code changes have occurred more slowly than originally expected given the complex code environment which has created external factors that have impacted or delayed the programs achievement of expected replication of demonstration projects. The program continues to work with other federal partners to drive towards a material-neutral, performance-based building code as its target to have shifted to performance-based standards will not be met.

While strong achievements have been made by the GCWood program, the evaluation has derived that that some of the targeted outcomes set by the program were ambitious including assessments for total carbon estimates

and the volume of wood used. Due to the delayed timelines of most projects, the evaluation could not determine progress towards the carbon sequestration targets or impact on the commercialization of wood.

Finally, while there is evidence that performance targets are established and tracked for the GCWood program, there are some inconsistencies in the recording of data and potentially some gaps in the identification of necessary indicators to measure progress. The evaluation has identified a need to revisit the program's performance framework, including the opportunity to incorporate GBA Plus considerations (e.g., through Indigenous engagement and data collection) into a future iteration of the program.

Recommendations and Management Response and Action Plan

Note: These management responses to the recommendations are based on the assumption that the GCWood program is renewed with sufficient financial and human resources to undertake them. The response activities detailed below are scalable depending on the new program funding and structure.

Recommendations	Management Response and Action Plan
Recommendation 1: CFS should develop and implement an engagement strategy to increase the reach of the program towards its efficiency and effectiveness: • Increase the communication of GCWood activities and outcomes among stakeholders. • Broaden the scope of the GCWood outreach to include non-traditional stakeholders such as insurance, finance and public sectors who have impacts on the successful implementation of the program. • Increase efforts towards the dissemination of all GCWood knowledge and research products to a wider audience.	**Management agrees**. In response to Recommendation #1, elements in future programming will include: dedicating human resources to action this recommendation, circulating a quarterly newsletter to communicate key activities and outcomes to program stakeholders; and funding to establish a website platform to disseminate knowledge and research marketed to key target audiences (including non-traditional stakeholders) in close collaboration with other provincial and industry partners. **Position Responsible:** ADM, CFS **Timing:** • Six months following approval of program renewal (No later than December 31st, 2023): develop an implementation strategy and plan for enhanced communications activities; and • One year after all authorities in place (No later than June 30, 2024): establish new communications vehicles (i.e., newsletter and website platform).
Recommendation 2: [REDACTED]	**[REDACTED]**

Recommendations	Management Response and Action Plan
Recommendation 3: The program should revisit its performance measurement framework to: a. include indicators about uptake and impact of educational resources, knowledge products and tools; b. establish intermediate targets that will help capture progress against longer-term outcomes such as code evolution; and c. clearly identify and justify the methodology and assumptions for targets (especially the potential for replicability).	**Management agrees**. In response to Recommendation #3, a renewed GCWood program shall: • work to improve the performance measurement framework of the GCWood program; • include indicators on uptake and impact of educational resources, knowledge products and tools; • establish an intermediate target to help capture progress against the longer-term outcome of code evolution; and • clearly identify and justify the methodology and assumptions for targets (especially the potential for replicability). Work is already underway to revise and make more robust the current performance metrics and the methodologies and assumptions behind them. **Position Responsible:** ADM, CFS **Timing:** Six months following approval of program renewal (No later than December 31st, 2023)

Introduction

This report presents the findings, conclusions, and recommendations from the evaluation of the Green Construction through Wood (GCWood) Program, under the Natural Resources Canada (NRCan) Forest Sector Competitiveness Program. The evaluation has been identified as a *Financial Administration Act* (FAA) requirement (G&C >$5M per year) and is evaluated under the Treasury Board (TB) *Policy on Results* (2016). The evaluation of this program was outlined in the NRCan Integrated Audit and Evaluation Plan 2020-2025 and fulfils the obligation to ensure that the program is evaluated for relevance, effectiveness, and efficiency. The findings of this evaluation will help inform NRCan's future programming, particularly in the Canadian Forest Service (CFS).

Program Context

Following Canada's acceptance of the 2016 Paris Agreement on climate change, the Government of Canada has continued to build on past commitments to address climate change through mitigation and adaptation strategies, including clean technologies and greenhouse gas (GHG) emissions reductions. The Pan-Canadian Framework on Clean Growth and Climate Change (PCF), first implemented in 2017, outlines Canada's strategy as it was defined at the start of the GCWood program. This commitment is evolving and ongoing, as recently demonstrated by the strengthened federal climate plan introduced in 2021.

Under this broad mandate, the Minister of Natural Resources Canada (NRCan) is among those responsible for delivering on the government priority of implementing the PCF, which expressly includes the Built Environment as an area where the Federal Government seeks to reduce carbon pollution. In line with that priority, the GCWood program was

launched in October 2017 (and announced in Budget 2017) with the objective of enhancing GHG mitigation opportunities in Canada's building construction industry. By promoting the use of low-emissions and sustainable building materials, GCWood supports Canada's commitment to reach its 2030 emissions reductions targets under the Paris Agreement and its long-term GHG emission reduction strategy.

The GCWood program profile notes that building with modern mass timber and engineered wood products has advantages over traditional building materials. Compared to traditional building materials such as steel and concrete, modern mass timber and engineered wood products provide the following advantages: reduced life-cycle GHG emissions; reduced pollutant emissions; increased speed of construction; improved energy efficiency for most buildings; and the opportunity to expand domestic manufacturing and use of new wood products.

However, while wood construction for single-family homes is very well known in Canada, barriers remain to increasing the use of modern mass timber and engineered wood in non-residential and multi-storey construction. There is a lack of awareness of modern engineered wood products compared to the familiarity that engineers, architects, and developers have with traditional building materials such as concrete and steel.

At the time GCWood was launched, the only national initiative with any resources directed toward supporting the construction, demonstration, and awareness of tall wood and hybrid wood buildings (over 6 storeys) was NRCan's Tall Wood Building Demonstration Initiative (TWBDI) delivered by the Expanding Market Opportunities (EMO) program (which was set to expire on March 31, 2018). Beyond that date, there would have been no national support for wood-based demonstration building initiatives, nor

any programming to support low-rise commercial wood building and timber bridge demonstration. While the efforts of the TWBDI to advance tall wood demonstration projects (greater than 10 storeys) and modernize building codes to increase height limits for wood structures saw great success over the four years the program was active, that initiative was delivered with modest funding carved out from the EMO program which had a broader mandate and scope. Sustained federal support was needed to build on successes to ensure a long-term transformational change in the use of wood for construction. GCWood is also distinct from previous programs because of its core focus on climate change and GHG emissions.

GCWood aims to address the gap in research and technical information needed to facilitate revisions to the 2020 and 2025 National Building Code of Canada (NBCC) and support additional demonstration projects by early adopters across Canada. These projects are to highlight the benefits and advantages of building with wood, spur replication of wood-based construction projects across the industry and ultimately, facilitate the commercial and regulatory uptake of tall wood buildings. Likewise, projects that demonstrate the use of wood in low-rise commercial buildings and timber bridges are to facilitate the commercial uptake of wood use in these types of applications.

Program Information

CFS created the GCWood program to showcase new construction technologies using mass timber and engineered wood products. According to NRCan’s Departmental Result Framework, the program is meant to help advance and promote market access, inclusiveness, and competitiveness for Canada’s natural resource sectors. The GCWood program falls under Program 3.1 - Forest Sector Competitiveness. Initially called Mitigation and

Advanced Solutions through Timber, (MASTT), the $55M over five years program (2018-2023) was built on the successes and lessons learned from the TWBDI [1],a component of the EMO program.

GCWood supports the use of wood materials in construction through:

- contribution funding to demonstration projects that use innovative wood and hybrid construction design;
- research, technology transfer and education activities; and
- encouraging revisions to building codes, including the NBCC.

These activities are intended to catalyze long-term transformational change in which sustainable wood products become a common building material, leading to long-term GHG emissions reductions. The program is expected to support Canadian firms and jobs by offsetting 'first-mover' costs of a variety of innovative wood product demonstration projects and providing guidance and expertise. To achieve these goals, the program has aimed to work closely with the Canadian Wood Council, which was also an initial recipient for the Wood Works! Program [2] and was involved with the delivery of TWBDI under the domestic component of the EMO program.

The GCWood program aims to provide information to the Canadian building design and construction industries. Eligible recipients include for profit and not-for-profit organizations such as companies, industry associations, research associations, and standards organizations, as well as Indigenous communities, provinces, territorial, regional, and municipal governments and their departments and agencies.

Program Components

The program has three components which are described below:

Building codes and standards revisions

Technical information is needed to support proposed code change processes and provisions to allow the adoption of mass timber buildings over six storeys and up to 12 storeys through encapsulated mass timber construction in the 2020 NBCC [3], and to facilitate the move towards a performance-based (material-neutral) code that will treat all construction materials equally (targeting the 2025 NBCC). This program component supports critical research and development (R&D) activities needed to facilitate revisions to the 2020 and 2025 editions of the NBCC. The adoption of performance-based codes requires extensive R&D activities to develop the performance criteria and to demonstrate that wood-based systems meet those criteria.

