Measuring Canadian Energy Subsidies

A Review of the State of the Art with Recommendations for Reform

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Executive Summary

Canada, as a significant energy producer and consumer, faces complex and contentious debates regarding energy subsidies within its energy policy landscape. A strong case has been made that governments should not be involved in subsidizing energy production or consumption. Canada participates in an international, intergovernmental effort to phase out inefficient fossil fuel subsidies. This international effort has left it to individual governments to define what constitutes an inefficient subsidy, to measure the magnitude of such subsidies, and to work toward their elimination. However, reaching agreement on the definition of what constitutes a subsidy and on the question of how subsidies should be measured has been difficult. This disagreement has practical consequences for the estimation of the levels of subsidization and is an impediment to their reform and eventual elimination.

This report reviews efforts to estimate energy subsidies in Canada. The purpose of the report is to document the nature and extent of controversies that have arisen in the development of these estimates. The thesis of this report is that we are far from achieving a consensus on key definitions of what constitutes a subsidy, on the proper methods for conducting this type of analysis, on the documentation of data sources and methods, or on the interpretation of the results. After reviewing various attempts to estimate energy subsidies in Canada, I describe the approach to this topic that has been developed by the United States Energy Information Administration (US EIA) as a potential option for resolving the current dysfunction in the Canadian literature.

Subsidies can be grouped into three categories: direct expenditures, tax expenditures, and interventions in product and factor markets that yield economic benefits for energy producers. While direct payment subsidies are less common, the controversy surrounding energy subsidy measurement arises from applying the concept of tax expenditure. The general principle that is often articulated as a guide to defining and measuring tax expenditure subsidies is that actual tax policies should be compared with a normative benchmark indicating what taxes should be due. If actual tax liabilities are less than what would be due should this benchmark be applied, the difference would represent a tax expenditure subsidy. The controversy that arises in attempts to estimate this form of subsidy is that the benchmark is a hypothetical norm and people can have quite different ideas as to what taxes should be due.

One approach is to calculate tax liabilities under a current tax regime and compare those liabilities with those that would be paid under a former tax regime or under the current tax policy in another sector. But this approach does not really address the question of what taxation should be due. Tax policy is notoriously complex and no one suggests that it is consistent. Labour income is taxed at a different rate from dividend income, which is taxed at a different rate from capital gains income. Business and trust income are also taxed at different rates from personal income. Do the different tax rates that apply to different categories of income constitute tax expenditure subsidies? Simply calculating the difference between the tax payments made under one tax policy and those that would be made under a previous tax policy or under the tax policy applied to some other category of income sidesteps the important conceptual determination of what taxes should be due in a given context.

The final category of subsidies involves government interference in product or factor markets that convey a benefit to energy producers. Some provincial governments receive royalty payments from businesses that extract hydrocarbons. Some critics have claimed that changes in provincial government royalty rates constitute an energy subsidy in this category. In the report I argue that this line of reasoning is incorrect in that provincial government royalty rates are not like market prices and that, therefore, changes in the royalty rates do not necessarily constitute subsidies.

Introduction

The characterization of subsidies in the energy sector, while complex and controversial, is important. Canada is an important producer of energy. And, given our geography and climate, Canadians are proportionately significant consumers of energy. Energy policy is a priority for many provincial governments and for the federal government. Several provincial governments receive substantial royalty payments from natural gas and oil extraction. And Canada is a signatory to several international conventions and agreements that have implications for domestic energy policy. Under these international agreements, national governments have been tasked with defining what constitutes an "inefficient energy subsidy" in their particular circumstances. Canada has not been able to produce its own definition. A definition is required to guide measurement of subsidies and also to begin the process of reform or elimination of such subsidies.

I group energy subsidies into three categories. The first category is direct payments. Direct payments involve a financial transfer from governments to producers or consumers related to the production or consumption of an energy product. An example would be a government program that offers a grant to households to install additional insulation. The household pays the contractor to install the insulation and subsequently receives a grant payment from the government for a portion of the cost. It is reasonably straightforward to calculate the value of direct payments. They are a category of government expenditure. But this transparency seems to be a political liability, and direct payments tend to be declining in significance in the energy sector.

The second category is tax expenditures. This concept originated in public finance, particularly in the analysis of government deficits and debt. Direct payments affect public finances on the expenditure side. But deficits are also influenced by tax policies on the revenue side. A change in tax policy that reduces revenues by $1 million has the same effect on a government deficit as a payment of $1 million on the expenditure side. As direct payments have become less common and less important as a category of energy subsidies, greater attention has been paid to subsidies that are implemented through changes in tax policy. While the concept of a tax expenditure has proven to be useful in the context of government budget and deficit analysis, its application in measuring energy subsidies is controversial. I will explore some of the problems that have arisen in the application of tax expenditure analysis in the measurement of energy subsidies later in this report.

A third category of subsidy is government provision of a good or service. This could take the form of government provision of transportation infrastructure. It also occurs when governments offer loans or business risk insurance on concessional terms. Subsidies in this category can occur through state owned enterprises. This category can also involve government distortions of product or factor markets which, among other things, alters prices for goods or services in the affected market. Barriers to imports or restrictions on new entrants to an industry are examples of subsidies in this category. Legalized nuisance or legislative shields against liability for environmental harms would be another form of this type of subsidy.

Several rationales have been offered in support of subsidies. There is an economic theory of subsidies, but there is also a practical history of subsidies which often bears no resemblance to that economic analysis. As I will show in this report, there is widespread disagreement among researchers regarding the nature, magnitude, and even the sign of subsidies in the oil and gas sector in Canada. Researchers have not been shy to level charges of bias and conflict of interest against other writers who have obtained different results from themselves. I would like to lay my cards on the table at the outset. Although there is an elegant economic literature, which I will summarize later in this report, that provides a justification for the use of subsidies in certain circumstances, the actual practice of governments providing subsidies to businesses virtually never satisfies those idealized justifications. I doubt that governments will ever agree to constrain themselves to abiding by the limits presented in economic theory. Consequently, I prefer a pragmatic approach. Subsidies in all forms and attached to all rationales should be viewed with skepticism. The aim should be to eliminate them all. This includes those directed at firms in the oil and gas industry, but everywhere else as well. The first step in such a project would be to come to an agreement as to how to define and measure these subsidies. I will review selected attempts to do this in the Canadian context below. The next step would be to measure the levels of subsidization for each of the categories of subsidy. The third step would be to develop a plan to phase out those subsidies over time. In the context of energy, this means measuring subsidies to so-called fossil fuels but also measuring subsidies to so-called renewable energy systems.

Milke and Kaplan (2021) documented the range of estimates of global fossil fuel subsidies that have been published:

> ... estimates of current worldwide oil and gas subsidies differ in the hundreds of billions of dollars. For example, the OECD puts them at just over $178 billion in 2019; the International Energy Agency (IEA) has them at just under $317 billion that same year; and the

International Renewable Energy Agency (IRENA) estimates fossil fuel subsidies were fully $447 billion in 2017, the year of its latest estimate.

Three of the most prominent international agencies engaged in the comparative analysis of fossil fuel subsidies, ostensibly following the generally accepted best practices for compiling such estimates, have produced a significant range of global estimates.

Background

The Office of the Auditor General of Canada (2017) reported that Canada, as a member of the G20 group of countries, and in keeping with the G20 resolution at its 2009 meeting in Pittsburgh, has committed itself to phase out or reform "inefficient fossil fuel subsidies." This goal was also affirmed in September of 2015 by members of the United Nations, including Canada. And the June 2016 North American Leaders' summit involving heads of state from Mexico, Canada, and the United States resolved to phase out inefficient fossil fuel subsidies by 2025. These resolutions left it to individual national governments to define what was meant by inefficient fossil fuel subsidies or what constituted policy reform in this area. The Office of the Auditor General of Canada (2017) concluded that the two federal government departments designated to be responsible for policy in this area in 2009, the Department of Finance and the Department of the Environment and Climate Change, had not, as of 2017, defined "what the 2009 G20 commitment to phase out and rationalize inefficient fossil fuel subsidies means in the context of Canada's national circumstances." The Auditor General also found that:

> … since 2009, six subsidies to the fossil fuel sector were reformed by legislation. Other tax measures for this sector were not reformed. We also found that the Department of Finance Canada did not consider all tax measures to determine whether they were inefficient fossil fuel subsidies under the commitment. The Department also did not develop an implementation plan with timelines to support the phase-out and rationalization by 2025 of remaining tax measures that are inefficient fossil fuel subsidies. In addition, the Department of Finance Canada refused to provide all the analyses that we requested for tax measures that focus on the fossil fuel sector. As a result, we could not provide assurance that the Department analyzed the social, economic, and environmental aspects of all these tax measures to support informed decision making relating to Canada's 2009 G20 commitment. We also found that while Environment and Climate Change Canada developed a plan to guide the initial stages of its work, it did not yet know the extent of federal non-tax measures that could be inefficient fossil fuel subsidies. These findings matter because without a clear understanding of the fossil fuel subsidies covered by the G20 commitment and without an implementation

> plan with timelines, the departments cannot ensure that they are providing the support needed for Canada to meet the commitment by 2025. (Office of the Auditor General of Canada, 2017)

In a statement that foreshadows controversies that will emerge in the text of this report, the Office of the Auditor General of Canada explains that:

> … identifying the inefficiency of fossil fuel subsidies requires understanding the circumstances in each country and the impact of different subsidies. If a particular energy subsidy affects the production or consumption of a fossil fuel, the subsidy is not automatically inefficient or wasteful. Well-implemented subsidies can help address market failures or respond to social needs.

