Tracking progress to the future

AN INDICATOR SET FOR POLICIES TO SUPPORT FUTURE FIT HYDROCARBONS

Policy Brief | APRIL 2022

Smart Prosperity Institute

energyfutureslab

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This policy brief was developed as part of Smart Prosperity's contribution to the Energy Futures Policy Collaborative hosted by the Energy Futures Lab. The Energy Futures Policy Collaborative is a new and exciting initiative developed by the Max Bell Foundation and the Energy Futures Lab to explore how Alberta and Canada can harness its existing hydrocarbon resources, assets, and expertise to build the clean economy of the future. Smart Prosperity is a member of the Working Group, and is serving as a strategic advisor on the project.

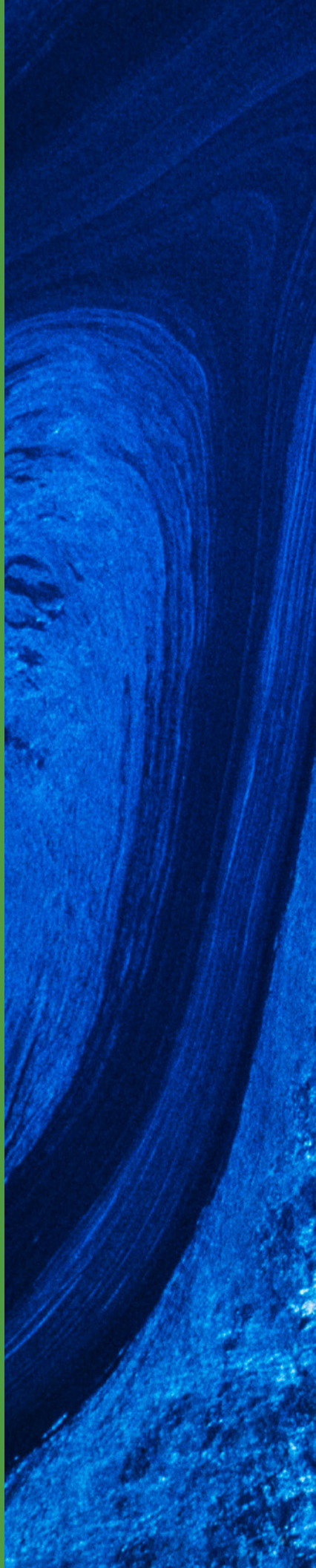
About Energy Futures Lab

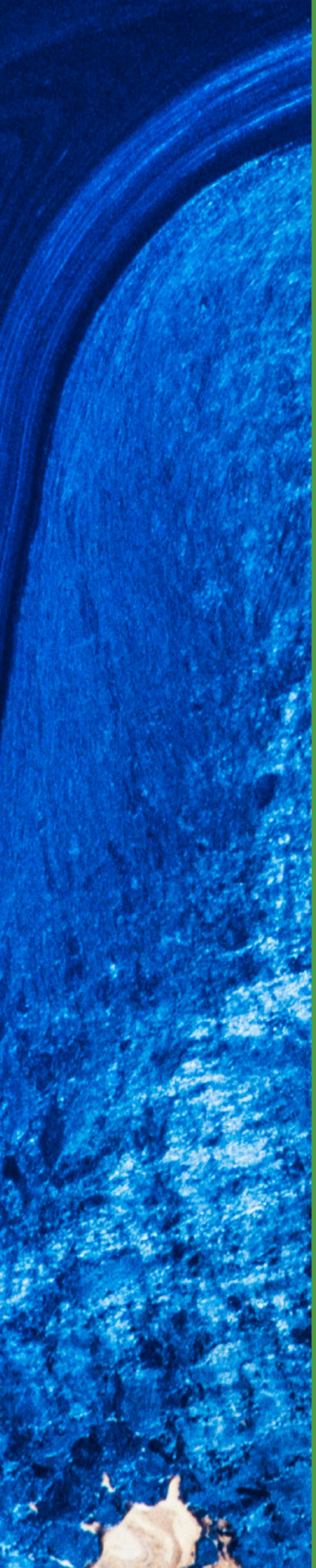
The Energy Futures Lab is is an award-winning, multi-stakeholder initiative to accelerate the transition to the energy system that the future requires of us. Initiated in the Fall of 2013, the Energy Futures Lab is powered by The Natural Step Canada, in collaboration with a number of Convening Partners and Funding Partners. The EFL also involves dozens more organizations in an unprecedented series of innovative partnerships and collaborations.

The Energy Futures Policy Collaborative is a new and exciting initiative developed by the Max Bell Foundation and the Energy Futures Lab to explore how Alberta and Canada can harness its existing hydrocarbon resources, assets, and expertise to build the clean economy of the future. Smart Prosperity is a member of the Working Group, and is serving as a strategic advisor on the project.

About Smart Prosperity Institute

Smart Prosperity Institute is a national research network and policy think tank based at the University of Ottawa. We deliver world-class research and work with public and private partners – all to advance practical policies and market solutions for a stronger, cleaner economy.





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Tracking Progress to the Future

Introduction

Alberta faces the challenge of developing and scaling areas of economic activity that are more competitive in a decarbonizing world. The Energy Futures Policy Collaborative (EFPC), of which Smart Prosperity Institute is a member, has pointed out that Alberta does not need to start from scratch to meet this challenge. Albertan firms are already exploring opportunities to repurpose assets from the existing hydrocarbon industry to create a cleaner economy. The EFPC has identified these opportunities – which it refers to collectively as "future-fit hydrocarbons" (FFH) – as a means that could advance their ultimate objective of building an economy that supports the well-being of Albertans in a decarbonizing world. As the EFPC has argued, a suite of federal and provincial policies is needed to support investment in FFH industries.[1]

Clear, measurable indicators of success make it easier for policymakers to develop, choose, and implement policies that are aligned with shared objectives. As part of its work with the EFPC, SPI has developed a set of indicators to help policymakers track the success of policies to support investment in FFH industries in Alberta. These indicators align with the criteria for FFH industries identified by EFPC's expert working groups[2]:

- Alignment with a net-zero greenhouse gas emissions trajectory
- Economic viability (including good paying jobs, a healthy balance of payments, resilience to carbon pricing and stranded asset risk, etc.)
- Building on current strengths through leveraging or repurposing existing assets, which could include infrastructure, workforce skills, intellectual property, or natural resources
- Alignment of business with environmental, social and governance (ESG) principles
- Promoting economic reconciliation with Indigenous communities

The indicators in this brief are intended to measure success at the level of either markets for FFH or the entire economy, rather than at the level of individual projects. Some of the indicators measure progress towards ultimate objectives, while others measure the presence of what are understood to be catalysts for this progress, such as the development of low-carbon economic activities. These indicators are intended to be used as a set to identify and implement policies that improve Alberta's competitiveness in a decarbonizing world while ensuring the wellbeing of all Albertans.

Choosing indicators

This policy brief organizes indicators into three categories, which were developed by the Canadian Institute for Climate Choices[3]:

- **Goals:** indicators of progress towards shared objectives
- **Catalysts:** indicators of low-carbon economic activity
- **Foundations:** indicators that low-carbon economic activity is improving the wellbeing of people and communities

To evaluate the success of policies supporting investment in FFH industries, SPI adapts these categories as follows:

- **Goals:** Is Alberta growing its economy while aligning with a net-zero emissions future?
  - Are emissions falling?
  - Is the economy growing, even as emissions fall?
- **Catalysts:** Are FFH industries developing in Alberta?
  - Are new ideas being developed?
  - Are there markets for innovations?
  - Are there firms to commercialize innovations?
- **Foundations:** Are FFH industries supporting the well-being of Albertans?
  - Are they creating jobs?
  - Do these jobs pay well?
  - Is anyone excluded?

Within these categories, SPI identifies a set of indicators which can be measured using publicly available data, which are summarized in Table 1.

Table 1: Indicators of success for policies supporting investment in future-fit hydrocarbon industries. All indicators are measured for Alberta unless indicated otherwise.

Question	Indicator	Unit	Why this indicator?
Goals: Is Alberta growing its economy while aligning with a net-zero emissions future?			
Are emissions falling?	Year-on-year reduction in absolute greenhouse gas emissions	Megatonnes CO_2 equivalent	Absolute emissions determine climate change and are an important component of climate risk for investors.
Is the economy growing, even as emissions fall?	Annual difference between emissions growth and GDP growth	Difference in percent growth	This captures Alberta's ability to develop low-carbon sources of economic activity.
Catalysts: Are future-fit hydrocarbon industries developing in Alberta?			
Are new ideas being developed?	Reported development of environmental innovations by firms in Alberta, Saskatchewan, Manitoba, British Columbia, and the territories	Percent of firms reporting environmental innovation	Innovation starts with research, development, and demonstration (RD&D). Private RD&D, along with public RD&D, determines the pool of innovations available for use and commercialization.
Are there markets for innovations?	Reported use of environmental and clean technology by firms in Alberta, Saskatchewan, Manitoba, British Columbia, and the territories	Percent of firms reporting use	Domestic markets can provide early sources of demand for innovations.
	Annual value of environmental and clean technology exports	Dollars	Export markets are important sources of demand given Canada's small population and risk-averse business environment. They are also a source of foreign exchange for the province.
	Annual public and private investment in enabling infrastructure	Dollars	Some FFH opportunities require infrastructure before they can be widely adopted. For example, hydrogen requires transportation infrastructure and battery electric or hydrogen fuel cell vehicles require refueling infrastructure.
Are there firms to commercialize innovations?	Number of firms on Cleantech Group's "Cleantech 100" list	Count	International recognition of Albertan FFH firms for market leadership is likely to shift global perceptions of the provincial economy.
Foundations: Are future-fit hydrocarbon industries supporting the well-being of Albertans?			
Are they creating jobs?	Annual difference between emissions growth and jobs growth	Difference in percent growth	Alberta is in need of alternative sources of employment beyond direct oil and gas production. In addition, job creation improves public perception of climate change policy. • An economy-wide measure captures indirect effects and avoids the difficulty of defining clean technology or FFH sectors • An ECT sector-specific measure indicates what might happen in the future if ECT sectors were to grow, and makes it easier to assess the impact of specific policies
	Number of jobs in the environmental and clean technology sector	Count	

Question	Indicator	Unit	Why this indicator?
Foundations: Are future-fit hydrocarbon industries supporting the well-being of Albertans?			
Do these jobs pay well?	Annual difference between emissions growth and mean employment income growth	Difference in percent growth	Employment income is an important determinant of human well-being, and also affects the popularity and durability of climate change policy. • An economy-wide measure captures indirect effects and avoids the difficulty of defining clean technology or FFH sectors • An ECT sector -specific measure indicates what might happen in the future if ECT sectors were to grow, and makes it easier to assess the impact of specific policies
	Mean hourly wage in the environmental and clean technology sector	Dollars	
Is anyone excluded?	Difference between representation in the energy and mining and minerals sector workforce, and representation in the population, for women, immigrants, Indigenous people, workers with a college or university degree, workers under 45, and visible minorities.	Difference in percent	There is evidence that these groups face barriers to employment and lower wages end environmental and clean technology sectors, undermining equity and poverty alleviation goals.
	Mean hourly wage disparities in the energy and mining and minerals sectors, by gender, age, immigration status, visible minority status, and Indigeneity	Dollars	
	Proportion of federal government spending on green energy or innovation infrastructure located in rural areas	Percent	Rural areas tend to have lower employment and income and depend on the hydrocarbon industry for Revenue. FFH policies could either exacerbate or help to improve this disparity.

