Employment Transitions and the Phase-Out of Fossil Fuels

By Jim Stanford
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Centre for FutureWork

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Summary and Main Findings

This report reviews the scale, trend, and regional distribution of employment in fossil fuel industries in Canada, in order to better understand the labour market challenges associated with the coming phase-out of fossil fuel use.

The major findings of the report include:

- Direct employment in fossil fuel industries (involving the extraction, processing, and distribution of fossil fuel energy) is relatively small: around 170,000 jobs in 2019, or under 1% of total Canadian employment.
- Fossil fuel employment has declined significantly since 2014. About 33,000 fossil fuel jobs disappeared between 2014 and 2019, and 17,500 more disappeared in 2020 during the COVID-19 pandemic and associated recession.
- The share of direct fossil fuel employment in Canada's total labour market has declined by about one-fourth since 2014: both because the numerator of that ratio (fossil fuel jobs) is shrinking, and the denominator (total employment) is growing. This pace of absolute and relative erosion is consistent with the complete phase-out of fossil fuel employment over a 20-year timetable. This would be consistent with Canada's commitment to carbon net neutrality by 2050.
- The decline in fossil fuel employment since 2014 occurred alongside strong performance in the overall Canadian labour market. Total employment expanded steadily through this period – recording a record-low unemployment rate in 2019. For every job that disappeared from fossil fuels between 2014 and 2019, 42 new positions were created in other industries.
- Fossil fuel jobs are distributed unevenly in Canada. There are 18 communities (including one major city, Calgary) where fossil fuel jobs account for over 5% of total employment. Even in most of those communities, however, fossil fuel industries are not the largest employer, and it is employment trends in other industries that will dominate regional labour market trajectories.
- The coming transition away from fossil fuel employment is not unprecedented. The report documents several other historical employment transitions in Canada that were larger than the coming phase-out of fossil fuel industries. Some of those transitions were managed successfully, others not so – but in every case labour markets responded and recovered.

- Canada's labour market is marked by huge and ongoing flows of labour: into and out of employment, between different jobs, across industries, occupations, and regions. Every year about one-fifth of private sector jobs turn over (including in fossil fuel industries). These normal adjustments facilitate large changes in employment patterns over time. Thanks to those adjustments (and buttressed by generous incentives and income supports), most fossil fuel workers will not need to find alternative work: they will transition directly from fossil fuel work into retirement or make other voluntary changes in their employment status.

- The phase-out of fossil fuel employment over 20 years implies a steady reduction in employment of 8500 positions per year. The Canadian labour market typically produces that many new jobs every 10 days. More than half of those disappearing positions will be absorbed through retirements (since most existing fossil fuel workers will retire over the next 20 years). There are many industries and occupations producing more than enough new work to single-handedly offset any remaining reductions in employment.

- Even absent climate change considerations, the quality and stability of fossil fuel jobs have been badly undermined in recent years by employer cost-cutting, automation, and other pressures. Real wages in fossil fuel industries have been falling, union representation has been eroded, and working conditions have deteriorated. Trying to "stop" climate policy will protect neither the quantity nor the quality of fossil fuel jobs. Other measures must be taken to protect these workers.

- The report surveys several examples of energy transitions that have occurred in other jurisdictions. When transitions are announced and planned in advance, when workers are supported with generous income supports and adjustment assistance (including retirement incentives), and when strong commitments are made to alternative employment creation (including but not limited to jobs in renewable energy projects), these transitions can occur without involuntary layoffs or severe disruption to communities.

The report lists ten key policy principles to guide a fair and effective transition away from fossil fuel employment. While normal labour market flexibility holds great potential to adapt to the gradual phase-out of fossil fuel jobs (especially if that phase-out is announced and planned well in advance), the transition will be fairer and more effective if it is guided by pro-active transition planning. Governments must be ready to intervene with strong income supports, retraining and relocation incentives, attractive retirement and pension arrangements, ambitious public and private investment stimulus, strong regional development and diversification strategies, and

more. Critically, fossil fuel workers must be provided with voice and power to participate meaningfully in the development and implementation of these plans. And an overarching commitment to expansionary macroeconomic policy will reinforce the capacity of labour markets to adjust to this important but manageable change.

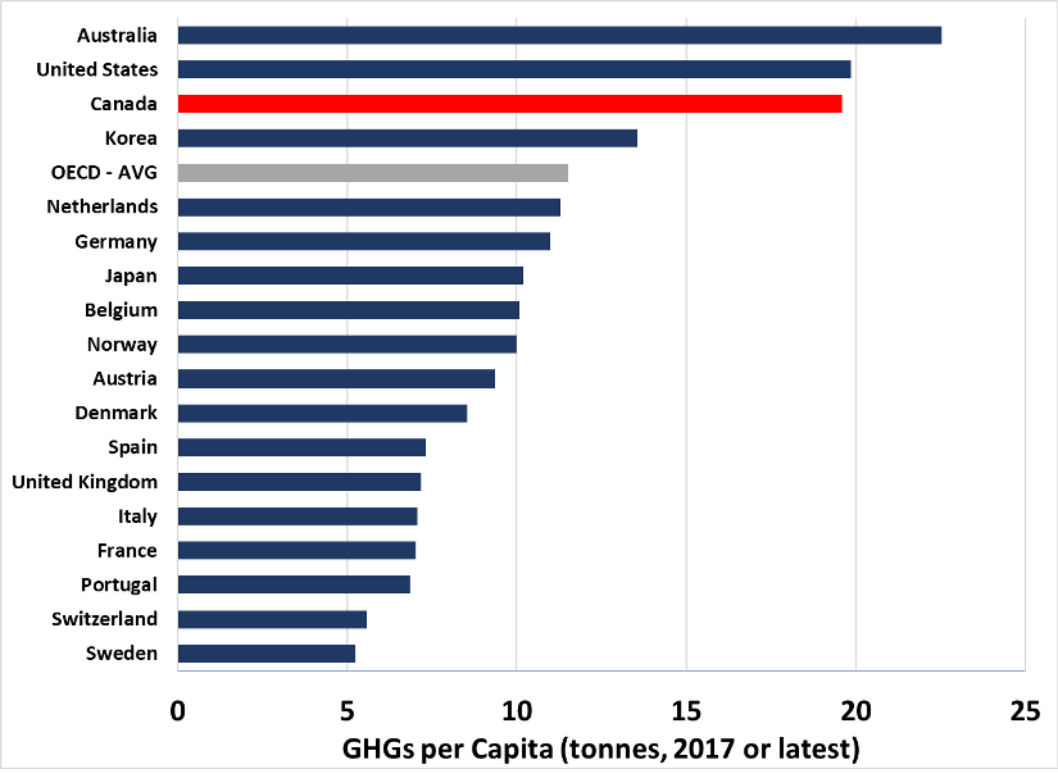
The employment challenges associated with the phase-out of fossil fuels are neither unprecedented nor unmanageable. They should not slow Canada's commitment to the coming energy transformation. To the contrary, it is better for fossil fuel workers (not just for the climate) to announce and commence that transition soon. Time is the friend of effective transitions, because it allows all stakeholders to prepare and adjust, and required changes to occur gradually and steadily. The alternative is to delay, defer, and deny the inevitable. Even then, fossil fuel jobs will still surely disappear: but in a sudden, unplanned, and harshly painful manner. It is far better, for both the climate and for fossil fuel workers, for this transition to be accepted, supported, and facilitated. Canada's labour market and environment will both be stronger for it.

Introduction: Canada's Responsibility

Climate change poses a fundamental threat to the well-being and security of people everywhere. And Canada is on the front lines of the challenge. Canada has a special responsibility to act, and quickly, for several reasons:

- Canadians are already suffering huge costs because of climate change. It is no longer an abstract prediction, it is now a reality: experienced in more frequent and expensive climate-related disasters, higher insurance premiums, escalating health effects, and other consequences.
- Canada is a rich country, that can well afford to invest in stabilizing the climate – for our own benefit, and the world's.
- Canada is one of the worst greenhouse gas (GHG) polluters in the world, with greenhouse gas emissions far out of proportion with our population.

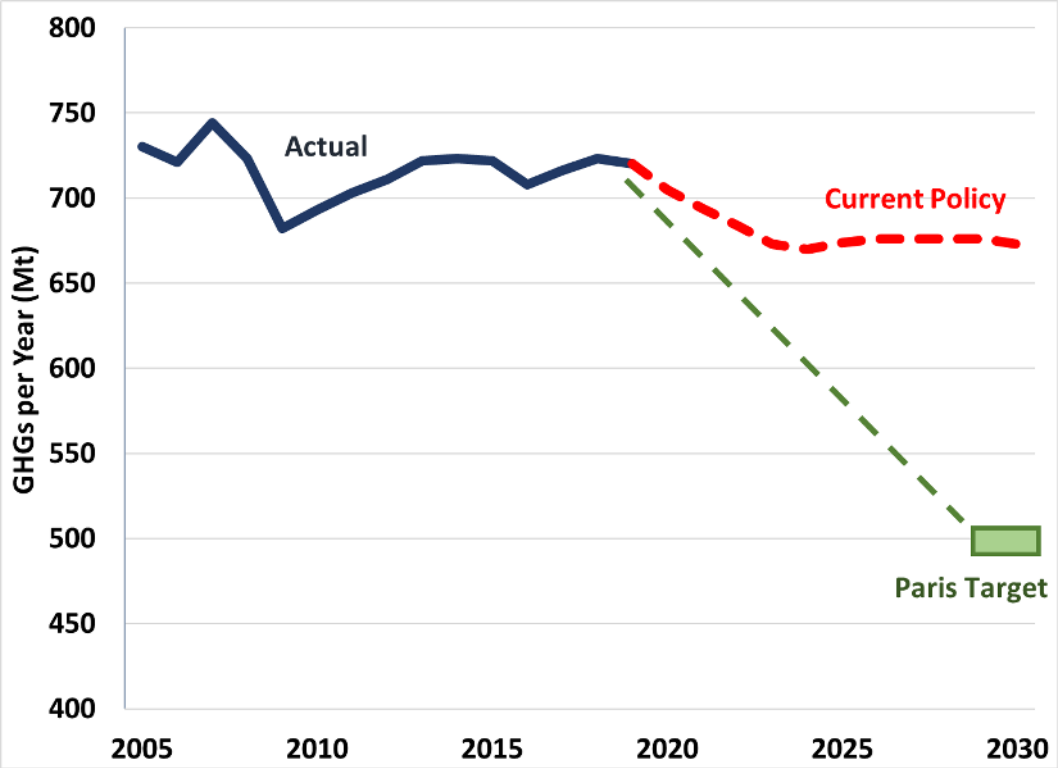
Figure 1. Greenhouse Gas Emissions per Capita, 2017



Source: Author's calculations from OECD *National Accounts at a Glance* and OECD *Greenhouse Gas Emissions*.

Indeed, as shown in Figure 1, Canada has the third highest GHG emissions per capita of any of the 36 industrial countries in the Organization for Economic Cooperation and Development (OECD). Our emissions – around 20 tonnes of CO^2 equivalent for every Canadian – are almost twice as high as the OECD average. We emit 4 times per person more than the average Swede.

Figure 2. Canadian Emissions and Targets, 2005-2030



Source: Government of Canada, "Progress towards Canada's greenhouse gas emissions reduction target." Current policy line is expected trajectory on basis of implemented policies as of 2019.

Canada has implemented some important emissions abatement policies, including a national carbon price framework, the phase-out of coal-fired electricity generation, and incentives for production and use of renewable energy in various settings. Nevertheless, as illustrated in Figure 2, those enacted policies will leave us far short of the emissions reduction target our government committed to as part of the historic Paris Agreement. Under that treaty, Canada committed to reduce total emissions by at least 30% below 2005 levels. That will require a reduction of 219 Mt (million tonnes) of annual emissions by 2030 compared to 2005 levels, and 209 Mt relative to 2019 emissions (which were only marginally reduced from 2005).

The Paris targets are designed to limit the rise in global temperatures to well below 2°C, and to strive to limit the increase to 1.5°C – which in itself still implies widespread damage and dislocation. Canada's commitment is inadequate to meet that goal, and

hence inconsistent with the spirit of the Paris Agreement. The same is true of the commitments made by most other industrialized nations.

That is why countries around the world must go further than those Paris targets. Ultimately, the global economy must move quickly toward full net carbon neutrality: whereby countries would only emit as much GHG as can be offset by various absorption mechanisms (such as forests and other carbon "sinks"). The Paris Agreement aims for carbon neutrality by the second half of this century, and over 70 countries around the world (including Canada) have now committed to reach net neutral carbon pollution positions by 2050.[1] Many important global companies have also committed to achieve net carbon neutrality in their own operations by 2050.[2]

Ultimately, meeting our Paris targets and moving to a net-neutral economy will require a full economic transition away from the production and consumption of fossil fuels – the biggest source of carbon pollution. Fortunately, there are many proven policies and technologies that can quickly reduce Canada's use of fossil fuels and hence our greenhouse gas emissions. These measures include faster roll-out of renewable energy sources, adoption of less polluting or non-polluting modes of transportation, energy conservation measures in buildings and houses, and better agriculture and forestry management. The key barrier holding back progress is neither technical nor economic. After all, alternative energy sources are now significantly less expensive than fossil fuels in most applications, including electricity generation and transportation.[3]

Some voices, in opposing measures to limit fossil fuel use and shift the energy system toward renewables, cite concerns about the economic and employment impacts of the decline of fossil fuel production and use. Canada is a major producer and exporter of fossil fuels (including petroleum, natural gas, and coal). Canadian-produced fossil fuels (used at home and abroad, via our energy exports) contribute significantly and disproportionately to global fossil fuel GHG emissions**.** Phasing out fossil fuel production and use is an inevitable priority, for Canada and other countries. But many fear this will deeply damage Canada's economy and labour market. Those with vested financial interests in fossil fuels exploit these fears to oppose the policy reforms needed to best position Canada in a sustainable, carbon-neutral energy future.

[1] See Murphy (2020).

[2] For example, the major companies cited by Geck (2019).

[3] See Bloomberg New Energy Finance (2020) for a summary of current cost comparisons indicating significant and growing cost advantages for renewable energy sources in electricity, transportation, and other uses.

Those fears are exaggerated. Contrary to the claims of petroleum industry lobbyists and government-funded "war rooms",[4] fossil fuel industries are a surprisingly modest source of direct employment in Canada. They directly account for under 1% of all jobs in Canada, and their relative importance has declined markedly in recent years. So long as it is accompanied by strong policies to support orderly transitions, protect affected workers and communities, and ensure strong job creation throughout the rest of the economy, the phase-out of fossil fuel industries can be achieved without major disruption or damage to Canada's overall labour market. To the contrary, this phase-out will generate important net employment opportunities: not just in renewable energy industries and projects, but in all other parts of the economy that benefit from more cost-effective, reliable, and sustainable sources of energy. In addition, of course, the phase-out of fossil fuels is also crucial for ensuring a habitable, sustainable environment.

This report will consider the employment dimensions of the coming transition from fossil fuels to renewable energy sources. The report begins by describing the current scale and regional distribution of direct jobs in fossil fuel industries. Direct employment in fossil fuel industries accounts for a very small share of total employment in Canada: under 1%. Moreover, that share has already declined substantially since 2014 – yet Canada's overall labour market performed very strongly in that time.[5] Fossil fuel jobs are distributed very unevenly across Canada: most regions have very few jobs in fossil fuel production and use, but some regions depend more heavily on those jobs. We identify 18 communities in Canada where fossil fuel jobs account for over 5% of local employment. But even in those communities, other industries (like the rapidly-growing health care sector) are just as important as, or more important than, fossil fuel jobs. Surprisingly, most fossil fuel jobs are located in large cities, with diverse and growing local labour markets; in those cities, the employment transitions associated with the phase-out of fossil fuels will be more manageable.

The relatively limited scope of fossil fuel employment in Canada does not mean these jobs are unimportant. Clearly they are vitally important to the individuals who fill those roles: they are trying to support themselves and their families in the face of persistent and worsening instability, declining real incomes, and deteriorating working conditions. These jobs are critical to those communities and regions with strong concentrations of fossil fuel work. By highlighting the surprisingly modest scale of fossil

[4] See Leach (2020) for a thorough review of factual errors in material recently published by the Alberta government-funded "Canadian Energy Centre."

[5] The onset of the COVID-19 pandemic and associated recession in 2020, of course, has disrupted the national economy and reduced overall employment sharply, for unrelated reasons.

fuel employment, we are not at all implying that these workers and communities should be "abandoned." To the contrary, since the number of direct fossil fuel jobs is relatively small, and the number of communities which depend heavily on them is limited, very generous, focused transition supports could and should be provided to assist affected workers and communities as the transition continues. This is much more compassionate than the false promises of fossil fuel lobbyists, who claim to be "standing up" for fossil fuel workers even as the (unplanned and unsupported) dislocation of their jobs gets worse.

This report also describes the many ways in which Canada's labour market demonstrates an impressive and ongoing flexibility. It reviews previous historical examples of employment transitions and restructuring in Canada, to show that the scale of transition associated with the phase-out of fossil fuels is not at all unprecedented. The ongoing flux and ferment of Canada's labour market is substantial and multi-dimensional: large movements occur into and out of employment every month, and by workers from one job to another. That constant, normal mobility across industries, occupations, and regions is clearly capable of absorbing the adjustments associated with the orderly, gradual phase-out of fossil fuels. Job opportunities in renewable energy and energy conservation projects can play a helpful role in this transition, as can jobs involving the amelioration and clean-up of previous fossil fuel production sites. However, those "clean energy" jobs are not necessary to facilitate a successful transition away from fossil fuel employment. The relatively few fossil fuel workers who may actually be displaced in the course of a planned transition away from fossil fuels[6] are more likely to end up working in health care or technology services or construction, not building windmills or installing solar panels. The diversity of alternative employment opportunities they face should inspire confidence that a gradual, planned transition away from fossil fuel work can be accomplished smoothly and fairly.

Through all these channels and more, the labour market demonstrates an impressive capacity to adjust to change, in most cases without dramatic dislocation. Enlisting that normal, ongoing flexibility will be critical in avoiding hardship from the phase-out of fossil fuels. The most powerful way to do this is to establish a clear and firm long-range timetable for the phase-out. That allows existing fossil fuel workers to anticipate change and plan their responses accordingly – and allows communities and industries to position themselves to make the most of a carbon-neutral future. It is not helpful to current or future fossil fuel workers to try to delay or deny the coming transition, pretending that fossil fuel industries can somehow continue their existing scale of

[6] As discussed below, most reductions in fossil fuel employment can be managed through retirements and other forms of voluntary attrition.

operations (or even expand further) for decades to come. To the contrary, it is a cruel hoax to entice future generations of workers to join an industry with such a time-limited existence. That exposes a future generation of fossil fuel workers to dislocation that will be far worse (imposed suddenly, amidst environmental and climatic crises) than if the transition is planned and well-managed.[7]

Finally, this report identifies key principles and policy measures to support an orderly, fair, and efficient transition of fossil fuel employment – without imposing an undue burden on the Canadians who currently work in those industries, nor the communities where they live. We show that normal adjustments in labour markets (including normal mobility, churn, and retirements) will be powerful and helpful in facilitating the necessary changes in employment patterns. But those automatic adjustments must be reinforced and directed by strong, active policy measures from government: to establish clear benchmarks and timelines for the phase-out of fossil fuels, so that employers and workers alike can make their best decisions, and then support the resulting adjustments with strong and generous measures to facilitate mobility (including retirement) and create other jobs. Successful employment transitions away from fossil fuels in other jurisdictions also inform this inventory of promising policy responses.

The phase-out of fossil fuels is going to occur, and more quickly than previously expected. There is no scientific or economic doubt that the transformation of global energy systems is accelerating, and fossil fuels will be replaced. It is our choice whether we move quickly to make that transition an orderly and effective one – or stand back until we are overtaken by global economic and environmental forces, and experience a transition that is far more chaotic, disruptive and expensive.

Worries about losing fossil fuel jobs should not slow down Canada's planning for and progress through this inevitable transition. To the contrary, if we truly care about fossil fuel workers and their communities, government should announce and commit to the transition clearly, with an explicit multi-year timetable, and support those affected with a suite of generous measures: including retirement and voluntary severance incentives, retraining and relocation grants, income protection, macroeconomic stimulus, and regional diversification strategies. Canada can absolutely achieve vibrant, strong, inclusive and fair labour market outcomes, even as we replace fossil fuels in our economic and industrial mix. Done right, this transition will produce a stronger labour market, and a better environmental future.

[7] The painful experience of the collapse of the northern cod fishery in Atlantic Canada, discussed below, is a potent warning of how transitions are much worse when imposed suddenly and forcibly, than when planned and managed.

Fossil Fuel Employment in Canada

Fossil fuel industries (and petroleum production in particular) are often portrayed as the "engine" of Canada's economy. Mega-investments in bitumen mining and processing, coal mines, LNG plants, and other huge facilities – mostly oriented around export shipments – generate front-page coverage in newspapers, and win top-priority attention from political leaders. In actual fact, however, fossil fuel industries constitute a small proportion of direct employment in Canada (under 1% of all jobs). More important, that share has been declining notably since 2014, and at a pace that would be consistent with the ultimate elimination of fossil fuel jobs over a 20-year time horizon. Yet overall Canadian labour market performance (until the COVID-19 pandemic, of course) actually strengthened during that period, even as our reliance on fossil fuel employment diminished.

MEASURING FOSSIL FUEL EMPLOYMENT

Measuring the number of jobs in Canada in fossil fuel industries is complicated by several factors. First, it is not always precisely obvious what constitutes a fossil fuel job, given the interactions between fossil fuel industries and other industries in the economy. Second, there are various sources of statistical data on employment in different industries, which incorporate differing definitions and limitations.

The most detailed source of employment data for specific industries and sub-industries is Statistics Canada's Survey of Employment, Payrolls and Hours (SEPH). This data is collected every month, on the basis of a comprehensive survey of employers. All large employers are included in the SEPH, along with a random sampling of smaller workplaces. The categorization of employment into various industries and sub-sectors is determined quite precisely in the SEPH: major employers fill out the SEPH survey each month, and their sectoral allocation is thus determined precisely and consistently. The SEPH also provides important detail on various types of employment, hours of work, and wages and salaries.

However, there are limitations to Statistics Canada's payroll employment statistics. Most importantly, the payroll data only includes waged employees, and does not include self-employment. Because the SEPH excludes self-employment, it will underestimate the *absolute number* of fossil fuel jobs.[8] But the relative *share* of total

[8] The SEPH estimate of average total employment for 2019 was 11% lower than the broader estimate of total employment provided by Statistics Canada's monthly household-based labour force survey.

Canadian employment accounted for by fossil fuel industries is actually *reduced* when we include self-employment. This is because the share of self-employment in fossil fuel industries (which are very capital-intensive, and hence not amenable to very small businesses) is smaller than in the economy as a whole. According to Statistics Canadas 2016 census data, under 5% of all employed people in key fossil fuel sub-sectors were self-employed – half the incidence of self-employment across the broader economy.[9] For this reason, the payroll employment data understates the absolute number, but overestimates the share, of fossil fuel employment.

A second limitation of the SEPH is that some employment data for specific industries or provinces is suppressed to preserve confidentiality (because the number of responding employers is too small to ensure anonymity). Two key fossil fuel sub-sectors are not regularly reported in the SEPH data: coal mining (for which employment data is reported intermittently) and pipelines (for which it has not been reported at all for several years).

We can turn to other sources of data to try to fill in some of the gaps in the SEPH data. For example, Statistics Canada's monthly Labour Force Survey (LFS), based on a rotating monthly survey of households, does capture self-employment, unlike the SEPH. However, while the LFS reports employment across very broad industry groupings, it does not provide a sufficiently disaggregated sectoral breakdown of employment to estimate the number of fossil fuel jobs.[10]

Another source of employment data is the Statistics Canada census, conducted every five years. Like the SEPH, the census provides a detailed industry breakdown of employment levels. But like the LFS, that categorization is based on individual household responses, which may not always correspond with the precise sectoral definitions applied to the SEPH data. The census also provides detailed employment data by province and community. Another limitation is that census estimates of total employment are contingent on the precise month the survey is collected (the 2016 census was collected in May of that year), and hence may be distorted by seasonal

[9] Author's calculations from Statistics Canada census data, Table 98-400-X2016290. Most workers in fossil fuel industries work for very large firms: two-thirds of employees in the broad mining sector (including petroleum) and seven-eighths of employees in utilities (including electrical utilities, gas distribution, and oil pipelines) work for firms with over 500 employees (He, Messacar, and Ostrovsky, 2017).

[10] Moreover, the allocation of employment to broad sectors in the LFS depends on respondents' judgments about what industry they work in, which may not perfectly match the classification scheme (called the North American Industry Classification System, or NAICS) used by Statistics Canada. Therefore, industry employment breakdowns are generally considered more accurate from employer-based surveys, such as SEPH.

factors (which are important in some fossil fuel industries). For all these reasons, both the level of employment reported in the census, and its sectoral allocation, must be treated with caution.

Given the strengths and limitations of each of these statistical sources, the following analysis of fossil fuel employment adopts the following approach. Our core analysis of fossil fuel employment by sub-sector relies on SEPH data, which has the most timely and precise industrial disaggregation. For the two fossil fuel sub-sectors not consistently reported in the SEPH (coal mines and pipelines), we extrapolate census data from 2016. We also utilize census data to consider the scale of self-employment in fossil fuel industries. Finally, our analysis of the provincial and regional distribution of fossil fuel jobs (in a latter section of this report) also utilizes the 2016 census data.

FOSSIL FUEL EMPLOYMENT BY SUB-SECTOR

Table 1 lists average payroll employment for 2019 in seven key segments of fossil fuel production and distribution in Canada, including:

- exploration, development and extraction of petroleum (oil and natural gas)
- service and support jobs related to petroleum and coal extraction (which are reported separately by Statistics Canada as the mining services industry)[11]
- refining and processing of fossil fuels (in the petrochemical industry)
- a portion of the electricity system (corresponding to the share of total electricity which is presently generated from fossil fuels – including coal, oil, and natural gas)
- natural gas distribution utilities
- coal mining
- fossil fuel pipelines.[12]

[11] Statistics Canada data do not disaggregate mining services employment into that which is associated with fossil fuels versus other kinds of mining; our approach is to allocate mining services employment to fossil fuel and other mining activities in proportion to their share of mining employment excluding support services.

[12] In addition to natural gas utilities, pipelines, and the electricity system, one additional sub-sector involved in distributing fossil fuel energy is the fuel retail network. Gasoline stations employed 83,000 Canadian workers in 2019, more than any of the fossil fuel sub-sectors included in Table 1. However, most of those businesses also perform other services (including vehicle service and maintenance, and convenience retail stores) which will continue after motor vehicles transition to alternative forms of

Table 1 Fossil Fuel Payroll Employment, 2019		
	2019	**Change from 2014**
Oil and Gas	55,853	-8,453
Mining Services[1]	36,369	-21,842
Petrochemicals	17,901	-1,201
Fossil Electricity (share)[2]	17,794	-491
Natural Gas Dist.	16,959	+1,317
Coal Mining	7,434[3]	-2,357
Pipelines[4]	7,000?	?
Total Fossil Fuel	**159,310**	**-33,028**
Canada: All Industries	16,962,603	+1,353,075
Fossil Fuel Share	0.94%	-0.29%

Source: Author's calculations from Statistics Canada Table 14-10-0202-01. Includes payroll employees only; annual averages.
1. Assumed fossil fuel share of all mining service jobs equal to share of petroleum and coal mining in total mining and petroleum employment (excluding services).
2. Assumed fossil fuel share of electricity industry employment equal to share of fossil fuel generation in total electricity generation.
3. 2018 data; 2019 estimate suppressed by Statistics Canada for confidentiality.
4. Approximate payroll employment in fossil fuel pipelines, based on 2016 census.

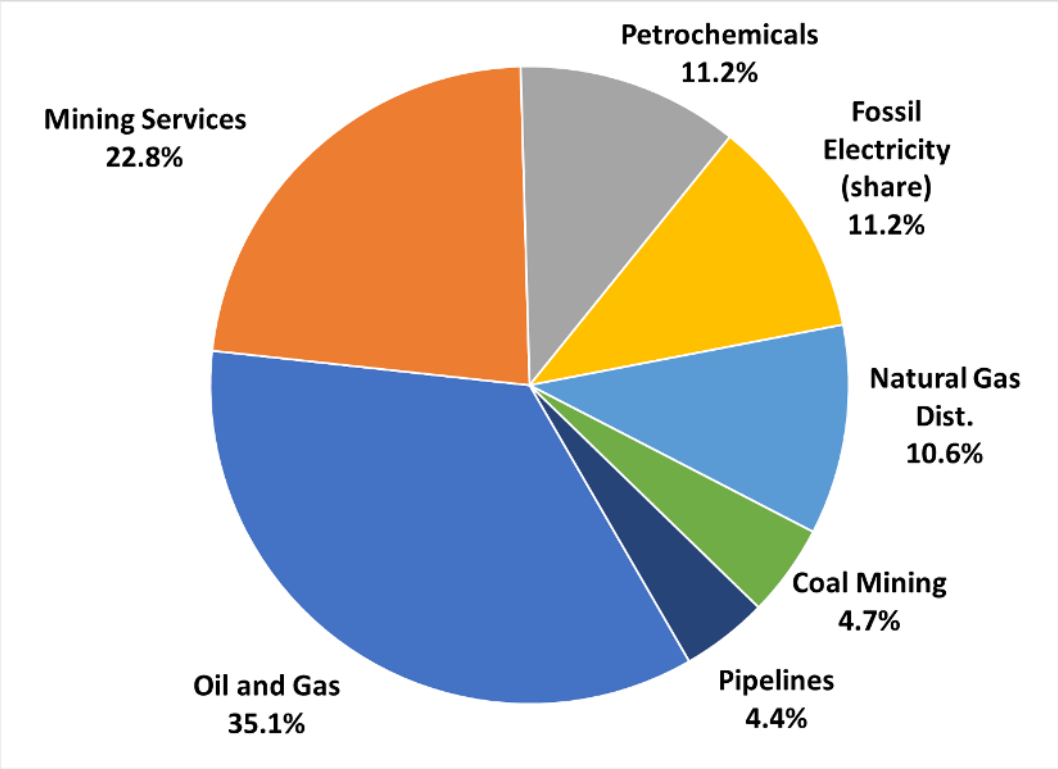
According to Statistics Canada's SEPH data, these seven fossil fuel sectors together directly employed about 160,000 payroll employees in 2019. That represents under 1% of total payroll employees in Canada's economy. And employment in these fossil fuel industries has been declining in recent years. Total payroll employment in those seven sectors declined by 33,000 positions from 2014 through 2019, a drop of over 17%. During that period, the seven fossil fuel sectors shed an average of 6,600 jobs per year. The share of these seven sub-sectors in total payroll employment thus declined by one-quarter over that five-year period: from 1.23% of total employment in 2014, to 0.94% in 2019. This decline in the relative importance of fossil fuel employment was driven by both the contraction of absolute fossil fuel jobs (a declining numerator) and by increasing employment in the rest of the economy (a growing denominator).

