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SPP Communiqués are brief articles that deal with a singular public policy issue and are intended to provide the reader with a focused, concise critical analysis of a specific policy issue.

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BIG AND LITTLE FEET PROVINCIAL PROFILES: ONTARIO^{*†}

Sarah Dobson and G. Kent Fellows

This communiqué provides a summary of the production- and consumption-based greenhouse gas emissions accounts for Ontario, as well as their associated trade flows. It is part of a series of communiqués profiling the Canadian provinces and territories.¹

In simplest terms, a production-based emissions account measures the quantity of greenhouse gas emissions produced in Ontario. In contrast, a consumption-based emissions account measures the quantity of greenhouse gas emissions generated during the production process for final goods and services that are consumed in Ontario through household purchases, investment by firms and government spending. Trade flows refer to the movement of emissions that are produced in Ontario but which support consumption in a different province, territory or country (and vice versa). For example, emissions associated with the production of an Ontario manufactured good that is exported to Quebec for sale are recorded as a trade flow from Ontario to Quebec. Moving in the opposite direction, emissions associated with the production of Alberta crude oil that is refined in Ontario and sold as motor gasoline to an Ontario consumer are recorded as a trade flow from Alberta to Ontario.

For further details on these results in a national context, the methodology for generating them and their policy implications, please see the companion papers to this communiqué series: (1) Fellows and Dobson (2017); and (2) Dobson and Fellows (2017). Additionally, the consumption emissions and trade flow data for each of the provinces and territories are available at: <http://www.policyschool.ca/embodied-emissions-inputs-outputs-data-tables-2004-2011/>.

Unless otherwise noted, all emissions data referenced in this communiqué are for 2011.

^{*} This research was financially supported by the Government of Canada via a partnership with Western Economic Diversification.

[†] This communiqué benefited from financial support provided by Alberta Innovates and by donors through The School of Public Policy's Energy for Life program.

¹ Nunavut, the Northwest Territories and the Yukon Territory are grouped into a single profile both for convenience and due to the underlying structure of available data.

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GRANDS ET PETITS PAS DES PROVINCES : L'ONTARIO*†

Sarah Dobson et G. Kent Fellows

Ce communiqué donne un aperçu de la comptabilisation des émissions de gaz à effet de serre liées à la production et à la consommation en Ontario, de même que des flux commerciaux qui y sont associés. Il fait partie d'une série de communiqués établissant le profil des provinces et territoires canadiens¹.

En termes simples, la comptabilisation des émissions de production mesure la quantité d'émissions de gaz à effet de serre produite en Ontario. En revanche, la comptabilisation des émissions de consommation mesure la quantité d'émissions de gaz à effet de serre générée pendant la production des biens et services finaux consommés en Ontario dans le cadre d'achats ménagers, d'investissements d'entreprises ou de dépenses gouvernementales. Les flux commerciaux font référence à la circulation des émissions produites en Ontario mais qui répondent à des besoins de consommation dans d'autres provinces, territoires ou pays (et vice-versa). Par exemple, les émissions associées à la production de biens manufacturiers en Ontario qui sont exportés au Québec pour la vente seront comptabilisées comme un flux commercial de l'Ontario vers le Québec. À l'inverse, les émissions associées à la production de pétrole brut albertain qui est ensuite raffiné en Ontario et vendu sous forme d'essence à moteur aux consommateurs ontariens seront comptabilisées comme un flux commercial de l'Alberta vers l'Ontario.

Pour plus de détails sur ces résultats dans leur contexte national, sur la méthodologie utilisée pour les établir et sur leurs répercussions pour les politiques, veuillez consulter les articles accompagnant cette série de communiqués : (1) Fellows et Dobson (2017); et (2) Dobson et Fellows (2017). Par ailleurs, les données sur les émissions liées à la consommation et aux flux commerciaux pour chacune des provinces et territoires sont disponibles à : <http://www.policyschool.ca/embodied-emissions-inputs-outputs-data-tables-2004-2011/>.

