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BIG AND LITTLE FEET PROVINCIAL PROFILES: MANITOBA*†

Sarah Dobson and G. Kent Fellows

This communiqué provides a summary of the production- and consumption-based greenhouse gas emissions accounts for Manitoba, 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 Manitoba. 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 Manitoba through household purchases, investment by firms and government spending. Trade flows refer to the movement of emissions that are produced in Manitoba but which support consumption in a different province, territory or country (and vice versa). For example, emissions associated with the production of Manitoba crops that are exported to Ontario for processing and sale in an Ontario grocery store are recorded as a trade flow from Manitoba to Ontario. Moving in the opposite direction, emissions associated with the production of motor gasoline in Alberta that is exported to Manitoba for sale are recorded as a trade flow from Alberta to Manitoba.

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 : LE MANITOBA[*†]

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 au Manitoba, 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 canadiens[1].

En termes simples, la comptabilisation des émissions de production mesure la quantité d'émissions de gaz à effet de serre produite au Manitoba. 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 au Manitoba 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 au Manitoba 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 récoltes au Manitoba qui sont exportées en Ontario pour la transformation et la vente dans une épicerie ontarienne seront comptabilisées comme un flux commercial du Manitoba vers l'Ontario. À l'inverse, les émissions associées à la production en Alberta d'essence à moteur exportée au Manitoba pour la vente seront comptabilisées comme un flux commercial de l'Alberta vers le Manitoba.

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.

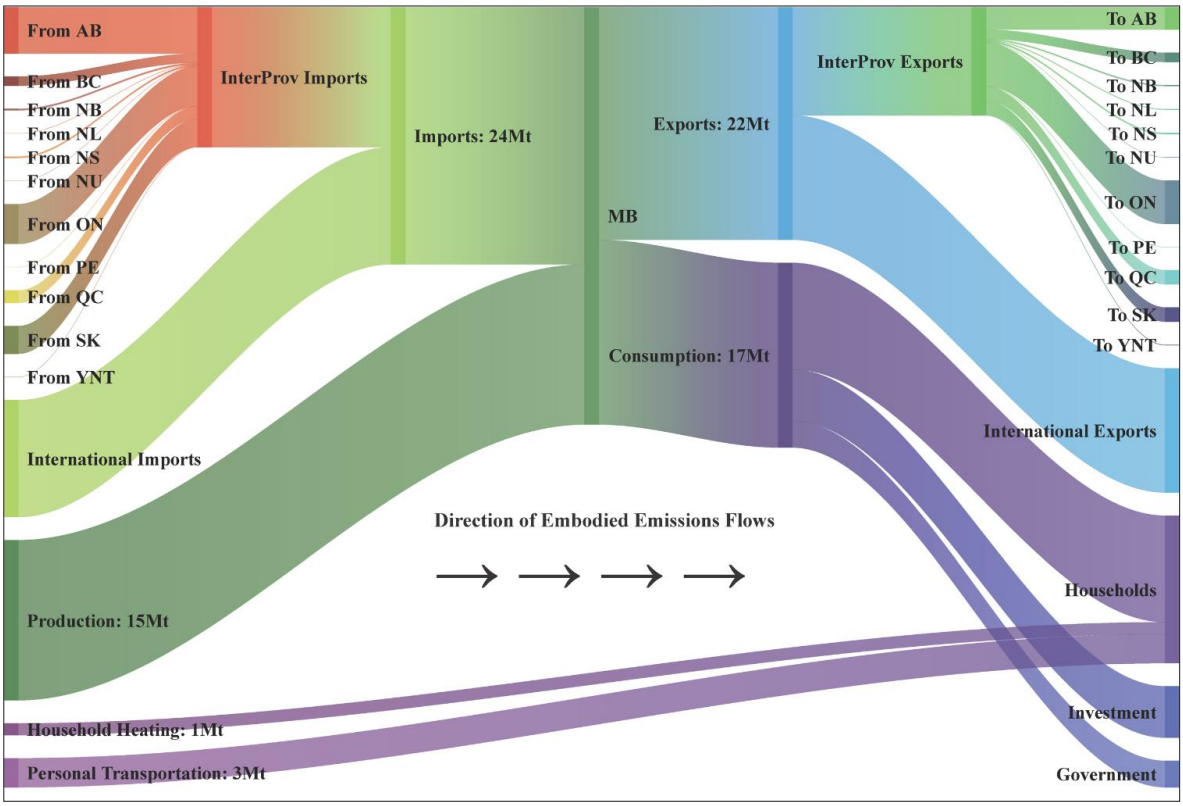
PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