Due to suppression of data for confidentiality reasons, two of the sectors included in Table 1 are estimates. The estimate for coal mining employment is from 2018 (before Statistics Canada began suppressing this detail). For pipelines, Statistics Canada has suppressed payroll employment data since 2002 (when there were 4,300 positions in that industry). The 2016 census indicated total employment in all pipelines (including

energy. Therefore we do not include gas station employment in our tally of fossil fuel jobs. See below for further discussion of employment in these "complementary" activities.

water pipelines) of 8,370 positions (including self-employment). In Table 1, we have estimated payroll employment in fossil fuel pipelines (excluding water pipelines) at 7,000 positions; that is likely an over-estimate.

Figure 3. Fossil Fuel Payroll Employment by Sector, 2019



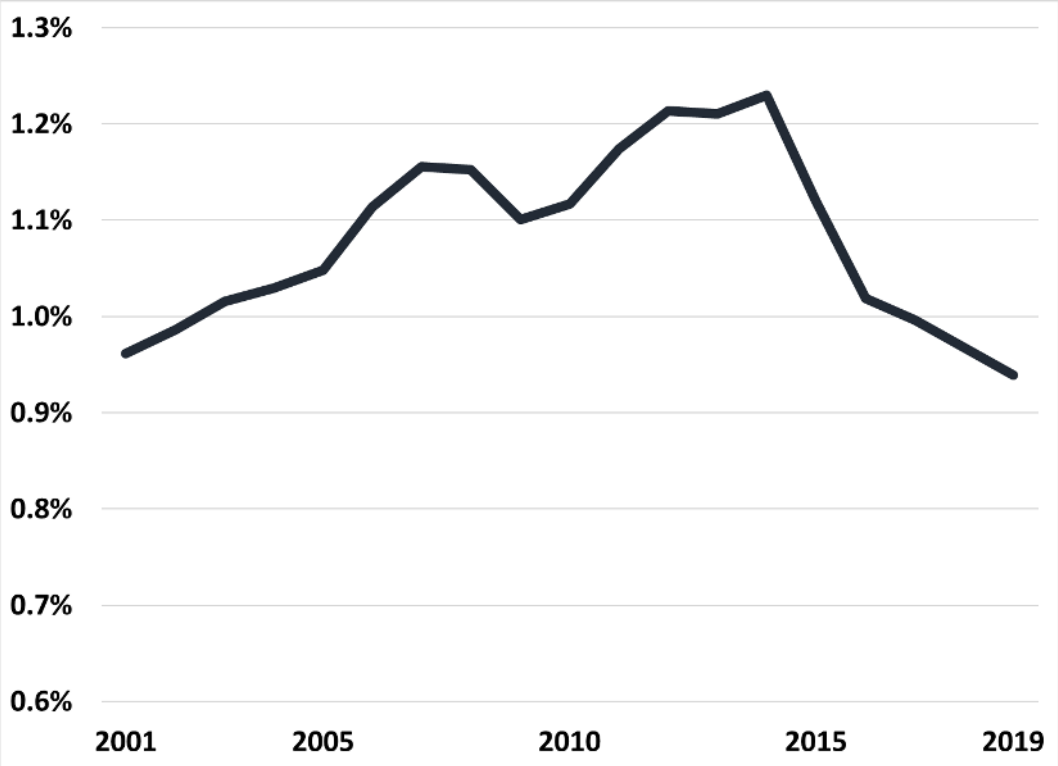
Source: Author's calculations from Statistics Canada Table 14-10-0202-01. Includes payroll employees only. Coal mining and pipelines estimated.

Figure 3 indicates the allocation of fossil fuel payroll employment across these seven identified sub-sectors. The oil and gas production sector is the largest source of fossil fuel jobs, accounting for over one-third of the total. Jobs in mining services (serving both petroleum and coal extraction) are the second-largest source of fossil fuel employment, representing over one-quarter of the total. Three other sub-sectors – petrochemical manufacturing, fossil fuel-fired electricity generation, and natural gas distribution – each provide between 11 and 12% of all fossil fuel jobs (between 17,000 and 18,000 positions each). The coal mining and pipeline industries are the smallest fossil fuel sub-sectors, with under 5% of the total (or 7000-7500 jobs) each.

Of these seven sub-sectors, all but one experienced declining employment from 2014 through 2019. This confirms that the erosion of fossil fuel employment is already being experienced broadly. The largest job losses were experienced in oil and gas extraction and related services – accounting for almost 30,000 lost jobs. Smaller job losses were also experienced in petrochemicals, fossil fuel-fired electricity, and coal mining. Only

the natural gas distribution sector experienced a growth in employment over this period, adding some 1,300 new jobs from 2014 through 2019.

Figure 4. Fossil Fuel Employment as Share Total Payroll Employment, 2001-2019



Source: Author's calculations from Statistics Canada Table 14-10-0202-01.

Figure 4 illustrates the evolution of the share of fossil fuel industries in total payroll employment in Canada, going back to 2001. Fossil fuel employment expanded in the mid-2000s, as rising global energy prices and a boom in new extraction projects (especially in Alberta's bitumen sector) led to rising demand for labour. At peak in 2014, these seven fossil fuel sectors accounted for over 190,000 payroll jobs in total, equal at that time to 1.23% of total payroll employment. After 2014, however, following the collapse in global oil prices and the resulting slowdown in new investment projects, the share of fossil fuel industries in total employment began to fall. By 2019 it had fallen below the proportion experienced in 2001: before the decade-long boom in the petroleum sector got started. In other words, the expansion in employment resulting from that decade of fossil fuel expansion has already been completely unwound.

It is important to highlight, again, that the share of fossil fuel jobs in total payroll employment declined by nearly one-quarter (from 1.23% to 0.94%) in just 5 years (from 2014 through 2019). In other words, since 2014 fossil fuel employment has travelled one-quarter of the distance to a complete phase-out. And as discussed below, the disappearance of fossil fuel work accelerated during 2020 during the

COVID-19 pandemic and resulting recession: another 17,500 fossil fuel jobs disappeared in the first months of 2020.

While the downturn in fossil fuel employment has certainly been painful for affected workers and some communities (made worse in most cases by the absence of appropriate support and transition measures), it occurred coincidentally with very strong performance in the overall labour market. Even as fossil fuel employment was falling quickly (in both absolute and relative terms), Canada simultaneously achieved the lowest national unemployment rate in the history of our modern labour force statistics. This certainly refutes the claims of fossil fuel lobbyists that Canada's entire economic and employment trajectory are tied to the maintenance and even expansion of fossil fuel industries. It also confirms that the phase-out of fossil fuel employment over coming years (say, over the next two decades[13]) is not a utopian idea: in fact, the pace of relative decline of fossil fuel employment has already been occurring at that pace,[14] coincident with strong overall labour market performance.

FOSSIL FUEL JOBS AND NATIONAL LABOUR MARKET PERFORMANCE

The decline in fossil fuel employment since 2014 did not have visible repercussions on the overall trajectory of Canada's labour market.[15] Indeed, the national economy created a net total of 1.35 million new payroll jobs over that same 5-year period (2014 through 2019), even as fossil fuel employment was declining.[16] The overall direction of Canada's labour market has been led by steady job creation in other industries, which overwhelmed the decline in fossil fuel employment. For every job that disappeared in fossil fuel industries between 2014 and 2019, other industries created a total of 42 offsetting jobs.

During that same five-year period, the overall unemployment rate gradually declined in Canada: falling to 5.7% in 2019. That was the lowest annual unemployment rate

[13] We utilize a 20-year timetable to simulate the impacts of the phase-out of fossil fuel industries. That would support the achievement of genuine carbon net neutrality by 2050 or earlier, allowing for implementation lags.

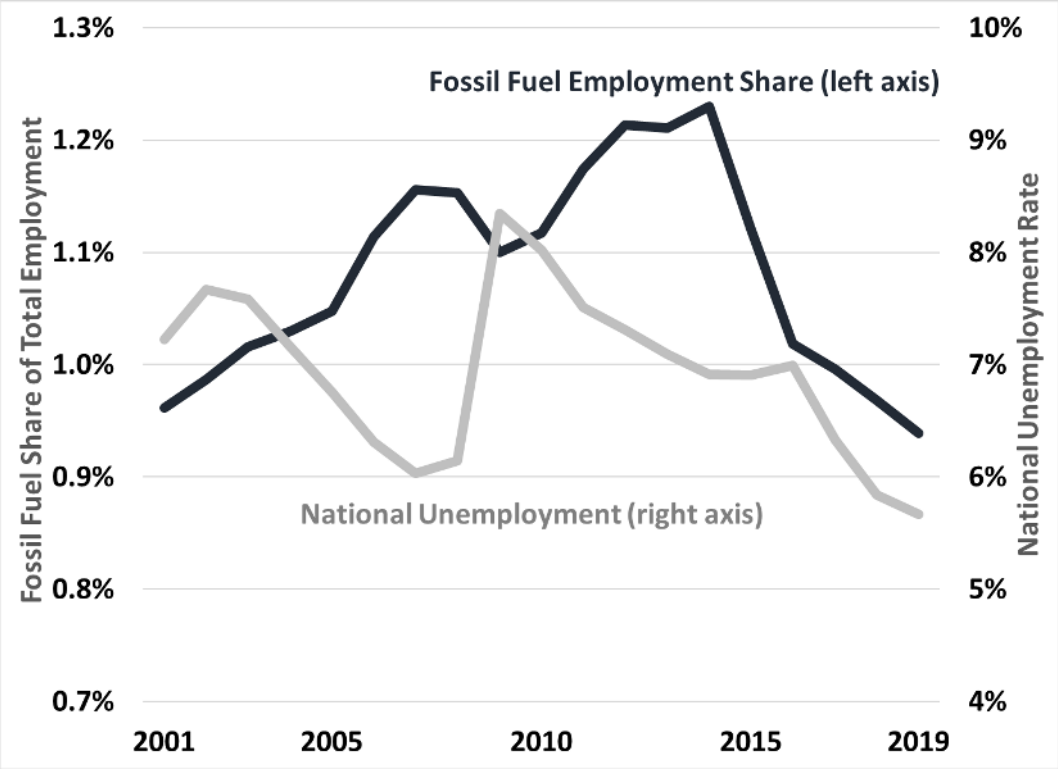
[14] If the share of fossil fuel employment in total employment continued to decline at the same pace it did between 2014 and 2019, it would reach 0 in 16 more years.

[15] The loss of fossil fuel jobs has obviously been felt more painfully in certain regions of Canada, as discussed further below.

[16] Of course, the COVID-19 pandemic and resulting recession has imposed an unprecedented shock on employment and labour force participation in Canada, discussed further below.

recorded by Statistics Canada since the advent of its modern labour force statistics in 1976.

Figure 5. Fossil Fuel Employment and Unemployment Trends, 2001-2019



Source: Author's calculations from Statistics Canada Tables 14-10-0202-01 and 14-10-0287-01.

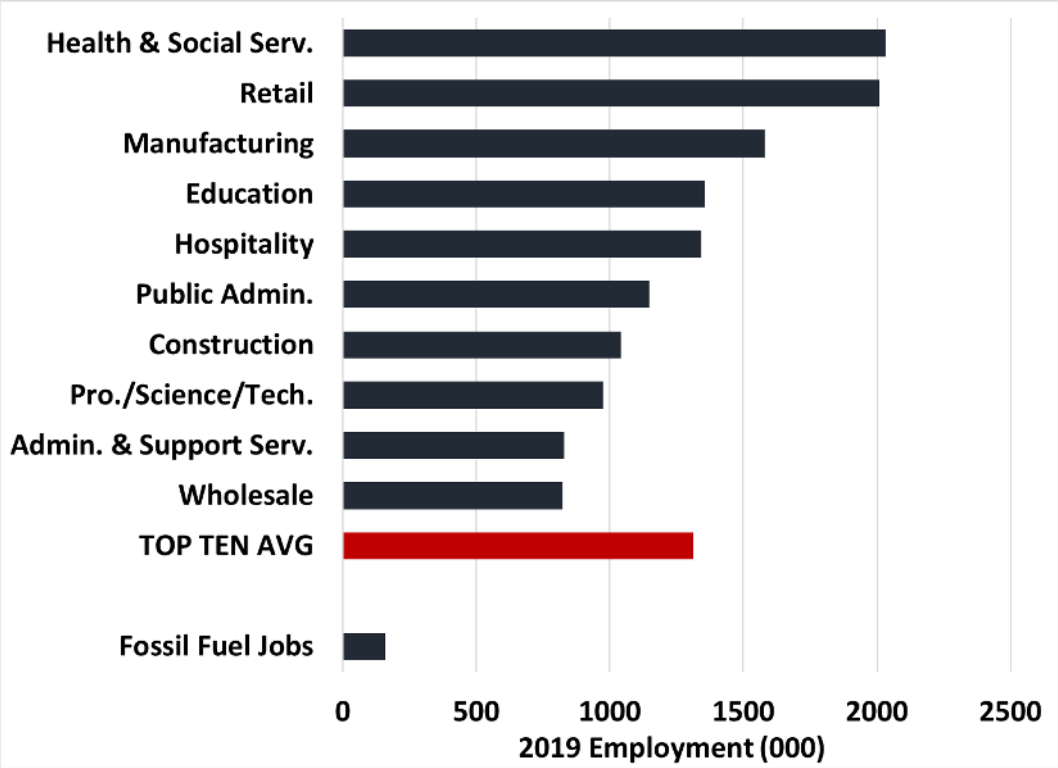
The contrast between fossil fuel jobs and the performance of the broader national labour market is illustrated in Figure 5. This graph compares the share of fossil fuel industries in total payroll employment (the same data indicated in Figure 4) against the evolution of the national unemployment rate. The expansion of fossil fuel employment during the resource boom of the 2000s did not have any clear or consistent influence on national unemployment in that period. The overall Canadian unemployment rate increased sharply during the 2008-09 global financial crisis. After 2009 the national unemployment rate declined steadily and gradually, despite the marked decline in fossil fuel employment that began in 2014. If anything there has been a (weak) *positive* correlation between the fossil fuel employment share and the national unemployment rate: since 2001, higher fossil fuel employment has been (weakly) associated with *higher* national unemployment, not lower.[17]

There are some plausible reasons why higher fossil fuel employment could be causally associated with higher national unemployment. For example, if a resource boom leads to strong appreciation of the Canadian currency, the negative spillover effects for

[17] The simple correlation coefficient between the two series is 0.206, but is not statistically significant.

employment in other tradeable sectors (like manufacturing) could outweigh job creation experienced within the energy industry.[18] However, the correlation between lower fossil fuel employment and lower national unemployment visible in Figure 5 is not statistically robust. The fossil fuel sector is too small to exert consistent and measurable impacts on the course of overall employment trends. The broader labour market is clearly dominated by developments in other (larger) sectors, macroeconomic and global developments, and demographic forces.

Figure 6: Canada's Biggest Employing Industries, 2019



Source: Author's calculations from Statistics Canada Table 14-10-0202-01.

The structural dominance of other, larger industries in determining the overall trajectory of Canada's labour market is confirmed in Figure 6, which compares total payroll employment in fossil fuel industries (from Table 1) to corresponding employment levels in Canada's 10 largest employing industries in 2019. Among the set of 20 broad industries defined by Statistics Canada (at the 2-digit level of disaggregation), there are only two – utilities and 'management of companies and enterprises' – that employ less people than the overall fossil fuel sector. By any standard, therefore, fossil fuel industries are far less important than other major sectors in determining Canadian employment patterns.

[18] See Clarke et al. (2013) for discussion and evidence of these effects in the Canadian case after 2002.

Canada's largest industry, measured by payroll employment, is health care and social services, which employs over 2 million Canadians (Table 2). That is 13 times as many jobs as are provided in fossil fuel industries. Other top employers include retail trade, manufacturing, education, and hospitality. As summarized in Table 2, the 10 largest sectors in Canada's labour market accounted for a combined total of 13.1 million jobs in 2019 – or over three-quarters of total payroll employment. On average, *each* of these large sectors employed 9 times as many workers (1.3 million workers each, on average) as the entire fossil fuel sector.

Table 2
Employment Growth, Canada's Largest Industries

Sector	Employment (2019, 000)	5 year Change (000)
Health Care & Social Services	2030.9	251.3
Retail Trade	2008.6	71.0
Manufacturing	1580.7	87.7
Education	1355.8	138.5
Hospitality	1342.2	140.8
Public Administration	1147.2	102.6
Construction	1041.2	65.9
Pro./Science/Tech. Services	973.8	132.0
Administration & Support Services	829.8	52.1
Wholesale Trade	822.9	44.1
Top Ten Total	**13133.2**	**1086.1**
Top Ten Average	1313.3	108.6
Fossil Fuel Jobs	159.3	-33.0

Source: Author's calculations from Statistics Canada Table 14-10-0202-01. Payroll employment.

Moreover, even modest changes in employment in those much larger industries will clearly swamp developments in fossil fuel industries in their impact on overall labour market conditions. For example, the last column of Table 2 reports the change in employment in each of Canada's largest industries over the five years from 2014 through 2019. Every one of Canada's top ten industries increased employment in that period, by a combined total of around 1.1 million jobs. Moreover, every one of those ten largest sectors created more new jobs than disappeared in the same period in the combined fossil fuel sector. In other words, the new jobs created between 2014 and

2019 in *any one* of those ten large industries was more than sufficient to *single-handedly* offset all jobs lost in the same period in fossil fuel work. Even Canada's hard-pressed manufacturing sector created almost 3 jobs between 2014 and 2019, for every job lost in fossil fuel industries.

Across all industry sectors, the Canadian economy created an average of 270,000 new payroll jobs per year over the past 5 years. In any single year, therefore, the economy produced 1.8 times as many *new* jobs, as are employed *in total* in fossil fuel production and use. In other words, the overall Canadian economy has been producing enough new jobs every 7 months, to *completely absorb* all jobs currently existing in fossil fuel production. In that context, it is obvious that the Canadian economy is very well able to absorb and reallocate work and workers who might otherwise be employed in fossil fuels. (More details on how to fairly and effectively manage that process are provided below).

Remember, too, that the full phase-out of fossil fuels will occur over many years: we simulate a two-decade transition (to underpin attainment of net carbon neutrality by 2050 or earlier). A gradual 20-year phase-out of fossil fuel production and use would imply an annual reduction in related payroll employment of around 8000 jobs per year.[19] That is barely large enough to even register in Canada's labour market statistics. For comparison, during the five-year period from 2014 through 2019, Canada's economy produced that many new jobs every 10 days.[20] And as will be discussed below, so long as the phase-out occurs gradually over a long announced timetable, most of those 8000 annual job reductions can be accomplished through retirement and other forms of voluntary severance.

ELECTRICITY TRANSFORMATIONS AND FOSSIL FUEL JOBS

As explained above, our estimates of total fossil fuel employment include an estimated share of employment in the electricity industry, assumed to correspond to the proportion of electricity produced from fossil fuel energy inputs (including coal, oil, and natural gas). This methodology overestimates the number of true fossil fuel positions, since it ascribes a full proportionate share of system-wide employment in the electricity industry to fossil fuels – including infrastructure and overhead functions

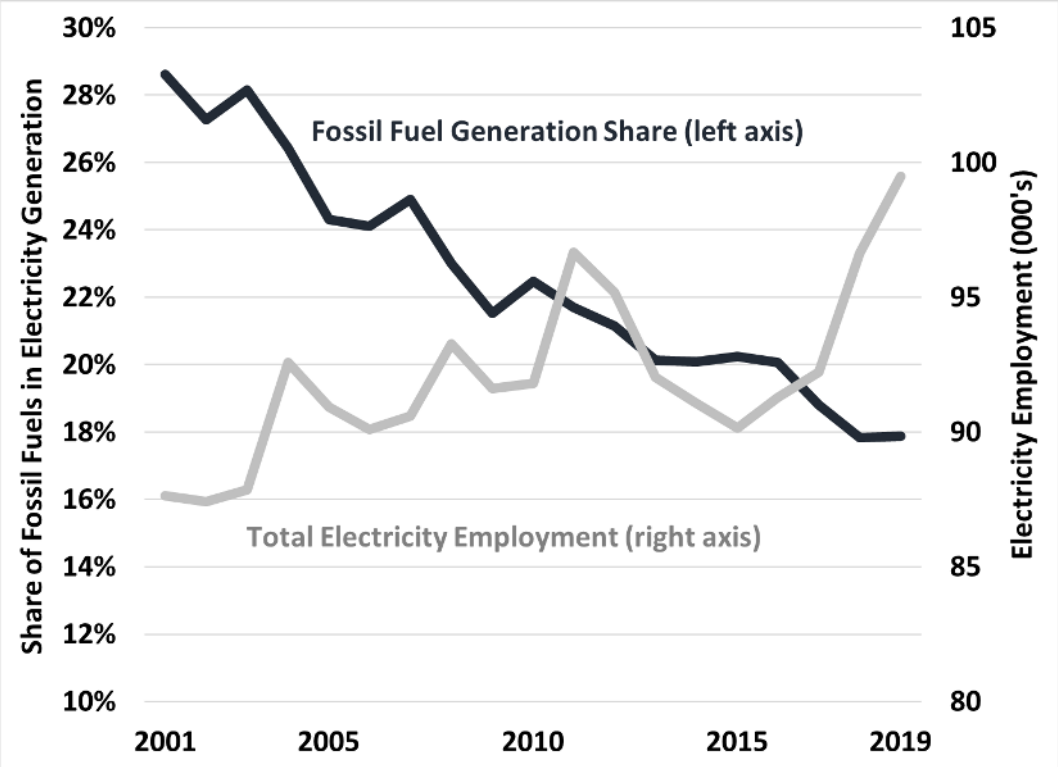
[19] If we include self-employment, discussed below, then the annual reduction in total fossil fuel employment required for a 20-year phase-out is 8500 positions per year.

[20] And during that same period fossil fuel employment was declining by about as much per year as would be required for this 20-year phase-out.

that have no direct connection to the source of the energy used to generate that electricity, and which will be needed even as the electricity system shifts further toward renewable sources.

Indeed, Canada's electricity system has already been rapidly shifting toward renewable energy sources. The federal government has mandated the complete phase-out of coal-fired power by 2030. Coal-fired generation has already been eliminated in Ontario; in 2019 coal accounted for 8% of total Canadian electricity generation, concentrated in four provinces: New Brunswick, Nova Scotia, Saskatchewan and Alberta. Natural gas plants account for another 9% of electricity generation (a share that has been stable since 2010), while oil accounts for a very small share (less than one-half of one percent).

Figure 7. Fossil Fuel Electricity Generation Share and Estimated Employment



Source: Author's calculations from Canada Energy Regulator (2019), Natural Resources Canada (2019), and Statistics Canada Table 14-10-0202-01.

Figure 7 illustrates the steady decline in the share of total electricity generated in Canada from fossil fuel sources over the last two decades. The share of electricity generated from fossil fuels has declined from close to 30% at the turn of the century to 18% in 2019. That reduced implied fossil fuel employment by about 8000 positions in that period. However, total employment in the electricity industry increased even as the transition away from fossil fuels gathered steam. Electricity system employment grew by 12,000 positions since the turn of the century.

The already-committed phase-out of coal-fired power in the coming decade (assuming that capacity is offset either with renewable power sources or by conservation and efficiency measures) will reduce estimated fossil fuel employment by another 8000 jobs. A full transition to renewables (phasing out natural gas power plants) would reduce fossil fuel employment by another 10,000 positions.

About 12% of all estimated fossil fuel jobs in Canada are in the electricity sector. This sector is already transitioning quickly toward renewables; that transition will accelerate in coming years, driven both by policy decisions (the phase-out of coal power) and the growing cost advantages of renewable power sources. Yet total electricity system employment is growing. The experience in this sector, therefore, confirms that the transition away from fossil fuel employment need not undermine total employment at all.[21]

CAPITAL INTENSITY AND SECTORAL EMPLOYMENT

One key reason for the small employment share of fossil fuel industries is that they are highly capital-intensive, and hence produce far fewer direct jobs for any given quantity of output than other sectors. Table 3 reports data on GDP (value-added) and employment for the seven fossil fuel sub-sectors listed in Table 1, and a composite weighted average for the fossil fuel sector as a whole. On average, only one job is produced in fossil fuel industries for every $1 million in value-added generated in the sector. Most of the revenue generated in these industries is received not by workers (through wages and salaries), but by the owners of the businesses (many of which are based in other countries, given heavy foreign ownership of Canada's fossil fuel industries). There is no other major sector in Canada's economy that generates fewer jobs per unit of output than fossil fuels. In contrast, across the economy as a whole an average of 8.6 jobs is generated for each $1 million of value-added. In other words, the rest of the economy (on average) is eight times more efficient at generating employment from a given amount of economic output. If the goal is genuinely to create and sustain employment, fossil fuel production is one of the worst ways to go about it. Among fossil fuel sub-sectors, the oil and gas sector is the least labour intensive: supporting just half a job with each $1 million of value-added. Pipelines are also very ineffective at creating jobs, supporting just 0.7 jobs per $1 million in value-added.

[21] The successful transition away from coal-fired electricity in Ontario, discussed below, is a good example of the potential for managing these transitions without displacing labour.

Table 3 Employment Intensity of Sector Output, 2019			
	GDP ($bil)	**Payroll Employment (000)**	**Jobs per $1m GDP**
Fossil Fuel Sectors			
Oil & Gas Extraction	109.2	55.9	0.5
Mining Services[1]	9.6	36.4	3.8
Refined Petroleum Products	11.3	17.9	1.6
Fossil Fuel Electricity[1]	6.3	17.8	2.8
Natural Gas Distribution	5.5	17.0	3.1
Coal Mining	3.4	7.4[2]	2.2
Pipelines	9.8	7.0[3]	0.7
TOTAL FOSSIL FUEL	**155.1**	**159.3**	**1.0**
Other Major Sectors			
Mining	147.8	200.5	1.4
Manufacturing	201.2	1580.7	7.9
Utilities	43.9	127.5	2.9
Construction	141.1	1041.2	7.4
Wholesale	102.2	822.9	8.1
Retail	102.2	2008.6	19.6
Hospitality	44.6	1342.2	30.1
Transportation	89.1	781.4	8.8
Information & Cultural	64.1	345.9	5.4
Finance	131.3	749.8	5.7
Prof., Science & Tech. Services	118.1	973.8	8.2
Management of Companies	9.4	109.4	11.7
Admin. & Support Services	52.2	829.8	15.9
Public Administration	133.4	1147.2	8.6
Education	104.4	1355.8	13.0
Health & Soc.Serv.	139.8	2030.9	14.5
Arts & Recreation	15.4	312.3	20.2
Other Services	37.9	556.6	14.7
TOTAL ECONOMY	**1971.8**	**16962.6**	**8.6**
Source: Author's calculations from Statistics Canada Tables 14-10-0202-01 and 36-10-0434-03. 1. Estimated shares associated with fossil fuels. 2. 2018 data. 3. Estimated based on 2016 census.			

INDIRECT JOBS AND FOSSIL FUEL PRODUCTION

The preceding analysis used payroll employment data disaggregated by industry (supplemented by census data where needed) to describe the level and trend of direct employment in several sub-sectors related to the production, processing and

distribution of fossil fuels. But there are other activities in the economy, and jobs associated with those activities, that are linked indirectly to fossil fuel production and use. Consider three major categories of these inter-industry linkages:

1. *Upstream (supply chain) linkages*: There are many industries which do not produce or process fossil fuels, but which provide inputs of goods and services to fossil fuel industries. These inputs include raw materials (like concrete, sand, or diluent), manufactured products (including machinery and equipment, steel, and others), construction (of buildings and facilities used in fossil fuel production), and services (ranging from finance to transportation to catering). Particularly in fossil fuel-producing regions,[22] these upstream activities (and the jobs associated with them) are important.

2. *Downstream (consumer spending) linkages*: When fossil fuel workers spend their earnings on the full range of consumer goods and services, they support the activity of various "downstream" industries. Sectors from home building to retail shops to restaurants and other consumer services all experience incremental business as a result of the spending power of fossil fuel workers. Again, these downstream linkages are especially evident in regions with a higher concentration of fossil fuel work.

3. *Complementary consumption*: There are other sectors which also utilize fossil fuels (at least currently) as part of the overall process of producing and delivering a service. Most automobiles today, for example, are powered by fossil fuels.[23] Buying, operating, and maintaining a motor vehicle (at present) is thus complementary to the consumption of fossil fuels.

Fossil fuel advocates often include these indirect jobs in their inflated estimates of the supposed number of jobs held to "depend" on fossil fuels.[24] But none of these upstream, downstream, or complementary positions can truly be considered "fossil fuel" jobs. The businesses and workers involved in those activities produce goods and services which are not inherently connected to the extraction and use of fossil fuels. And all these activities can and will carry on after fossil fuels are phased out.

[22] We discuss the regional distribution of fossil fuel work in detail below.

[23] Although the capability and competitiveness of electric vehicles are improving rapidly, and they are expected to account for a majority of vehicle sales within two decades.

[24] For example, Natural Resources Canada (2018) claims that Canada's broad "energy sector" (which also includes non-fossil-fuel activities) accounts for 900,000 jobs (about 70% of which are so-called indirect jobs). These claims are emphasized and exaggerated by petroleum industry lobbyists to create the impression that oil and gas "supports" far more jobs than actually exist in that sector. See a critique of these arguments by Leach (2020).

Construction and transportation services will still be needed; home-building, retail, hospitality and other downstream consumer services will still be provided; and people will still spend money on the purchase and maintenance of motor vehicles long after the internal combustion engine is relegated to technology museums. It is inappropriate, therefore, to consider these indirect jobs in an estimate of total fossil fuel employment.

