ECONOMIC RECOVERY PATHWAYS FOR CANADA'S ENERGY INDUSTRY: PART 3 – CANADIAN RENEWABLE ENERGY

Economic Recovery Pathways for Canada's Energy Industry: Part 3 – Canadian Renewable Energy

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Acronyms and Abbreviations

BCAP	Business Credit Available Program
CEBA	Canada Emergency Business Account
CECRA	Canada Emergency Commercial Rent Assistance
CEPCI	Chemical Engineering Plant Cost Index
CERI	Canadian Energy Research Institute
CEWS	Canada Emergency Wage Subsidy
CFS	Clean Fuel Standard
ERF	Emissions Reduction Fund
ESG	Environment, Social and Governance
FTE	Full-time Equivalent
GDP	Gross Domestic Product
I/O	Input-output
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
PPA	Power Purchase Agreements
PV	Photovoltaic
RE	Renewable Energy
RNG	Renewable Natural Gas
RRRF	Regional Relief Recovery Fund
TWS	Temporary Business Wage Subsidy

Executive Summary

Globally, the Renewable Energy (RE) sector has seen rapid growth in recent years. Canada has emerged as one of the top RE consumers in the world. Canada's clean energy sector contributes to around 3% of GDP, where 40% of this contribution accounts for direct RE.

Prior to COVID-19, the RE sector was one of the most rapidly growing sectors in Canada. The RE sector is at the center of options considered to achieve Canada's target for greenhouse gas emission reductions. It has a significant role in the country's transition to a low-carbon economy. As outlined in the Pan-Canadian Framework on Clean Growth and Climate Change, RE is to be used as a set of technical options for cleaner electricity generation and low carbon fuels for transportation, buildings, and industry. Several provinces have set minimum RE targets, and private corporations are starting to consider RE as a future proof investment option.

The full impact of the COVID-19 pandemic on Canada's RE sector is yet to be observed. Most RE projects are either owned and operated by provincially owned utilities or backed by long-term Power Purchase Agreements (PPA). However, economic downturns may dampen the growth of the RE sector. Some significant impacts may be due to supply chain disruptions, construction delays, labour shortages due to public health measures and low confidence in investing during economic downturns.

A review of COVID-19 pandemic economic relief programs and policies implemented to assist the industry identified 13 federal and provincial programs that can potentially assist the RE sector's growth and operations. The combined value of those relief measures is around CAD$500 – 800 million. Of which, only around CAD$130 million accounted for direct investments in the RE sector. Some of these projects are available to industry at large and not specific to the RE sector.

COVID-19 relief programs' main objective is to stimulate economic growth and create and sustain jobs for Canadians. In this study, one main research question we assessed is whether the RE sector can contribute to the post-pandemic economic recovery. In this study, we took a case study-based approach to estimate RE projects' potential to contribute to the GDP and create or sustain jobs. We conducted three illustrative case studies that assessed utility-scale wind power's economic development potential, distributed solar PV systems, and bioethanol production.

The results show that every CAD$1 million invested in utility-scale wind power can support 4-5 jobs and contribute CAD$0.5 million to the GDP. In the case of distributed solar PV, every CAD$1 million invested can support 5-7 jobs and contribute CAD$0.6 million to the GDP. In both cases, the said economic impacts are observed in the project development and construction phase. In the case of bioethanol production facilities, CAD$1 million invested in project development and construction can support 4-5 jobs and contribute CAD$0.5 million to the GDP. During the operations phase, a bioethanol production facility, similar to other production facilities, can create or sustain many local jobs.

Our analysis shows that the main programs that translate into pragmatic support for the sector benefit ongoing operations as in the wage subsidy program. We note that construction and financial challenges

may benefit from loan programs, but the more substantive impact on new projects is the supply chain impacts and the construction delays. Bridge loans may be useful in these situations, but the projects' delays undermine the projects' original financial structure, for which the existing support programs do not address.

Chapter 1: Introduction

Renewable energy (RE) is an integral part of Canada's energy system. Forms of RE may include renewable electricity (e.g., electricity produced using hydropower, solar, wind, geothermal, tidal resources, biomass, etc.), renewable heat (e.g., thermal energy produced using biomass and geothermal energy), renewable gaseous fuels (e.g., biogas, hydrogen produced through renewable sources), and renewable liquid fuels (e.g., bioethanol, biodiesel, renewable diesel). The Canadian RE sector comprises economic sectors that produce electricity, liquid, gaseous, and solid fuels using renewable sources and energy storage systems that increase the value and reliability for RE supply systems (Clean Energy Canada, 2019a). Sectors that directly support RE production, such as equipment manufacturing and system construction, can also be associated with the RE sector.

In 2019, Canada ranked 7th in the world production of renewable electricity (3%) and is currently the third-largest world producer of hydroelectricity. RE sources currently provide about 17.3% (2,090 PJ in 2017) of the country's total primary energy supply (NRCan, 2020a, 2020b). The total production of Canada's RE consists of 67.6% from hydro; 23.3% from solid biomass (wood and/or waste); 5.0% from wind; 1.7% from ethanol (included in gasoline); 1.0% from renewable municipal waste/landfill gas; 0.6% from biodiesel; 0.6% from solar photovoltaic (PV); 0.1% from solar thermal; and the rest (<0.01%) from tidal (NRCan, 2020a).

RE is at the center of options considered to achieve Canada's target for greenhouse gas emission reductions by the year 2030 (30% below 2005 levels, or 523 Mt CO2e) and has a significant role to play in the country's transition to a low-carbon economy. RE is expected to contribute to emission reductions options detailed in the Pan-Canadian Framework, including cleaner electricity generation and low carbon fuels for transportation, buildings, and industry. They are projected to be responsible for cuts of approximately 86 Mt CO2e (ECCC, 2016a).

Various forms of RE generation are generally considered as "the way of the future" related to the environment, social and governance (ESG) goals that are gaining more attention from governments and investors than ever before (Ross, 2020; Stikeman Elliott LLP, 2020). According to the International Energy Agency (IEA) estimates, the RE generation will cover about two-thirds of global electricity generation investment by 2040. In contrast, Bloomberg New Energy Finance (Bloomberg NEF) forecasts that about 77% of new power generation investments between 2019 and 2050 will be in RE (BloombergNEF, 2019; IEA, 2020a; Stikeman Elliott LLP, 2020).

The COVID-19 pandemic has had and will continue to have a significant impact on the world economy. In Canada, the budget deficit is expected to be around $343 billion in 2020-21. According to the Parliamentary Budget Office (PBO), relative to the size of the Canadian economy, the deficit would be 12.7 percent of the gross domestic product (GDP), and the federal debt-to-GDP ratio would rise to 48.4 percent of GDP in 2020-21 (PBO, 2020).

The Canadian economy was substantially impacted by the pandemic, leaving RE projects to face broad uncertainty. Irrespective of the stage of these projects, a number of challenges may emerge. The RE

sector's impact due to COVID-19 will be seen in the planning, construction, and operation stages (Sagar Kancharla, 2020). The impacts at the operational stage, particularly for renewable electricity generation systems, would be relatively lower. Most renewable electricity generating assets have power purchase agreements (between the power generator and utility companies), and therefore, the impact on revenue will be minimal. However, the impacts on new projects will likely be high and notable.

Some of the presumed issues for the various stakeholders include contractors, subcontractors, and suppliers being unable to perform their contractual obligations; delays in project schedules and other key deliverables; and project developers and investors being unable to make payments when due (Eggerman and Mehi, 2020a). Even though the full impact is unknown, developers may need to continue reviewing and adjusting future development plans. All project assumptions are highly uncertain. Operating, monitoring, and evaluating procedures may be considerably different when considering the requirements for more remote work. The lenders and the terms for lending are likely to be different. Another main impact on these projects is the delay in construction timelines. This could include global supply chain disruptions, shortage of on-site labour; financing challenges; site access restrictions; availability of cranes, construction equipment or transportation, non-issuance of permits, delays in leases, etc. (Gowling WLG, 2018). The original project economics could be changing substantially, such as through impacts to the Allowance for Funds During Construction (AFUDC) account (Sagar Kancharla, 2020). All these implications will likely change the project risk profile, causing concern to the project financiers. These challenges may change how developers will conceptualize, plan, and develop renewable projects, leading to uncertainties in the RE sector's growth.

As of May 2019, 135 major RE projects valued over $60 billion were planned or under construction in Canada. In addition, both federal and provincial governments have RE targets as part of their climate strategy. Along with the newly proposed clean fuel standard (CFS), Canada is on a path to implement policies and programs to accelerate RE's investments. Experts believe that the RE sector has been less impacted due to the COVID-19 pandemic, mainly due to electricity demand remaining constant and existing PPAs. However, having a lower impact from COVID-19 provides a potential opportunity for safe investment in the sector.

