ACW | Adapting Canadian Work and Workplaces

Baseline Reports from the Manufacturing Working Group

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Background

As described in earlier reports, the group is proposing to study three industries: automotive; food processing; and forestry/pulp and paper. Over the last few months we have been able to complete initial research reviews of the automotive and forestry sectors, the research in the food processing sector is underway. The attached reports reflect the research that has been completed and/or planned.

Actions

The next step will be for the manufacturing working group to review research information and determine next steps. This process will include:

1. Identifying projects and assigning leads
2. Determining project methodology and timelines
3. Assigning roles and responsibilities
4. Determining budget needs
5. Assessment and follow-up

ACW | Adapting Canadian Work and Workplaces

ACW Manufacturing Working Group: Auto Industry Baseline Report
Nov, 13, 2015

Membership: The current members of the Auto Industry Group are as follows:
Caleb Goods
John Holmes
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Research Focus
Our research focus is on reducing the greenhouse gas emissions of auto-manufacturing workplaces in Ontario. The Canadian automotive assembly and component industries are almost exclusively concentrated in the south west of Ontario, in close proximity to the large Michigan auto industry (Sweeney 2014). It is critically important to understand that it is difficult to analyze auto-manufacturing workplaces in Ontario without considering the sectors position within the context of the North American auto industry. The Canadian auto industry is deeply embedded within the United States (US) auto sector, as the US is the primarily location for Canadian auto exports. In 2014, approximately 80 per cent of Canada's total automotive export trade by value went to its southern neighbour (Holmes 2015b). Moreover, Canadian auto is shaped by its interconnection with the US and Mexican auto industries, via political economic forces such as trade, government policy and labour relations. The Canadian industry is also altered by wider internal competition for investment within multinational corporations (MNCs). Canadian subsidiaries of MNCs such as Toyota and Ford have increasingly had to compete for investment with Toyota and Ford subsidiaries from Mexico and the US, particularly the southern states of the US, and the lions share of these investments have progressively flowed to Mexico and the US, not Canada (CAPC 2014, Ingjatovic 2013). The geographical and political economic features of the larger North American auto industry need to contextualize any research into the Ontario auto sector. These contextual factors and the current state of the industry are discussed in the following section. Following this, the baseline report outlines the major research challenges of the industry, provides a review of current greening actions in the Ontario auto industry and concludes with a discussion of future research directions.

The Current State of the Canadian Auto Industry

Industry Structure and Key Companies
Automobile production involves a highly complex and sophisticated manufacturing process. The end product – a motor vehicle (and here we are exclusively concerned with cars and light trucks) assembled by an original equipment manufacturer (OEM), such as Ford, GM, Toyota or Honda – is built from literally thousands of discrete parts and modular sub-assemblies supplied by a large array of different firms organized into complex supply chains and production networks. Usually, analyses of the auto industry are organized around its two principal manufacturing segments: the motor vehicle assembly sector and the automotive parts sector.

Five global automakers currently operate automobile assembly facilities in Canada (Table 1). Several of these companies also operate Canadian captive in-house engine and transmission plants. Workers in all of the facilities operated by the so-called Detroit-3 (D3: General Motors of Canada (GMC), Ford Canada and Fiat-Chrysler (FCA) are unionized and represented by Unifor (and formerly, by the Canadian Autoworkers Union - CAW). Toyota and Honda owned facilities have been the target for organizing drives by CAW/Unifor, but remain non-union.

The automotive components and parts industry accounted for over 68,000 of the approximately 108,200 workers employed in the Canadian automotive industry in 2014 (see Table 2).[1] Firms engaged in automotive parts production in Canada can be divided into three broad groupings: (1) foreign-owned (especially US, Japanese, and European) global parts producers (e.g. Aisin Seiki; JCI; Brose; Dana; DENSO; Lear; Toyoda Gosei), (2) a handful of Canadian-owned parts producers that also have a significant global presence (e.g. Magna International, Linamar, Martinrea; ABC; Woodbridge), and, (3) a much larger number of small and medium sized Canadian-owned firms. Union density in the automotive parts sector (which would include the D-3 captive parts facilities) has declined over the last two decades and is now thought to stand at less than 40 percent.

Automotive component companies are commonly referred to as Tier 1, Tier 2, or lower tier suppliers. These labels refer to the commercial distance between the supplier and the OEM. Tier 1 companies supply automotive components or sub-systems directly to the assembly plant(s) of their OEM customers. Tier 2 suppliers typically provide components to the Tier 1 suppliers rather than supplying directly to the OEM and, in turn, lower tier suppliers provide more discrete and usually less complex parts to Tier 2 suppliers.[2] In addition to the tiered component manufacturers, there are also raw material providers which supply basic materials such as steel, glass, aluminum, resin, paint or rubber both directly to OEMs and to suppliers at various levels in the automotive supply chain.[3]

In Canada, all the vehicle assembly plants and over 90 percent of parts plants are located within a narrow 420km. corridor in southern Ontario that stretches from Windsor (directly across the border from Detroit) in the west to Oshawa (just east of Toronto) in the east. In essence, this corridor is the cross-border extension of, and functionally highly integrated with, the automotive regional production cluster centred on the US Great Lakes States (Michigan, Ohio, Indiana, and Illinois). Today, this regionally integrated production system competes for new investment within North America with other major automotive clusters located in the southern US and in Mexico. Thus, the fortunes of the Canadian automotive

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[1] The source for these employment numbers is the Survey of Employment, Payrolls and Hours (SEPH) found in CANSIM 281-0024. The Annual Survey of Manufacturers and Logging (ASML) found in CANSIM 301-0006 is an alternative source of data but with a longer time lag in the release of data. In both these surveys, Statistics Canada collects data on the basis of the North American Industry Classification System (NAICS). For the purposes of this report, the following NAICS industries are used: NAICS 3361 Automobile and Light-Duty Motor Vehicle Manufacturing and NAICS 3363 Motor Vehicle Parts Manufacturing. NAICS 3363 can be further subdivided at the 6-digit classification level into sub-industries such engine and engine parts, brake systems, seating and interior trim, metal stampings, etc. At one time, the automotive plastic parts industry was also classified under NAICS 3363 but subsequently was moved and nested under plastic products; NAICS 3261. The data presented here for NAICS 3363 do NOT include automotive plastic parts (NAICS 326193) for which data are not provided in the SEPH. Our best estimate of employment in the automotive plastic parts industry based on the ASML is between 12,000-13,000.

[2] However, these divisions are seldom black and white. A single parts manufacturer, for example, may be both a Tier 1 supplier to an OEM and a Tier 2 supplier to another Tier 1 company, or may be a Tier 1 supplier for one product and a Tier 2 supplier for a different product line.

[3] Typically, an OEM or Tier 1 supplier will negotiate preferred prices with raw material suppliers on behalf of its suppliers

industry are inexorably linked to the overall competitive performance of the broader Great Lakes regional cluster.

Recent Economic Performance

Output and Employment: The automotive industry in Canada experienced a significant expansion during the 1980s and 1990s and vehicle production peaked in 1999 at 3.057 million cars and light-trucks. After 2000, output and employment began to fall, first in the vehicle assembly sector and then in the automotive parts sector (see Table 3, and Figures 1 and 2). By 2008, output in Canada had fallen to 2.082 million vehicles; over 30 percent less than the peak attained in 1999 (see Table 3). Similarly, the value of manufactured shipments from the automotive parts sector fell by almost 50 percent between 2005 and 2009 (see Figure 2). The decline culminated in a precipitous fall in output and employment during the 2008-09 global financial crisis and accompanying 'Great Recession' (see Figures 1 and 2). An outright collapse of the automotive industry in Canada and the US was only averted by the financial intervention of governments in both countries in 2009 to facilitate the bankruptcy restructuring of General Motors (GM) and Chrysler. In the period since the Great Recession, recovery in both the auto assembly and parts industries has been much more muted in Canada as compared with the U.S. and Mexico. Canadian automotive employment levels in 2014 remained significantly below those in 2007 on the eve of the 2008-09 crisis (see Figure 1).

Automotive Trade: Trade policy and trade agreements, especially in relationship to the United States, have always played a significant role in shaping the growth of the Canadian auto industry (Imperial Preference (pre-WW II), the Auto Pact (1965), the Canada-US Free Trade Agreement (1989), NAFTA (1994)). The recent agreement in principle to establish a Trans-Pacific Partnership (TPP) agreement promises to have a major impact on the Canadian automotive industry (see below).

Canada consistently ran surpluses between 1982 and 2006 on its aggregate automotive trade with the rest of the world, but in 2007, on the eve of the global financial crisis, the automotive trade balance turned negative. The surplus had peaked at $14.6 billion in 1999; by 2014 the deficit stood at $10.3 billion (see Figure 3).[4] Canada's automotive trading relationship with the United States still exercises a major influence on the overall trade balance. During the 1990s, the large and growing surplus in vehicle trade with the US significantly outweighed negative balances in automotive parts with the US and much smaller but growing deficits in automotive trade (both vehicles and parts) with other countries (especially Japan, Mexico and the EU) (see Figure 3). After 1999, Canada's overall positive balance in automotive trade was steadily eroded as the positive balance with the US fell and the negative balances with other countries continued to increase.[5] Since 2007, Canada has registered persistent negative balances on its overall automotive trade. Diminished vehicle trade surpluses with the US are no longer sufficient to offset the negative balances in vehicles with every other country combined with the negative balances in parts with all countries, including the US. Imports of both vehicles and parts from Mexico and parts from Japan, China and Korea have all risen sharply. In 2014, the value of Canadian automotive parts exports was approximately 25 percent lower than in 2004 due to a

[4] Although $10 billion appears a large number, it represents only 7.2 percent of the value of Canada's total automotive trade (i.e. total value of exports plus imports);

[5] For a more detailed analysis see Holmes (2015b) *Whatever Happened to Canada's Automotive Trade Surplus? A Preliminary Note.* McMaster University: Automotive Policy Research Centre.

combination of the rising value of the Canadian dollar, the closing of Canadian parts plants during the Great Recession, and the logistical challenges faced by Canadian plants in supplying the southward shift in the centre of gravity of North American assembly capacity.[6] Canada's automotive trade deficit is only likely to further deepen, unless Canada is able to recapture a larger proportion of North American vehicle production by attracting investment into new assembly capacity. Recent developments in the industry are worrying. The threat of a further reduction in Canadian assembly capacity is very real given continuing uncertainty regarding the future of GM Oshawa assembly facilities and the FCA Bramalea car plant. The closing of one or more of these plants would significantly erode Canada's remaining positive vehicle trade balance with the US. At the same time, recent Canadian trade deals with South Korea and the EU could well result in a worsening of automotive trade balances for Canada and now the industry also has the TPP to contend with.

