10 Ways to Win the Global Race to Net-Zero:

Global insights to inform Canadian climate competitiveness

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10 Ways to Win the Global Race to Net-Zero:

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Executive Summary

From loss of life to loss of livelihoods, the COVID-19 pandemic has exposed both our vulnerability and our ability to overcome adversity through solidarity, cooperation, and ingenuity—traits that will prove essential in combatting another global crisis: climate change.

With each passing day, more countries—and, increasingly, more companies—pledge to limit global warming to 1.5°C by reaching net-zero greenhouse gas (GHG) emissions by 2050. Collectively, countries with net-zero targets represent 61% of global GHG emissions, 68% of global GDP, and 52% of the global population. Companies with net-zero commitments together represent sales of nearly USD 14 trillion.

Net-zero is the new normal. But how do we get there?

A growing body of research, modelling, and analysis is beginning to paint a picture of how countries can get to net-zero by mid-century. To better understand these possible pathways, we reviewed six reports focused on how different countries could get the job done. Across all the studies, there are several findings that stand out.

First, energy efficiency and electrification—substituting clean power for fossil fuels—have the capacity to deliver the greatest contribution. Second, while most efforts to date have focused on carbon dioxide (CO_2) emissions, we must also reduce other greenhouse gas emissions, such as methane and hydrofluorocarbons. And third, the decarbonization of heavy industry is challenging but essential, and hydrogen could prove a key enabler of these reductions.

Many of these actions are already being put into practice around the world, illustrating how governments and businesses are beginning to translate net-zero ambition into action, taking steps to deliver the systemic change needed to succeed by mid-century. Sweden, for example, is punching above its weight in the race to produce green steel, and Germany has the pole position in deploying a comprehensive strategy to ramp up production and use of hydrogen. The European Battery Alliance has launched a continental battery industry and is making rapid strides toward battery self-sufficiency for its rapidly growing electric vehicle industry. In all three cases, governments articulated the objective, convened and collaborated with business leaders to develop a roadmap, and provided significant resources to kickstart the journey.

Getting to net-zero also requires changes in governance, as exemplified by President Biden's "all-of-government" approach, which has included structural changes to enhance coordination and collaboration across the numerous departments and government agencies whose mandates impact—or are impacted by—climate change. In New Zealand, the government is advancing reconciliation by elevating Māori voices as equal partners in climate action. And recognizing that no region or person can be left behind in the energy transition, the European Union (EU) is forging new ground with its Just Transition Mechanism.

While these examples of leading and innovative approaches to systemic transition can't simply be copied and pasted into the Canadian context, we can draw some key insights to inform our own made-in-Canada solutions.

Informed and inspired by efforts elsewhere, we offer five strategies to accelerate action toward net-zero in Canada. First, we need to kickstart new industry consortia to work together and with government on roadmaps to net-zero. Second, we need to build Indigenous leadership into Canada's energy transition and climate action. Third, we need to organize and structure the federal government for net-zero success. Fourth, we need to support a just transition for Canadian workers that keeps pace with the energy transition. And fifth, we need to ensure a principled, transparent approach to when and how we rely on carbon removals and offsets.

On paper, "net-zero by 2050" appears feasible, but this ambitious goal demands wide-reaching, systemic transformation and cooperation across all sectors. If Canada is to achieve net-zero emissions and prosper in the process, the pace of our efforts will need to accelerate, and there's no time to lose.

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1.0 Net-Zero, New Normal

In late 2018, the release of the Intergovernmental Panel on Climate Change's (IPCC's) special report on the impacts of global warming sent shockwaves around the world. Coming on the heels of a decade that saw year after year of record-setting average temperatures and climate-fuelled forest fires, flooding, and drought, the report's dire finding that the world could exceed 1.5°C of global warming as early as 2030 was a wakeup call. In no uncertain terms, it made clear that "every bit of warming matters," illustrating clear benefits to limiting warming to 1.5°C rather than 2°C or higher (IPCC, 2018). But even more significantly—and optimistically—it concluded "that limiting warming to 1.5°C is possible within the laws of chemistry and physics but would require unprecedented transitions in all aspects of society" (IPCC, 2018).

This lit a fire under political and business leaders alike, and throughout 2019 a growing number of countries and companies began to adopt the 2050 target which, the IPCC report surmised, would offer the prospect of limiting warming to 1.5°C: net-zero greenhouse gas (GHG) emissions. Since then, "the phrase 'net-zero' has gone from being a somewhat obscure scientific concept to centre stage in discourse on halting climate change" (Black et al., 2021).

What is "net-zero"?

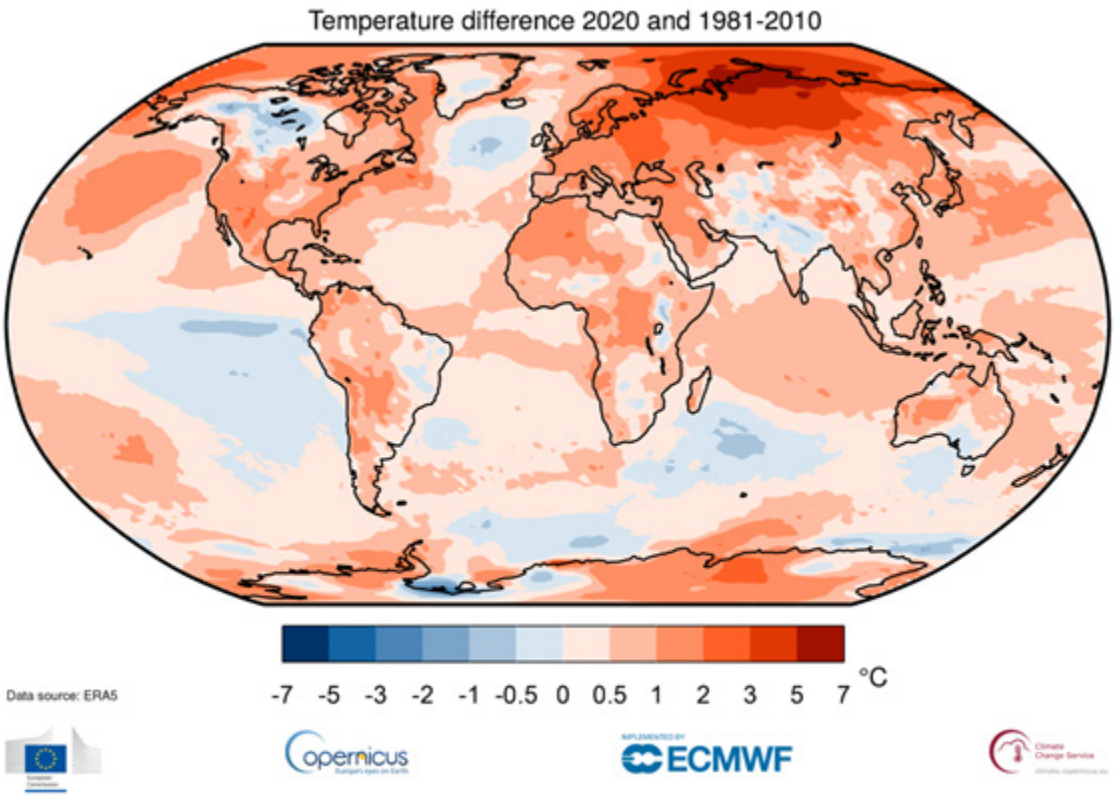
A net-zero economy is one in which the sum of all greenhouse gases equals zero.

After switching to non-polluting technologies, any remaining emissions are zeroed out by sucking carbon out of the atmosphere, whether through nature-based or technology-based removal.

Net-zero is the new normal.

While it might have been expected that the COVID-19 pandemic would slow or even derail this momentum for climate action, the opposite has occurred, and for a good reason. Last year the impacts of a changing climate continued to wreak havoc around the world—exemplified by record-breaking wildfires in Siberia, Australia, and California—and 2020 tied 2016 for the warmest year on record (Figure 1).

Figure 1. Temperature difference 2020 and 1981–2010

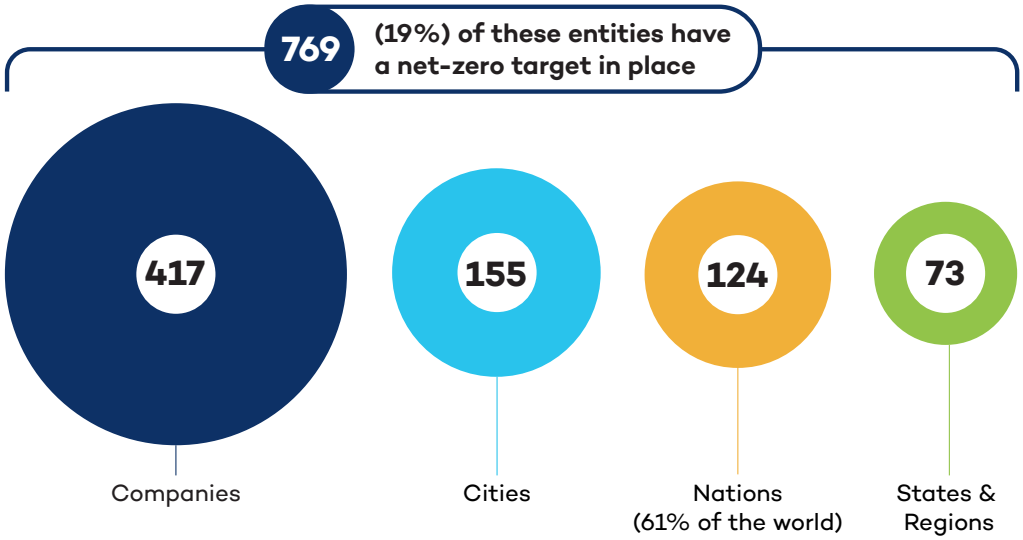


Air temperature at a height of two metres for 2020, shown relative to its 1981–2010 average. Source: ERA5.

Source: Copernicus Climate Change Service, n.d.

A March 2021 analysis conducted by the University of Oxford and the Energy & Climate Intelligence Unit surveyed more than 4,000 significant entities, including all nations, all states and regions in the 25 highest-emitting countries, all cities with a population above 500,000, and all companies in the Forbes Global 2000 list (Black et al., 2021). It found that 769 (19%) of these entities have a net-zero target in place, including 124 nations (61% of the world's total), 73 states and regions, 155 cities, and 417 companies (Figure 2).