With COVID-19 economic recovery plans being reviewed and implemented worldwide, RE has been a well-discussed topic as of late. According to the International Renewable Energy Agency (IRENA), RE remains a key part of the solution to COVID -19 economic recovery because RE provides the added benefit of investing in a clean, environmentally friendly industry (IEA, 2020b; IISD, 2020; IRENA, 2020). In Canada, federal, provincial and local governments have announced many relief measures that apply widely to all industries. In addition, with the onset of the COVID-19 pandemic, a few new or amended policies were ratified that allowed Canada to commit financial support for RE and clean energy. These include at least USD $267 million for unconditional clean energy support and at least USD $2.10 billion for conditional clean energy support (Energy Policy Tracker, 2020).

All governments in Canada are spending billions to stimulate the recovery of the Canadian economy and secure jobs for Canadians. The RE sector can play a central role in the resilient recovery of 'Canada's economy. Higher RE adoption can make Canada competitive in the 21st-century global economy, where lower carbon intensity is desired. RE creates employment throughout the supply chain from equipment

manufacturing, project development to operations (IRENA, 2019a). Identifying the importance of the RE sector, the Task Force for a Resilient Recovery, whose objective is to make Canada's economic recovery from COVID resilient to further economic impacts, recommends an investment of CAD$11.5 billion over the next five years to grow 'Canada's clean energy sectors (TFRR, 2020).

The primary objective of this study is to assess the magnitude of returns on directed support to the Canadian RE sector as part of economic stimulus programs to spur post-pandemic economic recovery.

The main components of this study are:

1. Review the status of the RE sector in Canada before the COVID-19 pandemic.
2. Review the impacts of COVID-19 pandemic-induced economic downturn on the RE sector.
3. Review and report existing support programs that have been implemented by federal and provincial governments to stimulate growth in the RE sector.
4. Through a case study approach, estimate the RE sector's potential to contribute to post-pandemic economic development.

Chapter 2: Renewable Energy Sector - Current Status, COVID-19 Impacts and Relief Measures

Pre COVID-19 Status of the Canadian Renewable Energy Sector

In Canada, the total clean energy[1] economy accounts for 3% of GDP and 2% employment. The renewable and alternative energy sector accounts for 40% of the total clean energy sector. The Canadian RE sector's growth rate is around 4.5% (Navius Research Inc., 2019a). Many technology and economic experts have expressed that focusing on the Canadian RE sector during the COVID-19 recovery stage could drive both the economy and Canada's GHG emission reduction targets forward (Mishra, 2020). Globally, institutions such as IRENA, the World Bank and the IEA have recognized investing in the RE sector as a key solution for economic recovery from COVID-19 impacts. While it is recognized that investing in the RE sector is important, it is worth looking into efforts so far to invest in the RE sector and the current impact on the RE sector from the COVID-19 pandemic.

Canada's RE and clean energy sector is growing faster than the rest of Canada's economy, as the industry is taking actions to make the natural resources sectors more sustainable (Clean Energy Canada, 2019a; Ross, 2020). RE generation increased by 18% between 2010 and 2017, and wind and solar energy have been the fastest developing sources of electricity in Canada (Clean Energy Canada, 2019a; NRCan, 2020a). For wind net electricity generation, there has been an almost 20-fold expansion (from 1,552 GWh in 2005 to 28,775 GWh in 2017), while solar power generation has increased rapidly, from 17 GWh in 2005 to 1,573 GWh in 2017 (NRCan, 2020a). As for biofuels, annual ethanol consumption in Canada has grown from approximately 1,700 million litres in 2010 to 3,047 million litres in 2017. The annual consumption of biodiesel more than tripled since 2010, from 123 million litres to 376 million litres in 2017 (Navius Research Inc., 2019b).

As of May 2019, there were 135 major RE projects (with a minimum $10 million capital worth threshold) planned or under construction in Canada, compared to 125 projects in 2018. They represent 30% of the total number (455) of major natural resources projects planned or under construction in Canada in 2019. They include 66 hydro projects valued at $49 billion, 29 wind projects valued at $8.6 billion, and 32 biomass/biofuels projects valued at $3 billion. Between June 2018 and June 2019, 15 RE projects were completed and became operational (including five hydro projects, five biomass/biofuels projects, four solar projects, and one wind project). (Energy and Mines 'Ministers' Conference 2019).

[1] Clean energy is a broader term used in publications and government policies and programs. While the exact definition of clean energy is not universally agreed on, among other things, it includes renewable energy, nuclear power, technologies that would reduce the environmental impacts of fossil energy sources (e.g., cogeneration, carbon capture utilization, and storage), and interventions to improve energy efficiency. This report focuses only on renewable energy.

While RE projects/investments are taking place in all provinces and territories, the portfolio of major RE projects differs for different jurisdictions. British Columbia leads the list with 64 RE projects (valued at $24 billion) in the BC inventory in 2019. In contrast, all other Canadian jurisdictions have zero to 20 RE projects planned or under construction in 2019. In particular, in 2019, major hydro facilities were planned or under construction in five provinces (BC, MB, ON, QC and NL), wind projects in seven jurisdictions (BC, AB, SK, ON, QC, PE and YT), solar projects in two provinces (AB, SK), and biofuel/biomass projects in four Canadian provinces (BC, AB, NB and NS) (Energy and Mines 'Ministers' Conference 2019).

It should be noted that the majority of existing federal, provincial and territorial climate change strategy documents now have their RE targets established (Orenstein and McLean, 2020), including a proposed increase in:

- use of RE sources by 2030, identifying opportunities to produce renewable fuels from biomass products (such as wood waste); using up to 100% of clean power by government buildings and vehicle fleets by 2025 on the federal level (ECCC, 2016b);
- RE output by 25% (QC, NS); up to 93% of electricity from the main grid from renewable sources (YT); support of the development of RE (NB, NL);
- bioenergy production by 50% (QC);
- low carbon fuel standard to 20% carbon intensity reduction by 2030 (BC), use of low-carbon fuels and increase the ethanol content of gasoline to 15% by 2025 (ON);
- production of renewable transportation fuels (BC);
- share of renewable gas in natural gas consumption to at least 15% (BC); uptake of renewable natural gas (ON).

In addition to the strategy documents, minimum amounts of renewable electricity production are mandated in legally binding legislation and regulations in Alberta, British Columbia, Nova Scotia, New Brunswick and Prince Edward Island (Orenstein and McLean, 2020).

There are also biofuel substitution requirements (Renewable Fuel Regulations) from the federal government that require fuel producers and importers to have an average renewable content of at least 5% based on the volume of gasoline and at least 2% of the volume of diesel fuel (NRCan, 2020a). The federal government's proposed Clean Fuel Standard (CFS) policy will eventually replace the existing Renewable Fuels Regulations (for the liquid fuels, in 2022, and for the gaseous and solid fuels approximately 12 months after the liquid fuels regulation is in force). However, in the short-term, the volumetric requirements will be maintained. Some provinces, such as Alberta, Saskatchewan, Manitoba, and Ontario, have implemented their own renewable fuel regulations that necessitate a higher biofuel content in gasoline and diesel fuel than prescribed by the federal regulations. In addition to the biofuel regulations (nine different pieces of legislation across Canadian jurisdictions), many other fuel substitution policies, which require switching to a lower carbon energy source, exist at the federal, provincial and territorial levels. They include four regulations related to electricity from renewable sources, four regulations for coal replacement, two regulations for zero-emission vehicles and one other regulation (Orenstein and McLean, 2020).

It is also worth mentioning that some provinces enabled specific regulations regarding renewable natural gas (RNG). For example, the Clean BC Strategy (2018) requires that at least 15% of residential and industrial natural gas consumption should come from renewable gas. The Made in Ontario Environment Plan (2018) also stipulates uptake of RNG. Quebec's Regulation respecting the quantity of renewable natural gas to be delivered by a distributor (2019) establishes the minimum quantity of RNG produced in Quebec by a natural gas distributor at 1% of the total quantity of natural gas as of 2020 and gradually increases that amount to 5% of the total quantity of natural gas distributed in 2025.

Impacts on the Renewable Energy Sector from COVID-19

The RE industry is facing uncertainty due to the pandemic, like many other sectors around the world. Supply chain disruptions, tax incentives reduction due to delayed projects, and increasing project financing are the key impacts. It is crucial to consider the impacts of the ongoing pandemic irrespective of the RE project stage, i.e. planning, construction or operation.

Supply Chain Disruption

For industries like RE that rely on specialized supply chains, the immediate impact is severe. China is the primary manufacturer of solar PV components parts: producing solar panels, inverters and racks. Most of the wind industry components are supplied from Europe and North America. The sudden COVID-19 outbreak has dramatically slowed production in China and Europe, jeopardizing equipment delivery schedules worldwide. When considering solar projects' supply chain, the factories are beginning to reopen in China. While production rates remained low at the beginning of the pandemic, the impact seems to be minimum due to existing supply contracts and a quick recovery in Chinese plants (Fang, 2020)

As a result of the COVID-19 outbreak-related supply chain disruptions, suppliers that fail to meet purchase orders have begun issuing *force majeure* notices, leaving developers struggling ('O'Brien et al., 2020). If a *force majeure* made a party's performance of its obligations under the contract impossible, then the failure (or delay) is excused for the duration of the *force* (Eggerman and Mehi, 2020b). In some contracts, the parties may also be able to terminate the contract, seek reimbursement or reduce the scope of work to be performed. Even in a less likely situation of a developer having access to a secondary supplier, the developer may not have sufficient additional capital to buy from an alternative source.