If ratified and implemented, the TPP deal announced on October 5, 2015 will in all likelihood have a profound negative impact on automotive production in Canada. The TPP will replace the NAFTA domestic (i.e. North American) content rules governing the tariff free movement of automotive products (62.5% for vehicles and 60% for automotive parts) with much lower TPP regional (i.e. from within the 12 TPP countries) content rules (45% for cars; 45% for "core" automotive parts; 40% for "other" parts and 35% for a further, as yet unspecified, grouping of parts). The following is a very preliminary analysis of how the TPP may impact the Canadian automotive industry[7]:

- The removal of the existing 6.1% tariff on vehicles imported from Japan could increase the North American market share of Japanese sourced vehicles at the expense of vehicles currently assembled in Canada (and the other NAFTA countries);
- Since the vast majority of automotive parts produced in Canada are used for the assembly of vehicles within North America, and even more particularly within the Great Lakes Region, any reduction in the number of vehicles assembled in North America will adversely impact the Canadian automotive parts industry;
- The TPP will allow OEMs (especially Japanese OEMs, such as Toyota, which already have well-developed networks of component suppliers in Asia) to source more parts from low-cost countries from either within the TPP (e.g. Vietnam, Malaysia) or outside (e.g. Thailand, China, Indonesia);
- opportunities to supply vehicle assembly plants in TPP markets outside of North America will open up for large Canadian-owned suppliers (e.g. Magna International, Linamar Martinrea etc.); companies with multinational footprints and access to mobile capital. Whilst such companies may well benefit and grow as a result of the TPP, their expansion will occur mostly outside of Canada. Not only will this create no new employment in the Canadian parts sector but they may well replace some components currently produced in their Canadian plants with parts produced within the TPP leading to a loss of Canadian employment;
- small and medium sized Canadian companies which primarily supply discrete and mostly lower-valued parts to vehicle assembly supply chains in Ontario and the broader Great Lakes Region will face new competitive pressure from large,

[6] Increasingly, Canadian-owned companies are shifting production to newly opened or expanded parts plants in the southern US and Mexico to overcome the logistically challenges in supplying assembly plants in the southern US and Mexico from their existing plants in Ontario.

[7] Pending full disclosure of the content of the TPP agreement as it pertains to the automotive industry.

multinational firms from TPP countries and elsewhere. This is the sector of the Canadian automotive industry considered most vulnerable under the TPP.

Collective Bargaining in the Automotive Industry[8]

Today, auto industry labour relations in Canada and the US are governed by very similar basic legal frameworks that emerged from the institutional restructuring of the 1930s. The archetypal Fordist auto labour relations system implemented after WW II produced a distinctive and highly uniform pattern of wages and workplace governance that persisted across the auto industry in the US and Canada well into the 1980s.[9] In the last couple of decades, however, the North American automotive labour relations landscape has been significantly transformed. Here, we focus on developments since 2000 and their impact on the automotive industry in Canada. However, it is impossible to discuss collective bargaining outcomes in Canada without reference to parallel bargaining by the United Auto Workers (UAW) in the United States.

In the 2000s, the D-3 and their unions (UAW and CAW) faced growing challenges precipitated by the D-3's continued loss of market share to transnational automakers and the failure by the two unions to organize the expanding transplant assembly sector or make significant inroads into the growing non-union component sector. The decade saw a substantial decline in employment in D-3 assembly plants and their key suppliers, significantly reduced wages and benefits for new hires, and numerous other contract concessions. By 2008, there were 435,000 fewer jobs in the US automotive sector as compared to 2000 and automotive employment in Canada fell by 36 percent between 2001 and 2009. Canada was faced with the steady erosion of the labour cost advantage it had enjoyed over the US in earlier decades as the value of Canadian dollar rose and the D-3 in the US off-loaded their health care costs and retiree benefits onto the UAW. Consequently, the CAW was forced to accept local concessions in efforts to secure new investment; a sharp reversal of the union's "no concessions" stance of the 1980s and 1990s.

What Chaison (2012) terms ultra-concessionary bargaining began in the auto sector in 2005 when the auto parts maker Delphi slashed existing wages and introduced two-tier wages such that newly hired workers would receive lower wages and benefits and never catch-up to existing workers. This was followed in 2007 by the UAW agreeing to two tier wages and benefits for "non-core" workers and the shifting of retiree health costs onto the union. In its 2008 round of bargaining with the D-3, the CAW did not agree to a permanent two-tier wage and benefit system but did agree to extend the time that it took for a new hire to reach the full job-rate and full benefits. In addition, the CAW agreed to a wage freeze, the suspension of Cost of Living Allowances (COLA), cuts to paid time-off, and, like the UAW, agreed to takeover retiree health costs (Holmes 2015a).

The 2008-09 global financial crisis and the impending bankruptcy of GM and Chrysler permitted the automakers, aided in a very significant and unprecedented way by the state, to extract further deep concessions from both the UAW and CAW. A crucial condition placed by both US and Canadian governments on the loans made to GM and Chrysler to assist their restructuring under bankruptcy protection was the requirement to bring 'all-in' labour costs at GM and Chrysler in line with the North American transplant operations of Toyota. In the US, besides 12 major plants closures, the concessions included the suspension until 2015 of the right to strike by UAW workers at GM and Chrysler, the reduction of hourly employment

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[8] This sections draws heavily on Holmes (2015a)

[9] For descriptions of this system see Katz (1985) and Holmes (1991)

by 50 percent compared to 2005 levels, and the implementation of two-tier labour contracts for *all* newly hired workers. Together with earlier bargaining concessions, these contract concessions significantly narrowed the gap in all-in labour costs in the US between the D-3 and the long established Toyota and Honda plants in Ohio, Kentucky and Ontario (see Stanford 2012).[10] In Canada, 3 major plants were scheduled to close, employment was slashed by 50 percent compared to 2005, and limits were placed on supplementary unemployment benefits (SUBs), but the right to strike was retained.

Heading into bargaining in Canada in 2012, the D-3 claimed that Canadian labour costs were now 20 per cent above the US and demanded this gap be closed in part by moving to a US-style two-tier employment structure. In the negotiated 4 year agreement, the CAW agreed to a freeze of base wages and suspension of COLA and, although it again rejected a permanent two-tier wage structure, the union did agree to a modified structure. New hires start at 60 per cent and only reach the full hourly rate after 10 years. In addition, they also have a less generous pension plan.

The impact of the development of the two-tier wage and benefits structure for US unionized autoworkers is now significant when comparing all-in labour costs between Canadian and US auto plants. In Canada, newly hired D-3 autoworkers start at around $20.00/hour and after 10 years achieve the top rate of $34.00. In the US, D-3 unionized production workers hired prior to the introduction of two tier have had their hourly wage frozen at $28.69 for almost a decade. Unionized production workers hired since 2007 are permanently stuck on a lower tier and make between $15.78 and $19.28 per hour doing the same jobs as Tier 1 workers they work alongside. The US parts sector is overwhelmingly non-union as are the transplant assemblers. The average hourly rate for non-union autoworkers is estimated to be $16.60. Recently, the Centre for Automotive Research (CAR) estimated that 45 percent of Chrysler workers were currently lower tier compared with 25 percent at Ford and 20 percent at GM. Two tier has been a major issue in the UAW 2015 round of bargaining that is just being concluded at the target company – FCA. In Canada, Unifor does not bargain with the D-3 until next year (2016) but the union's urgent need to secure new product commitments for both GM Oshawa and FCA Bramalea and the employers likely demands to reduce labour costs are two issues likely to dominate bargaining.

Although the auto industry in North America has recovered from the deep recession in 2008-09, union membership in the auto sector in both the US and Canada has been reduced to a shadow of its former self. As more transplants come on stream in the US South and Mexico, unionized assembly plants now account for barely half of total vehicle output in North America.[11] The significant wage premium over the manufacturing average that autoworkers once enjoyed has been greatly reduced. Given these trends, it is unlikely that the UAW and Unifor will ever regain either the membership numbers or the considerable power and influence they once enjoyed in shaping labour relations and employment practices; not only in the auto industry but also across the broader manufacturing economy.

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[10] Note, however, that newer transplants in such as the recently opened VW and KIA assembly plants in Tennessee and Georgia have lower wage rates in the $14 -$20/hour range.

[11] Of the 10 new assembly plants opened or announced in the US between 1997 and 2012, 8 were in right-to-work states and the other 2 were in Indiana which enacted right-to-work legislation in 2012 (Klier and Rubenstein 2010). Auto industry growth in Mexico has been phenomenal since 2008 and Mexico now produces significantly more vehicles than Canada.

Research Challenges

As is obvious from the outline of the Canadian automotive industry above, the automotive industry is globalized, fragmented and therefore highly complex. As Dicken points out, 'the automobile industry is a veritable spider web of short – and long-term technical and marketing alliances in a continuous state of flux' (2011, 346). Assessing climate change impacts and identifying the workplaces where greenhouse gases (GHGs) may be reduced across the global production networks of automotive manufacturing represents as significant challenge. A recent report suggests that 95 per cent of environmental impacts in the automotive and parts industry occur in the supply chain (GreenBiz Group 2015). Focusing our attention on the Ontario industry, as outlined above, provides a more manageable research landscape, but even here there are a number of substantial issues that need to be considered. These issues are discussed below.

Final Assembly Versus Componentry

The component and assembly sectors, although deeply interconnected, have marked differences. Vehicle assemblers have large workforces concentrated in a small number of assembly plants (see table 1). The component sector is more fragmented, there are approximately 637 part suppliers in Canada (Sweeney 2014), and component firm size and employee numbers range from large international suppliers, such as Magna, to small Canadian owned producers. This variability in the component sector also translates to a fragmentation of environmental impacts, whereby the GHGs of the component supply network are collectively significant, a noted above, however efforts to reduce GHGs within particular workplaces may results in little GHG reductions. Moreover, locating emission 'hotspots' within the highly complex component supply network is likely to be difficult. Final assembly plants are more discrete workplaces where environmental impacts, such as energy use, GHG emissions associated with finished products (paint) and water usage may be easier to assess and improve. However, the overall environmental impacts of assembly plants are possibly less significant than the component network. Final assemblers are large multinational corporations who have greater capacity, compared with the component industry, to pursue design, production and industry environmental change. Other noteworthy points of difference between the component and assembly sectors are unionization of workplaces, a smaller number of workers in the component sector are unionized, and policy context – government policy actions (both in terms of environmental actions and industry support) tend to focus more on the vehicle assembly segment.