Figure 2. Net-zero targets are gaining in popularity

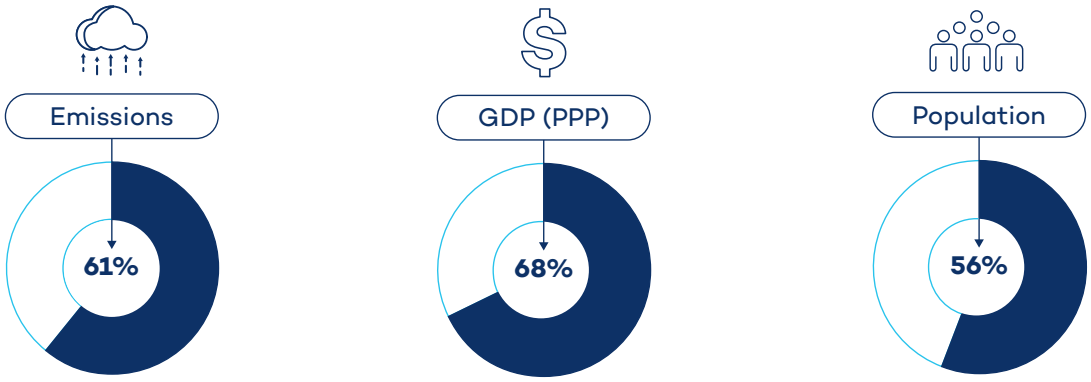


Source: Black et al., 2021

Perhaps most significantly, the world's three biggest emitters—China (by 2060), the United States, and the EU (both by 2050)—have all made net-zero commitments. India, the fourth largest emitter, is reportedly considering adopting a net-zero target by mid-century, and possibly as early as 2047 to mark the centenary of its independence from British rule (Chaudhary, 2021).

Collectively, countries with net-zero targets together represent 61% of global GHG emissions, 68% of global GDP (in PPP terms) and 52% of the global population (cities and regions add a further 4% of the total population covered, bringing it to 56%), and companies with net-zero commitments together represent sales of nearly $14 trillion (Figure 3) (Black et al., 2021).

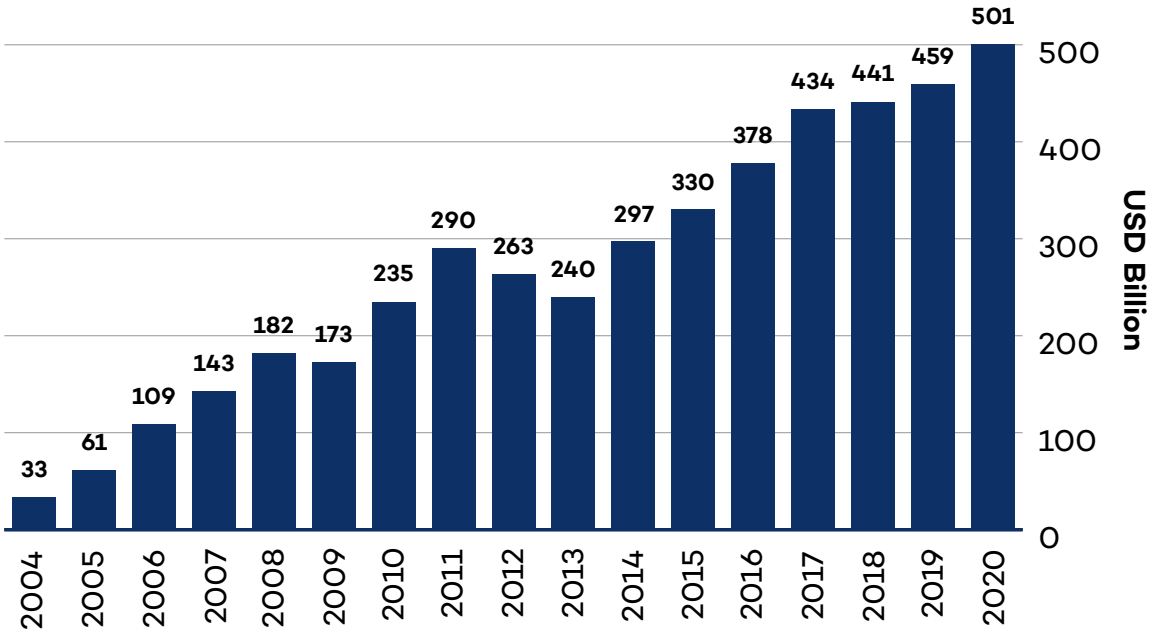
Figure 3. Percentage of GHG emissions, GDP and population covered by national net-zero pledges (the status of these pledges ranges widely, including proposed, in discussion, in policy document, in law, and achieved)



Source: Black et al., 2021

However, beyond setting targets, investment in clean energy and climate solutions grew significantly in 2020. Investment tracking by BloombergNEF tallied up a half trillion dollars of global energy transition investment, comprising investments in renewable energy, electrified transport, electrified heat, energy storage, hydrogen, and carbon capture and storage (CCS) (Figure 4) (BloombergNEF, 2021).

Figure 4. Global Energy Transition Investment, 2004–2020



Source: BloombergNEF, 2021

The investment flowing into clean energy isn't just virtuous: it's about value. A recent study by the International Energy Agency and Imperial College Business School examined the risk and return proposition in the energy transition by investigating the historical performance of fossil fuel and renewable energy companies around the world (International Energy Agency & Imperial College Centre for Climate Finance & Investment, 2021). It found that across all portfolios—global markets, advanced economies, emerging market and developing economies, and China—renewable power generated higher total returns relative to fossil fuels (Table 1). The study also determined that renewable power portfolios had proven more resilient through the unprecedented economic upheaval wrought by the COVID-19 pandemic, with fossil fuel returns falling by 30.8% compared to an 18.9% decline for renewable power between February and April 2020.

Table 1. Fossil Fuel and Renewable Power 5-year Portfolio Returns up to December 31, 2020

Portfolio	5 Years Total Return	
	Fossil Fuel	**Renewable Power**
Global Markets	59.3%	186.6%
Advanced Economies	52.9%	501.6%
Emerging Markets & Developing Economies	164.9%	121.2%
China Portfolios	-7.8%	29.0%

Source: International Energy Agency and Imperial College Business School, 2021.

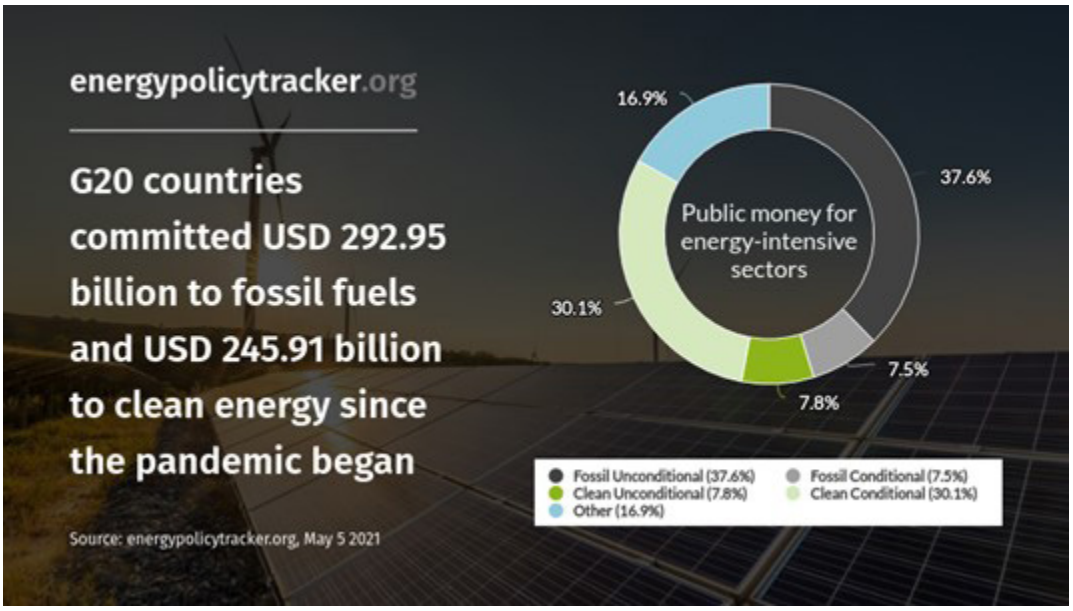
The momentum behind climate action in 2020 was also evidenced by its integration into post-COVID-19 economic recovery plans. "Shovel-worthy" stimulus projects and "building back better" initiatives featured significantly in some country's recovery plans, most notably in the EU.

Nonetheless, in G20 countries significant amounts of public support have continued to flow to fossil fuel energy, which has received USD 292 billion (CAD 354 billion) compared to USD 245 billion (CAD 297 billion) to clean energy (Figure 5) (Energy Policy Tracker, n.d.).[1] In Canada, clean energy was a bigger beneficiary of federal and provincial support (Figure 6), receiving USD 37 billion (CAD 45 billion) relative to USD 31 billion (CAD 38 billion) to fossil fuel energy (Energy Policy Tracker, n.d.).[2] It should be noted, however, that these figures do not account for public finance, including the USD 10.6 billion (CAD 13 billion) per year financing of oil and gas by Export Development Canada (Oil Change International & Friends of the Earth, 2020).

[1] Data current as of May 5, 2021.

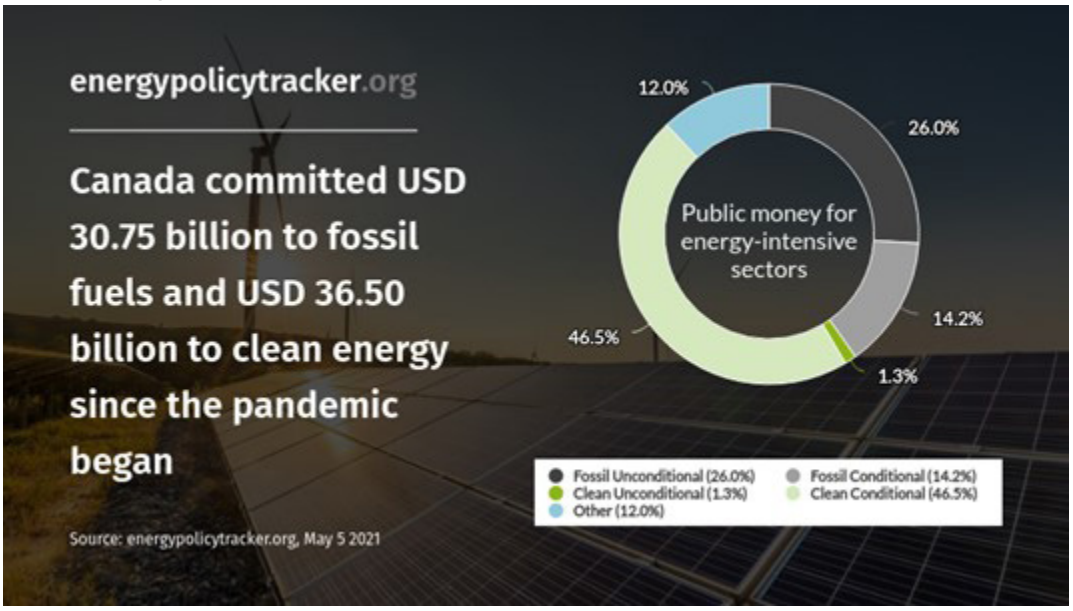
[2] Data current as of May 5, 2021.