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

Consumption Emissions = Production Emissions + Interprovincial Imports + International Imports – Interprovincial Exports – International Exports

Manitoba's total production emissions in 2011 were 18.8 megatonnes (Mt) of CO_2e (Figure 1), corresponding to per capita emissions of 15.3 t. The province is a net exporter of greenhouse gas emissions to international sources (-0.7 Mt) and a net importer of greenhouse gas emissions from the other provinces (+3.0 Mt). As Manitoba's interprovincial net imports exceed its international net exports, total emissions increase when moving to a consumption-based accounting approach, rising to 21.1 Mt total CO_2e emissions or 17.1 t of CO_2e per capita.[2]

FIGURE 1 EMISSIONS FLOWS THROUGH THE MANITOBA ECONOMY



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

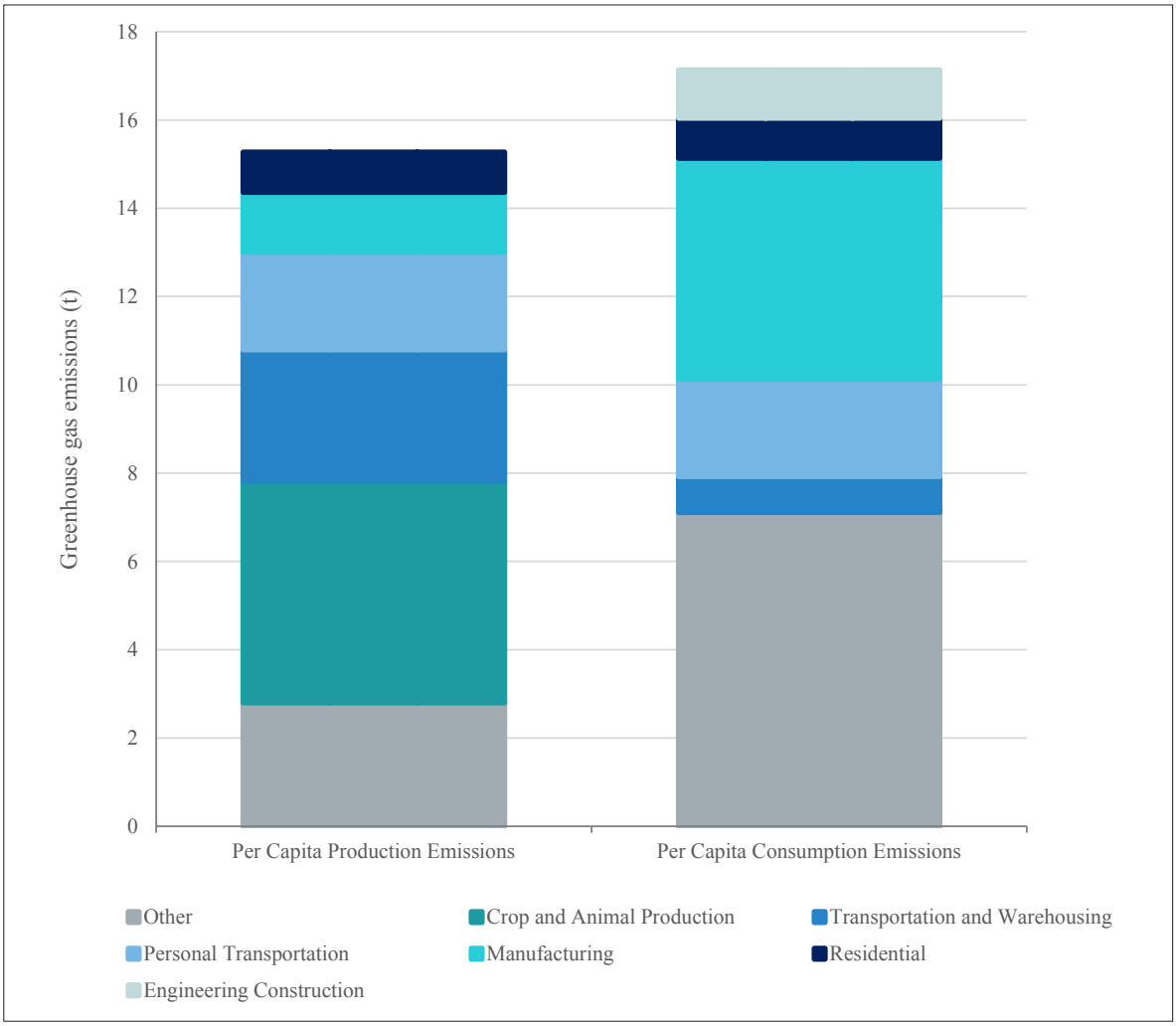
Data Source: Fellows, G. Kent and Sarah Dobson. 2017. "Embodied Emissions in Inputs and Outputs: A Value-Added Approach to National Emissions Accounting." *Canadian Public Policy*, 43(2): 140-164. https://doi.org/10.3138/cpp.2016-040.

