Commission on Carbon Competitiveness

The Transition Accelerator

The Right Move at the Right Time: A new Canadian industrial strategy

June 2025

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The **Commission on Carbon Competitiveness** (C3) is made up of leading Canadian and US experts in economics, climate policy, and trade law. C3 aims to help Canadian industry remain globally competitive as the world decarbonizes, reduce greenhouse gas emissions, attract new investment, and develop long-term competitive advantages in emerging low-carbon industries.

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The **Transition Accelerator** is putting Canada on a path to a strong competitive economy in a world driving to reduce emissions to carbon neutrality. We work with 300+ partner organizations to build out pathways to a prosperous low-carbon economy and avoid costly dead-ends along the way. By connecting systems-level thinking with real-world analysis, we're enabling a more affordable, competitive, and resilient future for all Canadians.

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Executive Summary

Canada Has an Opportunity to Create a New Canadian Industrial Strategy for Economic Growth

Canada finds itself facing a once-in-a-generation opportunity. Recent U.S. policy has completely upended our long-standing comfortable dependence on north–south trade and investment, forcing us to focus on diversification and ways to generate homegrown economic growth and prosperity. In any time of crisis, countries have an opportunity to consider policy options that in normal times would be deemed too difficult. This moment offers Canada the chance to revisit our past efforts at industrial policy to secure economic sovereignty by building our nation, to address long-standing problems of underperformance on productivity and innovation, and to foster enduring prosperity through Canada-based growth opportunities using what we term a "New Canadian Industrial Strategy."

This report explores how Canada should reinvent its approach to industrial policy, focused on both legacy industrial sectors and new innovative sectors and technologies. While the scope is industrial policy generally, it is clear that many of those key growth opportunities involve staking out turf in the burgeoning global green markets of the future. With the United States abandoning the pursuit of those markets at the federal level, now is an opportune time for Canada to step up as a stable destination for investment in our abundant resources and innovative green technologies.

If we heed the lessons of the past, industrial policy can play a critical role in Canada's new economic strategy. Industrial policy was key to the success of some of Canada's most highly productive growth industries, including oil sands extraction, canola, and satellites. Industrial policy has likewise been successfully used worldwide to build many of the most successful growth industries: electric vehicles in China, South Korea, and Japan; semiconductors in Taiwan; and aquaculture in Chile.

But industrial policy is no panacea. Past efforts have yielded high-profile failures, and many rightly worry about governments picking winners. Our analysis argues that Canada's governments and private sector can learn the lessons of global experience—positive and negative—and design a New Canadian Industrial Strategy that works.

Why Does Canada Need a New Industrial Strategy?

There are many reasons for Canada's low-productivity, low-innovation economy, but it is at least in part a product of shots never taken due to decades of adherence to a non-interventionist approach to industrial policy, a passive approach that ignores Canada's own successful industrial policy tradition. The result has been atrophy of the capacity and political will needed to identify opportunities and execute on them. If it continues this path, Canada risks falling further behind in the global race to capture supply chains for the next generation of clean technologies and in the competition to gain market share for low-carbon industrial goods.

While Canadians played important roles in inventing and advancing research breakthroughs in clean technologies such as batteries and electrolyzers, barriers to scaling up prevent Canadian firms from growing into leading technology suppliers in most clean technology supply chains. The result is repeated stories of clean technologies developed in Canada with public support, such as breakthrough innovation on lithium-ion batteries developed in Quebec in the 2000s, that are scaled into global businesses elsewhere—in this case by Contemporary Amperex Technology Limited (CATL), now the world's leading electric vehicle (EV) battery manufacturer, with strategic industrial policy support from the Chinese government. The end of the story is Canada having to offer generous investment incentives to coax back such firms to locate here for final assembly and deployment.

Canadian and International Experience Reveals Three Key Ingredients for Success

Fortunately, international and domestic best practice offers lessons to guide us. This report surveys industrial policy promotion of EVs in China, Korea, and Japan; semiconductors in Taiwan; and aquaculture in Chile, as well as Canadian success stories in the canola industry, the oil sands, and the satellite industry—all very different cases—and derives three common elements of successful efforts:

1. They target specific technologies/sectors and stick around for the long game—as long as the effort yields results.
2. They establish tailored coordination mechanisms that can continuously align industry and government efforts as innovators' needs evolve.
3. They augment a research and development (R&D)-focused strategy with a wide variety of other supporting policy instruments.

Element One: Targeting specific technologies/sectors

There are clear criteria for choosing a portfolio of technologies/sectors on which to focus, based on existing strengths. This can include technological capabilities of Canadian firms, size of Canadian footprint in the supply chain, size of global market opportunity, natural resource endowment, scientific expertise, existing government research infrastructure, and whether the technology is in alignment with a transition to net-zero.

The process by which those criteria are applied is critically important, involving transparent consultation and collaboration with, among others, governments, industry, and independent technology and policy experts.

It is also critical to ensure longevity of effort. Successful industrial policy is a long game, not a chasing of the flavour of the month with immediate payoffs. It works best when governments provide stable commitments guided by clear benchmarks. That said, it is not always a successful game, and there must be a regular process of review, guided by clear criteria, that determines whether any given effort should be continued or abandoned. Policy-makers, industry, and the general public must appreciate that patience is needed and that industrial policy is an investment that will inevitably yield some failures as well as successes.

Element Two: Coordination mechanisms

The second step involves creating mechanisms that bring together government and industry. Industrial policy is a partnership that requires governments to fully understand the realities and needs of industry and to design policy accordingly. The delicate balance required involves government agencies acquiring high-quality information and collaborating with the affected industries without becoming captured by them.

The specifics of the mechanism should be dictated by the realities of the technology or sector being supported. Canadian success stories include, for example, leadership by a non-profit industry association for canola and of a Crown corporation for oil sands. The task of these mechanisms is to identify the gaps and needs, identify the policies and partnerships needed to meet them, and align the various policy instruments (sometimes at different levels of government) with the evolving needs of the supported industry.

Element Three: The supporting policy mix

The third step involves identifying and implementing the suite of policies that are appropriate for the chosen technologies/sectors. These will differ from case to case, as identified by the coordinating mechanisms and can include for example: R&D support, venture capital-like financing, building legal frameworks, intellectual property protection, marketing/export support, standard setting, helping ensure a skilled workforce, efforts to ensure availability of needed infrastructure or inputs, and market creation through government procurement.

The broad range of necessary complementary policies implies the need for a high-level coordinating mechanism within government that can ensure the contributions of many different ministries.

Long-term coordination is key, since policy gaps may change over time as technologies and firms evolve. Canola promotion, for example, focused on R&D in the early days, but later turned to extension support and export expansion via standards.

A Central Authority Should Drive the Development of Canada's Industrial Policy

Success in these three steps does not require a substantial overhaul of Canada's government machinery; in large part, it can be achieved by better coordinating and focusing what already exists.

A high-level central authority needs to drive the effort, in part to help ensure effective cross-ministerial coordination. There are a variety of ways this could work. For example, a dedicated unit in Canada's Privy Council Office could support strategic decision making by a cabinet committee that leads on the industrial strategy file. This unit would need to draw on outside expertise in a nimble and ongoing way, perhaps through a standing round table or advisory task force of outside experts.

The central authority should ensure the performance of the three core industrial policy tasks as follows:

1. **Identify priorities:** Focus on 5–7 priority technologies/sectors, based on independent advice and broad provincial/territorial consultation. The current context demands agility and speed in assembling the initial list, but ultimately, choosing these sectors should be an ongoing, iterative process rather than a one-off effort. Regular transparent review by an independent advisory task force based on clear, realistic success metrics would allow for course correction as needed.

2. **Designate coordinators:** In each priority area, identify a tailored coordinating body (or independent intermediary) to lead the co-creation of technology/sector strategies with industry. These strategies or roadmaps should identify the opportunities, outline specific goals for investment or technology performance, identify policy gaps, and revise plans as the needs evolve. The roadmaps should be forged from a collaboration with industry, federal and provincial governments, and researchers, so the ideal coordinating bodies would be arms-length independent or public/private entities that bring together all the relevant actors for a sector in a nimble way. Canada has successfully used crown corporations and non-profit organizations in this intermediary role. Their combination of industry input and in-house technology-specific expertise should equip them to feed into the central authority as it makes strategy and adjusts in real time, guiding the deployment of policy support housed in federal and provincial entities.

3. **Align the policy mix:** Create new (or empower existing) mechanisms at the centre of government to ensure cross-government coordination of the policy mix identified in the sectoral/technology strategies created by the coordination bodies. An industrial strategy focus could be added to the cabinet committee focused on economic policy. This committee would need to be supported by a dedicated unit in the Privy Council Office.

Success Is Possible, but It Requires Decisive and Speedy Action

The detailed recommendations in this report are aimed at Canada's federal government as the primary coordinator and driver, though success demands that the effort be a partnership both with other levels of government and with the private sector.

In this time of fiscal constraint, it is essential to underline that industrial policy success does not have to be costly. It is often more about fixing coordination failures than about subsidies. Depending on the sector, the key bottleneck might be regulations, legal frameworks, or a lack of export support services. Indeed, lack of a holistic industrial policy framework may be more costly; without a strategic approach, governments risk falling into a pattern of deploying subsidies reactively in response to lobbying.

The need for a New Canadian Industrial Strategy is urgent. The opportunities presented by the moment are dynamic, and other countries are actively pursuing the types of strategies described here. With decisive and speedy action, Canada can turn the current crisis into a pivotal opportunity for resilient growth and prosperity.

TWO

Introduction

Canada finds itself facing a once-in-a-generation opportunity. Recent U.S. policy has completely upended our long-standing comfortable dependence on north–south trade and investment, forcing us to focus on diversification and ways to generate homegrown economic growth and prosperity. In any time of crisis, countries are afforded the opportunity to consider policy options that in normal times would be thought impossible. This moment offers Canada the chance to revisit our unfocused and inadequate efforts at industrial policy, to address long-standing problems of underperformance in productivity and innovation, and to foster enduring prosperity through Canada-based growth opportunities.

This report explores how Canada should reinvent its approach to industrial policy, focused on both legacy industrial sectors and new innovative sectors and technologies. While the scope is industrial policy generally, it is clear that many of those key growth opportunities involve staking out turf in the burgeoning global green markets of the future. The United States has effectively abandoned the pursuit of those markets at the federal level, a development which, while disastrous from an environmental perspective, gives Canada the chance to step up as a stable destination for investment in our abundant resources and innovative green technologies.

Seizing this moment requires more than cautious incrementalism—it demands bold, decisive action that might not be considered under normal circumstances. Ambitious goals backed by coordinated implementation frameworks are essential to build strong Canadian industries that can capture the opportunities inherent in the markets of the future, whether in legacy industrial sectors or in the growth sectors of the future. Markets for legacy industrial sectors such as steel, aluminum, and cement are projected to grow by up to six times worldwide over this century as population grows and emerging economies build out their infrastructure (Watari et al., 2021). The urgent need to respond to the climate crisis is driving monumental growth in entirely new sectors; the International Energy Agency (IEA) estimates that the global market value for six clean energy technologies—wind, solar photovoltaic (PV), electric vehicles (EVs), batteries, electrolyzers, and heat pumps—grew nearly fourfold between 2015 and 2023, surpassing USD 700 billion. This figure was equivalent to approximately half the value of all the natural gas produced globally in 2023 (IEA, 2024). The market for these technologies is set to nearly triple by 2035, to more than USD 2 trillion (IEA, 2024). Canada's long-term prosperity depends on its ability to build and scale these and other strategic industries.

Globally, governments are collaborating with innovators and industry leaders to transform the structure of their economies for higher growth and improved resiliency to shocks. Canada's main trading partners fiercely compete for technological leadership and domestic production of next-generation technologies that will be needed as the world decarbonizes. The European Union's (EU's) Clean Industrial Deal, for example, mobilizes over EUR 100 billion to support clean manufacturing, positioning the EU as a formidable competitor in the global clean economy.

In contrast, Canada's efforts to date have lacked coordination and focus. Since the 1990s, Canada has largely withdrawn from industrial policy, with the aerospace and automotive sectors serving as exceptions to the rule (Wolfe, 2015). Canadian governments have also relied excessively—more than other Organisation for Economic Co-operation and Development (OECD) peers—on sector-neutral framework instruments such as research and development (R&D) tax credits and academic research funding rather than deploying a comprehensive policy mix that reflects industry's needs (OECD, n.d.-a). This policy approach has not reversed Canada's uniquely chronic decline in business expenditure on R&D compared to its OECD peers (OECD, n.d.-a), nor its growing gap with the United States on intellectual property products investment and productivity. Without a comprehensive and aggressive industrial strategy, Canada risks economic marginalization, talent flight, and lost investment to jurisdictions that move faster and with greater clarity. Now is the moment for Canada to double down on a New Canadian Industrial Strategy and create the low-carbon value-added industries and innovation ecosystems that can anchor its economy for decades.