Production Versus Use GHGs

The production of internal combustion engine (ICE) vehicles only accounts for between 1/3 and 1/4 of the life cycle emissions of a vehicle – the rest is associated with the use of the vehicle, primarily the burning of fossil fuels (Ricardo 2011). For example, a report by the Ontario Environmental Commissioner found that 35 per cent of Ontario's total emissions came from transportation, making transport the largest source of GHG emissions within the Province (Schwartzel 2015). Greening production is therefore only part of the GHG automotive story. Moreover, the source of manufacturing GHGs and other environmental impacts is highly fragmented between upstream production, in the form of; plastics and chemicals, steel, aluminium, rubber and glass; and component and final assembly segments noted above. Indeed, the global automobile industry is 'responsible for almost half the world's oil consumption, and their manufacture uses up nearly half the world's output of rubber, 25% of its glass and 15% of its steel' (Dicken 2007:278). There are also arguments that the environmental impacts of fossil fuels generated by the use of vehicles ("tank to wheel") should extend further to encompass the overall impacts of fuel production ("well to wheel") (Clement and Evans 2014). This is particularly pertinent for alternative fuels. For example, an electric vehicle (EV) offers a substantial greenhouse gas emission improvement from the internal combustion engine. However, this upgrading depends upon green electricity production. An EV powered by average European electricity production is likely to reduce a vehicles global warming potential by approximately 20% over its life cycle (Hawkins et al. 2013). Equally, there is also significant hope for the development of low emission alternative fuels such as biofuels (Mikler 2009:66). However, a number of problems surround the use of biofuels, such as the destruction of ecosystems for biofuel crop plantations, the impact of turning food sources into fuel, using arable land for fuel crops rather than food and the negligible environment benefits of such alternative fuels. Indeed, there is evidence to suggest that when all environmental costs are factored into the production of biofuels, particularly fuels created from corn, soy or sugarcane, greenhouse gas emissions as an aggregate can be higher from biofuels than from ordinary petroleum (Scharlemann and Laurance 2008).

Growth of New and Disruptive Technologies

The growing shift to electrification as well as other revolutionary (disruptive) technological developments such as fuel cells is changing the industry. These changes will have major impacts on GHG emissions in the auto global production network and likely cause changes to aspects of the labour process and production network. For example, electrification will shift emissions from the use of cars to the electricity network; the growing battery auto sector associated with electrification may be dominated by new and non-auto manufacturers. New technologies may result in auto production emissions becoming more important in the overall lifecycle of vehicles. For example, battery production is generally more emission intensive but the use of battery-powered vehicles produces less GHGs, depending on the recharge energy source. Current efforts to make vehicles more fuel efficient via incremental technology shifts are already resulting in the growing use of different technologies and products, such as composite metals, carbon-fiber, aluminium and a move from heavy mechanical systems to lighter electrical systems. Indeed, the growth of electronics and information technologies within cars has the potentially to dramatically transform vehicles, the industry and current transport systems. Present efforts to develop semi-autonomous or autonomous vehicles are at the forefront of this IT transportation system shift. Both Google and Apple are developing autonomous vehicles that operate more like smartphones (The Economist 2014). For example, you may use an application on your smartphone to connect with a car close by to pick you up from work and as the car drives you to your next destination it communicates with other smart devices and vehicles to plan and execute the route. Such technologies have the potential to change car ownership and buying patterns, reduce congestion and may improve environmental performance. Canadian IT firms and auto component manufacturers are already seeking to develop these forms of smart vehicle technologies via the Connected Car project (Munim and Yates 2015). Where, how, by who, and indeed if these new technologies are mass-produced remains highly uncertain. Moreover, the environmental performance of such vehicles is unknown, but to date, these projects have been promoted more on the grounds of safety than ecological benefit.

Work Design

The automotive industry has been at the forefront of workplace organization and labour process design and redesign since Ford introduced the moving production line in the early twentieth century (Dassbach 2006) and Japanese manufacturers revolutionized the prevailing Fordist organization of work in the 1980s via 'just-in-time' (JIT) and lean production techniques. Beyond the more recent stripping back of wages, conditions and the collective power of unionized workers outlined above, efficiency and productivity gains associated with streamlining the labour and manufacturing processes have been connected by the industry to continuous improvements in the environmental performance of the auto workplace (Goods 2014:170). Indeed, highly flexible production lines allow auto assembly plants to produce a range of vehicles on one production line. Toyota Japan has also developed shorter production lines and 'shrunk' the size of some of its factories to reduce energy usage by up to 30 per cent (Goods 2014:140). Conversely, the JIT system demands the constant transportation of components between and within the highly fragmented production networks of the global automotive industry. Increasing automation and the potential impact of disruptive technologies, as outline above, suggests that the future of work in the automotive industry, in the long term, contains significant uncertainties and the need to green workplaces may add to this uncertainty. However, in the short-term automakers do not foresee significant work and labour process changes (Holmes and Hracs 2013).

Environmental Impacts Associated with the Auto Industrial Complex

The population of the United States 'alone now spend well over a *trillion* dollars every single year buying, equipping, fixing, fuelling, parking, insuring, and road building for their cars' (Dawson 2011:272). In 2009, there are 700 million passenger vehicles in the world and this is predicted to increase to 1.1 billion by 2020 (Mikler 2009:6). Research by the National Aeronautics and Space Administration (NASA) concluded, 'motor vehicles emerged as the greatest contributor to atmospheric warming now and in the near term. Cars, buses, and trucks release pollutants and greenhouse gases that promote warming, while emitting few aerosols that counteract it' (Voiland 2010). Globally, it is estimated that vehicle transportation accounts for '23-25 per cent of total carbon dioxide' emissions (Mikler 2009:4) and passenger motor vehicles are single-handedly responsible for one-tenth of global greenhouse gas emissions (World Resource Institute 2005). Vehicle exhaust emissions are also responsible for the majority of carbon monoxide and nitrogen oxide emission, sulphur oxide emissions which are a major contributor to acid rain (Mikler 2009). In 2009, 14 million cars were scrapped in the United States (Goldenberg 2010). Vehicle emissions are also a major cause of air pollution, which has substantial impacts on human health. Vehicle emissions have been associated with reduced fetal growth, asthma and other respiratory problems, cardiovascular mortality and some forms of cancer such as leukaemia and lung (Pereira et al. 2011, Boothe and Shendell 2008). The infrastructure associated with vehicle use, particularly roads, also makes a significant contribution to the destruction of ecosystems (Wells 2010:28). Moreover, the industry is deeply embedded within the exploitation of natural resources, particularly fossil fuels, and intersects with broader socio-political and economic issues such as the under or de- funding of public transit and sprawling urbanisation (Paterson 2007). This leads to the question - can auto ever be green? The answer to this question is unknowable, however what we can conclude is that the challenge of climate change requires immediate actions, reducing the GHGs of the auto industry, and transportation emission more generally, is a crucial step in this task.

Where Does All This Lead Us?

Canadian automotive manufacturing and efforts to reduce the GHGs of automotive workplaces encompasses a broad range of issues and research challenges. There is a need to draw further research boundaries around the Ontario auto industry and its green possibilities. For this reason our research focus will be on the final assembly plants of Ontario auto manufacturers. See Table 1 for the list of final assembly plants in Ontario. We have elected to focus on reducing greenhouse gas emissions in the assembly segment of the industry for both practical research and environmental reasons. Assembly plants are large, discrete workplace, many have unionized workforce and offer the best chance of gaining access to the industry. Environmentally, as outlined above, assemblers are large consumers of energy and they are, at this time, the primary drivers and purchases of industry environmental innovation and the focus of government industry and environmental policy.

Federal Policy Response

There has been a small reduction is Canadian transportation emission (see Table 4), which is meaningful in the context of growing vehicle ownership across Canada. This reduction in emissions is primarily due to the legislating of stronger vehicle emissions standard by the Canadian Government, in partnership with US Government, after the 2008 global financial crisis. The latest regulation requires that new vehicles achieve an average of 35.5 miles to the gallon or 15km per litre by 2016, representing a 25 per cent improvement upon the existing standard (Goods 2014). Because this is a fleet wide average inefficient vehicles such as the Ford F150 (which achieves approximately 22 mile per gallon) will continue to be sold despite falling well below the required efficiency level. Moreover, Holmes and Hracs note the new standards require a 15 per cent reduction in carbon dioxide emissions by 2016, with average vehicle carbon emissions limited to no more than 250 gram per mile or 155g per km (Holmes and Hracs 2013). Placing this in the international context this standard does not fall dramatically behind worlds best practise found in Europe, where the European-wide target for 2015 is 130g/km, although this is set to increase to 95 g/km by 2020 (National Transport Commission 2014).

The Canadian Government has also provided 'green' support to the local automotive industry via the Automotive Innovation Fund (AIF), which was first established in 2008 with a budget of $CAD250 million to operate for five years. According to the federal government, the purpose of programme is 'support automotive firms' strategic, large-scale research and development projects to build innovative, greener, more fuel-efficient vehicles' (Government of Canada 2014b). On 4 January 2014, Prime Minister Harper announced the extension of the AIF for a further five year with an addition $CAD250 million in funding, twelve months later the Canadian government announced an additional $500 million over two years for the programme to 'support significant new strategic research and development projects' (Government of Canada 2014b). Funding under the programme requires:

> Recipients are corporations incorporated pursuant to the laws of Canada carrying on business in Canada with proposals for private sector investments in Canada valued at more than $75 million over five years, for vehicle or powertrain assembly operations associated with significant automotive innovation and R&D initiatives. Automotive innovation and R&D initiatives other than vehicle or powertrain assembly are also eligible provided they meet the $75 million threshold (Government of Canada 2014a).

Projects eligible for funding must involve initiatives to develop and build greener, more fuel-efficient vehicles, with the following examples provided:

- new product development, e.g., advanced emissions technologies, energy efficient engines and transmissions, advanced materials, including engineered plastics, light weight components and materials;
- leading edge engineering and design, prototype development;

- advanced product testing with a view to ensuring cleaner, more efficient automotive performance and reduced greenhouse gases;
- the development of new production methods and process technologies, including advanced flexible manufacturing techniques;
- new or expanded facilities to produce leading-edge and more energy efficient vehicles and powertrains;
- substantive investments in new flexible manufacturing processes; and introduction of other transformative new production technologies to substantially increase productivity and efficiency (e.g., robotics, advanced IT systems, etc.) (Government of Canada 2014a).

Thus far, seven projects have received funding since 2008 under the AIF, the details of which are outlined in Table 5. Some of these projects have also received funding from the Provincial Ontario Government.

Provincial Level

There is no specific Provincial industry policy focused on improving the environmental performance of the automotive industry in Ontario. Ontario does have an industry assistance policy 'Southwestern Ontario Development Fund' that is available to a range of industries including automotive manufacturing. The policy is not linked to achieving environmental objectives, although clean technology is provided as an example of an eligible funding initiative. There does not appear to be a set pool of money for the industry programme, but funding per project is capped at a $ CAD1.5 million.