Figure 5. G20 government support for fossil fuels and clean energy during the COVID-19 pandemic



Source: Energy Policy Tracker, n.d., data current as of May 5, 2021.

Figure 6. Canadian government support for fossil fuels and clean energy during the COVID-19 pandemic



Source: Energy Policy Tracker, n.d., data current as of May 5, 2021.

While public financial support for post-pandemic economic recovery offers a key opportunity to orient economies toward a net-zero future, a much more comprehensive effort will be required from governments and businesses alike.

What can we learn from these trends and from the solutions identified by governments and industry around the world in pursuit of net-zero? And how can Canada respond and prosper on the path to net-zero by mid-century?

The answers to these questions—explored in the following sections—will shape Canada's future, socially, economically, and environmentally.

"No issue ranks higher than climate change on our clients' lists of priorities … There is no company whose business model won't be profoundly affected by the transition to a net-zero economy."

— Larry Fink, CEO of BlackRock (Blackrock, 2021)

2.0 Principles and Solutions for Net-Zero

Navigating to net-zero will require crossing new terrain—politically, economically, and technologically—and adopting a "transition approach." Such an approach "examines opportunities to transform the large-scale societal systems or sectors which give rise to our emissions" and, in practice, "means accelerating system or sector-level change to deliver net-zero and other societal benefits, rather than just trying to secure the lowest cost incremental GHG reductions" (Meadowcroft, 2021).

This shift away from a dominant focus on marginal abatement costs to one aimed at addressing systemic challenges needs to be guided by a set of clear principles. The Pembina Institute has articulated four overarching principles that can help guide Canada down robust pathways to net-zero (Turcotte & Dusyk, 2021):

1. **Canada's pathways to net-zero must put people first, prioritizing systemic change in the economy for the benefit of all**.
   This requires placing a greater focus on social justice and inclusion, ensuring pathways respect Indigenous rights and reconciliation, and enabling a broader understanding of the risks that transition will pose to different groups (including workers and trade unions, local and racialized communities, youth, new Canadians, women, and economically vulnerable populations).
2. **Canada's pathways must be anchored in science and respect a carbon budget**.
   While there are many possible scenarios for how to achieve net-zero emissions, not all are compatible with limiting global temperature rise to 1.5 degrees Celsius or less. Given that this is the ultimate measure of success, a carbon budget—accounting for the cumulative amount of emissions that can enter the atmosphere—can be a key tool to ensure success.
3. **Canada's pathways must prioritize early, deep, sustained, and technologically feasible direct emissions reductions in every sector**.
   Recognizing that delaying emission reductions leads to higher temperatures, with correspondingly greater economic damages from climate change and more aggressive and likely costlier actions later, a robust pathway requires an effort to peak emissions as quickly as possible, followed by a rapid decline.
4. **Canada's pathways must define an appropriate role for carbon removal and offsets**.
   Hard-to-decarbonize sectors or essential end uses that cannot yet be decarbonized will require the use of carbon removal to achieve net-zero emissions. However, carbon removal and offsets cannot be approached as an alternative to mitigation, but rather a measure of last resort. This will require a decision-making framework to guide the development and prioritized use of these measures.

Moving from principles to solutions, a growing body of research, modeling, and analysis is beginning to paint a picture of how countries can get to net-zero by mid-century. To better understand these possible pathways, we reviewed the following reports, which are broadly representative of current thinking on how to achieve net-zero GHG emissions by 2050:

- **Net-Zero: The UK's contribution to stopping global warming**, published in 2019 by the UK's Climate Change Committee (UK Committee on Climate Change, 2019).
- **Canada's Net-Zero Future**, published in 2021 by the Canadian Institute for Climate Choices (Dion et al., 2021).
- **Net-Zero America**: published in 2020 by Princeton University (Larson, 2020).
- **Net-Zero Europe: Decarbonization Pathways and Socioeconomic Implications**, published in 2020 by McKinsey (McKinsey, 2020).
- **Scaling up Climate Action: Australia**, published in 2020 by Climate Action Tracker (Climate Action Tracker, 2020).
- **Making Mission Possible**, published in 2020 by the Energy Transition Commission (Energy Transitions Commission, 2020).

There are several commonalities across these across all of these analyses, with the same key solutions consistently identified (Table 2). Some of the studies also differentiated between solutions based on the degree of certainty associated with the technology or process, identifying those with greater uncertainty (feasibility, cost, social acceptability) as "speculative" (UK) (UK Committee on Climate Change, 2019) or "wild cards"(Canada) (Dion et al., 2021). The Canadian Institute for Climate Choices found that from the present day to 2030, at least two-thirds of emissions reductions in 2030 would likely come from what they termed "safe bet solutions," with the remainder generated by "wild cards." However, from 2030 to 2050 these proportions flip, and in scenarios where "wild card" solutions are considered both cost-effective and scalable, they deliver as much as two-thirds of reductions (Dion et al., 2021).

Table 2. Common Net-Zero Solutions in Country-Level Studies

Study region	Efficiency	Clean power + electrification	Bioenergy (fuel or feedstock)	Hydrogen	Reduce non-CO_2 GHGs	CCS	Land use	CO_2 removal tech
UK	•	•	•	•	•	•	•	•
Canada	•	•	•	•	•	••	•	•
US	•	•	•	•	•	•	•	•
EU	•	•	•	•	•	•	•	•
Australia	•	•	•	•	•	•	•	–
ETC	•	•	•	•	•	•	•	•

• = included as a key pathway
• = flagged as a speculative/wild card pathway, with higher uncertainty

Some, but not all, of the studies referred to the need for behavioural and cultural changes to accompany technological solutions. Even then, such changes were found to be more speculative in nature. The Canadian Institute for Climate Choices identified several behavioural and cultural changes that could arise from voluntary actions, policy incentives or shifts in cultural norms, including: adoption of a more sustainable diet, shifts in travel behaviour, changes to household energy and material use patterns and changes to purchasing patterns (Dion et al., 2021).

Across all the studies, the following findings stand out:

- **Efficiency and electrification are central elements, with the capacity to deliver the greatest contribution toward achieving net-zero**. As McKinsey noted in its EU study "the power sector would become the central switchboard of the climate-neutral EU energy system" (McKinsey, 2020).
- **Reduction efforts must also include non-CO_2 emissions—such as methane and hydrofluorocarbons**—with oil and gas sector methane emissions offering relatively easier reduction potential relative to those from agriculture in the short-term, while agricultural emissions will become more important as oil and gas production declines.
- **Decarbonization of heavy industry**—such as steel, cement, chemicals, and other production of other energy-intensive goods will require specialized approaches—these could be radically different production methods, alternative products, or possibly the incorporation of CCS.

- **Hydrogen was flagged across all studies as a key energy carrier required for industrial decarbonization** (and in some analyses, heavy-duty vehicle and maritime applications), whether produced using electricity or from future systems using natural gas as a feedstock with CCS, and in some studies played a role in the electricity sector (as a source of storage and for power production).
- **While land use (reforestation, biochar etc.) contributes toward achieving net-zero in all studies, it is treated with caution**. For example, the Canadian Institute for Climate Choices notes "There are significant challenges in ensuring that the carbon sequestration attributed to nature-based solutions is genuine and credible" (Dion et al., 2021) While the Energy Transition Commission includes all pathways in its analysis, it is noteworthy that they conclude "It is undoubtedly technically possible to achieve net-zero GHG emissions by around mid-century, with the developed world reaching this target by 2050 and the developing world by 2060 at the latest, without relying on the permanent and significant use of offsets from afforestation, other forms of land-use change or negative emissions technologies" (Energy Transitions Commission, 2020).

3.0 Global Insights: Case studies

As the Transition Accelerator has noted, net-zero success will require "major changes in the large-scale systems we use to meet societal needs, including the way we produce and distribute energy, move people and goods, produce and consume food, and build and live within our cities" (Meadowcroft, 2021, p. 3). The following section introduces case studies that illustrate how governments and institutions are beginning to translate net-zero ambition into action, taking steps to deliver the systemic change needed to succeed by mid-century. It should be noted that the efforts outlined in the case studies below are, in effect, "works in progress." Their inclusion does not suggest Canada should simply copy them; instead, they have been selected as illustrative examples of leading and innovative approaches to systemic transition from which we can draw some insights to inform our own made-in-Canada solutions.

3.1 Driving Industrial Innovation: Green steel in Sweden

While Sweden is a relatively minor producer of steel in the global context, it has nonetheless emerged as a hotbed of innovation to produce "green" steel, from the Hydrogen Breakthrough Ironmaking Technology (HYBRIT) initiative to a new, green steel start-up venture called H2 Green Steel. For Sweden, the promise of delivering steel production consistent with the country's target of net-zero emissions by 2045 would eliminate the roughly 10% of national emissions that come from the steel sector, while also creating new market opportunities and demonstrating to larger economies how they could also decarbonize their respective steel sectors.

In 2016, the Swedish government launched the Fossil Free Sweden initiative, which aimed to improve dialogue with business, municipalities, and civil society in support of accelerating the reduction of GHG emissions and ensuring a competitive climate transition (Government of Sweden, 2020). That spring, three Swedish companies—LKAB (iron ore mining), SSAB (steel manufacturer) and Vattenfall (power utility)—announced their ambition to develop and demonstrate a fossil-free steel production process in Sweden, i.e., HYBRIT. Their proposed process would see coal replaced with hydrogen for the direct reduction of iron, combined with an electric arc furnace, making the process almost completely fossil free so long as the hydrogen is produced from electrolysis using low-carbon electricity (Åhman et al., 2018).

Following a SEK 7.7 million (CAD 1.1 million) government-funded feasibility study in 2016, the Swedish Energy Agency committed SEK 54 million (CAD 7.8 million) to a 4-year long HYBRIT research program in 2017 as part of its Industriklivet ("Industrial Leap") initiative, with an additional SEK 45 million (CAD 6.5 million) from the private sector for a total of SEK 99 million (CAD 14 million) (Government of Sweden, 2020). In 2018, also under the auspices of the Industriklivet, an additional SEK 9.7 million (CAD 1.4 million) was awarded for a feasibility study for a pilot plant, including its basic design, location, and technology choices for further development, which led to an additional SEK 528 million (CAD 77 million) being awarded for the construction of two pilot plants (Government of Sweden, 2020).

> In 2016, the Swedish government launched the Fossil Free Sweden initiative, which aimed to improve dialogue with business, municipalities, and civil society in support of accelerating the reduction of GHG emissions and ensuring a competitive climate transition.
>
> *Government of Sweden, 2020*

The Fossil Free Sweden initiative led 22 sectors and industries to develop roadmaps toward very low or zero emissions and fossil-free competitiveness, including the steel industry (Swedish Climate Policy Council, 2020). The steel industry's trade association—Jernkontoret—delivered its Climate Roadmap: For a Fossil-Free and Competitive Steel Industry in Sweden in 2018 (Jernkontoret, 2018).

The roadmap lays out commitments from the steel industry and the expectations of the government (Table 3).