At present, many of these indirect jobs (both upstream and downstream) are supported by economic stimulus arising from the activity of fossil fuel industries. But there are other ways in which the same upstream and downstream activities could be stimulated and maintained: through injections of other forms of investment, production, and employment. No-one is proposing that fossil fuel industries simply be shut down, to be replaced by nothing – although if left to its own devices, that is quite possibly what will occur as the global energy transformation gathers momentum. The best way to protect the livelihoods of workers (including those in upstream and downstream industries) is to ramp up of alternative channels of investment, job creation, and spending power. That would facilitate successful transitions for direct fossil fuel workers – and also maintain healthy economic conditions for the upstream and downstream industries which would be damaged by the sudden, unplanned withdrawal of fossil fuel activity. Boosting investment in other industries will support and anchor upstream supply chains; and creating employment in those other industries will sustain downstream consumer industries long after the last barrel of oil has been pumped.

In short, the indirect jobs which presently depend on fossil fuel industries do not inherently depend on fossil fuel extraction and use. Even in fossil-fuel-dependent regions, there are many other industries (both private and public) that can serve as "anchor industries" for regional and local economies: attracting investment, supporting upstream supply chains, and stimulating downstream consumer spending. Projects like renewable energy developments, non-carbon resource industries, hospitals, factories, universities, tourism facilities, and corporate head offices all generate strong indirect employment spin-offs (both upstream and downstream). Indeed, because they create relatively few direct jobs (just one job per $1 million in value-added, compared to 8.6 jobs per $1 million across the economy as a whole), fossil fuel industries have weaker local employment spin-offs than other leading industries. So as the economy transitions from fossil fuel production, to other leading industries, these spin-off employment effects will get stronger, not weaker. The crucial challenge is to make sure that investment, production and employment in other industries ramps up to fill the economic space currently performed by fossil fuel production. For this reason, an ambitious commitment to expanding investment and

employment in non-fossil-fuel industries must be a critical element of any effective transition plan: not just to create abundant opportunities for displaced fossil fuel workers, but also to sustain demand for the upstream and downstream sectors which currently depend on business from fossil fuel businesses and workers. The importance of this commitment to broader investment and job-creation is emphasized in the list of ten best practices in transition planning, discussed further below.

THE COVID-19 RECESSION AND FOSSIL FUEL EMPLOYMENT

The global COVID-19 pandemic has had dramatic impacts on employment in Canada and other countries, and fossil fuel industries have suffered disproportionately severe job losses during the resulting recession. The preceding analysis of fossil fuel employment was conducted using annual data up to 2019. But there is no doubt the pandemic and associated recession will alter the trajectory for fossil fuel industries for a long period of time to come. This section will consider initial evidence regarding the impact of the pandemic and recession on fossil fuel employment, on the basis of monthly payroll employment data published by Statistics Canada up to September 2020.[25] This data thus captures the first seven months of employment effects from the pandemic.

The pandemic affected fossil fuel industries in many ways:

- The reduction in economic activity in countries around the world reduced energy demand in general.
- Some important users of petroleum-based fuels (such as airlines) were hit especially hard by the pandemic.
- Electricity demand also declined – and where fossil fuels are used for peak-load generation (as is natural gas in some regions), this disproportionately reduced the use of fossil fuels.
- Instability and competition between global petroleum exporters (including members of OPEC and Russia) sparked a price war that resulted in an 80% decline in world oil prices, compared to pre-pandemic levels.

[25] Statistics Canada Catalogue 14-10-0201-01.

- Because of a quirk in speculative crude oil futures markets, oil prices actually became negative for a short time in April and May.[26] While that was a temporary phenomenon, it highlights the negative trajectory of fossil fuel prices.

- Prices for Canadian heavy oil products (including bitumen) fell even lower, due to their inferior quality and oversupplied market conditions in the central U.S. (where most Canadian oil is delivered).

- Global natural gas prices also declined dramatically, falling to their lowest point in 25 years in June (a decline of about one-third). Gas prices were suppressed both by reduced global demand and by a surge in supply (including from new LNG export facilities in Australia, Qatar, and even the U.S.).

- Global coal prices also fell by about 30% compared to pre-pandemic levels, dragged down by reduced demand and continued shifts toward renewable electricity generation in China, India, and other major markets.

For all these reasons, fossil fuel industries have faced an unprecedented conjuncture of negative effects – a "perfect storm." But that immediate crisis also reflects the longer-run erosion of global demand caused by energy conservation and rapid growth in renewables. These developments further chilled investment and exploration plans for fossil fuel firms in Canada and around the world, and accelerated restructuring initiatives that were already in motion.

Monthly Statistics Canada payroll data is available for 5 of the 7 specific fossil fuel sub-sectors that were included in Table 1 above.[27] Because of strong seasonal patterns in employment in some of these industries, it is best to measure shorter-term changes in employment on a year-over-year basis, comparing employment levels to the same month of the previous year.[28] Each of those 5 sub-sectors reduced employment in the year ending in September 2020,[29] by a combined total of over 17,500 positions between them (see Table 4).

[26] There was more oil on the market than purchasers were willing to buy, even at depressed prices, and as a result investors who held futures contracts had to pay others to take them off their hands (with the negative price reflecting costs of physically storing the oil until such time as it could be delivered to a customer). See McKinnon (2020) for more explanation.

[27] Monthly data on employment in coal mining and pipelines is unavailable for confidentiality reasons.

[28] Statistics Canada does not produce seasonally adjusted data on payroll employment for these detailed industry categories.

[29] Most recent monthly payroll data at time of writing.

Table 4 Change in Fossil Fuel Payroll Employment Year-over-Year, to September 2020			
	September 2020	**Change from September 2019**	
		Number	**Percent**
Oil and Gas	53,322	-3,341	-5.9%
Mining Services (share)[1]	24,889	-7,712	-23.7%
Fossil Electricity (share)[2]	17,714	-2,597	-12.8%
Natural Gas Distribution	15,901	-1,076	-6.3%
Petrochemicals	15,476	-2,824	-15.4%
Sub-Total (5 Fossil Fuel Sectors[3])	**127,302**	**-17,550**	**-12.1%**
Canada: All Industries	15,671,282	-1,212,642	-7.2%
5 Fossil Fuel Sector Share	**0.81%**	**-0.05%**	

Source: Author's calculations from Statistics Canada Table 14-10-0201-01 and 25-10-0015-01. Includes payroll employees only.
1. Assumed fossil fuel share of mining service jobs equals share of petroleum and coal mining in mining and petroleum employment (excluding services).
2. Assumed fossil fuel share of electricity industry employment equals share of fossil fuel generation in total electricity generation.
3. 2020 payroll employment data for coal mining and pipelines are unavailable.

The mining services industry accounted for the largest share of those job losses, reflecting the rapid decline in new exploration and development activity in the petroleum industry. With prices so low, and the outlook for a recovery so uncertain, oil companies have dramatically reduced their spending on new exploration, drilling, and development. The core oil and gas sector also shed over 3000 jobs, and the petroleum refining sector and fossil fuel-fired electricity generation each shed over 2500 more jobs.[30] About 1000 jobs were lost from natural gas utilities. Together, those job losses represent a 12% decline in employment in these 5 sectors from year-earlier levels.

That was significantly worse than the 7% decline in overall payroll employment in Canada over the same period. As a result, the share of those 5 fossil fuel sub-sectors in total employment incrementally fell during the year: by one-twentieth of a percentage

[30] The decline in estimated employment in fossil fuel-fired employment represents both a slight decline in total employment in the electricity sector, combined with a continued reduction in the share of total electricity generated from fossil fuel sources. Recall that we estimate fossil fuel-related electricity employment as the product of those two parameters.

point, to just 0.81% by September 2020. That decline in the fossil fuel share of total employment will likely get worse in coming months as national employment continues to improve as workplaces reopen after COVID.

There is little doubt that hiring conditions are getting worse, not better, in the petroleum industry as firms adjust to low global prices and reduced demand. For example, several major Canadian petroleum companies have announced staff reductions or layoffs since the pandemic struck: including Ovintiv (formerly Encana), Enbridge, and Suncor. Suncor noted it had planned to reduce staff anyway as part of a long-term cost-cutting strategy, but the job cuts were accelerated by the pandemic and recession.[31] Cenovus and Husky announced a merger, with planned elimination of one-quarter of the combined company's workforce (over 2000 jobs).[32] These structural changes suggest that much of the decline in petroleum employment experienced this year will not be reversed after the eventual reopening and recovery of the broader economy.

CONCLUSION: A SMALL AND DIMINISHING SHARE

Let us sum up this overview of the number of jobs that are directly tied to the extraction, distribution and use of fossil fuels in Canada. According to the most reliable source of sectoral employment data, under 1% of total payroll employment in Canada (or about 160,000 jobs) is located in seven industrial sectors which together comprise most of the composite fossil fuel industry. If we adjust that figure to include self-employed fossil fuel workers, the total grows to about 170,000 jobs in total – but the share of total employment is even lower (because self-employment in fossil fuel industries is less common than in the rest of the economy). The proportion of total Canadian employment accounted for by direct fossil fuel industries has declined significantly since 2014 – and falling. Between 2014 and 2019, some 33,000 fossil fuel jobs disappeared, yet overall employment in Canada grew strongly, and the national unemployment rate reached a record low in 2019. During the COVID-19 pandemic and resulting recession, another 17,500 fossil fuel jobs disappeared (representing a faster rate of job loss than experienced in the broader economy), and many of those job losses are likely permanent.

In sum, the statistical evidence tells a clear story: While fossil fuel employment is an important source of work in particular regions of Canada (and is certainly important to those who still work there today), its role in overall Canadian employment is modest

[31] See Seskus (2020).

[32] See Stephenson (2020).

and shrinking.[33] A managed transition away from fossil fuel work – planned, supported, and phased-in over many years – can certainly be accomplished successfully with minimum dislocation.

Looking forward to coming years, even without the accelerating transition to alternative energy sources, it is already apparent that fossil fuel industries will be insignificant as a source of new jobs. Even if energy prices recover and some new petroleum projects go ahead, there will be virtually no net hiring in fossil fuel industries. More likely, given weakening global demand for fossil fuels, depressed prices, continued infrastructure constraints, and aggressive cost-cutting by fossil fuel employers (shedding labour to protect profits despite lower energy prices), fossil fuel industries will see continued downsizing of their employment footprint. At the same time, aggregate employment in the broader economy will grow as the economy recovers from the current downturn associated with COVID-19, on the strength of ongoing population and economic growth. Therefore, the relative importance of fossil fuel employment in the overall Canadian labour market will continue to decline, regardless of the climate and energy policies we adopt. Instead of trying to deny and resist that trend, it makes more sense for policy to acknowledge it, and respond with a pro-active, supportive suite of policy measures: to facilitate the transition, assist those individuals and communities affected by it, and maximize the opportunities of a carbon-neutral economy.

[33] Other estimates of employment in the oil and gas sector have been published by PetroLMI (2019) and Wang (2020); despite methodological differences (for example, the PetroLMI estimates are based on a proprietary model), the order of magnitude of their estimates of direct employment are consistent with what is presented here.

The Regional Distribution of Fossil Fuel Employment

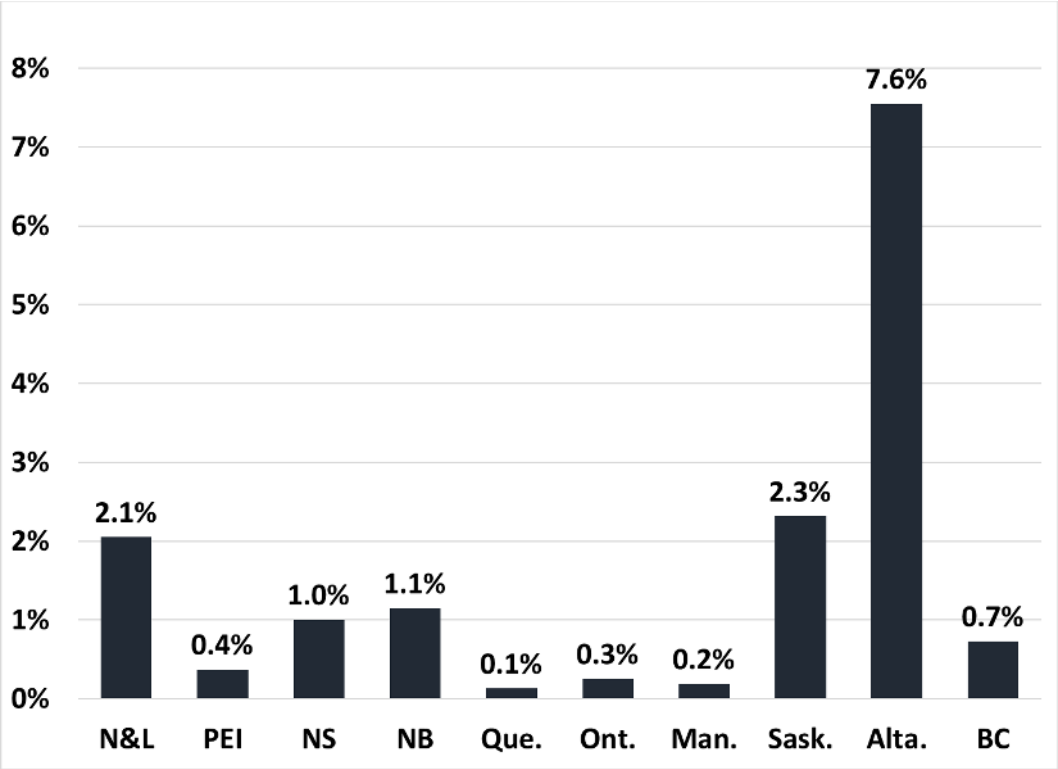
In the aggregate Canadian economy, fossil fuel industries directly account for under 1% of all jobs, and that share is already falling. It takes an extra million dollars of fossil fuel value-added to produce just one additional job. For the labour market as a whole, trends in other industries (which have much stronger employment spin-offs) will clearly dwarf the employment impact of any changes in fossil fuel industries – even their ultimate phase-out.

However, fossil fuel jobs are not evenly distributed across the country. In some provinces and communities, fossil fuel jobs are far more important than elsewhere. Hence those regions will feel the impact of the phase-out of fossil fuels more noticeably. This complicates the process of planning for employment transitions. But the number of communities that depend heavily on fossil fuel jobs is actually surprisingly small.

We can analyze the provincial and community distribution of fossil fuel employment on the basis of data from Canada's most recent census (conducted in 2016). It provides a detailed sectoral breakdown of employment data for each province and for over 150 specific communities (including large cities and smaller towns). Since employment in most fossil fuel industries has declined since 2016, the census data overstate the current importance of fossil fuel jobs in most regions and communities.[34] According to the census, as of May 2016 some 1.2% of Canadians worked in the seven fossil fuel sub-sectors identified in Table 1 (including self-employment). Since 2016, that share has declined.

[34] Keep in mind also the caution noted above, that census data (collected from individual household responses) may misallocate employment to various industries as a result of lack of precise knowledge among individual respondents regarding the precise definition of sectoral classifications.

Figure 8. Fossil Fuel Employment Shares by Province, 2016



Source: Author's calculations from Statistics Canada Census data, 98-400-X2016290.

Figure 8 illustrates the differing reliance on fossil fuel jobs across provinces in 2016.[35] Not surprisingly, fossil fuel jobs are most important in the petroleum-producing provinces. Alberta has by far the greatest reliance on fossil fuel work, with over 7% of all provincial employment accounted for by the seven fossil fuel sectors in 2016. 75% of all Canadian fossil fuel jobs in 2016 were located in Alberta. Saskatchewan and Newfoundland & Labrador also have greater-than-average reliance on fossil fuel jobs, over 2% of total provincial employment. All other provinces rank below the national average share of fossil fuel employment. Even in British Columbia (which has significant oil, natural gas, and coal production), reliance on fossil fuel employment is lower than the Canadian average. Perhaps surprisingly, New Brunswick and Nova Scotia were more dependent on fossil fuel jobs than B.C. in 2016. That reflects jobs in offshore petroleum activity, interprovincial commuters who work in fossil fuel jobs in Alberta, and provincial electricity generation systems which were still (at that time) heavily reliant on coal-fired facilities.

[35] The census data allocates employment on the basis of where each individual lives, not where they work; hence some regional and provincial data misportray the location of the work. For example, some fossil fuel employment recorded in provinces such as Newfoundland and Labrador, Nova Scotia, and New Brunswick reflects work that is actually performed in Alberta by interprovincial commuters (discussed further below).

Table 5 Fossil Fuel Dependent Communities, 2016		
Community	**Fossil Fuel Share of Total Employment**	**Industry Rank of Fossil Fuels**
Extreme Fossil Fuel Dependence (over 20%)		
Wood Buffalo, AB	31.6%	1
Estevan, SK	20.7%	1
Strong Fossil Fuel Dependence (10-20%)		
Lloydminster, AB/SK	16.8%	1
Cold Lake, AB	16.4%	2
Fort St. John, BC	14.1%	1
Sylvan Lake, AB	13.7%	2
Weyburn, SK	12.5%	2
Grande Prairie, AB	12.2%	2
Brooks, AB	10.4%	3
Moderate Fossil Fuel Dependence (5-10%)		
Calgary, AB	8.0%	5
Dawson Creek, BC	7.6%	6
Okotoks, AB	7.5%	6
Red Deer, AB	7.3%	6
Medicine Hat, AB	7.3%	5
Strathmore, AB	6.7%	6
Lacombe, AB	6.5%	7
Swift Current, SK	5.4%	8
Camrose, AB	5.4%	8
Average, 18 Fossil Fuel Dependent Communities	**9.3%**	**4**
Source: Author's calculations from Statistics Canada census data, Table 98-400-X2016290, as explained in text.		

We also analyzed the relative importance of fossil fuel employment in 152 different communities, defined in census data.[36] Table 5 lists communities with notable concentrations of fossil fuel jobs, grouped into 3 categories: extreme, strong, and

[36] These include cities (known as Census Metropolitan Areas, CMAs, with population of at least 100,000) and smaller communities (known as Census Agglomerations, CAs, with population of at least 10,000). Where communities cross a provincial border, we treat them as one community (including Ottawa/Gatineau, Campbelltown, Hawkesbury, and Lloydminster).

moderate dependence. There are 2 communities extremely dependent on fossil fuel employment (accounting for over 20% of total local employment). There are 7 strongly dependent communities, where fossil fuel jobs make up between 10% and 20% of total local employment. Finally, there are 9 moderately dependent communities where fossil fuel work accounts for 5-10% of total employment.[37] That latter category includes one city (Calgary). All other communities listed on Table 5 are medium-sized towns, with population between 10,000 and 100,000 (defined as "Census Agglomerations" in Statistics Canada's census). Table 5 reports fossil fuel employment in each of those communities as a share of total local employment. Table 5 also reports the ranking of the composite fossil fuel sector among all other local industries (as defined at the 2-digit level of aggregation).

The two communities most dependent on fossil fuel jobs are Wood Buffalo, Alberta (encompassing Fort McMurray and its concentrated bitumen industry) and Estevan, Saskatchewan. In both cases, the aggregate fossil fuel sectors ranks as the largest industry in the region: accounting for over 30% of employment in Wood Buffalo, and over 20% in Estevan. In the 7 strongly fossil fuel-dependent communities (where fossil fuel jobs accounted for 10-20% of local employment), the fossil fuel sector ranked between 1st and 3rd among all local industries. In the remaining 9 communities listed in Table 5, fossil fuel jobs accounted for between 5% and 10% of all local employment, and the composite fossil fuel industry ranked from 5th to as low as 8th among local employing sectors.

Together, those 18 identified fossil fuel-dependent communities accounted for a total of about 105,000 fossil fuel jobs, representing 9.5% of all employment in those communities. Those 18 communities accounted for close to half (45%) of all fossil fuel jobs in Canada in 2016, but only 6% of total national employment. Excluding Calgary (a large city with a very diverse labour market), the other 17 fossil-fuel-dependent communities in Table 5 accounted for only 1.7% of national employment. This concentration of fossil jobs in a relatively small number of communities suggests that the challenge of supporting transitions in fossil fuel-dependent communities is manageable: relatively few Canadians live in communities that are highly dependent on fossil fuel industries, and the number of such communities is small. That implies that concerted supports funded from federal and provincial revenues could be directed to those communities to support a better transition. Note also that even across these 18 particularly fossil fuel-dependent communities, fossil fuel industries still made up less than one-tenth of total employment in 2016. And across the 18

[37] A somewhat similar approach to categorizing communities as fossil fuel-dependent is followed by Marchand (2012), although measured according to total labour compensation rather than employment.

communities in total, fossil fuel employment ranked 4th among all employing sectors (at the 2-digit level). Even in these communities, then, it will be employment trends in other sectors that shape the overall health of the labour market.

It is certainly true that certain regions and communities in Canada will experience the employment effects of the transition away from fossil fuels more noticeably. But the number of communities that depend heavily on fossil fuel employment is small – and the combined population of those regions is also small. With appropriately targeted support measures and alternative job creation initiatives (discussed further below), those regionally concentrated impacts can be addressed, and local workers and residents supported and protected.

Table 6
Fossil Fuel Jobs in Urban and Rural Areas

	35 Cities (CMAs[1])	117 Towns (CAs[2])	Other (Rural)
Fossil Fuel Share Employment	0.9%	2.4%	1.7%
Share of all Fossil Fuel Jobs	56.0%	22.5%	21.5%
Rank Among Industries[3]	16	15	16

Source: Author's calculations from Statistics Canada Census data, 98-400-X2016290.
1. CMA=Census Metropolitan Area (min. pop. 100,000).
2. CA=Census Agglomeration (min. pop. 10,000).
3. Among industries defined at 2-digit level.

Another important dimension of the geographical distribution of fossil fuel jobs is the split between cities, smaller communities, and rural areas. Statistics Canada identifies 35 Census Metropolitan Areas (CMAs): urban concentrations with at least 100,000 residents, including at least 50,000 living in a defined central region.[38] Those 35 cities account for almost 75% of total employment in Canada. Statistics Canada also identifies 117 medium-sized towns, called Census Aggregations (CAs), with population of at least 10,000. The remaining population lives in rural areas and very small towns.

Table 6 reports the distribution of fossil fuel employment between CMAs, CAs, and rural regions on the basis of 2016 census data. Perhaps surprisingly, most fossil fuel jobs (56%) are located in cities. These urban fossil fuel jobs incorporate a wide range of occupations and functions, including head office jobs, technical and professional roles, manufacturing and distribution work. The fact that most fossil fuel jobs are located in

[38] See Statistics Canada, Catalogue 92-195X.

cities will ease the coming employment transitions, for several reasons. In those cities, fossil fuel jobs are never a dominant source of employment. Even in Calgary (Canada's most fossil fuel-dependent CMA), fossil fuel jobs account for just 8% of total employment, and fossil fuel industries collectively rank as only the 5th largest employer in that city – behind (in order) retail, health care, professional and technical services, and construction. In other cities with an important fossil fuel industry presence (including Edmonton, Regina, and St. John's), the collective presence of fossil fuel jobs ranks even lower (between 11th and 16th) among local employers. Clearly, for fossil fuel workers in urban areas, opportunities for transitioning to alternative employment are more available and accessible, given the size and economic diversity of the places they live. Population growth in Canada is faster in large cities, and this will also open up job opportunities for former fossil fuel workers. Finally, urban-living fossil fuel workers are more likely to possess skills (such as managerial, technical, and administrative functions) that are relatively transferable to alternative industries.

Across Canada's CMAs in total, fossil fuel industries accounted for 0.9% of total employment in 2016, slightly lower than the national average that year. Collectively, fossil fuel industries ranked as the 16th largest industry (at the 2-digit level) in Canada's cities. The fact that most fossil fuel jobs are located in these diversified and flexible cities, with numerous alternative employment opportunities available nearby, will be an important and positive factor in facilitating adjustment.

The remaining fossil fuel jobs are evenly split between medium-sized towns (CAs) and rural areas (including towns too small to be classified as CAs). CAs and rural areas each account for slightly over one-fifth of all fossil fuel jobs. As a share of total employment, fossil fuel jobs are more important in CAs, where they account for 2.4% of all employment. But that still leaves fossil fuel industries in aggregate as the 15th largest employer. In rural areas, fossil fuel jobs account for 1.7% of total employment, and rank collectively as the 16th largest employer.

The larger proportionate presence of fossil fuel jobs in towns and rural areas implies a more challenging transition process: both because fossil fuel jobs account for a larger share of total employment than in cities, and because local and regional labour markets are less diversified than in cities. However, that challenge in non-urban labour market adjustment is heavily concentrated among the small number of communities with fossil fuel employment concentrations higher than 5% of local employment. Table 5 listed 17 non-urban fossil-fuel-dependent CAs (all of the communities listed there other than Calgary). Those communities account for roughly 40,000 fossil fuel jobs, and that accounts for 80% of all CA-located fossil fuel jobs located across Canada. In the 100 remaining CAs, fossil fuel industries account for a very small share of total

employment (just 0.7%), and the combined fossil fuel industry never ranks higher than 10th among local employers (for industries defined at the 2-digit level).

So while the phase-out of fossil fuel employment will indeed be most challenging in the communities which presently depend strongly on those jobs, that regional adjustment problem is limited to a surprisingly small number of communities. There are only 17 medium-sized CAs, and one CMA (Calgary), where fossil fuel employment accounts for over 5% of total local employment. There are a handful of communities which will face serious challenges to their stability as fossil fuels are phased out.[39] In other cases, opportunities for reallocating work and production to other industries, and facilitating inter-regional and inter-sectoral mobility for affected workers, will be more promising. The point here is not to suggest that since the number of communities which do depend heavily on fossil fuels is small, they can be ignored by government policy. To the contrary, because the number of heavily affected communities is small, the rest of Canada can mobilize and concentrate significant resources to facilitate those transitions, but within an overall economic and fiscal envelope that is practical and sustainable. With only 17 medium-sized communities in the country depending moderately or strongly on fossil fuels (and one major city), and less than 1% of total employment directly engaged, a combined effort by all levels of government to support these workers and communities is absolutely feasible. The regional adjustment challenge is thus manageable: addressed with powerful but focused supports concentrated on a limited number of communities.

[39] Without doubt, Wood Buffalo is the most vulnerable community, given both its extreme reliance on fossil fuel work and its remoteness from other population and economic centres.

Comparing Fossil Fuel Industries and Health Care

Even in those provinces and communities which are most dependent on fossil fuel industries, fossil fuel jobs almost always make up a small minority of total employment. Indeed, in most cases, more jobs exist in the broader health care and social services sector (Canada's largest employer) than in fossil fuel industries. In other words, it is more accurate to describe those provinces and communities as "health care-dependent" economies, than to call them fossil fuel-dependent. This surprising finding dramatizes the leading importance of other major sectors (like health care) in determining employment trends throughout Canada – even in regions with a unique concentration of fossil fuel-related employment.

Table 7
Relative Employment,
Fossil Fuel Industries and Health Care, 2016

	Fossil Fuel Jobs		Health Care & Social Services Jobs	
	Number	**Share**	**Number**	**Share**
18 Fossil Fuel-Dependent Communities	103,700	9.3%	118,200	10.6%
Petroleum-Dependent Provinces				
Alberta	170,900	7.6%	245,900	10.9%
Saskatchewan	13,300	2.3%	76,600	12.6%
Newfoundland & Labrador	5,200	2.1%	37,100	14.7%
3 Petroleum-Dependent Provinces	189,350	6.1%	355,600	11.5%
Canada Total Economy	225,800	1.2%	2,138,000	11.7%

Source: Author's calculations from Statistics Canada Census data, Table 98-400-X2016290.

Table 7 compares total employment in fossil fuel jobs and in the broader health care sector in the most fossil fuel-dependent provinces and communities in Canada (based on 2016 census data). The first line of Table 7 reports combined data for the 18 fossil fuel-dependent communities listed above in Table 7 (all communities where fossil fuel industries accounted for over 5% of all total employment). The next lines report

corresponding data for the three most petroleum-dependent provinces. In all three provinces, and in aggregate for the 18 fossil-fuel-dependent communities, health care supported more jobs than fossil fuel industries. Across the 18 communities in total, health care accounted for 10.6% of total employment – versus 9.3% in fossil fuel roles. Across the 3 petroleum-producing provinces, health care accounted for 11.5% of total employment: almost twice as much as the 6.1% share in fossil fuel jobs. Even in Alberta, there were 45% more jobs in health care than in fossil fuel industries. In Canada as a whole, meanwhile, there were almost ten times as many jobs in health care and social services than in fossil fuel industries in 2016 – and that ratio has increased further since then (due both to expanded health care hiring and the decline in fossil fuel jobs).

We present this comparison between health care (Canada's largest source of work) and fossil fuel industries only to illustrate the fact that even in regions and communities where fossil fuel jobs are concentrated, most jobs are still found in other sectors. Moreover, the future growth of employment in those other, larger sectors will be the critical determinant of how labour markets adjust following the phase-out of fossil fuels. Health care is an informative comparator in this regard, since health care jobs exist in every community, many are high-skill and well-paid roles, and the industry as a whole faces an optimistic and expansionary future. Canada's ageing population and rising income levels ensure that health care will continue to grow as a share of total output and employment in the national economy. Moreover, since public policy decisions play a central role in the development of health care, the sector is amenable to efforts to deliberately shape investment and employment decisions in line with broader public policy priorities. Therefore, deliberate efforts to channel health care opportunities toward particular regions or communities could play an important role in managing the employment effects of the transition away from fossil fuels.

For example, it was shown in Table 5 that Wood Buffalo/Fort McMurray is by far the most fossil fuel-dependent community in Canada. Imagine if the federal and provincial governments cooperated on the establishment of major health care-related facilities (for research, administration, specialist care, and other services that could be provided to the broader provincial or even national populations) there. It might not seem like the most "convenient" location for facilities that serve a national service function, and inducements and supports will be required to both retrain current residents and attract requisite specialist workers to the community. But as part of sharing the burden of a transition that is important to the well-being of all Canadians, targeted investments like that could assist (both economically and politically) the coming adjustment. Similar strategies could be utilized to allocate other investments and facilities to fossil-fuel-dependent communities.

In addition to health care, there are multiple other industries which also provide more jobs than fossil fuel industries, even in fossil fuel-dependent regions. And hence the future growth of those industries will be equally helpful in facilitating adjustment to the phase out of fossil fuel employment. Other sectors like manufacturing, education, construction, public administration, and professional and technical occupations could all play a vital role in generating new opportunities, even in fossil fuel regions, as fossil fuel industries are phased out.

With public services such as health care, an argument is often made that those industries could not exist without fossil fuel industries to "pay their bills." This claim is false. The share of fiscal revenues generated by fossil fuel industries is not unusual, relative to the scale of their profits and revenues; indeed, in recent years (given huge losses incurred in most fossil fuel sub-sectors) those fiscal contributions are even less impressive. And governments do not need fossil fuel revenues in order to allocate resources to providing health care – even in fossil fuel-dependent communities. To the contrary, they possess abundant fiscal capacity to provide health care and other public services whenever their constituents desire them to be provided. Indeed, major public investments in health care and other public services fulfil a very similar structural function to investments in energy projects: they initiate production, spur aggregate demand, stimulate indirect activity (both upstream and downstream), and generate incomes and tax revenues. In this context, health care is no more dependent on fossil fuels, than fossil fuel industries are dependent on health care.

