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BIG AND LITTLE FEET PROVINCIAL PROFILES: BRITISH COLUMBIA[†]

Sarah Dobson and G. Kent Fellows

This communiqué provides a summary of the production- and consumption-based greenhouse gas emissions accounts for British Columbia, 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 British Columbia. 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 British Columbia through household purchases, investment by firms and government spending. Trade flows refer to the movement of emissions that are produced in British Columbia but which support consumption in a different province, territory or country (and vice versa). For example, emissions at the Port of Vancouver that are associated with goods that are subsequently exported to Ontario for sale are recorded as a trade flow from British Columbia to Ontario. Moving in the opposite direction, emissions associated with the production of Alberta crude oil that is refined in British Columbia and sold as motor gasoline to a British Columbia consumer are recorded as a trade flow from Alberta to British Columbia.

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.

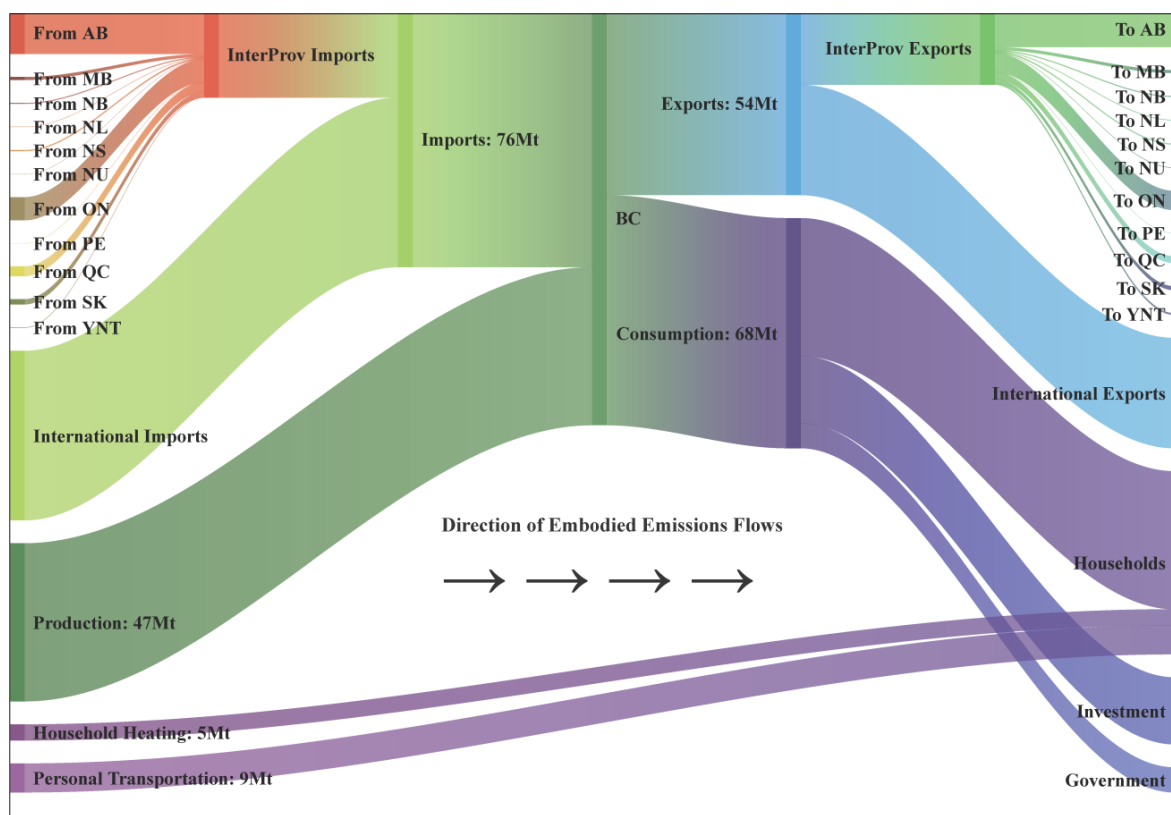
PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

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

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

British Columbia's total production emissions in 2011 were 59.9 megatonnes (Mt) of CO₂e (Figure 1), corresponding to per capita emissions of 13.3 t. The province is a net importer of greenhouse gas emissions internationally (+17.5 Mt) and from the other provinces (+3.8 Mt). British Columbia's emissions therefore increase when moving to a consumption-based accounting approach, rising to 81.2 Mt total CO₂e emissions or 18.0 t of CO₂e per capita.²