Two years later, the Office of the Auditor General of Canada (2019a, 2019b) renewed its criticisms of the Department of Finance and the Department of the Environment and Climate Change, arguing that those departments had still not provided the data and analysis that the Auditor General had requested.

On the Measurement of Tax Expenditure Subsidies

Most of the controversy in measuring energy subsidies in Canada has to do with the second general category of subsidies, tax expenditures. A common practice is to take definitions of tax expenditures from other contexts, such as trade agreements and government budget analysis, and apply those definitions to the measurement of energy subsidies.[1] It is not always clear that the concept translates well from one context to another. And available estimates of tax expenditure subsidies often lack detailed explanation and documentation that would be necessary for replication of calculations.

One important topic in the measurement of production subsidies in the oil and gas sector has to do with the tax treatment of certain categories of expenses and depreciation. Oil and gas production typically involves substantial capital commitments long before an enterprise generates revenue. Exploration may or may not lead to economically exploitable stocks to extract. How should the expenses for exploration be treated for business income taxation purposes? Should exploration expenses for unsuccessful exploration be treated the same as expenses for successful exploration? In both cases, should expenses be charged against revenue in their entirety as soon as revenues become positive, or should they be amortized over a number of years when revenue begins to accrue to the business? The treatment of depreciation on capital equipment, buildings, structures, and other assets is also potentially controversial. Tax authorities allow businesses to deduct capital cost or depreciation allowances against revenue in the determination of business income tax liability. Economic depreciation is the change in the market value of an asset over one time period. If a business employs an asset for one year, and the market value of that asset declines

1 Trade organizations such as the World Trade Organization (WTO) have developed rules with which member states must comply. Those rules have to do with government policies that affect trade in ways that are inconsistent with the obligations nation states take on as signatories to a trade agreement. The definition of what constitutes a subsidy is one aspect of these trade rules. The rules are developed through a process of negotiation among signatories to the trade agreement. Member states can lodge complaints under a trade agreement if they perceive that the actions of another member state constitute a subsidy under the standards and definitions developed under the agreement. Typically, an adjudication panel is appointed to review the claims of parties to the dispute, using the definition of a subsidy under the agreement as a guide.

by $10,000 during that year, then this amount should be deducted from the residual between revenues and other expenses to measure the economic profitability of that enterprise during that year. Tax depreciation attempts to approximate this economic depreciation. An estimate or approximation is necessary because it is generally difficult if not impossible to measure the change in the market value of every capital asset used by every business every year. As a practical compromise, tax authorities create categories of assets and allow specified depreciation rates for these categories to be deducted from net revenues of a business in order to arrive at a measure of taxable income. But these categories are inevitably arbitrary and the associated allowed rates of capital costing are estimates or averages. Capital equipment is heterogeneous and deprecation of the market value of assets is variable across contexts.

The Office Auditor General of Canada (2017) discusses several changes in tax policy that it considers to be policy reforms consistent with the G20 resolution. One example that they give is a change from treating "[e]xpenses of oil sands and oil shale leases and property, previously treated as Canadian development expenses (deductible at 30% annually)" to treating them "as Canadian oil and gas property expenses (deductible at 10% annually)." There are two questions here. First, did the previous tax treatment constitute a subsidy? The second question, if the answer to the first question is yes, is what is the appropriate measure of the subsidy? It is not a subsidy to allow a business to deduct business expenses from its revenues. Under cash accounting, business expenses are deducted from revenues in the year in which the expenses are incurred. But under accrual accounting, expenses are deducted from revenue in the year in which the revenue made possible by those expenditures is realized. Given the high initial expenses involved in energy development, Revenue Canada allows businesses to spread these initial expenses over future years when cash flow from the development becomes positive. Without the development expenses, the subsequent oil or gas revenue would not occur. The development expenses made possible a sequence of annual revenues over several years. What is the fair, equitable, and efficient way to allocate those development expenses over revenues in those future years? It might make sense to compound the development expenses forward and deduct this value from revenues proportionately to the distribution of annual production over the life of the oil or gas field. But this would be complex. So a simple percentage rule, say 10, 20, or 30 percent of the development expenses, is used by the tax authorities. This is an arbitrary compromise, and it could deviate from the conceptual ideal. But unless we calculate that conceptual ideal, we don't know if any particular rate is a subsidy.

The second question relates to how to calculate the value of the effect of this change in allowable expensing for the business. Assuming a simple linear amortization, allowing the deduction of accumulated expenses at 10 percent per year results in a reduction in business income each year for 10 years. For a rate of 30 percent per year, for the same total development expense, this results in a reduction in taxable income for a little more than 3 years (30 percent in years 1, 2 and 3 and the remaining 10 percent in year 4, again, assuming a simple linear amortization). For purposes of illustration, consider $1 million in development expenses. At a 30 percent rate, this would give a reduction in taxable business income of $300,000 per year for 3 years followed by a $100,000 reduction in the fourth year. At the 10 percent rate, this would result in a reduction in taxable business income of $100,000 per year for 10 years. Note that the total reduction in taxable business income is $1 million in either case. The "benefit" to the business of the higher expensing rate is a reduction in the tax liability for the first three years, the same tax liability in the fourth year and a higher tax liability in years 5 through 10. The net size of this benefit depends on, among other things, the rate of time preference of the owners of the business. It is not correct to calculate the benefit to the business simply as the difference in the allowable expense in the first year under the two rates. The same type of analysis applies to accelerated capital cost allowances. First, is it equitable and efficient to merge putatively two types of capital assets into a single category; and second, if the capital cost allowance for one asset category is higher than another asset category, then the deprecation charges for assets in the first category will lead to lower tax liability in early years and higher tax liability in later years.

The Office of the Auditor General (2017) includes flow-through shares as another category of subsidy for oil and gas production. Flow-through shares allow the issuing firm to transfer some of its development expenses, typically in an amount up to the purchase price of the share, to the purchaser of the share. The purchaser of the share can apply these transferred expenses against taxable income in some other area. We will see later that other international agencies and many environmental advocacy groups consider flow-through shares to constitute a subsidy to energy production. There are at least two problems with this view. First, flow-through shares are not unique to the oil and gas sector. One general practice in the characterization of subsidies to a specific industry is to differentiate between general policies and programs that are available to any industry and policies and programs that are exclusively available to the industry in question. The United States Energy Information Administration (US EIA), whose work I will discuss later in this report, does not include general policies and programs available to any industry in its calculations of subsidies provided to the energy sector.

A second problem in treating flow-through shares as a subsidy to the energy sector is that the benefits of flow-through shares only partially accrue to the firm issuing the shares. Oil and gas exploration and development is costly and time consuming. It can be some time before revenues are generated as a result of these initial development expanses. And future returns are uncertain. Exploration and development can be unsuccessful. Potential investors might be reluctant to commit capital to such prospects. A flow-through share enables an investor to apply a portion of those exploration and development expenses to tax liability in another unrelated enterprise. As a result, a flow-through share reduces tax liability in that other enterprise and therefore constitutes a tax expenditure related to that enterprise. But the tax expenditure is not related to the firm that sold the flow-through share. The tax offset may make investment in energy exploration and development sufficiently attractive to prompt investment. The energy firm does benefit in the sense that the enterprise would exist under this investment arrangement whereas it might not exist if only conventional shares were allowed. But the energy firm sacrifices the present value of the future reductions in its own tax liabilities because it has transferred expenses to owners of flow-through shares. Simply calculating the value of the capital raised through the sales of flow-through shares as the value of the subsidy to the energy production business, which seems to be the approach that has been taken, is incorrect.

Tax Expenditure Subsidies and the Benchmark Income Tax Measures

Calculation of tax expenditure subsidies involves comparing the tax revenue that would be collected under an existing tax policy with the revenue that would be collected under an alternative policy. The alternative policy is called the Benchmark Income Tax Measure. The Benchmark might be the tax rate applied to assets in another sector or to assets in a different asset category in the same sector. If the capital cost allowance for Asset Class 1 in Sector A is 10 percent per year, meaning that 10 percent of the book value of the asset could be deducted from net revenue in calculating income tax liability, and the capital cost allowance for Asset Class 1 in Sector B is 20 percent per year, then some contributors to the Canadian literature on this topic argue that the tax expenditure subsidy would be 10 percent for firms in Sector A. On the other hand, a tax collection department could determine that the Benchmark is a 10 percent capital cost allowance for Asset Class 1 in Sector A and 20 percent for Asset Class 1 in Sector B. In this case, there is no tax expenditure subsidy. This is at the core of the response of the Department of Finance to the inquiries of the Office of the Auditor General leading up to its 2017 report to Parliament. The Department of Finance stated that some of its taxation policies that were specific to the oil and gas sector were part of its Benchmark Income Tax Measures and therefore did not constitute subsidies. The Office of the Auditor General disagreed with this position, which illustrates a significant problem with the application of the Benchmark tax standard in the estimation of energy subsidies.