Technology transfer and education

The GCWood program aims to support the increased use of wood in the Canadian construction market (specifically high-rise buildings, low-rise non-residential buildings, and timber bridges), by providing technical and educational information targeted at educating designers, specifiers and architects, code officials and various levels of government on opportunities to use wood in non-traditional applications. There is currently a gap in advanced education for wood in architectural design, engineering and construction management programs which must be addressed for wood to be a commonly considered building material by practitioners and help develop the future design and construction capacity with wood. The GCWood program is designed to support the development of such curricula. In addition to education support, the program funds the development of several types of tools, including design and construction tools, costing tools, and life cycle assessment tools. These tools facilitate the design, construction, budgeting, and approval process of multi-storey wood buildings as well as quantify the carbon footprint of wood structures.

Education, tools, and R&D projects are selected through unsolicited proposals throughout the program period. For relevant project ideas that fit within the mandate of the GCWood program, program staff carefully review proposals and discuss internally to determine proposal eligibility. If a proposal makes it through this initial screening, the program staff request the applicant to put together a formal signed proposal using the Program template. Senior management are consulted before the formal project approval of all unsolicited proposals.

Wood and hybrid demonstration projects

This component covers incremental costs associated with the design, approval and construction of wood buildings and bridges to facilitate commercial and regulatory uptake, particularly by offsetting the costs and risks of introducing a new product to the market (‘first mover’ costs). Types of targeted demonstration projects funded in the past included tall wood and hybrid buildings, low-rise non-residential buildings, and timber bridges. Government of Canada funding through the program covers the incremental costs associated with wood-based building materials over traditional construction materials. Separate expressions of interest for each demonstration project type (three in total) are launched to solicit proposals which are evaluated by a panel of reviewers to ensure that the most technically sound and economically feasible projects are selected. In the past, the panel of reviewers was comprised of internal (NRCan and other government departments) and external technical experts. See Table 1 for project selection results.

The program provides non-repayable contributions of up to 100% of a project’s eligible incremental costs for the demonstration of innovative engineered wood products and systems. Funding recipients are required to

report on outputs and outcomes annually, as well as to provide a final report upon project completion. This information supports internal and broader reporting requirements, including those to central agencies.

Table 1: GCWood Calls for Proposals

	Tall Buildings	Low-Rise Buildings	Bridges
Expression of Interest	Tall-Wood Buildings	Low-Rise Non-Residential Demonstration Buildings	Timber Bridges
Closing Date	December 2017	December 2018	April 2019
Applications Received	13 applications	30 applications	13 applications
Contribution Agreements Signed	4 projects funded (all ongoing)	10 projects funded (2 completed)	2 projects funded (1 completed)

Program Management

The GCWood program is housed under the CFS Trade, Economics, and Industry Branch and leverages internal resources, other federal organizations, provincial partners, and relationships with industry associations. Selection of demonstration projects is determined via a comprehensive technical and financial review against published criteria. Funding agreements established between the Government of Canada and organizations are also governed by the terms and conditions of the

GCWood program and all applicable departmental and TB policies. Other activities under the GCWood program, such as research and technical information for code changes and design and education tools, are supported via the appropriate mechanism for the partnering organizations (i.e., letter of agreement, contribution agreement, contract).

The program also created a National Advisory Committee comprised of GCWood staff and external stakeholders to create and implement a national communications strategy for GCWood funded demonstration projects. The work of this committee is supported by regional/provincial working groups.

Expected Results and Logic Model

To assess the effectiveness of the GCWood program and ensure proper management oversight, a logic model was developed as part of the design process for the GCWood program. The logic model is presented in Figure 1.

> **Carbon sequestration** is the process of capturing and storing atmospheric carbon dioxide.

In the context of GCWood, change in Canada's built environment is planned for through the provision of technical and educational information to identify opportunities to use wood in non-traditional applications, which is different from other government programming and is expected to increase the use of mass timber in the Canadian construction market. Demonstration projects will enhance domestic capacity for implementing a wider variety of building systems across more regions of Canada, influencing the increased use of advanced engineered wood products. The anticipated increased use of mass timber and engineered wood will expand

the market for wood products directly impacting Canadian firms, jobs, and Canada's efforts to address climate change through carbon sequestration by increasing the amount of wood used in the construction industry.

Resources

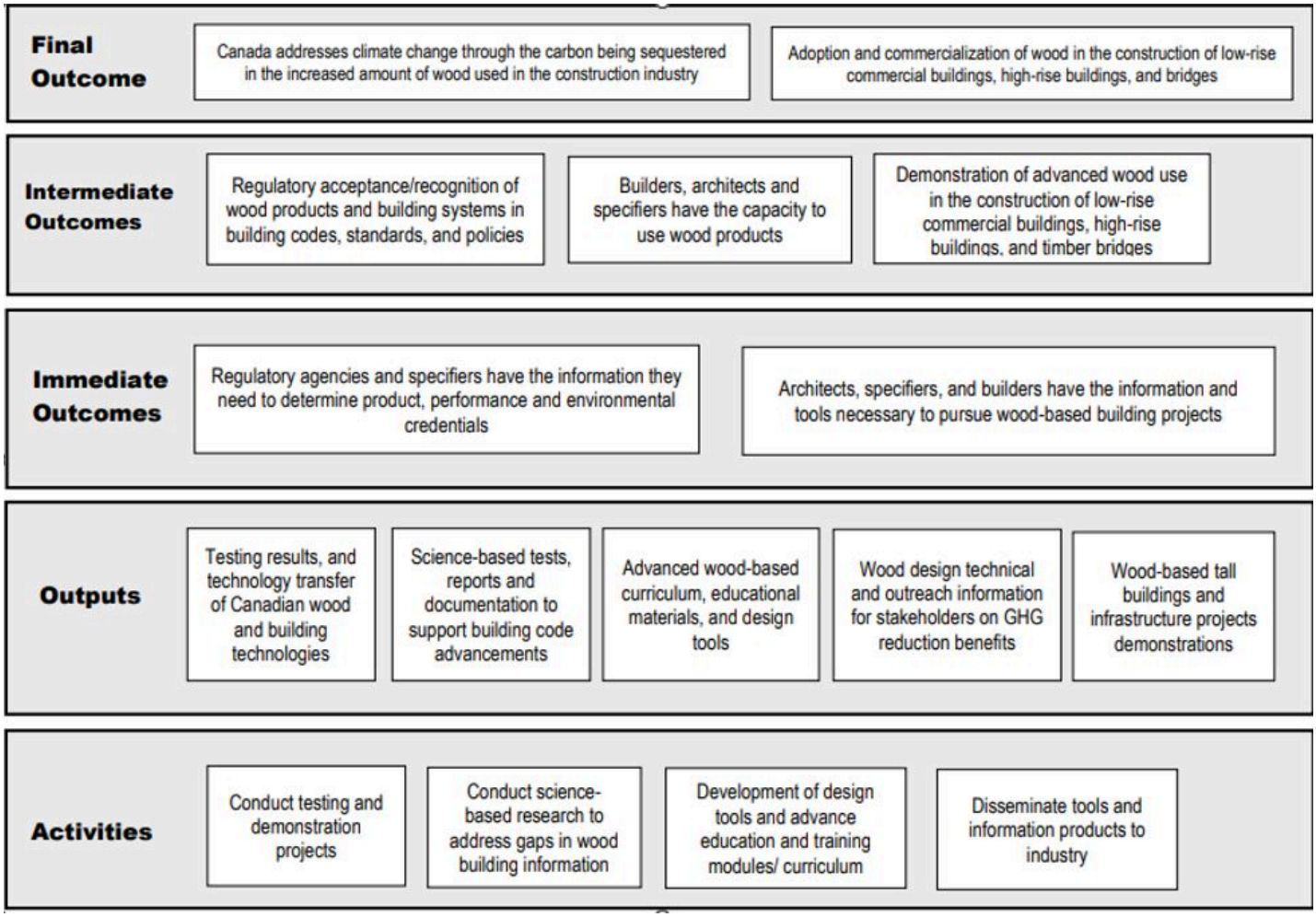
The GCWood program launch followed the Government of Canada's Budget 2017 announcement of $39.8M over four years, starting in April 2018. This initial announcement did not include one additional year of funding (2022-2023) bringing the total budget to $55M over five years.

Program design documents originally allocated two full-time equivalent (FTE) staff to the program. At the time of program launch, the distribution of allocated resources was as follows:

- Internal resources to manage initiatives ($1M and 0.25 FTEs).
- Contribution agreements to fund projects ($46M and 1 FTEs).
- Letters of agreement with other federal departments and agencies, as well as contracts with research organizations and academia to update building codes and update R&D activities ($5M and 0.5 FTEs).
- Agreements and contracts with industry associations to encourage spread of information ($3M and 0.25 FTEs).

