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BIG AND LITTLE FEET PROVINCIAL PROFILES: NEW BRUNSWICK[†]

Sarah Dobson and G. Kent Fellows

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

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.

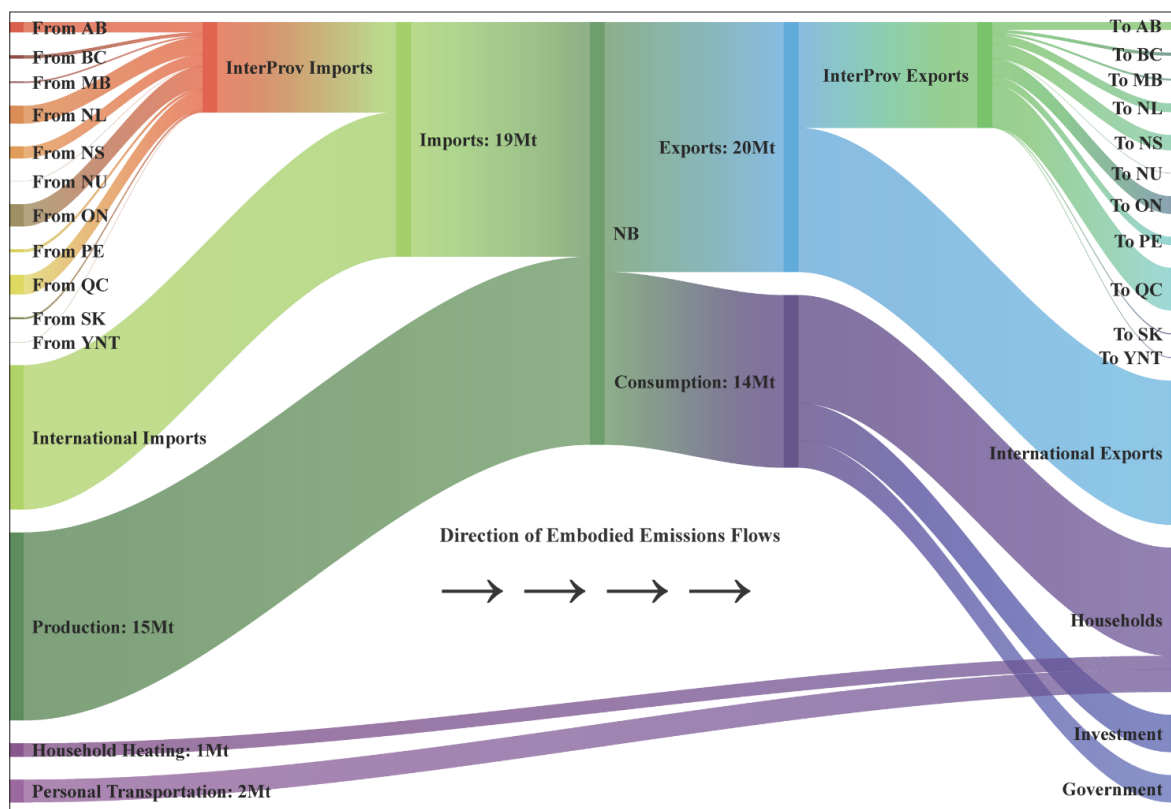
PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

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

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

New Brunswick's total production emissions in 2011 were 18.1 megatonnes (Mt) of CO₂e (Figure 1), corresponding to per capita emissions of 24.0 t. The province is a small net importer of greenhouse gas emissions from international sources (+0.03 Mt) and a net exporter of greenhouse gas emissions to the other provinces (-1.3 Mt). As New Brunswick's interprovincial net exports exceed its international net imports, total emissions decrease when moving to a consumption-based accounting approach, falling to 16.9 Mt total CO₂e emissions or 22.4 t of CO₂e per capita.²