Although various organizations have used the term "inefficient energy subsidies", no definition of this phrase has been developed for the Canadian context. This is a critical obstacle to progress in the measurement of energy subsidies. If we want to phase out the bad subsidies, we need to know how to identify them. The G20 agenda is not to eliminate all subsidies. It is only to eliminate the inefficient ones. Many attempts to estimate energy subsidies in Canada have not differentiated between efficient and inefficient subsidies. A common practice has been to consider all subsidies as inefficient. But this is not in keeping with the intentions of the international agreements to which Canada is a signatory.

Pigouvian Welfare Economics

One thread in economic thinking about taxation and subsidization can be traced to Professor Pigou's *Economics of Welfare*, published in 1920. According to this view, some production or consumption activities impose costs on or create benefits for third parties. These effects are called externalities. Two parties engage in an exchange from which they both expect to benefit. But someone else, the third party, experiences a loss or a gain from the exchange but was not a participant in that exchange. If the transaction between the two parties results in a harm to the third party, this is a negative external cost or negative externality. If the transaction results in a benefit to the third party, this constitutes a positive externality. Because the two parties to the transaction do not take the effects on third parties into account when they act, there is too much of the activity if there is a negative externality and too little of that activity if there is a positive externality. This results in inefficiency in the allocation of resources. Pigou's remedy for such external or third-party effects is a system of taxes and subsidies. Activities that generate external costs to third parties should be taxed. Activities that generate external benefits to third parties should be subsidized. Taxation reduces the amount of the activity causing the negative externality. Subsidization increases the amount of the activity causing the positive externality.

Implementation of this approach requires the imposition of a tax equal to the magnitude of the marginal external cost or the payment of a subsidy equal to the magnitude of the marginal external benefit. With the tax or subsidy in place, parties to an exchange take into account their own marginal benefits and costs but also the tax or subsidy. Economists say that this process internalizes the externality. The activity with the negative external effect becomes more costly with the tax and this discourages that activity. Activities with positive external effects take place at higher levels when the subsidy is applied.

Pigouvian welfare economics suggests that there is a potential role for governments to increase efficiency in the allocation of resources by using taxes and subsidies. This potential, however, is often thwarted by a difficult information problem. It is one thing to suspect or to claim that an activity generates costs or benefits to third parties. It is quite another thing to measure the magnitude of those benefits or costs objectively. Ronald Coase referred to this problem as "blackboard economics." He explained that it is one thing for an economist to draw lines on a graph on a blackboard, it is quite another thing to measure accurately the relative magnitudes involved. An accurate characterization of the size of an externality is necessary for setting the corrective Pigouvian tax or subsidy. A recent paper by Ricke et al. (2018) illustrates the challenges involved in modeling and estimating external costs. The purpose of the research was to estimate what economists call the social cost of carbon dioxide, which is the marginal external cost in present value terms of a unit of additional carbon dioxide emitted into the atmosphere. Previous literature reported estimates of the social costs of carbon dioxide ranging from $10 to $1000 per metric ton of carbon dioxide equivalent. Three emission scenarios were included in the analysis. Atmospheric concentrations from these scenarios became inputs into models that projected future climate. Projected changes in future climate were used to calculate future damages, which were then expressed as a present value in $US per metric ton of carbon dioxide equivalent emissions. These values were calculated at the national level for apparently every country in the world.

But my purpose here is not to describe the methods used in the study. Interested readers may review it for themselves. I am interested in the range of estimates that they generated. Figure 2 in the paper reports national estimates for the medium emission scenario and a 2 percent discount rate. Results are reported in ranges. The highest range is $50–$100 US per metric ton of carbon dioxide equivalent. Other ranges span $10–$50, $1–$10, $0–$1, -$1–$0 and -$10– -$1. Figure 2 reports that Russia, Mongolia, the Scandinavian countries, Germany, France, the United Kingdom, Poland, and Canada fall into the -$1 to -$10 range. A negative value for the social cost of carbon dioxide means that there is a small net benefit from climate change for these northern countries in this scenario. India falls into the highest category of $50–$100. The United States, China, Brazil, Saudi Arabia, and Mexico, among others, end up in the second highest social cost category of $10–$50. The authors, to their credit, take pains to emphasize the uncertainties involved in such ambitious modeling efforts and they discuss the sensitivity of their results to key assumptions and parameters in detail. My concern has to do with the use of such modeling and estimation results in the context of efforts to calculate energy subsidies that include calculations of uninternalized externalities. Which of the reported range of values for the social cost of carbon dioxide should be used as the value of the uninternalized externality? Which value should be used to set a carbon dioxide emission tax?

Ronald Coase (1960, especially sections VI and VII) also explained that what Pigou characterized as externalities often, upon closer examination of the legal and political history, turned out to be activities that operated behind a legislative shield of liability for what would otherwise be a trespass, nuisance, or violation of riparian rights. A better term for these negative externalities would be legalized nuisances. Actions which would otherwise constitute nuisances, and which would create liability for damages under customary common law, are given a shield against such liability, typically by a legislative measure that absolves the originator of the externality of liability. An alternative to internalizing the externality through a Pigouvian tax would be to remove this legislative shield against liability.

Pigouvian welfare economics is, however, not the only context in which the measurement of subsidies is important in economics. As I mentioned earlier, measurement of subsidies is also important in the context of resolving trade disputes. Measurement of taxes and subsidies is also important in public finance in the analysis of determinants of the level of government debt. The public finance literature also examines the incidence of taxes and subsidies (e.g., Atkinson and Stiglitz, 1980: Lectures 6 and 7). And there is a literature on efficient taxation that tries to shape tax policy in such a way as to minimize the efficiency effects of taxation and subsidization when taxes are being raised, not with a goal of internalizing externalities but with a goal of financing general government expenditure. But the main purpose for understanding and measuring energy subsidies is to characterize the effects of subsidies on the efficiency of resource use.[2] Subsidies encourage the production or consumption of a product. Taxation discourages this production or consumption. In the absence of externalities, or if the good in question is not a public good, subsidization and taxation can result in economically inefficient levels of production or consumption. Efficiency analysis typically requires an integrated approach that characterizes the net effect of a set of policies, some of which encourage and some of which discourage production or consumption. It also should include measures that apply to all stages of the supply chain, from extraction or primary production to processing and distribution to retail consumption.

2 For an excellent discussion of the welfare economics of fossil fuel subsidies in particular, see McKitrick (2017).

The Evolving Composition of Canadian Energy Production

Table 1 reports the International Energy Agency's estimates of Canadian energy production from 1990 to 2020. Total energy production in Canada grew from approximately 8.8 million terajoules in 1990 to about 12.2 million terajoules in 2020. Coal production declined by almost 60 percent during that time period, while natural gas production more than doubled. As of 2020, Natural Gas contributed 38.4 percent of total Canadian energy production, followed by Oil with 32.2 percent, Hydro with 11.3 percent, Nuclear with 8.7 percent, Biofuels and Waste with 4.5 percent, Coal with 3.6 percent. Wind and Solar, which made negligible contributions to the total in 1990, contributed 1.2 percent in 2020.

Table 1: Canadian Energy Production by Mode of Energy Production, 1990–2020 (terajoules per year)

	Coal	Natural gas	Nuclear	Hydro	Wind, solar, etc.	Biofuels and waste	Oil	Total
1990	1,015,733	2,291,986	812,033	1,068,253	94	455,522	3,203,476	8,847,097
1995	1,061,450	2,809,789	1,070,001	1,209,323	346	539,994	3,231,370	9,922,273
2000	1,327,108	3,109,048	794,171	1,290,632	1,123	579,702	3,646,619	10,748,403
2005	1,259,238	3,397,913	1,004,073	1,302,912	5,803	607,674	3,978,314	11,555,927
2010	966,974	3,169,256	988,996	1,264,860	33,964	554,646	4,031,050	11,009,746
2015	773,510	3,576,791	1,110,644	1,375,758	109,299	606,354	4,380,020	11,932,376
2020	441,733	4,702,400	1,071,393	1,384,682	147,150	556,286	3,942,190	12,245,834

Source: International Energy Agency, 2022.

International Estimates of Canadian Energy Subsidies

Several international agencies have produced estimates of fossil fuel subsidies for Canada. Coady et al. (2015: 4–5) used a novel and expansive definition of a subsidy and applied that definition in estimating fossil fuel subsidies globally. They produced global subsidy estimates that were substantially higher, at $4.9 trillion per year, than previous work by the International Energy Agency, the OECD, and the IMF. The International Energy Agency (2014) estimated global fossil fuel subsidies to be $548 billion in 2013. The OECD (2013) estimated them to be $50–90 billion annually for 34 OECD countries for the time period from 2005 to 2011. And the IMF (2013) had previously estimated pre-tax subsidies to be $492 billion and post-tax subsidies to be $2 trillion.

