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The University of Calgary is home to scholars in 16 faculties (offering more than 80 academic programs) and 36 Research Institutes and Centres including *The School of Public Policy*. Founded by Jack Mintz, President's Fellow, and supported by more than 100 academics and researchers, the work of The School of Public Policy and its students contributes to a more meaningful and informed public debate on fiscal, social, energy, environmental and international issues to improve Canada's and Alberta's economic and social performance.

# BIG AND LITTLE FEET PROVINCIAL PROFILES: TERRITORIES[†]

**Sarah Dobson and G. Kent Fellows**

This communiqué provides a summary of the production- and consumption-based greenhouse gas emissions accounts for the Yukon, Northwest Territories and Nunavut, 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 the territories. 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 the territories through household purchases, investment by firms and government spending. Trade flows refer to the movement of emissions that are produced in the territories but which support consumption in a different province or country (and vice versa). For example, emissions associated with the production of gold in Nunavut that is exported to Quebec for processing and sale are recorded as a trade flow from the territories to Quebec. Moving in the opposite direction, emissions associated with the production of British Columbia natural gas that is sold to a Northwest Territories utility and used to generate electricity for homes in the Northwest Territories are recorded as a trade flow from British Columbia to the territories.

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 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.

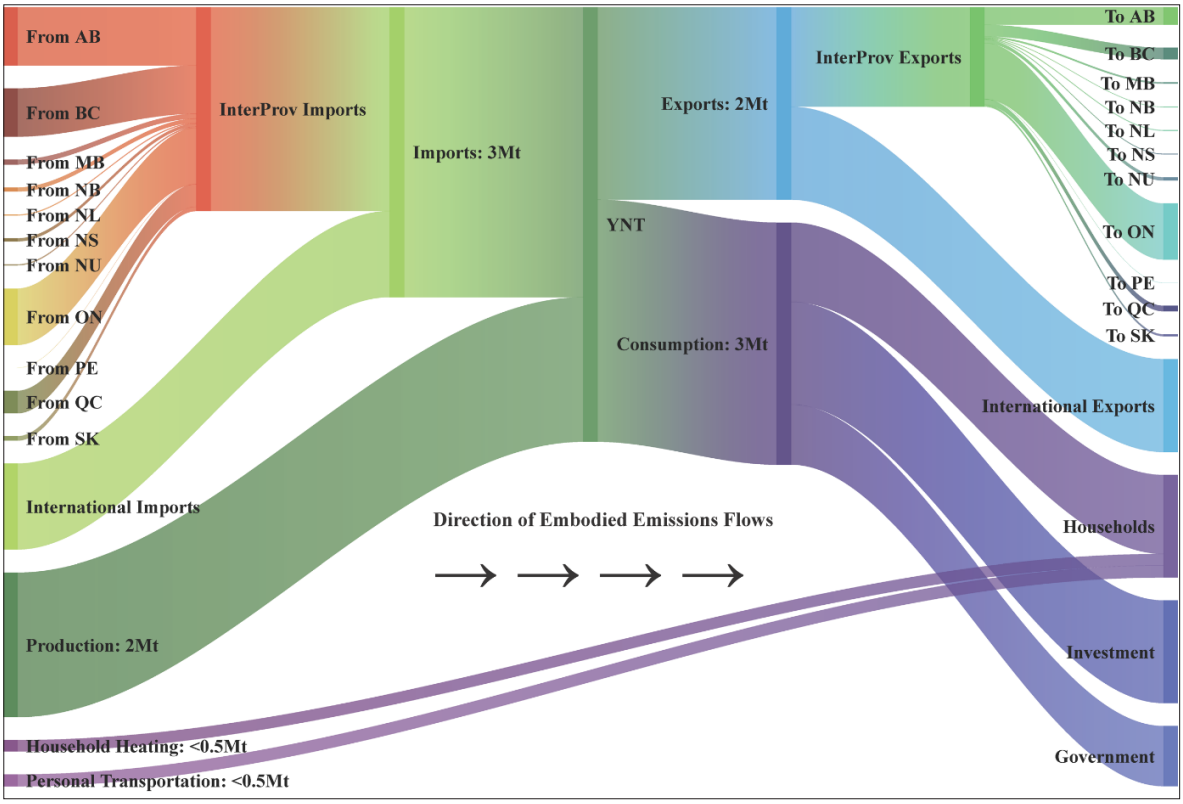
## PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