Some of these indicators measure progress towards the EFPC's objectives directly across the entire Albertan economy. For example, measuring the difference between economy-wide emissions growth and GDP growth indicates progress towards alignment with net zero targets and economic viability.

Other indicators measure economic activity in FFH industries to indicate progress towards EFPC's objectives. For example, employment patterns in FFH industries are used as a proxy for progress towards net-zero emissions, economic viability, economic reconciliation, and the alignment of business with ESG principles. Attainment of these objectives will ultimately require the involvement of the entire economy, but these sector-specific indicators tell us the status of critical low-carbon technologies, processes, and business models, and indicate how the well-being of Albertans might be impacted if these sectors were to grow.

These sector-specific indicators require a technical definition of FFH industries. The EFPC defines FFHs as economic activities that build on Alberta's existing assets and are competitive in a decarbonizing world.[4] There is no consistent data source for the first criterion, and this criterion is a means to improve Alberta's chance of competitive success in new markets rather than an end in itself. This brief therefore focuses on identifying sectors that meet the second criterion.

To identify low-carbon economic activities, SPI uses data from Statistics Canada's Environmental and Clean Technology Products Economic Account where possible. This data source identifies an "environmental and clean technology" (ECT) sector comprising economic as activities that have a low environmental impact or that help lower the environmental impact of other activities. This definition of the ECT sector uses the Clean Technology Taxonomy developed by Natural Resources Canada

and other government agencies.[5] However, this data is only available for some indicators, has only been collected since 2012, and can't be used to identify patterns over time as the clean technology taxonomy has changed several times. For example, many biofuels were not included in 2012 or 2015, but were in 2017 and 2018.

Where it is not possible to observe the ECT sector, SPI uses other categorizations of economic activities that are available in public data and that are somewhat aligned with FFH industries. The indicator for rural inclusion in federal infrastructure spending focuses on projects classified by Infrastructure Canada as either "green energy" infrastructure – a category which includes funding from the Building Canada Fund, Small Communities Fund, Green Infrastructure Fund, Infrastructure Stimulus Fund, Municipal Rural Infrastructure Fund, COVID-19 Resilience Stream, Arctic Energy Fund, and Rural & Northern Infrastructure Stream – or "innovation" infrastructure, which includes funding from the COVID-19 Resilience Stream and Small Communities Fund. As a last resort, SPI uses data for those North American Industry Classification System (NAICS) that contain the ECT sector, according to the clean technology taxonomy:

- Support activities for agriculture and forestry industries
- Oil and gas extraction industries
- Utilities industries
- Construction industries
- Manufacturing industries
- Wholesale trade industries
- Software publishers industry
- Data processing, hosting, and related services industry
- Professional, scientific, and technical services industry
- Management, scientific and technical consulting services industry
- Administrative and support, waste management and remediation services industries
- Repair and maintenance industry

The remainder of this brief describes each indicator, how to measure it, and why it is useful for policymakers considering policies to support investment in FFH industries. This brief also provides a preliminary analysis for each indicator that could be used as a baseline.

Indicators

Goals: Is Alberta growing its economy while aligning with a net-zero emissions future?

Two indicators can do much of the heavy lifting in assessing FFH policies' progress towards alignment with net zero and economic viability. The first is to measure whether GHG emissions are falling in the province, and the second is to measure whether the economy as a whole is growing as emissions fall.

Are emissions falling?

Why is this important to track?

In light of the climate crisis, it is important that greenhouse gas emissions be reduced as quickly as is feasible. This imperative is formalized in Canada's international commitments, including its Nationally Determined Contribution under the Paris Agreement.[6] In addition, emissions are a major determinant of exposure to climate change risk, for which investors are increasingly demanding consideration and compensation.[7]

Which indicators should be used?

SPI measures year-on-year changes in absolute greenhouse gas emissions reductions, in megatonnes of carbon dioxide equivalent (CO_2e), across the entire provincial economy. Since absolute emissions determine the severity of climate change and have a large influence on investor-perceived climate risk, absolute emissions reductions (rather than reductions in emissions intensity) are the appropriate indicator of success in aligning with net zero. Data on Alberta's greenhouse gas emissions is available in Canada's National Inventory Report.[8]

The picture in Alberta

Alberta emitted 275.85 Mt CO_2eq of greenhouse gases in 2019 – its third-highest-emitting year yet, after 2014 and 2015. **Alberta emits substantially more than other Canadian provinces, and its emissions are growing faster** (Figure 1).

Table 2: Indicator for assessing whether greenhouse gas emissions are declining

Indicator	Unit	Data source
Year-on-year change in absolute greenhouse gas emissions reductions	Megatonnes CO2 equivalent (Mt CO_2e)	ECCC (2019)

Figure 1: Absolute greenhouse gas emissions by Canadian province/territory.
Data source: ECCC (2019).

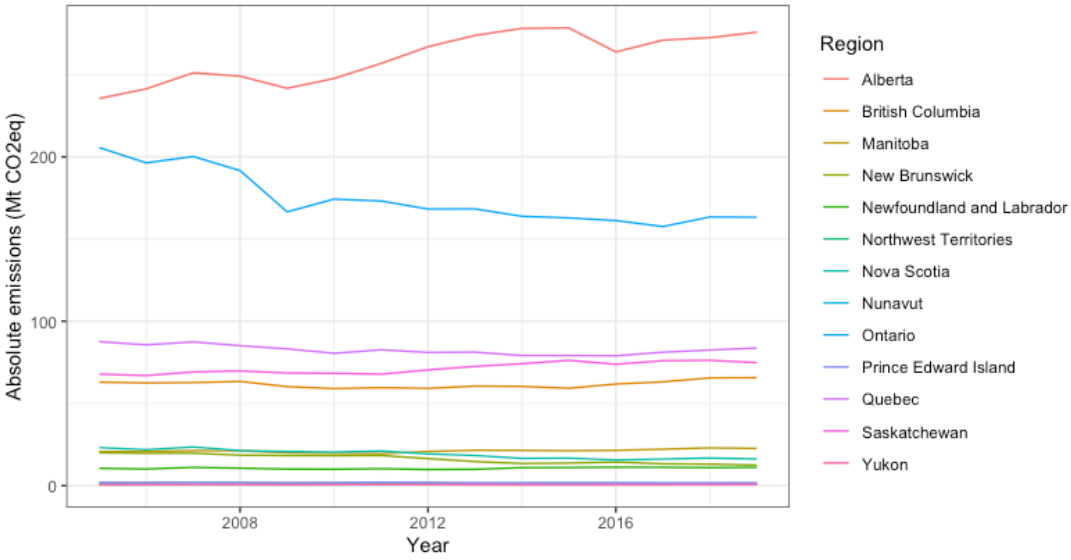
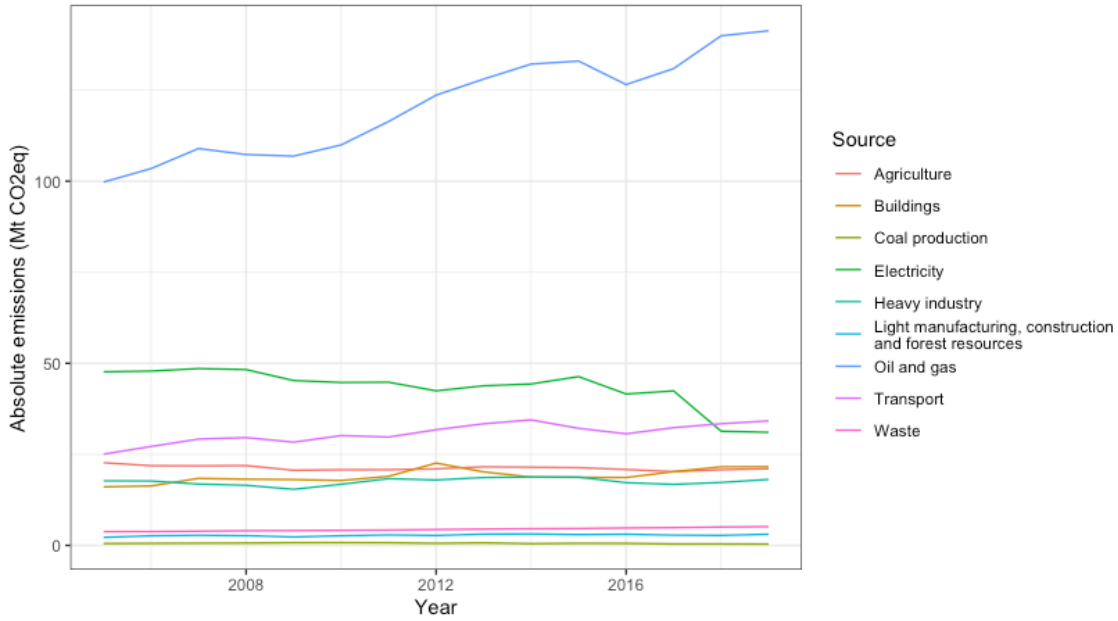


Figure 2: Sources of greenhouse gas emissions in Alberta. Data source: ECCC (2019).