However, during implementation, the distribution of resources was amended. For instance, two additional staff were added, which the department risked managed. Also, though GCWood does encourage industry partners to spread information, it did not end up providing funding to support information dissemination.

Figure 1: Logic Model



Source: Official Program Documentation (Performance Measurement and Risk Strategy)

▼ Text version:

Infographic showing the logic model for the Green Construction through Wood program.
The first row features two (2) final outcomes, which are:

- First Final Outcome - Canada addresses climate change through the carbon being sequestered in the increased amount of wood used in the construction industry.
- Second Final Outcome - Adoption and commercialization of wood in the construction of low-rise commercial buildings, high-rise buildings, and bridges.

The second row features three (3) intermediate outcomes that support program's final outcomes. The three intermediate outcomes are:

- Regulatory acceptance/recognition of wood products and building systems in building codes, standards, and policies.
- Builders, architects and specifiers have the capacity to use wood products.
- Demonstration of advanced wood use in the construction of low-rise commercial buildings, high-rise buildings, and timber bridges.

The third row features two (2) immediate outcomes, which are:

- Regulatory agencies and specifiers have the information they need to determine product, performance and environmental credentials.
- Architects, specifiers, and builders have the information and tools necessary to pursue wood-based building projects.

The fourth row features five (5) program outputs, which are:

- Testing results, and technology transfer of Canadian wood and building technologies.
- Science-based tests, reports and documentation to support building code advancements.
- Advanced wood-based curriculum, educational materials, and design tools.
- Wood design technical and outreach information for stakeholders on GHG reduction benefits.
- Wood-based tall buildings and infrastructure projects demonstrations.

The fifth row features four (4) activities, which are:

- Conduct testing and demonstration projects.

- Conduct science-based research to address gaps in wood building information.
- Development of design tools and advance education and training modules / curriculum.
- Disseminate tools and information products to industry.

Evaluation objectives and methods

The Audit and Evaluation Branch (AEB) included a commitment to conduct this evaluation in its Integrated Audit and Evaluation Plan 2020-2025. The AEB identified the need for this evaluation through its risk-based planning process and in response to a TB commitment to complete an evaluation. The evaluation also meets requirements for evaluation of ongoing grants and contributions programs under section 42.1 of the *Financial Administration Act* and the TB *Policy on Results*.

The evaluation covered the Department's direct program spending to date ($35.59M actual) on the GCWood program over the period of 2018-2019 through 2021-22. It covered relevance and performance (effectiveness and efficiency). Considerations was also given to the lessons learned with respect to the design and implementation of the program. The findings are intended to inform similar future NRCan programing, particularly in the Canadian Forest Service (CFS).

Evaluation Methods

The evaluation was conducted through three lines of evidence: document and literature review, key informant interviews, and case studies. The evidence was triangulated across lines of evidence to assess the relevance

of the program, measure the achievement of expected outcomes, and evaluate the efficiency of delivery. The lines of evidence also provided insight into best practices and lessons learned.

The interview data were analyzed using a qualitative analysis approach. The following qualifiers are used to give an idea of the frequency at which points were raised by respondents:

- A few – where fewer than 25% or at least two respondents shared an opinion;
- Some – where more than 25% and fewer than 50% of respondents shared an opinion;
- Half – where 50% of respondents shared an opinion;
- Most – where more than 50% and fewer than 90% of respondents shared an opinion; and
- Almost all/all – where 90% or more of respondents shared an opinion.

Table 2 provides details on each of the methods employed.

An Evaluation Working Group consisting of representatives from the GCWood program and NRCan's Audit and Evaluation Branch (AEB) supported the evaluation.

Table 2: Evaluation Methods

Interviews	Document Review	Case Studies

Interviews	Document Review	Case Studies
Thirty-three (33) interviews were conducted with: • NRCan staff (including direct program staff), n=5 • Academic and research organizations, n=5 • Other federal departments, n=4 • Provincial and municipal departments, n=4 • Industrial organizations, n=14 (including 6 project proponents) • Indigenous organizations, n=1 (project proponent)	The document and literature review included internal and publicly available documentation such as: • Program planning documents • Program tracking documents (progress against targets, contribution agreement tracking, communications, financial data) • Contribution agreements, quarterly reports • Program publications (e.g., State of Mass Timber Report 2021) • Other government publications about similar programs across Canada and abroad • Academic literature	Twelve (12) case studies selected based on funding parameters, regional distribution, and type of project: • Demonstration projects, n= 5 • Education & tools projects, n= 6 • NRCan/NRC project on building codes & standards, n=1 Methodology: • Key informant interviews, n=19 • Documents reviewed included: project proposals and supporting material, NRCan assessment documents, contribution agreements, progress reports, other project publications

Limitations and Considerations

Out of 16 demonstration projects funded through GCWood, only three were fully completed when the evaluation was conducted (and two of the three had submitted a final report). This limited the amount of information available related to intermediate and final outcomes for demonstration projects.

There is a small number of respondents within most stakeholder groups, and in many cases, key informants chose not to address interview questions or did not have sufficient knowledge on the various program components to provide answers. This limited the ability of the evaluation to triangulate qualitative data across groups in some instances.

While not a limitation to the evaluation, it should be noted that fewer interviews were conducted than planned for the case studies. Originally, the objective was to conduct two interviews per case: one with the project proponent and one additional interview, suggested by the proponent, who would also be knowledgeable about the GCWood project (e.g., collaborator or partner, resource user, engineer, etc.). However, in most cases, only the interview with the project proponent was completed, either because:

- The project proponent did not suggest any additional stakeholder(s) that could contribute to the case study.
- Additional key informants that were identified did not respond to an invitation to be interviewed.
- The discussion with the project proponent occurred too late in the data collection process (there was no time to reach out to the additional respondents).

What We Found – Relevance

Summary of Key Findings

Based on all lines of evidence, the evaluation found that the GCWood program is relevant. It responds to continuing needs for increasing awareness of wood as a viable building material; filling the gap in research and technical information related to wood; supporting building code evolution; promoting innovation and developing capacity and expertise for building with wood.

The initial design of the GCWood program was aligned with the needs of the forest industry at the time of implementation. The program undertook a market study as well as a stakeholder consultation exercise to gauge industry interest. All lines of evidence confirm that the program had significant support from the industry upon its creation and continues to be relevant to industry now as evidenced by public statements of support and acknowledgement by external interviewees of the expanding opportunities the program brings to the sector. Industry interviewees also stated that the sector would lose its current momentum in the absence of the program.

The program is aligned with the federal government’s roles and responsibilities to enable innovation by alleviating ‘first mover’ costs and de-risking investment. The program also aligns with NRCan’s mandate to support the use of wood and the creation of value-added products as well as its targeted efforts towards Canada’s climate change commitments.

The GCWood program's focus on demonstration, research and education aligns with the needs of the forest sector

NRCan documentation and all key informant interviewees confirm the GCWood program is still relevant because it responds to a long-term continued need to:

- Increase awareness of the use of wood for non-residential and multi-storey construction among important industry professions such as engineers, architects, and developers, including developing and training students and skilled tradespeople;
- Fill the gap in research and technical information needed to facilitate revisions to the NBCC to allow taller wood buildings and greater innovation with wood and to support the evolution of building codes to ensure a level playing field for wood-based construction materials;
- Test and promote innovative wood products and systems domestically; and
- Support research, provide integrated and construction design tools and develop capacity to understand and use new wood technologies as they become available.

The NRCan State of Mass Timber Report (2021) identifies the same ongoing needs in the mass timber industry related to growing the demand for mass timber, stronger wood education in Canada, code change, as well as demand for low-GHG construction materials and GHG emissions reductions. [4]

External interviewees explained that the GCWood program is the only existing program that strategically connects stakeholders from the primary (e.g., softwood lumber) and secondary (e.g., engineered wood) mass timber industry. All key informant and case study interviewees further underlined that the mass timber construction industry is complex and

emerging, and there are still major gaps in levels of knowledge, expertise, and costs. Interviewees across respondent groups emphasized the need to improve the existing knowledge and develop technical data about mass timber buildings. Case study interviewees also highlighted that, recognizing the recent improvements to the 2020 NBCC, there remains a need for code-related research and for work towards a performance-based building code. The majority opinion across all interviewee groups confirmed the need for the program to continue providing support for demonstration projects.

Industry values the GCWood program

Program documents indicate that before the launch of the GCWood program, the Forest Products Association of Canada had argued for continued investment in programming that promotes the use of Canadian wood to increase the sector's presence in Canadian and international arenas and help develop new markets. [5] Upon launching the GCWood program, the association made a public statement to show its support for the program.