Past Employment Transitions in Canadian History

Canadians are no strangers to economic change. Our national economy and labour force have experienced dramatic structural shifts in the past. And we will experience more of them in the future. Indeed, “change” has been a constant feature of Canada’s economic history.

Moreover, several of the previous economic and employment transitions successfully traversed by Canada in the past were significantly larger, in relative terms, than the coming transition away from fossil fuels. Some of those structural shifts were negative: involving major reductions in employment in certain industries or regions. Some were more positive: powered by the gravitational pull of growing industries, new jobs, new technologies, and new occupations. Change is easiest, in fact, when those two dimensions coincide: that is, when people displaced from one vocation have abundant alternative opportunities to pursue, and when rapidly growing industries have access to sources of labour and talent freed up by the contraction of other, older sectors.

Those past tectonic changes were inevitably accompanied by uncertainty, fear, and in some cases hardship. But in the end, Canada’s labour market, and the individuals who compose it, adjusted – in most cases surprisingly quickly. Entire industries disappeared, and new ones were born. Populations shifted from one place to another. New skills were learned, new investments made, new technologies perfected. And in the end, Canadians were better off: with higher productivity, higher incomes, more interesting jobs, and more rewarding, healthier lives. Our collective capacity to adapt is still with us today; we can have confidence in our continuing ability to manage change. Some of those transitions were managed and supported fairly and effectively, some were not. From those transitions which were disruptive, unplanned, and induced widespread hardship, we can learn crucial lessons about how to better prepare for structural change, and support those who are affected by it. And the whole range of experience of past transitions (good, bad, and ugly) confirms that the coming phase-out of fossil fuels poses an economic and social challenge that is neither unprecedented nor unmanageable.

In this section we review just some of the previous large employment transitions Canada has experienced. Relative to the corresponding population base at the time, all of these transitions were as large as or larger than the coming transition away from fossil fuels. They were all experienced without lasting increases in unemployment or

deterioration in living standards. This experience shows that – paired with smart policies and strong supports for affected workers and communities – the coming phase-out of fossil fuel industries can be managed fairly and effectively.

Agriculture: At the time of the 1901 census, over 40% of Canadians reported that they worked in the agricultural sector.[40] Today that share has declined to just 1.5%.[41] Measured as a share of the workforce, therefore, the decline in agricultural employment was 40 times greater than the coming transition away from fossil fuel jobs.[42] Of course, the long-run shift of work away from farms was an inevitable dimension of Canada's evolution into a modern industrial economy. To be sure, that involved painful decisions by many people, especially young people, to leave the rural communities where they were born and raised. They were ultimately motivated by a belief their lives would be improved by doing so. The disappearance of most of the jobs in an industry that once accounted for two-fifths of all work coincided with sustained increases in total employment in other industries, strong productivity growth, and rising living standards.

Urbanisation: The flip side of the coin of agricultural depopulation has been the explosive growth of population and employment in Canada's major cities. At the turn of the 20th century, 62.5% of Canadians lived in rural areas. Canada's cities had a combined population of just 2 million (37.5% of the national population).[43] Today those proportions have been more than reversed. In 2019, 27 million Canadians (72% of the national population) lived in cities with a population over 100,000. 12% of Canadians live in medium-sized towns (over 10,000), and 16% live in smaller towns and rural areas.[44] The increasing concentration of population (and employment) in Canada's major cities poses problems and challenges, including stressed infrastructure and high housing costs. Population in cities is growing three times faster than the population outside of cities.[45] But large cities have become the most important engines of Canada's economy. They offer substantially higher incomes and more

[40] Statistics Canada, *Historical Statistics of Canada*, Catalogue 11-516-X, Table D1-7.

[41] Author's calculations from Statistics Canada Table 14-10-0022-01.

[42] This decline in agricultural employment also occurred over a very long period of time: over a century. But even on an annualized basis, the rate of decline of agricultural employment as a share of total employment was several times faster than will be required to phase-out fossil fuel employment. The agricultural employment share fell by one-third of a percentage point per year, compared to a decline of one-twentieth of a percentage point per year required to phase out fossil fuel employment over the next two decades.

[43] Statistics Canada, *Historical Statistics of Canada*, Catalogue 11-516-X, Table A67-69.

[44] Authors calculations from Statistics Canada Table 17-10-0135-01.

[45] See Statistics Canada, "Canada's population estimates: Subprovincial areas," *The Daily*, February 13, 2020.

opportunities. Continuing urbanisation is boosting Canadian growth, productivity and incomes. Fortunately, most fossil fuel jobs in Canada are located in cities, most of which are experiencing rapid employment growth and offer a wide range of alternative employment prospects. That will be especially useful in the transition away from fossil fuel employment.

Women's Paid Work: Another enormous shift in Canada's labour market has been the dramatic increase in women's participation in paid work. In 1948, after the demobilization of war production (in which women had played a vital role), women constituted just 21% of the paid labour force in Canada.[46] (Of course, women always performed the vast majority of unpaid work in homes and communities.) Today women constitute almost half the paid workforce: 47.4% in 2019.[47] Adjusting to women's increased labour supply has required many changes: in families, in workplaces, in government policies. But initial fears that there wouldn't be enough work to employ so many women were completely unfounded. Today, in fact, women experience a slightly lower unemployment rate than men: an average of 5.3% for women in 2019, compared to 6.0% for men. The labour market adjusted to women's growing participation, and Canadians are better off for it.

Manufacturing: Canada once ranked in the top tier of manufacturing countries in the world, with a successful and disproportionately large presence in several technology-intensive manufacturing sectors – including automotive, aerospace, and telecommunications equipment. Today, Canada's manufacturing industry has been significantly damaged and downsized. At the turn of this century, the manufacturing sector employed over 2 million Canadians, and accounted for 16% of all employment.[48] Over one-quarter of those jobs (almost 600,000 positions) disappeared in the next decade. By 2010, manufacturing employment had shrunk to under 10% of all jobs. The loss of manufacturing work in the 2000s thus represents a loss of absolute jobs more than three times larger than the current level of fossil fuel employment, within half the timeframe suggested here. In relative terms (as a share of total employment), the decline of manufacturing employment was 6 times greater than would be required by the complete phase-out of fossil fuel industries. Ironically, much of the pain experienced in manufacturing was directly attributable to the explosive growth of petroleum production during the same period, including via its impact on the Canadian exchange rate and hence on the competitiveness of domestic manufacturing.[49]

[46] Statistics Canada, *Historical Statistics of Canada*, Catalogue 11-516-X, Table D146-159.

[47] Author's calculations from Statistics Canada Table 14-10-0287-01.

[48] All data in this section are author's calculations from Statistics Canada Table 14-10-0201-01.

[49] See Clarke et al. (2013) for detailed discussion of the deindustrialization side-effects of the expansion of the petroleum industry after 2002.

However, despite the pain of this downsizing, the regions most affected by the shut-down have adapted remarkably.

Most of the lost manufacturing jobs were located in Ontario and Quebec. In 2000, manufacturing accounted for 19% of employment in those two provinces; Ontario and Quebec then experienced over 80% of the manufacturing job losses over the subsequent decade. By 2010, manufacturing's share of employment in the two provinces fell to 12% – and it slipped by another percentage point over the following decade.[50] Despite the disruption in provincial labour markets from the rapid decline in manufacturing, both provinces subsequently experienced a strong rebound in total employment, spread across a diverse range of occupations. Overall unemployment rates in both provinces have been below the national average in recent years – and in Quebec, the unemployment rate reached a 50-year low in 2019. So while the crisis in Canadian manufacturing in the 2000s imposed severe hardship on many communities in those two provinces (and elsewhere),[51] and while that rapid downturn was facilitated by policy mistakes which failed to recognize the importance of domestic manufacturing, the reality is that manufacturing regions did adapt and survive.

Automotive Manufacturing: A notable (and particularly painful) dimension of the crisis of Canadian manufacturing in the 2000s was the downturn in Canada's automotive manufacturing sector, which experienced a particularly turbulent and painful contraction. The Canadian auto sector peaked in 1999, when we assembled over 3 million vehicles – ranking Canada as the 4th largest auto assembler in the world at the time, a remarkable achievement for a small country.[52] As of 2000, some 185,000 Canadians were employed in automotive manufacturing: including vehicle assembly, parts manufacturing, and bus and truck body production.[53] At that time, the auto industry accounted for more absolute jobs, and a significantly larger share of total employment, than fossil fuel industries do today. Almost all auto jobs were located in Ontario and Quebec, where the industry directly accounted for about 2.5% of all employment. In the face of growing international trade imbalances, a shift of production toward Mexico and other low-wage countries, and the impacts of the 2008-09 financial crisis (which pushed the major North American auto companies into restructuring), 40% of those auto jobs disappeared within a decade.[54] That

[50] Manufacturing employment thus declined by 8 percentage points as a share of total employment in Ontario and Quebec between 2000 and 2020. That is more than the relative share of fossil fuel jobs in total employment in Alberta today (around 7%).

[51] Even Alberta lost 20,000 manufacturing jobs between 2006 and 2009.

[52] For more on the history of Canada's automotive successes and subsequent downturn, see CAW-Canada (2012).

[53] Author's calculations from Statistics Canada CANSIM Table 281-0005.

[54] Author's calculations from Statistics Canada Table 14-10-0202-01.

represented a decline of some 75,000 positions. Without doubt, the crisis in the automotive industry was extremely damaging to auto-dependent communities and the provincial economies of Ontario and Quebec. But again, both the industry and the regional economies adjusted and adapted. Since 2010, Canadian auto employment has regained about 25,000 (or one-third) of those lost jobs. Recent investments (including in electric vehicle production) signal further expansion in the years ahead. Meanwhile, regional labour markets also adjusted, eventually generating new sources of investment and employment. The decline of automotive employment in part reflected the failure to appropriately manage the sectoral composition of Canada's economy – including a failure to prevent damaging side-effects from the 2000s petroleum boom. The industry should have been sustained and supported with a more balanced and far-sighted industrial strategy. Nevertheless, both the scale of the downturn, and the subsequent adjustments made by both the industry and the communities where it is concentrated, attest to the resilience and flexibility of Canada's economy and labour market.

Forestry: An equally cataclysmic industrial transformation has been experienced in British Columbia's forestry sector. In 2000 a total of over 90,000 B.C. workers worked in various forestry-related activities: including logging, pulp and paper manufacturing, and wood product manufacturing. At the time that represented 6% of total provincial employment.[55] The industry then experienced a "perfect storm" caused by multiple factors: including U.S. protectionist policies (penalizing exports of B.C. forest products), an epidemic of mountain pine beetles (related to warming temperatures) that destroyed millions of hectares of forest, the financial crisis of 2008-09 (centred in the U.S housing sector, causing painful damage for B.C. wood producers), and growing incidence of forest fires (also related to climate change). Combined employment in forestry-related sectors fell by half in the next decade, representing a loss of 45,000 positions. Forestry's share in total provincial employment fell steeply: to just 2.5% by 2010, and slipping further to around 2% at present.[56] The crisis in the provincial forestry sector has caused significant dislocation and hardship in particular communities. Like the crisis in manufacturing in Ontario and Quebec, forestry workers and communities should have received more support in preparing for and adapting to this historic change. But despite those policy failures, the overall B.C. economy and labour market have taken the downturn in stride. B.C.'s employment and population growth have remained very strong, and the province enjoyed Canada's lowest provincial unemployment rate for 4 straight years from 2016 through 2019.[57]

[55] Author's calculations from Statistics Canada CANSIM Table 281-0005.

[56] Author's calculations from Statistics Canada Table 14-10-0202-01.

[57] Author's calculations from Statistics Canada Table 14-10-0078-01.

Fisheries: Another economic shock related to environmental destruction was the collapse of the East Coast cod fishery in the mid-1990s. The collapse resulted from the cumulative effects of overfishing, and was felt most acutely in Newfoundland and Labrador. When the federal Department of Fisheries and Oceans imposed a moratorium on the northern cod fishery in 1992, an estimated 37,000 inshore fishers and fish plant workers in Newfoundland lost work.[58] Some have referred to the codfish closure as the largest single industrial lay-off in Canadian history,[59] representing a stunning 15% of the provincial labour force.[60] Federal and provincial governments provided various support and transition packages, including incentives to give up fishing licenses and relocate from small fishing communities to larger centres. The sudden closure of the cod fishery was predictably devastating to the province: the provincial unemployment rate (normally higher than the national average due to seasonal unemployment associated with fishing) rose from 18% in 1991 to 22% by late 1992. Over time the provincial economy gradually regained stability. Some workers found opportunity in alternative fisheries (such as crab, lobster, and halibut). Diversification into other industries (including offshore petroleum, education, electricity, tourism, and technology) also provided a broader and more stable employment base. The unemployment rate gradually fell, reaching 11.5% in by 2013. Interprovincial out-migration from Newfoundland peaked in 1997 when a net total of almost 10,000 residents left the province. Net outmigration slowed after that, and even reversed direction for several years after 2008, with the onset of a net inflow from other provinces.[61] The Newfoundland and Labrador economy still faces daunting economic and demographic challenges in the years ahead, that have been exacerbated by the COVID-19 pandemic and the downturn in petroleum revenues.[62] If anything, the painful experience of the cod moratorium is a warning of the dangers of unplanned, sudden, enforced shocks in important industries. By waiting until dramatic action was forced upon the province as a result of environmental breakdown, the process of adjustment was more chaotic and disruptive. This is a lesson that should be considered carefully in the case of fossil fuel industries: a planned, pro-active, and gradual

[58] See Harris (1999) and May (2009) for more details on the collapse of the fishery and its economic and social impacts.

[59] See Brearton (2015), for example.

[60] Author's calculations from Statistics Canada Table 14-10-0287-01.

[61] Author's calculations from Statistics Canada Table 17-10-0021-01. Since 2016 net migration has once again been outward.

[62] The rapid expansion of petroleum activity in the 2000s accelerated Newfoundland's post-cod transition, and rising GDP levels elevated the province (for a time) to "have" status within Confederation (even though household incomes in the province remained well below Canadian averages – confirming the inappropriateness of GDP as a measure of human well-being). Painfully, the province now faces another transition as a result of the more recent downturn in petroleum work.

transition away from fossil fuels will be far less disruptive and painful than one forced upon the industry and its stakeholders by an ultimate confrontation with environmental constraints. Despite that hardship, however, even the Newfoundland experience attests to the capacity of labour markets for adjustment and transition. The provincial labour market has not just survived this historic disruption – it has actually emerged stronger and more prosperous.

Scientific & Technical Services: A more positive story of adjustment and transition is provided by the experience of Canada's high-tech sector. Measured by the rate of growth of employment, the fastest-growing major sector in Canada has been the professional, scientific and technical services industry. Total employment grew 15% over the past 5 years – adding over 130,000 new positions.[63] The industry is skills-intensive, highly productive, and generates above-average earnings. Of course, rapid change may seem "easier" when it involves expansion and new opportunity. But rapid growth can be stressful, too. And the economic reality is that strong growth in vibrant sectors requires a relative contraction in other industries in order to free up needed resources and fill new positions. The continuing growth of Canada's high-tech industry will require a steady supply of available and qualified workers. Indeed, this sector alone is creating 3.5 times more jobs each year than would be required to offset the phase-out of existing fossil fuel employment over a 20-year timetable. This does not mean, of course, that fossil fuel workers must all retrain as tech workers: as explained below, most of the transition out of fossil fuel employment will be facilitated through normal patterns of entry, exit, and redeployment that occur in the labour market all the time. But the rapid growth of technical and scientific services confirms that in an aggregate sense, the creation of new work in other parts of the economy will more than fill the economic space opened up by the gradual phase-out of fossil fuel production.

* * * * *

This section demonstrates clearly that the coming transition of employment away from fossil fuel industries is not at all unprecedented in Canadian economic history. To the contrary, our national economy has repeatedly experienced major employment restructuring across industries and regions – in many cases much larger than what will be associated with the phase-out of fossil fuels. Sometimes those transitions were painful, sometimes they were characterized by positive opportunity. And we can surely learn from badly-managed cases how to anticipate change (rather than denying its necessity), seek opportunity in new industries and occupations (rather than trying to

[63] Author's calculations from Statistics Canada Table 14-10-0202-01.

delay adjustment), and support workers and communities in making transitions more smoothly and less painfully.

Moreover, fossil fuel industries are not the only industries in Canada in which dramatic structural change and employment transitions are occurring today. Consider Canada's retail sector, where tens of thousands of jobs have been eliminated in recent years by structural changes (including the collapse of traditional department stores, the rise of big box brands, and the shift to online shopping). Canada's transportation industry has been upended by new technologies and business models – such as the rise of digital on-demand platforms which threaten the livelihood of Canada's 50,000 taxi drivers.[64] Tens of thousands of jobs have disappeared in recent years from conventional media businesses (especially newspapers),[65] similarly disrupted by new technologies and business models – not to mention by the free-riding of global digital giants (like Google and Facebook).

Workers in all these industries face at least as much insecurity as do fossil fuel workers. But in these industries there has not been the same superficial alignment of interests between workers and powerful business forces working feverishly to preserve their once-profitable positions. Hence retail workers, taxi drivers, and journalists rarely receive expressions of "concern" from wealthy business leaders and crusading politicians.[66] In this context a more holistic and inclusive perspective must be adopted to the labour market challenges posed by economic and technological shifts of all kinds. The forces sparking those changes must be regulated and managed, and comprehensive approaches taken to supporting affected workers and communities, and ensuring that the overall trajectory of the labour market opens up abundant alternative opportunities for anyone displaced by them. As will be described in the next section, fossil fuel workers are just one part of a much larger and constant flow of workers who move between jobs, occupations, and industries every year.

[64] Estimate by Xu (2012).

[65] See Skelton (2018).

[66] As discussed below, this "concern" for the well-being of fossil fuel workers is inconsistent; where wages, working conditions, safety, and technological displacement are concerned, fossil fuel workers are treated as badly as as any other group of vulnerable workers.

A Labour Market in Constant Motion

The long history of dramatic change in Canadian employment patterns – both positive and negative – confirms that ongoing structural change is an inherent feature of the national labour market. Employment is constantly shifting across industries, occupations, regions, and demographic groups. Because it aggregates the decisions of millions of individual workers and employers – each following their own best judgments regarding personal, industrial, macroeconomic, and policy conditions – the overall labour market has an innate and impressive capacity to adjust over time. That flexibility will be crucial in facilitating the employment adjustments associated with the coming transition away from fossil fuels – adjustments which, as discussed above, are neither unprecedented nor unmanageable.

GROSS AND NET CHANGES IN EMPLOYMENT

To gain some perspective on the many forces that drive labour market adjustment, we start by considering the difference between gross and net changes in employment. This distinction sheds light on the impressive scale of the flows and adjustments that occur in employment every month. Media reporting on national job creation usually reports the *net* change in *total* employment from one month to the next. That number is usually positive: typically between 20,000 and 30,000 net new jobs in a month, representing a small expansion in the total amount of employment (with a typical growth rate of 0.1-0.2% per month). For example, during calendar 2019 the total level of employment reported in Statistics Canada's monthly Labour Force Survey grew by an average of 27,000 jobs per month.[67]

But underneath that rather undramatic gradual growth – think of it as the relatively calm "surface" of the labour market – is a constant whirlpool of labour market churn. The headline number reports net job creation across the whole economy: it equals the

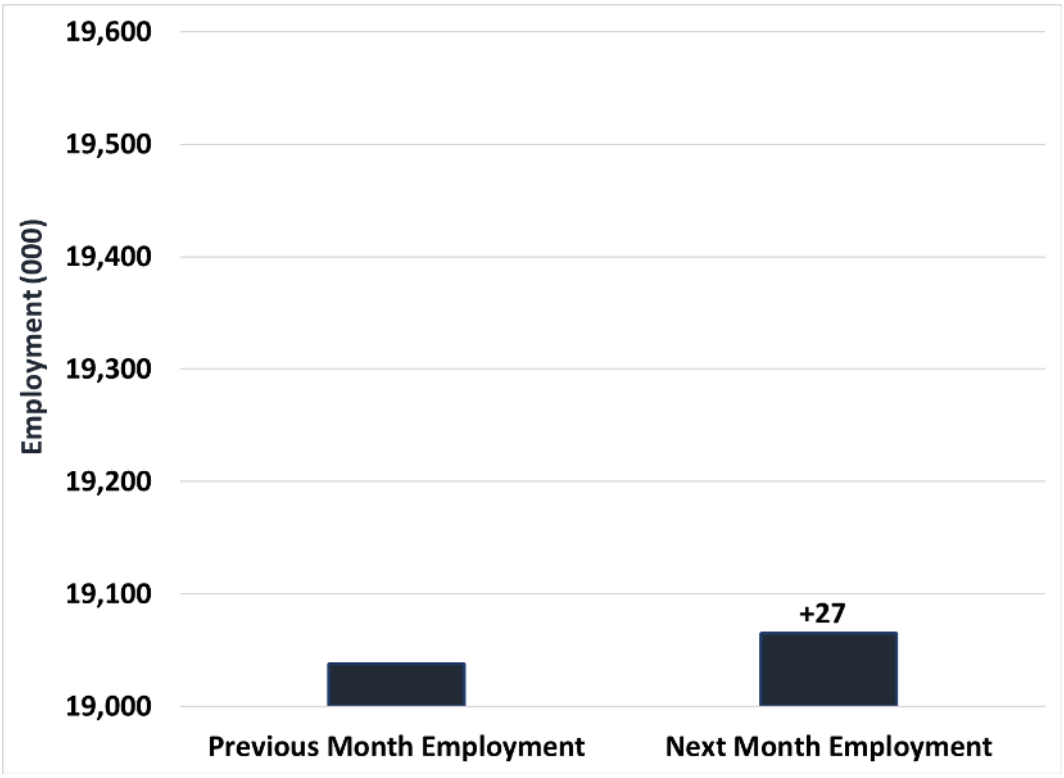
[67] Author's calculations from Statistics Canada Table 14-10-0287-01. Monthly fluctuations also reflect normal seasonal increases and decreases in total employment, and so the average absolute change in employment from one month to the next is larger than this: with an average absolute change of 115,000 in 2019 (with that change being negative in half of the months). Adjusted for seasonality, however, month-to-month changes are smaller and usually positive. Of course, due to the unprecedented labour market shocks associated with the COVID-19 pandemic and resulting recession, the absolute size of month-to-month employment fluctuations was much larger in 2020.

total (or gross) number of jobs created, less any jobs that disappeared. But on a gross basis, far more jobs are created each month than is implied by the monthly net total. However, most of those new jobs are offset by a substantial number of other jobs that disappeared in the month.

Similarly, the number of individual Canadians who find new work in a given month is much larger than the net number of new jobs created. That's because the large number of people finding new work, is offset by another large group of Canadians who *lost* work in that same month. There are many reasons why Canadians lose work. Some become unemployed involuntarily. But in non-recessionary times, most choose voluntarily to leave their jobs: for study, for family reasons, or to retire.

All of those significant, ongoing adjustments in the labour market even out to a relatively small monthly change in total net employment – but that net figure dramatically understates the true flux that regularly occurs. So we shouldn't be misled by the apparent "calm" on the surface of the labour market, to ignore the incredible dynamism constantly unfolding underneath.

Figure 9: Average Monthly Net Employment Creation, 2019



Source: Author's calculations from Statistics Canada Table 14-10-0287-01. Shows average monthly net job creation in 2019, applied against assumed starting point equal to July 2019 employment.

Figures 9 and 10 portray the stark differences between net and gross changes in employment.[68] The two figures provide contrasting illustrations of the changes in employment in a typical month in 2019; they are presented on equally-scaled y-axes to allow comparability across the two graphs. As indicated in Figure 9, total employment increased by an average of 27,000 positions per month that year.[69] To indicate the modest relative size of that monthly change, we apply the average monthly growth to the starting level of total employment at the midpoint of the year (in July). This represents a small, gradual expansion of total net employment: equivalent to an increase of 0.12% per month in the total number of people working.

However, that seemingly placid overall result hides enormous change and turmoil occurring throughout the labour market. The small monthly growth in net employment is the balance of many complicated, larger changes in underlying employment patterns: some positive, but many negative. In imagining how the labour market could adjust to a seemingly significant change – like the phase-out of fossil fuel production – it's important to understand and appreciate the intense change that it experiences all the time. That ongoing flexibility enhances the capacity of the labour market to absorb and adapt to other changes.

In contrast, consider some of the *gross* changes that also occur in the labour market in a typical month – but which are invisible in usual reporting on net employment totals. Statistics Canada collects but does not regularly report monthly data on gross labour market flows. However, recent analysis by Bourbeau (2019) provides interesting insight into the impressive size of those gross flows. Bourbeau considers average gross flows between three major categories of labour force status (employed, unemployed, and not in the labour force) over the period from 2007 through 2018. On average during that period, some 6.2% of Canada's working age population (considered all adults over age 15) changed their status between those categories in *any given month*.[70] Canada's working age population currently comprises over 31 million adults. At a typical rate of labour market mobility, therefore, this implies that some 1.8 million Canadians move into or out of employment, unemployment, or "inactivity" (the term to describe people not in the labour force) each month. Over the course of a year,

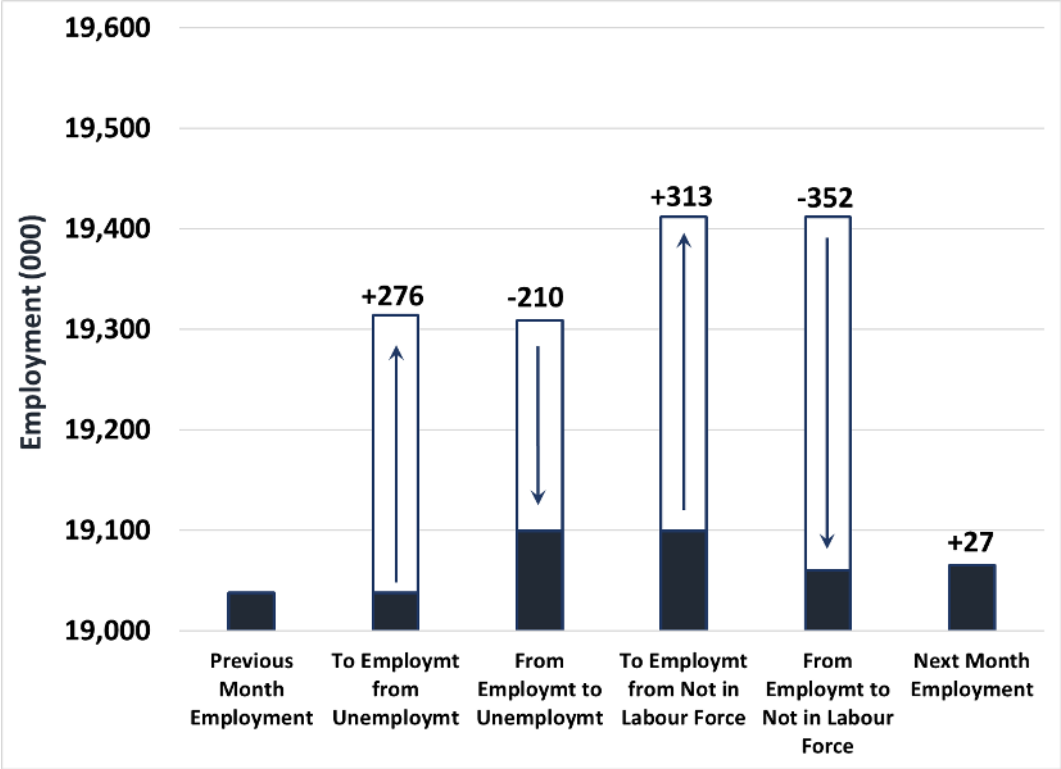
[68] Further perspective on the importance of gross vs. net employment flows in the Canadian context is provided by Bourbeau (2019), Kostyshyna and Luu (2019), Corak (2020), Rollin (2012), and Jones and Riddell (1998).

[69] Using original (non-seasonally-adjusted) data. This section does not illustrate regular seasonal flows into and out of employment, and thus understates the actual extent of monthly employment fluctuations.

[70] This rate of mobility in labour market status is broadly consistent with corresponding measures from countries which do regularly report gross labour market statistics, such as the U.S. and Australia.

several million Canadians change their labour force status.[71] This is a powerful and ongoing degree of mobility.

Figure 10: Average Monthly Gross Employment Changes, 2019



Source: Author's calculations from Statistics Canada Table 14-10-0287-01 and Bourbeau (2019), as explained in text.

To illustrate those large monthly gross flows, Figure 10 (using the same y-axis scaling as Figure 9) portrays the intermediate steps in traversing from one month's total stock of employment to the next month's. The simulation is derived from average monthly gross flows reported by Bourbeau (2019, Appendix Table 2) for the period from February 2016 through September 2018, scaled to reflect growth in the working age population since then.[72] Typically, around 590,000 Canadians start working in an average month.[73] That is 20 times larger than the average monthly net increase in

[71] The annual rate of mobility in labour market status does not equal 12 times the monthly rate, since some individuals will change their status more than once in a year.

[72] Gross flows will reflect both the ongoing growth in the overall size of the labour market (driven by demographic and participation changes), and also business cycle conditions (gross flows tend to be larger during recessions). By choosing the 2016-2018 period to benchmark our illustration of gross flows, we are selecting average flows that are broadly consistent with the state of the Canadian labour market prior to the COVID-19 pandemic. Actual gross flows in 2020 will be significantly larger than illustrated in Figure 10.

[73] Again, this does not include normal seasonal fluctuations in employment, which would make these gross flows even larger.

employment experienced in Canada in 2019. Less than half of those newly-employed Canadians each month had been officially 'unemployed' in the previous month. Instead, most new workers typically move directly into employment from having been not in the labour force (called "inactivity" by Statistics Canada). That includes individuals who graduated from school or higher education and began to work; it also includes Canadians who were neither working nor seeking work for other reasons (perhaps family responsibilities), but then decided to rejoin the labour force and were able to move directly into a job.