Sauf indication contraire, toutes les données d'émissions citées dans ce communiqué valent pour 2011.

* Cette recherche a été soutenue financièrement en partie par le gouvernement du Canada via Diversification de l'économie de l'Ouest Canada.

† Cet article a bénéficié d'un soutien financier du réseau *Alberta Innovates* et des donateurs du programme *Energy for life* de l'École de politiques publiques.

¹ Le Nunavut, les Territoires du Nord-Ouest et le Yukon sont regroupés en un seul profil tant par commodité qu'en raison de la structure sous-jacente des données disponibles.

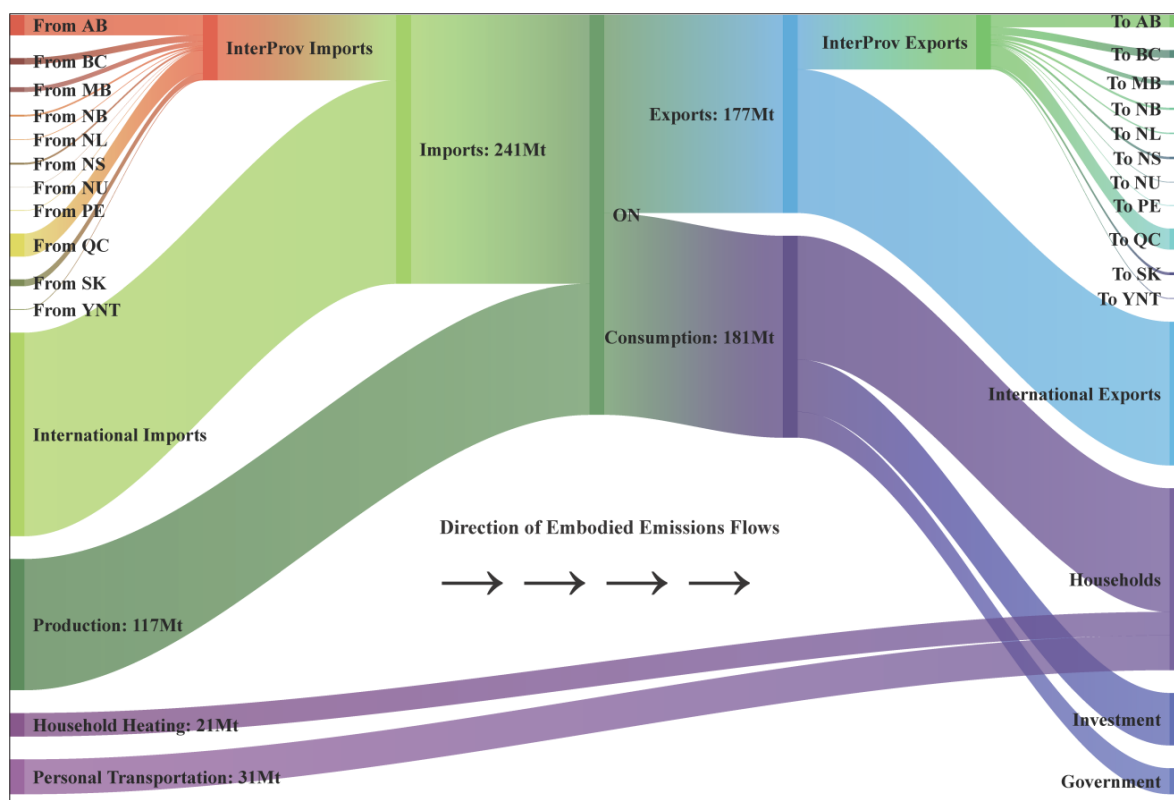
PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

The relationship between production- and consumption-based greenhouse gas emissions is given by the following equation:

$$\text{Consumption Emissions} = \text{Production Emissions} + \text{Interprovincial Imports} + \text{International Imports} - \text{Interprovincial Exports} - \text{International Exports}$$