This is the third paper by the Commission on Carbon Competitiveness, a group of experts that has come together to advise Canadian governments on how to position Canadian industry for success through the net-zero transition. The Commission argues that to achieve long-term carbon competitiveness, Canada must address four interwoven policy objectives: decarbonize Canadian industry, avoid carbon leakage, attract low-carbon investment across the economy, and foster the development of green sectors with high growth potential. The Commission's first two papers focused on the competitiveness challenges facing Canada's legacy heavy industrial sectors as they decarbonize and the policies that will address the risk of carbon leakage through this transition. This paper addresses the final two aspects of carbon competitiveness: how to attract investment and foster growth in legacy and emerging sectors that can secure Canadian prosperity for decades to come. A New Canadian Industrial Strategy will be essential to reaching this goal.

2.1 What Is Industrial Policy?

Industrial policy is defined as "policies that explicitly target the transformation of the structure of economic activity in pursuit of some public goal" (Juhász et al., 2023, p. 4). While the goal of industrial policy is typically to stimulate innovation, productivity, and economic growth, it could also be to promote climate transition, good jobs, or lagging regions (Juhász et al., 2023). Net-zero industrial policy, then, is "a set of policies and investments intended to advance the technologies, build the firms, and create the innovation ecosystems needed to decarbonize the economy" (Allan et al., 2022, at p. 3). Successful countries create innovation-focused strategies that seek to position their firms in global value chains in an ongoing process of action, learning, and adaptation.

Industrial policy typically strives to increase the country's sectoral and export-basket composition in innovative, value-added products and to diversify the markets for final goods and services. An economy that specializes in value-added products is better positioned to secure good-paying jobs for its citizens, high productivity, and high living standards than countries whose economic well-being depends on their trading partners' continued demand for their raw commodities. Diversified economies are more economically resilient since they produce value-added exports capable of commanding higher prices from a wide range of trading partners. Industrial policies, then, are designed to enable companies that produce innovative products to grow and thrive in diverse markets.

Boosting economic resiliency is seen as a key pathway to securing employment and prosperity. As such, industrial policy is usually motivated by economic, environmental, and security goals (Allan, Eaton, & Goldman, 2024). When practised successfully, industrial policy encompasses far more than just R&D support. Instead, the whole-of-government approach involves promoting strategic technology with grants and R&D funds, tax incentives, loans, strategic procurement, and building human capital, all of which protect domestic firms while strategically inducing foreign direct investment. It can involve influencing international technical standards to create international markets for a country's leading firms by aligning standards to reflect their product offerings. When wielded prudently, import and export measures can also be part of a successful industrial policy. Export promotion has been a key component of strategies to build the Canadian canola industry as well as competitive high-tech industries in Asia.

It is important to emphasize that successful industrial policy does not have to be expensive. This is illustrated in this report's case study of Taiwan, whose successful rise to prominence in semiconductor manufacturing cost about USD 35 million over less than a decade and completely transformed its economy (Breznitz, 2021, at p. 81). Thus, coordination rather than spending is the central component of all successful industrial policy. Harvard industrial policy expert Dani Rodrik emphasizes that "the right way of thinking about [industrial policy] is as a process of discovery, by the government no less than the private sector, instead of a list of specific policy instruments" (Rodrik, 2014, p. 485).

This report examines case studies from Canada and elsewhere to identify the elements that should form part of a New Canadian Industrial Strategy and argues that Canada must urgently put these elements in place. The passive laissez-faire era of industrial policy must come to an end. Canada is now faced not only with the chronic problems of low productivity and lagging innovation but also new economic threats from its largest trading partner and a global race to seize opportunities in the low-carbon transition. A thoughtful approach to industrial policy, informed by decades of experience, will enable Canada to seize the opportunity inherent in the current instability and build resilient high-growth industries.

2.2 Outline of the Report

Section Three outlines two common structural challenges that industrial policy often seeks to address:

- the **scale-up problem** of scaling innovative firms through and beyond the commercialization valley of death
- the **technological dependence problem** of ensuring that foreign direct investment doesn't foster technological dependence by stifling domestic innovation.

While Canadians played important roles in inventing and advancing research breakthroughs in clean technologies such as batteries and electrolyzers, barriers to scaling up prevent Canadian firms from growing into leading technology suppliers in most clean technology supply chains. The result is that too many clean technologies are invented here with public support, scaled into global businesses elsewhere, then coaxed back for final assembly and deployment with investment attraction incentives.

Section Four shows how lessons can be learned from how both Canada and its global peers have successfully used industrial policy to overcome the structural barriers associated with the scale-up and technological dependence problems. This will include summaries of best practices for dealing with these structural barriers from other countries (EVs in China, Korea, and Japan; semiconductors in Taiwan; and aquaculture in Chile) as well as Canadian success stories (the canola industry, the oil sands, the satellite industry). These cases have the following best practices in common: a) they target specific technologies with a long time horizon; b) they establish a coordination mechanism that can continuously align industry and government efforts as the needs of innovators evolve; and c) they augment an R&D-focused strategy with a wide variety of policy instruments. In short, policy-makers need to commit to targeting something, create a coordination mechanism, and offer more than just R&D support.

Section Five articulates a set of recommendations for contemporary Canadian industrial policy distilled from the lessons of Canadian and international case studies.

The recommendations include three concrete actions:

- set priorities: Create an advisory task force to enable the Privy Council Office (PCO) to decide on a portfolio of technologies that are the most appropriate candidates for support;
- designate coordinators: PCO should designate and support coordination bodies for each technology to co-create strategies with industry and other stakeholders, then align policy with the evolving needs of innovators.
- align the policy mix: Create a mechanism at the centre of government—we recommend it be housed in the PCO—to achieve cross-departmental alignment of the policy mix.

The conclusion emphasizes the need to pursue technology-specific industrial policies that follow the three identified best practices: a) commit to targeting promising technological niches; b) create a coordination mechanism; and c) offer more than just R&D support.

THREE

Structural Problems for Industrial Policy to Address

Industrial policy often refers to public action to help ameliorate structural barriers to scaling up innovative firms in strategic technology areas (Institute for Research on Public Policy, 2024). Two common structural challenges include:

- the scale-up problem, i.e., difficulty scaling innovative firms beyond the startup phase into global technology suppliers.
- the technological dependence problem, i.e., difficulty ensuring that foreign direct investment doesn't foster technological dependence by stifling domestic innovation.

This section will lay out the interconnected nature of these two problems, highlighting how their presence in most countries serves as a common challenge that most industrial policy seeks to address. While these challenges are largely ubiquitous, their exact manifestation can vary based on other structural features of a country's economy that have been built up over time, such as market size, natural resource endowment, skilled labour, industrial structure, and relationships with trading partners.

3.1 The Scale-up Problem

Box 1. Learning from the past: Innovation leaders in priority areas need long-term support

LESSON: IN THE ABSENCE OF A BROADER, LONG-TERM INDUSTRIAL POLICY, CANADA DIDN'T SUPPORT KEY EARLY MOVERS IN LITHIUM-ION BATTERY INNOVATION THROUGH THE COMMERCIAL "VALLEY OF DEATH."

Vancouver-based Moli Energy was a leading innovator of lithium-ion batteries in the 1980s. Moli was the first manufacturer of lithium-ion batteries in North America. However, after a Moli-made cell caught fire, the Province of British Columbia called in a loan and forced its sale to a Japanese consortium for CAD 5 million (Jarratt, 2020). The company had assets worth CAD 58 million and had received USD 120 million in government support. Canada's risk-averse, short-term approach failed to contextualize support for this company within a broader industrial policy that recognized the strategic importance of the underlying technology.

This stands in contrast with subnational governments in China providing patient capital in the form of loans from state-owned banks, revenue via municipal bus procurement and local content requirements for consumer incentives, and equity investment from public funds. This long-term support was crucial in helping innovative firms through the commercialization valley of death. For example, BYD "rose up by keeping a close relationship with the southern city of Shenzhen and making it the first city in the world to completely electrify its public bus fleet" (Yang, 2023). Similarly, a 2018 interview with CATL CTO Bob Gaylen noted that an estimated half of CATL sales on a pack basis were to Chinese bus makers and that in 2016, "CATL delivered more battery packs to one customer, Zhengzhou Yutong Bus, than Tesla had used in all of its cars since the U.S. EV maker's inception" (Schreffler, 2018). Finally, the regional government of Hefei acquired a 24.1% equity stake in NIO, a now-prominent EV maker that at the time was facing financial issues 5 years into its life.

Countries like China, the United States, Japan, and Korea have used industrial policy to help cohorts of innovative firms grow into global leaders in net-zero technologies, such as EVs (Allan et al., 2024). Similarly, successful innovation policy was behind Taiwan's approach to becoming a world-leader in semiconductors (Breznitz, 2021). These countries have industrial policies working to achieve specific targets that deploy policy mixes comprising a wide range of policy instruments to support cohorts of firms in scaling up their patented capabilities to become leading suppliers in global value chains. These policy instruments include supply-side (e.g., R&D grants) and demand-side (e.g., procurement) supports, as well as early technology readiness level R&D support (e.g., US Advanced Research Projects Agency – Energy) through to later-stage, large-scale demonstration financing (e.g., US Department of Energy's Hydrogen Hubs & Loan Program Office) (Office of Clean Energy Demonstrations, 2024). Policy design and implementation of these policy mixes is guided by strong information exchange via public–private coordination forums.

While Canadians played important roles in inventing and advancing research breakthroughs in clean technologies such as batteries and electrolyzers, barriers to scaling up related to access to risk capital, talent, and market access prevent Canadian firms from growing into leading technology suppliers (Denney et al., 2023). This is a long-standing problem, with observers over 40 years ago concluding that most "Canadian firms command such small fragments of even domestic markets that they have little international competitive strength or interests" (French, 1984, p. 99). Canada continues to have a poor record of creating scale-ups. Only 1 in 100 Canadian companies meet the definition of a scale up or what Statistics Canada refers to as a "high-growth firm," i.e., firms that experience 20% revenue growth for 3 years (Denney et al., 2021). However, scale-ups have significantly higher productivity growth levels and generate 20 times the revenue and 5–10 times the employment of non-scale-ups (Denney et al., 2021). Innovation, Science and Economic Development Canada's (ISED's) target in 2017's Innovation and Skills Plan was to "double the number of high-growth firms in Canada from 14,000 to 28,000 by 2025" (ISED, 2023). Unfortunately, progress toward this goal has been challenging; in 2022, Canada had 17,930 high-growth enterprises by revenue (20% growth over 3 years) (Statistics Canada, 2024).

Foreign capital can act as a barrier to scaling up domestic firms through what is called the "feeder cluster" problem. This occurs when promising startups relocate abroad, often because of foreign acquisition. Foreign venture capital investment is correlated with an increased likelihood of startups relocating internationally (Weik et al., 2024). Dan Breznitz (2021) identified this problem as occurring at the national level in countries like Israel and Canada, but also at the regional level, such as Atlanta's information communications technology cluster. Similarly, British industrial policy scholars have similarly emphasized that "the early sale of venture capital-backed science and technology-based start-ups is the most important problem facing UK innovation and industrial policy" (Connell & Reddy, 2024).

Foreign (often Silicon Valley-based) venture capital (VC) investment in startups eventually leads to their foreign relocation in a "self-reinforcing process" whereby feeder clusters "never really become entrepreneurial ecosystems at all, since their companies' most significant ties are with firms, investors, customers, and peers far away" (Breznitz, 2021). The lack of domestic capital willing to take a long-term perspective on domestic firms can create a reinforcing cycle of firms under pressure by foreign VCs to achieve an exit within a 5-year window. This liquidity event often takes the form of a foreign acquisition, given that the cumulative effect of the feeder cluster phenomenon is that there are relatively few large domestic firms in a position to buy the startup. As Breznitz's comparison of Shopify versus Research in Motion shows, even when a foreign VC-backed domestic firm (Shopify) successfully scales and doesn't relocate, the bulk of the financial upside flows to investors outside of the country rather than replenishing the domestic pool of patient capital needed to support the next generation of scale-ups (Breznitz, 2021).