FIGURE 1 EMISSIONS FLOWS THROUGH THE BRITISH COLUMBIA ECONOMY



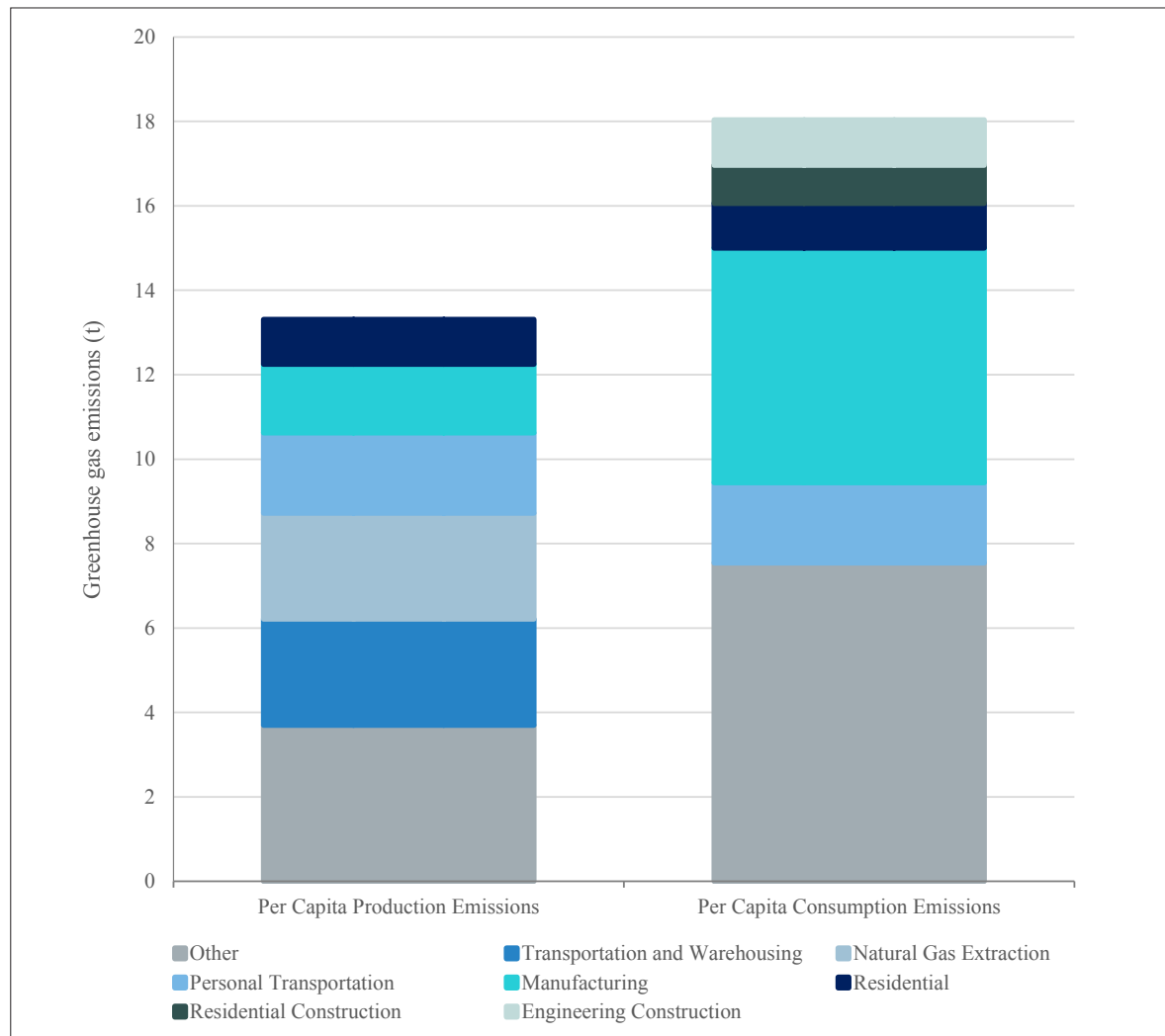
Data Source: Fellows, G. Kent and Sarah Dobson. 2017. "Embodied Emissions in Inputs and Outputs: A Value-Added Approach to National Emissions Accounting," *Canadian Public Policy*, 43(2): 140-164.
<https://doi.org/10.3138/cpp.2016-040>.

