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BIG AND LITTLE FEET PROVINCIAL PROFILES: NOVA SCOTIA[†]

Sarah Dobson and G. Kent Fellows

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

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.

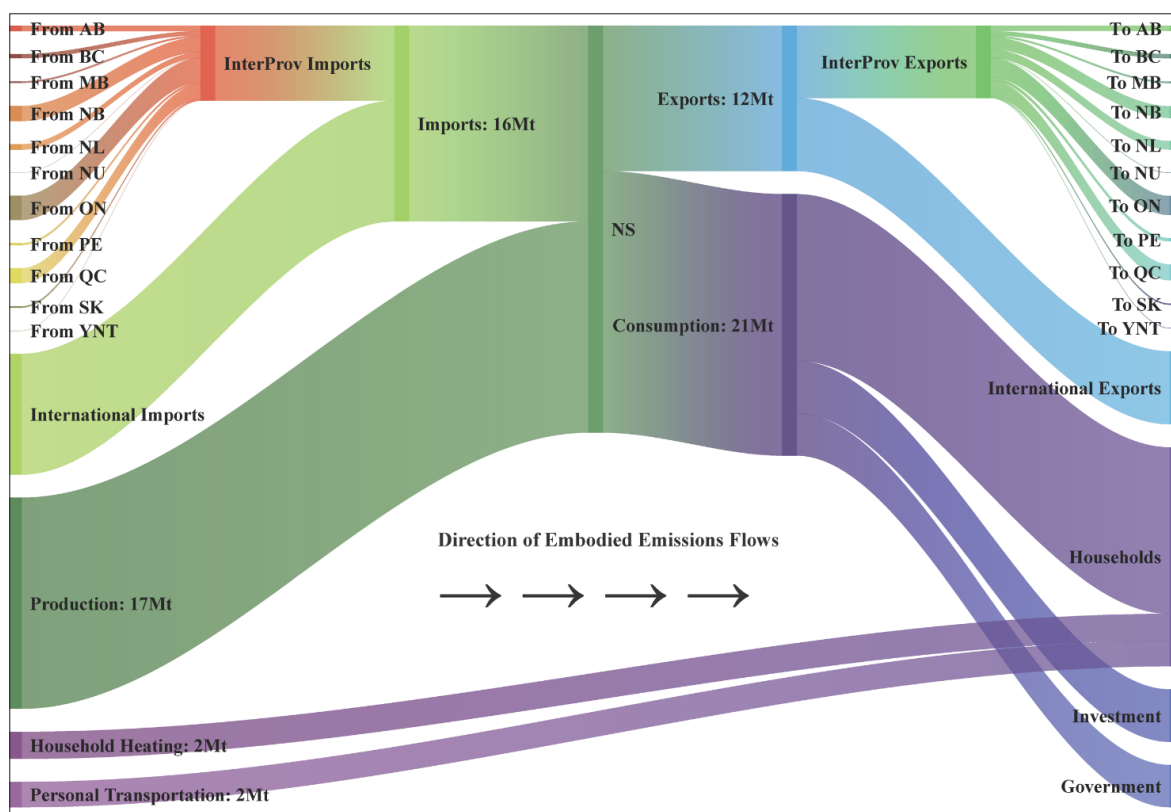
PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

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

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

Nova Scotia's total production emissions in 2011 were 21.3 megatonnes (Mt) of CO₂e (Figure 1), corresponding to per capita emissions of 22.5 t. The province is a net importer of greenhouse gas emissions from both international (+3.9 Mt) and interprovincial (+0.2 Mt) sources. Nova Scotia's emissions therefore increase when moving to a consumption-based accounting approach, rising to 25.4 Mt total CO₂e emissions or 26.9 t of CO₂e per capita.²