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 Manitoba are crop and animal production (5.0 t), transportation and warehousing (3.0 t), personal transportation (2.2 t), manufacturing (1.4 t) and residential (0.9 t). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (5.0 t), personal transportation (2.2 t), engineering construction (1.1 t), residential (0.9 t) and transportation and warehousing (0.8 t) (Figure 2).

FIGURE 2 BREAKDOWN BY SECTOR OF MANITOBA 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).

Four sectors – manufacturing, personal transportation, residential and transportation and warehousing – overlap as main sources of both production and consumption emissions in Manitoba. Emissions from the manufacturing sector more than triple (+3.6 t) when moving from a production- to a consumption-based accounting approach while emissions from the transportation and warehousing sector decrease by 73 per cent (-2.2 t) and 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 Manitoba, elsewhere in Canada and internationally being reallocated to Manitoba's manufacturing sector – and specifically household consumption and firm investment – under a consumption-based accounting approach. In contrast, in the transportation and warehousing sector a significant share of emissions is from the movement and storage of goods. As this is an intermediate step in bringing a final good to market, a consumption-based accounting approach reallocates these emissions to the sector and region in which consumption of the final good occurs. Transportation and warehousing emissions that remain in the sector under a consumption-based accounting approach are primarily those generated by household use of public transportation options including air, rail, taxi and bus. Last, 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 sector is the only sector that is a primary source of production emissions in Manitoba but not consumption emissions. Emissions in the sector fall by 90 per cent (-4.5 t) when moving from a production- to a consumption-based accounting approach. This is the result of a large share of output from the sector being sold to intermediate suppliers – food manufacturers, distributors, restaurants and grocery stores – in Manitoba, elsewhere in Canada and internationally. Production emissions associated with this output are subsequently reallocated to the sector and region that supply the final consumption good for which Manitoba's farm output is an input.