Table 3. Climate Roadmap: For a Fossil-Free and Competitive Steel Industry in Sweden

The steel industry will:	The political agenda must ensure:
Continue to help its customers to create climate-smart and resource-effective solutions with Swedish steel so that their production, use, and recycling becomes as efficient as possible.	A solid base for global competitiveness through efficient transportation and infrastructure, secure power supply, top-class competence supply, and appropriate operating conditions such as harmonized taxes and duties.
Continue to actively focus on research within prioritized areas that result in reduced direct emissions of fossil carbon dioxide.	Financing for long-term research and knowledge development, also ensuring that the government's Industriklivet campaign is maintained over parliamentary terms. Secured access to electricity and bio-based energy at internationally competitive costs.
Continue to evaluate its supply chains to reduce total emissions through active choices of transport, raw material, and more efficient recycling.	Facilitate increased collection of steel scrap and support the development of refined sorting of scrap. Invest more and faster in climate-smart means of transport such as railways. The steel industry also recommends the development of more electric highways and 74-tonne trucks.

The steel industry will:	The political agenda must ensure:
Continue to implement new techniques for reduced emissions when commercially competitive.	Efficient and predictable permit process, including required time plans and adaptation of legal frameworks to European legislation.
Further develop analysis and reporting models and declare relevant data so that the customers can evaluate the environmental performance of their suppliers' products.	Supporting further development of qualified lifecycle-based models for declaration of climate impact.

Source: Jernkontoret, 2018.

With the ongoing support of the Swedish government, HYBRIT is now moving ahead quickly, with the first demonstration plant scheduled to start production of 1.3 million tonnes of fossil-free sponge iron in 2026, with the goal of expanding to a full industrial scale of 2.7 million tonnes by 2030 and to be able to supply SSAB, among others, with feedstock for fossil-free steel (Vattenfall, 2021). In the near-term, HYBRIT will begin testing the use of hydrogen in iron ore reduction, so SSAB expects to be able to deliver the first fossil-free steel to customers for prototype manufacturing (Vattenfall, 2021) with Volvo stepping up as the first customer. Currently, plans are in place to begin manufacturing the first concept vehicles and machines with fossil-free steel later this year (Hill, 2021).

The roadmap also spawned a second fossil-free steel project, H2 Green Steel, which was announced by Vargas Holdings in 2020 (Vargas is also one of the largest shareholders in Northvolt, a Swedish "green" battery developer and manufacturer). The project aims to be operational by 2024 and produce 5 million tons of steel per year by 2030, using green hydrogen from a giga-scale hydrogen plant consuming 15 terawatt-hours of clean power by 2026 (11% of Swedish electricity consumption). In addition to Vargas, the project has attracted investment and partnership from Scania ("Fossil-free steel," 2021) a Swedish truck manufacturer whose CEO has been tapped to lead H2 Green Steel and aims to raise EUR 2.5 billion (CAD 3.7 billion) for the first phase of the project ("New Swedish venture," 2021).

In the span of just five years, the Swedish government set a clear direction and provided financial support, while the industry assumed responsibility for developing and owning the roadmap to fossil-free steel.

In the span of just five years, the Swedish government set a clear direction and provided financial support, while the industry assumed responsibility for developing and owning the roadmap to fossil-free steel. This collaborative approach between the Swedish government and the steel industry—as well as other key sectors (from clean power to automakers)—has put Sweden in the pole position in the global race to green steel.

Key Insights for Canada

While Canada's steel sector is a relatively smaller contributor to total national GHG emissions—2% compared to 10% in Sweden—it is well positioned to get on a path to net-zero emissions by 2050. Like in Sweden, Canadian steel producers stand to benefit from a low- to zero-carbon electricity supply as well as both policy and financial support from the federal government. In 2020, the Canadian Steel Producers Association established a goal of producing net-zero emission steel by 2050 (Canadian Steel Producers Association, 2020a) and has developed an associate R&D plan (Canadian Steel Producers Association, 2020b). An industry-developed roadmap to net-zero could be a critical next step. These collaborative efforts in Sweden and Canada can also serve as models to decarbonize other heavy industry sectors such as cement, chemicals, aluminum, and other metals.

3.2 A Holistic Approach to Hydrogen: Germany's hydrogen strategy

Driven by the need to decarbonize industrial sectors—at home and abroad—Germany has emerged as an early leader in methods to harness hydrogen on the road to net-zero GHG emissions, developing a comprehensive hydrogen strategy and offering significant financial support as part of the country's COVID-19 economic support.

Development of the strategy began in the summer of 2019 and involved four ministries: the Ministry for Economic Affairs and Energy (BMWi), Ministry of Transport and Digital Infrastructure (BMVI), Ministry for Economic Cooperation and Development (BMZ), and the Ministry of Education and Research (Goss, 2021). To kickstart the process, BMWi prepared a discussion paper that evolved and expanded— informed, in part, by a fall 2019 Federal Environment Agency study into Resource-Efficient Pathways Towards Greenhouse Gas-Neutrality (known as the RESCUE study) (Federal Environment Agency, 2019)—and the ministries continued to coordinate work on the strategy through the spring of 2020 (Goss, 2021).

In June of 2020 the German government announced that it would allocate EUR 9 billion from its COVID-19 pandemic economic support to advance hydrogen, nearly one-quarter of the EUR 40 billion earmarked for climate-related spending (Martin, 2020). Recognizing the climate benefit of having other countries drive forward on hydrogen—both for the global climate benefit and

because Germany foresees being an importer of hydrogen—EUR 2 of the EUR 9 billion (CAD 3 billion of the 13 billion) of funding is targeted toward international partnerships (Amelang, 2020). In the weeks that followed, the Ministry for Economic Affairs and Energy released The National Hydrogen Strategy, a comprehensive plan to position Germany as a global leader in hydrogen (German Federal Ministry for Economic Affairs and Energy, 2020).

Notably, the strategy states that "only hydrogen produced on the basis of renewable energies ('green' hydrogen) is sustainable in the long term" and therefore "it is the goal of the German government to use green hydrogen, to support a rapid market ramp-up, and to establish corresponding value chains" (German Federal Ministry for Economic Affairs and Energy, 2020). However, the strategy goes on to acknowledge that "the German government assumes that a global and European hydrogen market will develop over the next ten years. CO2-neutral (e.g., "blue" or "turquoise") hydrogen will also be traded on this market. Due to Germany's close integration into the European energy supply infrastructure, CO2-neutral hydrogen will therefore also play a role in Germany and, if available, will also be used on a transitional basis" (German Federal Ministry for Economic Affairs and Energy, 2020).

> "Hydrogen creates fresh potential for industrial policy and can help the German and European economy deal with the consequences of the coronavirus pandemic."
>
> *German National Hydrogen Strategy*

Table 4 summarizes the goals and ambitions of the Strategy. To translate these goals and ambitions into action, the Strategy includes an Action Plan of 38 measures for the promotion and expansion of hydrogen production and use in transport, industrial sectors, and heat, as well as associated infrastructure and supply, ongoing research, education and innovation, and action at the European level and internationally (German Federal Ministry for Economic Affairs and Energy, 2020).

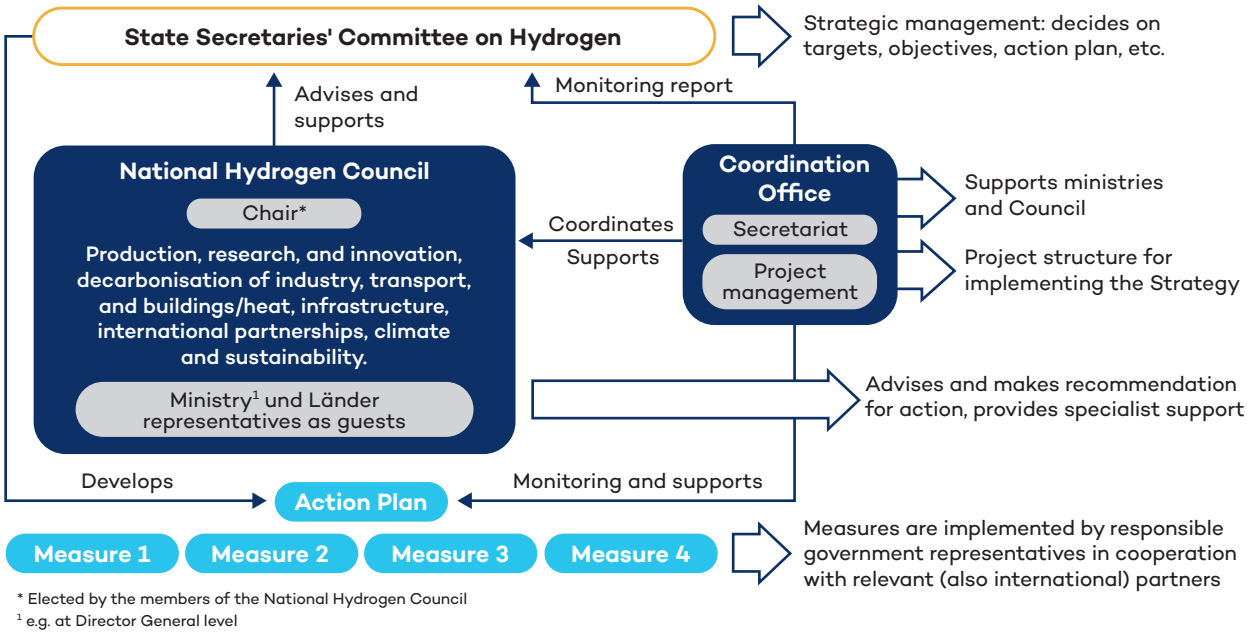
Table 4. Goals and ambitions of the German National Hydrogen Strategy

Assume global responsibility in emissions reductions by establishing hydrogen as an option for decarbonization.
Make hydrogen competitive by pushing cost reductions with a fast international market ramp-up, which would enable technological progress and scaling effects.
Develop a "home market" for hydrogen technologies in Germany and pave the way for imports.
Establish hydrogen as an alternative energy carrier to enable the decarbonization of hard-to-abate sectors.
Make hydrogen as a raw material for industry sustainable by switching current production from fossil to renewable energy (i.e., from grey/blue to green hydrogen).
Enhance the transport and distribution infrastructure by using Germany's existing gas infrastructure, but also by extending dedicated hydrogen networks or building new ones.
Support research and train qualified personnel in order to systematically get industrial-scale solutions to application maturity by 2030.
Design and accompany transformation processes in dialogue with businesses, science, and citizens.
Strengthen the German economy and secure global market opportunities for German companies.
Establish international hydrogen markets and cooperation because Germany will have to import sizable amounts of hydrogen in the medium and long terms.
Understand global cooperation as an opportunity.
Further develop and secure quality infrastructure for hydrogen production, transport, storage and use and create confidence given the special physical and chemical properties of hydrogen.
Constantly improving the policy environment and addressing current developments on an ongoing basis.