FIGURE 1 EMISSIONS FLOWS THROUGH THE NEW BRUNSWICK ECONOMY



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

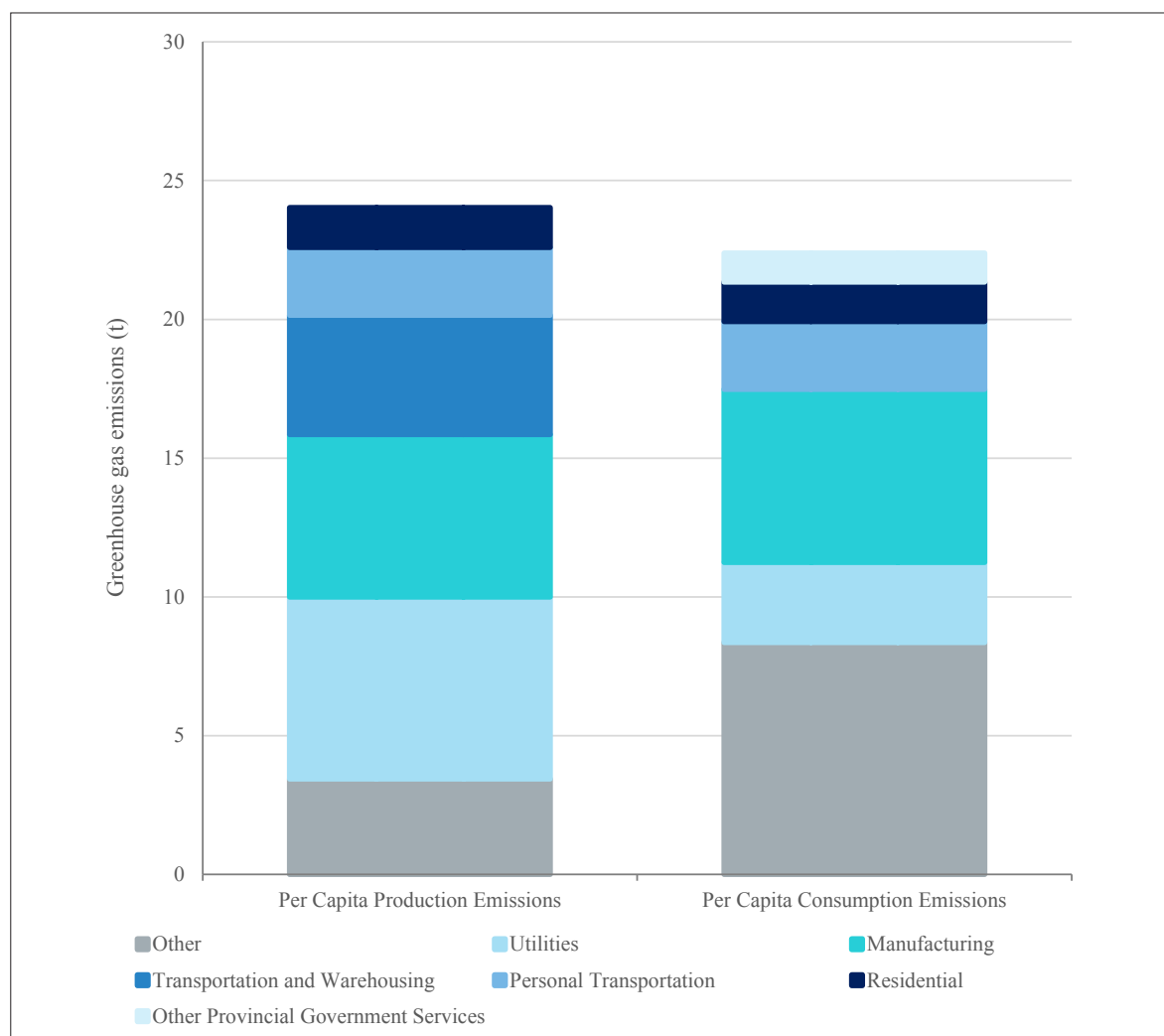
Data Source: Fellows, G. Kent and Sarah Dobson. 2017. "Embodied Emissions in Inputs and Outputs: A Value-Added Approach to National Emissions Accounting." *Canadian Public Policy*, 43(2): 140-164.
<https://doi.org/10.3138/cpp.2016-040>.