Supply chain disruptions also impact contractual and legal deadlines for projects under construction. Significant delays in delivery and construction may force projects to postpone their commercial operation date, i.e., delaying power delivering capabilities. Delaying the commercial operation stage may also trigger economic penalties.

Tax Credits

Some of the tax credits available for RE projects are time-sensitive. In 2015, as part of its tax measures, the Government of Canada extended to 2025 the Accelerated Capital Cost Allowance under Class 43.2 of the Income Tax Act, Annex II for RE equipment, and successively expanded its eligibility to new RE equipment (Canada Revenue Agency, 2019). Start-up expenses may also qualify as Canadian Renewable and Conservation Expenses and be fully deductible in the year they are incurred, carried forward for

deduction in later years or can be surrendered to shareholders through a flow-through share agreement. Delayed investments that may arise or supply chain interruptions could reduce the benefit of the tax allowances. Projects would need to be commissioned by 2023 to gain the full benefit of the enhanced first-year allowance.

The value of a tax equity investment depends entirely on the underlying project meeting development targets; if a certain objective is not met, the project may not qualify for the highest available tax credit. Thus, any delay in meeting those objectives could put the whole investment at risk. As long as the potential for pandemic-induced construction delays remains, so too will investors' concerns about their ability to utilize the tax credit program.

Operational Stage Impacts

Industry-wide, physical operations are impacted by COVID-19 due to measures such as site visit curtailments and reduced staffing. Major financial impacts could occur at the operating stage for RE projects without secured power purchase agreements (PPA). The financial impact on projects with PPAs may not be as severe as those without PPAs (S. Kancharla, 2020).

While the pandemic has reduced world energy demand, the effect on RE is less pronounced. Unlike the demand for crude oil, RE's demand is tied to broader decarbonization and sustainability goals. However, operational impacts could potentially lead to limitations or revenue deficits. Operational risks could increase with potential preventative and reactive maintenance delays. A lack of available on-site staff could result in reduced yield and a potential halt to production. On the financial front, maintaining agreed-upon financial ratios and working capital could be a challenge. Credit rating downgrades are also a looming threat.

COVID-19 Benefits Available for the Renewable Energy Sector

Operational, Cashflow Funding

Canadian governments (federal, provincial and local) announced many relief packages targeted to help with the COVID-19 recovery. In Part 1 and Part 2 of this series, Recovery Pathways for Canada's Energy Industry, Part 1 and Part 2 (Gallardo et al., 2020; Refaei et al., 2020), we highlighted the available packages for the energy industry. CERI categorized the Canadian relief programs into four categories based on the type of funding available; Grants, Subsidies, Payment Deferrals and Loans & Credit Programs. The definitions of these different categories are available in Part 1 of this series. Within these categories, some of the major industry-wide programs available for all sectors and that may impact the RE sector are as follows: Canada Emergency Wage Subsidy (CEWS); Temporary Business Wage Subsidy (TWS); Canada Emergency Commercial Rent Assistance (CECRA); Federal Income Tax Deferral; Deferral of Sales Tax Remittance and Customs Duty Payments; Canada Emergency Business Account (CEBA); Regional Relief Recovery Fund (RRRF); and Business Credit Available Program (BCAP) (Gallardo et al., 2020; Refaei et al., 2020).

In Parts 1 and 2(Gallardo et al., 2020; Refaei et al., 2020), CERI presented the economy-wide monetary benefit from these federal programs. These programs are implemented economy-wide and not directed

towards a specific sector. Here, we estimate the magnitude of the benefits the RE sector could potentially receive based on three scenarios.

- Scenario 1: All RE sector operations and investments are impacted proportionate to the industry norms. The RE sector's available funds are calculated based on a 1.2% total GDP contribution from the sector (Navius Research Inc., 2019a).
- Scenario 2: Only new Investments in the RE sector are impacted, not current operations. Investment in the RE sector is assumed as 5% of the total GDP contribution of 1.2%.
- Scenario 3: 50% of the RE sector's current operation and 100% of new investments in the RE sector are impacted, which translates to a total of 52.5% of total GDP contribution of 1.2%.

Table 2.1: Emergency Benefit Program Funds Available for the RE Sector

Name of Program	Type	Total Economy-Wide Benefits ($ million)	RE Sector Benefits Scenario 1 ($ million)	RE Sector Benefits Scenario 2 ($ million)	RE Sector Benefits Scenario 3 ($ million)
Canada Emergency Business Account (CEBA)	Loan	41,489	498	25	261
Regional Relief Recovery Fund (RRRF)	Loan	962	12	0.6	6
Business Credit Available Program (BCAP)	Loan	20,000	240	12	126
Canada Emergency Wage Subsidy (CEWS)	Subsidy	55,645	668	33	351
Canada Emergency Commercial Rent Assistance (CECRA)	Subsidy	483	6	0.3	3
Temporary Business Wage Subsidy (TWS)	Subsidy	1,344	16	0.8	8
Federal Income Tax Deferral	Deferral	150	2	0.1	1
Deferral of Sales Tax Remittance and Customs Duty Payments until June	Deferral	75	1	0.1	0.5
Total		***120,148***	***1,441***	***72***	***757***

Source: PBO, CERI

Scenario 1 assumes relief program funds available are maximized for the RE sector. However, according to industry experts, this is also the least likely scenario since, compared to other sectors such as conventional energy and tourism, the RE sector's impact is lower. Scenario 2 assumes the new investments in the RE sector are to be impacted. However, this scenario assumes that the RE sector operations are not impacted by the COVID-19 pandemic (these new investments account for the 5% growth expected in the RE sector). Scenario 3 is a pragmatic approach, where we assume 50% of operations and new investments are impacted. This is also the most likely scenario of the three scenarios analyzed.

The CERI estimated benefits under the three scenarios for the RE sector through the federal programs mentioned above are presented in Table 2.1. However, it should be noted that these programs are targeted at liquidity and not capital investments. For example, the above-mentioned loan programs are operational loans in nature, and the companies are expected to demonstrate how the COVID-19 pandemic impacts their cash flows. While these programs may not result in direct capital investment, there is potential for these programs to accelerate economic recovery and drive future capital investment. In addition, some of the federal programs could focus on the RE sector. For example, the Regional Relief Recovery Fund (RRRF) is focused on key regional industries, and regional agencies could focus on the RE sector as a key industry.

In addition to the above-mentioned federal government programs, there are many programs announced by the provincial and local governments available to the industry at large. These programs are available to the RE sector as well. These programs are highlighted in Recovery Pathways for Canada's Energy Industry Part 1 – Appendix A (Gallardo et al., 2020)

Capital Investment Funding Opportunities

Canadian investment in the RE sector is around CAD$9 billion per year for the last decade and has been increasing at a rate of around 5% (Navius Research Inc., 2019a). The benefits from major Government of Canada programs for new investments are estimated at around CAD$72 million, as illustrated in scenario 2 in Table 2.1.

Focusing on the whole energy sector, CERI identified 59 programs that can benefit the energy sector. These 59 programs exclude the ones listed in Table 2.1, Large Employer Emergency Financing Facility (LEEFF), Emissions Reduction Fund (ERF) and Funding for Orphan Wells in Alberta, Saskatchewan and British Colombia. As highlighted in Table A.1 (see Appendix A: Data), these 59 programs include both fiscal and other policies. Of those 59 programs, 18 programs directly benefit clean technologies, 16 programs aimed at providing relief measures by suspending or reversing environmental protection/clean technology programs, and 16 programs that directly benefit fossil fuel sectors.

Among the clean technology programs in Table A.1 (see Appendix A: Data), five programs could be identified as directly beneficial to the RE sector;

- Government of British Columbia - Innovative Clean Energy Fund
- Investment in clean technologies under Canada Economic Development for Quebec Regions
- Infrastructure Canada project funding for renewable green energy projects
- Quebec's support for production and distribution of renewable natural gas
- Investment in transmission infrastructure for wind energy production in Prince Edward Island

The total available funding from the above five programs is around CAD$138 million for direct investment in the RE sector. However, it should be noted that some of these programs are not exclusively for RE but apply largely to the clean energy sector. In addition, a further CAD$358 million direct funding is available for other clean technology initiatives (excluding mobility/transportation programs). Comparatively, the direct investment funding available for programs related to fossil fuels is around CAD$13 billion (including programs highlighted in Table A.1 (see Appendix A: Data), Federal government funding for Orphan wells

and Emissions Reduction Fund (ERF)). Here, as in Part 2, we note that the available programs' envelope does not always translate to providing practical financial support for the sector's most pressing challenges.