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*

Total production-based emissions in the Yukon, Northwest Territories and Nunavut in 2011 were 2.1 megatonnes (Mt) of $CO_2e$ (Figure 1 and Figure 2), corresponding to per capita emissions of 18.2 t. The territories are net importers of greenhouse gas emissions from both international (+0.1 Mt) and interprovincial (+2.0 Mt) sources. Their emissions therefore increase when moving to a consumption-based accounting approach, rising to 4.2 Mt total $CO_2e$ emissions or 36.9 t of $CO_2e$ per capita.[2]

**FIGURE 1 EMISSIONS FLOWS THROUGH THE YUKON AND NORTHWEST TERRITORIES ECONOMIES**



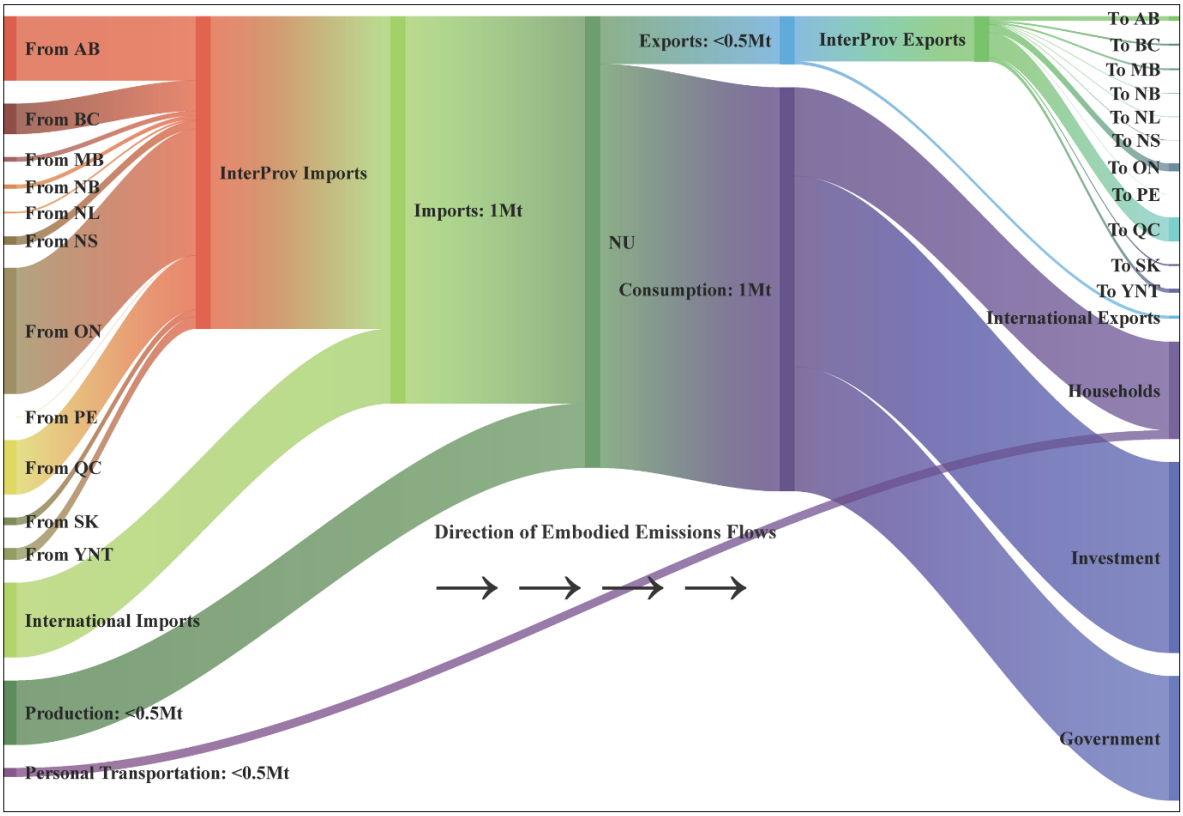

| | |
|---|---|
| Net exporter of emissions to: | Prince Edward Island, International |
| Net importer of emissions from: | British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador |

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.