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 British Columbia are transportation and warehousing (2.5 t), natural gas extraction (2.5 t), personal transportation (1.9 t), manufacturing (1.6 t) and residential (1.1 t). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (5.6 t), personal transportation (1.9 t), engineering construction (1.1 t), residential (1.1 t) and residential construction (0.9 t) (Figure 2).

FIGURE 2 BREAKDOWN BY SECTOR OF BRITISH COLUMBIA 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 – personal transportation, manufacturing and residential – overlap as main sources of both production and consumption emissions in British Columbia. Emissions from the manufacturing sector increase by 240 per cent (+3.9 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 British Columbia, elsewhere in Canada and internationally being reallocated to British Columbia's manufacturing sector – and specifically household consumption and firm investment – under a consumption-based accounting approach. In contrast, 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 transportation and warehousing and natural gas extraction sectors are primary sources of production emissions in British Columbia but not consumption emissions. Rather, emissions from the transportation and warehousing sector decrease by 66 per cent (-1.7 t) when moving from a production- to a consumption-based accounting approach while emissions from the natural gas extraction sector decrease by 77 per cent (-1.9 t). The decreases are a 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. Similarly, a significant share of British Columbia natural gas production is sold to oil and gas companies, utilities and manufacturers, where it is then used as an intermediate input in the production of other goods or the provision of services. Production emissions associated with the extraction of natural gas in British Columbia are subsequently reallocated to the sector and region that supply the final good or service for which British Columbia's natural gas was an input.

Last, the engineering and residential construction sectors are primary sources of consumption emissions in British Columbia but not production emissions. Per capita emissions in both sectors increase from virtually zero under a production-based accounting approach to 1.1 t in the engineering construction sector and 0.9 t in the residential construction sector under a consumption-based accounting approach. The increases are a result of both sectors absorbing all of the emissions associated with production of their 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 construction sectors 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, British Columbia'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 BRITISH COLUMBIA 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>					
12.0 t (67%)		4.4 t (24%)		1.6 t (9%)	
Top Sectors Contributing to Consumption Emissions					
Manufacturing:	4.3 t	Manufacturing:	1.3 t	Other provincial government services:	0.7 t
Personal transportation:	1.9 t	Engineering construction:	1.1 t	Other municipal government services:	0.3 t
Residential:	1.1 t	Residential construction:	0.9 t	Government health services:	0.2 t
Transportation and warehousing:	0.8 t	Natural gas extraction:	0.4 t	Government education services:	0.2 t
Accommodation and food services:	0.7 t	Non-residential building construction:	0.3 t	Other federal government services:	0.2 t
Other:	3.2 t	Other:	0.4 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

The majority of British Columbia’s interprovincial net imports of emissions are associated with goods purchased from the manufacturing sector, and are imported from Alberta, Ontario, Quebec and Saskatchewan. As British Columbia has only a single refinery in Burnaby, imports from the manufacturing sector in Alberta are most likely largely driven by the emissions embedded in refined petroleum products produced at Alberta refineries and exported to British Columbia for sale. The province also has small net imports of emissions from Ontario’s finance, insurance, real estate and rental and leasing sector, and from Alberta’s crude oil extraction sector. These flows are consistent with Ontario, and in particular Toronto, being Canada’s financial hub and with Alberta oil being the primary feedstock for the Burnaby refinery.

British Columbia has only two sectors with notable interprovincial net exports of emissions: transportation and warehousing and natural gas extraction. The transportation and warehousing sector is a net exporter of emissions to all the other provinces, with the largest exports going to Ontario and Quebec. This is consistent with ports in British Columbia being the primary entry point for Canadian imports from Asia. The largest recipient of net exports of emissions from the natural gas extraction sector is Alberta. This largely reflects the positioning of British Columbia natural gas production in the northeast of the province, making it a nearby supply source for industrial demand in Alberta’s oil sands.

INTERNATIONAL TRADE FLOWS

Internationally, the manufacturing sector is the main source of net imports of emissions to British Columbia, followed by the crop and animal production sector, the accommodation and food services sector and the utilities sector. The major sectors with net exports of emissions to international trading partners are transportation and warehousing, coal mining, natural gas extraction and wholesale trade. These trade patterns in emissions are consistent with Vancouver being a major North American import and export port for goods traded with Asia, and with coal and natural gas being British Columbia’s two largest sources of international exports outside of the manufacturing sector in 2011 (Industry Canada, 2017).

TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Total production emissions in British Columbia declined by seven per cent over the period of 2004 to 2011 (Figure 3). The province's population grew over this period (+8 per cent), leading to an even larger percentage drop in per capita production emissions (-14 per cent) (Figure 4). The decrease in emissions was largely driven by steadily declining production emissions in the province's manufacturing sector. This is consistent with declining output over this period within the manufacturing subsectors of pulp and paper, aluminum and other non-ferrous metals, and chemicals (Statistics Canada, 2017).

The decline in British Columbia'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 15 per cent from 2004 to 2011. When combined with a growing population, however, the net increase in total per capita consumption emissions falls to six per cent. British Columbia 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 1.5 t in 2004 to 4.7 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 31 per cent while per capita emissions increased by 21 per cent. The pattern of growth was not consistent, however, with total and per capita emissions rising sharply from 2004 to 2005, declining from 2005 to 2007 and then increasing again from 2007 to 2011. The sector that saw the largest increase in emissions over this period was natural gas extraction. The aggregate construction sector also saw a significant increase in emissions from 2004 to 2008 but emissions have since declined slightly, driven by falling emissions in the engineering construction sector post-2009.³

Total and per capita government consumption emissions initially decreased from 2004 to 2006. They were then generally increasing from 2006 to 2011, however, with only a single drop-off in 2009. On net, total and per capita government consumption emissions increased by 12 and three per cent respectively over the entire period of 2004 to 2011. Since 2009 the increase in emissions has been driven primarily by the other (non-health care and education) provincial government services sector.⁴ Consumption emissions in the remaining government subsectors have remained relatively constant.

Total and per capita household consumption emissions had the lowest rates of growth from 2004 to 2011, rising by only 10 and two per cent respectively. Absolute growth in total emissions, however, was the highest among the three consumption groups. The pattern of growth in total emissions was again not consistent with emissions increasing from 2004 to 2006, declining in 2007 and 2008, and then increasing again from 2008 to 2011. In contrast, per capita emissions were largely constant, hovering between a low of 11.8 tonnes (2004) and a high of 12.2 tonnes (2006). The manufacturing, transportation and warehousing, and accommodation and food services sectors all saw notable increases in household consumption emissions over this period, with most of the growth coming post-2009. The largest declines in household consumption emissions were observed in the finance, insurance, real estate and rental and leasing, utilities and retail trade sectors.

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, BRITISH COLUMBIA: 2004 TO 2011

