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SPP Communiqués are brief articles that deal with a singular public policy issue and are intended to provide the reader with a focused, concise critical analysis of a specific policy issue.

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BIG AND LITTLE FEET PROVINCIAL PROFILES: SASKATCHEWAN^{*†}

Sarah Dobson and G. Kent Fellows

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

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 : LA SASKATCHEWAN^{*†}

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 en Saskatchewan, 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 canadiens¹.

En termes simples, la comptabilisation des émissions de production mesure la quantité d'émissions de gaz à effet de serre produite en Saskatchewan. 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 en Saskatchewan 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 en Saskatchewan 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 en Saskatchewan qui sont exportées en Alberta pour la transformation et la vente dans les épiceries albertaines seront comptabilisées comme un flux commercial de la Saskatchewan vers l'Alberta. À l'inverse, les émissions associées à la production du gaz naturel albertain vendu à un service publique de la Saskatchewan pour assurer le chauffage des maisons saskatchewanaises seront comptabilisées comme un flux commercial de l'Alberta vers la Saskatchewan.

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.

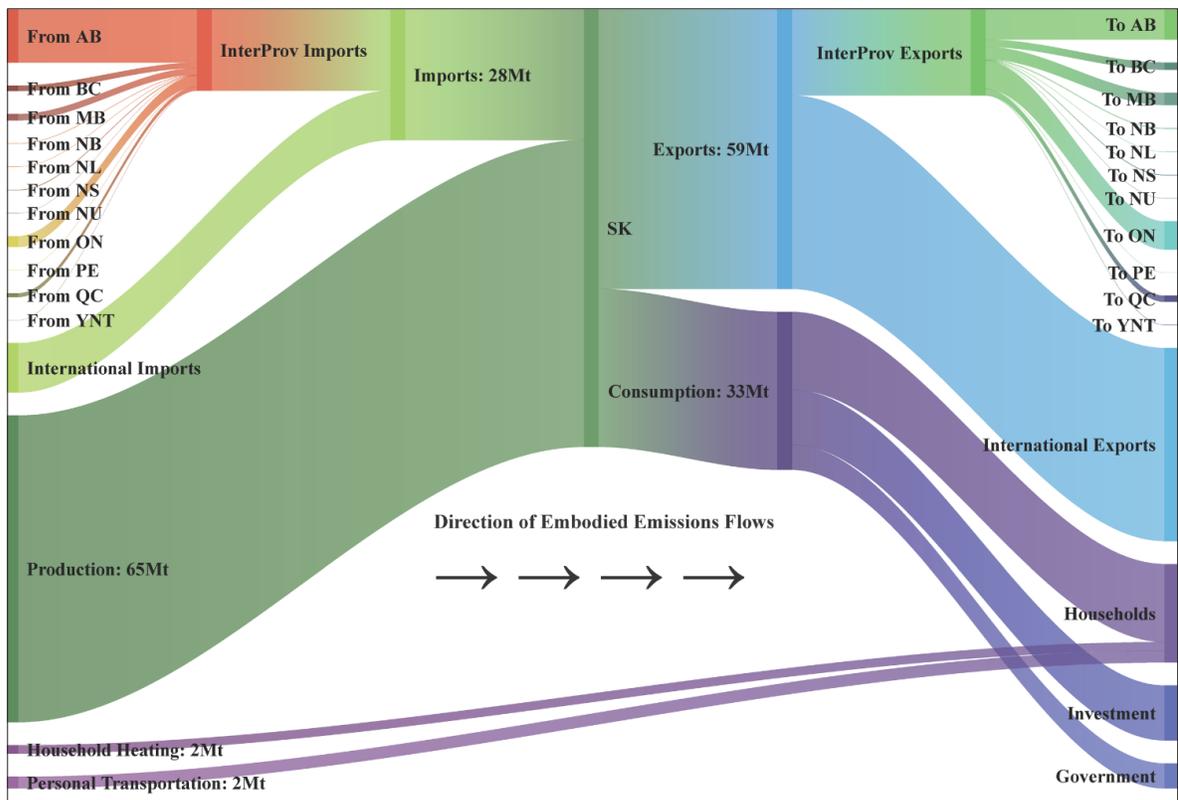
PRODUCTION- AND CONSUMPTION-BASED EMISSIONS ACCOUNTS

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

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

Saskatchewan's total production emissions in 2011 were 68.8 megatonnes (Mt) of CO₂e (Figure 1), corresponding to per capita emissions of 64.5 t. The province is a net exporter of greenhouse gas emissions internationally (-30.2 Mt) and from the other provinces (-1.0 Mt). Saskatchewan's emissions therefore decrease when moving to a consumption-based accounting approach, falling to 37.6 Mt total CO₂e emissions or 35.2 t of CO₂e per capita.²