**FIGURE 2 EMISSIONS FLOWS THROUGH THE NUNAVUT ECONOMY**



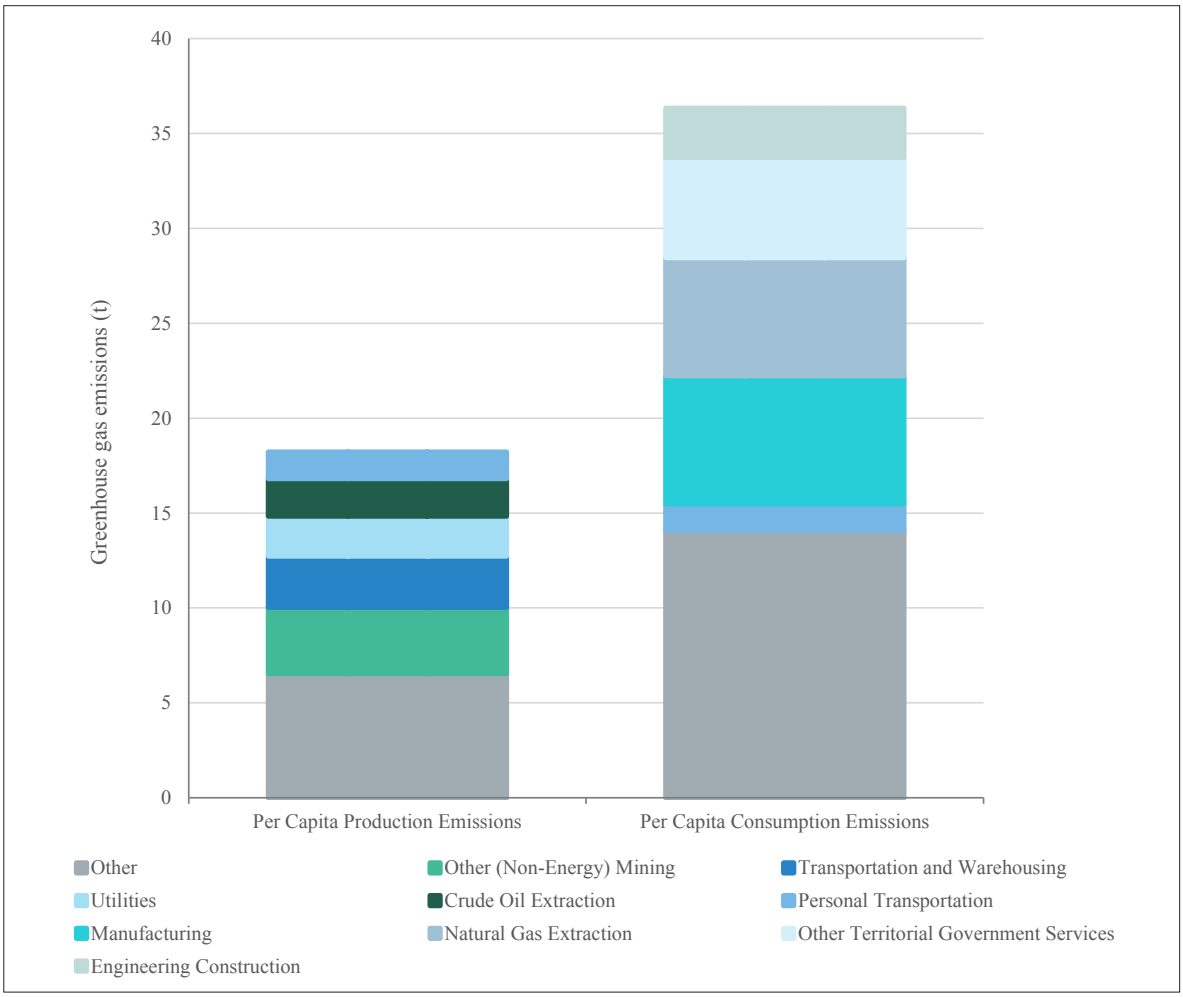

| | |
|---|---|
| Net exporter of emissions to: | N/A |
| Net importer of emissions from: | International, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador |

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/.