Ontario's total production emissions in 2011 were 169.4 megatonnes (Mt) of CO₂e (Figure 1), corresponding to per capita emissions of 12.8 t. The province is a net importer of greenhouse gas emissions internationally (+53.6 Mt) and from the other provinces (+9.8 Mt). Ontario's emissions therefore increase when moving to a consumption-based accounting approach, rising to 232.8 Mt total CO₂e emissions or 17.6 t of CO₂e per capita.²

FIGURE 1 EMISSIONS FLOWS THROUGH THE ONTARIO ECONOMY



Net exporter of emissions to:	British Columbia, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, Territories
Net importer of emissions from:	International, Alberta, Saskatchewan, Manitoba, Quebec

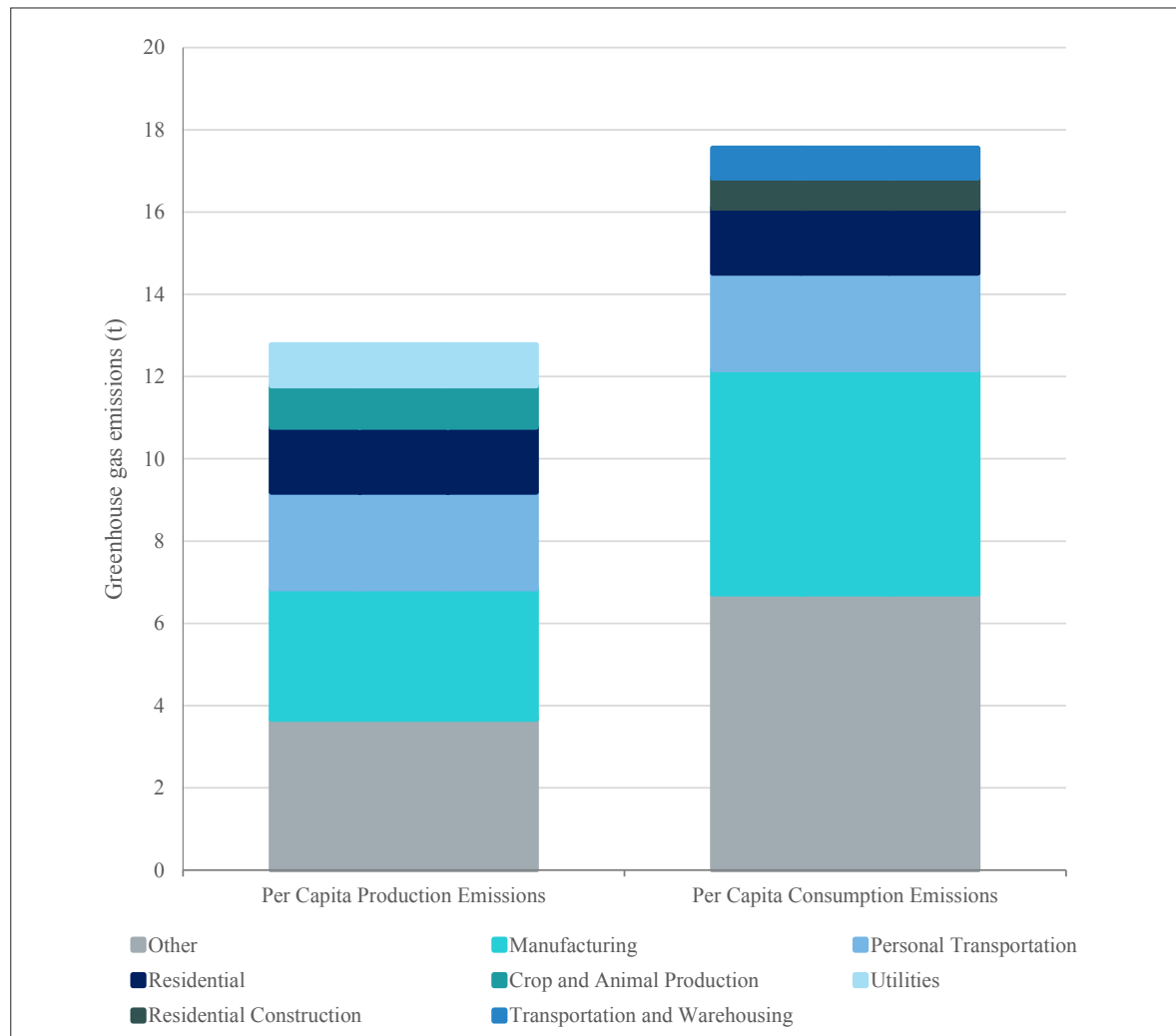
Data Source: Fellows, G. Kent and Sarah Dobson. 2017. "Embodied Emissions in Inputs and Outputs: A Value-Added Approach to National Emissions Accounting." *Canadian Public Policy*, 43(2): 140-164. <https://doi.org/10.3138/cpp.2016-040>.