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.

The largest sectors responsible for per capita production emissions in New Brunswick are utilities (6.6 t), manufacturing (5.9 t), transportation and warehousing (4.3 t), personal transportation (2.4 t) and residential (1.4 t). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (6.2 t), utilities (2.9 t), personal transportation (2.4 t), residential (1.4 t) and other provincial government services (1.0 t) (Figure 2).

FIGURE 2 BREAKDOWN BY SECTOR OF NEW BRUNSWICK 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 – utilities, manufacturing, personal transportation and residential – overlap as main sources of both production and consumption emissions in New Brunswick. Emissions from the utilities sector decrease by 56 per cent (-3.7 t) when moving from a production- to a consumption-based accounting approach while emissions from the manufacturing sector increase by seven per cent (+0.4 t) and emissions from the personal transportation and residential sectors remain unchanged. The decrease in emissions in the utilities sector is attributable to the fact that electricity purchased by firms and government accounts for a large share of output from the sector. This electricity – and its associated emissions – then becomes an intermediate input into the production

of goods or provision of services that are sold to final consumers in New Brunswick, other 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. Emissions that remain in the utilities sector under both a production- and a consumption-based accounting approach are primarily those associated with the generation of electricity for household use, which is a final consumption good. 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 increase in manufacturing sector emissions when moving from a production- to a consumption-based accounting approach 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 New Brunswick, elsewhere in Canada and internationally being reallocated to New Brunswick's manufacturing sector – and specifically household consumption and firm investment – under a consumption-based accounting approach. It is interesting to note, however, that among all the provinces New Brunswick has the smallest increase in manufacturing sector emissions when moving between the two emissions accounting approaches. This most likely reflects the impact of the Irving Oil Refinery, located in Saint John, New Brunswick. With a refinery capacity of approximately 300,000 barrels per day (the highest in Canada), a large share of output from Irving Oil is exported. Accordingly, a large share of external manufacturing sector emissions that flow into New Brunswick to support domestic consumption are offset by the export of production emissions associated with refined petroleum product output from the Irving Oil Refinery.

The transportation and warehousing sector is the only sector that is a primary source of production emissions in New Brunswick but not consumption emissions. Emissions from the sector fall by approximately 80 per cent (-3.5 t) when moving from a production- to a consumption-based accounting approach. This is the result of intermediate inputs comprising a large share of output from the sector. Specifically, 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.

Last, the other provincial government services sector is the only sector that is a primary source of consumption emissions in New Brunswick but not production emissions. Emissions increase from less than 0.1 t under a production-based accounting approach to 1.0 t under a consumption-based accounting approach. This increase is attributable to the sector absorbing all of the emissions associated with production of its inputs. For example, when the provincial government purchases electricity for use in its ministry offices, emissions associated with the electricity's production are reallocated from the utilities sector to the other provincial government services sector. Notably, output from the sector reflects primarily expenditures by government and the large majority of consumption emissions are therefore allocated to government spending.

As shown on the right-hand side of Figure 1, New Brunswick'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 NEW BRUNSWICK 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>					
15.5 t (69%)		4.0 t (18%)		2.9 t (13%)	
Top Sectors Contributing to Consumption Emissions					
Manufacturing:	4.5 t	Manufacturing:	1.8 t	Other provincial government services:	1.0 t
Utilities:	2.9 t	Engineering construction:	0.9 t	Other federal government services:	0.6 t
Personal transportation:	2.4 t	Residential construction:	0.6 t	Government health services:	0.5 t
Residential:	1.4 t	Non-residential building construction:	0.3 t	Other municipal government services:	0.5 t
Transportation and warehousing:	0.8 t	Natural gas extraction:	0.1 t	Government education services:	0.3 t
Other:	3.5 t	Other:	0.3 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