Canada's feeder cluster problem manifests in the recurring "invented here, scaled elsewhere" pattern of technological development. Canada's tradition of academic research and science excellence has produced numerous promising technologies (such as lithium iron phosphate EV batteries) (Allan et al., 2024) that were invented here with public support, scaled into global businesses elsewhere, then coaxed back for final assembly and deployment with investment attraction incentives. The corporate tax revenue and high-paying jobs (e.g., in management, human resources, and marketing) associated with domestically headquartered multinational firms are lost. Even in potentially more optimistic cases, such as Carbon Engineering, where the BC-based R&D footprint of the firm is intact after foreign acquisition, it remains to be seen how much of the non-R&D business functions will be based in Canada as the technology is scaled by its U.S.-based parent company (Oxy, 2023). The feeder cluster problem risks undermining public support for the type of long-term cleantech R&D grants that were key to the initial scaling up of promising firms like Carbon Engineering.

The most successful examples of industrial policy to mitigate the feeder cluster problem strive to ensure that domestic firms have access to homegrown patient capital. Taiwan structured its financial system to encourage domestic investors to back domestic companies (Breznitz, 2021). Another policy tool is using clawback conditions on R&D grants to penalize offshoring of manufacturing, as well as the sale and offshoring of publicly financed intellectual property. Israel has utilized this tool to incentivize continued domestic growth over early exit via foreign acquisition (Maggor, 2020). This mechanism does not solve the underlying feeder cluster nature of Israel's foreign VC-backed innovation system. Instead, the condition serves as a mechanism to delay the foreign acquisition until a point in the firm's life cycle where the multiplier penalty on the initial R&D grant becomes less of a disincentive for foreign acquisition.

Successfully scaling Canadian firms requires a balance of carrots and sticks that creates pathways to allow innovative entrepreneurs who have a desire to continue growing the business in Canada to do so. Regarding carrots, this necessarily goes beyond sector-neutral R&D tax credits and investments in academic research. Interviews with Canadian scale-up entrepreneurs reveal a preference for a more active role of the government in the form of demand-side (procurements, standards, export/intellectual property support), and targeted use of non-dilutive patient capital (grants, loans) innovation instruments (Denney et al., 2023). One of the most important antidotes to the feeder cluster phenomenon is the mobilization of dormant pools of domestic patient capital. The Government of Canada's efforts to mobilize pension funds to support technology scale-ups is a positive step in this direction. Regarding sticks, the recent efforts to update and strengthen the national benefits test in the Investment Canada Act provisions for reviewing foreign acquisitions in strategic industries such as critical minerals have potential to avert some of the most extreme cases of the feeder cluster phenomenon.

Conditions on supports (such as Israel's clawback mentioned above) are a promising approach. These firm-level interventions give the state leverage to tilt incentives toward domestic scale up. A recent Canadian example is the use of convertible notes that are stage gated into two tranches by the Canada Growth Fund (CGF), providing Vancouver-based Svante USD 50 million in first-of-a-kind deployment capital to scale its carbon capture technology while giving CGF leverage to catalyze expansion of Svante's Canadian footprint: "the second tranche of US$50M can be drawn for the development and construction of carbon capture projects with a focus on Canadian projects, subject to approval by both organizations" (CGF, 2024).

As Section Four will illustrate, successful examples of industrial policy (including Canadian ones) have focused squarely on equipping innovators with the capabilities they need to scale up, providing a supportive ecosystem, and evolving this support as the needs of their innovators change. This is achieved through a) a sustained commitment to a particular technology area; b) creation of a dedicated coordination body to facilitate alignment of private and public efforts; and c) the mobilization of a wide range of supply-side and demand-side policy instruments. Case studies include EVs in China, South Korea, and Japan, semiconductors in Taiwan, and aquaculture in Chile. Although these success stories involve very different product categories and economic and political structures, they all share the three elements described above.

3.2 The Technological Dependence Problem

The concept of technological sovereignty refers to a country's ability to "provide the technologies it deems critical for its welfare, competitiveness, and ability to act, and to be able to develop these or source them from other economic areas without one-sided structural dependency" (Edler et al., 2023). Technological dependence is intricately tied to the role of foreign capital in a country's innovation ecosystem through the "branch plant" problem. This phenomenon occurs where a country's economy is dominated by subsidiaries of large foreign firms that underinvest in R&D and source technology from abroad.

Canada's branch plant economic structure has long consisted of "truncated" branch plant foreign subsidiaries (Britton & Gilmour, 1978). This term originated with the Science Council of Canada in the 1970s, who warned that "truncation occurs when a subsidiary does not carry out all the functions—from original research to marketing—necessary for developing, producing and selling its goods" (Britton & Gilmour, 1978, p. 37). As such, "the factors which would make a subsidiary innovative, flexible and capable of developing new products for both domestic and world markets (e.g., R&D, marketing capacity, etc.) are usually entirely, or substantially, located elsewhere" (Britton & Gilmour, 1978, p. 37). Scholars have noted that Canada's structural pattern of technologically dependent development was built up over decades through the cumulative practices of subsidiaries sourcing technology from the existing headquarters' preferred network of suppliers versus conducting in-house R&D or sourcing from smaller Canadian firms (Smardon, 2014).

Foreign investment can either reinforce technological dependence by forming enclave clusters (Phelps et al., 2015) or help scale the capabilities of domestic firms via embedded cluster development (Perez-Aleman, 2005, p. 671). The distinction hinges on a foreign firm deciding to source inputs to production locally, rather than relying on existing relationships with global suppliers. While economic geographers' traditional assumptions were that foreign direct investment (FDI) firms are willing to share knowledge, technology, and supplier contracts with local firms in regions with sufficient absorptive capacity and market-friendly institutions, recent research calls into question this benevolent orientation (Samford et al., 2024). Breznitz et al. draw on numerous examples—such as Canadian automotive suppliers (Rutherford & Holmes, 2008), Georgia's EV battery manufacturing firms, and Mexico's electronics manufacturing sector—to emphasize that the default position for multinational firms is to rely on existing networks of suppliers from their home country rather than to take the risk of forging new relationships with smaller firms in host regions (Samford et al., 2024).

The most successful examples of industrial policy designed to mitigate the branch plant problem strive to ensure that FDI contributes to technological independence by bolstering the technological capabilities of domestic firms. Successful countries view policies to attract FDI through the lens of how the presence of large foreign multinational firms and investors can further the overarching goal of scaling innovative domestic firms. This is done by prioritizing investments that contribute to local innovation ecosystems/clusters, supply relationships, and knowledge transfer partnerships. For example, China "leapfrogged" to the technological frontier in EVs and batteries by ensuring that its firms had access to technological transfer from leading international automakers through the obligation to establish joint ventures with Chinese firms (Altenburg et al., 2022). Similarly, the EU is reportedly considering adding technology transfer requirements to bids from foreign firms for battery subsidies in December 2024 (Hancock et al., 2024).

Unlike China, policy-makers in smaller countries like Canada likely lack the ability to leverage access to their market to force joint venture FDI. However, policy efforts to link multinational enterprises with local suppliers should always accompany foreign investment attraction efforts. Networking programs can reduce information asymmetry by helping foreign firms become aware of local capabilities, thus de-risking the decision to source locally (Samford et al., 2024).

Box 2. EV example: Budget 2024's EV supply chain investment tax credit & Honda's battery manufacturing plant

LESSON: THIS IS AN EXAMPLE OF SUCCESSFULLY STRUCTURING FDI INCENTIVES TO INDUCE INVESTMENTS IN THE UPSTREAM SUPPLY CHAIN AS WELL AS IN DOWNSTREAM MANUFACTURING.

The federal government is contributing ITCs valued at CAD 2.5 billion toward Honda Canada's CAD 15 billion project, which will build a new EV assembly plant and a battery manufacturing plant in Alliston, Ontario. The facility will have a production capacity of 240,000 vehicles per year by 2028. Together with POSCO in a joint venture, the car manufacturer will also build a plant to produce cathode active material (CAM) and precursor material (pCAM). In addition, Honda will build a separator plant in partnership with Asahi Kasei. This is an investment in not just batteries, but the high-value-added midstream segment of the battery supply chain.

In particular, Budget 2024's EV supply chain ITC achieves this by covering 10% of the costs of buildings at various stages of the supply chain: cathode active materials production, battery production, and car assembly, (Allan, Eaton, & Kabbara, 2024). This is in addition to the clean manufacturing ITC of 30% for machinery and equipment. To qualify, a manufacturer must also be claiming the clean manufacturing ITC in all three of the segments of the supply chain. One of these segments could be through another company where the firm is at least a part owner. This new measure clearly intends to incentivize coordinated investments up the value chain.

FDI tends to focus on low-innovation final assembly and raw material extraction. Even when foreign firms do locate R&D centres in Canada, supply chain linkages and R&D collaboration with Canadian firms are often underdeveloped, minimizing the creation of regional innovation ecosystems that could facilitate knowledge transfer and the scaling of Canadian firms. However, there are cases of successful technology transfer from foreign direct investment. For example, Montreal's video game cluster is a case where an ecosystem of Canadian firms grew up in the shadow of a large foreign anchor firm that was initially lured to the region via tax incentives (Cohendet et al., 2021). In the following years, Ubisoft employees and their peers from local design schools and startups organically formed a vibrant cluster built on informal networks and meet-ups. This counterexample supports Samford et al.'s (2024) recommendation of fostering networks to ensure that a large multinational's presence adds to rather than detracts from regional innovation ecosystems.

FOUR

International and Domestic Best Practices

This section will survey international best practices and historical Canadian successes to show how each element of the prioritization framework helps overcome the structural barriers associated with the scale-up and technological dependence problems. Notwithstanding their differing political/economic contexts, these cases all include the following common elements:

- a sustained commitment to a particular technology area
- creation of a dedicated coordination body to facilitate alignment of private and public efforts as the needs of innovative firms evolve
- augmenting an R&D-focused strategy with the mobilization of a wide range of supply-side and demand-side policy instruments.

In short, policy-makers need to commit to targeting something, create a coordination mechanism, and offer more than just R&D support.

The cases summarized in this section all involve industrial policy that was successful in positioning domestic firms as key suppliers of high-value-added products. They involve the state applying a whole-supply chain lens rather than merely establishing passive R&D grant or tax credit programs. This proactive supply chain lens sees the state taking on a larger task of committing long term to identifying and supporting innovative firms as they scale, harnessing dedicated coordination mechanisms to identify gaps in the supply chain, funding and/or performing necessary R&D, and alleviating policy bottlenecks unrelated to R&D support.

4.1 International Examples of Successful Industrial Policy

Table 1. Summary of International Best Practices

Cases	Policy instruments	Coordination mechanisms
EVs China/South Korea/Japan	- Government R&D - FDI technology transfer - Procurement - Standards & Export Support	- State–industry and whole-of-government coordination via R&D consortiums (e.g., Japan's NEDO, South Korea's Battery Alliance)
Semiconductor manufacturing Taiwan	- Government R&D - Standards & Export Support - IPR protection	- State–industry and whole-of-government coordination via the Industrial Technology Research Institute (ITRI)
Aquaculture Chile	- Government R&D - Standards and export support	- State–industry and whole-of-government coordination via Corporación de Fomento de la Producción de Chile (CORFO)

Electric Vehicles—China, South Korea, and Japan

Sustained Commitment

China, South Korea, and Japan have achieved their current dominance in the EV and battery supply chain through long-term industrial policy commitments.[1] Japan has targeted EV R&D since the 1990s through the New Energy and Industrial Technology Development Organization (NEDO), within the Ministry of International Trade and Industry. Successive governments continued to renew battery-focused NEDO funding such that total battery R&D funding between 2009 and 2022 was approximately USD 584 million (JPY 92 billion) (Frauenhofer, 2024). Recent commitments continue the tradition of setting specific production- and innovation-related targets. For example, the Battery Industry Strategy (2022) increased this to achieving domestic capacity of 150 GWh and global production by Japanese firms reaching 600 GWh (or a 20% share of the global battery market) by 2030 (Allan et al., 2024).

South Korea is similarly committed to supporting its EV firms over lengthy time horizons. For example, South Korea's K-Battery Development Strategy (2021, USD 360 million) was boosted by an additional USD 723 million in 2022. This funding aims to leverage total public–private joint R&D investment of KRW 20,000 billion (USD 14.5 billion) by 2030 to achieve market share targets (40% of the global market) as well as innovation targets (commercialize lithium-sulfur batteries by 2025, solid-state batteries by 2027, and lithium-metal batteries by 2028).

[1] Much of the analysis from this section is drawn from Allan et al. (2024).