Adding the capital funding of CAD$138 million available to the RE sector and funding available under scenario 3 in Table 2.1, a total of approximately CAD$895 million is available as operational and capital funding for the RE sector in Canada through the benefit programs for the COVID-19 pandemic. This amount is from the 8 programs listed in Table 2.1 and 5 directly beneficial programs identified above for a total of 13. It should be noted that of the CAD$895 million benefits for the RE sector, CAD$351 million (46%) is through the CEWS program and, therefore, would apply only for current RE operations and projects that are under construction. As such, the upper limit of the benefits that can potentially benefit new projects and support new RE investments would be about CAD$544 million.

Chapter 3: Economic Growth Potential of Renewable Energy

Before the economic crisis induced by the COVID-19 pandemic, Canada's renewable energy sector was growing faster than the rest of the economy, creating and sustaining jobs for Canadians (Clean Energy Canada, 2019b). Many Canadian and international organizations advocate for implementing stimulus programs directed towards the RE sector as part of fiscal policies to stimulate the post-COVID-19 economic recovery. As reviewed in Chapter 2, at the time of compiling this report, federal and provincial governments' general and directed relief measures to assist the RE sector are approximately CAD $544 million.

In contrast, the Canadian Taskforce for Resilient Recovery recommends investing CAD$11.5 billion over the next five years to grow the country's clean energy sector (TFRR, 2020). The main argument for this recommendation is that a cleaner energy sector can make Canada competitive in the 21st century global economy, where a lower carbon intensity is desired. The objective of economic stimulus programs is to boost economic and employment growth. If public money is to be invested in stimulating the growth of the RE sector (or any other sector for that matter), it is important to quantify the potential of the RE sector to support jobs and contribute to the country's economic growth.

In this section, we develop an analysis to quantify the potential of RE projects to contribute to the economic growth (measured in contribution to the GDP) and to create and sustain jobs (measured in the number of jobs and labour income) in Canada. We respectfully recognize the work done by other organizations (for example, Clean Energy Canada (2019b), Pembina Institute (Jeyakumar, 2016), Solas Energy Consulting (2018), and TFRR (2020)) in quantifying employment and economic development potential of investments and operations in the RE sector in Canada. Our work is complementary to these other works and provides granular and project-level analysis that have been developed using Canadian data and models. Our observation is that most prior work has been conducted at an aggregated sector level or has used proxy measures.

Analysis Framework to Quantify the Economic Growth Potential of RE Projects

In recent literature, different statistical and economic models have been used to quantify the economic benefits of constructing and operating RE projects such as wind energy and solar energy projects. These include the use of industry statistics, input-output (I/O) models, computable general equilibrium, and regression models (IRENA, 2019b; Lambert and Silva, 2012; Pollin et al., 2009; Stavropoulos and Burger, 2020).

For this analysis, we use an I/O model-based approach. The main advantage of using I/O models is that they provide a well understood transparent framework that uses consistently collected and updated data sets from national industry accounts. Like any other economic analysis method, I/O models have limitations and challenges. We do not intend to repeat those limitations in detail, and interested readers

are encouraged to refer to other publications, including those by CERI (for example, see (Gallardo et al., 2020; Lambert and Silva, 2012; Miller and Blair, 2009)). As discussed in detail by Miller and Blair (2009), most of these limitations stem from the static nature of the framework. In other words, the I/O framework assumes that the structure, technology employed, and productivity of different economic sectors and inter-economic sector interactions would remain the same as the ones observed in the reference year used for the development of the I/O model used for a specific analysis.

The I/O model used for this analysis is the proprietary CERI multi-region I/O model. The model has been developed using the detailed level supply and uses data from Statistics Canada (2019). The model follows a well-documented mathematical framework (Ghanem, 2010; Miller and Blair, 2009). The data set used for model calibration tracks 492 products and services, 234 economic sectors, and 282 final demand sectors in 14 Canadian jurisdictions in the reference year 2016. This is the most up-to-date and detailed *supply and use* data set available in Canada. The advantage of using this type of holistic model is that it represents the entire economy, where we all live, and can show multiple economic impacts across many sectors and jurisdictions.

A typical I/O model analysis can estimate the economic impacts of changes in operations (for example, increase in production) or investments of an economic sector. However, one challenge in using I/O models to estimate the economic impacts of RE industries is that they are not explicitly tracked by Canadian supply and use data sets. Therefore, unlike conventional energy sectors, the CERI multi-region I/O model has been modified to estimate RE investment and operations' economic impacts.

We use an alternative modelling method known as the "synthetic industry" approach (Garrett-Peltier, 2017). In this case, spending to develop, construct, and operate RE operations is modelled as a demand shock. For example, an investment in a wind power system is modelled as an increase in the demand for equipment (e.g., wind turbines, towers, construction material, etc.) and services (e.g., construction services, financial services) required to develop the facility. I/O models that are based on supply and use tables—including the multi-region I/O model—can be set up to estimate the economic impacts of both industry output changes as well as changes in demand for products and services (see Ghanem (2010) and Guo et al. (2002) for the mathematical framework).

To estimate the economic impacts of growing the RE sector, we use three illustrative case studies. Using the CERI multi-region I/O model, we estimate the GDP growth and job creation or job sustaining potential of the following RE projects developed in Canadian provinces:

1. Utility-scale wind power plants
2. Distributed (i.e., residential and commercial-scale) solar photovoltaic (PV) projects
3. Corn-based ethanol (i.e., bioethanol) production facilities

Utility-scale wind power is selected for the analysis because wind power is one of Canada's fastest-growing electricity generation technologies. The wind industry in Canada is mature, and there is significant potential to develop more wind power in Canada. Similarly, commercial and residential distributed solar PV is a rapidly growing distributed electricity generation option. As reviewed in a recent CERI study, all Canadian provinces have policies, programs, and utility regulations to support distributed electricity

generation (CERI, 2020). Bioethanol production facilities are selected for the analysis, and the proposed Clean Fuel Standard will significantly increase the demand for biofuels in Canada. An analysis by Clean Energy Canada estimates that Canada will require 30 more biofuel production facilities to satisfy the biofuel demand stemming from the CFS implementation.

The analysis is limited to three RE industries, primarily due to logistic reasons. Other RE industries, such as hydropower, geothermal, and renewable natural gas, see growth across the country and are supported by provincial energy policies. Assessing the economic impacts of the growth in a broader set of RE and cleantech industries is a subject for future work.

Furthermore, the results presented in this report are for three provinces for each case study. As such, utility-scale wind and distributed solar PV case studies estimate the economic impacts of developing and operating those RE projects in Nova Scotia, Ontario, and Alberta, respectively, representing Atlantic, Central, and western regions. Corn-based bio-ethanol plants are assumed to be developed in Quebec, Ontario, and Manitoba. These three provinces dominate the corn production in Canada and, therefore, are suited to host bio-ethanol production plants. Once again, limiting the results for those provinces is primarily due to logistical reasons. Using the multi-region I/O model and a set of representative project development and operations costs, we estimate two types of economic effects:

1. Direct effects: Direct effects are due to activities of the sectors of the economy that are directly impacted by the RE development (e.g., wind power facility construction firm, equipment provider, wind power facility itself after constructed and energized)
2. Indirect effects: Indirect impacts are due to the activities of the sectors that are indirectly impacted by a RE development (e.g., steel industry that produces steel and steel products for wind turbine towers, cement industry)

We estimate the direct and indirect effects of the following economic impacts:

1. Contribution to the GDP
2. Job creation or job sustaining potential
3. Labour income

The RE project cost data required for this analysis was collected with reference to past CERI projects and publicly available publications. The data sets are validated through industry consultations.

Wind Power Plant Cost Data

CERI has evaluated several examples from available industry sources to determine the capital and operational cost for a wind power plant (Delphi Group, 2017; IRENA, 2012; Stefek et al., 2019). The following factors have been used to develop a 100MW wind power plant's capital operating costs in three Canadian provinces (See Table 3.1 for the full data set).