FIGURE 1 EMISSIONS FLOWS THROUGH THE SASKATCHEWAN ECONOMY



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

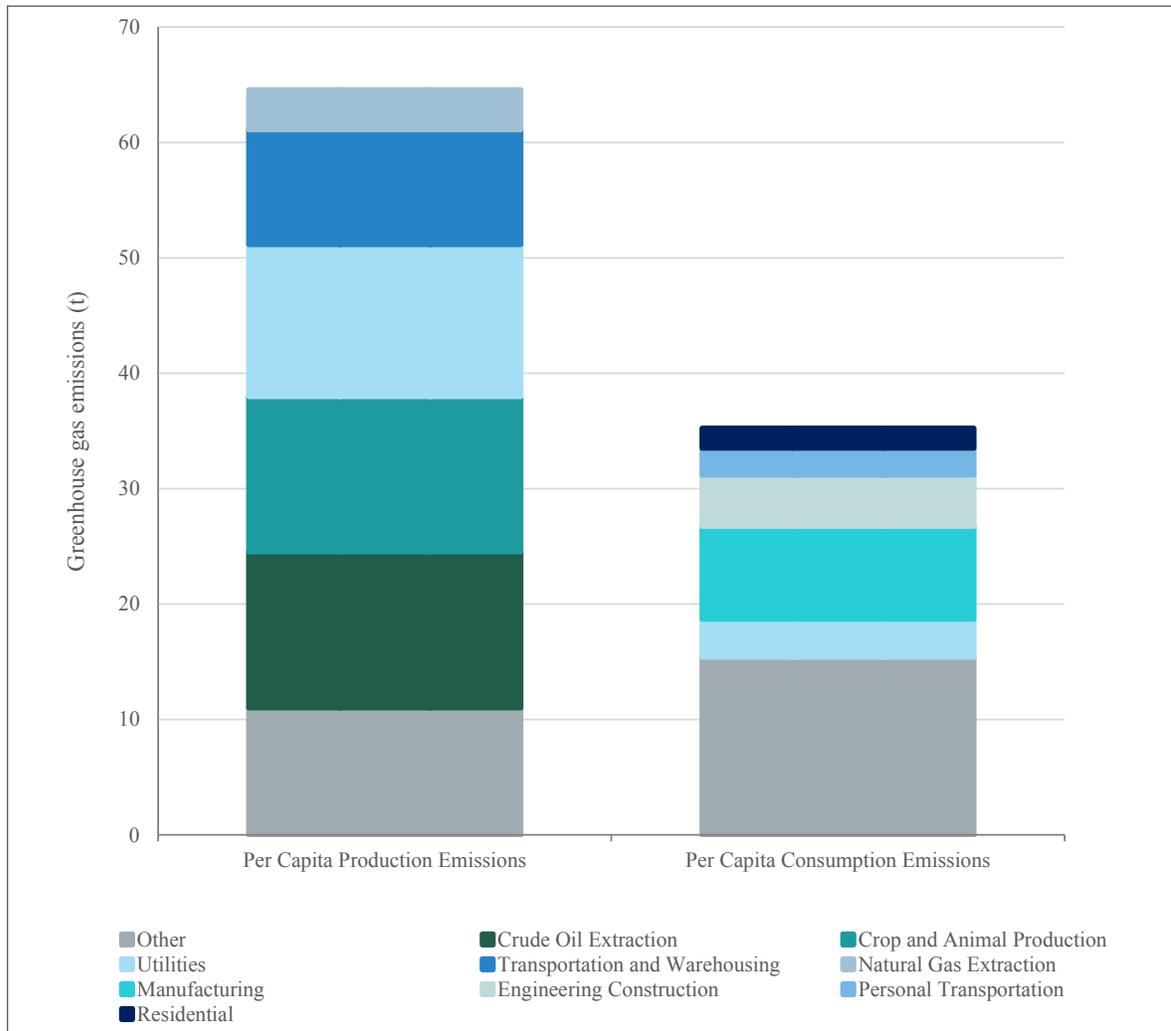
Data Source: Fellows, G. Kent and Sarah Dobson. 2017. "Embodied Emissions in Inputs and Outputs: A Value-Added Approach to National Emissions Accounting." *Canadian Public Policy*, 43(2): 140-164. <https://doi.org/10.3138/cpp.2016-040>.