Finally, the path to China's current EV dominance was laid out in 2015 via the "Made in China 2025" plan. The plan targeted "New Energy Vehicles" as one of seven "strategic emerging industries" and tied domestic adoption goals (80% EV share in total Chinese car sales and 20% share in the total vehicle stock by 2025) to goals for domestic content of core components and materials (rise to 40% by 2020 and 70% by 2025) (Allan et al., 2024). Technology-specific goals set in 2017 included achieving by 2025 next-generation batteries with an energy density on a cell level of 500 Wh/kg.

Coordination Body

All three countries have created coordination mechanisms to foster information flow between industry and government. This is essential for ensuring the industrial policy efforts continue to meet the evolving needs of each country's leading and emerging firms. In China, EV100 was created in 2014 to unite supply chain actors, including 178 domestic and 37 foreign members from upstream and downstream firms, government, and academia. The organization was headed by the former deputy director of the Development Research Centre of the State Council, lending credibility and prestige to its activities, which included producing roadmaps for technology development and diffusion. Similarly, the Korean Battery Alliance was announced in November 2022 as part of the Secondary Battery Industry Innovation Strategy: it serves as a forum to align public and private investments (including leading South Korean firms, such as Samsung SDI Co., SK On, LG Energy Solutions Ltd.).

Finally, Japan's Ministry of Economy, Trade and Industry created the Public–Private Storage Battery Industry Strategy Council in 2021. The council's 30 members include government officials, such as the Ministry of Economy, Trade and Industry and the Agency for Natural Resources and Energy; eight prominent battery manufacturers, five battery component suppliers, four industry/academic experts, and four industry associations. Working groups created a roadmap document in four themes: securing upstream resources; expanding and strengthening the production base of the supply chain; establishing rules for supply chain management; and commercializing next-generation batteries and skills development.

Policy Mix

China, Japan, and South Korea have secured technological superiority in EVs with industrial policies built around the central pillar of sustained support for R&D. Japan's NEDO runs collaborative public–private R&D consortium projects. NEDO's technology-focused consortiums sometimes include separate yet intersecting industry verticals (e.g., automotive firms learned from Sony's early use of batteries in consumer electronics). Similarly, South Korea has a long history of leveraging R&D grants to network together leading firms and emerging small and medium-sized enterprises (SMEs) in large-scale R&D consortiums for next-generation batteries.

Other supply-side policies included the strategic deployment of patient capital in the form of loans from state-owned banks and equity investment from public funds. For example, development banks in Japan and South Korea offer financing to support critical mineral sourcing agreements for domestic battery material makers. China's supply-side R&D support extended beyond grants and government labs to include requirements that foreign automakers form joint ventures with domestic firms. These early joint ventures were key to facilitating technology transfer during the 2010s.

While R&D supports were central features of all three countries' industrial policies, each of them also mobilized a wide range of supply-side and demand-side policy instruments to support their firms as they scaled up. China strategically augmented R&D support with demand-side measures like municipal transit procurement (beginning as early as the late 2000s) and domestic content requirements for purchase incentives. This provided steady revenue to Chinese battery firms to help them through the commercialization valley of death in the 2010s. Eligibility requirements for EV purchase incentives required batteries from approved (non-foreign) suppliers via 2015's "Battery Whitelist." While less explicit, South Korean eligibility for purchase incentives also favoured domestic firms, as they were calibrated to favour technical performance standards that resembled those of Korean firms (Thurbon et al., 2023).

Semiconductor Manufacturing—Taiwan

Sustained Commitment

Breznitz (2021, p. 81) notes that Taiwan's successful rise to prominence in semiconductor manufacturing cost about "$35 million over less than a decade to completely transform its economy," making it "quite possibly the most cost-effective innovation policy the world has ever seen." The case illustrates the importance of a sustained policy commitment toward a specific goal, combined with the power of having a dedicated coordination body with enough autonomy and capability to meaningfully mobilize public and private R&D efforts—ITRI—alongside a variety of other policy instruments.

The commitment to semiconductors began in 1974 when Minister for Economic Affairs and founder of ITRI Yun-hsuan Sun initiated a semiconductor strategy. The plan established a Technical Advisory Committee group of mostly Chinese-American workers in American electronics firms, such as at RCA's David Sarnoff Laboratories in New Jersey. The Committee recommended that ITRI establish the Electronic Research and Service Organization as a lab within ITRI with its first goal being "the development of technological capabilities to spur the growth of a semiconductor industry" (Breznitz, 2021, p. 79). This commitment persisted to this day, with the Electronic Research and Service Organization serving as the technological driver for generations of spinout firms, including the two largest pure-play semiconductor manufacturers, TSMC and UMC.

Coordination Body

ITRI was established in 1973 as a multi-field public research institute under the Ministry of Economic Affairs. It focuses on acquiring and developing existing technologies from foreign companies, then diffusing them among domestic firms to create whole supply chains. ITRI assumes the initial R&D risk, leaving industry to focus on final development and manufacturing. It currently has over 6,000 employees with highly specialized technical knowledge (Fasteau & Fletcher, 2024).

ITRI's primary coordination role is leading R&D services for Taiwan's industrial policies. It does this by participating in consortia with Taiwanese firms to jointly advance technologies, license them to existing firms, perform contract research, and form spinout companies comprising former ITRI staff technologies. ITRI's network-building effect has been described as performing a "bridging role" linking domestic firms with foreign technology and customers. This bridging role is led by ITRI's Industry, Science, and Technology International Strategy Center, which helps firms develop relationships with foreign companies and research organizations.[2]

ITRI's combination of a) clearly articulated technology focus areas with b) relative political autonomy in day-to-day operations proved essential for sustaining the long-term focus needed to develop its semiconductor industry. ITRI's Core Laboratories focus on targeted areas (currently big data, electronic and optoelectronic devices, manufacturing automation, measurement and standards, and advanced materials). Then, its Technology Integration Centers draw on the Core Laboratories' work, integrating it into cross-cutting technologies, such as microelectronic machines, green energy, and additive manufacturing. As priority technology focus areas evolve, ITRI funds new centres, which then contract with the laboratories to develop specific technologies.

ITRI's success is attributable to its ability to coordinate public–private R&D efforts, infusing foreign technology into domestic firms to build out a comprehensive domestic supply chain. Fasteau and Fletcher summarize ITRI's "Coherence and Coordination" strengths as follows:

> ITRI combines a) an authoritative central coordinating entity, b) autonomy for subunits in implementing its overall strategy, c) intensive continuing consultations and movement between government, industry and academia, and d) proactive organizational change in response to global economic and technological developments." (Fasteau & Fletcher, 2024)

ITRI's industry coordination role assigns specialized roles to individual companies and links them into production networks. This supply chain coordination approach is captured in the following quotation from the director of ITRI's Display Technology Center, John Chen: "The biggest strength of ITRI is the multidisciplinary cooperation. We create a complete manufacturing supply chain in its early stages. That is the secret. Then you can scale it up, you can have a complete supply chain for the industry" (Fasteau & Fletcher, 2024).

2 ITRI collaborates with leading public and private research organizations, including: Merck (United States), Fraunhofer-Gesellschaft, Applied Materials (United States), Corning Glass (United States), Underwriters Laboratories (United States), VTT (Finland), AIST (Japan), IMEC Belgium), NRC (Canada), LM Ericsson (Sweden), and TNO (Holland).

Taiwan coordinated regional cluster formation by providing physical and business infrastructure. In 1978, the cabinet adopted the Minister of Finance's Science and Technology Development Program. The program created a permanent advisory body for science and technology to be chaired by the finance minister and report directly to the Premier. This cross-government coordination mechanism went on to reinforce geographic coordination of industry and ITRI, via the Technology Development Program's call for the creation of science infrastructure, which led to the 1980 launch of Hsinchu Science-Based Industrial Park. Hsinchu Park "became an extremely important factor in Taiwan's semiconductor industry's success by enabling the geographical concentration of a complete chain" of manufacturers and suppliers within a 30-minute drive (Breznitz, 2021, p. 80).

Policy Mix

ITRI's support extends well beyond R&D. It helps SMEs through the commercialization valley of death by offering access to facilities, management and marketing advice, expertise, training, support, and connections to early-stage public and private funding (Fasteau & Fletcher, 2024). In addition to defending its own patents in litigation, ITRI has developed comprehensive support services through its Technology Transfer and Law Center to help domestic firms manage intellectual property, navigate patent litigation, and licensing negotiations with foreign firms. This is often done by grouping firms into alliances. ITRI will also strengthen the hand of strategic firms by auctioning off (under exclusive licences) ownership of a pool of patents related to specific technology areas.

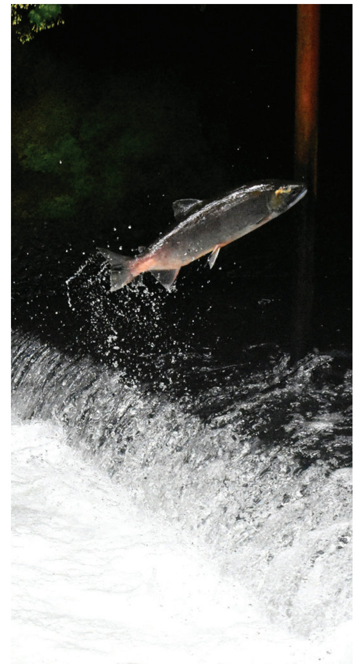
Financing is also a key policy lever to help scale domestic firms. ITRI has a direct role in this policy domain, via equity investments in spinout firms to commercialize technologies from ITRI's R&D programs. This occurs through ITRI's subsidiary the Industrial Technology Investment Corporation. Finally, a key feature of Taiwan's success has been its financial regulations, which strategically incentivize domestic financing for domestic firms (Breznitz, 2021).

Aquaculture—Chile

Sustained Commitment

Chile's state innovation agency spearheaded the transformation of the country's traditional fishing industry into salmon aquaculture. Chile's salmon exports increased from USD 38 million in 1989 to more than USD 1 billion in 2003, making Chile the world's top exporter of farmed salmon (Perez-Aleman, 2005). An early commitment to the sector occurred in 1967 through a joint venture between Chile's National Fisheries Service and the Japan International Cooperation Agency that provided foreign technical assistance to domestic firms until 1987. In 1988, Chile's state economic development agency, Corporación de Fomento de la Producción de Chile (CORFO), through its affiliate Fisheries Development Institute, took the lead in identifying and remedying various technological, operational, and supply chain bottlenecks in the transition to aquafarming (Breznitz et al., 2018).

Coordination Body



CORFO successfully coordinated Chile's ascent to become a leading aquaculture exporter. CORFO has been labelled a "directed upgrader" innovation agency by Breznitz et al. (2018). Directed upgraders are innovation agencies that perform R&D, are situated in the core of the government structure, and are well-embedded in traditional industry networks. CORFO assumed leadership—with input from industry leaders and other government departments—in identifying seven "high-potential" sectors, focusing on existing national strengths: mining, aquaculture, agriculture, special interest tourism, construction, creative economy, and advanced manufacturing. CORFO

> maintains close relationships to the private sector—both individual firms and industry organizations—as a means of understanding the kinds of market failures that prevent Chilean firms from upgrading or what technologies might be imported from abroad to assist the local economy. (Breznitz et al., 2018, pp. 7–8)

Policy Mix

CORFO has played a leading role in R&D, augmented with other supply-side and demand-side policy instruments. CORFO successfully scaled up domestic firms in the late 1980s and early 1990s by improving foreign technology originally sourced in the early 1970s via a Japanese joint venture. This positioned the country's cohort of domestic firms to once again benefit from foreign multinationals increasing their investment in the cluster in the 1990s and 2000s. Foreign firms' entry pushed domestic firms to be more competitive and to expand into other value-added segments of the supply chain:

> In the Chilean salmon cluster, the entrance of foreign [multinational corporations] MNCs does not represent the classic case of a cluster that forms around one dominant foreign MNC, nor an example of the commodity chain view in which an MNC buyer dominates a cluster of subordinate local companies. (Breznitz et al., 2018, pp. 7–8)

The reason for this mutually beneficial relationship is that policy-makers built up domestic firms through industrial policies prior to the expansion of foreign firms. Indeed, the initial efforts to build up local firms relied on inputs and technical assistance from foreign firms (e.g., seeds, feed, etc.). This deliberate sequencing results in "Chilean entrepreneurs and MNCs have become more interdependent, increasing the flows of ideas, capital and organizational resources" (Breznitz et al., 2018, pp. 7–8). Competition has also put pressure on Chilean firms to move into value-added areas previously dominated by foreign firms, such as feed and egg production (Breznitz et al., 2018, pp. 7–8).