Data tables are available at: <http://www.policyschool.ca/embodied-emissions-inputs-outputs-data-tables-2004-2011/>.

² Production and consumption totals indicated here include residential and personal transportation emissions. However, these emissions are not "embodied" in any traded good within the provincial economies, since they are produced during the act of final consumption by households. As such, these emissions are recorded as separate parallel flows in Figure 1.

The largest sectors responsible for per capita production emissions in Ontario are manufacturing (3.2 t), personal transportation (2.3 t), residential (1.6 t), crop and animal production (1.0 t) and utilities (1.0 t). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (5.4 t), personal transportation (2.3 t), residential (1.6 t), residential construction (0.7 t) and transportation and warehousing (0.7 t) (Figure 2).

FIGURE 2 BREAKDOWN BY SECTOR OF ONTARIO PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS



Note: See the appendix of Dobson and Fellows (2017) for a full listing of the sectors included in the “Other” category. Note also that the figure displays individually only the top five sectors contributing to per capita production emissions and the top five sectors contributing to per capita consumption emissions. As a result, a sector that is a primary source of production emissions but not consumption emissions will be included in the “Other” category for consumption emissions (and vice versa).

Three sectors – manufacturing, personal transportation and residential – overlap as main sources of both production and consumption emissions in Ontario. Emissions in the manufacturing sector increase by 72 per cent (+2.3 t) when moving from a production- to a consumption-based accounting approach while emissions from the personal transportation and residential sectors remain unchanged. The increase in manufacturing sector emissions is attributable to three factors. First, the sector uses substantial intermediate inputs with associated emissions produced by upstream suppliers. Second, the sector is a key supplier of final consumption goods for households and firm investment. Third, the sector engages in significant trade with a large share of intermediate inputs and final consumption goods being produced by suppliers in other provinces

and internationally. Combined, these factors result in a large number of production emissions from Ontario, elsewhere in Canada and internationally being reallocated to Ontario's manufacturing sector – and specifically household consumption and firm investment – under a consumption-based accounting approach. It is interesting to note, however, that although the increase in Ontario manufacturing sector emissions is significant, the province's large domestic manufacturing sector means that it is on the lower end relative to many of the other provinces. Provinces with smaller manufacturing sectors, which in turn must import a greater share of their intermediate and final goods, see much larger emissions increases, often in excess of 200 per cent. In comparison, emissions from the personal transportation and residential sectors are unchanged when moving from a production- to a consumption-based accounting approach as all of the production emissions in these sectors are generated by household consumption of fossil fuels in personal vehicles and in homes. Production and consumption emissions are therefore the same.