The Ontario Government also has a *Jobs and Prosperity Fund* which is scheduled to provide $ CAD2.5 billion over 10 years to enhance productivity, bolster innovation and grow Ontario's exports. Again, there is no explicit focus on the auto industry or climate change.

Industry Response

Inline with the research challenges and current directions outlined above, vehicle assemblers operating in Canada have focused on technological solutions (such as improving fuel efficiency and developing alternative propulsion systems) that revolve around the environmental impacts of car usage, primarily GHGs. To a lesser degree, vehicle assemblers also highlight environmental improvements they have made at their manufacturing operations in Canada, the most significant of which are outlined below.

GM

GM Canada's Oshawa and St Catherine's facilities signed up to a voluntary Environmental Protection Agency (EPA) Energy Star Challenge to reduce emissions to reduce energy used per unit of production by at least 10 percent within five years (GM Canada). This was achieved by:

- Converting various areas to LED lighting
- Upgrading various motors and drives on equipment to be more efficient

Other workplace environmental actions at GM Canada's facilities include reducing volatile paint shop emissions by over 80% since 2005, diverting material from landfill and significantly increasing recycling rates. GM also states that it is working with its suppliers to improve environmental outcomes in its supply chain, but there is no specific details provided (GM Canada 2015a).

Toyota

Toyota Canada launched a $27 million Combined Heat and Power (CHP) initiative at their Cambridge plant that is due to come online in 2015, it is projected to save enough energy each year to power more than 7,400 homes and has been described as the largest energy saving initiatives ever developed in Ontario (Toyota North America 2014:45). The Toyota facility has also introduced water recycling processes to its paint shop to reduce water usage by 400,000 liters annually. These and other environmental measures are linked to existing work design and labour process practices via the concept of the 'Toyota Way' or 'Kaizen'.

Honda
Currently recycles 99% of its production waste, has achieved ISO 14001 certification, and has set process optimization and energy efficiency targets for 2020; however the details of these targets are not publically available (Honda Canada 2015).

Ford
The Oakville Assembly Plant in Canada was the first Ford North American vehicle assembly plant to achieve zero waste to landfill status, and now all Ford manufacturing operations in Canada have achieved zero waste to landfill (Ford Motor Company 2014:287).

Chrysler
There was little or no information available online regarding Chrysler's Canadian operations and environmental improvements, there is only broader information highlighting improvements across their global operations.

Organised Labour's Response
Unifor, formerly the Canadian Auto Workers (CAW) has not updated its environmental policy since the formation of Unifor, the below discussion therefore primarily focuses on the work of the CAW.

The CAW initially responded positively with regard to pursuing a green shift within the Canadian automotive industry. It supported the Kyoto Protocol, advocated the job benefits of greener manufacturing, and adopted a policy that recognised that the ecological crisis required a shift away from a 'business as usual' approach (Nugent 2011:64-5). In a 2007 report, *Climate Change and Our Jobs: Finding the Right Balance*, the CAW outlined a range of options which it considered would be essential for the long-term greening of the automotive industry and creation of green jobs (2007:14):

- Lighter materials
- More efficient engines and transmission
- High-powered battery systems
- Improved vehicle maintenance
- Clean diesel engines
- Biofuels
- Hybrid engine systems
- Electric vehicles
- Fuel cells
- End-of-life recycling requirements for automotive producers

Some local actions were subsequently undertaken by the CAW. In 2011, the CAW launched a four-day pilot education program to inform small groups of members about climate change, its impact on work and the economy, and what effect a transformation to a green economy would have on workers (Canadian Auto Workers 2011). Windsor CAW Local 444 was also part of a multi-stakeholder group trying to promote new investments in "green" manufacturing products in the Windsor area.

The CAW has been criticised by environmental groups and academics in recent years for backing away from its green stance and adopting a more job-defensive approach (Nugent 2011, Hrynyshyn and Ross 2011). This defensive shift developed out of a restructuring of automotive manufacturing in Canada in the 2000s, as outlined above, which resulted in significant job cuts, growing competition from Mexico and the southern states of the US and a move to producing larger vehicles (Nugent 2011:67). The CAW's green position was placed under further pressure as the global financial crisis caused job and production cuts across the industry. Unsurprisingly, the position of the CAW shifted to a survival focus. The Canadian automotive industry and its members' jobs have also become more reliant on the production of profitable SUVs and pickup trucks. Nugent suggests that this has led the CAW to 'engage a defensive corporatist strategy that has...generally [adhered] to the adage that what is good for GM is good for GM workers and their communities' (2011:67). This resulted in the now former CAW National President stating that the environment is important 'but our members' jobs are much more important' (Hargrove 2007), that 'green cars can come in big packages' (Hargrove 2004), and that the policies of environmentalists were green 'insanity' (Nugent 2011:68).

In 2012, the CAW released a position paper 'Re-Thinking Canada's Auto Industry', with a section dedicated to the union's environmental position. The union broadly commits to the need for continued environmental improvement and argues that with the right action, greening the industry can benefit the environment and workers interests as new green vehicles require additional advanced technologies that can be made in Canada. These right actions include:

- Industry policy that '[r]ecognize and support the need for sustainable vehicles, and combine regulations with made in- Canada content of green vehicles & components' (CAW 2012:31).
- Incentives to trade-in highly polluting vehicles.
- Extending the responsibility of car producers so they become responsible for the end of vehicle life recycling process.

CAW/Unifor Green EBA Clauses

Based on the data available, CAW/Unifor have sought to include two 'green clauses' in enterprise bargaining agreements (EBAs) negotiated with the D-3. The first clauses sets up a fund, paid for by the employer, for environmental related training and issues, this fund also cover other issues such as occupational health and safety. The second clause focuses on the establishment of a workplace environmental committee consisting of two union representatives and two company representatives. Beyond general procedural processes, the clauses outlining the workplace environmental committee establish that the committee:

1. Review and discuss issues involving the environment, recycling and energy conservation which pertain to employees.
2. Discuss and make recommendations regarding potential future programs for the plant concerning the environment, recycling and energy conservation.
3. Promote and support ongoing programs in the plants relating to the environment.

4. Receive and discuss appropriate issues referred to them by the employees or the Company.
5. Develop and issue educational materials to employees and their families concerning the environment, recycling and energy conservation.
6. Receive environmental training from the Company during the annual meeting.

It is not known if these environmental committees are actually operational.

Proposed Research Agenda

As stated above, given the complexity of the automotive industry we have determined that the research agenda at present will primarily focus on the assembly plants of the OEMs. From here our proposed research agenda moves in two directions:

The first research agenda item comes from a clear recognition that we simply do not know what environmental actions, if any, are taking place within OEMs. It is therefore critical that we establish what is happening with OEMs and once this is established outline possible future environment actions. Thus, the first research question is:

1. How do workplace environmental actions with OEMs currently function, if they exist, and what workplace actions could be taken to 'green' auto work and worker places?

Some subsequent questions that flow from this include:
-What role do the workforce and/or union play in green workplace initiatives (i.e. EBA)?
-Are there any differences between workplaces in terms of environmental actions and worker engagement?

The second research agenda is based on our understanding that the long term future of Ontario's auto manufacturing industry is highly uncertain and faces significant challenges, particularly in the milieu of the ecological crisis and the global shift in automotive manufacturing to lower cost destinations. In this context our second research question is:

2. How can autoworkers, and more broadly the Ontario auto industry, be transitioned into the green economy in Ontario over the medium to long term?

Some subsequent questions that flow from this include:
-What are the opportunities for employment in a green economy for former autosector workers?
-How do they understand their role in the shift to a green economy?
-What role do labour unions and policy makers play in the development of workforce and skills training in the green economy?

Both of these research agenda items require us to engage with key actors, such as; auto workers, policy makers, unions; auto companies and industry groups. We envisage that a large number of in-depth qualitative interviews will be required to adequately respond to the above and emergent research questions.

Table 1: Vehicle Assembly Plants, Canada, 2015

Company	Location	Vehicles Assembled
FCA Canada (Fiat Chrysler)	Brampton, ON	Chrysler 300; Dodge Challenger; Dodge Charger
	Windsor, ON	Dodge Grand Caravan; Chrysler Town and Country; Cargo Van
GM Canada	Oshawa, ON	Chevrolet Equinox; Chevrolet Impala
	Oshawa, ON	Buick Regal; Chevrolet Camaro; Chevrolet Impala; Cadillac XTS
	Ingersoll, ON*	Chevrolet Equinox; GMC Terrain
Ford Canada	Oakville, ON	Ford Edge; Ford Flex; Lincoln MKT; Lincoln MKX
Honda Canada Manufacturing	Plant 1 Alliston, ON	Honda Civic
	Plant 2 Alliston, ON	Honda Civic, Honda CRV
Toyota Motor Manufacturing Canada (TMMC)	North Plant Cambridge, ON	Toyota Corolla
	South Plant Cambridge, ON	Lexus RX350, Lexus RX450h
	Woodstock, ON	Toyota RAV4; Toyota RAV4EV

* Formerly GM-Suzuki joint-venture, now solely GM
Source: Industry Canada, May 2015

Table 2: Automotive Employment, Canada: 2001-2014

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Vehicle Assembly (NAICS 3361)	53,204	52,038	49,971	50,114	49,808	47,460	47,481	42,172	35,617	37,188	37,401	37,207	38,880	40,161
Automotive Parts (NAICS 3363)	98,869	96,777	98,306	97,317	96,514	92,292	87,311	79,358	61,191	60,600	61,529	64,361	65,028	68,078
Total	152,073	148,815	148,277	147,431	146,322	139,752	134,792	121,530	96,808	97,788	98,930	101,568	103,908	108,239

Source: Statistics Canada: CANSIM 281-0024

Table 3: Automobile and Light-Duty Motor Vehicle Production, North America: 1999-2014 (Thousands)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
USA	13,025	12,800	11,425	12,280	12,1151	11,989	11,947	11,264	10,781	8,694	5,731	7,763	8,662	10,366	11,066	11,661
Canada	3,057	2,962	2,533	2,629	2,553	2,712	2,688	2,572	2,579	2,082	1,490	2,068	2,135	2,463	2,380	2,394
Mexico	1,534	1,936	1,841	1,805	1,575	1,577	1,6843	2,045	2,095	2,168	1,561	2,342	2,681	3,002	3,055	3,365
Total	17,616	17,697	15,798	16,714	16,243	16,278	16,319	15,882	15,455	12,944	8,783	12,173	13,478	15,831	16,501	17,420

Source: OICA various years http://www.oica.net/category/production-statistics/

Table 4: Change in Canadian GHG Emissions Transport Sector (Mt CO_2 eq)