Last, the engineering construction sector is the only sector that is a primary source of consumption emissions in Manitoba but not production emissions. Emissions in the sector increase from only 0.1 t under a production-based accounting approach to 1.1 t under a consumption-based accounting approach. The increase in emissions is driven by the sector absorbing all of the emissions associated with production of its inputs. For example, when an oil and gas services firm purchases cement to secure a well casing, emissions associated with the production of the cement are reallocated from the other (non-energy) mining and manufacturing sectors to the engineering construction sector. Notably, output from the engineering construction sector reflects only expenditure by firms, and all of the consumption emissions are therefore allocated to firm investment.

As shown on the right-hand side of Figure 1, Manitoba'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 MANITOBA PER CAPITA CONSUMPTION EMISSIONS BY CONSUMPTION GROUP AND SECTOR

Household Consumption Emissions		Firm Investment Consumption Emissions		Government Consumption Emissions	
Per Capita Consumption Emissions ***(Share of Total Per Capita Consumption Emissions)***					
11.2 t *(65%)*		3.9 t *(23%)*		2.0 t *(12%)*	
Top Sectors Contributing to Consumption Emissions					
Manufacturing:	3.7 t	Manufacturing:	1.3 t	Other provincial government services:	0.7 t
Personal transportation:	2.2 t	Engineering construction:	1.1 t	Other federal government services:	0.4 t
Residential:	0.9 t	Residential construction:	0.7 t	Government education services:	0.3 t
Transportation and warehousing:	0.8 t	Non-residential building construction:	0.4 t	Government health services:	0.3 t
Accommodation and food services:	0.6 t	Natural gas extraction:	0.2 t	Other municipal government services:	0.3 t
Other:	3.0 t	Other:	0.2 t	Other Aboriginal government services:	0.1 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

Manitoba's primary source of net interprovincial imports of emissions is from the manufacturing sectors in Alberta, Ontario, Saskatchewan and Quebec. As Manitoba does not have a refinery, imports from the manufacturing sectors in Alberta and Saskatchewan are most likely largely driven by the emissions embedded in refined petroleum products produced at refineries in these provinces and exported to Manitoba for sale. Manitoba additionally has large net imports of greenhouse gas emissions from the natural gas extraction sectors in Alberta and Saskatchewan. Although Manitoba does not have any natural gas power plants, 61 per cent of the province's homes used natural gas as the primary fuel for household heating in 2011 (Statistics Canada, 2011). Other large sources of net imports of emissions are the crop and animal production sector in Saskatchewan, the retail trade sector in Alberta and the finance, insurance, real estate and rental and leasing sector in Ontario.

The crop and animal production sector is the largest source of interprovincial exports from Manitoba. Ontario, Alberta, Saskatchewan and Quebec receive the largest flows of emissions from the sector, and Manitoba is a net exporter to all provinces except Saskatchewan. The province additionally has large net exports of emissions in the transportation and warehousing sector to Ontario and Quebec, and in the manufacturing sector to British Columbia.

INTERNATIONAL TRADE FLOWS

Manitoba's largest source of net international imports of greenhouse gas emissions is the manufacturing sector. The province also has small net international imports from the accommodation and food services, and natural gas extraction sectors. Net imports of emissions, however, are more than offset by net international exports in the crop and animal production, transportation and warehousing, wholesale trade and crude oil extraction sectors. This is largely consistent with agricultural output (including wheat, canola, swine and soya) and crude oil being two of Manitoba's largest exports in 2011 (Industry Canada, 2017).

TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Total production emissions in Manitoba declined over the period of 2004 to 2011 (-8 per cent) (Figure 3). Manitoba's population grew over this period (+5 per cent), leading to an even larger percentage drop in the province's per capita production emissions (-13 per cent) (Figure 4). The decline in total emissions is largely a result of a substantial drop in emissions from the province's crop and animal production sector over the period of 2008 to 2011. This is consistent with declining crop production in the sector over this same period, although rising output from 2004 to 2008 while emissions stayed relatively constant also suggests a move towards less carbon-intensive farming practices (Statistics Canada, 2017).