Based on stakeholder consultations before the official launch of the program, the program expected a high level of support from the industry. The Canadian Forest sector is a major contributor to the country's economy comprising 205,000 employees, $23.7 billion (B) to Canada's nominal gross domestic product (GDP) and $33B worth of export products. The increased demand for wood and wood products for construction is expected to increase the financial performance of the sector by boosting the demand for wood and wood products. [6]

All key informant interviewees from industry confirmed that the sector values the program, seeing how the program has increased the capacity of the mass timber industry to build and innovate with wood. The program

> "[GCWood represents] *the greatest opportunity that the industry has seen for generations*."
>
> – Industry Interviewee

also provided an opportunity for knowledge sharing among practitioners. The program provides financial support to proponents, but projects ultimately benefit a wide range of end-users, such as architects, developers, specifiers, etc. A few demonstration project proponents indicated that the program is also appreciated by forest-dependent communities where the products are sourced or processed. Industry representatives suggest that there are no other similar resources that address the multi-dimensional needs of the industry. Those industry interviewees also stated that the sector would lose its current momentum in the absence of the program.

The GCWood program aligns with current federal government priorities related to climate change mitigation and increasing the forest sector's competitiveness

> "By focusing on innovation and good, green jobs, and by working with like-minded countries – we will build a more resilient, sustainable, and competitive economy. As a country, we want to be leaders in producing the world's cleanest steel, aluminum, **building products**, cars, and planes."
>
> – Speech from the Throne, November 23, 2021 (emphasis added).

The document review established that the GCWood program aligns with the Canadian government's priorities in the areas of GHG mitigation and forest sector competitiveness. [7] Under the Paris Agreement, Canada's target is a 30 percent reduction in GHG emissions below 2005 levels by

2030. [8] According to the Pan-Canadian Framework on Clean Growth and Climate Change (PCF), one of the new actions for reducing emissions and increasing carbon sequestration via the forest is by increasing the use of wood in construction, and updating building codes. [9] NRCan and external interviewees emphasized the relevance of the program to the federal government's commitment on climate change. Those interviewees expressed that the program is strongly aligned with the PCF, as well as the Government's Green Building Strategy towards decarbonizing the built environment.

Program documents also affirm that NRCan has a mandate to support diversification and innovation in the forest sector to sustain economic competitiveness. [10] The mandate letter from the Prime Minister to the Minister of Natural Resources states that the department intends to "[build] off successful investments in the Green Construction through Wood and Investments in Forest Industry Transformation programs." [11] The forest sector is at the heart of NRCan activities, and plays an important role in the low-carbon economy. [12] The program is aligned with the NRCan mandate to support the forestry sector through increasing the use of wood in many applications and creating of value-added products.

The GCWood program has a unique and necessary role in supporting NRCan and the federal government to increase the use of wood in the Canadian construction market.

The forest products sector is a key driver for the Canadian economy. Yet, recent studies show that Canada could experience major wood supply shortages and/or increased wood supply costs due to climate change. Hence, these studies suggest it is imperative that the government prioritize action to assist in its continuing growth and strength. In the past, the government has provided support through significant investments in other

programs that support the development of innovation in wood products and building applications such as the Forest Innovation Program, Investments in Forest Industry Transformation and the EMO Program.

The document review and key informant interviews indicate that there is a necessary role for the federal government in the advancement of mass timber buildings. While mass timber construction is not entirely new to the industry, there is an important role for the government to improve the public perception on the use and advantages of mass timber and innovative wood products for non-residential and multi-storey construction. The outreach and education components of the GCWood program are one way government can fulfill this role. All GCWood-funded research and testing studies are also public under a Creative Commons license, further enabling the dissemination of knowledge for shared public benefit. GCWood also helps to de-risk innovation and build the trust of investors. Respondents across the different case studies also noted that changing building codes to enable the development of the mass timber industry requires strong federal government involvement. Case study interviewees explained that neither the provinces and territories, nor industry, have the financial capacity to fund the large-scale testing and research projects needed to support demonstrations and code evolution.

The evaluation found no evidence of duplication with existing programs in Canada or within NRCan. GCWood is currently the only program of its kind in Canada with significant resources directed toward supporting the construction, demonstration, and awareness of tall-wood and hybrid wood buildings.

What We Found – Effectiveness: Expected and Unexpected Outcomes

Summary of Key Findings

The evaluation found that the program has met and is on track to achieve its planned immediate outcomes. Planned activities and outputs have been completed or are reasonably forecasted to be completed by target dates. The program has met or exceeded its targets in terms of the production and dissemination of knowledge (e.g., through publications, training events, development of tools and databases, etc.). The program has succeeded in providing relevant information about wood use in construction to regulatory agencies, specifiers and other stakeholders directly involved in the sector. Despite this, there is opportunity to more broadly increase awareness of the program and disseminate tools and research outputs. Case studies and industry interviews identified several players, outside of the immediate sector stakeholders, that would benefit from increased awareness of mass timber for construction (e.g., the finance, insurance, and public sectors).

Recommendation 1: CFS should develop and implement an extended engagement and outreach strategy to increase the reach of the program:

- To increase the communication of GCWood activities and outcomes among stakeholders;
- To broaden the scope of the GCWood outreach to include non-traditional stakeholders such as insurance, finance, and public sectors who can have effects on the successful implementation of the program; and,

- To increase efforts towards the dissemination of all GCWood knowledge and research products to a wider audience.

The program has also made significant progress towards achieving its intended intermediate outcomes and funded the intended number of demonstration projects (except for timber bridges). Targets related to increasing capacity in the sector have all been met or are on track. For example, the program has enabled and contributed to further research in academia and professional networks. The program has also made an important contribution to code upgrades, although the target for the establishment of a performance-based building code by 2025 was ambitious and not met. Some case study proponents and industry interviewees suggested that the program needs to expand the scope of its demonstration objectives to include opportunities for increasingly innovative approaches (e.g., pre-fab use) and additional target audiences for uptake (e.g., public sector).

Recommendation 2: [REDACTED]

There is some indication of the program's contribution towards longer-term outcomes regarding lowered GHG emissions and increased commercialization of wood, but the evidence is inconclusive due to the incomplete stage of projects. Additionally, several external factors impact the extent to which the program can achieve its intended outcomes. Demonstration projects were delayed by the COVID-19 pandemic and other challenges related to construction; the price of mass timber remains high across Canada, and the pace of building code changes are slow and unpredictable.

However, most NRCan and industry interviewees engaged through the evaluation are confident that the program makes an important contribution to the intended outcomes, even if some are hard to

measure quantitatively. GCWood projects have garnered strong public interest leading to awards for mass wood construction. The program has been able to influence the development of mass timber programs in other Canadian jurisdictions and other countries.

To contribute to planned outcomes, the GCWood program supported three types of initiatives:

a. Demonstration projects for tall-wood building, non-residential low-rise buildings, and timber bridges;
b. Research, education, and tool development projects; and,
c. A stream of activities related to building code improvements (collaborative work between the GCWood program team at NRCan and collaborators at NRC).

Immediate Outcomes

The GCWood program has met, exceeded or is on track to achieve all of its planned immediate outcome targets related to informing stakeholders about the characteristics and applications of wood for construction.

GCWood has provided funding to 15 projects explicitly focused on research, education, and tool development. Examples of such projects include the development of technical guides and practical tools for cost-benefit analysis and carbon calculation, etc.

A review of the program's performance reporting confirms that GCWood has exceeded its March 2020 and 2021 targets related to the following activities:

Activities	Targets	Results
Science-based information products produced and made publicly available to stakeholders	5-8 information products	16 information products published
Advanced education and training modules developed	12-16 modules	33 modules developed
Life-cycle assessment tools/databases created	4-6 tools/databases	10 such tools/ databases created

The program is also on track to meeting its objectives of holding 60 education and training events by March 2023. Forty-four events have been held as of the time the evaluation was conducted, which is significant given the impact of the pandemic on in-person types of activity.

> The **Yukon Street Office Building** in Vancouver has received press attention, authored research papers on the project, and will present results at the 2023 World Conference on Timber Engineering.

Through its activities, the program has increased the amount of information available to stakeholders. All research funded by GCWood is intended to be available under a ‘Creative Commons’ copyright condition, including research conducted through demonstration projects. NRCan interviewees noted that GCWood is the first program within NRCan to require proponents (through contribution agreements) to openly share data and information from their projects publicly. The program encourages proponents to share project material (e.g., testing reports, design information) on their websites, or through conferences, publications, and

workshops. Through this ‘Creative Commons’ feature, NRCan can also mobilize the data and research developed with GCWood funding to help inform other projects and facilitate advancement. For instance, GCWood can provide testing and engineering data for free to a proponent pursuing an alternative solution under the building code for a wood-based project. This is another way the program can contribute to lowering the incremental costs of innovating with wood. In addition, GCWood is considering the creation of a national online repository for all this material to be made available publicly.