	2005	2012	2020*
Transportation	168	165	167

* Predicted change from 2005 to 2020

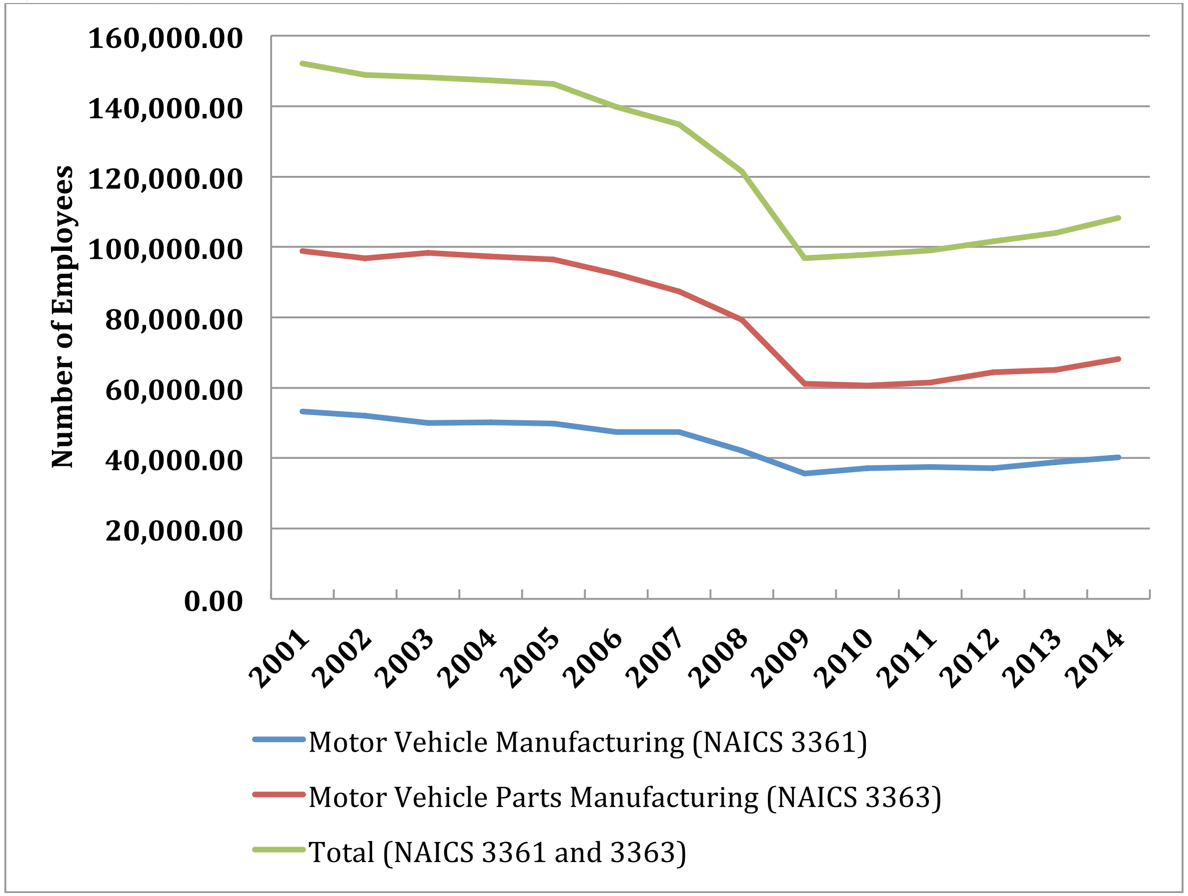
Source: (Environment Canada 2014:iv)

Table 5: Canadian Government Automotive Funding Initiatives

Company	Announcement Date	Corporate Funding $CAD	Federal Government Funding $CAD	Project Details:
Toyota	July 2015	$321m	$59m	Investing in a project to use advanced lightweight materials to secure production of Lexus vehicles in Canada
Linamar	January 2015	$500m	$50.7m	Project Transmission: to produce fuel-efficient powertrain components for next-generation transmissions
Ford	September 2013	$716m	$71.6m	Project Northern Star: to install a state-of-the-art manufacturing platform at the Oakville Assembly Complex and to conduct fuel consumption and emissions R&D
Toyota	January 2013	$120m	$16.875m	Project Lexus; to establish an assembly line for the new Lexus RX450h hybrid, supporting hybrid expertise in the Canadian supplier base, and to increase capacity for the RX350 model in Cambridge, Ontario
Magna	February 2012	$199m	$21.79m	Changing Gear Project: to develop energy-efficient components for vehicles and innovative powertrain components for next-generation vehicles
Toyota	July 2011	$506m	$70.84m	Project Green Light: to maximize production efficiency, reduce emissions and upgrade equipment to permit the production of more fuel-efficient vehicles including electric vehicles
Linamar	September 2009	$365m	$54.8m	Green & Fuel Efficient Powertrain Project: develop and commercialize advanced components and modules in three product areas: transmissions, engines and drivelines
Ford	September 2008	$730m	$80m	Renaissance Project: establish a flexible engine assembly plant and create an advanced powertrain research centre in Windsor, Ontario

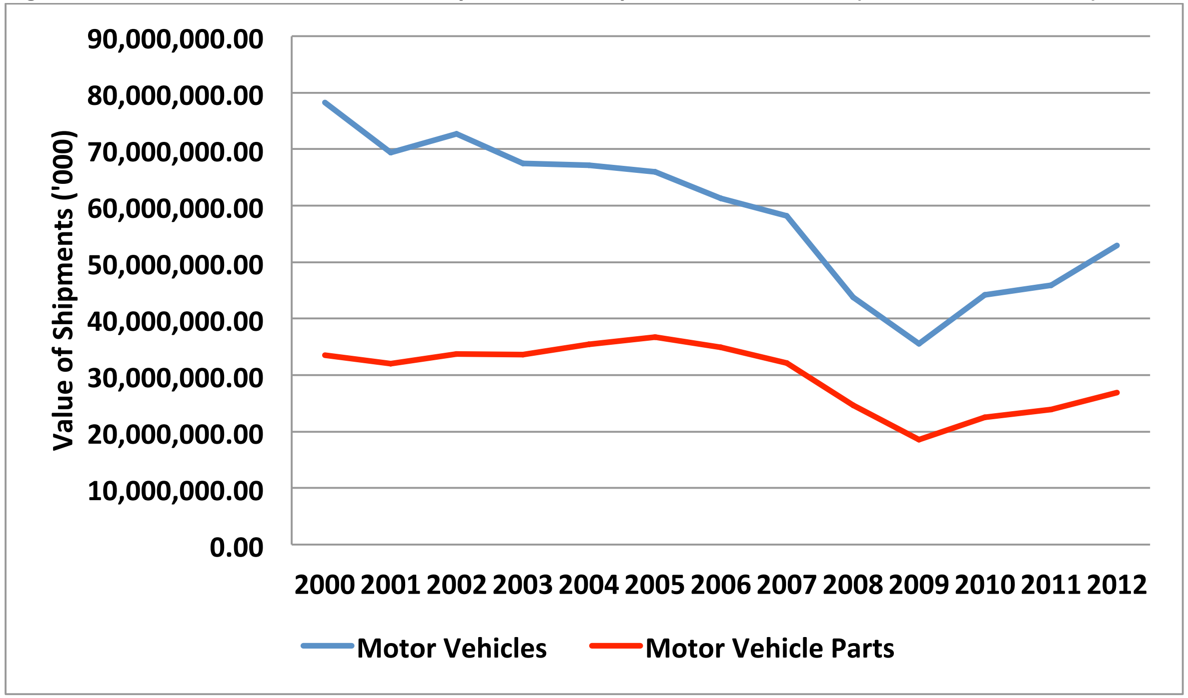
Source: (Government of Canada 2014c)

Figure 1: Employment, Canadian Automotive Industry, 2001-2014



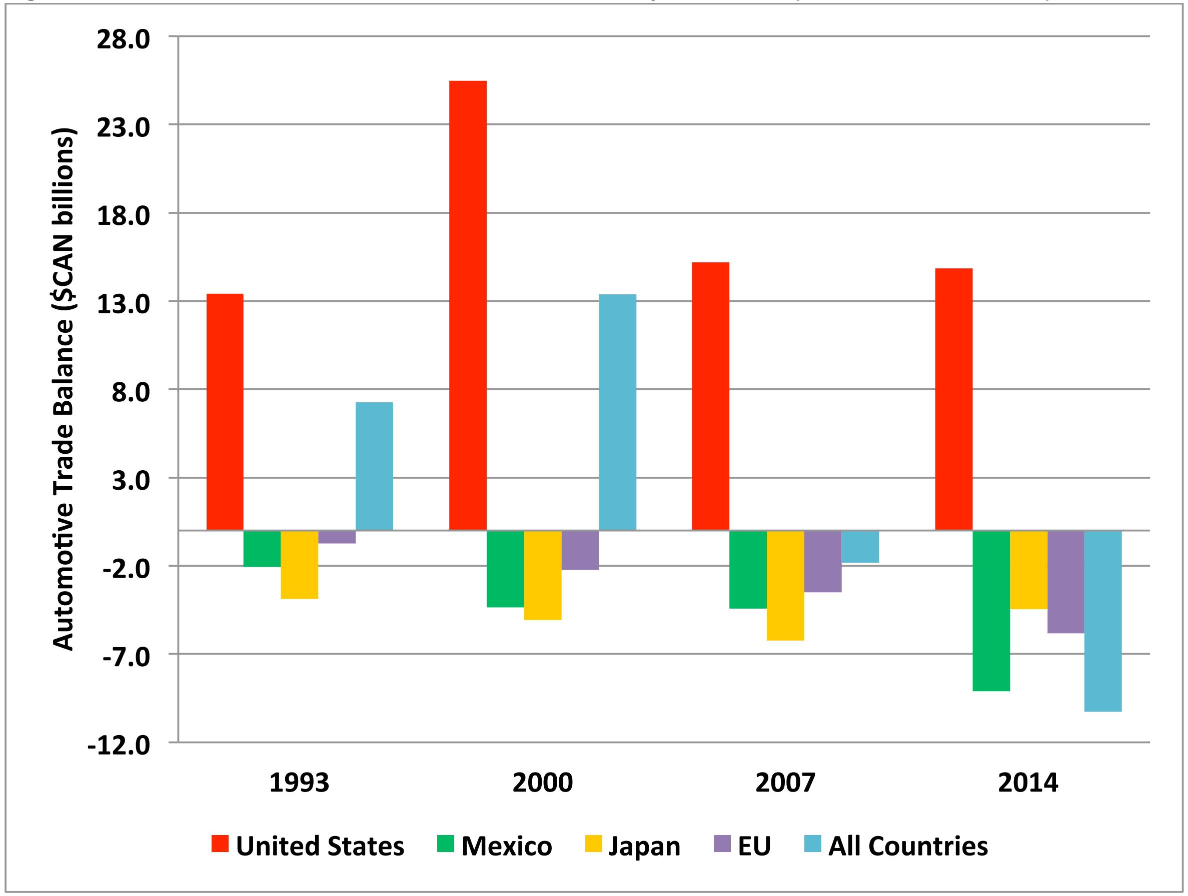
Source: Statistics Canada. Table 281-0024 - Survey of Employment, Payrolls and Hours (SEPH)

Figure 2: Canadian Automotive Industry, Value of Shipments: 2000-2012. (current CAN$ 1000s)



Source: CANSIM 301-0003 and 301-0006

Figure 3: Automotive Trade Balances, Canada: selected years. (current $CAN billions)



Source: Industry Canada: Strategis On-line Trade Database

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Greenhouse Gas Emissions in Canadian Forestry – A Background Report

I. Research Focus

This background paper explores the emission of greenhouse gasses (GHGs) in Canadian forestry. It is an interesting time to be looking at this topic as 2015 marks the target year, announced in 2007, by which the forest industry had targetted to achieve industry-wide carbon neutrality without the purchase of offsetting carbon credits.[12] Whether this goal has been achieved will not be known until late 2016. While an introductory section gives insight to the different conversations that revolve around GHGs and forestry, the principle focus here is on energy use and the corresponding emissions created by the different stages of manufacturing in the forestry industry. A broad understanding of forestry's productive chain is adopted here – one that includes the initial harvesting of trees, their processing into intermediate and/or finished products, and the reforestation efforts that are required for Canadian forests to remain a *renewable resource*. With this said, individual production processes remain as potential emissions hot spots for the industry. A mapping of the various production chains in wood and pulp/paper is useful here as is understanding that unused wood is a source of GHGs in and of itself.