The decline in Manitoba'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 17 per cent from 2004 to 2011. When combined with a growing population, however, the net increase in per capita consumption emissions falls to 11 per cent. Manitoba was a net exporter of emissions in 2004, with per capita net exports measuring 2.1 t. With production emissions declining and consumption emissions increasing, it transitioned to being a net importer of emissions in 2010. In 2011, per capita net imports to the province measured 1.9 t.

Consumption emissions related to firm investment saw the largest percentage growth from 2004 to 2011. Specifically, total firm investment consumption emissions increased by 41 per cent while per capita emissions increased by 34 per cent. Total and per capita emissions were generally consistently growing over this period, with only two years of decline in 2007 and 2009. The increase in emissions was driven almost entirely by the aggregate construction sector, with engineering construction accounting for the majority of the growth in construction-sector emissions since 2009.[3] The only sector with a notable decline in firm investment consumption emissions was manufacturing.

Total and per capita government consumption emissions increased by 23 and 17 per cent respectively from 2004 to 2011. Emissions were mostly gradually increasing, with only one marked decline in 2009. Since 2009 the largest source of growth has been the other (non-education and health) provincial government services sector.[4] Smaller levels of growth were also observed in the government education and other federal government services sectors. Emissions in the remaining government subsectors were largely unchanged.

Total and per capita household consumption emissions had the lowest rates of growth from 2004 to 2011, rising by 10 and five per cent respectively. Absolute growth in total emissions, however, was the highest among the three consumption groups. Similar to firm investment emissions, household consumption emissions were generally increasing over the period with only two years of decline in 2006 and in 2008. The sectors with the largest increases in emissions over this period were manufacturing and transportation and warehousing while those with the largest decreases were finance, insurance, real estate and rental and leasing, and utilities.