Photo of the Green Construction through Wood program logo

The program also worked to establish the visibility of demonstration projects to drive further uptake of similar wood innovations. The program formed a National Advisory Committee to develop a communication framework regarding the demonstration projects, and a regional working group that helped support the implementation of communications. GCWood funded proponents committed to disseminate information about their work through promotional material (e.g., one-pagers, videos, announcements), outreach activities, and participation in industry events. A framework was developed for each project that outlined pre-construction, construction, and post-construction communications activities mainly targeted to public audiences or those already in the industry (e.g., timber engineering, architectural engineering, construction, etc.). The program also developed a branding style guide for all demonstration projects to use to create a consistent look and feel for the communications products intended for announced projects. Proponents interviewed for case studies confirmed that they

shared their work via various forums, as well as informally with industry partners. Some demonstration projects funded through GCWood, especially tall-wood projects, have been covered in the media.

NRCan staff and most case study and external key informant interviewees confirmed that there has been good uptake of publications and resources developed with GCWood program funding (e.g., the State of Mass Timber report, technical guides, conference flyers) and that these outputs are indeed being used by stakeholders, proponents indicate they are using these materials. However, a few case study interviewees indicated there may be room for improvement in terms of further dissemination of information produced with program support. Interview findings show that there is limited communication of the program activities across funding recipients. Most of the industry interviewees are only familiar with the component of the program that relates to them. There is a need to circulate general program updates and outcomes across funding recipients from all program components to increase the visibility of the program and program outcomes.

Figure 2 provides examples from the case studies to further illustrate the way GCWood information outputs have been used by regulatory bodies and other stakeholders.

Figure 2: Case Study Examples of Information Produced and Used

Testing

The Canadian Wood Council and partners conducted demonstration fire tests on the performance and dynamics of a fire in mass timber buildings. The project engaged industry, design professionals and fire services from across Canada in discussions and helped push for consideration of using wood in a variety of builds going forward.

Increasing the Use of a Carbon Calculator Tool

Stakeholders in Ontario, British Columbia and the Maritimes have expressed an interest in using the CECOBOIS carbon-calculator tool Gestimat. The GCWood Program has funded work to translate and upgrade the tool for use across Canada.

Strategic Planning and Goal Setting

Market share and forecasting data produced by a GCWood project has been used to inform provincial program development (e.g., BC's creation of the Mass Timber Implementation Office).

▼ Text version:

A diagram showing three examples of case studies in three difference boxes. Each box includes the type of case study, as well as the information produced and used.

Box 1. The first example of case study is “testing”. The Canadian Wood Council and partners conducted demonstration fire tests on the performance and dynamics of a fire in mass timber buildings. The project engaged industry, design professionals and fire services from across Canada in discussions and helped push for consideration of using wood in a variety of builds going forward.

Box 2. The second example of case study is “Increasing the Use of a Carbon Calculator Tool”. Stakeholders in Ontario, British Columbia and the Maritimes have expressed an interest in using the CECOBOIS carbon-calculator tool Gestimat. The GCWood Program has funded work to translate and upgrade the tool for use across Canada.

Box 3. The third example of case study is “Strategic Planning and Goal Setting”. Market share and forecasting data produced by a GCWood project has been used to inform provincial program development (e.g., BC's creation of the Mass Timber Implementation Office).

There was a sense among industry interviewees that the program could do more to broadly disseminate tools and research outputs to public sector decision-makers, practitioners, and other entities that commission construction projects. For example, case study interviewees suggested targeting public sector entities such as municipalities, who – if informed about wood – could further incorporate wood resources into their programs and policies. In terms of enhancing education activities, a few industry representatives suggested targeting the insurance and finance communities, where a better understanding of the risks associated with wood could support lower premiums and more advantageous financing options.

Intermediate Outcomes

The program will achieve the number of targeted demonstration projects planned for in all areas except bridges and has further opportunity to expand the types of demonstration projects it funds.

Demonstration projects can inspire builders and other stakeholders to opt for wood, as they exemplify the various uses of the material and increase confidence in the potential of wood as a viable construction option. The program has funded the intended number of demonstration projects for two of the three building categories targeted through the calls for proposals. Four tall-wood building projects are ongoing, which so far satisfies the intended target of four to six projects to be completed by 2025. Assuming that all ongoing projects are completed, the program will largely

exceed its target of supporting two to three commercial low-rise demonstrations as GCWood has signed 10 contribution agreements in this area.

GCWood projects have gathered strong public interest leading to recognition of achievements for mass timber construction and the program has been able to influence the development of mass timber agendas in other jurisdictions.

NRCan interviewees explained that GCWood influenced the development of mass timber programming in other jurisdictions. This includes the Ontario Mass Timber Program (now discontinued), which was developed based on GCWood. Although that program is no longer active, Ontario has continued to exchange with GCWood as the province persists in developing wood policy and programming. British Columbia also used GCWood as an inspiration for its program and is looking to align with the GCWood program renewal direction. Alberta has reached out to the program for information about possibly replicating the GCWood model and representatives from the government of New Zealand have also expressed an interest.

The level of public interest associated with the program was mentioned by some case study interviewees and found through the document review. Some of the projects funded under GCWood received industry awards or other accolades (e.g., The Arbour, CNL Builds, Nature’s Path, University of Toronto Academic Tower). The GCWood program and buildings supported through program are also being covered in news articles and blog posts. Winning awards in industry-relevant publications can raise the profile of building projects, which could contribute to increased replication of the demonstration projects. The wins also indicate that the program selection criteria are attracting high-quality projects.

Photo of a best design award by the Architects Newspaper

However, the program had intended to support three to four timber bridge

demonstration projects but has funded only two. The evaluation found that the reasons for missing this target were not fully within the program's control. GCWood received 13 applications for mass-timber bridge demonstration projects (the same number of applications as for the tall-wood call for proposal) and selected five projects for funding. Despite being shortlisted, three proponents withdrew their projects from the GCWood program. Of these, one proponent opted to pursue funding from other federal government programs as they did not want to be limited to the difference in cost of material (e.g., only supported for the difference between the cost of mass timber versus other common materials such as steel), one proponent ended up choosing a different material for construction, and the last project was cancelled. GCWood adapted to these circumstances by supporting additional low-rise non-residential projects with high replicability potential as well as funding other research and information products such as a bridge maintenance guide related to timber bridges.

> "*For some governments, there is a potential to raise awareness of their role in the development of policies that can promote wood in the public sector. [...] The development of the mass timber sector will require the exemplarity of public buildings built with wood. This will also support the development of expertise*."
>
> GCWood Proponent

Interviewees across all respondent groups confirmed the need for the program to continue providing support for demonstration projects but suggest that the program needs to shift its focus from "exciting" tall buildings to more common, practical projects to speed up commercialization of wood buildings (e.g., hospitals, schools, car

dealerships) to further support the adoption of wood in the public and private sectors. It was also expressed that the need to incorporate innovative ideas in the types of demonstration projects was necessary, referring to opportunities to support options such as modular buildings, prefabrication, and larger outdoor structures. Additionally, industry interviewees pointed out that most of the activities related to the adoption of wood construction are still concentrated in British Columbia and Ontario and limited in other parts of Canada. The program did shortlist demonstration projects in other provinces including Atlantic Canada, Quebec, and Alberta, but some proponents cancelled or withdrew those projects. The document review confirms that all demonstration projects under GCWood, except one located in Quebec, were conducted in those two provinces.

The program contributes to increasing knowledge about wood-based construction in academic institutions as well as in professional networks.

Some of the research and education-focused projects funded by GCWood directly intend to increase knowledge about wood in academic institutions and professional networks. The program reports that educational products produced by the program have reached over 1,800 professionals to date and that over 6,700 education hours have been delivered so far through symposiums, conferences, and various workshops (already exceeding the target of 6,000 hours by 2025). In addition, the following projects directly contribute this outcome:

- The Canadian Wood Council developed the Advanced Wood Education Roadmap, which has and will continue to guide curriculum development for university programs in architecture and engineering, and impact trades education in colleges.

- FPInnovations' Tall Wood Buildings Technical Guide is being used as a reference for professionals and educators.
- The program has also supported initial steps towards the creation of the Canadian Wood Construction Research Network to allow stakeholders involved in wood-related research to coordinate across Canada, and eventually fill existing research gaps. Some knowledge sharing has already occurred between researchers through the planning for this initiative.

To an extent, other knowledge products supported through GCWood (such as FPInnovations' Market Share Reports) have also played a role in contributing to this outcome as researchers can use the market data to identify research questions and scope their activities.

Photo of the George Brown College – Limberlost building (formally The Arbour building).

Source: publicly available for download

Demonstration projects funded under GCWood are also having an impact on knowledge in academia and professional networks. For instance, a case study interviewee confirmed that since the construction of George Brown College's 10-storey mass timber academic facility, Limberlost (formally The Arbour), other universities and colleges in Canada have reached out to the institution for information about its design.

Through their work on code changes, NRCan and the National Research Council (NRC) also contribute to increasing the knowledge of researchers, educators, and professionals. For instance, the two organizations have shared research results related to performance-based codes directly with stakeholders through a 2022 engagement workshop comprising 90 participating organizations. Interview results also indicate that the results of NRCan and NRC research studies have reached a wide range of stakeholders through the standing committees of the Canadian Commission on Building and Fire Codes, as well as the Commission's Code Change process.