The Coady et al. (2015) report covered gasoline, diesel fuel, kerosene, natural gas, coal, and certain aspects of electricity production. They defined pre-tax subsidies as the difference between the price that consumers pay for an energy product and the private cost of supplying that energy product. They defined post-tax subsidies to include the pre-tax subsidy plus the revenues that would be collected if a Pigouvian externality tax were applied to the relevant energy product, and finally an additional amount to reflect the consumption tax that would have been paid if a consumption tax were used to finance government expenditures (instead of income and wealth taxes). The Pigouvian tax for external costs included estimates of damages for local air and water pollution problems, as well as a levy to reflect damages arising from projected climate change. In addition to these externality costs, the hypothesized Pigouvian tax included a component that reflected the social costs of traffic congestion and traffic collisions. Given that these Pigovian taxes are generally not implemented, Coady et al. (2015) calculate the revenues that these taxes would generate were they to be applied, and this uncollected revenue is included as one of the elements in their overall subsidy estimates. They report that post-tax energy subsidies are dramatically higher than previously estimated—$4.9 trillion (6.5 percent of global GDP) in 2013 and projected to reach $5.3 trillion (6.5 percent of global GDP) in 2015. Coal accounts for the largest component of their estimates.

McKitrick (2017) has already pointed out the analytical limitations of this study and there is no need to revisit that critique here. Of the estimated global total of US$4.9

trillion in subsidies, approximately US$4.15 trillion, or 85 percent, consists of the value of uninternalized externalities. The countries in the Emerging and Developing Asia category make the largest contribution to the total, a little less than US$2.5 trillion.[3] Most of this goes to coal.

I would like to focus on the implications of the Coady results for Canada. Canada is included in a group of countries labelled as the Advanced Economies.[4] There are 33 political units included in this category. The Advanced Economies, in total, contribute approximately US$1.2 trillion, or about 24 percent to the overall total subsidy estimate. This is the second largest contribution to the total estimate. Petroleum is responsible for the largest portion of this amount. Coady et al. (2005) do not report individual country estimates for subsidies, so it is not possible to isolate Canada's contribution. In 2012, Canada's GDP was a little under 5 percent of the total GDP of the United States, Japan, Germany, France, the United Kingdom, Italy, Canada, Australia, and Spain.

I said earlier that the Coady et al. (2015) study used a novel and expansive definition of subsidy. It should therefore not be surprising that they produced larger estimates of global subsidies than previous studies. The main difference in their definition from previous work was the inclusion of estimated uninternalized externalities in their calculations. As I mentioned previously, it is one thing for economists to claim that a given activity produces external costs or benefits that are not taken into account by participants in market exchanges. It is quite another thing to estimate the magnitude of these external effects. There are some controversial aspects regarding the way external costs were estimated. For example, their external effects calculations include an estimate of the costs of traffic congestion and traffic collisions. They attribute these costs to fossil fuels, namely gasoline and diesel. The assumption seems to be that fossil fuels are singularly responsible for these costs. But consider a hypothetical where all internal combustion engine vehicles had been replaced by electric or hydrogen vehicles. If the total number of vehicles stayed the same, it is reasonable to expect that there would still be congestion and collisions. Furthermore, even in a world with extensive use of internal combustion engine vehicles, without diesel and gasoline

3 The Emerging and Developing Asia category consists of Bangladesh, Brunei Darusallan, Cambodia, China, India, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Papua New Guinea, Philippines, Sri Lanka, Thailand, and Vietnam.

4 The Advanced Economies consist of Australia, Austria, Belgium, Canada, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hong Kong, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Malta, the Netherlands, New Zealand, Norway, Portugal, Singapore, the Slovak Republic, Spain, Sweden, Switzerland, Taiwan, the United Kingdom, and the United States.

there would be no congestion or collisions because vehicular traffic would come to a stop without fuel. But there would also be no congestion or collisions if there were no steel, aluminum, or fibreglass to fabricate vehicles. Furthermore, some congestion is due to inadequate construction and maintenance of roads and related infrastructure as well as generally unpriced scarcity in rationing roadway space during peak traffic periods. And it is generally acknowledged that impaired vehicle operators are responsible for a disproportionate number of collisions. So should steel, aluminum, fibreglass, alcohol, drugs, and poor roads be considered as joint factors causing these external costs? Allocation of all of the costs of collisions and congestion to a single input in the vehicular transportation system, fuel, seems arbitrary.

The International Energy Agency (2022: 63) identifies flow-through shares in the fossil fuel sector as the most significant remaining inefficient fossil fuel subsidy. Flow-through shares, however, are not unique to the energy sector. The IEA does not explain why it considers these arrangements to be inefficient, or what standard of efficiency they have in mind in rendering this judgment. They do report that:

> The tax expenditure associated with flow-through shares for oil and gas and coal mining is forecasted to be approximately CAD $8 million per year for 2020 and 2021, though the bulk comes from oil and gas. (IEA, 2022: 63)

If this is the extent of fossil fuel subsidies in Canada, this amounts to CA$0.21 per person per year. The IEA publishes a list of the 25 largest fossil fuel subsidy countries. Canada is not on that list.

Canadian Estimates of Energy Subsidies

Sawyer and Stiebert (2010) published estimates of fossil fuel subsidies in Canada as part of the Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD). They used a definition of subsidy based on the World Trade Organization's (WTO) *Agreement on Subsidies and Countervailing Measures* (ASCM). The ASCM determines that four types of subsidies exist, where government:

1. Provides direct transfer of funds or potential direct transfer of funds or liabilities;
2. Foregoes or does not collect revenue;
3. Provides goods or services or purchases goods;
4. Provides income or price support.

The ASCM definition excludes uncompensated environmental externalities such as air or water pollution.

Sawyer and Stiebert (2010) estimate that the Government of Canada and the respective provincial governments, namely Alberta, Saskatchewan, and Newfoundland and Labrador, provided a total of CA$2.8 billion in subsidies for oil production in 2008. These three provinces account for more than 97 percent of oil production in Canada. They identified a total of 63 subsidy programs that apply to the oil industry in these three provinces: 18 in Alberta, 19 in Saskatchewan, 9 in Newfoundland and Labrador, and 17 at the federal level. Most of these subsidies seek to increase exploration and development activity, with a focus on reducing the costs of exploration, drilling, and development through a mix of tax breaks and royalty reductions. Provincial and federal subsidies for production in Alberta each accounted for a little over CA$1 billion of the total. Reduction in provincial royalty payments accounted for 78 percent of the total provincial subsidy estimate for Saskatchewan and 46 percent of the total provincial subsidy estimate for Alberta. They found that subsidies primarily directed at encouraging companies to bring new oil resources into production comprised 59 percent of total subsidies ($1.68 billion).

McKenzie and Mintz (2011) were critical of the Sawyer and Stiebert subsidy estimates, which they saw as representative of a group of studies, describing the approach as "flawed and misleading." They agree in principle with the intent of attempts to measure energy subsidies, taking the position that:

> the appropriate principle for business fiscal policy is to raise revenue in the most efficient manner by setting tax rates as low as possible on neutral bases that do not favour one form of activity over another. Explicit subsidies should generally be avoided. Royalties should be efficiently set to capture rents accruing to the government that owns the resources available for extraction. Only in a limited number of cases is some deviation appropriate from these principles; for example, the imposition of taxes (or regulations) to reduce environmental harms or tax incentives or subsidies to encourage innovative activity that would otherwise not be undertaken due to the inability of firms to appropriate the full social returns to research. (McKenzie and Mintz, 2011:2)

Their criticism of previous studies was that the methods used by Sawyer and Stiebert and others failed to produce economically meaningful estimates of the magnitude of subsidies. Their criticisms are arranged under 4 headings:

1. The study employs a definition of a subsidy that was designed for a different purpose.
2. The approach inappropriately adds together individual tax expenditure and royalty relief items without appropriately accounting for important interactions.
3. The method used to estimate subsidies is not based upon an economic model which emphasizes the impact of taxes, royalties, and subsidies on investment at the margin.
4. It is not based upon an economically meaningful benchmark.

Sawyer and Stiebert (2010) used the definition of a subsidy that has been developed by the WTO for use as its standard in trade disputes. The advantage of this definition is that it has been tested and applied in a range of trade dispute cases at the WTO. McKenzie and Mintz argue, however, that the purpose for which this definition was developed makes it well-suited for the context in which it has been used but not well-suited for application in the measurement of subsidies in other contexts, including measuring subsidies of fossil fuels for comparative or policy purposes.

Many available measures of subsidy include tax expenditures as part of the total amount of subsidy. Tax expenditure measures were developed to help understand the effects of changes in tax policy on government budgets. Direct payment types of subsidies affect government budgets on the expenditure side. Changes in tax policy to favour a particular industry affect government budgets on the revenue side. Concern for government budget deficits requires attention be paid to both the revenue and the expenditure sides of the budget. Tax expenditure methods were developed in this context.

McKenzie and Mintz (2011) argue that the effects of subsidies should be measured through their effects on the marginal costs and marginal revenues of a production activity if the purpose is to assess the impacts of those subsidies on resource allocation, and in particular on output levels. The critical policy question is "Does a subsidy increase the level of output of the subsidized product?" The economic perspective on this question emphasizes the effects on the marginal unit of production. Effects on inframarginal units of production may affect the financial viability of the business producing the product, but not change the level of output. What we really need to know is whether a subsidy increases the level of fossil fuel production relative to what would be obtained in the absence of the subsidy. McKenzie and Mintz (p. 7) explain that the way that the WTO definition is applied in the Sawyer and Stiebert (2010) study does not differentiate between a subsidy which changes marginal revenues or costs in a manner that increases fossil fuel production and a subsidy which, presumably through adoption of better technology, reduces environmental externalities. In the Pigouvian framework, a subsidy of technology development that reduces environmental externalities from a production activity would not be an inefficient subsidy. It could be efficiency enhancing.[5] So it is an error to add the value of subsidies which increase output to the value of subsidies which reduce externalities, since they can have opposite effects on efficiency.