CORFO worked with other agencies to "fund public research, establish the Salmon Technology Institute, determine the most auspicious locations for aquafarms, and establish the collective standards that would help enable producers to penetrate sophisticated export markets" (Breznitz et al., 2018, pp. 7–8). When fish disease threatened exports in 1993, CORFO funded 45% of the collaborative R&D effort to develop vaccines for fish disease with the leading industry association. The association diffused best practices in disease management among its member companies (Breznitz et al., 2018, pp. 7–8).

Beyond R&D, CORFO also used demand-side policy instruments, such as standards. These quality seal certification standards were originally developed through the industry association, financed by government. The government then created national regulations inspired by the industry set standards, making them into mandatory quality norms for any plant operating in Chile (Breznitz et al., 2018, pp. 667–668).

4.2 Homegrown Successes From the Canadian Tradition of Industrial Policy

This section will draw from Canadian industrial policy success stories in the canola industry, oil sands, and the satellite industry. Importantly, the section shows that Canada's successful industrial policy tradition is as much about applying innovation to add value to traditional natural resource sectors (canola oil and oil sands) as it is about creating novel products in emerging industries (satellites). These examples illustrate the various governance mechanisms and policy instruments that successfully overcame the structural barriers associated with the scale-up and technological dependence problems. Policy-makers strategically deployed public investments in R&D (oil sands and canola) and strategic procurement (satellites) to successfully scale R&D-intensive Canadian firms into global exporters. Similar to the international cases discussed above, these cases all include the following common elements: a) a sustained commitment to a particular technology area; b) creation of a dedicated coordination body to facilitate alignment of private and public efforts as the needs of innovative firms evolve; and c) augmenting an R&D-focused strategy with the mobilization of a wide range of supply-side and demand-side policy instruments. In short, policy-makers committed to targeting something, created a coordination mechanism, and offered more than just R&D support.

While these cases share core similarities with the international examples, analyzing them yields insights into how these general best practices can be tailored effectively to the Canadian context. This involves adapting industrial policy approaches to suit both political institutions and economic structures. As a regionally differentiated economy with a decentralized form of federalism, industrial policy is sometimes more effective if it is coordinated across levels of government. For example, the canola case illustrates how federal R&D produced breakthroughs that were then diffused through industry by both federal and provincial extension programs. The Alberta Oil Sands Technology and Research Authority (AOSTRA) oil sands case is even more decentralized, with the bulk of the R&D and diffusion initiatives occurring at the provincial level in Alberta. Both cases show how different types of arms-length innovation organizations (a non-profit organization for canola and a Crown corporation for oil sands) with technology-specific mandates can be effective in marshalling the coordination needed to align various policy instruments (sometimes at various levels of government) with the evolving needs of the nascent industry. The satellite case study illustrates a successful industry born largely out of federal government R&D and procurement. This case also offers a lesson in designing a coordination mechanism (the Interdepartmental Committee on Space [ICS]) to overcome the tendency for siloed fragmentation amongst federal departments, which is an institutional feature of Westminster government that can frustrate effective industrial policy.

Table 2. Summary of Domestic Best Practices

Cases	Policy instruments	Coordination mechanisms
Canola oil	- State–industry and intergovernmental coordination via the Rapeseed Association of Canada	- State–industry and intergovernmental coordination via the Rapeseed Association of Canada
Oil sands	- State–industry coordination via AOSTRA	- State–industry coordination via AOSTRA
Satellites	- Whole-of-government coordination via ICS	- Whole-of-government coordination via ICS

Canola Oil

Sustained Commitment

Canada's canola industry is a prime example of how persistent public–private coordination over decades can align government R&D, standard setting, and extension services to create a new industry in a traditional sector. Canola has grown from breakthroughs in federal labs in Canada to become the world's third most important edible oil crop behind corn and palm (Phillips, 2018). Rapeseed oil represents USD 5.26 billion in exports in 2023, while rapeseed represents USD 4.71 billion (Observatory of Economic Complexity, n.d.-b).

First used for industrial oils in WWII, government researchers in the early 1960s developed novel rapeseed varieties that were then replaced by new canola-quality seeds that had better nutritional profiles in the 1970s. The 1980s saw demand for the product increase thanks to international standard setting and health testing (Phillips, 2018). At the same time, supply was expanded thanks to extension programs that diffused the novel varieties and growing techniques to producers. In the mid-1990s, intellectual property regimes enabled transgenic, herbicide-tolerant varieties to be introduced. Finally, new oil profile seeds have been introduced in differentiated food and industrial markets in the past 20 years.

Coordination Body

The Rapeseed Association of Canada (RAC, now called the Canola Council of Canada) served as an effective mechanism for information sharing and coordination of public and private efforts. Formed as a non-profit entity in 1967, most (70%) of the Association's budget came from crushers and exporters through a voluntary CAD 0.50 per tonne levy on rapeseed exports and seed crushed domestically (Phillips, 2018). The government also partnered with the association as a delivery mechanism when the Federal Department of Industry, Trade, and Commerce set up the CAD 1.25 million Rapeseed Utilization Assistance Program, funded by the federal department but administered by the research committee of the Association (Phillips, 2018).

The organization's coordination efforts solved a collective action problem in the mid-1960s. After years of R&D advancements by federal scientists, rapeseed as an oil crop "had reached a threshold where more investment in both product development and in market structures (e.g., extension, foreign market development) was required, but no single institution, public or private, had the means or incentive to undertake the work alone … with the benefits of any individual's investments likely being shared with a wide variety of free riders" (Phillips, 2018, p. 106).

The RAC effectively coordinated R&D efforts in universities and government labs toward solving the most pressing issues. For example, export markets threatened to shut out Canadian producers in response to a 1970 European study that found that high erucic acid varieties (the kind dominant in Canada at the time) caused heart problems. The RAC quickly expedited research for low-erucic acid varieties:

> [W]hile their financial contribution was small (only about 2.5% vs 80% from government and 17% from industry), the RAC was instrumental in signaling industry and farmer interest to the universities and in targeting efforts on specific research priorities. During the 1967–1973 period, about 95% of the technologies and all of the new varieties came from public labs, and the results were released without restriction to producers (Phillips, 2018, p. 106.

This hybrid R&D model was combined, with the RAC also taking the lead in partnership with the federal government (Agriculture and Agri-Food Canada) in market development, extension, and public relations. A rapid changeover to low-erucic acid varieties ensued (86% complete by 1973 and 95% complete by 1974). Phillips summarizes the importance of the RAC's arm's length status from both producers and government, which bolstered its credibility as a coordination mechanism:

> Given that the Association did not engage in actual market transactions or handling of the product and did not take a position on the marketing system, it was able to act as a credible voice in the market. Without the efforts of the Association, many believe it would have been highly unlikely that any of the firms or actors in the sector would have been able to put together the necessary package of programs both to push rapeseed research forward at that critical juncture and to lay the groundwork for expanding production and export markets. The market development problems were simply too large. (Phillips, 2018, p. 107–108)

Policy Mix

The multi-decade rise of canola in Canada is a result of a wide range of policy instruments, evolving from government R&D, extension services, standard setting, and setting intellectual property rules. As discussed above, the RAC (now the Canola Council of Canada) played a key coordination role in mobilizing many of these supports, particularly supply-side R&D in the decades prior to the 1980s.

The Council was particularly effective in simultaneously facilitating the supply of canola through R&D and extension while also creating demand through standards and marketing. Specifically, the R&D enabled the setting of specific standards, which in turn enabled marketing and export market development. For example, by 1978, R&D breakthroughs positioned the association to enact what Phillips calls is its "most astute and fundamental step": registering the "canola" trademark, restricting the designation to rapeseed varieties with less than 5% erucic acid (lowered to 2% in 1986) and less than 30 micromoles of glucosinolates per gram. The RAC then changed its name to the Canola Council of Canada in 1980 to reflect the new standard. The RAC also coordinated demand-side policy efforts, such as international standards and marketing, to open export markets for Canadian firms:

> The Council funded extensive research into the health benefits of canola and by 1984 … the Council and Agriculture Canada presented data to the United States Food and Drug Administration, which ultimately granted canola oil the status of "generally regarded as safe" (GRAS) in 1985. (Gray et al., 2006)

This new demand was then serviced thanks to supply-side extension programs. In 1998, the Canola Council of Canada created an extensive extension program, with multiple sites in Alberta, Saskatchewan, and Manitoba. These programs were coordinated with the continuing provincial extension programs in Alberta, Saskatchewan, and Manitoba.

Oil Sands

Sustained Commitment

Crude petroleum is Canada's largest export (USD 106 billion in 2023) (Observatory of Economic Complexity, n.d.-b). The key technology that unlocked the majority of Canada's oilsands is steam-assisted gravity drainage (SAGD). SAGD is vital to Alberta's current prosperity: of the 165 billion barrels of established reserves in the Alberta oilsands, only 20% is recoverable without SAGD (i.e., via mining) (Hastings-Simon, 2019, p. 37). SAGD was invented and diffused as a deliberate industrial policy led by the province of Alberta between 1974 and 2000.

In the early 1970s, Alberta's conventional oil industry was critical of the oil sands and advocated for a limited government role in supporting innovation as a third-party coordinator and arm's-length funder. They preferred innovation investments in enhanced oil recovery from conventional oil reserves, which fit better with their existing business model. However, in 1972, newly elected Premier Peter Lougheed put forward a more disruptive vision to increase government revenues from conventional production and use the funds to develop the technology necessary to unlock the in situ oilsands. On January 14, 1974, the Lougheed government announced the creation of AOSTRA as part of its "Energy Breakthrough" project "to achieve as rapidly as possible the breakthrough in research and technology that is essential to guarantee production of that part of Alberta's Oil Sands that cannot be recovered through a surface mining process" (Hastings-Simon, 2019, p. 37).

Sustained commitment to this goal over time was a crucial ingredient for success: “AOSTRA’s success required a clear vision for the effort in the face of pressure for other priorities, long-term sustained investment at a significant level and acceptance of a certain level of failure” (Hastings-Simon, 2019, p. 21). This commitment was reinforced via multiple funding renewals, “even when the 10-year report had only limited progress to show for the more than $854 million (2019 dollars) in government investment to date” (Hastings-Simon, 2019, p. 21). Ultimately, AOSTRA CAD 1.4 billion (2019 dollars) from 1975 to 1994 (Hastings-Simon, 2019, p. 21). Oil and gas royalties collected by Alberta each year consistently exceed this amount (e.g., CAD 28 billion in 2022) (Canadian Association of Petroleum Producers, 2023).

Coordination Body

Hastings-Simon’s 2019 study of AOSTRA highlights its importance as a coordination mechanism in unlocking the oil sands and diffusing this technology among industry. This success is attributed to its steady funding and relative autonomy from interference in day-to-day operations as a Crown corporation. The result was a technically competent organization that could partner in joint R&D ventures with industry. This enabled AOSTRA to partner with industry without its research interests being captured by incumbent interests looking to incrementally improve technology relevant to conventional oil extraction business models. This autonomy also enabled experimentation and risk-taking in the form of AOSTRA making sole investments. In 1984, 10 years into the program, faced “with the failure to recruit any industry funding partners, AOSTRA’s leadership broke with the rules—that all projects must have at least a 50-per-cent industry contribution—and made the critical decision to proceed with constructing the underground test facility and testing of SAGD as a government-led project without any industry matching funds” (Canadian Association of Petroleum Producers, 2023). This testing site yielded the breakthrough results that eventually led to industry willingness to co-fund research and license the Crown corporation-owned intellectual property.

Policy Mix

Hastings-Simon (2019, p. 2) summarizes AOSTRA's industrial policy lessons regarding the importance of R&D diffusion as follows: "there needs to be a clear mechanism for knowledge diffusion and recovery of the value of the knowledge created." AOSTRA used a unique intellectual property ownership structure. In contrast to the approach taken in many other public–private innovation partnerships, AOSTRA retained the intellectual property and licensed it to the firms that participated in the pilots. AOSTRA provided additional support for the scaling up of the industry following the technical breakthrough through favourable royalty structures, other subsidies, and tax reductions.

Satellites

Sustained Commitment

Canada's space sector has become a prominent source of economic prosperity, with over 200 firms and 12,624 employees in 2022 (Canadian Space Agency, 2024). The sector produced CAD 5 billion in revenues, 75% of which came from the satellite industry. The story of the Canadian satellite industry is one of a successful industrial policy where government R&D and procurement served as a springboard to scale the capabilities of Canadian firms to become global exporters (40% of 2022 revenues for the space sector came from export markets, mainly in the United States and Europe) (Canadian Space Agency, 2024).

The first significant expression of Canada's commitment to creating a satellite industry occurred in 1974 via the strategy document A Canadian Policy for Space. Central to this policy was the following statement: "The government endorses the principle that a Canadian industrial capability for the design and construction of space systems must be maintained and improved through a deliberate policy of moving government space research and development out into industry" (Atkinson & Coleman, 1989). As shown below, successive governments adhered to achieving this goal through a consistent industrial policy approach combining R&D and diffusion through procurement.