The program has made important contributions to increasing the acceptance of wood in codes, standards, and policies, although some of the targets associated with code reform were ambitious.

NRCan and NRC's Work on Code Evolution

Work supported by GCWood has had an important impact on building code changes. Most notably, GCWood collaborated with NRC to complete fire and seismic performance research and testing projects that informed the integration of tall-wood buildings up to 12 storeys (using encapsulated mass timber) into the 2020 NBCC. Over 20 jurisdictions have adopted those code changes (which exceed the program target of 8-12). This was one incremental code change directly supported by GCWood.

Through the program, NRCan also developed an advocacy strategy to drive the evolution of the National Building Code towards a material-neutral, performance-based code (PBC). The program funded NRC to complete specific research projects to support progress towards this objective. The work completed to date includes mass timber science-based tests, an international scan on PBC design, and a review and analysis of the NBCC provisions for specific PBC change recommendations.

NRCan through a consultant submitted a formal Code Change Request to transition the building code toward a performance based one to the Canadian Commission on Building and Fire Codes (CCBFC) towards what should have been the end of the 2020 code update (at the right time to inform discussions on the next round of changes). However, because the publication of the 2020 code took two additional years to release, [13] discussions about PBC at the Commission are yet to begin. NRCan project leads, and NRC collaborators noted that amending codes is a long-term, complex endeavour that can only progress at the pace of the Commission's processes, which is outside of the program's control. Consequently, the original GCWood target of shifting to a PBC by 2025 was ambitious.

> "*The research work done with NRC [on the building code] so far has been successful and one of the manifestations of that is NRC and Codes Canada now taking PBC codes as a priority. A transition to a PBC by 2025 was very ambitious, but we can see this becoming a strong priority by 2025*."
>
> – NRCan Interviewee

NRCan and NRC case study interviewees identified that the knowledge products generated under this project have laid a foundation for change and can contribute to the eventual development of performance-based standards. The work done in this area has also strengthened the business

case for the adoption of PBC provisions. Government key informant interviewees described significant successes under this file, including prioritizing the shift to PBC by NRC, Codes Canada, and the provinces. Another advancement captured during the interviews is the success by NRC in receiving new TB funding to focus on PBC updates. Respondents attributed these advancements at least in part to the work completed by GCWood.

Impact of Other Projects on Codes, Standards and Policy

In addition to NRC and NRCan's work on code changes, other projects funded under GCWood also directly generate information that can inform changes to codes, standards, and policies. For example, the Mass Timber Fire Testing by the Canadian Wood Council provided stakeholders with information that can support the case for regulation or codes changes in favour of wood. Also, GCWood-funded demonstration projects add to the body of work demonstrating the effectiveness of wood in different contexts. Projects that develop expertise and build capacity in the wood sector (e.g., the Advanced Wood Education Roadmap, Tall Wood Buildings Technical Guide) also indirectly support progress towards this outcome. These projects impact demand and ability to use wood, which can in turn contribute to policy, code, or standard changes (e.g., inspiring decision-makers to incorporate wood in their environmental policies).

Final Outcomes

There is limited information available to measure progress towards the program's long-term outcomes of influencing climate change and the adoption and commercialization of wood.

Final outcome targets in the GCWood performance framework relate to total carbon benefits and the volume of wood used.

Total carbon benefits refer to the amount of carbon sequestered (or stored) inside wood, as well as the amount of GHG emission avoided in the manufacturing process of wood (as opposed to using steel or concrete or another material that results in higher emissions). As for wood use, it refers to the volume of wood (typically in cubic meters) used in a construction project.

Replicability

In the context of GCWood, replicated projects are new buildings and bridges that incorporate innovative wood-based systems, design concepts/features, or advanced building technologies based on research and demonstrations funded by GCWood.

The GCWood final outcome targets were established in 2017 to reflect the results of GCWood demonstration projects (i.e., the carbon benefits and the amount of wood used for each project), but also include the impact of *replicated projects* informed by demonstrations, code changes and other research supported by the program. The original targets were defined as a range, premised on 18 demonstration projects being funded, and a low forecast of 44 replicated projects and a high forecast of 77 projects being replicated, by 2030.

Estimating the number of replications at the onset of the program was noted to be difficult. The evaluation determined that GCWood had confirmed 9 replicated projects and is tracking an additional 10 to 12 potential projects. This is in a context where the COVID-19 pandemic delayed the delivery of GCWood demonstration projects, and code changes occurred more slowly than originally expected. The program expects that outreach and education efforts, as well as the drive towards carbon-

neutrality, will support an exponential growth in the number of replications. Although this remains difficult to estimate precisely, the program identified that it is still reasonable to assume, under current conditions, that the number of replications by 2030 will be somewhere between 44 and 77, as originally estimated.

Impact on Commercialization of Wood

The final outcome targets for wood product use were established prior to the launch of GCWood, based on an estimation of material use for a "typical":

- Tall wood building (UBC Brock Commons was used as a benchmark, with estimated wood volume at 2,233 m^3);
- Non-residential four-storey mass timber building (estimated wood volume of 1,142 m^3); and,
- Timber bridge (estimated wood volume of 1,316 m^3).

Information on wood purchased and used specifically for GCWood demonstration projects will be available once projects are completed. If projects are completed as planned, they will represent some 28,909 m^3 of wood product used. So far, the two finished projects have used their planned intended volumes of mass timber, totalling 1,476 m^3.

The program's original target was in the range of 295,000-590,000 m^3 (125-250 Million Board Feet - MBF). The performance framework had this target established for 2025 (the time horizon of the demonstration projects), when it really should have been set for 2030 or later (to account for the time needed for replications). Based on current project figures, however, it appears that this original target was ambitious. If some 77 projects are replicated by 2030, based on the average amount of wood used in demonstration projects, the result would be closer to 190,000 m^3 of wood

product used (i.e., the some 29,000 m^3 of wood used by GCWood projects, plus the wood used by 77 replicated projects based on the GCWood estimate of average wood use per project). The delayed publication of the 2020 NBCC to 2022 is likely one of the factors behind a lower number of replicated projects than anticipated. Earlier adoption of the new code would have been a driver for the construction of mass timber in tall wood buildings.

However, the majority of interviewees across respondent groups are confident that the program makes a significant contribution to boosting the adoption of wood in construction, indicating that wood construction is gaining momentum with practitioners and investors across the country. These respondents also indicate that the program's efforts will yield positive impacts beyond the end of the funding period and completion of the projects, in the longer term. However, industry interviewees explained that this growth is still at an early stage and faces major constraints such as price, supply-side issues, and labour shortages. For these reasons, investors and developers may still be reluctant to opt for wood over other building materials.

Impact on GHG Emissions

> A **Life-Cycle Assessment** is a compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle.

The direct total carbon benefits expected from funded demonstration projects is 38,031 tonnes. The actual carbon benefits of projects will be confirmed as demonstration proponents submit a final Life-Cycle

Assessment upon project completion. So far, only two projects have completed assessments and reported a total of 1,316 tonnes mitigated.

Based on the low- and high-forecast replication numbers discussed above, GCWood originally announced it would achieve a total carbon benefit of 0.5 to 2.0 million tonnes of CO_2 equivalent emissions by 2030, and a cumulative impact of 1.6 to 6.4 million tonnes between 2020 and 2030. Again, based on currently available figures, this seems to have been an ambitious target. The average total carbon benefit per project estimated by the program is around 2,380 tonnes. 77 replications would arrive at about 0.18 million tonnes of CO_2 equivalent emissions by 2030, including the GHG emissions saved through GCWood demonstration projects.

Socio-Economic Impact of the Program

It is too early for the program to have data on socio-economic impacts, but the interviews and case studies provide anecdotal evidence of effects.

GCWood is a climate-change focussed program – its core outcomes relate primarily to wood use and, ultimately, avoidance of GHG emissions. However, the program's reporting requirements include those of the Forest Sector Competitiveness program, and so economic indicators such as job creation are included in the reporting framework for demonstration projects. Demonstration projects, in their final report, are asked to provide information such as the labour-person resources required for construction, permanent staff maintaining and administering the new building, etc.

The two final project reports that are available, together with the case studies, document the creation of jobs across multiple disciplines (engineers, architects, and other building professionals) through demonstration projects. In the case of the Waswanipi Commercial Building

Complex and Duchesnay Bridge projects, local First Nation communities played a major role. These projects leveraged local expertise and increased local capacity, illustrating how demonstration projects can be favorable to communities with forest industry expertise or resources.

Interviewees across respondent groups and case studies explained that, by aiming to grow the market for wood as a building material, the GCWood program will indirectly contribute to creating new job opportunities in this sector in the long term. However, attributing such market labour impacts directly to the program would be premature at this stage. Most key informant and case study interviewees reported seeing improvements in the industry in general – growing demand or interest, greater capacity, technical innovations – and indicated that the program presumably played a role.