- Nameplate capacity is assumed as 100 MW
- Cost values have been inflated using a 2% yearly rate of inflation

- A set of location factors with detailed costs developed by CERI (2018) is used to address the variability of construction and labour cost values in each province
- Utility costs (electricity and natural gas) have been adjusted between provinces according to approximate current market prices and previous CERI analysis of Canada's provincial electricity systems

Table 3.1: Capital and Operating Costs of a 100MW Wind Power Plant

Category	Product or service	Nova Scotia	Ontario	Alberta
Capital costs (in thousand CAD)				
Equipment	Power, distribution and other transformers	2,391	2,492	2,360
Equipment	Switchgear, switchboards, relays and industrial control apparatus	1,453	1,514	1,434
Equipment	Turbines, turbine generators, and turbine generator sets	146,247	152,412	144,320
Equipment	Other electrical equipment and components	7,123	7,423	7,029
Construction	Electric power engineering construction	9,415	9,986	10,176
Construction	Other engineering construction	20,875	22,140	22,562
Development & Other	Engineering design and related services	2,545	2,699	2,751
Development & Other	Legal services	937	994	1,013
Total capital cost		190,049	198,666	190,632
Operating and maintenance costs (in thousand CAD/year)				
Labour	Administrative	43	45	46
Labour	Field Salaries (i.e., onsite wind technicians, etc.)	265	281	287
Labour	Management	106	113	115
Materials & services	Consumables/Tools and Misc. Supplies	224	232	216
Materials & services	Fees, Permits, Licenses	18	18	17
Materials & services	Fuel (motor vehicle gasoline)	35	36	34
Materials & services	Insurance	663	687	638
Materials & services	Replacement Parts/Equipment/ Spare Parts Inventory	1,963	2,032	1,889
Materials & services	Site Maint/Misc. Services	35	36	34
Materials & services	Utilities	101	72	67
Materials & services	Vehicles	89	92	85
Total operating and maintenance costs		3,542	3,644	3,428

Source: CERI

Table 3.2: Capital Costs of Distributed (residential and commercial) Solar PV Systems

Category	Product or service	Residential	Commercial
Capital costs (in thousand CAD/MW)			
Equipment	Solar PV modules	605	586
Equipment	Inverter	432	288
Equipment	Balance of the system	337	184
Construction	Installtion labour & other costs	1,530	1,224
Total capital cost		2,903	2,281

Source: CERI

Distributed Solar PV Cost Data

The capital costs of residential and commercial solar PV systems are obtained using a recent CERI analysis of distributed electricity generation in Canada (CERI, 2020). The data set has been developed using industry surveys and adjusted for current prices by considering capital cost reduction due to technology learning. Residential and commercial solar PV systems are assumed to have negligible operating and maintenance costs.[2] We assume the same capital costs for all provinces. Table 3.2 shows the capital costs assumed for this analysis. The typical capacity of a residential solar PV system is about 6-8 kW, and that of a commercial system is about 50-1000 kW. For this analysis, we estimate the economic impacts of a collection of residential and commercial solar PV systems with an aggregated capacity of 1MW.

Bioethanol Plant Cost Data

CERI has created a multi-source dataset after reviewing and vetting several data sources that have been developed using industry surveys. The dataset was used to determine the capital and operational cost for a bioethanol plant (IRENA, 2016, 2015; NERL, 2016). The following factors are used to evaluate a bioethanol plant's capital and operating costs that has a production capacity of 100 million litres per year (million L/year).

- Chemical engineering plant cost index (CEPCI) is used to inflate capital cost values to the current year
- Other cost values are adjusted for inflation, assuming an annual inflation rate of 2%
- Feedstock corn price has been adjusted between the US and Canada using a ratio of 3.25:5 based on available corn market prices
- CERI standard location factors have been used to adjust values between provinces except for utilities
- Utility costs (electricity and natural gas) have been adjusted between provinces according to approximate current market prices.

The capital and operating costs of bioethanol plants assumed for this analysis are presented in Table 3.3.

[2] A notable limitation of this assumption is the cost of inverter replacement around year 8-10 since commissioning of a solar PV system. Sensitivity analyses found the associated economic impacts to be insignificant.

Table 3.3: Capital and Operating Costs of a Bioethanol Plant with a Production Capacity of 100 million L/year

Category	Product or service	Quebec	Ontario	Manitoba
Capital costs (in thousand CAD)				
Equipment	Boiler Generator	23,018	23,930	24,386
Equipment	Feed Handling System	5,755	5,982	6,096
Equipment	Process equipment	47,188	49,056	49,991
Equipment	Water Treatment	13,811	14,358	14,631
Equipment	Storage	2,302	2,393	2,439
Equipment	Spare Parts	2,211	2,298	2,342
Construction	Engineering construction	11,509	11,965	12,193
Development & other	Loan Fees	4,422	4,597	4,684
Development & other	Construction Insurance	1,105	1,149	1,171
Development & other	Land	3,316	3,448	3,513
Total capital cost		114,637	119,177	121,447
Operations and maintenance costs (in thousand CAD/year)				
Labour	Labour	4,737	4,925	5,019
Fixed	Materials	1,579	1,642	1,673
Fixed	Services	1,895	1,970	2,008
Fixed	Insurance/Other	316	328	335
Other variable costs	Waste Disposal	316	328	335
Other variable costs	Water	632	657	669
Other variable costs	Electricity	1,746	3,355	1,684
Other variable costs	Natural Gas	7,833	8,122	7,546
Other variable costs	Enzymes	2,211	2,298	2,342
Other variable costs	Yeast	316	328	335
Other variable costs	Chemicals	2,211	2,298	2,342
Other variable costs	Denaturant	4,106	4,268	4,350
Feedstock	Feedstock Cost	179,684	179,684	179,684
Total operating and maintenance costs		207,581	210,205	208,320

Source: CERI

Economic Impacts of RE Investments and Operations

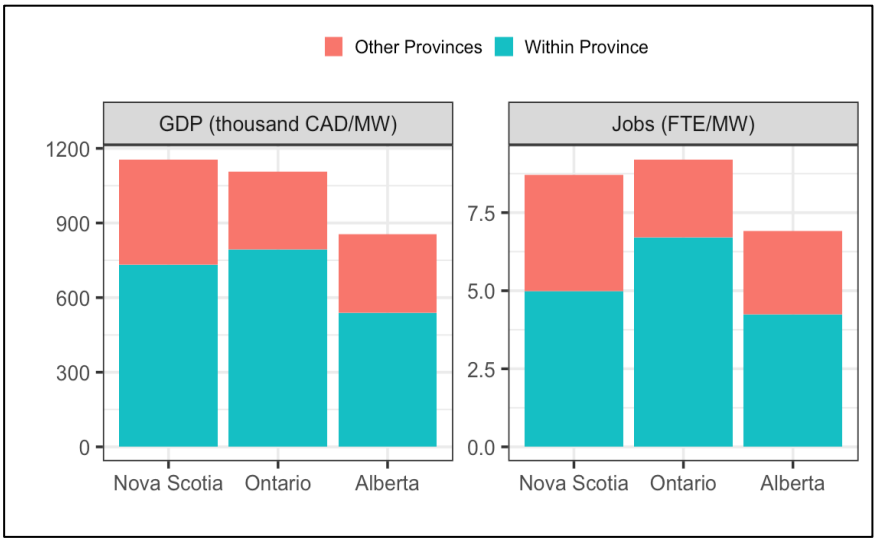
Economic Development Potential of Utility-scale Wind Power

The economic development potential of constructing utility-scale wind power projects in Nova Scotia, Ontario, and Alberta is depicted in Figure 3.1. The figure summarizes the contribution to the GDP (measured in CAD/MW) and jobs created or sustained (measured in full-time equivalent (FTE) jobs per MW). The results are normalized by project capacity to enable scaling of the results[3]. The results can be

[3] Note that the estimates of the economic development potential pertain to the full construction phase.

linearly scaled to estimate wind power facilities' economic impacts with installed capacities of 50-200 MW. Note that the figure only shows the project development and construction phase impacts. In addition to the project construction phase impacts, there will be direct and indirect jobs created or sustained during the utility-scale operational phase. The estimated operational phase employment impacts of utility-scale wind power in all provinces is about 0.2 FTE/MW, and the average annual labour income would be about 65,000 - 70,000 CAD/FTE.

Figure 3.1: Economic Impacts (Direct and Indirect Effects) of Construction of Utility-Scale Wind Power in Select Provinces



Source: CERI

As shown in Figure 3.1, approximately 60% of the direct and indirect impacts (both GDP and jobs) would be observed within the province where the project is developed. Construction of a utility-scale wind farm can potentially create or sustain 4-7 direct and indirect jobs in the host province and another 3-4 indirect jobs in other provinces per 1 MW of installed capacity. We observe that the economic impacts are dominated by the spending on equipment (wind turbines, towers, grid interface equipment, etc.), followed by construction-related spending. Most provinces do not produce the equipment required for wind power within the province, and they need to be imported from other provinces or countries. In the process of procuring them, jobs are created or sustained throughout the supply chain.

To gain insights into the economic sectors impacted by wind power developments, Table 3.4 summarizes the economic impacts by the sectors in which they are observed and geographic location. For each province, the top three sectors by job creation or sustainment are indicated in the table. Impacts in other sectors are aggregated and indicated as "other sectors. "

Table 3.4: Summary of Development and Construction Phase Economic Impacts of Utility Scale Wind Power in Select Provinces

Province of the economic activity	Origin and type of impacts	Contributing Sector	GDP (thousand CAD/MW)	Jobs (FTE/MW)	Labour income (thousand CAD/MW)
Nova Scotia	Within Province (Direct and indirect impacts)	Other engineering construction	147	1.4	109
		Machinery, equipment and supplies wholesaler-distributors	109	1.3	107
		Electric power engineering construction	52	0.5	24
		Other sectors	424	1.8	114
		All sectors	732	5.0	354
	Other Provinces (Indirect impacts)	All sectors	425	3.7	274
	Total direct and indirect impacts	**All sectors in all provinces**	**1,156**	**8.7**	**628**
Ontario	Within Province (Direct and Indirect Impacts)	Machinery, equipment and supplies wholesaler-distributors	281	1.8	174
		Other engineering construction	93	0.9	81
		Engine, turbine and power transmission equipment manufacturing	51	0.7	55
		Other sectors	368	3.3	221
		All sectors	793	6.7	532
	Other Provinces (Indirect Impacts)	All sectors	315	2.5	202
	Total direct and indirect impacts	**All sectors in all provinces**	**1,108**	**9.2**	**734**
Alberta	Within Province (Direct and Indirect Impacts)	Machinery, equipment and supplies wholesaler-distributors	204	1.5	136
		Other engineering construction	98	1.0	71
		Electric power engineering construction	61	0.3	27
		Other sectors	177	1.4	108
		All sectors	541	4.3	342
	Other Provinces (Indirect Impacts)	All sectors	315	2.7	210
	Total direct and indirect impacts	**All sectors in all provinces**	**856**	**6.9**	**552**

Source: CERI
Note: In each project development province, the top three industries by employment impacts are indicated.