This is mostly explained by Alberta's oil and gas extraction sector. It emits more than twice as much each year as the second most emitting sector, electricity, and it is the only sector whose emissions are growing substantially each year (Figure 2). Electricity is also a large source of emissions, although these have dropped in recent years as Alberta has moved away from coal powered electricity generation.

Which future-fit hydrocarbon criteria does this indicator align with?

- **Alignment with a net-zero greenhouse gas emissions trajectory**: Reducing absolute greenhouse gas emissions, together with emissions removal, determines progress towards net zero.
- **Economic viability**: Absolute greenhouse gas emissions are an important determinant of climate change risk, which increasingly influences investment decisions. Progress in reducing absolute emissions will increase jurisdictional attractiveness for investors by reducing the risk of stranded assets and reputational damage.

Is the economy growing, even as emissions fall?

Why is this important to track?

Absolute emissions reduction and the wellbeing of Albertans are both important objectives and it is not desirable to achieve one at the expense of the other. A drastic drop in GDP is likely to harm Albertans' wellbeing, particularly as the world adjusts to the climate change crisis. For this reason, SPI measures the difference in growth of economy-wide emissions and GDP to indicate Alberta's success in balancing net-zero alignment and economic viability.

Which indicators should be used?

SPI's indicator is the difference in year-on-year growth between provincial gross domestic product (GDP) and emissions. Data on Alberta's greenhouse gas emissions is available in Canada's National Inventory Report,[9] and data on its GDP is available from Statistics Canada.[10]

Table 3: Indicator for assessing whether economy is growing while emissions fall

Indicator	Unit	Data source
Annual difference between emissions growth and GDP growth	Difference in percent growth	ECCC (2019) Statistics Canada (2021a)

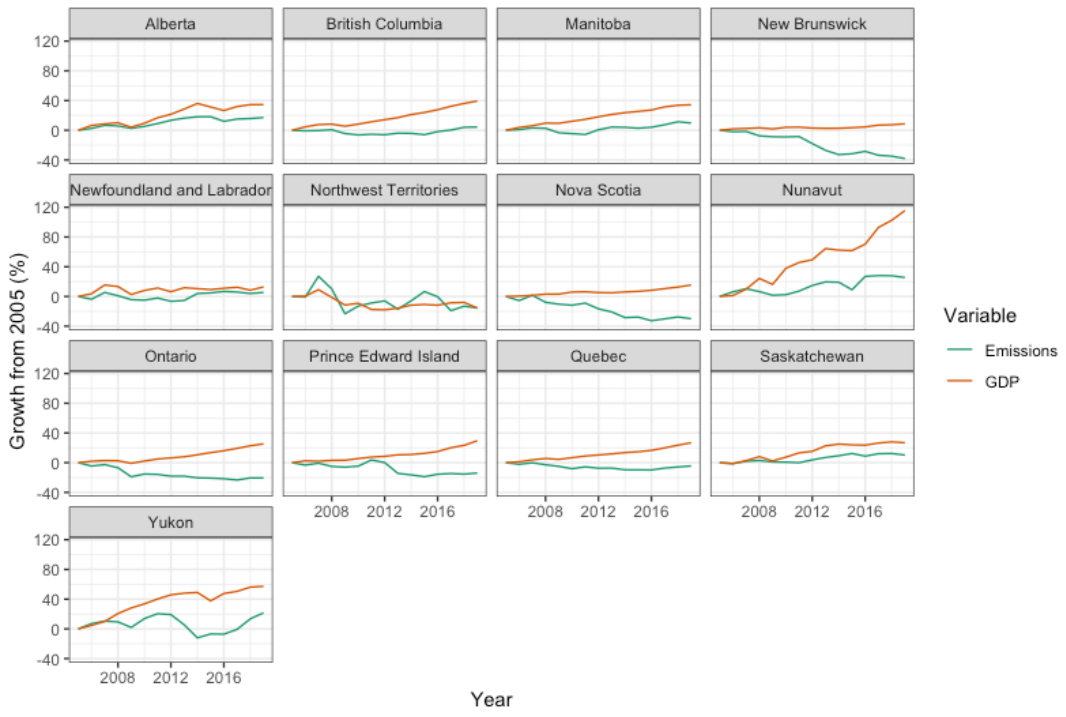


Figure 3: Emissions and GDP growth in Canadian provinces and territories. Data source: ECCC (2019) and Statistics Canada (2021a).

The picture in Alberta

Encouragingly, GDP is growing more quickly than emissions in Alberta (Figure 3). However, **this decoupling process is occurring more slowly in Alberta than in other Canadian provinces**, with the exception of Saskatchewan, whose economy also relies on oil and gas. The comparison with other jurisdictions is important both because other jurisdictions exemplify what is possible and because they compete with Alberta for investment.

Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability**: GDP growth is a component of economic viability.

Catalysts : Are future-fit hydrocarbon industries developing in Alberta?

While economy-wide indicators are important, sector-specific indicators provide hints as to future economy-wide developments. As previously discussed, it is possible to identify areas of economic activity that are likely to be competitive in a decarbonizing world by looking at Statistics Canada's economic data on environmental and clean technology (ECT) sectors.[11]

When examining the ECT sector, it is helpful to go beyond macro-level indicators. For example, the contribution of ECT sectors to Alberta's GDP, a macro-level indicator, indicates the scale of these economic activities relative to the provincial economy (Figure 4). Alberta fares poorly by this metric. However, this metric is limited in that it can be inflated by a weak economy (the less non-ECT economic activity there is, the higher the score) and in that it only provides a snapshot at a point in time, with no indication of the potential future development of the ECT sector.

To get a better picture of Alberta's readiness to compete in a decarbonizing world and identify areas for improvement, policymakers can examine each stage of the innovation cycle separately.

Figure 4: Contribution of ECT sector to provincial or territorial GDP.
Data source: Statistics Canada (2021b).

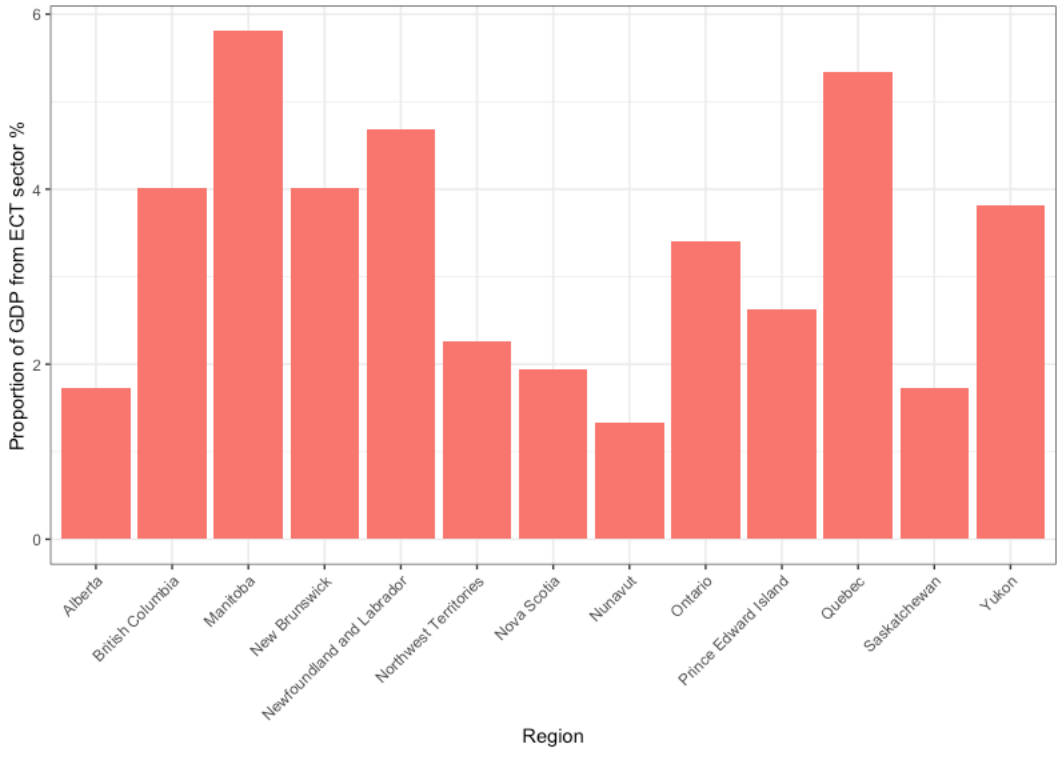


Table 4: Indicator for assessing if new ideas are being developed

Indicator	Unit	Data source
Reported development of environmental innovations by firms in Alberta, Saskatchewan, Manitoba, British Columbia, and the territories	Percent of firms reporting environmental innovation	Statistics Canada (2021c)

Elsewhere, SPI as part of the EFPC, has called for a complimentary suite of FFH policies supporting the creation of new ideas, stimulating early markets, and helping companies grow and commercialize – three different stages of the innovation cycle – as well as ensuring the health of the entire innovation system.[12] Here, separate indicators are developed for each of these stages.

Are new ideas being developed?

Why is this important to track?

Research, development and demonstration (RD&D) activity in Alberta today will determine which technologies, processes, and business models are available to be used and commercialized tomorrow. It will also determine whether Albertan consumers and businesses will need to purchase intellectual property from other jurisdictions or whether they will be able to use and export their own intellectual property and expertise.

Which indicators should be used?

Public and private RD&D have both played a role in developing the technologies, processes, and business models that make FFH industries possible. That said, Canada has tended to have stronger public RD&D than private RD&D.[13] For this reason, SPI's indicator focuses on private RD&D.