Coordination Body

Canada's successful satellite industrial policy involved a powerful combination of a central agency-resourced coordination body, the ICS, with a technically competent line department, the Department of Communications (DOC). This served to concentrate decision-making responsibility for the space industry among the five relevant government departments/agencies: DOC, which managed most of the experimental communications programs, including Hermes and Anik B; the National Research Council's Space Science Program, which led the Shuttle Remote Manipulator System (the Canadarm) by SPAR Aerospace; the Department of National Defence's search and rescue experimental project; the Department of Energy, Mines and Resources' Canada Centre for Remote Sensing; and the Department of the Environment's meteorological satellites (Atkinson & Coleman, 1989).

The ICS was formed in 1969 and empowered in 1974 through the strategy document A Canadian Policy for Space. With a permanent secretariat housed in the Ministry of State for Science and Technology, the ICS integrated and presented to Cabinet all new program proposals relating to space. Scholars summarized the importance of this coordinating role as follows:

> this was a key step...without this responsibility, decision making tends to be confused and ineffective. The ICS became, accordingly, a mechanism for coordinating the various agency interests, integrating these interests in developing an overall plan, and consulting with industry in assessing the viability of the plans. (Atkinson & Coleman, 1989, p. 106)

This gave the ICS the capability to fulfill its role to ensure that departments submitted plans that conformed to the principle: "Canada's satellite systems are designed, developed and constructed in Canada, by Canadians using Canadian components" (Department of Communications, 1980, p. 17). These contracts fostered industrial expertise in Canadian companies that went on to become leading exporters (e.g., SPAR Aerospace, MacDonald, Dettwiler and Associates, Comdev).

The whole-of-government coordination achieved through the ICS enabled the DOC to foster coordination with industry players via a whole-supply-chain approach. For example, in 1989, when Canada partnered with the United States to launch a remote communications satellite that required new ground-station technology not available in Canada, the government made efforts to ensure the project supported the formation of Canadian industrial technological capabilities rather than merely importing the technology. Four years before the decision, the DOC published a discussion paper to ensure that 80% of the demand for ground terminals could be met from Canadian suppliers. It also targeted 10% of the U.S. market for Canadian industry. The plans set out in the document "were very detailed both as to products and components, and to timing. The paper was then used as the starting point for discussions between likely participant firms in industry and the department's own scientists" (Atkinson & Coleman, 1989, pp. 111–112).

The Government of Canada's coordination mechanisms for its space industrial policy are currently being revitalized. This follows calls from industry associations for a recommitment to the goal of supporting the 200 innovative firms comprising Canada's space sector with strategic investment and procurement (Canadian Space Agency, 2024). Regarding coordination mechanisms, Budget 2024 announced the establishment of a National Space Council, "a whole-of-government approach to support space exploration, space utilization, technology development, research and security" (Government of Canada, 2024). The Council aims to harness coordination to address cross-cutting issues that span commercial, civil, and defence space domains. The establishment of a national space council meets a long-standing request from industry stakeholders, such as Space Canada, an industry association representing approximately 80 space sector companies (Datta, 2024).

Policy Mix

Canada's space industry (particularly the commercial satellite industry) is a great example of successful use of R&D and strategic procurement to support the emergence of Canadian scale-ups that went on to become leading exporters.

Regarding R&D, the DOC took over from the National Research Council the administration of the Pilot Industry/Laboratory Program, which provided funding for the transfer of technology from government laboratories to firms. The DOC steadily expanded its R&D capabilities through the Communications Research Centre's David Florida Laboratory, which "served as the focal point for research and development on satellite technology in Canada, transferring the fruits of its labours to industry" (Atkinson & Coleman, 1989, pp. 111–112). The lab provided, on a cost-recovery basis, "all the necessary equipment and assembly areas needed to perform integration and environmental testing of space aircraft" such as commercial satellites Anik C, Anik D, and Anik 02 (Atkinson & Coleman, 1989, pp. 111–112).

Crown corporations were another mechanism the DOC used for moving government R&D into the industry. Telesat Canada, created in 1969 and jointly owned by the telecommunications carriers and the federal government, was mandated to develop a domestic space and communications industry. Telesat Canada launched Anik A1 in 1972, making Canada the first country to place a commercial communications satellite in geostationary orbit (Globe and Mail, 2002). In 1979, the Canadian government ended Telesat Canada's legal monopoly on Earth stations, allowing other entities to enter the market (New Space Economy, n.d.).

The Anik satellite series highlights how procurement and R&D combined to assist not only Telesat but a larger domestic supply chain as well. Atkinson and Coleman use Canadian firm SPAR Aerospace to illustrate the government's commitment to harnessing procurement and the David Florida research lab toward the principle of fostering "Canadian-based prime-contractor capability": "SPAR was the prime contractor for the Anik D series of satellites. Spar parlayed this contract—and the exposure it received from another product, the Canadarm—into its selection as the prime contractor for the Brazilian communications satellite" (Atkinson & Coleman, 1989, p. 110).

Support went beyond R&D and procurement to include export market development. The DOC supported Canadian firms bidding to provide Earth stations in New Guinea and China via government-to-government negotiations and guarantees. This helped SPAR secure the Brazilian contract. The DOC also organized the CAD 8 million SPAR-Embratel training program, which was funded by the Canadian International Development Agency to train engineers and technicians to operate Brazil's communications satellite (Atkinson & Coleman, 1989).

The federal government continues to invest in backing the Canadian satellite industry. On September 13, 2024, the federal government announced an agreement with Telesat to operate the Telesat Lightspeed satellite network. (Lowrie, 2024). With a CAD 2.14 billion investment from the federal government, Telesat Lightspeed will be Canada's largest ever space program, providing affordable internet and 5G networks via Telesat's low-Earth-orbit satellite network. The Crown corporation Canada Development Investment Corporation (CDEV) worked with the Department of Innovation, Science and Economic Development and the Department of Finance to structure the transaction. As part of the agreement, CDEV established a new subsidiary to manage the loan, as well as hold and manage the Government of Canada's loan and stock warrants (CDEV, n.d.-a).

4.3. Best Practice: Lessons from Canadian and international experience

As noted above, a survey of these successful case studies shows that all of them involve three common elements:

1. They target specific technologies/sectors and stay for the long haul, i.e., as long as the effort is yielding results (See Box 3).
2. They establish tailored coordination mechanisms that can continuously align industry and government efforts as the needs of innovators evolve (See Box 4).
3. They augment an R&D-focused strategy with a wide variety of other supporting policy instruments (See Box 5).

As well, the case studies demonstrate that successful industrial policy has the following elements:

- ways to inject high-quality expertise into strategy and learning at multiple points;
- central authority and buy in from the centre of government to signal priorities and achieve cross-government coordination;
- decentralized problem solving so that the firms and experts on the front lines are directly connected to policy-making and implementation, allowing the industrial policy to generate solutions to problems as they arise;
- a way to enforce policy discipline to ensure that the industrial policy is not captured by industry interests, meaning it uses conditional support to push businesses to achieve ambitious, yet realistic targets.

The section that follows lays out concrete recommendations to help design a New Canadian Industrial Strategy in line with these guidelines.

Box 3. Short-lived coordination bodies: Government of Canada's Economic Strategy Tables (2017–18) and the Ontario Government's Sector Partnership Fund (1992–1995)

LESSON: PERMANENT BODIES ARE NEEDED TO COORDINATE SECTOR-SPECIFIC INDUSTRIAL POLICY

Government of Canada's Economic Strategy Tables (2017-18) included 90 CEOs and were chaired by industry leaders in six key sectors: advanced manufacturing, agri-food, clean technology, digital industries, health/biosciences, and resources of the future. Each table produced a report authored by up to 15 CEOs. During 2017 and 2018, the tables held 34 meeting, 67 engagements sessions with businesses across the country, and eight meetings with provincial, territorial, and federal governments (Government of Canada, 2019). A subsequent report was commissioned by some of the chairs of the tables in 2020 in response to the COVID-19 pandemic under the Industry Strategy Council title.

Follow-up analysis found that participants lamented the ad-hoc nature of the process, noting that the tables did not feel like they were part of a larger, ongoing/strategic relationship in service of a larger industrial strategy (Southin, 2022, p. 190). Their recommendations for areas for improvement included making the tables permanent, targeted on implementation and specific challenges, and better connected to whole-of-government/ intergovernmental strategies.

Another promising, if short-lived, collaboration mechanism was the Ontario Government's CAD 150 million Sector Partnership Fund (1992–1995). Funding for cooperative projects boosting technological capabilities and specialized technological infrastructure was allocated based on strategies created by industry sectors. To qualify for funding, a sector had to develop a strategy identifying common goals, challenges, opportunities, and action plans (Bradford, 1998). Despite substantial interest at the outset by 28 different sectors and over 2,000 individual participants, approval delays by central agencies hindered the rollout of the funds for sector projects (Wolfe, 2002). The program was abruptly cancelled by the new Progressive Conservative government in 1995.

Box 4. Coordinating bodies: EV/battery & mass timber supply chain examples

Accelerate's recent Battery Innovation Roadmap called for the Government of Canada to establish a national battery alliance through a public–private partnership model for strategy development and collaboration (Allan et al., 2024). This body would facilitate the exchange of high-quality information, enabling collaborative problem solving for uncovering problems and solutions in markets and innovation processes. The Alliance would work closely with funding agencies such as the Canada Innovation Corp (CIC) and the Office of Energy Research and Development to coordinate R&D across the ecosystem. The Alliance should manage expert and industry groups to provide inputs into R&D needs, like the approach of the European Battery Alliance or Li-Bridge in the United States.

Similarly, the Mass Timber Roadmap called for the creation of a "Mass Timber Alliance" to bring together existing leaders like the Canadian Wood Council, FPInnovations, Forestry Innovation Investment, the Forest Products Association of Canada, firms, and government agencies (Allan & Eaton, 2024). This public–private coordination body would develop and advance policy and program priorities. Coordination topics would include setting building archetypes for the housing crisis and shaping policy to stimulate supply and demand for mass timber to scale Canadian industrial capability in every step along the forest-to-construction supply chain.

Box 5. R&D support without targeted industrial policy enriches foreign competitors

LESSON: CANADA'S INABILITY TO SCALE ITS EV BATTERY SCIENTIFIC EXCELLENCE INTO HOMEGROWN INDUSTRIAL CAPACITY SHOWS HOW ACADEMIC RESEARCH NEEDS TO BE EMBEDDED IN A BROADER SUITE OF SUPPORTING POLICIES.

The lithium-iron-phosphate (LFP) battery suffered from low conductivity until a Québec-based consortium of the Université de Montréal and Hydro-Québec invented a coating technology in the 2000s. In the absence of a broader Canadian battery industrial policy, the consortium allowed its patent to be used in China without licensing fees so long as the batteries were not sold outside of China (Mitra Chem, 2022). Chinese industrial policy (particularly procurement) then helped scale LFP at CATL, which is now the world's largest battery producer (Allan et al., 2024). The Québec-based consortium's patent expired in 2022. CATL is now free to export its technology and production capabilities around the world.

Box 5. R&D support without targeted industrial policy enriches foreign competitors (continued)

Similar to CATL, Tesla's growth was fuelled by a combination of U.S. industrial policy (particularly Department of Energy loans) and Canadian public research funding. Tesla received over six strategic patents in exchange for jointly funding battery research at Dalhousie University with the Government of Canada's Natural Sciences and Engineering Research Council of Canada (NSERC) since 2016 (Shirouzu & Lienert, 2020). In an October 2020 interview with The Logic, Principal Investigator Jeff Dahn said, "We have the ability to publish our work—that's highly important for graduate students so they can get jobs afterwards—and in exchange for that, Tesla gets the IP. That's the deal that we made. It may not be the best deal, but it works for us" (McIntyre & Hemmadi, 2020). The renewed contract (2021–2026) sees CAD 2.9 million from NSERC and an additional CAD 3.1 million from Tesla (MacDonald & Charlton, 2021). The terms of the contract between Tesla and the Dalhousie research team were not disclosed.

"Canada's battery research community has always been at the cutting edge. With the right support and investment, we can translate this scientific excellence into homegrown industrial capacity."

- Jeff Dahn, Professor Emeritus, Principal Investigator, NSERC/Tesla Canada/Dalhousie Alliance Grant, quoted in Accelerate's Battery Innovation Roadmap (Allan et al., 2024)

FIVE

Recommendations: Synthesizing an approach for Canada

This section articulates a set of recommendations for a New Canadian Industrial Strategy, distilled from the best practices from Canadian and international case studies.