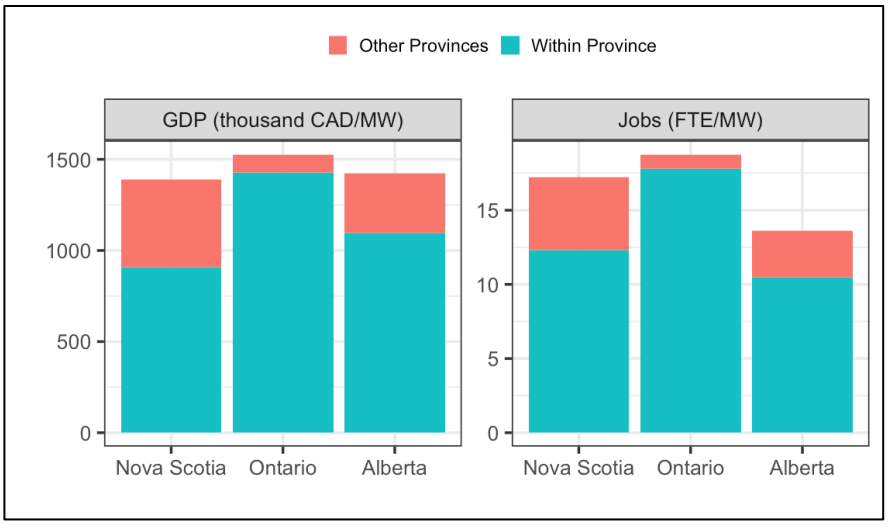
From the results presented in Table 3.4, the economic impacts due to the development and construction of wind power are dominated by sectors that involve equipment supply chains (with the top impacted sector being Machinery, equipment and supplies wholesaler-distribution sector) and construction. These are established sectors in Canada that have seen reduced economic activities due to economic downturns due to the COVID-19 pandemic, as well as longer-term increased trade concerns. Compared to the other

two provinces, the GDP contribution and the employment impact are lower in Alberta (on a per MW basis) because the equipment and services procured through international imports are higher. We also observe that equipment supply chain sectors in Ontario dominate irrespective of the province in which the wind power development occurs, the indirect impacts in other provinces. Ontario plays a key role in the supply chain for energy sector investment, generally.

Economic Development Potential of Distributed Solar Photovoltaic

The economic impacts of the construction of distributed solar PV systems are summarized in Figure 3.2 and Table 3.5. Similar to wind power results, the economic impacts are normalized by installed capacity to estimate impacts per 1MW installed capacity. As discussed before, the operations phase impacts of distributed solar PV are minimal.

Figure 3.2: Economic Impacts (Direct and Indirect Effects) of Construction of Distributed Solar PV Systems in Select Provinces



Source: CERI

In the case of distributed solar PV systems, the GDP and employment development benefits are dominated (70 – 92%) within the province (i.e., local impacts) impacts. The construction of distributed solar PV systems can potentially support a higher number of jobs in the host province and other provinces. The number of direct and indirect jobs created or sustained within the province where the systems are installed is estimated to be 12-18 per 1 MW of installed capacity. In addition, another 1-5 indirect jobs are created or sustained in other provinces, making the total employment impact 14-19 FTE/MW. This is the highest employment support potential of the RE industries assessed. This observation (the fact that distributed solar PV having the highest employment impact among all RE technologies during the construction phase) is consistent with analysis conducted by other organizations focusing on Canada as well as other countries. The Solar PV equipment supply chain is currently well established in Ontario, and the impacts of that were evident in the analysis. Irrespective of the province in which the system is installed, a higher number of direct (when the systems are installed in Ontario) and indirect economic benefits (both GDP and employment-related impacts) are observed in Ontario.

It should, however, be noted that the majority of impacts can be attributed to the construction (i.e., installation of solar PV systems) of a distributed solar PV system (See Table 3.4). In terms of post COVID-19 economic recovery, this an important fact to be noted. The installation of solar PV systems will be done by building repair and construction and service sectors, which tend to have a workforce dominated by the local population. Furthermore, distributed solar PV systems can be deployed in a very short period of time, with a minimal amount of planning and permitting period (generally, a few months). This allows for immediate economic activities.

Table 3.5: Summary of Development and Construction Phase Economic Impacts of Distributed Solar PV Systems in Select Provinces

Province of the economic activity	Origin and type of impacts	Contributing Sector	GDP (thousand CAD/MW)	Jobs (FTE/MW)	Labour income (thousand CAD/MW)
Nova Scotia	Within Province (Direct and indirect impacts)	Repair construction	553	7.2	412
		Services to buildings and dwellings	28	1.2	25
		Machinery, equipment and supplies wholesaler-distributors	43	0.5	42
		Other sectors	283	3.4	187
		All sectors	907	12.3	666
	Other Provinces (Indirect impacts)	All sectors	482	4.9	311
	Total direct and indirect impacts	**All sectors in all provinces**	**1,389**	**17.2**	**978**
Ontario	Within Province (Direct and Indirect Impacts)	Repair construction	997	13.6	827
		Machinery, equipment and supplies wholesaler-distributors	102	0.6	63
		Services to buildings and dwellings	19	0.6	15
		Other sectors	308	2.9	198
		All sectors	1,426	17.8	1,103
	Other Provinces (Indirect Impacts)	All sectors	101	1.0	65
	Total direct and indirect impacts	**All sectors in all provinces**	**1,527**	**18.8**	**1,167**
Alberta	Within Province (Direct and Indirect Impacts)	Repair construction	578	5.6	470
		Services to buildings and dwellings	43	1.1	34
		Machinery, equipment and supplies wholesaler-distributors	81	0.6	54
		Other sectors	392	3.2	237
		All sectors	1,094	10.5	796
	Other Provinces (Indirect Impacts)	All sectors	331	3.1	210
	Total direct and indirect impacts	**All sectors in all provinces**	**1,425**	**13.6**	**1,006**

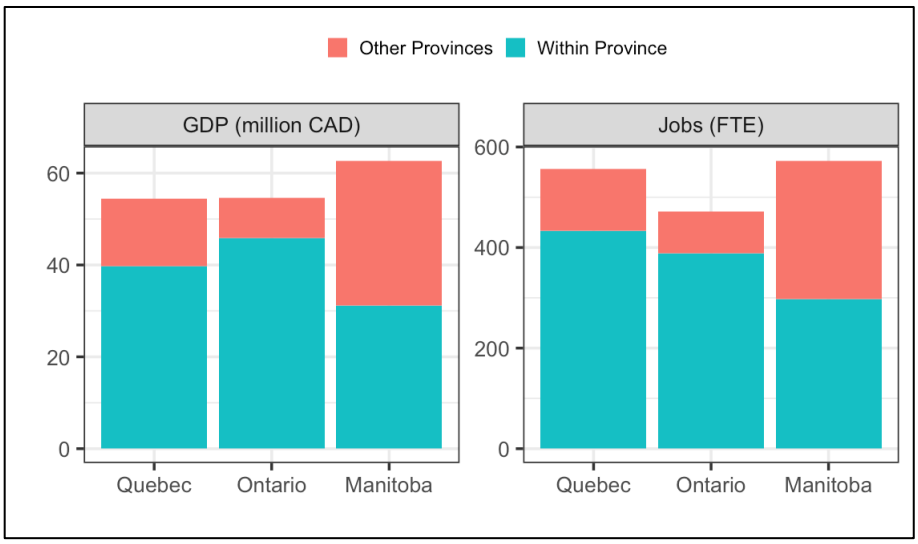
Source: CERI

Note: In each project development province, the top three industries by employment impacts are indicated.

Economic Development Potential of Bioethanol Production

As previously discussed, the third RE case study we assessed is the construction and operation of a corn-based bioethanol production facility constructed in Quebec, Ontario, or Manitoba. Those three provinces currently produce over 90% of Canadian corn production. The bioethanol production facility is assumed to have a production capacity of 100 million L/year. Figure 3.3 depicts the GDP and employment impacts of developing and constructing the bioethanol production facility in one of the provinces mentioned above. Table 3.6 summarizes the economic impacts attributable to the facility's development and construction phase, and Table 3.7 summarizes the impacts during a typical year during the operations phase.