McKenzie and Mintz (2011) report that the bulk of the subsidy estimates reported by Sawyer and Stiebert (2010), about 84 percent, arise from estimates of tax expenditures or royalty reductions. They present three criticisms of the tax expenditure calculations. First, individual federal tax changes interact with other federal tax measures and also with provincial business income tax measures. Reduction of tax liabilities from one measure may increase tax liabilities under another tax measure or under provincial business income taxation policy. So it is inappropriate to simply add the individual tax adjustments together. A net effect calculation is required. Second, provincial royalty payments are deducted from revenue in the calculation of business income tax liability. So a reduction in the rate at which royalties are levied increases

5 Of course, there are other ways to address production externalities, such as dismantling legislative shields against liability for nuisances, which would also create an incentive for the firm generating the externalities to internalize those external costs.

net revenue which increases tax liability. So, again, simply adding reductions in royalties to the total subsidy calculation without adjusting for the increased tax liability results in an over-estimate of the level of subsidization. Third, some types of subsidy—they discuss subsidies for the purchase of capital equipment—result in a lower book value for the capital asset in question. This results in lower future depreciation charges against revenues and the higher net returns result in higher future tax liabilities.

Sawyer and Stiebert (2010) include reductions in royalties charged by provincial governments as one element of their overall subsidy estimates. Their calculations treat the royalty level prior to the reduction as a market price and the new royalty rate as a distortion of that market price that favours the resource extraction firm. McKenzie and Mintz point out that a simple application of the difference between the new royalty rate and the old rate multiplied by the level of current production needs to be netted out against the increase in business income tax liability arising from the higher net revenues accruing to the firm under this lower input cost.

While it is generally accepted that a government policy that changes prices for inputs or outputs can constitute a subsidy, I disagree that this is what is happening when a provincial government changes its resource pricing policy. Resource royalties are not market prices. Resource royalties are fees set by provinces to generate revenue from natural resources that they own. Market prices arise from the interaction of buyers and sellers. Resource royalties are more like sellers' offer prices. If an apartment building owner is currently charging $1,000 per month for apartment rentals and observes that, at that rent, vacancy is rising in the building, that owner may decide to reduce rents to $900 per month in order to attract more tenants. If a landowner offers farmland for rent for $500 per acre per year and no tenants express interest, then the landowner might consider reducing this rental rate. Resource royalty rates, like these rental offers, can reflect provincial government resource owners' responses to changing demand and supply conditions; if a provincial government reduces its royalty rate for resource extraction, this does not necessarily constitute a subsidy. Depending on the elasticity of the demand that a province faces for a natural resource that it owns, reducing per-unit royalty payments can increase provincial revenues. And when a royalty scheme involves an initial payment or bid for access to the resource and a subsequent per unit charge for extraction, a reduction in the per-unit charge can increase the amount of the initial bid.

McKenzie and Mintz (2011: Table 1) present their own estimates of fossil fuel subsidy levels for four provinces in Canada, based on their analysis of marginal effective tax and royalty rates. They explain that if the purpose of measuring a subsidy is to assess the effect of that subsidy on resource allocation, specifically output, then a marginal analysis based on the marginal effective tax rate is required. They use the marginal effective tax rate in the non-resource sector as their standard of comparison. Their results indicate that, when royalties are included in the analysis, the marginal effective tax rate for fossil fuel production in Alberta (for both conventional and oil sands production) and Saskatchewan is higher than the marginal effective tax rate for the non-resource sectors in those provinces. This situation is reversed for Newfoundland and Labrador. This suggests that fossil fuel production is not subsidized in Alberta or Saskatchewan but that it is subsidized in Newfoundland and Labrador. The marginal effective tax rate for fossil fuel production in Alberta is higher than the marginal effective tax rate in the non-resource sector by over 13 percent for conventional production and by over 7 percent for oil sands production. In Saskatchewan, the marginal effective tax rate for fossil fuel production is about 14 percent higher than the rate for the non-resource sector.

Chassin (2014) also reviewed the subsidy calculations in the Sawyer and Stiebert (2011) report. He concluded that many of the items included in that report as subsidies should not be treated as subsidies. Chassin estimated that oil production subsidies in Canada amounted to approximately CA$210 million in 2014. Two of the larger components of this estimate, accelerated capital cost allowances ($90 million in support in 2014) and the Atlantic Investment Tax Credit ($50 million in support in 2014), were to be phased out in 2015. Chassin estimated that after these two programs ended, about $71 million per year of subsidies would remain. Chassin argues that tax treatment of exploration and development expenses and the use of flow-through shares to finance the initial phases of energy production enterprises should not be considered subsidization, when the costs of bearing the uncertainty and risk associated with such enterprises are taken into account. Chassin also argues that it is important to differentiate between subsidies which can be directly linked to increasing production and subsidies for research technology development to enhance efficiency and environmental performance in energy production from oil and gas. He concludes that the latter form of support should not be considered a subsidy for oil and gas production. Unlike the Sawyer and Stiebert study, Chassin reports estimates of Canadian subsidies for wind, solar, and biofuel energy production, arguing that the production subsidies that have been directed at oil and gas production are small relative to government support for wind, solar, and biofuels. He also explains that governments in Canada received an average of about CA$18 billion in resource royalty payments from natural gas and oil extraction in recent years. His ongoing estimate of $71 million per year in subsidy support represents less than one half of one percent of that royalty revenue.

Chassin pointed out that while many petroleum producing countries subsidize consumption of fossil fuels, Canada has not followed that route. In fact, gasoline consumption is subject to taxation by various levels of government. In 2012, gasoline taxes in Canada averaged CA$0.393 per litre, which accounted for about 31 percent of the retail price of gasoline. Federal excise taxes on vehicle fuels totaled $5.4 billion, and provincial tax revenues from vehicle fuels totalled $8.3 billion in that year. Chassin estimates that each Canadian pays about $395 per year in fuel taxes.

Touchette and Gass (2018) make an important point that is relevant to the purpose of this paper, that the tax expenditure subsidy estimates reported in previous IISD work arose in a context of high oil and gas prices. The time period covered in their study, in contrast, was a period of lower oil and gas prices. Tax expenditures evaporate when the taxed enterprises are not profitable. Touchette and Gass also expect that market conditions for fossil fuels, globally, will result in them ceasing to be important sources of energy production by the middle of the 21st century; if this expectation is correct, then any measure that extends the lifespan of fossil fuel energy sources is a waste of resources.

Kaplan and Milke (2020) reviewed previous estimates of fossil fuel subsidies for Canada. They also used the Supply and Use Tables from Statistics Canada to compile their own estimates for 2016, the latest year of data then available. Their analysis covered the period from 2010 to 2016. They estimated that federal, provincial, and local subsidies to the fossil fuel sector amounted to CA$1.9 billion for the time period in question, or about CA$217 million per year. They compared this level of support to 14 other industries or sectors (Kaplan and Milke, 2020: Table 1). A total of 11 other industries or sectors received as much support as, or higher support than, the fossil fuel sector between 2010 and 2016.

Environmental Defence Canada published estimates of Canadian Federal Government subsidies to oil and gas production for 2020. Their estimated total (Environmental Defence Canada, 2021: 1) of direct expenditures was CA$3.28 billion,[6] and an additional amount of support of CA$13.47 billion was attributed to the Canada Export Development Corporation. The appendix to the report lists 14 Federal programs or expenditure categories that make up the CA$3.26 billion in direct expenditures. (Environmental Defence Canada, 2021: 8–9). Four of the programs or expenditure categories are identified as COVID-related support programs. Two of the programs are identified as support for indigenous communities and organizations. And six

6 The Appendix to the report contained a table of expenditures by program and the expenditures in this table summed to CA$3.26 billion.

of the programs involve support for research and technology development efforts to reduce emissions and innovate cleaner energy technologies. These expenditures may or may not meet a Pigouvian standard for efficiency enhancing subsidies. But none of the programs or expenditure categories are what most disinterested readers would have in mind as Federal Government support for oil and natural gas production. Earlier in the report, energy subsidies are characterized as contributing to climate change by "making it cheaper to find, extract, process, transport and export fossil fuels, subsidies encourage more fossil fuel production" (p. 3). It is difficult to see, however, how the actual programs and expenditures included in these estimates of Federal Government support would have such an effect.

The April 2021 Environmental Defence (Appendix, p. 9) report also lists five programs that they claim might result in subsidies for the oil and gas sector, one of which is identified as a COVID-related program and three of which are identified as part of Canada's climate plan. The fifth program is the Low Carbon Economy Fund. Again, these are not programs that most disinterested readers would think of as Canadian Federal Government efforts to sustain or expand production of oil and natural gas. The report also lists several tax policies related to calculation of depreciation and the treatment of expense items that are suggested as possible subsidies, although a lack of government data is cited as an obstacle to the calculation of subsidy amounts.