Why don't Canadian newspaper headlines trumpet that 590,000 jobs were created in a typical month? Well, because almost as many other jobs *disappear* in a typical month. Hence the net change in overall employment is much smaller than the gross adjustments. Our simulation suggests that around 560,000 Canadians flow *out* of employment per month.[74] Most of those losing employment transitioned directly from employment to being outside of the labour market (including hundreds of thousands of Canadians who retire each month, but also those who leave the "active" labour market for other reasons[75]). Only a minority of job-losers in a typical month (under 40% during the 2016-18 period) moved into "official" unemployment. During a recession, however, the share of job-losers who move into unemployment tends to be larger.

As indicated in Figure 10, therefore, there is an enormous amount of "to and fro" occurring within the labour market every month. Almost always, those changes balance out to comparatively small net changes in total employment. Moreover, there are other important gross changes occurring in the labour market that are not captured in Figure 10. For example, over 500,000 Canadians per month, on average, also change their status from officially unemployed to inactive, or vice versa. And hundreds of thousands of Canadians change from one job to another every month – an adjustment which is not captured in gross flow statistics, since those people were employed in both months. Similarly, many workers change their hours or arrangements of work, while staying with their current employer: for example, changing from full-time to part-time status, or vice versa. In total, around 2.5 million

[74] The specific flows into and out of employment illustrated in Figure 10 are adjusted to reflect growth in the working age population to 2019, and to provide for consistency with the average monthly increase in net employment that was also recorded in 2019. Indeed, gross employment flow data are not generally consistent with observed changes in net employment due to difficulties in matching individuals in rotating panel data and other outflows (see Kostyshyna and Luu, 2019, fn 6). For these reasons, the flows illustrated in Figure 10 should be considered as illustrative only.

[75] Other reasons for moving from employment to 'inactivity' could include returning to higher education, taking on family care responsibilities, or losing work but not undertaking active job search (perhaps because of lack of available job prospects).

Canadians (over 10% of the labour force) experiences some change in their employment status in any given month: into or out of employment or the labour force, from one job to another, or between part-time and full-time hours. Put differently, the number of Canadians who change their employment status in a typical *month* is about 15 times greater than the total number working directly in fossil fuel industries. (Indeed, as discussed below, those fossil fuel workers are themselves moving into and out of their jobs at a relatively rapid rate.) This provides some important perspective on the task of reallocating labour that will be associated with the phaseout of fossil fuels. That reallocation will be an important change, to be sure – but the Canadian labour market reallocates a much larger number of workers, in total, *every single month*.

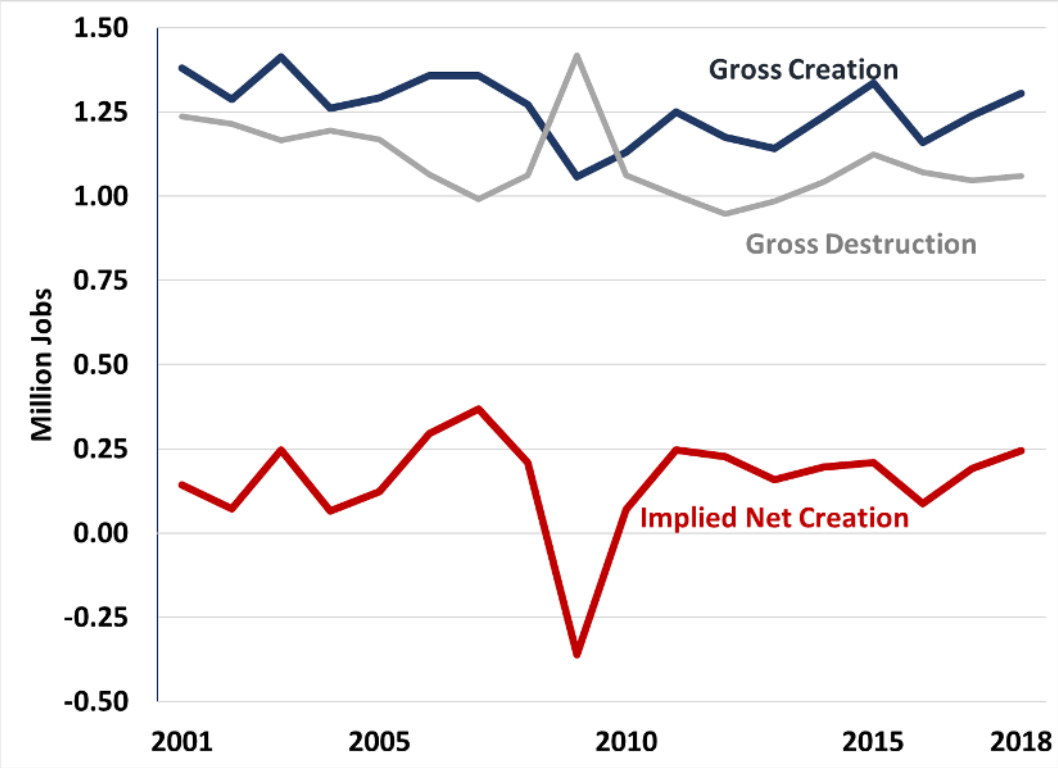
As discussed, Statistics Canada data on gross employment flows do not include transitions from one job to another. Since someone moving from one job to another does not change their labour market status (they are considered "employed" both before and after the job change), this movement is not captured in rotating monthly gross flow statistics. However, Kostyshyna and Luu (2019) have developed a novel strategy for estimating the extent of these job-to-job transitions, by combining information on employment status (being employed in the previous month and the current month) with data on job tenure (reporting less than one month in their current job). On this basis, they estimate that an average of 0.75% of employed workers change jobs in a typical month (based on 20-year averages starting in 1997). Job-to-job transitions are more frequent for self-employed individuals than for employees (about 0.65% of whom change jobs in a given month). They are far more frequent for young workers, and tend to vary pro-cyclically over the business cycle (workers are more likely to leave one job for another when the unemployment rate is low). This is another important dimension of employment mobility: over a 12-month period these job-to-job transitions imply that up to 9% of employed workers will typically change jobs in a year.[76]

The preceding data on gross and net employment changes is based on the monthly labour force survey, and derived from monitoring the month-to-month changes in members of the rotating panel of survey respondents maintained by Statistics Canada. Data on *annual* gross employment flows are more complicated to assemble (since each panel of LFS respondents only continues for 6 months). However, annual estimates of gross employment flows in the private sector are separately reported by Statistics Canada using a very different method. A Statistics Canada survey of private business

[76] To the extent that some workers change jobs more than once in a year, then the cumulative incidence of job-to-job transitions (measured in workers rather than specific transitions) will be less than 12 times the monthly rate.

dynamics distinguishes companies which increased employment in a particular year (including companies which grew, and newly formed companies) from those that reduced their employment (including companies which shrank or ceased operations). Those data can be interpreted as measures of gross employment creation and destruction.[77] This alternative source confirms the rapid and constant pace of job turnover in Canada's labour market.

Figure 11. Annual Gross Employment Flows, Private Sector, 2001-2018



Source: Author's calculations from Statistic Canada Tables 33-10-0164-01 and 33-10-0165-01. Implied net creation equals the difference between gross creation and gross destruction; this series does not perfectly reflect directly reported net growth in private sector employment.

The evolution of gross employment creation and destruction in private sector firms is illustrated in Figure 11. On average since the turn of the century, private sector firms have created about 1.25 million new jobs each year. At the same time, however, the private sector was also destroying almost as many new jobs each year. Net job creation in the private sector depends on the difference between the two gross flows (and averaged about 150,000 net new jobs per year). That difference is generally

[77] This measure will underestimate gross flows by virtue of its categorization of firms into those which grew and shrank over the course of the previous year. A company which both created and eliminated jobs in the course of a year would be allocated into only one of those categories (based on which gross flow was larger), and only its net employment change included within the overall measure of gross flows.

positive, but it was negative during the recession of 2009 (and will be negative again in 2020). The flow of annual gross employment creation is thus typically about 8 times larger than the annual growth in net employment.[78]

Both monthly and annual data on gross employment flows confirm, therefore, an impressive ongoing flexibility of the labour market in allocating and reallocating labour. In any given period of time (monthly or annually), the total flow of job creation exceeds the net change in employment (and the net flow of job-hunters) many times over. Thanks to this ongoing churn, the overall labour market possesses enormous flexibility to respond to even seemingly large shifts in the structure or location of employment. Adjustments in those normal flows can facilitate major changes in the overall structure of employment without causing "drama" at the macroeconomic level.

Another indicator of gross turnover in employment, and the reasons for it, can be derived from Statistics Canada data regarding people who are not employed, but stopped working in the previous year. This data is collected from anyone who does not work: both unemployed people (those not working but actively seeking it) and those who are not in the labour force (that is, who are "inactive" in Statistics Canada's terminology). In 2019, about 1.25 million Canadian workers stopped working voluntarily and left the labour market. Almost 500,000 of those workers stopped working to go back to school, and some 270,000 retired; the others stopped working for a variety of other reasons (including illness, personal or family reasons, and dissatisfaction with their previous jobs). Another 850,000 Canadians lost their jobs involuntarily in the previous year and were no longer working – either because they gave up looking (and left the labour market), or else had not yet found work. In total, over 2 million Canadians shift from employment to non-employment each year.

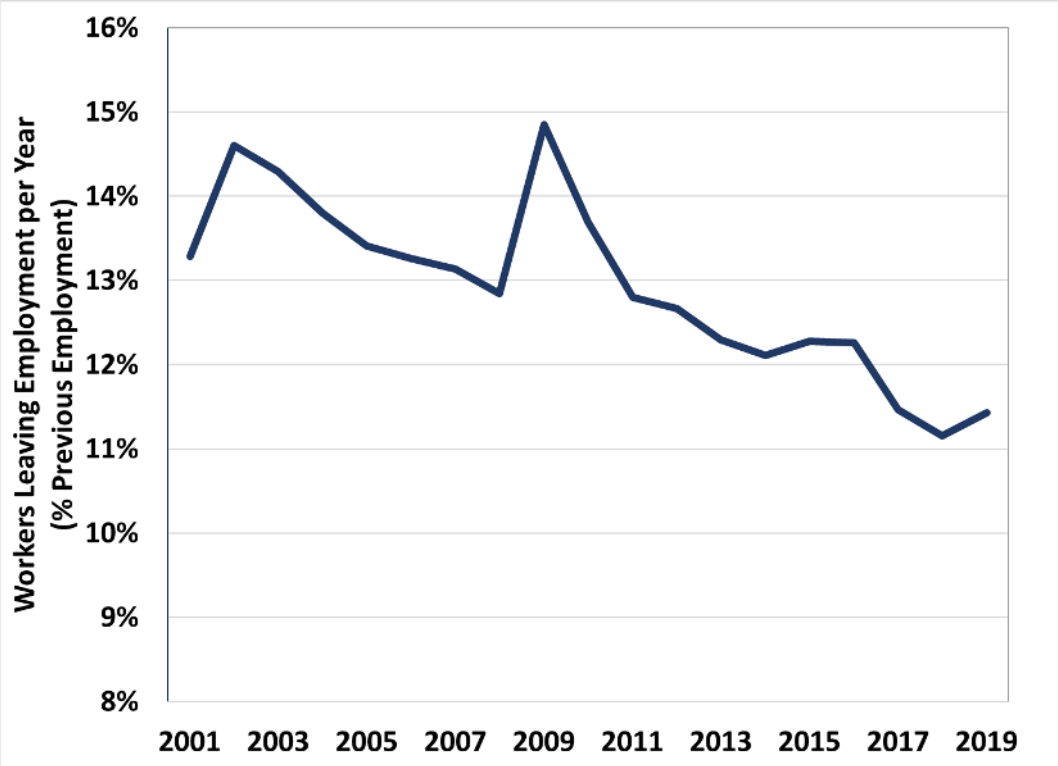
Expressed as a proportion of the previous year's employment, these data indicate that over 11% of employed Canadians in 2018 were no longer working in 2019. Most of them (close to 60%) stopped working voluntarily. Figure 12 illustrates the share of workers who stop working in a given year. The rate of employment cessation has declined over the past two decades (due in part to the ageing of the workforce[79]). Of those leaving work, the share who did so voluntarily has been broadly stable (at more than half). An exception was during the recession year of 2009, when the rate of cessation temporarily jumped, and most of those departures were involuntary. A

[78] As noted above, this approach underestimates gross flows by including only the net employment change of each reporting business.

[79] There are contrasting demographic influences on this trend: younger workers are more likely to stop working to go back to school (the most important reason for voluntarily stopping work), but older workers are obviously more likely to retire. The net effect will be a modest decline in the overall cessation rate as the population ages.

similar, more dramatic shift will be visible in 2020, given the impact of the COVID-19 recession.[80]

Figure 12. Rate and Composition of Employment Cessation, 2001-2019



Source: Author's composition from Statistics Canada Tables 14-10-0287-01 and 14-10-0125-01. Annual averages.

These statistics on departures from work (both voluntary and involuntary) can be interpreted as a measure of gross employment turnover. In non-recessionary times, over 11% of Canadian workers will stop working in a given year – most of them voluntarily. (This does not include Canadians who changed jobs.) This represents a flow of gross exits from employment 200 times greater than what would be associated with the phase-out of fossil fuel employment over a 20-year period.

INDUSTRY LEVEL GROSS EMPLOYMENT FLOWS

The preceding Statistics Canada data on gross employment creation and destruction in the private sector also provides additional insight into the inter-sectoral nature of employment adjustments in Canada's labour market. Table 8 provides a measure of

[80] During the spring quarter of 2020 (most recent data at time of writing), the number of people who worked within the last year but were no longer working surged to 21% of the previous year's employment level, and 70% of those had stopped working due to loss of their job (rather than voluntary departure).

industry-level gross employment volatility since the turn of the century.[81] Volatility is described here as the sum of gross employment creation (by new or growing firms) and gross employment destruction (by closed or shrinking firms), as a proportion of average total employment in each sector.[82] There are major differences in this gross volatility across Canadian industries.

Table 8
Average Annual Gross Employment Volatility
Private Sector Industries, 2001-2018

Sector	Annual Job Churn per Year (%)[1]
Management of companies	35.6
Construction	28.4
Real estate and rental and leasing	26.7
Agriculture, forestry, fishing and hunting	26.1
Professional, scientific and technical services	24.2
Mining, quarrying, and oil and gas extraction	24.1
Administrative and support services	23.6
Information and cultural industries	22.4
Accommodation and food services	21.5
Other services	19.7
Arts, entertainment and recreation	19.1
Manufacturing	17.9
Wholesale trade	17.8
Transportation and warehousing	16.4
Retail trade	15.6
Finance and insurance	14.6
Utilities	10.8
PRIVATE SECTOR AVERAGE	**20.4**

Source: Author's calculations from Statistics Canada Table 33-10-0164-01.
1. Churn defined as sum of gross employment creation and destruction each year as proportion of sector employment (prior and current year average).

[81] This Statistics Canada data on annual gross employment creation and destruction is available only to 2018.

[82] Employment is measured as the average of employment in the previous and current year.

Table 8 reports gross employment creation and destruction each year in 17 different broad industry groupings in Canada's private sector.[83] On average across the full private sector, the combination of job creation and job destruction sums to over one-fifth of the total stock of employment. Gross volatility in employment is highest in the very small "management of companies" sector (consisting of holding companies and other investment firms), followed by construction and real estate. Gross volatility is lowest in utilities (with job churn barely half the private sector average) and the finance sector.

Table 1 listed seven specific sub-sectors which compose the overall fossil fuel industry. Those seven sub-sectors belong to four broader sectors (defined at the 2-digit level): mining (petroleum, coal, and related mining services), utilities (electricity and natural gas distribution), and one each in manufacturing (refined petroleum products) and transportation (pipelines). Over two-thirds of all fossil fuel jobs are located in the broader mining sector. Table 8 confirms that gross job churn in the mining industry has been higher than average in the overall private sector: with gross employment creation (at new or growing firms) and destruction (at closed or shrinking firms) equal to almost one job in four each year since the turn of the century. Gross employment volatility has been even greater in mining in the turbulent years since 2014. In contrast, job volatility in the other broad sectors corresponding to fossil fuel work (utilities, manufacturing, and transportation) is lower than the economy-wide average. Across all fossil fuel sub-sectors, average gross employment flows are at least as high as the one-in-five average annual churn reported for the overall private sector.

Another perspective on industry-level job turnover is provided by Statistics Canada data on job tenure by industry. The annual rate of job turnover can be proxied by the proportion of employment in each industry or occupation that has been with their current employer or business for less than 12 months. That will be exactly identical to the proportion of existing employees that leave their job in a year, in industries which experience stable overall employment. For industries with shrinking total employment (such as most fossil fuel sectors since 2014), the proportion of workers with less than one year of job tenure underestimates the true rate of job departures. For industries with growing total employment, the share of workers with less than one year tenure overestimates the rate of departures.

[83] Sectors dominated by public employers are excluded – namely, health care and social services, education, and public administration.

Table 9 Job Tenure by Industry, 2019		
Sector	**Share Under 1 Year (%)**	**Average Tenure (months)**
Agriculture	15.7%	194.7
Mining, forestry, fishing	18.3%	99.3
Utilities	9.7%	140.5
Construction	21.2%	95.0
Manufacturing	16.6%	116.8
Wholesale and retail trade	24.9%	85.9
Transportation and warehousing	18.6%	105.2
Finance, real estate, rental	14.8%	111.9
Professional, scientific and technical services	19.8%	91.6
Business, building and other support services	25.7%	77.4
Educational services	14.9%	123.8
Health care and social assistance	15.1%	110.1
Information, culture and recreation	22.5%	97.5
Accommodation and food services	36.3%	51.9
Other services	19.2%	99.0
Public administration	12.6%	129.1
ECONOMY-WIDE AVERAGE	**19.9%**	**101.5**
Source: Author's calculations from Statistics Canada Table 14-10-0054-01. Annual average.		

Table 9 indicates that across the economy as a whole, one in five workers in 2019 had been with their current employer for less than one year. This is consistent with the pace of gross employment churn reported in Table 8 above. Again, there is wide variation in job tenure across industry sectors, and our effort to measure job turnover rates in fossil fuel industries is again limited by the 2-digit level of industrial aggregation reported in this Statistics Canada data. In the broad mining sector,[84] job tenure by this measure is broadly comparable to economy-wide averages. The proportion of workers with less than one year of tenure was 18.3%, slightly lower than the national average (suggesting slightly less turnover), while average tenure in mining

[84] For this survey Statistics Canada amalgamates mining with the (much smaller) forestry and fishing industries. This will not substantially impact the results, since fishing and forestry employment is small relative to mining employment.

was slightly shorter than the national average, at 99 months (suggesting slightly more turnover). The broader manufacturing and transportation sectors (which also include some fossil fuel workers) also report a smaller share of short-tenure workers than the economy-wide average: 16.6% in manufacturing, and 18.6% in transportation. The utilities sector had the longest average tenure of any non-agricultural industry (almost 12 years), and the smallest proportion of workers with less than one year of turnover (less than 10%).

Considering a weighted average of these broad sectoral estimates, we conclude that 17-18% of fossil fuel workers leave their jobs each year. That is a rapid rate of job turnover, with dramatic and cumulating impact on the composition of the workforce in the broader fossil fuel sector. Some of those workers move to another job within the same industry. Others move to jobs in other industries, leave the labour market, or retire. As discussed below, this normal turnover is a powerful factor in facilitating employment transitions over time.

OTHER INDICATORS OF EMPLOYMENT FLEXIBILITY

We have already described a national labour market that is marked by continual and far-reaching change. Gross inflows and outflows of employment, at both the aggregate and the sectoral level, attest to the constant reallocation of labour between different jobs and different industries. There are other indicators that further attest to the breadth of change and flexibility that characterize Canada's labour market, and fossil fuel industries in particular:

Temporary Jobs: Temporary employment constitutes a significant share of total employment in Canada. In 2019, about 2.1 million Canadians were employed in temporary, time-limited jobs. That represented 12.8% of all employment.[85] The downside of temporary employment (for the workers who fill those jobs) was demonstrated in dramatic fashion during the COVID-19 recession. Over 30% of temporary jobs disappeared in just the first two months of the pandemic – a pace of job loss twice as fast as the decline in overall employment.[86] Temporary work is common in fossil fuel industries. In the broader mining sector (which encompasses about two-thirds of all fossil fuel jobs), temporary work is slightly more common than in the economy as a whole: 13% of mining jobs were temporary in 2019. Temporary jobs were less common in the other broad sectors which incorporate fossil fuel jobs: around 10% in transportation, 8% in utilities, and 6% in manufacturing. On a weighted

[85] Author's calculations from Statistics Canada Table 14-10-0072-01.

[86] See Stanford (2020a) for more details.

average basis, we conclude that over 10% of fossil fuel workers are in temporary jobs. For them, the inevitability of future employment transitions will not come as a surprise: they already live that reality.

Multiple Job-Holding: Another dimension of constant flux in Canadian employment patterns is the growing number of Canadians who work in more than one job. As of 2019, some 1.1 million Canadians (or about 6% of all employed people) held more than one job.[87] Multiple job-holding is especially frequent for part-time workers, among young and women workers, and in the services sector. Multiple job-holding is relatively uncommon in fossil fuel occupations: according to Fulford and Patterson (2019), the rate of multiple job-holding is lower in the broad mining sector (with about 3% of all workers working in more than one job) than any other industry. Nevertheless, multiple job holding represents another dimension of flexibility in fossil fuel labour patterns. Multiple job-holders are familiar with the reality of adjusting work across multiple employment relationships, as the demand for their services fluctuates. Hence they are already attuned to the inevitability of labour market change.

Migrant and Commuting Workers: Regional labour shortages during the 2000s and early 2010s led many fossil fuel employers to look further afield to recruit labour. This was especially common for remote resource projects, like new bitumen facilities built in northern Alberta during the last 15 years. Workers were hired from interprovincial or international populations, often on a temporary or commuting basis. Fly-in/fly-out (FIFO) arrangements became common in many remote locations, with workers commuting for multi-week shifts from homes located elsewhere in Canada. At least 15 bitumen projects in the Fort McMurray area utilize FIFO arrangements, involving the operation of 7 private airports in addition to 40% of all traffic through the Fort McMurray airport.[88] In excess of 20,000 production workers in that region alone are employed on a FIFO basis, flying in from elsewhere in Alberta or other provinces.[89] Just the population of FIFO workers in the Fort McMurray region, therefore, single-handedly accounts for over 10% of all fossil fuel employment in Canada. On the basis of matched employment and tax data, Statistics Canada identified over 100,000 "interprovincial workers" (who work in Alberta but live in another province) in Alberta in 2008;[90] not all of those workers were employed in fossil fuel industries, but many were.

[87] Author's calculations from Statistics Canada Table 14-10-0044-01.

[88] See Oil Sands Community Alliance (2018).

[89] Derived from Oil Sands Community Alliance (2018).

[90] See Laporte, Lu, and Schellenberg (2013).

Similarly the expansion of the temporary foreign worker system has been another source of ultra-flexible labour for employers in some industries. In 2017, some 550,000 foreign migrant workers were employed in Canada, representing almost 3% of all employment (Lu, 2020). They face especially precarious work arrangements, since their right to stay in Canada generally depends on their continuing employment. The use of temporary foreign workers is relatively rare in fossil fuel industries: TFWs account for about 1% of all employment in the broader mining sector (Lu, 2020).

Interprovincial Migration: In addition to Canadians who cross provincial boundaries to commute to work, Canada's labour market has also been reshaped over time by significant flows of interprovincial migration. Employment opportunities are a major motive for interprovincial migration, and those flows constitute another important dimension of the labour market's capacity to adjust to change. In the last decade, about 2.7 million Canadians moved from one province to another.[91] Interprovincial migrants tend to be younger than the Canadian average, and more likely to be labour force participants. That cumulative flow of interprovincial migration over the last decade thus represents over 10% of the national labour force (or over 1% each year).[92] Alberta experienced the greatest in-migration during that period, with some 675,000 Canadians moving there in the last decade – although on a net basis, since 2016 more people have left Alberta than moved there. Ontario and B.C. have also experienced large inflows of interprovincial migrants: 640,000 to Ontario in the last decade, and 540,000 to B.C. Quebec has experienced a consistent net outflow of interprovincial migrants, although that flow has slowed in recent years as the provincial economy strengthened.

AGEING AND RETIREMENT

Another dimension of natural, ongoing labour market adjustment is the inevitable fact that workers get old and eventually retire. Around 250,000 Canadians (about 1.25% of all employed people) retire from work each year.[93] And workers currently employed in fossil fuel industries are somewhat older, on average, than the overall Canadian workforce. Therefore, the normal outflow of retiring workers will be especially important in facilitating adjustment to the phase-out of fossil fuel production and use.

[91] Author's calculations from Statistics Canada Table 17-10-0021-01.

[92] Not all interprovincial migrants are in the labour force, so these figures are not strictly comparable.

[93] Statistics Canada Table 14-10-0125-01.

Table 10 Average Age of Fossil Fuel Workers, 2016		
Sub-Sector	**Average Age**	**Share Workers Over 40**
Oil & Gas Extraction	42.2	55.5%
Coal Mining	44.1	61.1%
Mining Services	41.2	51.5%
Fossil Fuel Electricity	43.3	60.4%
Natural Gas Distribution	42.7	57.8%
Refined Petroleum Products	42.7	57.1%
Pipelines	41.2	52.2%
Fossil Fuel Total	**42.1**	**55.2%**
Economy-Wide Average	41.8	54.6%
Source: Author's calculations from Statistics Canada census data, Catalogue 98-400-X2016290.		

Table 10 reports the average age of workers employed in the various sub-sectors of the broader fossil fuel industry in 2016, on the basis of Statistics Canada census data. On average, fossil fuel workers in 2016 were somewhat older than the average of the overall Canadian workforce. Workers in coal mining and electricity generation were the oldest among these sub-sectors: coal miners, on average, are 2.3 years older than the average workforce, and electricity workers 1.5 years older. Workers in the mining services industry are the youngest of the fossil fuel sub-sectors, with an age profile slightly younger than the national average.[94]

Table 10 also reports the proportion of existing employees in 2016 who were over 40 years at the time (and hence would be over 44 today). Again, these data indicate that the fossil fuel workforce is older than the Canadian average. More than 55% of fossil fuel workers were over 40 years of age in 2016. This means most fossil fuel workers would normally retire within the course of the next 20 years.[95] With targeted incentives for early retirement, the role of retirements in facilitating the employment transitions associated with fossil fuel phase-out would be accentuated accordingly.

The data in Table 10 understate the average age of fossil fuel workers today, for two reasons. First, 4 years have passed since the 2016 census was undertaken. Second,

[94] This finding is consistent with He, Messacar, and Ostrovsky (2017), who also report average age of employed people in mining, utilities and manufacturing as being older than the average for the overall labour market.

[95] The average retirement age in Canada in 2019 was 64.3 years; see Statistics Canada Table 14-10-0060-01.

almost all of the fossil fuel sub-sectors (other than natural gas distribution) have decreased employment since 2016. During times of downsizing, younger workers are more likely to lose work (since they have less experience and seniority, and are more likely to be in temporary or part-time roles which are more easily eliminated by employers). Thus the average age of the remaining workforce tends to increase during an industry downturn.

The relatively advanced age of the fossil fuel workforce constitutes an important advantage in planning for the economic transition away from fossil fuel production and use. A larger-than-proportional share of these workers will be retiring from their careers anyway over the next two decades. That will ease the process of adjustment, since a substantial proportion of existing workers can plan to retire normally from the industry as it gradually phases down.

CONCLUSION: DIMENSIONS AND CUMULATIVE EFFECTS OF FLEXIBILITY

In sum, Canada's labour market demonstrates numerous dimensions of flexibility which ensure that the overall pattern of employment can constantly change in response to economic, demographic, and regional influences. A summary of these dimensions is provided in Table 11.

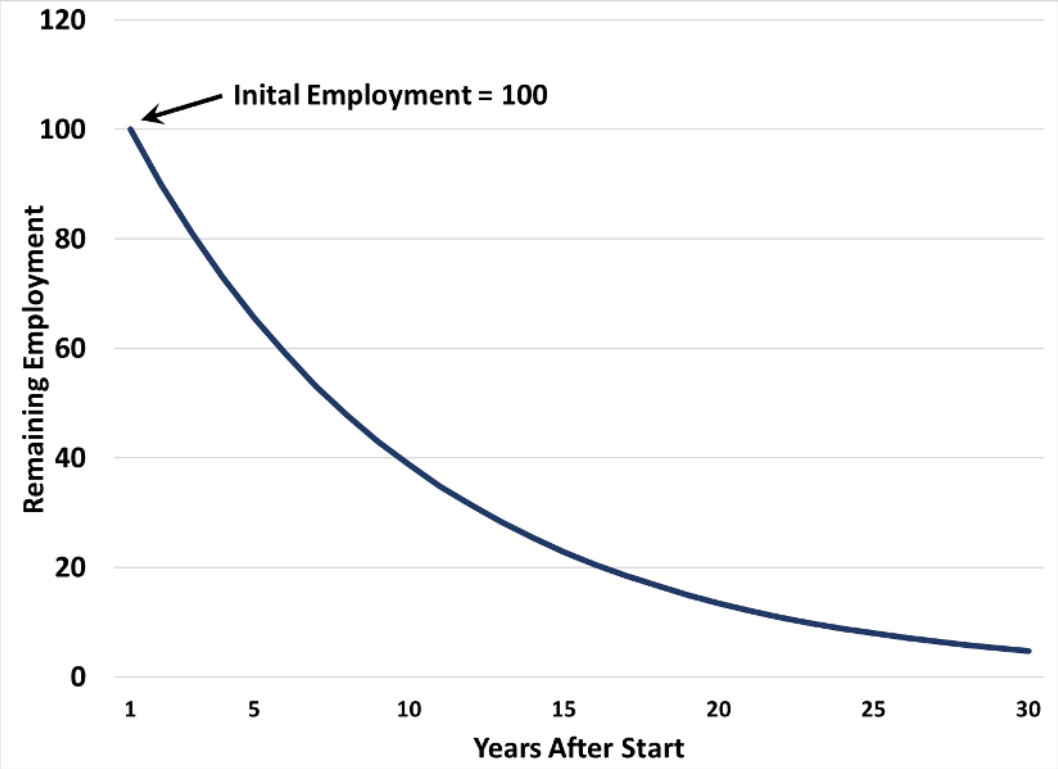
A very substantial share of the employed Canadian workforce experiences some fundamental change in the nature of their work every single year: entering or exiting employment (for many reasons), switching jobs, or changing the occupation, hours, or status of their work with an existing employer. Clearly, Canada's labour market is characterized by a constant and intense "hum" of change all the time – even when aggregate employment levels are stable. That constant, underlying flexibility allows labour markets to adapt effectively to major changes in the structure or location of employment. Adaptation works better, of course, when supported by active and generous policy measures: including strong income support, retraining and relocation supports, early retirement incentives, and generous pensions.