New Brunswick is a large interprovincial net exporter of greenhouse gas emissions in the manufacturing sector to Quebec, Newfoundland and Labrador, Nova Scotia, Alberta and Prince Edward Island. Exports to Quebec, Nova Scotia and Prince Edward Island are likely driven in large part by the export of refined petroleum products from the Irving Oil Refinery. The province additionally has significant net exports of emissions in the utilities sector to Prince Edward Island, in the transportation and warehousing sector to Quebec and Ontario, and in the administrative and support, waste management and remediation services sector to Quebec. The export of emissions to the utilities sector in Prince Edward Island is consistent with New Brunswick being the only interconnection for electricity imports to Prince Edward Island (CBC News, 2011). Accordingly, in 2011 just over six per cent of total available electricity (generated and imported) in New Brunswick was exported to Prince Edward Island (Statistics Canada, 2017b).

New Brunswick’s largest source of interprovincial net imports of emissions is from the crude oil and natural gas extraction sectors in Newfoundland and Labrador. This is consistent with Newfoundland and Labrador crude oil being the only available domestic feedstock for the Irving Oil Refinery.³ New Brunswick additionally has notable net imports of emissions from the support activities for oil and gas extraction sector in Alberta, from the manufacturing and finance, insurance, real estate and rental and leasing sectors in Ontario, and from the natural gas extraction sector in Nova Scotia. Natural gas imports are used primarily for electricity generation, with natural gas accounting for 17 per cent of total electricity generation in New Brunswick in 2011 (Statistics Canada, 2017a; Statistics Canada, 2017b). Household consumption of natural gas in New Brunswick is limited as it is not a primary heating source (Statistics Canada, 2011).

³ Newfoundland and Labrador has limited natural gas production, all of which is flared, re-injected or otherwise used by its oil and gas industry (Statistics Canada, 2017c). For technical reasons, however, our disaggregation of Statistics Canada data for the mining and oil and gas sector does not appropriately distinguish between marketable natural gas production and natural gas that is used as an input to further crude oil production in Newfoundland and Labrador. As a result, exports of emissions from the natural gas extraction sector are identified as a separate flow when in actuality these emissions are embedded in exports from the province’s crude oil extraction sector (as the natural gas was an input to crude oil production). We intend to address this in any future iterations of the model.

INTERNATIONAL TRADE FLOWS

The Irving Oil Refinery has a pronounced impact on New Brunswick's international trade profile in emissions. Specifically, the majority of the refinery's feedstock is imported crude oil from the United States and overseas, and a portion of its output is distributed in the northeast U.S. Accordingly, New Brunswick's largest source of net imports of international emissions is the crude oil extraction sector and its largest source of net exports is the manufacturing sector. Other sectors that have notable net imports of emissions internationally are the other (non-energy) mining, natural gas extraction, fishing, hunting and trapping, and accommodation and food services sectors. On the export side, New Brunswick also has large net exports of emissions in the transportation and warehousing, wholesale trade and utilities sectors.

TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Total production emissions in New Brunswick declined over the period of 2004 to 2011 (-17 per cent) (Figure 3). New Brunswick's population grew only slightly over this period (+1 per cent), leading to a comparable percentage drop in the province's per capita production emissions (-17 per cent) (Figure 4). The decline in total emissions is largely a result of a substantial decrease in emissions from the province's utilities sector. This is consistent with a sharp decrease in the amount of electricity generated from fuel oil over this period (Statistics Canada, 2017a).

While New Brunswick's production emissions declined over the period of 2004 to 2011, consumption emissions in the province remained relatively constant. Specifically, total consumption emissions in the province increased by only one per cent while per capita consumption emissions increased by less than half a per cent. New Brunswick was a net exporter of greenhouse gas emissions in 2004. With consumption emissions remaining largely unchanged and production emissions decreasing, per capita net exports from the province declined from 6.8 t in 2004 to only 1.6 t in 2011.