There are two noteworthy assumptions made in the Environmental Defence (2021) report. On page 5, the report states that demand for oil and natural gas will "continue to fall." No source is offered for this assumption and no data are presented to justify it. Almost two years later, with the turmoil that has visited global energy markets in the intervening months, this assumption might be viewed with some skepticism. The second assumption is implicit. The report assumes that actions by Canada on energy policy will have an effect on the future climate of Canada. This is the assumption that Canada matters when it comes to greenhouse gas emissions. This report is not alone in making this assumption. But many people making the same assumption does not make that assumption true. Canada contributes approximately 1.6 percent of global greenhouse gas emissions each year. Canada's emissions could disappear and that would have no effect on the future climate conditions that Canadians would face.

Tucker and DeAngelis (2020) report that G20 countries have spent an average of US$77 billion per year on fossil fuel subsidies since the Paris Accord was signed in 2015. They estimate that China is responsible for the largest contribution to this total, averaging about US$25 billion from 2016 to 2018 (see their Figure A). They identify Canada as the second largest contributor to the G20 total, estimating that Canada spent US$10.6 billion per year from 2016 to 2018, which they report is an increase from the comparable level from 2013 to 2015. The bulk of the Canadian support is for oil and natural gas. No Canadian support is attributed to coal. The $10.6 billion in support for Canada for 2016 to 2018 is attributed exclusively to Export Development Canada, an export credit agency (Figure 9, p. 18; Box 6, p, 20).

Geddes et al. (2020) developed a scorecard which they applied to G20 countries' actions in implementing the 2015 Paris Accord. Canada ranked 5th on the scorecard among the OECD G20 member countries, behind Germany, France, Japan and Italy. Geddes et al. estimate that the G20 countries provided US$584 billion in support for fossil fuel production and consumption per year for the period from 2017 to 2019 (p. iv). This total consisted of 4 percent for direct expenditures, 14 percent for tax expenditures, 29 percent for price supports, 9 percent for concessional loans and loan guarantees, and 44 percent for the activities of state-owned enterprises (Geddes et al.,| 2020: 8). Their total estimate is inclusive of direct payments, tax expenditures, price supports, public finance (concessional, loans and loan guarantees), the activities of state-owned enterprises, and programs related to the effects of COVID. They estimate that a least US$170 billion in support was related to COVID measures implemented by the G20 governments, but that support is not isolated in the percentage categories listed above. Canada's support for fossil fuels was attributed to the operations of Export Development Canada, based on the work of Tucker and DeAngelis (2020).

Corkal at al. (2020) estimate that Canadian Federal government subsidies to the oil and gas sector amounted to CA$593.2 million non-tax subsidies in 2019. They characterized this as an under-estimate, however, since they were unable to obtain data from the Government of Canada to calculate support in the form of tax expenditures. They include 12 programs or projects (Table 1, p. 4-5) in their calculations of non-tax subsidies. However, this set of programs or projects includes a one-time CA$275 million contribution to the development of an LNG facility in British Columbia as well as expenditures related to technology and innovation, emissions reduction, and regional energy related projects. The criterion for identifying an expenditure as an oil and gas subsidy seems to be that the payment went to an organization that is involved in oil and gas production, without regard to the intended purpose of the program making the expenditure or to the efficiency effects of that expenditure on output. Development of technology that improves efficiency of energy production or consumption, or that reduces emissions, may or may not be an economically justified use of tax revenues by governments. But the connection between those types of expenditures and the promotion of the production and use of fossil fuel energy needs to be demonstrated, not assumed.

Corkal et al. (2020: Table 2) included a list of programs or projects that they considered to be fossil fuel subsidies but for which they were unable to quantify the amounts. One of the items on this list, interestingly, is Export Development Canada. Corkal et al. state that, between 2015 and 2018, Export Development Canada provided CA$11.6 billion in financing for domestic and international oil and gas development, but that they were unable to determine how much of that amount constituted a subsidy. Corkal et al. also list the tax-related measures that the Office of the Auditor General of Canada (2017) identified and that I discussed previously.

Lann and Corkal (2020) identified 128 federal and provincial tax-related policies that they claimed represent tax expenditure subsidies for the Canadian oil and gas sector. The Lann and Corkal report is important in that it acknowledges previous contributions to the literature by Chassin, Mackenzie and Mintz, and McKitrick. They are unfortunately dismissive of the criticisms made by those authors. They charge these researchers with conflicts of interest:

> Efforts by independent researchers to improve transparency in Canada's accounting of tax subsidies have been met by considerable opposition from Canada's oil and gas industry and the researchers they fund (Canadian Association of Petroleum Producers [CAPP], 2017; Chassin, n.d.; Jaremko, 2020; Kaplan & Milke, 2020; McKenzie & Mintz, 2011; McKitrick, 2017). **Vested interests have sought to narrow the definition of subsidies to exclude tax expenditures benefiting the sector; they have advocated estimation methods that would minimize subsidy estimates, and, in some cases, they state that subsidies to the sector simply do not exist.** (Lann and Corkal (2020: 2; emphasis in the original)

It is not clear if they are claiming that all researchers whose results have differed from their own have done so with ulterior motives. I would like to see more documentation in support of this claim. But the real issue is the need to properly define and measure energy subsidies in the Canadian context. If some researchers have proposed definitions and produced estimates that are flawed, it is important to identify the relevant errors and correct them.

Lann and Corkal (2020: 4) estimated that total annual fossil fuel subsidies by the federal and provincial governments in Canada totaled approximately CA$4.8 billion per year in 2018 and 2019,[7] and that CA$3.2 billion of this was in the form of foregone revenue. They were only able to quantify the effects of about 50 percent of the 128 measures that they identified, citing a lack of transparency on the part of the provincial governments and the federal government. So they state that the aggregate estimate of forgone revenues of CA$3.2 billion is an underestimate.

Lann and Corkal recommend that all tax expenditure subsidies be included in a comprehensive measure of industry support. However, they are not so comprehensive in their recommendations to suggest that subsidy calculations should be done for all energy production systems, a point to which I will return later in this report. Like other authors whose work I have discussed, Lann and Corkal are critical of COVID-related expenditures or support going to businesses involved in oil or gas production. Presumably, they would have wanted the federal and provincial governments not to provide COVID-related support for businesses or workers in the oil and gas industry. Lann and Corkal reject a distinction that I have made elsewhere in this report between subsidies which have a direct effect on output of natural gas or oil and subsidies which support efforts to reduce emissions and other environmental problems associated with the extraction, production, and distribution of oil and natural gas.

Touchette and Gass (2018) extended the earlier work by researchers at the Institute for Sustainable Development, based on the framework and approach proposed by Sawyer and Stiebert (2010). They focus on the four years prior to 2018. Unlike previous work, however, and in contrast with the title of their report, they do not report an aggregate estimate of subsidization for fossil fuels for Canada. They do present a series of tables on individual components of what could be used to calculate and aggregate subsidy amounts. Their first table lists seven taxation categories, but only one of those categories, flow-through shares, is costed. The total reported is CA$265 million for 2016 to 2018, but the note for this cell explains that this value was obtained from Finance Canada and that Finance Canada does not disaggregate tax expenditures in this category to differentiate between various sectors that access this financing option. The note also acknowledges that flow-through shares are used in the renewable resource sector, so we can't determine how much of the amount is attributable to fossil fuel businesses. And it is not clear how that subsidy amount is calculated for

7 This result is reported in Table 2 of the report. The table reports subsidy estimates for the federal government and for several provincial governments. Each estimate is taken from previously published literature, cited in the final column of the table. But the report itself does not discuss how each of the estimates were calculated from this previously published literature.

flow-through shares. The beneficiary of a flow-through share is the purchaser, who can use up to the cost of the share to reduce tax liabilities against some other income source. Is that income source the recipient of the subsidy? Or does part of the subsidy accrue to the business issuing the share? And is the entire value of the share a subsidy or only some portion? The remaining six tables in the report list a range of programs and projects that relate mostly to technology development, including projects to reduce the environmental externalities associated with some forms of fossil fuel production. The authors claim that these programs and expenditures should be considered support for fossil fuel production. But I suspect that most readers would not see a clear connection between the information presented in these tables and subsidization that directly increases fossil fuel production.