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 Saskatchewan are crude oil extraction (13.5 Mt), crop and animal production (13.5 Mt), utilities (13.2 Mt), transportation and warehousing (9.9 Mt) and natural gas extraction (3.4 Mt). In comparison, the largest sectors responsible for per capita consumption emissions are manufacturing (8.0 Mt), engineering construction (4.5 Mt), utilities (3.3 Mt), personal transportation (2.3 Mt) and residential (1.7 Mt) (Figure 2).

FIGURE 2 BREAKDOWN BY SECTOR OF SASKATCHEWAN 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).

Only a single sector – utilities – overlaps as a main source of both production and consumption emissions in Saskatchewan. When moving from a production- to a consumption-based accounting approach emissions from the utilities sector decrease by 75 per cent (-9.9 t). This 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 Saskatchewan,

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 crude oil extraction, crop and animal production, transportation and warehousing and natural gas extraction sectors are primary sources of production emissions in Saskatchewan but not consumption emissions. The change in emissions when moving from a production- to a consumption-based accounting approach is most drastic in the crude oil extraction sector, with emissions falling to zero (-13.5 t). This is because crude oil is not consumed in its raw form, but is rather an input into the production of refined petroleum products. Production emissions from the sector are subsequently reallocated to the sector and region – most often interprovincial or international – in which consumption of the refined petroleum product occurs. Substantial decreases in emissions are also observed in the crop and animal production (-96 per cent/-12.9 t), transportation and warehousing (-86 per cent/-8.5 t) and natural gas extraction (-66 per cent/-2.3 t) sectors. This is again a function of these sectors producing primarily intermediate inputs. Specifically, a large share of output from the crop and animal production and natural gas extraction sectors are sold to intermediate suppliers – food manufacturers, distributors, restaurants and grocery stores in the crop and animal production sector and oil and gas companies, utilities and manufacturers in the natural gas extraction sector. Under a consumption-based accounting approach production emissions associated with this output are reallocated to the sector and region that supply the final consumption good or service for which Saskatchewan's farm output or natural gas is an input. Similarly, 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 under a consumption-based approach to the sector and region where final consumption of the good occurs.

Last, the manufacturing, engineering construction, personal transportation and residential sectors are primary sources of consumption emissions in Saskatchewan but not production emissions. Emissions from the manufacturing sector more than triple (+5.4 t) when moving from a production- to a consumption-based accounting approach while emissions from the engineering construction sector increase by nearly 10 times (+4.0 t). In comparison, emissions in the personal transportation and residential sectors remain unchanged. The increase in emissions in the manufacturing sector is a result of three related 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 Saskatchewan, elsewhere in Canada and internationally being reallocated to Saskatchewan's manufacturing sector – and specifically household consumption and firm investment – under a consumption-based accounting approach. The increase in emissions in the engineering construction sector is similarly 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. Last, emissions in the personal transportation and residential sectors do not change 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.

As shown on the right-hand side of Figure 1, Saskatchewan’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 SASKATCHEWAN 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>					
19.4 t (55%)		10.9 t (31%)		5.0 t (14%)	
Top Sectors Contributing to Consumption Emissions					
Manufacturing:	5.2 t	Engineering construction:	4.5 t	Government education services:	1.2 t
Utilities:	3.3 t	Manufacturing:	2.9 t	Other provincial government services:	1.2 t
Personal transportation:	2.3 t	Residential construction:	1.2t	Other municipal government services:	1.2 t
Residential:	1.7 t	Natural gas extraction:	1.0 t	Government health services:	0.6 t
Transportation and warehousing:	1.4 t	Non-residential building construction:	0.6 t	Other Aboriginal government services:	0.4 t
Other:	5.5 t	Other:	0.7 t	Other federal government services:	0.4 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

Saskatchewan’s status as a net interprovincial exporter of emissions is driven primarily by its oil and gas and agricultural sectors. The province has large net exports of emissions in the crude oil extraction sector to Ontario, and in the natural gas extraction sector to both Manitoba and Ontario. In the crop and animal production sector Saskatchewan is a net exporter of emissions to all but two provinces (British Columbia and Newfoundland and Labrador), with the largest emissions flows going to Alberta, Ontario, Quebec and Manitoba. Saskatchewan also has notable exports of emissions in the manufacturing sector to Alberta, Manitoba, British Columbia, Ontario and Quebec. Once accounting for imported emissions to the manufacturing sector, however, Saskatchewan is a net exporter of emissions only to Manitoba and British Columbia.