Figure 3.3: Economic Impacts (Direct and Indirect Effects) of Design and Construction of a Bioethanol Production Facility in Select Provinces



Source: CERI
Note: The production capacity of the facility is assumed to be 100 million L/year

Table 3.6: Summary of Development and Construction Phase Economic Impacts of a 100 million L/year Bioethanol Production Facility in Select Provinces

Province of the economic activity	Origin and type of impacts	Contributing Sector	GDP (thousand CAD)	Jobs (FTE)	Labour income (thousand CAD)
Quebec	Within Province (Direct and indirect impacts)	Machinery, equipment and supplies wholesaler-distributors	8,533	90	6,667
		Other engineering construction	5,686	64	4,581
		Boiler, tank and shipping container manufacturing	3,770	47	3,126
		Other sectors	21,717	232	13,945
		All sectors	39,706	433	28,319
	Other Provinces (Indirect impacts)	All sectors	14,759	124	9,271
	Total direct and indirect impacts	**All sectors in all provinces**	**54,465**	**557**	**37,590**
Ontario	Within Province (Direct and Indirect Impacts)	Machinery, equipment and supplies wholesaler-distributors	13,539	86	8,378
		Other engineering construction	4,654	45	4,056
		Industrial machinery manufacturing	2,749	26	2,076
		Other sectors	24,882	230	15,347
		All sectors	45,824	388	29,857
	Other Provinces (Indirect Impacts)	All sectors	8,723	84	5,663
	Total direct and indirect impacts	**All sectors in all provinces**	**54,547**	**472**	**35,519**
Manitoba	Within Province (Direct and Indirect Impacts)	Machinery, equipment and supplies wholesaler-distributors	7,557	66	5,479
		Other engineering construction	4,609	50	3,621
		Boiler, tank and shipping container manufacturing	2,816	33	1,892
		Other sectors	16,118	148	9,311
		All sectors	31,100	297	20,303
	Other Provinces (Indirect Impacts)	All sectors	31,639	276	20,450
	Total direct and indirect impacts	**All sectors in all provinces**	**62,739**	**573**	**40,754**

Source: CERI
Note: In each project development province, the top three industries by employment impacts are indicated.

Table 3.7: Summary of Operations Phase Economic Impacts in a Typical Year of a 100 million L/year Bioethanol Production Facility in Select Provinces

Province of the economic activity	Origin and type of impacts	Contributing Sector	GDP (thousand CAD)	Jobs (FTE)	Labour income (thousand CAD)
Quebec	Within Province (Direct and indirect impacts)	Crop production (except cannabis, greenhouse, nursery and floriculture production)	82,371	883	24,813
		Support activities for crop and animal production	2,218	40	1,508
		Facilities and other support services	3,699	34	1,024
		Other sectors	32,840	336	18,400
		All sectors	121,128	1290	45,745
	Other Provinces (Indirect impacts)	All sectors	25,409	219	13,857
	Total direct and indirect impacts	**All sectors in all provinces**	**146,537**	**1509**	**59,602**
Ontario	Within Province (Direct and Indirect Impacts)	Crop production (except cannabis, greenhouse, nursery and floriculture production)	52,033	699	19,267
		Support activities for crop and animal production	2,285	46	1,875
		Repair construction	1,919	26	1,592
		Other sectors	32,835	282	17,158
		All sectors	89,072	1050	39,892
	Other Provinces (Indirect Impacts)	All sectors	30,938	264	13,752
	Total direct and indirect impacts	**All sectors in all provinces**	**120,010**	**1314**	**53,644**
Manitoba	Within Province (Direct and Indirect Impacts)	Crop production (except cannabis, greenhouse, nursery and floriculture production)	54,430	380	11,111
		Support activities for crop and animal production	2,098	30	1,343
		Building material and garden equipment and supplies dealers	1,383	22	837
		Other sectors	22,403	196	11,391
		All sectors	80,314	628	24,682
	Other Provinces (Indirect Impacts)	All sectors	72,063	614	33,076
	Total direct and indirect impacts	**All sectors in all provinces**	**152,378**	**1242**	**57,758**

Source: CERI
Note: In each project operations province, the top three industries by employment impacts are indicated. The feedstock to produce ethanol is assumed to be corn.

The results show that a bioethanol production facility's design and construction with an annual production capacity of 100 million L can create or sustain about 500 – 570 direct and indirect jobs. The total direct and indirect GDP contribution would be about CAD$120 – 150 million or about 50% of the total investment cost. The construction phase's economic impacts are roughly shared equally among equipment and construction spending. In all three provinces, some equipment is produced within the respective provinces, contributing to the economic growth in the local manufacturing sectors. In Quebec and Ontario, local direct and indirect impacts dominate (77 - 80%) the total impacts. In Manitoba, a considerable amount of equipment and construction services are imported from Ontario, making the within province direct and indirect impacts approximately half of the total impacts.

The operation phase economic impacts of bioethanol production facilities modelled in this analysis dominate the total potential for economic growth. The contribution to the GDP and employment impacts in a typical operations year is about twice as much of those during the facility construction phase. The vast majority of the economic benefits would be observed in the crop production and support services for crop production (about 400 to 900 FTE/year depending on the province). The workforce in crop production and support sectors consists mainly of the local population. Therefore, a bioethanol plant has the potential to make prolonged contributions to the local economy.

In addition to contributing to local economies, developing bioethanol production plants can facilitate other provincial and national environmental policies. For example, the proposed Clean Fuel Standard would require the minimum volumetric fraction of renewable fuels in gasoline to be 10% by 2030. Bioethanol facilities can increase the domestic supply chain of biofuels.

Chapter 4: Conclusions

Before the COVID-19 pandemic, the global RE sector was experiencing rapid growth. Canada's RE sector was not an exception, and the country's RE and clean energy sector was growing faster than the rest of Canada's economy. The RE sector is at the center of options considered to achieve Canada's target for greenhouse gas emission reductions. It has a significant role to play in the country's transition to a low-carbon economy. As outlined in the Pan-Canadian Framework on Clean Growth and Climate Change, RE is to be used as a set of technical options for cleaner electricity generation and low carbon fuels for transportation, buildings, and industry. Several provinces have set minimum RE targets, and private corporations are starting to consider RE as a future proof investment option.

The full impact of the COVID-19 pandemic on Canada's RE sector is yet to be observed. It still accounts for a relatively small part of the country's GDP, and most RE projects are either owned and operated by provincially owned utilities or backed by a long term PPA. However, economic downturns may dampen the growth of the RE sector. Some significant impacts may be due to supply chain disruptions, construction delays, and labour shortages due to public health measures (e.g., quarantine orders). These challenges may change how developers will conceptualize, plan, and develop renewable projects, leading to uncertainties in the RE sector's growth.

A review of COVID-19 pandemic economic relief programs and policies implemented to assist the industry identified about 13 federal and provincial programs that can potentially assist the RE sector's growth and operations. The combined value of those relief measures is about CAD$500 – 800 million. However, only about CAD$138 million is directed to grow the RE sector. The rest of the relief measures are offered for the economy at large.

COVID-19 relief programs' main objective is to stimulate economic growth and create and sustain jobs for Canadians. In this study, one main research question we assessed in this study is whether the RE sector can contribute to the post-pandemic economic recovery. In this study, we took a case study-based approach to estimate RE projects' potential to contribute to the GDP and create or sustain jobs. We conducted three illustrative case studies that assessed the economic development potential of utility-scale wind power, distributed solar PV systems, and bioethanol production.

The results show that every CAD$1 million invested in utility-scale wind power can support 4-5 jobs and contribute CAD$0.5 million to the GDP. In the case of distributed solar PV, every CAD$1 million invested can support 5-7 jobs and contribute CAD$0.6 million to the GDP. In both cases, the said economic impacts are observed in the project development and construction phase. In the case of bioethanol production facilities, CAD$1 million invested in project development and construction can support 4-5 jobs and contribute CAD$0.5 million to the GDP. During the operations phase, a bioethanol production facility can create or sustain a significant number of local jobs.

Only three RE case studies are assessed in this study. The RE development potential in Canada goes beyond these three technologies. For example, there is a significant amount of existing and proposed

hydropower and utility-scale solar PV projects in Canada. Technologies such as geothermal energy have significant potential to provide renewable electricity and renewable heat.

Furthermore, geothermal energy may have a high potential for employment skills, knowledge, and technology transferability from the existing oil and gas industry. Biomass conversions to electricity, heat, and fuels are widely observed in Canada, and it can benefit other industries such as forestry and pulp and paper. While this analysis only assessed one renewable fuel production option (i.e., corn-based bioethanol), existing and proposed regulations to reduce the carbon intensity of diesel will increase the demand for renewable diesel (e.g., biodiesel and hydrogenation derived renewable diesel) (NRCan, 2010). Another observation widely cited in previous studies is that the potential to create or sustain jobs from RE investment is similar to fossil fuel-based energy conversion systems (for example, natural gas or coal based electricity generation systems) (Garrett-Peltier, 2017; Jeyakumar, 2016). Further analysis is required to assess the employment impacts of a broader set of RE technologies.