Determining the "Tax That Is Due"

A fundamental problem associated with the measurement of tax expenditures as a form of subsidy can be seen in the definition provided by Lann and Corkal (2020), a definition they attribute to the WTO and UNCTAD:

> Government revenue due (by a final consumer, individual or household) that is foregone or not collected (without monetary transfer); Tax and duty exemptions, reductions, other fiscal incentives reducing the burden of taxes otherwise due. (Lann and Corkal, 2020: 9)

The measurement problem has to do with who determines what payment is "due"? In the dispute between the Office of the Auditor General of Canada and the Department of Finance that I discussed earlier, the Department of Finance stated that the tax expenditures that the Auditor General wanted to measure constituted the Department of Finance's "benchmark." This declaration means that, according to the Department of Finance, the hypothesized taxes are not in fact "due." Citizens may have a different view, depending on their interests. Clearly, other government departments may have a different view. But it is arguably the Department of Finance which has the responsibility to determine what taxes are "due." In many cases, the approach taken to calculating subsidies which take the form of tax expenditures depends on what the analyst assumes is correct about that tax policy. And clearly opinions differ on this matter. Lann and Corkal (2020) acknowledge this problem:

> **Identifying the correct benchmark is crucial, as all tax subsidies need to be measured against it.** In Figure 1, the benchmark is the standard tax rate of 30%. All the benchmark tax rates together (e.g., income, corporate, GST rates) make up the benchmark system. Some researchers, particularly those funded by the oil and gas industry, argue that certain tax measures that benefit fossil fuels should be *part of* the benchmark system. They misleadingly claim that deductions on taxes and royalties merely "neutralize" the bias of the tax system against capital-intensive industries like oil and gas, which has high upfront exploration and infrastructure costs (see Section 3.3 for a refutation of this argument.) (Lann and Corkal, 2020: 12) [8]

8 There is a *discussion* of the argument in the indicated section. You can decide for yourself if this discussion constitutes a refutation. This reader was unconvinced.

Again however, they use innuendo to ascribe ulterior motives and bias to researchers who disagree with their preferred approach. In any jurisdiction there is, at one point in time, a current tax code which is used to calculate what tax payments are due from what taxpayers. And there is a potentially infinite number or alternative hypothetical tax codes, each of which would result in a different regime of payments due from taxpayers. Under current taxation practices in Canada, labour income, dividend income, capital gains, and business income are all taxed at different rates. I am not suggesting that the current tax code in Canada is ideal or even that its component elements are consistent with one another. What I am saying is that the difficulties of establishing the legitimacy of proposed alternative hypothetical tax codes are not trivial. A fair and reasonable tax code may allow different rates of depreciation for different types of assets. It may also allow different treatment of the carry-forward of expenses for different types of enterprises when those enterprises experience significantly different profiles of expenses and revenues over time.

Lann and Corkal (2020) present a simplified example to illustrate the calculation of a tax expenditure subsidy. This example is also useful as an illustration of the implicit assumptions that are involved in these calculations. They hypothesize a business with a taxable income of $1 million. The assumed current business income tax rate is 30 percent. The tax liability is $300,000. Then they suppose a change in the tax rate for this type of business, a reduction in the rate from 30 to 20 percent. Under the new rate, the tax liability is $200,000. The difference of $100,000 is the tax expenditure subsidy. The implicit assumption in this example, however, is that the tax rate of 30 percent is the fair, equitable, and efficient rate. But what if it is not? What if the rate of 20 percent is the fair, equitable, and efficient rate for businesses in this industry? Then, the difference of $100,000 is not a tax expenditure subsidy but rather a reduction in excess taxation. Both the 30 percent rate and the 20 percent rate are aspects of tax policy set by a legislature. There is nothing sacred about either rate. It is a prerogative of the legislature to set tax rates. It may seek to advance various policy aims in doing so. To treat existing tax rates as a normative benchmark implies that the legislature in the past was able to set the ideal rate of assessment for all time. But policy aims change. Market conditions change. And the government's fiscal situation can change. These factors can prompt a legislature to revisit its taxation regime. The calculation of tax expenditure subsidies assumes that any change in tax policy which results in a net reduction in the tax burden on an activity is a subsidy of that activity. But it could be that this change in tax policy is actually a reduction in overtaxation. So using the existing tax rates and structure as the benchmark is arbitrary.

There are no easy options here. One approach would be to determine the optimal rate of taxation for each category of economic activity and use that optimal rate as the benchmark in calculating tax expenditure subsidies. The problem with that approach is that the determination of these optimal tax rates would rely on abstract economic models and assumptions that are inherently controversial. The other option would be to assume that the tax rates set by the legislature are the normative benchmark of what taxes are "due." With this option, changes in taxation policy made by legislatures could, by definition, never constitute tax expenditure subsidies.

Other Modes of Energy Production

A great deal of effort has been directed at measuring subsidies to fossil fuel-based energy production in Canada. But other forms of energy production receive subsidies. Mark Milke (2017) examined energy subsidies provided by Natural Resources Canada as well as by the provincial governments in Ontario and Alberta. He adopts a corporate welfare perspective. His analysis focuses on direct expenditures rather than the more indirect measures of government support for business. He documented the then-current expenditure commitments by the three governments but also identified government commitments that could give rise to selected future expenditures. He does not distinguish between grants and loans, which, in principle, could be repaid in the future. Loans could be offered at concessional interest rates, but it does not appear that Milke analyzed this aspect.

Milke reports that Natural Resources Canada disbursed CA$3.3 billion in energy-related subsidies between 2000 and 2016. Almost 80 percent of this amount consisted of grants and loans to companies with green or renewable energy projects. About 14 percent went to what Milke labels more traditional corporate welfare, subsidizing the development or application of new technology. Projects involving carbon capture, storage, and transportation received CA$196 million in support and CA$9.5 million went to biomass energy projects.

Citing analysis by the province's Auditor General, Milke reports that Ontario provided CA$1.5 billion in grants and loans to green or renewable energy projects between 2004 and 2015. The Global Adjustment system, which pays electricity producers an additional amount beyond what they receive as a market price for their output amounted to CA$37 billion between 2006 and 2014. Milke concludes that 4 percent of Ontario's corporate welfare expenditures have been allocated to traditional energy subsidies and 96 percent to green and renewable energy subsidies for the time period he studied.

In Alberta, Milke estimates a total disbursement of CA$6.7 billion between 2011 and 2017, of which he estimates 67 percent went to green or renewable energy projects. Of the remaining amount, CA$820 million went to what he described as tradition subsidies, once again for technology development and application, and CA$1.2 billion went to carbon capture, storage, and transportation projects.

With these few exceptions, the available estimates of subsidies to fossil fuel production in Canada are presented without references to subsidy rates to other modes of energy production. So, even if we accept the claim that fossil fuels are subsidized, we can't compare the magnitude of that subsidization to other sources of energy. In contrast, the United States Energy Information Administration has published estimates of subsidies for all modes of energy production in the United States since 2008. This comprehensive, consistent, and ongoing measurement of energy subsidies offers an alternative to the current situation in Canada.

The United States Energy Information Administration

The United States Energy Information Administration (US EIA) was created in 1978 as an independent data collection and analysis unit within the United States Department of Energy. The US EIA published estimates of energy subsidies in the United States in 2008 (based on 2007 data), 2011 (based on 2010 data), 2015 (based on 2013 data) and 2018 (based on 2016 data).

The US Energy Information Administration 2018 (2016) Report

The data and analysis of the US EIA is limited to US federal government interventions and subsidies. State and municipal or local levels of government are excluded. The US EIA excludes benefits from federal government programs and policies that are not specific to the energy sector. In that respect, they differ from what has been done in many studies in Canada, which have included estimates of the benefits to particularly fossil fuel energy producers under general government policies and programs that are not exclusive to the energy sector. The estimates use an inventory approach, calculating subsidies for a set of categories and subcategories without any economic analysis of potential interdependencies or offsets that might exist among the categories of subsidies. The US EIA considers four types of interventions and subsidies (2018: 1), namely tax expenditures, direct expenditures, research and development support, and Department of Energy loan guarantees.

Tax Expenditures

The US EIA includes tax expenditure estimates in its calculation of energy subsidies in the United States. They define tax expenditures as US Federal tax “credits, deductions, deferrals, preferential rates and exemptions (exclusions)” (US EIA, 2018: 19). Tax expenditures are calculated as the difference between actual revenues collected under existing tax policies and the hypothetically higher revenues that would have been collected under a different tax regime. So their estimates under this heading are subject to the criticisms that I made earlier about this practice internationally and in Canada about the hypothetical and sometimes subjective standard that is applied in the determination of what “taxes are due.” One feature of the US EIA reporting, however, is that they present separate totals for each of their four categories of interventions and subsidies for each of the modes of energy production that they include in their analysis. This allows readers to make their own judgments regarding the overall magnitude of subsidization. And their approach is applied consistently across all modes of energy production, which facilitates comparisons.

Direct Expenditures

Direct expenditures include grants, subsidized loans, and other forms of payments. Direct expenditures are often used as an alternative to tax credits, a sub-category of tax expenditures, when the recipient is not expected to have a tax liability against which the tax credit could be applied. The US EIA relies on the Catalogue of Federal Direct Assistance for its primary data source for its estimates of this category of subsidies.

Research and Development Support

The US Departments of Agriculture, Defence, Energy, the Interior, and Transportation, the US Environmental Protection Agency, and the National Science Foundation all support research and development related to energy.

US Department of Energy Loan Guarantees

The US Department of Energy provides loan guarantees for organizations developing "clean energy technologies that are typically unable to obtain financing because of their high technology risks" (US EIA, 2018: 2). Loan guarantees were issued in 2010, but not in 2013 or 2016.

General Findings of the 2018 US EIA Report

Table 2 reports US EIA estimates of domestic energy production in the United States by fuel source or mode of production for FY2010, FY2013, and FY2016. Production levels for each fuel source or mode of production have been converted to trillions of btu. Natural gas, crude oil, and coal constitute the bulk of US energy production in each of the three years. Coal production fell by about one third and natural gas increased by about one third over the time period however, so the composition of energy supply changed substantially over this relatively short time period. Wind and solar energy production grew at a rapid rate over this time period but even by 2016 made up a small share of overall energy production in the United States. The contribution of natural gas to total energy production in the United States in 2016 was over 16 times the contribution of wind energy in that same year. This is important to keep in mind when we turn our attention to the US EIA's estimates of subsidy per unit of output.