The crop and animal production and utilities sectors are primary sources of production emissions in Ontario but not consumption emissions. Emissions from both sectors decrease by 50 per cent (-0.5 t) when moving from a production- to a consumption-based accounting approach. This is the result of a large share of output from both sectors being sold to intermediate suppliers – food manufacturers, distributors, restaurants and grocery stores in the crop and animal production sector, and firms and government in the utilities sector. Final products or services that use either agricultural products or electricity as an input are then purchased from other sectors by consumers in Ontario, elsewhere in Canada and internationally. Production emissions are subsequently reallocated to the sector and region that supply these final products and services. It is worth noting that for the utilities sector, electricity consumed by households is a final consumption good and its associated emissions would therefore be allocated to household consumption. Unlike other provinces with significant production emissions from the utilities sector, however, fossil fuel electricity contributes only a minority share to Ontario's electricity mix (accounting for 19 per cent of in-province electricity production by utilities in 2011 (Statistics Canada, 2017a)). As a result, utility consumption emissions in Ontario are notable (0.5 t per capita) but much lower than other provinces that rely more heavily on fossil fuels.

Last, the residential construction and transportation and warehousing sectors are primary sources of consumption emissions in Ontario but not production emissions. Emissions in the residential construction sector increase from nearly zero under a production-based accounting approach to 0.7 t under a consumption-based accounting approach as the sector absorbs all of the emissions associated with production of its inputs. For example, when a builder purchases timber for framing a home, emissions associated with production of the timber are reallocated from the forestry and manufacturing sectors to the residential construction sector. Notably, output from the residential construction sector reflects only expenditure by firms and all of the consumption emissions are therefore allocated to firm investment. In contrast, emissions from the transportation and warehousing sector decrease by 19 per cent (-0.2 t) when moving from a production- to a consumption-based accounting approach. This is because the consumption-based accounting approach reallocates production emissions associated with the transportation and storage of goods to the sector and region where final consumption of these goods occurs. Consumption emissions from the sector are primarily those generated by household use of public transportation options including air, rail, ferry, taxi and bus.

As shown on the right-hand side of Figure 1, Ontario's consumption emissions can additionally be broken down by household, firm investment and government spending. Per capita consumption emissions for each of these groups, as well as the breakdown of emissions in each of these groups by sector, are summarized in Table 1.

TABLE 1 ONTARIO PER CAPITA CONSUMPTION EMISSIONS BY CONSUMPTION GROUP AND SECTOR

Household Consumption Emissions		Firm Investment Consumption Emissions		Government Consumption Emissions	
Per Capita Consumption Emissions <i>(Share of Total Per Capita Consumption Emissions)</i>					
12.3 t (70%)		3.5 t (20%)		1.7 t (10%)	
Top Sectors Contributing to Consumption Emissions					
Manufacturing:	3.8 t	Manufacturing:	1.7 t	Other provincial government services:	0.4 t
Personal transportation:	2.3 t	Residential construction:	0.7 t	Other municipal government services:	0.4 t
Residential:	1.6 t	Engineering construction:	0.4 t	Other federal government services:	0.3 t
Transportation and warehousing:	0.7 t	Non-residential building construction:	0.3 t	Government health services:	0.3 t
Accommodation and food services:	0.7 t	Finance, insurance, real estate and rental and leasing:	0.1 t	Government education services:	0.3 t
Other:	3.2 t	Other:	0.3 t	Other Aboriginal government services:	0.03 t

Note: See the appendix of Dobson and Fellows (2017) for a full listing of the sectors included in the “Other” category for household and firm investment emissions. The appendix additionally lists household and firm investment consumption emissions for each of these sectors. Government consumption emissions by sector are fully accounted for as they are limited to the six government-specific sectors listed in the table.

INTERPROVINCIAL TRADE FLOWS

Ontario’s primary sources of net interprovincial imports of emissions are the crude oil and natural gas extraction sectors in Alberta and Saskatchewan. This is consistent with Ontario having minimal crude oil and natural gas production of its own, and relying on imports as feedstock for its oil refineries, and as a fuel for household heating and natural gas power plants. The province also has significant net imports of greenhouse gas emissions from the manufacturing sector in Quebec, the transportation and warehousing sector in British Columbia, and the crop and animal production sectors in Saskatchewan and Manitoba.