Source: Amelang, 2020.

The strategy also sets up a governance structure (Figure 7), led by the State Secretaries' Committee on Hydrogen, which is accountable for implementation. Should implementation be delayed or targets missed, "the State Secretaries' Committee will immediately take corrective action in coordination with the Federal Cabinet, adapting the action plan to the new requirements" (German Federal Ministry for Economic Affairs and Energy, 2020). The Committee will be advised and supported by a National Hydrogen Council, consisting of 26 high-level experts from business, science, and civil society with relevant expertise spanning the fields of production, research and innovation, industrial decarbonization, transport and buildings/heat, infrastructure, international partnerships, and climate and sustainability (German Federal Ministry for Economic Affairs and Energy, 2020).

Figure 7. Governance structure of the National Hydrogen Strategy



Source: German Federal Ministry for Economic Affairs and Energy, 2020.

The strategy is already showing evidence of influencing private sector investments, notably GET H2, ("New alliance aims," 2021), a consortium of seven companies looking to launch a green hydrogen infrastructure network powering an industry hub; H2morrow, a collaborative blue hydrogen steel initiative between German gas transmission system operator OGE, steel producer Thyssenkrupp, and Norwegian energy company Equinor ("OGE, Thyssenkrupp and Equinor," 2021); and a pioneering underground hydrogen storage pilot led by German energy provider EWE (Meza, 2021).

Key Insights for Canada

As with the preceding case study on steel in Sweden, the German hydrogen strategy illustrates the significant speed and scale of investment that is being achieved through consortia and industry–government partnership. The governance structure, with clear roles and responsibilities for both government and external experts, is also noteworthy and currently lacking in Canada. In addition, while accepting that blue hydrogen may play a transitional role, the German strategy squarely focuses on green hydrogen. This stands in contrast to Canada's strategy, which, while cognizant of the need to reduce the carbon intensity of hydrogen over time, is relatively more focused on the opportunity to leverage its natural gas resources to produce blue hydrogen. However, Canada will need to remain cognizant of domestic end-user and export market preferences, with jurisdictions like Germany and California orienting toward green hydrogen, as well as the cost and complexity of hydrogen export.

3.3 Advancing Electrification Through Collaboration: The European Battery Alliance

By 2017 it was clear to European political leaders that electrification of transportation was going to be central to decarbonizing how people and goods were moved around the EU. While European carmakers assembled battery packs for electric cars, there were no significant players in battery cells. Seeing batteries as being "at the heart of the ongoing industrial revolution," the European Commission believed "their development and production play a strategic role in the ongoing transition to clean mobility and clean energy systems" (Simon, 2017).

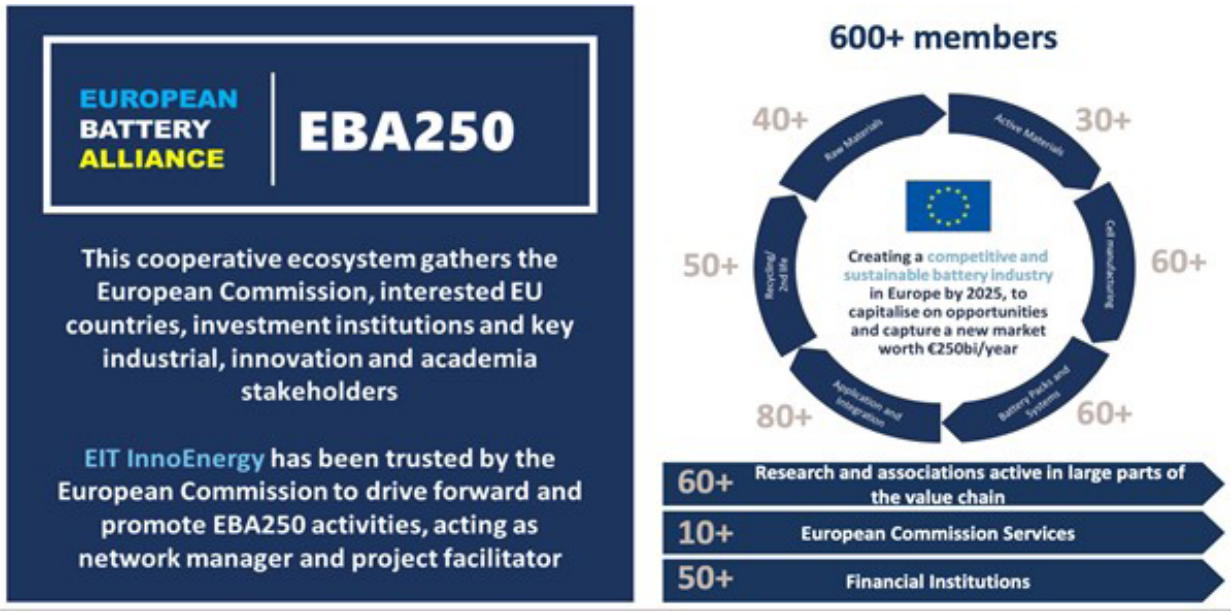
To seize this opportunity, in October of 2017, the Vice President of the European Commission, Maroš Šefčovič—joined by political officials from Germany, France, and Poland—launched the European Battery Alliance (EBA) with the aim of creating a competitive manufacturing value chain in Europe, with sustainable battery cells at its core. The European Institute of Innovation and Technology's InnoEnergy group (EIT InnoEnergy) was tasked with convening and facilitating the EU industrial, academic, and financial sectors to deliver recommendations on enabling framework conditions by the end of that year.

The goal? A competitive and sustainable European battery value chain that could capture a new European market worth EUR 250 billion (CAD 369 billion) per year by 2025.

> "The lack of a domestic, European cell manufacturing base jeopardises the position of EU industrial customers because of the security of the supply chain, increased costs due to transportation, time delays, weaker quality control or limitations on the design. So, we need to act fast—and collectively—to overcome this competitive disadvantage and capitalise on our leadership in many sectors of the battery value chain, from materials to system integration and recycling."
>
> *European Commission Vice President Maroš Šefčovič (Simon, 2017)*

Today, the EBA brings together 120 European and non-European stakeholders representing the entire battery value chain (Figure 8), but it started off much smaller.

Figure 8. Overview of the European Battery Alliance



Source: von Dalwigk, 2021.

In December of 2017, the EBA convened its first workshop involving 60 stakeholders to explore key questions such as supply chains, technology development, and market push to inform recommendations to the European Commission. In January of 2018, 90 stakeholders came together to take the recommendations and turn them into concrete actions, arriving at 43 necessary actions—18 of which were identified as high priority—to enable the EBA to capture a significant share of the entire value chain. These 18 priority actions were delivered to the Clean Energy Industrial Forum—a key forum for industrial stakeholders, EU political leaders, and policy-makers to discuss priorities— in February. Believing that the EBA needed to continue to be industry driven, the EU Commission officially directed EIT InnoEnergy to implement the EBA action plan, which led to a workshop with 115 stakeholders to provide input into the EU Strategic Action Plan for Batteries, which was released in May of 2018 (European Commission, 2018). Since then, the EBA has continued to advance priority actions across seven areas to secure the EU's battery value chain (Table 5).

> By the end of 2020, the EBA was already being lauded for its success in accelerating battery development in Europe, including attracting EUR 60 billion (CAD 89 billion) of investment in the EU's battery ecosystem—three times more than in China.
>
> *"The European battery industry," 2020*

Table 5. European Battery Alliance Priority Actions

Secure access to sustainably produced battery raw materials at a reasonable cost	1. Secure access to raw materials from resource-rich countries outside the EU. 2. Facilitate the expansion/creation of European sources of raw materials. 3. Secure access to secondary raw materials through recycling in a circular economy of batteries.
Make Europe the global leader in sustainable battery technology	4. Support the growth of a cell manufacturing industry with the smallest environmental footprint possible. This will provide a key competitive and commercial edge against competitors. 5. Create and sustain a cross-value chain ecosystem for batteries. This includes mining, processing, materials design, second life, and recycling within the EU, encouraging cross-sectoral initiatives between academia, research, industry, policy-makers, and the financial sector.
Support European battery manufacturing in order not to miss the expected massive growth in market demand (EUR 250 billion per year in 2025)	6. Ensure the availability of high-quality and high-performance cells for European industries to maintain the competitiveness of several European industries. 7. Front-loading financially, e.g., IPCEI (Important Projects of Common European Interest) and/or other financial instruments such as tax incentives, the necessary investments are critical to be prepared for demand uptake. 8. Accelerate the process and cut time to market to meet market demand and surpass international competitors.
Grow Europe's research and innovation (R&I) capacity. Develop and strengthen skilled workforces in all parts of the value chain and make Europe attractive for world-class experts.	9. Increase the demand for e-mobility solutions including "yellow machines." 10. The batteries and battery systems must be seen as pluri-functional in the context of both the power and transportation sectors. For energy storage systems (ESSs), regulation (or absence of regulation) enabling the right business models is crucial. 11. Use incentives to make storage an alternative to conventional grid reinforcement. 12. Enable integration of ESSs at all levels of the power system, including behind the meter.

Create and support new markets for batteries, e.g., through the "Clean Energy" & "Mobility" packages. This includes new initiatives to support sustainable solutions for the power, transportation, and industry sectors in line with EU climate goals.	13. Create a competitive advantage with constant incremental (e.g., lithium-ion) and disruptive (e.g., solid-state) R&I linked to the industrial ecosystem. This applies to all the steps of the value chain (advanced materials, new chemistries, advanced manufacturing process, BMS, recycling, business model innovations). 14. Conduct advanced research in battery chemistry, battery systems, manufacturing, and recycling. Increase universities' output in these areas through the involvement of industrial stakeholders. 15. Attract worldwide talent with lighthouse projects for cell manufacturing. This is necessary because sufficient and key human capital skills are missing in Europe, especially in the field of applied process design. 16. Make Europe attractive for world-class experts and create a competent workforce.
Involve the EU citizens in the journey: inform, educate, and motivate.	17. At the end of the supply chain there is always a business-to-consumer (B2C) transaction. Public sector efforts (education in schools, role modelling and so on) should be invested in the general population's awareness and understanding of the entire value chain so that there is relevant societal appropriation from the start. Fighting to keep the supply chain in Europe will definitely help bridge the gap between EU citizens and politicians.
Ensure maximum safety for European citizens and create a competitive advantage through standardization.	18. Standardize storage-related installations and safety rules, including charging infrastructure, active load compensation, and the enabling of vehicle-to-grid solutions.

In September 2019, EIT InnoEnergy, one of the primary architects of the EBA framework and the head of the industrial development program, launched a Business Investment Platform. The platform connects financial institutions and businesses in the battery industry, aiming to speed up investment and reduce risks: it also offers coaching to businesses to help strengthen their investment case.