Table 2: US Energy Information Administration Estimates of United States Energy Production by Category, 2010–2016 (trillion btu)

	FY2010	FY2013	FY 2016
Natural Gas	24,105	28,220	32,652
Crude Oil	11,512	15,370	18,797
Coal	21,657	20,223	14,807
Nuclear	8,318	8,099	8,352
Biomass	4,358	4,680	4,963
Hydroelectric	2,588	2,582	2,482
Wind	863	1,557	2,038
Solar	88	205	533
Geothermal	207	215	209

Source: Author's calculations based on Tables 1, 3, and 4 of US EIA (2018).

Table 3 reports such calculations for 2016. The US EIA calculated support levels and production levels for nine fuel sources or modes of production for electricity production in that year, namely coal, natural gas, and petroleum liquids, nuclear, biomass, geothermal, hydroelectric, solar, wind, and a residual category (other). The US EIA also estimated the level of support or subsidization provided by the federal government in that year for each of the nine categories. Not all US federal energy subsidies are directly attributed to these nine categories. Additional subsidies are paid to promote conservation and end-use efficiencies. Table 3 reports the subsidy estimates for each of the nine categories listed above divided by the electricity output generated by each fuel source or mode of production. The units of measurement in the table are 2016 $US per 10,000 kWh of electricity produced.[9] The negative value for natural gas and petroleum liquids arose from the tax expenditure component of the subsidy calculations turning negative in that year, indicating that rather than subsidizing this category, tax expenditures became tax revenues. Previous years' estimates of subsidization for natural gas and petroleum liquids were positive. Table 3 indicates that there is substantial variation in subsidization across the nine categories. Setting aside the estimate for natural gas and petroleum liquids, the estimated subsidy level ranged from $1.42 per 10,000 kWh for hydroelectric to $437.45 per 10,000 kWh for solar.

9 The US EIA estimates that the average household in the United States used about 11,000 kwh in 2015, so the calculations in table 2 approximate the subsidy per household per year.

Table 3: US Energy Information Administration Estimates of Subsidies per 10,000 kwh of Electricity Production, 2016

	Subsidy per 10,000 kwh
Coal	$10.45
Natural Gas and Petroleum Liquids	-$5.40
Nuclear	$4.57
Other	$80.48
Biomass	$12.54
Geothermal	$53.75
Hydroelectric	$1.42
Solar	$437.45
Wind	$57.55

Source: Author's calculations based on Tables 2, 3, and 4 of US EIA (2018).

Table 4 reports US EIA estimates of total subsidies per fiscal year for nine categories of electricity production. The variation in support over time is remarkable. For natural gas and petroleum liquids the level of total support varied from almost $3 billion (2016 $US) in FY2010 to -$773 million (2016 $US) in 2016. Wind and solar received the largest and fourth largest subsidies in FY2010, and the largest and second largest in FY2013 and FY2016. This table covers a short time period relative to the development time for most electricity infrastructure. The variation in the level of support over such a short time period is an illustration of what economists call policy risk.

Table 4: US Energy Information Administration Estimates of Total Subsidies for Electricity Production, 2010, 2013, and 2016 (2016 US$ millions)

	FY2010	FY2013	FY2016
Coal and Refined Coal	1,062	1,104	1,262
Natural Gas and Petroleum Liquids	2,976	2,796	-773
Nuclear	1.537	1,390	365
Other	410	280	169
Biomass	1,037	572	79
Geothermal	83	358	86
Hydroelectric	95	233	38
Solar	1,116	5,756	2,231
Wind	5,705	6,187	1,266

Source: US EIA, 2018: Tables 3, 4.

Total US federal subsidies (US EIA, 2018: Table 1) were about US$38 billion in FY2010, US$29.3 billion in FY2013, and fell to about US$15 billion in FY2016 (2016 $US). This trend, in part, reflects the winding down of programs and policies authorized under the American Recovery and Reinvestment Act of 2009. Over this time period, total energy production in the United States increased from about 74 trillion btu in 2010 to almost 85 trillion btu in 2016.

The largest share of US federal energy subsidies in 2010, 2013, and 2016 went to renewables which received 42 percent of the total in 2010, 52 percent in 2013, and 45 percent in 2016. Renewables include wind, solar, biomass, geothermal, and hydroelectric. The largest share of support for renewables was tax expenditures in 2010, direct expenditures in 2013, and tax expenditures, almost exclusively, in 2016. In comparison, natural gas and petroleum liquids received 8 percent of total federal support in 2010, 10 percent in 2013, and -5 percent in 2016. The negative value for natural gas and petroleum liquids in 2016 was driven by a negative value of US$940 million (2016 dollars) for tax expenditures for this category of energy production. This result is attributed to “changes to tax expenditure estimates for oil and natural gas related activities for FY2016” (US EIA, 2018: 19).

The composition of support for renewable energy production varied substantially between 2010 and 2016. In 2010 (US EIA, 2018: Table 4), about $8.4 billion went to renewable electricity production and $7.3 billion went to biofuels. This changed to about $13.4 billion to renewable electricity production and $1.9 billion to biofuels in 2013. In 2016, support for renewable electricity had fallen to $3.9 billion and support for biofuels increased from the 2013 level to $2.8 billion.

There is no Canadian counterpart to the US EIA but the US experience is noteworthy for thinking about future efforts to measure energy subsidies in Canada. First, the US EIA uses an inventory approach, so it is subject to the criticism that that approach ignores interactions among categories of subsidies that are important in the Canadian context, where provincial governments in particular set royalty rates for natural resource harvest and extraction. Second, the US EIA is an independent and impartial data collection and analysis institution. It has no policy agenda. So it is less subject to criticisms of bias that have arisen in the Canadian literature. Third, the US EIA has used a consistent framework and approach over a considerable period of time and its data collection and analysis include fossil fuel as well as renewable energy production, which facilitates comparisons over time and across modes of energy production. This makes it much easier to put total as well as per-unit of output measures of support in perspective. Canada is not in a position to undertake such systematic comparisons. The sustained existence of the US EIA has also given the organization time to develop documentation of its data sources and methods of calculations. Finally, the procedures that the US EIA uses to measure tax expenditure energy subsidies are subject to the same criticisms that I made of international and Canadian efforts in this area.

Discussion and Implications for the Measurement of Canadian Energy Subsidies

The state of the art in measuring energy subsidies in Canada is in disarray. Published estimates vary in size and even in the sign of subsidization. Some of the tensions include whether an inventory approach to estimation is up to the task, or if an economic modeling approach is required. Should the effort be focused on the efficiency, specifically the output, effects, or should all subsidy categories be included in the calculations? Do energy subsidy calculations need to be limited to programs, policies, and measures that are specific to the energy industry, or should general programs, policies, and measures that are available to other industries but to which energy production organizations may apply be included in the total measurement of subsidy? Should subsidy estimates for all modes of energy production be compiled on a consistent basis or should these estimates only be developed for fossil fuels? Should definitions and categories of subsidies developed for other purposes be employed uncritically in the context of measuring energy subsidies, or is a contextually customized approach needed? Are all the sub-categories of subsidy to be treated equally, or are some sub-categories more important or less controversial than others? Should subsidies be calculated on a net or a gross basis? This is particularly important in the Canadian context where governments, especially provincial governments, receive substantial natural resource royalty payments. Clearly, there is a need for better documentation of sources of data and methods of calculation of subsidy estimates.

Should subsidies be estimated on a gross or a net basis (i.e., net of the revenues governments receive in royalties and in tax revenues)? One of the arguments that is made in the literature discussed in this report is that subsidies in the form of tax expenditures represent revenue foregone by various levels of government that could have been spent on other worthwhile programs. But governments also receive substantial royalty payments from oil and gas extraction. If oil and gas production is phased out, then those royalty payments will disappear. And this is also a loss in revenue that could have been spent on other worthwhile programs.

Canada does not have an independent agency like the US Energy Information Administration. What we have is ad hoc collections of individuals and organizations involved in measuring and reporting energy subsidies. It is difficult to interpret and compare these measurements and claims because supporting documentation of data sources and methods is not transparent. Furthermore, the allegations that some authors are compromised by conflicts of interest compound the challenges of interpretation. The FY2021 budget for the US EIA is about US$127 million. But this budget covers other functions and responsibilities of the organization beyond its work in periodically compiling energy subsidy estimates. Maybe Canada needs a counterpart to the US EIA. If measuring energy subsidies is important, and if my claim that the current state of the art in Canada is dysfunctional is accepted, then maybe an independent impartial agency would be a better alternative to the current situation. The US model of creating an agency by statute and funding its operations by appropriations is not the only way to achieve this. Energy companies and environmental organizations could contribute the amounts that they are currently spending on activity in this area to an independent and impartial foundation. That foundation, if it were effectively governed by a board committed to the highest standards of independence and impartiality, could oversee the data collection, analysis, and communication efforts. I suspect this this would not give us worse outcomes than what we have now.

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