FIGURE 1 EMISSIONS FLOWS THROUGH THE NOVA SCOTIA ECONOMY



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

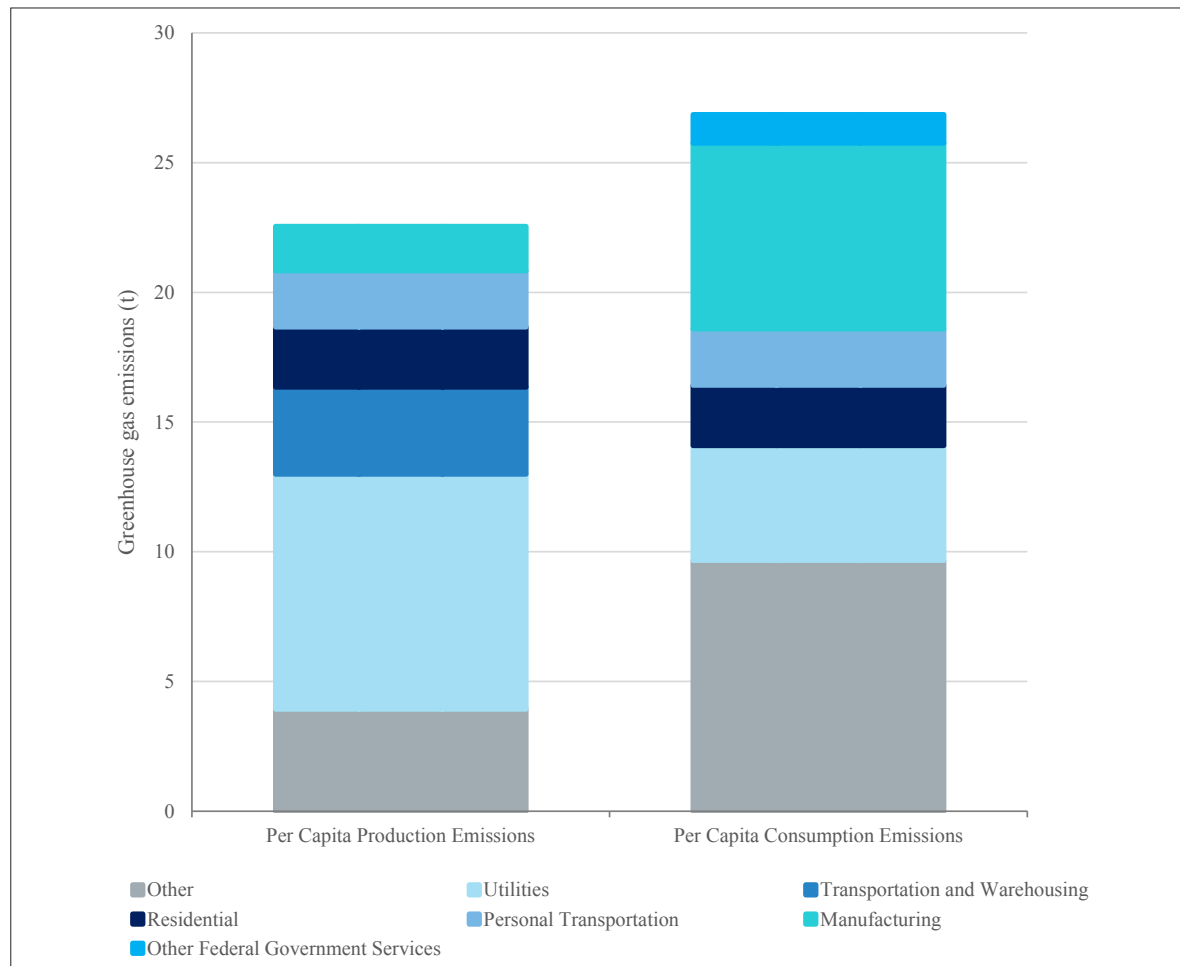
Data Source: Fellows, G. Kent and Sarah Dobson. 2017. "Embodied Emissions in Inputs and Outputs: A Value-Added Approach to National Emissions Accounting." *Canadian Public Policy*, 43(2): 140-164. <https://doi.org/10.3138/cpp.2016-040>.

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 Nova Scotia are utilities (9.1 t), transportation and warehousing (3.4 t), residential (2.3 t), personal transportation (2.2 t) and manufacturing (1.7 t). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (7.2 t), utilities (4.4 t), residential (2.3 t), personal transportation (2.2 t) and other federal government services (1.1 t) (Figure 2).