Following the introduction, the discussion moves onto trends in production, emissions, and employment in forestry before looking at the flow of these industrial processes. An obvious way to measure improvement in GHG emissions is by looking at the energy or emissions intensity of the industry – specifically the energy used and/or emissions generated for a set unit of output. This measure is employed in analyzing real changes in forestry emissions.

Overall, the industry is found to have improved immensely in its emissions intensity. Three trends are highlighted here: fuel switching, improved energy efficiency, and energy systems optimization. There are a variety of influences that have encouraged the continuous improvementof the industry. These incentives originate in public policy, economic incentives, and social pressure/responsibility. A concluding section addresses the challenges inherent to addressing both these hot spots and the broader issues that forestry appears likely to confront. Included here is a highlighting of some of the issues and research opportunities that exist within these contexts.

II. Introduction

Though somewhat removed from the years of peak production, forestry remains a significant contributor to Canadian economy. Combined; harvesting, wood manufacturing, and paper manufacturing countributed nearly $20 Billion CAD (roughly 1.25%) to Canadian GDP in 2014. The most recent annual report on forestry by Natural Resources Canada highlights that forestry remains an export-oriented sector – accounting for 6% of all Canadian exports in 2012.[13]

Trade globalization has and will continue to impact the industry. While the United States has traditionally been the largest purchaser of Canadian forestry products, the rapid growth in demand from the Chinese economy is effectively leading to the evolution of a global marketplace in forestry products.

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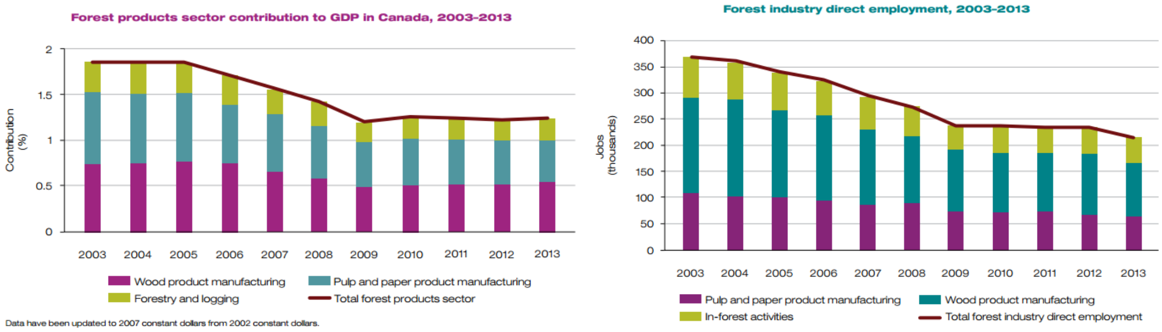
[12] "Canadian Forest Products Industry Aims to be First Canadian Carbon-Neutral Sector", The Forest Products Association of Canada, 31 Oct 2015 http://www.fpac.ca/canadian-forest-products-industry-aims-to-be-first-carbon-neutral-sector/.

[13] Natural Resources Canada, The State of Canada's Forests – Annual Report 2014, (2014) 31 Oct 2015 < http://www.nrcan.gc.ca/forests/report/16496>.

As this occurs, price convergence and market diversification are suggested to be sources of opportunity for Candian industry as they buffer against the cyclical swings and price volatility that can plague regional markets.

With this said, the industry's relevance to Canada's overall economy has diminished of late. Specifically, The contribution of forestry to Canadian GDP is down almost a third from the high water mark of the early 2000s and the same can be said of employment in forestry (Diagram I). While still employing nearly 200,000 Canadians in 2014, this is significantly lower than the 308,000 employed just ten years earlier.[14]

Diagram I – Trends in Forestry – Employment and Contribution to GDP



Source: Natural Resources Canada (2014)

The forestry industry is a complex subject to broach, particulary in in the context of GHG emissions. Not only is the industry composed of multiple constituent sectors but, by nature, it has a unique influence on the net transfer of carbon dioxide (the most emmitted GHG) to the atmosphere. To this point, discussions about forestry and GHGs typically involve three concepts – sequestration, emissions, and avoided emissions.

Sequestration and Avoided Emissions

Sequestration, while not the focus here, is important to understand as a concept related to forestry. Simply, it is the process by which trees (and other plants) soak up and store carbon dioxide (CO_2). This CO_2 remains stored in the tree while alive and growing and is released after that (through burning or decay, for example). Thus, the net contribution of CO_2 from forestry is directly impacted by the net balance of trees that are taken out of Canadian forests. If more trees are removed (deforestation) than replanted there will be a net increase in CO_2 to the atmosphere and if more trees are replanted (afforestation) there will be a net decrease.

With this said, Natural Resources Canada (NRC) reports that the rate of deforestation in Canada is among the lowest in the world and that the forest industry is legally bound to reforest all logged areas.[15]

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[14] Greg Keenan, David Parkinson, and Brent Jang, "Paper Trail: The decline of Canada's forest industry", The Globe and Mail 5 Dec 2014, 31 Oct 2015 http://www.theglobeandmail.com/report-on-business/economy/paper-trail-the-fall-of-forestry/article21967746/.

[15] Natural Resources Canada, Deforestation in Canada: Key myths and facts, 31 Oct 2015 http://www.nrcan.gc.ca/forests/fire-insects-disturbances/deforestation/13419.

This is corroborated by a National Council for Air and Stream Improvement (NCASI) report's finding that less than 10% of annual deforestation can be directly attributed to the forest sector and that this portion predominantly owes to the construction of pemanent settlements and logging roads in previously forested areas.[16]

Sequestered CO_2 can remain stored in a piece of wood or released through the combustion of that wood and the corresponding production of energy. Both of these strategies are compared to next best alternatives – wood versus concrete houses, or bio instead of fossil fuel for example – to calculate the avoided emissions that correspond to using wood in a specific application. This is a popular topic as of late as advances in wood technology are increasing its viability as a replacement for more emissions intensive materials (concrete, for example).

Emissions
Though found to have a negligible impact on deforestation and a positive impact on decreasing GHGs through avoided emissions, forestry is also a source of GHG emissions. This happens primarily through the energy consumption of the industry's production processes – be it through the use of fossil fuel, natural gas, electricity (indirectly), or biofuels. In addition to this, unused wood waste that ends up in a landfill emits methane (another GHG) and warrants mention in this discussion.

These emissions are the focus of this background paper. The discussion is a complicated one as the forest industry is a diverse one made up of multiple production processes in multiple sectors. Specifically, though they originate from the same place, one must differentiate between the sectors of pulp/paper and wood products. Further, wood products might take the form of lumber, plywood, oriented strand board (OSB), particleboard (PB), and medium density fibreboard (MDF).[17] These products can differ not only in energy and emissions intensity, but also in the fact that some are inputs – both as physical ingredient and fuel source – for others. These production chains and the emissions that they produce are discussed in the next section.

III. The Forest Industry's Production Chain

1. Harvesting
Regardless of final destination, the first stage in forestry's production process involves the actual harvesting of the tree. While often overlooked, this activity is not insignificant – contributing roughly $4 Billion to Canadian GDP in 2014. Further, though deforestation in Canada is reported to be negligible, the contribution of harvesting activities to net GHG production may not be.

A 2015 study compared the fuel consumption of specific harvesting techniques in three different countries.[18] The results are reproduced in Table I and highlight that there may be room for improvement

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[16] Brad Upton, Rein Miner, and Kirsten Vice, "The Greenhouse Gas and Carbon Profile of the Canadian Forest Products Industry Special Report No. 07-09", National Council for Air and Stream Improvement, Research Triangle Park, NC, USA: NCASI Publications (2007), 14.
[17] Natural Resources Canada, Status of Energy Wood Use in Canadian Wood Products Sector (2010), 2.
[18] M.R. Ghaffariyan, R. Apolit, and M. Kuehmaier, "Analysis and control of fuel consumption rates of harvesting systems: A review of international studies," Industry Bulletin-Australian Forest Operations Research Alliance (AFORA) 15 (2015), 3.

in Canadian operations. These findings bear consideration in the context of a harvesting industry that has become increasingly reliant on fuel-powered machinery.

Once harvested, felled trees are transported to the respective plants and mills that will process them into intermediate or finished objects. This is a fossil fuel intensive process and the largest source of pre-mill emissions.[19] From here, harvested trees might travel down one of two distinct paths.

2. Pulp / Paper

Environment Canada reports that the Canadian pulp and paper industry is the world's largest exporter of market pulp and paper and generates 57,500 direct and 250,000 indirect jobs. The wood fiber inputs for the industry are a mix of sawmill residue (55%), logs and chips (21%), and recycled paper (24%). Pulping generally takes one of two forms. The first is a mechanical process wherein fibres are pressed through narrow plates with steam, pressure, and/or chemicals often assisting the process. The second involves the cooking and breaking down of raw materials using an aqueous chemical solution that is generally recycled after use.[20] In these processes, energy is used to power the equipment used in the pulping process – be it the mechanized operations or the heating and cooling applications (the generation of steam or hot water, for example).