[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, MANITOBA: 2004 TO 2011

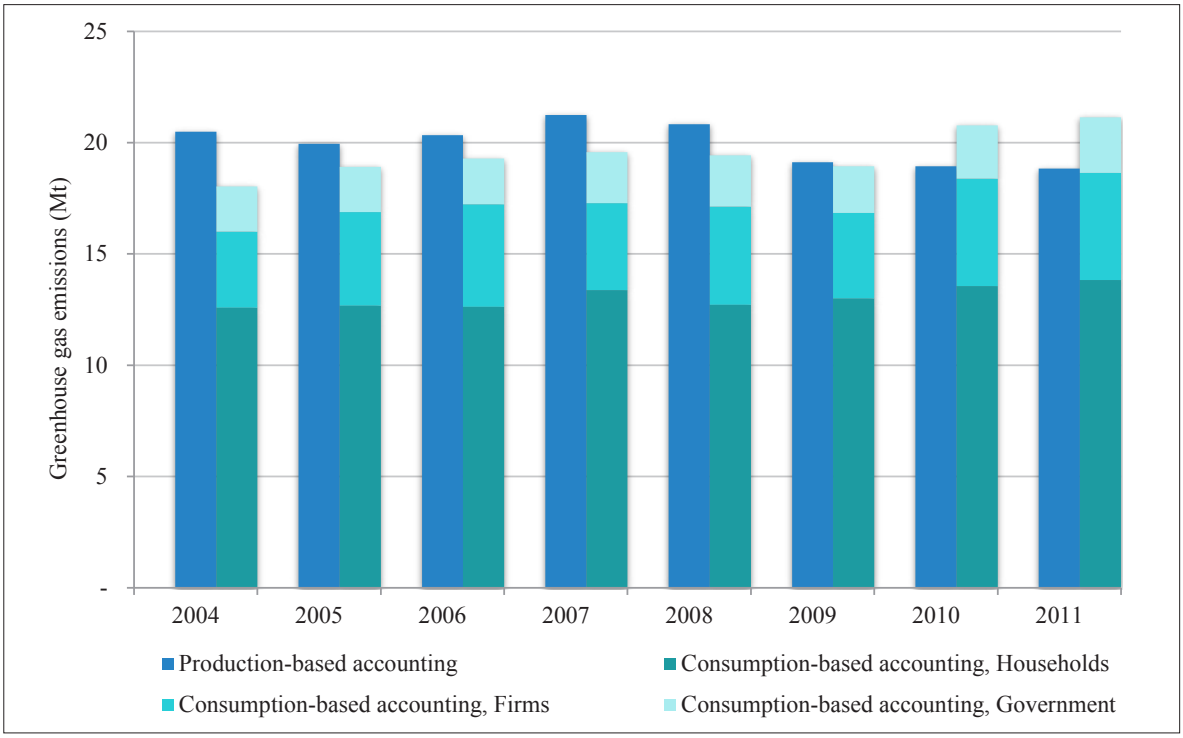
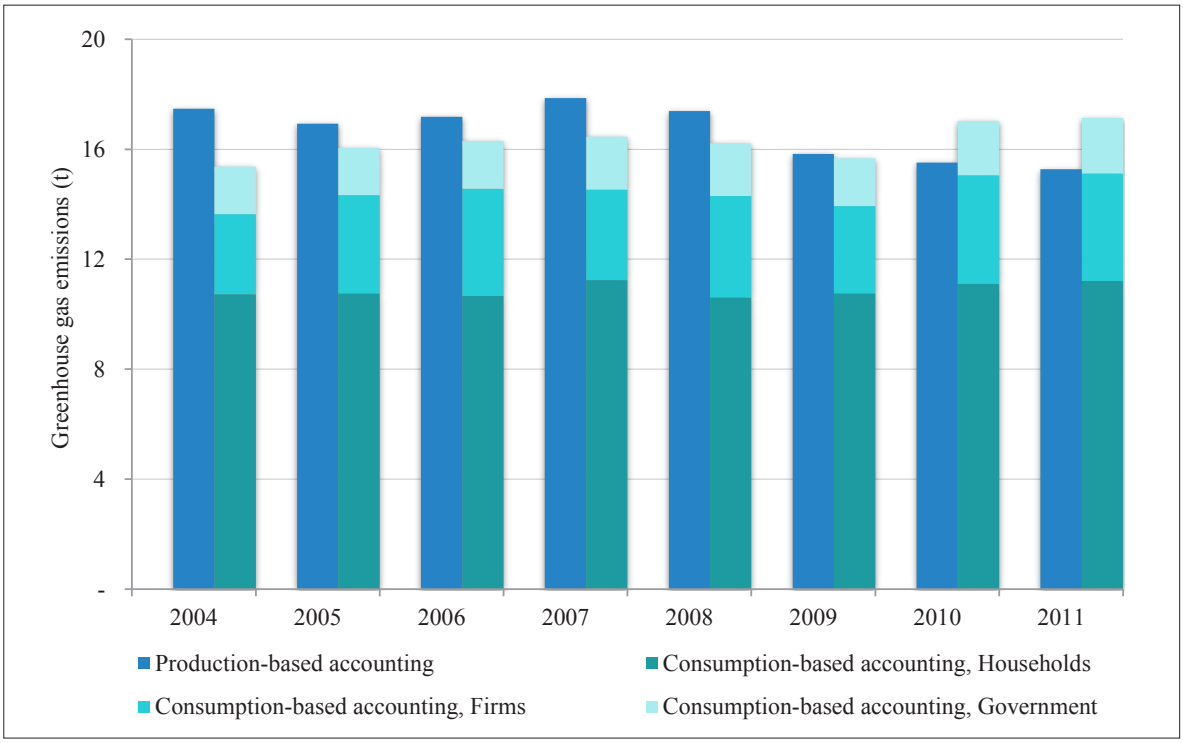


FIGURE 4 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, MANITOBA: 2004 TO 2011



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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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