Table 11 Dimensions of Employment Flexibility	
Indicator of Flexibility	**Magnitude**
Transitions Into and Out of Employment	About 3% of employed Canadians transition to non-employment per month, and about 3% transition to employment (from unemployment or inactivity) per month.
Job-to-Job Transitions	Up to 9% of employed workers change jobs within a typical year (remaining employed through the transition).
Gross Job Creation and Job Destruction	New and growing firms create new jobs equal to 7.5% of private sector employment each year. Gross employment creation and job destruction in fossil fuel industries equals over 10% of employment each year.
Job Tenure	About 20% of Canadian workers have been in their current jobs less than one year. About 17-18% of fossil fuel workers have been in their current jobs less than one year.
Temporary Employment	13% of employment in mining is temporary.
Multiple Job-Holding	3% of mining workers hold multiple jobs.
Migrant & Long Commuting	10% or more of fossil fuel employment is FIFO; 1% of mining workers are temporary foreign migrants.
Interprovincial Migration	About 1% of the national labour force moves from one province to another each year.
Retirement	About 275,000 Canadians (or 1.5% of total employment) retire per year. Workers in fossil fuel industries are older than the average for the overall labour market. Most fossil fuel workers will reach normal retirement age within the next 20 years.
Source: Summation of references cited above.	

The preceding evidence suggests a surprisingly rapid pace of exit from jobs in fossil fuel occupations in Canada, most of it voluntary. Gross rates of employment creation and destruction generally exceed 10% per year each (producing a combined “churn” rate of over 20%). Indeed, around 17-18% of fossil fuel workers have been in their current jobs for less than a year – and a larger proportion leave their jobs in a given year. Over time, the ongoing flux in employment patterns facilitates dramatic changes in the overall structure of employment.

Consider, for example, an initial population of 100 representative employees in the fossil fuel industry. We assume that 10% of fossil fuel workers normally leave their jobs and exit the industry in a given year: either to retire, to leave the labour market, or to find work in another industry.[96] With an annual industry-exiting turnover rate of 10% per year, that initial population of 100 workers dissipates rapidly over time, based solely on normal, mostly voluntary departures from their previous positions. Figure 13 illustrates the steady, powerful impact of that normal, ongoing employee turnover. At a 10% annual turnover rate, fully 60% of the initial workforce has left after 10 years, and over 85% have left over 20 years.

Figure 13: Dissipation of Fossil Fuel Jobs Through Normal Exit



Source: Author's calculation as described in text. Simulates annual turnover of 10%.

Facilitating a downsizing in employment while protecting people currently working in the sector can therefore be largely accomplished by taking advantage of this natural turnover. Most existing fossil fuel workers will naturally and voluntarily move on to doing something else within the next two decades – a feasible timeline for the phase-out of fossil fuel use. So long as that natural flow and flexibility is harnessed, most of the employment transition associated with the phase-out of fossil fuels can occur naturally and relatively painlessly (at least for the individual workers involved). The crucial complement to that strategy, however, must also be to *limit inward flows of*

[96] Based on the indicators of turnover described above, actual annual turnover in fossil fuel jobs is much higher than 10%, so this illustration underestimates the extent of cumulative change.

labour to the sector at the same time. If the substantial natural flow of departing workers is simply replaced by new hires, then the adjustment problem is simply recreated and deferred.

To take full advantage of the natural forces of normal turnover, severance, and retirement, a clear timetable for phasing out fossil fuels must be established as far in advance as possible. If the commitment to phasing out fossil fuels is diluted or delayed (perhaps due to political considerations), then the resulting employment transitions become more difficult – because in the meantime, many more individuals will have started to work, in an industry that will soon disappear. In contrast, committing well in advance to a fossil fuel phase-out will accelerate the pace of departures from the existing workforce, since many workers will then look for and take advantage of alternative opportunities that arise during the transition period. That anticipatory turnover can be supported with generous severance, retraining and relocation incentives (as discussed further below).

All of these avenues of flexibility will be necessary and valuable as Canada's labour market adjusts to the continuing contraction of fossil fuel industries. As we have noted, the scale of that adjustment is not large, relative to the overall size of the labour market, or to other historic shifts in Canada's employment patterns. By enlisting these normal, ongoing processes of labour market adjustment, and giving ample time for adjustments to occur, the employment transition away from fossil fuels can be accomplished without shock or displacement. Most adjustment will not involve "moving" fossil fuel workers into alternative kinds of employment – even into roles associated with the energy transition (like renewable energy projects). Rather, most of the adjustment will involve leveraging normal processes of labour market flexibility: to encourage exits from, and discourage entries into, occupations and industries that are going to inevitably disappear. Canada's labour market is diverse and constantly changing. In that context, the reallocation of 1% of current employment toward other activities over a 20-year period, while supporting the personal transitions of workers currently filling those roles, is an eminently manageable challenge.

Other Threats to Fossil Fuel Jobs

The coming phase-out of fossil fuels poses a significant but manageable challenge to the employment and income security of workers currently employed there. But the status quo situation in these industries is hardly conducive to a secure and stable employment outlook anyway. Simply rejecting climate policies and trying to postpone the phase-out of fossil fuel production cannot guarantee the existing jobs and incomes of people currently employed in fossil fuel work. To the contrary, fossil fuel workers face a range of other daunting threats and challenges to their jobs, incomes, and working conditions – many emanating from their employers, who often pose disingenuously as "defenders" of fossil fuel jobs. Indeed, both the quantity and quality of fossil fuel work has been undermined by aggressive practices of fossil fuel companies striving to extract as much profit as possible, while the industry still exists.

Here are several of the other threats to work in fossil fuel industries today:

Automation: Fossil fuel companies are moving quickly to implement labour-saving systems and technologies in their mining, processing, and transportation operations. This push has been reinforced by the decline in global prices since 2014, which squeezed profit margins and spurred automation. Major bitumen mines, refineries, and transport systems have seen widespread automation with autonomous trucks, extraction systems, and loading equipment.[97] Well drilling has also seen significant employment reductions thanks to automated drilling systems. Application of automatic and data-driven systems in geology, engineering, and business service holds further potential to reduce labour demand, even in offices. O'Reilly (2019) has analyzed the probability of automation of different occupations in the petroleum industry, estimated to be as high as 80-95% for jobs such as welders, machine operators, process technicians, and heavy machinery operators. McKinsey and Co. (2019) estimate automated mining technologies could reduce labour demand in major mining operations by 30%. One consequence of automation is the relocation of some fossil fuels jobs (involving operation of automated systems) to urban areas. Some high-tech extraction and transportation systems can now be operated from dedicated technical centres which may be far away from direct production – including in major cities. This will make it easier for workers in those jobs to identify alternative

[97] See Moore (2019) and Querengesser (2018) who report the rapid implementation of autonomous trucks in bitumen mines. Hussey (2020) documents other labour-saving advances, including horizontal multi-well drilling pads, remote monitoring, information technology analytics, and replicated designs and modularization.

employment opportunities (with their high-tech skills) as fossil fuel production winds down.

Job Insecurity: To further reduce labour costs, fossil fuel companies have expanded their use of labour hire firms, outsourced contractors, temporary workers, and other practices to enhance "flexibility" and reduce job security for fossil fuel workers. These practices have become more common as companies cut costs and risks associated with traditional employment models. In the past, most workers were direct employees of the top-tier petroleum or mining company; today those major companies may employ more contractors than direct employees. The incidence of part-time work in the broader mining sector has also grown significantly since the industry downturn after 2014.[98]

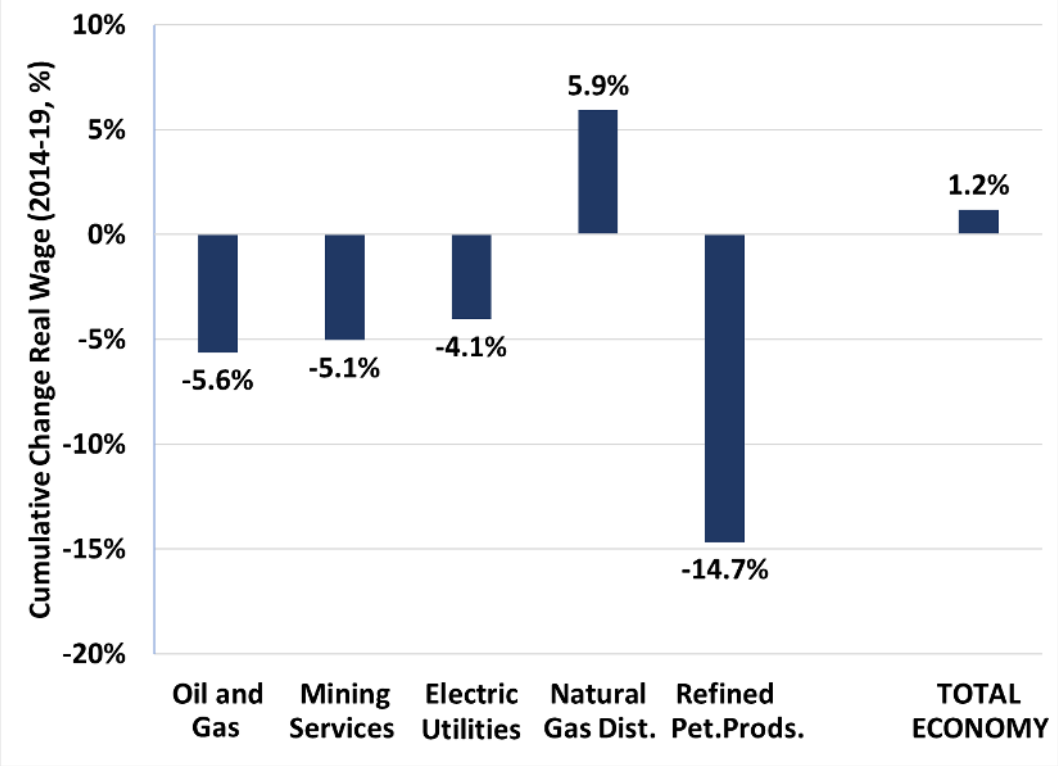
Falling Wages: Because of generally weak employment conditions, the fall in global energy prices, and aggressive efforts to cut labour costs by employers, real wages in fossil fuel jobs have declined noticeably in recent years. To be sure, average weekly wages in fossil fuel industries are higher than in many other occupations – partly reflecting long hours and difficult conditions (including high pay under fly-in fly-out arrangements). More recently, however, real wages have fallen in most fossil fuel sub-sectors.

Figure 14 illustrates the cumulative change in real wages from 2014 through 2019 in several of the specific fossil fuel sub-sectors identified in Table 1.[99] Since 2014, wages in all but one of those sub-sectors lagged behind inflation, producing a decline in real compensation. In the case of refined petroleum products, average weekly wages actually declined in nominal terms. The only exception to this trend has been in natural gas distribution utilities, where real wages grew almost 6% since 2014. Across the composite fossil fuel sector, the real purchasing power of wages has declined by around 5%. This contrasts to modest but positive increases in average real wages recorded across the Canadian labour market during the same period. So while compensation in fossil fuel industries is still higher than average, this "premium" is shrinking considerably as real wages in fossil fuel industries are suppressed.

[98] Author's calculations from Statistics Canada Table 14-10-0023-01.

[99] Data refer to average weekly wages including overtime, from Statistics Canada Table 14-10-0331-01. Wages data are unavailable for coal mines and pipelines.

Figure 14: Real Wage Growth by Industry



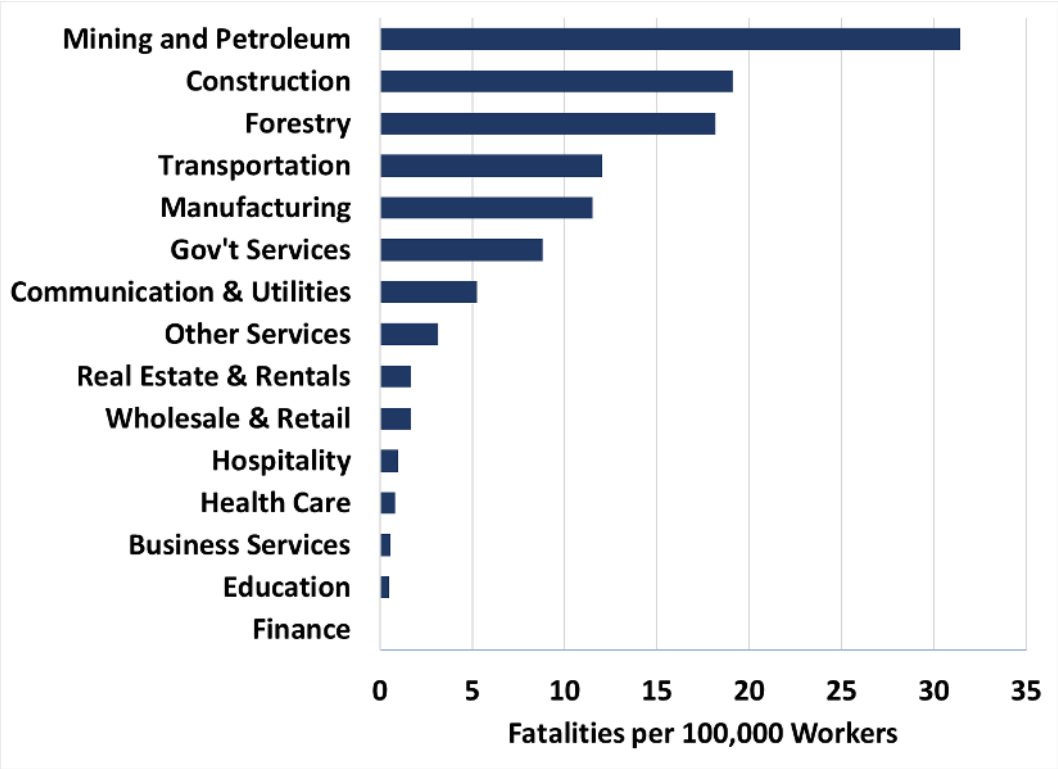
Source: Author's calculations from Statistics Canada Tables 14-10-0331-01 and 18-10-0006-01.

The decline in real earnings in the petroleum industry will be exacerbated by recent legislative changes in Alberta regarding the determination of overtime pay. New legislation there allows employers to avoid normal overtime premiums through strategic "averaging" of working hours over multi-week periods, and limit overtime payments for working on holidays (Littlewood, 2020).

Health and Safety Risks: Fossil fuel jobs carry inherent health and safety risks, arising from challenging settings, heavy machinery, and other features of the work. Those risks can be moderated by rigorous occupational safety practices, strong union representation, and better education and training. As indicated in Figure 15, fatality rates and other safety indicators are significantly worse in the broad sectors which encompass fossil fuel employment (mining, utilities, manufacturing, and transportation). Average fatality rates in the mining and petroleum sector are the worst of any sector in the whole economy. In 2018, 63 workers died on the job in this sector (an increase of over 50% from 2017). The rate of fatalities that year (per 100,000 employees) was more than 5 times higher than the average rate for the economy as a whole.[100]

[100] Author's calculations from Association of Workers' Compensation Boards of Canada (2020) and Statistics Canada Table 14-10-0202-01.

Figure 15: Workplace Fatalities, 2018



Source: Author's calculations from Association of Workers' Compensation Boards of Canada (2020) and Statistics Canada Table 14-10-0202-01.

Some of the health and safety risks associated with fossil fuel jobs are inherent to the nature of the work. But the downward pressure on labour costs experienced since the 2014 collapse in world energy prices, combined with other changes (like widespread deunionization), has certainty undermined progress toward safer workplaces in this sector. More recently, citing the financial challenges facing the petroleum industry, the Alberta government has changed the workers' compensation system to reduce benefit payments to injured workers, and reduce requirements for employers to hire them back (Bellefontaine, 2020).

Migrant Labour and Long Commuting: Another factor undermining the quality of work in many fossil fuel settings is the preponderance of work arrangements that require workers to travel long distances to get to work. As discussed earlier, interprovincial and fly-in/fly-out (FIFO) commuters, who travel regularly for multi-week shifts at remote locations far from their homes, constitute a significant share of total fossil fuel employment in Canada: likely over 10%. Published evidence has documented the significant physical and mental health, familial, and social consequences of long-distance commuting work.[101] Those stresses contribute to turnover rates in FIFO

[101] See, for example, Storey (2010), Lang (2020), and Centre for Transformative Work Design (2018).

positions that are far higher than in other forms of employment.[102] These challenges and consequences associated with long commuting must be weighed against the relatively high incomes which these jobs generate.

Deunionization: Employers in most industries have tried to reduce the influence of unions and collective bargaining in recent years, in order to reduce labour costs and enhance control over workplaces. Across Canada, the proportion of employed workers represented by a union and protected by a collective agreement has declined slowly but steadily, falling about 2 percentage points since the turn of the century.[103] But that drive to reduce union representation has been especially intense in fossil fuel industries.

Table 12
Deunionization by Sector, 2000-2019

Sector	Union Density, 2019	Change, 2000-2019
Mining	20.7%	-9.5%
Manufacturing	25.3%	-8.9%
Transportation	38.8%	-4.7%
Utilities	67.1%	-4.4%
Information, Culture & Recreation	24.3%	-3.5%
Hospitality	5.8%	-2.7%
Wholesale & Retail	12.2%	-2.5%
Finance, Real Estate & Rental	8.5%	-2.4%
Construction	30.5%	-2.0%
Health Care & Social Services	53.7%	-1.0%
Professional, Scientific & Technical	4.5%	-0.8%
Other Services	10.0%	0.0%
Education	72.2%	0.1%
Agriculture	4.4%	0.8%
Public Administration	72.1%	1.6%
Business & Support Services	18.2%	5.5%
TOTAL ECONOMY	**30.2%**	**-2.1%**

Source: Author's calculations from Statistics Canada Table 14-10-0070-01.

[102] For example, see Beach, Brereton and Cliff (2003), who found annual turnover of over 20% among FIFO workers in 7 Australian mining operations.

[103] Unionization in Canada has been relatively stable compared to many other industrial countries, where union representation has declined more steeply; see Stanford (2020b) for a detailed comparison.

Table 12 reports the change in union density by broad sector in Canada's economy, measured as the proportion of total workers with union coverage.[104] Once again, the specific fossil fuel sub-sectors considered fall into their respective broad sectoral categories: mining, manufacturing, transportation, and utilities. The broad mining sector[105] has experienced the most rapid decline in union representation of any industry since 2000. Union representation has fallen almost one-third, from 30.2% in 2000 to just 20.7% in 2019. This sector (where two-thirds of fossil fuel workers are employed) is now significantly less unionized than the overall economy (though still somewhat more unionized than the private sector average). The loss of union power inevitably translates into an erosion of wages, benefits, and working conditions.

The other broad sectors encompassing the remaining fossil fuel sub-sectors (manufacturing, transportation, and utilities) have also experienced significant reductions in union representation: ranging from a 9-point decline for manufacturing to a 4-point decline in utilities. Workers in all fossil fuel industries, therefore, have faced a noted erosion of union protection in recent years. The difficult economic conditions which most of these industries have endured since 2014 have sparked more intense opposition to union activity by many fossil fuel employers. As a result, fewer fossil fuel workers have had the protection of a union through these challenging times. Moreover, the erosion of union representation has also undermined the extent to which fossil fuel workers have any organized voice to express their priorities and defend their interests as the transition of Canada's energy system proceeds.

Responding to the financial needs of fossil fuel employers, the Alberta government has introduced new legislation to severely restrict union activity in that province – including U.S.-style "right-to-work" provisions, requiring individual members to approve any spending by their unions on advocacy or lobbying activities (Littlewood, 2020). Even as it poses as a defender of fossil fuel jobs, the Alberta government is acting aggressively to take away basic labour rights from the people doing those jobs.

* * * * *

For all of these reasons, existing workers in fossil fuel industries already face an uncertain and pessimistic employment outlook. The quantity of total employment in these industries will continue to decline, regardless of what climate policies are pursued by Canada: global demand for fossil fuels is falling, and that will inevitably translate into reduced output and work in our fossil fuel industries. Meanwhile, fossil fuel employers are shedding labour to protect profit margins – through automation,

[104] The number of union members is slightly lower than this, since some union agreements cover workers who are not members.

[105] In this data, mining is again amalgamated with the smaller forestry and fishing sectors.

outsourcing, and other strategies. Fossil fuel workers will continue to fight for better and more secure jobs, supported by their unions (for those who have one). But it is folly to think that the current jobs and incomes in this sector could be "saved" if only Canada rejected policies to reduce emissions, and did more to "support" this sector. The best chance for securing decent livelihoods and retirements for fossil fuel workers is to adopt policies to create new jobs, support transitions, and protect incomes and pensions. Pretending that delaying the inevitable energy transition could somehow help workers whose jobs are already being eliminated and degraded (by their own employers) merely diverts attention from the true sources of their insecurity and exploitation.

Fossil Fuel Industries and Canada's Macroeconomic Performance

This report has considered the role of fossil fuel industries in Canada's labour market, and the mechanisms through which employment patterns can and will adjust to the coming phase-out of fossil fuel production and use. There are other dimensions, of course, to the economic role played in Canada by fossil fuel industries. While it is not within the scope of this report to consider those dimensions in detail, we briefly review some of the other macroeconomic impacts of fossil fuel industries, and how they will change as fossil fuels are phased out. Common claims that the industry is central to Canada's overall economic well-being are overstated. The industry has a significant economic footprint, to be sure, but that footprint is already shrinking. And like the labour market, Canada's overall macroeconomy has a proven capacity to adjust and adapt. So long as economic policy settings are appropriate, other industries will develop and expand to offset the gradual erosion of fossil fuel activity.

GDP: Gross Domestic Product (GDP) represents the total value of goods and services produced in the formal monetary economy. GDP can be measured in nominal or real terms: the latter is adjusted to account for changes in the price of output. This distinction is vital in the case of fossil fuel industries, because of the persistent volatility of global energy prices. When world oil prices are very high, the apparent nominal GDP contribution resulting from fossil fuel output seems large. When commodity prices plunge, however, then nominal GDP from fossil fuel industries contracts sharply. Real GDP in fossil fuel industries is meant to measure changes in the physical quantity of production (adjusted for quality factors). Real GDP in fossil fuel production has grown steadily in line with growing petroleum output, driven primarily by new bitumen facilities.[106] However, whether that growth in physical output translates into healthy realized revenues and incomes depends on the state of global commodity prices, which have been very weak since 2014. More recently, fossil fuel prices (especially for oil, but also for natural gas and coal) plumbed new lows during the COVID-19 pandemic and global recession.[107]

[106] Total Canadian oil production doubled between 2003 and 2019, reaching 4.5 million barrels per day; close to two-thirds of total oil production now comes from bitumen operations (Canada Energy Regulator, "Estimated Production of Canadian Crude Oil and Equivalent").

[107] In spring 2020 crude oil futures prices fell below zero for a temporary period.

The relative contribution of fossil fuels to national GDP is larger than its contribution to employment, for the simple reason that output per worker is much higher in these very capital-intensive industries. This is why it takes so much more output to support a single job in fossil fuel production than in other sectors (as indicated in Table 3). According to Statistics Canada, the oil and gas industry accounted for 5.5% of national GDP measured at basic prices (in real terms) in 2019, up from 5.1% in 2000 (before the big expansion of the 2000s). But that figure is distorted by Statistics Canada's methodology for measuring industry-level real GDP: its estimates use prevailing prices in 2012, when prices for Canadian crude oil were more than twice as high (in Canadian dollars) as they were in 2019. The impact of the collapse in oil prices is thus invisible in industry-level real GDP statistics: they measure changes in physical output of the sector, valued at the same prices as prevailed in 2012. If we adjust for the collapse in prices after 2014, then the current contribution of oil and gas to current nominal GDP is around half of the share implied by the 2012-denominated real GDP data: likely less than 3%.[108]

If fossil fuel industries are phased out gradually over the coming 20 years, this implies an annual reallocation of national GDP of perhaps one-fifth of one percent each year. Even if that reduction in fossil fuel output were *not* offset by alternative forms of production and employment, that would not constitute a noticeable difference in the long-run growth trajectory of the economy. But fossil fuel production will not simply disappear. It will be *replaced* by alternative forms of work and production: including alternative energy production and systems, of course, but also all of the other sectors and industries that make up Canada's diverse and sophisticated economy. So long as policy settings support the reallocation of resources and the maintenance of total output at close to full potential, the gradual reallocation of labour and other resources (like capital) implied by an orderly, gradual phase-out of fossil fuels will have no negative effect on GDP growth. And by leaving our economy and society better positioned for a carbon-neutral future, with a stronger foundation of new technology and sustainable reliable energy, this transition will clearly enhance Canada's long-run growth potential.

International Trade: Most fossil fuel production in Canada is exported, mostly to the U.S. The large expansion in petroleum extraction since 2002 has thus had an important influence on the structure of Canada's international trade. At peak in 2014, petroleum products accounted for 22% of Canada's total merchandise exports, in nominal

[108] Statistics Canada does not produce regular data on nominal GDP by industry, so the industry's share of current nominal GDP can only be estimated.

terms.[109] That declined to 16% by 2019 – and will fall further this year due to severe weakness in fossil fuel prices. Coal exports account for just over 1% of total merchandise exports, and that share has been relatively stable over the past decade. However, the decline in fossil fuel exports had no visible impact on the national balance of international payments: Canada's current account deficit actually narrowed over this period, from a high of $60 billion (or 3% of GDP) in 2013 when petroleum exports were booming, to $47 billion (2% of GDP) in 2019.

The disproportionate role of fossil fuel exports in Canadian international trade must be placed in a broader macroeconomic context. The rise and fall of fossil fuel exports has had a muted impact on overall trade and economic performance, for several reasons:

- First, the nominal value of resource exports (like the nominal value of the industry's contributions to GDP) fluctuate dramatically with global commodity prices. In recent years prices have been very weak, and the long-term shift away from fossil fuel energy sources will further suppress fossil fuel prices.[110] Thus while the physical quantity of exported energy has grown, the *value* of those exports has declined – and will continue to do so.

- Second, the export revenues generated by fossil fuel exports are offset by other outgoing payments closely related to petroleum production. In particular, capital equipment in the petroleum sector is primarily sourced from foreign suppliers, so new investment projects result in expensive imports of capital goods; also, the high degree of foreign ownership in petroleum requires large outward payments of profits and dividends to foreign owners. For both reasons, the net impact on Canada's balance of payments of petroleum exports is further muted.

- Third, the rise of petroleum exports has had a documented negative impact on other exports, which were squeezed out by currency appreciation and other side-effects of the resource boom.[111] So even in their heyday, petroleum exports may not have had *any* positive impact on total exports at all. Indeed, in the 5 years since 2014 (when the downturn in petroleum exports began), Canada's non-energy exports performed robustly, growing 19% – helped along by a lower Canadian dollar and other adjustments. Total merchandise exports grew, even as petroleum exports declined.

[109] Unless otherwise noted, all data in this section based on author's calculations from Industry Canada, Trade Data Online.

[110] Oil and gas exports over the first half of 2020 declined by 28% – twice as fast as the decline in other exports.

[111] See the empirical evidence and discussion in Clarke et al. (2013) and Sharpe and Waslander (2014).

- Fourth, the general role of merchandise exports in Canada's total economic performance has declined substantially in recent years. Merchandise exports have fallen as a share of total output, from a peak of 40% of GDP in 2000 to under 25% today. (Services exports increased marginally relative to GDP over the same period.) So while international trade is still obviously important to Canada's economic performance, the national economy is increasingly dependent primarily on *domestic* output and purchasing power trends.

For all these reasons, the erosion of petroleum and other fossil fuel exports as these industries are phased out, and customers (in Canada and abroad) turn to renewable energy sources, will not fundamentally undermine Canada's overall trade trajectory.

Capital Investment: Fossil fuel industries have also accounted for a disproportionate share of total capital spending by Canadian businesses since the turn of the century. At peak, when the petroleum industry undertook the simultaneous construction of several bitumen and related mega-projects, the petroleum industry single-handedly accounted for over 25% of all fixed non-residential capital spending in Canada.[112] In 2014, the industry invested over $90 billion in new capital. By 2019 that had fallen by half.[113] The most recent surveys expect another 25% decline in petroleum fixed capital spending in 2020 – representing a cumulative drop in investment spending of over 60% since global energy prices fell in 2014. Luckily, private capital spending in other sectors grew by over 10% between 2014 and 2019, filling most of the void left by retreating investment in the petroleum sector.

There is no doubt that major capital projects generate significant direct and indirect economic activity, and the boom in construction of new extraction facilities – centred in northern Alberta, but with some spillover to other regions – certainly created many job opportunities. However, the extreme boom-and-bust pattern of capital spending in fossil fuel industries had many drawbacks, as well. The unplanned, "gold rush" nature of the expansion artificially inflated labour and living costs. Because the industry overbuilt new production capacity that will exceed demand from world markets (as well as exceeding capacity to deliver that product to market), substantial write-downs of capital assets are already occurring, and more will occur in coming years. Most of the capital equipment and machinery installed in those megaprojects was imported, and thus contributed to Canada's chronic current account deficit. The impacts of those enormous capital investments on productivity (usually boosted by capital investment)

[112] Data in this section based on author's calculations from Statistics Canada Tables 34-10-0036-01 and 36-10-0097-01.

[113] Hussey (2020) provides company-specific detail on the collapse of capital spending in the oil sands sector.

were also questionable – both because of the underutilization of overbuilt capacity, and the underlying long-run decline in labour productivity in the oil and gas sector (discussed below). For all these reasons, while large capital projects contributed to short-term and often unsustainable regional booms, their long-run benefits have been questionable.

Capital spending is a vital, leading force in economic development and job creation, and Canadian policy-makers need to take active measures to accelerate both private and public capital spending. However, capital spending in fossil fuel industries will never regain the peaks it experienced over the last 15 years – nor should we want it to. Capital investment in fossil fuel industries will continue to decline as the industry's constrained future prospects become more clearly appreciated: by financial investors, policy-makers, and the voting population. Some capital spending will be required to address the environmental damage which is one legacy of fossil fuel activity (such as the new program to clean up orphan oil and gas wells in western Canada announced by the federal government). The transformation of the energy system will also require very large capital investments in generation, distribution, and energy efficiency technology. With appropriate policy settings and fiscal incentives, those alternative investments will fill the economic space left by the coming retrenchment of capital spending in fossil fuel sectors.