The largest sectors responsible for per capita production emissions in the territories are other (non-energy) mining (3.5 t), transportation and warehousing (2.7 t), utilities (2.1 t), crude oil extraction (2.0 t) and personal transportation (1.4 t). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (6.8 t), natural gas extraction (6.2 t), other territorial government services (5.3 t), engineering construction (2.6 t) and personal transportation (1.4 t) (Figure 3).

**FIGURE 3 BREAKDOWN BY SECTOR OF PRODUCTION AND CONSUMPTION EMISSIONS IN THE TERRITORIES**




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).

Personal transportation is the only sector that overlaps as a main source of both production and consumption emissions in the territories. Emissions are unchanged when moving from a production- to a consumption-based accounting approach as all of the production emissions in the sector are generated by household consumption of fossil fuels in personal vehicles. As a result, production and consumption emissions are by definition the same.

The other (non-energy) mining, transportation and warehousing, utilities and crude oil extraction sectors are primary sources of production emissions in the territories but not consumption emissions. Emissions from the crude oil extraction sector fall to zero (-2.0 t) when moving from a production- to a consumption-based accounting approach as the territories do not have any refineries and all of their crude oil production is therefore exported. The (non-energy) mining sector similarly sees a substantial decrease in emissions of 84 per cent (-2.9 t). This is because minerals are not generally consumed in their raw form, but are instead used as inputs into the production of manufactured goods such as steel, wiring or jewelry. Production emissions from the sector are subsequently reallocated to the sector and region – often interprovincial or international – in which consumption of the manufactured good occurs. Emissions in the transportation and warehousing, and utilities sectors fall by 70 per cent (-1.9 t) and 56 per cent (-1.2 t) respectively

when moving from a production- to a consumption-based accounting approach. This is again the result of intermediate inputs comprising a large share of output from both sectors. Specifically, in the transportation and warehousing sector the storage and transportation of goods are generally intermediate steps in bringing a final good to market. Accordingly, production emissions associated with these steps are reallocated in a consumption-based approach to the sector and region where final consumption of the good occurs. In the utilities sector a large share of generated electricity is purchased by firms and government, where it becomes an intermediate input into the production of goods or provision of services for final consumers in the territories, the provinces or internationally. Accordingly, under a consumption-based accounting approach these emissions are reallocated to the sector and region in which final consumption of these goods and services occurs.

Last, the manufacturing, natural gas extraction, other territorial government services and engineering construction sectors are primary sources of consumption emissions in the territories but not production emissions. In the manufacturing sector, per capita emissions increase from only 0.1 t under a production-based accounting approach to 6.8 t under a consumption-based approach. This is attributable to two factors. First, the sector is a key supplier of final consumption goods for households and firm investment and second, the territories have very limited domestic manufacturing. As a result, the large majority of manufactured goods sold in the territories are imported in their final form and the emissions associated with manufacturing and transporting them to the territories are accordingly reallocated to household consumption and firm investment. Per capita emissions in the natural gas extraction sector also increase substantially – from 1.0 to 6.2 t – when moving from a production- to a consumption-based accounting approach. This increase is attributable to natural gas being a key investment expenditure for firms operating in the territories, and to the territories having minimal domestic natural gas production. Firms must therefore import natural gas from the provinces and all of the emissions associated with producing the natural gas and moving it to the territories are subsequently reallocated to firm investment. Last, per capita emissions in the territorial government services sector increase from 0.3 to 5.3 t while emissions in the engineering construction sector increase from 0.1 to 5.0 t. Both increases are a result of these sectors absorbing all of the emissions associated with production of their inputs. For example, the sectors will be allocated emissions from the utilities sector that are associated with the production of electricity used in territorial government buildings and on engineering construction sites. Notably, output from the other territorial government services sector reflects primarily expenditures by government while output from the engineering construction sector reflects only expenditures by firms. Accordingly, the large majority of consumption emissions in the other territorial government services sector are allocated to government spending while those in the engineering construction sector are allocated entirely to firm investment.