One way to evaluate private RD&D is by measuring spending or activity. RD&D expenditures is the standard indicator – it is used, for example, in the Intergovernmental Panel on Climate Change's assessment reports[14] – but there is unfortunately no publicly available data on private RD&D expenditures on ECT technologies, processes, and business models. Instead, SPI's indicator uses Statistics Canada's Survey of Innovation and Business Strategy, which asks a sample of firms whether they have made a product or process innovation with environmental benefits in a set time period. SPI's indicator is the percent of firms reporting environmental innovation. It is worth noting that the Survey of Innovation and Business Strategy does not collect data separately for Alberta but rather groups it together with the other prairie provinces, the Territories, and British Columbia. This is unfortunate, given that Alberta has a very different economic profile with respect to emissions than British Columbia, for example. More granular public data on private environmental innovation would be valuable.

Another way to measure private RD&D is through its outputs, including formal intellectual property such as patents. Patent statistics indicate the inventiveness of firms and there is evidence that patenting activity is associated with economic performance.[15] Unfortunately, there is little publicly-available data on ECT patenting activity by Albertan firms, residents, or organizations. Patent data can be obtained through the proprietary PATSTAT database and "tagged" as ECT or non-ECT, using a scheme such as the United Nations Environment Programme and the European Patent Office's widely-used "Climate Change and Mitigation Technologies" patent tagging scheme.[16]

The picture in Alberta

Firms in the "Rest of Canada" category, which includes Alberta, report environmental Innovations at a similar rate to those in Ontario, while Quebec has a higher rate (see Table 5).

When it comes to the type of environmental innovations made by firms in the "Rest of Canada", most focus on improving resource use efficiency, with very few focusing on renewable fuels (Table 6).

Table 5: Percent of firms reporting an innovation with environmental benefits.
Data source: Statistics Canada (2021c).

Region	2015-2017	2017-2019
Atlantic Region	21.1	23.6
Ontario	23.9	24.1
Quebec	28.1	28.4
Rest of Canada	23.1	22.7

Table 6: Percent of firms in the "Rest of Canada" category that reported engaging in each type of environmental innovation. Data source: Statistics Canada (2021c).

Type	2015-2017	2017-2019
Innovations with environmental benefits from production through efficient use of resources	46.8	45.9
Improved resource efficiency through reduced material use per unit of output	24.1	20.5
Improved resource efficiency through reduced energy use per unit of output	20.8	21.9
Improved resource efficiency by replacing material with less greenhouse-gas-intensive alternatives	12	12.7
Reduced consumption of resources through recycling (water, waste or material)	29.7	30.0
Renewable fuels (ethanol, biodiesel, biogas, biochar, hydrogen)	5.1	5.4

Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability (profitable, exportable, resilient to carbon pricing and stranded asset risk, etc.):** The invention and development of new ideas tends to improve the economic competitiveness of firms. When innovations have an environmental benefit, it also makes economic activities more competitive in a decarbonising world.
- **Building on current assets and strengths through leveraging or repurposing existing assets:** By increasing their RD&D activity, firms can build on Canada and Alberta's world-class performance in fundamental research and public RD&D in ECT domains.17 In addition, a growing volume of business RD&D investment in Canada is conducted by large, foreign-owned firms (Munro and Lamb, 2021), and Canadian-owned firms will need to invest in RD&D to compete.

Are there markets for innovations?

Why is this important to track?

The presence of markets for FFHs determines whether FFH industries are profitable and whether their environmental benefits are felt. Canadian ECT firms have struggled with market access in the past due to Canada's low domestic ECT adoption rates, small population, lack of access to ECT export markets, and lack of infrastructure supporting the use of certain ECT technologies, known as enabling infrastructure.[18] To improve market access for FFH industries, governments can encourage domestic demand, increase exports, and unlock new markets by investing in enabling infrastructure.[19]

FFH exports are also important to track as Alberta is in need of a source of foreign exchange as oil and gas exports to the United States decline. Clean technology export opportunities in Canada grew by $8.3 billion in 2007 to $12.4 billion in 2017, growing by 47% over the ten year period.[20] The National Economic Strategy Tables set a federal target of increasing

Table 7: Indicators to assess whether there are markets for innovations

Indicator	Unit	Data source
Reported use of environmental and clean technology by firms	Percent of firms reporting use	Statistics Canada (2021d)
Annual value of international environmental and clean technology exports	Dollars	Statistics Canada (2021e)
Annual public and private investment in clean infrastructure	Dollars	Statistics Canada (2021f)

clean technology exports to $80 billion by 2025,[21] and over 80% of the revenues raised by Albertan ECT sector firms in 2018 came from the United States,[22] illustrating the importance of export-based growth.

Which indicators should be used?

This section discusses indicators for three aspects of FFH market access: domestic demand, export markets, and enabling infrastructure.

Domestic demand

SPI's indicator focuses on business markets, as most FFH industries do not sell directly to consumers, but rather to other businesses.[23] Statistics Canada's Survey of Innovation and Business Strategy include data on the percent of surveyed firms reporting use of different types of ECTs.[24] Once again, this data source unfortunately groups Alberta with British Columbia, the other prairie provinces, and the Territories in the "Rest of Canada" category.

International exports

SPI's indicator is the annual value of international environmental and clean technology exports from Alberta. This data is available from Statistics Canada's Environmental and Clean Technology Products Economic Account.[25]

Enabling infrastructure

Tracking infrastructure investment can provide clues as to what the economy will look like decades in the future because of the long lifetime of most infrastructure investments. SPI's indicator is annual public and private investment in clean infrastructure, measured using infrastructure investment data from Statistics Canada's Infrastructure Economic Accounts.[26] Investments in low-carbon infrastructure are not tagged as such, but the dataset divides them into categories that can be used to approximate a low-carbon infrastructure category. This brief considers the following categories of infrastructure to be enabling infrastructure for FFH industries*:

- Electric power infrastructure
- Transportation machinery and equipment (which includes road and rail transport but not pipelines)
- Pollution abatement
- Electric power equipment
  - Turbines, turbine generators, and turbine generator sets
  - Nuclear reactor steam supply systems
  - Power and distribution transformers

The picture in Alberta

Domestic demand

Firms in the "Rest of Canada" category report using ECTs at a rate comparable to Quebec but lagging behind Ontario (Table 8).

The most commonly used ECTs are those focussed on reducing pollution of air and water. ECTs in the other two categories, which are more relevant to climate change, are used less frequently although their use is growing more quickly. These categories, provided by the dataset, include the following activities:

- Environmental protection: air and environment protection or remediation; waste management, reduction or recycling; and water or wastewater treatment
- Sustainable resource management: alternative fuels; non-emitting energy supply e.g., solar, wind, hydro, nuclear; bio-products; smart grid; energy storage; energy management and efficiency improvements; water management or recycling; agriculture, aquaculture, forestry or biodiversity improvements; and sustainable mining
- Adapted goods: energy efficient transportation; energy efficient equipment or appliances; and advanced or lightweight materials

Table 8: Percent of firms using clean technologies. Data source: Statistics Canada (2021d).

	2017	2019
Atlantic Region	66.9	77.6
Ontario	78.0	72.3
Quebec	73.6	72.0
Rest of Canada	73.6	80.9

* The Canadian Institute for Climate Choices also considers installments of low-carbon infrastructure to be an indicator for clean growth (Canadian Institute for Climate Choices, 2020).

Figure 5: Percent of firms in the "Rest of Canada" category (comprising Alberta, BC, the other prairie provinces and the Territories) that use ECTs. Data source: Statistics Canada (2021d).

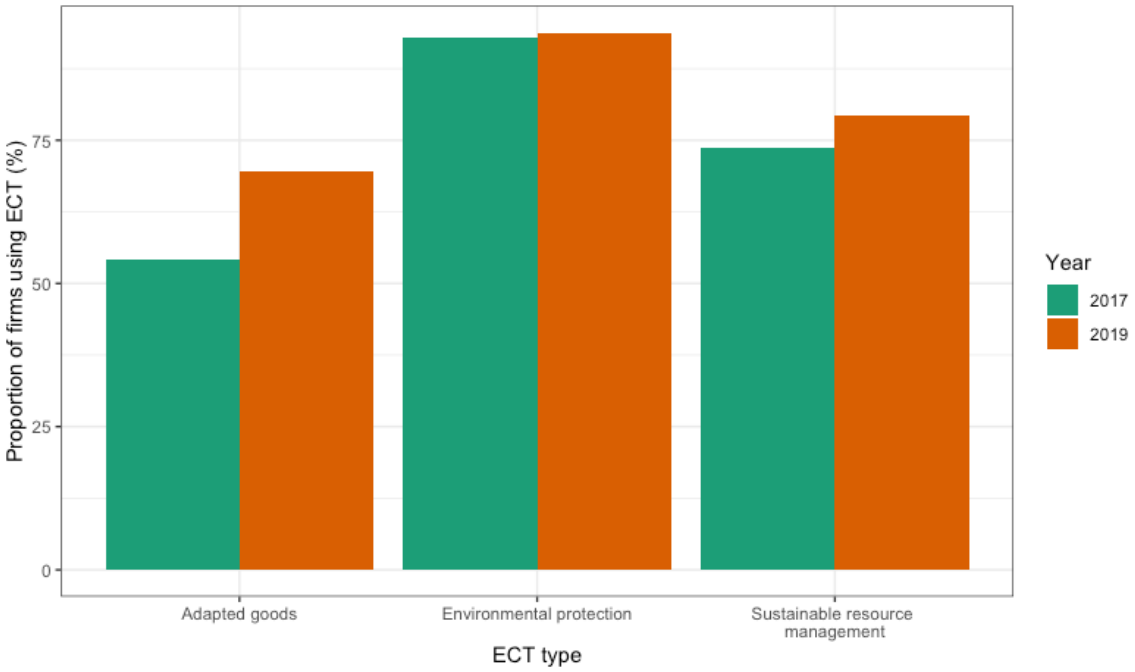
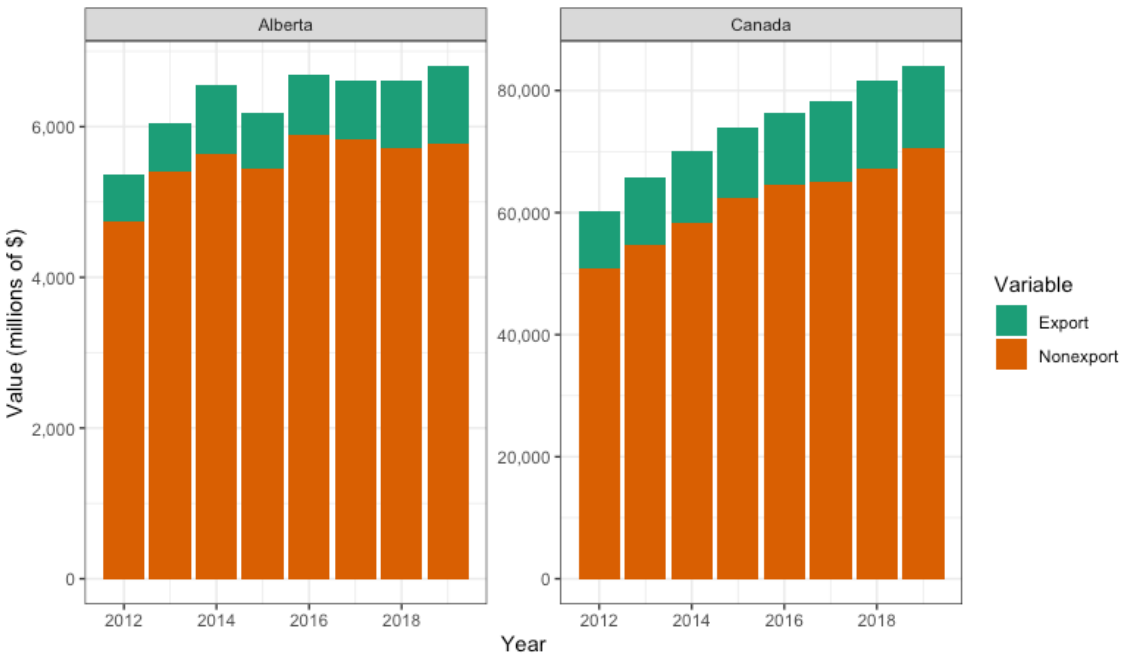