The main conclusion drawn from the analysis is that a relief program that is directed towards growing the RE sector in Canada can satisfy the objectives of economic stimulus programs and contribute to the post-pandemic economic recovery. Developing the RE sector can also contribute to environmental and climate change mitigation goals set by Canada's federal and provincial governments.

Our analysis shows that the main programs that translate into pragmatic support for the sector benefit ongoing operations as in the wage subsidy program. We note that construction and financial challenges may benefit from loan programs, but the more substantive impact on new projects is the supply chain impacts and construction delays. Bridge loans may be useful in these situations, but the projects' delays undermine the projects' original financial structure, for which the existing support programs do not address.

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Appendix A: Data

Table A.1: Energy Sector-based COVID-19 Relief Programs Announced Since March 2020

Jurisdiction	Category	Name	Endorsing Agency	Value Committed (CAD)
British Columbia	Clean Technology	Innovative Clean Energy (ICE) Fund announcements; September 2020	Government of British Columbia - Innovative Clean Energy Fund	8,500,000
British Columbia	Other Energy	Relief on electricity bills by BC Hydro	BC Hydro	Not Estimated
Federal	Clean Technology	Investment in clean technologies under Canada Economic Development for Quebec Regions	Canada Economic Development for Quebec Regions (CED)	7,348,387
Federal	Clean Technology	Infrastructure Canada project funding for renewable green energy projects since March 2020	Infrastructure Canada	29,709,789
Federal	Clean Technology	COVID-19 Resilience funding stream and expanded eligibility for Infrastructure Canada programs	Infrastructure Canada	Not Estimated
Alberta	Clean Technology	Funding for green building technologies via Smart Sustainable Resilient Infrastructure Association	Alberta Innovates	2,800,000
Alberta	Clean Technology	Funding for Net Zero Aquatic Facility in Drayton		6,320,165
British Columbia	Clean Technology	Low-interest financing for home energy retrofits		4,100,000
Federal	Clean Technology	Second phase of Community Efficiency Financing initiative		300,000,000
Federal	Clean Technology	Funding for South Baffin Energy Management Project	Environment and Climate Change Canada	18,300,000
Federal	Clean Technology	Funding for green building technologies via Smart Sustainable Resilient Infrastructure Association	Western Economic Diversification Canada	3,000,000

Federal	Clean Technology	Smart Grid technology investment in London Hydro	Natural Resources Canada	5,100,000
Federal	Clean Technology	Electric vehicle chargers in Oakville	Natural Resources Canada	220,000
Nunavut	Clean Technology	Funding for South Baffin Energy Management Project	Government of Nunavut	8,600,000
Prince Edward Island	Clean Technology	Investment in transmission infrastructure for wind energy production in Prince Edward Island	Infrastructure Canada	22,750,000
Federal	Clean Technology	Funding for Algoma Steel climate action initiatives	Environment and Climate Change Canada	4,000,000
Quebec	Clean Technology	Support for production and distribution of renewable natural gas		70,000,000
Federal	Clean Technology	Clean Technology for 'Alberta's Natural Resources Sectors		6,000,000
Federal	Clean Policy Reversals	Delay of publication and implementation of the Clean Fuel Standard	Government of Canada	Not Estimated
Alberta	Clean Policy Reversals	Temporary suspension of requirement for companies to report exceeding certain air quality guidelines in certain circumstances	Alberta government	Not Estimated
Alberta	Clean Policy Reversals	Reduction of environmental protections to prevent coal mining in the Foothills and Rockies	Alberta government	Not Estimated
Alberta	Clean Policy Reversals	Deadline extension for large, industrial greenhouse gas emitters to submit compliance reports and emissions reduction plans	Alberta government	Not Estimated
Alberta	Clean Policy Reversals	Suspension of additional reporting requirements for oil, gas and coal companies	Alberta government	Not Estimated
Alberta	Clean Policy Reversals	Suspension of certain environmental reporting requirements for the Environmental Protection and Enhancement Act (EPEA), the Water Act and the Public Lands Act	Environmental Protection and Enhancement Act, Water Act, and the Public Lands Act	Not Estimated

British Columbia	Clean Policy Reversals	Delay in British Columbia carbon tax increase	Government of British Columbia	Not Estimated
British Columbia	Clean Policy Reversals	Increased flexibility in environmental reporting	Government of British Columbia	Not Estimated
British Columbia	Clean Policy Reversals	Deferral of carbon tax and fuel tax payments	Government of British Columbia	Not Estimated
Federal	Clean Policy Reversals	Extension of deadline for pollution data reporting by industry	Government of Canada	Not Estimated
Federal	Clean Policy Reversals	Extension of deadline for greenhouse gas emissions reporting by industry	Government of Canada	Not Estimated
Nova Scotia	Clean Policy Reversals	Air pollution emission fee deferrals	Government of Nova Scotia	Not Estimated
Quebec	Clean Policy Reversals	Suspension of pursuing penalties for companies who breach environmental obligations	Quebec government	Not Estimated
Saskatchewan	Clean Policy Reversals	Deferral of environmental reporting programs and data reporting requirements	Saskatchewan government	Not Estimated
Saskatchewan	Clean Policy Reversals	Flexibility on enforcement for companies who breach environmental obligations	Saskatchewan government	Not Estimated
Saskatchewan	Clean Policy Reversals	Postponed deadline for companies to report greenhouse gas emissions data	Saskatchewan government	Not Estimated
Saskatchewan	Clean Policy Reversals	Suspension of penalties for oil and gas companies who breach environmental obligations	Saskatchewan government	Not Estimated
Alberta	Emission Reduction	Natural Gas Challenge investment by Emissions Reduction Alberta	Alberta government	58,000,000
Alberta	Fossil Fuel	Expanded eligibility in the Technology Innovation and Emissions Reduction (TIER) regulation	Alberta Environment and Parks	Not Estimated
Alberta	Fossil Fuel	Utility bill payment deferral for electricity and natural gas for select consumers	Bill 14, Utility Payment Deferral Program Act	Not Estimated
Alberta	Fossil Fuel	Investment in natural gas infrastructure in northern Alberta	Alberta government	16,000,000
Alberta	Fossil Fuel	Extensions for oil and gas tenures by one year	Alberta government	Not Estimated
Alberta	Fossil Fuel	Funding the Alberta Energy Regulator for 6 months by covering industry levies	Alberta government	113,000,000

Alberta	Fossil Fuel	Temporary 90% reduction of the operating budget of Canadian Energy Centre	Alberta government	Not Estimated
Alberta	Fossil Fuel	Loan guarantee from the Alberta government for TC 'Energy's Keystone XL pipeline	Alberta government	6,000,000,000
Alberta	Fossil Fuel	Equity investment from the Alberta government for TC 'Energy's Keystone XL pipeline	Alberta government	1,430,000,000
British Columbia	Fossil Fuel	Deferring and postponing pipeline and orphan well liability levies for oil and gas companies		11,000,000
British Columbia	Fossil Fuel	Decrease in natural gas levy	British Columbia Oil and Gas Commission	Not Estimated
Federal	Fossil Fuel	Changes to Export Development Act removing cap on finance and some risk protections	Export Development Act	Not Estimated
Federal	Fossil Fuel	Streamlined review process for companies proposing exploratory oil and gas drilling off the coast of Newfoundland and Labrador	Impact Assessment Agency of Canada	Not Estimated
Newfoundland and Labrador	Fossil Fuel	Extension of fuel tax exemption permits	Government of Newfoundland and Labrador	Not Estimated
Northwest Territories	Fossil Fuel	Rent relief for public land	Government of Northwest Territories	2,700,000
Nova Scotia	Fossil Fuel	Fee deferrals for onshore petroleum drilling applications	Government of Nova Scotia	Not Estimated
Ontario	Fossil Fuel	Purchase of natural gas power plants	Ontario Power Generation	2,800,000,000
Saskatchewan	Fossil Fuel	Regulatory relief for Saskatchewan oil and gas producers	Saskatchewan government	11,400,000
Alberta	Other Energy	Extension of consultation periods for Indigenous consultation on natural resource projects	Alberta government	Not Estimated
Federal	Other Energy	FedDev Ontario investment in biodiesel	Federal Economic Development Agency for Southern Ontario	Not Estimated
Federal	Other Energy	Broad Support for the Minerals and Metals Sector		Not Estimated

Ontario	Other Energy	Fixed electricity price for all time-of-use electricity customers	Ontario government	Not Estimated
Ontario	Other Energy	Cost relief for electricity for residential, farm and small business consumers	Ontario government	17,000,000
Ontario	Other Energy	Deferral of Global Adjustment charges for industrial and commercial electricity consumers	Ontario government	Not Estimated

Source: www.energypolicytracker.org