As shown on the right-hand side of Figure 1 and Figure 2, consumption emissions in the territories 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 PER CAPITA CONSUMPTION EMISSIONS IN THE TERRITORIES 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)*** | | | | | |
| 12.5 t *(34%)* | | 15.1 t *(41%)* | | 9.2 t *(25%)* | |
| **Top Sectors Contributing to Consumption Emissions** | | | | | |
| Manufacturing: | 4.1 t | Natural gas extraction: | 6.2 t | Other territorial government services | 5.2 t |
| Personal transportation: | 1.4 t | Manufacturing: | 2.6 t | Other federal government services: | 1.0 t |
| Residential: | 1.1 t* | Engineering construction: | 2.6 t | Government education services: | 1.0 t |
| Utilities: | 0.9 t | Residential construction: | 1.1 t | Government health services: | 0.8 t |
| Crop and animal production: | 0.8 t | Non-residential building construction: | 1.0 t | Other municipal government services: | 0.7 t |
| Other: | 4.2 t | Other: | 1.7 t | Other Aboriginal government services: | 0.6 t |

* Residential household consumption emissions for the territories as a whole are weighted down as a result of there being no available data on residential emissions in Nunavut. In the Yukon and Northwest Territories per capita household consumption emissions in the residential sector are 1.6 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

The largest sources of net imports of greenhouse gas emissions to both the Yukon and Northwest Territories and Nunavut are the manufacturing sector and the natural gas extraction sector. As previously noted, the territories have only a very limited domestic manufacturing sector. As a result, they are a net importer of greenhouse gas emissions from all of the other provinces, with the largest flows coming from Alberta, Quebec, Ontario and British Columbia. Imports in the natural gas extraction sector come from Ontario,[3] British Columbia and Alberta and are driven primarily by large firm investment expenditures in the sector and limited domestic natural gas production within the territories. Natural gas is additionally used for a small amount of electricity generation in the Northwest Territories (Statistics Canada, 2017). The territories also have smaller net imports of emissions from the transportation and warehousing sectors in British Columbia, Alberta and Saskatchewan, from the crop and animal production sectors in Alberta and British Columbia, from the professional, scientific and technical service sectors in Alberta and Ontario, and from the wholesale trade, accommodation and food services, and retail trade sectors in Alberta.

The territories' largest flows of net interprovincial exports of greenhouse gas emissions are from the crude oil extraction sector in the Yukon and Northwest Territories to Ontario, Alberta and British Columbia. Although crude oil production in the territories is not significant – it averaged only 10,500 barrels per day in 2011 – as previously noted, there are no refineries in the territories and all of the production is exported (National Energy Board, 2016). Other large sources of net exports of emissions is the other (non-energy) mining sector in Nunavut to Quebec, and the transportation and warehousing sector in the Yukon and Northwest Territories to Ontario and Saskatchewan.

[3] As natural gas production in Ontario is limited, emissions from Ontario are mostly likely associated with re-exports of natural gas imported into Ontario.

## INTERNATIONAL TRADE FLOWS

The largest source of net international imports of greenhouse gas emissions to the Yukon and Northwest Territories and Nunavut is the manufacturing sector. The only sector with significant net exports of emissions internationally is the other (non-energy) mining sector in the Yukon and Northwest Territories. This is consistent with diamond, tungsten, copper, zinc and lead being the largest international exports from the Yukon and Northwest Territories in 2011 (Industry Canada, 2017). In Nunavut the largest flow of international emissions exports is from the fishing, hunting and trapping sector. This is consistent with fur pelts being Nunavut's largest non-manufacturing export in 2011 (Industry Canada, 2017).

## TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Total production emissions in the territories increased from 2004 to 2007 and then declined from 2007 to 2011, resulting in a net decline in total production emissions over the period of 2004 to 2011 (-17 per cent) (Figure 3). The population of the territories grew over this period (+8 per cent), leading to an even larger percentage drop in per capita production emissions (-23 per cent) (Figure 4). The decline was driven primarily by falling emissions in the transportation and warehousing and personal transportation sectors.