Productivity: Fossil fuel jobs tend to demonstrate higher average productivity levels than other work. This is because these capital-intensive industries employ few workers, relative to the amount of output which they produce. (This is the flip-side of the very weak employment-generating effects of fossil fuel production, summarized in Table 3.) However, while average productivity levels are higher in fossil fuel production, the trend in productivity in the industry is strongly negative. Productivity tends to decline over time in extractive industries such as petroleum, due to the exhaustion of the most easily-extracted reserves of the resource. As a result, it takes more work and expense to extract other, less accessible reserves. Sharpe and Waslander (2014) report that labour productivity in the oil and gas industry declined at an average annual rate of 6.4% between 2000 and 2012 – cumulating to a 55% drop in average real output per worker over that time. Only inflated commodity prices can make such unproductive activity *profitable*. The reallocation of employment, over an extended period of time, from an industry with high but rapidly falling productivity, into other sectors with lower but steadily rising productivity, will have negligible effects on overall productivity growth.

* * * * *

There is no doubt that fossil fuel industries play a significant role in Canada's overall macroeconomic system. The number of jobs in fossil fuel industries is modest (under 1% of all employment). The fossil fuel sector's contributions to GDP, exports, investment and productivity are proportionately larger than its employment footprint – but by those measures, too, the claims of industry lobbyists that Canada's prosperity depends critically on continued expansion of fossil fuel industries are false. The Canadian economy can and must adjust to the decline and eventual disappearance of fossil fuel industries: best achieved in a planned, orderly way, but inevitable in any event. The scale of readjustment and reallocation toward other industries is entirely feasible. Indeed, the dramatic decreases in fossil fuel nominal output, exports, and capital spending already been experienced since 2014, during a time when the overall Canadian economy performed strongly, prove that Canada's economy can function well with a declining fossil fuel footprint. Of course, the effects of declining fossil fuel employment have been felt more severely in the provinces and communities which depend most on those industries. But even there, overall economic activity has continued to expand. In Alberta, for example, employment was 3% higher in 2019 than in 2014 (when fossil fuel employment peaked), and average weekly wages had also regained and surpassed their 2014 levels.[114]

It is essential that economic policy facilitate the coming transition as fossil fuel industries continue to contract. This must include expansionary macroeconomic settings (to ensure that displaced resources, including people, are absorbed in other, growing sectors), a strong focus on facilitating private and public capital spending (including in renewable energy), and industrial and technology strategies to ensure that Canada captures the maximum possible spin-off benefits from the global shift to a carbon-neutral economy.

[114] Author's calculations from Statistics Canada Tables 14-10-0288-01 and 14-10-0203-01.

Planning an Orderly Transition

The preceding profile of the quantity, quality, and regional distribution of fossil fuel employment in Canada provides crucial context for the development of strategies to manage the transition away from fossil fuels effectively and fairly. There is no question that transition away from fossil fuels will occur. It is not in Canada's power to stop the accelerating transformation of the global energy system: the rest of the world is moving ahead steadily with new policies and technologies to eliminate most demand for fossil fuels (including those produced in Canada). We can stop this no more than we could stop the change in fashion tastes which eliminated global demand for Canadian-harvested beaver pelts centuries ago. What we can control is how the coming transition occurs. It can be planned, orderly, and fair – or it can be chaotic, controlled by others, and painful.

As a country we can choose to recognize and prepare for the coming transformation, positioning ourselves to capture maximum benefits (both economic and environmental) from it, and support individuals and communities affected by it. Or we can choose to try to ignore what is happening, and maintain or even expand our fossil fuel footprint in hopes of avoiding the tectonic changes that are already obvious. That would produce a disorderly and destructive transition: in which facilities and entire industries close suddenly and chaotically, after some critical point is reached when they can no longer economically function.

By committing to an orderly and gradual transition, we can adjust our decisions and investments (including investments that workers make in their skills and career choices, the decisions governments make about infrastructure and public services, and the decisions of private businesses about capital and technology) to make the most of the shift to renewable energy sources. We can assist all stakeholders – businesses, workers, communities, public agencies – in preparing for that change, seizing opportunities associated with a renewables-led energy system, and positioning Canada as a leader rather than a laggard in the new industries that are emerging. We can also commit to systematically and fairly supporting and protecting individuals who will be most affected by the phase-out of fossil fuels: some who will need to find new work (in new industries, occupations or regions), more who will transition to other stages of life (like retirement or further education). We can also support those regions and communities (there aren't many) which depend heavily on fossil fuel industries today: helping them build the industries and attract the investments required to diversify and transform their local economies.

The preceding analysis of fossil fuel employment informs several principles and best practices for planning effective employment transitions. This section discusses the crucial policies that will be central to any successful transition plan (summarized in Table 13):[115]

Table 13 Top Ten Principles for Effective Transition Planning
1. Commit Now to Planned Phase-Out of Fossil Fuels
2. Stage Transitions Over Time
3. Facilitate Intra-Industry Mobility
4. Encourage Voluntary Exit
5. Support for Reskilling and Relocation
6. Income Protections for Affected Workers
7. Voice and Representation for Fossil Fuel Workers
8. Vibrant Macroeconomic and Labour Market Management
9. Support Regional Adjustment and Diversification
10. Invest in Amelioration and Clean-Up

1. Commit Now to Planned Phase-Out of Fossil Fuels: Fossil fuels will disappear as a major source of energy within the foreseeable future. Given that reality, it is unhelpful, and indeed cruel, to encourage more workers – including some just entering the workforce – to try to build their livelihoods in an industry that will soon disappear. As described above, most of the coming decline in fossil fuel employment can be absorbed through normal attrition and retirement. But that only works if those normal departures are not replaced with new hires. A firm and clear signal must be sent to all stakeholders in the industry, and most critically to future workers, that the fossil fuel industry is disappearing. This will require overcoming vested opposition from narrow political and economic quarters, who still hope to preserve an industry that has been very profitable for them, but that cannot continue. By confirming the long-run trajectory of decarbonization, and communicating it clearly to all stakeholders, needless waste and cost will be avoided in the future. The federal government's commitment to carbon net neutrality by 2050 is an important step in this regard, but needs to be reinforced with more specific timetables for the phase-out of various components of the overall energy system, and consistent commitments by other levels of government.

[115] For a more comprehensive discussion of principles and best practices in transition planning, please see Stanford (2017).

2. Stage Transitions Over Time: Time is the best friend of well-planned structural transitions: the longer the transition can be planned in advance, and the more gradually it is implemented, the more easily can its negative effects be managed and ameliorated. So in addition to announcing a firm long-term plan for the transition away from fossil fuels, it is also critical that closures be implemented steadily and gradually over time. Reaching net zero emissions by 2050 provides a long-term runway for shrinking these industries to zero. So long as that phase-out occurs evenly (and is not deferred and back-end-loaded with continuing delays and denial), it implies an annual reduction in fossil fuel employment of just a few thousand jobs per year – most of which could certainly be absorbed through retirements and voluntary severance. That employment transition would be barely noticeable in a labour market that comprises 20 million working people, one-third of whom experience some major change in their employment activity every single year. Steady reductions in fossil fuel employment will require the imposition of discipline and planning on the private decisions of individual businesses; by requiring them to adhere to a timetable for future phase-out, they will be pushed to make the most of their existing workforces, and the normal boom-and-bust tendencies of these industries can be stabilized.

3. Facilitate Intra-Industry Mobility: The potential benefits provided by the normal flow of retirements and voluntary departures can be harnessed most powerfully when transition planning allows for mobility by fossil fuel workers across firms, facilities, and locations within the same industry. In essence, when a single facility downsizes or closes, a proportion of its workers will be able to move into retirement or some other voluntary transition; this reduces the number of involuntary departures which would otherwise occur. If worker mobility is allowed across locations, then younger workers (who cannot yet qualify for early retirement) could move to other facilities or locations that continue to operate, filling vacancies opened by retirements or voluntary departures from those workplaces.[116] In fact, the number of such vacancies (at facilities that continue to operate) could be increased through early retirement and voluntary severance incentives for senior workers at *all* locations (not just those imminently closing).

This sort of intra-industry mobility allows the downsizing of an overall industry to occur in a gradual, rational manner, with minimum involuntary displacement. It has been crucial in the successful experience of previous industry-wide shut-downs achieved in Germany, Ontario, and other jurisdictions (described in more detail below). But the strategy requires a capacity to plan industry-wide downsizing and facilitate worker mobility at an industry-wide level. When an industry is owned by one large firm (such

[116] Inter-plant preferential hiring and transfer arrangements negotiated in Canada's auto industry during the turbulent 2000s provide a good example of this method for reducing involuntary layoffs.

as a public utility), this is readily achievable. It is more challenging in the case of industries that are structured around competitive, fragmented private businesses. In that case, establishing some form of sector-wide planning and transition authority can facilitate the needed planning and mobility. While it may seem counter-intuitive for government to "buy in" to a dying industry, expanding public ownership in the fossil fuel industry would also achieve this needed capacity to plan industry-wide phase-outs.[117]

4. Encourage Voluntary Exit: Once a clear and firm timetable for phase-out of fossil fuel facilities has been established and communicated, most affected workers will immediately begin developing alternative plans for themselves and their families. The more these workers are able to anticipate and prepare for the phase-out, the smaller will be the involuntary displacement. Pro-active adjustment and mobility well in advance of final closures can be accelerated through the ongoing provision of incentives and supports for personal transitions of all kinds. These incentives will reinforce individuals' willingness to accept alternative opportunities. They could include packages for early retirement; incentives and buy-outs for other voluntary severance; income protection for people moving to other positions with potentially lower wages; and paid leave and financial support for retraining or enrolment in higher education. Maximizing the potential of these voluntary departures requires long lead times for downsizing and closures. This is another benefit of sector-wide planning for the phase-out, because it provides affected workers with clear, long-term guidance of the future of their respective facilities.[118] On the other hand, leaving downsizing decisions up to individual companies (typically forced by market or financial disruptions) will lead to more sudden and thus painful displacements.

5. Support for Reskilling and Relocation: For some workers who transition from fossil fuel jobs to alternative industries or occupations, new skills and training will be required. This is not a universal problem: in many cases (including many technical, trades, management and professional occupations), fossil fuel workers' existing skill sets will be readily transferable to alternative applications. Keep in mind, too, that most of an orderly phase-out of fossil fuel work will not involve any reallocation of workers to new careers, so long as the transition plan makes best use of the natural forces of voluntary turnover and retirements. In some cases, however, access to

[117] Germany nationalized ownership of black coal mines as part of its long-run plan to shut down coal mining; this experience is discussed further below.

[118] The long-run timetable for closure of coal-fired electricity plants in Ontario is a good example of the benefits of advance notice to workers; most knew several years in advance that their facilities would close, and could make personal plans and decisions accordingly.

retraining and continuing education can facilitate movement to new occupations and industries.

Retraining is often held out as a "magic bullet" solution for structural adjustment situations, but it is rarely backed up with genuine resources and quality opportunities. For retraining to play its potential role, fiscal investments in vocational training and lifelong learning opportunities must be substantial and consistent. An economy-wide strategy for transitioning away from fossil fuels must be accompanied by urgent action to strengthen Canada's underdeveloped vocational training system, and generous support for tuition and living costs for fossil fuel workers undertaking retraining (including reforms to allow displaced workers to take courses without losing employment insurance benefits).

A similarly generous approach will also be required to support regional relocation by affected workers. As described in Table 5 above, there are a few communities in Canada (but not many) which depend heavily on fossil fuel jobs. Planning for the phase-out of fossil fuels will require targeted regional support for diversification and job creation in those communities (discussed further below). Nevertheless, some workers and their families affected by the phase-out will opt to relocate to other parts of Canada. Financial support for relocation (including moving and resettlement costs, and compensation for the potential impacts of fossil fuel closures on housing and property prices) will further lubricate this process of regional mobility.

6. Income Protections for Affected Workers: Even with advance planning, phased closures, and support for redeployment and relocation, some workers in fossil fuel industries may still confront a loss of income resulting from the closure of their workplace. That may even be true for workers who successfully find alternative employment in other industries or occupations – but whose new jobs do not offer equivalent compensation. These workers should be provided with transitional income protection, to compensate for losses experienced as a result of a broader policy decision (namely, phasing out fossil fuel production) which was implemented to benefit society as a whole.

Financial investors and business owners expect and regularly receive this sort of compensation: when policy decisions by government alter the viability or profitability of their investments, compensation to the owners of capital is routinely paid.[119] In the case of coming energy transitions, such compensation to business owners is likely to be substantial, given the capital-intensive nature of production. Even more ambitious

[119] For example, Alberta electric utilities were provided with over $1 billion compensation for the policy-induced closure of coal-fired generation plants in that province; see Coal Transition Coalition (2017).

supports should be provided to affected workers. Given the relatively small size of employment reductions implied by a long-term phase-out plan, and the potential to manage most transitions through retirement, redeployment, and voluntary exit, the costs of even a generous income-protection scheme would be modest.

Fossil fuel workers should be provided with generous income security benefits (delivered through the EI system or other targeted programs), with adjustments in eligibility to facilitate relocation and retraining. Transitional wage supplements (replacing, say, any reductions in employment income for a 5-year period, capped at age 65 for older workers) should be offered to those who accept alternative employment but at lower wages.

A striking analysis of the modest cost of even strong income guarantees for transitioning fossil fuel workers is provided by U.S. economists Robert Pollin and Brian Callaci (2016), who modeled a comprehensive fossil fuel transition plan for the U.S. economy. Their proposed plan includes an income protection guarantee, guaranteed pensions, retraining grants, and other transition supports. They project an annual loss of employment of about 16,500 positions per year over 20 years in the U.S. from the gradual phase out of coal, petroleum, and ancillary industries in the U.S.[120] Most of those job losses (83%) can be offset through retirement and attrition. Redeployment, retraining, and a 5-year 100% income guarantee for the remaining workers would cost an average of only $600 million per year – very small relative to other costs associated with the coming energy transition.

7. Voice and Representation for Fossil Fuel Workers: Fossil fuel business leaders express shallow "solidarity" with their employees while opposing climate policy measures. That solidarity ends quickly, however, when it comes to negotiating wages, working conditions, and top-notch safety practices (as confirmed by the preceding review of deteriorating wages and working conditions in fossil fuel industries). Fossil fuel workers need more bargaining power, ideally through rejuvenated union representation, to resist employer efforts to cheapen or outsource labour, and to protect their share of industry value-added so long as the industry exists. Stronger collective voice and representation would also provide fossil fuel workers with more influence as the industry traverses the coming transition. Workers should have strong organized representation in developing phase-out plans, designing incentives and transition supports, and ensuring that promised measures are effectively implemented and enforced. The joint federal-provincial task force established to develop and

[120] As discussed above, the implied loss of fossil fuel payroll employment in Canada consistent with a 20-year phase-out period would be less than 8,000 jobs per year – less than half the estimated pace for the U.S.

recommend a best-practice plan for phasing-out coal-fired electricity generation, which had strong union representation, is a good example of the importance of strong worker voice in transition planning; so is the process undertaken in Alberta after 2015 to implement a similar plan there.[121]

8. Vibrant Macroeconomic and Labour Market Policies: Any employment transition is easier to absorb when the strength of overall labour market conditions is reinforced through a top-priority commitment to reducing unemployment and supporting job creation. Thanks to the strong labour market conditions that prevailed through the initial decades of the postwar era in Canada, enormous transitions in the composition of employment in those decades (including large shifts away from rural communities, and the rapid expansion of whole new industries) occurred with relatively little hardship. Commitment to enhancing the quantity of jobs must also be matched with a multi-dimensional emphasis on lifting the *quality* of work: including higher minimum labour standards and conditions, more secure and stable working hours, steady improvements in wages, and opportunities for collective representation. When workers are presented with a range of appealing employment opportunities, their concern and resistance to the eventual loss of their current vocation is eased substantially. It is only when good jobs are scarce, and workers feel there is little prospect of decent alternative employment, that they fight more desperately to hang on to existing jobs – even those with an inherently time-limited future.

The critical importance of this macroeconomic dimension in transition planning is amplified when we consider the impact of fossil fuel phase-out on the various indirect activities (both upstream and downstream) that presently depend on the production and incomes of fossil fuel industries. Ensuring a successful reorientation for those indirect businesses and workers will require determined commitment to macroeconomic expansion, job-creation, and strong efforts to nurture investment in other sectors (both private and public) that could also serve as anchors for supply chains and regional economic activity.

9. Support Regional Diversification: As described in Figure 8 and Tables 5 and 6 above, fossil fuel jobs are not distributed evenly across Canada; they are heavily concentrated in three provinces and a few regions. Relatively few communities are truly dependent on fossil fuel jobs for direct employment: in only 18 communities do fossil fuel jobs constitute more than 5% of local employment. And surprisingly, most fossil fuel jobs are located in large cities, where opportunities for employment transitions will be readily available. Nevertheless, special attention must be paid in any transition plan to

[121] See Task Force on Just Transition (2019), Coal Transition Coalition (2017), and Hussey and Jackson (2019) for details.

supporting regional communities which experience larger employment losses from the phase-out of fossil fuels. Providing ample notice of coming transitions will be especially important in regional communities, to facilitate their early preparation, adjustment, and diversification efforts.

A whole suite of potential industries could provide alternative employment opportunities in regions which currently depend heavily on fossil fuel jobs. Remember, even in those 18 especially fossil fuel-dependent communities, an average of only 9% of local jobs are in fossil fuel industries. Health care is a bigger employer, even in those communities; continuing growth in that sector (which is growing faster than fossil fuel industries will shrink) will be important to future labour market adjustments. Other public services (such as education, public administration, safety, and transportation) are also vital. Decisions regarding the location of key public service facilities (including health care, education, public administration, research and science, and others) can consider the need for diversification in fossil fuel-dependent communities. Private sector industries (including agriculture, non-fossil-fuel mining, manufacturing, construction, and business services) can also contribute to the revitalization of investment and job creation in these regions.

Targeted government support for job creation in highly affected regions can aid the coming employment transitions. That can include expansion of direct public sector investments and hiring in targeted regions to deliberately offset declines in fossil fuel employment. These will be especially important in more remote communities (such as Wood Buffalo/Fort McMurray) which will require targeted injections of investment and job creation to preserve their viability as fossil fuel activity wanes.[122] It can also include fiscal supports and other aid for private sector regional projects, including special tax incentives or co-investments, R&D and training supports for new private ventures, and favourable provisions for development approvals and levies.

10. Invest in Amelioration and Clean-Up: In addition to their impact on global climate, fossil fuel industries have produced other negative environmental externalities. These include more localized problems with polluted or abandoned production sites: including mines, oil and gas wells, and pipelines. In some cases, those local problems also reinforce the global climate crisis: for example, leaking methane from improperly decommissioned natural gas wells and pipelines makes a significant (and often undocumented) contribution to Canada's overall emissions of greenhouse gases

[122] The challenge of survival for remote resource-dependent communities after resource extraction has ended is not unique to fossil fuel industries; Canada has dozens of mining towns and resource communities which faced downsizing or even abandonment after their respective industries declined or collapsed. Larger communities have a better opportunity of remaining viable through diversification.

(Chesnaux, 2020). There will be considerable work required to repair this environmental damage; hiring displaced fossil fuel workers to perform that work would make an obvious and fitting contribution to employment transitions. Re-employing fossil fuel workers in cleaning up previous sites is a logistically and geographically convenient transition measure. A start in this task was made with a new federal government program (during the COVID-19 economic crisis) to provide $1.7 billion in financial support for remediation of abandoned wells in Alberta, Saskatchewan, and B.C. It is estimated the program will support several thousand jobs – a welcome offset to the continuing decline in overall employment in the petroleum sector.

* * * * *

There are reasons to be optimistic about the capacity of all stakeholders – coordinated and led by government – to develop feasible, compassionate, and effective plans for an orderly transition away from fossil fuels. There are numerous policy levers which can be invoked, in a consistent and multi-dimensional effort to manage the downsizing of fossil fuel work, facilitate adjustments by workers and communities, and create new opportunities in the growing industries that will dominate Canada's future labour market. The labour market naturally exhibits a remarkable flexibility, as individuals constantly respond to changing economic, personal, and demographic conditions to make the most of their work lives. Situated properly within a firm, long-term phase-out timetable, these normal adjustments will do much of the heavy lifting of transition. However, the overall transition process must be led and managed through pro-active policy actions of government: it cannot be left to private market forces. Historical and international experience confirms that when structural change occurs in a spontaneous, private, unplanned manner, it results in needless displacement, hardship, and volatility. In contrast, a process that is planned and supported, with advance notice, generous supports, and voice and participation for all stakeholders – most critically including fossil fuel workers themselves – can achieve the coming transition fairly and effectively.

Successful Transitions Around the World

The ten principles identified above for successful transition planning are not "rocket science": it is self-evident, once the timetable for fossil fuel phase-out has been confirmed and the underlying flexibility of labour markets fully engaged, that orderly employment transitions can be facilitated without imposing hardship or dislocation on the existing workforce. Indeed, there are numerous examples of successful transition programs that have facilitated the phase-out of fossil fuel sectors in other countries. These experiences confirm that through the combination of advance notice, phased shut-downs, intra-industry mobility, and generous support for retirement and redeployments, fossil fuel industries can be completely retired without turmoil, involuntary unemployment, or community hardship. These successful real-world examples prove that a fair and orderly transition away from fossil fuels need not be disruptive or painful; done right, it can leave the economy (as well as the environment) much stronger.

Germany: The carefully planned closure of black coal mining in Germany occurred over a 20-year period, and was completed in 2018. It provides an outstanding example of the advantages of advance notice, staged closures, and generous support for retirement and mobility.[123] The industrial regions of the Ruhr and Saar valleys in Germany had long been heavily dependent on coal mining and related activities. Employment in those industries was shrinking for decades due to new technology and competition from other fuel sources. Ownership of the mines was consolidated (with public equity participation) in 1969 in a new integrated firm, RAG Aktiengesellschaft, to facilitate continuing planned restructuring and also promote diversification into other industries. In 1997 a "Coal Compromise" was reached, involving the company, the federal and state governments, unions, and affected communities. This Compromise ended previous subsidies for coal mining and initiated the gradual shutdown of the whole industry. Employment fell from 81,000 jobs in 1997 to just 2,000 when the last active mine closed. Most of the downsizing was accomplished through retirement of miners, supported by strong extra incentives for those below normal retirement age. Over 10,000 workers were also reassigned through the phase-out to work in other locations, after their own mines closed. Strong supports were provided for retraining and redeployment to other jobs within RAG (including in its growing non-mining

[123] For more details on the German transition, see Sheldon *et al*. (2018) and O'Malley (2019).

divisions) and external firms in other industries. Germany's very strong apprenticeship and job placement system assisted in this process. The orderly shutdown of this major regional employer thus occurred without a single involuntary layoff, and caused no undue damage to regional or national labour markets. Similar strategies are now being employed in a parallel plan to close down coal-fired electricity generation plants in Germany (and associated lignite mines) by 2038 or sooner. A transition and regional development aid package worth €40 billion will facilitate those adjustments. Thanks to the same combination of advance notice, staged closures, intra-industry mobility, and generous support for retirement and voluntary severance, the government has committed that this shutdown will also occur without involuntary lay-offs.

Netherlands: The successful German shutdown of black coal mining mimicked many features of the successful earlier closure of coal mining in the Dutch region of South Limburg. This somewhat poorer region of the Netherlands had been heavily dependent on coal mining, until the discovery of inexpensive natural gas in the North Sea in the mid-1960s destroyed the economic viability of that industry. The government, industry, unions, and community development planners implemented a 20-year plan for phase-out of coal.[124] In the first decade of the plan, industry employment fell by 50,000 positions. One-third of that downsizing was accomplished through retirements, one-third through voluntary displacement and/or reallocation to other jobs, and one-third to jobs at external firms. A dedicated regional development corporation (called LIOF) was created, supported with public capital, to implement a long-term industrial diversification strategy for the region. That corporation still exists, long after coal mining ended, and has several divisions which undertake a range of goods and service-producing activities. A central motto of the whole plan, proposed originally by participating Dutch unions, was "no closure without new employment." This is an apt guiding principle which should apply to modern transition planning.

Ontario: Ontario completed the successful planned shut-down of all coal-fired electricity generation, without incurring a single forced redundancy for affected workers.[125] Between 2005 and 2014, the province's publicly-owned power utility, Ontario Power Generation, closed a total of 19 coal-fired generating units at 5 locations with a combined generating capacity of 7500 MW. The first closure was announced in 2001 (4 years in advance); a schedule for the remaining closures was announced in 2003. The closures were staged over a decade to ensure continued stability in electricity supply and facilitate an orderly adjustment of affected workers. At peak, the coal-fired plants employed a total of approximately 2000 direct workers.

[124] See Karkare and Ashraf (2019) and Gales and Hölsgens (2017) for details of the plan and its effects.

[125] For more details on the Ontario experience, see Ministry of Energy, Ontario (2015), and Harris, Beck and Gerasimchuk (2015).

Two of the coal-fired generating plants were converted to biomass production, preserving local employment. In the others, which closed entirely, affected workers were offered alternative employment at other OPG locations, or generous early retirement and severance incentives (negotiated with the unions representing OPG workers). No involuntary lay-offs were experienced. The shutdown of coal-fired electricity in Ontario still ranks as the largest single emissions reduction initiative ever completed in North America. Ontario's experience has informed a similar transition strategy for a nation-wide closure of coal-fired electricity in other provinces, which will be completed by 2030.[126]

U.K. The U.K. has experienced one of the fastest reductions in greenhouse gas emissions of any industrial country in recent years (down 30% in the last decade), on the strength of a stable and bipartisan commitment to ambitious emissions reductions and roll-out of renewable energy sources. The U.K. was traditionally a major producer of both coal and petroleum, so the employment transitions associated with this energy transformation have been important. In earlier years, the forced closure of regional coal pits (for economic, not environmental, reasons) without transition support (imposed in the turbulent 1980s) provided a case study in how *not* to manage employment transitions. More recently the transition toward renewable energy has been accomplished with more benign labour market impacts. An estimated 225,000 British workers are employed in low carbon and renewable energy projects (Office for National Statistics, 2020). Some projects – such as massive offshore wind power developments – have directly re-employed workers formerly occupied in offshore petroleum (Ambrose, 2020). The U.K. transition strategy has not been as integrated or comprehensive as those in Germany, the Netherlands, or Spain,[127] but overall labour market outcomes in the U.K. remained strong (with an unemployment rate below 4% in 2019, and relatively strong wage growth) even as the shift to renewable energy accelerated.

Spain: The Spanish government has announced a plan to close its remaining 10 coal mines over the coming decade, accompanied by a program of generous early retirement subsidies, job creation in reclamation and remediation, and redeployment into renewable energy jobs.[128] Any miner aged over 48 at the time their mine closes will be eligible for early pension; that is expected to offset at least 60% of the job losses. Younger workers can be redeployed into new work associated with closing the mines, reclaiming associated land areas, and converting them into other uses. Others

[126] For details see Task Force on Just Transition (2019).

[127] Friends of the Earth Scotland (2019) make several suggestions for a stronger employment transition programme.

[128] See Neslen (2018) for further details.

will be provided assistance transitioning into new jobs in renewable energy and other alternative industries. The transition program should avoid forced redundancies for any of the industry's existing workforce (under 2000 workers). On a parallel track the government is implementing an ambitious sustainable hydrogen development scheme, with key investments targeted toward regions and communities impacted by the coal closures (Ministerio para la Transición Ecológica, 2020).

U.S. States: It is perhaps ironic that the American economy has experienced a very rapid transition away from the use of coal in electricity generation. U.S. coal use for power generation declined by almost half in 10 years after 2008;[129] it continued to decline rapidly despite the 2016 election promise by former U.S. President Donald Trump to "rebuild" the coal industry. This experience attests to the fact that competitive pressures clearly overwhelm ideological positioning in energy use decisions, and the positioning of political leaders as "champions" of fossil fuels cannot stop the accelerating transformation of the world energy system. Unfortunately, the U.S. has no national-level transition plan to assist workers affected by the shift away from coal. But pro-active policy measures enacted in several U.S. states have shown that these energy transitions can be accelerated, while supporting regional labour markets and affected workers. For example, New York State has implemented a Clean Energy Standard that will ensure 70% of electricity is generated from renewable sources by 2030, and that the electricity system is carbon-free by 2040.[130] The state's last coal-fired power plant closed in 2020 (Prohaska, 2020). Major investments in renewable energy developments – including $7 billion (U.S.) in tenders announced in 2020 for on-shore, offshore, and port-based renewable energy projects – are tied to project labour agreements that provide for training and targeted hiring for dislocated workers. Washington State has also committed to a 100% renewable electricity supply by 2045 under its new Clean Energy Transformation Act, which also features an emphasis on job training and adjustment measures.[131] Several other U.S. states have also enacted ambitious clean energy transition plans[132] that typically feature a significant role for labour training and adjustment measures, and have won support from labour advocates and unions.

Australia: Australia still relies on coal for around half of its total electricity supply. However, coal-fired capacity is being replaced by renewable energy developments, and governments have undertaken some important measures to facilitate a less

[129] U.S. Energy Information Administration (2020).

[130] See New York State Energy Research and Development Authority (2019) for more details.

[131] See Bernton and Brunner (2019) and Washington State Department of Commerce (2019) for more details.