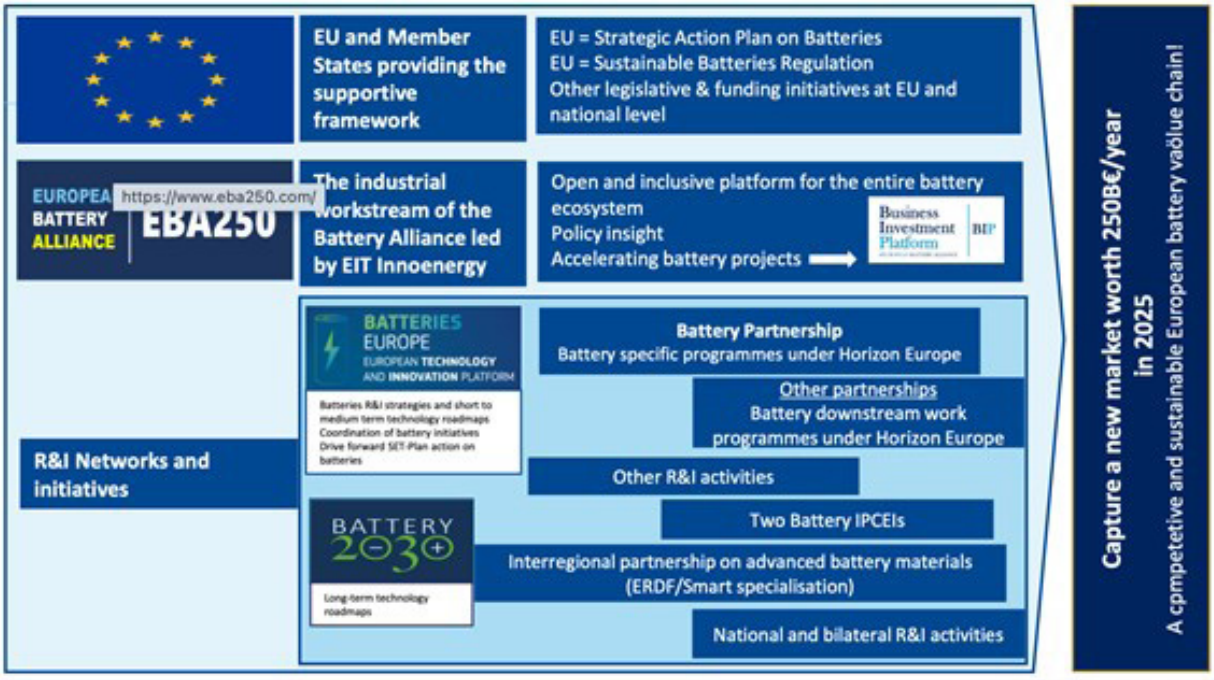
By the end of 2020, the EBA was already being lauded for its success in accelerating battery development in Europe, including attracting EUR 60 billion (CAD 89 billion) of investment in the EU's battery ecosystem—three times more than in China ("The European battery industry," 2020). As a result, by 2025 the EU could be self-sufficient in battery cells (with 15 large-scale battery cell factories under construction) and could have a third of global production by 2030 (Abnett, 2020; Patel & Krukowska, 2021).

"Since the launch of the European Battery Alliance (EBA) at the end of 2017, Europe has developed from a conventional and niche battery cell manufacturing hub to a serious candidate for taking global leadership in advanced rechargeable battery technology."

"The European battery industry," 2020

While much progress has already been made, the EBA's work is just getting started: in January 2021, the European Commission approved an additional EUR 2.9 billion (CAD 4.3 billion) of public funding to the EBA (as an IPCEI) to support R&I in all segments of the battery value chain (EBA, 2021). As a model of collaboration between policy-makers and business leaders, the EBA is illustrating how industrial policy can be effectively aligned with decarbonization toward net-zero, delivering both emission reductions and economic opportunity (Figure 9).

Figure 9. Collaboration between the EU and member states, the European Battery Alliance and R&I Networks



Source: von Dalwigk, 2021.

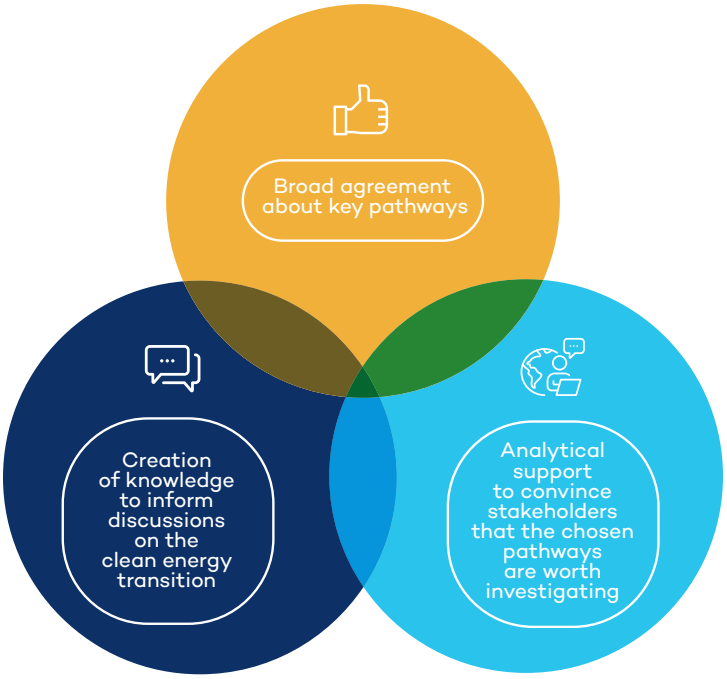
Key Insights for Canada

While Canada has had recent success in securing automaker investment in EV manufacturing capacity, we don't currently produce the batteries needed for this production. Recent efforts by the federal government to begin developing a "Mines to Mobility" strategy—spanning the value chain from mining, metal and mineral processing, cell and battery production, and EV parts and assembly—are encouraging, as is the creation of the Zero Emission Vehicle Industry Coalition (Jarratt, 2020). While these efforts are good news for Canada, we are well behind leading nations, and the competition with the United States will undoubtedly be fierce, although there are encouraging signs of cross-border collaboration on the EV battery supply chain (Government of Canada, 2021). Regardless, effective and efficient collaboration and coordination between government and business will be critical to success. With a strong mining and automotive industry, Canada clearly has the potential to be a global leader in battery production, but we need to move more quickly to keep up. Collaborative efforts with other countries could help accelerate these efforts.

3.4 Business & Civil Society Collaboration: The Energy Transition Commission

In 2015 the Energy Transitions Commission (ETC) was launched by a diverse group of public and private sector leaders with the stated purpose of developing "actionable insights to help energy decision-makers in their efforts to meet the twin objectives of economic development and climate change mitigation" (ETC, 2015). Its approach is centred around three dimensions, as depicted in Figure 10.

Figure 10. Energy Transition Commission strategic approach



Source: ETC, 2015

Since its founding, the ETC's activities have focused on offering:

- A trusted, authoritative fact base regarding key debates related to the energy transition.
- Engagement with energy policy and investment decision makers and change agents.
- An open learning community among thought-leaders and practitioners to accelerate the two-way flow of ideas and know-how between the worlds of research and practice, and between developing and developed economies.
- Public intellectual goods such as practical tools that support energy decision making.

The *Better Energy, Greater Prosperity* report (2017) outlined the environmental and human health impacts of electricity generation technologies, as well as forecasting that variable renewable power systems would produce power at a cost below fossil fuels by the 2030s (ETC, 2017). In 2018 the *Mission Possible* report outlined possible routes to decarbonize hard-to-abate sectors (cement, steel, plastics, trucking, shipping, and aviation), describing likely technologies for decarbonization by sector, cost impacts, and key policy levers to accelerate decarbonization (ETC, 2018).

In September 2020 the *Making Mission Possible* paper (ETC, 2020)—reviewed in Section 2 of this report—updated the findings from the 2019 Mission Possible report. Most recently, the ETC has published two targeted primers: *Making Clean Electrification Possible: 30 Years to Electrify the Global*

Economy (Energy Transitions Commission, 2021b) and *Making the Hydrogen Economy Possible: Accelerating Clean Hydrogen in an Electrified Economy* (ETC, 2021c).

As described in Table 6, the ETC has also undertaken country-specific work in both developed and developing economies, offering more detailed analysis and guidance relative to the overarching reports described above.

Table 6. Country-level activities of the Energy Transition Commission

India	In India, the ETC works in partnership with The Energy and Resources Institute (TERI), an India-based institution providing research for policy-makers in the areas of energy, environment, and natural resources. TERI hosts the World Sustainable Development Summit, which in 2021 brought together civil society, business leaders, and politicians including Indian Prime Minister Narendra Modi and U.S. Special Presidential Envoy for Climate John Kerry (TERI, 2021). Discussion themes relating to net-zero included energy and industry transition, nature-based solutions, climate finance, and the circular economy.
China	In 2019 the ETC published *China 2050: A Fully Developed Rich Zero-Carbon Economy*, a report that found the cost for China to reach net-zero by 2050 is affordable given the country's high savings and investment rate (ETC, 2019a). This report contributed to the momentum for net-zero pledges leading up to China's own announcement in September 2020 of a net-zero target of 2060. A subsequent report, released after China's announcement, focused on the fundamental challenges to China's power system to support the massive electrification that will be required to achieve this target (ETC, 2021a).
Australia	In Australia, the ETC helped establish (and continues to act as a partner to) the Australian Industry Energy Transitions Initiative, an industry-led initiative focusing on how Australia can help transform global high-carbon supply chains (Australian Industry Energy Transitions Initiative, n.d.). The Initiative aims to support Australian industry "to develop pathways and take action towards net-zero emissions across critical supply chains of the Australian economy," especially in hard-to-abate sectors (Australian Industry Energy Transitions Initiative, n.d.).

Beyond writing reports, the ETC has played an important role as convener and partner. In 2019 the ETC created the Mission Possible Platform for hard-to-abate sectors—launched at that year's World Economic Forum— "bringing together business leaders from heavy industry and heavy-duty transport sectors to work on concrete actions to set these carbon-intensive sectors on a path to climate neutrality, in collaboration with a network of experts and policy partners" (ETC, 2019b).

This platform evolved into the Mission Possible Partnership in 2020 and has grown to include more than 400 companies as members, as well as the We Mean Business coalition and the Rocky Mountain Institute. With initiatives organized around seven sectors—aluminum, cement, chemicals, iron and steel, aviation, shipping, and heavy road transport—it offers each sector a four-step process (Bhat et al., 2021):

1. Convene a critical mass of ambitious industry leaders and agree on a shared vision for sector decarbonization.
2. Leverage existing analysis to develop a sector-specific, viable, high-ambition roadmap to net-zero emissions by 2050 that will be a collaborative exercise with the industry and other stakeholders.
3. Develop commitments to action that tie concrete measures in line with the net-zero roadmap milestones, thereby embedding the roadmap in corporate strategies.
4. Build the market infrastructure needed to track and support the ongoing implementation of these ambitious commitments via metrics, standards, and tool kits, as well as the rigorous implementation of best-practice public disclosure.