Unsurprisingly, Ontario’s largest source of emissions exports is the manufacturing sector. Excluding Quebec, Ontario is a net exporter of manufacturing emissions to all of the remaining provinces and territories. Despite Quebec being the only province with which Ontario is a net importer of manufacturing emissions, it is also the largest recipient of Ontario emissions, receiving nearly 40 per cent of total interprovincial exports from the Ontario manufacturing sector in 2011. Ontario’s second largest source of net exports is the finance, insurance, real estate and rental and leasing sector. This is consistent with the province, and Toronto in particular, being the financial hub of Canada and the head office location for many of the national firms in this sector. Emissions exports from this sector are much smaller than those from the manufacturing sector, however, as it is primarily service-oriented and emissions sources are largely constrained to those associated with office heating and business travel.

INTERNATIONAL TRADE FLOWS

Internationally, Ontario has large net imports of emissions in the manufacturing, other (non-energy) mining, crop and animal production, accommodation and food services, transportation and warehousing, crude oil extraction and natural gas extraction sectors. International imports of crude oil extraction and natural gas extraction emissions are lower than domestic imports, consistent with Ontario historically deriving the majority of its crude oil feedstock and natural gas supplies from domestic sources. The only sector in Ontario with large net exports of emissions internationally is wholesale trade.

TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Total production emissions in Ontario declined over the period of 2004 to 2011 (-15 per cent) (Figure 3). The province's population grew over this period (+7 per cent), leading to an even larger percentage drop in per capita production emissions (-20 per cent) (Figure 4). The decrease in total emissions was largely the result of a substantial drop in emissions from the province's utilities and manufacturing sectors. This is consistent with Ontario's coal phase-out, which the government announced in 2003 and commenced in 2005, as well as notable declines in output from a large number of the province's manufacturing subsectors (Ontario Ministry of Energy, 2017; Statistics Canada, 2017b).

The decline in Ontario's production emissions over the period of 2004 to 2011 did not translate into a decline in consumption emissions. Rather, total consumption emissions in the province increased by 13 per cent from 2004 to 2011. When combined with a growing population, however, the net increase in per capita consumption emissions falls to five per cent. Ontario was a net importer of greenhouse gas emissions in 2004 and with consumption emissions increasing and production emissions decreasing, its per capita net imports increased from 0.7 t in 2004 to 4.8 t in 2011.

Consumption emissions related to firm investment saw the largest percentage growth from 2004 to 2011. Specifically, total firm investment consumption emissions increased by 30 per cent while per capita emissions increased by 22 per cent. The impact of the 2008/2009 global recession is strongly evident with total and per capita emissions increasing moderately from 2004 to 2007, dropping sharply in both 2008 and 2009 and then spiking up in 2010 and 2011. The sectors that saw the largest increases in emissions were manufacturing and the aggregate construction sector, with residential construction driving the majority of the growth in construction sector emissions since 2009.³

Total and per capita government consumption emissions also increased over the 2004 to 2011 period, rising by 18 and 10 per cent respectively. Emissions were mostly gradually increasing, with only one notable decline in 2009. Since 2009 moderate increases in consumption emissions have been observed across all government subsectors.⁴

In contrast to firm and government consumption emissions, the increase in total household consumption emissions (+8 per cent) was nearly entirely offset by Ontario's growing population. Per capita household consumption emissions therefore remained relatively unchanged, increasing by less than one per cent. Emissions did not follow a consistent pattern, however, with total emissions ranging from 151.1 Mt (2004 low) to 162.8 Mt (2011 high) and per capita emissions ranging from 11.7 tonnes (2009 low) to 12.7 tonnes (2007 high). Additionally, there were large differences in trends within consumption subsectors. Most notably, household consumption emissions in the manufacturing, transportation and warehousing, and accommodation and food services sectors were increasing while emissions in the utilities sector and the finance, insurance, real estate, and rental and leasing sector (where consumption emissions are largely driven by upstream electricity emissions) were decreasing. This indicates that Ontario's contracting manufacturing sector has not resulted in emissions decreases on the consumption side. Rather, emissions have risen as domestic firms and final consumers have substituted towards greater purchases of imported goods. In contrast, the coal power phase-out has been effective in driving down both production and consumption emissions in the province.