Firm investment is the only subgroup for which consumption emissions increased from 2004 to 2011. Specifically, total firm investment consumption emissions increased by 22 per cent while per capita emissions increased by 21 per cent. Total and per capita emissions were generally consistently growing over the period, with only a single year of marked decline in 2008. The increase in emissions was driven primarily by the aggregate construction sector, with engineering construction accounting for the majority of the growth in construction sector emissions since 2009.⁴

Total and per capita government consumption emissions decreased by three and four per cent respectively from 2004 to 2011. Emissions did not follow a consistent pattern, however, and remained relatively constant overall, varying between 2.1 Mt (2009 low) and 2.3 Mt (2005 high). Since 2009 emissions across the government subsectors have been generally constant, although small increases were observed in the other (non-health care and education) federal and provincial government services sectors.⁵

Total and per capita household consumption emissions were most consistent over the period of 2004 to 2011, declining by only two and three per cent respectively. There was a small amount of variation in emissions from 2004 to 2008; since 2009, however, per capita emissions have been virtually constant at 15.5 t and total emissions have varied only between 11.6 and 11.7 Mt. Transportation and warehousing and manufacturing were the only subsectors for which there was a notable increase in household consumption emissions from 2004 to 2011. In contrast, numerous subsectors saw large decreases in household consumption emissions. The largest drop was in the utilities sector, with the majority of the drop coming in 2010 and 2011. Other sectors that saw large decreases in emissions were finance, insurance, real estate and rental and leasing, personal transportation and retail trade.

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 3 TOTAL PRODUCTION AND CONSUMPTION EMISSIONS, NEW BRUNSWICK: 2004 TO 2011