Supported by both its knowledge sharing and establishment of new partnerships, the ETC appears to be having a broader impact encouraging corporate pledges to lower emissions and set net-zero targets (Mace, 2020a) and, ultimately, contributing to a virtuous cycle: more investor interest in companies setting net-zero targets, and more drive from companies hoping to attract investment (Mace, 2020b).

Key Insights for Canada

Canada has seen various initiatives to convene business leaders around climate action, but none have had the diversity, depth of analysis, or staying power of the ETC. While government can do its part to capitalize upon the economic opportunities arising from climate solutions, ultimately, it is Canada's business community that will keep us in the hunt or see us fall behind. To date, our private sector has lagged its global (particularly European) peers, and while there are some encouraging signs that Canadian business leaders recognize this (Business Council of Canada, 2021), a more proactive and collaborative approach to seizing opportunities here is warranted. To catalyze the needed business leadership toward net-zero, the ETC may serve as a useful model to replicate in Canada.

3.5 Net-Zero Necessitates an "All-of-Government" Approach: The Biden Administration

As the UK Climate Change Committee has advised, successfully responding to the net-zero challenge will require the effort to be "embedded and integrated across all departments, at all levels of Government and in all major decisions that impact on emissions" (UK Committee on Climate Change, 2019). Because many solutions cut across systems (for example, hydrogen has a role in electricity generation, transportation, industry and heating), identifying, understanding and enabling them requires "fully integrated policy, regulatory design and implementation," complemented by new frameworks to ensure all departments sufficiently prioritize net-zero GHG emissions and are sufficiently resourced to respond accordingly (UK Committee on Climate Change, 2019).

In his campaign platform, President Joe Biden promised an "all-of-government approach" to climate change, weaving together government investments in research and development, using public procurement to crowd in private sector investment in climate solutions, considering environmental justice, promoting American clean energy exports and investments around the world, driving private and public climate finance, and ensuring climate resilience through adaptation (Biden Harris Campaign, 2020).

Following his inauguration, President Biden has moved swiftly on climate action, issuing an Executive Order on Tackling the Climate Crisis at Home and Abroad just days into his administration (The White House, 2021a). The order "puts the climate crisis at the heart of the United States' foreign policy and national security," creating a Special Presidential Envoy for Climate and pledging to integrate climate considerations into all leading international fora, including the G7, G20, and bodies for energy, aviation, shipping, and sustainable development" (Vivid Economics, 2021).

On the global stage, former Secretary of State John Kerry was appointed the United States Special Presidential Envoy for Climate Change, a position that—with its inclusion on the National Security Council—will both reframe climate change as a national security issue and work to rebuild goodwill with countries who lost trust in the United States under the Trump administration.

Domestically, it implements global best practice by establishing an intra-governmental National Climate Task Force "to coordinate a government-wide response to the climate crisis" (Vivid Economics, 2021).

> "It is the policy of my Administration to organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure."
>
> *U.S President Joe Biden, The White House, 2021a.*

To deliver domestic action, the National Climate Task Force—chaired by the White House's first-ever National Climate Adviser Gina McCarthy—is tasked with weaving climate policy throughout the U.S. federal government. The aim of the task force is to ensure key government departments and agencies (Table 7) integrate climate change into their decision making, including:

- Leveraging government procurement
- Investing in a nation-wide sustainable infrastructure rebuilding program
- Revitalizing energy communities (i.e., just transition for fossil fuel-dependent workers and communities)
- Investing in clean energy with a focus on environmental justice.

Table 7. Departments and Agencies comprising the National Climate Task Force

National Climate Advisor (Chair)	Secretary of Education	Administrator of General Services
Secretary of the Treasury	Secretary of Labor	Chair of the Council on Environmental Quality
Secretary of Defense	Secretary of Health and Human Services	Administrator of the Environmental Protection Agency
Attorney General	Secretary of Housing and Urban Development	Director of the Office of Management and Budget
Secretary of the Interior	Secretary of Transportation	Director of the Office of Science and Technology Policy

Secretary of Agriculture	Secretary of Energy	Assistant to the President for Domestic Policy
Secretary of Commerce	Secretary of Homeland Security	Assistant to the President for National Security Affairs

Source: The White House, 2021c.

Whether President Biden's "all-of-government" approach to climate action succeeds will be judged by the policies, programs, and investments his administration delivers, and ultimately by whether the United States economy is put on a trajectory to achieve its 2030 GHG reduction target and net-zero emissions by 2050. But if the recently introduced American Jobs Plan (The White House, 2021b) and new Nationally Determined Contribution to achieving the Paris agreement (Government of the United States, 2021) are any measure, this approach is already making a difference.

Key Insights for Canada

Canada's federal government has made significant strides in climate governance, from the establishment of a Cabinet Committee on Economy and the Environment to a focus on climate action in the mandate letters of all ministers, including specific deliverables for some. Similarly, climate change is increasingly being considered in everything from government procurement to policy development, and the recent Healthy Environment, Healthy Economy plan pledges to "Apply a climate lens to integrate climate considerations throughout government decision-making. Meeting climate goals means government decisions must consider climate ambitions in a rigorous, consistent and measurable manner . . . This transformation will require an aligned approach that ensures that government spending and decisions support Canada's climate goals" (Government of Canada. December, 2020). These are encouraging moves that could be aided by structural changes to enhance coordination and collaboration across the numerous ministries and government agencies whose mandates impact or are impacted by climate change.

3.6 Advancing Reconciliation: Māori climate leadership

New Zealand (Māori: Aotearoa) has, since its independence from Britain, had a unique relationship between the settler government and the Indigenous Māori. Treaties signed between the Māori and Britain in the 19th century granted the Māori more rights than Indigenous Peoples in most other European colonies, setting a precedent that would influence New Zealand's settler–Indigenous relations up to modern times. Having secured political rights, Māori leaders have campaigned to have their values better reflected in New Zealand's laws and governance institutions. A groundbreaking victory came in 2017 when New Zealand's government granted the Whanganui River the same rights as a living person (Lui, 2017). Other locations sacred to the Māori have since been given this special status.

After consultation with Māori groups, the New Zealand government established a new ministry, Te Uru Rākau (Forestry New Zealand) in May 2018. That same year, it began the One Billion Trees Programme—New Zealand's flagship carbon sequestration project (Te Uru Rākau, 2019). The program defines Māori development as one of its key desired outcomes, including not only afforestation of Māori land but broader economic development. A principal channel for Māori engagement is the hui, a Māori assembly.

Also in 2018, the Office of the Māori Climate Commissioner was established to elevate Māori voices in decision making around how to meet New Zealand's obligations under the 2015 Paris Agreement (Māori Carbon Foundation, 2018b). Donna Awatere Huata was appointed as the first Māori Climate Commissioner, with a mandate to provide research and advice to New Zealand's government and civil society based on a Māori worldview, as well as facilitate opportunities for Māori to learn and engage with other stakeholders to address climate change. Awatere Huata previously served as a Member of Parliament and represented New Zealand at the United Nations Permanent Forum on Indigenous Issues.

In addition to influencing policy direction, Māori leaders have created additional forums to increase Māori participation in government projects related to climate change. The Māori Carbon Collective (formerly known as the Māori Carbon Foundation), for example, was formed to boost Māori participation in New Zealand's Carbon Market (Māori Carbon Foundation, n.d.). One initiative under this effort brought together Māori leaders to establish a carbon-trading business with the goal of planting 150 million trees on communal Māori land in support of the One Billion Trees program (Office of the Māori Climate Commission, 2018). Sir Mark Solomon, head of the Māori Carbon Collective, described the importance of an enabling framework; "a key role for the crown . . . is to provide a set of carbon rules, and offer certainty that encourages groups such as the Maori Carbon Foundation to make investments with Maori landowners" (Māori Carbon Foundation, 2018a).

Despite the initiatives and progress outlined above, much remains to be done to affirm and strengthen the role of the Māori in climate change policy and program development and implementation in New Zealand. In April of this year the Office of the Māori Climate Commissioner responded to the release of the Climate Change Commission's first draft emissions

budget by pointing out that "while the commission focuses on a number of initiatives that will require working with Māori, Māori have had no role as an equal partner under Te Tiriti in setting the strategy and highlighting the contribution Māori can make" ("Equal partnership," 2021).

As Māori Climate Commissioner Awatere Huata summed things up, only by working with the Māori as equals at the table can the minister "deliver a truly inclusive and actionable strategy that is fit for purpose for all of Aotearoa" ("Equal partnership," 2021).

Key Insights for Canada

As evidenced by the above case study, elevating Indigenous voices offers an important opportunity to advance reconciliation and climate action—but only if this is done as equal partners. Indigenous communities in Canada have played a leading role in advancing clean energy projects, with significant involvement in over 197 projects ranging from Impact Benefit Agreements to direct ownership of projects (Indigenous Clean Energy, n.d.). Increased attention to Indigenous leadership, self-determination, and funding priorities committed in the federal Healthy Environment, Healthy Economy climate plan are encouraging, though co-development and decision making by Indigenous Peoples will be critical to fully implementing the tenets of Indigenous climate leadership.

3.7 Enabling a Just Transition: The EU approach

In December of 2019, the EU unveiled the European Green Deal, which "sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind" (European Commission, 2019). In recognition of the fact that "not all regions and Member States start from the same point," the European Green Deal includes a Just Transition Mechanism intended to "support those regions that rely heavily on very carbon-intensive activities" by supporting "the citizens most vulnerable to the transition, providing access to reskilling programmes and employment opportunities in new economic sectors" (European Commission, 2019).

> "We must show solidarity with the most affected regions in Europe, such as coal mining regions and others, to make sure the Green Deal gets everyone's full support and has a chance to become a reality."
>
> *Frans Timmermans, Executive Vice-President of the European Commission*
> *European Commission, n.d.*

Support is available to all member states, with a focus on those regions that are most carbon intensive or have the most people working in the fossil fuel sector. Those states seeking support must develop territorial transition plans setting out ways to best address social, economic, and environmental challenges out to 2030 (European Commission, 2019). Figure 11 illustrates both the beneficiaries and forms of support offered under the mechanism.

Figure 11. Beneficiaries and support offered under the Just Transition Mechanism

People and citizens, most vulnerable to the transition

The Just Transition Mechanism will protect them by:

- Facilitating employment opportunities in new sectors and those in transition
- Offering re-skilling opportunities
- Improving energy-efficient housing
- Investing to fight energy poverty
- Facilitating access to clean, affordable and secure energy

Companies and sectors, active in or comprising carbon-intensive industries

The Just Transition Mechanism will protect them by

- Supporting the transition to low-carbon technologies and economic diversification based on climate-resilient investments and jobs
- Creating attractive conditions for public and private investors
- Providing easier access to loans and financial support
- Investing in the creation of new firms, SMEs and start-ups
- Investing in research and innovation activities

Member States and regions, with high dependence on fossil fuel and carbon-intensive industries

The Just Transition Mechanism will protect them by

- Supporting the transition to low-carbon and climate-resilient activities
- Creating new jobs in the green economy
- Investing in public and sustainable transport
- Providing technical assistance
- Investing in renewable energy sources
- Improving digital connectivity
- Providing affordable loans to local public authorities
- Improving energy infrastructure, district heating and transportation networks.