Figure 6: International exports of ECTs as a proportion of ECT sector GDP in Alberta and in Canada. Data source: Statistics Canada (2021a, 2021b, 2021e).



International exports

Alberta exported $4.8 billion in ECT sector goods and services to international markets in 2019. International exports account for a similar proportion of ECT sector goods and services in Alberta and in Canada as a whole, and in both cases this proportion has grown over time (Figure 6).

Enabling infrastructure

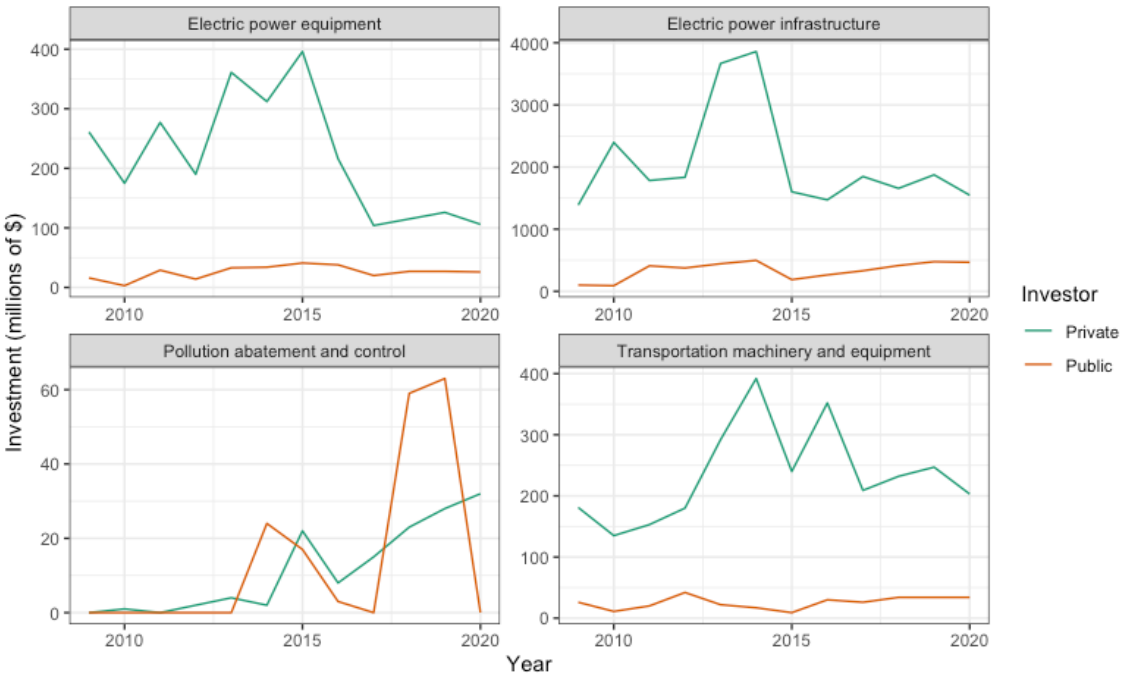
There is no discernible trend over time in investment in clean and enabling infrastructure in Alberta, except in the case of pollution and abatement control infrastructure (Figure 7). This is also the only type of clean or enabling infrastructure for which public investment outstrips private, although both types of investment in pollution abatement control infrastructure have grown over time. These numbers indicate that public and private investment in electric power equipment, electric power infrastructure, and transportation machinery and equipment are not keeping pace as climate change commitments grow more ambitious.

Public and private investment in electric power infrastructure and oil and gas infrastructure has been comparable in Alberta, with no discernible trend over time relative to each other (Figure 8). Private investment in oil and gas infrastructure has fallen since its peak in 2016, likely due to a combination of falling American demand, transportation constraints, commodity price fluctuations and climate change action. It is interesting to note that public investment in oil and gas infrastructure has continued to rise over time.

Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability**: Access to markets will determine the ability of FFH industries to earn revenue.
- **Alignment with a net-zero greenhouse gas emissions trajectory**: If FFH industries are unable to access markets and earn revenues, then their environmental benefits – both from use and from displacing higher carbon economic activities – will not be felt.
- **Building on current strengths through leveraging or repurposing existing assets**: For many FFH industries, infrastructure Investments are needed to facilitate repurposing of existing assets. For example, clean hydrogen could be transported and stored using existing natural gas pipelines and storage infrastructure, but investments are needed to make this happen.

Figure 7: Clean infrastructure investment in Alberta. Data source: Statistics Canada (2021f).



Are there firms to commercialize innovations?

Why is this important to track?

While both incumbent and new entrant firms have a role to play in transitioning economic activities to be more competitive in a decarbonizing world, new entrants have been critical in advancing ambition and championing disruptive innovation. If new entrants are based in Alberta, Alberta will be better positioned to share in the benefits of FFH industries, from jobs to indirect economic effects and beyond.

Which indicators should be used?

One publicly-available measure of successful new ECT sector firms is the "Global Cleantech 100" published by the Cleantech Group, which lists firms judged by a panel of experts to be most likely to make a significant market impact in the next five years.[27] SPI's indicator is the number of Alberta-based firms on this list.

The picture in Alberta

In 2021, **there were no Albertan firms on the Global Cleantech 100 list.** Five were from Ontario, four from British Columbia, and one each from Quebec and Nova Scotia. It is worth noting that one firm on the list, Carbon Engineering, was founded in Alberta and partially developed at the University of Calgary but moved to British Columbia for its piloting phase.[28]

For those interested in digging deeper, the Cleantech Group and other organizations also offer more detailed proprietary data on clean technology startups.

Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability**: International recognition of firms in FFH industries will determine these industries' ability to attract investment.
- **Alignment with a net-zero greenhouse gas emissions trajectory**: If firms in FFH industries are not having a market impact and receiving respective international recognition, then FFH's environmental benefits – both from use and from displacing higher carbon economic activities – will not be felt.

Figure 8: Investment in electric power infrastructure and oil and gas engineering construction infrastructure in Alberta. Data source: Statistics Canada (2021f).

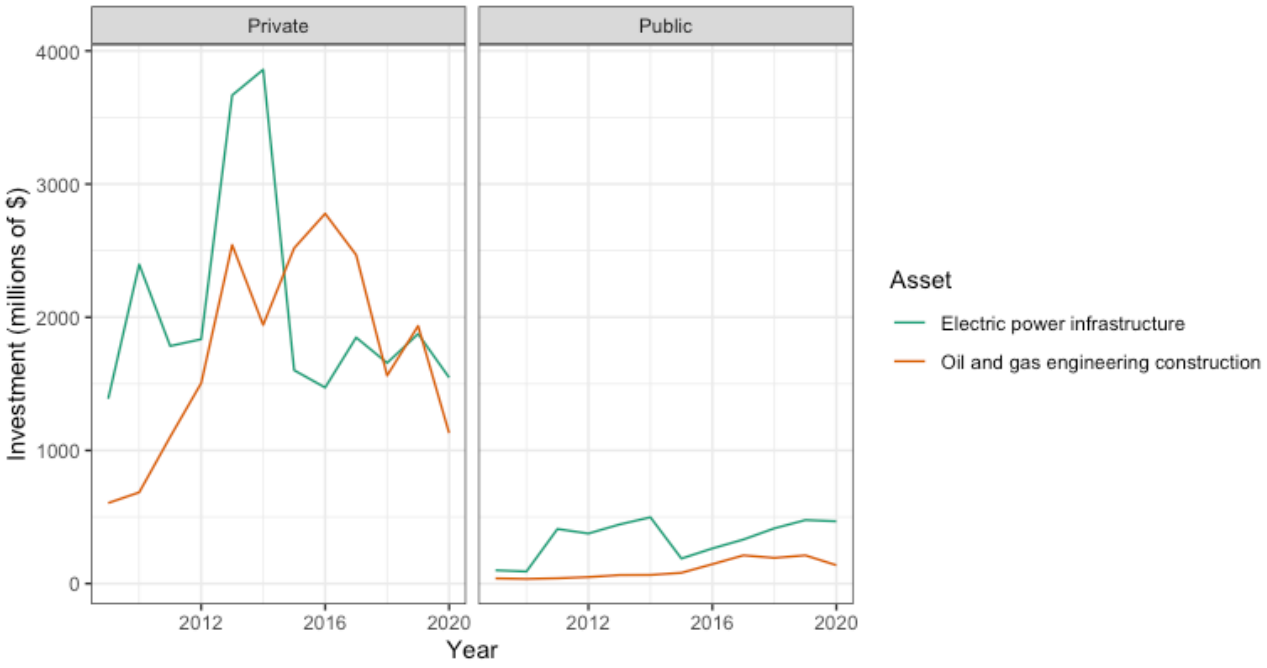


Table 9: Indicator for whether there are firms to commercialize innovations

Indicator	Unit	Data source
Number of firms on Cleantech Group's "Global Cleantech 100" list	Count	Cleantech Group (2021)

Foundations: Are future-fit hydrocarbon industries supporting the well-being of Albertans?