³ Prior to 2009 emissions data are only available for the aggregate construction sector.

⁴ Prior to 2009 emissions data are only available for the aggregate government services sector.

FIGURE 3 TOTAL PRODUCTION AND CONSUMPTION EMISSIONS, ONTARIO: 2004 TO 2011

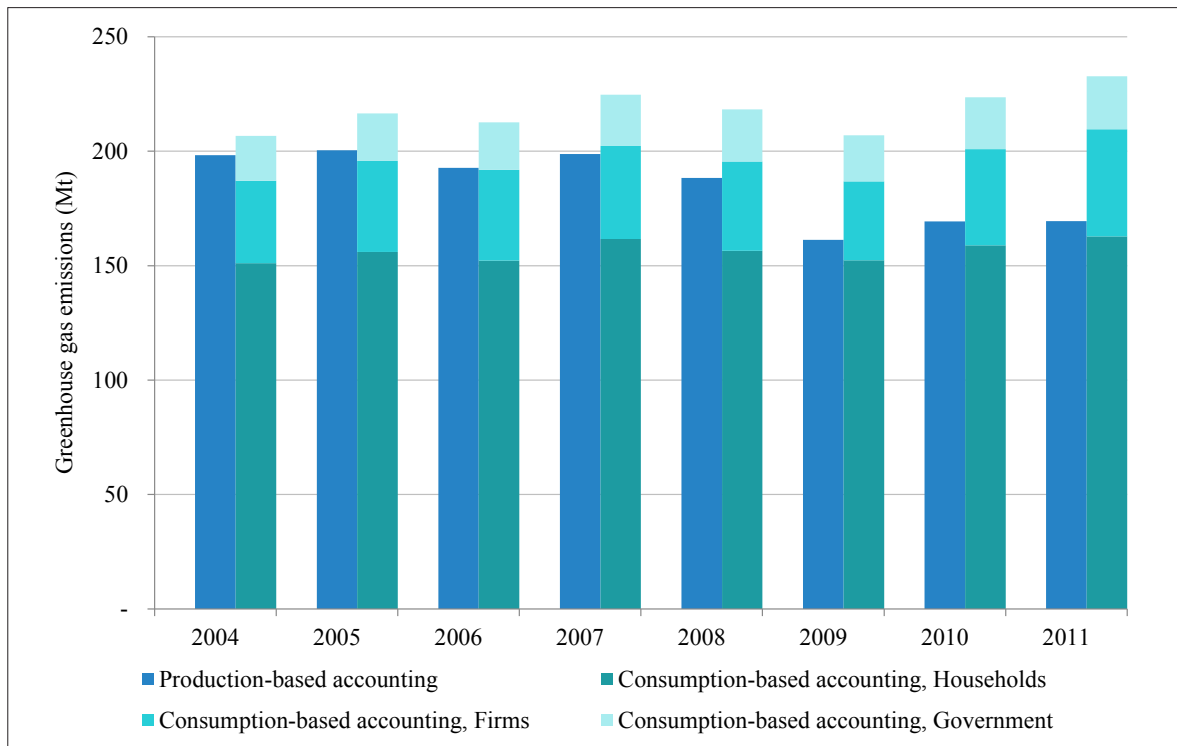
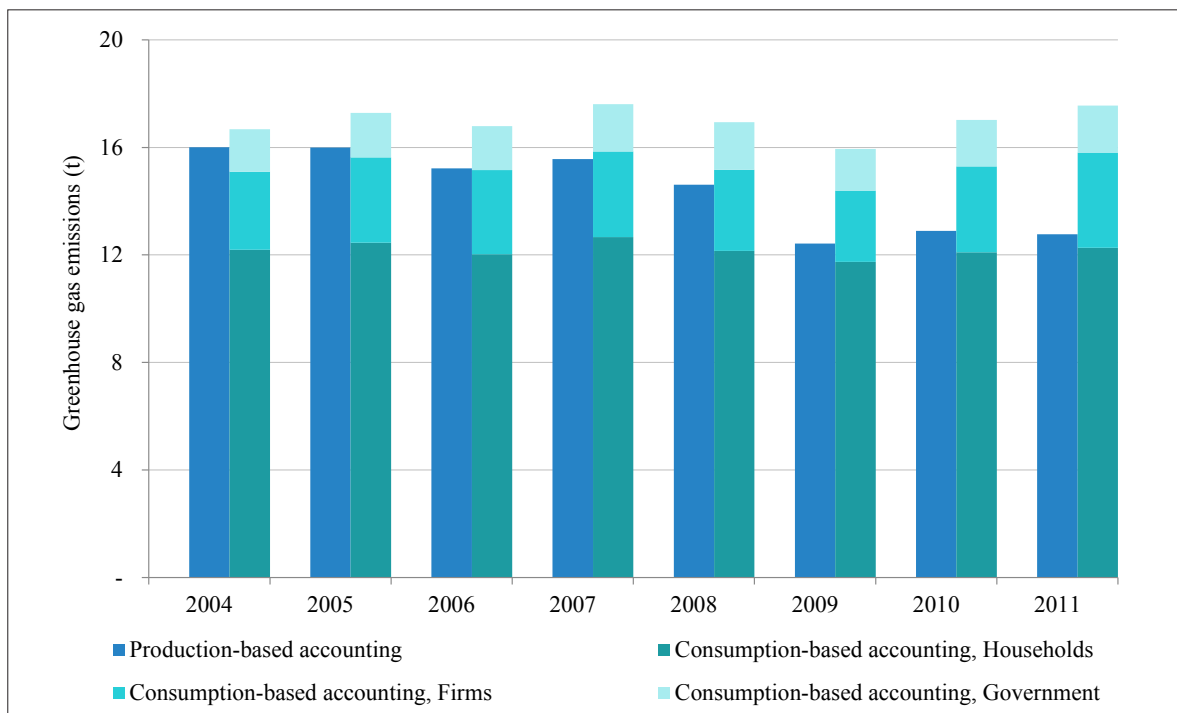