The decline in production emissions in the territories over the period of 2004 to 2011 did not translate into a decline in consumption emissions. Rather, total consumption emissions in the territories increased by 27 per cent while per capita emissions increased by 17 per cent. The territories were a net importer of greenhouse gas emissions in 2004. With consumption emissions increasing and production emissions decreasing, per capita net imports to the territories increased from 7.9 t in 2004 to 18.7 t in 2011.

Consumption emissions related to firm investment saw the largest percentage and absolute growth from 2004 to 2011. Specifically, total firm investment consumption emissions doubled while per capita emissions increased by 86 per cent. Emissions followed three distinct trends – steadily increasing from 2004 to 2007, two years of decline in 2008 and 2009 (likely as a result of the global recession), and then increasing again in 2010 and 2011. The increase in emissions, particularly since 2009, was driven primarily by rising firm expenditures in the natural gas extraction sector. In contrast, firm investment consumption emissions in the manufacturing sector remained relatively unchanged from 2004 to 2011 while emissions in the aggregate construction sector decreased, with the residential construction sector driving most of the decline since 2009.[4]

Total household consumption emissions also increased over the period of 2004 to 2011 (+5 per cent) but when combined with a growing population, per capita household emissions declined (-3 per cent). Household consumption emissions followed a similar pattern to firm investment although after increasing post-recession in 2010, emissions fell again in 2011. The manufacturing, accommodation and food services, and crop and animal production sectors all saw notable increases in household consumption emissions over this period. In contrast, the sectors that saw the largest decreases in household consumption emissions were finance, insurance, real estate and rental and leasing, and retail trade.

Last, government was the only consumption group that saw a net decrease in both total and per capita consumption emissions from 2004 to 2011, with total emissions declining by five per cent and per capita emissions declining by 12 per cent. Emissions did not follow a consistent pattern, however, and remained relatively constant overall, varying between 1.0 Mt (2005 and 2009 low) and 1.3 Mt (2007 high). Relative to 2009, government consumption emissions have increased slightly across all of the government subsectors.[5]

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[4] Prior to 2009 emissions data are only available for the aggregate construction sector.

[5] Prior to 2009 emissions data are only available for the aggregate government services sector.