The purpose of economic development is to improve well-being, meaning policymakers need tools to ensure that FFH policies are furthering, rather than undermining, Albertans' ability to earn good livelihoods as well as equity among Albertans.

Are future-fit hydrocarbon industries creating jobs?

Why is this important to track?

The population of Alberta is growing, meaning job opportunities need to grow as well. In addition, new sources of employment are needed as employment in oil and gas extraction falls. In 2020, over 2% of working Albertans worked in the oil and gas extraction sector, to say nothing of sectors that directly support oil and gas extraction such as finance, engineering, and environmental cleanup.[29] The drop in employment in the oil and gas extraction sector is driven by a multitude of factors, including commodity prices, trade dynamics, climate change action, and automation (the ratio of jobs per unit of GDP has fallen steadily since 2013).[30]

Policymakers who use job creation statistics to inform policy risk rewarding low productivity.[31] High employment per unit of output signals success when used as a measure of job creation, and failure when used as a measure of productivity. Because of this risk, this indicator should not be used alone: other indicators, such as GDP and labour compensation, are needed to fill in the picture. Additionally, ownership considerations may be important for some measures to look beyond employment figures. Nonetheless, employment remains a useful indicator, particularly in light of trends in automation and public discourse around potential conflicts between jobs and climate change action. There is evidence that expected or real impacts on employment determine both the popularity and durability of clean energy policies.[32]

Which indicators should be used?

To determine the impact of FFH policies on employment, it is helpful to combine economy-wide indicators with sector-specific indicators. SPI's economy-wide indicator is the difference in growth of employment and emissions across the entire Albertan economy.[33] This indicator directly measures the outcome of interest – that is, whether Albertans can remain employed while emissions fall – and is easy to measure using public data and well-established definitions. It also captures indirect impacts on employment, such as those resulting from changes in energy prices.

However, this economy-wide indicator does not suggest what is likely to happen in the future. It is also very difficult to attribute changes in the value of this economy-wide indicator to specific FFH policies, because it is determined by so many different factors. A sector-specific indicator, measuring employment in ECT sectors, suggests how many people these sectors could employ if they were to scale in the future and what the immediate employment impact of policies supporting these sectors might be. SPI's sector-specific indicator is the number of jobs in the ECT sector.

Table 10: Indicator to assess whether future-fit hydrocarbon sectors are creating jobs

Indicator	Unit	Data source
Annual difference between emissions growth and jobs growth	Difference in percent growth	ECCC (2019) Statistics Canada (2021g)
Number of jobs in the environmental and clean technology sector	Count	Statistics Canada (2021h)

The picture in Alberta

In 2019, Alberta's ECT sector employed 31,774 people. **Employment in the sector has grown by almost 40% since 2012**, when the dataset begins. Indeed, as shown in Figure 8, employment growth has outstripped GDP growth in the ECT sector, while in Alberta's economy as a whole, the opposite has been true. This phenomenon which could have many explanations, from jobs in the ECT sector being more difficult to automate, to the ECT sector being less productive, to something else entirely. This should be investigated further.

Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability**. The ability of FFH industries to employ Albertans is a component of their viability as a source of economic activity in Alberta.

Do future-fit hydrocarbon jobs pay well?

Why is this important to track?

Average income from employment is widely recognized as an important determinant of human wellbeing. For example, the widely-used Human Development Index uses gross national income per capita to measure standards of living.[34] Average income in FFH industries is also likely to determine the popularity and durability of FFH policies. In Alberta, wages in the oil and gas extraction extraction sector have historically been higher than those in other sectors, especially for Albertans with low levels of education.[35] This presents a challenge for efforts to replace traditional oil and gas extraction as a source of employment. That said, there is evidence that jobs in clean energy can have higher and more equitable pay than the national average.[36] Tracking compensation can help governments ensure that FFH policies live up to this potential.

Figure 9: Growth in jobs, GDP, and emissions in Alberta, in the ECT sector and overall.
Data source: Statistics Canada (2021a; 2021b; 2021g; 2021h) and ECCC (2019).

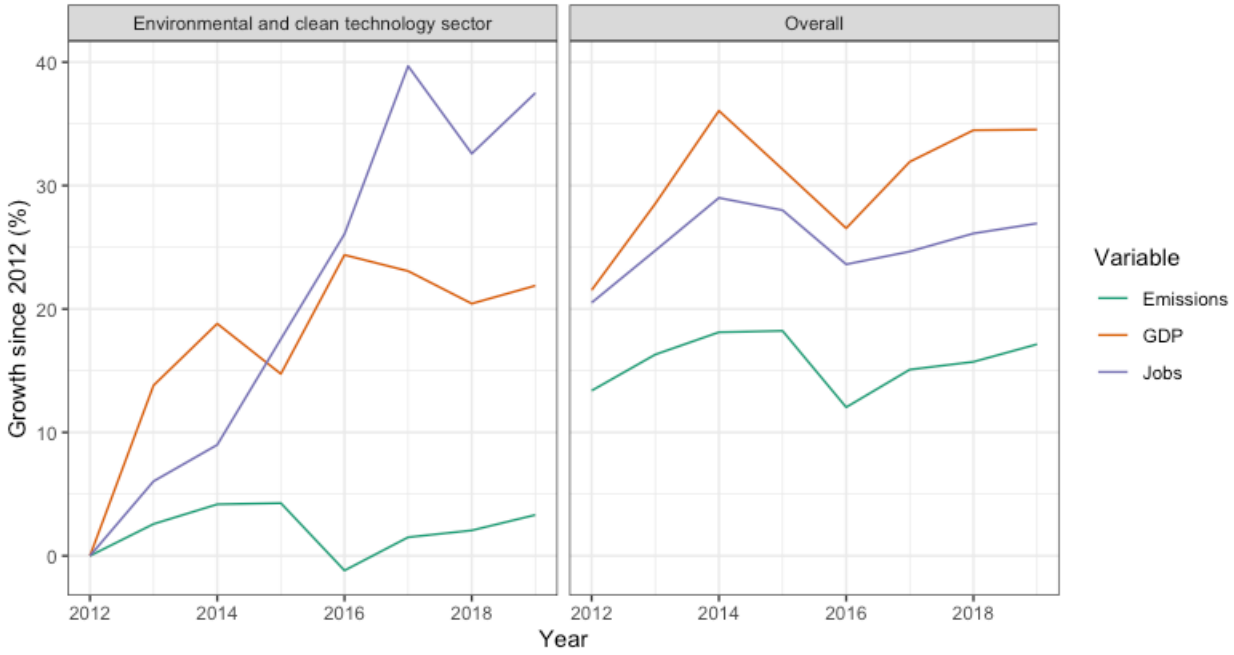


Table 11: Indicator for assessing whether future-fit hydrocarbon jobs pay well

Indicator	Unit	Data source
Annual difference between emissions growth and mean employment income growth	Difference in percent growth	ECCC (2019) Statistics Canada (2021i)
Mean annual income in the environmental and clean technology sector	Dollars	Statistics Canada (2021b)

Which indicators should be used?

When tracking the success of FFH policies in sustaining good-paying jobs, it is helpful to use a mix of economy-wide and sector-specific indicators.

SPI's economy-wide indicator is the difference in percentage growth between emissions and average weekly earnings across the entire Alberta economy. Once again, this indicator captures the indirect effects of FFH policies on earnings, including through changes in energy prices and resulting impacts on the economy. It also does not rely on definitions for ECT sectors, which vary. Because wages need to rise to keep pace with inflation, this indicator is more useful for making comparisons between jurisdictions than for identifying trends over time within a jurisdiction (identifying trends over time would require the standardization of this indicator by a measure of inflation). This indicator is also limited in that it does not suggest what is likely to happen in the future and is difficult to use to evaluate the effects of specific FFH policies because it is determined by so many factors.

A sector-specific indicator, focusing on compensation in the ECT sector, can fill in these gaps. SPI's sector-specific indicator is the mean annual income in the ECT sector. The Environmental and Clean Technology Products Economic Account does not provide wage or salary data, but it does provide data on total compensation and total employment in the sector each year. In this brief, mean annual income is estimated by dividing total compensation by total employment.

The picture in Alberta

When it comes to decoupling wages and emissions, Alberta is one of the worst-performing provinces or territories, despite the fact that wages have grown more quickly than emissions in Alberta (Figure 10). This is because Alberta's emissions have grown where most other provinces' and territories' emissions have fallen or remained constant over time.

Mean annual wages in the ECT sector have been consistently lower than those in the mining, oil and gas sector, although higher than the Albertan average (Figure 11). While it is encouraging that ECT sector wages are higher than average, if FFH industries are to repurpose human assets from the hydrocarbon industry, they will need to offer competitive wages. As Figure 11 shows, the discrepancy between wages in these sectors has not shrunk over time.

Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability**: The ability of FFH industries to sustain good paying jobs for Albertans is a component of their viability as a source of economic activity in Alberta.
- **Alignment with a forward-looking ESG approach**: Labour conditions, including the ability to pay workers a "living wage", is becoming an important criterion for ESG investors.[37]

Figure 10: Growth in mean hourly wage and GHG emissions across the entire Alberta economy. Date source: ECCC (2019); Statistics Canada (2021i)

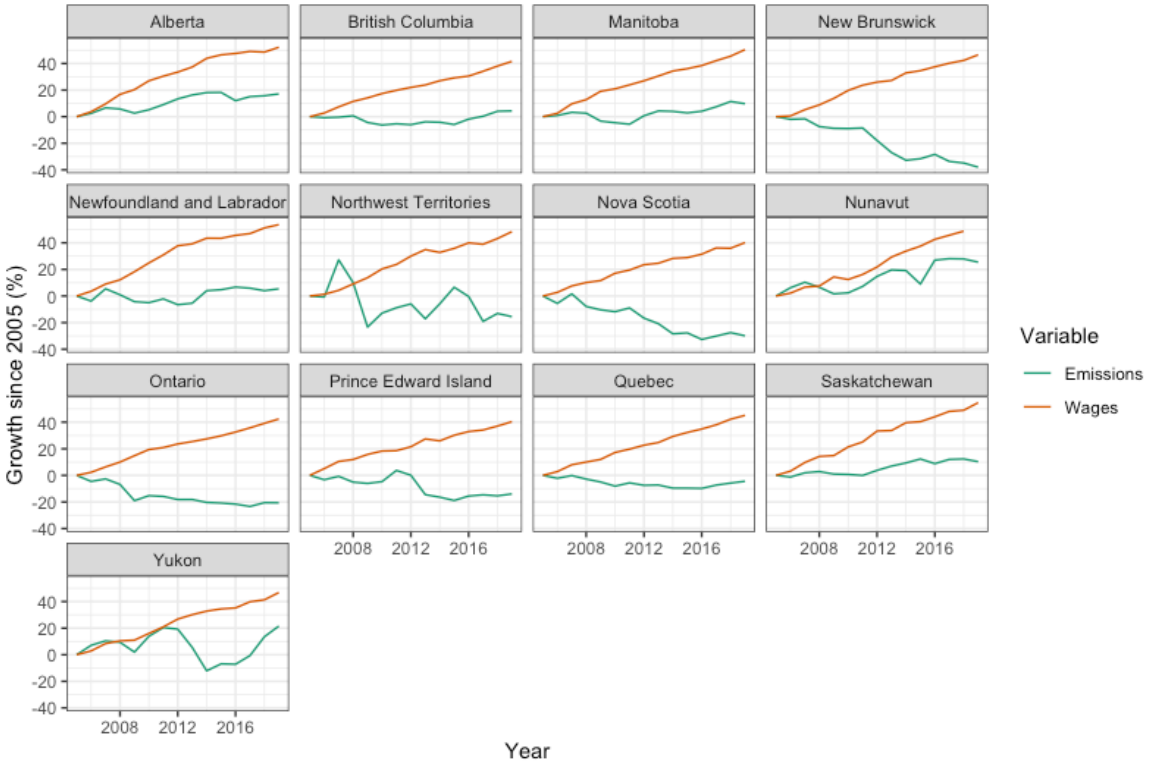
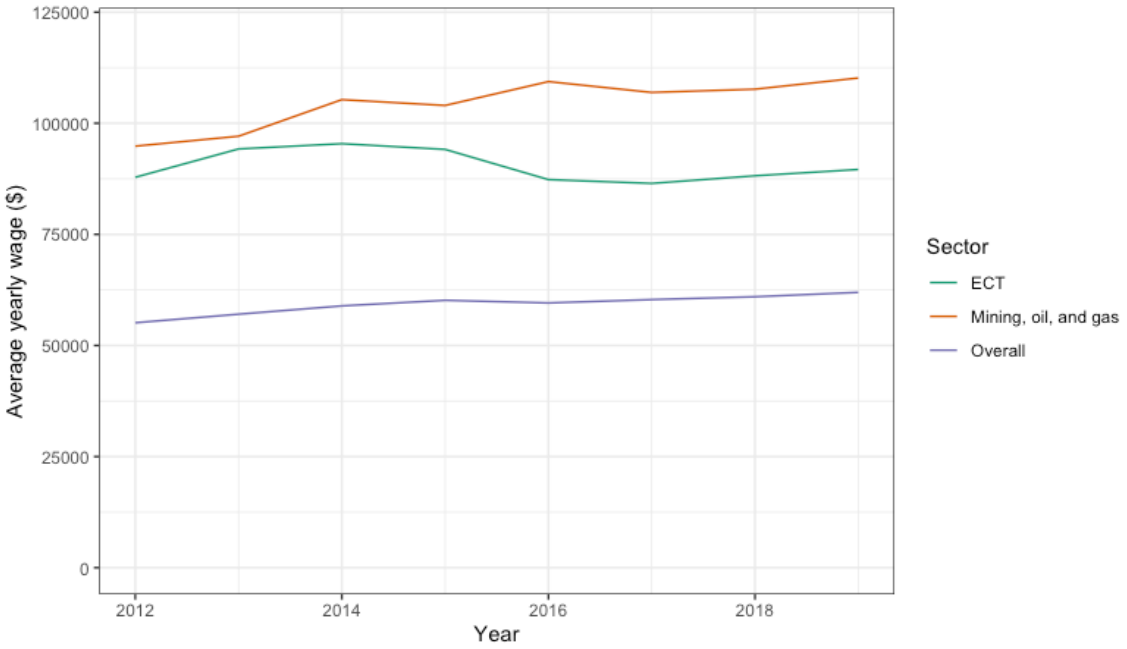


Figure 11: Average yearly income in Alberta. Data source: Statistics Canada (2021i, 2021b).



Is anyone excluded?

Why is this important to track?

There is a danger that Albertans will benefit unequally from FFH policies if these policies are not designed carefully. Tracking the experience of different population subgroups is important to ensuring that FFH policies reduce inequities and improve the wellbeing of marginalized groups, rather than undermining other policies with these ends.

There are several reasons to track the effect of FFH policies separately for different demographic groups. First, women, racialized people and young people tend to face barriers to participation in ECT sectors, where current workers are disproportionately white, male, and middle-aged.[38] More research is needed on the nature of these barriers in Canada's ECT sectors. Second, if FFH industries are to repurpose human assets from the hydrocarbon industry, there is a danger of reproducing inequities that currently exist within the latter. Finally, FFH policies have an important role to play in advancing economic reconciliation with Indigenous peoples, as these activities are likely to involve activities in Indigenous groups' traditional territories.[39]

FFH policies could also either exacerbate or narrow urban-rural economic divides, depending on their design. Rural Alberta has already been hit hard by the challenges faced by the oil and gas extraction sector, with municipalities losing large portions of their revenues when firms have gone bankrupt.[40] Rural areas tend to have lower incomes and higher levels of unemployment in Canada, but Alberta is one of a handful of provinces where the reverse is true.[41] Many FFH industries have significant potential to drive rural prosperity, but this will not happen automatically, particularly as rural areas tend to have lower levels of education.[42]

Which indicators should be used?

Demographic differences

FFH policies could have unequitable effects along many axes of demographic difference, including but not limited to, race, immigration status, education, age, gender, disability, and Indigenous status.[43] For many of these, there is little publicly available data, and none have publicly available data broken down by ECT sector (the new ECTPEA Human Resources module does, but it is not available on Statistics Canada's website).

Public data on mean hourly wages and total employment by gender, age, immigration status, visible minority status, and Indigenous status, are available from Statistics Canada's Natural Resources Satellite Account. This data source divides economic activities into categories that do not align with NAICS sectors or the Canadian Clean Technology Taxonomy's definition of ECT sectors. However, its categories include the energy and mining and minerals sectors, which align roughly with FFH industries. This alignment is not perfect: these sectors include many activities that are not future-fit and omit manufacturing of inputs such as solar panels, although they include supporting services like solar panel installation and repair. Including activities in the energy sector that are not future-fit is helpful because repurposing human assets from the hydrocarbon

Table 12: Indicator for assessing whether anyone is excluded from participating in the economy

Indicator	Unit	Data source
Difference between representation in the energy and mining and minerals sector workforce, and representation in the population, for women, immigrants, Indigenous people, workers without a college or university degree, workers under 45, and visible minorities	Difference in percent	Statistics Canada (2021j)
Wage gap in the energy and mining and minerals sectors for women, immigrants, Indigenous people, workers without a college diploma or university degree, workers under 45, and visible minorities	Dollars earned by group members for each dollar earned by non-members	Statistics Canada (2021j)
Proportion of average yearly federal government contributions to green energy and innovation infrastructure located in rural areas	Percent	Infrastructure Canada (2021)

industry may involve reproducing inequalities that currently exist in that industry.

To put the representation of different demographic groups in the workforce into context, those groups' representation in the population is calculated using data from the 2016 census. Annual data that defined demographic groups in the same way as the employment data set was not available.

It is important to note that, while SPI's indicator includes employment and wage differences based on Indigenous status, this is far from a complete indicator of the extent to which FFH policies support economic reconciliation. This is a complex objective and some elements can only be assessed qualitatively. There is important work to be done in developing indicators in this area, but it is outside the scope of this brief and the ability of its authors.

Rural inclusion

To indicate rural inclusion, SPI coded projects in Infrastructure Canada's project list[44] as either rural or non-rural, based on whether they had at least one beneficiary location outside a census metropolitan area or census agglomeration. SPI's indicator is the proportion of federal government spending on green energy or innovation infrastructure located in rural areas, averaged over the period from 2005 to 2020.

The picture in Alberta

Demographic differences

When it comes to representation in the energy and mining and minerals workforce, **the most serious representation gap seems to be for women**. Women made up roughly 50% of the population in 2016, but their representation in the workforce has hovered around 30% (Figure 12). Meanwhile immigrants, workers under 45, and college- or university-educated workers are overrepresented relative to their representation in the population.

Wage disparities are apparent for several groups. **Visible minorities, women, Indigenous people, younger people, and those without a college or university education all earned less than employees outside these groups** (Figure 13). Strikingly, female workers experience more of a wage discount than workers without a college or university degree, which may be explained by the fact that the oil and gas extraction sector has offered unusually high wages to workers without a college diploma or university degree while being dominated by men.[45] It is interesting to note that immigrants tend to earn more than non-immigrants.

Figure 12: Representation of different demographic groups in the energy or mining and minerals sector workforce from 2009 to 2019 and in the population in 2016. Data source: Statistics Canada (2018; 2021j).