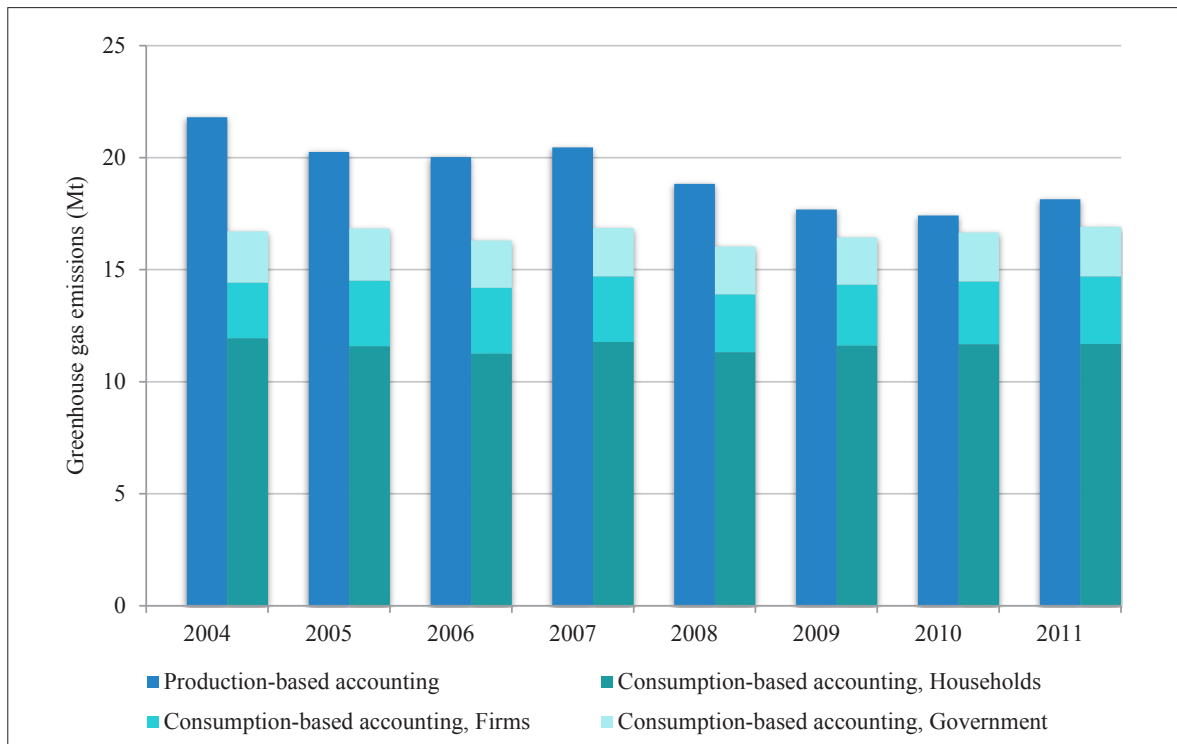
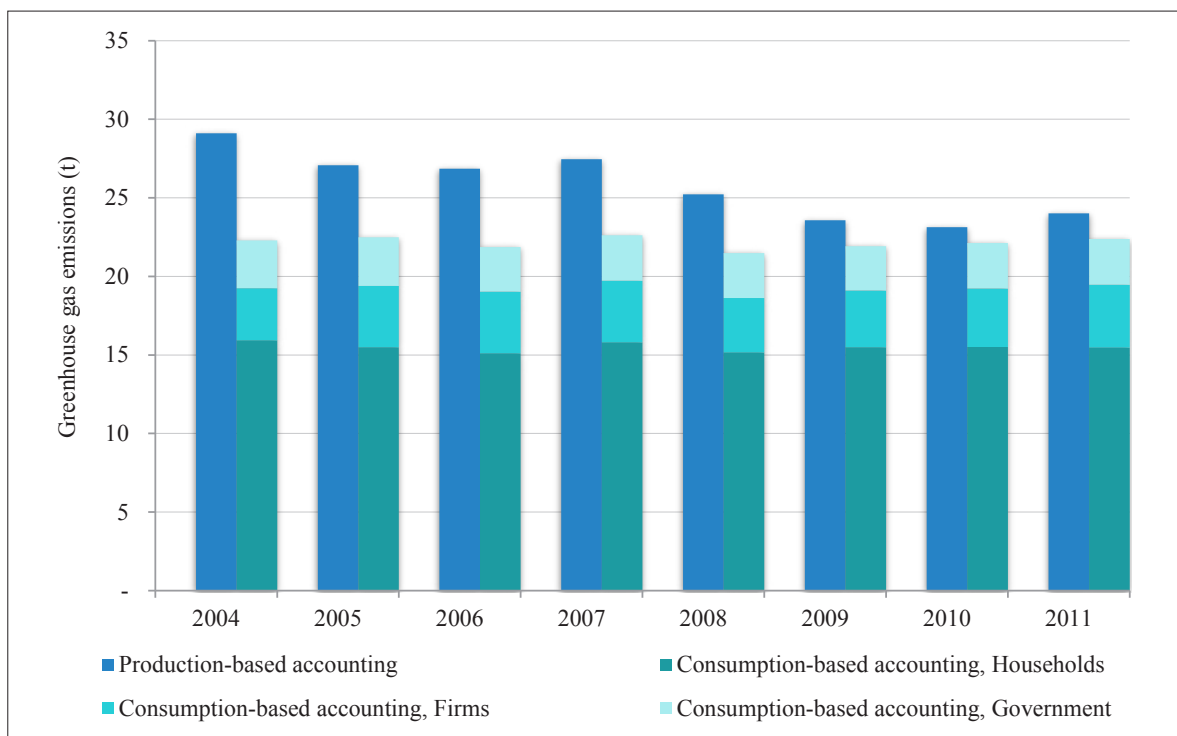


FIGURE 4 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, NEW BRUNSWICK: 2004 TO 2011



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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.

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