**FIGURE 4 TOTAL PRODUCTION AND CONSUMPTION EMISSIONS, TERRITORIES: 2004 TO 2011**

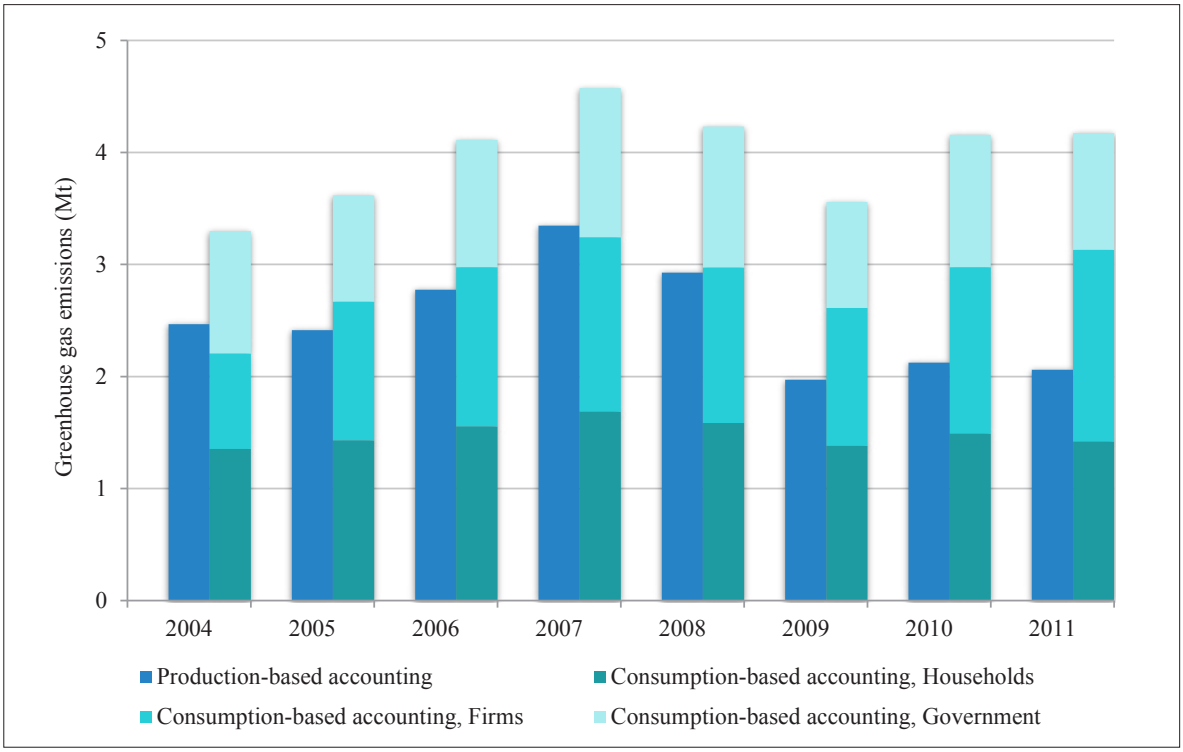
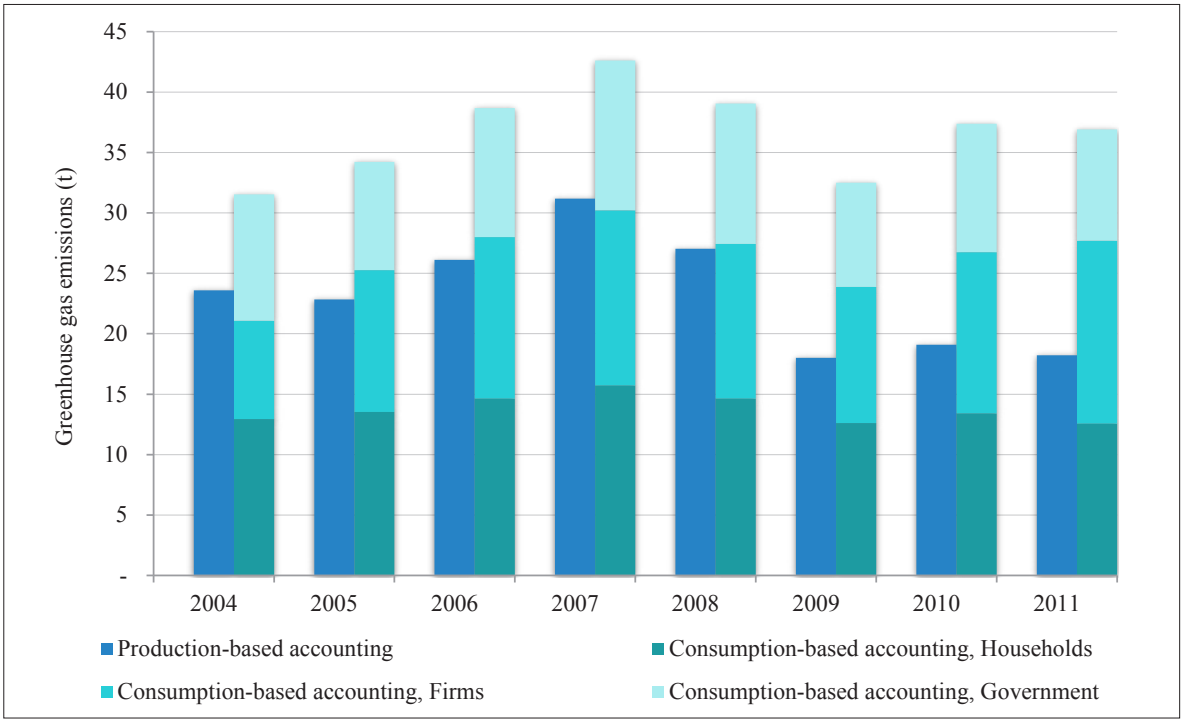



**FIGURE 5 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, TERRITORIES: 2004 TO 2011**



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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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