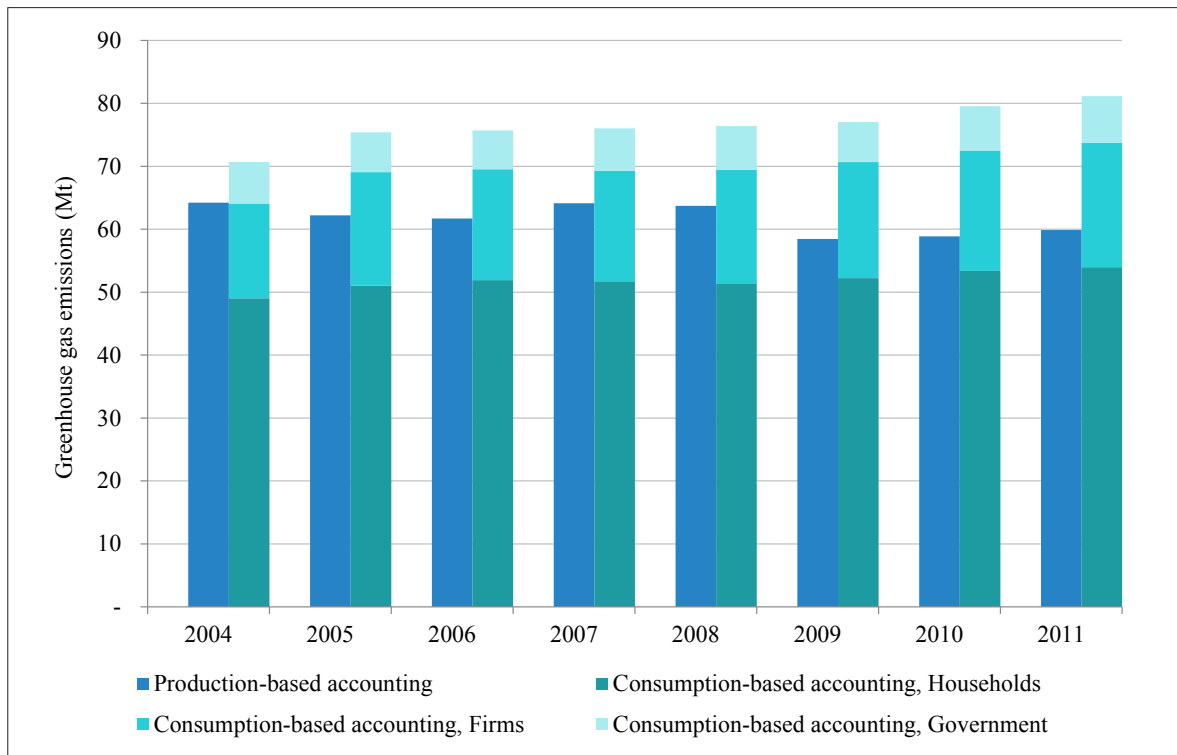
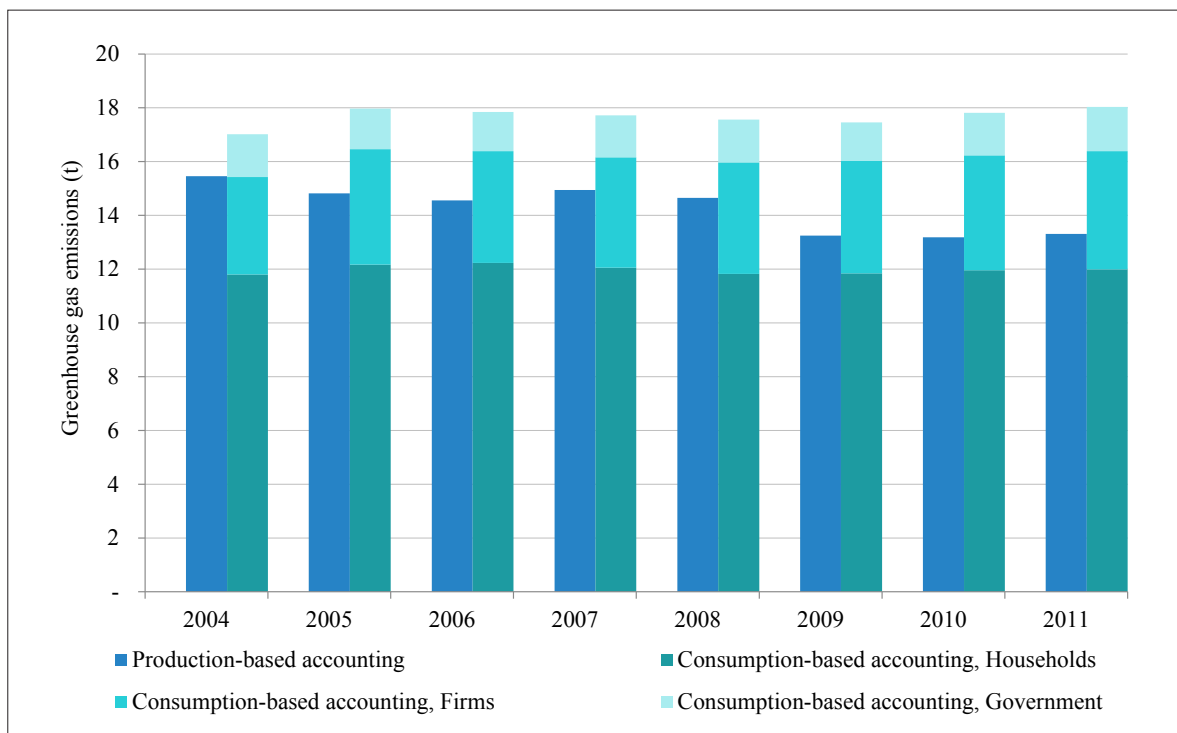


FIGURE 4 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, BRITISH COLUMBIA: 2004 TO 2011



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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.

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