3. Wood Products

Lumber

Softwood lumber production is the largest sector in Canada's wood products industry. Three distinct stages occur in its production – sawing, kiln drying, and finishing (surface planing and packaging). Along the way, wood waste is produced as logs are transformed into finished lumber. This waste is either burned on-site to heat buildings and dry lumber, or sold to other wood processors to be used as an input into their systems.

The sawing process involves the initial breaking down of felled logs into different dimensions of rough lumber. It is a highly automated one that involves computer controlled scanning, optimizer and conveyor systems. Next, lumber is loaded into kilns and dried to a predetermined moisture content. Different factors – such as wood species, dimension, and initial moisture content can influence this drying process. This is the most energy intensive stage of the lumber production chain.

Once dried, the lumber is then moved to the planing mill to be trimmed down to final dimensions, graded, and then stacked and packaged by grade. In this stage, energy goes into operating the various machinery associated with planing and packaging and wood waste is produced as lumber is trimmed, shaved, and planed down to a finished product.

Plywood

The production of plywood is a more complex one than lumber. Logs are first soaked to facilitate easier debarking and then moved to a lathe. The lathe peels the log down into a continuous sheet of veneer which is then dryed to a predetermined moisture content. Once dry, the veneers are coated in an

[19] Upton, Miner and Vice, 8.
[20] Environment Canada, "Pulp and Paper", 31 Oct 2015 https://www.ec.gc.ca/Air/default.asp?lang=En&n=CB1E071C-1.

adhesive resin, layered in overlapping and perpendicular patterns, and then hot pressed into plywood. The plywood is then trimmed, patched, and sorted by grade for shipment.

OSB

The manufacture of OSB involves the breaking down and then recomposition of logs into strand board. After soaking, logs are debarked and then cut into strands which are dried to a predetermined moisture content. Once dry, strands are blended with an adhesive resin, formed, and then pressed into panels before being cooled, cut, graded and edge-coated.

Composite Panel Board (Particleboard and Fibreboard)

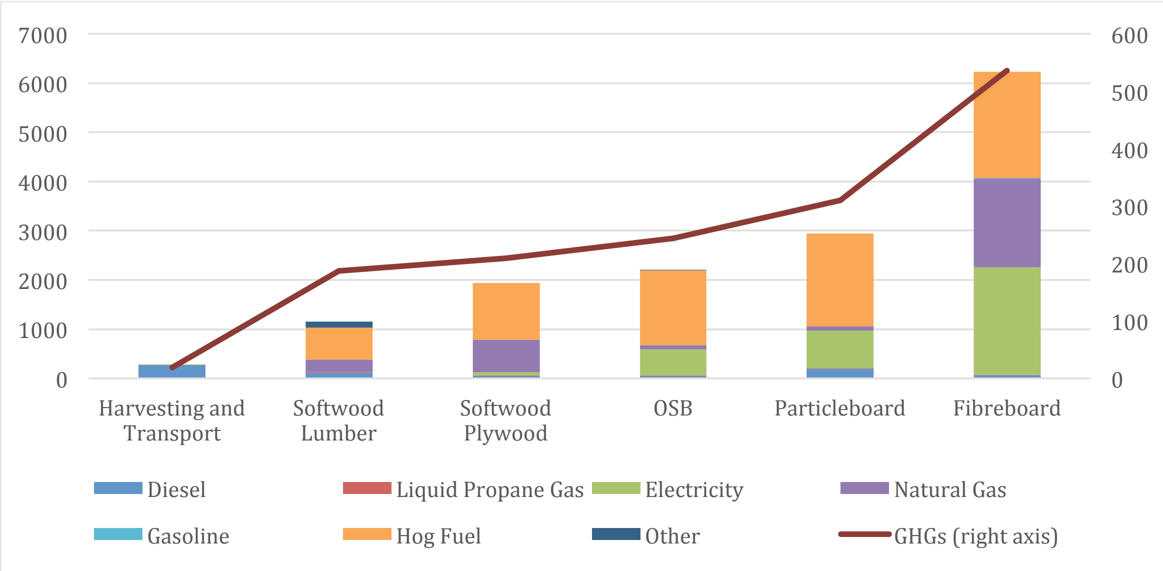
Being almost entirely dependent on the by-products of other wood manufacturers for raw material, the composite board sector has been called the original recycler of the wood industry. Inputs used in composite board production include sawdust, shavings, wood chips and clippings procured from other wood processors. Once these materials are procured, they are refined and then sized and screened. Next the material is dryed and blended with wax before being formed into a mat that is then pressed and finished.

Energy Requirements of Wood Product Manufacturing

In 2009, NRC published a document outlining the energy requirements, wood resource use, and global warming potential of the Canadian wood industry. Information was derived from surveys of selected mills and the information derived is considered a representative sample of resource and energy use in each product category.

Diagram II summarizes energy requirements per m^3 of output and highlights the report's finding that energy requirements per unit of output increased with the complexity of the good being produced. Corresponding with this are higher GHGs per unit of output. These GHGs are produced along multiple stages of the production process in both direct (through the consumption of fuel to power machines and kilns) and indirect (unused wood waste) manners.

Diagram II – Energy Intensity of Select Wood Product Production



Source: Natural Resources Canada (2010)

4. *Reforestation*
To bring forestry full circle, we return to the original site of harvest. Specifically, the reforestation that the industry undertakes is what ensures that net emissions from deforestation are indeed zero. Little information exists with regards to the emissions produced by reforestation, though the manual nature of this work suggests that it might be low in emissions intensity.

Overall – Emissions in Forestry
Putting all of this together allows for an overall understanding of operations and potential sources of emissions in the forest industry. Significant here are the energy requirements for transportation and operation as well as the net change in carbon stored in forests and wood products. With this said, some energy sources are lower in emissions intensity than others – with biofuels leading the way as a carbon neutral fuel source.

IV. Recent Performance
Some distinct stories emerge in analyzing forest industry indicators. While pulp/paper has suffered from a consistent downward trend in demand for its outputs, the demand for wood products – though interupted by the global recession of the late 2000s – has enjoyed consistent growth in recent decades.

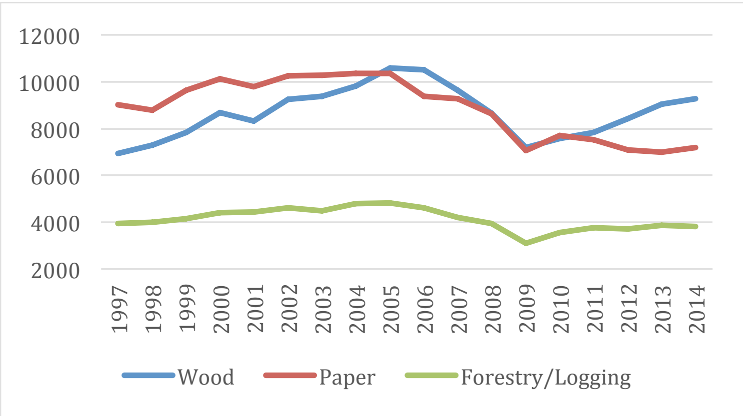
At the same time, the available data indicates that employment in both industries has dropped considerably since its peak in the early 2000s. Further, the aforementioned recession had a pronounced effect on these levels that has persisted in spite of a relative recovery in wood production.

For a variety of reasons, emissions in forestry have fallen considerably in the last quarter century. While some of this is the result of decreases in production, controlling for output (as best we can) illustrates that far more has been going on. Specifically, the emissions intensity of wood and pulp/paper has fallen consistently and significantly (with the exception of a slight increase in wood in recent years).

Production and Employment

Due to significant data limitations, a summary of productivity in wood and pulp/paper is limited to monetary indicators. While the dollar value of output might be a reasonable proxy for physical output, this is less than ideal as a variety of factors can influence monetary measures of output (cost of labour and product selling price, for example).[21] What we do know is that both industries enjoyed relatively stable growth from 1990 to the mid-2000s. Their experiences have diverged somewhat since -then as wood appears to have rebounded of late while the demand for pulp/paper has continued to fall as technological advances shift previously paper-dependent sectors to other mediums.

Diagram III – GDP of Forestry Related Industries in Canada 1997-2014 ($Billions)

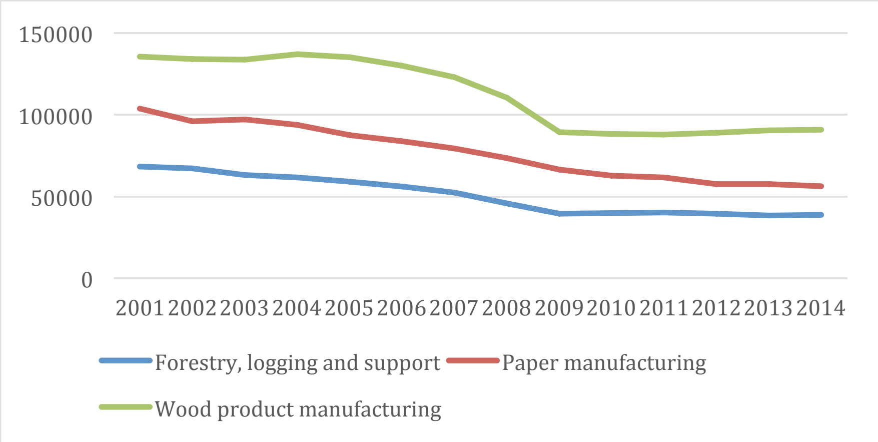


Source: Statistics Canada, Cansim Table 379-0031.

Employment figures over the last decade tell a different story. In particular, employment in pulp/paper has suffered from a fairly linear decline since 2001. On the other hand, wood manufacturing and forestry have stabilized at new, post-recession levels of employment even as economic activity appears to have begun to recover. This could be indicative of efficiency gains in the industry, increased automation, and/or of the downturn catalyzing the termination of inefficient practices at both the employee and mill levels.

[21] John Nyboer, "Energy Use and Related Data: Canadian Wood Products Industry 1990, 1995-2013", CIEEDAC (March 2015), 7.

Diagram IV – Employment in Forestry Related Industries in Canada (2001-2014)



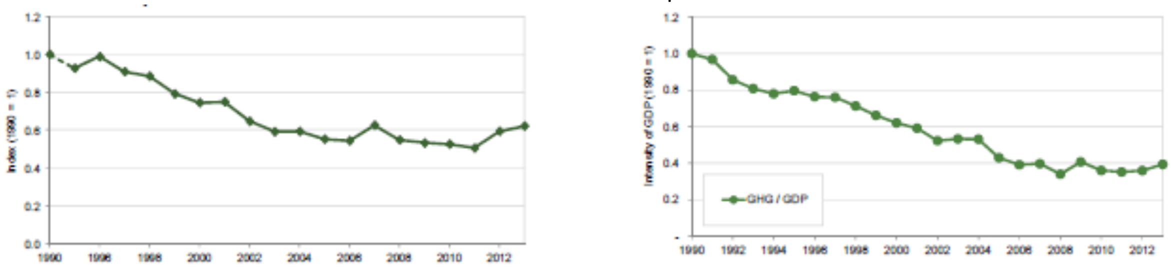
Source: Statistics Canada, Cansim Table 281-0024.