Canada currently lacks a systematic approach to industrial policy. Decades of reliance on non-targeted instruments such as Scientific Research & Experimental Development tax credits led to an erosion of the industrial policy capacity needed to proactively identify and support strategic priorities (outside of continued legacy support to the automotive and aerospace sectors). Recognizing the need to reverse the persistent decline in business expenditure on R&D, the current government added a more interventionist approach, layering onto the policy mix new direct grant and contribution programs, such as the Strategic Innovation Fund. These programs lacked a strategic focus, opting instead for an open-call, passive model of making support available to all sectors/technologies. Assessing applications in this manner taxed the already limited technology-specific capacity within government, which was often housed in other departments (Net-Zero Advisory Body, 2025).

Without technology-specific, whole-of-government strategies informed by dialogue with industry, the new clean growth programs such as the CGF risk continuing to be overstretched. We need an approach that mobilizes a broad policy mix to position Canadian firms as leaders within strategically targeted supply chains.

This moment presents a critical opportunity for Canada to draw from its successful industrial policy tradition. This does not require a lengthy overhaul of government machinery. The following recommendations aim to better coordinate what already exists.

Recommendation 1: Create an advisory task force to support the government's strategic capacity

Create an advisory task force comprised of independent experts to equip the Prime Minister's Office (PMO)/PCO with the requisite expertise to serve as a strong central authority to lead on forming and evaluating industrial strategy. The task force should be comprised of independent experts to advise the PMO/PCO on strategic priorities, catalytic investments, and policy design.

Based on the recommendations from the Advisory Task Force, the PMO/PCO should signal high-level whole-of-government direction for industrial policy by identifying 5–7 priority opportunities. The current context demands agility and speed in assembling the initial list, but ultimately, selecting these sectors should be an ongoing, iterative process rather than a one-off effort. Regular transparent review based on clear, realistic success metrics should allow for course correction without stifling the coordination body's autonomy.

Rationale

PMO/PCO lacks the industry expertise needed to identify technology/sector focus areas for Canada's industrial policy. This lack of strategic direction reinforces a) an uncoordinated array of passive, technology-agnostic programs unable to achieve critical mass in any given technology area, and b) a lack of measurable success metrics, such as global market share or technological performance benchmarks.

Many experts have called for the creation of a technology advisory task force or council at the PMO/PCO level. Budget 2024 promised to create an "advisory Council on Science and Innovation" to "help guide research priorities moving forward." This Council "will be made up of leaders from the academic, industry, and not-for-profit sectors, and be responsible for a national science and innovation strategy to guide priority setting" (Government of Canada, 2024). Innovation policy experts welcomed this move, noting that, unlike many advanced economies, Canada has not had an advisory council for science, technology and innovation policy since the demise of the Science, Technology and Innovation Council in 2015 (Dufour, 2024). Indeed, the 2023 Report of the Advisory Panel on the Federal Research Support System ('Bouchard report') emphasized that since the dissolution of the Science, Technology and Innovation Council, "Canada has a worrisome vulnerability in independent strategic advice capacity" (ISED, 2023b). To address this, the report advocated for the following:

> The panel strongly recommends that the government proceed with the creation of an independent advisory body to provide the government with strategic policy advice on science, research and innovation, and evaluate and publicly report on the support for, and performance of these activities in Canada. This body would also play a key role in setting a vision for the future, shaping Canada's longer-term science, research and innovation priorities and an ambitious, multi-year national strategy to achieve them. (ISED, 2023b, p. 7)

This is the sort of entity that should be tasked with providing the advice needed for the Government of Canada to get ambitious things done.

Implementation

The advisory task force should seek input from the provinces and territories to jointly identify and prioritize opportunity areas that industrial policies should target. This can build on existing regional priorities identified through NRCan's Regional Energy and Resource Tables (Natural Resources Canada, n.d.). Regional Tables are underway in 10 provinces and territories: British Columbia, Manitoba, Ontario and the 4 Atlantic provinces (New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador) as well as the Northwest Territories, Nunavut, and Yukon. An alternate collaboration has been established with Alberta, an Alberta–Canada Deputy Minister-level working group.

Provincial governments, regional industry groups, and federal regional development agencies will be well-placed to identify these opportunity areas, as they know their region's industrial strengths best. While regional equality is always an important consideration in allocating federal resources, this should not come at the expense of concentrating sufficient resources to achieve a globally competitive scale. Selecting opportunity areas where the supply chain will cross provincial and regional lines may help mitigate this. Similarly, it will be important to avoid the tendency to select technology/sector areas that are too broad (e.g., "advanced manufacturing"). A fiscally constrained environment will make it even more vital to be selective when deciding which areas to strategically target.

The areas of focus should be prioritized based on existing strengths, such as technological capabilities of Canadian firms, size of Canadian footprint in the supply chain, size of global market opportunity, natural resource endowment, scientific expertise, and existing government research infrastructure, and, importantly, whether the technology is in alignment with a transition to net-zero.

Research by the Transition Accelerator[3] canvased existing studies of Canada's opportunities to identify seven consensus areas that will experience growing demand as the world transitions to eliminate net emissions by mid-century:

- EVs and the battery supply chain
- carbon capture, utilization, and storage
- hydrogen
- biofuels
- value-added agriculture (e.g., alternative proteins)
- value-added forestry (e.g., mass timber)
- critical minerals.

[3] See: Allan, Eaton, Goldman, Islam et al. (2022) (2021); BCG (2021); Duruflé & Carbonneau (2016); RBC Economics (2021a, 2021b) 2020).

The study's three selection criteria (market potential, resource potential, innovation potential) provide a useful framework for how governments should weigh various net-zero opportunity areas. Market potential refers to the potential size of both domestic and international markets. Resource potential refers to the availability of relevant natural resources (natural capital), upstream inputs, or specialized labour skills (human capital). Finally, innovation potential assesses whether Canada could build an advantage in the production of a technology or good due to the nature of innovation in the relevant associated sector or industry (patents, academic research expertise, innovative firms) (Allan, Eaton, Goldman, Islam et al., 2022). Appendix A illustrates the application of the selection criteria to the cases of the EV and battery supply chain and the mass timber supply chain.

Subsequent analysis by the Transition Accelerator noted that Canada's natural resource endowment makes it well-positioned to capture segments of global supply chains, provided that strategic industrial policies cultivate advanced production and innovation capabilities (Allan et al., 2024). Several of these opportunities have been expanded on in technology-specific roadmaps co-created by TA and industry to articulate opportunities, targets, barriers, policy solutions (e.g., Mass Timber Roadmap [Allan & Eaton 2024], Sustainable Aviation Fuel [Allan et al., 2023], Battery Value Chain [Allan, Kabbara, Trytten et al., 2022], etc.). These three opportunity areas are compelling places to start, as they have the advantage of being created by business leaders in their respective supply chains. However, other opportunity areas will surely emerge.

Recommendation 2: Select and support coordination bodies for each technology/sector to create strategies that infuse industry expertise into policy design and implementation

Create new (or designate existing) arms-length coordination bodies or intermediaries to lead the co-creation of technology/sector strategies with industry and align the deployment of the policy mix. A different coordinating body would be needed for each of the five to seven priority areas of focus.

Rationale

The current policy approach lacks permanent, technology- or sector-specific forums for information exchange with industry and other experts. This makes it hard to a) identify policy gaps, and b) mobilize the correct mix policy instruments as the needs of industry evolve.

This report's case studies illustrate the importance of having a technology/sector-specific arms-length organization with the right mix of embeddedness within private sector networks and autonomy from being captured by specific dominant industrial interests, so as to be able to pursue collective goods for the innovation ecosystem and the broader public interest. These intermediaries serve to inject real-time techno-economic expertise into the policy-making process, surfaced through continuous dialogue with industry and other experts.

Similarly, a growing number of industry actors have called for permanent coordination bodies to better align Canada's fragmented industrial policy instruments. The Clean Technology Economic Strategy Table, convened by the federal government in 2018, explicitly recommended the creation of a standing mechanism for ongoing collaboration between government and industry to identify policy gaps, coordinate regulation, and align policy across departments (Government of Canada, 2018a). The members of the Economic Strategy Tables wanted them to become an ongoing "board of directors" to advise on and track the implementation of their recommendations (Government of Canada, 2018b). Similarly, the Canadian Manufacturers & Exporters' Canada's Net Zero Industrial Strategy report called on the government to create a senior working group "that regularly measures our progress against targets and adjusts plans, policies, supports and regulations accordingly" (Wilson & Arcand, 2022, p. 16). These proposals recognize the need to inject outside information, but industrial policy best practice suggests that these intermediaries are best when independent from both industry and government (Net-Zero Advisory Body, 2022).

Importantly, while the forums called for by some of the above-mentioned groups are defined at the broad level (e.g., "cleantech" or "manufacturing"), the case studies in this report illustrate the importance of the coordination body being as specific as possible. This granular focus facilitates: a) identifying the relevant experts to consult, b) clarity and specificity in identifying the needs of the industry, and c) generating actionable guidance on the policy instruments needed to fill gaps as innovative firms grow. Accelerate, the national zero-emission vehicle supply chain coalition, has similarly argued for a national battery alliance to ensure public investments in EVs, batteries, and related supply chains are strategically deployed and cross-departmentally aligned with the goal of scaling up Canadian innovators.

Implementation

Two models emerge from this report's case studies as promising coordination mechanisms for aligning state and industry industrial policy efforts: a) the Crown corporation model; and b) the non-profit organization model. As summarized in the chart below, both organizational vehicles could be successful for coordinating industrial policy for net-zero opportunity areas, provided that they can achieve a sufficient degree of technological focus to achieve scale and autonomy to experiment with program design and implementation.

Table 3. Summary of Coordination Mechanisms

	Canadian Examples	Considerations
The Crown corporation model	- AOSTRA (1974–2000) - CDEV (1982) - CGF (2022) - CIC (2026?)	- AOSTRA's technology-specific mandate effectively focused R&D efforts. - CDEV acts at the behest of the Department of Finance for large, one-off projects (e.g., Trans Mountain) and launching open-call, cross sectoral funding programs (e.g., CGF). - CGF and CIC likely have the autonomy to experiment rapidly, but this risks spreading resources thinly across too many technologies.
The non-profit organization model	- RAC (1967) - Global innovation clusters (GICs) (2018)	- The RAC effectively aligned multiple federal and provincial policy instruments. - GICs have the autonomy to align existing federal and provincial programs; however, the current focus risks spreading resources thinly across too many technologies.

The Crown Corporation Model

As a Crown corporation, AOSTRA's technology-specific mandate enabled it to focus effectively its R&D efforts. Contemporary Canadian industrial policy has embraced the Crown corporation model, but not to a lesser degree of specificity. The CGF is a good example of this. The CAD 15 billionfund was introduced in Budget 2022 (Department of Finance, n.d.) and created in December 2022 via CDEV. CGF has the broad mandate of "building a financially prudent portfolio of investments that unlock private sector investment in Canadian businesses and projects to help grow Canada's economy at speed and scale on the path to emissions reductions, in the interest of remaining competitive globally over the longer term" (Canada Growth Fund, n.d.). In 2023, "CGF engaged the services and expertise of the Public Sector Pension Investment Board in the implementation of the CGF mandate" (CDEV, n.d.-b).

It is still too early to tell if the broad "clean growth project" mandate will enable the growth fund to tip the scales in any particular technology area. This will likely depend on whether the Public Sector Pension Investment Board managers decide to spread resources across all technology areas in a passive, project-by-project approach, or whether the CGF has the desire and capacity to concentrate its funds and coordination efforts to focus proactively on coordinating entire supply chains, linking Canadian firms with foreign innovation networks, and mobilizing other policy levers outside of its mandate.

One promising coordination mechanism would be an independent innovation agency, established by the Government of Canada, such as the proposed CIC. First proposed in Budget 2022, the CIC is a forthcoming Crown corporation with the proposed mandate to enhance business investment in R&D across all sectors and regions. The Department of Finance articulated in a blueprint for the CIC in February 2023 that it would have an initial budget of CAD 2.6 billion over 4 years, and would be "expected to begin its operations in 2023" (Department of Finance, 2023a). The National Research Council's Industrial Research Assistance Program would be integrated into the CIC. However, a subsequent announcement by Finance Canada and ISED on December 19, 2023, delayed the full implementation of the CIC to "no later than 2026-2027" (Finance Canada, 2023b). While the CIC will ultimately operate as a parent Crown Corporation, CDEV incorporated the CIC as a subsidiary as an interim measure (CDEV, 2023).