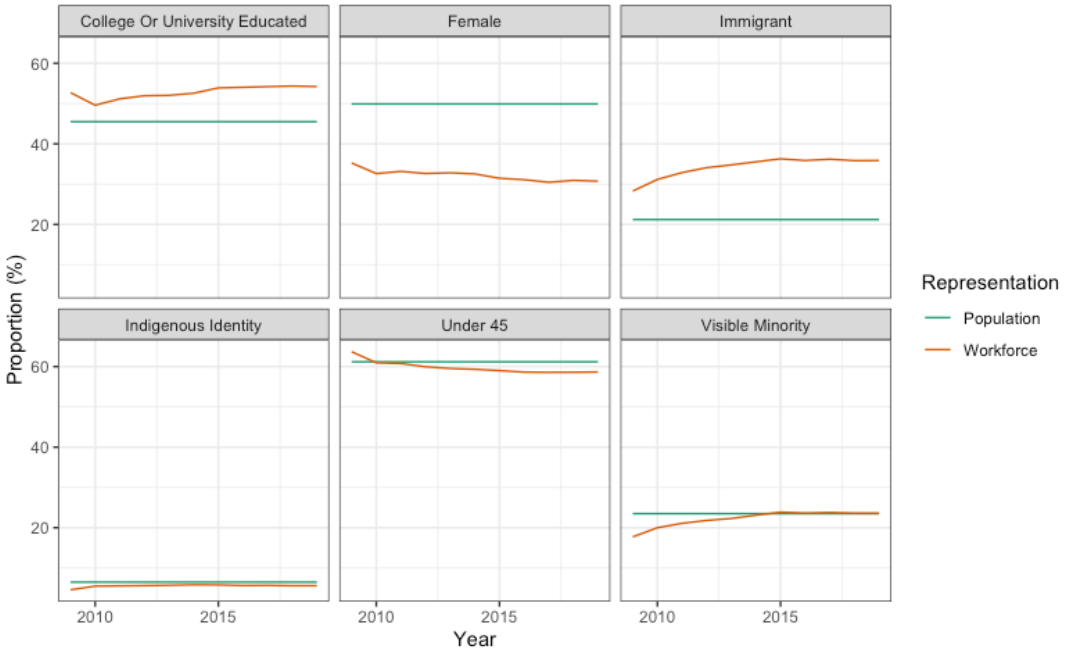


Figure 13: Dollars earned by energy and mining and minerals workers from different demographic groups for every dollar earned by non-members.
Data source: Statistics Canada (2021j).

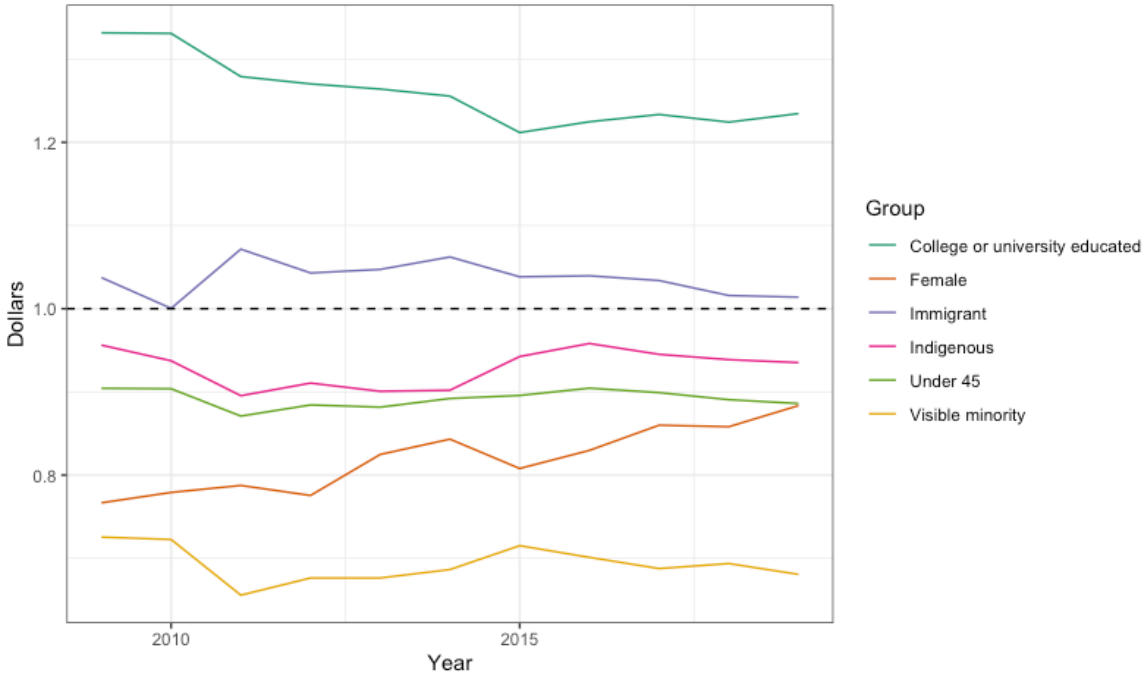


Table 13: Yearly total and per-capita federal contributions to infrastructure projects in Alberta, averaged over the period from 2005 to 2020. Data source: Statistics Canada (2021j)

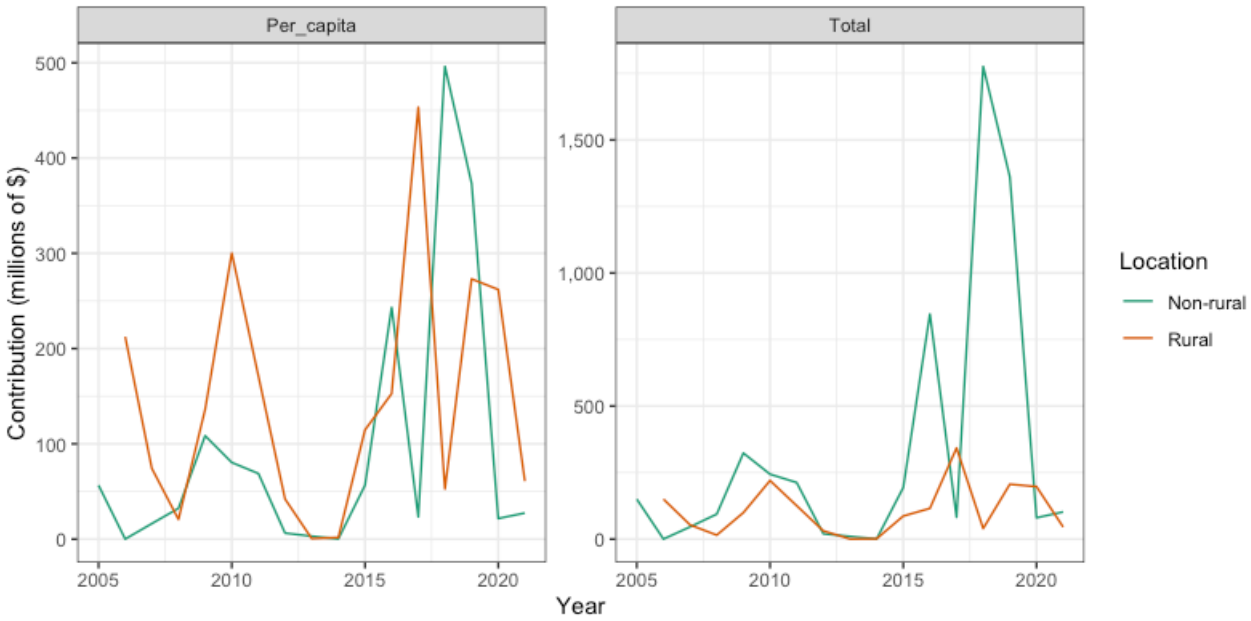
	Green energy and innovation infrastructure		All infrastructure	
	Total contributions	Per capita contributions	Total contributions	Per capita contributions
Non-rural	1.4	0.3	362.5	105.8
Rural	0.6	0.7	103.9	139.7

Rural inclusion

The federal government has contributed more, on average, to non-rural infrastructure projects each year than rural ones in Alberta. However, per capita contributions are higher for rural areas (Table 5; Figure 14), despite the fact that the opposite is true across Canada due to the size of federal contributions to public transit projects.[46]

The appropriate level of per-capita spending on infrastructure in rural areas, compared to non-rural ones, is a policy decision, and while both the federal and provincial governments in Alberta have made commitments to rural development, neither has taken an explicit position on this.[47] The discrepancy between both total and per capita contributions for rural and non-rural areas is narrower for green energy and Innovation infrastructure than for infrastructure as a whole.

Figure 14: Federal contributions to all types of infrastructure projects in Alberta, by location. Data source: Statistics Canada (2021j).



Which future-fit hydrocarbon criteria does this indicator align with?

- **Economic viability**: The accessibility to all Albertans of the economic benefits created by FFH industries is a component of their viability as a source of economic activity in Alberta.
- **Building on current strengths**: Policies to help workers transition from the oil and gas extraction sector to FFH industries will need to be wary of reproducing inequalities that exist in the former.
- **Alignment with a forward-looking ESG approach**: Employment and pay equity, particularly on the basis of gender, is a key criterion for ESG investors (Resch et al, 2019).
- **Promoting economic reconciliation**: One of the Truth and Reconciliation Commission's calls to action for the Canadian business community was to "ensure that Aboriginal peoples have equitable access to jobs, training, and education opportunities in the corporate sector, and that Aboriginal communities gain long-term sustainable benefits from economic development projects".[48] Other recommendations include respect for free, prior, and informed consent, which this brief does not attempt to quantify.

Conclusion

Defining what policy success looks like makes it easier for policymakers to identify, design, and implement policies that advance shared objectives. The Energy Futures Policy Collaborative has identified economic development objectives for Alberta and proposed a suite of policies to advance them by encouraging investment in future-fit hydrocarbons: economic activities that use assets from Alberta's existing hydrocarbon industry but which are more competitive in a decarbonizing world. In this policy brief, Smart Prosperity Institute outlines how policymakers could use publicly-available data to assess these policies' success in decoupling greenhouse gas emissions from economic growth, growing future-fit hydrocarbon industries, and ensuring that these industries are improving the wellbeing of all Albertans. While there are gaps in public data availability, there is enough data to suggest both the promise of future-fit hydrocarbons in Alberta, and the fact that there is work to do if they are to be a source of inclusive, sustainable prosperity in Alberta in the future.

Endnotes

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