External Factors Impacting the Program

Several external factors impact the extent to which the program can achieve its intended outcomes.

Some external factors have had a positive influence on GCWood. Interviewees across respondent groups mentioned Canada's emphasis on achieving a low-carbon economy that is driving strong interest in innovations that can help reduce emissions, including the use of wood in construction. The adoption of the 2015 and 2020 buildings codes by many jurisdictions represent important progress in terms of facilitating innovation and increasing the viability of wood as an option for construction. Regarding the code change component specifically, various external factors have contributed to code improvements and progress towards a PBC:

- NRC and NRCan's respective contributions in terms of specialized expertise, networks and responsibilities;
- Support for PBC by the provinces and territories, and other stakeholders;
- The PBC supports achieving national harmonization of codes, which the CCBFC and Codes Canada have identified as a priority; and,
- Interest in PBC in the United States, which is a major Canadian trade partner for wood.

Various negative factors did hinder the achievement of outcomes. Some of the demonstration projects were impacted by the type of challenges that can befall any construction project, such as labour strikes, supply chain issues, and poor weather conditions.

CFS responded to the impacts of the pandemic on projects.

- Meetings between NRCan and proponents were changed from in-person to virtual.
- The program re-profiled unspent funds for some projects that were delayed due to COVID-19 restrictions and associated challenges (e.g., delays with permitting, supply-chain disruptions, restricted access to facilities, and difficulty in gathering stakeholders or providing live training).
- The program offered advanced payments, task amendments, and additional funding where justifiable to help recipients.
- The program coordinated with other NRCan programs to avoid lapsing funds during the pandemic years.

Another negative external factor noted by many industry interviewees is that the price of mass timber remains high across Canada. The program could not provide support for the purchasing of material, however. To avoid domestic tensions with other material industries, as well as issues related to the softwood lumber trade dispute with the United States, the GCWood program was explicitly designed to *not* provide funding for purchasing mass timber or other softwood lumber products directly. The program only covered the incremental eligible costs of using wood as an innovative approach. This was made clear in all outward facing materials and communications with recipients but did limit the ability of the program to address the issue of cost.

Finally, external factors related to the issue of code evolution also have an impact on program outcomes. Moving towards a material-neutral code is a complex, research-intensive endeavour and the pace of code change procedures is outside the program's control. Shifting to a PBC also requires extensive engagement of all stakeholders along the supply chain and in the construction sector. It is worth noting that stakeholders who represent other building materials are not necessarily in favour of the adoption of a PBC. Finally, the adoption of building code provisions by jurisdictions is also outside of the program's control.

What We Found – Efficiency and Economy

Summary of Key Findings:

The evaluation found that – other than the issues caused by COVID-19 – the GCWood program was delivered as intended and in an efficient manner. The governance structure and program processes were

clearly defined and effective. Stakeholders saw the program model as effective and suggested no major changes and no alternative models for delivery were found.

Design strengths of the program included the engagement of a variety of stakeholders, and balanced coverage of the different components included under the program (i.e., different categories of demonstration projects, education initiatives, R&D, and work on code changes) with the benefit being the complementarity of the components to support the sector at varying points in the lifecycle of innovation. While operating within NRCan grants and contributions terms and conditions, the program was able to accommodate proponents when faced with pandemic-related challenges.

The GCWood program was delivered within its available funding envelope, but the program had to engage additional staff (students, part-time and other personnel) as the number of FTEs assigned to the program in the design phase turned out to be insufficient. While comment on the efficiency of administrative processes was not specifically asked of interviewees, a few industry representatives did cite delays in administrative processes by the program and suggested the program was understaffed. The role that GCWood program staff play on multiple other NRCan programs caused confusion for external stakeholders, in addition to many external interviewees not being able to distinguish GCWood from predecessor programs, in particular the TWBDI, a component of the EMO program.

Performance targets are established and tracked for GCWood with some inconsistencies in the recording of data and potentially some gaps in the identification of necessary indicators to measure progress.

Project reporting templates need to be reviewed as proponents across many types indicate requirements are burdensome and repetitive.

Recommendation 3: The program should update its performance measurement framework:

- Include indicators about uptake and impact of educational resources, knowledge products and tools;
- Establish targets that will help capture progress against longer-term outcomes such as code evolution; and,
- Clearly identify and justify the methodology and assumptions for targets (especially the potential for replicability).

A GBA Plus analysis was conducted at the planning stage of the program and looked at gender as an identify factor. There are opportunities to incorporate equity, diversity, and inclusion considerations (e.g., through Indigenous engagement and data collection) into a future iteration of the program.

The GCWood Program was delivered as planned, except for challenges associated with limited initial internal capacity and implications resulting from the pandemic.

GCWood program documents show that the governance structure and program processes were clearly defined. Other documents such as funding agreement templates, logic model, Performance Measurement and Risk Strategy (PMRS), demonstration project review and selection process, unsolicited funding application process, terms of reference for evaluation panel, etc., were provided to guide program processes.

The evaluation found that program resources were used mostly as planned. The program spent between 81% and 95% of its available funds in any given fiscal year, except for fiscal year 2020/21 where the program slightly overspent (107%).

	Allocated	Planned	Actual	Balance (Allocated vs Actual)	
2018-19	$4,111,385	$4,111,385	$3,918,121	$193,264	95%
2019-20	$8,030,429	$8,030,429	$6,665,621	$1,364,808	83%
2020-21	$10,229,474	$13,229,474	$10,965,516	-$736,042	107%
2021-22	$17,328,250	$17,328,250	$14,042,504	$3,285,746	81%
Total	**$39,699,538**	**$42,699,538**	**$35,591,763**	**$4,107,775**	**90%**

The GCWood program was established as a five-year program with $55M in funding. However, Budget 2017 announced it as a four-year program starting in FY 2018/19 with $39.8M in funding. This led to minor challenges in communications, budgeting, and agreement negotiations.

The program expended funds as expected for grants and contributions, however, it had to spend more funds than expected on operations. GCWood was originally designed to require two FTEs (one program officer and one technical officer). After several months of program operations, it became clear to program staff that the size and complexity of the program was such that it could not be effectively co-delivered within the EMO team without additional FTEs and dedicated management. The program

addressed this challenge by hiring co-op students, part-time workers, and bringing in additional resources from NRCan's Policy Analyst Recruitment and Development Program (PARDP) rotations. This resourcing issue should be considered in the design of any future program similar to GCWood.

> "*They didn't look into resources so much early on. [GCWood] could use a couple more permanent positions. Although PARDPs and students help, there is a lot of work to train them, so the core team is overworked*."
>
> NRCan Interviewee

The evaluation also found that having NRCan staff working on multiple programs creates some confusion amongst external stakeholders in terms of distinguishing GCWood from other programs in the CFS, such as EMO and TWBDI. Through the interviews, external stakeholders found it difficult to distinguish GCWood from other NRCan programs, with staff being assigned to multiple programs contributing to the confusion. Additionally, the GCWood program was initially called the Mitigation and Advanced Solutions through Timber program and was built on the successes and lessons learned from the TWBDI, a component of the EMO program. Industry and other federal government interviewees had a hard time distinguishing between programs. This is also a design consideration for future programming.

Most interviewed proponents confirmed that the program team they interacted with for their GCWood project demonstrated a high level of efficiency and professionalism. External interviewees commended the program team for managing the funding contributions in a manner that mitigated the impacts of the COVID-19 pandemic. The program offered as much accommodation as possible within the terms and conditions to help proponents adjust to disruptions. However, NRCan staff and proponents

would also like to see greater flexibility in grants and contributions to minimize the need for frequent re-profiling or burdensome modifications to agreements when unexpected situations occur.

The evaluation identified no alternative delivery model that would have produced the same outcomes more efficiently. The GCWood program presents design features that support effective implementation.

Other than the issues of insufficient FTEs and rigidity of the contribution agreements (raised internally), the interviews and document review found the program model to be adequate and effective. The governance structure and program processes were clearly defined, and the evaluation found no issues with the management of the program. External interviewees thought the inclusion of R&D, education and tool development was a strong feature of the program, and the budgets allocated to the different components were balanced. A review of twenty other similar programs indicates that most other jurisdictions with wood-based programs use a similar approach to funding a diversity of projects (including grants or contributions to fund demonstrations, funding for R&D, as well as outreach and education) to further the adoption of wood in the construction sector. Where GCWood stands out from the comparator programs is through its work on building code evolution (a unique feature), and the inclusion of timber bridges as a stand-alone category for proposals.

> "*There was a good spread of the resources, among the demo projects, research, and the education roadmap. The educational component is good. They complement each other well. It supports the industry from different vantage points*."
>
> – Interviewee from Academia

Interviews also highlight that the program engaged multiple stakeholder groups and partners, hence creating a broad network of key actors across the country. For instance, the GCWood's National Advisory Committee was comprised of experienced government and industry partners to advise on communication regarding the demonstration projects.