[132] As of May 2020, 15 U.S. states and territories had enacted legislation to move to 100% clean electrical energy; see Ricketts *et al.* (2020) for details.

disruptive transition for affected workers. For example, the private electricity power operator Engie closed its coal-fired plant in Hazelwood, Victoria in 2017. Unfortunately, this decision was made with little notice to employees and the surrounding community; the company had even recruited new workers to move to the remote Hazelwood region just months before the closure announced, needlessly exacerbating the resulting adjustment challenges.[133] This experience dramatizes the importance of long-run, publicly-announced timetables (rather than short-term private decisions) for facilitating effective and fair employment transitions. Nevertheless, the Victoria state government responded to the Hazelwood events with an ambitious package of transition supports, including a worker transfer scheme (that allowed some workers at Hazelwood to move to other electricity plants in the region), the creation of a Latrobe Valley Authority to finance diversification and job creation initiatives in the region, and a Mine Rehabilitation Commission to sponsor remediation work (that employed some of the displaced workers).[134] Another upcoming closure, at AGL's Liddell coal-fired generation plant in New South Wales, will occur according to an agreement with its union to avoid any lay-offs through voluntary severance incentives (including early retirements) and the redeployment of remaining workers to alternate work at the site or nearby locations (including AGL's growing battery, pumped hydro, and gas generation operations).[135]

* * * * *

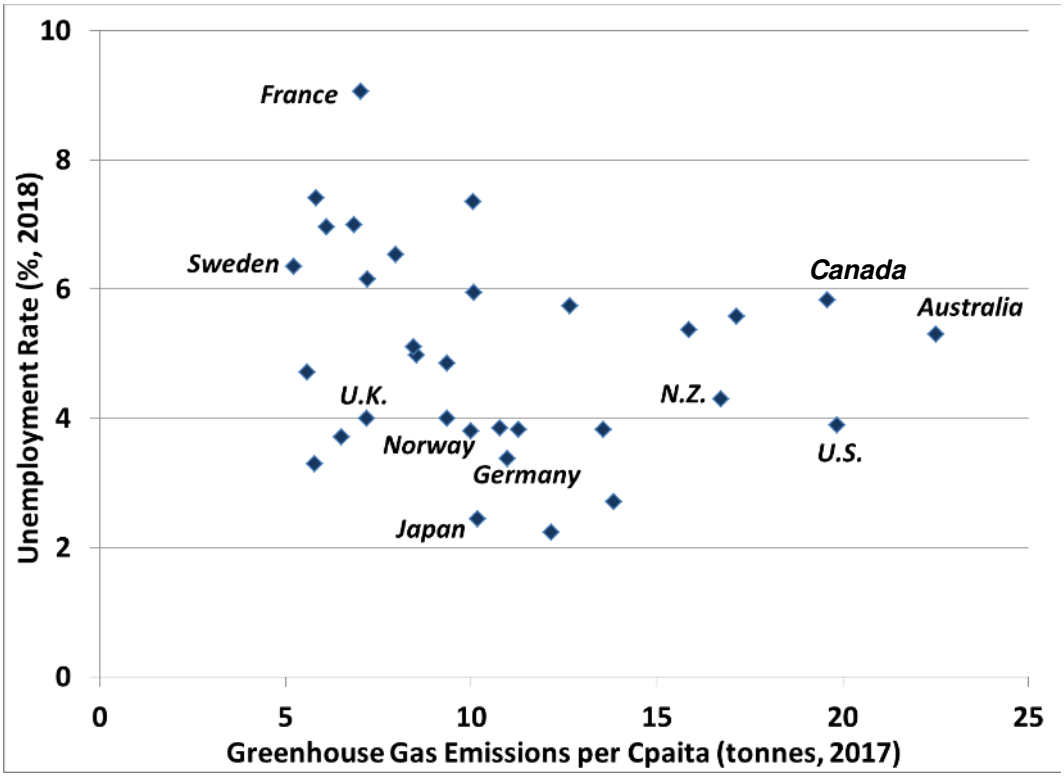
In addition to these specific examples of successful employment transitions away from fossil fuels in other countries, international empirical evidence certainly confirms that there is no negative association between emissions reduction (driven increasingly by the expansion of renewable energy production) and overall labour market performance. Figure 16 compares the level of greenhouse gas emissions (per capita) for numerous industrial countries, against the unemployment rate each recorded in 2018.

[133] In Australia's mostly privatized and decentralized electricity system, decisions over operation of individual generation facilities reflect private corporate priorities and expectations – including the impact of plant closures on volatile spot market electricity prices and hence prices.

[134] See Minister for Jobs, Innovation and Trade (2017) and Cain (2019) for summaries.

[135] See CFMEU Mining and Energy (2017).

Figure 16: Greenhouse Gas Emissions and Labour Market Performance



Source: Author's calculations from OECD Greenhouse Gas Emission and OECD Labour Force Statistics.

Canada is located close to the far right side of Figure 16, with one of the highest rates of GHG emissions per capita in the industrialized world. Almost all other industrial countries (other than Australia and the U.S.) have lower emissions per capita. Many of those lower-emitting countries also have lower unemployment rates than Canada (including Japan, the U.K. and Germany). Some less-emitting countries have higher unemployment rates than Canada. Overall, there is no statistically significant correlation between emissions and unemployment. Thus there is no international evidence that deferring the coming energy transition away from fossil fuels will somehow "save" jobs. Indeed, by delaying innovation and exacerbating adjustment costs, denying and delaying the energy transition will be harmful for labour markets.

In sum, the evidence is overwhelming that the transition away from fossil fuels, and the shift toward a low-carbon economy, can and must be accomplished while maintaining strong labour market performance. That happy combination will best be achieved through a combination of a clear and consistent long-run commitment to the phase-out of fossil fuels – with ambitious supports to facilitate transition, create new jobs (across the whole suite of industries, not just renewable energy functions), and improve job quality for all workers.

Good Alternative Jobs: Where Will They Come From?

There is a common tendency to connect the disappearance of jobs in fossil fuel industries with the creation of new jobs in renewable energy industries. To be sure, the roll-out of renewable energy projects will have important and positive employment effects. Indeed, because fossil fuel industries are highly capital-intensive, and not very effective at generating work (for given quantities of output), most studies find that the shift from fossil fuels to renewable energy will have a net positive impact on direct energy employment.[136] Certainly, the new employment opportunities associated with renewable energy systems will make an important contribution to the labour market transitions associated with the phase-out of fossil fuels.

However, it is not necessary to limit consideration of the employment effects of the energy transition just to those two energy sectors: one growing, one disappearing. As we have seen, the Canadian labour market experiences an ongoing, powerful process of adjustment – visible every month – through which workers transition across jobs, occupations, industries, and regions. This process involves *all* sectors of the economy. And there is no reason to expect that reallocating fossil fuel workers into renewable energy jobs will be the only – or even an especially important – dimension of the adjustment to the phase-out of fossil fuels.

In Canada, the renewable energy industry is certainly expanding, generating parallel growth in direct employment. There are no official statistics available on employment across the range of renewable energy projects and systems, but various case studies and simulations indicate that the number of jobs in this broad area is significant and growing. Navius Research (2019) estimates that employment in clean energy production systems increased by some 11,000 positions between 2010 and 2017 – primarily in electricity generation, transmission, and distribution.[137] Jeyakuman (2016) models potential new employment in renewable electricity generation in Alberta, associated with the province's Renewable Energy Policy. She estimates that close to 3000 new jobs would be created after 10-15 years of expansion – enough to offset all jobs lost in the province's existing coal-fired electricity generating facilities. In B.C., Lee and Klein (2020) suggest that investing 2% of provincial GDP in renewable energy and

[136] For example, see Hoffman (2017).

[137] Navius also estimates employment in various industries and activities that *utilize* renewable energy, such as public transit and energy-efficient buildings.

energy conservation initiatives (as proposed by Nicholas Stern in his landmark report[138]) would create and maintain 42,000 jobs in the provincial economy – far more than are presently supported by fossil fuel industries in that province. Clean Energy Canada (2019), IRENA (2019), and Ecology Action Centre (2019) also emphasize the job-creating potential of renewable energy and energy conservation projects.

Despite the encouraging prospects for new employment in renewable energy, however, it is not essential that the number of new jobs created in renewable energy must equal or exceed the number of current jobs in fossil fuel industries to avoid large-scale dislocation of fossil fuel workers (and fossil fuel-dependent communities) as the energy transformation occurs. And it is certainly not necessary that individuals currently employed in fossil fuel occupations should primarily seek reemployment in renewable energy projects. As we have seen, the labour market is a complex, interrelated system. Jobs are created and destroyed constantly across the full range of industries that make up the economy. And individuals make transitions in all directions: into and out of the labour force, into and out of employment and unemployment, changing their hours, occupations, job types, and industries. What matters is that the overall pace of job creation, *across the full set of industries and regions,* be sustained at a healthy and consistent rate. Combined with timely support for individuals and communities which face especially challenging employment transitions, this will ensure the phase-out of fossil fuel employment is managed efficiently and fairly.

Indeed, as we have shown, most existing fossil fuel workers will not need to switch to another job at all, so long as the phase-out of fossil fuel production is announced and planned well in advance, and closures are staged at sensible increments. Most existing fossil fuel workers will retire anyway by the time the phase-out of fossil fuel use is completed; thousands more will voluntarily leave their jobs for other reasons. And as described above, the experience of other jurisdictions confirms that under these conditions most affected workers simply retire when their normal working lives are over (or almost over). In the successful German, Ontario, and Spanish transitions, few fossil fuel workers needed to find alternative work. Instead, a well-planned and well-staged transition allowed them to exit voluntarily. The essential complement to this strategy is to ensure that their former positions are not back-filled with a new generation of younger workers who would then bear a needless burden of adjustment costs. This reinforces the importance of long-term, industry-level planning, which is critical for maximizing the benefits of these gradual, ongoing labour market adjustments.

[138] See Jowit and Wintour (2008).

For those fossil fuel workers who do seek alternative vocations, they will have a wide choice of industries and occupations in which to seek employment. Since the labour market incorporates ongoing flows and adjustments across all of its components, it is neither possible nor desirable to "assign" displaced fossil fuel workers to any particular destination. And since the labour market creates far more new jobs across the whole range of industries and occupations than could conceivably be displaced from fossil fuel industries (under any reasonable phase-out timetable), there is no question that there will be enough alternative jobs to absorb those fossil fuel workers who do need or desire to find alternative work.

The diversity and abundance of alternative employment prospects is summarised in Table 14. The federal government generates regular forecasts of future employment through its Canadian Occupational Projection System (COPS). These forecasts are disaggregated by sector and occupation, and are intended to guide labour market planning by employers, educational institutions, and individuals (including students and job-seekers). The latest COPS forecast indicates rates of job creation expected in various sectors of the economy, as well as across broad occupational groupings. In Table 14, we compare those flows of new jobs to the number of fossil fuel workers who are likely to need to seek alternative employment. We assume a 20-year timetable for the phase-out of fossil fuel industries, which implies an annual reduction in fossil fuel employment (including self-employment) of around 8500 jobs per year. However, as explained, most of those disappearing jobs will correspond to the retirement of existing workers; examples of transition planning from other countries confirm that with sufficient notice and generous incentives, most affected workers can move straight into retirement (rather than having to seek alternative employment at all). Therefore, Table 14 cautiously assumes that over half of affected workers are able to move into retirement, and hence less than half the required annual decline in fossil fuel employment (at most around 4000 jobs per year) will require former fossil fuel workers to obtain alternative employment.[139] Keep in mind that hundreds of times that many Canadian workers change their employment status every *month*. So assisting 4000 fossil fuel workers to find new work in a year represents a small scale of adjustment in the context of Canada's large, diverse, and flexible labour market.

As indicated in Table 14, there are many industries and occupations which will *single-handedly* generate enough new jobs every year to more than absorb the entire annual flow of workers potentially displaced from fossil fuel industries over a 20-year timetable. The growing health care and social service sector alone will create ten times

[139] In Germany, Spain, and Ontario, a large majority of existing workers were able to move directly into retirement, and hence the number of alternative positions required would be smaller than assumed here.

as many jobs each year as would be displaced from fossil fuel industries, under the preceding assumptions. Of course, workers seeking a new career will need to possess the right skills, and be in the right location, for those new jobs – and that is why generous retraining and relocation supports will be needed to ease their transition. But even in most communities that depend on fossil fuel employment for a significant share of local employment, the pace of job creation across the full suite of other industries will be sufficient to absorb the portion of displaced fossil fuel workers who would actually seek alternative employment (rather than transitioning into retirement or other opportunities). In most cases, the local health care sector alone will create more than enough new work to single-handedly absorb all displaced fossil fuel workers – let alone the other industries which those workers could consider. Of course, this requires consistent commitment by governments and other stakeholders to support public services like health care; and where appropriate, new investment and employment opportunities should be targeted to communities most affected by the phase-out of fossil fuels.

Table 14
Projections of Annual Employment Growth, 2019-2028

By Industry		**By Occupation**	
Health Care	46,450	Sales & Service	41,120
Computer Systems	10,600	Health Professionals	37,960
Finance	10,190	Education Professionals	25,310
Law & Accounting	9,780	Sciences	22,980
Retail	9,580	Trades & Transport	18,370
Social Assistance	8,250	Business Occupations	17,750
Construction	6,970	Art & Culture	5,700
Manufacturing	6,900	Manufacturing Trades	4,080
Annual displacement of fossil fuel workers: about 4000[1]			

Source: Author's calculations from Employment and Social Development Canada (2019).
1. Assumes 20-year phase-out of industry; over half of jobs absorbed via retirement.

Part of the challenge of planning an orderly and effective transition is also to ensure that alternative jobs for former fossil fuel workers possess attractive features: such as decent compensation, stable hours and tenure, and collective representation. At present, many fossil fuel jobs offer above-average compensation levels – although, as noted, this largely reflects long hours and often unpleasant aspects of the jobs (such as remote work, harsh physical conditions, and fly-in fly-out arrangements). Moreover, as described above, fossil fuel jobs have been degraded in recent years by aggressive cost-cutting by employers: evidenced by labour hire and contracting-out practices, real wage cuts, and health and safety risks. Union representation in fossil fuel jobs has also been reduced more rapidly than in any other part of the economy. So the common

assumption that fossil fuel jobs are relatively “good” jobs is not justified. Nevertheless, the higher incomes paid in the sector still raise a legitimate concern about the extent to which alternative employment will be able to replace those incomes and offer decent, stable livelihoods. This concern makes it all the more important that, in addition to prioritizing strong job creation at the macroeconomic level, government also commits to labour reforms aimed at improving the quality and stability of jobs across the economy. Measures which could lift job quality would include higher minimum wages, a strengthening and expansion of other minimum labour standards, and support for collective bargaining (which has eroded in recent years in most private sector industries, including fossil fuel sectors).

Conclusion: No Time to Waste

Many discussions about climate policy are imbued with a sense of urgency, and rightly so. Scientists have warned that humanity has a limited window of opportunity – perhaps a decade – to shift decisively onto a trajectory of rapid emissions reduction (followed quickly by the elimination of net GHG pollution). We must move quickly to stabilise the climate, limit warming, and avoid the catastrophic consequences of larger shifts in global temperature.

Our review of the employment aspects of the transition from fossil fuels, however, provides an additional, economic rationale as to why the transition must start sooner rather than later – and why we need a transparent, firm timetable to guide the retirement of fossil fuel industries. Labour market transitions are immensely more manageable and less costly when they are announced well in advance, and phased in gradually over time. That gives labour market participants ample time to react and plan their subsequent actions and adjustments. It warns younger workers not to build new careers in these industries – which have such a limited lifespan ahead of them, thus avoiding needless displacement in later years. And it allows the entire transition process to harness the natural power of ageing: with appropriate notice and a gradual staging of shutdowns, most exits from fossil fuel employment can be achieved through retirement and other voluntary departures. With appropriate mobility and redeployment supports, forced redundancies can be avoided entirely.

So for the sake of fossil fuel workers, as well as the sake of the planet, the inevitable phase-out of fossil fuels must be announced and confirmed quickly and firmly, and the process of wind-down commenced. This phase-out will be complemented, of course, by expansion of renewable energy technologies, with all of their economic spin-offs – including the creation of tens of thousands of new jobs. However, new jobs in renewables will play at most a supporting role in an effective, orderly labour market transition. Most fossil fuel workers will not end up producing solar panels or windmills; in fact, if we manage this transition effectively, most fossil fuel workers will not need to find new jobs at all. As with the climate itself, the sooner we start this transition, the lower its ultimate costs will be, and the greater its net benefits.

Delaying these necessary actions only makes matters worse – including for fossil fuel workers. In this context, statements of supposed “solidarity” with fossil fuel workers expressed by some business leaders and political representatives are entirely dubious. Pretending that fossil fuel industries can carry on as “normal” for decades to come (or worse could actually be *expanded*) is a cruel hoax. This would needlessly increase the

ultimate disruption and cost for workers – including young workers, who would be lured into an industry which must soon shut down. Indeed, this concern for fossil fuel jobs and workers was always very selective, anyway. As we have seen, jobs in fossil fuel industries are insecure at the best of times, subject to unpredictable cycles of demand and powerful threats that have nothing to do with climate policy. Whenever coal and petroleum companies can profitably replace their Canadian employees with automated technology, or outsource labour to lower-cost contractors, or undermine labour standards (such as overtime premiums or workers compensation protections, both recently weakened in Alberta), they do so without hesitation. Indeed, these attacks on the job security, wages, and working conditions of fossil fuel workers have become more intense in recent years as employers try to protect profits despite weak commodity prices. So all Canadians, including fossil fuel workers themselves, should be skeptical when opponents of climate and energy transition claim they are "defending" fossil fuel workers. Their solidarity is fleeting: invoked only when it coincides with the corporate interests of the fossil fuel industry.

Our statistical description of Canada's labour market and its powerful, ongoing capacity to adapt to change confirms that a gradual phase-out of fossil fuel industries would be a modest and manageable transition in the overall world of work in Canada. The number of Canadians employed today in fossil fuel jobs is small: under 1% of total employment. The rise and (inevitable) fall of fossil fuel employment is dwarfed by much larger forces shaping the labour market: including new jobs in larger sectors (like health care and social services, professional and technical work, construction, and education), and the regular to-and-fro that characterizes our highly flexible labour market (including gross entries, departures, and retirements much larger than the coming reduction in fossil fuel employment). 2.5 million Canadians – many times more than those who work in fossil fuel jobs – change their employment status every month. This demonstrated capacity of Canadian workers to change and adapt will be an enormous asset as our economy evolves toward a low-carbon future – just as Canadians adjusted to other, larger employment shifts in our history.

Many fossil fuel jobs are concentrated in a handful of regional communities, and this complicates the transition process. But even there, most jobs are in other industries, including vibrant sectors like health care that will have more powerful impacts on the labour market over time than the gradual elimination of fossil fuel work.

The key to preparing for this inevitable change, and ensuring that it occurs in an orderly and fair manner, is time. Hence the phase-out of fossil fuels must be announced (and firmly committed to) well in advance. It must be enacted gradually, with staged reductions and closures – not back-end-loaded through deferrals and delays. Where possible, existing fossil fuel workers can use that time to complete their

careers normally. But that only works if younger workers are not hired to replace them. They must not be lured, under essentially false pretenses, into investing in careers which will not last for long. Supports for retraining, redeployment, relocation, and regional job creation can ease the process further. The cost of these supports would be small, relative to the scale of the capital investments and other expenses that will also occur as part of the coming energy transition.

In short, there is absolutely no contradiction between eliminating Canada's current (limited) reliance on fossil fuels, and having a strong labour market (with secure jobs, good working conditions, and rising wages). International experience confirms there is no connection whatsoever between labour market performance and emissions intensity. Canada can negotiate the transition away from fossil fuel jobs. What is required is a firm, consistent commitment to do so, and the provision of meaningful support to make the transition effective, steady and fair.

References

Ambrose, Gillian (2020). "'It'll be around forever': fossil fuel workers switch to new jobs in renewables," *The Guardian*, October 6.

Anderson, Drew (2020). "$1.7B to clean up orphaned and abandoned wells could create thousands of jobs," *CBC News*, April 17.

Association of Workers' Compensation Boards of Canada (2020). *National Work Injury, Disease and Fatality Statistics, 2016-2018* (Toronto: Association of Workers' Compensation Boards of Canada).

Bellefontaine, Michelle (2020). "New Bill would Roll Back NDP Changes to Alberta Workplace Safety Rules," *CBC News Online*, November 5.

Bernton, Hal, and Jim Brunner (2019). "Clean power is now the law; Inslee signs bill for zero-carbon electricity by 2045," *Seattle Times*, 8 May.

Bloomberg New Energy Finance (2020). *Electric Vehicle Outlook 2020* (New York: Bloomberg).

Bourbeau, Emannuelle (2019). "Labour market dynamics since the 2008/2009 recession," Labour Statistics Research Papers, Catalogue no. 75-004-M – 2019001 (Ottawa: Statistics Canada).

Brearton, Steve (2015). "The biggest layoffs in Canadian history," *Canadian Business*, January 23.

Campolieti, Michele (2011). "Ins and outs of unemployment in Canada, 1976-2008." *Canadian Journal of Economics* 44(4), pp. 1331-49.

Canada Energy Regulator (2019). *Canada's Energy Future 2019: Energy Supply and Demand Projections to 2040* (Calgary: Canada Energy Regulator).

CAW-Canada (2012). *Re-thinking Canada's Auto Industry: A Policy Vision to Escape the Race to the Bottom* (Toronto: CAW-Canada).

Centre for Transformative Work Design (2018). *Impact of FIFO Work Arrangements on the Mental Health and Wellbeing of FIFO Workers* (Perth: WA Mental Health Commission).

Chesnaux, Romain (2020). "Climate Change Nightmare: Canada Has a Gas Leak Problem," *The National Interest* (blog), March 4.

Clarke, Tony, Diana Gibson, Brendan Haley, and Jim Stanford (2013). *Bitumen Cliff: Lessons and Challenges of Bitumen Mega-Developments for Canada's Economy in an Age of Climate Change* (Ottawa: Canadian Centre for Policy Alternatives).

Clean Energy Canada (2019). *Missing the Bigger Picture* (Vancouver: Clean Energy Canada).

Coal Transition Coalition (2017). *Getting It Right: A Just Transition Strategy for Alberta's Coal Workers* (Edmonton: Coal Transition Coalition).

Corak, Miles (2020). "What you need to know about Statistics Canada's survey of the labour market," *Economics for Public Policy* (blog), April 3.

Delphi Group (2017). *Alberta Wind Energy Supply Chain Strategy* (Ottawa: Canadian Wind Energy Association).

Ecology Action Centre (2019). *Nova Scotia Environmental Goals and Sustainable Prosperity Act: Economic Costs and Benefits for Proposed Goals* (Halifax: Ecology Action Centre).

Employment and Social Development Canada (2020). *Canadian Occupational Projection System* (COPS), 2019 to 2028 projections, http://occupations.esdc.gc.ca/sppc-cops/w.2lc.4m.2@-eng.jsp.

Friends of the Earth Scotland (2019). *Sea Change: Climate Emergency, Jobs and Managing the Phase-Out of UK Oil and Gas Extraction* (Edinburgh: Friends of the Earth Scotland).

Fulford, Meghan, and Martha Patterson (2019). "Multiple jobholders in Canada," *Labour Statistics at a Glance*, Catalogue 71-222-X (Ottawa: Statistics Canada).

Gales, Ben, and Rick Hölsgens (2017). "Coal Transition in the Netherlands: An Historical Case Study," University of Groningen.

Harris, Michael (1999). *Lament for an Ocean: The Collapse of the Atlantic Cod Fishery* (Toronto: McLelland and Stewart).

Harris, Melissa, Marisa Beck and Ivetta Gerasimchuk (2015). *The End of Coal: Ontario's Coal Phase-Out* (Winnipeg: International Institute for Sustainable Development).

He, Jiaosheng, Derek Messacar, and Yuri Ostrovsky (2017). "The Relationship between Firm Size and Age of Workforce: A Cross-industry Analysis for Canada*," Analytical Studies: Methods and References*, Catalogue 11-633-X, No. 010 (Ottawa: Statistics Canada).

Hoffman, Allen (2017). “Jobs? Investing in Renewables Beats Fossil fuels,” *Energy Post*, 19 May.

Hussey, Ian (2020). *The Future of Alberta’s Oil Sands: Industry: More Production, Less Capital, Fewer Jobs* (Edmonton: Parkland Institute).

Hussey, Ian, and Emma Jackson (2019). *Alberta’s Coal Phase-Out: A Just Transition?* (Edmonton: Parkland Institute).

International Renewable Energy Agency (2019). *Renewable Energy and Jobs Annual Review 2019* (Abu Dhabi: IRENA).

Jeyakumar, Binnu (2016). *Job Growth in Clean Energy: Employment in Alberta’s Emerging Renewables and Energy Efficiency Sectors* (Calgary: Pembina Institute).

Jones, Stephen R. G., and W. Craig Riddell (1998). “Gross Flows of Labour in Canada and the United States,” *Canadian Public Policy* 24(Supp. 1), pp. S103-S120.

Jowit, Juliette, and Patrick Wintour (2008). “Cost of Tackling Global Climate Change Has Doubled, Warns Stern,” *The Guardian*, June 26.

Karkare, Poorva, and Nadia Ashraf (2019), “Limburg’s Black Gold, the Move Away From It and Lessons for Other Countries,” European Centre for Development Policy Management, October 28.

Kostyshyna, Olena, and Corinne Luu (2019). “The State of Labour Market Churn in Canada,” Staff Analytical Note 2019-4 (Ottawa: Bank of Canada).

Lang, Sydney (2020). “A Crisis of Mobility: The Inherent Precarity of the Fly-In, Fly-Out Workforce,” *Canadian Law of Work Forum* (blog), May 23.

Laporte, Christine, Yuqian Lu and Grant Schellenberg (2013). “Inter-provincial Employees in Alberta,” *Analytical Studies Branch Research Paper Series*, Catalogue 11F0019M — No. 350 (Ottawa: Statistics Canada).

Leach, Andrew (2020). “The fiasco that is Alberta's energy 'war room',” *CBC News Opinion*, July 30.

Lee, Marc, and Seth Klein (2020). *Winding Down BC’s Fossil Fuel Industries: Planning for Climate Justice in a Zero-Carbon Economy* (Vancovuer: Canadian Centre for Policy Alternatives).

Littlewood, Case (2020). “A Return to Balance or Empowering the Powerful? Alberta’s Bill 32,” Centre for Constitutional Studies (Edmonton: University of Alberta),

https://ualawccsprod.srv.ualberta.ca/2020/08/a-return-to-balance-or-empowering-the-powerful-albertas-bill-32/.

Lu, Yuqian (2020). “The distribution of temporary foreign workers across industries in Canada,” *Data for Insights to a Better Canada* (Ottawa: Statistics Canada).

Marchand, Joseph (2012). “Local labor market impacts of energy boom-bust-boom in Western Canada,” *Journal of Urban Studies* 71(1), pp. 165-174.

May, Art (2009). “The Collapse of the Northern Cod,” *Newfoundland Quarterly* (St. John’s: Memorial University).

McKinnon, Judy (2020). “Why Oil Prices Turned Negative,” *Inspired Investor*, RBC, April 23.

Ministerio para la Transición Ecológica, Government of Spain (2020). “Renewable Hydrogen, Executive Summary,” https://www.miteco.gob.es/images/es/h2executivesummary_tcm30-513831.pdf.

Ministry of Energy, Ontario (2015). *The End of Coal* (Toronto: Government of Ontario), https://www.ontario.ca/page/end-coal.

Moore, Paul (2019). “Canada’s oil sands majors continue on their autonomous haulage journey,” *International Mining*, July 29.

Natural Resources Canada (2018). “10 Key Facts on Canada’s Energy Sector” (Ottawa: Natural Resources Canada), https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/10-Key-Facts-on-Canada_s-Energy-Sector-2018-en%20.pdf.

Natural Resources Canada (2019). “Electricity Generation Energy Use and Generation by Energy Source” (Ottawa: Natural Resources Canada), http://oee.rncan-nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=HB&sector=egen&juris=00&rn=1&page=0.

Navius Research (2019). *Quantifying Canada's Clean Energy Economy: An Assessment of Clean Energy Investment, Value-Added and Jobs* (Vancouver, Navius Research).

Neslen, Arthur (2018). “Spain to Close Most Coalmines in €250m Transition Deal,” *The Guardian*, 27 October.

New York State Energy Research and Development Authority (2019). *Clean Energy Standard Annual Progress Report: 2018 Compliance Year* (Albany: NYSERDA).

O'Malley, Nick (2019). "How Germany closed its coal industry without sacking a single miner," *Sydney Morning Herald*, 14 July.

O'Reailly, Breanne (2019). "How Automation and Data Analytics Will Affect Jobs in Canada's Energy Industry," *CERIC Blog*, February 6.

Office for National Statistics, U.K. (2020). "Low carbon and renewable energy economy, UK 2018," Environmental Accounts.

Oil Sands Community Alliance (2018). "The Rotational Workforce in the Athabasca Oil Sands Area" (Fort McMurray: Oil Sands Community Alliance).

PetroLMI (2019). *2019 Oil and Gas Labour Market Update* (Calgary: PetroLMI).

Querrengesser, Tim (2018). "Automation vs. Humanity and the Future of Alberta's Oilsands," *Huffington Post*, November 21.

Ricketts, Sam, Rita Cliffton, Lola Oduyeru, and Bill Holland (2020). "States Are Laying a Road Map for Climate Leadership," Center for American Progress, April 30.

Rollin, Anne-Marie (2012). "Measures of Employment Turnover Post 2000: Gross Employment Gains and Losses Versus Net Employment Change," *Statistics Canada Analytical Paper*, Catalogue no. 11-626-X — No. 009.

Seskus, Tony (2020). "Suncor Energy to cut staff by up to 15% over next year and a half," *CBC News*, October 2.

Sharpe, Andrew, and Bert Waslander (2014). *The Impact of the Oil Boom on Canada's Labour Productivity Performance, 2000-2012* (Ottawa: Centre for the Study of Living Standards).

Sheldon, Peter, Raja Junankar and Anthony De Rosa Pontello (2018). *The Ruhr or Appalachia? Deciding the Future of Australia's Coal Power Workers and Communities* (Sydney: University of New South Wales, Industrial Relations Research Centre).

Skelton, Chad (2018). "There are Fewer Journalists in Canada than 15 Years Ago – but not as Few as you Might Think," *J-Source*, May 4.

Stanford, Jim (2020a). *10 Ways the COVID-19 Pandemic Must Change Work for Good* (Vancouver: Centre for Future Work).

Stanford, Jim (2020b). "Holding the Line: Canadian Union Power in International Perspective," *Canadian Law of Work Forum* (blog), February 28.

Stephenson, Amanda (2020). “Cenovus-Husky merger would cut up to 25% of workforce, much of it in Calgary,” *Calgary Herald*, October 27.

Storey, Keith (2010). “Fly-in/Fly-out: Implications for Community Sustainability,” *Sustainability* 2(5), pp. 1161-1181.

Task Force on Just Transition for Canadian Coal Power Workers and Communities (2019). *A Just and Fair Transition for Canadian Coal Power Workers and Communities* (Gatineau: Environment and Climate Change Canada).

U.S. Energy Information Administration (2020). “U.S. Coal Consumption by Major End Users,” https://www.eia.gov/energyexplained/coal/use-of-coal.php.

Xu, Li (2012). “Who Drives a Taxi in Canada?”, Citizenship and Immmigration Canada, March, https://www.canada.ca/content/dam/ircc/migration/ircc/english/pdf/research-stats/taxi.pdf.

Wang, Weimin (2020). “Canada’s oil and gas sector: The decline in production and investment and the impact on the economy,” Statistics Canada, July 8, https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00045-eng.htm.

Washington State Department of Commerce (2019). “Clean Energy Transformation Act: A Brief Overview” (Olympia: Dept. of Commerce), https://www.commerce.wa.gov/growing-the-economy/energy/ceta/.