On the import side, although Saskatchewan was Canada’s second largest producer of crude oil and third largest producer of natural gas in 2011 (National Energy Board, 2016), its production levels fall far short of those in Alberta. As a result, Saskatchewan has significant net imports of emissions from Alberta’s crude oil and natural gas extraction sectors. It is additionally a small net importer of manufacturing sector emissions from Alberta, Quebec and Ontario.

INTERNATIONAL TRADE FLOWS

Internationally, the crude oil extraction sector is the main source of Saskatchewan’s net exports of emissions, followed by the crop and animal production sector, transportation and warehousing and other (non-energy) mining. This is consistent with crude oil, potash, agricultural output (including canola seeds and oil, wheat, peas and lentils) and uranium being the largest exports from Saskatchewan in 2011 (Industry Canada, 2017). The only sector with significant net imports of international emissions to Saskatchewan is manufacturing.

TIME TREND OF PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS

Although there were small annual fluctuations, on net total production emissions in Saskatchewan stayed virtually constant over the period of 2004 to 2011 (+0.1 per cent) (Figure 3). As the province's population grew over this period (+7 per cent) per capita production emissions in the province declined (-6 per cent) (Figure 4). The lack of change in overall production emissions, however, masked significant changes within the province's subsectors. Specifically, rising emissions in Saskatchewan's transportation and warehousing, other (non-energy) mining, crop and animal production and coal mining sectors were largely offset by falling emissions in the crude oil extraction, utilities and natural gas extraction sectors.

Apart from a small decrease from 2004 to 2005, Saskatchewan's total and per capita consumption emissions were generally increasing from 2004 to 2011. On net, total consumption emissions in the province increased by 15 per cent while per capita emissions increased by eight per cent. Saskatchewan was a net exporter of greenhouse gas emissions in 2004. With production emissions holding largely steady and consumption emissions increasing, the province's per capita net exports fell from 36.3 t in 2004 to 29.3 t in 2011.

The majority of the growth in consumption emissions was driven by rising emissions associated with firm investment. Specifically, total and per capita firm investment consumption emissions increased by 42 and 33 per cent respectively from 2004 to 2011. After 2005 the increase in firm investment consumption emissions was generally steady, with only one year of decline in 2009, likely as a result of the global recession. The sectors that saw the largest increases in emissions were manufacturing and the aggregate construction sector, with engineering construction driving the majority of the growth in construction sector emissions since 2009.³

Total and per capita government consumption emissions also increased from 2004 to 2011, rising by 15 and eight per cent respectively. Emissions did not display any evident pattern, however, varying between a low of 4.3 Mt in 2006 and a high of 5.7 Mt in 2010. There was a similar inconsistency across emissions in the government consumption subsectors since 2009. Specifically, consumption emissions related to other (non-health care and education) provincial and municipal services decreased while those related to other federal and Aboriginal government services increased. Consumption emissions in the government health and education services subsectors were virtually unchanged.⁴

Last, total household consumption emissions increased by 4 per cent from 2004 to 2011. When combined with a growing population, however, per capita emissions decreased by 2 per cent. Similar to government consumption emissions, household emissions did not follow any clear pattern but rather varied between 19.6 Mt (2005 low) and 21.4 Mt (2010 high). The economic sectors with the largest increases in per capita household consumption emissions were manufacturing and transportation and warehousing while significant decreases in emissions were observed in the utilities, finance, insurance, real estate and rental and leasing, 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, SASKATCHEWAN: 2004 TO 2011