FIGURE 2 BREAKDOWN BY SECTOR OF NOVA SCOTIA 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, residential, personal transportation and manufacturing – overlap as main sources of both production and consumption emissions in Nova Scotia. Emissions from the utilities sector decrease by 51 per cent (-4.6 t) when moving from a production- to a consumption-based accounting approach while emissions from the manufacturing sector more than quadruple (+5.5 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 Nova Scotia, 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. 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 Nova Scotia, elsewhere in Canada and internationally being reallocated to Nova Scotia's manufacturing sector – and specifically household consumption and firm investment – under a consumption-based accounting approach. 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 transportation and warehousing sector is the only sector that is a primary source of production emissions in Nova Scotia but not consumption emissions. Emissions from the sector fall by approximately 70 per cent (-2.4 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 federal government services sector is the only sector that is a primary source of consumption emissions in Nova Scotia but not production emissions. Emissions increase from only 0.2 t under a production-based accounting approach to 1.1 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 federal government purchases electricity for use in its Nova Scotia regional offices, emissions associated with the electricity's production are reallocated from the utilities sector to the other federal 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, Nova Scotia'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 NOVA SCOTIA 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)					
18.7 t (70%)		4.5 t (17%)		3.6 t (13%)	
Top Sectors Contributing to Consumption Emissions					
Manufacturing:	4.6 t	Manufacturing:	2.5 t	Other federal government services:	1.1 t
Utilities:	4.4 t	Residential construction:	0.8 t	Other municipal government services:	0.7 t
Residential:	2.3 t	Engineering construction:	0.4 t	Government education services:	0.7 t
Personal transportation:	2.2 t	Non-residential building construction:	0.4 t	Government health services:	0.6 t
Transportation and warehousing:	1.0 t	Government education services:	0.1 t	Other provincial government services:	0.6 t
Other:	4.2 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

Nova Scotia’s largest source of net interprovincial imports of emissions is from the manufacturing sectors in New Brunswick and Ontario. Imports from New Brunswick are most likely driven by the emissions embedded in refined petroleum products produced at the Irving Oil Refinery in Saint John, New Brunswick and sold in Nova Scotia. The province additionally has notable imports of emissions from the manufacturing sectors in Quebec, Alberta and British Columbia. However, exports of emissions to these provinces from Nova Scotia’s manufacturing sector are of a similar magnitude, meaning that net emissions flows are not significant. Other sources of net imports of emissions to Nova Scotia are the crop and animal production sector in Ontario and the natural gas and crude oil extraction sectors in Newfoundland and Labrador. Imports of emissions in the natural gas and crude oil extraction sector have likely declined to zero since 2011,³ however, as Nova Scotia’s only refinery – the Imperial Oil Refinery in Dartmouth – closed in 2014 (Erskine, 2014).

Nova Scotia has large net interprovincial exports of greenhouse gas emissions in the manufacturing sector to Newfoundland and Labrador, and in the transportation and warehousing sector to Ontario, Quebec, Newfoundland and Labrador and Prince Edward Island. Exports from the transportation and warehousing sector are consistent with Port Hawkesbury and Halifax having major international ports for importing goods into Canada. Nova Scotia also has small interprovincial net exports of emissions in the natural gas extraction sector to New Brunswick. This reflects the transfer of emissions embedded in Nova Scotia offshore natural gas production that is used for electricity generation in New Brunswick.

INTERNATIONAL TRADE FLOWS

Internationally, Nova Scotia has large net imports of emissions in the manufacturing, crude oil extraction, other (non-energy) mining and coal mining sectors. As just noted, however, the closure

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.

of Nova Scotia's only refinery in 2014 has likely resulted in imported crude oil extraction emissions declining to zero. Imported emissions in the coal mining sector are consistent with imported coal being the largest single generation source of electricity in Nova Scotia in 2011, accounting for 40 per cent of total electricity generation in the province (Statistics Canada, 2017a; Statistics Canada, 2017b). On the export side, Nova Scotia has large net international exports of emissions in the transportation and warehousing, natural gas extraction, wholesale trade and fishing, hunting and trapping sectors. Emissions exports from these sectors are consistent with Nova Scotia having two major international ports, and with natural gas and shellfish being the province's two largest sources of non-manufacturing exports in 2011 (Industry Canada, 2017).

TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Total production emissions in Nova Scotia declined over the period of 2004 to 2011 (-11 per cent) (Figure 3). Nova Scotia'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 (-12 per cent) (Figure 4). The decrease in total emissions is largely a result of steadily declining emissions from the province's utilities sector; first gradually from 2004 to 2009 and then followed by a substantial drop in 2010. This is consistent with a drastic decrease (-97 per cent) in fuel oil and diesel-fired electricity generation in the province, as well as a smaller drop-off (-11 per cent) in coal-fired electricity generation (Statistics Canada, 2017a).

While Nova Scotia's production emissions declined over the period of 2004 to 2011, consumption emissions in the province increased. Specifically, total consumption emissions in the province increased by six per cent while per capita emissions increased by five per cent. Nova Scotia was a small net exporter of emissions in 2004, with per capita net exports measuring 0.1 t. With production emissions declining and consumption emissions increasing, Nova Scotia transitioned to being a net importer of emissions in 2005 and by 2011 per capita net imports had increased to 4.3 t.

Consumption emissions related to firm investment saw the largest percentage growth from 2004 to 2011. Specifically, both total and per capita firm investment consumption emissions increased by 35 per cent. Emissions were relatively constant from 2004 to 2007, declined sharply in 2008 and have grown steadily since then. The increase in emissions is attributable primarily to higher firm investment consumption emissions in the manufacturing sector. In contrast, emissions in the aggregate construction sector have declined since 2004. Since 2009 the decline has been driven primarily by falling emissions from the engineering construction sector.⁴

Total and per capita household consumption emissions increased by six and five per cent respectively from 2004 to 2011. Emissions followed roughly two periods of growth – first from 2004 to 2007 and then again from 2008 to 2011. Manufacturing and transportation and warehousing were the only subsectors for which there was a notable increase in household consumption emissions from 2004 to 2011, with most of the increase coming post-2008. Subsectors that saw significant decreases in household consumption emissions were finance, insurance, real estate and rental and leasing, retail trade and utilities.

In contrast to firm investment and household consumption emissions, total and per capita government consumption emissions both decreased by 15 per cent from 2004 to 2011. Government emissions were generally higher over the first half of the time period and then displayed a more marked decline in both 2008 and 2009. Since 2009 government consumption emissions have been largely constant, with limited variation in emissions across all of the government subsectors.⁵