FIGURE 4 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, ONTARIO: 2004 TO 2011



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About the Authors

Sarah Dobson (PhD, UC Berkeley) is a research associate at The School of Public Policy, University of Calgary. Her research interests are focused on studying the design, implementation and evaluation of energy and environmental regulatory policy. In prior work she has considered such issues as the welfare implication of climate change policy, and the optimal design of regulatory policy to take into account the trade-off between the economic benefits of resource development and the ecological consequences of management decisions. Sarah's work with The School of Public Policy covers a range of topics including carbon pricing, climate change policy design, political response to hydraulic fracturing, and markets for Canadian oil and LNG.

G. Kent Fellows (PhD, Calgary) is a research associate at The School of Public Policy, University of Calgary. Kent has previously worked as a researcher for the University of Alberta's School of Public Health and as an intern at the National Energy Board. He has published articles on the effects of price regulation and bargaining power on the Canadian pipeline and pharmaceutical industries as well as the integration of renewable generation capacity in the Alberta electricity market. His current research agenda focuses on the area of computational economics as applied to the construction and use of large-scale quantitative models of inter-sector and interprovincial trade within Canada. Kent is also involved in forwarding The School of Public Policy's Canadian Northern Corridor research program, which is aimed at studying the concept of a multi-modal linear infrastructure right of way through Canada's North and near North.

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