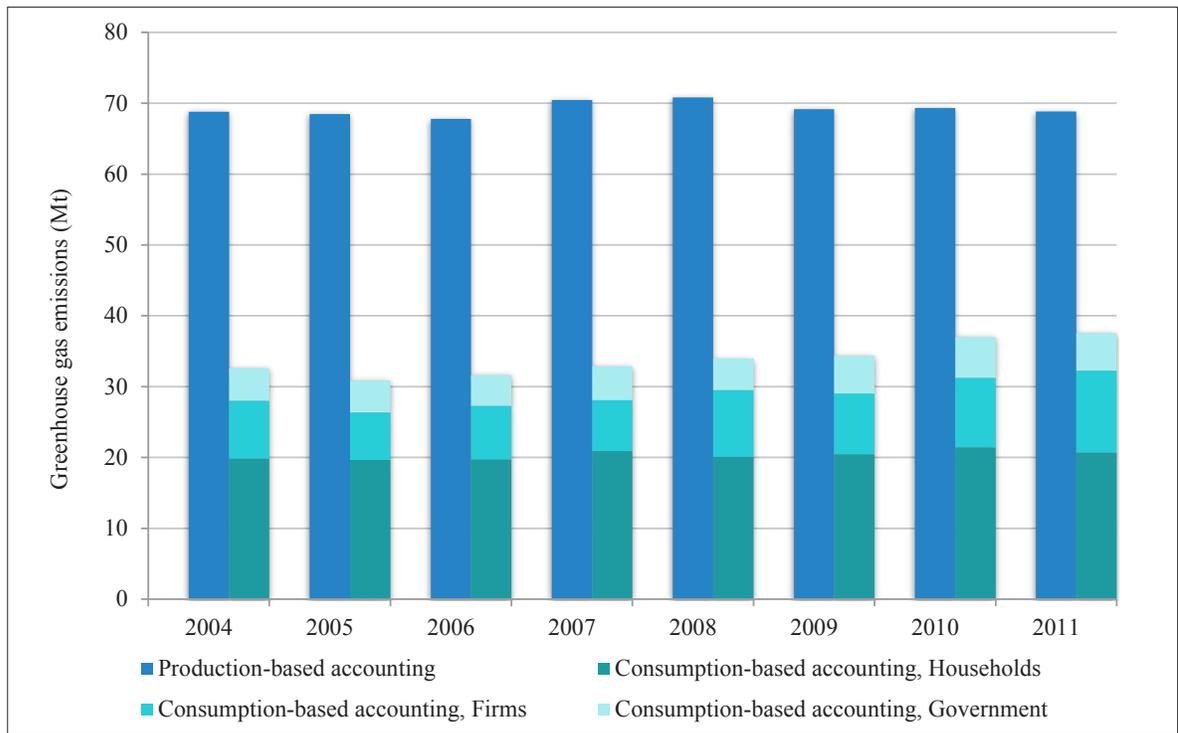
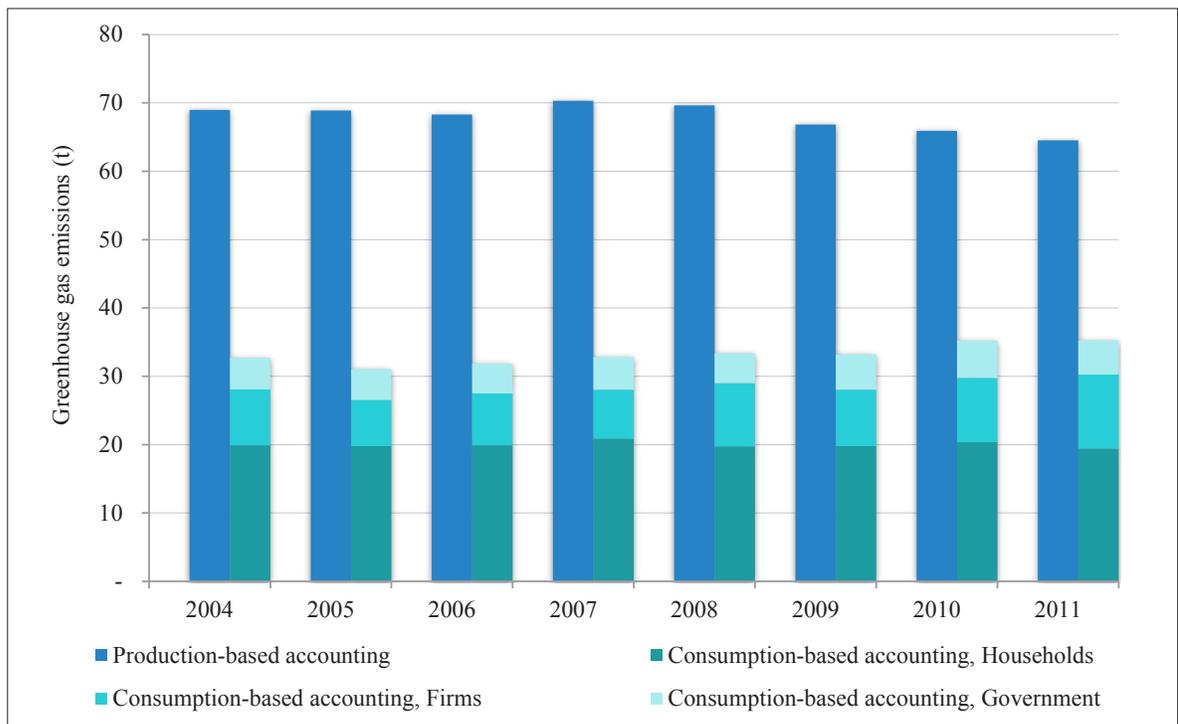


FIGURE 4 PER CAPITA PRODUCTION AND CONSUMPTION EMISSIONS, SASKATCHEWAN: 2004 TO 2011



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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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