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, NOVA SCOTIA: 2004 TO 2011

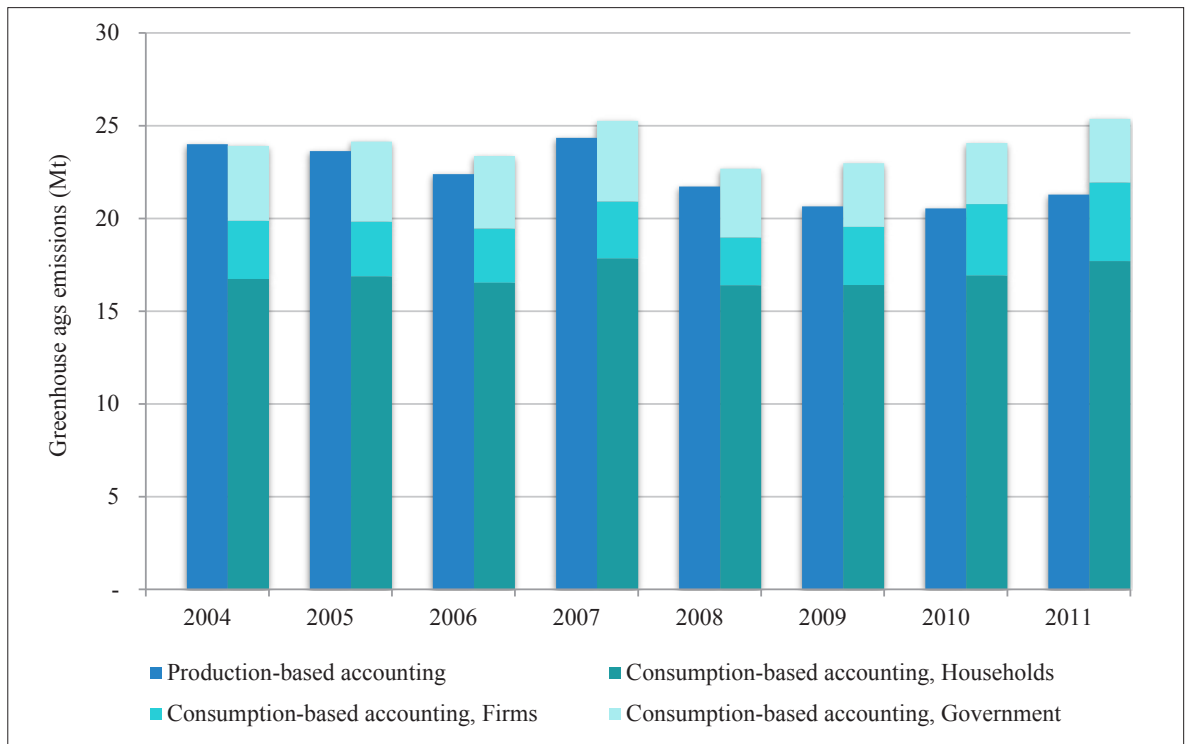
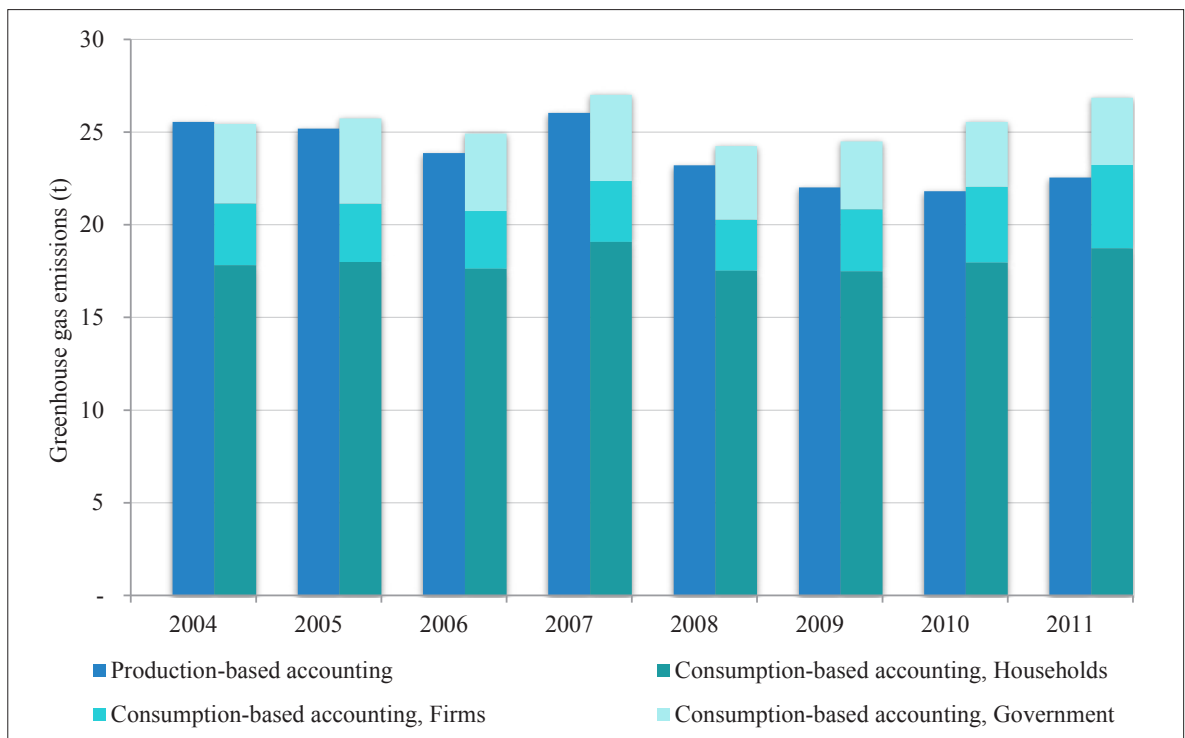


FIGURE 4 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, NOVA SCOTIA: 2004 TO 2011



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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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