Several external and case study interviewees noted that the program model could have been used successfully to fund more calls for proposals and include other types of demonstration projects. Because demonstration projects can be quite large-scale and the development of a full application takes time, a few respondents suggested improving the sequencing of calls and the lengthening the application windows to increase opportunities for proponents to submit proposals.

Photo of a gender-based analysis plus logo.

Efforts related to equity, diversity and inclusion were aligned with federal requirements at the time of program design. There are opportunities to do better in this area in a future iteration of the program.

A GBA Plus analysis conducted at the planning stage of the program only looked at gender as an identifying factor and identified that the forestry industry is male dominated. The analysis also surmised that more women are expected to be filling more high-skilled positions in the long-term, according to current labour market trends. The program committed to address any difficulties that may arise towards at-risk groups.

Some projects covered through case studies provide examples of including equity, diversity, and inclusion (EDI) values (see Table 3), however, this is occurring by chance and not by design of the program.

Table 3: Examples of EDI in GCWood Supported Projects

EDI in Construction	EDI in the Sector	EDI in Project Implementation
George Brown College made changes to original plans to include a fitness facility on the ground floor (for accessibility), and incorporated gender-neutral bathrooms.	The Canadian Wood Council intends to survey practicing engineers and recent graduates involved in wood projects across Canada, to research whether there is a linkage between the availability of wood engineering/design courses and better outcomes on equity, diversity, and inclusion.	The Mass Timber Fire Testing project had a female engineer who designed the structure to be used for testing, and the engineers employed for fire testing are from various diverse groups.

One case study interviewee noted that there may be opportunities for the program to consider increasing Indigenous engagement, especially given First Nations communities' proximity and experience related to mass timber.

The performance measurement framework and reporting requirements could be revisited to identify targets and assumptions more clearly.

The GCWood program has a PMRS against which performance is tracked but reconciling performance data was difficult in some instances. Particularly when it came to assessing progress against longer-term

outcomes. The program does not clearly document its methods for calculating and projecting GHG benefits or volumes of wood use and does not track incremental results instead only tracking results for the entirety of a project. The assumptions used at the time the estimated targets were developed are not documented.

The document review identified that the program does not measure uptake or usage of knowledge products and research being produced by projects. The program would benefit from a follow-up survey to assess uptake of materials. For future indicators, it will be helpful to consider how success will be measured and what data may need to be collected, as well as allocating budget for any necessary data collection activities. Alternately, the phrasing of targets may need to be reconsidered.

In a future iteration of the program, targets should be set so they can better capture the progress made along the long-term trajectory of code evolution. The methodology and assumptions for quantitative final outcome indicators (i.e., on GHG emissions and use of wood) should be more clearly laid out. Specifically, the program should be specific on methods for calculating and projecting GHG benefits.

In addition, several proponents noted that the reporting requirements for GCWood, although manageable, were somewhat heavy and changed several times during the program. NRCan interviewees as well as funding recipients agreed that a clearer, simpler reporting mechanism is desired. However, NRCan interviewees explained that the program is required to report under various frameworks (e.g., PCF, Forest Sector Competitiveness, Mission Innovation). To satisfy those requirements, the program has to ask for different information from the proponents at different points in time, which contributes to the reporting burden.

Conclusions

The evaluation concludes that there is continuing relevance for the GCWood program, and that it aligns with the needs of the sector for ongoing research, technology transfer and education surrounding mass timber and hybrid construction designs (particularly through demonstration, testing and building code change). The program enables innovation by alleviating ‘first mover’ costs and de-risking investment, a role appropriate for the federal government. As strengthened action on climate change is a whole-of-government effort in Canada, and the main theme of commitments for NRCan’s Minister, the program’s goals for carbon sequestration align well with the departmental mandate.

The GCWood program was delivered as intended and in an efficient manner within its available funding envelope. However, the program did not have enough resources to initially deliver on its commitments and had to engage additional staff (students, part-time and other personnel); in part due to other programs being supported by the staff. The number of FTEs initially assigned to the program turned out to be insufficient as well as the program having limited visibility to distinguish it from other NRCan programs causing confusion. This will need to be considered when designing a future program. The COVID-19 pandemic did cause challenges for the program, in particular delays to the demonstration projects, but the program was able to accommodate proponents through amendments to contribution agreements.

With its governance structure and program processes clearly defined and effective, the program delivery model is sound. The program engaged a variety of stakeholders during design and the implementation of balanced

coverage of the different components included under the program (i.e., different categories of demonstration projects, education initiatives, R&D, and work on code changes) has proven to fill identified gaps.

With fair consideration for the delays caused by the COVID-19 pandemic, the program has succeeded in its production and provision of information and tools for wood use in construction to regulatory agencies, specifiers and other stakeholders directly involved in the sector. Planned activities and outputs have been completed or are reasonably forecast to be completed. Its innovative use of a Creative Commons copyright condition within its contribution agreements has resulted in increasing the amount of publicly available information for all stakeholders. Demonstration projects have also progressed, and the program will have more examples of tall-wood and commercial low-rise buildings, and bridges to contribute to further adoption and commercialization of wood in construction in Canada. The GCWood projects are attracting strong public interest and receiving awards for mass wood construction, increasing visibility which will contribute to enhancing the uptake of wood innovations. Now may be the right time to expand the scope of demonstration objectives to include opportunities for increasingly innovative approaches (e.g., pre-fab use) and additional target audiences for uptake (e.g., public sector).

There is strong evidence that the program has made significant contributions towards revisions to the NBCC including new provisions to allow tall-wood buildings up to 12 storeys and played a key role in having more than 20 other Canadian jurisdictions adopt these code changes. The program continues to work with other federal partners to drive towards a material-neutral, performance-based building code as its target to have shifted to performance-based standards will not be met. Code changes

have occurred more slowly than originally expected given the complex code environment which has created external factors that have impacted or delayed the programs achievements.

While strong achievements have been made by the GCWood program, the evaluation has derived that that some of the targeted outcomes set by the program were ambitious including assessments for total carbon estimates and the volume of wood used. Estimates were based on the results of GCWood demonstration projects but also the impact of replicated projects informed by the demonstrations, anticipated code changes and other research funded by the program. Due to the delayed timelines of most projects, the evaluation could not determine progress towards the carbon sequestration targets or impact on the commercialization of wood.

There were also external factors impacting the ability of the program to achieve its outcomes including supply chain issues and the effect of materials cost. It would be of benefit to the program to investigate how it might assist in mitigating some of these additional pressures on demonstration projects in particular.

Additionally, although the program deployed significant efforts to meet its objectives for knowledge dissemination, the evaluation found that additional work can be done to disseminate tools and research outputs more broadly to a more expansive audience, such as public sector decision-makers, practitioners, entities that commission construction projects, in addition to other adjacent sectors, such as the insurance and finance industries.

Finally, while there is evidence that performance targets are established and tracked for the GCWood program, there are some inconsistencies in the recording of data and potentially some gaps in the identification of necessary indicators to measure progress. This indicates a need to revisit

the program's performance framework, including an opportunity to incorporate GBA Plus considerations (e.g., through Indigenous engagement and data collection) into a future iteration of the program.

Appendix: Evaluation Team

Michel Gould – Chief Audit and Evaluation Executive

Stephanie Kalt – Evaluation Director

Olive Kamanyana – Evaluation Manager

Oluwadamilola Pikuda – Junior Evaluation Analyst

Kira Dlusskaya - Policy Analyst Recruitment and Development Program

Goss Gilroy Inc (GGI) – External consultants

Footnotes

1 NRCan's EMO program had undertaken a TWBDI with a $5M funding envelope from 2013-2017. It was the first of its kind in Canada to issue an expression of interest and then select tall wood projects to be funded.

2 "Wood WORKS! (known as Cecobois in Quebec) is a Canadian Wood Council program, which is industry led and is intended to help increase the use of wood in non-residential, mid-rise, and tall building markets in Canada. The initiative seeks to build proficiency in using wood through training, networking, and direct technical support." Accessed January 6, 2022.

3 The NBCC is developed by the Canadian Commission on Building and Fire Codes and published by the NRC.

4 Construction using wood contributes to emission reduction in two key ways. The first one is through carbon sequestered into the wood itself. The other is carbon emissions avoided by using wood as opposed to other construction material the production and use of which generates more emissions.

5 Forest Products Association of Canada: Recommendations for 2019 Federal Budget (August 2018), page 5.

6 The State of Canada's Forests. Annual Report 2020, page 49.

7 Internal program documentation

8 A Forest Bioeconomy Strategy for Canada, CCFM (2017), page 12.

9 Pan-Canadian Framework on Clean Growth and Climate Change, page 23.

10 NRCan Departmental Plan 2017-2018, page 16.

11 PM Letter to the Minister of Natural Resources, page 5.

12 Pan-Canadian Framework on Clean Growth and Climate Change, page 22.

13 The National Building Code of Canada 2020 was released in the spring of 2022.

Date modified:

2025-02-10