Emissions

Both wood and pulp/paper have made considerable progress in emissions mitigation since 1990. Specifically, pulp/paper has seen a relatively consistent downward trend in emissions that likely relates to both improved processes and decreased production. This has culminated in the industry's emissions intensity (emissions / production) declining to 40% of its 1990 level. Concurrently, the wood industry has lowered its emissions intensity to 60% of 1990 levels, though there has been a slight shift upwards in recent years. This increase of late is attributed to the increased use of natural gas in production processes.

Diagram V - GHG Emissions Intensity in Canadian Forestry Production

Wood Production | Paper Production



Source: Canadian Institute of Energy End-Use Data and Analysis Centre (CIEEDAC), Wood Products Industry Factsheet, 2014; CIEEDAC, Pulp and Paper Industry Factsheet, 2014.

Much of the decrease in emissions intensities in both industries has been attributed to the increasing adoption of fuel switching technologies. Fuel switching is the process of substituting away from more to less GHG intensive energy sources (electricity and biofuels specifically). Switching to biofuels is an especially attractive strategy in forestry because of the fact that many of the byproducts of their production processes can be burned for energy. Additional benefits to fuel switching are that biofuels are less emissions intensive than alternative fuels and that fuel switching negates the emissions associated with sending wood waste to landfills (both through decomposition and the emissions related to transporting wood waste to landfills).

While fuel switching had a relatively significant effect on industry emissions through the late 1990s and early 2000s, more recent emissions reductions have been achieved through systems optimization and gains in energy efficiency. To this point, research has highlighted that drying kilns are the biggest energy consumer in the forest industry. Improvements in kiln use and design, for example, have helped to decrease the energy requirements of wood and pulp/paper mills. Design related improvements include a conversion to continuous-flow kilns as well as the realization that drying can be achieved more efficiently by accounting for the characteristics (species, dimension, original moisture content, for example) of wood that is being dried. While both social[22] and financial incentives have facilitated these gains, three significant public programs have promoted energy efficiency in forestry.

Investments in Forestry Industry Transformation (IFIT)
IFIT's goal was to "de-risk" the adoption of new technologies. With an initial budet of $100 million from 2010 to 2014, IFIT received 107 applications and granted funds for 14 approved projects. Amongst the objectives of IFIT were:

- *Deployed technologies that produced or would lead to the production of new non-traditional bio-products and bioenergy, including novel applications of technologies not traditionally found within the sector*
- *Involved value-chain optimization by matching the wood fibre attributes to the needs of the end products*
- *Increased environmental performance while diversifying markets with new, higher value products*

IFIT's most recent performance report indicates that 6 of the 14 projects have been completed with 7 more in progress (5 on time and 2 delayed) with one deemed unsuccessful. Though information is not available for all 14 projects, Natural Resources Canada has published a number of project summaries (http://www.nrcan.gc.ca/forests/federal-programs/13139). Approved projects have included involved adopting wood dust as a fuel source and switching from a chemical to a hot-water intensive pulping practice.

Pulp and Paper Green Transformation Program (PPGTP)
Spanning from 2009 to 2012, the PPGTP invested nearly $1 billion into the pulp and paper industry's adoption of "green-focussed" capital investments. The project rewarded pulp/paper mills with $0.16 per litre of black liquor produced between January and May 2009. This was a benefial step in and of itself as black liquor – a by-product of chemical pulping – is a source of renewable energy and a catalyst in certain recycling operations at pulp and paper mills. These funds could then be invested in projects that would "achieve measurable environmental benefits through energy efficiency improvements, renewable energy production, emission reductions and similar means."[23]

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[22] A desire to avoid reliving the experiences of the "War in the Woods" that was waged over logging in the 1990s is cited as an impetus for proactive measures to improve sustainable practices.

[23] Natural Resources Canada, "Pulp and Paper Green Transformation Program: Mission accomplished", 31 Oct 2015 http://www.nrcan.gc.ca/forests/federal-programs/13141/

In total, 24 different pulp and paper companies were awarded funding for 98 different projects in 38 different communities across Canada. Benefits from these projects include improved energy efficiency, reductions in GHG emissions, and the generation of renewable energies including thermal (steam) and electrical (biofuel).[24] Gains in energy generation are highlighted as a potential new revenue stream through which the pulp/paper industry might remain competitive amidst falling demand for its primary output.

Forest Innovation Program (FIP)
While the FIP is expected to have a neutral or positive impact on mill-level GHG emissions, it bears mention as promoting decreased GHG emissions at the social level. Specifically, the FIP invested roughly $200 million in promoting research, development, and technology transfer activies in Canada's forest sector. The emphasis here was in supporting first-in-kind projects that promoted bio-intensive products and energy processes in four key areas:

- Next-generation building systems
- Bio-product development
- Integrated value maximization
- Innovation deployment

V. Emerging Issues, Challenges, and Opportunities
According to industry representatives, one of the biggest obstacles to reducing GHGs in forestry is that most of the possible reductions have already been achieved – though efforts continue unabated. In this context, a variety of opportunities emerge. One of the biggest challenges for research involves the aforementioned confidentiality related to output in the industry. As with any subject, a greater availability of data facilitates a deeper analysis of issues and trends. Unfortunately, this problem appears to be growing worse as CIEEDAC has highlighted that growing confidentiality in the wood and pulp/paper industries has become problematic in recent years.[25] Greater data availability in production levels, especially at the individual sector and mill levels is needed.

In addition to this paucity of data, a number of other questions emerge with regards to emissions in forestry. While the industry is celebrated for making considerable gains in energy and emissions intensity, the emphasis has been on the mill-level and the growing reliance of biofuels therein. Against this backdrop, a 2011 article by the Canadian Centre for Policy Alternatives (CCPA) suggests that a greater carbon focus is still possible for the industry as a whole.

Specifically, the article begins by highlighting Rob Kozak's[26] question of why one of the world's largest manufacturers of Douglas-fir window frames is located in Manitoba and importing its raw materials from Oregon rather than British Columbia's Douglas-fir abundant sawmills. At the same time, the article points out that the "the products shipped in growing numbers to China are overwhelmingly commodities, and many of them low-end commodities at that – raw logs or cut boards used for nothing

[24] Natural Resources Canada, Pulp and Paper Green Transformation Program – Report on Results, (2012),2.
[25] Nyboer 21.
[26] Rob Kozak, "Value-Added Wood Products From British Columbia – Getting Beyond the Rhetoric", BC Forest Professional Magazine, Jan-Feb 2007.

more than forming concrete."[27] These observations are framed as symptomatic of a larger issue in the forestry industry – namely an emphasis on the production of primary goods and the lengthening of production chains across national and international distances. It would be beneficial to understand the emissions related to these international supply chains.

In addition to this, the CCPA report questions the viability of the increasing reliace on bioenergy in the industry. Specifically, while bioenergy production is currently reliant on residual products from mill production processes and dead or dying trees (from the BC pine beetle phenomenon, for example), a time is envisioned when the supply of these materials might be stressed. With this in mind, the article is raises questions about whether living wood resources might be looked at as a fuel source in and of themselves – and what implications that will have for wood supply as a whole.[28]

The report also highlights some causes for concern with regards to reforestation activities. Specifically, both the health and mix of reforested areas are called into question. A growing prominence of low-value trees in reforested is highlighted to have a "locking-in" effect on future economic activity. At the same time, independent audits of reforestation efforts that were deemed successful have found that health and quantity indicators are lower than originally thought. Since the carbon neutrality of biofuel consumption is premised on the assumption of zero deforestation, better audits of forest health and species makeup are essential.

On the micro-level of production, research could look at the GHG emissions associated with specific steps of the manufacturing process and compare them to international best practices. For example, the fuel consumption in harvesting and emissions due to the deforestation associated with harvesting infrastructure and logging roads are potential areas of research in forestry's first stage. Further down the production chain, the increasing automation of mill practices could be evaluated both for its gross impact on emissions as well as on employment levels. The stagnation of jobs in the wood products industry while production seems to have rebounded could be of particular interest here.

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[27] Ben Parfitt, "Making the case for a Carbon Focus and Green Jobs In BC's Forest Industry", Canadian Centre for Policy Alternatives, (Aug 2011), 4.
[28] Parfitt, 10.

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Harvesting				
Transport				
Softwood Lumber	Softwood Plywood	OSB	Composite Panel Board	
Backing/Barking/Soaking	Soaking/Thawing	Soaking/Conditioning	Offsite Generation	(Slasking)
Breadkdown and Sawing	Conditioning	Debarking		(Debarking)
End Trimming	Slashing	Flaking	Transport	(Cutting)
Sorting	Debarking	Screening		(Milling)
Stacking	Peeling	Drying	Screening	
Drying	Clipping	Blending	Drying	
Thickness Planing	Preliminary Sorting	Mat Forming	Cyclone	
Grading	Drying	Pressing	Blending	
End Trimming	Final Sorting	Finishing	Forming	
Sorting	Patching	Shipping	Trimming	
Stacking and Shipping	Splicing		Pressing	
	Glue Application		Cooling	
	Composting		Sanding	
	Pre-Pressing		Trimming	
	Trimming/Sanding		Finishing	
	Sorting		Shipping	
	Shipping			

Source: Natural Resources Canada (2010).

ACW | Adapting Canadian Work and Workplaces

Food Manufacturing Group Baseline
Nov, 13, 2015

Research Focus:
The Food section of the Manufacturing Working Group focuses on the manufacture of food in 3 food groups in Canada and the US: fish, livestock and cereal. Research will be carried out on Canada and the US in the coming year.

Research Questions:

- What is the structure of production chains in each of the three food groups, both countries?
- What are the common components in the production chains of the three food groups?
- Where are the GHG 'hotspots' in each production chain?
- What action—green initiatives-- have been taken recently to shrink GHGs in each of the three production chains?
- Who are the actors driving the shrinking of GHGs in each of the 3 food groups?
- What do we know about the effectiveness of these green initiatives? What do we need to know?
- What role are unions and workers playing in greening the manufacture of fish, livestock and cereal?

Research Projects:
In the coming year we will carry out the following research projects:

1. The manufacture of fish: Canada

Principal researchers: Kerry Murray, the Newfoundland and Labrador Federation of Labour and an academic researcher

2. The manufacture of meat: Canada and US: Derek Johnstone, United Food and Commercial Workers of Canada, and one academic researcher
3. The manufacture of cereals: Canada, or Canada and US.
4. Mapping union 'greening' initiatives in Canada and US, all 3 sectors: Carla Lipsig-Mummé and a partner organization.