The CIC has the potential autonomy to experiment rapidly, but risks spreading resources too thinly across too many technologies. It is also unclear whether the CIC will be able to serve as the coordination hub to align policy instruments from other federal and provincial departments. Like the RAC, Taiwan's ITRI and Chile's CORFO were able to successfully mobilize non-R&D policy instruments, such as intellectual property and standard setting, export support, and technology extension supports.

The Non-Profit Organization Model

Non-profit organizations (including industry associations, exemplified by this report's case study of the RAC) may prove to be effective coordinating bodies. These could be new or existing entities, depending on the degree to which existing organizations have the independence to avoid being captured by industry interests while also having the embedded network connections with the relevant stakeholders. The non-profit model was used for the GICs and shows promise, particularly if initial design and implementation shortcomings related to a lack of regional/technology focus can be addressed as the program evolves (Munro et al., 2022).

Established by the federal government in 2018, GICs' non-profit status gives them the potential to have the autonomy needed to experiment with programs, albeit within their proscribed model of aligning private R&D efforts through matching grants for collaborative R&D. However, the criterion that each project requires at least one Canadian SME is a promising mechanism for encouraging technology transfer from foreign firms and building customer bases for domestic ones.

Some GICs are narrowly focused on particular sectors. For example, Protein Industries Canada (PIC) has stimulated private R&D largely in the advanced protein sector. Canola sector examples included projects focused on low-carbon processing (PIC, 2024), processes for making novel canola protein (PIC, 2022), and the commercialization of a high-protein canola meal for use in the aquaculture, feed, and food sectors (PIC, 2024). This project is implemented by AGT, which is trying to create a renewable diesel canola crushing facility (King, 2025).

However, not all GICs are as focused on particular technology areas as PIC (e.g., "advanced manufacturing" or "digital"). This creates a potential risk of spreading resources too thinly across too many technologies and regions, a common critique of the GICs from innovation policy experts (Munro et al., 2022). Having more narrowly defined focus areas might enable the GICs to emerge as a coordinating voice for the sector, similar to the RAC's ability to align multiple federal and provincial R&D and extension efforts. This would build on the GICs' existing function as an informal coordinator of policy supports from multiple levels of government (Conteh, 2020). Moreover, a more clearly specified technology focus area might enable the GICs to move from the current firm-level, reactive, project-by-project syndication of policy supports to a more systematic, proactive approach to aligning policy supports for the whole supply chain.

Recommendation 3: Align the policy mix: Create a mechanism at the centre of government to achieve cross-departmental alignment of the policy mix

Create new (or empower existing) mechanisms at the centre of government to align the deployment of the policy mix identified in the sectoral/technology strategies created by the coordination bodies.

Rationale

Successful industrial policy requires the coordination of many policy instruments housed in many departments (e.g., R&D, procurement, infrastructure, standards, skills, permitting, and export support). The current policy mix falls short on this front. There is a growing recognition in government of the institutional gaps impeding effective industrial policy delivery. In 2025, The Net-Zero Advisory Body's report Collaborate to Succeed conducted interviews with senior officials across multiple federal departments, revealing a shared concern about the need for stronger cross-departmental coordination (Net-Zero Advisory Body, 2025). Many of these officials pointed to the absence of clear, strategic signals from central agencies, such as the PCO and the PMO, suggesting that clearer direction on national industrial priorities would improve internal alignment and execution.

An example of the current system's inability to coordinate policy across departments can be seen in the contrast between the successful use of strategic procurement to create Canada's commercial satellite industry (detailed in this report's case study) and the inconsistent uptake across departments of the Innovative Solutions Canada program. This highlights the importance of having a strong mechanism at the centre of government to ensure coordination. For satellites, the Interdepartmental Committee on Space ensured that all federal departments procuring satellites adhered to the strategic priority of building out Canada's domestic capabilities. In contrast, the Innovative Solutions Canada program does not have specific technological focus areas and has struggled since its 2017 founding to get 21 departments and agencies to spend their required 1% of 2015–2016 R&D and procurement budgets on solutions from innovative Canadian firms (Hemmadi, 2024). In 2022–23—the last year for which the program published an annual report—expenditures totalled CAD 39.6 million, just 34.8 % of the mandated amount (Innovative Solutions Canada, n.d.).

Implementation

Various options exist for the Government of Canada to strengthen cross-government coordination of the industrial policy mix. In the end, critical decisions are made by cabinet, and so a cabinet committee should be charged with overseeing and reviewing industrial strategy. Delegating strategy to the line departments will mean that national priorities are caught up in in the long timelines and turf wars that attend interdepartmental coordination. A truly national industrial strategy will cross departmental lines. Hence, an effective central authority is necessary to ensure that relevant departments design and deploy policy instruments to meet the evolving needs of industry, as surfaced and articulated in the coordinator's strategies.

An industrial strategy focus could be added to the cabinet committee focused on economic policy. This committee would need to be supported by a dedicated unit in the PCO. Given the challenges associated with creating and developing real-time expertise in the public service, something like the independent task force of outside experts outlined above would be needed to support cabinet and the PCO in formulating clear strategies and implementation plans.

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Conclusion

The central contribution of this report is to articulate principles of a Canadian approach to industrial policy for carbon competitiveness. Again, net-zero industrial policy is "a set of policies and investments intended to advance the technologies, build the firms, and create the innovation ecosystems needed to decarbonize the economy" (Allan, Eaton, & Meadowcroft, 2022). This report charts a path toward a Canadian approach to carbon competitiveness by re-examining Canadian success stories to identify the elements of the Canadian approach to industrial policy. International comparisons illustrate how the Canadian approach has many elements similar to those responsible for the success of industrial policy in other countries: a) target specific technology areas and see them through to success or failure, b) create coordination mechanisms, and c) mobilize broad policy mixes.

The variety in the cases selected illustrates that there is no one universal policy design for executing these three activities. The targeted technology may be a very specific, radically disruptive, and novel innovation (e.g., SAGD oil sands extraction) or it may be a matter of building out the domestic supply chain based on building on existing technology from abroad (e.g., semiconductor manufacturing in Taiwan and aquaculture in Chile). The coordination mechanisms may be in-house government R&D labs (e.g., Taiwan's ITRI), arms-length crown corporations (AOSTRA), or non-profit organizations (e.g., RAC). Finally, while R&D support is always a central focus, the exact mix of complementary policy instruments can vary widely according to what is needed by innovative firms at specific points in the industry's evolution.

Industrial policy was key to the success of some of Canada's most highly productive growth industries, such as oil sands extraction, canola, and satellites. Unfortunately, the successes are too few relative to our global competitors. This is not a case of too many missed shots (e.g., "government can't pick winners"). Instead, Canada's low-productivity, low-innovation economy is a product of shots never taken due to decades of adherence to a non-interventionist approach to industrial policy. This approach ignores the best practices drawn from abroad and from Canada's own industrial policy tradition. This resulted in an erosion of the policy capacity and political will needed to identify industrial policy opportunities and execute on them. Institutional fragmentation inherent in decentralized federalism and our government structures exacerbated the uncoordinated nature of historical and contemporary industrial policy approaches deployed by provinces and the Government of Canada. If it continues on this path, Canada risks falling further behind in the global race to capture supply chains for the next generation of energy technologies.

The report's analysis of homegrown success stories also highlights lessons about successfully tailoring international best practices to reflect the political and economic realities specific to Canada. While industrial policy success is never guaranteed, Canadian policy-makers can confidently draw on these best practices from our own tradition as well as those of our main competitors. The most important thing is to act now with a boldness that matches that of our trading partners and rivals in the fiercely competitive race to advance and profit from the industries of tomorrow.

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Appendix A. Applying the Three "Potential" Criteria to the Candidate Focus Areas

The tables below show how the process of selecting technologies/sectors to focus on might apply the criteria of market potential, resource potential, and innovation potential. This section draws from roadmaps co-created by the Transition Accelerator and industry leaders: the Mass Timber Roadmap with the The Forest Products Association of Canada and the Canadian Wood Council (Allan & Eaton, 2024); the *Roadmap for Canada's Battery Value Chain* with the Battery Metals Association of Canada (Allan et al., 2022); and *Canada's Battery Innovation Roadmap with Accelerate* (Allan et al., 2024).

The Electric Vehicle and Battery Supply Chain

Table A1. Canada's Potential in the Electric Vehicle and Battery Supply Chain

Market potential	Bloomberg New Energy Finance projects that the global battery market will grow 5x from 1,000 GWh/yr in 2024 to over 5,000 GWh/yr in 2035 (Allan et al., 2024). A Canadian target was set in partnership with the Battery Metals Association of Canada, Energy Futures Lab, and Accelerate in A Roadmap for Canada's Battery Value Chain: produce 1,300,000 electric vehicles in Canada by 2030 as well as the raw materials, processed metals, and batteries for 100 GWh of battery capacity. This would replicate Canada's current 10% share of North American automotive manufacturing (Allan, Kabbara, Trytten, et al., 2022).
Resource potential	Canada possesses rich deposits of most of the critical minerals needed for EVs (e.g., fifth largest global nickel producer; some of the largest known rare earth reserves) (Accelerate, n.d.). Bilateral trade in critical minerals between Canada and the United States is worth CAD 38.2 billion annually, representing 59% of Canada's total critical mineral exports in 2023(Natural Resources Canada, 2024). Canada's critical mineral exports (2023) are heavily skewed toward upstream primary products (CAD 19.5 billion) and smelting and refining products (CAD 21.6 billion) compared to downstream semi-fabricated products (CAD 10 billion) (Natural Resources Canada, 2024). Focusing on the refining and semi-fabricated products stages is the best strategy for maximizing value addition. For example, moving from spodumene lithium ore to lithium hydroxide or lithium carbonate increases the value by 4 or 5 times (Allan, Kabbara, Trytten, et al., 2022). Downstream manufacturing of battery cell packs represents a smaller value capture opportunity as pack costs will likely decline until they are marginally above active material costs (Wentker et al., 2019). Finally, midstream battery materials may be more resilient to U.S. tariffs than downstream assembly, given strong international demand and fewer U.S. cross-border inputs.

Innovation potential	Canada has a strong academic research base in battery technology (e.g., Hydro-Québec, Dalhousie University, University of Calgary, and University of Waterloo research centres). Governments have made a CAD 46 billion bet on the battery/EV assembly industry (Allan et al., 2024). However, the Battery Innovation Roadmap warns that "these investments in assembly could result only in a thin industry: high-value components and intellectual property from other countries is simply assembled in Canada" (Allan et al., 2024). The report emphasizes that "Canada needs to build a vibrant innovation ecosystem to lead in the technologies and components that create high value batteries" (Allan et al., 2024).

The Electric Vehicle and Battery Supply Chain

TABLE A2. Canada's Potential in the Mass Timber Supply Chain

Market potential	Mass timber construction materials enable buildings to be built up to 25% faster, while lowering embodied carbon up to 40% (Allan & Eaton, 2024). The current global mass timber market (as of 2023) is estimated to be USD 1.6 billion–2.3 billion (Allan & Eaton, 2024). Canada's share is estimated at USD 379 million. This corresponds to about 20% of a central estimate of the global market, meaning a target of 25% of global market share reflects only a modest increase in market share (Allan & Eaton, 2024). Projected annual growth rates for the mass timber sector both in North America and globally are 13%–14% through 2030, representing an increase of approximately 150% (Allan & Eaton, 2024).
Resource potential	Canada has the most certified sustainable forests in the world (158 million ha) (Allan & Eaton, 2024). However, currently, mass timber, at 200,000 to 300,000 m3 per year, accounts for less than 1% of Canada's wood supply (softwood and hardwood), and only 1%–2% of North America's softwood lumber production (as of 2021) (Allan & Eaton, 2024). North American production of mass timber products in 2022 has been estimated at approximately 350,000 m3, with a production capacity of at least 800,000 m3 (Allan & Eaton, 2024). While lagging Europe, North American production grew about 15% in 2022, with production capacity seeing an even larger increase (Allan & Eaton, 2024). There are at least 23 operating or potential mass timber manufacturing facilities in North America—of which seven are in Canada (Alberta, British Columbia, Manitoba, Ontario, and Quebec).
Innovation potential	Canada has a strong innovation potential in mass timber, built up through over 600 mass timber buildings completed and 124 projects under construction/planning (Allan & Eaton, 2024). Innovative firms like BC-based Kalesnikoff are expanding into modular and prefabricated products (Kalesnikoff, 2024). The University of Toronto's Mass Timber Institute aims to help position Canada as a global leader in sustainable mass timber research, education, development, and export (Mass Timber Institute, n.d.).

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