Source: European Commission, n.d.

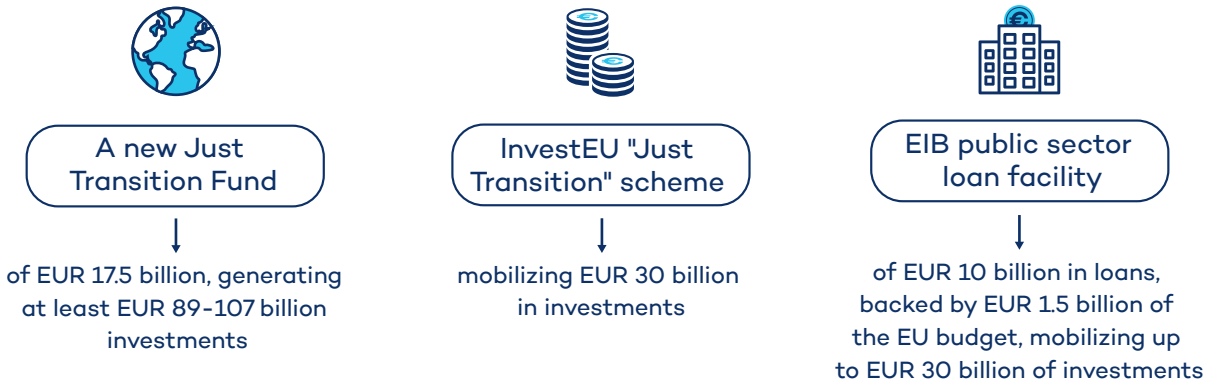
The Mechanism is composed of three pillars (Figure 12). The Just Transition Fund (JTF)—the first pillar—provides support to member states for just transition projects that meet criteria based on "industrial emissions in regions with high carbon intensities, employment in industry and in coal and lignite mining, production of peat and oil shale, and the level of economic development"

(European Parliament, 2020a). While originally proposed by the European Commission at the scale of EUR 40 billion (CAD 59 billion), the EU Council rejected this amount, settling on EUR 17.5 billion (CAD 26 billion)—it should be noted that this is considerably higher than the EUR 7.5 billion (CAD 11 billion) recommended pre-COVID. Funding from the JTF is awarded based on Territorial Just Transition Plans prepared by member states and subject to funding criteria.

The second pillar, InvestEU, must earmark at least 30% of its spending toward the European Green Deal projects, including Just Transition, with the aim of fostering economic growth in Just Transition territories (EU, n.d.). The InvestEU Advisory Hub will also provide technical assistance and capacity building to project partners.

The final pillar is the European Investment Bank (EIB) public sector loan facility, which aims to mobilize EUR 25 billion and 30 billion in public investment over the 2021–2027 period (European Parliament, 2020b). A grant and a loan component will combine EU support with loans provided by a finance partner.

Figure 12. Three pillars of the EU Just Transition Mechanism



Source: European Commission, n.d.

Planning and executing a just transition is new terrain, and not without its challenges and ensuing criticism. For example, funding criteria have proved controversial, with some arguing that they favour member states that have not committed to a coal phase-out (Climate Action Network Europe, 2020), while countries that are already quickly transitioning away from coal will receive insufficient support. Nonetheless, there is little doubt that a proactive approach to ensuring a just transition is critical to enabling the energy transition to proceed at the pace and scale required to achieve net-zero emissions by 2050.

Key Insights for Canada

As we have observed to date, a key challenge to Canada's climate action efforts will be ensuring that workers and industry have the opportunity to work hand in hand with government on policy development, thus ensuring that solutions have the buy-in of all partners. The EU has adopted a proactive approach, ensuring programs and funding are in place before the impacts of the energy transition are experienced. This is critically important in sectors where economic well-being is linked to fossil fuel production, as reported by the Task Force on Just Transition for Canadian Coal Power Workers and Communities (Canada's Task Force on Just Transition for Canadian Coal Power Workers and Communities, 2018). The EU approach described above is consistent with recent Canadian research by the Centre for Future Work, which suggests that a "clear timetable for phase-out, combined with generous supports for retirement, redeployment, and regional diversification" can enable a gradual transition from fossil fuels without any involuntary layoffs (Stanford, 2021). The federal government has committed to developing Just Transition legislation but has been slow to act—to secure and sustain the trust and confidence of workers who stand to be impacted, this work must be a top priority.

4.0 Implications and Opportunities for Canada

Since 2015, the Canadian government has taken significant steps to "bend the curve" on GHG emissions, and at the recent Leaders' Summit on Climate convened by President Biden, Prime Minister Trudeau announced Canada's intention to increase our 2030 Paris Agreement target, from a 30% reduction to 40%–45% below 2005 levels, en route to achieving net-zero emissions by 2050.

Achieving this goal will be a large and complex task, and there will certainly be surprises along the way to 2050. If Canada is to achieve net-zero emissions and prosper in the process, the pace of our collective efforts will need to accelerate. As evidenced by the case studies, many countries have a head start, but their early efforts also enable Canada to be a fast follower.

To win the race to net-zero, we offer the following recommendations.

Recommendations: 10 Ways to Win the Global Race to Net-Zero

Five Key Solutions on the Path to Net-Zero

Our review of various studies exploring pathways to net-zero emissions finds significant commonalities regardless of the country for which they were developed. While this may be unsurprising—there are only so many sources of emissions and solutions to reducing them—it is nonetheless instructive, and five common areas for action emerge:

Solution #1: Improvements in energy efficiency: Reducing the amount of energy used, especially in commercial and residential buildings and manufacturing plants, is often the quickest way to lower emissions and save money. The federal government's climate change plan includes a variety of measures and programs that will help cut energy waste and emissions, but it will require additional action and effort by provincial governments as well.

Solution #2: Massive electrification of products and processes, enabled by the expansion of clean electricity: Converting heating and cooling systems, industrial processes, and vehicles to clean electricity can reduce emissions and increase efficiency, as electricity-driven technologies are considerably more efficient than their combustion alternatives. Meeting this demand will require additional wind, solar, hydro, and geothermal capacity, as well as other low-carbon energy sources to support the shift to electrification. Improved grid connections and batteries will be required to share and smooth supply.

Solution #3: Development of low-carbon fuels: For applications that cannot be electrified, hydrogen, synthetic fuels, or next-generation biofuels are needed as alternative power sources. Key to developing these fuels will be efforts to align and link supply and demand, such as the Edmonton Region Hydrogen Hub.[3]

Solution #4: Decarbonization of heavy industry: The production of steel, cement, chemicals, and other energy-intensive goods represents a significant fraction of global emissions and will require specialized approaches—these could include radically different production methods, alternative products, or possibly the incorporation of CCS.

Solution #5: Carbon removal, by either nature or negative-emissions technologies: Recognizing that delaying emission reductions leads to higher temperatures—with correspondingly greater economic damages from climate change and more aggressive and likely costlier actions later—a robust pathway requires an effort to peak emissions as quickly as possible, followed by a rapid decline. Consequently, Canada's pathways must prioritize early, deep, sustained, and technologically feasible direct emissions reductions in every sector. However, complete decarbonization will be difficult or impossible to achieve in every sector, and carbon capture fitted to biomass generating plants and other negative emissions technologies will be required to address residual emissions—but these should be considered measures of last resort, with a defined and limited role.

Five Strategies to Kickstart Near-Term Action

In consideration of the five pathways noted above—and drawing upon the case studies describing efforts in other countries and by other organizations—we recommend the following priorities for near-term action:

Strategy #1: Kickstart new industry consortia toward net-zero

From Swedish steel to the EBA, it's clear that countries are making major progress—and unleashing billions in investment—through major new partnerships between industry, government, and civil society. In Canada, we need leaders committed to achieving net-zero emissions to convene similar collaborative efforts to advise governments and engage the public on pathways and policy priorities that position Canada to compete and prosper in a net-zero economy. A first priority for these efforts should be the development of sector-specific roadmaps to net-zero, with a focus on accelerating near-term deployment of "safe bet" solutions (efficiency and electrification) and further developing and testing "wild card" solutions (hydrogen as well as carbon capture, utilization, and storage technologies [CCUS]) where "safe bets" are insufficient to meet necessary emissions reductions.

[3] See Edmonton Region Hydrogen Hub, at https://erh2.ca/

Strategy #2: Building Indigenous leadership into Canada's energy transition and climate action

Upholding the rights and self-determination of Indigenous Peoples and strengthening nation-to-nation relationships will be paramount to Canada's efforts toward net-zero. Co-development of climate policy with Indigenous Peoples—and flexible funding arrangements that transfer capacity and authority to Indigenous Peoples—will be critical for meaningful reconciliation and full implementation of the UN Declaration on the Rights of Indigenous Peoples (UNDRIP). Indigenous businesses and communities are already creating opportunities in the energy transition, with more than 2,000 clean energy projects across Canada (Indigenous Clean Energy, 2020) and have plans for energy-efficient homes in Indigenous communities (Indigenous Clean Energy, 2021). It is imperative that Indigenous governments, leaders, and communities play an active role in navigating and benefiting from Canada's journey to net-zero as equal partners.

Strategy #3: Organize the federal government for net-zero success

The federal government should adopt and model a fit-for-purpose whole-of-government approach from the Prime Minister's Office to the Privy Council Office to a new, multi-department Climate Action Secretariat. With a focus on integration and efficiency, the Secretariat would be responsible for navigating competing priorities, trade-offs, and synergies between federal departments, liaising with provincial governments on climate action, developing and updating plans and shepherding implementation by federal departments.

Strategy #4: Support a just transition that keeps pace with the energy transition

We have always known that Canada's non-renewable resources are just that: non-renewable, meaning that our economy must eventually transition. The climate crisis and the new global race to net-zero have accelerated that timeline. In fairness to Canada's workers, we need to develop a proactive approach to ensuring no Canadian is left behind in this transition. A Just Transition Act, based on guidelines adopted by the International Labour Organization, is urgently needed to create a framework for the policies, programs, and funds needed to support Canadian workers throughout the transition.

Strategy #5: Ensure a principled, transparent approach to carbon removals and offsets as measures of last resort

While efforts should focus primarily—and on a priority basis—on achieving zero GHG emissions, complete decarbonization will be difficult or impossible to achieve in every sector. Consequently, carbon removals (technology and nature-based) will have a role to play in addressing residual emissions. But the optimal and realistic scale of negative emissions is a crucial outstanding question. The Canadian government should develop principles and a policy framework for the use of carbon removals and offsets/international credit trading in achieving net-zero, including how to manage risks (additionality, permanence, biodiversity, and community impacts, etc.) associated with their use.

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